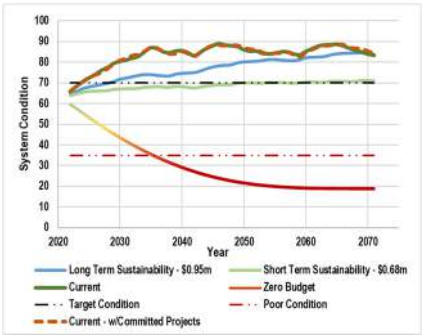
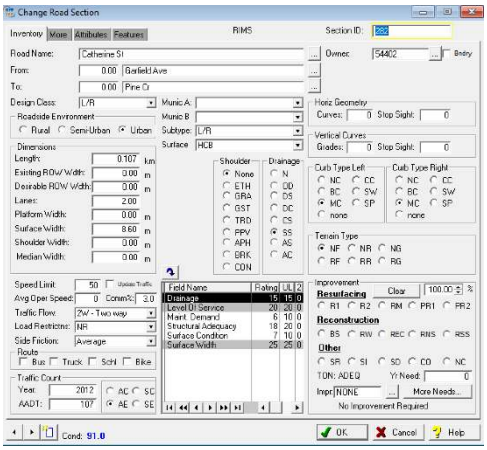
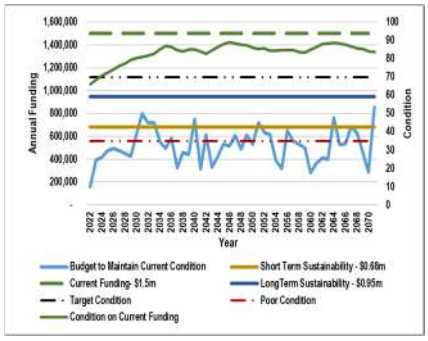
Town of Petrolia
2021 State of the Infrastructure and Asset Management Plan for Roads







4 ROADS MANAGEMENT SERVICES

Kitchener, Ontario
www.4roads.ca

4 ROADS MANAGEMENT SERVICES

Kitchener, Ontario

September 17, 2021

Town of Petrolia
411 Greenfield Street Box 1270,
Petrolia, Ontario, N0N 1R0

Attention: **Mr. Mike Thompson, Director of Operations**

2021 State of the Infrastructure and Asset Management Plan for Roads,

Dear Mr. Thompson;

4 Roads Management Services Inc. (4 Roads) is pleased to provide this report to the Town of Petrolia. The 2021 project updated the condition data on the roads, and updated costing and analysis on the entire road system.

The 2021 field review included the entire Town road system. Updated estimates for recommended improvements and replacement costs have been developed based on current unit pricing provided by the Town. Calculations for Time of Need, Improvement and Replacement Costs and Performance modeling were developed generally in accordance with the Ministry of Transportation's Inventory Manual for Municipal Roads, 1991.

Regulation 588/17, Asset Management Planning for Municipal Infrastructure, requires that all lifecycle activities are to be considered in the development of a 10 year plan that will maintain or improve the average condition of the asset group. The methodology used to develop the work plan is in conformity with the requirements of Regulation 588/17.

We trust that the information provided in this report will be beneficial to the Town of Petrolia in the continuing evolution of their Asset Management Plans. Please do not hesitate to call or email if you require any further information or discussion on any aspect of the report. Thank you for the opportunity to prepare this report. If 4 Roads Management Services Inc. may be of any further service, please do not hesitate to contact the undersigned.

Yours truly,

David Anderson, CET, President

Digitally signed by David Anderson, CET, President
DN: cn=David Anderson, CET, President gn=David Anderson, CET, President c=CA Canada l=CA Canada o=4 Roads Management Services Inc. e=dave.anderson@4roads.ca
Reason: I am the author of this document
Location: Kitchener
Date: 2021-09-26 09:46-04:00

David Anderson, CET, President,
4 Roads Management Services Inc.
Dave.anderson@4roads.ca
519 505 5065

Town of Petrolia
2021 State of the Infrastructure and Asset Management Plan for Roads

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Executive Summary

Project Scope

The scope of this report is to prepare a State of the Infrastructure (SOTI) report that includes:

- Field review and condition rating on all of the road assets within the Town of Petrolia road system.
- Updated dimensional information, where improvements have occurred
- Add or change road sections to better reflect the constitution of the road system, as required.
- Develop replacement costs for each road asset, based on current unit costs and standard formulae from the Inventory Manual for Municipal Roads, 1991.
- Develop/review recommendations for improvement and associated costing on deficient assets
- Develop recommendations for annual budgets based on current costs for Long Term Sustainability and major program areas based on updated unit costs.
- Develop analysis on the effect of current and recommended budgets on overall system performance.
- Develop a 10 year work plan, integrating committed projects
- Provide Asset Management Strategy recommendations
- Provide the answers to the basic asset management questions;
    - What you have?
    - Where it's located?
    - What condition is it in?
    - What is it worth?
    - What will it cost to replace it?
    - Useful remaining life?
    - What service level will be required over the service life?
- A report on the foregoing.
- An updated geodatabase

The 2021 State of the Infrastructure Report summarizes the road system survey conducted during the summer of 2021. The report includes projects that will be completed subsequent to the field work, including rehabilitations, resurfacing, and reconstruction and capital works in progress. The survey identifies the condition of each road asset by its time of need and recommended maintenance, rehabilitation or reconstruction treatment.

Further, the report provides an overview of the physical and financial needs of the road system in its entirety as well as by road section. Both information sources are used to develop programming and budgets. However, once a road section reaches the project design stage, further detailed review, investigation, and design will be required to address the specific requirements of the specific project.

This report should not be confused with a road safety audit. A road safety audit is the formal safety performance examination of an existing or future road or intersection, which qualitatively estimates and reports on potential road safety issues, and identifies opportunities for improvements for all road users. Typically, and more predominantly in a lower tier, rural municipality on lower volume road sections, the road system has some deficiencies with the existing horizontal and vertical alignment.

Town of Petrolia staff provided information with respect to their database/network, and updated unit costs from current tenders.

Asset Management Planning – Historical and Current Context

Road Needs Studies (RNS) were implemented by the Ministry of Transportation Ontario (MTO) in the 1960's, and evolved into the current methodology by the late 1970's. The most current version of the Inventory Manual for Municipal Roads is dated 1991, and is the methodology used for this report.

The process was originally created by the MTO as a means to equitably distribute conditional grant funding between municipalities. The practice was discontinued by a number of municipalities, when conditional funding for roads was eliminated in the mid 1990's. The RNS process is a sound, consistent asset management practice that still works well today, and in view of the increasing demands on efficiency and asset management, represents a sound business practice that is beneficial to continue.

To put the Road Needs Study in a more current context, the State of the Infrastructure (SotI) is essentially a Road Needs Study. This project enhances the basic requirements of a condition report by providing detailed analysis of the data and development of a work plan based on the data, the current budget, incorporating modern asset management principles.

In August 2012, the Province of Ontario, introduced a requirement for an Asset Management Plan (AMP) as a prerequisite for municipalities seeking funding assistance for capital projects from the province; effectively creating a conditional grant. To qualify for future infrastructure grants, an AMP had to be developed and approved by a municipal council by December 2013. On April 26, 2013 the province announced that it had created a $100 million Infrastructure Fund for small, rural and northern municipalities.

Subsequently, the province has introduced further initiatives for infrastructure funding: Ontario Community Infrastructure Fund (OCIF) and the Small Communities Fund (SCF). An Asset Management Plan (AMP) approved by Council is required as part of the submission for OCIF Applications. Asset Management Plans were to be reviewed for comprehensiveness.

On December 27, 2017, the Province filed Regulation 588/17, Asset Management Planning for Municipal Infrastructure. The regulation identifies provincial requirements and timelines for development and implementation of asset management plans. Initially, AMP's will have to include the 'core' assets; water and waste water linear and treatment, roads, bridge and culvert structures, and storm water linear and treatment.

Regulation 588/17 requires an Asset Management Plan (AMP) for core assets by July 1, 2022 that is based on condition data that is no more than two years old. This project positions the Town well for compliance with the Regulation from a road asset perspective. Conditional Grants are not new to Ontario. Until the mid-1990's, Road Needs Studies (RNS) were completed by municipalities and submitted to the Ministry of Transportation (MTO) on an annual basis in order to receive provincial funding for their road programs.

Town of Petrolia (ToP or the Town) is currently evolving the AMP for the various asset groups, roads being one of them. A key component of the AMP is a *'State of the Infrastructure'* (SotI) review of the asset or asset group. This report provides the SotI review of the Town of Petrolia road system and also provides recommendations for budgets and road asset programming; effectively an Asset Management Plan for Roads.

The work plan developed as a deliverable for this project, cross integrates assets from the other core assets; water waste water, and storm sewer. The resultant model illustrates the effect on the road asset group over time. A requirement of O.Reg 588/17, is to create a work plan that maintains the condition of the assets over a 10-year period.

Report Methodology Overview

Regulation 588/17 Asset Management Planning for Municipal Infrastructure requires;

> '*v. a description of the municipality's approach to assessing the condition of the assets in the category, based on recognized and generally accepted good engineering practices where appropriate.'*

Data collection and road ratings were completed generally in accordance with the Ministry of Transportation Ontario (MTO) *Inventory Manual for Municipal Roads* from 1991. (*Inventory Manual or IM*). The ratings are either a standalone value or incorporated into calculations performed by the software. The ratings or calculations then classify the road section as a 'NOW', '1 to 5', or '6 to 10' year need for maintenance, rehabilitation or reconstruction in six critical areas.

The *Inventory Manual* offers a holistic review of each road section, developing a Time of Need (TON) or an Adequate rating in six areas that are critical to municipal decision making:

- Geometrics
- Surface Type
- Surface Width
- Capacity
- Structural Adequacy
- Drainage

The Time of Need is a prediction of the time until the road requires reconstruction, ***not the time frame until action is required***. Generally, the closer the timeline to reconstruction, the greater the deterioration of the road is. For example, a road may be categorized as a '6 to 10' year need with a resurfacing recommendation. This road should be resurfaced as soon as possible to further defer the need to reconstruct.

Reporting and analysis is on an individual road asset (or road section) basis. Road sections should be reasonably consistent throughout their length, according to roadside environment, surface type, condition, cross section, speed limit, traffic count or a combination of these factors. For example, new sections should be created as surface type, surface condition, cross-section, or speed limit changes as appropriate or practical.

Accurate and current traffic counts are critical in managing a road system and their importance cannot be emphasized enough, particularly truck traffic. Traffic counts establish road maintenance classifications for Minimum Maintenance Standards purposes, as per Ontario Regulation 239/02 (*Minimum Maintenance Standards for Municipal Roads, revised May 3, 2019*), functional classifications as per Regulation 588/17 classification (*Asset Management Planning for Municipal Infrastructure*), as well as determining appropriate geometry, structure, and cross-section when the road is rehabilitated or reconstructed. The Town does not have a traffic counting program. A traffic counting program, including truck counts, should be initiated and be updated on a regular cycle, as a risk management exercise. The changes in traffic patterns resultant from the pandemic may skew the traffic counts downward, causing an inaccurate determination of the O.Reg 239/02 classification, which would pose a potential liability for the Town.

Road conditions are evaluated during a field inspection. The ratings are either as a standalone value or incorporated into calculations performed by the software in accordance with the *Inventory Manual*, that then classify the road section as a 'Now', '1 to 5', or '6 to 10' year need for maintenance, rehabilitation or reconstruction into the six critical areas noted above.

Recommendations are made based on the defects observed and other information available in the database at the time of preparation of the report. Once a road asset reaches the project level, the municipality may have selected another alternative based on additional information, asset management strategy, development considerations or available funding.

'NOW' needs represent road sections that require reconstruction or major rehabilitation. 'NOW' needs are the backlog of work required on the road system; however, 'NOW' needs may not necessarily be the priority, from an asset management perspective. Preservation and resurfacing treatments typically offer a better Return on Investment (ROI) than major rehabilitation or reconstruction. Construction improvements identified within this time period are representative of roads that have little or no service life left and are in poor condition, or have a significant drainage or capacity need. Resurfacing treatments are never a 'NOW' need, with the following exceptions;

- RW (Resurface and Widen) as this is driven by the road asset's capacity.
- PR1 or PR2 (Pulverize and resurface 1 or 2 lifts of asphalt)
- When the surface type is inadequate for the traffic volume (i.e., gravel road over 400AADT)
- When the surface is gravel and the roadside environment is Urban or Semi-Urban

'1 to 5' identifies road sections where reconstruction is anticipated within the next five years, based upon a review of their current condition. These roads can be good candidates for resurfacing treatments that would extend the life of the road (depending on any other deficiencies), deferring the need to reconstruct. These roads would be considered to be in fair condition.

'6 to 10' identifies road sections where reconstruction improvements are anticipated within six to ten years, based upon a review of their current condition. These roads can be good candidates for resurfacing treatments that would extend the life of the road (depending on any other deficiencies), thus deferring the need to reconstruct. These roads would be considered to be in good condition.

'ADEQ' identifies road sections that do not have reconstruction or resurfacing needs, although minor maintenance such as crack sealing, other preservation treatments or spot drainage may be required. These roads would be considered to be in good to excellent condition.

This report summarizes the identified needs through a number of tabular appendices.

When the *Inventory Manual* was originally developed, the Province provided funding for municipal road systems; the road systems were measured by their system adequacy. The system adequacy is the percentage of the road system that is not a "NOW" need. This would be a Level of Service (LOS) measure.

The *Inventory Manual* provides direction that roads with a traffic volume of less than 50 vehicles per day *are deemed to be adequate*, even if they have structural, geometric, or drainage deficiencies that would otherwise be identified as being in a Time of Need. This factor does have an effect of the System Adequacy measure.

Originally, the intention was that the low volume roads were to be corrected within the maintenance allocation (as opposed to the capital allocation). Conditional grant funding no longer exists as it did until the mid 1990's.

To gain a more accurate reflection of the condition of the road network, the roads with an AADT of less than 50 have been analyzed and report as follows;

Section 3895, Mutual Street From the south end to Third St. The length is 0.044km. As such this factor does not have a significant affect on the overall ratings.

Asset Management Plan Development Requirements

Regulation 588/17 required an asset management plan for core assets by July 1, 2021.(Since revised to July 1, 2022). Core assets for the Town of Petrolia would include roads, structures greater than 3m span, and storm water linear and treatment assets.

Regulation 588/17 provides significant guidance in the development of the asset management plan and states in part;

> *"4. For each asset category, the lifecycle activities that would need to be undertaken to maintain the current levels of service as described in paragraph 1 for each of the 10 years following the year for which the current levels of service under paragraph 1 are determined and the costs of providing those activities based on an assessment of the following:*
>
> *I. The full lifecycle of the assets.*
>
> *ii. The options for which lifecycle activities could potentially be undertaken to maintain the current levels of service.*
>
> *iii. The risks associated with the options referred to in subparagraph ii.*
>
> *iv. The lifecycle activities referred to in subparagraph ii that can be undertaken for the lowest cost to maintain the current levels of service."*

With respect to the requirement to maintain the current levels of service, the current funding level for the road assets appears to be sufficient to sustain the system over the long term. This is discussed further in Sections 8, 9, and 10 of the report.

Observations from Field Review and Data Analysis

During the field review, and in reviewing the data and the needs for the road network, there were several unique aspects of the network that came to light:

- With respect to system and Level of Service measures (all assume completion of 2021 proposed work);
    - System Adequacy measure for the Town of Petrolia road system is 71.2% by Centreline kilometres (Cl-km). Graph 5 illustrates the system condition measures over time
        - The System Adequacy is above the target established by the Ministry of Transportation when condition road funding was provided to municipalities. The target for system adequacy for a lower tier system was 60%. Petrolia's System Adequacy and has declined since 2012 but is still in an acceptable range.
        - Gravel road review was not conducted during spring break-up. However, the length of gravel roads is very short, to there is not significant affect to the overall system ratings.
    - Weighted Average Pavement Condition is 60.8 (Structural Adequacy) 4 Roads recommends a minimum of 70 (14 Structural Adequacy). Graph 5 illustrates the condition changes over time. The current condition is below 4 Roads recommended level and has been slowly declining over time.
    - Good to Very Good roads for the entire system is 53.9 % when measured by the Structural Adequacy metric (distress).
    - Percentage of the system with potential Capacity issue is 0%.
- With respect to asset management programming and practices;
    - The directive of O.Reg 588/17 to develop a program to sustain the assets over a 10 year period is more easily achieved managing a single asset, and in a larger system. This is significantly more difficult and expensive when managing multiple assets, and in smaller systems. For example, when road sections, are reconstructed due to the demands of the water and waste water systems, it detracts from road project selection from a pure asset management perspective; however, it is necessary to cross integrate assets in the development of a 'holistic' work plan.

  - The system metrics are in a slightly declining condition. This relates in part to the previous bullet with respect to system size. System Adequacy is above target, and given the directive of 588/17 to sustain the system condition over time, the system performance model appears to comply with that directive.
  - O.Reg 588/17 requires work plan development based on condition data that is no more than two years old. The Town inspection regimen since 2012 has been to conduct biannual inspections. . The current project produces condition data within two years of the AMP due date. As such, the current report is regulatory compliant with respect to condition data currency.
  - The slight decline in condition is also related to not being able to undertake the resurfacing projects that had been previously contemplated.
  - Some of the road sections that require improvement/upgrade are resultant from adjacent development. A development charges bylaw would provide an additional funding source for some projects.
  - Nearly all of the traffic counts are estimated.

- With respect to observed defects and needs;
  - The area west of Valentina St, north of and including Tom Street appears to have thin asphalt which may account in part for the performance.
  - Valentina Street South is deteriorating more quickly than anticipated.
  - Garden Crescent from Heritage Heights Lane to First Avenue has a poor ride and is deteriorating more quickly than anticipated. Possible causes would include an initial poor design standard, that may have not included granular base or subdrains, or load transfer bars between the slabs.
  - Drainage is potentially a cause for the poor performance on Tank Street.
  - The gravel roads were not inspected during the spring breakup period.
- A Resurfacing or Rehabilitation treatment is required on 10.316 CL km of hard top roads (Asphalt and Surface Treated). Of that amount, 2.062 CL km are NOW needs, or are in poor condition.

Needs and Funding Recommendations

Based on the current review of the road system, the current system adequacy measure is 71.2% by Centre Line Kilometres meaning that, 28.8% of the road system, is deficient in the 'NOW' time period and in poor condition.

Based on the current unit costs being experienced, the estimated total cost of recommended improvements is **$17,936,403.** The improvement costs include **$10,738,050** for those roads identified as NOW needs and **$7,198,353** is for road work required in the '1 to 10' year time period or for maintenance. Included in those amounts is **$124,944** is for work on road sections that are adequate due to low traffic volume or are maintenance or preservation activities. The costs doe not include storm sewer assets.

Based on the composition of the road system, budget recommendations have been developed for annual capital and maintenance programs as follows:

- **$950,000** for the annualized Long Term Sustainability based on current replacement cost. (This cost does not include storm sewers; they are considered a separate asset in Petrolia. This would be considered the long term sustainable funding level. (This would be similar to the PSAB 3150 amortization value except using current replacement cost.). The estimated *replacement cost* of the road system is $47,498,000. The *current value* of the roads system is estimated to be $39,752,800.

The design life for a road structure has typically been considered to be 50 years before reconstruction / replacement. However, in an urban setting in particular, with the underground utilities typically having an expected life in the 75 year range, it would seem more pragmatic to match the lifecycles of the road and utility assets. Road assets can be designed to last 75 years with only resurfacing required. Rural cross sections should be treated similarly.

- **$645,000** on average annually for hot mix resurfacing, based upon an 18 (18.2) year cycle. This would approximate an average of 1.77 CI km per year.
- **$19,700** on average annually, for single surface treatment of existing surface-treated roads, based on a seven-year cycle (this does not include additional padding or geometric correction).
- **$1,950** on average annually for gravel road resurfacing. This estimate is based on resurfacing gravel roads with 75mm every 3 years and utilizing the unit cost for maintenance gravel.
- **$12,800** on average annually for crack sealing on a 5 year cycle.

For modeling purposes, 4 Roads has created a funding level described as 'Short Term Sustainability'. This funding level should theoretically preserve the condition of the road system for up to a 10 year period. The Short Term Sustainability- funding level, is the total of the recommended funding levels for hot mix resurfacing, single surface treatment gravel road resurfacing and crack sealing: **$679,400**. The premise being that if the pavement maintenance, preservation and resurfacing programs are adequately funded, then the system should be sustained over the short term.

To sustain the road system over the entire life cycle, the Long Term Sustainability funding level is required as ultimately, replacement will be required. In Petrolia's circumstances, asset management is more of a challenge due to the system size, and the program being driven to some extent by other assets. It is 4 roads understanding that there was a period of time where increases were held to zero for a long number of years and very little capital improvement occurred. The pace of correction or improvement in asset management is very slow. The effects of decisions made over a decade or more ago take a significant time period to recover from.

To clarify, the Short Term Sustainability funding level is the required funding level to sustain or improve the road system over the short term; it is not the total of all of the above recommendations. Sustainable funding over the long term or life cycle has to be at the Long Term Sustainability level. The Short Term budget and performance model thereof, are computer derived. Intangible values and decisions and the effects of other external forces cannot be incorporated into the model. As such, the preservation model is the minimum required to maintain the system- in theory. Theoretically, the 'Short Term Sustainability' funding level would work. Practically, that would rely on every assumption and rating to be absolutely correct, and the program adhered to explicitly. From a more pragmatic perspective and to deal with the real life realities of maintaining a road system, it should be greater.

Municipal pavement management strategies are critical to managing the performance of the road system, more so, if funding is limited. Funding constraints should push the strategy toward those programs that extend the life cycle of the road by providing the correct treatment at the optimum time. Resurfacing, rehabilitation, and preservation projects should be a higher priority than reconstruction projects. The objective is to "keep the good roads good".

As the municipality advances the development of their Asset Management Plan (AMP), a paradigm shift will be required in the way that we approach management of assets. Traditionally, municipalities have spent a fixed amount on capital and maintenance each year. As evidenced by Table ES 16, programs are not at a consistent funding level on an annual basis. The annual budget overall is met, however, the distribution of costs between traditional capital and maintenance activities varies. That variance is being driven by the demands of the road system based on

condition and project selection is based on condition and best Return on Investment. This concept should be applied to all assets.

Re-stated, instead of the traditional capital and maintenance line items, consider the gross budget as the annual reinvestment level, with program funding levels fluctuating within the gross amounts, but driven by asset condition.

The prime goal of any pavement management strategy should be to maintain overall system adequacy. The funding level for road-related programming should be set at a sufficient level so as to ensure that overall system adequacy does not decrease over time.

In addition to the budgetary recommendations, the following recommendations are provided for the management of the road inventory.

1. The information and budget recommendations included in this report be used to further develop the corporate Asset Management Planning.
2. The current annual expenditure on road asset should remain, until the Level of Services measures are all met.
3. Funding levels to be adjusted annually to accommodate growth / system expansion.
4. Funding should be adjusted annually to accommodate inflation.
5. Consideration should be given to the implementation of a Development Charges By-Law.
6. The work plan should;
    - Ensure that the preservation and resurfacing programs are optimized. This is particularly critical for those sections that are not going to be affected by upgrade due to development demands.
    - The work plan should cross integrate assets.
    - The work plan should be followed to optimize investments and performance of the road system.
7. The road asset inspection interval should be continued at the current 2 year interval.
8. Town of Petrolia should initiate a traffic counting program to be updated and repeated on a regular basis. The counting should include the percentage of truck traffic.
9. The status of the Boundary Road Agreements should be reviewed.
10. The Level of Service for System Adequacy should be a Minimum of 60%.
11. The Level of Service for Average Condition should be a minimum of 70.
12. The Level of Service for Good to Very Good Roads should be a minimum of 60%.
13. If a Quality Assurance Program does not exist, it should be developed.
14. The Design Criteria should be reviewed for new developments to ensure that Petrolia is receiving quality product that does not impact ratepayers prematurely.
15. Consideration should be given to the development of a maintenance paving program for those roads sections that are in poor condition that will not be addressed in the shorter term programming.
16. Master Drainage Plans should be developed for those areas of the Town where they currently do no exist.
17. Develop a corporate asset management system throughout the organization with the development of a Standard Operating Procedure (SOP) for asset management.

18. Improve the understanding of the evaluation systems being used for various assets.

Summary Information

All tabular data has been adjusted for boundary roads unless otherwise noted

Table ES 1: Boundary Roads Summary

Adjacent Agency	Asset ID	Street Name	Roadside Environment			TOTAL
			Rural	Semi Urban	Urban	
Township of Enniskillen	751	Discovery Line	0.3	0	0	0.3
Township of Enniskillen	752	Discovery Line	0.45	0	0	0.45
Township of Enniskillen	753	Discovery Line	0.28	0	0	0.28
Township of Enniskillen	754	Discovery Line	0	0.16	0	0.16
TOTAL			**1.03**	**0.16**	**0**	**1.2**
					Adjustment	**0.6**

Table ES 2: Classification by Roadside Environment and Surface Type

Material Description	Roadside Environment						TOTAL		% OF TOTAL	
	Rural		Semi Urban		Urban					
	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km
Concrete	0	0	0	0	2.791	5.582	**2.791**	**5.582**	7.01%	7.01%
Gravel, Stone, Other Loosetop	0	0	0.159	0.318	0	0	**0.159**	**0.318**	0.40%	0.40%
High Class Bit.-asphalt	1.672	3.343	3.071	6.142	26.771	53.542	**31.514**	**63.027**	79.14%	79.14%
Low Class Bit.-surface treated	2.777	5.554	2.373	4.746	0.208	0.416	**5.358**	**10.716**	13.46%	13.46%
TOTAL	**4.449**	**8.897**	**5.603**	**11.206**	**29.77**	**59.54**	**39.822**	**79.643**		
% OF TOTAL	11.17%	11.17%	14.07%	14.07%	74.76%	74.76%				

Table ES 3: Classification by Roadside Environment and Functional Class (Inventory Manual)

Functional Classification	Lanes	Roadside Environment						TOTAL		% OF TOTAL	
		Rural		Semi Urban		Urban					
		Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
200	2	0.192	0.384	0	0	0	0	**0.192**	**0.384**	0.48%	0.48%
400	2	2.907	5.813	0	0	0	0	**2.907**	**5.813**	7.30%	7.30%
500	2	1.02	2.04	0	0	0	0	**1.02**	**2.04**	2.56%	2.56%
ALL	2	0	0	0.391	0.782	0	0	**0.391**	**0.782**	0.98%	0.98%
L/R	2	0.33	0.66	3.3	6.6	29.167	58.334	**32.797**	**65.594**	82.36%	82.36%
LCI	2	0	0	1.912	3.824	0.603	1.206	**2.515**	**5.03**	6.32%	6.32%
TOTAL		**4.449**	**8.897**	**5.603**	**11.206**	**29.77**	**59.54**	**39.822**	**79.643**		
% OF TOTAL		11.17%	11.17%	14.07%	14.07%	74.76%	74.76%				

Table ES 4: Replacement Cost by Functional Classification (Inventory Manual)

Functional Classification	Lanes	Roadside Environment						TOTAL		% OF TOTAL		Cost /km ($)
		Rural		Semi Urban		Urban						
		Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	
200	2	160,586	0.192	0	0	0	0	**160,586**	**0.192**	0.34%	0.48%	836,385
400	2	3,352,188	3.423	0	0	0	0	**3,352,188**	**3.423**	7.06%	8.47%	979,313
500	2	1,008,692	1.02	0	0	0	0	**1,008,692**	**1.02**	2.12%	2.52%	988,914
ALL	2	0	0	68361	0.391	0	0	**68,361**	**0.391**	0.14%	0.97%	174,836
L/R	2	721,380	0.33	2322081	3.3	37354636	29.167	**40,398,097**	**32.797**	85.05%	81.14%	1,231,762
LCI	2	0	0	1682723	1.994	827401	0.603	**2,510,124**	**2.597**	5.28%	6.43%	966,548
TOTAL		**5,242,846**	**4.965**	**4,073,165**	**5.685**	**38,182,037**	**29.77**	**47,498,048**	**40.42**			
% OF TOTAL		11.04%	12.28%	8.58%	14.06%	80.39%	73.65%					

**Not adjusted for boundary roads*

Table ES 5: Average Replacement Costs by Asset Class

Asset Class for Performance Modelling	Roadside Environment: Rural		Semi Urban		Urban		TOTAL		% OF TOTAL		Cost / km ($)
	Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	Repl. Cost	Cl-km	
CON-U	0	0	0	0	3,616,832	2.791	**3,616,832**	**2.791**	7.61%	6.90%	CON-U
GST1-S	0	0	124,542	0.159	0	0	**124,542**	**0.159**	0.26%	0.39%	GST1-S
HCB3-U	0	0	0	0	8,781,668	6.752	**8,781,668**	**6.752**	18.49%	16.70%	HCB3-U
HCB4-R	2,355,754	2.046	0	0	0	0	**2,355,754**	**2.046**	4.96%	5.06%	HCB4-R
HCB4-S	0	0	2,286,749	3.153	0	0	**2,286,749**	**3.153**	4.81%	7.80%	HCB4-S
HCB4-U	0	0	0	0	25,521,071	20.019	**25,521,071**	**20.019**	53.73%	49.53%	HCB4-U
LCB1-R	2,887,092	2.919	0	0	0	0	**2,887,092**	**2.919**	6.08%	7.22%	LCB1-R
LCB1-S	0	0	1,661,874	2.373	0	0	**1,661,874**	**2.373**	3.50%	5.87%	LCB1-S
LCB1-U	0	0	0	0	262,466	0.208	**262,466**	**0.208**	0.55%	0.51%	LCB1-U
TOTAL	**5,242,846**	**4.965**	**4,073,165**	**5.685**	**38,182,037**	**29.77**	**47,498,048**	**40.42**			TOTAL
% OF TOTAL	11.04%	12.28%	8.58%	14.06%	80.39%	73.65%					% OF TOTAL

Note: Not adjusted for Boundary Roads

Table ES 6: Traffic Count History

Year	AADT Counted	AADT Estimated	TOTAL	% OF TOTAL
2012	0	36.897	**36.897**	91.28%
2015	0.125	2.384	**2.509**	6.21%
2017	0	0.433	**0.433**	1.07%
2019	0	0.52	**0.52**	1.29%
2021	0	0.061	0.061	0.0015
TOTAL	**0.125**	**40.295**	**40.42**	

Note: Not adjusted for Boundary Roads

Table ES 7: Classification by Ontario Regulation 239/02 Classification by Lanes and Roadside Environment

Lanes	Roadside	O.Reg 239/02 Classification				TOTAL		% OF TOTAL	
		5		6					
		Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
2	Rural	4.773	9.546	0.192	0.384	4.965	9.93	12.28%	12.28%
2	Semi Urban	3.621	7.242	2.064	4.128	5.685	11.37	14.06%	14.06%
2	Urban	19.059	38.118	10.711	21.422	29.77	59.54	73.65%	73.65%
TOTAL		**27.453**	**54.906**	**12.967**	**25.934**	**40.42**	**80.84**		
% OF TOTAL		67.92%	67.92%	32.08%	32.08%				

Note: Not adjusted for Boundary Roads

Table ES 8: Classification by O.Reg 588/17 Road Classification by Lanes and Roadside Environment (*Dec 27, 2017*)

Lanes	Roadside	Regulation 588/17 Classification, Asset Management Planning for Municipal Infrastructure						TOTAL		% OF TOTAL	
		Arterial		Collector		Local					
		Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km
2	R	0	0	0	0	4.965	9.93	**4.965**	**9.93**	12.28%	12.28%
2	S	0	0	0	0	5.685	11.37	**5.685**	**11.37**	14.06%	14.06%
2	U	0	0	0	0	29.77	59.54	**29.77**	**59.54**	73.65%	73.65%
TOTAL		**0**	**0**	**0**	**0**	**40.42**	**80.84**	**40.42**	**80.84**		
% OF TOTAL		0	0	0	0	100.00%	100.00%				

Note: Not adjusted for Boundary Roads

Table ES 9: O.Reg 588/17 Level of Service Measures for Roads

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)	Level of Services Measure for Roads
Scope	Description, which may include maps, of the road network in the municipality and its level of connectivity.	Number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality. **12.68** sq. km	Arterial Roads = **0%** Collector Roads = **0%** Local Roads = **637.5%**
	Description or images that illustrate the different levels of road class pavement condition.	1. For paved roads in the municipality, the average pavement condition index value. 2. For unpaved roads in the municipality, the average surface condition (e.g. excellent, good, fair or poor).	Weighted Average Overall road condition is **60.8** Weighted average paved road condition is **60.8** Weighted average gravel road condition is **40.0.**

Table ES 10: Time of Need by Length and MMS Class –All Needs

Time of Need	O.Reg 239/02 Classification 5		6		TOTAL		% OF TOTAL	
	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
1 to 5	5.928	11.856	1.351	2.702	**7.279**	**14.558**	18.01%	18.01%
6 to 10	2.737	5.474	1.68	3.36	**4.417**	**8.834**	10.93%	10.93%
ADEQ	10.241	20.482	6.861	13.722	**17.102**	**34.204**	42.31%	42.31%
NOW	8.547	17.094	3.075	6.15	**11.622**	**23.244**	28.75%	28.75%
TOTAL	**27.453**	**54.906**	**12.967**	**25.934**	**40.42**	**80.84**		
% OF TOTAL	67.92%	67.92%	32.08%	32.08%				
System Adequacy	68.9%	68.9%	76.3%	76.3%	**71.2%**	**71.2%**		
Good to Very Good	47.3%	47.3%	65.9%	65.9%	**53.2%**	**53.2%**		

Note: ****Includes all potential Time of Needs elements including Capacity, Drainage, Surface Width, Surface Type, Geometry and Structural Adequacy ;Includes work proposed for 2021***
****Roads with AADT<50 are deemed ADEQ; 0.1% of the system has <50 AADT***
Not adjusted for Boundary Roads, Gravel roads were not reviewed during spring break-up

Table ES 11: Drainage by Time of Need

Roadside Environment	Time of Need 1 to 5	6 to 10	ADEQ	NOW	TOTAL	% OF TOTAL
Rural	0.677	2.7	1.072	0	**4.45**	11.17%
Semi Urban	1.064	3.317	1.222	0	**5.60**	14.07%
Urban	0.795	0.067	28.609	0.299	**29.77**	74.76%
TOTAL	**2.536**	**6.084**	**30.903**	**0.299**	**39.822**	
% OF TOTAL	6.37%	15.28%	77.60%	0.75%		

Table ES 12: Drainage by Roadside Environment and Drainage Type

Drainage Type	Roadside Environment Rural	Semi Urban	Urban	TOTAL	% OF TOTAL
AS - Adjacent Road, Storm Sewer	0	0.317	0.105	**0.422**	1.06%
DS - Ditch and Storm Sewer	0.375	2.819	0.129	**3.323**	8.34%
N - None	0	0.338	0	**0.338**	0.85%
OD - Open Ditch	4.074	1.707	0	**5.781**	14.52%
SS - Storm Sewer	0	0.422	29.536	**29.958**	75.23%
TOTAL	**4.449**	**5.603**	**29.77**	**39.822**	
% OF TOTAL	11.17%	14.07%	74.76%		

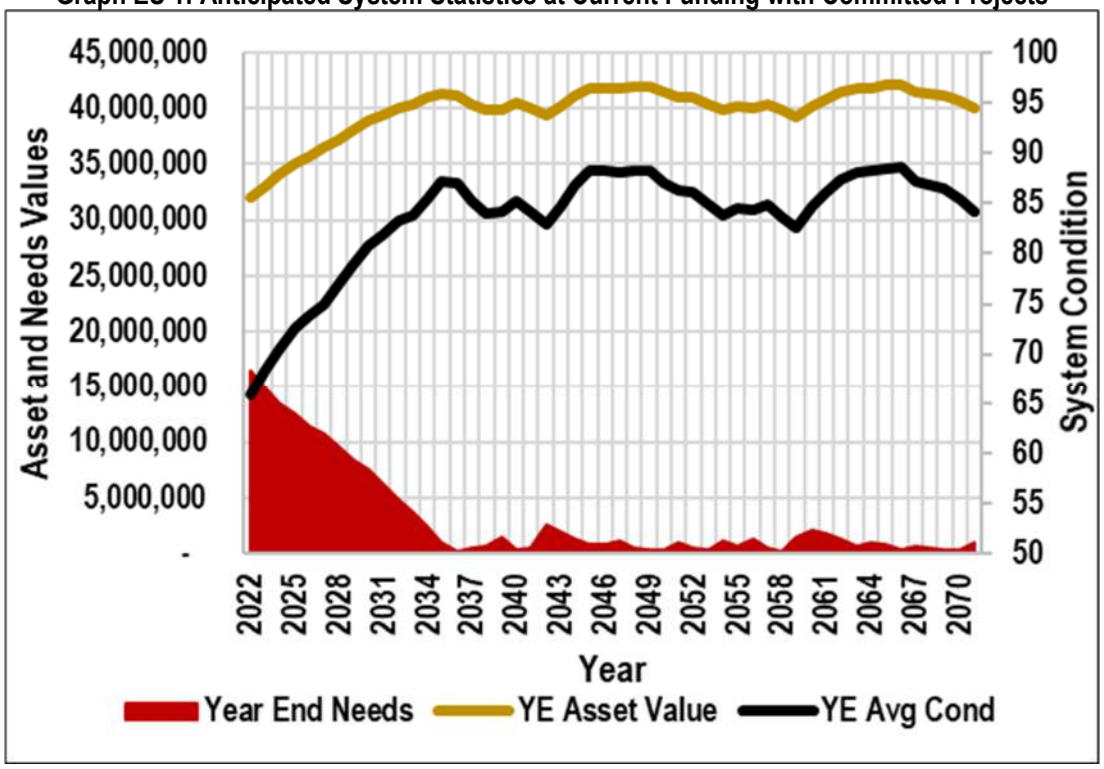
Table ES 13: Improvement Costs by Improvement Type and Roadside Environment per Centre Line Kilometre

Improvement Class	Improvement ID / Description		Roadside Environment						TOTAL		% OF TOTAL		Cost / km ($)
			Rural		Semi Urban		Urban						
			Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	
Const	BS	Base and Surface	0	0	20,622	0.044	0	0	20,622	0.044	0.11%	0.11%	468,682
Const	NONE	No Improvement Required	0	0	0	0.069	0	13.371	0	13.44		33.75%	-
Const	REC	Reconstruction - Rural	1931669	1.979	1269571	1.607	0	0	3201241	3.586	0.1785	9.01%	892,705
Const	RNS	Reconstruction Nominal Storm Sewer	328,155	0.375	1,947,788	2.626	6395304	4.92	8,671,246	7.921	48.34%	19.89%	1,094,716
Maint	CRK	Crack Sealing	384	0.192	190	0.095	5,104	2.552	5,678	2.839	0.03%	7.13%	2,000
Maint	SD	Spot Drainage	1181	0.656	369	0.205	0	0	1,550	0.861	0.01%	2.16%	1,800
Maint	SR	Spot Repairs	0	0	0	0	30,000	0.815	30,000	0.815	0.17%	2.05%	36,810
Rehab	PR2	Pulverize and Resurface 2 - 100mm	319,043	0.517	328244	0.821	0	0	647,287	1.338	3.61%	3.36%	483,772
Rehab	R1	Basic Resurfacing 1 - 50mm	142,753	0.73	0	0	948452	2.459	1,091,205	3.189	6.08%	8.01%	342,178
Rehab	R2Urehab	Urban HCB Rehabilitation	0	0	69365	0.136	4,198,210	5.653	4,267,576	5.789	23.79%	14.54%	737,187
TOTAL			**2,723,185**	**4.449**	**3,636,149**	**5.603**	**11,577,070**	**29.77**	**17,936,403**	**39.822**			
% OF TOTAL			15.18%	11.17%	20.27%	14.07%	64.55%	74.76%					

Table ES 14: Improvement Costs by Improvement Type and Time of Need

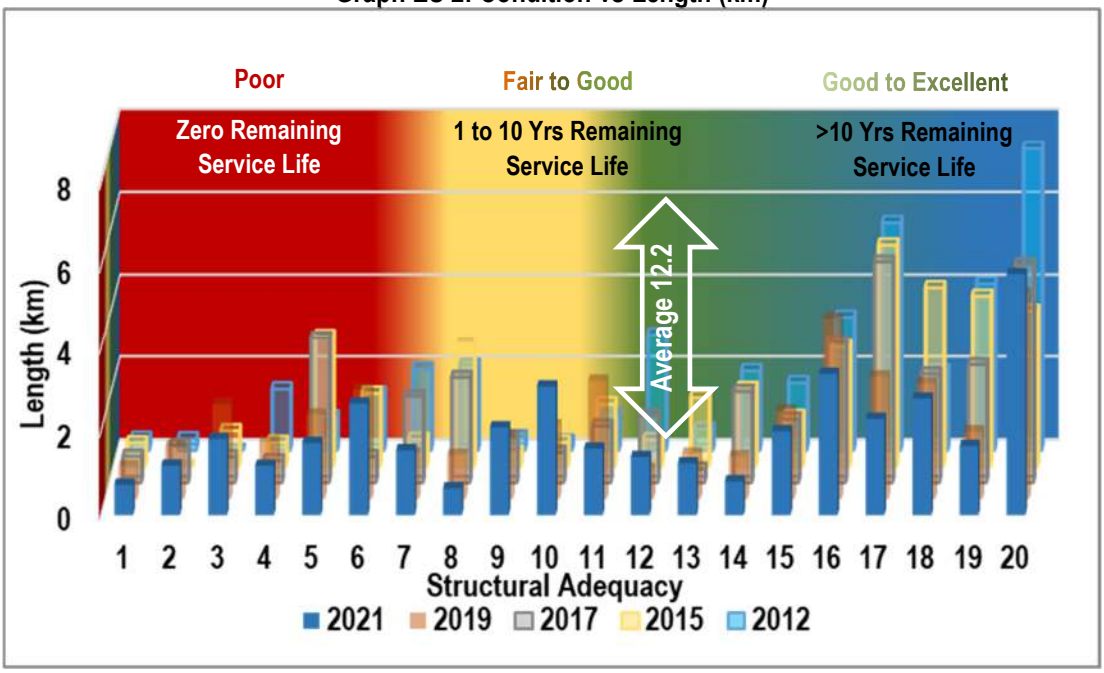
Improvement Class	Improvement ID/Desc		Time of Need								TOTAL		% OF TOTAL	
			1 to 5		6 to 10		ADEQ		NOW					
			Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km
Const	BS	Base and Surface	-	0	-	0	20,622	0.044	-	0	**20,622**	**0.044**	0.11%	0.11%
Const	NONE	No Improvement Required	-	0	-	0	-	13.355	-	0.085	**0**	**13.44**		33.75%
Const	REC	Reconstruction - Rural	930,812	1.149	141,388	0.164	-	0	2,129,040	2.273	**3201241**	**3.586**	0.1785	9.01%
Const	RNS	Reconstruction Nominal Storm Sewer	1,174,206	0.922	229,293	0.313	-	0	7,267,747	6.686	**8,671,246**	**7.921**	48.34%	19.89%
Maint	CRK	Crack Sealing	-	0	-	0	5,678	2.839	-	0	**5,678**	**2.839**	0.03%	7.13%
Maint	SD	Spot Drainage	-	0	1,433	0.796	117	0.065	-	0	**1,550**	**0.861**	0.01%	2.16%
Maint	SR	Spot Repairs	-	0	10,000	0.123	20,000	0.692	-	0	**30,000**	**0.815**	0.17%	2.05%
Rehab	PR2	Pulverize and Resurface 2 - 100mm	184,560	0.489	60,405	0.082	-	0	402,322	0.767	**647,287**	**1.338**	3.61%	3.36%
Rehab	R1	Basic Resurfacing 1 - 50mm	132,821	0.332	958,384	2.857	-	0		0	**1,091,205**	**3.189**	6.08%	8.01%
Rehab	R2Urehab	Urban HCB Rehabilitation	3,250,108	4.387	-	0	78,527	0.107	938,941	1.295	**4,267,576**	**5.789**	23.79%	14.54%
TOTAL			**5,672,507**	**7.279**	**1,400,903**	**4.335**	**124,944**	**17.102**	**10,738,050**	**11.106**	**17,936,403**	**39.822**		
% OF TOTAL			31.63%	18.28%	7.81%	10.89%	0.70%	42.95%	59.87%	27.89%				

Graph ES 1: Anticipated System Statistics at Current Funding with Committed Projects



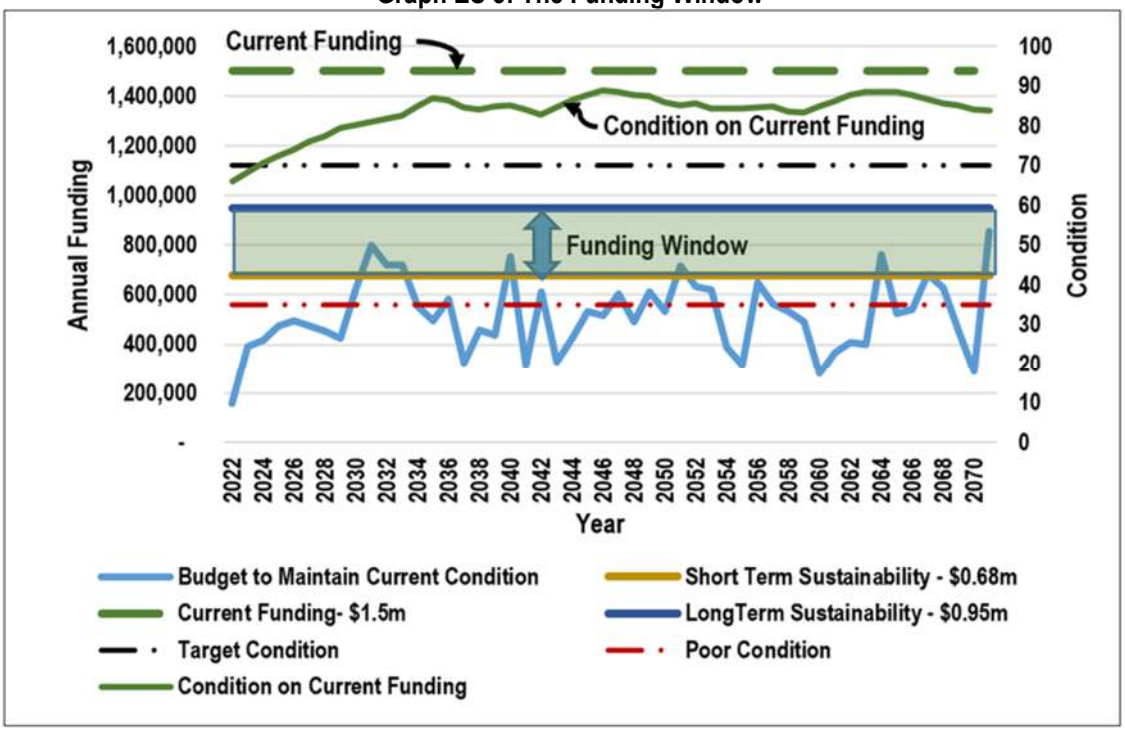
**Assumes perpetual pavement performance, Does not anticipate WWW or expansion influences*

Graph ES 2: Condition vs Length (km)

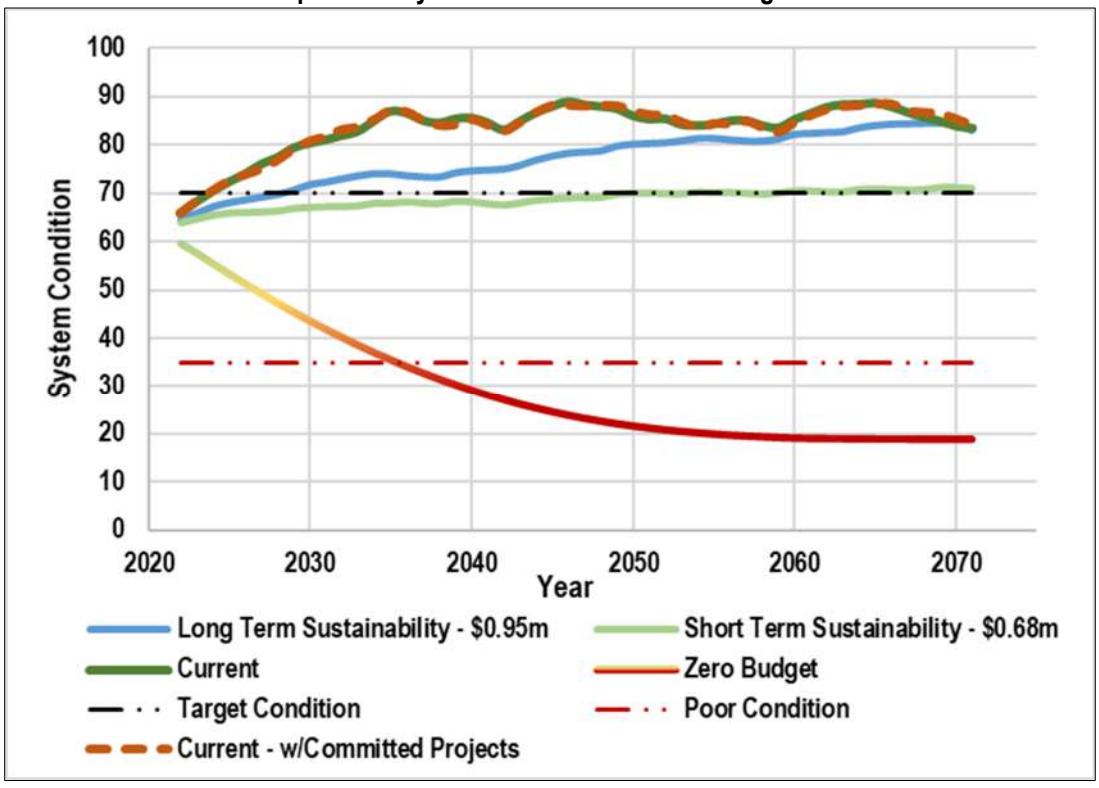


Note: Physical Condition is Structural Adequacy multiplied by 5; Average is 60.8, recommended 70 or greater

Graph ES 3: The Funding Window



Graph ES 4: System Performance vs Funding Level



Graph ES 5: System Condition Measures vs Time

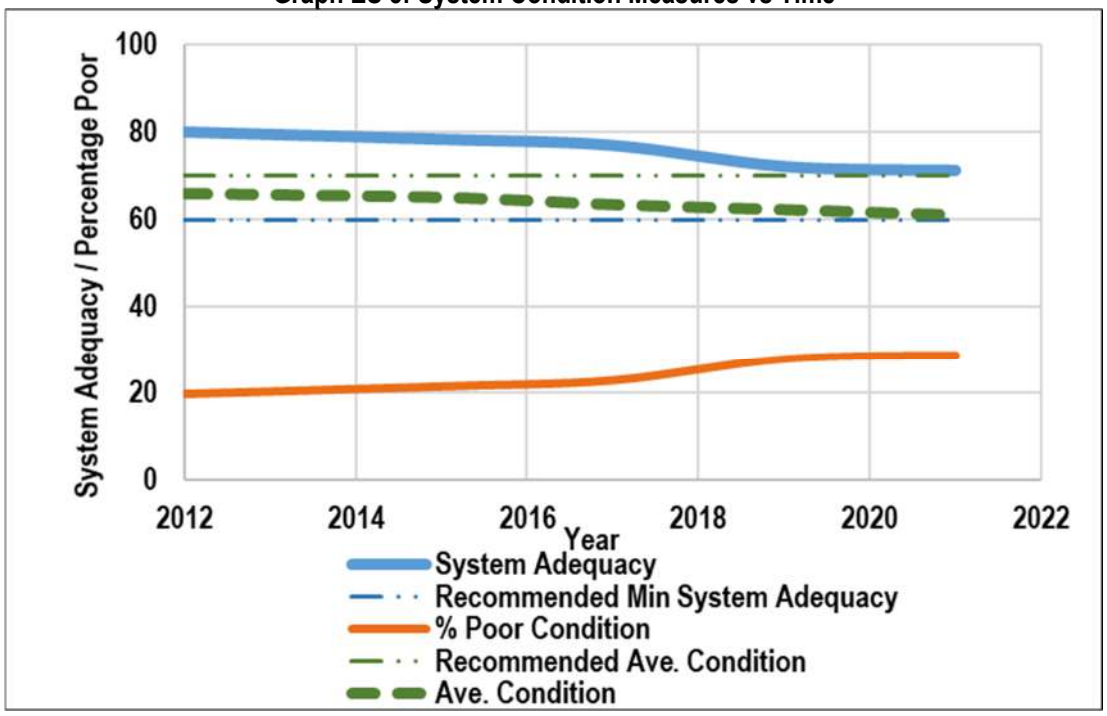


Table ES 15: Good to Very Good Roads by Structural Adequacy

Structural Adequacy	Roadside						Description	TOTAL		% OF TOTAL	
	Rural		Semi Urban		Urban						
	CL-Km	Lane-Km	CL-Km	Lane-Km	CL-Km	Lane-Km		CL-Km	Lane-Km	CL-Km	Lane-Km
1	0	0	0.64	1.28	0.092	0.184	Poor	**0.732**	**1.464**	1.84%	1.84%
2	0.959	1.918	0.156	0.312	0.076	0.152	Poor	**1.191**	**2.382**	7.11%	7.11%
3	1.545	3.09	0.126	0.252	0.157	0.314	Poor	**1.828**	**3.656**	13.39%	13.39%
4	0	0	0.726	1.452	0.46	0.92	Poor	**1.186**	**2.372**	8.69%	8.69%
5	0.367	0.733	0.412	0.824	0.952	1.904	Poor	**1.731**	**3.461**	12.67%	12.67%
6	0	0	0.31	0.62	2.37	4.74	Poor	**2.68**	**5.36**	19.63%	19.63%
7	0	0	0.372	0.744	1.186	2.372	Poor	**1.558**	**3.116**	11.41%	11.41%
8	0	0	0.159	0.318	0.483	0.966	Fair	**0.642**	**1.284**	4.70%	4.70%
9	0	0	1.31	2.62	0.796	1.592	Fair	**2.106**	**4.212**	15.42%	15.42%
10	0	0	0	0	3.089	6.178	Fair	**3.089**	**6.178**	4.54%	4.54%
11	0	0	0.464	0.928	1.137	2.274	Fair	**1.601**	**3.202**	2.35%	2.35%
12	0.33	0.66	0.307	0.614	0.76	1.52	Good	**1.397**	**2.794**	2.05%	2.05%
13	0.4	0.8	0	0	0.844	1.688	Good	**1.244**	**2.488**	1.83%	1.83%
14	0	0	0.164	0.328	0.646	1.292	Good	**0.81**	**1.62**	1.19%	1.19%
15	0.656	1.312	0.088	0.176	1.271	2.542	Good to Very Good	**2.015**	**4.03**	2.96%	2.96%
16	0	0	0.095	0.19	3.302	6.604	Good to Very Good	**3.397**	**6.794**	4.99%	4.99%
17	0	0	0	0	2.313	4.626	Good to Very Good	**2.313**	**4.626**	3.40%	3.40%
18	0.192	0.384	0	0	2.609	5.218	Good to Very Good	**2.801**	**5.602**	4.11%	4.11%
19	0	0	0	0	1.66	3.32	Good to Very Good	**1.66**	**3.32**	2.44%	2.44%
20	0	0	0.274	0.548	5.567	11.134	Good to Very Good	**5.841**	**11.682**	8.50%	8.50%
TOTAL	**4.449**	**8.897**	**5.603**	**11.206**	**29.77**	**59.54**		**39.822**	**79.643**		
% OF TOTAL	11.17%	11.17%	14.07%	14.07%	74.76%	74.76%					
% Poor	35.5%	35.5%	16.6%	16.6%	63.7%	63.7%		**53.9%**	**53.9%**		
% Fair	0.0%	0.0%	34.5%	34.5%	18.5%	18.5%		**18.7%**	**18.7%**		
% Good to Very Good	64.5%	64.5%	48.9%	48.9%	17.8%	17.8%		**27.4%**	**27.4%**		

Note: Based on Structural Adequacy Rating only

Table ES 16: 10 Year Program from Performance Model at Current Funding Level with Committed Projects (20210826)

Improvement Type	Year 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Grand Total
CRK	5,678	2,386	12,720	1,948	476	15,027	4,880	4,374	5,828	4,074	**57,391**
PR2	402,322	184,560		60,405							**647,287**
R1	320,383	610,106	130,982	29,735	140,045	416,003	361,064	692,352	405,626	618,955	**3,725,251**
R2Urehab	215,412	327,848	613,006	1,277,091	1,068,185	374,563	178,794			64,781	**4,119,680**
REC							494,400	626,200			**1,120,600**
RNS	542,700	348,300	707,500	97,500	279,000	648,700	440,497	140,100	1,083,282	807,913	**5,095,492**
SD	1,550										**1,550**
SR	10,000	20,000									**30,000**
SST			17,909					29,751			**47,660**
Grand Total Roads	**1,498,045**	**1,493,200**	**1,482,117**	**1,466,679**	**1,487,706**	**1,454,293**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	**14,844,911**
Water and Wastewater Linear											
Water	400,000	300,000	420,000	-	213,785	481,016	-	-	-	-	1,814,801
Storm and Sanitary Sewers	525,000	250,000	550,000	350,000	342,056	769,626	-	-			2,786,682
Gross Total	**2,423,045**	**2,043,200**	**2,452,117**	**1,816,679**	**2,043,547**	**2,704,935**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	19,446,394
Funding Sources											
General Levy	1,498,045	1,493,200	1,482,117	1,466,679	1,487,706	1,454,293	1,479,635	1,492,777	1,494,736	1,495,723	14,844,911
DC	0	0	0	0	0	0	0	0	0	0	0
Rate Supported	925,000	550,000	970,000	350,000	555,841	1,250,642	-	-	-	-	4,601,483
Required from Capital Reserve											0
Total Funding	**2,423,045**	**2,043,200**	**2,452,117**	**1,816,679**	**2,043,547**	**2,704,935**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	**19,446,394**

Improvement Type	Year 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Grand Total
CRK	5,678	2,386	12,720	1,948	476	15,027	4,880	4,374	5,828	4,074	**57,391**
PR2	402,322	184,560		60,405							**647,287**
R1	320,383	610,106	130,982	29,735	140,045	416,003	361,064	692,352	405,626	618,955	**3,725,251**
R2Urehab	215,412	327,848	613,006	1,277,091	1,068,185	374,563	178,794			64,781	**4,119,680**
REC							494,400	626,200			**1,120,600**
RNS	542,700	348,300	707,500	97,500	279,000	648,700	440,497	140,100	1,083,282	807,913	**5,095,492**
SD	1,550										**1,550**
SR	10,000	20,000									**30,000**
SST			17,909					29,751			**47,660**
Grand Total	**1,498,045**	**1,493,200**	**1,482,117**	**1,466,679**	**1,487,706**	**1,454,293**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	**14,844,911**

Note: Performance Model is based on the current funding level and includes committed projects It does not account for expansion projects.

Table ES 17: Improvement Type Abbreviation Summary

Inventory Manual Improvements (not all utilized in Petrolia)	
Code	**Description**
R1	Basic Resurfacing, Basic Resurfacing
R2 or R2Urehab	Basic Resurfacing – Double Lift, in urban area, remove and replace 2 lifts
RM	Major Resurfacing – removes existing asphalt and replace with existing plus and additional lift.
PR1	Pulverizing and Resurfacing
PR2	Pulverizing and Resurfacing – Double Lift
BS	Tolerable standard for lower volume roads: – Rural and Semi-Urban Cross sections only. Improves drainage and adds structure (granular base) and a surface but not to a reconstruct standard. Typically specified where width is to an acceptable standard.
RW	Resurface and Widen- adds additional lanes and resurfaces the entire road
REC	Reconstruction
RNS,	Reconstruction with Nominal Sewers
SRR	Storm Sewer Installation and Road Reinstatement
SD	Spot Drainage
SR	Spot Road
Additional Treatments in Petrolia	
CRK	Crack sealing
GRR	Gravel road resurfacing 75mm
GRR2	Gravel road resurfacing 150mm
SST	Single Surface Treatment

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1 Introduction and Background

Road Needs Studies (RNS) were implemented by the Ministry of Transportation Ontario (MTO) in the 1960's, and evolved into the current methodology by the late 1970's. The most current version of the Inventory Manual for Municipal Roads is dated 1991, and is the methodology used for this report.

The process was originally created by the MTO as a means to distribute conditional funding, on an equitable basis, between municipalities. The practice was discontinued by a number of municipalities, when conditional funding for roads was eliminated in the mid 1990's. The RNS process is a sound, consistent asset management practice that still works well today, and in view of the increasing demands on efficiency and asset management, represents a sound business practice that is beneficial to continue.

To put the Road Needs Study in a more current context, the State of the Infrastructure (SotI) is essentially a Road Needs Study.

In August 2012, the Province of Ontario, introduced a requirement for an Asset Management Plan (AMP) as a prerequisite for municipalities seeking funding assistance for capital projects from the province; effectively creating a conditional grant. To qualify for future infrastructure grants, an AMP had to be developed and approved by a municipal council by December 2013. On April 26, 2013 the province announced that it had created a $100 million Infrastructure Fund for small, rural and northern municipalities.

Subsequently, the province has introduced further initiatives for infrastructure funding: Ontario Community Infrastructure Fund (OCIF) and the Small Communities Fund (SCF). An Asset Management Plan (AMP) approved by Council is required as part of the submission for OCIF Applications. Asset Management Plans were to be reviewed for comprehensiveness.

On December 27, 2017, the Province filed Regulation 588/17, Asset Management Planning for Municipal Infrastructure. The regulation identifies provincial requirements and timelines for development and implementation of asset management plans. Initially, AMP's will have to include the 'core' assets; water and waste water linear and treatment, roads, bridge and culvert structures, and storm water linear and treatment.

Regulation 588/17 requires an Asset Management Plan (AMP) for core assets by July 1, 2022 that is based on condition data that is no more than two years old. This project positions the Town well for compliance with the Regulation.

Conditional Grants are not new to Ontario. Until the mid-1990's, Road Needs Studies (RNS) were completed by municipalities and submitted to the Ministry of Transportation (MTO) on an annual basis in order to receive provincial funding for their road programs.

Town of Petrolia (ToP or the Town) is currently evolving the AMP for the various asset groups, roads being one of them. A key component of the AMP is a *'State of the Infrastructure'* (SotI) review of the asset or asset group. This report provides the SotI review of the Town of Petrolia road system and also provides recommendations for budgets and road asset programming; effectively an Asset Management Plan for Roads.

The work plan developed as a deliverable for this project, cross integrates assets from the other core assets; water waste water, and storm sewer. The resultant model illustrates the effect on the road asset group over time. A requirement of O.Reg 588/17, is to create a work plan that maintains the condition of the assets over a 10-year period.

The scope of this report is to prepare a State of the Infrastructure (SOTI) report that includes:

- Field review and condition rating on all of the road assets within the Town of Petrolia road system.
- Updated Dimensional information, where improvements have occurred
- Add or change road sections to better reflect the constitution of the road system, as required.
- Develop replacement costs for each road asset, based on current unit costs and standard formulae from the Inventory Manual for Municipal Roads, 1991.
- Develop/review recommendations for improvement and associated costing on deficient assets
- Develop recommendations for annual budgets based on current costs for Long Term Sustainability and major program areas based on updated unit costs.
- Develop analysis on the effect of current and recommended budgets on overall system performance.
- Develop a 10 year work plan
- Provide Asset Management Strategy recommendations
- Provide the answers to the basic asset management questions;
    - What you have?
    - Where it's located?
    - What condition is it in?
    - What is it worth?
    - What will it cost to replace it?
    - Useful remaining life?
    - What service level will be required over the service life?
- A report on the foregoing.
- An updated geodatabase

The 2021 SotI summarizes the condition data survey conducted during the summer of 2021. The database identifies the condition of each road asset by its time of need and recommended maintenance, rehabilitation or reconstruction treatment.

Recommendations are made based on the defects observed and other information available in the database at the time of preparation of the report. Once a road asset reaches the project level, the municipality may have selected another alternative based on additional information, asset management strategy, development considerations or available funding.

Further, the report provides an overview of the physical and financial needs of the road system in its entirety, as well as by road section. Both information sources are used to develop programming and budgets. However, once a road section reaches the project design stage, further detailed review, investigation, and design will be required to address the specific requirements of each project.

This report should not be confused with a road safety audit. A road safety audit is the formal safety performance examination of an existing or future road or intersection, which qualitatively estimates and reports on potential road safety issue and identifies opportunities for improvements for all road users Typically, and more predominantly in a lower tier, rural municipality on lower volume road sections, the road system has some deficiencies with the existing horizontal and vertical alignment

The Town provided updated information with respect to their database/network, which included sections that had been added or removed from the system, and other segment data.

The Inventory Manual methodology is discussed further in Section 2 of this report and Appendix A.

2 Asset Condition Rating Methodology

2.1 Asset Management Planning for Municipal Assets - Regulation 588/17 Requirements

Regulation 588/17, Asset Management Planning for Municipal, Infrastructure requires;

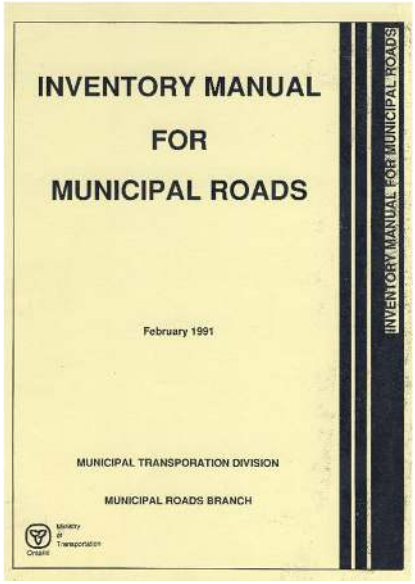
> *'v. a description of the municipality's approach to assessing the condition of the assets in the category, based on recognized and generally accepted good engineering practices where appropriate*.'

2.2 Asset Condition Rating Methodology

As an asset management practice the Town of Petrolia is updating the condition and attribute information for the road system. This ensures that pavement management decision making is based upon current data from field survey information and is completed in accordance with standard engineering practice. The road section reviews follow the methodology of the Ministry of Transportation Inventory Manual for Municipal Roads, 1991.

2.2.1 Inventory Manual History

From the 1960's until the mid 1990's, the Ministry of Transportation (MTO) required municipalities to regularly update the condition ratings of their road systems in a number of key areas. The process was originally created by the MTO, as a means to distribute conditional funding, on an equitable basis, between municipalities. The reports were referred to as a 'Road Needs Study' (RNS) and were required in order to receive a conditional grant to subsidize the municipal road programs. After the introduction in the 1960's by the MTO, the methodology evolved into the current format by the late 1970's. The most current version of the Inventory Manual is dated 1991, and is the methodology used for this report. The practice was discontinued by a number of municipalities, when conditional funding for roads was eliminated in the mid 1990's.



2.2.2 Inventory Manual Overview

The Inventory Manual Methodology is a sound, consistent, asset management practice that still works well today, and in view of the increasing demands on efficiency and asset management, represents a sound asset management practice that should be repeated on a cyclical basis. The road section review identifies the condition of each road asset by its time of need and recommended rehabilitation strategy.

Town of Petrolia SotI & AMP Report summarizes the road system survey conducted during the summer of 2021. The SotI Report provides an overview of the overall condition of the road system by road section, including such factors as structural adequacy, drainage, and surface condition. The study also provides an indication of potential deficiencies in the horizontal and vertical alignment elements, as per the Ministry of Transportation's manual, "Geometric Design Standards for Ontario Highways".

The report provides an overview of the physical and financial needs of the road system, which may be used for programming and budgeting. However, once a road section reaches the project design stage, further detailed review, investigation, and design will be required to address the specific requirements of the project.

Asset Management, by its' very nature, is holistic. Managing a road network based solely on pavement condition would be critically deficient in scope in terms of the information required to make an informed decision as to the improvements required on a road section.

The *Inventory Manual* offers a holistic review of each road section, developing a Time of Need (TON) or an Adequate rating in six areas that are critical to municipal decision making:

- Geometrics
- Surface Type
- Surface Width
- Capacity
- Structural Adequacy
- Drainage

Evaluations of each road section were completed generally in accordance with the MTO's *Inventory Manual for Municipal Roads* (1991). Data collected was entered directly into WorkTech's Asset Foundation software. Condition ratings, Time of Need, Priority Ratings, and associated costs were then calculated by the software, in accordance with the *Inventory Manual*. Unit costs for construction were provided by Town of Petrolia staff.

Road sections should be reasonably consistent throughout their length, according to roadside environment, surface type, condition, cross section, speed limit, or a combination of these factors. As an example, section changes should occur as surface type, surface condition, cross-section, or speed limit changes.

The Condition Ratings, developed through the scoring in the *Inventory Manual*, classify roads as 'NOW', '1 to 5', or '6 to 10' year needs for reconstruction. The Time of Need is a prediction of the time until the road requires reconstruction, *not the time frame until action is required*. For example, a road may be categorized as a '6 to 10' year need with a resurfacing recommendation. This road should be resurfaced as soon as possible, to further defer the need to reconstruct.

Field data is obtained through a visual examination of the road system and includes: structural adequacy, level of service, maintenance demand, horizontal and vertical alignment, surface and shoulder width, surface condition, and drainage. The Condition Rating is calculated based upon a combination of other calculations and data.

To best utilize the database information and modern asset management concepts, it has to be understood that the Time of Need (TON) ratings are the estimated time before the road would require reconstruction. NOW needs are still roads that require reconstruction; however, it is not intended that '1 to 5' and '6 to 10' year needs are to be acted on in that timeframe. The '1 to 5' and '6 to 10' year needs are current candidates for resurfacing treatments that will elevate their structural status to 'ADEQ', and offer the greatest return on investment for a road authority (notwithstanding a drainage or capacity need, etc.).

The Time of Need ratings from the Structural Adequacy perspective are described more fully in Appendix A.

2.2.3 Inventory Manual Overview -Gravel Road Inspections

Item 87 – Structural Adequacy provides the following direction on the evaluation of gravel roads;

"Loose Top Sections

Appraise each section on the basis of two conditions during the spring

(a) SOFT SPOTS, as indicated by rutting and Frost Boils
(b) FROST BOILS only.

Table 2.1: Inventory Manual Table 87

Point Rating	Proportion of Section Length Exhibiting Soft Spots (Include the length of Frost Bolls)	Proportion of Section Length Exhibiting Frost Boils (Exclude the Length of Soft Spots which do not Boil)
20	Less than 5%	No Boils
19 to 15	5%-15%	Less than 5%
14 to 12	16%-20%	6%-10%
11 to 8	21%-25%	11%-15%
7 to 1	More than 25%	More than 15%

The gravel roads inspections were *not* undertaken during the spring breakup.

2.3 Improvement Recommendations

Improvement recommendations are predicated upon the field observations and ratings, dimensional data collected, and traffic information. As a project advances, further design, traffic and geotechnical studies should be undertaken to confirm the nature and extent of the improvement required.

Improvement recommendations are provided to correct the observed deficiencies. The road agency may elect to utilize a holding strategy as an interim measure due to budget constraints or other programming that has been prioritized.

During the course of the preparation of the work plan, some recommendations were changed to align with the Town's improvements that are in part being driven by other assets or master plans.

2.3.1 Defects and Quality Assurance

As with the production of any product, the goal is to minimize defects to the greatest extent possible.

Quality Control is the system or process that the supplier undertakes to ensure that the product is provided as specified.

Quality Assurance is the system or process that the receiver of the product employs to assure itself that the product that it is receiving is in fact what was specified.

During the course of the field reviews a number of defects were noted, as follows;

- The area west of Valentia St, north of and including Tom Street appears to have thin asphalt which may account in part for the performance. The anecdotal information is that the same area is services by combination sewers.
- Valentia Street South is deteriorating more quickly than anticipated.
- Garden Crescent from Heritage Heights Lane to First Avenue has a poor ride and is deteriorating more quickly than anticipated. Possible causes would include an initial poor design standard/poor construction standard, that may have not included granular base or subdrains, or load transfer bars between the slabs. Quality Control and Quality Assurance may have been lacking also.

- Drainage is potentially a cause for the poor performance on Tank Street.

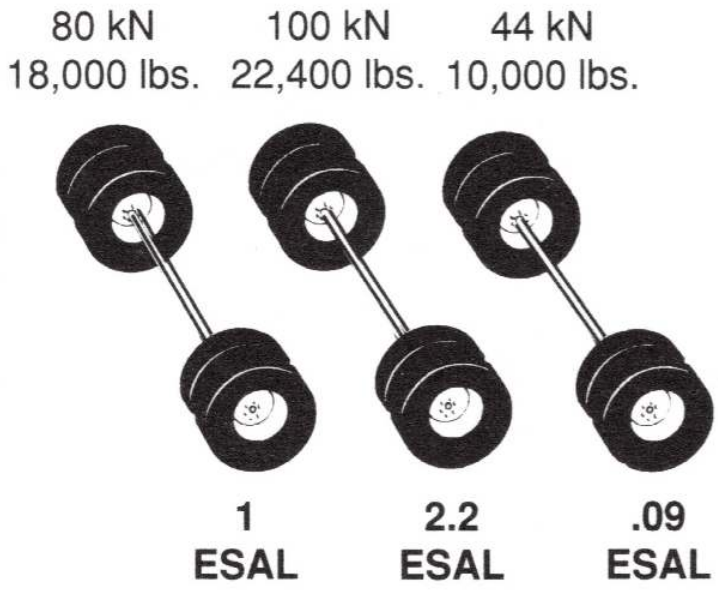
There is an associated cost with quality assurance, but that far outweighs the life cycle cost of receiving product that does not meet standard. *'You get what you inspect – not what you expect.'*

Defects are discussed in greater detail in Appendix B

2.3.2 Traffic Impact on Improvement Recommendations

Improvement recommendations are heavily predicated on traffic, and particularly heavy commercial traffic and buses. The number and type of heavy vehicles is critical to pavement design and ultimately, its' performance. Under-designed pavement will not perform as expected.

Figure 2-1: ESAL Comparison from Asphalt Institute Thickness Design Manual



When designing a road, the traffic loading from different vehicles has to be converted to, and expressed in, common terms. In Ontario (and across North America) Equivalent Single Axle Loads (ESAL's) are used to design pavement structure and the determine the required consensus properties of materials.

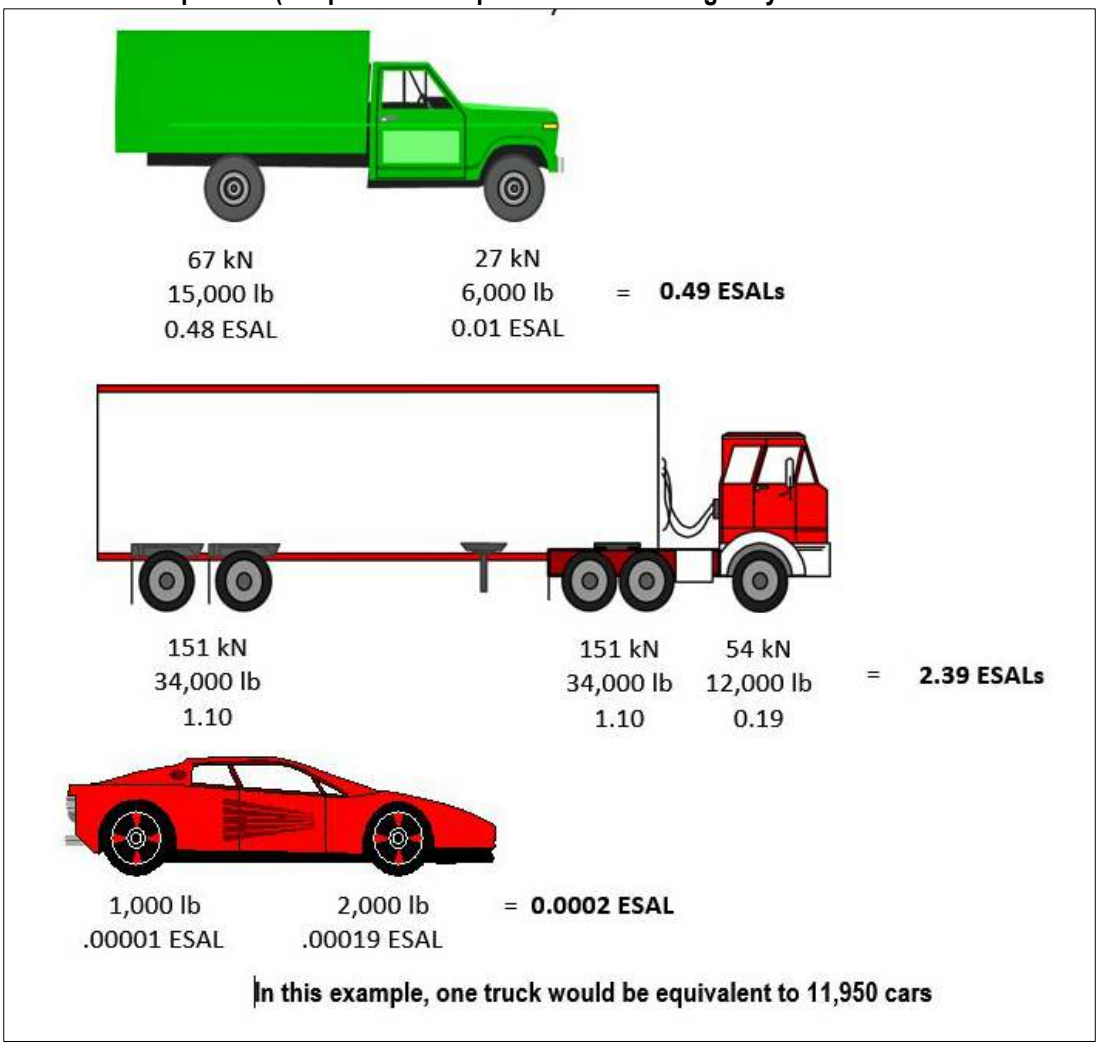
The ESAL measurement has been in use for a significant length of time and has its roots in the older Imperial or Standard measures. The metric system was adopted in Canada in 1977. One ESAL is 18,000 lbs, 18kips or 80 Kilonewtons. In Ontario the maximum load for a single axle is 10 tonnes, which equals 100 Kilonewtons, or 2.2 ESAL's.

The American Association of State Highway and Transportation Officials (AASHTO) and the Asphalt Institute (AI) are often cited references for pavement design. The formula to determine load equivalencies is very complex, however, at a high level, a simplified formula may be used to approximate the load equivalency factor. This formula is sometimes referred to as the Fourth Power Law or the Generalized Fourth Power Law. The Load Equivalency Factor may be used to illustrate the relative difference in damage between particular loadings.

Equation 2-1: Load Eqivalency Factor

$$\text{Load Equivalency Factor} = \left[\frac{\text{Specific Axle Load}}{18{,}000 \text{ lbs}} \right]^4$$

Figure 2-2: ESAL Comparison (Adapted from Asphalt Institute for Highway and Street Rehabilitation Manual)



2.3.1 Traffic Counts

Section 2.3.2 identifies the impact of traffic, particularly trucks, on the performance of the roads and the inherently greater pavement structure that is required to carry said traffic. This reinforces the need to have current traffic information that would include the type and number of vehicles that are using the road in order that an appropriate pavement structure may be determined.

The Town does not have a regular traffic counting program. A traffic counting program should be initiated and include the percentage of trucks, count year, and the type of count - actual or estimated. The importance of traffic counts is also discussed in Section 3.2.2.

The changes in traffic patterns resultant from the pandemic may skew the traffic counts downward causing an inaccurate determination of the O.Reg 239/02 classification, which would pose a potential liability for the Town.

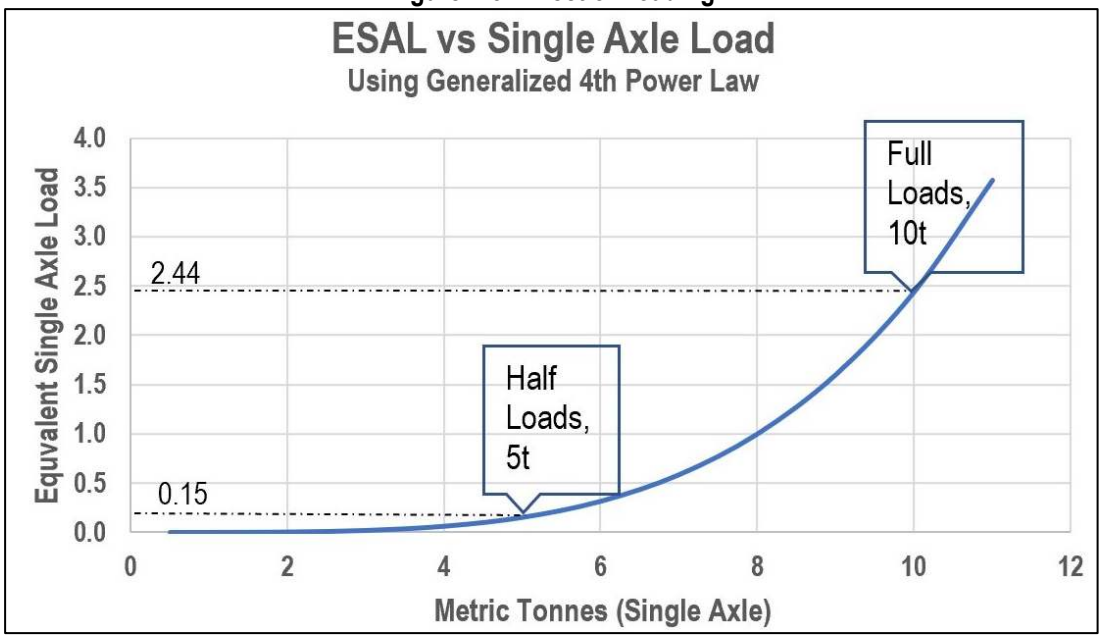
2.3.2 Seasonal Half Load Restrictions

The discussion in the Section 2.3.2 identifies the effect the heavy vehicles have on a pavement structure. During the spring break-up season- typically March 1 to April 30- frost is coming out of the ground which reduces the ability of the road structure to carry loads.

From the paper entitled 'Proposed System for Co-ordinating Spring Load Restrictions in Ontario' presented at the 2013 Transportation Association of Canada Conference, the following provides an easily understood explanation for the need for half load restrictions ;

> *Roads and highways in northern climates are affected by seasonal growth and melting of ice beneath the surface, especially on roads with a non-engineered base beneath the driving surface. Ice growth can be advantageous by increasing the bearing strength of road materials, or disruptive where moisture accumulates locally in frost heaves or boils. Melting of ice can lead to weakening of road materials where melt near the surface is more rapid than at depth, and excess moisture is trapped above a non-permeable subsurface layer, leading to rutting and pavement cracking.*
>
> *The effects of freezing and thawing of low volume roads in Ontario is mitigated through temporary Winter Weight Premiums (WWP) during the frozen season and Half Load Restrictions or Spring Load Restrictions (SLR) during the thaw season on designated road sections (Ontario, 2013). They are intended to provide a balance between the access needed by the trucking and resource industry and the added road repair and maintenance costs borne by the Ministry of Transportation or local municipalities.*

Figure 2-3: Effect of Loading



The Highway Traffic Act Section 122 provides authority to a municipality to impose load restrictions. The timing of the imposition of spring load restrictions should be based on the conditions, not just the date. Climate change has introduced significant variability into the commencement the spring thaw, and as such, there should be delegated authority to staff to impose the restrictions as conditions occur.

Half Load Restrictions should commence as determined by the conditions and/or the date.

2.4 Types of Improvements

This report identifies ratings that are resultant from identification of deficiencies on each road section that equate to a TON in one or more of the six critical areas: Geometry, Surface Type, Surface Width, Capacity, Structural Adequacy, or Drainage. Based on the ratings and the deficiencies noted an improvement type recommendation is also provided.

The key factor in providing an improvement type recommendation is the visual survey. During the visual survey, a determination is made as to whether the appearance and performance of a road relates to an underlying structural problem, or simply to aged surface materials. A road's structural or drainage problem would tend to result in a reconstruction/ replacement treatment recommendation, whereas aged surface materials would result in a resurfacing/rehabilitation treatment recommendation. A determination of the root cause of the problem or the condition is critical; reconstructing a road that should have had some type of resurfacing treatment would be an ineffective use of available resources.

For the purposes of this report, the standard improvement types and associated costing formulae identified in the Inventory Manual have been used where applicable. Other improvement types have been developed to more fully evolve the development of a more holistic work plan that includes capital and major maintenance activities

The following table provides a list of road improvements used for the development of this report.

Appendix B of this report includes a discussion of pavement structure and defects.

Table 2.2: Average Improvement Costs per Kilometre by Improvement Type

Improvement Class	Improvement ID / Description		TOTAL		% OF TOTAL		Cost / km ($)
			Imp. Cost	Cl-km	Imp. Cost	Cl-km	
Const	BS	Base and Surface	20,622	0.044	0.11%	0.11%	468,682
Const	NONE	No Improvement Required	0	13.44		33.75%	-
Const	REC	Reconstruction - Rural	3201241	3.586	0.1785	9.01%	892,705
Const	RNS	Reconstruction Nominal Storm Sewer	8,671,246	7.921	48.34%	19.89%	1,094,716
Maint	CRK	Crack Sealing	5,678	2.839	0.03%	7.13%	2,000
Maint	SD	Spot Drainage	1,550	0.861	0.01%	2.16%	1,800
Maint	SR	Spot Repairs	30,000	0.815	0.17%	2.05%	36,810
Rehab	PR2	Pulverize and Resurface 2 - 100mm	647,287	1.338	3.61%	3.36%	483,772
Rehab	R1	Basic Resurfacing 1 - 50mm	1,091,205	3.189	6.08%	8.01%	342,178
Rehab	R2Urehab	Urban HCB Rehabilitation	4,267,576	5.789	23.79%	14.54%	737,187
TOTAL			**17,936,403**	**39.822**			
% OF TOTAL							

Table 2.3: Road Improvement Types

Inventory Manual Improvements (not all utilized in Petrolia)	
Code	**Description**
R1	Basic Resurfacing, Basic Resurfacing
R2 or R2Urehab	Basic Resurfacing – Double Lift, in urban area, remove and replace 2 lifts
RM	Major Resurfacing – removes existing asphalt and replace with existing plus and additional lift.
PR1	Pulverizing and Resurfacing
PR2	Pulverizing and Resurfacing – Double Lift
BS	Tolerable standard for lower volume roads: – Rural and Semi-Urban Cross sections only. Improves drainage and adds structure (granular base) and a surface but not to a reconstruct standard. Typically specified where width is to an acceptable standard.
RW	Resurface and Widen- adds additional lanes and resurfaces the entire road
REC	Reconstruction
RNS,	Reconstruction with Nominal Sewers
SRR	Storm Sewer Installation and Road Reinstatement
SD	Spot Drainage
SR	Spot Road
Additional Treatments in Petrolia	
CRK	Crack sealing
GRR	Gravel road resurfacing 75mm
GRR2	Gravel road resurfacing 150mm
SST	Single Surface Treatment

2.4.1 Town of Petrolia Recommendations and Costing

The bench mark improvements from the Inventory Manual represent a sound methodology for developing a project cost. In the absence of any municipality specific formulae, the bench mark costs work well to produce a representative cost to undertake a specified improvement.

In the bench mark costing, there are four cost factors that are added to the material and placement costs of a project;

- Basic Construction Factor
- Engineering Factor
- Contingency Factor and,
- Terrain and Soil Type Factor

Over the years, additional treatments have been developed and have been identified in Table 2.2 under the heading additional treatments. Where an additional treatment has been created, consideration has been given to the usage of the above mentioned factors, as deemed appropriate.

Appendix A includes fuller descriptions of each of the above noted improvements.

Appendix B of this report includes a discussion of Pavement Structure and defects.

3 State of the Infrastructure

3.1 Scope / Asset Type(s)

This report addresses road assets only. The content will provide review and analysis of the road system from a number of perspectives including condition rating, functional classification, roadside environment, replacement cost, Regulation 239/02 classification and Regulation 588/17 Classification.

Petrolia has identified storm sewers as a separate asset. The cost of storm sewers is included in the replacement / improvement recommendation RSS - Reconstruct with storm sewers.

For the Petrolia project RNS – Reconstruct with nominal storm sewers is used to develop the replacement cost for roads only. The 'nominal' storm sewers includes only subdrain and adjustments to manholes and catchbasins.

3.2 Road Asset Inventory and Classification

Assets are classified by different measures dependent upon regulation and end usage of the information. The following sections of the report define the road assets by a number of parameters including road surface type, roadside environment, and Regulations 239/02 and 588/17.

For performance modeling purposes, 4 Roads has created asset classes that are defined by surface type, roadside environment and traffic. Appendix C of this report provides further discussion on asset classes for performance modeling.

3.2.1 Surface Types and Roadside Environment

Roadside environment and surface type criteria of a road section are useful in characterization of the road section, and in determining costs for replacement, reconstruction and rehabilitation treatments.

The *Inventory Manual* classifies the roadside environment as Rural, Semi-Urban or Urban. The classification is determined by length, servicing, and adjacent land use.

- ***Rural Roads*** – within areas of sparse development, or where development is less than 50% of the frontage, including developed areas extending less than 300 m on one side or 200 m on both sides, with no curbs and gutters.
- ***Semi-Urban Roads*** – within areas where development exceeds 50% of the frontage for a minimum of 300 m on one side, or 200 m on both sides, with no curbs and gutters, with or without storm/combination sewers, or for subdivisions where the lot frontages are 30 m or greater.
- ***Urban Roads*** – within areas where there are curbs and gutters on both sides, served with storm or combination sewers, or curb and gutter on one side, served with storm or combination sewers, or reversed paved shoulders with, or served by, storm or combination sewers, or for subdivisions with frontages less than 30 m.

Table 3.1: Surface Type and Roadside Environment Distribution

Material Description	Roadside Environment						TOTAL		% OF TOTAL	
	Rural		Semi Urban		Urban					
	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km	CL-km	Lane-km
CON -Concrete	0	0	0	0	2.791	5.582	**2.791**	**5.582**	7.01%	7.01%
G/S -Gravel, Stone, Other Loosetop	0	0	0.159	0.318	0	0	**0.159**	**0.318**	0.40%	0.40%
HCB-High Class Bit.-asphalt	1.672	3.343	3.071	6.142	26.771	53.542	**31.514**	**63.027**	79.14%	79.14%
LCB-Low Class Bit.-surface treated	2.777	5.554	2.373	4.746	0.208	0.416	**5.358**	**10.716**	13.46%	13.46%
TOTAL	**4.449**	**8.897**	**5.603**	**11.206**	**29.77**	**59.54**	**39.822**	**79.643**		
% OF TOTAL	11.17%	11.17%	14.07%	14.07%	74.76%	74.76%				

3.2.2 Ontario Regulation 239/02 Classification- Minimum Maintenance Standards for Municipal Highways

In the 1990's, municipalities experienced an escalation of claims and resultant awards for damages which in turn increased the cost of municipal insurance. Increased insurance costs typically resulted in a reduction of available funding for the provision of services as municipalities strove to keep annual tax increases to a minimum.

A draft regulation was created and circulated to municipal stakeholders and agencies for comment over a period of years, starting in the late 1990's. The premise being that, this would represent a standard for maintenance for municipalities that – if met - and documented- would provide the municipalities with a level of defense in claim. (Reference the Ontario Municipal Act) The consultative process occurred over a lengthy period of time.

In November 2002, Ontario Regulation 239/02 (O.Reg 239/02), Minimum Maintenance Standards for Municipal Highways (MMS) came into effect. Essentially, if a municipality met the standard and documented it, they would not be negligent per Section 44(3)c of the Municipal Act noted above.

O.Reg 239/02 created 6 classifications for roads based on AADT (traffic count) and speed limit. Table 3.2 shows O.Reg 239/02 traffic/speed/ classification matrix as amended by O.Reg 366/18.

Regulation 239/02 provided for a review five years after its original implementation. A process to revise Regulation 239/02, chaired by the Ontario Good Roads Association (OGRA), culminated in a revised regulation, Regulation 23/10, coming into effect in February 2010.

In the late fall of 2011, a court decision (Giuliani) was rendered that effectively created case law that negated the protection that the MMS afforded, and in particular, Tables 4 and 5 of the regulation (Tables 4 and 5 addressed Snow Accumulation and Icy Roads in that revision of the MMS). Essentially, the decision created a new standard that went beyond the original MMS. The effect on a municipality is that a higher standard of weather monitoring, documentation and proactive response (as opposed to reactive) to monitoring would be required, particularly in the case of ice formation prevention (anti icing).

OGRA re-called the MMS committee to further amend the regulation, to address the outcome of the Giuliani decision. As a result of the committee meetings and discussions with the province, Regulation 47/13 came into effect, amending Regulations 239/02 and 23/10, on January 25 2013.

As noted, Regulation 239/02 provides for review at 5 year intervals. Effective May 3, 2018, the next revision of the regulation came into effect (O.Reg 366/18). There are a number of revisions in the updated regulation that affected

the MMS classifications and also modified and added a number of service delivery standards for bike lanes and sidewalks.

Table 3.2: O.Reg 239/02, as amended by O.Reg 366/18, Minimum Maintenance Standard Road Classification

Column 1 Average Daily Traffic (number of motor vehicles)	Column 2 91 - 100 km/h speed limit	Column 3 81 - 90 km/h speed limit	Column 4 71 - 80 km/h speed limit	Column 5 61 - 70 km/h speed limit	Column 6 51 - 60 km/h speed limit	Column 7 41 - 50 km/h speed limit	Column 8 1 - 40 km/h speed limit
53,000 or more	1	1	1	1	1	1	1
23,000 - 52,999	1	1	1	2	2	2	2
15,000 - 22,999	1	1	2	2	2	3	3
12,000 - 14,999	1	1	2	2	2	3	3
10,000 - 11,999	1	1	2	2	3	3	3
8,000 - 9,999	1	1	2	3	3	3	3
6,000 - 7,999	1	2	2	3	3	4	4
5,000 - 5,999	1	2	2	3	3	4	4
4,000 - 4,999	1	2	3	3	3	4	4
3,000 - 3,999	1	2	3	3	3	4	4
2,000 - 2,999	1	2	3	3	4	5	5
1,000 - 1,999	1	3	3	3	4	5	5
500 - 999	1	3	4	4	4	5	5
200 - 499	1	3	4	4	5	5	6
50 - 199	1	3	4	5	5	6	6
0 - 49	1	3	6	6	6	6	6

The Minimum Maintenance Standards do not have to be adopted by a municipal council per se. The regulation is provincial, applies to all municipalities, and is available for municipalities to use as a defense if they have met the standard and documented it. The more important issue would be to ensure that a municipality has the appropriate Standard Operating Procedures (SOP's) in place, and that they are followed and documented, rather than trying to reword or parallel the language of the regulation into a document that is agency specific. SOPs are a (management) staff created document that identifies service delivery processes to staff, and do not require Council approval. Policy is the purview of Council; SOPs are how staff deliver on the direction of the policy.

Traffic counts are important for a number of decision making purposes, with respect to the road system. Accurate, defensible traffic counts, in conjunction with the posted speed limits, are used in determining the MMS class of the respective road sections. Roads are divided into six service classes by posted speed and traffic count, with Class 1 being the highest service level and Class 6 being the lowest. There are no service standards for Class 6 roads which are low traffic volume and low speed as identified in Table 2.1

The caveat is that, whereas there are no service standards for Class 6 roads, there are geometric design standards for low volume roads that are still applicable for width, curves and other geometry. Road structure will be dependent on traffic type.

The regulation defines response time by MMS class and defect type. Response time is defined as the time from when the municipality becomes aware that a condition exists, until the time that the condition is corrected or brought within the limits specified in the regulation. For example, the response time that is required to remove snow accumulation is 12 hours for a Class 3 road, and 16 hours for a Class 4 road.

This may have a significant impact with respect to the equipment and staffing that may be required to meet the standard, particularly in the case of winter control. The implications are that this increased service level may require the municipality to increase the inspection frequency, staff, and machinery to deliver the service beyond the service delivery hours that may currently exist.

Traffic Counts are critical to the accurate classification of road sections and decision making for capital and operational programs. The Town of Petrolia records indicate the history of the traffic counting program as shown in Table 3.3 .

Table 3.3: Traffic Count History

Year	AADT Counted	AADT Estimated	TOTAL	% OF TOTAL
2012	0	36.897	**36.897**	91.28%
2015	0.125	2.384	**2.509**	6.21%
2017	0	0.433	**0.433**	1.07%
2019	0	0.52	**0.52**	1.29%
2021	0	0.061	0.061	0.0015
TOTAL	**0.125**	**40.295**	**40.42**	

Not adjusted for Boundary Roads

Town of Petrolia currently does not collect traffic data. Traffic information is based almost entirely on estimated counts and should not be relied upon for an accurate determination of the Town of Petrolia MMS Classifications. The Town of Petrolia should initiate a traffic counting program to be updated and repeated on a regular basis. The counting should include the percentage of truck traffic.

As noted earlier in the report, truck and other heavy traffic is the primary driver in the pavement structure design.

The distribution of the MMS Classes across the Town of Petrolia road system is detailed in Table 3.4.

Table 3.4: Minimum Maintenance Standards Class Distribution

Time of Need	O.Reg 239/02 Classification 5		6		TOTAL		% OF TOTAL	
	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
1 to 5	5.928	11.856	1.351	2.702	**7.279**	**14.558**	18.01%	18.01%
6 to 10	2.737	5.474	1.68	3.36	**4.417**	**8.834**	10.93%	10.93%
ADEQ	10.241	20.482	6.861	13.722	**17.102**	**34.204**	42.31%	42.31%
NOW	8.547	17.094	3.075	6.15	**11.622**	**23.244**	28.75%	28.75%
TOTAL	**27.453**	**54.906**	**12.967**	**25.934**	**40.42**	**80.84**		
% OF TOTAL	67.92%	67.92%	32.08%	32.08%				
System Adequacy	68.9%	68.9%	76.3%	76.3%	**71.2%**	**71.2%**		
Good to Very Good	47.3%	47.3%	65.9%	65.9%	**53.2%**	**53.2%**		

Traffic information is based almost entirely on estimated counts and should not be relied upon for an accurate determination of the Town of Petrolia MMS Classifications. *Not adjusted for Boundary Roads

3.2.3 Functional / Existing / Design Classifications per the Inventory Manual for Municipal Roads

Roads are further classified within the database by classes such as Local, Collector, or Arterial and Residential or Industrial. Items 33 and 105 in the *Inventory Manual* provide further direction on determination of the Existing or Design Classes of road. Generally, the classifications are predicated on the existing use, roadside environment, and anticipated growth over either the ten- or twenty-year planning horizon.

The road sections are classified by the rater, at the time of the field review. Table 3.5 identifies the Functional Road Class Distribution.

Table 3.5: Functional Road Class Distribution (Inventory Manual)

Functional Classification	Lanes	Roadside Environment						TOTAL		% OF TOTAL	
		Rural		Semi Urban		Urban					
		Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
200	2	0.192	0.384	0	0	0	0	**0.192**	**0.384**	0.48%	0.48%
400	2	2.907	5.813	0	0	0	0	**2.907**	**5.813**	7.30%	7.30%
500	2	1.02	2.04	0	0	0	0	**1.02**	**2.04**	2.56%	2.56%
ALL	2	0	0	0.391	0.782	0	0	**0.391**	**0.782**	0.98%	0.98%
L/R	2	0.33	0.66	3.3	6.6	29.167	58.334	**32.797**	**65.594**	82.36%	82.36%
LCI	2	0	0	1.912	3.824	0.603	1.206	**2.515**	**5.03**	6.32%	6.32%
TOTAL		**4.449**	**8.897**	**5.603**	**11.206**	**29.77**	**59.54**	**39.822**	**79.643**		
% OF TOTAL		11.17%	11.17%	14.07%	14.07%	74.76%	74.76%				

Adjusted for Boundary Roads

3.2.4 O. Reg 588/17 Classification – Asset Management Planning for Municipal Infrastructure

Regulation 588/17, Asset Management Planning for Municipal Infrastructure was enacted on December 27, 2017. In part the regulation provides for another functional classification of road sections within a system. The classification takes a broader brush than the Inventory Manual, classifying road sections as Arterial, Collector, or Local, based directly on the Regulation 239/02 road classification.

Class 1 and 2 are Arterial; Class 3 and 4 are Collector; Class 5 and 6 are Local.

Table 3.6 identifies Regulation 588/17 Classification. For the purposes of this report, 4 Roads has aligned the urban and semi urban functional classifications with O.Reg 588/17. Urban and Semi-urban road sections have been classified in accordance with this table.

Table 3.6: Ontario Regulation 588/17 Functional Road Classification

Lanes	Roadside	Regulation 588/17 Classification, Asset Management Planning for Municipal Infrastructure						TOTAL		% OF TOTAL	
		Arterial		Collector		Local					
		Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km	Cl-km	Lane-km
2	Rural	0	0	0	0	4.965	9.93	**4.965**	**9.93**	12.28%	12.28%
2	Semi Urban	0	0	0	0	5.685	11.37	**5.685**	**11.37**	14.06%	14.06%
2	Urban	0	0	0	0	29.77	59.54	**29.77**	**59.54**	73.65%	73.65%
TOTAL		**0**	**0**	**0**	**0**	**40.42**	**80.84**	**40.42**	**80.84**		
% OF TOTAL		0	0	0	0	100.00%	100.00%				

Not adjusted for Boundary Roads.

3.3 Horizontal and Vertical Alignment

The changes in direction and elevation of the road are referred to as the horizontal and vertical alignment. The changes in direction should be designed and constructed such that the posted speed limit of the road section may be safely maintained throughout the section. If maintaining the posted speed in safety cannot be achieved, then the horizontal or vertical curve would be identified as substandard.

Lower volume roads that have not been reconstructed, tend to closely follow (or avoid) the existing contours of the land. In southern Ontario, which is relatively flat, there was a greater tendency to follow the alignments of the original Township surveys. However, where these roads were adjacent to larger streams and rivers, there was still a tendency to follow the topography. The result was/is a road alignment that tends to change vertical and horizontal direction frequently; at times without much notice.

When a new road is designed, one of the considerations is the Safe Stopping Distance (SSD). The calculation of the distance to stop safely from any given speed is based upon several factors, such as posted speed limit, reaction times, and friction. When road sections are evaluated for a State of the Infrastructure report, the number of vertical and horizontal curves that appear to be deficient are identified. The identification is based on whether there is sufficient SSD for the posted speed limit. The following table is an excerpt from the Geometric Design Standards for Ontario Highways, and indicates the SSD's required for various design speeds.

Figure 3-1: Safe Stopping Distance

Table C2-1
MINIMUM STOPPING SIGHT DISTANCE ON WET PAVEMENTS

Speed *v*		Perception and Brake Reaction		Coefficient of friction wet pav't	Braking distance on level	S-Min. Stopping sight distance	
Design	Assumed condition	Time	Distance			calculated	rounded
km/h	km/h	s	m	*f*	m	m	m
40	40	2.5	28	0.380	17	45	45
50	50	2.5	35	0.358	27	62	65
60	60	2.5	42	0.337	42	84	85
70	70	2.5	49	0.323	60	109	110
80	79	2.5	55	0.312	79	134	135
90	87	2.5	60	0.304	98	158	160
100	95	2.5	66	0.296	120	186	185
110	102	2.5	71	0.290	141	212	215
120	109	2.5	76	0.283	165	241	245
130*	116	2.5	81	0.279	190	271	275
140*	122	2.5	85	0.277	211	296	300
150*	127	2.5	88	0.273	232	320	320
160*	131	2.5	91	0.269	251	342	345

**Design Speeds above 120 km/h are beyond the normal range of application*

On rural roads, one of the effects of substandard alignments is a decrease in the Average Operating Speed through the road section. An Average Operating Speed that is significantly lower than the posted speed will result in a Geometric Need for the road section. The following table from the *Inventory Manual* identifies the limits that will trigger a geometric need for typical posted speed limits.

Table 3.7: Posted Speed vs. Minimum Tolerable Operating Speed

Item	Speed					
Legal Speed Limit	40	50	60	70	80	90
Minimum Tolerable Operating Speed	35	45	50	60	65	75

The following pictures were not taken in Town of Petrolia, but provide examples of potentially substandard alignments.

Figure 3-2: Potentially Substandard Vertical and Horizontal Alignment

Photos not from Town of Petrolia

Appendix H of this report includes a listing of potentially substandard vertical and horizontal alignment. These sections should be reviewed to ensure signage is compliant with the Ontario Traffic Manual(s)

3.4 Drainage

Adequate drainage is critical to the performance of a road to maximize the life expectancy. Roads are designed, constructed, and maintained in order to minimize the amount of water that may enter, or flow over, the road structure.

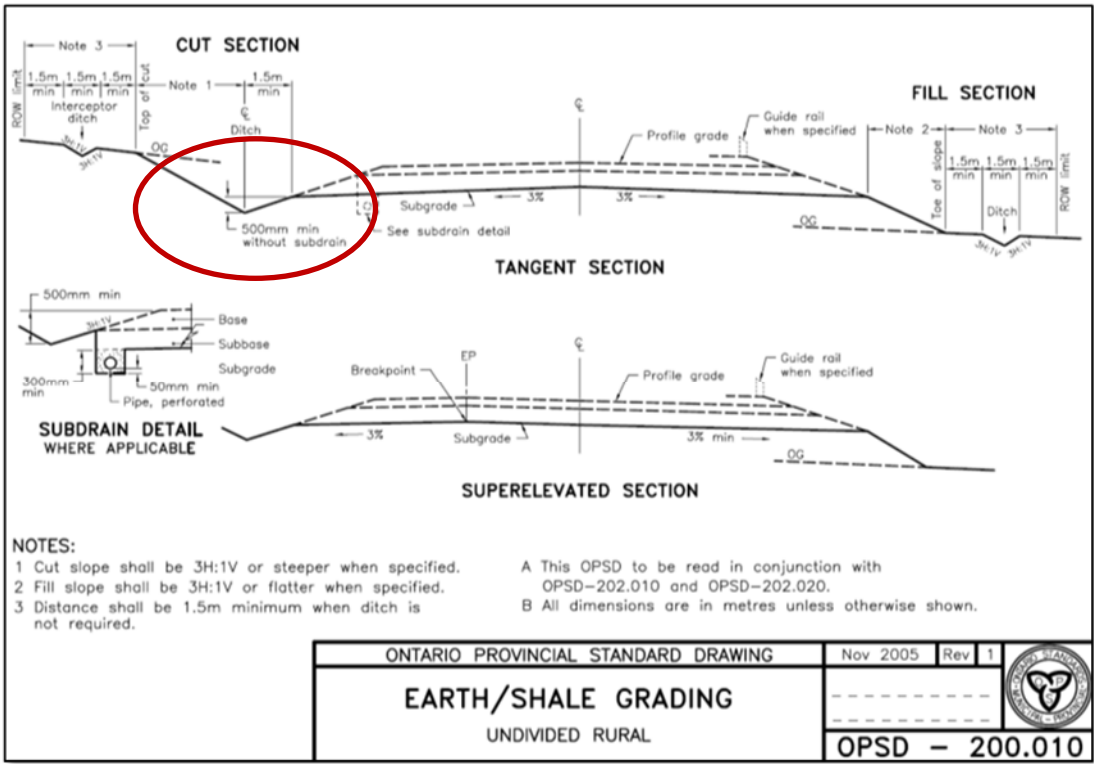
In the case of water flowing over the road, assessment must be made of the circumstances on a site-specific basis. Factors that should be considered include the traffic volumes of the road section, economic impacts to the loss of the use of the road, upgrade costs, and risks. In certain circumstances, water ponds or flows on the road by design, as part of the storm water management plan.

Water in a road base can cause different reactions at different times of the year. In non-freezing conditions, the granular road base can become saturated. Too much water displaces the granular material; it removes the material's ability to support the loads for which it was designed. Too much water in the granular material actually acts like a lubricant and facilitates the displacement of the material under load.

In freezing conditions, water in the road structure can cause frost heave, potholes, and pavement break-up as the water freezes and expands. Generally, a saturated granular road base results in structural failure of the road.

Figure 3-3 provides an example of a rural road, illustrating what the relationship between the gravel road base and the drainage should be. The relationship is the same in an urban system, although not as obvious. Rural road drainage is typically achieved through roadside ditches. Rural road ditches should be a minimum of 500 mm below the granular road base, to ensure that the road base remains free from moisture and maintains its ability to support loads.

Figure 3-3: OPSS 200.10



Urban roads typically have a storm sewer pipe network that carries the minor storm event. The roadway itself is often part of the overland flow route for the major event. The drainage of the granular road base is accomplished through sub-drains installed below the curb and gutter, lower than the lowest elevation of the granular base. This satisfies the same purpose as the ditch in a rural cross-section, by providing an outlet to ensure that the granular base remains dry.

Evaluations of the drainage scores were in part predicated upon the structural score. For example, where a road section had virtually no ditch, or very minimal ditching but the road structure did not show any signs of failure typically observed when there is inadequate drainage, then generally a rating was between 12 and 14 and an 'SD- (Spot drainage) improvement noted. Where it was obvious that the inadequate ditch was exacerbating the distress on the road or there was occasional flooding, the score would be further reduced and the improvement type would be some type of major rehabilitation or reconstruction dependent upon the traffic volumes. Table 3.8 provides an overview of the drainage needs of the road system by Time of Need.

Table 3.8: Drainage by Time of Need

Roadside Environment	Time of Need				TOTAL	% OF TOTAL
	1 to 5	6 to 10	ADEQ	NOW		
Rural	0.677	2.7	1.072	0	**4.45**	11.17%
Semi Urban	1.064	3.317	1.222	0	**5.60**	14.07%
Urban	0.795	0.067	28.609	0.299	**29.77**	74.76%
TOTAL	**2.536**	**6.084**	**30.903**	**0.299**	**39.822**	
% OF TOTAL	6.37%	15.28%	77.60%	0.75%		

Table 3.9: Drainage by Roadside Environment and Drainage Type

Drainage Type	Roadside Environment			TOTAL	% OF TOTAL
	Rural	Semi Urban	Urban		
AS - Adjacent Road, Storm Sewer	0	0.317	0.105	**0.422**	1.06%
DS - Ditch and Storm Sewer	0.375	2.819	0.129	**3.323**	8.34%
N - None	0	0.338	0	**0.338**	0.85%
OD - Open Ditch	4.074	1.707	0	**5.781**	14.52%
SS - Storm Sewer	0	0.422	29.536	**29.958**	75.23%
TOTAL	**4.449**	**5.603**	**29.77**	**39.822**	
% OF TOTAL	11.17%	14.07%	74.76%		

Adjusted for Boundary roads.

Maintenance of the drainage system(s) is critical to the long-term performance of a road system. Low volume rural roads tend to have a winter maintenance program that includes the application of sand to improve traction. Over time, that sand builds up on the edge of the pavement, to a point where it effectively blocks runoff from getting to the ditch. The runoff is trapped at the edge of pavement, where it saturates that area of the road bed, contributing to the early failure of the edge of the pavement. This element of the road cross-section is not scored as part of the overall evaluation.

Presence or absence of roadside berms is not evaluated during a road review. This is a maintenance issue, however, if roadside berms are not removed, the effect on the overall pavement is similar to not having a ditch. Water cannot drain from the road and it enters into the granular base potentially saturating it. The saturated base cannot support load.

Figure 3-4: Shoulder Berm

3.4.1 Drainage Outlet and Master Planning

Correcting drainage issues is not quite as simple as digging a ditch or installing a storm sewer. In Ontario, Common law for drainage is such that water cannot simply be collected and directed. It has to be directed to a legal, adequate outlet. There are two primary methodologies to achieve the legal outlet; a Class Environmental Assessment Process or a petition for a Municipal Drain under the Drainage Act. The 'adequate' component is an engineering function/ assessment.

4 Roads understands that Stormwater Drainage Master Plans have been developed for new developments, but may not exist for some of the older areas of the town, west of Bear Creek. As the reconstruction plans for this area evolve, understanding the requirements for pipe sizing and overland flow routes is required.

3.5 Boundary Roads

Boundary roads, are roads that a municipality would have in common with the abutting municipality. In order to manage the joint responsibilities, a Boundary Road Agreement that identifies the responsibilities of both agencies is created. The agreements are usually in writing; however, some are informal.

The Boundary Road Agreement should identify costs sharing and responsibility arrangements for maintenance or capital works on the road section. From a risk management perspective, the agreement reduces the risk for one of the parties in the event of a claim, depending upon the content of the agreement.

Boundary road reporting can be dealt with in one of two ways: the length can be split to provide a more accurate depiction of the road system that is actually maintained by the agency, or they may not be adjusted. When MTO was providing subsidy, the roads were adjusted for reporting and accounting purposes. For the purposes of this report adjustment has been made to the road system sizes to account for the 50% sharing of the length of the boundary roads.

When a boundary is reconstructed on a day labour basis by the adjacent municipalities, the project should be treated no differently than if the work were being tendered. The exposure to risk for the municipality is no different. Defining

who is the 'contractor' is critical. The assignment of the various aspects of the work should be clear and the timing for completion of the tasks clearly identified and adhered to.

The Town of Petrolia has 1.2 kilometres of boundary roads per Table 3.10.

Table 3.10: Boundary Roads

Adjacent Agency	Asset ID	Street Name	Roadside Environment			TOTAL
			Rural	Semi Urban	Urban	
Township of Enniskillen	751	Discovery Line	0.3	0	0	0.3
Township of Enniskillen	752	Discovery Line	0.45	0	0	0.45
Township of Enniskillen	753	Discovery Line	0.28	0	0	0.28
Township of Enniskillen	754	Discovery Line	0	0.16	0	0.16
TOTAL			**1.03**	**0.16**	**0**	**1.2**
					Adjustment	**0.6**

The status of the boundary road agreements should be reviewed.

4 Road System Condition

Regulation 588/17 requires that;

'3. *For each asset category,*

i. a summary of the assets in the category,

ii. the replacement cost of the assets in the category,

iii. the average age of the assets in the category, determined by assessing the average age of the components of the assets,

iv. the information available on the condition of the assets in the category, and

v. a description of the municipality's approach to assessing the condition of the assets in the category, based on recognized and generally accepted good engineering practices where appropriate.'

Regulation 588/17 also requires that;

'2. The current performance of each asset category, determined in accordance with the performance measures established by the municipality, such as those that would measure energy usage and operating efficiency, and based on data from at most two calendar years prior to the year in which all information required under this section is included in the asset management plan.'

The Town of Petrolia is updating condition and attribute information for the road system in preparation for the 2022 Asset Management Plan required by O.Reg 588/17. The road system was updated in 2012, 2015, 2017, 2019, and in 2021 with this project. The review interval is consistent with the requirements of O.Reg 588/17 since 2015. Regular updates of asset condition are a good asset management practice.

The road section reviews follow the methodology of the Ministry of Transportation Inventory Manual for Municipal Roads, 1991.This ensures that pavement management decision making is based upon current data from field survey information and is completed in accordance with standard engineering practice. The Inventory Manual specifies that gravel roads be evaluated during the spring break-up period. The gravel road reviews were not conducted during the spring break up period

An Asset Management Plan for Core Assets is required by July 1, 2022, based on dated collected no more than 2 years prior to the development of the plan. The 2021 project satisfies the regulation's requirements.

4.1 Road System Condition by Time of Need

The Inventory Manual methodology results in overall rating of road sections by Time of Need (TON); NOW, 1 to 5, 6 to 10, or Adeq (Adequate). Table 4.1 provides a breakdown of the road system by time of Need and MMS Class.

Table 4.1: Roads System by Time of Need and MMS Class

Time of Need	O.Reg 239/02 Classification 5		6		TOTAL		% OF TOTAL	
	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km	Cl km	Ln km
1 to 5	5.928	11.856	1.351	2.702	**7.279**	**14.558**	18.01%	18.01%
6 to 10	2.737	5.474	1.68	3.36	**4.417**	**8.834**	10.93%	10.93%
ADEQ	10.241	20.482	6.861	13.722	**17.102**	**34.204**	42.31%	42.31%
NOW	8.547	17.094	3.075	6.15	**11.622**	**23.244**	28.75%	28.75%
TOTAL	**27.453**	**54.906**	**12.967**	**25.934**	**40.42**	**80.84**		
% OF TOTAL	67.92%	67.92%	32.08%	32.08%				
System Adequacy	68.9%	68.9%	76.3%	76.3%	**71.2%**	**71.2%**		
Good to Very Good	47.3%	47.3%	65.9%	65.9%	**53.2%**	**53.2%**		

Note: Includes all potential Time of Needs elements including Capacity, Drainage, Surface Width, Surface Type, Geometry and Structural Adequacy

4.2 Road System Adequacy

The system adequacy is a measure of the ratio of the 'NOW' needs to the total system, and includes needs from the six critical areas described earlier in the report. The overall TON is the most severe or earliest identified need. For example, a road section may appear to be in good condition, but is identified as a NOW need for capacity, indicating that it requires additional lanes. Similarly, it may be classified as a NOW need for drainage resultant from periodic flooding. Appendix A includes a more detailed description of the Inventory Manual methodology.

Equation 4-1: System Adequacy Calculation

$$\text{System Adequacy} = \frac{\text{Total System (km)} - \text{NOW Deficiencies (km)}}{\text{Total System (km)}} \times 100$$

Based on the current review of the road system, the current system adequacy measure is 71.2% meaning that, 71.2% of the road system is in fair to good to very good condition. The inverse would be that 28.8% of the system is in poor condition. The road system currently measures 40.42 CL-km (unadjusted for boundary roads), with 11.622 CL-km rated as deficient in the 'NOW' time period.

The *Inventory Manual* provides direction that roads with a traffic volume of less than 50 vehicles per day *are deemed to be adequate*, even if they have structural, geometric, or drainage deficiencies that would otherwise be identified as being in a Time of Need. This factor does have an effect of the System Adequacy measure. As such, the System Adequacy, as measured following the Inventory Manual methodology, may not be the public's perception of the system condition.

Originally, the intention was that the low volume roads were to be corrected within the maintenance allocation (as opposed to the capital allocation). Conditional grant funding no longer exists as it did until the mid 1990's.

To gain a more accurate reflection of the condition of the road network, the roads with an AADT of less than 50 have been analyzed and report as follows;

- Section 3895, Mutual Street From the south end to Third St. The length is 0.044km. As such this factor does not have a significant affect on the overall ratings.

One further caveat is that the gravel roads were not reviewed during the spring break-up period as specified by the Inventory Manual. Once spring grading and gravelling have been completed, soft spots and frost boils cannot be assessed. The length of gravel roads in Petrolia is very short, so this does not have a significant effect on the overall condition rating of the system. Andrew St. and the south end of Mutual St. would be 'NOW' needs s they are semi urban roads with a gravel surface. The Inventory Manual methodology deems that semi urban roads are required to be hard topped.

The traditional target adequacy for upper-tier road systems (Regions and Counties) was 75%, while a lower-tier's target adequacy was 60%; a lower tier urban municipality was 70%. Based on these former MTO targets, which were in effect when the municipal grant system was in place, and the merge of the aforementioned system types, 4 Roads recommendation is that the target adequacy for Town of Petrolia should be 60%, as a minimum. The minimum target adequacies were established by MTO, to reflect the nature and purpose of the road system.

The estimates provided in this report for standard improvements are in accordance with the formulae in the *Inventory Manual,* and utilize the unit costs as identified in Table 4.2. These costs include adjustment factors as per the *Inventory Manual*, such as Basic Construction, Terrain, Contingency Roadside Environment, and Engineering.

Table 4.2: Current Unit Costs

Item	Unit	2021 (BMC) Cost ($)	Item	Unit	2021 (BMC) Cost ($)
Excavation	m^3		Manholes	ea	7,500.00
Hot Mix Asphalt	t	135.00	Manhole removed	ea	1,100.00
Single Surface Treatment	m^2	3.25	Manholes-Adjust	ea	750.00
Granular A	t	28.50	Catch Basins	ea	2,500.00
Granular B	t	27.00	Catch-Basins- Removed	ea	810.00
Granular M (Maintenance Gravelling)	t		Catch Basin Leads	linear m	160.00
Conc Base	m^3		Catch Basins – Adjust	ea	950.00
Conc- Curb and Gutter-place	linear m	45.00	Asphalt Planing	m^2	7.00
Conc- Curb and Gutter-removal	linear m		Asphalt Pulverizing	m^2	3.00
Subdrains	linear m	21.00	Crack Sealing	lm	2.00
Storm Sewer-525mm	linear m	420.00	Slurry		3.00
Microsurfacing	m^2	3.50			

The Town provided current unit costs that were available. Where unit costs were not available, 4 Roads provided costs utilized on other current projects.

4.3 Record of Assumptions –TON, Improvement and Replacement Costs

The methodology of this report is such that the Inventory Manual itself forms the basis of a large number of assumptions in terms of;

- Dimensional requirements for the development of improvement and replacement costs
- Structural requirements based on road classification
- Time of needs based on the ratings and subsequent calculations

Deterioration assumptions effect of treatments on the asset are included in Appendix C.

With respect to the urban or semi urban cross sections, where there were sewers, it was generally assumed that the storm sewers were adequate. The resultant improvement type of those sections would then be RNS – Reconstruction Nominal Sewers. With respect to some semi urban sections the recommendations were also RNS as it appeared that the short length of a section could be adequately drained via curb and gutter to a storm sewer on an adjacent sewer.

Table 4.3: Improvement Costs by Improvement Type and Time of Need

Improvement Class	Improvement ID/Desc		Time of Need								TOTAL		% OF TOTAL	
			1 to 5		6 to 10		ADEQ		NOW					
			Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km
Const	BS	Base and Surface	-	0	-	0	20,622	0.044	-	0	**20,622**	**0.044**	0.11%	0.11%
Const	NONE	No Improvement Required	-	0	-	0	-	13.355	-	0.085	**0**	**13.44**		33.75%
Const	REC	Reconstruction - Rural	930,812	1.149	141,388	0.164	-	0	2,129,040	2.273	**3201241**	**3.586**	0.1785	9.01%
Const	RNS	Reconstruction Nominal Storm Sewer	1,174,206	0.922	229,293	0.313	-	0	7,267,747	6.686	**8,671,246**	**7.921**	48.34%	19.89%
Maint	CRK	Crack Sealing	-	0	-	0	5,678	2.839	-	0	**5,678**	**2.839**	0.03%	7.13%
Maint	SD	Spot Drainage	-	0	1,433	0.796	117	0.065	-	0	**1,550**	**0.861**	0.01%	2.16%
Maint	SR	Spot Repairs	-	0	10,000	0.123	20,000	0.692	-	0	**30,000**	**0.815**	0.17%	2.05%
Rehab	PR2	Pulverize and Resurface 2 - 100mm	184,560	0.489	60,405	0.082	-	0	402,322	0.767	**647,287**	**1.338**	3.61%	3.36%
Rehab	R1	Basic Resurfacing 1 - 50mm	132,821	0.332	958,384	2.857	-	0	-	0	**1,091,205**	**3.189**	6.08%	8.01%
Rehab	R2Urehab	Urban HCB Rehabilitation	3,250,108	4.387	-	0	78,527	0.107	938,941	1.295	**4,267,576**	**5.789**	23.79%	14.54%
TOTAL			**5,672,507**	**7.279**	**1,400,903**	**4.335**	**124,944**	**17.102**	**10,738,050**	**11.106**	**17,936,403**	**39.822**		
% OF TOTAL			31.63%	18.28%	7.81%	10.89%	0.70%	42.95%	59.87%	27.89%				

Table 4.4: Improvement Needs by Roadside Environment

Improvement Class	Improvement ID / Description		Roadside Environment						TOTAL		% OF TOTAL		Cost / km ($)
			Rural		Semi Urban		Urban						
			Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	Imp. Cost	Cl-km	
Const	BS	Base and Surface	0	0	20,622	0.044	0	0	20,622	0.044	0.11%	0.11%	468,682
Const	NONE	No Improvement Required	0	0	0	0.069	0	13.371	0	13.44		33.75%	-
Const	REC	Reconstruction - Rural	1931669	1.979	1269571	1.607	0	0	3201241	3.586	0.1785	9.01%	892,705
Const	RNS	Reconstruction Nominal Storm Sewer	328,155	0.375	1,947,788	2.626	6395304	4.92	8,671,246	7.921	48.34%	19.89%	1,094,716
Maint	CRK	Crack Sealing	384	0.192	190	0.095	5,104	2.552	5,678	2.839	0.03%	7.13%	2,000
Maint	SD	Spot Drainage	1181	0.656	369	0.205	0	0	1,550	0.861	0.01%	2.16%	1,800
Maint	SR	Spot Repairs	0	0	0	0	30,000	0.815	30,000	0.815	0.17%	2.05%	36,810
Rehab	PR2	Pulverize and Resurface 2 - 100mm	319,043	0.517	328244	0.821	0	0	647,287	1.338	3.61%	3.36%	483,772
Rehab	R1	Basic Resurfacing 1 - 50mm	142,753	0.73	0	0	948452	2.459	1,091,205	3.189	6.08%	8.01%	342,178
Rehab	R2Urehab	Urban HCB Rehabilitation	0	0	69365	0.136	4,198,210	5.653	4,267,576	5.789	23.79%	14.54%	737,187
TOTAL			**2,723,185**	**4.449**	**3,636,149**	**5.603**	**11,577,070**	**29.77**	**17,936,403**	**39.822**			
% OF TOTAL			15.18%	11.17%	20.27%	14.07%	64.55%	74.76%					

5 Replacement Cost Valuation

Program funding recommendations are a function of the dimensional information, surface type, roadside environment, and functional class of the individual assets. Recommended funding for the road system should include sufficient capital expenditures that would allow for the replacement of infrastructure as the end of design life is approached, in addition to sufficient funding for maintenance, to ensure that that full life expectancy may be realized.

Budgetary recommendations in this report do not include items related to development and growth or roads under another road authority's jurisdiction. The Town should consider those items as additional to the recommendations in this report. Generally, that type of improvement or expansion to the system would be funded from a different source, such as Development Charges.

The budget recommendations bear a direct relationship to the value of the road system. 4 Roads estimates the cost to replace the road system, to the current standard, at **$47,498,000**. This estimate is based on the municipality's unit costs using the standardized formulae in the Inventory Manual. The current estimated value of the road system is $39,752,800.

Unit costs should be reviewed and adjusted annually. Unit cost changes impact funding requirements directly.

Table 5.1: Replacement Cost by Functional Classification (Inventory Manual)

Functional Classification	Lanes	Roadside Environment						TOTAL		% OF TOTAL		Cost /km ($)
		Rural		Semi Urban		Urban						
		Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	
200	2	160,586	0.192	0	0	0	0	**160,586**	**0.192**	0.34%	0.48%	836,385
400	2	3,352,188	3.423	0	0	0	0	**3,352,188**	**3.423**	7.06%	8.47%	979,313
500	2	1,008,692	1.02	0	0	0	0	**1,008,692**	**1.02**	2.12%	2.52%	988,914
ALL	2	0	0	68361	0.391	0	0	**68,361**	**0.391**	0.14%	0.97%	174,836
L/R	2	721,380	0.33	2322081	3.3	37354636	29.167	**40,398,097**	**32.797**	85.05%	81.14%	1,231,762
LCI	2	0	0	1682723	1.994	827401	0.603	**2,510,124**	**2.597**	5.28%	6.43%	966,548
TOTAL		**5,242,846**	**4.965**	**4,073,165**	**5.685**	**38,182,037**	**29.77**	**47,498,048**	**40.42**			
% OF TOTAL		11.04%	12.28%	8.58%	14.06%	80.39%	73.65%					

Replacement costs for urban roads do not include storm sewers

Table 5.2: Replacement Cost by Performance Model Asset Class

Asset Class for Performance Modelling	Roadside Environment						TOTAL		% OF TOTAL		Cost / km ($)
	Rural		Semi Urban		Urban						
	Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	Repl. Cost	CI-km	
CON-U	0	0	0	0	3,616,832	2.791	**3,616,832**	**2.791**	7.61%	6.90%	1,295,891
GST1-S	0	0	124,542	0.159	0	0	**124,542**	**0.159**	0.26%	0.39%	783,283
HCB3-U	0	0	0	0	8,781,668	6.752	**8,781,668**	**6.752**	18.49%	16.70%	1,300,602
HCB4-R	2,355,754	2.046	0	0	0	0	**2,355,754**	**2.046**	4.96%	5.06%	1,151,395
HCB4-S	0	0	2,286,749	3.153	0	0	**2,286,749**	**3.153**	4.81%	7.80%	725,261
HCB4-U	0	0	0	0	25,521,071	20.019	**25,521,071**	**20.019**	53.73%	49.53%	1,274,842
LCB1-R	2,887,092	2.919	0	0	0	0	**2,887,092**	**2.919**	6.08%	7.22%	989,069
LCB1-S	0	0	1,661,874	2.373	0	0	**1,661,874**	**2.373**	3.50%	5.87%	700,326
LCB1-U	0	0	0	0	262,466	0.208	**262,466**	**0.208**	0.55%	0.51%	1,261,856
TOTAL	**5,242,846**	**4.965**	**4,073,165**	**5.685**	**38,182,037**	**29.77**	**47,498,048**	**40.42**			
% OF TOTAL	11.04%	12.28%	8.58%	14.06%	80.39%	73.65%					

Replacement costs for urban roads do not include storm sewers

6 Asset Condition Assessment and Plan Updates

6.1 Condition Assessment Cycle Recommendation

Regulation 588/17 requires that condition information be current within 2 years of the preparation of the Asset Management Plan for core assets required for July 1, 2022.

This project would make the municipality compliant for the condition of the road system with respect to the preparation of an Asset Management Plan for 2022.

The road system was updated in 2012, 2015, 2017, 2019, and in 2021 with this project. The review interval is consistent with the requirements of O.Reg 588/17 since 2015. Regular updates of asset condition are a good asset management practice.

The current condition rating for the asset meets the requirements of O.Reg 588/17; the program development is based upon data that is *'based on data from at most the two calendar years prior to the year.'*

7 Level of Service (LOS)

As noted in Section 4 of this report, road system condition and Level of Service (LOS) measures are inextricably linked, and for that reason, some of the measures are shown in both areas of this report. For roads, as with most assets, a single measure for condition or level of service may not provide a complete or accurate view of the performance of an asset group.

Level of Service has a different meaning for different interests. For instance, the cost per unit may not have an impact to a ratepayer whose chief concern may be actual service delivery itself. Similarly, cost or expenditure per unit may not illustrate the condition of the asset to the end user.

Regulatory compliance with Regulation 239/02 may also be considered a level of service. The regulation provides for correction/resolution to identified defects with specified time periods dependent upon posted speed limit and traffic count.

4 Roads believes that multiple service measures may be required to adequately relate the condition of an asset to the various user groups; condition, operating costs, and end user. The following sections identify various measurements of service of the road system.

Regulation 588/17, Asset Management Planning for Municipal Infrastructure, requires that hard topped surfaces be rated using a Pavement Condition Index (PCI). The regulation is non-specific as to the PCI methodology. Table 4 from the regulation is shown below.

Table 7.1: Regulation 588/17, Table 4

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)
Scope	Description, which may include maps, of the road network in the municipality and its level of connectivity.	Number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality.
Quality	Description or images that illustrate the different levels of road class pavement condition.	1. For paved roads in the municipality, the average pavement condition index value. 2. For unpaved roads in the municipality, the average surface condition (e.g. excellent, good, fair or poor).

From **ASTM 6433**, Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys;

> *2.1.4 pavement condition index (PCI)—a numerical rating of the pavement condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best possible condition.*
>
> *4.1 The PCI is a numerical indicator that rates the surface condition of the pavement. The PCI provides a measure of the present condition of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety). The PCI cannot measure structural capacity nor does it provide direct measurement of skid resistance or roughness. It provides an objective and rational basis for determining maintenance and repair needs and priorities. Continuous monitoring of the PCI is used to establish the rate of pavement deterioration, which permits early identification of major rehabilitation needs. The PCI provides feedback on pavement performance for validation or improvement of current pavement design and maintenance procedures.*

There is also a significant difference in the weighting of ride in the PCI measure. In some of the MTO methodologies it is significantly weighted whereas, for example, in ASTM 6433, ride is rated indirectly on four of nineteen distresses. In the Inventory Manual methodology, 'ride' (Surface Condition) is not a trigger for any improvement or time of need. Further, there is not necessarily a relationship between ride and distress.

In WorkTech, Physical Condition is the Structural Adequacy multiplied by 5 to produce a score from 5 to 100; effectively a PCI by definition.

There a number of PCI methodologies in use in Ontario.

The different methodologies can produce a different 'PCI' for the same section of road. As such, it is critical for an agency to understand the methodology used, and trigger points for treatments. There is further explanation of this concept in Appendix C of this report.

A PCI is one type of measure for level of service.

7.1 Current Level of Service Measurement

7.1.1 System Adequacy

System Adequacy was discussed earlier in the report as a measure of the condition of the road system. It also represents a level of service measure. The current system adequacy is 71.2% indicating that 71.2% of the system is in fair to good to excellent condition. The inverse is that 28.8% of the road system is in poor condition.

- The System Adequacy is above the target established by the Ministry of Transportation when condition road funding was provided to municipalities. The Town is a lower tier rural and small urban municipality. 4 Roads is recommending a target system adequacy of 60.
- Gravel roads were not reviewed during the spring break-up period.

All Level of Service / Condition measures consider that the 2021 program was completed.

The above comments would be applicable to all Level of Service condition measures.

7.1.2 Physical Condition

The Physical Condition is an alternate method of describing the condition of a road section or the average condition of the road system. By the ASTM definition, it is a Pavement Condition Index (PCI). The value is the structural adequacy converted to be expressed as a value out of 100, instead of 20. This methodology lends itself to modeling and comparators that may be more easily understood. There isn't a 1:1 relationship between the weighted average physical condition and the system adequacy.

The Weighted Average Physical Condition of the road system is currently 60.81.

4 Roads' recommendation is that the weighted average Physical Condition be at 70 or above.

7.1.3 Good to Very Good Roads

It has been assumed that the 6-10 and adequate roads are good to very good and this has been expressed as a percentage of the system. Good to Very Good roads represent 53.9% of the road system based on CL-km and the Structural Adequacy measure. If all 6 measures are included, the good to very good roads would be 53.2%.

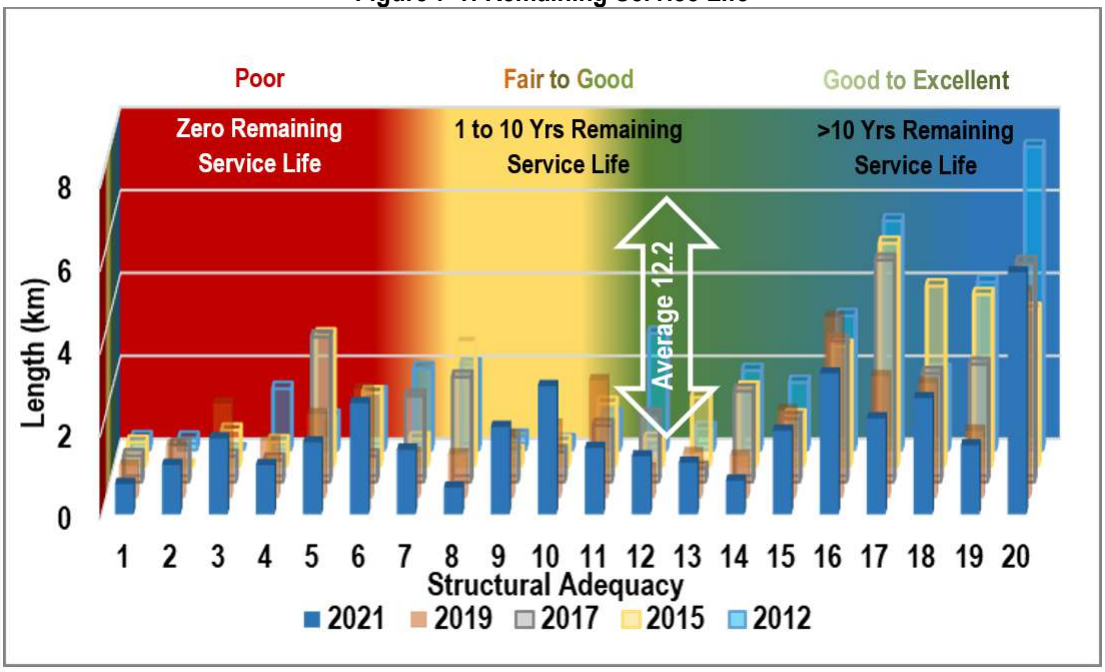
4 Roads recommendation is that Good to Very Good roads be at 60% or higher.

7.1.4 Estimated Remaining Service Life

As indicated previously, the Time of Need is really a prediction model in terms of an estimate based on current condition to the time for reconstruction. The TON then also provides an estimate of the remaining life in the road system/section. The following figure summarizes the structural adequacy ratings of the road system and illustrates the estimated remaining service life of the road system.

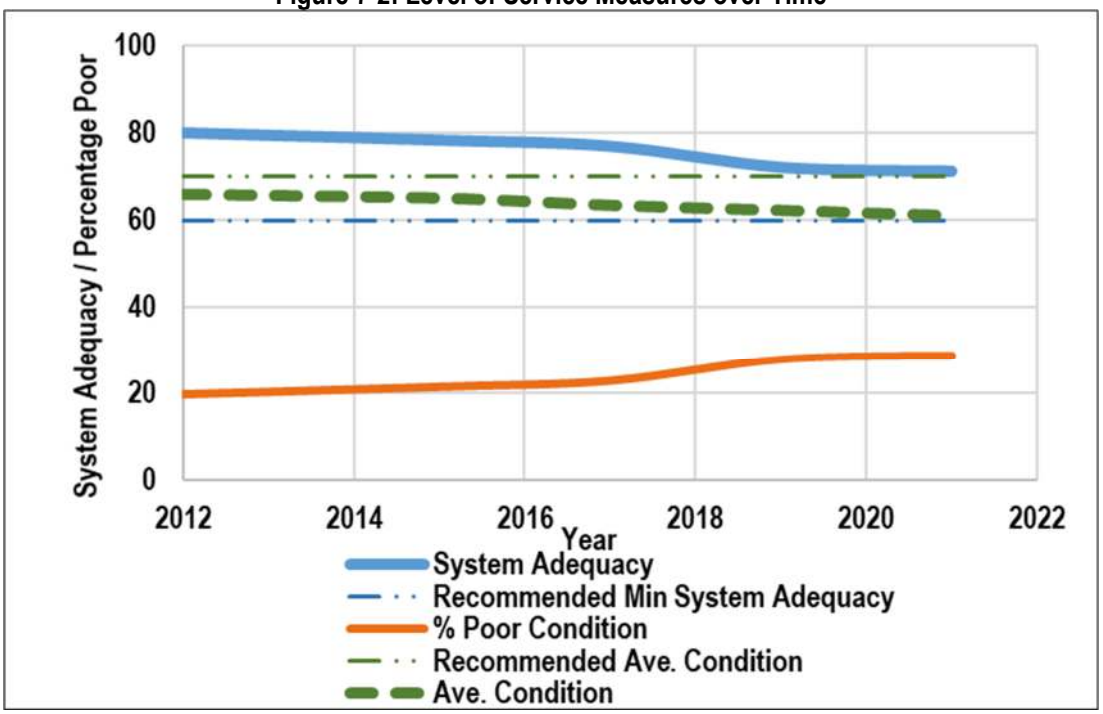
Based on the current weighted average physical condition, the entire system would have approximately 14 years until it reached the poor designation if no further expenditures were made.

Figure 7-1: Remaining Service Life



Note: Physical Condition is Structural Adequacy multiplied by 5; Average is 60.8; recommended 70 or greater

Figure 7-2: Level of Service Measures over Time



7.1.5 Capacity

The *Inventory Manual* methodology includes a calculation to determine if there is potential for a capacity problem on road assets. The calculation is based on a number of data fields in the database including but not limited to AADT, pavement width, shoulder width, terrain, and the number of entrances.

The Town of Petrolia does not appear to have any potential capacity issues. Item 94 in the Inventory Manual addresses the capacity calculation and guidance for developing an appropriate recommendation.

7.1.6 Regulation 588/17 Level of Service Measures

Regulation 588/17 came into effect December 27, 2017, and provides different service measures dependent upon asset type.

Table 7.2: Regulation 588/17 Level of Service Measures for Roads

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)	Level of Services Measure for Roads
Scope	Description, which may include maps, of the road network in the municipality and its level of connectivity.	Number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality. **12.68** sq. km	Arterial Roads = **0%** Collector Roads = **0%** Local Roads = **637.5%**
	Description or images that illustrate the different levels of road class pavement condition.	1. For paved roads in the municipality, the average pavement condition index value. 2. For unpaved roads in the municipality, the average surface condition (e.g. excellent, good, fair or poor).	Weighted Average Overall road condition is **60.8** Weighted average paved road condition is **60.8** Weighted average gravel road condition is **40.0.**

8 Asset Management Strategy

8.1 Asset Management Definition

Asset management has almost as many definitions as there are agencies that manage assets.

In 1999, the Transportation Association of Canada adopted a definition prepared by the U.S. Department of Transportation

> *'Asset Management is a framework for making cost effective resource allocation, programming and management decisions. It combines engineering principles with sound business practices and economic theory, and provides tools to facilitate a more organized, logical and comprehensive approach to decision making.'*

This definition may be applied to any asset.

Regardless of the source of the definition, the key themes that keep being repeated are;

- Managing
- Strategic
- Effective
- Efficient
- $$$$$!!
- Service
- Optimizing asset life cycle
- Risk Management

8.1.1 Asset Management and PSAB

Asset Management and PSAB both address tangible capital assets – but from completely different perspectives.

From a very simplistic perspective, PSAB 3150 establishes standards on how to account for and report tangible capital assets in government financial statements. It deals with the historic costs and amortization. Financial reporting is a requirement of the Municipal Act, 2001.

Asset management deals with the same assets but from a current and future planning perspective. Asset management is a requirement of O.Reg 588/17 Asset Management Planning for Municipal Infrastructure, made under the Infrastructure for Jobs and Prosperity Act, 2015.

8.2 Asset Management Systems

Asset Management software alone *is not* an asset management system.

ISO is the International Organization for Standardization. The following excerpt is from ISO 55001;

> *'An asset management system is a set of interrelated and interacting elements of an organization, whose function is to establish the asset management policy and asset management objectives, and the processes, needed to achieve those objectives. In this context, the elements of the asset management system should be viewed as a set of tools, including policies, plans, business processes and information systems which are integrated to give assurance that the asset management activities will be delivered.'*

An agency managing assets has to have 'rules of engagement' to ensure the asset management system functions as intended and there is a reproducibility of results.

The level of granularity of the rules begins with issues as simple as what constitutes a valid entry code for a data field, how assets are created and defined or how the unit costs are developed. Is it defensible and repeatable?

ISO 55000, 55001, and 55002 are all asset management related and speak in detail to asset management and asset management systems.

8.3 Asset Management Goal

As an absolute minimum, the objective of any asset management plan, or strategy, should be to ensure that the overall condition of an asset group does not diminish over time. This objective is also a requirement of Regulation 588/17 for the asset management plans that are due July 1, 2022.

The outcome of an asset management strategy is heavily predicated, and inextricably linked to the available funding and project selection. Funding has to be adequate to sustain the asset group. For most municipalities this is a significant challenge. Project selection and program development are optimized through selection of treatments with the best Return on Investment (ROI), applied at the right time/condition.

8.3.1 Asset Management Plan (AMP) and O.Reg 588/17

On December 27, 2017, the Province of Ontario filed Regulation 588/17, Asset Management Planning for Municipal Infrastructure. The regulation provides the province's requirements for scope and content for a municipal asset management plan. Regulatory Compliance is required for a successful application for a conditional grant for municipal infrastructure projects.

Table 8.1: Municipal Asset Management Plan Implementation Schedule (from MOI later dated May 31, 2019

Date	Milestone
July 1, 2019	Date for municipalities to have a finalized strategic asset management policy that promotes best practices and links asset management planning with budgeting, operations, maintenance and other municipal planning activities.
July 1, 2021	Date for municipalities to have an approved asset management plan for core assets (roads, bridges and culverts, water, wastewater and stormwater management systems) that identifies current levels of service and the cost of maintaining those levels of service.
July 1, 2023	Date for municipalities to have an approved asset management plan for all municipal infrastructure assets that identifies current levels of service and the cost of maintaining those levels of service.
July 1, 2024	Date for municipalities to have an approved asset management plan for all municipal infrastructure assets that builds upon the requirements set out in 2023. This includes an identification of proposed levels of service, what activities will be required to meet proposed levels of service, and a strategy to fund these activities.

The Milestone date for the Asset Management Plan for Core Assets was subsequently revised to be July 1, 2022

The regulation is a complex document and should be reviewed in detail by municipalities as soon as possible.

Although the timelines appear to be reasonable, once the requirements for content of the Strategic Asset Management Policy are reviewed, it will be obvious that there should be significant understanding of the asset groups at the time of preparation of the policy as there are potentially significant budget implications, particularly if the asset groups are not at a reasonable average condition currently and/or are underfunded.

Section 11.8.1 includes further discussion on the Regulatory requirements with respect to work plan development.

8.3.2 AMP Funding Level Development

The development of an appropriate asset management plan, may be a daunting task for municipalities. An AMP for the primary assets is a requirement of O.Reg 588/17.

The AMP development will be particularly daunting.

To be clear, <u>the current budget does not define or limit the AMP</u>. The funding level is driven by the assets, their condition and lifecycle costs and required lifecycle activities – not the current budget. The budget should be determined by the requirements of the lifecycle activities of the assets.

AMP's that are developed to match current budgets- if underfunded- will result in failure and non compliance with O.Reg 588/17.

Section 11 of this report provides recommendations for funding levels for long term sustainability and programs.

Most agencies are not fully funded, and a large number are not even funded sufficiently as to maintain the current condition of their system. In those circumstances, the strategy should be twofold:

- Focus should be on a pavement management strategy that utilizes available funding on preservation and resurfacing programs as a priority. Reconstruction and replacement candidates will remain reconstruction and replacement candidates and cost increases will be incremental with inflation. Preservation and resurfacing opportunities that are missed will escalate in cost by several hundred percent depending on site specifics.
- Develop the financial plan in order that there is sufficient funding to maintain the condition of the road system through prioritizing preservation and rehabilitation treatments.

The current funding level for Town of Petrolia appears to be sufficient to sustain the road system.

The caveat being that the model assumes that the recommended program will be adhered to and deterioration will be as predicted. Further, there will be some road sections in poor condition that will not be addressed in the program.

8.4 Priority Rating vs. Condition Rating

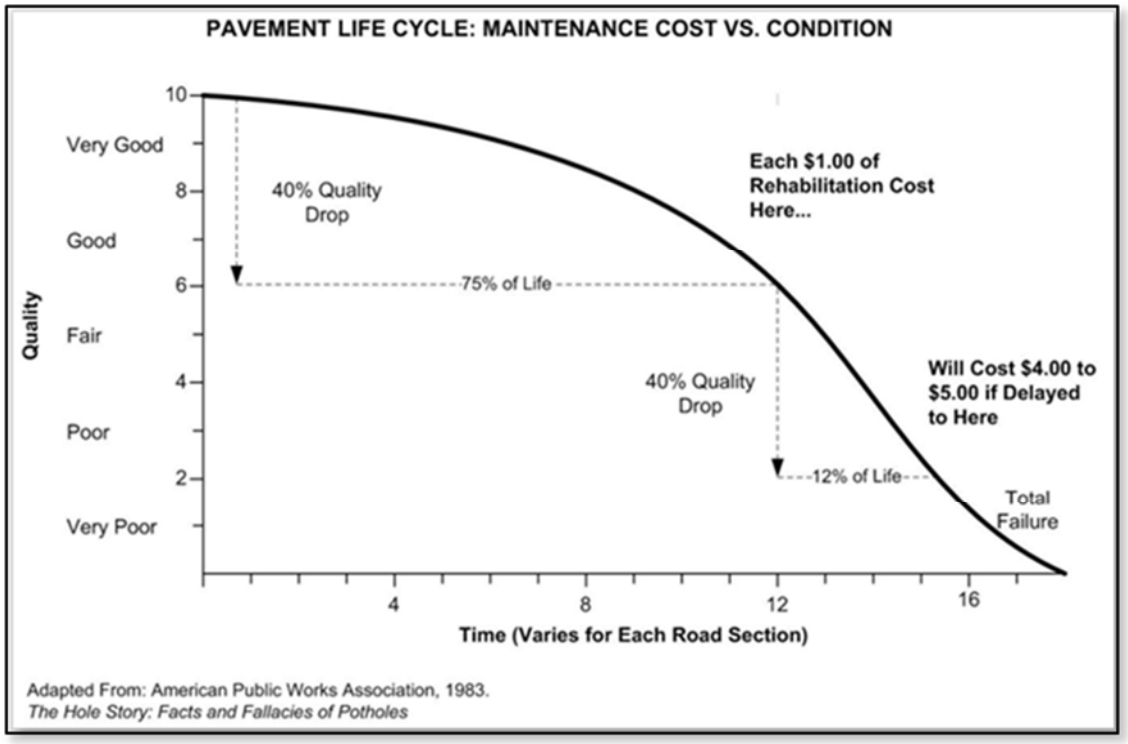
Information in a database may be sorted and analyzed in numerous ways. Understanding what the information in a data field represents, is key to the analysis. The Inventory Manual has many rated and calculated data fields and thus provides for many ways to sort data. Some commonly used representations, or sorting of information, from the database include:

- Priority Rating
- Priority Guide Number
- Structural Adequacy (Condition)

Priority Rating is a calculated field in the Inventory Manual, and is a function of the traffic count and the overall condition rating of the road section, which includes ratings for width, curves, drainage etc…. This approach adds weight to the traffic count of the section; a higher volume road in poorer condition will have a higher priority number. Although the word 'priority' is included in the field name, a road section that has a higher calculated 'Priority Rating' is *not* necessarily a higher priority in the broader sense of asset management.

Similarly, a municipality may choose to sort the road sections based on condition and cost per vehicle. The Priority Guide Number data field would assist in providing that analysis, as sorting on that parameter would prioritize road sections that have higher traffic and thus a lower cost per vehicle.

Figure 8-1: Treatment Cost vs. Deterioration



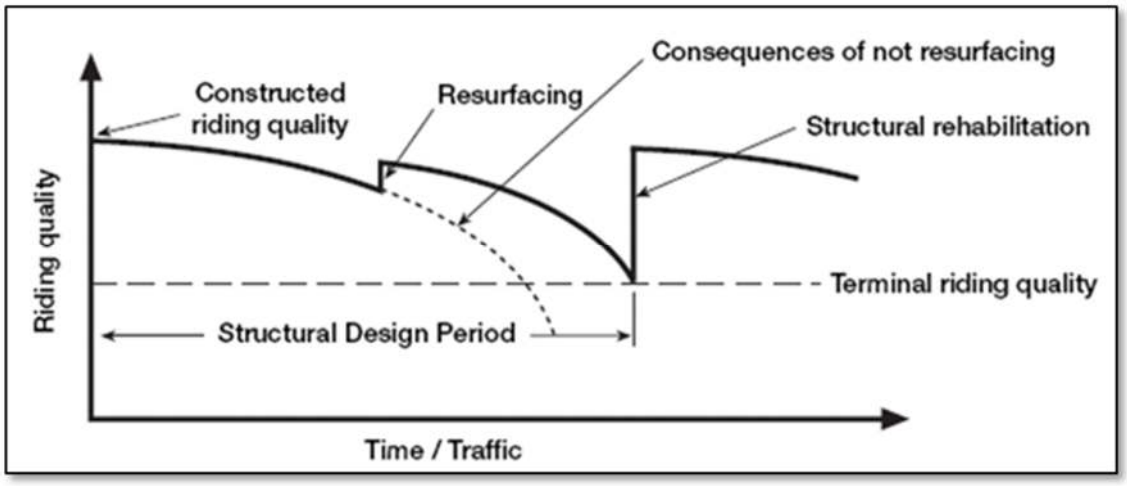
Developing a road capital program around the Priority Rating or Priority Guide Number fields will result in programming that would lead to a less efficient expenditure of funds and reduced system performance per budget dollar, as road sections with high traffic and in poor condition would be selected first, as opposed to selecting the best rehabilitation candidates at the appropriate time in their life cycles. The exception to this statement would be cases where rehabilitation funding is at a high enough level to ensure that the preservation program requirements can be met.

To paraphrase Regulation 588/17, program development is to be based on selecting the lowest cost lifecycle activities that will maintain the condition of the system over a 10 year period.

From a more current asset management perspective, project selection should be predicated by condition (Structural Adequacy, PCI or PQI) depending on agency. Figure 8-2 clearly illustrates the financial advantages of managing the road system by performing the right treatment at the right time of the asset life cycle. If appropriate strategies are not undertaken at the correct time, available funding usage is less effective.

Ideally, if a road is constructed and maintained with timely appropriate maintenance and resurfacing, the road system will reach a point where the majority of the activities will be preservation and resurfacing. Figure 8-2 clearly illustrates the effect the life span of a pavement by applying the correct treatment at the correction time in the life cycle.

Figure 8-2: Pavement Management- The Right Treatment at the Right Time



Source: Wirtgen Cold Recycling Manual

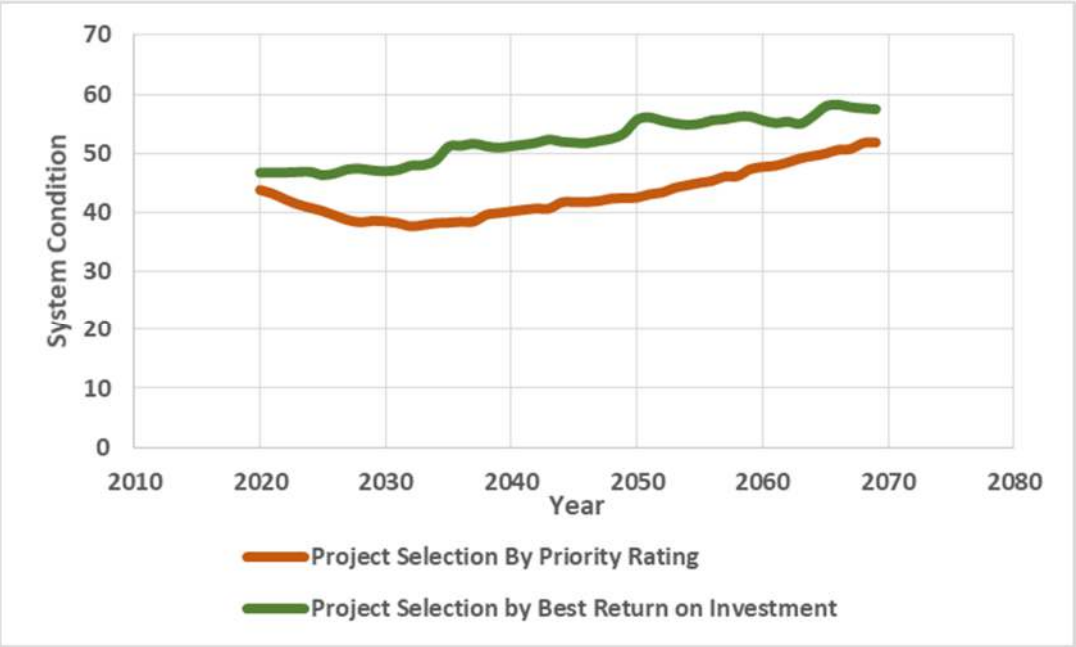
If an agency's budget is fully funded, the programming will include reconstruction, resurfacing, and preservation programs. Prioritization within the different programs will vary as demands are different. However, within the resurfacing and preservation programs, the pavement condition should drive the decision making.

Figure 8-3 illustrates the difference in system performance over time where best Return on Investment drives the project selection rather than worst first. The model is not for the Town of Petrolia system; however, it illustrates the point. When available funding is limited, treatment / project selection is critical. Prioritizing worst first projects will result in a considerably poorer performance of the road system over time.

The green line is system performance based on a best return on investment project selection and the orange line is the system performance based on the priority number. (The priority number is a function of condition and traffic – a poor condition road with high traffic would generate a higher priority number.) The differences in performance are more dramatic when annual budgets are minimal.

Where funding is limited, resurfacing and preservation programs should be prioritized over the construction program. The effect of this approach will be that 'NOW' need roads will remain 'NOW' needs. However, by virtue of their 'NOW' need condition, 'NOW' need roads will require increased maintenance and likely generate increased complaints from the driving public. To deal with this eventuality, a municipality should create a **'maintenance paving budget'**, over and above the resurfacing budget. The purpose of this budget is to defer the reconstruction needs and reduce maintenance efforts and complaints until the road can be reconstructed.

Figure 8-3: System Performance –Worst First (Priority #) vs Best ROI



Note: Example not from the Town of Petrolia road system data

8.5 Optimal Programming and Network Condition

Section 7.1.2 of this report provides information on the current weighted average physical condition of the road system. Figure 8-4 from the Transportation Association of Canada's Pavement Asset Design and Management Guide provides a visual representation of various measures of road network and individual section performance.

4 Roads has recommended that the weighted average Physical Condition of the Network be a minimum of 70. Figure 8-4 supports that recommendation based on the following analysis. Using the Inventory Manual methodology, the trigger for pavement rehabilitation is a Structural Adequacy of 14, which is a Physical Condition of 70. From the graph, the average network condition should be higher than the trigger value for network rehabilitation; supporting 4 Roads recommendation that the weighted average Physical Condition be greater than 70.

Figure 8-4: Service Levels and Triggers for Pavement Improvements

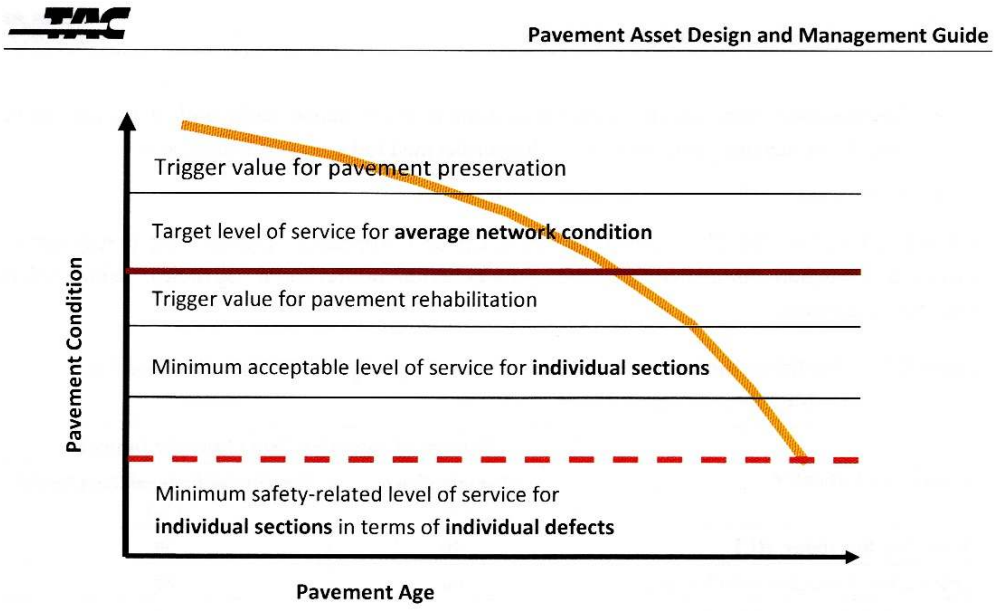


Figure 5.3 – Types of Service Levels and Trigger Levels for Pavements [Adapted from FCM 2003]

8.6 Cross Asset Integration and Project Prioritization

Prioritizing projects from a purely asset management perspective is a relatively straightforward exercise, regardless of funding level. Complications arise when the specific needs, commitments of the agency, and priorities of other utilities factor into the decision making process.

The road system is, in reality, a utility corridor. Multiple utilities in both urban and rural roadside environments will present conflicting demands and priorities in advancing projects. The State of the Infrastructure provides ratings that deal strictly with the condition of various factors as they relate to the road section. Those factors have to be considered in conjunction with needs and priorities that may exist for other utilities or pending development. In fact, the condition of other infrastructure within the road allowance may be the key element in the prioritization. For example, a road rated as a reconstruction project may have a relatively low priority rating, but a trunk storm sewer servicing a greater area may require immediate installation. The priority of the road is then dictated by the other utility, and should be integrated into the capital plan, to best serve all interests. To some extent, this is the circumstance in Petrolia.

Less tangible priorities may also be project prioritization tools for some agencies. For example, an agency may want to advance projects that also include bus routes or bike lanes.

As a municipal road program is developed, opportunities to complete work on smaller sections adjacent to the main project, at a lesser cost than if completed as a stand-alone project, should be considered to realize economies of scale, and complete improvements that may otherwise be passed over.

The caveat to this discussion is the requirement of Regulation 588/17 that the overall system condition be maintained.

8.7 Gravel Roads Management Strategy

Town of Petrolia has a small gravel road system of 0.159 centre line kilometres (0.4% of the system). The budget recommendation is approximately $1,950 annually, for the materials only (Placed on the site) and includes maintenance gravel and road base upgrades. This would place 75mm (3 inches) every 3 years.

The foregoing is a typical recommendation to municipalities that have rural gravel roads as part of their system.

In Petrolia's circumstances, there are 2 gravel roads sections with a semi urban cross section. From the Inventory Manual methodology, semi urban or urban roads should have a hard surface; either surface treatment or hot mix. Further, both of Petrolia's gravel road sections have other defects, such as drainage and pavement structure. The recommendation would be to reconstruct both sections to an urban standard.

The remaining discussion in this section is provided for information regarding gravel road systems, and given the foregoing paragraph, not really relevant to Petrolia.

Proper maintenance of a gravel road surface is deceptively expensive. Costs include gravel, dust control, and grading. Frequently, budget analysis proves that the per-kilometre cost of gravel road maintenance is greater than the per-kilometre cost for hard top maintenance. For this reason, conversion of gravel surface roads to hard top roads generally proves to make economic sense and improves user satisfaction.

Road agencies in both Canada and the United States, have conducted studies that have generally indicated that, dependent upon local unit costs, gravel road conversion to hardtop, can be a cost-effective strategy. One source indicates that this may be effective management for roads with traffic volumes as low as 100 AADT.

Appendix D of this report includes additional information on gravel road conversions including a flow chart to illustrate the decision matrix for conversion. Benefits to converting a gravel road include:

- Customer satisfaction
- Reduced maintenance costs for routine maintenance
- Reduced maintenance costs for winter maintenance

Appendix D of this reports identifies a criteria for selection of potential gravel road conversion candidates. Gravel roads were not reviewed during the spring break-up.

Gravel road conversion to hard top over time is the recommended strategy.

8.8 Gravel Resurfacing Program Analysis

Gravel roads can be deceptively expensive to manage and maintain.

Gravel roads tend to be the 'forgotten' asset. Gravel roads form an integral component of the road asset group for a large number of municipalities and should be managed as any other asset.

Most aspects of municipal service delivery are in fact an asset management decision. The decision whether to surface treat a road, or have the road remain as a gravel surface, is very much an asset management decision.

This report provides a recommended annual cost for gravel road maintenance of 75mm additional gravel to be added every three years, and does not included regular grading or dust control costs. The additional 75mm of gravel was a typical standard that was used in the past by many municipalities. Due to the natural life cycle wear and tear, maintenance, and winter control activities, gravel roads require additional gravel on a regular basis to ensure continuing performance.

One of the difficulties in determining the deterioration of a gravel road is that the wearing surface and the granular layers are one and the same, so the extent of deterioration may not be as obvious until the deterioration is significant. Appropriate gravel road maintenance can be deceptively expensive. Frequently, high level budget analysis proves that the per-kilometre cost of adequate gravel road maintenance is greater than the per-kilometre cost for hard top maintenance. This is further exacerbated as traffic volume on a gravel road increases.

8.9 Gravel Road Conversion to Hard Top

Aggregate specifications include many requirements to ensure performance, including gradation. The gradation of aggregates was designed in order that the granular base can support load and drain. Gravel roads become contaminated very quickly after placement of new material due to adjacent business operations tracking material on to the road surface and in some instances even the municipal grading operation may contaminate the material.

The contamination interferes with the granular material's ability to support load and drain. As such, given the cost to maintain a gravel road, it would appear logical that once a gravel road is structurally sound and has clean material placed on the surface, placing a hard top – typically surface treatment- to preserve the investment.

Appendix D of this report provides further information on conversion selection criteria.

As noted in section 8.7, the recommendations to convert the gravel roads to hardtop is predicated by roadside environment and drainage.

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9 Program Funding Recommendations

9.1 Overview

Program funding recommendations are a function of the dimensional information, surface type, roadside environment, functional class of the individual assets and current unit costing. Recommended funding for the road system should include sufficient capital expenditures that would allow the replacement of infrastructure as the end of design life is approached, in addition to sufficient funding for maintenance, to ensure that that full life expectancy may be realized.

Budgetary recommendations in this report do not include items related to development and growth; those should be considered as additional. Generally, that type of improvement or expansion to the system would be funded from a different source, such as Development Charges.

The budget recommendations bear a direct relationship to the value of the road system. 4 Roads estimates the cost to replace the road system, to its current standard, at **$47,498,000** based on current unit costs and the standardized calculations in the Inventory Manual. The budget recommendations provided in this report are based on the constitution of the road system. This represents an opportunity to develop a financial plan in concert with the asset management plan, for a phased implementation.

9.2 Program Funding Recommendations

9.2.1 Current Replacement Costs and Long Term Sustainability

The estimated replacement value of the Town road system to the current standard is **$47,498,000**. This equates to an annualized capital replacement of **$950,000** based on a 50 year period. This would represent the Long Term Sustainable funding level. (This would be similar to the PSAB 3150 amortization value using current replacement cost instead of historic cost.) The current value of the road system is estimated to be $39,752,800.

The Long Term Sustainability funding level is strictly a function of the replacement cost and the life cycle period and would best be described as an 'Accountaneering' number. This estimate does not include bridges, culverts, cross culverts less than 3 m, sidewalks, storm sewers, or street lighting. The typical design life for a road structure has typically been considered to be 50 years before reconstruction/replacement.

However, in an urban setting in particular, with the underground utilities typically having an expected life in the 75 year range, it would seem more pragmatic to match the lifecycles of the road and utility assets. Road assets can be designed to last 75 years with only resurfacing required. Rural cross sections should be treated similarly.

The estimated replacement/depreciation is based upon the replacement value of the road system over a 50-year life cycle. However, the 50-year life cycle can only be a reality if maintenance and preservation treatments such as crack sealing and hot mix asphalt overlays are delivered at the appropriate time. Inadequate maintenance and preservation will result in premature failure and increased life cycle costs.

Analogies to houses and cars sometimes make road maintenance easier to understand. If a house does not have the roof renewed within the correct time frame, there will be damage to the structure, below the roof, and if this is not dealt with, it will result in a rapid deterioration of the house. Similarly, roads require crack sealing and resurfacing at the appropriate time, during the life cycle, in order to maximize the life expectancy of the asset. Preservation and maintenance extend the useful life of the pavement, reducing life cycle costs.

9.2.2 Hot Mix Resurfacing

Roads require major maintenance throughout the life cycle, in order to optimize and maximize the asset life span. Roads require resurfacing at the appropriate interval, for the respective class of road. Different agencies categorize the expense differently, usually dependent upon the dollar value; however, resurfacing is essentially a maintenance activity.

Resurfacing schedules are dependent upon traffic loading and the percentage of commercial traffic. Higher traffic volumes and percentages of commercial traffic shorten the interval between resurfacings. Optimal resurfacing intervals will vary from ten to twenty years (or more), depending upon the road function, classification, and quality of design and construction.

The Hot Mix Asphalt Resurfacing recommendation in this report is based upon the distribution of the Town's hot mix asphalt inventory. As such, the optimal budget calculation will focus on the 18 (18.2)-year interval, for hot mix roads. This would represent an average of 1.77 CL-km of resurfacing annually.

Table 9.1: Hot Mix Asphalt Roads by Asset Class and Life Cycle (unadjusted length)

Asset Class	Life Cycle Yrs	Asset Qty. (CL-km)	Weighted Average (Yrs)
A/C-R	19	0	0
A/C-S	19	0	0
A/C-U	19	0	0
HCB1-R	9	0	0
HCB1-S	9	0	0
HCB1-U	9	0	0
HCB2-R	12		
HCB2-S	12		
HCB2-U	12		
HCB3-R	15		
HCB3-S	15	6.76	3.16084788
HCB3-U	15	2.05	1.21415212
HCB4-R	19	3.17	1.877493766
HCB4-S	19	20.1	11.90461347
HCB4-U	19	32.08	18.2
Totals		**6.76**	**3.16084788**

Given the aforementioned, and the information with respect to surface type contained in Table 3.1 the funding for the annual resurfacing program should be **$645,000** per year on average, in order to maintain the system at its current adequacy level. This estimate is for the major resurfacing work only and does not include any estimated costs for other pavement preservation activities or programs. Table 9.1 identifies the distribution of hot asphalt roads by asset class and the basis for the recommendation for the annual program budget recommendation.

9.2.3 Crack Sealing

Crack sealing is a preservation activity that extends the life of a hot mix asphalt surface. A program estimate is provided based on crack sealing one metre per two lane metre of pavement every 5 years at the unit cost provided by 4 Roads, that we believe to be representative. Based on that premise, the recommended budget for crack sealing is **$12,800**.

9.2.4 Surface Treatment Resurfacing

Most agencies report that the average life of surface treated road is seven years. Similar to the concept applied to the development of the hot mix resurfacing recommendations, the surface-treated road network should be completely resurfaced every seven years, or approximately 14% (28 km)of the surface treated inventory in each calendar year.

At a unit cost of $3.25 per square metre, the annual program size should be **$19,700** on average, exclusive of any other preparatory work.

9.2.5 Gravel Road Resurfacing

When MTO was providing maintenance subsidy, the standard practice for gravel road maintenance was to place approximately 75 mm of gravel on each gravel road section, every three years.

Since the conditional grant system was discontinued, a large number of municipalities have reduced the amount of gravel that has been placed on gravel roads, to the point where the gravel roads in the system are a major maintenance problem, particularly in the latter part of the winter and early spring. If the granular base is not replenished, the road structure will disappear through normal usage, and the remaining gravel typically becomes contaminated by other materials, such as the native soil and winter sand.

Town of Petrolia has 0.159 km of gravel surfaced roads, as per Table 3.1 of this report. Using the Town's benchmark costing, the annual gravel resurfacing program size should be **$1,950** per year, based on adding 75 mm of gravel every three years. (This is 75mm across the entire platform.) This estimate does not include costs for re-grading, dust control, or gravel road conversion.

9.3 Short and Long Term Sustainability and the Funding Window Concept

Typically, municipalities, and more particularly public works departments, prepare annual budgets that have specific line items for capital, operational and maintenance expenditures. The definitions for capital and operational costs can vary between municipalities and road authorities.

From a pure asset management perspective, project selection and annual programming should be driven by asset condition, rather than a fixed line item amount. Section 8 of this report, provided a review of this asset management philosophy.

Rather than have a fixed line item for certain activities, 4 Road recommends that all of the major maintenance and rehabilitation and construction activities be considered as the annual re-investment amount. Annual expenditures will meet the overall bottom line, however, when projects and programs are driven by condition, the annual line items will vary.

The funding window is the zone between the short and long term sustainability funding recommendations.

The 'funding window' is the range between the Short Term Sustainability and the Long Term Sustainability funding levels. Re-stated, instead of the traditional capital and maintenance line items, consider the gross budget as **the annual reinvestment level**, with program funding levels fluctuating within the gross amounts, but driven by asset condition.

As an example, if the 'capital' and 'operations' line item limitation were imposed on a municipality that has experienced significant growth, then opportunities to optimize funding will be missed. In municipalities experiencing significant growth, there will be a need for treatments within that development at a similar timeframe. For example, the roads will need to be resurfaced within a year or two of each other. If they are not resurfaced at the appropriate condition, then the condition will deteriorate and improvement will be more expensive. This concept is illustrated in Figure 8-1 and Figure 8-2.

For modeling purposes, 4 Roads has created a funding level described as the Short Term Sustainability or 'Preservation Funding level which should provide maintain the condition of the system over a short time frame and provide that Short Term Sustainability of the road system.

The Short Term Sustainability is the total of the recommended funding levels for hot mix resurfacing, single surface treatment, gravel road resurfacing and crack sealing: **$679,400.** The premise being that if the pavement maintenance, preservation and resurfacing programs are adequately funded, then the system should be sustained over the short term; five to 10 year maximum. The caveat is that the program that is developed through a performance model at this funding level ***must*** be adhered to strictly, or the system will deteriorate.

The Short Term Sustainability funding and performance model thereof, are computer derived. Intangible values and decisions and the effects of other external forces cannot be incorporated into the model. As such the model is the minimum required to maintain the system- in theory. **Theoretically, the 'Short Term Sustainability' funding level would work. Practically, that would rely on every assumption and rating to absolutely correct, and the program adhered to explicitly.** From a more pragmatic perspective and to deal with the real life realities of maintaining a road system, it should be greater.

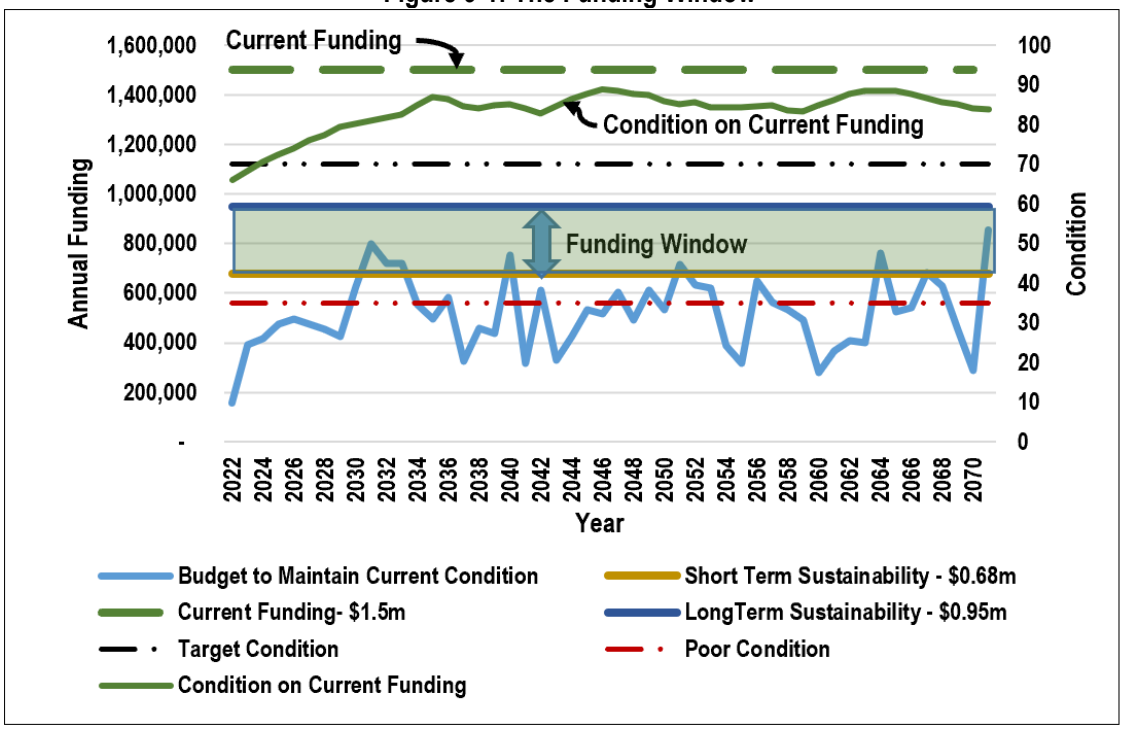
To sustain the road system over the entire life cycle the Long Term Sustainability funding level is required. Performance modeling is discussed in Section 9 of this report. 4 Roads has calculated that the annualized replacement cost -Long Term Sustainability- at **$950,000**. In 2021, the gap between short and long term sustainability is significant due to the unit cost increases of earth excavation, manholes, and catchbasins.

Figure 9-1 depicts the necessity to fund at the long Term Sustainability replacement . The entire amount does not have to be expended each year, but should be placed in a reserve until the demands on the system exist.

Municipal pavement and asset management strategies are critical to managing the performance of the road system, more so, if funding is limited. Funding constraints should push the strategy toward those programs that extend the life cycle of the road by providing the correct treatment at the optimum time as a priority. Resurfacing, rehabilitation, and preservation projects should be a higher priority than reconstruction projects. The objective is to "keep the good roads good".

As the municipality advances the development of their Asset Management Plan (AMP), a paradigm shift will be required in the way that we approach management of assets. Traditionally, municipalities have spent a fixed amount on capital and maintenance each year. As evidenced by Table 10.3, programs are not at a consistent funding level on an annual basis. The annual budget overall is met, however, the distribution of costs between traditional capital and maintenance activities varies. That variance is being driven by the demands of the road system based on condition. Project selection is based on condition and best Return on Investment. This concept can and should be applied to all assets.

Figure 9-1: The Funding Window



In Petrolia's circumstances, the current funding level appears to be satisfactory. .The graph illustrates that – theoretically- the current budget will hold the condition of the system. However, that would only be true:

- If the anticipated performance of the road assets followed the deterioration curve exactly
- If the work plan developed by the model were adhered to explicitly

For this reason, 4 Roads typically recommends the funding window with a minimum funding level of the Short Term Sustainability budget as a target for the short term and the Long Term Sustainability funding level over the life cycle.

Petrolia has several unique circumstances which has resulted in the current funding level being above the long term sustainability level;

- The road system is small. In larger systems that are a mix of urban and rural, there is more of an ability to undertake lower cost activities on longer stretches of rural road to sustain the system adequacy, and system average condition.
- 75% of the road system is urban. Other utilities in the road allowance and under the road will drive the program to some extent.
- Proximity to development, or proposed development, may also drive the program to facilitate servicing. In the majority of municipalities, there are development charges. Petrolia does not have development charges, so those roads and other assets that are affected by development are costs borne directly by the ratepayer.
- Anecdotal information acquired during previous studies would suggest that tax increases were held to 0% for several years and very little infrastructure work was undertaken. As such, there is an element of catch-up.

9.4 Annual Budget Adjustments

9.4.1 Inflation

The typical approach to annual budget adjustments is to adjust with some reference or consideration to the Consumer Price Index (CPI). Public Works Departments have not fared well with this approach, as a large portion of the Public Works Budget is expended on commodities and services that typically vary/increase at a rate significantly higher than the CPI. Public Works Departments' annual increases based solely on CPI, will generally result in a continual downward spiral in overall condition of the road system and service levels. Decreasing service levels increase risk. Ontario is becoming much more litigious; therefore, the reduction in service levels increases the risk for a municipality, and the cost of service provision versus the cost of litigation should be considered.

In recent years, increases and decreases in fuel, asphalt, and salt have been disproportionate to the CPI. As such, consideration should be given to annual adjustments in road funding, which are more reflective of the actual experience. Some municipalities provide for such disproportionate changes in their budget process, in order that the specific impacts of a commodity price increase and service delivery are considered.

9.4.2 Plant Adjustment (System Changes)

Most municipalities experience development-related growth. Growth comes at a cost, both in the longer-term, with additional resurfacing and replacement requirements, and in the shorter-term, with Operational budgets. Operational budgets should be adjusted on a pro-rata basis to account for the additional length of road that has to be maintained.

Capital budgets and forecasts should also be adjusted annually, to reflect the changes in the system, and integrated into the longer-term financial plan.

10 Performance Modeling- Budget Effect on System Performance

10.1.1 Asset Management Plan Analysis

The asset management plan is a function of the assets, the required life cycle activities and funding. Required funding is driven by the plan and the life cycle activities – not necessarily the current funding level. The development process for all elements is dynamic, iterative, and holistic on a number of levels. It is complex.

From Regulation 588/17;

> *"4. For each asset category, the lifecycle activities that would need to be undertaken to maintain the current levels of service as described in paragraph 1 for each of the 10 years following the year for which the current levels of service under paragraph 1 are determined and the costs of providing those activities based on an assessment of the following:*
>
> *i. The full lifecycle of the assets.*
>
> *ii. The options for which lifecycle activities could potentially be undertaken to maintain the current levels of service.*
>
> *iii. The risks associated with the options referred to in subparagraph ii.*
>
> *iv. The lifecycle activities referred to in subparagraph ii that can be undertaken for the lowest cost to maintain the current levels of service."*

A work plan and lifecycle activities – a Performance Model – were developed using WorkTech Asset Management Foundation software, which 4 Roads is a licensed user of.

Performance models may be developed with as many variables for weighting of attributes that may be included in the database. Models that develop work plans based on a Return on Investment (ROI) scenario produce results in terms of project selection that are consistent with the concepts of asset management and selection of the right treatment at the right time. From available funding, the treatments offering the best ROI are selected as a priority. Those treatments are typically crack sealing, micro paving and resurfacing.

The provincial guidelines for the preparation of an AMP indicate that the following must be considered;

- Options must be compared on Lifecycle cost- the total cost of constructing, maintaining, renewing and operating an infrastructure asset throughout its service life. Future costs must be discounted and inflation must be incorporated.
- Assessment of all other relevant direct and indirect costs and benefits associated with each option.
    - Direct benefits and Costs
        - Efficiencies and network effects
        - Investment scheduling to appropriately time expansion in asset lifecycles
        - Safety
        - Environmental
        - Vulnerability to climate change
    - Indirect Benefits and Costs
        - Municipal wellbeing and costs
        - Amenity values
        - Value of culturally or historically significant sites
        - Municipal image

- Assessment of Risks associated with all potential options. Each option must be evaluated based on its potential risk, using an approach that allows for comparative analysis. Risks associated with each option can be scored based on quantitative measures when reasonable estimates can be made of the probability of the risk event happening and the cost associated with the risk event. Qualitative measures can be used when reasonable estimates of probability and cost associated with the risk event cannot be made.

Significant effort (and expense) will be required to meet all of these requirements.

10.1.2 Performance Model Overview

A properly developed performance model will satisfy the majority of the requirements identified in the foregoing. Key elements of a Performance Model will include;

- Deterioration Curves identifying anticipated deterioration of an appropriately constructed asset over the life cycle of the asset
- 'Trigger' points throughout the deterioration curve identifying appropriate treatments at condition ranges
- Current costing for all treatments identified

To capture the essence of the provincial requirements, development and use of a Performance Model is recommended. Through modeling and the resultant output, the following may be addressed;

- Review of options and lifecycle effects based on a Return on Investment Analysis
- Efficiencies and network effects

- Budget requirements to achieve LOS goals

As noted in section 10.1.1, Regulation 588/17 requires a work program that considers the lifecycle activities of each asset over a 10 year period and results in a program that maintains the average condition of the asset group. The most effective means to achieve this goal is through a performance model. WorkTech Asset Manager Foundation includes a performance modeling capability, which has been used to develop the work plan for this project.

Through performance modeling, appropriate budget levels, programming and associated costs can be determined, delivering key elements of any plan that can be refined or revisited as circumstances change. Once a model is developed, then the effect of any alternatives may also be measured.

4 Roads is of the opinion a number of other requirements that the province has identified should not be addressed until they reach the project stage. Further, a number of those requirements would be addressed through a Class Environmental Assessment process.

This particular series of Performance Models is based on the road system in the condition that it exists today in terms of the currents pavement distress information and the current dimensional information. Section 10.4 of this report discusses a 10 year performance model.

10.2 System Performance at Various Budget Levels

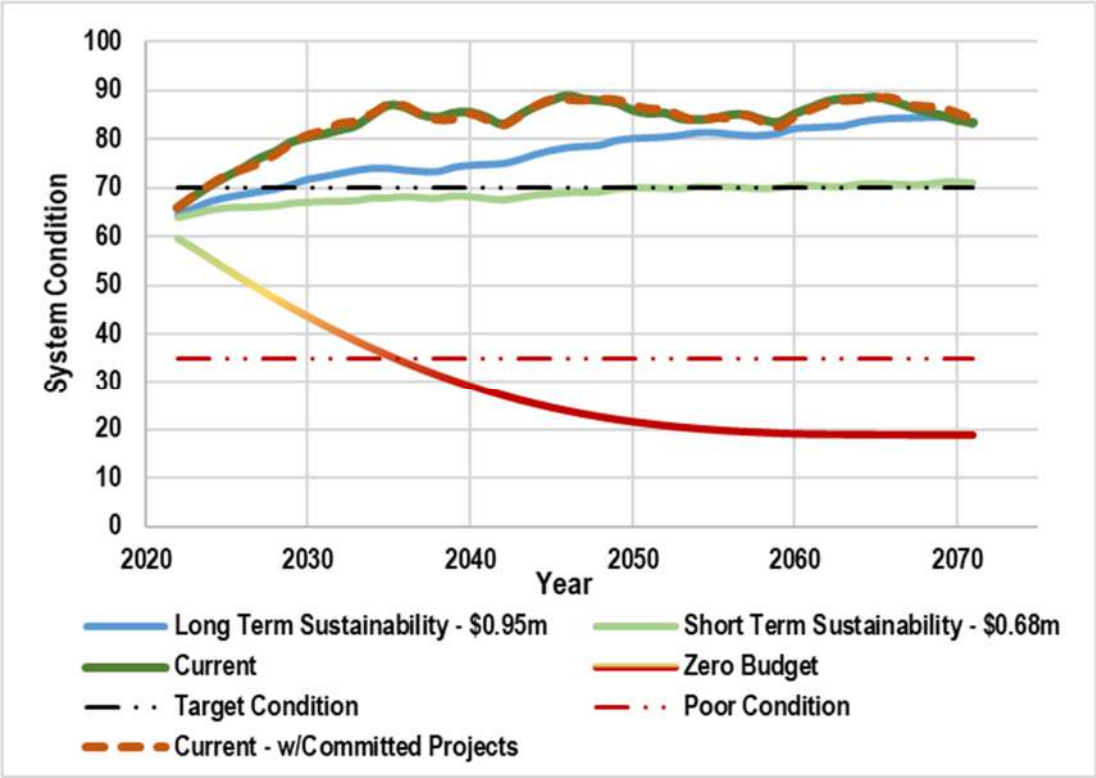
This report includes budget recommendations for various aspects of the programming that are typical to road departments. The budget recommendations do not include the expansion program related to growth and development. System performance can be predicted based on the level of funding.

4 Roads has prepared four different 50-year performance models for the road system. The models have been prepared with the following parameters:

- Zero budget – demonstrates the effect of no work being performed on the road system and how quickly it will deteriorate
- Short Term Sustainability /Preservation budget – $679,400-This includes the total dollar value of the budget recommendations for Hot Mix Asphalt resurfacing, surface treatment, gravel road resurfacing and crack sealing.
- Current Budget - increases over time to $1.5m
- Current Budget with Committed Projects – $1.5m
- Long Term Sustainability budget- $950,000 full replacement cost of the road system annualized.

The Average Physical Condition of the road system is currently 60.8 The performance model calculations all begin with the current Physical Condition and for purposes of the graphing, the year-end Physical Condition is displayed, based on the effects that the improvements have had on the overall condition of the road system.

Figure 10-1: Performance Modeling at Various Budget Levels



Notes: Short Term Sustainability assumes perpetual performance of the road after initial rehabilitation and is not influenced by other asset demands

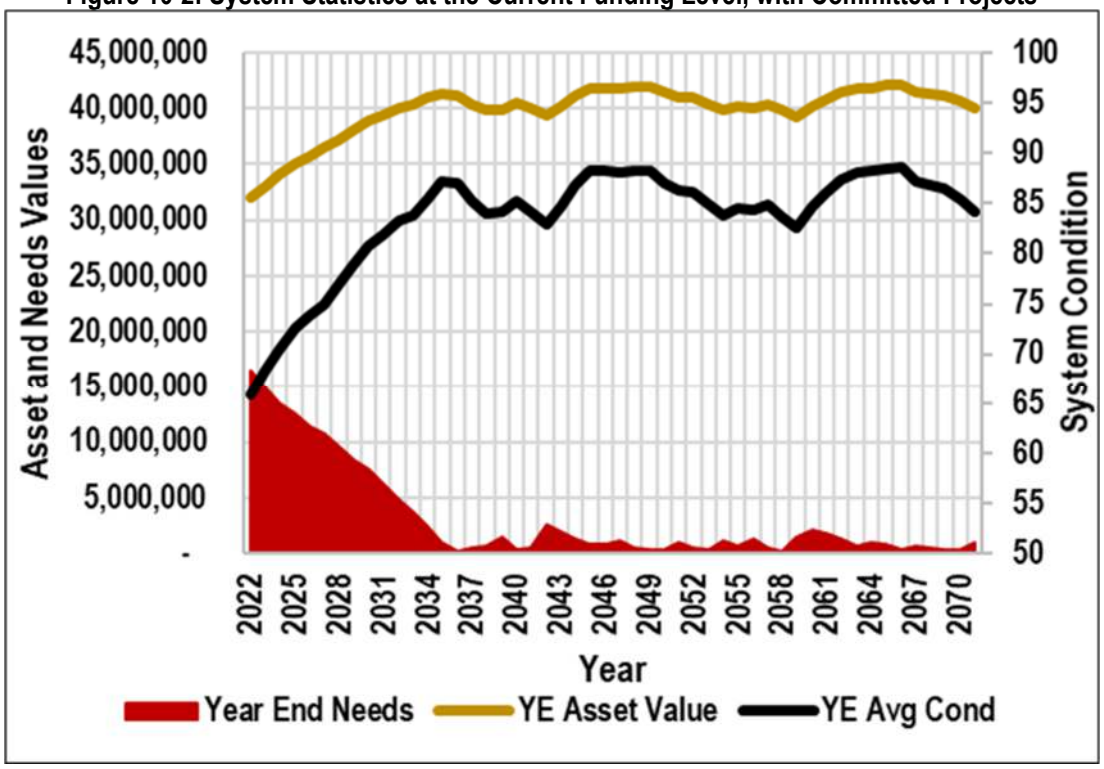
From Figure 10-1, the performance at the current funding level, including committed projects, increases the average system condition over time The model is reliant on anticipated deterioration. If road sections deteriorate more quickly, then the current funding and committed programming is not sufficient to sustain the system.

Further, there will be some road sections in poor condition that will not be addressed in the program.

In reviewing the results of the performance models, it should be understood that, with the methodology being used, the trigger for a resurfacing activity is a Physical Condition of 70 for hot mix roads. At appropriate funding levels the system condition improves over time.

The effect of a funding level has many measures, not just the performance of the condition of the system. Figure 10-2 illustrates the effect of the current funding level on the average system condition, the value of the road system and the cumulative needs.

Figure 10-2: System Statistics at the Current Funding Level, with Committed Projects



Notes: The model assumes perpetual performance of the road after initial rehabilitation and is not influenced by other asset demands

The deterioration curves that have been used consider an average/typical performance for the various road classes. When used in the model at a reasonable funding level the overall average system condition will remain at a similar level as the model will treat the pavements as perpetual. This concept is illustrated in Table 10.1 using Town of Petrolia Section 932, Tom St, Charlie St. to Joe St.

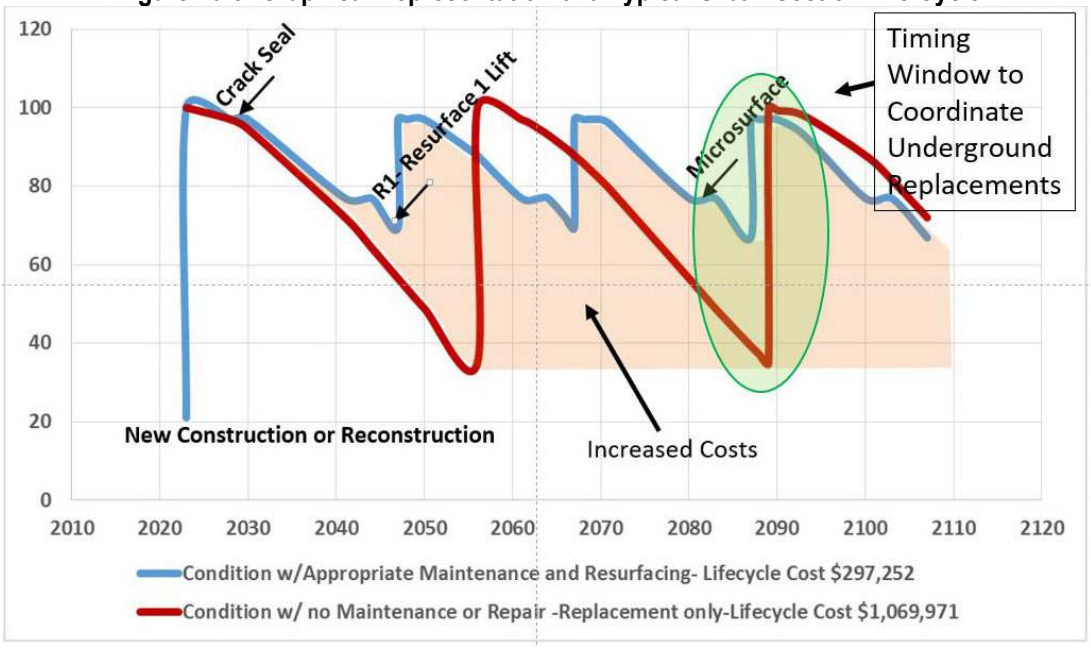
Table 10.1: Sample Section Life Cycle (from 2021 Study)

Asset 932, Tom Street, Charlie to Joe								
Year	Improvement Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	ROI
2025	RNS	$ 116,091	5	100		$ 5,805	$ 116,091	0.95
2030	CRK	$ 184	97	97	2	$ 112,608	$ 112,608	7.19
2046	R1	$ 36,738	69.47	97		$ 80,648	$ 112,608	0.95
2047	CRK	$ 184	97	97	2	$ 112,608	$ 112,608	7.19
2063	R1	$ 36,738	69.47	97		$ 80,648	$ 112,608	0.95
2064	CRK	$ 184	97	97	2	$ 112,608	$ 112,608	7.19

For the purposes of a short to mid-term plan considering the pavement as performing as a perpetual pavement does not pose a problem. The aggregate road base will deteriorate over time however, the time frame where that may be contributory to the road decline would be beyond 50 years. Condition data is collected regularly and monitoring and analysis would alert the municipality to changes that are occurring.

Figure 10-3 provides a graphical representation of the two distinctly different approaches to asset management. The blue line represents a treatment selection based on treatment selection by condition and the best ROI. The Red line represents a road management by reconstructing and then deteriorating to failure and then reconstructing or major rehabilitation. The cost difference is approximately 3 times.

Figure 10-3: Graphical Representation of a Typical Urban Section Life Cycle



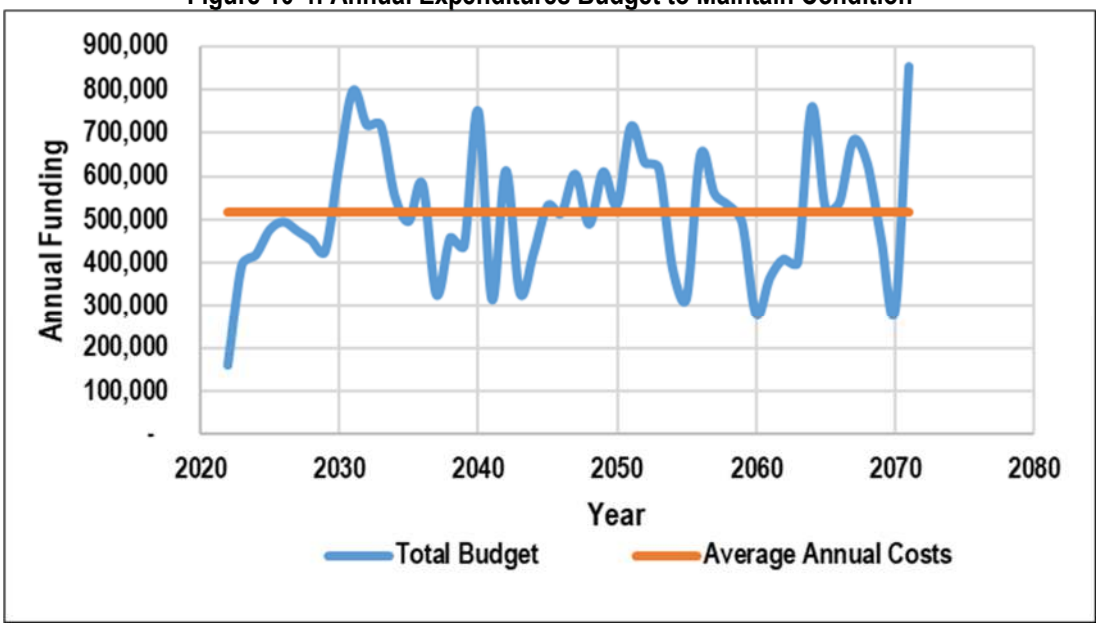
Note: Life cycle with appropriate maintenance includes crack sealing, microsurfacing, resurfacing and reconstruction.
The orange shaded area represents the difference in life cycle costs between the strategies

Figure 10-4 illustrates the typical effect on budget requirements by holding the condition of the system at a specified level. If the orange line represented the average annual expense, the budget years above that line would require debt financing or funding from reserves. Conversely, in those years where the funding requirement is less than the annual average then the unspent funds would accumulate in a reserve.

Deterioration curves developed by 4 Roads have been utilized for development of funding and prediction models and based on our experience with a large cross-section of municipalities and resultant feedback, we believe that those deterioration profiles are representative. The models indicate that the overall condition of the road system will continue to increase over time to a point where the average physical condition will be in the mid 70's range. A physical condition beyond that level may be indicating an over-expenditure/inefficiency in the programming. An average physical condition above 70 would indicate that the average road only requires maintenance.

In a number of the models created for this project, all of the funding will not be spent each year once the average rises above 70. The deterioration curves that have been used consider an average/typical performance for the various road classes.

Figure 10-4: Annual Expenditures Budget to Maintain Condition



10.3 Record of Assumptions -Performance Modeling

10.3.1 Pavement Classification for Modeling

In order to develop budget recommendations, 4 Roads adds an additional classification of roads differentiated by surface type, roadside environment and traffic volume. It is anticipated that each road classification will deteriorate at a different rate. Differentiation by roadside environment within a classification permits calculation of the different replacement costs to reflect the servicing and feature differences.

Table 10.2: Road Asset Classes

Asset Class	Subtype	Material	Roadside Envt	AADT Low	AADT High
A/C	All	A/C	R	1	100,000
CM1	All	C/M	R	1	3,000
CON	All	CON	R	1	100,000
GST1	All	G/S	R	1	10,000
HCB1	All	HCB	R	20,000	100,000
HCB2	All	HCB	R	10,000	19,999
HCB3	All	HCB	R	1,000	9,999
HCB4	All	HCB	R	1	999
ICB	All	ICB	S	1	3,000
LCB1	All	LCB	R	1	2,000

Figure 10-5: Typical Treatment Selection vs. Condition for Hot Mix Asphalt Roads

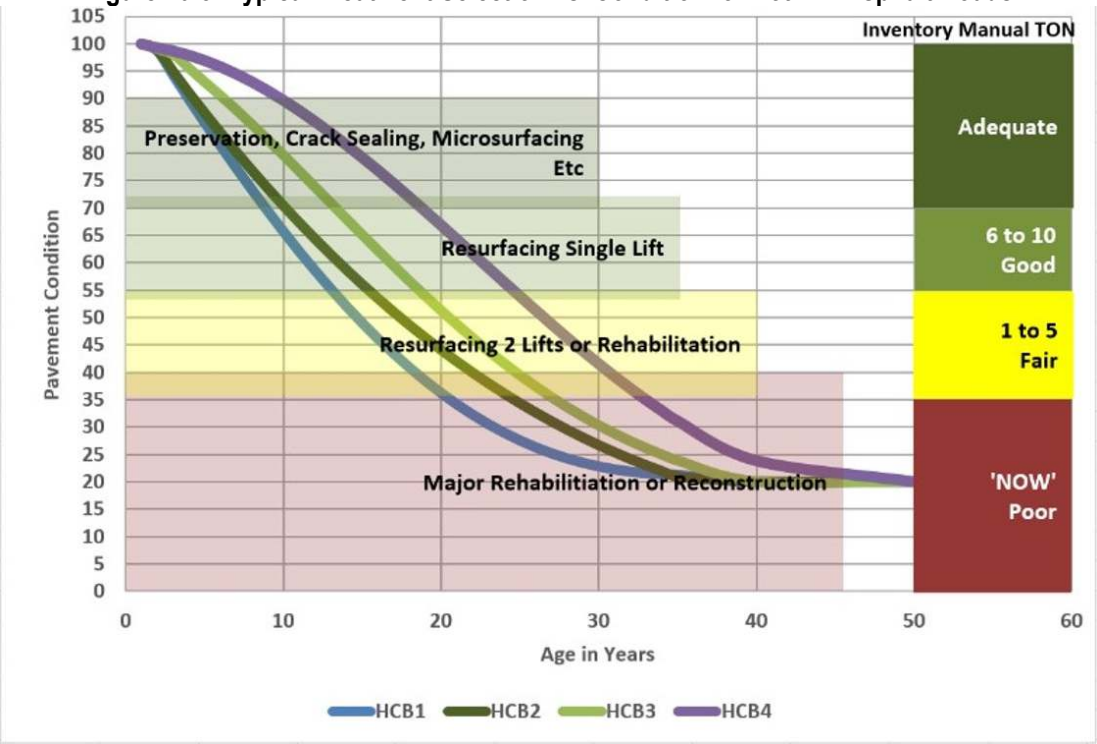


Figure 10-5 illustrates treatment selection by time and asset classes for hot mix roads. Typical treatments and/or improvements have been superimposed over the deterioration curves, to illustrate the general timelines for implementing the treatments. Other road asset classes have been treated similarly. An important concept to remember is that as a road deteriorates the cost of rehabilitation increases. The deterioration curves, improvement types, current unit costs and current condition ratings are essentially the assumptions used to develop budget and programming recommendations in this report. Appendix C provides detail on the deterioration curves for all road asset classes.

10.4 10 Year Program Performance Model

Appendix G includes the results of a 10 Year program based on the ROI Performance model. The funding is at the current funding level and includes committed projects. This performance models will select treatments by condition and best Return on Investment (ROI) after the committed projects have been included.

The resultant project selection from the model may vary from the current operational programs and forecast as the model will select projects in the following order;

- Committed projects
- Projects based on best ROI initially and
- then expend remaining funds on other projects.

Generally, models can be a starting point for program development but has to be metered with decisions than cannot be easily introduced into a model, such as committed projects.

The model does not include any new/additional road sections; only work on existing road sections.

Table 10.3: Performance Model Summary - 10 Year Program- Current Funding Level with Committed Projects 20210826

Improvement Type	Year 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Grand Total
CRK	5,678	2,386	12,720	1,948	476	15,027	4,880	4,374	5,828	4,074	**57,391**
PR2	402,322	184,560		60,405							**647,287**
R1	320,383	610,106	130,982	29,735	140,045	416,003	361,064	692,352	405,626	618,955	**3,725,251**
R2Urehab	215,412	327,848	613,006	1,277,091	1,068,185	374,563	178,794			64,781	**4,119,680**
REC							494,400	626,200			**1,120,600**
RNS	542,700	348,300	707,500	97,500	279,000	648,700	440,497	140,100	1,083,282	807,913	**5,095,492**
SD	1,550										**1,550**
SR	10,000	20,000									**30,000**
SST			17,909					29,751			**47,660**
Grand Total Roads	**1,498,045**	**1,493,200**	**1,482,117**	**1,466,679**	**1,487,706**	**1,454,293**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	**14,844,911**
Water and Wastewater Linear											
Water	400,000	300,000	420,000	-	213,785	481,016	-	-	-	-	1,814,801
Storm and Sanitary Sewers	525,000	250,000	550,000	350,000	342,056	769,626	-	-			2,786,682
Gross Total	**2,423,045**	**2,043,200**	**2,452,117**	**1,816,679**	**2,043,547**	**2,704,935**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	19,446,394
Funding Sources											
General Levy	1,498,045	1,493,200	1,482,117	1,466,679	1,487,706	1,454,293	1,479,635	1,492,777	1,494,736	1,495,723	14,844,911
DC	0	0	0	0	0	0	0	0	0	0	0
Rate Supported	925,000	550,000	970,000	350,000	555,841	1,250,642	-	-	-	-	4,601,483
Required from Capital Reserve											0
Total Funding	**2,423,045**	**2,043,200**	**2,452,117**	**1,816,679**	**2,043,547**	**2,704,935**	**1,479,635**	**1,492,777**	**1,494,736**	**1,495,723**	**19,446,394**

Note: Does not include any new/additional road sections; only work on existing road sections
Road costs do not include costing for storm sewers; shown as a separate asset cost

11 Recommendations

In addition to the budgetary recommendations, the following recommendations are provided for the management of the road inventory.

1. The information and budget recommendations included in this report be used to further develop the corporate Asset Management Planning.
2. The current annual expenditure on road asset should remain, until the Level of Services measures are all met.
3. Funding levels to be adjusted annually to accommodate growth / system expansion.
4. Funding should be adjusted annually to accommodate inflation.
5. Consideration should be given to the implementation of a Development Charges By-Law.
6. The work plan should;
    - Ensure that the preservation and resurfacing programs are optimized. This is particularly critical for those sections that are not going to be affected by upgrade due to development demands.
    - The work plan should cross integrate assets.
    - The work plan should be followed to optimize investments and performance of the road system.
7. The road asset inspection interval should be continued at the current 2 year interval.
8. Town of Petrolia should initiate a traffic counting program to be updated and repeated on a regular basis. The counting should include the percentage of truck traffic.
9. The status of the Boundary Road Agreements should be reviewed.
10. The Level of Service for System Adequacy should be a Minimum of 60%.
11. The Level of Service for Average Condition should be a minimum of 70.
12. The Level of Service for Good to Very Good Roads should be a minimum of 60%.
13. If a Quality Assurance Program does not exist, it should be developed.
14. The Design Criteria should be reviewed for new developments to ensure that Petrolia is receiving quality product that does not impact ratepayers prematurely.
15. Consideration should be given to the development of a maintenance paving program for those roads sections that are in poor condition that will not be addressed in the shorter term programming.
16. Master Drainage Plans should be developed for those areas of the Town where they currently do no exist.
17. Develop a corporate asset management system throughout the organization with the development of a Standard Operating Procedure (SOP) for asset management.
18. Improve the understanding of the evaluation systems being used for various assets.

Appendix A: Inventory Manual Methodology Overview

Asset Condition Rating Methodology
The Inventory Manual for Municipal Roads

Regulatory Requirements in Ontario

Regulation 588/17 Asset Management Planning for Municipal Infrastructure requires;

> '*v. a description of the municipality's approach to assessing the condition of the assets in the category, based on recognized and generally accepted good engineering practices where appropriate.'*

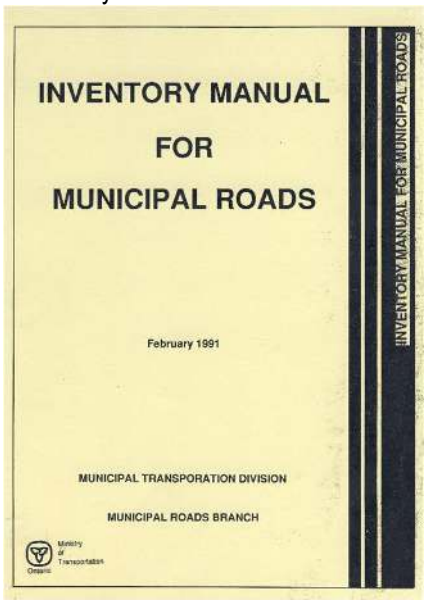
Data collection and road ratings were completed generally in accordance with the Ministry of Transportation Ontario (MTO) *Inventory Manual for Municipal Roads* from 1991. (*Inventory Manual or IM*). The ratings are either a standalone value or incorporated into calculations performed by the software. The ratings or calculations then classify the road section as a 'NOW', '1 to 5', or '6 to 10' year need for maintenance, rehabilitation or reconstruction in six critical areas.

Inventory Manual History

From the 1960's until the mid-1990's, the Ministry of Transportation (MTO) required municipalities to regularly update the condition ratings of their road systems in a number of key areas. The process was originally created by the MTO as a means to distribute conditional funding between municipalities, on an equitable basis. The reports were referred to as a 'Road Need Study' (RNS) and were required in order to receive a conditional grant to subsidize municipal road programs. After the introduction in the 1960's by the MTO, the methodology evolved into the current format by the late 1970's. The most current version of the Inventory Manual is dated 1991, and is the methodology used for this report and supported by WorkTech Asset Manager Foundation Software. The practice was discontinued by a number of municipalities when conditional funding for roads was eliminated in the mid 1990's.

Inventory Manual Overview

The Inventory Manual Methodology is a sound, consistent, asset management practice that still works well today, and in view of the increasing demands on efficiency and asset management, represents a sound road asset inventorying and management system. Road system reviews should be repeated on a cyclical basis. The road section review identifies the condition of each road asset by its time of need and recommended rehabilitation treatment.



In addition to condition ratings, the Inventory Manual also provides guidance in terms of data fields that should be included in a road system database in order to make comprehensive decisions with respect to improvements. There is more to an improvement recommendation than just condition.

To put terminology in a more current context, the past Road Needs Study is now *'The State of the Infrastructure Report (SotI)'.* The SotI analyzes and summarizes the road system survey data collected (or provided) and provides an overview of the overall condition of the road system by road section, including such factors as structural adequacy, drainage, and surface condition. The study also provides an indication of apparent deficiencies in horizontal, and vertical alignment elements, as per the Ministry of Transportation's manual, "Geometric Design Standards for Ontario Highways".

The report provides an overview of the physical and financial needs of the road system, which may be used for programming and budgeting. However, once a road section reaches the project design stage, further detailed review, investigation, and design will be required to address the specific requirements of the project.

Asset Condition Rating Methodology
The Inventory Manual for Municipal Roads

Asset Management by its' very nature is holistic. Managing a road network based solely on pavement condition would be critically deficient in scope in terms of the information required to make an informed decision as to the improvements required on a road section.

The *Inventory Manual* offers a holistic review of each road section, developing a Time of Need (TON) or an Adequate rating in six areas that are critical to municipal decision making:

- Geometrics
- Surface Type
- Surface Width
- Capacity
- Structural Adequacy
- Drainage

Evaluations of each road section were completed generally in accordance with the MTO's *Inventory Manual for Municipal Roads* (1991). Data collected was entered directly into WorkTech's Asset Manager Foundation software. Condition ratings, Time of Need, Priority Ratings, and associated costs were then calculated by the software, in accordance with the *Inventory Manual*. Unit costs for construction are typically provided by municipal staff.

Road sections should be reasonably consistent throughout their length, according to roadside environment, surface type, condition, cross section, speed limit, or a combination of these factors. As an example, section changes should occur as surface type, surface condition, cross-section, or speed limit changes.

Field data is obtained through a visual examination of the road system and includes: structural adequacy, level of service, maintenance demand, horizontal and vertical alignment, surface and shoulder width, surface condition, and drainage. The Condition Rating is calculated based upon a combination of other calculations and data.

The Condition Ratings, developed through the scoring in the *Inventory Manual*, classify roads as 'NOW', '1 to 5', or '6 to 10' year needs for reconstruction. **The Time of Need is a prediction of the time until the road requires reconstruction, *not the time frame until action is required***. It is in essence, a prediction model. For example, a road may be categorized as a '6 to 10' year need with a resurfacing recommendation. This road should be resurfaced as soon as possible, to raise the condition, and to further defer the need to reconstruct. Graph 1 provides a graphical explanation.

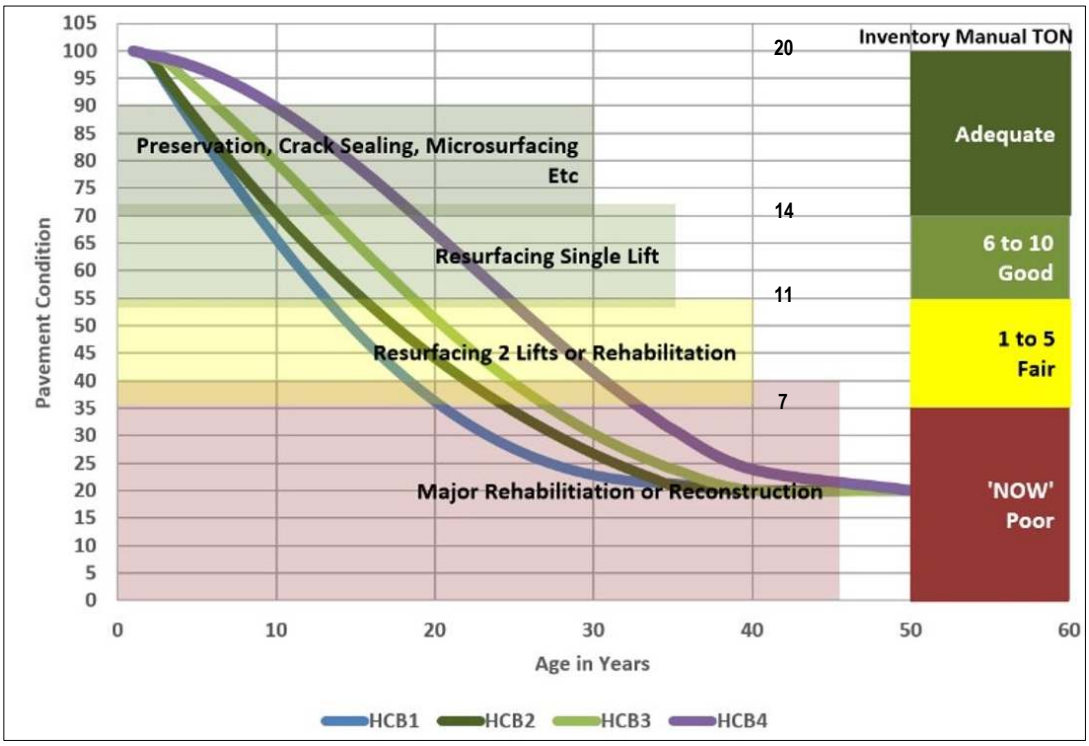
To best utilize the database information and modern asset management concepts, it has to be understood that the Time of Need (TON) ratings are the estimated time before the road would require reconstruction. NOW needs are still roads that require reconstruction; however, it is not intended that '1 to 5' and '6 to 10' year needs are to be acted on in that timeframe for resurfacing recommendations. The '1 to 5' and '6 to 10' year needs are current candidates for resurfacing treatments that will elevate their structural status to 'ADEQ', and offer the greatest return on investment for a road authority (notwithstanding a drainage or capacity need, etc.).

O.Reg 588/17 also requires Level of Service measures for hard topped roads by Pavement Condition Index (PCI). By definition, a PCI is a rating of the road condition between 1 and 100. (ASTM 6433). O.Reg 588/17 is non specific as to the PCI methodology. This is discussed in further detail in Appendix C.

The structural or distress rating in the Inventory Manual has a maximum score of 20, which can be a bit more difficult to relate to than a 1 to 10 or 1 to 100 rating. For the purposes of Graph 1, the Structural Adequacy rating (distress) has been multiplied by 5 to produce a rating on a 1 to 100 scale which may be more readily understood.

When the Structural Adequacy rating is depicted as a 1 to 100 rating, and shown graphically, it is obvious that even given the vintage of the origins of the Inventory Manual (late 1970's), the pavement management concepts of the Ministry of Transportation were well evolved even at that time. Graph 1 is very much in keeping with what are considered to be modern pavement management concepts.

Graph 1: Time of Need vs. Typical Improvement For Hot Mix Asphalt Surface



'NOW' Needs

'NOW' needs represent the backlog of work required on the road system. A 'NOW' need is not necessarily the highest priority from asset management or return on investment perspectives. Construction improvements identified within this time period are representative of roads that have little or no service life left and are in poor condition. Theoretically a resurfacing strategy is never a 'NOW' need, with the exceptions of a PR1 or PR2 treatment recommendation (Pulverize and resurface one or two lifts of asphalt) and where the surface type is inadequate for the traffic volume.

If a road with an improvement recommendation of "resurface" deteriorates too far, it becomes a 'NOW' construction need. A 'NOW' need rating may be triggered by substandard ratings in any of the Structural Adequacy, Surface Type, Surface Width, Capacity, Drainage, or Geometrics data fields.

These roads would be described as being on 'Poor' condition and exhibit distress over greater than 20% of the surface area of the section.

'1 to 5' Year Needs

'1 to 5' Identifies road sections where reconstruction is anticipated within the next five years, based upon a review of their current condition. These roads can be good candidates for resurfacing treatments that would extend the life of the road (depending on any other deficiencies), thus deferring the need to reconstruct.

These roads would be described as being in 'Fair' condition and exhibit distress over 15% to 20% of the surface area of the section.

'6 to 10' Year Needs

'6 to 10' Identifies road sections where reconstruction improvements are anticipated within six to ten years, based upon a review of their current condition. These roads can be good candidates for resurfacing treatments that would extend the life of the road (depending on any other deficiencies), thus deferring the need to reconstruct.

These roads would be described as being in 'Good' condition and exhibit distress over 10% to 15% of the surface area of the section.

Needs with a 1 to 5, or 6 to 10 year, 'Time of Need' rating are prime candidates for resurfacing or rehabilitation treatments and should be acted on in the very near future.

The 1 to 5 and 6 to 10 year 'Time of Need' ratings may be misleading without adding some context to the discussion. This is a prediction of the time to when reconstruction would be anticipated, if no action is taken, not the time to act on the current recommendation.

ADEQ'

An ***'ADEQ'*** rating encompasses a wide range of conditions that include the following:

- Roads with a traffic volume of less than 50 vehicles per day will be deemed adequate, and deficiencies on those roads are to be corrected with the maintenance budgets
- Gravel Roads with a structural adequacy rating that is not a 'NOW' need (more than 25% distress) is adequate; there is no further differentiation by time period
- Roads that do not require improvement other than maintenance and exhibit distress over 0% to 10% of the surface area of the section.

These roads would be described as being in good to excellent condition, with the potential exception the ADEQ rating of roads with less than 50 AADT. Roads with less than 50 AADT may be ADEQ but be in poor condition

INVENTORY MANUAL TREATMENTS

Table A.1: Road Improvement Types

Inventory Manual Improvements	
Code	**Description**
R1	Basic Resurfacing
R2	Basic Resurfacing – Double Lift
RM	Major Resurfacing – removes existing asphalt and replace with existing plus and additional lift.
PR1	Pulverizing and Resurfacing – Single Lift
PR2	Pulverizing and Resurfacing – Double Lift
BS	Tolerable standard for lower volume roads: – Rural and Semi-Urban Cross sections only. Improves drainage and adds structure (granular base) and a surface but not to a reconstruct standard. Typically specified where width is to an acceptable standard.
RW	Resurface and Widen- adds additional lanes and resurfaces the entire road
REC	Reconstruction
RNS	Reconstruction Nominal Storm Sewers (Urban: no new sewer, adjust manholes, catch basins, add sub-drain, remove and replace curb and gutter, granular, and hot mix)
RSS	Reconstruction including Installation of Storm Sewers (New storm sewers, and manholes in addition to the above)
NC	Proposed Road Construction
SRR	Storm Sewer Installation and Road Reinstatement
SD	Spot Drainage
SR	Spot Road
SI	Spot Intersection

Inventory Manual Improvements	
Code	**Description**
CO	Carry Over project
Additional Treatments*	
CRK	Crack sealing
CRKsd	Crack Sealing and Spot Drainage
DST	Double Surface Treatment. Typically specified where it appears that the gravel road surface is adequate and may be a converted to a hard top surface.
DSTrehab	Pulverize and existing surface treated road, add 75mm of gravel, double surface treat, and spot drainage improvements. Typically specified where the road appears to be structurally sound but the surface treatment is deteriorated beyond the point where it should not be re surface treated,
DSTrehab2	In addition to DSTrehab components, base stabilization with magnesium chloride and fog seal over the DST
Fog Seal	Thin spray of bituminous material over surface treated roads to reduce aggregate loss
GRR	Gravel road resurfacing 75mm
GRRsd	Gravel road resurfacing 75mm and spot drainage
GRR2	Gravel road resurfacing 150mm
GRRsd	Gravel road resurfacing 150mm and Spot Drainage
MICRO	Microsurfacing
Slurry	Slurry Seal
SST	Single Surface Treatment
SSTsd	Single Surface Treatment and spot drainage
R2Urehab	Urban resurfacing with 2 lifts, CB and MH adjustments (Very similar to R2 in an urban environment.)

Additional Improvement Types developed by 4 Roads not included in the Inventory Manual

Inventory Manual Improvement Types

For each Type of Improvement **(Item 104)**, there are a number of specific road improvements that are included in the total cost relative to the Roadside Environment **(Item 32)** and the Design Class **(Item 105)**. The computer will check a number of Items on the appraisal sheet in order to select the appropriate factors and cross section standards and then calculate the Bench Mark Cost. For example, a Resurfacing and Widening improvement coded under Item 104 is a significantly different road cross section and cost when applied to a rural road vs. an urban arterial. The computer will make all of the necessary checks to arrive at the recommended improvement cost.

Described in the following pages are the road improvements and associated construction activities costed for each Type of Improvement listed under Item 104. Please note, that the Codes **(CO)** – Carry Over, **(SR)** – Spot Road, **(SI)** – Spot Intersection and **(SD)** – Spot Drainage are direct cost inputs and **are not** included in the Bench Mark Cost system.

(R1) - BASIC RESURFACING

(Single Lift of Hot Mix – 50 mm)

Rural and Semi-Urban Roads (Cross Section A)

(a) Hot mix padding for 20% of area to be resurfaced
(b) Single life of hot mix (50 mm)
(c) Granular material to raise shoulders to new surface grade

Urban Roads – Granular Base (Cross Section B-1)
– Concrete Base (Cross Section C-1)

(a) Minor base repairs for 10% of area to be resurfaced
(b) Hot mix padding for 20% of area to be resurfaced
(c) Curb removal and replacement on both sides for 50% of section length
(d) Planning 1.0m of existing pavement along both curbs
(e) Adjust manholes and catch basins to new surface grade
(f) Single lift of hot mix (50 mm)

(R2) - BASIC RESURFACING

(Double Lift of Hot Mix – 100 mm)

Rural and Semi-Urban Roads (Cross Section A)

(a) Hot mix padding for 20% of area to be resurfaced
(b) Double lift of hot mix (100 mm)
(c) Granular materials to raise shoulder to new surface grade

Urban Roads – Granular Base (Cross Section B-1)
– Concrete Base (Cross Section C-1)

(a) Minor base repairs for 10% of area to be resurfaced
(b) Hot mix padding for 20% of area to be resurfaced
(c) Curb removal and replacement on both sides for 50% of section length
(d) Planning 1.0 m of existing pavement along both curbs
(e) Adjust manholes and catch basins to new surface grade
(f) Double lift of hot mix (100 mm)

(RM) - MAJOR RESURFACING

(Double Lift of Hot Mix – 100 mm)

Urban Roads (Arterials and Collectors) – Granular Base (Cross Section B-1)
– Concrete Base (Cross Section C-1)

(a) Base repairs for 50% of area to be resurfaced
(b) Planning for 50% of area to be resurfaced
(c) Curb removal and replacement on both sides for 50% of section length
(d) Adjust manholes and catch basins to new surface grade
(e) Double lift of hot mix (100 mm)

(PR1) - PULVERIZING AND RESURFACING

(Single lift of Hot Mix – 50 mm)

Rural Roads (Cross Section A)

(a) Pulverize existing hard top surface
(b) Single lift of hot mix (50 mm)
(c) Granular material to raise shoulders to new surface grade

(**PR2) - PULVERIZING AND RESURFACING (Double Lift of Hot Mix – 100 mm**)

Rural Roads (Cross Section A)

(a) Pulverize existing hard top surface
(b) Double lift of hot mix (100 mm)
(c) Granular material to raise shoulders to new surface grade

(BS) - BASE AND SURFACE

Rural Roads – Tolerable Standard (50 to 100 AADT) (Cross Section D)

(a) Granular material for base
(b) Granular material for loose top surface
(c) Minimal shoulder widening
(d) Minor Ditching

Rural Roads – Design Standard (200 to 399 AADT) (Cross Section D)

(a) Placing granular material
(b) Minimal shoulder widening
(c) Double surface treatment
(d) Minor ditching

Rural Roads – Design Standard (400 plus AADT) (Cross Section D) and Semi-Urban Roads – Design Standard (Cross Section D)

(a) Placing granular material
(b) Minimal shoulder widening
(c) Hot mix (50/100 mm, see table F-1)
(d) Minor ditching

(RW) - RESURFACE AND WIDEN

Rural Roads – Tolerable Standard (50 to 199 AADT) (Cross Section E)

(a) Excavating for widening
(b) Ditching and side culvert replacement
(c) Granular material for widening base
(d) Granular material for loose top surface

Rural Roads – Design Standard (200 to 399 AADT) (Cross Section E)

(a) Excavating for widening
(b) Ditching and side culvert replacement
(c) Granular material for widening base
(d) Double surface treatment

Rural Road – Design Standard (400 plus AADT) (Cross Section E) and Semi-Urban Roads – Design Standard (Cross Section E)

(a) Excavating for widening
(b) Ditching and side culvert replacement
(c) Granular material for widening base
(d) Base Course of hot mix for widening
(e) Hot mix Padding for 20% of existing surface area
(f) Single life of hot mix (50 mm)

Urban Roads – Design Standard – Granular Base (Cross Section F)

(a) Excavating for widening
(b) Curb and Gutter removal
(c) Catch Basin removal
(d) Base repair 10% of existing surface area
(e) Granular material for widening
(f) Place catch basins and leads
(g) New curb and gutter
(h) New sub-drains
(i) Base course of hot mix for widening
(j) Hot mix padding for 20% of existing surface area
(k) Adjust manholes to new surface grade
(l) Single lift of hot mix (50 mm) curb to curb

Urban Roads – Design Standard – Concrete Base (Cross section G)

(a) Excavating for widening
(b) Curb and gutter removal
(c) Catch basin removal
(d) Base repair for 10% of existing surface area
(e) Place new catch basins and leads
(f) Granular material for widening
(g) Concrete base for widening
(h) New curb and gutter
(i) New subdrains
(j) Base course of hot mix for widening
(k) Hot mix padding for 20% of existing surface area
(l) Adjust manholes to new surface grade
(m) Single lift of hot mix (50 mm) curb to curb

(REC) - RECONSTRUCTION (RURAL and SEMI-URBAN)

Rural Roads – Design Standard (200 to 399 AADT) (Cross Section H)

(a) Excavate base material
(b) Ditching and side culvert replacement
(c) Grading
(d) Granular material
(e) Double surface treatment

Rural Roads – Design Standard (400 plus AADT) Cross Section H
and
Semi-Urban Roads – Design Standard (Cross Section H)

(a) Excavate base material
(b) Ditching and side culvert replacement
(c) Grading
(d) Granular material
(e) Hot mix (50/100 mm, see Table F-1)

Rural and Semi-Urban Roads – Design Standard (Concrete Surface)
(Cross Section P)

(a) Excavate base material
(b) Ditching and side culvert replacement
(c) Grading
(d) Granular Material
(e) Concrete base and surface

(RNS) - RECONSTRUCTION NOMINAL STORM SEWERS (URBAN)

Urban Roads – Design Standard – Granular Base (Cross Section I)

(a) Excavate base material
(b) Curb and gutter removal
(c) Granular base
(d) New curb and gutter
(e) New sub-drains
(f) Adjust manholes and catch basins
(g) Hot mix (50/100 mm, see Table F-1)

Urban Roads – Design Standard – Concrete Base (Cross Section J)

(a) Excavate base material
(b) Curb and gutter removal
(c) Granular base
(d) Concrete base
(e) New curb and gutter
(f) New sub-drains
(g) Adjust manholes and catch basins
(h) Hot mix (50/100 mm, see Table H-5)

Urban Roads – Design Standard – Concrete Surface (Cross Section O)

(a) Excavate base material
(b) Curb and gutter removal
(c) Granular base
(d) Concrete base and surface
(e) New curb and gutter
(f) New sub-drains
(g) Adjust manholes and catch basins

(RSS) - RECONSTRUCTION INCLUDING INSTALLATION OF STORM SEWERS

Urban Roads – Design Standard – Granular Base (Cross Section K)

(a) Excavate base material
(b) Curb and gutter removal
(c) Storm sewer removal
(d) Manhole and Catch Basin removal including leads
(e) New storm sewers
(f) New manhole and catch basins including leads
(g) New curb and gutter
(h) New sub-drains
(i) Granular base
(j) Hot mix (100/150 mm, see Table F-1

Urban Roads – Design Standard – Concrete Base (Cross Section L)

(a) Excavate base material
(b) Curb and gutter removal
(c) Storm sewer removal
(d) Manhole and Catch Basin removal including leads
(e) New storm sewers
(f) New manhole and catch basins including leads
(g) New curb and gutter
(h) New sub-drains
(i) Granular base
(j) Concrete base
(k) Hot mix (50/100 mm, see Table F-1)

Urban Roads – Design Standard – Concrete Surface (Cross Section Q)

(a) Excavate base material
(b) Curb and gutter removal
(c) Storm sewer removal
(d) Manhole and Catch Basin removal including leads
(e) New storm sewers
(f) New manhole and catch basins including leads
(g) New curb and gutter
(h) New sub-drains
(i) Granular base
(j) Concrete base and surface

(NC) - PROPOSED ROAD CONSTRUCTION

Rural Roads – Design Standard (200 – 399 AADT) (Cross Section H)

(a) Grading
(b) Ditching and cross culverts
(c) Granular base
(d) Double surface treatment

Rural Roads – Design Standard (400 plus AADT) (Cross Section H)

(a) Grading
(b) Ditching and cross culverts
(c) Granular base
(d) Hot mix (50.100 mm, see Table F-1)

Semi-Urban Roads

New Construction does not apply to semi-urban roads as there is no existing frontage development.

Urban Roads – Design Standard – Granular Base (Cross Section K)

(a) Grading
(b) Storm Sewers
(c) Manholes and catch basins including leads
(d) Curb and gutter
(e) Sub-drains
(f) Granular base
(g) Hot mix (100 mm/150 mm, see Table F-1)

Urban Roads – Design Standard – Concrete Base (Cross Section L)

(a) Grading
(b) Storm Sewers
(c) Manholes and catch basins including leads
(d) Curb and gutter
(e) Sub-drains
(f) Granular base
(g) Concrete base
(h) Hot mix (50 mm/100 mm , see Table F-1)

(SRR) - STORM SEWER INSTALLATION AND ROAD REINSTATEMENT (URBAN AND SEMI-URBAN)

Urban and Semi-Urban Roads – Granular Base (Cross Section M)

(a) Trenching and removal of existing storm sewers
(b) New manholes and adjust catch basin leads
(c) New storm sewer including bedding
(d) Granular materials in trench
(e) Hot mix to restore surface grade (100/150 mm, see Table F-1)

Urban and Semi-Urban Roads – Concrete Base (Cross Section N)

(a) Trenching and removal of existing storm sewers
(b) New manholes and adjust catch basin leads
(c) New storm sewers including bedding
(d) Granular material in trench
(e) Concrete base for trenched area
(f) Hot mix to restore surface grade (50/100 mm, See Table F-1)

Urban and Semi-Urban Roads – Concrete Surface (Cross Section R)

(a) Trenching and removal of existing storm sewers
(b) New manholes and adjust catch basin leads
(c) New storm sewers including bedding
(d) Granular material in trench
(e) Concrete base and surface for trenched area

(MICRO) SINGLE LIFT OF MICROSURFACING

Urban, Semi-Urban and Rural Roads with a HCB (High Class Bituminous) surface type

(a) Unit cost per square metre of Microsurfacing

(SST) SINGLE LIFT OF SURFACE TREATMENT

Urban, Semi-Urban and Rural Roads with a LCB (Low Class Bituminous) surface type

(a) Unit cost per square metre of Single Surface Treatment

(SSTplus) SINGLE LIFT OF SURFACE TREATMENT, GEOMETRIC CORRECTION DITCHING IMPROVEMENTS

Semi-Urban and Rural Roads with a LCB (Low Class Bituminous) surface type

(a) Unit cost per square metre of Single Surface Treatment
(b) 20% Surface area padding to 50mm to correct geometric deficiencies
(c) Earth Excavation allowance to provide for minor ditch improvements and berm removal

(DST) DOUBLE LIFT OF SURFACE TREATMENT

Urban, Semi-Urban and Rural Roads with a LCB (Low Class Bituminous) surface type

(a) Unit cost per square metre of Double Surface Treatment

Appendix B: Pavement Structure and Defects

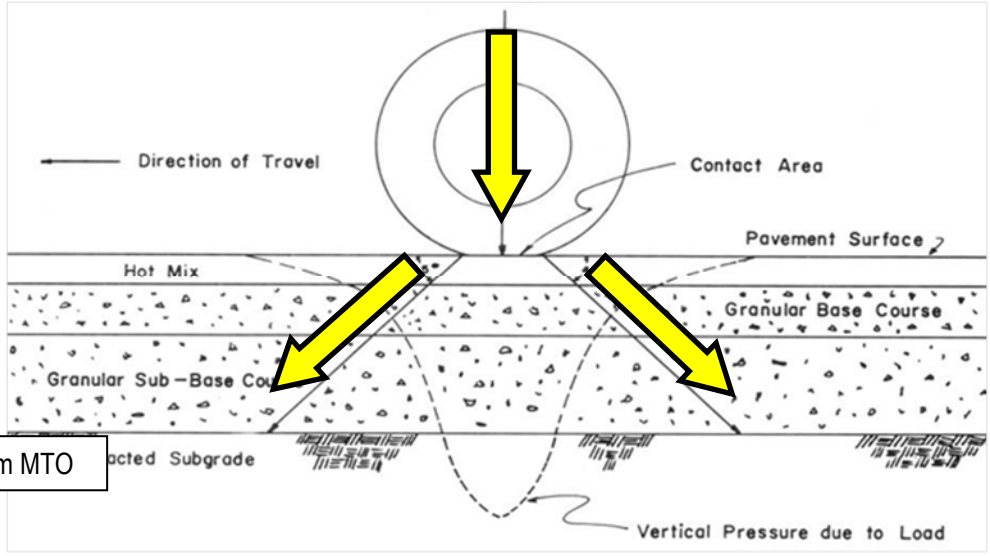
Pavement Structure and Defects

To assist in understanding the content and methodology and recommendations of the report, the following discussion provides an overview of how flexible and rigid pavement structures are designed and function. The majority of municipal roads would be described as having a flexible pavement structure. Hot mix asphalt, surface treatment, and gravel road surfaces are typical flexible pavement road structures. Other pavement structure types include rigid and composite, and are more typically found on 400 series highways, or on arterial roads of larger urban centres.

Flexible Pavement Road Structure

Load is applied to the pavement structure, and ultimately to the native sub-grade, via wheel loads of vehicles. The pavement structure between the native sub-grade and the load application point has to be designed such that the load that is transmitted to the sub-grade is not greater than the sub-grade's ability to support the load. The figure below shows a typical flexible pavement structure and how applied load dissipates.

Figure 1: Load Distribution though Pavement Structure



From MTO

Table 1: Stress vs Depth

Depth Below Surface	Stress (psi)	Stress (Kpa)
At Surface	90	620.50
8" (200 mm) Below	11	75.84
11" (275 mm) Below	7	48.26
16" (400 mm) Below	4	27.58

If the road structure is insufficient to support the imposed load, then dependent on the sufficiency of the native soil, the soil may deform and migrate into the granular base. The granular base is then contaminated -from a geotechnical perspective- and will have reduced capacity to support load.

Surface materials experience the highest loading at the point of contact with the vehicle's tire. Radial truck tires, running from 110 psi to 120 psi (760 kpa to 830 kpa), can have an impact 20 times higher at the surface, than at the

compacted sub-grade, as shown in the above table. The loading actually occurs in three dimensions, in a conical fashion, dissipating both vertically and horizontally as it passes through the pavement structure. Loading decreases exponentially as it passes through the road structure. Therefore, materials of lesser strength, or lesser quality, may be used deeper in the road structure.

As a rule of thumb, the closer the road building materials are placed to the surface of the road, the higher the quality of the material required. Similarly, the poorer the sub-grade, or native material, the deeper/stronger the road structure has to be to carry the same loads.

Traffic counts, particularly the percentage of trucks, are critical to structural design of the pavement. Pavements are designed based on the estimated number of Equivalent Single Axle Loads (ESAL's) over the design period. One ESAL is 8 tonnes, or 80 kN. Depending upon the source, the effect of a single EASL on the pavement structure can be equivalent of up to 12,000 passenger cars. The effect of farm machinery would be very similar to that of heavy trucks. However, the Highway Traffic Act does permit certain types of farm machinery and equipment to use the roads, even during half load season, so this is an additional consideration when designing road structure and particularly low volume rural roads with farm equipment.

Figure 2: Structurally Inadequate Low Volume Road

Pavement evaluation involves a review of each road section and an assessment of the type and extent of the distress(es) observed. Treatment recommendations are predicated by whether the cause of the major distress(es) is structural or non-structural, while also considering other factors such as truck count, drainage, pavement width, etc...

Flexible pavements will have age-related distresses and wearing such as thermal cracking and oxidation. These distresses are non-structural; however, once a crack develops and water enters the pavement structure, deterioration will accelerate. Poor construction practices, quality control, or materials may produce other non-structural surface defects, such as segregation and raveling, which will also result in a reduced life expectancy of the surface asphalt.

Figure 3: Wheelpath Fatigue Cracking

Fatigue cracking indicates structural failure and can manifest itself in many forms, such as wheel path, alligator, and edge cracking. It can be localized or throughout a road section. When roads that have exhibited fatigue cracking are rehabilitated, there should be particular attention paid to the rehabilitation treatment, to ensure that the upgraded facility has sufficient structure.

Flexible Pavement Road Structure Design

There are a number of flexible pavement structural design methodologies and associated software. The simplest way to describe structural design may be the Granular Base Equivalency (GBE) Methodology. This GBE methodology is still used in Ontario by a number of agencies, and is frequently used as a cross-check where more sophisticated analysis has been undertaken.

The measurement is unit-less and relates to the structural value of one millimetre of Granular 'A' material. The relationship of the typical road building materials is expressed in either of the two following ways:

- **1 mm of HMA = 2 mm of Granular A = 3 mm of Granular B**

Or

- **HMA = 2, Granular A = 1, Granular B = 0.67**

To gain some perspective on what this means in terms of typical construction activities, the following table indicates a typical subdivision road construction as expressed in GBE.

Table 2 Granular Base Equivalency

Material	Example 1 Depth	Granular Base Equivalency	Example 2 Depth	Granular Base Equivalency
Hot Mix Asphalt (HMA)	100	200	150	300
Granular A	150	150	300	300
Granular B	300	200	0	0
TOTAL GBE	**550**	**550**	**600**	**600**

When reconstruction and rehabilitation projects are undertaken, and use of alternate materials and/or road structure is contemplated, the GBE concept is important to bear in mind, as different treatments such as Expanded Asphalt and Cold in Place recycling, also have a structural value. For design purposes, it may be prudent to use a conservative equivalency of 1.5 for these products (although, some sources indicate GBE's of up to 1.8).

As an example, if a 200 mm pavement is replaced with 150 mm of Expanded Asphalt or Cold in Place Recycling, with a 50 mm overlay of Hot Mix asphalt, a pavement structure with a GBE of 400 is replaced by a pavement structure with a GBE of 325; a significant difference. (Using a GBE of 1.5 for the Expanded or Cold in Place.) Premature failure will be the result of an under-designed pavement structure, wasting quality resources and available funding.

The purpose of this example is to illustrate the different structural values that products have. Expanded Asphalt and Cold in Place recycling are both excellent products to rehabilitate pavement structures when used appropriately.

The MTO's *Pavement Design and Rehabilitation Manual Second Edition 2013* is an excellent resource for use in pavement structure design and rehabilitation, and is available from the online MTO Catalog.

Thin Lift Pavements

Hot mix asphalt mixes are designed in Ontario either by the Marshall Method or the Superpave Method. Through time, this has resulted in a number of commonly used mixes that are typically sorted by size. One of the parameters used to describe that sizing is the Nominal Maximum Aggregate Size (NMAS).

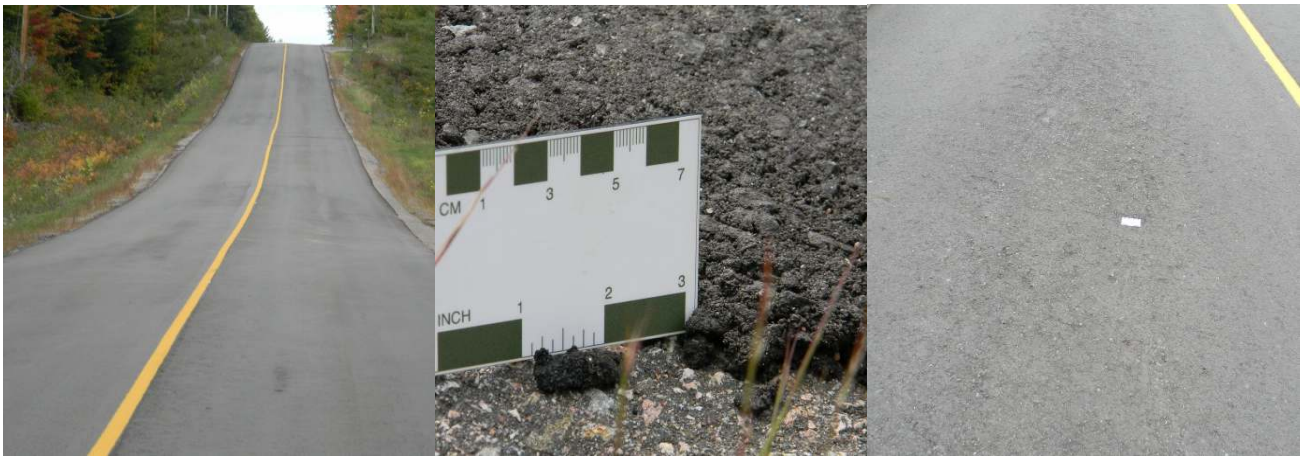
In the Marshall Mix Method, typical mix designations are HL1, HL2, HL3, HL4, and HL8. In the Superpave mix design methodology, mixes are designated by the NMAS. The NMAS is one sieve size larger than the first sieve to retain 10% or more.

The following table identifies the NMAS for the more commonly used mixes, and indicates recommended minimum lift thicknesses for them.

Table 3: Recommended Minimum Lift Thicknesses

Mix Type	NMAS (mm)	Lift Thickness Range (mm)
SP 9.5	9.5	30 to 40
SP 12.5	12.5	40 to 50
SP 19	19.0	60 to 80
HL3	13.2	40 to 55
HL4	16.0	50 to 65
HL8	19.0	60 to 80

Figure 4: Thin Lift Pavement



Thin lift with inappropriate aggregate size

Rigid Pavement Structure

Rigid Pavements are constructed of concrete, or concrete with an asphalt wearing surface. The fundamental difference between a flexible pavement and a rigid pavement is the method in which the load is transferred. Whereas the flexible pavement distributes load through the pavement structure in a conical fashion, with a higher point load directly beneath the loading point, the rigid pavement structure distributes that load in a beam-like fashion, more evenly across the pavement structure. Rigid pavements may have an exposed concrete wearing surface, or they may be covered with an asphaltic concrete wearing surface.

The resulting rigid pavement structure is usually thinner overall, when compared to a flexible pavement, designed to accommodate the same traffic loading. This does not necessarily translate into a reduced cost of construction. Any comparison of costs between flexible and rigid pavements should be on a life cycle basis, for the most accurate assessment.

Older concrete pavements were prone to failure at joints, as load transfer caused a slight movement in the concrete slab, and with the intrusion of water, a structural failure. Newer concrete pavements are designed with improved load transfer technology.

Figure 5 Flexible vs. Rigid Pavement Structure(s)

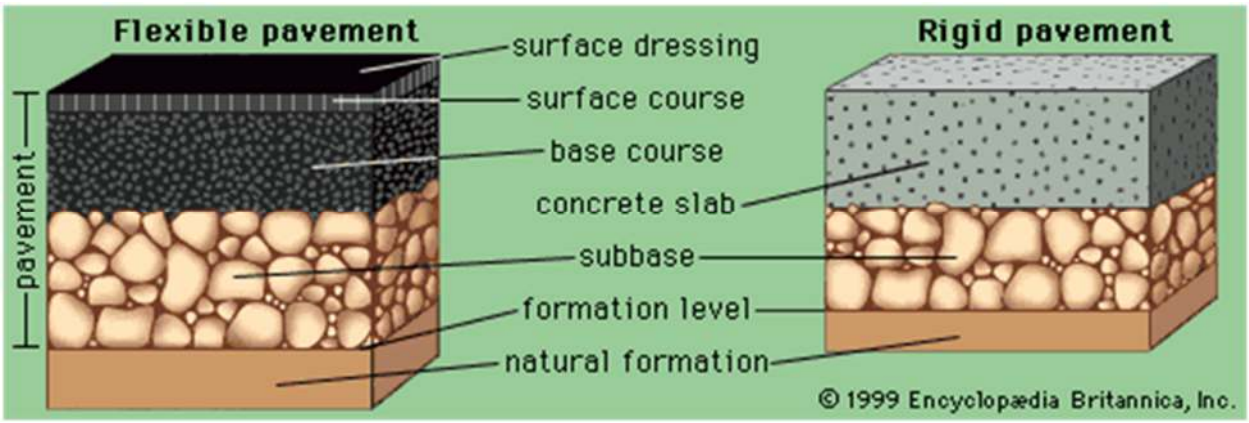
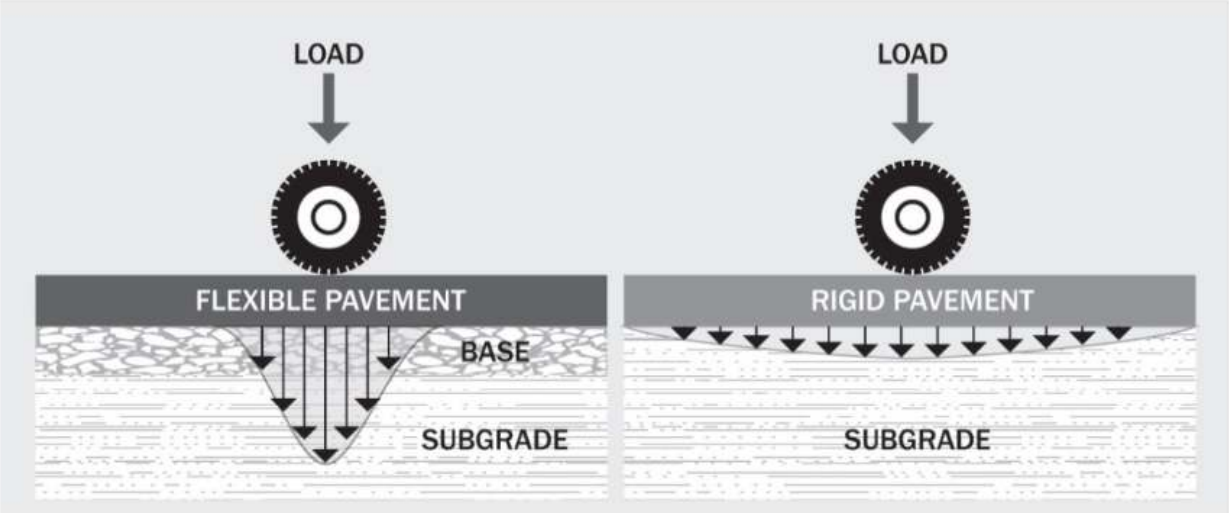


Figure 6: Flexible vs Rigid Pavement Load Distribution (CTAA Hot Mix Asphalt)



Flexible Pavement Distresses and Treatment Selection

Treatment recommendation is dependent upon the condition of the road section at the time of the review.

Treatment Selection – Critical Area Analysis

When using the Inventory Manual methodology all of the 'holistic' needs are considered in the recommendation. For example, a road may appear to require only a resurfacing, however, when the other critical areas are reviewed, there

may be a capacity problem which would then result in a recommendation to resurface and widen (RW) that would address both the pavement condition and the need for additional lanes.

Another example would be where the pavement is exhibiting some type of distress but there is also poor drainage. The recommendation would then be to reconstruct (REC if rural, RSS if urban).

Treatment Selection for Non-Structural Rehabilitation

Resurfacing recommendations are predicated upon the type and extent of distress noted. For example, all pavements will develop thermal/transverse cracking as they age. As the age of the pavement increases, the frequency of the cracking increases. If the spacing of the cracks is still greater than 10m, then the R1 – resurface with one lift of asphalt – treatment will typically be sufficient to restore the road as the treatment provides for overlay and base asphalt repair. However, if the frequency of transverse cracking , which may have become transverse alligator cracking if left unattended too long, then the recommendation will be more extensive, such as a PR2- Pulverize and resurface with 2 lifts of asphalt. The following illustrates transverse cracking.

Figure 7: Transverse /Thermal Cracking (Non Structural)

Reflective Cracking

Paving over an active crack(s) will result in a crack(s) in the same location within 2 to 3 years. As a rule of thumb, the crack will migrate through at approximately 25mm per year. Therefore it would be anticipated that if a 50mm overlay is placed, then the cracking would reappear in approximately 2 years. This is not an efficient usage of available funding.

Figure 8: Reflective Transverse Cracking on Newer Pavement

Treatment Selection for Structural Rehabilitation

Road sections exhibiting structural failure such as fatigue cracking require a more extensive rehabilitation to restore the performance of the road section. In simple terms, placing a single lift of asphalt over structurally failed asphalt will guarantee the same failure in a very short time period. Unless the single lift overlay is placed knowingly as a holding strategy, it should be avoided on structurally deficient pavements. For pavements that have failed structurally or have too frequent transverse cracking, the recommendation is typically PR2 as a minimum provided the drainage is adequate or requires only minor improvement.

Figure 9: Overlay on Failed Pavement and Resultant Reflective Cracking

The above figures illustrate a pavement that has failed both structurally and has very frequent severe transverse cracks. Placement of a 50mm overlay over this type of pavement condition will result in rapid failure and is not recommended, other than if a holding treatment is absolutely necessary. The figure above and to the right illustrates a newer pavement that already has very frequent transverse cracks appearing, likely the result of paving over a failed pavement. Under normal circumstances, the first transverse / thermal cracks generally appear in approximately 4 to 6 years and the cracks are 40m to 50m or more apart. Reflective cracking is dependent on overlay thickness. As a rule of thumb, the cracks will reappear on the surface at approximately 25mm/year. A 50mm overly over a cracked surface will should the underlying defects in approximately 2 years.

Appendix C: Deterioration Curve Detail

Asset Classes and Deterioration Curves for Roads

Asset Classes

In order to utilize the Best Practice and Performance Modeling modules of the WorkTech Asset Manager Foundation software (WT), assets must be defined by an asset class.

Conventional wisdom has been to define road assets by their functional classes such as Arterial, Collector or Local, and then further differentiate by usage, such as residential or commercial. From a performance modeling perspective, using the functional classification will only work to a point, as the traffic on a functional class can and does vary significantly between agencies. There may also be differences in surface materials, which will have different performance and life cycle events.

Functional classifications also vary dependent on the methodology being utilized. Commonly used classification systems have been developed a number of agencies including the Transportation Association of Canada (TAC) and the Ontario Ministry of Transportation (MTO). Both utilize combinations of roadside environment, functional classifications, and in some cases, speed limit. In both these examples, surface materials are not a consideration in the classification.

In Ontario, Regulation 239/02, Minimum Maintenance Standards for Municipal Highways, and Regulation 588/17, Asset Management Planning for Municipal Infrastructure also provide for road asset classification.

The various classification systems all serve a purpose. However, within any given functional classification, roadside environment, surface material, traffic count and commercial traffic counts can vary significantly. Those parameters result in varying performance, replacement and treatment costs. To develop more accurate pavement performance prediction models, parameters that are common to a group of assets have to be accommodated in the road asset classification (and are not accommodated in the aforementioned classification methodologies.) The performance/deterioration of a road section is more predictable based on surface type and traffic volume rather than by functional class.

Based on that philosophy, 4 Roads developed road asset classifications based on by Surface Type, Traffic Volume and Roadside Environment. Roadside Environment has been added to permit the calculation of different replacement costs between rural and urban cross-sections.

Typically, the traffic range for road assets with a gravel (G/S) or surface treated surface (LCB) is quite limited. However, road assets with a hot mix asphalt surface (HCB) may have a significant variance in traffic volume, and a resultant difference in anticipated performance. As such, road assets with more limited traffic ranges have been differentiated by surface type and roadside environment. For HCB road assets the profiles are subdivided by road side environment, and further subdivide into four traffic ranges.

Table 1: Road Asset Surface Materials

Acronym	Description	Acronym	Description
ETH	Earth	C/M	Cold Mix
G/S	Gravel Stone or Other Loose Top	HCB	High Class Bituminous
HFL	High Float, similar to LCB	CON	Concrete
LCB	Low Class Bituminous (Surface Treatment)	A/C	Asphalt over Concrete
ICB	Intermediate Class Bituminous	OTH	Other

Table 2 identifies the road asset classes that have been developed for use in WT by 4 Roads Management Services Inc.

Asset Classes and Deterioration Curves for Roads

Table 2: Road Asset Classes

Asset Class	Subtype	Material	RDSE Envt	AADT Low	AADT High
A/C-R	All	A/C	R	1	100,000
A/C-S	All	A/C	S	1	100,000
A/C-U	All	A/C	U	1	100,000
CM1-R	All	C/M	R	1	3,000
CM1-S	All	C/M	S	1	3,000
CM1-U	All	C/M	U	1	3,000
CON-R	All	CON	R	1	100,000
CON-S	All	CON	S	1	100,000
CON-U	All	CON	U	1	100,000
GST1-R	All	G/S	R	1	10,000
GST1-S	All	G/S	S	1	10,000
HCB1-R	All	HCB	R	20,000	100,000
HCB1-S	All	HCB	S	20,000	100,000
HCB1-U	All	HCB	U	20,000	100,000
HCB2-R	All	HCB	R	10,000	19,999
HCB2-S	All	HCB	S	10,000	19,999
HCB2-U	All	HCB	U	10,000	19,999
HCB3-R	All	HCB	R	1,000	9,999
HCB3-S	All	HCB	S	1,000	9,999
HCB3-U	All	HCB	U	1,000	9,999
HCB4-R	All	HCB	R	1	999
HCB4-S	All	HCB	S	1	999
HCB4-U	All	HCB	U	1	999
ICB-S	All	ICB	S	1	3,000
ICB-U	All	ICB	U	1	3,000
ICB1-R	All	ICB	R	1	3,000
LCB1-R	All	LCB	R	1	2,000
LCB1-S	All	LCB	S	1	2,000
LCB1-U	All	LCB	U	1	2,000

Asset classes are differentiated by surface material, roadside environment and traffic range.

Deterioration Curves

From **ASTM 6433**, Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys, Pavement Condition Index is defined as follows;

> *'2.1.4 pavement condition index (PCI)—a numerical rating of the pavement condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best possible condition.*
>
> *4.1 The PCI is a numerical indicator that rates the surface condition of the pavement. The PCI provides a measure of the present condition of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (localized roughness and safety). The PCI cannot measure structural capacity nor does it provide direct measurement of skid resistance or roughness. It provides an objective and rational basis for determining maintenance and repair needs and priorities. Continuous monitoring of the PCI is used to establish the rate of pavement deterioration, which permits early identification of major rehabilitation needs. The PCI provides feedback on pavement performance for validation or improvement of current pavement design and maintenance procedures.'*

In WorkTech, Physical Condition is the Structural Adequacy multiplied by 5 to produce a score from 5 to 100; very much a parallel to the PCI and its' inherent usage as identified above.

When using the Inventory Manual (IM) methodology, Structural Adequacy is a measurement of the percentage of the surface of the road that is exhibiting distress. The rater will consider the type of distress as well as the other critical areas (surface width, capacity, geometry, drainage, and surface type) in order to provide a recommendation for an improvement. In the IM, any, or multiple of the critical areas, may produce a Time of Need (TON). The overall TON of the road section is the worst of all of the TON's. For example, if five of the TON's are ADEQ, and one is NOW, the section is a NOW need.

All deterioration curves relate to the 'Physical Condition' data field in WorkTech. The Physical Condition deterioration curve is specific to the Inventory Manual and therefore the trigger points and definition of the curve will be different than other methodologies. It should be noted that different evaluation methodologies will produce varying deterioration curves and trigger points. Familiarity with the rating system being utilized is essential.

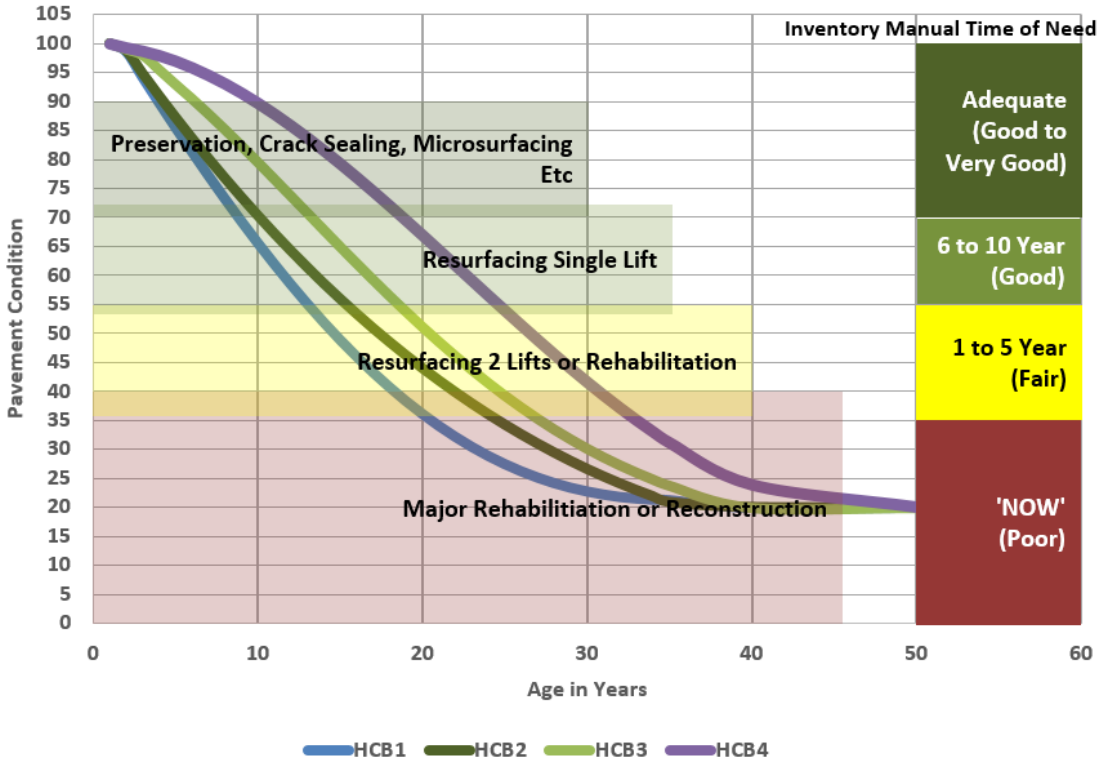
It would be possible, but very difficult, to develop performance models around all of the critical areas. So for the purposes of the performance modeling, Structural Adequacy (distress) has been selected to be the driver in the decisions with respect to the model. This is typical with most performance modeling software.

Models can be configured to weight factors, such as condition, and traffic in project selection to develop a program. From a pure asset management perspective, weighting project selection for best return on investment (ROI) will produce a work plan that most effectively utilizes available funding.

Models may also be configured to select the improvement recommended from the field review or use the deterioration curve based on just the structural rating. Typically, 4 Roads uses the recommended treatment as that should address all of the defects, not just the pavement defects. In the early years of the model, if a project is selected that has a recommended improvement type resultant from the field review, that improvement will be used for the project in the year that it is selected based on the model configuration and available funding. In the later years, presumably after all current deficiencies have been corrected, the model will revert to the assigned asset class for deterioration and project selection based on estimated condition.

The deterioration curves are the same for each asset class regardless of roadside environment. The difference is the improvement and replacement costs; urban treatments are more expensive. For example, for urban sections, the replacement improvement is RSS- Reconstruction with Storm Sewers, rather than REC- Reconstruction Rural.

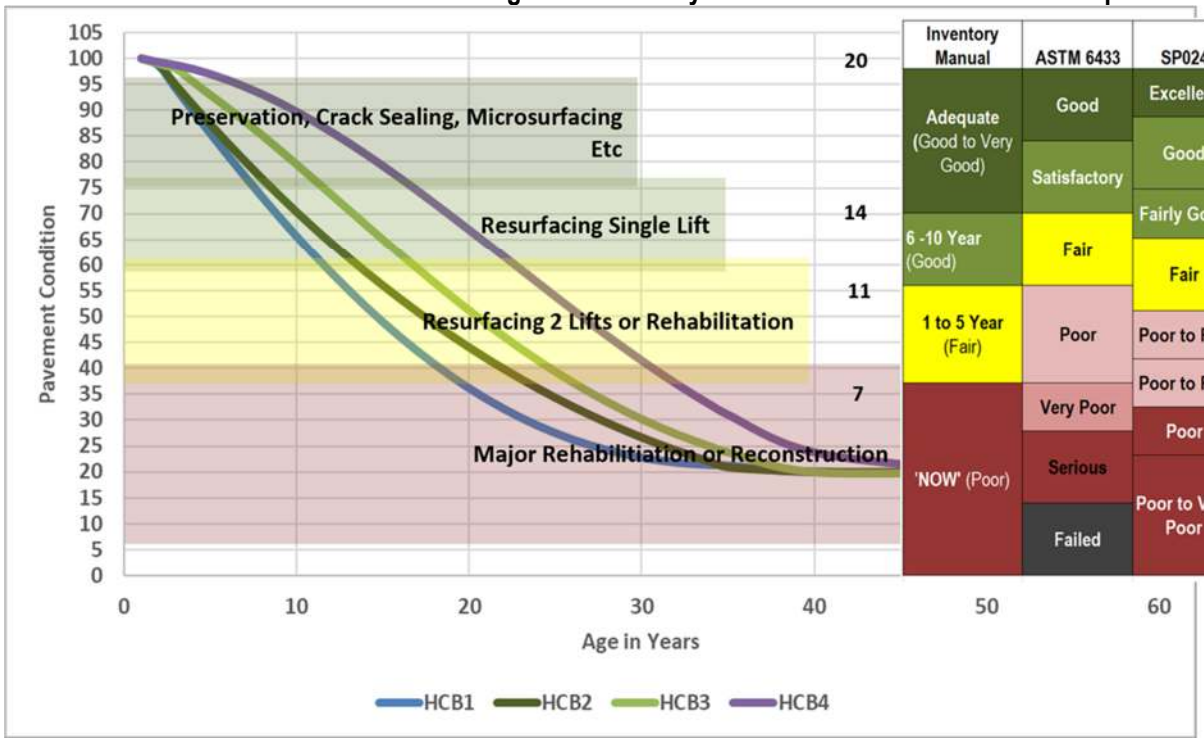
Figure 1: Physical Condition versus Improvement Selection by Hot Mix Asphalt Asset Class



Where the MTO PCI / Inventory Manual Condition Rating format is being used, the PCI data is entered to produce a PCI score from different formulas that represent the defects and weightings by surface type. The PCI score is then used to approximate a Structural Adequacy score (and a Physical Condition). Table 3 identifies the approximations to convert PCI to Structural Adequacy and a Time of Need.

Once a Structural Adequacy Score has been determined, the TON is also calculated. What this achieves is the detail of PCI data collection and the strength of the holistic evaluation of the Inventory Manual.

Figure 2: Inventory Manual / Pavement Condition Comparisons



Inventory Manual	ASTM 6433	SP024	PAV81	
Adequate (Good to Very Good)	Good	Excellent	Excellent	No Maintenance Required
	Satisfactory	Good	Good	Normal Maintenance Only
6 -10 Year (Good)	Fair	Fairly Good	Fairly Good	Resurface in 3-5 years
		Fair	Fair	Resurface within 3 Years
1 to 5 Year (Fair)	Poor	Poor to Fair	Poor to Fair	Reconstruct in 4-5 years or resurface within 2 years with extensive padding
		Poor to Fair	Poor to Fair	Reconstruct in 3-4 years
'NOW' (Poor)	Very Poor	Poor	Poor	Reconstruct in 2-3 years
	Serious	Poor to Very Poor	Poor to Very Poor	Reconstruct within 2 Years
	Failed			

Figure 3:Inventory Manual / Physical Condition Comparison to SP021

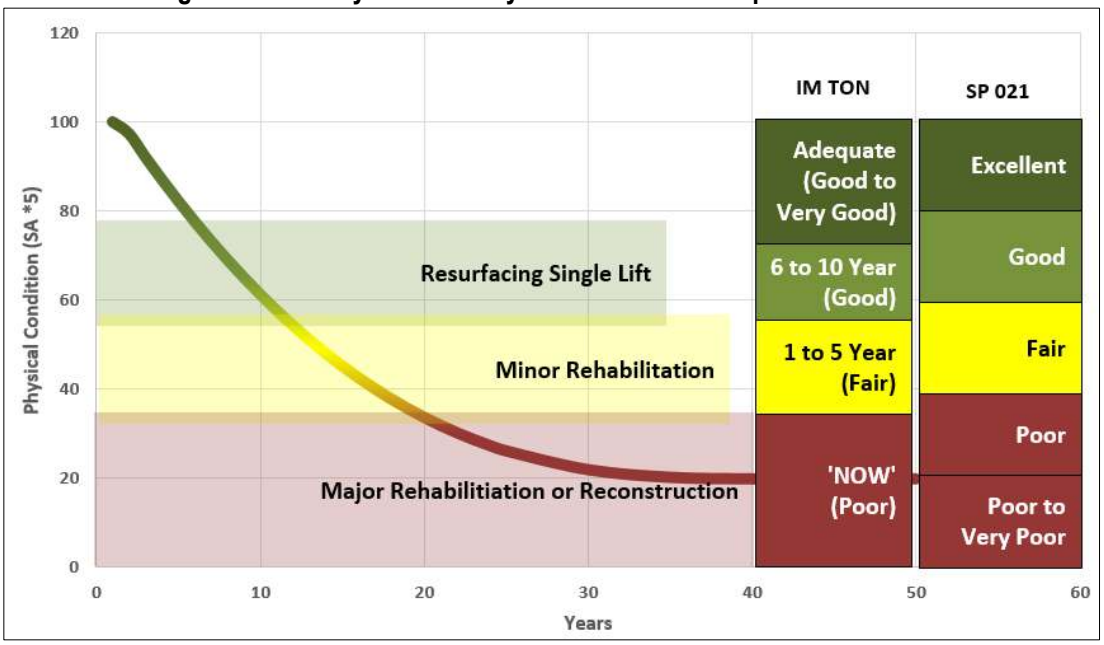
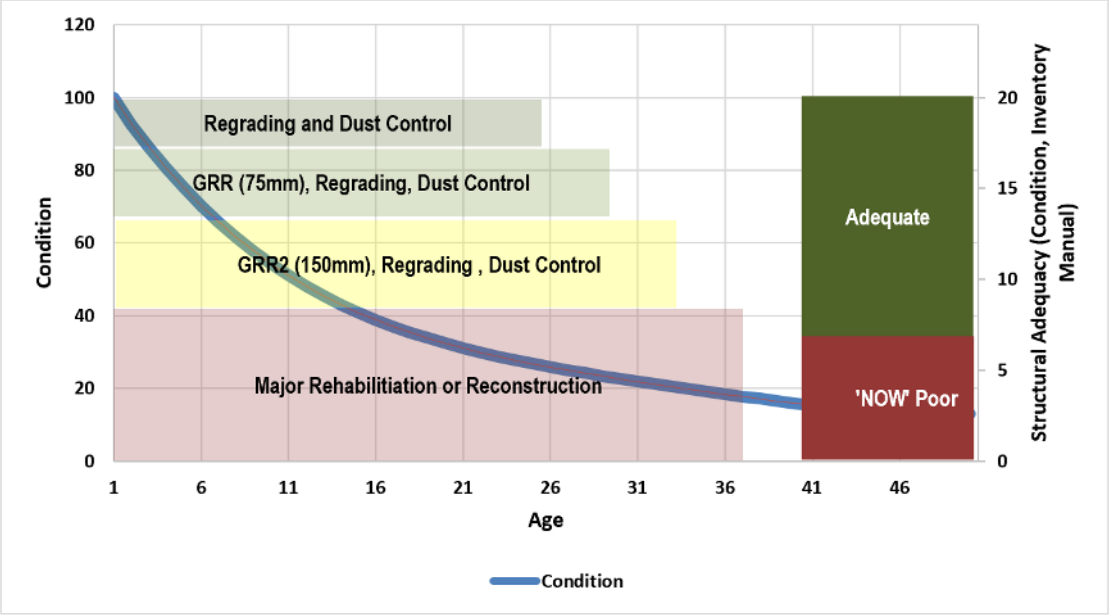


Figure 4: Inventory Manual TON vs Improvement Recommendation for Gravel Roads



Improvement Types- Effect on the Asset

Appendix A of this report includes a summary of the improvement types that are included in the inventory Manual. In WorkTech there is no restriction on what may be developed as an improvement type for a road agency. However, regardless of the improvement types that are used, the effect that the improvement has on the asset has to be understood in order to use performance modeling.

Asset Classes and Deterioration Curves for Roads

Table 4 identifies a number of improvement types and further identifies the effect that they have on a road asset. A similar approach may be taken with other assets.

The effect that a treatment has on an asset is critical to the analysis. Inaccurate determination of the effect of a treatment on an asset will produce an inaccurate – and indefensible- result. The following chart is a comparison of the deterioration of a road section without any treatment applied versus a road section that has appropriate treatment at the optimal condition, producing a more cost effective life cycle.

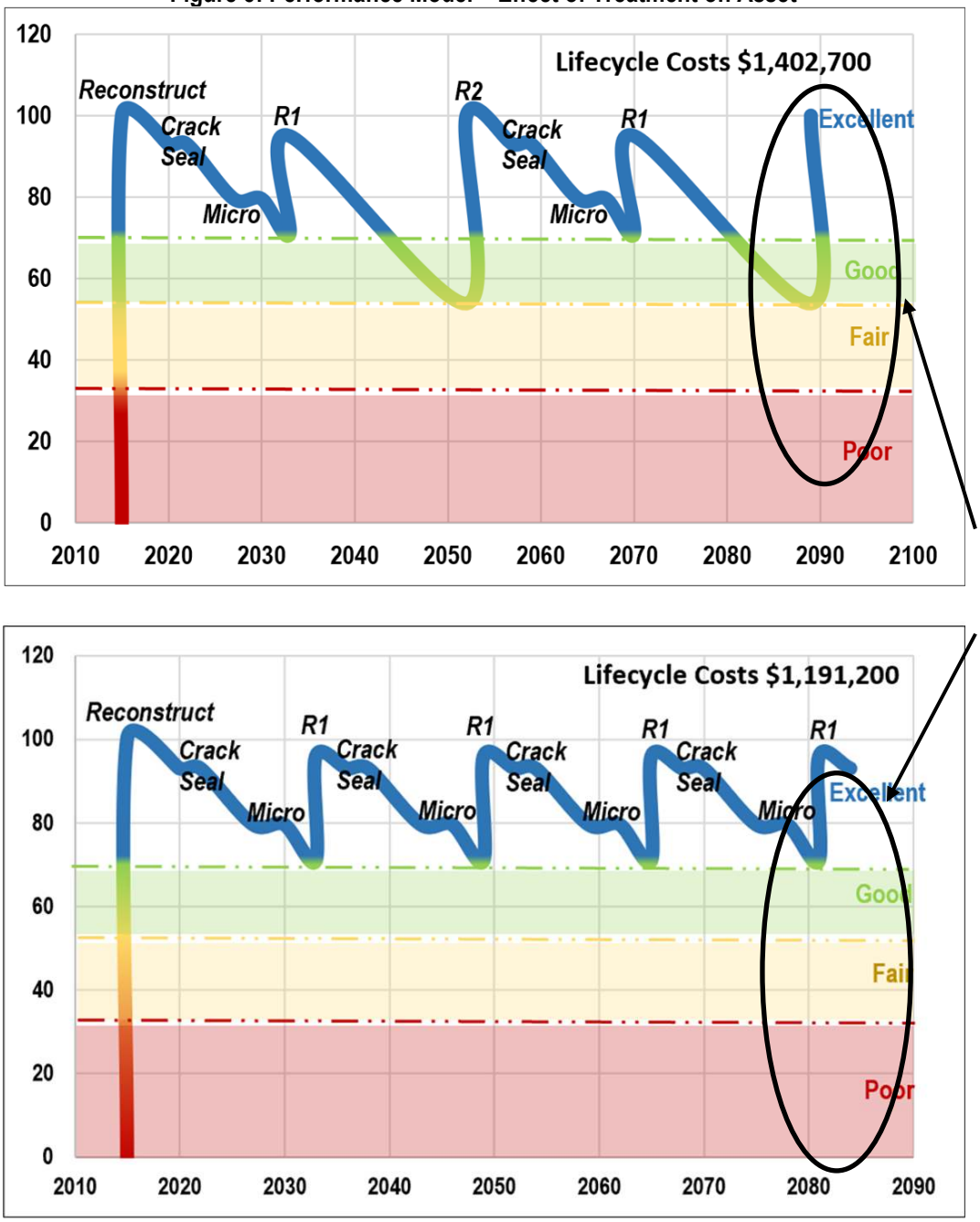
Table 3: Treatment Effect on the Asset

Code	Description	Effect on the Asset
R1	Basic Resurfacing – Single Lift	Increase Physical Condition by 27
R2	Basic Resurfacing – Double Lift	Increase Physical Condition to 100
RM	Major Resurfacing	Increase Physical Condition to 100
PR1	Pulverizing and Resurfacing – Single Lift - Generally not recommended by 4 Roads	Increase Physical Condition to 90
PR2	Pulverizing and Resurfacing – Double Lift –May be substituted with CIR, CIREAM, with appropriate structural investigation	Increase Physical Condition to 100
BS	Base and Surface Tolerable – Tolerable standard for lower volume roads – Rural and Semi-Urban Cross sections only	Increase Physical Condition to 95
RW	Resurface and Widen	Increase Physical Condition to 97
REC	Reconstruction	Increase Physical Condition to 100
RNS	Reconstruction Nominal Storm Sewers (Urban: no new sewer, adjust manholes, catch basins, add sub-drain, remove and replace curb and gutter, granular, and hot mix)	Increase Physical Condition to 100
RSS	Reconstruction including Installation of Storm Sewers (New storm sewers and manholes in addition to the above)	Increase Physical Condition to 100
NC	Proposed Road Construction	Increase Physical Condition to 100
NONE	No Improvement Recommended	No Effect
SRR	Storm Sewer Installation and Road Reinstatement	No Effect
CRK	Crack Sealing	Hold Physical Condition for 2 Years
MICRO	Microsurfacing	Hold Physical Condition for 3 years
GRR	Gravel Road Resurfacing – add 75mm	Hold Physical Condition for 3 years
GRR2	Gravel Road Resurfacing - Add 150mm	Increase Physical Condition by 20
SST	Single Surface Treatment	Increase Physical Condition to 90
DST	Double Surface Treatment	Increase Physical Condition to 95
DSTrehab	Double Surface Treatment Rehabilitation- Pulverize, Add 75mm Aggregate, Double Surface Treat to edge of rounding, Ditching	Increase Physical Condition to 95

Performance Model Project Selection

From a pure asset/pavement management perspective, 4 Roads believes that project selection based on return on investment of the improvement type will produce a work plan that optimizes available funding. Typically, if the return on investment (ROI) scenario is selected, the preservation and resurfacing activities offer the highest ROI and are prioritized within the work plan model.

Figure 5: Performance Model – Effect of Treatment on Asset



Notes: *Lifecycle activities will depend on initial design and asphalt thickness*

Top graph may more closely resemble a perpetual pavement life cycle; bottom graph may more closely resemble a lower volume road such as in a subdivision

Figure 5 illustrates several different aspects of performance model output including the effect of a treatment on an asset and the effect of multiple treatments undertaken at the optimal asset condition to produce a cost effective management strategy.

Similar calculations are utilized to determine the scenario ROI and the improvement type ROI. The following is excerpted from the WorkTech Manual.

Scenario Return on Investment

$$ROI = \frac{(End\ of\ Scenario\ Asset\ Value - Do\ Nothing\ Asset\ Value)}{Total\ Budget\ (all\ years)}$$

Improvement Type Return on Investment

$$ROI = \frac{(Value\ if\ Funded - Do\ Nothing\ Value)}{Improvement\ Cost.}$$

Within any given scenario, weightings may be applied that will affect project selection. Weighting factors may be applied for best condition, worst condition

Calculation Methods (from the WorkTech Manual)

The calculation method choice tells the program whether to determine budget needs or, optimize a given budget. Choices are as follows

- ***Calculate Budget to Maintain Current Average Condition**. The program will determine the budget and work plan to keep the average condition for each service class at the current level. For example, if Arterial Roads are at an average condition of 72, the program will determine what is needed to maintain the average condition of 72.*
- ***Calculate Budget to Produce Desired Average Condition**. The program will determine the budget and work plan required to produce the entered average condition value at the end of the scenario.*
- ***Calculate Results for Entered Budgets**. You will enter the available budget by year and the program will optimize this based on your spending objective.*

Spending Objective (from the WorkTech Manual)

With any of the above Calculation Methods the program needs to make choices on which improvements to fund. The program will do this based on your spending objective. You have the option of selecting one of several pre-defined objectives or, creating a custom spending priority objective. Options for your spending objective are as follows

Return on Investment *The program will prioritize work that results in the highest return on investment.*

$$ROI = \frac{(Asset\ Value\ if\ Work\ is\ Funded - Do\ Nothing\ Asset\ Value)}{Cost\ of\ Required\ Work}$$

Needs Savings *The program will prioritize work which results in the highest reduction in Needs.*

$$Needs\ Savings\ Percent = \frac{(Current\ Needs - Next\ Year\ Needs\ if\ work\ is\ Funded)}{Cost\ of\ Required\ Work}$$

Best Condition *The program will prioritize assets based on condition value.*

Lowest Condition	*The program will prioritize assets based on inverse condition (1 / condition)*
Custom	*Displays the Custom Priority Setup Group Box. May be defined by one or more weighting formulas.*
	Weighting types may include ROI, Needs Savings, Inverse Condition, Service Class and AADT or combinations thereof.

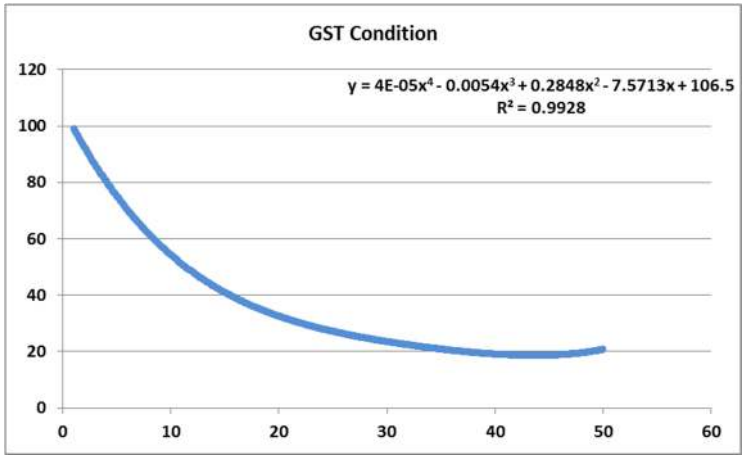
Deterioration Curves by Surface Type and Traffic Volume

The following pages includes tables and graphs indicating the anticipated performance of an appropriately constructed road asset and the condition triggers for treatments. The deterioration curves by asset class used in concert with the table indicating the treatment effect on the asset, and the agency's unit costs, will produce a performance model that demonstrates the effect on the system at various budget levels and produce a program based on input parameters.

Asset Classes and Deterioration Curves for Roads

Gravel Roads- All Roadsides, all AADT

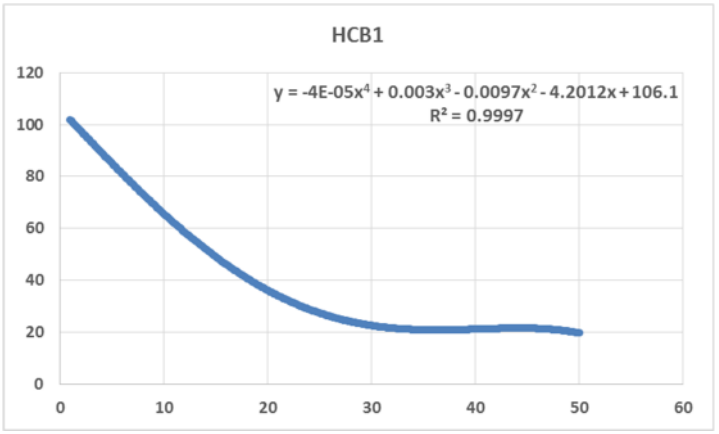
Year	Condition	Imp Type	Description
1	100	NONE	No Improvement Required
2	92.45	NONE	No Improvement Required
3	86.21	GRR	75mm of Granular A
4	80.43	GRR	75mm of Granular A
5	75.11	GRR	75mm of Granular A
6	70.21	GRR	75mm of Granular A
7	65.7	GRR2	150mm of additional Gravel
8	61.55	GRR2	150mm of additional Gravel
9	57.75	GRR2	150mm of additional Gravel
10	54.27	GRR2	150mm of additional Gravel
11	51.07	GRR2	150mm of additional Gravel
12	48.15	GRR2	150mm of additional Gravel
13	45.48	GRR2	150mm of additional Gravel
14	43.04	GRR2	150mm of additional Gravel
15	40.81	BS	Base and Surface
16	38.77	BS	Base and Surface
17	36.9	BS	Base and Surface
18	35.2	REC	Reconstruction - Rural
19	33.63	REC	Reconstruction - Rural
20	32.19	REC	Reconstruction - Rural
21	30.86	REC	Reconstruction - Rural
22	29.64	REC	Reconstruction - Rural
23	28.51	REC	Reconstruction - Rural
24	27.45	REC	Reconstruction - Rural
25	26.47	REC	Reconstruction - Rural
30	22.28	REC	Reconstruction - Rural
35	18.88	REC	Reconstruction - Rural
40	20	REC	Reconstruction - Rural
45	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural



Asset Classes and Deterioration Curves for Roads

HCB1 All Roadsides- AADT > 20,000, assumes 10% Commercial

Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	98.61	NONE	No Improvement Required
3	94.19	NONE	No Improvement Required
4	89.83	CRK	Crack Sealing
5	85.55	CRK	Crack Sealing
6	81.36	CRK	Crack Sealing
7	77.26	MICRO	Microsurfacing -Pavement Preservation
8	73.28	MICRO	Microsurfacing -Pavement Preservation
9	69.4	R1	Basic Resurfacing 1 - 50mm
10	65.65	R1	Basic Resurfacing 1 - 50mm
11	62.02	R1	Basic Resurfacing 1 - 50mm
12	58.54	R1	Basic Resurfacing 1 - 50mm
13	55.19	R2	Basic Resurfacing 2 - 100mm
14	52	R2	Basic Resurfacing 2 - 100mm
15	48.96	R2	Basic Resurfacing 2 - 100mm
16	46.08	R2	Basic Resurfacing 2 - 100mm
17	43.36	R2	Basic Resurfacing 2 - 100mm
18	40.81	R2	Basic Resurfacing 2 - 100mm
19	38.41	R2	Basic Resurfacing 2 - 100mm
20	36.19	REC	Reconstruction - Rural
22	32.24	REC	Reconstruction - Rural
23	30.51	REC	Reconstruction - Rural
24	28.95	REC	Reconstruction - Rural
25	27.55	REC	Reconstruction - Rural
26	26.3	REC	Reconstruction - Rural
27	25.21	REC	Reconstruction - Rural
28	24.27	REC	Reconstruction - Rural
29	23.47	REC	Reconstruction - Rural
30	22.82	REC	Reconstruction - Rural
35	21.31	REC	Reconstruction - Rural
40	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural

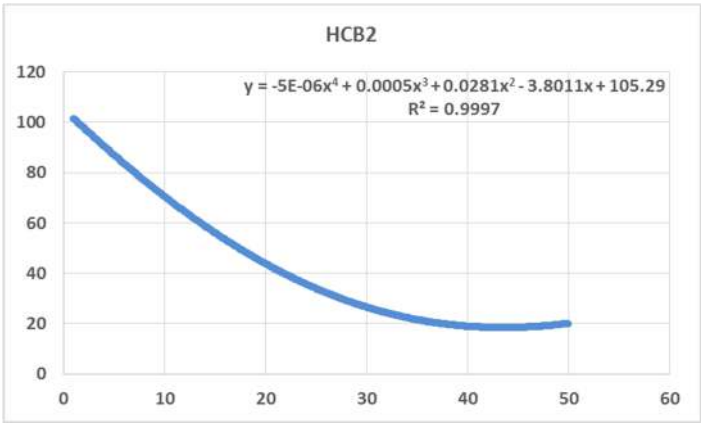


Where 'REC' is specified, 'RSS' is utilized for an Urban Roadside Environment

Asset Classes and Deterioration Curves for Roads

HCB 2 All Roadsides- AADT >10,000 <20,000, Assumes 10% Commercial

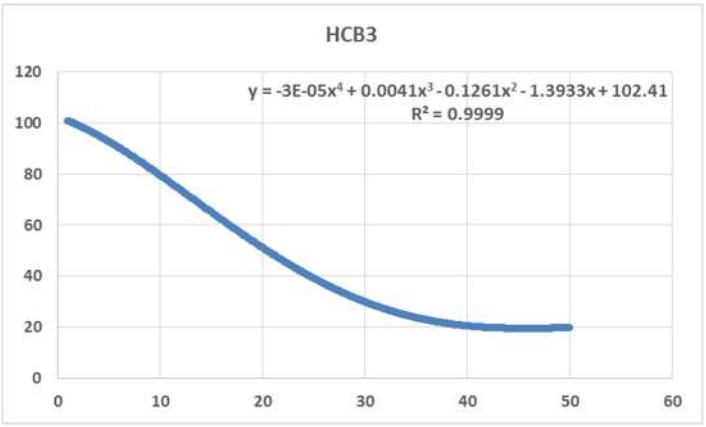
>Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	98.79	NONE	No Improvement Required
3	94.85	NONE	No Improvement Required
4	91.01	CRK	Crack Sealing
5	87.29	CRK	Crack Sealing
6	83.68	CRK	Crack Sealing
7	80.18	CRK2	Crack Sealing
8	76.79	MICRO	Microsurfacing -Pavement Preservation
9	73.51	MICRO	Microsurfacing -Pavement Preservation
10	70.33	R1	Basic Resurfacing 1 - 50mm
11	67.26	R1	Basic Resurfacing 1 - 50mm
12	64.28	R1	Basic Resurfacing 1 - 50mm
13	61.41	R1	Basic Resurfacing 1 - 50mm
14	58.63	R1	Basic Resurfacing 1 - 50mm
15	55.95	R2	Basic Resurfacing 2 - 100mm
16	53.38	R2	Basic Resurfacing 2 - 100mm
17	50.89	R2	Basic Resurfacing 2 - 100mm
18	48.5	R2	Basic Resurfacing 2 - 100mm
19	46.2	R2	Basic Resurfacing 2 - 100mm
20	43.99	R2	Basic Resurfacing 2 - 100mm
21	41.87	R2	Basic Resurfacing 2 - 100mm
22	39.84	R2	Basic Resurfacing 2 - 100mm
23	37.89	R2	Basic Resurfacing 2 - 100mm
24	36.03	R2	Basic Resurfacing 2 - 100mm
25	34.26	REC	Reconstruction - Rural
26	32.56	REC	Reconstruction - Rural
27	30.95	REC	Reconstruction - Rural
28	29.42	REC	Reconstruction - Rural
29	27.97	REC	Reconstruction - Rural
30	26.59	REC	Reconstruction - Rural
35	20.86	REC	Reconstruction - Rural
40	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural



Where 'REC' is specified, 'RSS' is utilized for an Urban Roadside Environment

HCB 3 All Roadsides – AADT 1,000 < 10,000, Assumes 10% Commercial

>Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	99.44	NONE	No Improvement Required
3	97.46	NONE	No Improvement Required
4	95.29	NONE	No Improvement Required
5	92.95	CRK	Crack Sealing
6	90.48	CRK	Crack Sealing
7	87.88	CRK2	Crack Sealing
8	85.18	CRK2	Crack Sealing
9	82.4	CRK2	Crack Sealing
10	79.56	MICRO	Microsurfacing -Pavement Preservation
11	76.67	MICRO	Microsurfacing -Pavement Preservation
12	73.76	MICRO	Microsurfacing -Pavement Preservation
13	70.83	R1	Basic Resurfacing 1 - 50mm
14	67.91	R1	Basic Resurfacing 1 - 50mm
15	65.01	R1	Basic Resurfacing 1 - 50mm
16	62.14	R1	Basic Resurfacing 1 - 50mm
17	59.31	R1	Basic Resurfacing 1 - 50mm
18	56.54	R1	Basic Resurfacing 1 - 50mm
19	53.83	R2	Basic Resurfacing 2 - 100mm
20	51.19	R2	Basic Resurfacing 2 - 100mm
21	48.63	R2	Basic Resurfacing 2 - 100mm
22	46.17	R2	Basic Resurfacing 2 - 100mm
23	43.8	R2	Basic Resurfacing 2 - 100mm
24	41.53	R2	Basic Resurfacing 2 - 100mm
25	39.37	R2	Basic Resurfacing 2 - 100mm
26	37.31	R2	Basic Resurfacing 2 - 100mm
27	35.37	R2	Basic Resurfacing 2 - 100mm
28	33.54	REC	Reconstruction - Rural
29	31.82	REC	Reconstruction - Rural
30	30.22	REC	Reconstruction - Rural
35	23.83	REC	Reconstruction - Rural
40	20	REC	Reconstruction - Rural
45	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural

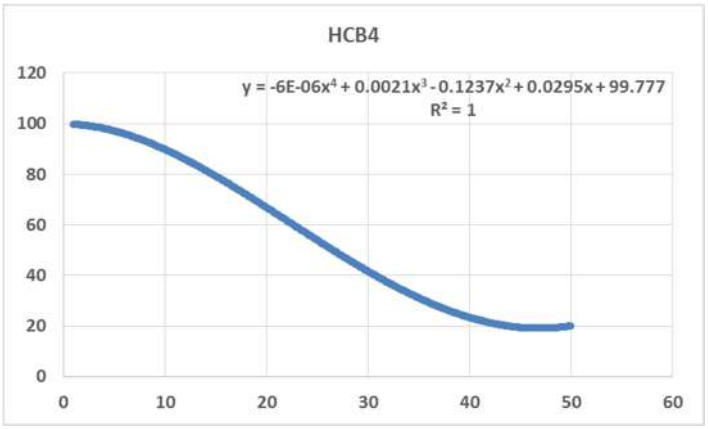


Where 'REC' is specified, 'RSS' is utilized for an Urban Roadside Environment

Asset Classes and Deterioration Curves for Roads

HCB 4 All Roadsides- AADT <1,000, Assumes 5% Commercial

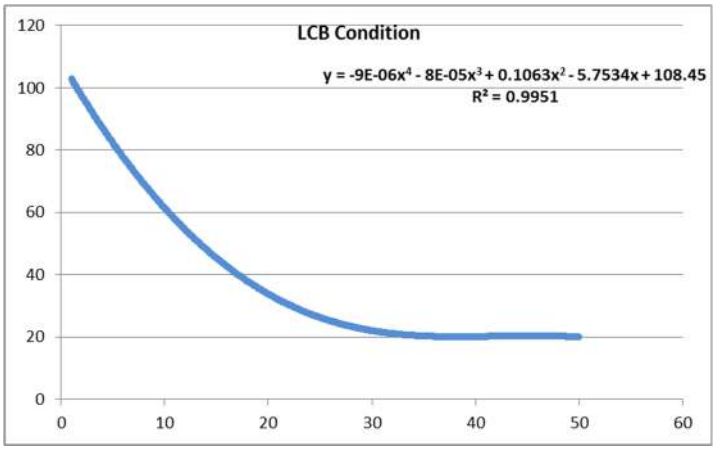
Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	99.3	NONE	No Improvement Required
3	98.73	NONE	No Improvement Required
4	97.96	NONE	No Improvement Required
5	97	CRK	Crack Sealing
6	95.86	CRK	Crack Sealing
7	94.55	CRK	Crack Sealing
8	93.09	CRK	Crack Sealing
9	91.48	CRK	Crack Sealing
10	89.73	CRK	Crack Sealing
11	87.85	CRK	Crack Sealing
12	85.85	CRK	Crack Sealing
13	83.76	CRK	Crack Sealing
14	81.56	CRK	Crack Sealing
15	79.27	MICRO	Microsurfacing – Pavement Preservation
16	76.91	MICRO	Microsurfacing – Pavement Preservation
17	74.48	MICRO	Microsurfacing – Pavement Preservation
18	72	MICRO	Microsurfacing – Pavement Preservation
19	69.47	R1	Basic Resurfacing 1 - 50mm
20	66.91	R1	Basic Resurfacing 1 - 50mm
21	64.32	R1	Basic Resurfacing 1 - 50mm
22	61.71	R1	Basic Resurfacing 1 - 50mm
23	59.1	R1	Basic Resurfacing 1 - 50mm
24	56.5	R1	Basic Resurfacing 1 - 50mm
25	53.91	R2	Basic Resurfacing 2 - 100mm
26	51.35	R2	Basic Resurfacing 2 - 100mm
27	48.82	R2	Basic Resurfacing 2 - 100mm
28	46.33	R2	Basic Resurfacing 2 - 100mm
29	43.91	R2	Basic Resurfacing 2 - 100mm
30	41.55	R2	Basic Resurfacing 2 - 100mm
35	31.1	REC	Reconstruction - Rural
40	23.85	REC	Reconstruction - Rural
45	21.06	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural



Where 'REC' is specified, 'RSS' is utilized for an Urban Roadside Environment

LCB All roadsides – All AADT's

Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	98.61	NONE	No Improvement Required
3	94.19	NONE	No Improvement Required
4	89.84	NONE	No Improvement Required
5	85.56	NONE	No Improvement Required
6	81.36	NONE	No Improvement Required
7	77.26	SST	Single Surface Treatment
8	73.28	SST	Single Surface Treatment
9	69.4	SST	Single Surface Treatment
10	65.65	SST	Single Surface Treatment
11	62.02	SST	Single Surface Treatment
12	58.54	SST	Single Surface Treatment
13	55.19	SST	Single Surface Treatment
14	52	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
15	48.96	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
16	46.08	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
17	43.36	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
18	40.81	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
19	38.41	DSTrehab	Double Surface Treat Rehab inc Spot Drainage
20	36.19	REC	Reconstruction - Rural
21	34.13	REC	Reconstruction - Rural
22	32.24	REC	Reconstruction - Rural
23	30.51	REC	Reconstruction - Rural
24	28.95	REC	Reconstruction - Rural
25	27.55	REC	Reconstruction - Rural
30	22.82	REC	Reconstruction - Rural
35	21.31	REC	Reconstruction - Rural
40	21.92	REC	Reconstruction - Rural
45	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural



Where 'REC' is specified, 'RSS' is utilized for an Urban Roadside Environment

Appendix D: Gravel Road Conversions

Gravel Road Conversion Overview

Gravel roads tend to be the 'forgotten' asset. Gravel roads form an integral component of the road asset group for a large number of municipalities and should be managed as any other asset.

Most aspects of municipal service delivery are in fact an asset management decision. The decision whether to surface treat a road, or have the road remain as a gravel surface, is very much an asset management decision.

This report provides a recommended annual cost for gravel road maintenance of 75mm additional gravel to be added every three years, and does not included regular grading or dust control costs. The additional 75mm of gravel was a typical standard that was used in the past by many municipalities. Due to the natural life cycle wear and tear, maintenance, and winter control activities, gravel roads require additional gravel on a regular basis to ensure continuing performance.

One of the difficulties in determining the deterioration of a gravel road is that the wearing surface and the granular layers are one and the same, so the extent of deterioration may not be as obvious until the deterioration is significant. Appropriate gravel road maintenance can be deceptively expensive. Frequently, high level budget analysis proves that the per-kilometre cost of adequate gravel road maintenance is greater than the per-kilometre cost for hard top maintenance. This is further exacerbated as traffic volume on a gravel road increases.

Road agencies in both Canada and the United States have conducted studies that have generally indicated that, dependent upon local unit costs, gravel road conversion to hardtop can be a cost-effective management strategy. One source indicates that this may be effective management for roads with traffic volumes as low as 100 AADT.

A number of factors have to be assessed and analysed to render an appropriate decision such as:

- Traffic volumes
- Material costs
- Anticipated life cycle costs (and unit costs)
- Anticipated performance
- Current condition of the road, drainage, width, etc

With respect to traffic volumes,

- The Ministry of Transportation's Inventory Manual for Municipal Roads, 1991, deemed that a gravel road with over 400 AADT was a 'NOW' need and required a hard top surface
- Applied Research Technology prepared a report in 2002 for the United States Federal Highways Administration (USFHA) and the State of South Dakota, which determined that user costs were lower for roads with some type of hard surface vs roads with gravel or stabilized gravel surfaces
- The USFHA Gravel Roads Maintenance and Design Manual suggests in Appendix D of that document that the average daily volumes used to justify conversion to hard to range for 50 AADT to 400 AADT. Decisions are all reflective of assessed construction, maintenance and user costs.

If the argument for conversion may be made from a financial perspective, then there are additional factors that should be considered from physical and risk perspectives. Other factors for consideration include:

- Platform width
- Drainage
- Structural Adequacy
- Traffic Volume and Type

Conversion candidates should have a width that meets or exceeds the minimum standard width for the traffic volume of the road section plus minimum 0.5 metre shoulder, be ***structurally sound***, and have good drainage. Structural soundness may be obtained through geotechnical examination or documented past performance. A decision matrix for gravel road conversion may be found at the end of this document.

Benefits to converting a gravel road include:

- Customer satisfaction
- Reduced maintenance costs for routine maintenance
- Reduced maintenance costs for winter maintenance, dependent upon local practices
- Reduced complaints

Analysis Methods

Like other road assets, gravel roads have lifecycle maintenance and rehabilitation costs that should be addressed as part of any asset management plan. Life cycle costs include regular addition of gravel, dust control, grading and labour. Grading will typically include equipment costs for a motor grader.

There are a number of potential tools that may be used to assist in the analysis and decision to convert a gravel surface to hard. A Net Present Value Analysis (NPV) or a performance model are two methods that may be used to develop a decision.

Net Present Value (NPV) Analysis

Process

Given the above noted, a Net Present Value (NPV) assessment of the gravel road, in comparison with a surface treated road section or other hard top surface, should be undertaken as it may be more cost-effective to convert/upgrade the gravel road to a hard surface; typically surface treatment. The NPV analysis will compare the lifecycle costs for status quo and conversion assuming inflation rates and discounts rates for the analysis period.

It is preferable to address the cost comparisons over a period of time where the life cycles may conclude concurrently. For instance, if the gravel maintenance is on a three year basis and the surface treatment is seven, then the cycles coincide at 21 years. Total life cycle cost over that time period should be considered. Whatever other surface type is being compared with the gravel road surface should include the same factors as for gravel so there is a 1:1 comparison.

Equipment

As part of a holistic review of service delivery, consideration should be given to the equipment hourly rates and replacement. *Accurate* hourly rates are required to provide a true assessment. Equipment rates should include capital depreciation/replacement and operating costs.

One of the factors driving the overall cost is the equipment that is required to properly maintain a gravel road system - particularly graders. Part of the gravel road conversion analysis should include:

- Has the hourly rate for the equipment been calculated properly to include capital depreciation and maintenance costs?

  - A new grader will typically cost close to $500,000. At a 20-year life span, there is a minimum of $25,000 in annual capital depreciation alone on the grader. If the grader were replaced on a 10 year cycle, the annual capital depreciation would be $50,000.
  - What is the current rate for the grader? If there is not full cost recovery on the grader hourly rate, then the cost for gravel road maintenance is not accurate either.
- Is the grader used for any other purpose/activities?
- What is the length of the gravel road system? A commonly used measure to justify a grader is 75 kilometres of gravel for each grader.
- How many hours per year is the grader operated?
- Are there other pieces of equipment that could be used or rented to maintain the gravel roads?

As a rule of thumb, one grader is required for approximately 75 kilometres of gravel roads, dependent upon the distribution of the gravel roads across the system. The current replacement cost of a grader is in the $500,000 range and yearly usage may not be that high, which translates into a higher hourly rate for the equipment.

Performance Model -Gravel vs Surface Treatment

The following is a high level analysis using a performance model. Unit costs for this analysis are not specific to an individual agency but are representative of user costs experienced in 2020. Unit costs used for the evaluations are as follows.

Table 1: Unit Costs

Item ID	Description	Unit Price	Units
UPExcavate	Excavation	15	m3
UPGranA	Granular A	20	tonne
UPGranB	Granular B	15	tonne
UPDSurfTr	Double Surface Treatment	7	m2
UPSSurfTr	Single Surface Treatment	3.5	m2

Assumptions

- Both road sections are the same length
- Both were in the same initial condition
- Both were rehabilitated to the same standard, ditching, a total of 300mm of Granular material. In addition, one section received a double surface treated surface (the other remained as gravel)
- All calculations are in current dollars; no adjustments for inflation or discounts rates
- Gravel roads would receive a 75mm layer of gravel every 3 years.
  - At a lesser condition the gravel section would receive a 150mm lift.
- Surface treated roads would theoretically receive a re-treatment every 7 years
- Surface Treatment does not have a structural value
- Cost for gravel road regrading and dust control are not included

The discussion focuses on modelling 2 sections as described above.

The model is set to make decisions based on anticipated deterioration of the assets and an analysis of the best Return on Investment for the model and for the treatment selection. Formulae for the ROI analysis are as follows;

From the WorkTech Manual;

Scenario Return on Investment

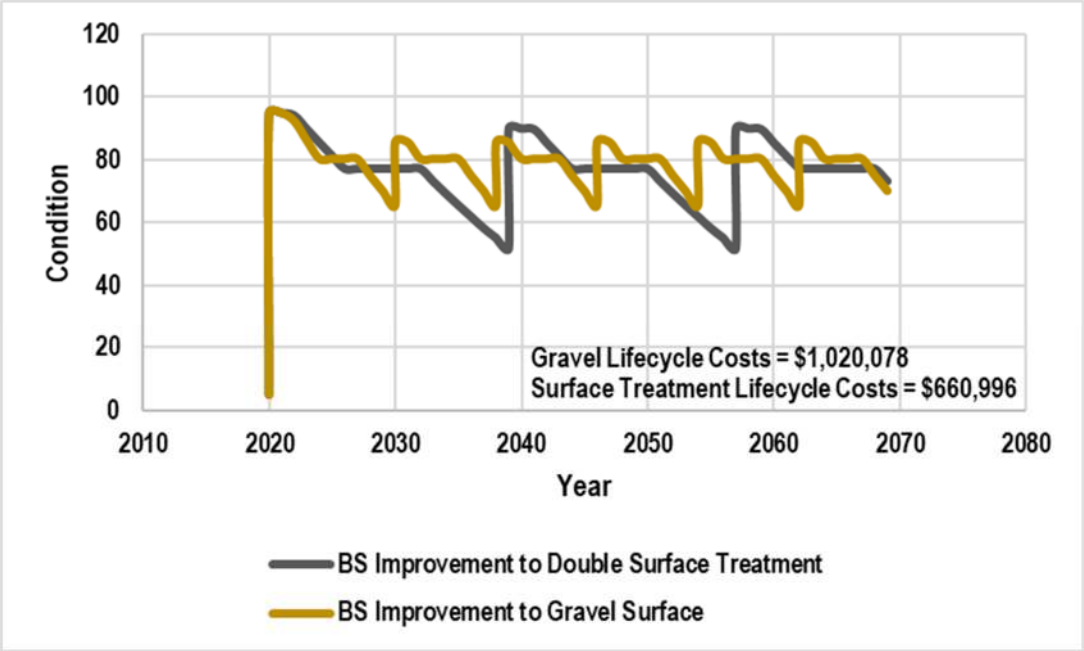
$$ROI = \frac{(End\ of\ Scenario\ Asset\ Value - Do\ Nothing\ Asset\ Value)}{Total\ Budget\ (all\ years)}$$

Improvement Type Return on Investment

$$ROI = \frac{(Value\ if\ Funded - Do\ Nothing\ Value)}{Improvement\ Cost.}$$

Deterioration curves are shown at the end of the document

Figure 1: Performance Model Output



The model shows a significant cost differential between the sections over the 50 year period

The payback period is approximately 12 years; the costs for both service delivery models are similar at this juncture. Going forward, the gravel costs contribute to a much higher life cycle cost.

For the gravel roads, the model initially selects a 75mm layer of material and then lets the condition deteriorate to the condition where 150mm of material is required. This sequence of events repeats throughout the remainder of the model.

For the surface treated road, the model treatment selection is similar. Initially it selects a single surface treatment, then allows the condition to reduce to the point where a surface treatment with some padding is required and the analysis shows it offered a better ROI.

This is a simple analysis. Analyses conducted by other sources have included vehicle costs, the aforementioned maintenance costs etc. Maintenance cost assessment should be conducted using appropriate equipment rates.

Asset Management Perspective

Ontario Regulation 588/17, Asset Management Planning for Municipal Infrastructure, provides significant guidance in the development of the asset management plan and states in part

> *"4. For each asset category, the lifecycle activities that would need to be undertaken to maintain the current levels of service as described in paragraph 1 for each of the 10 years following the year for which the current levels of service under paragraph 1 are determined and the costs of providing those activities based on an assessment of the following:*
>
> *I. The full lifecycle of the assets.*
>
> *ii. The options for which lifecycle activities could potentially be undertaken to maintain the current levels of service.*
>
> *iii. The risks associated with the options referred to in subparagraph ii.*
>
> *iv. The lifecycle activities referred to in subparagraph ii that can be undertaken for the lowest cost to maintain the current levels of service."*

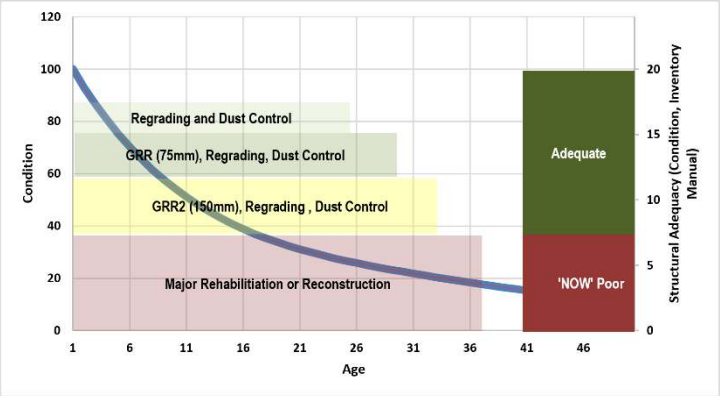
Figure 1 provides a graphic representation of the cost benefit of gravel road conversion to hard top on a life cycle basis. Given the directive of the regulation, gravel road conversion to hard top surface appears to be consistent with the regulation.

Gravel Road Conversion

Gravel Roads- All Roadsides, all AADT

Year	Condition	Imp Type	Description
1	100	NONE	No Improvement Required
2	92.45	NONE	No Improvement Required
3	86.21	GRR	75mm of Granular A
4	80.43	GRR	75mm of Granular A
5	75.11	GRR	75mm of Granular A
6	70.21	GRR	75mm of Granular A
7	65.7	GRR2	150mm of additional Gravel
8	61.55	GRR2	150mm of additional Gravel
9	57.75	GRR2	150mm of additional Gravel
10	54.27	GRR2	150mm of additional Gravel
11	51.07	GRR2	150mm of additional Gravel
12	48.15	GRR2	150mm of additional Gravel
13	45.48	GRR2	150mm of additional Gravel
14	43.04	GRR2	150mm of additional Gravel
15	40.81	GRR2	150mm of additional Gravel
16	38.77	GRR2	150mm of additional Gravel
17	36.9	GRR2	150mm of additional Gravel
18	35.2	GRR2	150mm of additional Gravel
19	33.63	REC	Reconstruction - Rural
20	32.19	REC	Reconstruction - Rural
21	30.86	REC	Reconstruction - Rural
22	29.64	REC	Reconstruction - Rural
23	28.51	REC	Reconstruction - Rural
24	27.45	REC	Reconstruction - Rural
25	26.47	REC	Reconstruction - Rural
30	22.28	REC	Reconstruction - Rural
35	18.88	REC	Reconstruction - Rural
40	20	REC	Reconstruction - Rural
45	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural

Every treatment will not be undertaken every year. The model will select the correct treatment based on the condition

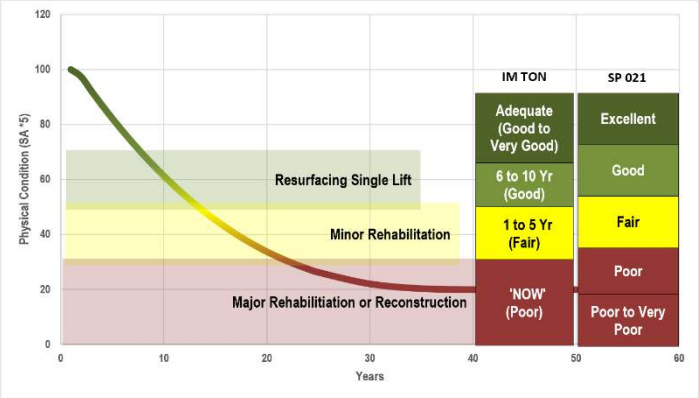


Gravel Road Conversion

LCB Roads- All Roadsides, all AADT

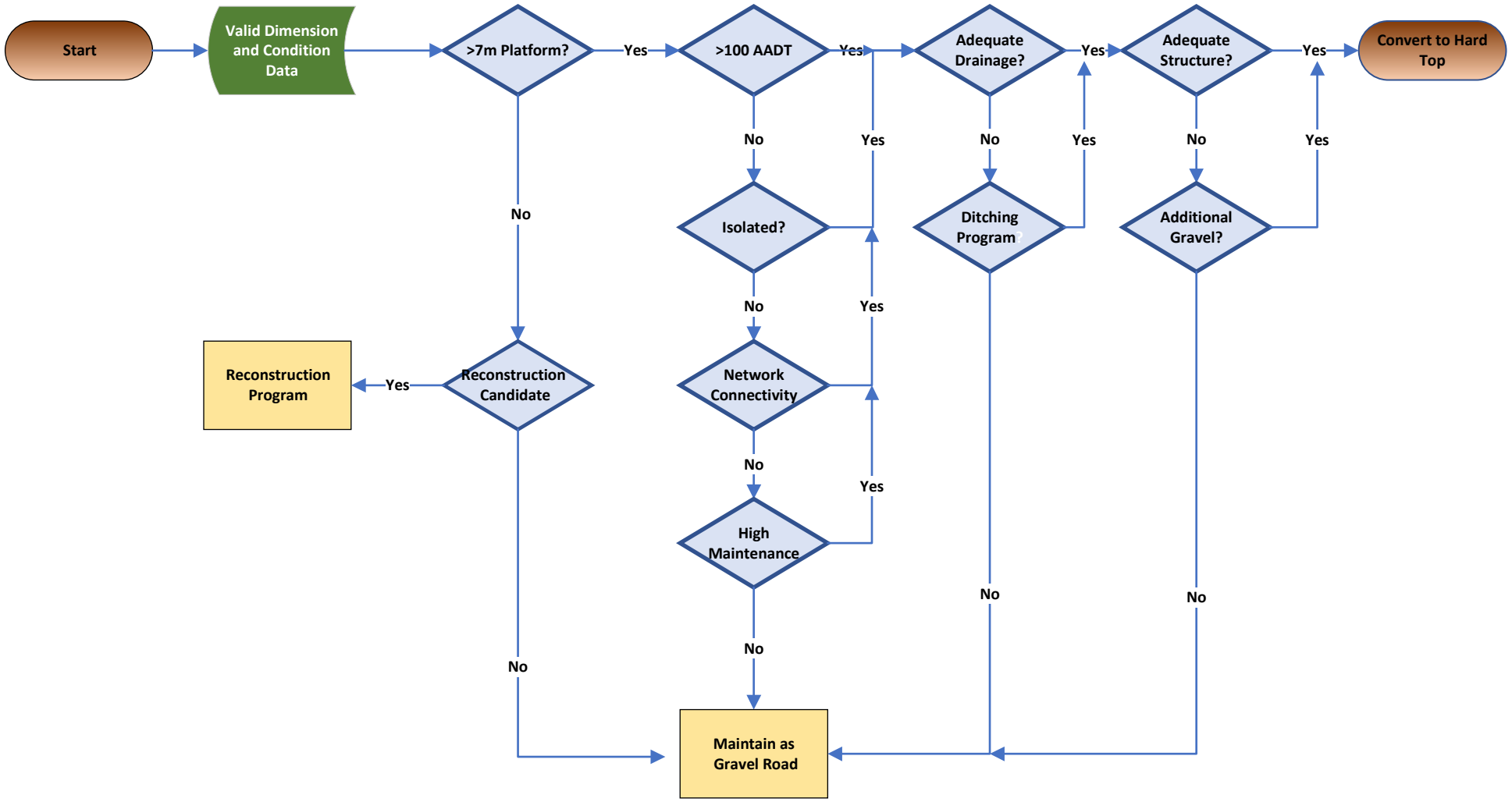
Year	Condition	Imp. Type	Description
1	100	NONE	No Improvement Required
2	98.61	NONE	No Improvement Required
3	94.19	NONE	No Improvement Required
4	89.84	NONE	No Improvement Required
5	85.56	NONE	No Improvement Required
6	81.36	NONE	No Improvement Required
7	77.26	SST	Single Surface Treatment
8	73.28	SST	Single Surface Treatment
9	69.4	SST	Single Surface Treatment
10	65.65	SST	Single Surface Treatment
11	62.02	SST	Single Surface Treatment
12	58.54	SST	Single Surface Treatment
13	55.19	SST	Single Surface Treatment
14	52	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
15	48.96	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
16	46.08	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
17	43.36	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
18	40.81	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
19	38.41	SSTplus	Single Surface Treatment plus 10% padding to correct geometry
20	36.19	REC	Reconstruction - Rural
21	34.13	REC	Reconstruction - Rural
22	32.24	REC	Reconstruction - Rural
23	30.51	REC	Reconstruction - Rural
24	28.95	REC	Reconstruction - Rural
25	27.55	REC	Reconstruction - Rural
30	22.82	REC	Reconstruction - Rural
35	21.31	REC	Reconstruction - Rural
40	21.92	REC	Reconstruction - Rural
45	20	REC	Reconstruction - Rural
50	20	REC	Reconstruction - Rural

Every treatment will not be undertaken every year. The model will select the correct treatment based on the condition



Well Constructed Gravel Road

Gravel Road Conversion Decision Matrix



4 ROADS
MANAGEMENT SERVICES

Appendix E: Regulation 588/17 – Asset Management Planning for Municipal Infrastructure

Français

ONTARIO REGULATION 588/17

made under the

INFRASTRUCTURE FOR JOBS AND PROSPERITY ACT, 2015

Made: December 13, 2017
Filed: December 27, 2017
Published on e-Laws: December 27, 2017
Printed in *The Ontario Gazette*: January 13, 2018

ASSET MANAGEMENT PLANNING FOR MUNICIPAL INFRASTRUCTURE

CONTENTS

INTERPRETATION AND APPLICATION

Definitions

1. (1) In this Regulation,

"asset category" means a category of municipal infrastructure assets that is,

(a) an aggregate of assets described in each of clauses (a) to (e) of the definition of core municipal infrastructure asset, or

(b) composed of any other aggregate of municipal infrastructure assets that provide the same type of service; ("catégorie de biens")

"core municipal infrastructure asset" means any municipal infrastructure asset that is a,

(a) water asset that relates to the collection, production, treatment, storage, supply or distribution of water,

(b) wastewater asset that relates to the collection, transmission, treatment or disposal of wastewater, including any wastewater asset that from time to time manages stormwater,

(c) stormwater management asset that relates to the collection, transmission, treatment, retention, infiltration, control or disposal of stormwater,

(d) road, or

(e) bridge or culvert; ("bien d'infrastructure municipale essentiel")

"ecological functions" has the same meaning as in Ontario Regulation 140/02 (Oak Ridges Moraine Conservation Plan) made under the *Oak Ridges Moraine Conservation Act, 2001*; ("fonctions écologiques")

"green infrastructure asset" means an infrastructure asset consisting of natural or human-made elements that provide ecological and hydrological functions and processes and includes natural heritage features and systems, parklands,

stormwater management systems, street trees, urban forests, natural channels, permeable surfaces and green roofs; ("bien d'infrastructure verte")

"hydrological functions" has the same meaning as in Ontario Regulation 140/02; ("fonctions hydrologiques")

"joint municipal water board" means a joint board established in accordance with a transfer order made under the *Municipal Water and Sewage Transfer Act, 1997*; ("conseil mixte de gestion municipale des eaux")

"lifecycle activities" means activities undertaken with respect to a municipal infrastructure asset over its service life, including constructing, maintaining, renewing, operating and decommissioning, and all engineering and design work associated with those activities; ("activités relatives au cycle de vie")

"municipal infrastructure asset" means an infrastructure asset, including a green infrastructure asset, directly owned by a municipality or included on the consolidated financial statements of a municipality, but does not include an infrastructure asset that is managed by a joint municipal water board; ("bien d'infrastructure municipale")

"municipality" has the same meaning as in the *Municipal Act, 2001*; ("municipalité")

"operating costs" means the aggregate of costs, including energy costs, of operating a municipal infrastructure asset over its service life; ("frais d'exploitation")

"service life" means the total period during which a municipal infrastructure asset is in use or is available to be used; ("durée de vie")

"significant operating costs" means, where the operating costs with respect to all municipal infrastructure assets within an asset category are in excess of a threshold amount set by the municipality, the total amount of those operating costs. ("frais d'exploitation importants")

(2) In Tables 1 and 2,

"connection-days" means the number of properties connected to a municipal system that are affected by a service issue, multiplied by the number of days on which those properties are affected by the service issue. ("jours-branchements")

(3) In Table 4,

"arterial roads" means Class 1 and Class 2 highways as determined under the Table to section 1 of Ontario Regulation 239/02 (Minimum Maintenance Standards for Municipal Highways) made under the *Municipal Act, 2001*; ("artères")

"collector roads" means Class 3 and Class 4 highways as determined under the Table to section 1 of Ontario Regulation 239/02; ("routes collectrices")

"lane-kilometre" means a kilometre-long segment of roadway that is a single lane in width; ("kilomètre de voie")

"local roads" means Class 5 and Class 6 highways as determined under the Table to section 1 of Ontario Regulation 239/02. ("routes locales")

(4) In Table 5,

"Ontario Structure Inspection Manual" means the Ontario Structure Inspection Manual (OSIM), published by the Ministry of Transportation and dated October 2000 (revised November 2003 and April 2008) and available on a Government of Ontario website; ("manuel d'inspection des structures de l'Ontario")

"structural culvert" has the meaning set out for "culvert (structural)" in the Ontario Structure Inspection Manual. ("ponceau structurel")

Application

2. For the purposes of section 6 of the Act, every municipality is prescribed as a broader public sector entity to which that section applies.

STRATEGIC ASSET MANAGEMENT POLICIES

Strategic asset management policy

3. (1) Every municipality shall prepare a strategic asset management policy that includes the following:

1. Any of the municipality's goals, policies or plans that are supported by its asset management plan.
2. The process by which the asset management plan is to be considered in the development of the municipality's budget or of any long-term financial plans of the municipality that take into account municipal infrastructure assets.
3. The municipality's approach to continuous improvement and adoption of appropriate practices regarding asset management planning.
4. The principles to be followed by the municipality in its asset management planning, which must include the principles set out in section 3 of the Act.

5. The municipality's commitment to consider, as part of its asset management planning,
    i. the actions that may be required to address the vulnerabilities that may be caused by climate change to the municipality's infrastructure assets, in respect of such matters as,
        A. operations, such as increased maintenance schedules,
        B. levels of service, and
        C. lifecycle management,
    ii. the anticipated costs that could arise from the vulnerabilities described in subparagraph i,
    iii. adaptation opportunities that may be undertaken to manage the vulnerabilities described in subparagraph i,
    iv. mitigation approaches to climate change, such as greenhouse gas emission reduction goals and targets, and
    v. disaster planning and contingency funding.
6. A process to ensure that the municipality's asset management planning is aligned with any of the following financial plans:
    i. Financial plans related to the municipality's water assets including any financial plans prepared under the *Safe Drinking Water Act, 2002*.
    ii. Financial plans related to the municipality's wastewater assets.
7. A process to ensure that the municipality's asset management planning is aligned with Ontario's land-use planning framework, including any relevant policy statements issued under subsection 3 (1) of the *Planning Act*, any provincial plans as defined in the *Planning Act* and the municipality's official plan.
8. An explanation of the capitalization thresholds used to determine which assets are to be included in the municipality's asset management plan and how the thresholds compare to those in the municipality's tangible capital asset policy, if it has one.
9. The municipality's commitment to coordinate planning for asset management, where municipal infrastructure assets connect or are interrelated with those of its upper-tier municipality, neighbouring municipalities or jointly-owned municipal bodies.
10. The persons responsible for the municipality's asset management planning, including the executive lead.
11. An explanation of the municipal council's involvement in the municipality's asset management planning.
12. The municipality's commitment to provide opportunities for municipal residents and other interested parties to provide input into the municipality's asset management planning.

(2) For the purposes of this section,

"capitalization threshold" is the value of a municipal infrastructure asset at or above which a municipality will capitalize the value of it and below which it will expense the value of it. ("seuil de capitalisation")

Update of asset management policy

4. Every municipality shall prepare its first strategic asset management policy by July 1, 2019 and shall review and, if necessary, update it at least every five years.

ASSET MANAGEMENT PLANS

Asset management plans, current levels of service

5. (1) Every municipality shall prepare an asset management plan in respect of its core municipal infrastructure assets by July 1, 2021, and in respect of all of its other municipal infrastructure assets by July 1, 2023.

(2) A municipality's asset management plan must include the following:

1. For each asset category, the current levels of service being provided, determined in accordance with the following qualitative descriptions and technical metrics and based on data from at most the two calendar years prior to the year in which all information required under this section is included in the asset management plan:
    i. With respect to core municipal infrastructure assets, the qualitative descriptions set out in Column 2 and the technical metrics set out in Column 3 of Table 1, 2, 3, 4 or 5, as the case may be.
    ii. With respect to all other municipal infrastructure assets, the qualitative descriptions and technical metrics established by the municipality.
2. The current performance of each asset category, determined in accordance with the performance measures established by the municipality, such as those that would measure energy usage and operating efficiency, and based on data from

at most two calendar years prior to the year in which all information required under this section is included in the asset management plan.

3. For each asset category,
    i. a summary of the assets in the category,
    ii. the replacement cost of the assets in the category,
    iii. the average age of the assets in the category, determined by assessing the average age of the components of the assets,
    iv. the information available on the condition of the assets in the category, and
    v. a description of the municipality's approach to assessing the condition of the assets in the category, based on recognized and generally accepted good engineering practices where appropriate.
4. For each asset category, the lifecycle activities that would need to be undertaken to maintain the current levels of service as described in paragraph 1 for each of the 10 years following the year for which the current levels of service under paragraph 1 are determined and the costs of providing those activities based on an assessment of the following:
    i. The full lifecycle of the assets.
    ii. The options for which lifecycle activities could potentially be undertaken to maintain the current levels of service.
    iii. The risks associated with the options referred to in subparagraph ii.
    iv. The lifecycle activities referred to in subparagraph ii that can be undertaken for the lowest cost to maintain the current levels of service.
5. For municipalities with a population of less than 25,000, as reported by Statistics Canada in the most recent official census, the following:
    i. A description of assumptions regarding future changes in population or economic activity.
    ii. How the assumptions referred to in subparagraph i relate to the information required by paragraph 4.
6. For municipalities with a population of 25,000 or more, as reported by Statistics Canada in the most recent official census, the following:
    i. With respect to municipalities in the Greater Golden Horseshoe growth plan area, if the population and employment forecasts for the municipality are set out in Schedule 3 or 7 to the 2017 Growth Plan, those forecasts.
    ii. With respect to lower-tier municipalities in the Greater Golden Horseshoe growth plan area, if the population and employment forecasts for the municipality are not set out in Schedule 7 to the 2017 Growth Plan, the portion of the forecasts allocated to the lower-tier municipality in the official plan of the upper-tier municipality of which it is a part.
    iii. With respect to upper-tier municipalities or single-tier municipalities outside of the Greater Golden Horseshoe growth plan area, the population and employment forecasts for the municipality that are set out in its official plan.
    iv. With respect to lower-tier municipalities outside of the Greater Golden Horseshoe growth plan area, the population and employment forecasts for the lower-tier municipality that are set out in the official plan of the upper-tier municipality of which it is a part.
    v. If, with respect to any municipality referred to in subparagraph iii or iv, the population and employment forecasts for the municipality cannot be determined as set out in those subparagraphs, a description of assumptions regarding future changes in population or economic activity.
    vi. For each of the 10 years following the year for which the current levels of service under paragraph 1 are determined, the estimated capital expenditures and significant operating costs related to the lifecycle activities required to maintain the current levels of service in order to accommodate projected increases in demand caused by growth, including estimated capital expenditures and significant operating costs related to new construction or to upgrading of existing municipal infrastructure assets.

(3) Every asset management plan must indicate how all background information and reports upon which the information required by paragraph 3 of subsection (2) is based will be made available to the public.

(4) In this section,

"2017 Growth Plan" means the Growth Plan for the Greater Golden Horseshoe, 2017 that was approved under subsection 7 (6) of the *Places to Grow Act, 2005* on May 16, 2017 and came into effect on July 1, 2017; ("Plan de croissance de 2017")

"Greater Golden Horseshoe growth plan area" means the area designated by section 2 of Ontario Regulation 416/05 (Growth Plan Areas) made under the *Places to Grow Act, 2005*. ("zone de croissance planifiée de la région élargie du Golden Horseshoe")

Asset management plans, proposed levels of service

6. (1) Subject to subsection (2), by July 1, 2024, every asset management plan prepared under section 5 must include the following additional information:

1. For each asset category, the levels of service that the municipality proposes to provide for each of the 10 years following the year in which all information required under section 5 and this section is included in the asset management plan, determined in accordance with the following qualitative descriptions and technical metrics:
    i. With respect to core municipal infrastructure assets, the qualitative descriptions set out in Column 2 and the technical metrics set out in Column 3 of Table 1, 2, 3, 4 or 5, as the case may be.
    ii. With respect to all other municipal infrastructure assets, the qualitative descriptions and technical metrics established by the municipality.
2. An explanation of why the proposed levels of service under paragraph 1 are appropriate for the municipality, based on an assessment of the following:
    i. The options for the proposed levels of service and the risks associated with those options to the long term sustainability of the municipality.
    ii. How the proposed levels of service differ from the current levels of service set out under paragraph 1 of subsection 5 (2).
    iii. Whether the proposed levels of service are achievable.
    iv. The municipality's ability to afford the proposed levels of service.
3. The proposed performance of each asset category for each year of the 10-year period referred to in paragraph 1, determined in accordance with the performance measures established by the municipality, such as those that would measure energy usage and operating efficiency.
4. A lifecycle management and financial strategy that sets out the following information with respect to the assets in each asset category for the 10-year period referred to in paragraph 1:
    i. An identification of the lifecycle activities that would need to be undertaken to provide the proposed levels of service described in paragraph 1, based on an assessment of the following:
        A. The full lifecycle of the assets.
        B. The options for which lifecycle activities could potentially be undertaken to achieve the proposed levels of service.
        C. The risks associated with the options referred to in sub-subparagraph B.
        D. The lifecycle activities referred to in sub-subparagraph B that can be undertaken for the lowest cost to achieve the proposed levels of service.
    ii. An estimate of the annual costs for each of the 10 years of undertaking the lifecycle activities identified in subparagraph i, separated into capital expenditures and significant operating costs.
    iii. An identification of the annual funding projected to be available to undertake lifecycle activities and an explanation of the options examined by the municipality to maximize the funding projected to be available.
    iv. If, based on the funding projected to be available, the municipality identifies a funding shortfall for the lifecycle activities identified in subparagraph i,
        A. an identification of the lifecycle activities, whether set out in subparagraph i or otherwise, that the municipality will undertake, and
        B. if applicable, an explanation of how the municipality will manage the risks associated with not undertaking any of the lifecycle activities identified in subparagraph i.
5. For municipalities with a population of less than 25,000, as reported by Statistics Canada in the most recent official census, a discussion of how the assumptions regarding future changes in population and economic activity, set out in subparagraph 5 i of subsection 5 (2), informed the preparation of the lifecycle management and financial strategy referred to in paragraph 4 of this subsection.
6. For municipalities with a population of 25,000 or more, as reported by Statistics Canada in the most recent official census,

i. the estimated capital expenditures and significant operating costs to achieve the proposed levels of service as described in paragraph 1 in order to accommodate projected increases in demand caused by population and employment growth, as set out in the forecasts or assumptions referred to in paragraph 6 of subsection 5 (2), including estimated capital expenditures and significant operating costs related to new construction or to upgrading of existing municipal infrastructure assets,

ii. the funding projected to be available, by source, as a result of increased population and economic activity, and

iii. an overview of the risks associated with implementation of the asset management plan and any actions that would be proposed in response to those risks.

7. An explanation of any other key assumptions underlying the plan that have not previously been explained.

(2) With respect to an asset management plan prepared under section 5 on or before July 1, 2021, if the additional information required under this section is not included before July 1, 2023, the municipality shall, before including the additional information, update the current levels of service set out under paragraph 1 of subsection 5 (2) and the current performance measures set out under paragraph 2 of subsection 5 (2) based on data from the two most recent calendar years.

Update of asset management plans

7. (1) Every municipality shall review and update its asset management plan at least five years after the year in which the plan is completed under section 6 and at least every five years thereafter.

(2) The updated asset management plan must comply with the requirements set out under paragraphs 1, 2 and 3 and subparagraphs 5 i and 6 i, ii, iii, iv and v of subsection 5 (2), subsection 5 (3) and paragraphs 1 to 7 of subsection 6 (1).

Endorsement and approval required

8. Every asset management plan prepared under section 5 or 6, or updated under section 7, must be,

(a) endorsed by the executive lead of the municipality; and

(b) approved by a resolution passed by the municipal council.

Annual review of asset management planning progress

9. (1) Every municipal council shall conduct an annual review of its asset management progress on or before July 1 in each year, starting the year after the municipality's asset management plan is completed under section 6.

(2) The annual review must address,

(a) the municipality's progress in implementing its asset management plan;

(b) any factors impeding the municipality's ability to implement its asset management plan; and

(c) a strategy to address the factors described in clause (b).

Public availability

10. Every municipality shall post its current strategic asset management policy and asset management plan on a website that is available to the public, and shall provide a copy of the policy and plan to any person who requests it.

TABLE 1

WATER ASSETS

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)
Scope	1. Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal water system. 2. Description, which may include maps, of the user groups or areas of the municipality that have fire flow.	1. Percentage of properties connected to the municipal water system. 2. Percentage of properties where fire flow is available.
Reliability	Description of boil water advisories and service interruptions.	1. The number of connection-days per year where a boil water advisory notice is in place compared to the total number of properties connected to the municipal water system. 2. The number of connection-days per year due to water main breaks compared to the total number of properties connected to the municipal water system.

TABLE 2

WASTEWATER ASSETS

Column 1	Column 2	Column 3

Service attribute	Community levels of service (qualitative descriptions)	Technical levels of service (technical metrics)
Scope	Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal wastewater system.	Percentage of properties connected to the municipal wastewater system.
Reliability	1. Description of how combined sewers in the municipal wastewater system are designed with overflow structures in place which allow overflow during storm events to prevent backups into homes. 2. Description of the frequency and volume of overflows in combined sewers in the municipal wastewater system that occur in habitable areas or beaches. 3. Description of how stormwater can get into sanitary sewers in the municipal wastewater system, causing sewage to overflow into streets or backup into homes. 4. Description of how sanitary sewers in the municipal wastewater system are designed to be resilient to avoid events described in paragraph 3. 5. Description of the effluent that is discharged from sewage treatment plants in the municipal wastewater system.	1. The number of events per year where combined sewer flow in the municipal wastewater system exceeds system capacity compared to the total number of properties connected to the municipal wastewater system. 2. The number of connection-days per year due to wastewater backups compared to the total number of properties connected to the municipal wastewater system. 3. The number of effluent violations per year due to wastewater discharge compared to the total number of properties connected to the municipal wastewater system.

TABLE 3

STORMWATER MANAGEMENT ASSETS

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)
Scope	Description, which may include maps, of the user groups or areas of the municipality that are protected from flooding, including the extent of the protection provided by the municipal stormwater management system.	1. Percentage of properties in municipality resilient to a 100-year storm. 2. Percentage of the municipal stormwater management system resilient to a 5-year storm.

TABLE 4

ROADS

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)
Scope	Description, which may include maps, of the road network in the municipality and its level of connectivity.	Number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality.
Quality	Description or images that illustrate the different levels of road class pavement condition.	1. For paved roads in the municipality, the average pavement condition index value. 2. For unpaved roads in the municipality, the average surface condition (e.g. excellent, good, fair or poor).

TABLE 5

BRIDGES AND CULVERTS

Column 1 Service attribute	Column 2 Community levels of service (qualitative descriptions)	Column 3 Technical levels of service (technical metrics)
Scope	Description of the traffic that is supported by municipal bridges (e.g., heavy transport vehicles, motor vehicles, emergency vehicles, pedestrians, cyclists).	Percentage of bridges in the municipality with loading or dimensional restrictions.
Quality	1. Description or images of the condition of bridges and how this would affect use of the bridges. 2. Description or images of the condition of culverts and how this would affect use of the culverts.	1. For bridges in the municipality, the average bridge condition index value. 2. For structural culverts in the municipality, the average bridge condition index value.

COMMENCEMENT

Commencement

11. This Regulation comes into force on the later of January 1, 2018 and the day it is filed.

Appendix F: Sample Road Section

MUNICIPAL ROAD APPRAISAL

A. IDENTIFICATION

Road Name: Catherine St
From: Garfield Ave
To: Pine Cr
Road Section No.: 282
Length: 0.11 km:
Old Section No.:
Owner: 54402
Road Value: 135,018
MunicA
☐ Shared?
Special Designation: CBL
Patrol:
Shared With:
MunicB
Owner Share: 100.00
Designation 2
Adjacent Road Section No.:
Year Assumed:

B. EXISTING CONDITIONS

Horizontal Alignment
Substandard Curves:
Substandard S.S.D.:

Vertical Alignment
Substandard Grades:
Substandard S.S.D.:

Right of Way Width
Existing: 0 m
Desirable: 0 m
Terrain: NF - Non R
Drainage: SS - Storm Sewer

Roadside Env.: U
Existing Class: L/R
Number of Lanes: 2.00
Surface Type: HCB
Platform Width: m
Surface Width: 8.600 m
Median Width:
Shoulder Type: None
Shoulder Width:

Curb/Gutter
Left: MC
Right: MC
Sidewalk Width Left: Right:
Boulevard Width Left: Right:
Parking:
Existing Surface Depth:
Existing Gran "A" Depth:
Existing Gran "B" Depth:

C. TRAFFIC DATA

Legal Speed Limit: 50
Avg. Operating Speed: 0
Traffic Operation: 2W
Route Designations
☐ Bus ☐ Truck Route
☐ School ☐ Bicycle
Load Restrictions: NR

	Traffic Count		10 Year Traffic Forecast	
Year:	A-2012-E		2022	
AADT:	107		109	
DHV Factor:	10.3	%	10.3	%
DHV:	11	vph	11	vph
Trucks:	3.00	%	3.0	%
Peak Directional Split:		%		
10 Year Growth Factor:	1.02			
Capacity:			1,474	vph

D. APPROVALS

Date: 2021-08-23 Inspected By: D. Anderson, CET
Approved By:

E. ROAD NEEDS

Field	Max Points	Rating	Comments
Drainage	15.0	15	
Level Of Service	20.0	20	
Maint. Demand	10.0	6	
Structural Adequacy	20.0	18	
Surface Condition	10.0	7	
Surface Width	25.0	25	

F. FUNCTIONAL NEEDS

Field	Existing	Min Tolerable	Time of Need	Comments
Capacity	A	E	ADEQ	
Drainage	15	8	ADEQ	
Geometrics	N/A	N/A	ADEQ	
Structural Adequacy	18	8	ADEQ	
Surface Type	HCB	Hardtop	ADEQ	
Surface Width	8.6	5.5	ADEQ	

Impr.Class	Improvement	Description	Override?	Percent	Time of Need	Year	Base/ Const Cost
Const	NONE	No Improvement Required	☒ Override	100.00	ADEQ		0.00
					Const Subtotal:		**0.00**

G. ENGINEERING RECOMMENDATIONS

Year (Re)Constructed:
Design Class: L/R
Design Width: 6.00 m

Improvement Length: 0.107 km
☒ Set Values Manually?
Time of Need: ADEQ
Improvement Type: NONE No Improvement Required

Ratings

Priority Rating:	6
Guide Number:	0
$/Vehicle km:	0.00

H. IMPROVEMENT COSTS

Total Base/Construction:

TOTAL:	0.00
Owners Share:	0.00

Appendix G: Program from Performance Model 20210826

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2022	736	1	0	Centre St	(to) Robert St-to-Andrew St	CRK	$ 168	85	85	2	$ 90,097	$ 90,097	0.084
2022	799	1	0	Garfield Ave	(to) Florence Ave-to-Maple St	CRK	$ 428	85	85	2	$ 229,531	$ 229,531	0.214
2022	757	1	0	Discovery Line	(to) Petrolia Discovery Centre-to-Bridge	SD	$ 1,181	75	75	1	$ 517,827	$ 517,827	0.656
2022	722	1	0	Applewood Dr	(to) Parkside Ct-to-Evergreen Trail	CRK	$ 310	85	85	2	$ 166,249	$ 166,249	0.155
2022	723	1	0	Applewood Dr	(to) Evergreen Trail-to-Garfield Ave	CRK	$ 182	85	85	2	$ 97,605	$ 97,605	0.091
2022	747	1	0	Country View Dr	(to) Henderson Dr-to-NW Corner	CRK	$ 232	85	85	2	$ 124,419	$ 124,419	0.116
2022	748	1	0	Country View Dr	(to) Valentina St S.-to-Henderson Dr	CRK	$ 486	85	85	2	$ 260,636	$ 260,636	0.243
2022	986	1	0	Fairway Court	(to) West End Cul De Sac-to-First Ave	CRK	$ 390	85	85	2	$ 209,153	$ 209,153	0.195
2022	991	1	0	Lorne Ave	(to) Midblock-to-Princess St	SD	$ 117	100	100	1	$ 47,566	$ 47,566	0.065
2022	737	1	0	Centre St	(to) Andrew St-to-James St	CRK	$ 172	80	80	2	$ 86,816	$ 86,816	0.086
2022	745	1	0	Country View Dr	(to) Bluebird St-to-East End Cul De Sac	CRK	$ 106	80	80	2	$ 53,502	$ 53,502	0.053
2022	816	1	0	Henry Ave	(to) Oil St-to-Warren Ave	CRK	$ 128	80	80	2	$ 64,607	$ 64,607	0.064
2022	824	1	0	Hunter Ct	(to) West End Cul De Sac-to-Valentina St S.	CRK	$ 194	80	80	2	$ 97,920	$ 97,920	0.097
2022	914	1	0	Rosemount Dr	(to) Parkside Ct-to-Redwood Ct	CRK	$ 184	80	80	2	$ 92,873	$ 92,873	0.092
2022	990	1	0	Glenview Rd	(to) Petrolia South Limits-to-330m North of Petrolia South Limits	R1	$ 60,378	60	97		$ 432,828	$ 699,739	0.33
2022	786	1	0	First Ave	(to) Garden-to-150m East of Garden Crescent (West Leg)	CRK	$ 1,396	80	80	2	$ 704,620	$ 704,620	0.698
2022	921	1	0	Stanley Ave	(to) South Limit-to-Discovery Line	SD	$ 252	100	100	1	$ 93,986	$ 93,986	0.14
2022	751	1	0	Discovery Line	(to) West town limit-to-Stanley	PR2	$ 92,655	15	100		$ 41,987	$ 279,916	0.3
2022	753	1	0	Discovery Line	(to) Eureka St-to-Centre St	PR2	$ 87,714	25	100		$ 66,247	$ 264,987	0.284
2022	752	1	0	Discovery Line	(to) Stanley Ave-to-Eureka St	PR2	$ 138,674	25	100		$ 104,735	$ 418,941	0.449
2022	746	1	0	Country View Dr	(to) NW Corner-to-Bluebird St	CRK	$ 136	90	90	2	$ 77,225	$ 77,225	0.068
2022	779	1	0	Evergreen Trail	(to) Applewood Dr-to-Rosemount	CRK	$ 186	90	90	2	$ 105,617	$ 105,617	0.093
2022	911	1	0	Redwood Ct	(to) Rosemount Dr-to-North End Cul De Sac	CRK	$ 118	90	90	2	$ 67,004	$ 67,004	0.059
2022	940	1	0	Victoria Ave	(to) Princess St-to-Queen St	CRK	$ 288	90	90	2	$ 163,536	$ 163,536	0.144
2022	988	1	0	Discovery Line	(to) 400m West of Oil Heritage Rd-to-Oil Heritage Rd	R1	$ 82,376	65	97		$ 274,292	$ 409,328	0.4
2022	858	1	0	Maude St	(to) Joe St-to-South end (extension)	PR2	$ 83,279	25	100		$ 46,157	$ 184,626	0.25
2022	857	1	0	Maude St	(to) Joe St-to-Dufferin Ave	SR	$ 10,000	80	80	2	$ 554,254	$ 554,254	0.524
2022	937	1	0	Valentina St S.	(to) Henderson Dr-to-Hunter Ct	R1	$ 61,341	55	97		$ 106,185	$ 187,272	0.153
2022	938	1	0	Valentina St S.	(to) Hunter Ct-to-Country View Dr	R1	$ 71,480	55	97		$ 124,230	$ 219,096	0.179
2022	849	1	0	Lancey St	(to) Emmeline St-to-East End Cul De Sac	R2Urehab	$ 126,246	35	100		$ 91,863	$ 262,466	0.208
2022	879	1	0	Pearl St	(to) England Ave-to-First Ave	R2Urehab	$ 89,166	30	100		$ 50,348	$ 167,827	0.133
2022	770	1	0	Emmeline St	(to) Emma St-to-Lancey St	R1	$ 44,808	65	97		$ 107,447	$ 160,344	0.131
2022	939	1	0	Vanderwal Dr	(to) Discovery Line-to-North End Cul De Sac	CRK	$ 384	90	90	2	$ 144,527	$ 144,527	0.192
2022	845	1	0	King Well Lane/Gemfield	(to) Kerby St-to-Eureka St	CRK	$ 190	80	80	2	$ 14,150	$ 14,150	0.095
2022	3895	1	1	Mutual St	(to) South End-to-Third St	RNS	$ 20,700	40	100		$ 11,816	$ 29,539	0.044
2022	838	1	1	Kentail St	(to) Third St-to-Petrolia Line	RNS	$ 92,000	35	100		$ 30,242	$ 86,405	0.117
2022	860	1	1	Mutual St	(to) Third St-to-Petrolia Line	RNS	$ 87,000	35	100		$ 28,431	$ 81,231	0.121
2022	930	1	1	Third St	(to) Fourth St-to-Kentail St	RNS	$ 96,571	35	100		$ 32,746	$ 93,559	0.134

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2022	931	1	1	Third St	(to) Kentail St-to-Mutual St	RNS	$ 111,429	60	100		$ 60,743	$ 101,239	0.145
2022	933	1	1	Valentina St N.	(to) South End Cul De Sac-to-Petrolia Line	RNS	$ 135,000	5	100		$ 6,306	$ 126,117	0.186
							$1,498,045						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2023	990	1	0	Glenview Rd	(to) Petrolia South Limits-to-330m North of Petrolia South Limits	CRK	$ 660	97	97	2	$ 699,739	$ 699,739	0.33
2023	770	1	0	Emmeline St	(to) Emma St-to-Lancey St	CRK	$ 262	97	97	2	$ 160,344	$ 160,344	0.131
2023	937	1	0	Valentina St S.	(to) Henderson Dr-to-Hunter Ct	CRK	$ 306	97	97	2	$ 187,272	$ 187,272	0.153
2023	938	1	0	Valentina St S.	(to) Hunter Ct-to-Country View Dr	CRK	$ 358	97	97	2	$ 219,096	$ 219,096	0.179
2023	988	1	0	Discovery Line	(to) 400m West of Oil Heritage Rd-to-Oil Heritage Rd	CRK	$ 800	97	97	2	$ 409,328	$ 409,328	0.4
2023	876	1	0	Parkside Dr	(to) Parkside Pl-to-35m South of Rosemount Drive	R1	$ 85,502	64.3	97		$ 209,399	$ 315,791	0.223
2023	716	1	0	Albany St	(to) Dufferin Ave-to-Walnut St E	R1	$ 71,830	64.3	97		$ 170,441	$ 257,039	0.21
2023	906	1	0	Progress Dr	(to) West End-to-Oil Heritage Rd	PR2	$ 184,560	43.9	100		$ 178,928	$ 407,489	0.489
2023	850	1	0	Lorne Ave	(to) Maude St-to-Midblock	R1	$ 25,956	59.1	97		$ 48,474	$ 79,560	0.065
2023	738	1	0	Centre St	(to) James St-to-200m North of Portland	R1	$ 116,529	59.1	97		$ 212,541	$ 348,840	0.285
2023	3640	1	0	Annie St	(to) West St-to-Huggard St	R1	$ 41,206	59.1	97		$ 74,575	$ 122,399	0.1
2023	771	1	0	England Ave	(to) Petrolia Line-to-Pearl St	R2Urehab	$ 71,188	29.4	100		$ 35,937	$ 122,400	0.097
2023	772	1	0	England Ave	(to) Pearl St-to-South End	R2Urehab	$ 68,986	29.4	100		$ 34,825	$ 118,614	0.094
2023	805	1	0	Glenview Rd	(to) Dufferin Ave-to-Wellington St	R1	$ 129,711	59.1	97		$ 234,868	$ 385,486	0.31
2023	781	1	0	Fifth Ave	(to) First Ave-to-Fourth St	R2Urehab	$ 187,674	29.4	100		$ 90,397	$ 307,893	0.244
2023	734	1	0	Catherine St	(to) 70m East of Juniper-to-Eureka St	R1	$ 59,046	64.3	97		$ 124,990	$ 188,496	0.154
2023	767	1	0	Ella St	(to) Emma St-to-Warren Ave	R1	$ 52,203	69.5	97		$ 137,628	$ 192,168	0.157
2023	848	1	0	Lancey St	(to) Warren Ave-to-Emmeline St	R1	$ 9,310	69.5	97		$ 24,545	$ 34,272	0.028
2023	768	1	0	Emma St	(to) Ella St-to-Emmeline St	R1	$ 18,813	69.5	97		$ 48,214	$ 67,320	0.055
2023	831	1	0	Joe St	(to) Valentina St S.-to-Tom St	SR	$ 10,000	78	78	2	$ 186,430	$ 186,430	0.168
2023	856	1	0	Maude St	(to) Dufferin Ave-to-Lorne Ave	SR	$ 10,000	69	69	2	$ 112,213	$ 112,213	0.123
2023	749	1	1	Derby St	(to) Mutual St-to-Holland St	RNS	$ 58,462	58.5	100		$ 31,754	$ 54,244	0.08
2023	750	1	1	Derby St	(to) Holland St-to-Oil Heritage Rd	RNS	$ 226,538	29	100		$ 61,454	$ 212,277	0.31
2023	819	1	1	Holland St	(to) Derby St-to-Petrolia Line	RNS	$ 63,300	73.3	100		$ 43,292	$ 59,077	0.088
							$1,493,200						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2024	801	1	0	Garfield Ave	(to) Mulberry Pl-to-Parkside Ct	CRK	$ 262	87.9	87.9	2	$ 163,785	$ 163,785	0.131
2024	802	1	0	Garfield Ave	(to) Parkside Dr-to-Golden Gate Cl	CRK	$ 184	87.9	87.9	2	$ 115,024	$ 115,024	0.092
2024	803	1	0	Garfield Ave	(to) Golden Gate Circle-to-Applewood Dr	CRK	$ 202	87.9	87.9	2	$ 126,277	$ 126,277	0.101
2024	3607	1	0	Nelson St	(to) Princess St-to-Dufferin Ave	CRK	$ 736	82.4	82.4	2	$ 382,634	$ 382,634	0.368
2024	985	1	0	First Ave	(to) 120m West of Garden Crescent (West Leg)-to-Glenview R	CRK	$ 730	82.4	82.4	2	$ 379,515	$ 379,515	0.365
2024	798	1	0	Garfield Ave	(to) Petrolia Line-to-Florence Ave	CRK	$ 316	93	93	2	$ 185,317	$ 185,317	0.158
2024	866	1	0	Oil St	(to) Walnut St E-to-Petrolia Line	CRK	$ 216	83.8	83.8	2	$ 114,148	$ 114,148	0.108
2024	877	1	0	Parkside Dr	(to) Parkside Pl-to-Garfield Ave	CRK	$ 370	83.8	83.8	2	$ 195,532	$ 195,532	0.185
2024	878	1	0	Parkside Pl	(to) South End Cul De Sac-to-Parkside Dr	CRK	$ 120	83.8	83.8	2	$ 63,416	$ 63,416	0.06
2024	282	1	0	Catherine St	(to) Garfield Ave-to-Pine Cr	CRK	$ 214	89.7	89.7	2	$ 121,152	$ 121,152	0.107
2024	790	1	0	Fourth St	(to) Petrolia Line-to-Third St	CRK	$ 234	89.7	89.7	2	$ 132,475	$ 132,475	0.117
2024	808	1	0	Golden Gate Circle	(to) West End Cul De Sac-to-Garfield Ave	CRK	$ 258	89.7	89.7	2	$ 146,062	$ 146,062	0.129
2024	920	1	0	Sixth St	(to) First Ave-to-Fourth St	CRK	$ 482	89.7	89.7	2	$ 272,875	$ 272,875	0.241
2024	3642	1	0	Jennie St	(to) West St-to-Huggard St	CRK	$ 190	94.6	94.6	2	$ 113,343	$ 113,343	0.095
2024	3656	1	0	West St	(to) Annie St-to-Petrolia Line	CRK	$ 226	94.6	94.6	2	$ 134,819	$ 134,819	0.113
2024	3657	1	0	West St	(to) Jennie St-to-Annie St	CRK	$ 226	94.6	94.6	2	$ 134,819	$ 134,819	0.113
2024	728	1	0	Bluebird St	(to) Country View Dr-to-Joe St	CRK	$ 198	94.6	94.6	2	$ 118,116	$ 118,116	0.099
2024	743	1	0	Chestnut St	(to) Walnut St E-to-School St	CRK	$ 212	94.6	94.6	2	$ 126,467	$ 126,467	0.106
2024	780	1	0	Evergreen Trail	(to) Rosemount Dr-to-North End Cul De Sac	CRK	$ 106	94.6	94.6	2	$ 63,233	$ 63,233	0.053
2024	791	1	0	Fourth St	(to) Third St-to-Fifth Ave	CRK	$ 214	94.6	94.6	2	$ 127,660	$ 127,660	0.107
2024	792	1	0	Fourth St	(to) Fifth Ave-to-Sixth St	CRK	$ 208	94.6	94.6	2	$ 124,081	$ 124,081	0.104
2024	793	1	0	Fourth St	(to) Sixth St-to-South End	CRK	$ 106	94.6	94.6	2	$ 63,233	$ 63,233	0.053
2024	807	1	0	Glenview Rd	(to) 330m North of Petrolia South Limits-to-Kerr St	CRK	$ 636	94.6	94.6	2	$ 379,401	$ 379,401	0.318
2024	851	1	0	Lorne Ave	(to) Princess St-to-Queen St	CRK	$ 284	94.6	94.6	2	$ 169,418	$ 169,418	0.142
2024	915	1	0	Rosemount Dr	(to) Redwood Ct-to-Evergreen Trail	CRK	$ 176	94.6	94.6	2	$ 104,991	$ 104,991	0.088
2024	876	1	0	Parkside Dr	(to) Parkside Pl-to-35m South of Rosemount Drive	CRK	$ 446	97	97	2	$ 315,791	$ 315,791	0.223
2024	757	1	0	Discovery Line	(to) Petrolia Discovery Centre-to-Bridge	SST	$ 17,909	73.3	90		$ 505,882	$ 621,392	0.656
2024	805	1	0	Glenview Rd	(to) Dufferin Ave-to-Wellington St	CRK	$ 620	97	97	2	$ 385,486	$ 385,486	0.31
2024	3640	1	0	Annie St	(to) West St-to-Huggard St	CRK	$ 200	97	97	2	$ 122,399	$ 122,399	0.1
2024	716	1	0	Albany St	(to) Dufferin Ave-to-Walnut St E	CRK	$ 420	97	97	2	$ 257,039	$ 257,039	0.21
2024	734	1	0	Catherine St	(to) 70m East of Juniper-to-Eureka St	CRK	$ 308	97	97	2	$ 188,496	$ 188,496	0.154
2024	738	1	0	Centre St	(to) James St-to-200m North of Portland	CRK	$ 570	97	97	2	$ 348,840	$ 348,840	0.285
2024	767	1	0	Ella St	(to) Emma St-to-Warren Ave	CRK	$ 314	97	97	2	$ 192,168	$ 192,168	0.157
2024	768	1	0	Emma St	(to) Ella St-to-Emmeline St	CRK	$ 110	97	97	2	$ 67,320	$ 67,320	0.055
2024	848	1	0	Lancey St	(to) Warren Ave-to-Emmeline St	CRK	$ 56	97	97	2	$ 34,272	$ 34,272	0.028
2024	850	1	0	Lorne Ave	(to) Maude St-to-Midblock	CRK	$ 130	97	97	2	$ 79,560	$ 79,560	0.065
2024	830	1	0	Joe St	(to) Tom St-to-Maude St	CRK	$ 192	89	89	2	$ 121,555	$ 121,555	0.096
2024	854	1	0	Maude St	(to) Annie St-to-Petrolia Line	CRK	$ 226	89	89	2	$ 132,970	$ 132,970	0.113

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2024	813	1	0	Hartford St	(to) Petrolia Line-to-North St	CRK	$ 180	89	89	2	$ 101,075	$ 101,075	0.09
2024	839	1	0	Kentail St	(to) Petrolia Line-to-North St	CRK	$ 190	89	89	2	$ 106,690	$ 106,690	0.095
2024	862	1	0	North St	(to) Hartford St-to-Kentail St	CRK	$ 396	89	89	2	$ 222,364	$ 222,364	0.198
2024	863	1	0	North St	(to) Kentail St-to-Wood St	CRK	$ 340	89	89	2	$ 190,918	$ 190,918	0.17
2024	864	1	0	North St	(to) Wood St-to-Oil Heritage Rd	CRK	$ 724	89	89	2	$ 406,544	$ 406,544	0.362
2024	950	1	0	Wood St	(to) Petrolia Line-to-North St	CRK	$ 192	89	89	2	$ 107,813	$ 107,813	0.096
2024	926	1	0	Tank St	(to) Petrolia Line-to-End of Curb and Gutter	R2Urehab	$ 217,326	41.5	100		$ 181,364	$ 436,602	0.346
2024	984	1	0	First Ave	(to) 150m East of Garden Crescent (West Leg)-to-120m West c	R2Urehab	$ 207,672	27.4	100		$ 93,182	$ 340,701	0.27
2024	904	1	0	Princess St	(to) Grove St-to-Wellington St	R1	$ 50,516	61.7	97		$ 98,115	$ 154,224	0.126
2024	797	1	0	Garden Cr	(to) First Ave-to-Heritage Heights Ln	R2Urehab	$ 188,008	33	100		$ 103,624	$ 314,202	0.249
2024	944	1	0	Warren Ave	(to) Lancey St-to-Henry Ave	R1	$ 39,734	66.9	97		$ 93,718	$ 135,864	0.111
2024	3641	1	0	Jennie St	(to) Huggard St-to-Maude St	R1	$ 40,732	66.9	97		$ 86,119	$ 124,848	0.102
2024	744	1	1	Chestnut St	(to) School St-to-south end	RNS	$ 96,000	10	100		$ 9,590	$ 95,901	0.076
2024	818	1	1	Hickory St	(to) School St-to-Walnut St E	RNS	$ 77,000	20	100		$ 14,366	$ 71,832	0.107
2024	844	1	1	King St	(to) Dufferin Ave-to-Petrolia Line	RNS	$ 451,000	27.8	100		$ 125,018	$ 450,514	0.346
2024	917	1	1	School St	(to) Greenfield St-to-Hickory St	RNS	$ 45,545	23.1	100		$ 9,770	$ 42,294	0.063
2024	918	1	1	School St	(to) Hickory St-to-Chestnut St	RNS	$ 37,955	23.1	100		$ 8,219	$ 35,580	0.053
							$1,482,117						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2025	857	1	0	Maude St	(to) Joe St-to-Dufferin Ave	CRK	$ 1,048	78	78	2	$ 540,397	$ 540,397	0.524
2025	3641	1	0	Jennie St	(to) Huggard St-to-Maude St	CRK	$ 204	97	97	2	$ 124,848	$ 124,848	0.102
2025	904	1	0	Princess St	(to) Grove St-to-Wellington St	CRK	$ 252	97	97	2	$ 154,224	$ 154,224	0.126
2025	944	1	0	Warren Ave	(to) Lancey St-to-Henry Ave	CRK	$ 222	97	97	2	$ 135,864	$ 135,864	0.111
2025	855	1	0	Maude St	(to) Annie St-to-Jennie St	CRK	$ 222	90	90	2	$ 132,085	$ 132,085	0.111
2025	795	1	0	Gables Ave	(to) Jacs Ct-to-107m S of Jacs Court	R2Urehab	$ 71,735	39.3	100		$ 53,022	$ 135,018	0.107
2025	754	1	0	Discovery Line	(to) Centre St-to-Former Railway Crossing	PR2	$ 60,405	53.9	100		$ 76,222	$ 141,388	0.164
2025	916	1	0	Sanway Ct	(to) West End Cul De Sac-to-Eagan Ave	R2Urehab	$ 89,166	35	100		$ 51,629	$ 147,637	0.117
2025	935	1	0	Valentina St S.	(to) Charlie St-to-Joe St	R2Urehab	$ 72,823	35	100		$ 42,362	$ 121,138	0.096
2025	758	1	0	Dufferin Ave	(to) Huggard St-to-Maude St	R2Urehab	$ 68,383	43.8	100		$ 56,375	$ 128,709	0.102
2025	865	1	0	Northridge Pl	(to) Petrolia Line-to-North End Cul De Sac	R2Urehab	$ 72,699	39.3	100		$ 50,048	$ 127,447	0.101
2025	970	1	0	Lane Behind Church	(to) King St-to-West End Cul De Sac	R1	$ 29,735	64.3	97		$ 58,624	$ 88,411	0.07
2025	776	1	0	Eureka St	(to) Maple St-to-Catherine St	R2Urehab	$ 190,028	43.8	100		$ 150,332	$ 343,224	0.272
2025	777	1	0	Eureka St	(to) Catherine St-to-Ernest St	R2Urehab	$ 114,576	43.8	100		$ 90,641	$ 206,944	0.164
2025	778	1	0	Eureka St	(to) Ernest St-to-Discovery Line	R2Urehab	$ 384,248	43.8	100		$ 303,981	$ 694,020	0.55
2025	823	1	0	Huggard St	(to) Dufferin Ave-to-Arena Lot	R2Urehab	$ 125,053	35	100		$ 68,588	$ 196,135	0.123
2025	901	1	0	Princess St	(to) Dufferin Ave-to-Lorne Ave	R2Urehab	$ 88,380	43.9	100		$ 68,706	$ 156,470	0.124
2025	764	1	1	Edward St	(to) Ignatiefna St-to-Valentine St S	RNS	$ 97,500	20	100		$ 18,332	$ 91,662	0.123
							$1,466,679						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2026	831	1	0	Joe St	(to) Valentina St S.-to-Tom St	CRK	$ 336	76	76	2	$ 181,650	$ 181,650	0.168
2026	970	1	0	Lane Behind Church	(to) King St-to-West End Cul De Sac	CRK	$ 140	97	97	2	$ 88,411	$ 88,411	0.07
2026	769	1	0	Emma St	(to) Emmeline St-to-East End	R1	$ 27,022	69.5	97		$ 69,253	$ 96,696	0.079
2026	900	1	0	Princess St	(to) Lorne Ave-to-Petrolia Line	R2Urehab	$ 159,653	41.6	100		$ 117,443	$ 282,655	0.224
2026	902	1	0	Princess St	(to) Nelson St-to-Dufferin Ave	R2Urehab	$ 221,662	41.6	100		$ 163,058	$ 392,437	0.311
2026	735	1	0	Centre St	(to) Petrolia Line-to-Robert St	R2Urehab	$ 68,306	37.3	100		$ 41,441	$ 111,043	0.088
2026	826	1	0	Jacs Ct	(to) Gables Ave-to-North End Cul De Sac	R1	$ 15,890	69.5	97		$ 38,571	$ 53,856	0.044
2026	912	1	0	Robert St	(to) Eureka St-to-Centre St	R2Urehab	$ 226,516	41.6	100		$ 157,290	$ 378,556	0.3
2026	936	1	0	Valentina St S.	(to) Charlie St-to-Henderson Dr	R2Urehab	$ 79,280	41.6	100		$ 55,052	$ 132,495	0.105
2026	800	1	0	Garfield Ave	(to) Maple St-to-Mulberry Pl	R2Urehab	$ 104,648	37.3	100		$ 60,607	$ 162,397	0.091
2026	827	1	0	James St	(to) Eureka St-to-Centre St	R2Urehab	$ 208,120	46.3	100		$ 170,708	$ 368,462	0.292
2026	905	1	0	Princess St	(to) Grove St-to-Kerr St	R1	$ 44,101	69.5	97		$ 96,427	$ 134,640	0.11
2026	856	1	0	Maude St	(to) Dufferin Ave-to-Lorne Ave	R1	$ 53,032	68	97		$ 110,586	$ 157,748	0.123
2026	910	1	1	Railroad St	(to) Station St-to-Tank St	RNS	$ 157,696	79.3	100		$ 129,035	$ 162,779	0.129
2026	922	1	1	Station St	(to) Petrolia Line-to-46m North of Petrolia Line	RNS	$ 60,652	15	100		$ 9,310	$ 62,068	0.046
2026	923	1	1	Station St	(to) 46m North of Petrolia Line-to-Railroad St	RNS	$ 60,652	22.7	100		$ 10,950	$ 48,173	0.046
							$1,487,706						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2027	775	1	0	Eureka St	(to) Petrolia Line-to-Maple St	CRK	$ 750	93	93	2	$ 439,835	$ 439,835	0.375
2027	908	1	0	Queen St	(to) Dufferin Ave-to-Lorne Ave	CRK	$ 250	93	93	2	$ 146,612	$ 146,612	0.125
2027	751	1	0	Discovery Line	(to) West town limit-to-Stanley	CRK	$ 300	97	97	2	$ 271,519	$ 271,519	0.3
2027	752	1	0	Discovery Line	(to) Stanley Ave-to-Eureka St	CRK	$ 449	97	97	2	$ 406,373	$ 406,373	0.449
2027	811	1	0	Greenfield St	(to) Dufferin Ave-to-South End	CRK	$ 116	97	97	2	$ 86,262	$ 86,262	0.058
2027	809	1	0	Greenfield St	(to) Petrolia Line-to-Walnut W	CRK	$ 268	97	97	2	$ 184,922	$ 184,922	0.134
2027	948	1	0	Wingfield St	(to) Petrolia Line-to-Walnut St E	CRK	$ 270	97	97	2	$ 181,036	$ 181,036	0.135
2027	913	1	0	Robert St	(to) Centre St-to-Fletcher St	CRK	$ 274	97	97	2	$ 175,703	$ 175,703	0.137
2027	3605	1	0	Princess St	(to) Wellington St-to-Nelson St	CRK	$ 330	97	97	2	$ 201,960	$ 201,960	0.165
2027	724	1	0	Applewood Dr	(to) Garfield Ave-to-Catherine St	CRK	$ 486	97	97	2	$ 297,432	$ 297,432	0.243
2027	731	1	0	Catherine St	(to) Pine Cr-to-Pine Cr	CRK	$ 172	97	97	2	$ 105,264	$ 105,264	0.086
2027	732	1	0	Catherine St	(to) Pine Cr-to-Juniper Cr	CRK	$ 174	97	97	2	$ 106,488	$ 106,488	0.087
2027	733	1	0	Catherine St	(to) Juniper Cr-to-70m East of Juniper	CRK	$ 136	97	97	2	$ 83,232	$ 83,232	0.068
2027	765	1	0	Egan Ave	(to) Petrolia Line-to-Florence Ave	CRK	$ 316	97	97	2	$ 193,392	$ 193,392	0.158
2027	769	1	0	Emma St	(to) Emmeline St-to-East End	CRK	$ 158	97	97	2	$ 96,696	$ 96,696	0.079
2027	773	1	0	Ernest St	(to) 50m West of Kells Street-to-Eureka St	CRK	$ 300	97	97	2	$ 183,600	$ 183,600	0.15
2027	774	1	0	Ernest St	(to) Applewood Dr-to-50m West of Kells Street	CRK	$ 632	97	97	2	$ 386,784	$ 386,784	0.316
2027	788	1	0	Florence Ave	(to) Garfield Ave-to-Egan Ave	CRK	$ 440	97	97	2	$ 269,280	$ 269,280	0.22
2027	810	1	0	Greenfield St	(to) Walnut W-to-Dufferin Ave	CRK	$ 416	97	97	2	$ 254,592	$ 254,592	0.208
2027	814	1	0	Hawthorne Pl	(to) West End Cul De Sac-to-Sycamore Dr	CRK	$ 152	97	97	2	$ 93,024	$ 93,024	0.076
2027	826	1	0	Jacs Ct	(to) Gables Ave-to-North End Cul De Sac	CRK	$ 88	97	97	2	$ 53,856	$ 53,856	0.044
2027	834	1	0	Juniper Cr	(to) Catherine St-to-Juniper Cr South	CRK	$ 444	97	97	2	$ 271,728	$ 271,728	0.222
2027	835	1	0	Juniper Cr	(to) Juniper North-to-Sycamore Dr	CRK	$ 432	97	97	2	$ 264,384	$ 264,384	0.216
2027	836	1	0	Kells St	(to) Ernest St-to-North End Cul De Sac	CRK	$ 262	97	97	2	$ 160,344	$ 160,344	0.131
2027	841	1	0	Kerby St	(to) Petrolia Line-to-Florence Ave	CRK	$ 320	97	97	2	$ 195,840	$ 195,840	0.16
2027	842	1	0	Kerby St	(to) Florence Ave-to-North End	CRK	$ 214	97	97	2	$ 130,967	$ 130,967	0.107
2027	849	1	0	Lancey St	(to) Emmeline St-to-East End Cul De Sac	CRK	$ 416	97	97	2	$ 254,592	$ 254,592	0.208
2027	879	1	0	Pearl St	(to) England Ave-to-First Ave	CRK	$ 266	97	97	2	$ 162,792	$ 162,792	0.133
2027	896	1	0	Pine Cr	(to) Catherine St-to-Catherine St	CRK	$ 606	97	97	2	$ 370,872	$ 370,872	0.303
2027	905	1	0	Princess St	(to) Grove St-to-Kerr St	CRK	$ 220	97	97	2	$ 134,640	$ 134,640	0.11
2027	925	1	0	Sycamore Dr	(to) Maple St-to-North End Cul De Sac	CRK	$ 268	97	97	2	$ 164,016	$ 164,016	0.134
2027	929	1	0	Third St	(to) First Ave-to-Fourth St	CRK	$ 488	97	97	2	$ 298,656	$ 298,656	0.244
2027	941	1	0	Walnut St W	(to) Albany St-to-Wingfield St	CRK	$ 170	97	97	2	$ 104,040	$ 104,040	0.085
2027	949	1	0	Wingfield St	(to) Walnut St E-to-Dufferin Ave	CRK	$ 416	97	97	2	$ 254,592	$ 254,592	0.208
2027	980	1	0	Country View Dr	(to) Englehart Dr-to-Valentina St S.	CRK	$ 206	97	97	2	$ 126,072	$ 126,072	0.103
2027	981	1	0	Country View Dr	(to) South End-to-Englehart Drive	CRK	$ 380	97	97	2	$ 232,559	$ 232,559	0.19
2027	982	1	0	Englehart Drive	(to) Country View Dr-to-250m E of Countryview Drive	CRK	$ 500	97	97	2	$ 306,000	$ 306,000	0.25
2027	983	1	0	Englehart Drive	(to) 250m E of Countryview Drive-to-South End	CRK	$ 258	97	97	2	$ 157,896	$ 157,896	0.129

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2027	992	1	0	Sunset Court	(to) Ernest St-to-North End Cul De Sac	CRK	$ 150	97	97	2	$ 91,800	$ 91,800	0.075
2027	795A	1	0	Gables Ave	(to) 107m S of Jacs Court-to-South End Cul De Sac	CRK	$ 122	97	97	2	$ 65,147	$ 65,147	0.061
2027	942	1	0	Walnut St W	(to) Wingfield St-to-Greenfield St	CRK	$ 138	97	97	2	$ 53,364	$ 53,364	0.069
2027	838	1	0	Kentail St	(to) Third St-to-Petrolia Line	CRK	$ 234	97	97	2	$ 83,813	$ 83,813	0.117
2027	858	1	0	Maude St	(to) Joe St-to-South end (extension)	CRK	$ 500	97	97	2	$ 179,087	$ 179,087	0.25
2027	930	1	0	Third St	(to) Fourth St-to-Kentail St	CRK	$ 268	97	97	2	$ 90,752	$ 90,752	0.134
2027	931	1	0	Third St	(to) Kentail St-to-Mutual St	CRK	$ 290	97	97	2	$ 98,202	$ 98,202	0.145
2027	933	1	0	Valentina St N.	(to) South End Cul De Sac-to-Petrolia Line	CRK	$ 372	97	97	2	$ 122,333	$ 122,333	0.186
2027	3895	1	0	Mutual St	(to) South End-to-Third St	CRK	$ 88	97	97	2	$ 28,653	$ 28,653	0.044
2027	860	1	0	Mutual St	(to) Third St-to-Petrolia Line	CRK	$ 242	97	97	2	$ 78,794	$ 78,794	0.121
2027	921	1	0	Stanley Ave	(to) South Limit-to-Discovery Line	CRK	$ 280	97	97	2	$ 91,166	$ 91,166	0.14
2027	804	1	0	Gem Ave	(to) Petrolia Line-to-North End Cul De Sac	R1	$ 149,748	66.9	97		$ 316,615	$ 458,999	0.375
2027	945	1	0	Wellington St	(to) Princess St-to-Glenview Rd	R1	$ 153,552	66.9	97		$ 323,369	$ 468,791	0.383
2027	843	1	0	Kerr St	(to) Princess St-to-Glenview Rd	R1	$ 112,703	66.9	97		$ 236,406	$ 342,719	0.28
2027	815	1	0	Henderson Dr	(to) Country View Dr-to-Valentina St S.	R2Urehab	$ 145,967	43.9	100		$ 109,154	$ 248,585	0.197
2027	820	1	0	Huggard St	(to) Petrolia Line-to-Annie St	R2Urehab	$ 115,822	39.3	100		$ 71,341	$ 181,669	0.114
2027	821	1	0	Huggard St	(to) Annie St-to-Jennie St	R2Urehab	$ 112,774	39.3	100		$ 69,464	$ 176,888	0.111
2027	729	1	1	Cardinal Cr	(to) Joe St-to-Corner	RNS	$ 189,318	31.1	100		$ 57,688	$ 185,493	0.147
2027	730	1	1	Cardinal Cr	(to) Oozloffsky St S-to-corner	RNS	$ 227,182	27.8	100		$ 64,080	$ 230,919	0.183
2027	873	1	1	Oozloffsky St S	(to) Joe St-to-North End Cul De Sac	RNS	$ 232,200	23.9	100		$ 55,375	$ 232,181	0.184
							$1,454,293						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2028	771	1	0	England Ave	(to) Petrolia Line-to-Pearl St	CRK	$ 194	97	97	2	$ 118,728	$ 118,728	0.097
2028	772	1	0	England Ave	(to) Pearl St-to-South End	CRK	$ 188	97	97	2	$ 115,056	$ 115,056	0.094
2028	781	1	0	Fifth Ave	(to) First Ave-to-Fourth St	CRK	$ 488	97	97	2	$ 298,656	$ 298,656	0.244
2028	804	1	0	Gem Ave	(to) Petrolia Line-to-North End Cul De Sac	CRK	$ 750	97	97	2	$ 458,999	$ 458,999	0.375
2028	843	1	0	Kerr St	(to) Princess St-to-Glenview Rd	CRK	$ 560	97	97	2	$ 342,719	$ 342,719	0.28
2028	945	1	0	Wellington St	(to) Princess St-to-Glenview Rd	CRK	$ 766	97	97	2	$ 468,791	$ 468,791	0.383
2028	906	1	0	Progress Dr	(to) West End-to-Oil Heritage Rd	CRK	$ 978	97	97	2	$ 395,264	$ 395,264	0.489
2028	750	1	0	Derby St	(to) Holland St-to-Oil Heritage Rd	CRK	$ 620	97	97	2	$ 205,909	$ 205,909	0.31
2028	749	1	0	Derby St	(to) Mutual St-to-Holland St	CRK	$ 160	97	97	2	$ 52,617	$ 52,617	0.08
2028	819	1	0	Holland St	(to) Derby St-to-Petrolia Line	CRK	$ 176	97	97	2	$ 57,305	$ 57,305	0.088
2028	943	1	0	Walnut St E	(to) Greenfield St-to-Oil St	R1	$ 55,443	69.5	97		$ 149,024	$ 208,080	0.17
2028	794	1	0	Gables Ave	(to) Eureka St-to-Jacs Ct	R1	$ 31,419	69.5	97		$ 76,265	$ 106,488	0.087
2028	717	1	0	Albany St	(to) Walnut St W-to-Petrolia Line	R1	$ 52,853	69.5	97		$ 121,849	$ 170,136	0.139
2028	3639	1	0	Annie St	(to) Huggard St-to-Maude St	R2Urehab	$ 78,326	41.6	100		$ 52,430	$ 126,185	0.1
2028	806	1	0	Glenview Rd	(to) Wellington St-to-Kerr St	R2Urehab	$ 100,468	41.6	100		$ 67,114	$ 161,527	0.126
2028	907	1	0	Queen St	(to) Lorne Ave-to-Petrolia Line	R1	$ 109,138	67.9	97		$ 228,159	$ 325,845	0.222
2028	812	1	0	Grove St	(to) Princess St-to-Glenview Rd	R1	$ 112,211	69.5	97		$ 246,327	$ 343,944	0.281
2028	874	1	0	Oriole Pk	(to) Joe St-to-North End Cul De Sac	RNS	$ 79,497	33	100		$ 26,218	$ 79,497	0.063
2028	726	1	1	Barretts Lane	(to) Petrolia Line-to-England Ave	REC	$ 197,400	5	100		$ 9,869	$ 197,371	0.294
2028	741	1	1	Charlie St	(to) Tom St-to-Short St	RNS	$ 103,500	21.6	100		$ 22,360	$ 103,472	0.082
2028	919	1	1	Short St	(to) South End Cul De Sac-to-Charlie St	RNS	$ 141,400	26.3	100		$ 37,155	$ 141,328	0.112
2028	932	1	1	Tom St	(to) Charlie St-to-Joe St	RNS	$ 116,100	5	100		$ 5,805	$ 116,091	0.092
2028	987	1	1	Discovery Line	(to) Bridge-to-400m West of Oil Heritage Rd	REC	$ 297,000	10	100		$ 29,680	$ 296,803	0.282
							$1,479,635						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2029	926	1	0	Tank St	(to) Petrolia Line-to-End of Curb and Gutter	CRK	$ 692	93	93	2	$ 405,822	$ 405,822	0.346
2029	984	1	0	First Ave	(to) 150m East of Garden Crescent (West Leg)-to-120m West c	CRK	$ 540	93	93	2	$ 316,682	$ 316,682	0.27
2029	753	1	0	Discovery Line	(to) Eureka St-to-Centre St	SST	$ 3,766	77.3	90		$ 204,755	$ 238,488	0.284
2029	844	1	0	King St	(to) Dufferin Ave-to-Petrolia Line	CRK	$ 692	97	97	2	$ 436,999	$ 436,999	0.346
2029	717	1	0	Albany St	(to) Walnut St W-to-Petrolia Line	CRK	$ 278	97	97	2	$ 170,136	$ 170,136	0.139
2029	744	1	0	Chestnut St	(to) School St-to-south end	CRK	$ 152	97	97	2	$ 93,024	$ 93,024	0.076
2029	794	1	0	Gables Ave	(to) Eureka St-to-Jacs Ct	CRK	$ 174	97	97	2	$ 106,488	$ 106,488	0.087
2029	797	1	0	Garden Cr	(to) First Ave-to-Heritage Heights Ln	CRK	$ 498	97	97	2	$ 304,776	$ 304,776	0.249
2029	812	1	0	Grove St	(to) Princess St-to-Glenview Rd	CRK	$ 562	97	97	2	$ 343,944	$ 343,944	0.281
2029	943	1	0	Walnut St E	(to) Greenfield St-to-Oil St	CRK	$ 340	97	97	2	$ 208,080	$ 208,080	0.17
2029	789	1	0	Florence Ave	(to) Egan Ave-to-Kerby St	SST	$ 6,327	77.3	90		$ 202,807	$ 236,219	0.208
2029	757	1	0	Discovery Line	(to) Petrolia Discovery Centre-to-Bridge	SST	$ 17,909	77.3	90		$ 533,500	$ 621,392	0.656
2029	991	1	0	Lorne Ave	(to) Midblock-to-Princess St	SST	$ 1,749	77.3	90		$ 36,749	$ 42,809	0.065
2029	818	1	0	Hickory St	(to) School St-to-Walnut St E	CRK	$ 214	97	97	2	$ 69,677	$ 69,677	0.107
2029	917	1	0	School St	(to) Greenfield St-to-Hickory St	CRK	$ 126	97	97	2	$ 41,025	$ 41,025	0.063
2029	918	1	0	School St	(to) Hickory St-to-Chestnut St	CRK	$ 106	97	97	2	$ 34,513	$ 34,513	0.053
2029	816	1	0	Henry Ave	(to) Oil St-to-Warren Ave	R1	$ 22,706	69.5	97		$ 56,103	$ 78,336	0.064
2029	3582	1	0	Oozloffsky St N	(to) 316 m South of Petrolia Line-to-Petrolia Line	R1	$ 126,188	66.9	97		$ 266,801	$ 386,784	0.316
2029	3592	1	0	Oozloffsky St N	(to) Ignatiefna St-to-316 m South of Petrolia Line	R1	$ 121,795	66.9	97		$ 257,514	$ 373,320	0.305
2029	786	1	0	First Ave	(to) Garden-to-150m East of Garden Crescent (West Leg)	R1	$ 283,174	67.9	97		$ 598,222	$ 854,352	0.698
2029	914	1	0	Rosemount Dr	(to) Parkside Ct-to-Redwood Ct	R1	$ 35,274	69.5	97		$ 80,648	$ 112,608	0.092
2029	799	1	0	Garfield Ave	(to) Florence Ave-to-Maple St	R1	$ 82,051	70.8	97		$ 191,294	$ 261,936	0.214
2029	745	1	0	Country View Dr	(to) Bluebird St-to-East End Cul De Sac	R1	$ 21,164	69.5	97		$ 46,460	$ 64,872	0.053
2029	899	1	1	Portland Ave	(to) West End Cul De Sac-to-Centre St	RNS	$ 140,100	15	100		$ 21,010	$ 140,066	0.111
2029	928	1	1	Tank St	(to) Discovery Line-to-North Town Limit	REC	$ 626,200	10	100		$ 62,617	$ 626,174	0.677
							$1,492,777						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2030	758	1	0	Dufferin Ave	(to) Huggard St-to-Maude St	CRK	$ 204	93	93	2	$ 119,635	$ 119,635	0.102
2030	776	1	0	Eureka St	(to) Maple St-to-Catherine St	CRK	$ 544	93	93	2	$ 319,027	$ 319,027	0.272
2030	777	1	0	Eureka St	(to) Catherine St-to-Ernest St	CRK	$ 328	93	93	2	$ 192,354	$ 192,354	0.164
2030	778	1	0	Eureka St	(to) Ernest St-to-Discovery Line	CRK	$ 1,100	93	93	2	$ 645,092	$ 645,092	0.55
2030	754	1	0	Discovery Line	(to) Centre St-to-Former Railway Crossing	CRK	$ 164	97	97	2	$ 137,146	$ 137,146	0.164
2030	823	1	0	Huggard St	(to) Dufferin Ave-to-Arena Lot	CRK	$ 246	97	97	2	$ 190,251	$ 190,251	0.123
2030	3582	1	0	Oozloffsky St N	(to) 316 m South of Petrolia Line-to-Petrolia Line	CRK	$ 632	97	97	2	$ 386,784	$ 386,784	0.316
2030	3592	1	0	Oozloffsky St N	(to) Ignatiefna St-to-316 m South of Petrolia Line	CRK	$ 610	97	97	2	$ 373,320	$ 373,320	0.305
2030	745	1	0	Country View Dr	(to) Bluebird St-to-East End Cul De Sac	CRK	$ 106	97	97	2	$ 64,872	$ 64,872	0.053
2030	795	1	0	Gables Ave	(to) Jacs Ct-to-107m S of Jacs Court	CRK	$ 214	97	97	2	$ 130,967	$ 130,967	0.107
2030	816	1	0	Henry Ave	(to) Oil St-to-Warren Ave	CRK	$ 128	97	97	2	$ 78,336	$ 78,336	0.064
2030	865	1	0	Northridge Pl	(to) Petrolia Line-to-North End Cul De Sac	CRK	$ 202	97	97	2	$ 123,624	$ 123,624	0.101
2030	901	1	0	Princess St	(to) Dufferin Ave-to-Lorne Ave	CRK	$ 248	97	97	2	$ 151,776	$ 151,776	0.124
2030	914	1	0	Rosemount Dr	(to) Parkside Ct-to-Redwood Ct	CRK	$ 184	97	97	2	$ 112,608	$ 112,608	0.092
2030	916	1	0	Sanway Ct	(to) West End Cul De Sac-to-Eagan Ave	CRK	$ 234	97	97	2	$ 143,208	$ 143,208	0.117
2030	935	1	0	Valentina St S.	(to) Charlie St-to-Joe St	CRK	$ 192	97	97	2	$ 117,504	$ 117,504	0.096
2030	856	1	0	Maude St	(to) Dufferin Ave-to-Lorne Ave	CRK	$ 246	90	90	2	$ 146,364	$ 146,364	0.123
2030	764	1	0	Edward St	(to) Ignatiefna St-to-Valentine St S	CRK	$ 246	97	97	2	$ 88,912	$ 88,912	0.123
2030	824	1	0	Hunter Ct	(to) West End Cul De Sac-to-Valentina St S.	R1	$ 38,735	66.9	97		$ 81,898	$ 118,728	0.097
2030	737	1	0	Centre St	(to) Andrew St-to-James St	R1	$ 35,163	66.9	97		$ 72,611	$ 105,264	0.086
2030	736	1	0	Centre St	(to) Robert St-to-Andrew St	R1	$ 34,346	67.9	97		$ 71,992	$ 102,816	0.084
2030	934	1	0	Valentina St S.	(to) Joe St-to-Edward St	RNS	$ 328,155	15	100		$ 52,941	$ 352,943	0.375
2030	985	1	0	First Ave	(to) 120m West of Garden Crescent (West Leg)-to-Glenview Rd	R1	$ 146,916	70.8	97		$ 326,273	$ 446,760	0.365
2030	3607	1	0	Nelson St	(to) Princess St-to-Dufferin Ave	R1	$ 150,466	70.8	97		$ 328,954	$ 450,431	0.368
2030	895	1	0	Pettibone St	(to) Eureka St-to-Andrew St	RNS	$ 112,070	10	100		$ 10,473	$ 104,727	0.156
2030	727	1	0	Blanche St	(to) South End Cul De Sac-to-Dufferin Ave	RNS	$ 108,410	15	100		$ 15,886	$ 105,905	0.126
2030	782	1	0	First Ave	(to) Petrolia Line-to-Third St	RNS	$ 147,637	20	100		$ 29,527	$ 147,637	0.117
2030	783	1	0	First Ave	(to) Third St-to-Fifth Ave	RNS	$ 136,280	20	100		$ 27,256	$ 136,280	0.108
2030	784	1	0	First Ave	(to) Fifth Ave-to-Sixth St	RNS	$ 133,757	20	100		$ 26,751	$ 133,757	0.106
2030	787	1	0	Fletcher St	(to) Petrolia Line-to-Robert St	RNS	$ 116,973	20	100		$ 23,395	$ 116,973	0.084
							$1,494,736						

Town of Petrolia

10 Year Work Plan from Performance Model 20210826

Year	Asset ID	Fund	Proj	Street Name	Description	Imp. Type	Cost	Start Cond	End Cond	Yrs Hold	Start Value	End Value	Length
2031	800	1	0	Garfield Ave	(to) Maple St-to-Mulberry Pl	CRK	$ 182	93	93	2	$ 150,948	$ 150,948	0.091
2031	907	1	0	Queen St	(to) Lorne Ave-to-Petrolia Line	CRK	$ 444	93	93	2	$ 312,240	$ 312,240	0.222
2031	735	1	0	Centre St	(to) Petrolia Line-to-Robert St	CRK	$ 176	93	93	2	$ 103,214	$ 103,214	0.088
2031	922	1	0	Station St	(to) Petrolia Line-to-46m North of Petrolia Line	CRK	$ 92	97	97	2	$ 60,206	$ 60,206	0.046
2031	737	1	0	Centre St	(to) Andrew St-to-James St	CRK	$ 172	97	97	2	$ 105,264	$ 105,264	0.086
2031	824	1	0	Hunter Ct	(to) West End Cul De Sac-to-Valentina St S.	CRK	$ 194	97	97	2	$ 118,728	$ 118,728	0.097
2031	827	1	0	James St	(to) Eureka St-to-Centre St	CRK	$ 584	97	97	2	$ 357,408	$ 357,408	0.292
2031	900	1	0	Princess St	(to) Lorne Ave-to-Petrolia Line	CRK	$ 448	97	97	2	$ 274,175	$ 274,175	0.224
2031	902	1	0	Princess St	(to) Nelson St-to-Dufferin Ave	CRK	$ 622	97	97	2	$ 380,664	$ 380,664	0.311
2031	910	1	0	Railroad St	(to) Station St-to-Tank St	CRK	$ 258	97	97	2	$ 157,896	$ 157,896	0.129
2031	912	1	0	Robert St	(to) Eureka St-to-Centre St	CRK	$ 600	97	97	2	$ 367,199	$ 367,199	0.3
2031	936	1	0	Valentina St S.	(to) Charlie St-to-Henderson Dr	CRK	$ 210	97	97	2	$ 128,520	$ 128,520	0.105
2031	923	1	0	Station St	(to) 46m North of Petrolia Line-to-Railroad St	CRK	$ 92	97	97	2	$ 46,728	$ 46,728	0.046
2031	722	1	0	Applewood Dr	(to) Parkside Ct-to-Evergreen Trail	R1	$ 59,134	69.5	97		$ 135,874	$ 189,719	0.155
2031	723	1	0	Applewood Dr	(to) Evergreen Trail-to-Garfield Ave	R1	$ 34,891	69.5	97		$ 79,772	$ 111,384	0.091
2031	747	1	0	Country View Dr	(to) Henderson Dr-to-NW Corner	R1	$ 46,322	69.5	97		$ 101,687	$ 141,984	0.116
2031	748	1	0	Country View Dr	(to) Valentina St S.-to-Henderson Dr	R1	$ 97,037	69.5	97		$ 213,017	$ 297,432	0.243
2031	986	1	0	Fairway Court	(to) West End Cul De Sac-to-First Ave	R1	$ 77,869	69.5	97		$ 170,939	$ 238,680	0.195
2031	831	1	0	Joe St	(to) Valentina St S.-to-Tom St	R1	$ 77,779	70	97		$ 167,309	$ 231,843	0.168
2031	857	1	0	Maude St	(to) Joe St-to-Dufferin Ave	R1	$ 225,923	70	97		$ 484,972	$ 672,032	0.524
2031	742	1	0	Charlie St	(to) Short St-to-Valentina St N.	RNS	$ 119,876	20.6	100		$ 24,742	$ 119,876	0.095
2031	759	1	0	Dufferin Ave	(to) Maude St-to-Princess St	RNS	$ 183,528	20	100		$ 36,706	$ 183,528	0.129
2031	822	1	0	Huggard St	(to) Jennie St-to-Dufferin Ave	RNS	$ 197,605	20	100		$ 39,521	$ 197,605	0.124
2031	859	1	0	Mulberry Pl	(to) Garfield Ave-to-East End Cul De Sac	RNS	$ 181,707	20	100		$ 36,341	$ 181,707	0.144
2031	762	1	0	Dufferin Ave	(to) Glenview Rd-to-Blanche St	RNS	$ 125,197	23.1	100		$ 28,870	$ 125,197	0.088
2031	875	1	0	Parkside Ct	(to) 35m South of Rosemount Drive-to-North End Cul De Sac	R2Urehab	$ 64,781	35	100		$ 24,270	$ 69,402	0.09
							$1,495,723						

Appendix H: Critical Deficiencies by Asset ID

Critical Deficiencies by Street Name

Current Inspection Batch

ID	Street Name	From Description	To Description	Surface	Length	AADT	Cap.	Drain	Geo	SA	Width	Type	Imp	Overall TON
716	Albany St	Dufferin Ave	Walnut St E	High Class Bit.-asphalt	0.210	210	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
717	Albany St	Walnut St W	Petrolia Line	High Class Bit.-asphalt	0.139	139	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
718	Andrew St	Pettibone St	Centre St	High Class Bit.-asphalt	0.165	165	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
719	Andrew St	Centre St	east end	Gravel, Stone, Other Loosetop	0.115	115	ADEQ	1-5	ADEQ	ADEQ	ADEQ	NOW	RNS	NOW
3639	Annie St	Huggard St	Maude St	High Class Bit.-asphalt	0.100	100	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
3640	Annie St	West St	Huggard St	High Class Bit.-asphalt	0.100	100	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
722	Applewood Dr	Parkside Ct	Evergreen Trail	High Class Bit.-asphalt	0.155	155	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
723	Applewood Dr	Evergreen Trail	Garfield Ave	High Class Bit.-asphalt	0.091	91	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
724	Applewood Dr	Garfield Ave	Catherine St	High Class Bit.-asphalt	0.243	188	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
726	Barretts Lane	Petrolia Line	England Ave	Low Class Bit.-surface treated	0.294	294	ADEQ	1-5	ADEQ	NOW	NOW	ADEQ	REC	NOW
727	Blanche St	South End Cul De Sac	Dufferin Ave	Low Class Bit.-surface treated	0.126	126	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
728	Bluebird St	Country View Dr	Joe St	High Class Bit.-asphalt	0.099	99	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
729	Cardinal Cr	Joe St	Corner	High Class Bit.-asphalt	0.147	147	ADEQ	1-5	ADEQ	1-5	ADEQ	ADEQ	RNS	1-5
730	Cardinal Cr	Oozloffsky St S	corner	High Class Bit.-asphalt	0.183	183	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
731	Catherine St	Pine Cr	Pine Cr	High Class Bit.-asphalt	0.086	86	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
732	Catherine St	Pine Cr	Juniper Cr	High Class Bit.-asphalt	0.087	87	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
733	Catherine St	Juniper Cr	70m East of Juniper	High Class Bit.-asphalt	0.068	200	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
734	Catherine St	70m East of Juniper	Eureka St	High Class Bit.-asphalt	0.154	200	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
282	Catherine St	Garfield Ave	Pine Cr	High Class Bit.-asphalt	0.107	107	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
735	Centre St	Petrolia Line	Robert St	High Class Bit.-asphalt	0.088	1,000	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
736	Centre St	Robert St	Andrew St	High Class Bit.-asphalt	0.084	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
737	Centre St	Andrew St	James St	High Class Bit.-asphalt	0.086	750	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
738	Centre St	James St	200m North of Portland	High Class Bit.-asphalt	0.285	750	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
739	Centre St	200m North of Portland	020-108 (333 Centre)	High Class Bit.-asphalt	0.585	750	ADEQ	6-10	ADEQ	1-5	ADEQ	ADEQ	REC	1-5
740	Centre St	020-108 (333 Centre)	Discovery Line	High Class Bit.-asphalt	0.236	750	ADEQ	6-10	ADEQ	1-5	ADEQ	ADEQ	REC	1-5
741	Charlie St	Tom St	Short St	High Class Bit.-asphalt	0.082	82	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
742	Charlie St	Short St	Valentina St N.	High Class Bit.-asphalt	0.095	95	ADEQ	NOW	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
743	Chestnut St	Walnut St E	School St	High Class Bit.-asphalt	0.106	106	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
744	Chestnut St	School St	south end	High Class Bit.-asphalt	0.076	76	ADEQ	ADEQ	ADEQ	NOW	NOW	ADEQ	RNS	NOW
745	Country View Dr	Bluebird St	East End Cul De Sac	High Class Bit.-asphalt	0.053	53	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
746	Country View Dr	NW Corner	Bluebird St	High Class Bit.-asphalt	0.068	68	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
747	Country View Dr	Henderson Dr	NW Corner	High Class Bit.-asphalt	0.116	116	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
748	Country View Dr	Valentina St S.	Henderson Dr	High Class Bit.-asphalt	0.243	243	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
980	Country View Dr	Englehart Dr	Valentina St S.	High Class Bit.-asphalt	0.103	130	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
981	Country View Dr	South End	Englehart Drive	High Class Bit.-asphalt	0.190	190	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
749	Derby St	Mutual St	Holland St	Low Class Bit.-surface treated	0.080	80	ADEQ	6-10	ADEQ	6-10	ADEQ	ADEQ	RNS	6-10
750	Derby St	Holland St	Oil Heritage Rd	Low Class Bit.-surface treated	0.310	310	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
751	Discovery Line	West town limit	Stanley	High Class Bit.-asphalt	0.300	900	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	PR2	NOW
752	Discovery Line	Stanley Ave	Eureka St	High Class Bit.-asphalt	0.449	900	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	PR2	NOW
753	Discovery Line	Eureka St	Centre St	Low Class Bit.-surface treated	0.284	900	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	PR2	NOW
754	Discovery Line	Centre St	Former Railway Crossing	High Class Bit.-asphalt	0.164	900	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	PR2	6-10
755	Discovery Line	Former Railway Crossing	Tank St	High Class Bit.-asphalt	0.164	900	ADEQ	6-10	ADEQ	6-10	ADEQ	ADEQ	REC	6-10
756	Discovery Line	Tank St	Petrolia Discovery East Limit	Low Class Bit.-surface treated	0.328	900	ADEQ	6-10	ADEQ	1-5	ADEQ	ADEQ	REC	1-5
757	Discovery Line	Petrolia Discovery Centre	Bridge	Low Class Bit.-surface treated	0.656	900	ADEQ	6-10	ADEQ	ADEQ	ADEQ	ADEQ	SD	6-10
987	Discovery Line	Bridge	400m West of Oil Heritage Rd	Low Class Bit.-surface treated	0.282	900	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	REC	NOW
988	Discovery Line	400m West of Oil Heritage Rd	Oil Heritage Rd	High Class Bit.-asphalt	0.400	900	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
758	Dufferin Ave	Huggard St	Maude St	High Class Bit.-asphalt	0.102	1,000	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
759	Dufferin Ave	Maude St	Princess St	High Class Bit.-asphalt	0.129	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW

Critical Deficiencies by Street Name

Current Inspection Batch

ID	Street Name	From Description	To Description	Surface	Length	AADT	Cap.	Drain	Geo	SA	Width	Type	Imp	Overall TON
760	Dufferin Ave	Princess St	Queen St	High Class Bit.-asphalt	0.142	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
761	Dufferin Ave	Queen St	Glenview Rd	High Class Bit.-asphalt	0.177	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
762	Dufferin Ave	Glenview Rd	Blanche St	High Class Bit.-asphalt	0.088	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
763	Dufferin Ave	Blanche St	Greenfield St	High Class Bit.-asphalt	0.124	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
764	Edward St	Ignatiefna St	Valentine St S	High Class Bit.-asphalt	0.123	750	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
765	Egan Ave	Petrolia Line	Florence Ave	High Class Bit.-asphalt	0.158	158	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
766	Egan Ave	Florence Ave	Sanway Ct	High Class Bit.-asphalt	0.107	107	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	R2Ureh	ADEQ
767	Ella St	Emma St	Warren Ave	High Class Bit.-asphalt	0.157	157	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
768	Emma St	Ella St	Emmeline St	High Class Bit.-asphalt	0.055	55	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
769	Emma St	Emmeline St	East End	High Class Bit.-asphalt	0.079	79	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
770	Emmeline St	Emma St	Lancey St	High Class Bit.-asphalt	0.131	131	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
771	England Ave	Petrolia Line	Pearl St	High Class Bit.-asphalt	0.097	97	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
772	England Ave	Pearl St	South End	High Class Bit.-asphalt	0.094	94	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
982	Englehart Drive	Country View Dr	250m E of Countryview Drive	High Class Bit.-asphalt	0.250	250	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
983	Englehart Drive	250m E of Countryview Drive	South End	High Class Bit.-asphalt	0.129	129	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
773	Ernest St	50m West of Kells Street	Eureka St	High Class Bit.-asphalt	0.150	150	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
774	Ernest St	Applewood Dr	50m West of Kells Street	High Class Bit.-asphalt	0.316	316	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
775	Eureka St	Petrolia Line	Maple St	High Class Bit.-asphalt	0.375	1,300	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
776	Eureka St	Maple St	Catherine St	High Class Bit.-asphalt	0.272	1,300	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
777	Eureka St	Catherine St	Ernest St	High Class Bit.-asphalt	0.164	1,300	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
778	Eureka St	Ernest St	Discovery Line	High Class Bit.-asphalt	0.550	1,300	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
779	Evergreen Trail	Applewood Dr	Rosemount	High Class Bit.-asphalt	0.093	93	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
780	Evergreen Trail	Rosemount Dr	North End Cul De Sac	High Class Bit.-asphalt	0.053	53	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
986	Fairway Court	West End Cul De Sac	First Ave	High Class Bit.-asphalt	0.195	400	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
781	Fifth Ave	First Ave	Fourth St	High Class Bit.-asphalt	0.244	244	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
782	First Ave	Petrolia Line	Third St	High Class Bit.-asphalt	0.117	2,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
783	First Ave	Third St	Fifth Ave	High Class Bit.-asphalt	0.108	2,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
784	First Ave	Fifth Ave	Sixth St	High Class Bit.-asphalt	0.106	2,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
785	First Ave	Sixth St	Garden Cr	High Class Bit.-asphalt	0.423	2,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
786	First Ave	Garden	150m East of Garden Crescent (West Leg)	High Class Bit.-asphalt	0.698	1,500	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
984	First Ave	150m East of Garden Crescent (West Leg)	120m West of Garden Crescent (West Leg)	High Class Bit.-asphalt	0.270	1,500	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
985	First Ave	120m West of Garden Crescent (West Leg)	Glenview Rd	High Class Bit.-asphalt	0.365	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
787	Fletcher St	Petrolia Line	Robert St	High Class Bit.-asphalt	0.084	84	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
788	Florence Ave	Garfield Ave	Egan Ave	High Class Bit.-asphalt	0.220	220	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
789	Florence Ave	Egan Ave	Kerby St	Low Class Bit.-surface treated	0.208	208	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
790	Fourth St	Petrolia Line	Third St	High Class Bit.-asphalt	0.117	350	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
791	Fourth St	Third St	Fifth Ave	High Class Bit.-asphalt	0.107	350	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
792	Fourth St	Fifth Ave	Sixth St	High Class Bit.-asphalt	0.104	350	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
793	Fourth St	Sixth St	South End	High Class Bit.-asphalt	0.053	53	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
794	Gables Ave	Eureka St	Jacs Ct	High Class Bit.-asphalt	0.087	87	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
795	Gables Ave	Jacs Ct	107m S of Jacs Court	High Class Bit.-asphalt	0.107	107	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
795A	Gables Ave	107m S of Jacs Court	South End Cul De Sac	High Class Bit.-asphalt	0.061	60	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
796	Garden Cr	First Ave	Heritage Heights	Concrete	0.645	645	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	RNS	1-5
797	Garden Cr	First Ave	Heritage Heights Ln	High Class Bit.-asphalt	0.249	249	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
798	Garfield Ave	Petrolia Line	Florence Ave	High Class Bit.-asphalt	0.158	1,200	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
799	Garfield Ave	Florence Ave	Maple St	High Class Bit.-asphalt	0.214	1,200	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ

Critical Deficiencies by Street Name

Current Inspection Batch

ID	Street Name	From Description	To Description	Surface	Length	AADT	Cap.	Drain	Geo	SA	Width	Type	Imp	Overall TON
800	Garfield Ave	Maple St	Mulberry Pl	High Class Bit.-asphalt	0.091	1,200	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
801	Garfield Ave	Mulberry Pl	Parkside Ct	High Class Bit.-asphalt	0.131	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
802	Garfield Ave	Parkside Dr	Golden Gate Circle	High Class Bit.-asphalt	0.092	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
803	Garfield Ave	Golden Gate Circle	Applewood Dr	High Class Bit.-asphalt	0.101	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
804	Gem Ave	Petrolia Line	North End Cul De Sac	High Class Bit.-asphalt	0.375	375	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
989	Gem to Garfield Alley	Gem Ave	Garfield Ave	High Class Bit.-asphalt	0.160	50	ADEQ	ADEQ	ADEQ	NOW	NOW	ADEQ	RNS	NOW
990	Glenview Rd	Petrolia South Limits	330m North of Petrolia South Limits	High Class Bit.-asphalt	0.330	648	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
805	Glenview Rd	Dufferin Ave	Wellington St	High Class Bit.-asphalt	0.310	310	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
806	Glenview Rd	Wellington St	Kerr St	High Class Bit.-asphalt	0.126	126	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
807	Glenview Rd	330m North of Petrolia South Limits	Kerr St	High Class Bit.-asphalt	0.318	318	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
808	Golden Gate Circle	West End Cul De Sac	Garfield Ave	High Class Bit.-asphalt	0.129	129	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
809	Greenfield St	Petrolia Line	Walnut W	High Class Bit.-asphalt	0.134	500	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
810	Greenfield St	Walnut W	Dufferin Ave	High Class Bit.-asphalt	0.208	208	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
811	Greenfield St	Dufferin Ave	South End	High Class Bit.-asphalt	0.058	58	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
812	Grove St	Princess St	Glenview Rd	High Class Bit.-asphalt	0.281	281	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
813	Hartford St	Petrolia Line	North St	Concrete	0.090	90	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
814	Hawthorne Pl	West End Cul De Sac	Sycamore Dr	High Class Bit.-asphalt	0.076	76	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
815	Henderson Dr	Country View Dr	Valentina St S.	High Class Bit.-asphalt	0.197	197	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
816	Henry Ave	Oil St	Warren Ave	High Class Bit.-asphalt	0.064	64	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
818	Hickory St	School St	Walnut St E	Low Class Bit.-surface treated	0.107	107	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
819	Holland St	Derby St	Petrolia Line	Low Class Bit.-surface treated	0.088	88	ADEQ	6-10	ADEQ	ADEQ	ADEQ	ADEQ	RNS	6-10
820	Huggard St	Petrolia Line	Annie St	High Class Bit.-asphalt	0.114	400	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
821	Huggard St	Annie St	Jennie St	High Class Bit.-asphalt	0.111	400	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
822	Huggard St	Jennie St	Dufferin Ave	High Class Bit.-asphalt	0.124	400	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
823	Huggard St	Dufferin Ave	Arena Lot	High Class Bit.-asphalt	0.123	400	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
824	Hunter Ct	West End Cul De Sac	Valentina St S.	High Class Bit.-asphalt	0.097	97	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
825	Ignatiefna St	Edward St	Petrolia Line	High Class Bit.-asphalt	0.496	750	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
826	Jacs Ct	Gables Ave	North End Cul De Sac	High Class Bit.-asphalt	0.044	50	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
827	James St	Eureka St	Centre St	High Class Bit.-asphalt	0.292	292	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
3641	Jennie St	Huggard St	Maude St	High Class Bit.-asphalt	0.102	102	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
3642	Jennie St	West St	Huggard St	High Class Bit.-asphalt	0.095	95	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
830	Joe St	Tom St	Maude St	Concrete	0.096	300	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
831	Joe St	Valentina St S.	Tom St	Concrete	0.168	300	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	SR	ADEQ
832	Joe St	Cardinal Cr	Valentina St S.	High Class Bit.-asphalt	0.067	300	ADEQ	6-10	ADEQ	1-5	ADEQ	ADEQ	RNS	1-5
833	Joe St	West End	Cardinal Cr	High Class Bit.-asphalt	0.218	218	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
834	Juniper Cr	Catherine St	Juniper Cr South	High Class Bit.-asphalt	0.222	222	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
835	Juniper Cr	Juniper North	Sycamore Dr	High Class Bit.-asphalt	0.216	216	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
836	Kells St	Ernest St	North End Cul De Sac	High Class Bit.-asphalt	0.131	131	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
838	Kentail St	Third St	Petrolia Line	Low Class Bit.-surface treated	0.117	117	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
839	Kentail St	Petrolia Line	North St	Concrete	0.095	95	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
841	Kerby St	Petrolia Line	Florence Ave	High Class Bit.-asphalt	0.160	250	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
842	Kerby St	Florence Ave	North End	High Class Bit.-asphalt	0.107	107	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
843	Kerr St	Princess St	Glenview Rd	High Class Bit.-asphalt	0.280	280	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
844	King St	Dufferin Ave	Petrolia Line	High Class Bit.-asphalt	0.346	800	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
845	King Well Lane/Gemfield	Kerby St	Eureka St	High Class Bit.-asphalt	0.095	95	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
847	King Well Lane/Gemfield	Centre St	Fletcher St	High Class Bit.-asphalt	0.136	400	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureha	1-5
848	Lancey St	Warren Ave	Emmeline St	High Class Bit.-asphalt	0.028	400	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10

Critical Deficiencies by Street Name

Current Inspection Batch

ID	Street Name	From Description	To Description	Surface	Length	AADT	Cap.	Drain	Geo	SA	Width	Type	Imp	Overall TON
849	Lancey St	Emmeline St	East End Cul De Sac	High Class Bit.-asphalt	0.208	208	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
970	Lane Behind Church	King St	West End Cul De Sac	High Class Bit.-asphalt	0.070	70	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
991	Lorne Ave	Midblock	Princess St	Low Class Bit.-surface treated	0.065	100	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	SD	ADEQ
850	Lorne Ave	Maude St	Midblock	High Class Bit.-asphalt	0.065	100	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
851	Lorne Ave	Princess St	Queen St	High Class Bit.-asphalt	0.142	142	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
852	Maple St	Garfield Ave	Sycamore Dr	High Class Bit.-asphalt	0.300	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
853	Maple St	Sycamore Dr	Eureka St	High Class Bit.-asphalt	0.222	1,000	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
854	Maude St	Annie St	Petrolia Line	Concrete	0.113	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
855	Maude St	Annie St	Jennie St	Concrete	0.111	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
856	Maude St	Dufferin Ave	Lorne Ave	Concrete	0.123	1,000	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	SR	6-10
857	Maude St	Joe St	Dufferin Ave	Concrete	0.524	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	SR	ADEQ
858	Maude St	Joe St	South end (extension)	High Class Bit.-asphalt	0.250	250	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	PR2	NOW
859	Mulberry Pl	Garfield Ave	East End Cul De Sac	High Class Bit.-asphalt	0.144	144	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
860	Mutual St	Third St	Petrolia Line	Low Class Bit.-surface treated	0.121	185	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
3895	Mutual St	South End	Third St	Gravel, Stone, Other Loosetop	0.044	10	ADEQ	1-5	ADEQ	ADEQ	NOW	NOW	BS	ADEQ
3607	Nelson St	Princess St	Dufferin Ave	High Class Bit.-asphalt	0.368	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
862	North St	Hartford St	Kentail St	Concrete	0.198	198	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
863	North St	Kentail St	Wood St	Concrete	0.170	170	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
864	North St	Wood St	Oil Heritage Rd	Concrete	0.362	362	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
865	Northridge Pl	Petrolia Line	North End Cul De Sac	High Class Bit.-asphalt	0.101	101	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
866	Oil St	Walnut St E	Petrolia Line	High Class Bit.-asphalt	0.108	108	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
3582	Oozloffsky St N	316 m South of Petrolia Line	Petrolia Line	High Class Bit.-asphalt	0.316	750	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
3592	Oozloffsky St N	Ignatiefna St	316 m South of Petrolia Line	High Class Bit.-asphalt	0.305	750	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
873	Oozloffsky St S	Joe St	North End Cul De Sac	High Class Bit.-asphalt	0.184	184	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
874	Oriole Pk	Joe St	North End Cul De Sac	High Class Bit.-asphalt	0.063	63	ADEQ	1-5	ADEQ	1-5	ADEQ	ADEQ	RNS	1-5
875	Parkside Ct	35m South of Rosemount Drive	North End Cul De Sac	High Class Bit.-asphalt	0.090	55	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
876	Parkside Dr	Parkside Pl	35m South of Rosemount Drive	High Class Bit.-asphalt	0.223	258	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
877	Parkside Dr	Parkside Pl	Garfield Ave	High Class Bit.-asphalt	0.185	185	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
878	Parkside Pl	South End Cul De Sac	Parkside Dr	High Class Bit.-asphalt	0.060	60	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
879	Pearl St	England Ave	First Ave	High Class Bit.-asphalt	0.133	133	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	R2Ureh	NOW
895	Pettibone St	Eureka St	Andrew St	Low Class Bit.-surface treated	0.156	156	ADEQ	1-5	ADEQ	NOW	NOW	ADEQ	RNS	NOW
896	Pine Cr	Catherine St	Catherine St	High Class Bit.-asphalt	0.303	103	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
899	Portland Ave	West End Cul De Sac	Centre St	High Class Bit.-asphalt	0.111	111	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
900	Princess St	Lorne Ave	Petrolia Line	High Class Bit.-asphalt	0.224	224	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
901	Princess St	Dufferin Ave	Lorne Ave	High Class Bit.-asphalt	0.124	124	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
902	Princess St	Nelson St	Dufferin Ave	High Class Bit.-asphalt	0.311	311	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
904	Princess St	Grove St	Wellington St	High Class Bit.-asphalt	0.126	126	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
905	Princess St	Grove St	Kerr St	High Class Bit.-asphalt	0.110	110	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
3605	Princess St	Wellington St	Nelson St	High Class Bit.-asphalt	0.165	165	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
906	Progress Dr	West End	Oil Heritage Rd	High Class Bit.-asphalt	0.489	489	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	PR2	1-5
907	Queen St	Lorne Ave	Petrolia Line	High Class Bit.-asphalt	0.222	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
908	Queen St	Dufferin Ave	Lorne Ave	High Class Bit.-asphalt	0.125	1,000	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
910	Railroad St	Station St	Tank St	High Class Bit.-asphalt	0.129	200	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
911	Redwood Ct	Rosemount Dr	North End Cul De Sac	High Class Bit.-asphalt	0.059	59	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
912	Robert St	Eureka St	Centre St	High Class Bit.-asphalt	0.300	300	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
913	Robert St	Centre St	Fletcher St	High Class Bit.-asphalt	0.137	137	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
914	Rosemount Dr	Parkside Ct	Redwood Ct	High Class Bit.-asphalt	0.092	92	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
915	Rosemount Dr	Redwood Ct	Evergreen Trail	High Class Bit.-asphalt	0.088	88	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ

Critical Deficiencies by Street Name

Current Inspection Batch

ID	Street Name	From Description	To Description	Surface	Length	AADT	Cap.	Drain	Geo	SA	Width	Type	Imp	Overall TON
916	Sanway Ct	West End Cul De Sac	Eagan Ave	High Class Bit.-asphalt	0.117	117	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
917	School St	Greenfield St	Hickory St	Low Class Bit.-surface treated	0.063	63	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
918	School St	Hickory St	Chestnut St	Low Class Bit.-surface treated	0.053	53	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
919	Short St	South End Cul De Sac	Charlie St	High Class Bit.-asphalt	0.112	112	ADEQ	NOW	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
920	Sixth St	First Ave	Fourth St	High Class Bit.-asphalt	0.241	241	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
921	Stanley Ave	South Limit	Discovery Line	High Class Bit.-asphalt	0.140	140	ADEQ	6-10	ADEQ	ADEQ	ADEQ	ADEQ	SD	6-10
922	Station St	Petrolia Line	46m North of Petrolia Line	High Class Bit.-asphalt	0.046	200	ADEQ	ADEQ	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
923	Station St	46m North of Petrolia Line	Railroad St	High Class Bit.-asphalt	0.046	200	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
992	Sunset Court	Ernest St	North End Cul De Sac	High Class Bit.-asphalt	0.075	75	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
925	Sycamore Dr	Maple St	North End Cul De Sac	High Class Bit.-asphalt	0.134	134	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
926	Tank St	Petrolia Line	End of Curb and Gutter	High Class Bit.-asphalt	0.346	1,000	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
927	Tank St	End of Curb and Gutter	Discovery	Low Class Bit.-surface treated	1.020	1,000	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	REC	NOW
928	Tank St	Discovery Line	North Town Limit	Low Class Bit.-surface treated	0.677	677	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	REC	NOW
929	Third St	First Ave	Fourth St	High Class Bit.-asphalt	0.244	244	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
930	Third St	Fourth St	Kentail St	Low Class Bit.-surface treated	0.134	134	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
931	Third St	Kentail St	Mutual St	Low Class Bit.-surface treated	0.145	145	ADEQ	6-10	ADEQ	6-10	ADEQ	ADEQ	RNS	6-10
932	Tom St	Charlie St	Joe St	High Class Bit.-asphalt	0.092	92	ADEQ	NOW	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
933	Valentina St N.	South End Cul De Sac	Petrolia Line	Low Class Bit.-surface treated	0.186	186	ADEQ	1-5	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
934	Valentina St S.	Joe St	Edward St	High Class Bit.-asphalt	0.375	750	ADEQ	6-10	ADEQ	NOW	ADEQ	ADEQ	RNS	NOW
935	Valentina St S.	Charlie St	Joe St	High Class Bit.-asphalt	0.096	350	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
936	Valentina St S.	Charlie St	Henderson Dr	High Class Bit.-asphalt	0.105	350	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R2Ureh	1-5
937	Valentina St S.	Henderson Dr	Hunter Ct	High Class Bit.-asphalt	0.153	250	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R1	1-5
938	Valentina St S.	Hunter Ct	Country View Dr	High Class Bit.-asphalt	0.179	179	ADEQ	ADEQ	ADEQ	1-5	ADEQ	ADEQ	R1	1-5
939	Vanderwal Dr	Discovery Line	North End Cul De Sac	High Class Bit.-asphalt	0.192	100	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
940	Victoria Ave	Princess St	Queen St	High Class Bit.-asphalt	0.144	144	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	CRK	ADEQ
943	Walnut St E	Greenfield St	Oil St	High Class Bit.-asphalt	0.170	170	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
941	Walnut St W	Albany St	Wingfield St	High Class Bit.-asphalt	0.085	85	ADEQ	ADEQ	ADEQ	ADEQ	NOW	ADEQ	NONE	NOW
942	Walnut St W	Wingfield St	Greenfield St	High Class Bit.-asphalt	0.069	69	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
944	Warren Ave	Lancey St	Henry Ave	High Class Bit.-asphalt	0.111	111	ADEQ	ADEQ	ADEQ	6-10	ADEQ	ADEQ	R1	6-10
945	Wellington St	Princess St	Glenview Rd	High Class Bit.-asphalt	0.383	383	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
3656	West St	Annie St	Petrolia Line	High Class Bit.-asphalt	0.113	113	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
3657	West St	Jennie St	Annie St	High Class Bit.-asphalt	0.113	113	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
948	Wingfield St	Petrolia Line	Walnut St E	High Class Bit.-asphalt	0.135	135	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
949	Wingfield St	Walnut St E	Dufferin Ave	High Class Bit.-asphalt	0.208	208	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ
950	Wood St	Petrolia Line	North St	Concrete	0.096	96	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	ADEQ	NONE	ADEQ

Appendix I: Needs Sorted by Time of Need and Improvement Category

Total Needs Summary by Improvement Type

Current Inspection Batch

Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
R2Ureh										
27.00	984	First Ave	150m East of Garden Crescent (West Leg)	120m West of Garden Crescent (West Leg)	1,500	0.270	NOW	Rehab	R2Urehat	207,672.22
24.00	847	King Well Lane/Gemfield	Centre St	Fletcher St	400	0.136	1-5	Rehab	R2Urehat	69,365.22
21.00	800	Garfield Ave	Maple St	Mulberry Pl	1,200	0.091	1-5	Rehab	R2Urehat	104,648.10
21.00	926	Tank St	Petrolia Line	End of Curb and Gutter	1,000	0.346	1-5	Rehab	R2Urehat	217,326.37
20.00	776	Eureka St	Maple St	Catherine St	1,300	0.272	1-5	Rehab	R2Urehat	190,028.35
20.00	777	Eureka St	Catherine St	Ernest St	1,300	0.164	1-5	Rehab	R2Urehat	114,575.92
20.00	778	Eureka St	Ernest St	Discovery Line	1,300	0.550	1-5	Rehab	R2Urehat	384,248.49
19.00	781	Fifth Ave	First Ave	Fourth St	244	0.244	NOW	Rehab	R2Urehat	187,674.15
19.00	758	Dufferin Ave	Huggard St	Maude St	1,000	0.102	1-5	Rehab	R2Urehat	68,383.30
19.00	735	Centre St	Petrolia Line	Robert St	1,000	0.088	1-5	Rehab	R2Urehat	68,306.36
18.00	797	Garden Cr	First Ave	Heritage Heights Ln	249	0.249	NOW	Rehab	R2Urehat	188,007.90
17.00	823	Huggard St	Dufferin Ave	Arena Lot	400	0.123	1-5	Rehab	R2Urehat	125,053.02
16.00	772	England Ave	Pearl St	South End	94	0.094	NOW	Rehab	R2Urehat	68,986.13
16.00	879	Pearl St	England Ave	First Ave	133	0.133	NOW	Rehab	R2Urehat	89,166.47
16.00	935	Valentina St S.	Charlie St	Joe St	350	0.096	1-5	Rehab	R2Urehat	72,823.49
16.00	820	Huggard St	Petrolia Line	Annie St	400	0.114	1-5	Rehab	R2Urehat	115,822.40
15.00	849	Lancey St	Emmeline St	East End Cul De Sac	208	0.208	NOW	Rehab	R2Urehat	126,246.46
15.00	771	England Ave	Petrolia Line	Pearl St	97	0.097	NOW	Rehab	R2Urehat	71,187.81
15.00	821	Huggard St	Annie St	Jennie St	400	0.111	1-5	Rehab	R2Urehat	112,774.43
15.00	936	Valentina St S.	Charlie St	Henderson Dr	350	0.105	1-5	Rehab	R2Urehat	79,280.44
15.00	912	Robert St	Eureka St	Centre St	300	0.300	1-5	Rehab	R2Urehat	226,515.55
14.00	827	James St	Eureka St	Centre St	292	0.292	1-5	Rehab	R2Urehat	208,119.55
13.00	916	Sanway Ct	West End Cul De Sac	Eagan Ave	117	0.117	1-5	Rehab	R2Urehat	89,166.18
12.00	900	Princess St	Lorne Ave	Petrolia Line	224	0.224	1-5	Rehab	R2Urehat	159,653.34
12.00	902	Princess St	Nelson St	Dufferin Ave	311	0.311	1-5	Rehab	R2Urehat	221,661.57
12.00	815	Henderson Dr	Country View Dr	Valentina St S.	197	0.197	1-5	Rehab	R2Urehat	145,966.61
11.00	806	Glenview Rd	Wellington St	Kerr St	126	0.126	1-5	Rehab	R2Urehat	100,468.04
11.00	795	Gables Ave	Jacs Ct	107m S of Jacs Court	107	0.107	1-5	Rehab	R2Urehat	71,735.43
11.00	3639	Annie St	Huggard St	Maude St	100	0.100	1-5	Rehab	R2Urehat	78,326.09
11.00	865	Northridge Pl	Petrolia Line	North End Cul De Sac	101	0.101	1-5	Rehab	R2Urehat	72,698.82
10.00	901	Princess St	Dufferin Ave	Lorne Ave	124	0.124	1-5	Rehab	R2Urehat	88,379.54
9.00	875	Parkside Ct	35m South of Rosemount Drive	North End Cul De Sac	55	0.090	1-5	Rehab	R2Urehat	64,781.15
6.00	766	Egan Ave	Florence Ave	Sanway Ct	107	0.107	ADEQ	Rehab	R2Urehat	78,526.75
						5.789				4,267,575.65
R1										
21.00	990	Glenview Rd	Petrolia South Limits	330m North of Petrolia South Limits	648	0.330	6-10	Rehab	R1	60,377.51
15.00	988	Discovery Line	400m West of Oil Heritage Rd	Oil Heritage Rd	900	0.400	6-10	Rehab	R1	82,375.65
14.00	738	Centre St	James St	200m North of Portland	750	0.285	6-10	Rehab	R1	116,529.44
12.00	805	Glenview Rd	Dufferin Ave	Wellington St	310	0.310	6-10	Rehab	R1	129,710.76
12.00	937	Valentina St S.	Henderson Dr	Hunter Ct	250	0.153	1-5	Rehab	R1	61,340.72
11.00	716	Albany St	Dufferin Ave	Walnut St E	210	0.210	6-10	Rehab	R1	71,830.28
11.00	938	Valentina St S.	Hunter Ct	Country View Dr	179	0.179	1-5	Rehab	R1	71,479.82
10.00	876	Parkside Dr	Parkside Pl	35m South of Rosemount Drive	258	0.223	6-10	Rehab	R1	85,502.12

Total Needs Summary by Improvement Type

Current Inspection Batch

Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
10.00	3640	Annie St	West St	Huggard St	100	0.100	6-10	Rehab	R1	41,205.75
10.00	734	Catherine St	70m East of Juniper	Eureka St	200	0.154	6-10	Rehab	R1	59,046.31
10.00	850	Lorne Ave	Maude St	Midblock	100	0.065	6-10	Rehab	R1	25,956.36
10.00	848	Lancey St	Warren Ave	Emmeline St	400	0.028	6-10	Rehab	R1	9,310.07
9.00	770	Emmeline St	Emma St	Lancey St	131	0.131	6-10	Rehab	R1	44,808.41
8.00	767	Ella St	Emma St	Warren Ave	157	0.157	6-10	Rehab	R1	52,202.87
8.00	3641	Jennie St	Huggard St	Maude St	102	0.102	6-10	Rehab	R1	40,731.52
8.00	904	Princess St	Grove St	Wellington St	126	0.126	6-10	Rehab	R1	50,515.88
8.00	970	Lane Behind Church	King St	West End Cul De Sac	70	0.070	6-10	Rehab	R1	29,735.04
8.00	944	Warren Ave	Lancey St	Henry Ave	111	0.111	6-10	Rehab	R1	39,733.55
7.00	768	Emma St	Ella St	Emmeline St	55	0.055	6-10	Rehab	R1	18,812.69
						3.189				1,091,204.75
PR2										
33.00	751	Discovery Line	West town limit	Stanley	900	0.300	NOW	Rehab	PR2	92,655.27
33.00	752	Discovery Line	Stanley Ave	Eureka St	900	0.449	NOW	Rehab	PR2	138,674.05
33.00	753	Discovery Line	Eureka St	Centre St	900	0.284	NOW	Rehab	PR2	87,713.65
26.00	754	Discovery Line	Centre St	Former Railway Crossing	900	0.164	6-10	Rehab	PR2	60,405.15
24.00	858	Maude St	Joe St	South end (extension)	250	0.250	NOW	Rehab	PR2	83,278.73
17.00	906	Progress Dr	West End	Oil Heritage Rd	489	0.489	1-5	Rehab	PR2	184,559.78
						1.936				647,286.63
SR										
14.00	856	Maude St	Dufferin Ave	Lorne Ave	1,000	0.123	6-10	Maint	SR	10,000.00
12.00	857	Maude St	Joe St	Dufferin Ave	1,000	0.524	ADEQ	Maint	SR	10,000.00
9.00	831	Joe St	Valentina St S.	Tom St	300	0.168	ADEQ	Maint	SR	10,000.00
						0.815				30,000.00
SD										
21.00	757	Discovery Line	Petrolia Discovery Centre	Bridge	900	0.656	6-10	Maint	SD	1,180.80
10.00	921	Stanley Ave	South Limit	Discovery Line	140	0.140	6-10	Maint	SD	252.00
8.00	991	Lorne Ave	Midblock	Princess St	100	0.065	ADEQ	Maint	SD	117.00
						0.861				1,549.80
CRK										
12.00	845	King Well Lane/Gemfield	Kerby St	Eureka St	95	0.095	ADEQ	Maint	CRK	190.00
12.00	786	First Ave	Garden	150m East of Garden Crescent (West Leg)	1,500	0.698	ADEQ	Maint	CRK	1,396.00
10.00	799	Garfield Ave	Florence Ave	Maple St	1,200	0.214	ADEQ	Maint	CRK	428.00
10.00	736	Centre St	Robert St	Andrew St	1,000	0.084	ADEQ	Maint	CRK	168.00
10.00	737	Centre St	Andrew St	James St	750	0.086	ADEQ	Maint	CRK	172.00
8.00	986	Fairway Court	West End Cul De Sac	First Ave	400	0.195	ADEQ	Maint	CRK	390.00
7.00	748	Country View Dr	Valentina St S.	Henderson Dr	243	0.243	ADEQ	Maint	CRK	486.00
6.00	745	Country View Dr	Bluebird St	East End Cul De Sac	53	0.053	ADEQ	Maint	CRK	106.00
6.00	747	Country View Dr	Henderson Dr	NW Corner	116	0.116	ADEQ	Maint	CRK	232.00
6.00	722	Applewood Dr	Parkside Ct	Evergreen Trail	155	0.155	ADEQ	Maint	CRK	310.00
6.00	824	Hunter Ct	West End Cul De Sac	Valentina St S.	97	0.097	ADEQ	Maint	CRK	194.00

Total Needs Summary by Improvement Type

Current Inspection Batch

Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
6.00	914	Rosemount Dr	Parkside Ct	Redwood Ct	92	0.092	ADEQ	Maint	CRK	184.00
5.00	939	Vanderwal Dr	Discovery Line	North End Cul De Sac	100	0.192	ADEQ	Maint	CRK	384.00
5.00	940	Victoria Ave	Princess St	Queen St	144	0.144	ADEQ	Maint	CRK	288.00
5.00	911	Redwood Ct	Rosemount Dr	North End Cul De Sac	59	0.059	ADEQ	Maint	CRK	118.00
5.00	816	Henry Ave	Oil St	Warren Ave	64	0.064	ADEQ	Maint	CRK	128.00
5.00	723	Applewood Dr	Evergreen Trail	Garfield Ave	91	0.091	ADEQ	Maint	CRK	182.00
5.00	746	Country View Dr	NW Corner	Bluebird St	68	0.068	ADEQ	Maint	CRK	136.00
5.00	779	Evergreen Trail	Applewood Dr	Rosemount	93	0.093	ADEQ	Maint	CRK	186.00
						2.839				5,678.00
RNS										
41.00	895	Pettibone St	Eureka St	Andrew St	156	0.156	NOW	Const	RNS	112,070.40
39.00	934	Valentina St S.	Joe St	Edward St	750	0.375	NOW	Const	RNS	328,154.64
36.00	818	Hickory St	School St	Walnut St E	107	0.107	NOW	Const	RNS	76,868.80
36.00	825	Ignatiefna St	Edward St	Petrolia Line	750	0.496	NOW	Const	RNS	389,645.37
34.00	783	First Ave	Third St	Fifth Ave	2,000	0.108	NOW	Const	RNS	136,280.30
34.00	933	Valentina St N.	South End Cul De Sac	Petrolia Line	186	0.186	NOW	Const	RNS	134,871.87
33.00	784	First Ave	Fifth Ave	Sixth St	2,000	0.106	NOW	Const	RNS	133,756.60
33.00	785	First Ave	Sixth St	Garden Cr	2,000	0.423	NOW	Const	RNS	533,764.49
33.00	782	First Ave	Petrolia Line	Third St	2,000	0.117	NOW	Const	RNS	147,636.99
33.00	744	Chestnut St	School St	south end	76	0.076	NOW	Const	RNS	95,900.95
32.00	989	Gem to Garfield Alley	Gem Ave	Garfield Ave	50	0.160	NOW	Const	RNS	63,892.08
31.00	860	Mutual St	Third St	Petrolia Line	185	0.121	NOW	Const	RNS	86,926.41
31.00	917	School St	Greenfield St	Hickory St	63	0.063	NOW	Const	RNS	45,259.20
31.00	918	School St	Hickory St	Chestnut St	53	0.053	NOW	Const	RNS	38,075.21
31.00	764	Edward St	Ignatiefna St	Valentine St S	750	0.123	NOW	Const	RNS	97,452.02
31.00	750	Derby St	Holland St	Oil Heritage Rd	310	0.310	NOW	Const	RNS	226,868.88
29.00	923	Station St	46m North of Petrolia Line	Railroad St	200	0.046	NOW	Const	RNS	49,087.15
28.00	759	Dufferin Ave	Maude St	Princess St	1,000	0.129	NOW	Const	RNS	183,527.64
28.00	852	Maple St	Garfield Ave	Sycamore Dr	1,000	0.300	NOW	Const	RNS	378,556.38
27.00	760	Dufferin Ave	Princess St	Queen St	1,000	0.142	NOW	Const	RNS	202,022.68
27.00	761	Dufferin Ave	Queen St	Glenview Rd	1,000	0.177	NOW	Const	RNS	251,817.00
26.00	727	Blanche St	South End Cul De Sac	Dufferin Ave	126	0.126	NOW	Const	RNS	108,409.96
26.00	853	Maple St	Sycamore Dr	Eureka St	1,000	0.222	NOW	Const	RNS	280,131.73
25.00	844	King St	Dufferin Ave	Petrolia Line	800	0.346	NOW	Const	RNS	450,514.38
25.00	932	Tom St	Charlie St	Joe St	92	0.092	NOW	Const	RNS	116,090.62
24.00	930	Third St	Fourth St	Kentail St	134	0.134	NOW	Const	RNS	99,866.20
24.00	838	Kentail St	Third St	Petrolia Line	117	0.117	NOW	Const	RNS	91,912.32
24.00	762	Dufferin Ave	Glenview Rd	Blanche St	1,000	0.088	NOW	Const	RNS	125,197.16
23.00	763	Dufferin Ave	Blanche St	Greenfield St	1,000	0.124	NOW	Const	RNS	176,414.16
23.00	742	Charlie St	Short St	Valentina St N.	95	0.095	NOW	Const	RNS	119,876.18
23.00	719	Andrew St	Centre St	east end	115	0.115	NOW	Const	RNS	97,289.00
23.00	822	Huggard St	Jennie St	Dufferin Ave	400	0.124	NOW	Const	RNS	197,604.88
21.00	922	Station St	Petrolia Line	46m North of Petrolia Line	200	0.046	NOW	Const	RNS	62,068.33
21.00	919	Short St	South End Cul De Sac	Charlie St	112	0.112	NOW	Const	RNS	141,327.72
21.00	819	Holland St	Derby St	Petrolia Line	88	0.088	6-10	Const	RNS	63,219.20

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Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
21.00	796	Garden Cr	First Ave	Heritage Heights	645	0.645	1-5	Const	RNS	813,896.22
20.00	833	Joe St	West End	Cardinal Cr	218	0.218	NOW	Const	RNS	275,084.31
20.00	730	Cardinal Cr	Oozloffsky St S	corner	183	0.183	NOW	Const	RNS	230,919.39
20.00	899	Portland Ave	West End Cul De Sac	Centre St	111	0.111	NOW	Const	RNS	140,065.86
20.00	873	Oozloffsky St S	Joe St	North End Cul De Sac	184	0.184	NOW	Const	RNS	232,181.25
20.00	931	Third St	Kentail St	Mutual St	145	0.145	6-10	Const	RNS	108,064.17
19.00	859	Mulberry Pl	Garfield Ave	East End Cul De Sac	144	0.144	NOW	Const	RNS	181,707.06
18.00	718	Andrew St	Pettibone St	Centre St	165	0.165	NOW	Const	RNS	208,206.01
18.00	787	Fletcher St	Petrolia Line	Robert St	84	0.084	NOW	Const	RNS	116,973.14
18.00	749	Derby St	Mutual St	Holland St	80	0.080	6-10	Const	RNS	58,009.40
18.00	832	Joe St	Cardinal Cr	Valentina St S.	300	0.067	1-5	Const	RNS	95,320.55
17.00	741	Charlie St	Tom St	Short St	82	0.082	NOW	Const	RNS	103,472.08
17.00	729	Cardinal Cr	Joe St	Corner	147	0.147	1-5	Const	RNS	185,492.62
15.00	874	Oriole Pk	Joe St	North End Cul De Sac	63	0.063	1-5	Const	RNS	79,496.84
						7.921				8,671,245.80
REC										
52.00	726	Barretts Lane	Petrolia Line	England Ave	294	0.294	NOW	Const	REC	197,370.99
47.00	927	Tank St	End of Curb and Gutter	Discovery	1,000	1.020	NOW	Const	REC	1,008,692.11
41.00	928	Tank St	Discovery Line	North Town Limit	677	0.677	NOW	Const	REC	626,173.98
37.00	987	Discovery Line	Bridge	400m West of Oil Heritage Rd	900	0.282	NOW	Const	REC	296,803.28
31.00	739	Centre St	200m North of Portland	020-108 (333 Centre)	750	0.585	1-5	Const	REC	491,700.71
30.00	740	Centre St	020-108 (333 Centre)	Discovery Line	750	0.236	1-5	Const	REC	196,661.50
26.00	756	Discovery Line	Tank St	Petrolia Discovery East Limit	900	0.328	1-5	Const	REC	242,450.05
25.00	755	Discovery Line	Former Railway Crossing	Tank St	900	0.164	6-10	Const	REC	141,388.00
						3.586				3,201,240.62
NONE										
13.00	941	Walnut St W	Albany St	Wingfield St	85	0.085	NOW	Const	NONE	0.00
11.00	907	Queen St	Lorne Ave	Petrolia Line	1,000	0.222	ADEQ	Const	NONE	0.00
10.00	985	First Ave	120m West of Garden Crescent (West Leg)	Glenview Rd	1,000	0.365	ADEQ	Const	NONE	0.00
10.00	3592	Oozloffsky St N	Ignatiefna St	316 m South of Petrolia Line	750	0.305	ADEQ	Const	NONE	0.00
10.00	843	Kerr St	Princess St	Glenview Rd	280	0.280	ADEQ	Const	NONE	0.00
10.00	854	Maude St	Annie St	Petrolia Line	1,000	0.113	ADEQ	Const	NONE	0.00
10.00	804	Gem Ave	Petrolia Line	North End Cul De Sac	375	0.375	ADEQ	Const	NONE	0.00
9.00	801	Garfield Ave	Mulberry Pl	Parkside Ct	1,000	0.131	ADEQ	Const	NONE	0.00
9.00	802	Garfield Ave	Parkside Dr	Golden Gate Circle	1,000	0.092	ADEQ	Const	NONE	0.00
9.00	812	Grove St	Princess St	Glenview Rd	281	0.281	ADEQ	Const	NONE	0.00
9.00	3582	Oozloffsky St N	316 m South of Petrolia Line	Petrolia Line	750	0.316	ADEQ	Const	NONE	0.00
9.00	945	Wellington St	Princess St	Glenview Rd	383	0.383	ADEQ	Const	NONE	0.00
8.00	942	Walnut St W	Wingfield St	Greenfield St	69	0.069	ADEQ	Const	NONE	0.00
8.00	864	North St	Wood St	Oil Heritage Rd	362	0.362	ADEQ	Const	NONE	0.00
8.00	717	Albany St	Walnut St W	Petrolia Line	139	0.139	ADEQ	Const	NONE	0.00
7.00	769	Emma St	Emmeline St	East End	79	0.079	ADEQ	Const	NONE	0.00
7.00	830	Joe St	Tom St	Maude St	300	0.096	ADEQ	Const	NONE	0.00
7.00	803	Garfield Ave	Golden Gate Circle	Applewood Dr	1,000	0.101	ADEQ	Const	NONE	0.00

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Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
7.00	790	Fourth St	Petrolia Line	Third St	350	0.117	ADEQ	Const	NONE	0.00
7.00	862	North St	Hartford St	Kentail St	198	0.198	ADEQ	Const	NONE	0.00
7.00	910	Railroad St	Station St	Tank St	200	0.129	ADEQ	Const	NONE	0.00
7.00	905	Princess St	Grove St	Kerr St	110	0.110	ADEQ	Const	NONE	0.00
7.00	943	Walnut St E	Greenfield St	Oil St	170	0.170	ADEQ	Const	NONE	0.00
6.00	920	Sixth St	First Ave	Fourth St	241	0.241	ADEQ	Const	NONE	0.00
6.00	863	North St	Kentail St	Wood St	170	0.170	ADEQ	Const	NONE	0.00
6.00	866	Oil St	Walnut St E	Petrolia Line	108	0.108	ADEQ	Const	NONE	0.00
6.00	877	Parkside Dr	Parkside Pl	Garfield Ave	185	0.185	ADEQ	Const	NONE	0.00
6.00	794	Gables Ave	Eureka St	Jacs Ct	87	0.087	ADEQ	Const	NONE	0.00
6.00	807	Glenview Rd	330m North of Petrolia South Limits	Kerr St	318	0.318	ADEQ	Const	NONE	0.00
6.00	813	Hartford St	Petrolia Line	North St	90	0.090	ADEQ	Const	NONE	0.00
6.00	826	Jacs Ct	Gables Ave	North End Cul De Sac	50	0.044	ADEQ	Const	NONE	0.00
6.00	855	Maude St	Annie St	Jennie St	1,000	0.111	ADEQ	Const	NONE	0.00
6.00	3607	Nelson St	Princess St	Dufferin Ave	1,000	0.368	ADEQ	Const	NONE	0.00
6.00	282	Catherine St	Garfield Ave	Pine Cr	107	0.107	ADEQ	Const	NONE	0.00
5.00	808	Golden Gate Circle	West End Cul De Sac	Garfield Ave	129	0.129	ADEQ	Const	NONE	0.00
5.00	878	Parkside Pl	South End Cul De Sac	Parkside Dr	60	0.060	ADEQ	Const	NONE	0.00
5.00	950	Wood St	Petrolia Line	North St	96	0.096	ADEQ	Const	NONE	0.00
4.00	775	Eureka St	Petrolia Line	Maple St	1,300	0.375	ADEQ	Const	NONE	0.00
4.00	798	Garfield Ave	Petrolia Line	Florence Ave	1,200	0.158	ADEQ	Const	NONE	0.00
4.00	791	Fourth St	Third St	Fifth Ave	350	0.107	ADEQ	Const	NONE	0.00
4.00	792	Fourth St	Fifth Ave	Sixth St	350	0.104	ADEQ	Const	NONE	0.00
4.00	839	Kentail St	Petrolia Line	North St	95	0.095	ADEQ	Const	NONE	0.00
3.00	851	Lorne Ave	Princess St	Queen St	142	0.142	ADEQ	Const	NONE	0.00
3.00	834	Juniper Cr	Catherine St	Juniper Cr South	222	0.222	ADEQ	Const	NONE	0.00
3.00	793	Fourth St	Sixth St	South End	53	0.053	ADEQ	Const	NONE	0.00
3.00	3605	Princess St	Wellington St	Nelson St	165	0.165	ADEQ	Const	NONE	0.00
3.00	743	Chestnut St	Walnut St E	School St	106	0.106	ADEQ	Const	NONE	0.00
3.00	915	Rosemount Dr	Redwood Ct	Evergreen Trail	88	0.088	ADEQ	Const	NONE	0.00
3.00	908	Queen St	Dufferin Ave	Lorne Ave	1,000	0.125	ADEQ	Const	NONE	0.00
3.00	929	Third St	First Ave	Fourth St	244	0.244	ADEQ	Const	NONE	0.00
2.00	925	Sycamore Dr	Maple St	North End Cul De Sac	134	0.134	ADEQ	Const	NONE	0.00
2.00	948	Wingfield St	Petrolia Line	Walnut St E	135	0.135	ADEQ	Const	NONE	0.00
2.00	980	Country View Dr	Englehart Dr	Valentina St S.	130	0.103	ADEQ	Const	NONE	0.00
2.00	981	Country View Dr	South End	Englehart Drive	190	0.190	ADEQ	Const	NONE	0.00
2.00	982	Englehart Drive	Country View Dr	250m E of Countryview Drive	250	0.250	ADEQ	Const	NONE	0.00
2.00	983	Englehart Drive	250m E of Countryview Drive	South End	129	0.129	ADEQ	Const	NONE	0.00
2.00	913	Robert St	Centre St	Fletcher St	137	0.137	ADEQ	Const	NONE	0.00
2.00	896	Pine Cr	Catherine St	Catherine St	103	0.303	ADEQ	Const	NONE	0.00
2.00	728	Bluebird St	Country View Dr	Joe St	99	0.099	ADEQ	Const	NONE	0.00
2.00	731	Catherine St	Pine Cr	Pine Cr	86	0.086	ADEQ	Const	NONE	0.00
2.00	732	Catherine St	Pine Cr	Juniper Cr	87	0.087	ADEQ	Const	NONE	0.00
2.00	733	Catherine St	Juniper Cr	70m East of Juniper	200	0.068	ADEQ	Const	NONE	0.00
2.00	3642	Jennie St	West St	Huggard St	95	0.095	ADEQ	Const	NONE	0.00

Total Needs Summary by Improvement Type

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Priority#	ID	Street Name	From	To	AADT	Length	TON	Imp. Class	Imp	Imp. Cost
2.00	3656	West St	Annie St	Petrolia Line	113	0.113	ADEQ	Const	NONE	0.00
2.00	3657	West St	Jennie St	Annie St	113	0.113	ADEQ	Const	NONE	0.00
2.00	724	Applewood Dr	Garfield Ave	Catherine St	188	0.243	ADEQ	Const	NONE	0.00
2.00	765	Egan Ave	Petrolia Line	Florence Ave	158	0.158	ADEQ	Const	NONE	0.00
2.00	773	Ernest St	50m West of Kells Street	Eureka St	150	0.150	ADEQ	Const	NONE	0.00
2.00	774	Ernest St	Applewood Dr	50m West of Kells Street	316	0.316	ADEQ	Const	NONE	0.00
2.00	780	Evergreen Trail	Rosemount Dr	North End Cul De Sac	53	0.053	ADEQ	Const	NONE	0.00
2.00	788	Florence Ave	Garfield Ave	Egan Ave	220	0.220	ADEQ	Const	NONE	0.00
2.00	789	Florence Ave	Egan Ave	Kerby St	208	0.208	ADEQ	Const	NONE	0.00
2.00	809	Greenfield St	Petrolia Line	Walnut W	500	0.134	ADEQ	Const	NONE	0.00
2.00	810	Greenfield St	Walnut W	Dufferin Ave	208	0.208	ADEQ	Const	NONE	0.00
2.00	835	Juniper Cr	Juniper North	Sycamore Dr	216	0.216	ADEQ	Const	NONE	0.00
2.00	836	Kells St	Ernest St	North End Cul De Sac	131	0.131	ADEQ	Const	NONE	0.00
2.00	814	Hawthorne Pl	West End Cul De Sac	Sycamore Dr	76	0.076	ADEQ	Const	NONE	0.00
2.00	841	Kerby St	Petrolia Line	Florence Ave	250	0.160	ADEQ	Const	NONE	0.00
2.00	842	Kerby St	Florence Ave	North End	107	0.107	ADEQ	Const	NONE	0.00
1.00	811	Greenfield St	Dufferin Ave	South End	58	0.058	ADEQ	Const	NONE	0.00
1.00	795A	Gables Ave	107m S of Jacs Court	South End Cul De Sac	60	0.061	ADEQ	Const	NONE	0.00
1.00	949	Wingfield St	Walnut St E	Dufferin Ave	208	0.208	ADEQ	Const	NONE	0.00
1.00	992	Sunset Court	Ernest St	North End Cul De Sac	75	0.075	ADEQ	Const	NONE	0.00
						13.440				0.00
BS										
24.00	3895	Mutual St	South End	Third St	10	0.044	ADEQ	Const	BS	20,621.96
						0.044				20,621.96
						40.420				17,936,403.21
						40.420				17,936,403.21

Appendix J: Inventory Manual References

TABLE F-1 ROAD DESIGN STANDARDS

RURAL ROAD STANDARDS

		50-199 AADT 200	200-399 AADT 300	400-999 AADT 400	1000-1999 AADT 500	2000-2999 AADT 600	3000-3999 AADT 700	4000+ AADT 800	4 lanes & Exp 4LN,EXP
Shw	Surface Width (m)	6.0	6.0	6.5	6.5	7.0	7.0	7.5	15.0
DOP	Shoulder Width (m)	1.5	1.5	1.5	2.5	2.5	3.0	3.0	3.0
DA	Hot Mix (mm)		*16	50	50	100	100	100	100
DB	Granular A (mm)	150	150	150	150	150	150	150	150
	Southern Ontario								
DB	*Granular B (mm)*								
	BS	150	150	150	150	150	150	150	150
	RW, REC,NC	300	300	450	450	450	450	450	450
	Northern Ontario								
DB	*Granular B (mm)*								
	BS	250	250	250	250	250	250	250	250
	RW, REC,NC	400	400	550	550	550	550	550	550
	Concrete Surface								
DC	Concrete (mm)	150	150	150	225	225	225	225	225
DB	Granular B (mm)	150	150	150	150	150	150	150	150

* Double Surface Treatment (DST) assumed to equal 16 mm of Hot Mix

Note: Class 100 rural roads are eligible for maintenance subsidy only.

SEMI-URBAN ROAD STANDARDS

		Local Roads		Collector Roads		Arterials
		Residential LR	Comm/Ind LCI	Residential CR	Comm/Ind CCI	All Lanes ART
Shw	Lane Width (m)	3.0	3.25	3.25	3.75	3.75
DOP	Shoulder Width (m)	1.5	1.5	2.5	2.5	3.0
DA	Hot Mix (mm)	50	50	50	100	100
DB	Granular A (mm)	150	150	150	150	150
	Southern Ontario					
DB	*Granular B (mm)*					
	BS	150	150	150	150	150
	RW, REC	250	300	300	450	450
	Northern Ontario					
DB	*Granular B (mm)*					
	BS	250	250	250	250	250
	RW, REC	350	400	400	550	550
	Concrete Surface					
DC	Concrete (mm)	150	150	225	225	225
DB	Granular B (mm)	150	150	150	150	150

URBAN ROAD STANDARDS

		Local Roads		Collector Roads		Arterials	Expressways
		Residential LR	Comm/Ind LCI	Residential CR	Comm/Ind CCI	All Lanes ART	All Lanes EXP
	Through Lane Width (m)	3.0	3.25	3.25	3.75	3.75	3.75
	Parking Lane Width (m)	2.5	2.5	2.5	2.5	3.0	3.0
	Curb Offset each side (m)	.5	.5	.5	.5	.5	.5
	Granular Base						
DOP	Hot Mix (mm)	100	100	100	150	150	150
DA	Granular A (mm)	150	150	150	150	150	150
DB	Granular B (mm)						
	Southern Ontario	300	300	300	300	450	450
	Northern Ontario	400	400	400	400	550	550
	Concrete Base						
DOP	Hot Mix (mm)	50	50	50	50	100	100
DC	Concrete (mm)	150	150	200	200	200	200
DB	Granular B (mm)	150	150	150	150	150	200
	Concrete Surface						
DC	Concrete (mm)	150	150	250	250	250	250
DB	Granular B (mm)	150	150	150	150	150	150

Note: Bench Mark Costs will not exceed the design standards specified in the above tables

Feb 1, 1991 F - 12

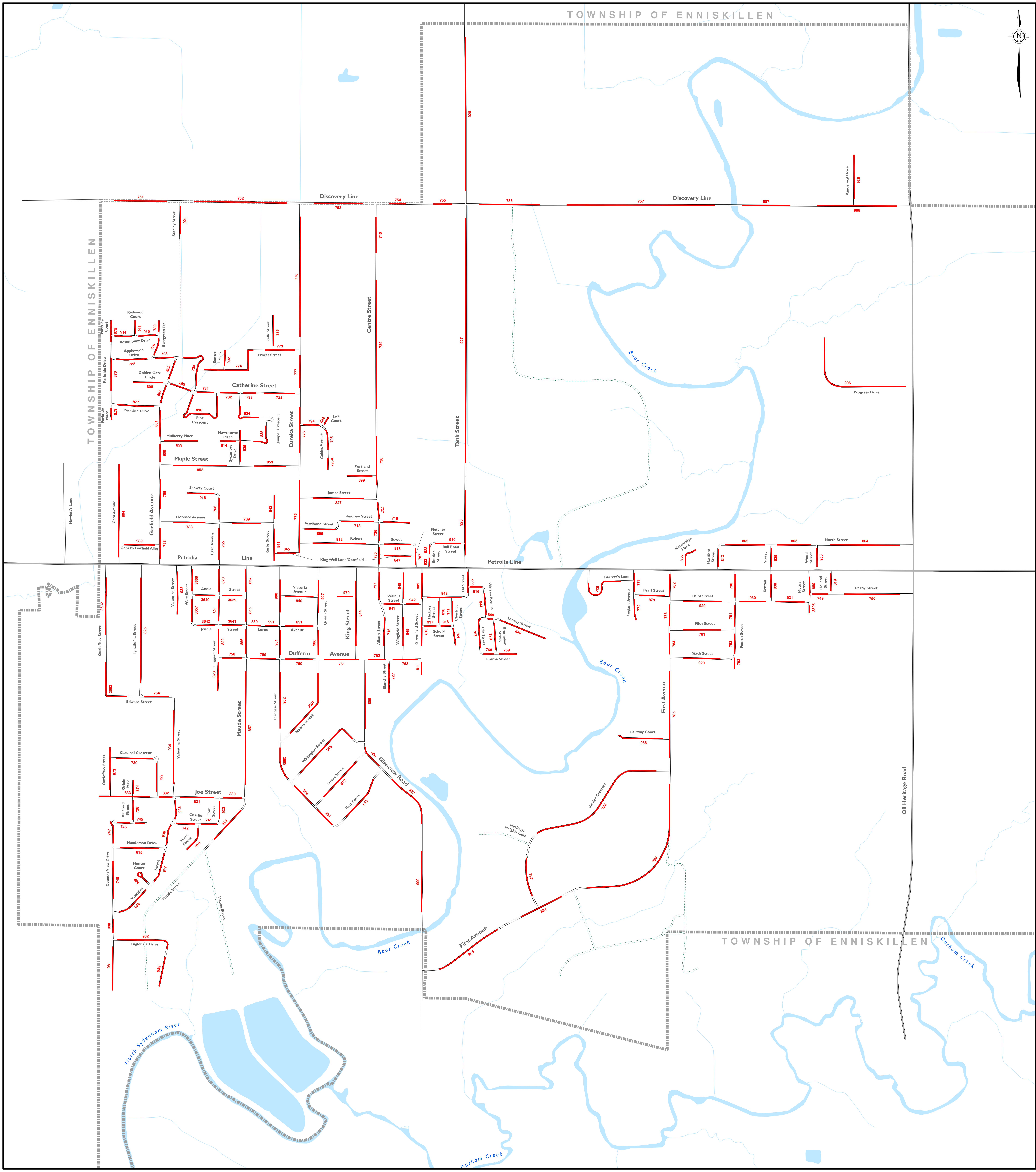
TABLE 93R - MINIMUM TOLERABLE SURFACE WIDTH - RURAL (metres)

	EXISTING CLASS									
	100	200	300	400	500	600	700	800	4LN	EXP
ROADWAY WIDTH	5.0	5.5	5.5	6.0	6.0	6.0	6.5	6.5	13.0	3.5/lane

TABLE 93SU - MINIMUM TOLERABLE SURFACE WIDTH - SEMI-URBAN and URBAN (metres)

	SEMI-URBAN		URBAN	
FUNCTIONAL CLASSIFICATION	2 Way (2W,2M)	1 Way (1W,1M)	2 Way (2W,2M)	1 Way (1W,1M)
2-lane Local Residential	5.0	5.0	5.5	5.5
2-lane Local Comm. & Ind.	5.5	5.5	6.0	6.0
2-lane Collector Residential	5.5	5.5	6.0	6.0
2-lane Collector Comm. & Ind.	6.0	6.0	6.5	6.5
2-lane Arterial	6.0	6.0	6.5	6.5
3-lane Local Comm. & Ind.	9.0	8.7	9.0	8.7
3-lane Collector Residential	9.0	8.7	9.0	8.7
3-lane Collector Comm. & Ind.	9.0	8.7	9.0	8.7
3-lane Arterial	9.0	9.0	9.5	9.5
4-lane Collector Residential	11.0	11.0	11.5	11.5
4-lane Collector Comm. & Ind.	12.0	12.0	12.5	12.5
4-lane Arterial	12.0	12.0	12.5	12.5
5-lane Arterial	15.0	15.0	15.5	15.5
6-lane Arterial	18.0	18.0	18.5	18.5
7-lane Arterial	21.5	21.5	22.0	22.0
8-lane Arterial	24.5	24.5	25.0	25.0
9-lane Arterial	27.5	27.5	28.0	28.0
Expressway	—	—	3.5/ln	3.5/ln

Appendix K: Section Map



LEGEND

ROAD INVENTORY SECTIONS

ARTERIAL ROAD

LOCAL/COLLECTOR ROAD (ADJACENT MUNICIPALITY)

TRAIL/ACCESS ROAD

UNOPENED ROW

OTHER FEATURES

WATERCOURSE

WATERBODY

MUNICIPAL BOUNDARY

CIMA+

4 ROADS MANAGEMENT SERVICES

CLIENT:

Town of PETROLIA

you'll be surprised!

PROJECT NAME:

2021 PETROLIA ROAD NEEDS STUDY

SHEET TITLE:

ROAD INVENTORY SECTIONS

SCALE:

0 50 100 200 300 400 metres

1:5,000

FIGURE No.

1

PROJECT No: C14-0419	DATE: 9/15/2021
DRAFTER: S. ELLIOTT	APPROVER: D. CAMPBELL