



**Road Needs Study Report –  
2019 Update**

**Township of North Frontenac**

**D.M. Wills Project No.17-4622**

**D.M. Wills Associates Limited**  
PARTNERS IN ENGINEERING  
Peterborough

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**Prepared for  
Township of North Frontenac**



## Executive Summary

The Township of North Frontenac (Township) retained the services of D.M. Wills Associates (Wills) to undertake a review of the Township's existing hardtop road network, and assess its physical condition as well as confirm various road attributes. Data collected during the field review was used to develop a prioritized listing of the road network needs, the results of which are documented in this report.

The Township's road infrastructure system spans a total of 339 km primarily within a rural setting, with small areas of urban and semi-urban development. The road network includes surfaces ranging from gravel to hot mix paved (asphalt). The Township has approximately 158 km of gravel roads, 173 km of surface treated roads (Low class bituminous (LCB)), and 8 km of hot mix asphalt paved roads (high class bituminous (HCB)). Gravel roads were not inspected as part of this study, but have been included in the inventory documented in this report.

Two primary indicators of the relative health of a road are the structural adequacy and surface condition ratings. Updating the 2107 average structural adequacy and surface condition rating for the Township's hard top road network to account for recent work provides ratings of 14.8/20 and 7.7/10 respectively.

**2% (~4 km) of the road network had a Structural "NOW" need, 10% (~17 km) has a Structural "1-5" year need, and 59% (~107 km) of the road network has a Structural "6-10" year need in 2017. 20 km have been addressed since the 2017 study.**

It should be noted that a structural "NOW" need does not explicitly mean that work must be undertaken on the road immediately (although this may be so in some cases). A structural "NOW" need means that a significant portion of the road is showing distress of the road bed and requires significant intervention i.e. reconstruction or major rehabilitation to renew its service life. A structural "1-5" year need is expected to become a "NOW" need in the next five years, and a "6-10" year need is expected to become a "NOW" need in the next 10 years.

Many "6-10" year reconstruction needs may be deferred by timely resurfacing, extending their service lives. As highlighted above, the Township had a significant portion of their roads (59%) with a "6-10" Year Structural Need in 2017.

### Preservation Management

In addition to addressing currently deficient roads (i.e. capital reconstruction), a dedicated preservation management approach is required, **and perhaps even more important**, to "keep the good roads good"; the fundamental principle being that it costs much less to maintain a good road than it does to let it fail and then reconstruct it, from a life cycle cost perspective. Ultimately, the goal of preservation management is to extend the useful life of a road and road network, maximizing the municipality's investment over the road life-cycle.

Road resurfacing is an effective way of extending the overall life of the pavement structure and therefore a road resurfacing program is highly recommended. Roads with a structural adequacy of 12/20 or greater are included as candidates for potential resurfacing. Preliminary recommendations and prioritization for road resurfacing are based on condition rating and traffic demands on each road section, as per the Inventory Manual. A road with higher traffic volumes and fair structural adequacy is given priority over a road with moderate traffic and good structural adequacy score, in an attempt to intervene and extend the life of the road before it deteriorates to a level that can no longer be resurfaced (i.e. more expensive reconstruction is required). Specific resurfacing treatment recommendations must be assessed through further field investigation and detail design effort, prior to selecting and implementing the resurfacing strategy.

Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a resurfacing program and related budget is recommended as follows:

#### **Hot Mix Paved Roads:**

- 8.0 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 0.4 km / year.
- **Annual budget \$114,400:** (0.4 km / year x \$143,000 / In **RMP1** x 2 lanes).

#### **Surface Treated Roads:**

- 173.0 km of surface treated roads (LCB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 24.7 km / year.
- **Annual budget \$617,500** (24.7 km / year x \$25,000 / km **ST1**).

Gravel roads require regular maintenance. Maintenance includes regular grading and reapplication of new gravel. Typically, gravel roads should be resurfaced on a 3 - 5 year cycle.

#### **Gravel Roads:**

- 158 km of earth / gravel roads.
- 75mm gravel every 5 years.
- Annual gravelling of 31.6 km.
- Granular A (\$22,000 / km).
- **Annual budget \$695,200** (31.6 km / year x \$22,000 **G**) \*\*.

\*\* Cost based on supply and application of gravel by external forces.

**The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at \$1,427,100 per year.**

Further to the recommendations above with respect to resurfacing, it is also recommended that regular maintenance in the form of roadside ditch cleanout and clearing be undertaken as a critical component to preservation management in order to extend the useful service life of the existing roads.

### **Capital Improvements**

Preliminary recommendations and prioritization for planned capital improvements i.e. reconstruction, have been developed based on the condition rating and traffic demands on each road section, as per the Inventory Manual. Those roads identified as having a “NOW” or 1 - 5 year need have been included in the capital improvement plan for reconstruction.

A total length of approximately 12.6 km of roads were identified as having structural needs in the “NOW” or 1 – 5 year periods in 2017 and have not been addressed. The estimated cost to improve these roads is approximately \$ 2.2 M.

A road segment with a structural adequacy score of less than 12/20 is considered a “NOW” or “1-5 Year” need.

An additional length of approximately 23 km of road is identified as having inadequate surface widths. Generally, provided no operational or safety concerns are identified, roads with surface width deficiencies are typically addressed / considered at the next full reconstruction cycle. All roads currently meet the minimum tolerable standard for surface type, based on the Inventory Manual methodology. Additional guidance regarding road surface types is discussed within the document.

### Road System Inventory

Township of North Frontenac Road System in Kilometres (As of November 2017)		
<b>A.</b>	<b>Surface Type</b>	<b>Totals*</b>
	Earth	0
	Gravel (loose Top Gravel)	158
	Surface Treatment (LCB & ICB)	173
	Hot Mix Asphalt (HCB)	8
<b>Total A</b>		<b>339 km</b>
<b>B.</b>	<b>Roadside Environment</b>	
(i)	<b>Rural</b>	
	Earth	0
	Gravel (loose Top Gravel)	158
	Surface Treatment (LCB & ICB)	173
	Hot Mix Asphalt (HCB)	7
<b>Total Rural</b>		<b>338 km</b>
(ii)	<b>Semi-Urban</b>	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	0
	Hot Mix Asphalt (HCB)	0
<b>Total Semi-Urban</b>		<b>0 km</b>
(iii)	<b>Urban</b>	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	0
	Hot Mix Asphalt (HCB)	1
<b>Total Urban</b>		<b>1 km</b>
<b>Total B</b>		<b>339 km</b>
<i>*Estimated to the nearest kilometre.</i>		

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## **1.0 Purpose, Background and Study Method**

### **1.1 Purpose**

The purpose of the 2019 Road Needs Study Report is to incorporate work done on the hardtop road inventory within the Township of North Frontenac (Township) since the 2017 report. Using this information, a prioritized listing of the road network needs is developed. The information derived from the study and documented in this report will provide assistance to the Township for developing and executing a planned road maintenance and improvement program.

The Township retained the services of D.M. Wills Associates (Wills) to undertake a review of the existing hardtop road network, and assess its physical condition as well as confirm various attributes in 2017. Data collected as a result of the field review is used to develop a prioritized listing of the road network needs, the results of which are documented in this report.

### **1.2 Background**

The Township of North Frontenac is located in the County of Frontenac, in the heart of eastern Ontario cottage country. The Township is largely rural with some scattered urban/semi-urban developments.

In 2017, a Road Needs Study Report was undertaken to inventory and document the Township's existing hardtop road assets. Additionally, in 2018 a Gravel Road Evaluation Study Report was undertaken to inventory and assess the Township's existing gravel road assets. This current study update (2019) utilizes and builds from the road asset information documented in the 2017 Road Needs Study.

### **1.3 Study Objectives**

Based on discussion with Township staff, the following study objectives were identified:

- Provide a current inventory and value of the Township's hardtop roads, assess road conditions and needs, and develop a priority listing for construction needs and improvements.
- Provide a prioritized list of capital projects for the Township to invest in.

To ensure compliance with the latest Ministry of Transportation (MTO) guidelines, the inventories were completed in accordance with the most current edition of the Inventory Manual for Municipal Roads.

## 1.4 Study Methodology

The procedure utilized to complete the study was generally in accordance with the Ministry of Transportation's Inventory Manual for Municipal Roads (February 1991). Wills undertook the field study in October/November of 2017.

During the field study, a visual assessment of the following road characteristics was documented to assess the current adequacy of the road:

- Platform Width (overall width of road).
- Surface Width (width of pavement surface).
- Shoulder Width.
- Surface Type (gravel, low class bituminous, or high class bituminous).
- Drainage Type (open ditches vs. storm sewers etc.).
- Surface Condition (assigned based on Ride Condition Rating for this Study).
- Maintenance Demand.
- Roadside Environment.
- Capacity.
- Alignment.

### Critical Deficiencies

Critical deficiencies represent road characteristics that result in increased maintenance costs or lead to an inadequate level of service. Road sections may be assessed as critically deficient if any one (1) of the following characteristics fall below the minimum tolerable standards defined in the MTO Inventory Manual:

- Surface type - Insufficient surface type for traffic volumes.
- Surface width - Insufficient width of the road surface excluding the shoulders.
- Capacity - Inability of the road to accommodate traffic volumes at peak periods.
- Structural Adequacy - Inability of the road base to support vehicular traffic.
- Drainage - Increased frequency of flooding or excessive maintenance effort required to prevent flooding.

Critically deficient roads have generally reached the end of their service life and/or require major work to improve e.g. widening or new surface type. As such, reconstruction is generally required.

#### Surface Type

The following parameters were used to assess the adequacy of the road surface type. Road sections with traffic volumes (AADT) in excess of the Minimum Tolerable values for Earth and Gravel in **Table 1**, were noted as critically deficient triggering a "Now" surface type need as per the Inventory Manual Method.

**Table 1 - Surface Type by Annual Average Daily Traffic (AADT)**

Surface Type	AADT		
	Inventory Manual		MTO Pavement Design and Rehabilitation Manual <sup>1</sup>
	Minimum Tolerable	Design Standard	
Earth (E)	<50	-	-
Gravel (G)	<400	0-199	0 - 199
Low Class Bituminous (LCB) / Surface Treatment	-	200-399	200 - 1500
High Class Bituminous (HCB) / Hot Mix	-	400+	>1500

**Table 1** provides further guidance with respect to surface type from both the Inventory Manual as well as the MTO Pavement Design and Rehabilitation Manual.

As detailed in Table 1, Gravel surfaces are generally considered acceptable for AADT of less than 200 vehicles but may be tolerable up to 400 AADT. Transition to Surface Treatment should be considered above 200 AADT. Gravel road maintenance costs (resurfacing, grading, dust suppression, etc.) versus surface treatment costs are key considerations.

Low Class Bituminous (LCB) i.e. Surface Treatment may be acceptable for traffic volumes between 200 and 1500 AADT. A transition to a Hot Mix or High Class Bituminous surface from Surface Treatment must be considered on a case by case basis. The following factors require consideration:

- Surface Treatment Maintenance Costs
- Commercial Vehicle Loading
- Roadside Environment (Urban, Semi-urban, vs. Rural)
- On-street Parking
- Adjacent Drainage Infrastructure i.e. curb and gutter, catch basins etc.
- Asphalt Availability/Cost
- Surface/Platform Width
- Traffic Volume Growth
- Sub-base Quality
- Roadbed Frost Susceptibility
- Future Resurfacing/Rehabilitation Costs

<sup>1</sup> Ministry of Transportation. Pavement Design and Rehabilitation Manual, Second Edition, 2013, Table 3.3.3 Structural Design Guidelines for Flexible Pavement – Secondary Highways

Vehicle loading is one of the key considerations for pavement design and ultimately the decision between Hot Mix or Surface Treatment. Roads with high levels of commercial traffic require a more substantial pavement structure. The values noted in Table 1, for the “MTO Method” are generally reflective of a highway with 10% commercial vehicles. Roads with AADT in excess of 400 vehicles with a good sub-base and commercial vehicles up to 10% may still perform very well with a Surface Treatment. Existing/past performance of a Surface Treatment can be an excellent indicator when considering the upgrade to Hot Mix.

Surface Width

Surface widths that fall below minimum tolerable standards, as detailed in the MTO Inventory Manual are noted as critically deficient triggering a “Now” need.

The minimum tolerable surface widths for rural roads are included in **Table 2** below:

**Table 2 – Rural Road Surface Width by Annual Average Daily Traffic (AADT)**

	AADT							
	1-49	40-199	200-399	400-999	1000-1999	2000-2999	3000-3999	4000+
Road Width (m)	5.0	5.5	5.5	6.0	6.0	6.0	6.5	6.5

Capacity

An in-depth traffic capacity analysis was not completed as part of the scope of this Road Needs Study. Decisions with respect to expansion of roads should be made within the context of a Transportation Master Plan or Official Plan for the Township.

However, from a general perspective, a two lane road can typically provide adequate service up to an AADT of approximately 12,000 vehicles. The functionality of a road from a capacity standpoint is of course dependent upon other factors in combination with volume. Adjacent land uses, number of access points i.e. entrances and side roads etc. also have a significant impact on how the road functions.

A rural road with limited entrances and side roads will have a much greater capacity to flow traffic versus an urban street with many entrances and side road intersections. The AADT of 12,000 can be used as a ‘rule of thumb’ to trigger further analysis on the road capacity and operation. For the purposes of this study, a detailed capacity analysis was not undertaken as part of the scope of work. All roads were assigned to be adequate from a capacity perspective noting the highest road segment AADT of 615 vehicles.

### Structural Adequacy

In cases where road base or structure is showing distress over more than 20% of the length of the road section, a score between 1 and 7 (out of 20) is assessed and the road section is assigned a “Now” need and considered Critically Deficient per the Inventory Manual. The structural adequacy rating is often the best indicator of the overall road section’s health.

It should be noted that a structural “NOW” need does not explicitly mean that work must be undertaken on the road immediately (although this may be so in some cases). A structural “NOW” need means that a significant portion of the road is showing distress of the road bed and requires significant intervention i.e. reconstruction or major rehabilitation to renew its service life. A structural “1-5” year need is expected to become a “NOW” need in the next five years, and a “6-10” year need is expected to become a “NOW” need in the next 10 years.

### Drainage

A road section is assessed as a “Now” need for drainage generally when a road becomes impassible due to water one or more times a year. This information is not readily accessible from inspection. Characteristics such as ditching, water ponding on or around the road, and evidence of past washouts were used to assess road drainage. As such, a road was given a “Now” need for drainage if there were evident drainage problems that would likely lead to an impassable road during a heavy rain or a rapid snow melt.

## **2.0 The Road System**

### **2.1 Inventory and Classification**

All roads in the municipal road system were inventoried according to the methods outlined in the Inventory Manual for Municipal Roads.

The inventory procedure requires that each road in the system be studied as a separate unit. Initially, the road system was divided into sections so that each conformed, as close as possible, to the following requirements:

- Uniform traffic volume
- Uniform terrain
- Uniform physical conditions
- Uniform adjacent land

Depending on location with respect to the built up areas, roads were classified in a manner generally descriptive of the type of construction as follows:

- Urban - Roads with curb and gutter and storm sewer drainage.
- Semi-Urban - Roads in built up areas (development exceeds 50% of the 50% of the frontage) without curb and gutter or curb and gutter on one (1) side only.
- Rural - Roads with development on less than 50% of the frontage.

Rural roads were further evaluated based on estimated traffic volumes; such as 0 to 50 vehicles per day, 51 to 200, and 201 to 400 etc. For the purpose of this study, traffic volumes were adopted or estimated from existing traffic data, and previous estimates provided by the Township.

**Table 3** summarizes the total road length in kilometres by surface type and road environment as of November, 2017.

The existing road system consists of 339 km of roadway, 158 km of gravel roads, 173 km of surface treated roads (LCB) and 8 km of HCB (asphalt paved) roads; with all calculations being approximate and rounded to the nearest kilometre.

**Table 3 - Road System Inventory**

Township of North Frontenac Road System in Kilometres (As of September 2017)		
<b>A.</b>	<b>Surface Type</b>	<b>Totals*</b>
	Earth	0
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<i>*Estimated to the nearest kilometre.</i>		

### 3.0 Road Needs

The primary purpose of the study is to develop a list of all roads within the Township ranked according to priority with respect to road needs.

The method of evaluating road needs in terms of type, cost and timing of improvements is identified in the Inventory Manual for Municipal Roads.

It is important to note that budgetary restrictions will often influence the level of upgrades to the road system and therefore it is imperative to maximize the improvements based on availability of funds and needs priority.

### 3.1 Critical Deficiencies

The inventory of the road system revealed that certain road sections are now deficient or will become deficient during the study period.

As noted previously, critical deficiencies include road characteristics which result in increased maintenance costs and which inevitably lead to an inadequate level of service. A road section is critically deficient if any one of the following characteristics fall below the minimum tolerable standards defined in the Inventory Manual.

- Surface type - Incorrect surface type to suit traffic volumes on the roadway.
- Surface width - Insufficient width of the road surface excluding the shoulders.
- Capacity - Inability of the road to accommodate traffic volumes at peak periods.
- Structural Adequacy - Inability of the road base to support vehicular traffic.
- Drainage - Increased frequency of flooding or excessive maintenance effort required to prevent flooding.

Of the 181 km of hardtop roads inventoried, a total of 25 km were found to be critically deficient and have not yet been addressed. Of the 25 km, approximately 2 km represents roads with AADT of less than 50 vehicles. Regardless of condition, roads with AADT of fifty (50) or less are typically assigned as "Adequate" (as per the Ministry protocol) for the purpose of the system adequacy calculation.

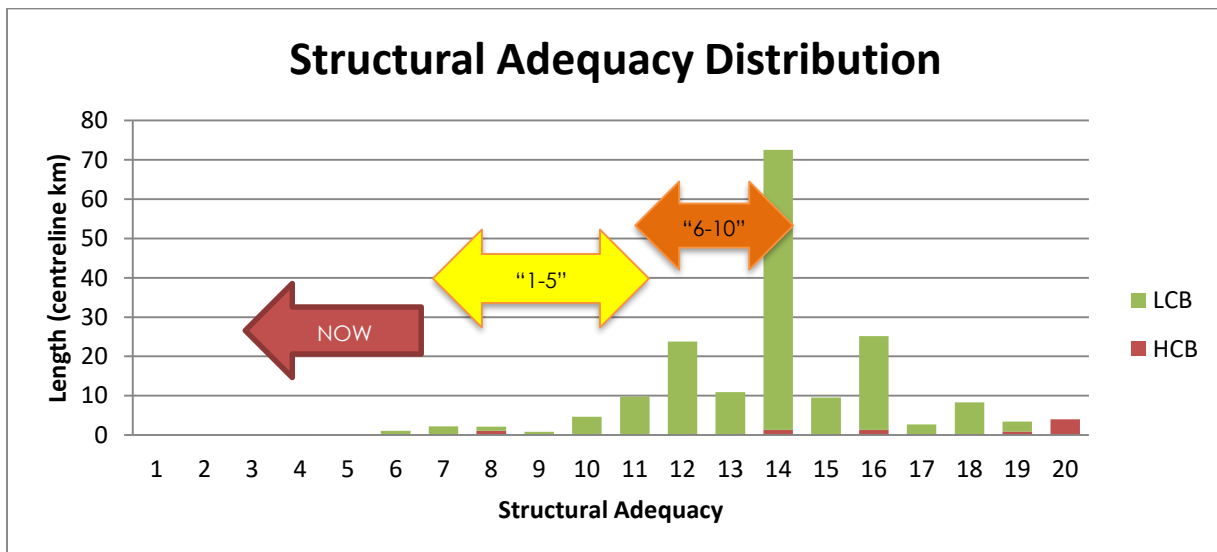
The overall system adequacy for the Township's hardtop road network, which is based upon the total road kilometres less the identified critically deficient ("NOW" needs) roads, is as follows:

$$\text{2017 System Adequacy} = \frac{181 - (25 - 2)}{181} \times 100\% = 87\%$$

The average 2017 surface condition rating of all hardtop roads was 7.2/10 while the average 2017 structural adequacy rating is 13.9/20. This suggests that the typical road has a fair to good riding quality, but just at the point where significant rehabilitation or reconstruction is required.

A review of the structural adequacy distribution of the Township's roads identifies a group of roads, approximately 30%, are in very good condition (structural adequacy of 15 and over), and with regular resurfacing and preservative maintenance, should not require reconstruction in the next 10 years. Another cohort of roads, approximately 60% are in average condition (Structural Adequacy from 12 to 14). Some of these roads may continue to perform well, but without timely resurfacing and preventative maintenance, many of them are expected to become NOW or 1 – 5 year needs. The remaining hard top road network, is well distributed over the very poor to poor range (structural adequacy from 4 to 11). Most of these roads will require reconstruction over the next 5 years to fully repair them.

It is therefore recommended that, while the Township endeavors to repair these poor roads as part of its 10-year capital plan, every reasonable effort is made, through preservation management, to prevent the current cohort of fair roads from becoming capital reconstruction needs themselves.



### 3.2 Priority Ratings of Roads

A mathematical empirical formula was used to calculate the priority rating for each road section. The priority rating is a weighted calculation which takes into account the existing traffic volume and overall condition rating of the road.

This priority analysis is an impartial procedure to place the deficiencies in order of relative need. **A higher Priority Rating number indicates a relatively greater need for improvement.**

The formula takes into account the current traffic volume (AADT), whether it is from actual road counts or estimated road counts and the Condition Rating (CR) of the road at the time of this Road Needs Study Report. The formula is as follows:

$$\text{Priority Rating} = 0.2 \times (100 - \text{CR}) \times (\text{AADT} + 40)^{0.25}$$

In utilizing the above equation Wills identified a priority listing for review with Township staff. It is important to emphasize that the priority rating calculation considers only CR and traffic volumes.

When developing the recommended capital expenditure plan consideration may be given to the remaining useful service life of a road / roadbed with a view to coordinating major reconstruction efforts at / near the end of the road's life. Furthermore, while a priority rating will give a general idea of which roads should be improved before others, it does not prescribe an exact order for road improvements nor does it determine the timing of preservation and rehabilitation work. For example, it may be wise to defer the full reconstruction of a high priority road ("let the bad roads fail") in favour of resurfacing work on a medium priority road ("keep the good roads good").

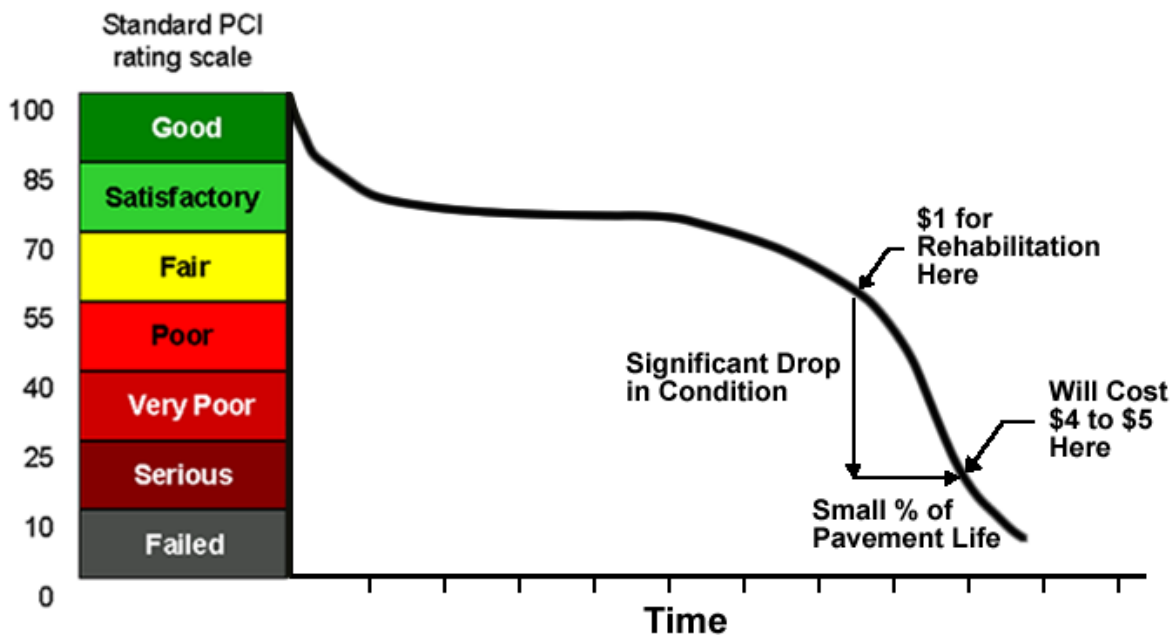
## 4.0 Roads Best Management Practices

The key to managing a pavement / road network is the timing of maintenance and rehabilitation activities. This idea evolves from the fact that a pavement's structural integrity does not fall constantly with time. A pavement generally provides a constant, acceptable condition for the first part of its service life and then begins to deteriorate very rapidly. In many cases, maintenance and rehabilitation measures are not taken until structural failure or noticeable changes in ride quality become apparent. This is the "fix it once it is already broken" approach.

The unfortunate consequence of this decision is that maintenance and rehabilitation becomes exponentially more expensive over the life of the pavement and is often overlooked until the pavement condition reaches a severe state of distress. There is opportunity for substantial cost savings when intervention is made *before* the pavement becomes severely compromised; i.e. "fix it before it breaks". **Figure 1** illustrates the underlying principle in support of a preservation management approach to pavement infrastructure. The principle also has application to each of the classes of roads maintained by the Township. Significant cost savings will result from proactive intervention rather than simply waiting as long as possible before performing maintenance.

Examples of approach to roads management with their associated cost implications over the lifecycle of a road are set out below in **Figure 1** and are provided as an illustration of the benefit of a "preservation management approach".

**Figure 1- Typical Service Life of an Asphalt Pavement**



### 4.1 Example Life Cycle Cost Analysis

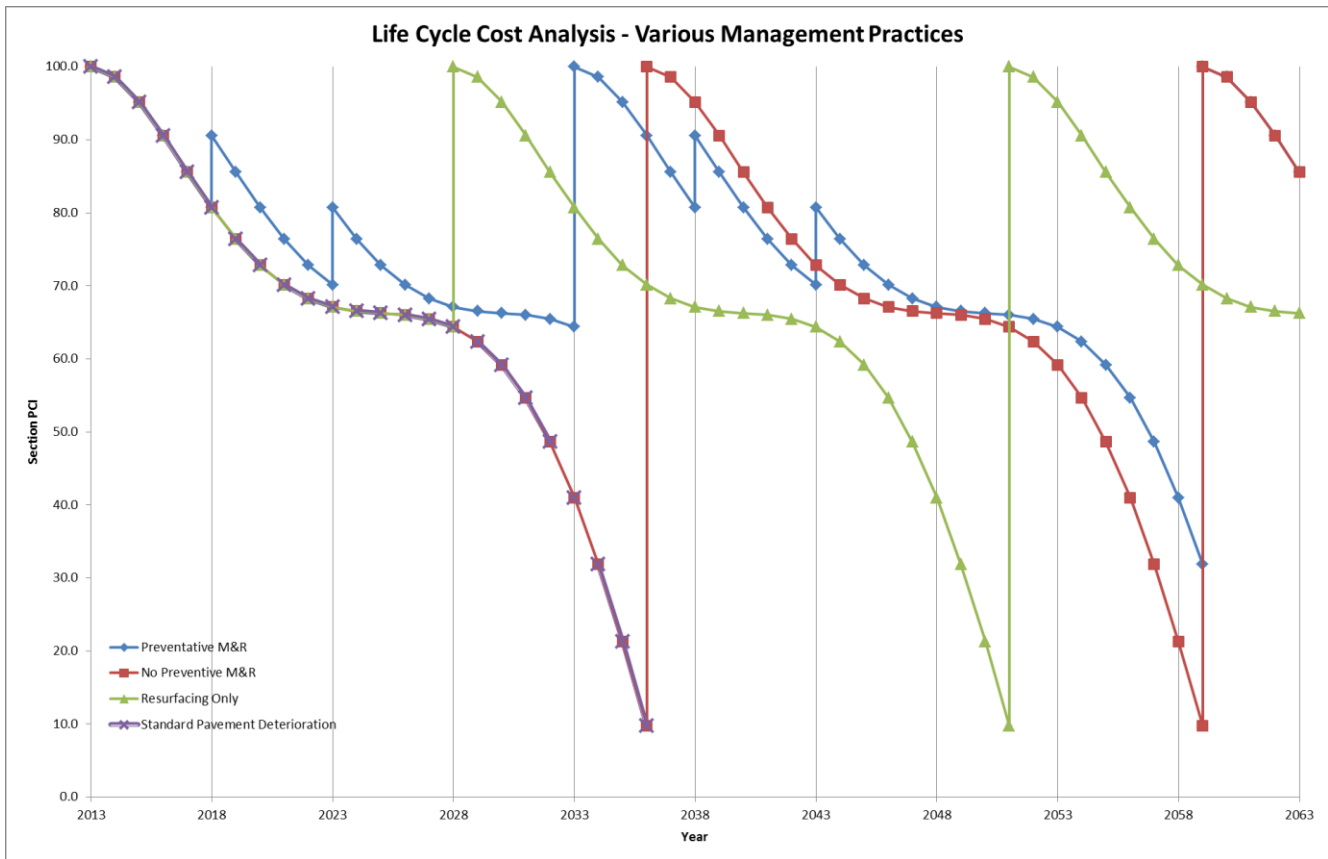
The following life cycle costs analysis compares three (3) different municipalities Municipality 1, Municipality 2 and Municipality 3; each with three (3) distinct approaches to pavement management. For this analysis we will assume each of the three (3) municipalities has 7000 m<sup>2</sup> of pavement, i.e. 1 km of asphalt paved road that is 7 m wide. In each scenario, the road is assumed to have been constructed in 2013 and will operate under normal traffic loading.

The Life Cycle Cost Analysis (LCCA) assumes no user costs. The LCCA uses a discount rate of 2.5% / year.

The LCCA shows the three (3) different municipalities and tracks their pavement management decisions and related condition over the specified time period. Municipality 1 represents decisions made based on strategic preventive maintenance and rehabilitation (M&R), Municipality 2 represents decisions based on no preventive M&R and Municipality 3 represents decisions based on resurfacing only.

Figure 2 below illustrates a time- pavement condition plot for each municipality.

**Figure 2 - Time-Condition Plot for 3 Municipalities**



The costs associated with the corresponding maintenance and rehabilitation decisions are outlined in the following three (3) charts:

Preventive M&R										
Year	Age	Treatment	Δ PCI	PCI <sub>q</sub>	Quantity	Unit	Unit Cost	Total Cost	Present Worth	
		-- Annual Ditching/Clearing --								
2018	5	Localized Preventive - Rout and Seal	81-90	Satisfactory-Good	1000	m	\$1.50	\$1,500.00	\$1,325.78	
2023	10	Global Preventive - Slurry Seal	70-81	Satisfactory-Good	7000	m <sup>2</sup>	\$6.50	\$45,500.00	\$35,544.53	
2033	20	Surface Course	64-100	Poor-Good						
		Mill and Dispose of Surface Course			7000	m <sup>2</sup>	\$12.00	\$84,000.00		
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50		
							\$204,487.50	\$124,792.78		
2038	25	Localized Preventive - Rout and Seal	81-88	Satisfactory-Good	4500	m	\$1.50	\$6,750.00	\$3,640.89	
2043	30	Global Preventive - Slurry Seal	68-78	Satisfactory-Good	7000	m <sup>2</sup>	\$6.50	\$45,500.00	\$21,691.79	
2048	35	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	5%	m <sup>2</sup>	\$30.00	\$10,500.00	\$4,424.40	
2053	40	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	10%	m <sup>2</sup>	\$30.00	\$21,000.00	\$7,821.04	
2058	45	Full Reconstruction	32-100	Serious-Good						
		Remove Asphalt Full Depth			7000	m <sup>2</sup>	\$15.00	\$105,000.00		
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	\$35.00	\$14,700.00		
		40mm Base Course			686	t	\$125.00	\$85,750.00		
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50		
							\$325,937.50	\$107,290.28		
2063	5	Localized Preventive - Rout and Seal	81-90	Satisfactory-Good	1000	m	\$1.50	\$1,500.00	\$436.41	
			<b>Final PCI in 2063:</b>	<b>90</b>	<b>Good</b>				<b>Net:</b>	<b>\$306,967.90</b>
									<b>Residual Value:</b>	<b>\$85,346.08</b>
									<b>Total Cost:</b>	<b>\$221,621.82</b>

The policy of Municipality 1 is to strategically intervene with preventative maintenance measures over the course of the pavement's service life. Two (2) significant maintenance measures are performed on the pavement at various times and ultimately extend the service life of the pavement, prorating the total cost of the pavement over a longer period of time. Eventually, a full reconstruction is required and this cycle repeats. The total life cycle costs are substantially less when compared to Municipality 2 and 3, at a total of \$221,622 over 50 years.

No Preventive M&R									
Year	Age	Treatment	Δ PCI	PCI <sub>q</sub>	Quantity	Unit	Unit Cost	Total Cost	Present Worth
2023	10	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	5%	m <sup>2</sup>	\$30.00	\$10,500.00	\$8,202.58
2028	15	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	10%	m <sup>2</sup>	\$30.00	\$21,000.00	\$14,499.78
2030	17	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	20%	m <sup>2</sup>	\$30.00	\$42,000.00	\$27,602.19
2036	23	Full Reconstruction	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m <sup>2</sup>	\$15.00	\$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	\$35.00	\$14,700.00	
		40mm Base Course			686	t	\$125.00	\$85,750.00	
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50	
							\$325,937.50	\$184,707.88	
2043	7	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	5%	m <sup>2</sup>	\$30.00	\$10,500.00	\$5,005.80
2048	12	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	10%	m <sup>2</sup>	\$30.00	\$21,000.00	\$8,848.79
2053	17	Safety/Stopgap Maintenance - AC Patching/Leveling	N/A	N/A	20%	m <sup>2</sup>	\$30.00	\$42,000.00	\$15,642.09
2059	23	Full Reconstruction	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m <sup>2</sup>	\$15.00	\$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	\$35.00	\$14,700.00	
		40mm Base Course			686	t	\$125.00	\$85,750.00	
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50	
							\$325,937.50	\$104,673.45	
Final PCI in 2063:			86	Good				Net:	\$369,182.56
								Residual Value:	\$81,552.92
								Total Cost:	\$287,629.64

The policy of Municipality 2 is to simply construct the pavement and wait until serious deficiencies begin to appear before acting. This approach unfortunately remains common still today. Over the last period of the pavement's life, maintenance is required to ensure safety and operation until the pavement becomes completely destroyed. Once the pavement has failed, a complete reconstruction is carried out restoring the pavement to new condition. This cycle repeats again until a second reconstruction is required. The total costs are substantial and total \$287,630 over 50 years.

Resurfacing Only									
Year	Age	Treatment	Δ PCI	PCI <sub>q</sub>	Quantity	Unit	Unit Cost	Total Cost	Present Worth
2028	15	Surface Course	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m <sup>2</sup>	\$12.00	\$84,000.00	
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50	
							\$204,487.50	\$141,191.58	
2051	23	Full Reconstruction	10-100	Serious-Good					
		Remove Asphalt Full Depth			7000	m <sup>2</sup>	\$15.00	\$105,000.00	
		Add and Compact Corrective Aggregate/Correct Crossfall (25mm avg.)			420	t	\$35.00	\$14,700.00	
		40mm Base Course			686	t	\$125.00	\$85,750.00	
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50	
							\$325,937.50	\$127,534.43	
2067	15	Surface Course	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m <sup>2</sup>	\$12.00	\$84,000.00	
		50mm Surface Course			892.5	t	\$135.00	\$120,487.50	
							\$204,487.50	\$53,898.67	
Final PCI in 2063:			66	Good				Net:	\$322,624.67
								Residual Value:	\$62,587.12
								Total Cost:	\$260,037.55

The policy of Municipality 3 is periodic resurfacing. The pavement is constructed and time passes until early signs of serious distress are observed. This occurs after the time when preventive maintenance is neither appropriate nor possible, but before the pavement becomes completely destroyed. Resurfacing is performed and restores the pavement to almost new condition. The pavement then deteriorates for the remainder of its life, requiring significant maintenance in the last years before it becomes completely destroyed. A full reconstruction is then carried out and the cycle continues. The total costs are in between that of Municipality 1 and 2 at \$260,038 over 50 years.

It may be easy to see upfront cost savings by understanding that as long as any costs associated with maintaining the pavement are deferred as long as possible, money will be saved. The reality is that extending a pavements service life prorates the total cost of the pavement over a longer period of time and ultimately becomes more economical in the long run. If preventive maintenance measures are strategically planned and carried out then the service life of the pavement can be maximized and substantial reconstruction costs can be deferred for longer periods of time. In a time when economy and efficiency are becoming more and more important, this type of proactive management is essential in the management of infrastructure.

## 4.2 Preservation Management Approach

### 4.2.1 Gravel Roads

The Township currently maintains approximately 158 km of gravel road. The proposed preservation management approach for this class of road is outlined in the following **Table 4** and **Table 5**.

**Table 4 - Preservation Management Approach- Gravel Surface**

Action	Frequency
Regrade surfaces to maintain smooth / safe driving surface and proper crossfall.	As needed, generally 2-3 times per year for higher volume gravel, or more frequently as necessary; 1-2 for lower volume.
Add calcium to tighten surface, retain aggregate and reduce dust.	Each spring on all roads of higher volume and as needed during summer months.
Ditching and brushing of right-of-ways to improve roadbed drainage and safety.	Complete road network every 10 years.

**Table 5 - Capital Activities – Gravel Roads**

Action	Frequency
Add layer (75 mm) of granular material to road surface.	Every 3-5 years for gravel roads.
Base and sub-base improvements.	As needed or as dictated by traffic volumes.
Reconstruct / convert to hard top.	As dictated by traffic volumes.

### 4.2.2 Surface Treated Roads

Surface treated roads have a hard wearing surface that must be preserved in order to be effective. The Township currently maintains 173 km of surface treated roads. Unlike gravel roads, a significant investment has been made in the surface and consequently these roads must be managed properly to obtain the longest possible service life from the surface.

**Table 6 - Preservation Management Approach – Surface Treated Roads**

Activity	Age (Years)	Ride Condition Rating	Estimated Service Life Extension (Years)
Slurry Seal	3	8	4
Slurry Seal	6	7	3
Double Surface Treatment	10	6	5
Pulverize and DST	14	<4	8

In addition to the noted preservation approach in **Table 6**, the following best management practices may be employed to preserve the surface, extend the service life and reduce life cycle costs of surface treated roads:

1. Surface treatment shall be applied to the entire road platform, from “grass to grass”, including any shoulders. This will eliminate grading on surface treated roads, which has a tendency to damage the edge of the surface treatment and cause premature failure of the surface.
2. Suitable new technologies will be utilized where they can be demonstrated to reduce life cycle costs, such as fibre-reinforced surface treatment. This technology can be used to mitigate reflective cracking (if cracks are narrow and inactive) when a single or double surface treatment is applied over an aging surface. It can eliminate the need for pulverizing the underlying surface in certain situations and can reduce overall costs.
3. Assess drainage and culvert needs prior to any significant renewal or rehabilitation strategy and complete any improvements concurrently. This will eliminate the need to cut / excavate a relatively new surface to replace a culvert.
4. Ditching and clearing (brushing) of the right-of-ways (ROW) to improve roadbed drainage and safety.

### 4.2.3 Asphalt Roads

Asphalt surfaces are the smoothest and most durable hard top surface used by the Township however; they are also the most expensive. The Township currently maintains 9 km of asphalt surface roads. Asphalt provides a constant, acceptable condition for the initial portion of its service life but then begins to deteriorate rapidly as it ages. Surface defects such as cracking and raveling are the first signs of the deterioration. If left untreated, the pavement will rapidly deteriorate to the point where reconstruction is the only option. A preservation management strategy can mitigate this by applying renewal treatments earlier in the pavements life before the conditions begin to deteriorate too far. **Table 7** below summarizes preservation management activities to be considered for asphalt roads:

**Table 7 - Preservation Management Approach – Rural Asphalt Roads**

Activity	Age (Years)	Ride Condition Rating	Estimated Service Life Extension (years)
Crack seal	2-6	9	2
Slurry Seal / Microsurface	4-8	8	4-6
Overlay	12-15	6-7	10
Pulverize and Pave	20-25	< 5	20
Reconstruct	30	< 4	30

*Note: Slurry seal can be used on lower volume paved roads (less than 1000 vehicles per day). For roads with volumes in excess of 1000 AADT, microsurfacing should be considered.*

In addition to the above noted preservation approach, the following best management practices may be employed to extend the service life and reduce life cycle costs of asphalt roads:

1. Review the condition of other infrastructure, particularly underground infrastructure prior to implementing any major renewal or rehabilitation of the pavement. Any repairs or capital upgrades to other infrastructure should be coordinated. This should reduce utility cuts in newer asphalt.
2. Repair potholes in the surface in a timely fashion to prevent saturation and weakening of road base.
3. Undertake regular shouldering program of rural paved roads to promote proper drainage. Poorly maintained shoulders allow surface water to pond and saturate the road base, which weakens the base and leads to cracking at the edge of pavements.
4. Undertake a ditching program to ensure there is adequate drainage for road base on rural roads. This will reduce the likelihood of structural distresses caused by softening of the road base due to poor drainage.
5. Specify the appropriate type of performance graded asphalt cement for the location.
6. Undertake a clearing program to reduce shading of the roadbed and remove roots / vegetation from the road base.

### **4.3 Application of Preservation Management Approach**

The preservation management activities detailed in each of the tables above are not necessarily intended or required to be completed on each and every road. Road deterioration rates and the type of deterioration will dictate when action should be taken and what kind of treatment is most appropriate. The intention of the above is to outline the series of techniques to be considered in an effort to realize and extend the useful service life of the road asset for the lowest overall lifecycle cost while maintaining the highest overall condition. As detailed in the life cycle costs analysis presented above, the preservation management approach to roads is proven to yield the lowest overall life-cycle costs.

Each of the preservation management activities for gravel, surface treatment and asphalt roads identified above (including route and seal, slurry seal, resurfacing etc.), shall be considered as part of the regular Road Needs Study Report every five (5) years. Recommendations on the specific treatments required shall be documented and prioritized in this Report.

## 5.0 Road Needs Study Summary Table

### 5.1 Types of Improvements

All roads were examined to appraise the extent and type of improvement necessary.

“Order of Magnitude” construction costs were developed for each of the below options on a per kilometre basis. An estimated cost for isolated frost heave repairs was also considered.

***The below alternative rehabilitation strategies are considered preliminary in nature and are intended to assist in providing an order of magnitude cost estimate to rehabilitate the road. Further field investigations and engineering design is required to confirm and develop the rehabilitation strategies for each road.***

#### 5.1.1 Asphalt

High Class Bituminous roads (HCB) or hot mix asphalt roads have rehabilitation alternatives ranging from a simple overlay to complete reconstruction. The following is a listing of standard road rehabilitation techniques that were considered for HCB or hot mix asphalt roads.

<b>RO1</b>	Resurfacing, Single-Lift Overlay.
<b>RO2</b>	Resurfacing, Double-Lift Overlay.
<b>RMP1</b>	Resurfacing, Mill and Pave 1-Lift.
<b>RMP2</b>	Resurfacing, Mill and Pave 2-Lifts.
<b>PP1</b>	Pulverize and Pave 1-Lift.
<b>PP2</b>	Pulverize and Pave 2-Lifts.
<b>Recon 1R</b>	Excavate and Reconstruct Road and Pave 1-Lift – Rural.
<b>Recon 1S</b>	Excavate and Reconstruct Road and Pave 1-Lift – Semi-Urban.
<b>Recon 2S</b>	Excavate and Reconstruct Road and Pave 2-Lifts – Semi-Urban.
<b>Recon 2U</b>	Excavate and Reconstruct Urban Road and Pave 2-Lifts – Urban.
<b>SS</b>	Slurry Seal (Preventative Maintenance)
<b>MS</b>	Microsurfacing (Preventative Maintenance)
<b>RS</b>	Route and Seal (Preventative Maintenance)

### 5.1.2 Surface Treatment

Surface treated roads are generally able to be rehabilitated with either a single or double Low Class Bituminous (LCB) overlay treatment. They may also be upgraded to HCB pavement or downgraded to gravel. In some cases, previous resurfacing of LCB roads has occurred or the LCB surface or road structure has deteriorated to a state where a simple overlay surface treatment is not feasible. In these cases consideration can be given to removal or pulverizing of the existing surface treatment and placement of a new application. In some cases, where it is necessary to improve the overall roadbed structure, the addition of Granular A to build up the road and the reapplication of a surface treatment is recommended. The following is a listing of standard road rehabilitation techniques that were considered for LCB (surface treated) roads:

- ST1** Single Surface Treatment.
- ST2** Double Surface Treatment.
- ST2R** Double Surface Treatment, with Removal of Existing.
- ST2A** Double Surface Treatment, over New Granular A.
- ST2PA** Double Surface Treatment, over Pulverized Existing and New Granular A.
- ST2PAW** Double Surface Treatment, over Pulverized Existing and New Granular A with 1 m Widening.
- SS** Slurry Seal (Preventative Maintenance)

### 5.1.3 Gravel

Gravel roads can likewise be upgraded with the reapplication of Gravel (G) or surface treatments (ST1).

## 5.2 Benchmark Construction Costs

A Unit Price Form found in **Appendix A** is based on average prices for the local area was prepared. The unit prices were used to prepare an array of benchmark construction costs.

For the Township of North Frontenac, the following design standards, **Table 8**, were utilized for development of the benchmark cost estimate for reconstruction. It should be noted that these are suggested standards and therefore should not necessarily be used as standards for detail design of roadway improvements.

**Table 8 - Design Standards for Construction Cost Estimates**

Functional Classification	Surface Width (m)	Shoulder Width (m)	Granular A Depth (mm)	Granular B Depth (mm)	Hot Mix Depth (mm)*
Rural R200 (50 to 199 vpd)	6.0	1.5	150	450	-
Rural R300 (200 to 399 vpd)	6.0	1.5	150	450	16*
Rural R400 (400 to 999 vpd)	6.5	1.5	150	450	50
Semi - Urban Local Residential	6	1.5	150	450	50
Semi - Urban Local Industrial	6.5	1.5	150	450	50
Urban Local Residential	8.5	-	150	450	100
Urban Local Industrial	9.0	-	150	450	100

Note - Prime and Double Surface Treatment is based on 16 mm of Hot Mix.

## 6.0 Improvement Plan

### 6.1 Road Needs

The Road Needs Summary Table is included on the next page, **Table 9** noting the recommended Capital Construction Plan in terms of priorities throughout the Township. AADT is based on previous counts / estimates provided by the Township. All costs are based on 2019 dollars and should be adjusted for inflation based on program year, for budgeting purposes. The capital improvements are listed in descending priority based on traffic volumes and Condition Rating, as described previously.

**Table 9 - Township of North Frontenac Road Needs – Capital Construction Plan**

Priority	Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Structural Adequacy
High	1495 <sup>4</sup>	Smith Road (Class 4 and 6)	Ardoch Road Westerly 1.1 km (Class 4)	1.10	100	ST2A - Double Surface Treatment with Granular A	\$157	NOW
	1605	Lodge Road (Class 4)	Ardoch Road Northerly	0.55	100	ST2A - Double Surface Treatment with Granular A	\$79	1-5
	1075	Myers Cave Road (Class 4)	Harlow Road Northerly 3.13 km	3.13	150	ST2A - Double Surface Treatment with Granular A	\$447	1-5
Medium	1045	Henderson Road (Class 4)	Junction of Harlow Road Southerly 1.05 km	1.10	200	Recon 1R - Full Reconstruction + 1 Lift	\$579	1-5
	1060	Kashwakamak Lake Rd. (Class 4)	Harlow Road Northerly 3.0 km	3.00	150	ST2A - Double Surface Treatment with Granular A	\$428	1-5
	1240	Ardoch Road (Class 4)	11.95 km South of Smith Road Southerly 0.80 km	0.80	312	ST2A - Double Surface Treatment with Granular A	\$114	1-5
	1225	Ardoch Road (Class 4)	9.10 km South of Smith Road Southerly 0.25 km	0.25	312	ST2A - Double Surface Treatment with Granular A	\$36	1-5
	1230	Ardoch Road (Class 4)	9.35 km South of Smith Road Southerly 2.0 km	2.00	312	ST2A - Double Surface Treatment with Granular A	\$286	1-5
Low	1760	Station Road (Class 6)	Road 509 Westerly 0.17 km	0.17	49	ST2A - Double Surface Treatment with Granular A	\$24	NOW
	1070	Little Pond Road (Class 6)	Highway 41 Easterly	0.35	49	ST2A - Double Surface Treatment with Granular A	\$50	NOW
	1055	Jewel Road (Class 6)	0.20 km East of Little Pond Road Easterly 0.15 km	0.15	49	ST2A - Double Surface Treatment with Granular A	\$21	NOW
	1050	Jewel Road (Class 6)	Little Pond Road Easterly 0.20 km	0.20	49	ST2A - Double Surface Treatment with Granular A	\$29	NOW

**Notes:**

1. Rehabilitation strategy to be confirmed by geotechnical investigations at detail design.
2. Timing of storm sewer/culvert work should be considered in conjunction with road reconstruction and vice versa, where applicable.
3. Costing is zero for roads within the network but maintained by others (i.e. boundary roads).
4. Smith Road (Section 1495) was treated with ST1 as a holding strategy in 2018 and work on underlying structural concerns may be deferred until the treatment fails

## 6.2 Annual Resurfacing Program

Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a resurfacing program / budget is recommended, in addition to the noted capital construction works, as follows:

Hot Mix Paved Roads:

- 8.0 km of paved roads (HCB).
- Degradation rate 0.25 / year (rating drops from 10 to 5, over a 20-year period).
- Annual resurfacing 0.4 km / year.
- Annual budget \$114,400: (0.4 km / year x \$143,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 173.0 km of surface treated roads (LCB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 24.7 km / year.
- Annual budget \$617,500 (24.7 km / year x \$25,000 / km **ST1**).

Gravel roads require regular maintenance. Maintenance includes regular grading and reapplication of new gravel. Typically, gravel roads should be resurfaced on a 3-5 year cycle.

Gravel Roads:

- 158 km of earth / gravel roads.
- 75mm gravel every 5 years.
- Annual gravelling of 31.6 km.
- Granular A (\$22,000 / km).
- Annual budget \$695,200 (31.6 km / year x \$22,000 **G**) \*\*.

\*\* Cost based on supply and application of gravel by external forces.

The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at \$1,427,100 per year.

Relative road preservation / resurfacing priorities for all roads not included in the previous Capital Reconstruction priorities table are listed below in **Table 10**, Township of North Frontenac's Resurfacing Priorities. Roads are listed in order of descending preservation priorities.

**Table 10 - Township of North Frontenac, Resurfacing Priorities**

Priority	Sect. No.	Road Name	From - To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Structural Adequacy	Surface Type Need	Surface Width Need
High	1525	Canonto Road (Class 4)	2.76 km West of Folger Road Westerly 0.45 km	0.45	200	ST2 - Double Surface Treatment	\$19	ADEQ	ADEQ	NOW
	1080	Myers Cave Road (Class 4)	4.08 km North of Harlow Road Northerly 0.62 km	0.62	150	ST2 - Double Surface Treatment	\$26	6 - 10	ADEQ	NOW
	1480	Road 509 (Class 4)	9.4 km West of Bdry (start of C&G East End of Plevna to Road 506	0.35	600	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1285	Buckshot Lake Road (Class 4)	8.11 km West of Jct of Roads 509/506 N'ly from County Boundary	0.79	400	Preventative Maintenance	-	ADEQ	ADEQ	NOW
	1245	Ardoch Road (Class 4)	1.6 km South of Road 506 Easterly 0.435 km	0.44	312	RMP1 - Mill & Pave, 1 Lift	\$126	6 - 10	ADEQ	ADEQ
	1265	Buckshot Lake Road (Class 4)	Junction of Roads 509/506 Westerly 1.45 km	1.45	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1680	Road 509 (Class 4)	4.0 km North of Morrow Road Northerly 0.8 km	0.80	600	ST2 - Double Surface Treatment	\$34	6 - 10	ADEQ	ADEQ
	1000	Gull Lake Road (Class 4 and 6)	Henderson Road Easterly 1.30 km (Class 4)	1.30	100	ST2A - Double Surface Treatment with Granular A	\$186	6 - 10	ADEQ	NOW
	1755	South Lavant Road (Class 4)	2.0 km East of Road 509 Easterly 3.21 km	3.21	100	ST2 - Double Surface Treatment	\$135	6 - 10	ADEQ	NOW
	1615	River Road (Class 4)	Road 509 Southerly 1.4 km	1.40	150	ST2 - Double Surface Treatment	\$59	ADEQ	ADEQ	NOW
1625	River Road (Class 4)	0.75 km South of Lothlonen Road South to End of Surf. Treatment	0.80	150	ST2 - Double Surface Treatment	\$34	ADEQ	ADEQ	NOW	

	1640	Road 509 (Class 4)	Elphin-Maberley Road Northerly 2.4 km	2.40	600	ST2A - Double Surface Treatment with Granular A	\$343	6 - 10	ADEQ	ADEQ
High	1620	River Road (Class 4)	1.4 km South of Road 509 to Lothlonen Road	2.25	150	ST2 - Double Surface Treatment	\$95	ADEQ	ADEQ	NOW
	1590	Gulley Road	1.34 km East of Road 509 Easterly 0.75 km	0.75	150	ST2 - Double Surface Treatment	\$32	ADEQ	ADEQ	NOW
	1435	Road 506 (Class 4)	Junction of Road 509 Westerly 0.25 km (west end of C&G)	0.25	520	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
Medium	1100	North Mazinaw Heights Road (Class 4)	0.45 km South of Highway 41 Southerly 0.50 km	0.50	100	ST2 - Double Surface Treatment	\$21	6 - 10	ADEQ	ADEQ
	1385	River Road (Class 4 and 6)	Ardoch Road Easterly 1.3 km (Class 4)	1.30	100	ST2 - Double Surface Treatment	\$55	ADEQ	ADEQ	NOW
	1660	Road 509 (Class 4)	5.8 km North of Elphin-Maberley Road to 0.3 km Northerly	0.30	600	ST2A - Double Surface Treatment with Granular A	\$43	6 - 10	ADEQ	ADEQ
	1520	Canonto Road (Class 4)	Folger Road Westerly 1.57 km	1.57	200	ST2 - Double Surface Treatment	\$66	6 - 10	ADEQ	ADEQ
	1170	Skootamatta Lake Road (Class 4)	1.75 km from Highway 41 to Jacques Bay Road	0.80	300	ST2 - Double Surface Treatment	\$34	ADEQ	ADEQ	ADEQ
	1505	Arcol Road (Class 4 and 6)	Canonto Road Northerly 1.2 km (Class 4)	1.20	100	ST2A - Double Surface Treatment with Granular A	\$171	6 - 10	ADEQ	ADEQ
	1160	Shabameka Lake Road (Class 4 and 6)	Head Road North and East (Class 4)	2.00	100	ST2 - Double Surface Treatment	\$84	6 - 10	ADEQ	NOW
	1750	South Lavant Road (Class 4)	Road 509 Easterly 2.0 km	2.00	100	ST2 - Double Surface Treatment	\$84	6 - 10	ADEQ	ADEQ
	1345	Buckshot Lake Road (Class 4)	9.87 km West of Junction of Roads 509/506 Westerly 0.21 km	0.21	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ

<b>Medium</b>	1350	Buckshot Lake Road (Class 4)	10.08 km West of Junction of Roads 509/506 Westerly 0.68 km	0.68	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1320	Buckshot Lake Road (Class 4)	6.68 km West of Junction of Roads 509/506 Westerly 0.14 km	0.14	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1335	Buckshot Lake Road (Class 4)	8.9 km West of Junction of Roads 509/506 Westerly 0.48 km	0.48	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1340	Buckshot Lake Road (Class 4)	9.38 km West of Junction of Roads 509/506 Westerly 0.49 km	0.49	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1090	Myers Cave Road (Class 4)	3.13 km North of Harlow Road Northerly 0.95 km	0.95	150	ST2 - Double Surface Treatment	\$40	6 - 10	ADEQ	ADEQ
	1290	Buckshot Lake Road (Class 4)	10.60 km West of Jct of Roads 509/506 W'ly to North Shore Road	1.73	400	Preventative Maintenance	-	ADEQ	ADEQ	NOW
	1695	Road 509 (Class 4)	10.4 km North of Morrow Road Westerly 0.9 km	0.90	600	ST2A - Double Surface Treatment with Granular A	\$129	6 - 10	ADEQ	ADEQ
	1400	Road 506 (Class 4)	4.77 km West of Ardoch Road Westerly to North Road	1.45	520	ST2 - Double Surface Treatment	\$61	6 - 10	ADEQ	ADEQ
	1545	Canonto Road (Class 4)	4.11 km West of Folger Road Westerly 0.68 km	0.68	250	ST2 - Double Surface Treatment	\$29	6 - 10	ADEQ	ADEQ
	1540	Canonto Road (Class 4)	4.79 km West of Folger Road Westerly 0.15 km	0.15	250	ST2 - Double Surface Treatment	\$6	6 - 10	ADEQ	ADEQ
	1535	Canonto Road (Class 4)	4.94 km West of Folger Road Westerly 0.68 km	0.68	250	ST2 - Double Surface Treatment	\$29	6 - 10	ADEQ	ADEQ
	1325	Buckshot Lake Road (Class 4)	6.82 km West of Junction of Roads 509/506 Westerly 1.13 km	1.13	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
1330	Buckshot Lake Road (Class 4)	7.95 km West of Junction of Roads 509/506 Westerly 0.16 km	0.16	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ	

Medium	1165	Shabameka Lake Road (Class 4 and 6)	1.75 km North of Head Road Northerly 1.0 km (Class 4)	1.00	100	Preventative Maintenance	-	ADEQ	ADEQ	NOW
	1675	Road 509 (Class 4)	0.8 km North of Morrow Road Northerly 0.74 km	0.74	600	ST2 - Double Surface Treatment	\$31	6 - 10	ADEQ	ADEQ
	1655	Road 509 (Class 4)	4.8 km N of Elphin-Maberley Rd North 1 km (SpringFlowers La)	1.00	600	ST2 - Double Surface Treatment	\$42	6 - 10	ADEQ	ADEQ
	1665	Road 509 (Class 4)	6.1 km North of Elphin-Maberley Rd to 0.6 km North of Morrow Rd	1.45	600	ST2A - Double Surface Treatment with Granular A	\$207	6 - 10	ADEQ	ADEQ
	1530	Canonto Road (Class 4)	5.62 km West of Folger Road Westerly to Road 509	3.20	250	ST2 - Double Surface Treatment	\$134	6 - 10	ADEQ	ADEQ
	1130	Road 506 (Class 4)	10.75 km West of Boundary between Wards 1 & 2 Westerly 0.45 km	0.45	520	ST2 - Double Surface Treatment	\$19	6 - 10	ADEQ	ADEQ
	1065	Kashwakamak Lake Road (Class 4)	3.0 km North of Harlow Road Northerly	2.50	150	ST2 - Double Surface Treatment	\$105	ADEQ	ADEQ	ADEQ
	1075	Myers Cave Road (Class 4)	Harlow Road Northerly 3.13 km	3.13	150	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1305	Buckshot Lake Road (Class 4)	5.4 km West of Junction of Roads 509/506 Weasterly 1.28 km	1.28	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1570	Canonto Road (Class 4)	1.57 km West of Folger Road Westerly 0.28 km	0.28	250	ST2 - Double Surface Treatment	\$12	6 - 10	ADEQ	ADEQ
	1565	Canonto Road (Class 4)	1.85 km West of Folger Road Westerly 0.91 km	0.91	250	ST2 - Double Surface Treatment	\$38	6 - 10	ADEQ	ADEQ
	1025	Harlow Road (Class 4)	7.16 km East of Highway 41 Easterly 0.54 km	0.54	500	ST2A - Double Surface Treatment with Granular A	\$77	6 - 10	ADEQ	ADEQ
	1215	Ardoch Road (Class 4)	1.60 km South of Smith Road Southerly 2.75 km	2.75	312	ST2A - Double Surface Treatment with Granular A	\$393	6 - 10	ADEQ	ADEQ

Medium	1650	Road 509 (Class 4)	4.0 km North of Elphin-Maberley Road North 0.8 km	0.80	600	ST2 - Double Surface Treatment	\$34	6 - 10	ADEQ	ADEQ
	1500	South Road (Class 4 and 6)	Road 506 South to Twin Oaks Road (Class 4)	2.50	100	Preventative Maintenance	-	ADEQ	ADEQ	NOW
	1685	Road 509 (Class 4)	8.15 km North of Morrow Road Northerly to 1.75 km Northerly	1.75	600	ST2 - Double Surface Treatment	\$74	6 - 10	ADEQ	ADEQ
	1490	Sand Lake Road (Class 4)	1.7 km South of Buckshot Road Southerly	0.40	100	ST2 - Double Surface Treatment	\$17	ADEQ	ADEQ	ADEQ
	1405	Road 506 (Class 4)	North Road Westerly 0.37 km	0.37	520	ST2A - Double Surface Treatment with Granular A	\$53	6 - 10	ADEQ	ADEQ
	1725	Road 509 (Class 4)	1.5 km North of Morrow Road Northerly 2.6 km	2.60	600	ST2 - Double Surface Treatment	\$109	6 - 10	ADEQ	ADEQ
	1645	Road 509 (Class 4)	2.4 km North of Elphin-Maberley Road North 1.0 km	1.00	600	ST2 - Double Surface Treatment	\$42	6 - 10	ADEQ	ADEQ
	1715	Road 509 (Class 4)	4.8 km North of Morrow Road Northerly to 0.4 km Northerly	0.40	600	ST2 - Double Surface Treatment	\$17	6 - 10	ADEQ	ADEQ
	1720	Road 509 (Class 4)	5.2 km North of Morrow Road Northerly to 2.95 km Northerly	2.95	600	ST2 - Double Surface Treatment	\$124	6 - 10	ADEQ	ADEQ
	1690	Road 509 (Class 4)	9.9 km North of Morrow Road Westerly 0.5 km	0.50	600	ST2 - Double Surface Treatment	\$21	6 - 10	ADEQ	ADEQ
	1710	Road 509 (Class 4)	River Road Westerly to Boundary	3.40	600	ST2 - Double Surface Treatment	\$143	6 - 10	ADEQ	ADEQ
	1460	Road 509 (Class 4)	Ward 3 Boundary Westerly 2.75 km	2.75	600	ST2 - Double Surface Treatment	\$116	6 - 10	ADEQ	ADEQ
1105	North Mazinaw Heights Road (Class 4)	0.95 km South of Highway 41 Southerly to End	1.25	100	Preventative Maintenance	-	ADEQ	ADEQ	NOW	

<b>Medium</b>	1085	Myers Cave Road (Class 4)	4.74 km North of Harlow Road to Road 506	2.05	150	ST2 - Double Surface Treatment	\$86	ADEQ	ADEQ	ADEQ
	1475	Road 509 (Class 4)	8.0 km West of Boundary Westerly 1.40 km	1.40	600	ST2 - Double Surface Treatment	\$59	ADEQ	ADEQ	ADEQ
	1295	Buckshot Lake Road (Class 4)	5.2 km West of Junction of Roads 509/506 Westerly 0.2 km	0.20	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1275	Buckshot Lake Road (Class 4)	2.5 km West of Junction of Roads 509/506 Westerly 1.2 km	1.20	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1360	Matawatchan Road (Class 4)	From 8.9 km East of Buckshot Lake Road Easterly	2.50	200	ST2 - Double Surface Treatment	\$105	6 - 10	ADEQ	ADEQ
	1380	North Shore Road (Class 4 and 6)	Buckshot Road Easterly (Class 4)	0.35	100	Preventative Maintenance	-	ADEQ	ADEQ	NOW
	1365	Mountain Road (Class 4 and 6)	Road 509 Northerly 1.25 km (Class4)	1.25	150	ST2 - Double Surface Treatment	\$53	ADEQ	ADEQ	ADEQ
	1255	Ardoch Road (Class 4)	5.34 km South of Smith Road Southerly 0.49 km	0.49	312	ST2 - Double Surface Treatment	\$21	6 - 10	ADEQ	ADEQ
	1560	Canonto Road (Class 4)	3.21 km West of Folger Road Westerly 0.53 km	0.53	250	ST2 - Double Surface Treatment	\$22	ADEQ	ADEQ	ADEQ
	1555	Canonto Road (Class 4)	3.74 km West of Folger Road Westerly 0.27 km	0.27	250	ST2 - Double Surface Treatment	\$11	ADEQ	ADEQ	ADEQ
	1550	Canonto Road (Class 4)	4.01 km West of Folger Road Westerly 0.1 km	0.10	250	ST2 - Double Surface Treatment	\$4	ADEQ	ADEQ	ADEQ
	1470	Road 509 (Class 4)	4.40 km West of Boundary Westerly 3.6 km	3.60	600	ST2 - Double Surface Treatment	\$151	6 - 10	ADEQ	ADEQ
	1485	Sand Lake Road (Class 4)	Buckshot Road Southerly 1.7 km	1.70	100	ST2 - Double Surface Treatment	\$71	ADEQ	ADEQ	ADEQ
	1670	Road 509 (Class 4)	0.6 km North of Morrow Rd to 0.2 km Northerly	0.20	600	ST2 - Double Surface Treatment	\$8	6 - 10	ADEQ	ADEQ

Medium	1390	Road 506 (Class 4)	0.25 km West of Road 509 Westerly 1.1 km	1.10	520	ST2A - Double Surface Treatment with Granular A	\$157	6 - 10	ADEQ	ADEQ
	1425	Road 506 (Class 4)	2.21 km West of Road 509 Westerly 2.39 km	2.39	520	ST2A - Double Surface Treatment with Granular A	\$341	6 - 10	ADEQ	ADEQ
	1430	Road 506 (Class 4)	4.71 km West of Road 509 Westerly 3.5 km	3.47	520	ST2A - Double Surface Treatment with Granular A	\$496	6 - 10	ADEQ	ADEQ
	1180	Skootamatta Lake Road (Class 4)	0.65 km South of Highway 41 Westerly	1.00	300	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1370	Mountain Road (Class 4 and 6)	1.25 km North of Road 509 N'y 0.75 km	0.75	150	ST2 - Double Surface Treatment	\$32	ADEQ	ADEQ	ADEQ
	1465	Road 509 (Class 4)	2.75 km West of Boundary Westerly 1.65 km	1.65	600	ST2 - Double Surface Treatment	\$69	6 - 10	ADEQ	ADEQ
Low	1395	Road 506 (Class 4)	1.60 km West of Ardoch Road Westerly 2.0 km	2.00	520	ST2 - Double Surface Treatment	\$84	6 - 10	ADEQ	ADEQ
	1260	Ardoch Road (Class 4)	4.35 km South of Smith Road Southerly 0.99 km	0.99	312	ST2 - Double Surface Treatment	\$42	6 - 10	ADEQ	ADEQ
	1250	Ardoch Road (Class 4)	5.83 km South of Smith Road Southerly 1.45 km	1.45	312	ST2 - Double Surface Treatment	\$61	6 - 10	ADEQ	ADEQ
	1515	Ardoch Road (Class 4)	14.25 km South of Smith Road Southerly to Boundary	2.00	312	ST2A - Double Surface Treatment with Granular A	\$286	6 - 10	ADEQ	ADEQ
	1375	Mountain Road (Class 4 and 6)	2.0 km North of Road 509 N'y 2.0 km	2.00	150	ST2 - Double Surface Treatment	\$84	ADEQ	ADEQ	ADEQ
	1410	Road 506 (Class 4)	0.6 km West of North Road Westerly 1.50 km	1.50	520	ST2 - Double Surface Treatment	\$63	6 - 10	ADEQ	ADEQ
	1110	Road 506 (Class 4)	Boundary between Wards 1 & 2 Westerly 1.9 km	1.90	520	ST2 - Double Surface Treatment	\$80	6 - 10	ADEQ	ADEQ
	1010	Harlow Road (Class 4)	3.89 km East of Highway 41 Easterly 0.21 km	0.21	500	ST2 - Double Surface Treatment	\$9	ADEQ	ADEQ	ADEQ

Low	1135	Road 506 (Class 4)	11.20 km west of Boundary between Wards 1 & 2 Westerly 1.35 km	1.35	520	ST2 - Double Surface Treatment	\$57	6 - 10	ADEQ	ADEQ
	1125	Road 506 (Class 4)	7.59 km West of Boundary between Wards 1 & 2 Westerly 1.56 km	1.56	520	ST2 - Double Surface Treatment	\$66	6 - 10	ADEQ	ADEQ
	1195	South Mazinaw Heights Road (Class 4)	0.35 km North of Highway 41 Northerly 1.1 km	1.10	100	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1200	South Mazinaw Heights Road (Class 4)	1.45 km North of Highway 41 Northerly 0.5 km	0.50	100	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1190	South Mazinaw Heights Road (Class 4)	Highway 41 Northerly 0.35 km	0.35	100	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1095	Myers Cave Road (Class 4)	4.70 km North of Harlow Road Northerly 0.04 km	0.04	150	ST2 - Double Surface Treatment	\$2	ADEQ	ADEQ	ADEQ
	1705	Road 509 (Class 4)	12.1 km North of Morrow Road Westerly 0.75 km	0.75	600	ST2 - Double Surface Treatment	\$32	6 - 10	ADEQ	ADEQ
	1300	Buckshot Lake Road (Class 4)	3.70 km West of Junction of Roads 509/506 Westerly 0.20 km	0.20	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1235	Ardoch Road (Class 4)	11.35 km South of Smith Road Southerly 0.60 km	0.60	312	ST2 - Double Surface Treatment	\$25	6 - 10	ADEQ	ADEQ
	1740	Road 509 (Class 4)	3.4 km North of Elphin-Maberley Road North 0.06 km	0.06	600	ST2 - Double Surface Treatment	\$3	ADEQ	ADEQ	ADEQ
	1735	Road 509 (Class 4)	3.46 km North of Elphin-Maberley Road North 0.22 km	0.22	600	ST2 - Double Surface Treatment	\$9	ADEQ	ADEQ	ADEQ
	1730	Road 509 (Class 4)	3.68 km North of Elphin-Maberley Road North 0.32 km	0.32	600	ST2 - Double Surface Treatment	\$13	ADEQ	ADEQ	ADEQ

Low	1280	Buckshot Lake Road (Class 4)	3.90 km West of Junction of Roads 509/506 Westerly 1.30 km	1.30	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1595	Gulley Road	0.56 km East of Road 509 Easterly 0.78 km	0.78	150	ST2 - Double Surface Treatment	\$33	ADEQ	ADEQ	ADEQ
	1585	Gulley Road	2.09 km East of Road 509 Easterly 0.58 km	0.58	150	ST2 - Double Surface Treatment	\$24	ADEQ	ADEQ	ADEQ
	1580	Gulley Road	Road 509 Easterly 0.56 km	0.56	150	ST2 - Double Surface Treatment	\$24	ADEQ	ADEQ	ADEQ
	1175	Skootamatta Lake Road (Class 4)	Highway 41 Southerly 0.65 km	0.65	300	ST2 - Double Surface Treatment	\$27	ADEQ	ADEQ	ADEQ
	1700	Road 509 (Class 4)	11.3 km North of Morrow Road Westerly 0.56 km	0.56	600	ST2 - Double Surface Treatment	\$24	6 - 10	ADEQ	ADEQ
	1630	Road 509 (Class 4)	Central/North Frontenac Boundary N'ly to Mississippi River Br.	7.25	600	ST2 - Double Surface Treatment	\$305	6 - 10	ADEQ	ADEQ
	1355	Lookout Hill Road (Class 4)	Road 509 Northerly	0.16	100	ST2 - Double Surface Treatment	\$7	ADEQ	ADEQ	ADEQ
	1030	Harlow Road (Class 4)	0.33 km East of Highway 41 Easterly 3.56 km	3.56	500	ST2 - Double Surface Treatment	\$150	ADEQ	ADEQ	ADEQ
	1015	Harlow Road (Class 4)	4.10 km East of Highway 41 Easterly 3.06 km	3.06	500	ST2 - Double Surface Treatment	\$129	ADEQ	ADEQ	ADEQ
	1020	Harlow Road (Class 4)	7.70 km East of Highway 41 Easterly 0.28 km	0.28	500	ST2 - Double Surface Treatment	\$12	ADEQ	ADEQ	ADEQ
	1270	Buckshot Lake Road (Class 4)	1.45 km West of Junction of Roads 509/506 Westerly 0.61 km	0.61	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1420	Road 506 (Class 4)	1.35 km West of Road 509 Westerly 0.7 km	0.70	520	ST2 - Double Surface Treatment	\$29	6 - 10	ADEQ	ADEQ

Low	1140	Road 506 (Class 4)	12.55 km West of Boundary between Wards 1 & 2 1.44 km Westerly	1.44	520	ST2 - Double Surface Treatment	\$60	6 - 10	ADEQ	ADEQ
	1440	Road 506 (Class 4)	2.05 km West of Road 509 Westerly 0.16 km	0.16	520	ST2 - Double Surface Treatment	\$7	6 - 10	ADEQ	ADEQ
	1415	Road 506 (Class 4)	2.1 km West of North Road Westerly to Boundary	2.58	520	ST2 - Double Surface Treatment	\$108	6 - 10	ADEQ	ADEQ
	1445	Road 506 (Class 4)	3.60 km West of Ardoch Road Westerly 1.11 km	1.11	520	ST2 - Double Surface Treatment	\$47	6 - 10	ADEQ	ADEQ
	1455	Road 506 (Class 4)	4.6 km West of Road 509 Westerly 0.11 km	0.11	520	ST2 - Double Surface Treatment	\$5	6 - 10	ADEQ	ADEQ
	1450	Road 506 (Class 4)	4.71 km West of Ardoch Road Westerly 0.06 km	0.06	520	ST2 - Double Surface Treatment	\$3	6 - 10	ADEQ	ADEQ
	1155	Road 506 (Class 4)	5.3 km West of Boundary between Wards 1 & 2 Westerly 2.29 km	2.29	520	ST2 - Double Surface Treatment	\$96	6 - 10	ADEQ	ADEQ
	1210	Ardoch Road (Class 4)	2.0 km S of Hwy 506 to Southerly 2.0 km	2.00	312	ST2 - Double Surface Treatment	\$84	6 - 10	ADEQ	ADEQ
	1220	Ardoch Road (Class 4)	7.28 km South of Smith Road Southerly 1.87 km	1.87	312	ST2 - Double Surface Treatment	\$79	6 - 10	ADEQ	ADEQ
	1315	Buckshot Lake Road (Class 4)	2.36 km West of Junction of Roads 509/506 Westerly 0.29 km	0.29	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1575	Elphin-Maberley Road (Class 4)	Road 509 Easterly	2.00	150	ST2 - Double Surface Treatment	\$84	ADEQ	ADEQ	ADEQ
	1510	Ardoch Road (Class 4)	Ward 2-3 Boundary Easterly 1.50 km	1.50	312	ST2 - Double Surface Treatment	\$63	ADEQ	ADEQ	ADEQ
	1310	Buckshot Lake Road (Class 4)	2.21 km West of Junction of Roads 509/506 Westerly 0.15 km	0.15	400	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ

<b>Low</b>	1005	Harlow Road (Class 4)	Highway 41 Easterly 0.33 km	0.33	500	ST2 - Double Surface Treatment	\$14	ADEQ	ADEQ	ADEQ
	1035	Head Road (Class 4 and 6)	Highway 41 Easterly 0.9 km (Class 4)	0.90	100	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1145	Road 506 (Class 4)	13.85 km West of Boundary between Wards 1 & 2, 1.0 km Westerly	1.00	520	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1115	Road 506 (Class 4)	1.9 km West of Boundary between Wards 1 & 2 to 2.5 km Westly	2.50	520	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1120	Road 506 (Class 4)	4.4 km West of Boundary between Wards 1 & 2 Westerly 0.9 km	0.90	520	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1205	Ardoch Road (Class 4)	Road 506 Southerly 1.6 km	1.60	312	ST2 - Double Surface Treatment	\$67	ADEQ	ADEQ	ADEQ
	1635	Road 509 (Class 4)	Mississippi River Bridge North to Elphin-Maberley Road	1.11	600	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1040	Head Road (Class 4 and 6)	0.90 km East of Highway 41 Easterly 1.0 km (Class 6)	1.00	49	ST2 - Double Surface Treatment	\$42	ADEQ	ADEQ	NOW
	1610	Mountain Chute Road (Class 6)	Hydro Dam Southerly 0.95 km	0.95	49	ST2 - Double Surface Treatment	\$40	ADEQ	ADEQ	ADEQ
	1150	Road 506 (Class 4)	14.85 km West of Boundary between Wards 1 & 2, Westly to Hwy 41	1.90	520	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1745	Robertsville Road (Class 6)	Road 509 Easterly to 1.0 km East of Road 509	1.00	49	Preventative Maintenance	-	ADEQ	ADEQ	ADEQ
	1185	Snider Road (Class 6)	Highway 41 Northerly	0.65	49	ST2 - Double Surface Treatment	\$27	ADEQ	ADEQ	ADEQ

**Notes:**

1. Priorities in descending order. The higher the priority rating the greater the need.
2. Rehabilitation strategy to be confirmed by geotechnical investigations at detail design.
3. Costing is zero for roads within the network but maintained by others (i.e. boundary roads).

### 6.3 Preservation Management

Preservation techniques seal the surface as to prevent water infiltration into the granular base. Route and Seal is used on HCB pavements to seal individual cracks. Slurry Seal / Microsurfacing is used on LCB and HCB pavements to seal large areas, although wide / active cracks will reflect through the treatment. An annual preservation management budget has been estimated as follows:

Given the Township's short total length of HCB roads, it is not practical to fund a standalone Route and Seal program.

#### Slurry Seal / Microsurfacing

- 8 km of paved roads (HCB).
- 173 km of surface treated roads (LCB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 25.1 km of road to preserve per year (0.4 km HCB and 24.7 km of LCB).
- **Annual budget \$351,400** (25.1 km x \$14,000 / km **Slurry Sealing / Microsurfacing**).

### 6.4 Road Maintenance

Preventative road and roadside maintenance is critical to prolonging the useful service life of a road and maximizing the capital investment. A continuous road and roadside maintenance program is recommended to reduce the road degradation rates. Ditch cleanout and clearing of vegetation from the right-of-way should be carried out on a regular basis. This can either be accomplished through dedicated internal Township forces or sub-contracting to private contractors. Consideration may be given to a dedicated capital program of ditch cleanout and clearing, to ensure resources are dedicated to these important activities.

## 7.0 Replacement Cost

In conjunction with this Road Needs Study Report, a replacement cost for the road asset was calculated based strictly on roadbed materials i.e. sub-base, base and surface. Road design standards noted in **Table 8** were used to estimate the existing depth of road bed materials for the purpose of the replacement cost calculation.

The total replacement cost for the Township's hardtop road infrastructure is approximately \$ 35.5 M.

Note this cost represents the theoretical road bed materials costs only and does not include items such as removal of the existing road bed, installation of signs, pavement markings, lighting, drainage infrastructure, property etc.

## 8.0 Summary

D.M. Wills Associates (Wills) undertook a review of the Township of North Frontenac's (Township) existing hardtop road network to assess its physical condition and confirm various road attributes. Data collected as a result of the field review was used to develop a prioritized listing of the road network needs based primarily on condition and traffic volumes.

Wills undertook the field study in October/November of 2017. A visual assessment of each road within the Township was undertaken to assess the current condition of the road. Inspection data was updated in 2019 to reflect work done since 2017.

**2% (~4 km) of the road network had a Structural “NOW” need, 10% (~17 km) has a Structural “1-5” year need, and 59% (~107 km) of the road network has a Structural “6-10” year need in 2017. 20 km have been addressed since the 2-17 study.**

### Preservation Management

In addition to addressing currently deficient roads (i.e. capital reconstruction), a dedicated preservation management approach is required, **and perhaps even more importantly**, to “keep the good roads good”; the fundamental principle being that it costs much less to maintain a good road than it does to let it fail and then reconstruct it, from a life cycle cost perspective. Ultimately, the goal of preservation management is to extend the useful life of a road and road network, maximizing the municipality's investment over the road life-cycle.

Road resurfacing is an effective way of extending the overall life of the pavement structure and therefore a road resurfacing program is highly recommended. Roads with a structural adequacy of 12/20 or greater are included as candidates for potential resurfacing. Preliminary recommendations and prioritization for road resurfacing are based on condition rating and traffic demands on each road section, as per the Inventory Manual. A road with higher traffic volumes and fair structural adequacy is given priority over a road with moderate traffic and good structural adequacy score, in an attempt to intervene and extend the life of the road before it deteriorates to a level that can no longer be resurfaced (i.e. more expensive reconstruction is required). Specific resurfacing treatment recommendations must be assessed through further field investigation and detail design effort, prior to selecting and implementing the resurfacing strategy.

**Based on typical degradation rates for gravel roads, surface treatment, and hot mix, a total resurfacing program, (hot mix, surface treatment and gravel) is estimated at \$1,427,100 per year.**

Further to the recommendations above with respect to resurfacing, it is also recommended that regular maintenance in the form of roadside ditch cleanout and

clearing be undertaken as a critical component to preservation management in order to extend the useful service life of the existing roads.

### **Capital Improvements**

Preliminary recommendations and prioritization for planned capital improvements i.e. reconstruction, have been developed based on the condition rating and traffic demands on each road section, as per the Inventory Manual. Those roads identified as having a "NOW" or 1 - 5 year need have been included in the capital improvement plan for reconstruction.

A total length of approximately 12.6 km of roads were identified as having structural needs in the "NOW" or 1 – 5 year periods in 2017 and have not been addressed. The estimated cost to improve these roads is approximately \$ 2.2 M.

An additional length of approximately 23 km of road is identified as having inadequate surface widths. Generally, provided no operational or safety concerns are identified, roads with surface width deficiencies are typically addressed / considered at the next full reconstruction cycle. All roads currently meet the minimum tolerable standard for surface type, based on the Inventory Manual methodology.

The time of inspection plays a significant role in assessing a road's condition. Certain deficiencies, particularly for gravel roads, are only obvious during the "spring break-up" period. By midsummer, any evidence to suggest these deficiencies may have disappeared due to regular grading and grooming activities and general drying of the roadbed. The field work for this study was carried out in October/November 2017, by which time of "spring break-up" was not evident.

We trust the above and attached information will be of benefit to the Township and appreciate the opportunity to assist the Township in developing its road improvement plan.

Respectfully submitted,



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Michael Lang, P. Eng.  
Manager, Transportation Engineering

ML/ESP/ms

## Statement of Limitations

This report has been prepared by D.M. Wills Associates on behalf of the Township of North Frontenac. The conclusions and recommendations in this report are based on available background documentation and discussions with applicable Township staff at the time of preparation.

The report is intended to update the 2017 Roads Needs Study Report findings to reflect work done between 2017 and 2019 and assist the Township in developing budgetary plans for investment into their road network.

Any use which a third party makes of this report, other than as a Road Needs Study Report is the responsibility of such third parties. D.M. Wills Associates Limited accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or action taken based on using this report for purposes other than as a summary of the 2019 Road Needs Study Update findings.

# **Appendix A**

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Unit Price Form

## ROAD IMPROVEMENT COSTS Township of North Frontenac

Unit Costs	Units	Unit Cost
Granular A (Supply Only)	m3	\$9.00
Granular A	t	\$20.00
Granular B	t	\$14.00
Hot Mix	t	\$150.00
Earth Excavation	m3	\$29.00
Asphalt Removal	m2	\$4.00
Asphalt Removal - Partial Depth	m2	\$2.50
Removal of Concrete Curb & Gutter	m	\$19.00
Concrete Curb & Gutter	m	\$110.00
In-Place Full Depth Reclamation	m2	\$1.10
Surface Treatment - Single	m2	\$3.50
Surface Treatment - Double	m2	\$6.00
Granular A Conversion	2.4	t/m3
Granular B Conversion	2	t/m3
Hot Mix Conversion	2.45	t/m3

Gravel (75mm)								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Quantity	Unit Cost	Cost/km (x 1000)	
Granular A	6.0	75	2.4	t	1080	\$20.00	\$ 22	
<b>G</b>							<b>22</b>	(per Kilometre)

Frost Heave Treatment								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Quantity	Unit Cost	Cost/50m Digout (x 1000)	
Earth Excavation	8.0	800		m3	320	\$29.00	\$ 9	
Granular A	7.0	150	2.4	t	126	\$20.00	\$ 3	
Granular B	8.0	650	2	t	520	\$14.00	\$ 7	
<b>FT</b>							<b>19</b>	(per Kilometre)

Surface Treatment - Rural/Semi Urban - Single [ST1]								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Quantity	Unit Cost	Cost/km (x 1000)	
Surface Treatment - Single (Overlay)	7.0			m2	7000	\$3.50	\$ 25	
<b>ST1</b>							<b>25</b>	(per Kilometre)

Surface Treatment - Rural/Semi Urban - Double [ST2]								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Quantity	Unit Cost	Cost/km (x 1000)	
Surface Treatment - Double (Overlay)	7.0			m2	7000	\$6.00	\$ 42	
<b>ST2</b>							<b>42</b>	(per Kilometre)

Surface Treatment - Rural/Semi Urban - Double with Removal of Existing [ST2R]								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)
Surface Treatment - Double	7.0			m2		7000	\$6.00	\$ 42
Removal Asphalt Pavement	7.0	16		m2		7000	\$4.00	\$ 28
<b>ST2R</b>							<b>70</b>	(per Kilometre)

Surface Treatment - Rural/Semi Urban - Double with Granular Base [ST2A]								
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)
Surface Treatment - Double	7.0			m2		7000	\$6.00	\$ 42
Granular A	7.0	300	2.4	t		5040	\$20.00	\$ 101
<b>ST2A</b>							<b>143</b>	(per Kilometre)

Surface Treatment - Rural/Semi Urban - Double with Pulverization and Granular Base [ST2PA]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Surface Treatment - Double	7.0			m2		7000	\$6.00	\$ 42	
Granular A	7.0	300	2.4	t		5040	\$20.00	\$ 101	
Pulverizing	7.0			m2		7000.0	\$1.10	\$ 8	
Minor Items @ 25%								\$ 2	
<b>ST2PA</b>							<b>152</b>	(per Kilometre)	

Surface Treatment - Rural/Semi Urban - Widening and Double with Pulverization and Granular Base [ST2PAW]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Surface Treatment - Double	7.0			m2		7000	\$6.00	\$ 42	
Granular A	7.0	300	2.4	t		5040	\$20.00	\$ 101	
Pulverizing	7.0			m2		7000.0	\$1.10	\$ 8	
Earth Excavation		2	450	m3		900	\$29.00	\$ 26	
Granular B		1	300	t		600	\$14.00	\$ 8	
Minor Items @ 25%								\$ 11	
<b>ST2PAW</b>								<b>196</b>	(per Kilometre)

Resurfacing - Rural/Semi Urban Single Lift Overlay [RO1]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction **	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	3	50	2.45	t	74	441	\$150.00	\$ 66	
Granular A	1.5	50	2.4	t		180	\$20.00	\$ 4	
Minor Items @ 15%								\$ 10	
<b>RO1</b>								<b>80</b>	(per Lane Kilometre)

Resurfacing - Rural/Semi Urban - Double Lift Overlay [RO2]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction **	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	3	90	2.45	t	66	728	\$150.00	\$ 109	
Granular A	1.5	90	2.4	t		324	\$20.00	\$ 6	
Minor Items @ 15%								\$ 17	
<b>RO2</b>								<b>133</b>	(per Lane Kilometre)

Resurfacing - Urban - Single Lift Mill and Pave [RMP1]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	4.25	50	2.45	t		521	\$150.00	\$ 78	
Remove Curb and Gutter				m		200	\$19.00	\$ 3.80	
Curb and Gutter - 20%				m		200	\$110.00	\$ 22.00	
Milling	4.25			m2		4250	\$2.50	\$ 10.63	
Minor Items @ 25%								\$ 29	
<b>RMP1</b>								<b>143</b>	(per Lane Kilometre)

Resurfacing - Urban - Double Lift Mill and Pave [RMP2]									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	4.25	90	2.45	t		937	\$150.00	\$ 141	
Remove Curb and Gutter				m		200	\$19.00	\$ 3.80	
Curb and Gutter - 20%				m		200	\$110.00	\$ 22.00	
Milling	4.25			m2		4250	\$2.50	\$ 10.63	
Minor Items @ 25%								\$ 44	
<b>RMP2</b>								<b>221</b>	(per Lane Kilometre)

Pulverize and Pave One Lift [PP1] Rural/Semi-Urban									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	3	50	2.45	t		367.5	\$150.00	\$ 55	
Granular A	1.5	50	2.4	t		180	\$20.00	\$ 4	
Pulverize	3			m2		3000	\$1.10	\$ 3.30	
Minor Items @ 25%								\$ 16	
<b>PP1</b>								<b>78</b>	(per Lane Kilometre)

Pulverize and Pave Two Lifts [PP2] Rural/Semi-Urban									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Hot Mix	3	90	2.45	t		661.5	\$150.00	\$ 99	
Granular A	1.5	90	2.4	t		324	\$20.00	\$ 6	
Pulverize	3			m2		3000	\$1.10	\$ 3	
Minor Items @ 25%								\$ 27	
<b>PP2</b>								<b>136</b>	(per Lane Kilometre)

Semi-Urban: Resurfacing and Widening - Residential (Single Lift Widening)									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction **	Quantity	Unit Cost	Cost/km (x 1000)	
Earth Excavation	2	500		m3		1000	\$29.00	\$ 29	
Granular A	5	150	2.4	t		1800	\$20.00	\$ 36	
Granular B	5	300	2	t		3000	\$14.00	\$ 42	
Hot Mix	8	50	2.45	t	196	1176	\$150.00	\$ 176	
Milling	4			m2		4000	\$2.50	\$ 10	
Minor Items @ 25%								\$ 73	
							<b>RW1</b>	<b>367</b>	(widening one side)

Commercial and Industrial (Double Lift Widening)									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Earth Excavation	2	600		m3		1200	\$29.00	\$ 35	
Granular A	5	150	2.4	t		1800	\$20.00	\$ 36	
Granular B	5	450	2	t		4500	\$14.00	\$ 63	
Hot Mix	8	90	2.45	t	353	2117	\$150.00	\$ 318	
Milling	4			m2		4000	\$2.50	\$ 10	
Minor Items @ 25%								\$ 115	
							<b>RW2</b>	<b>577</b>	(widening one side)

Gravel Road Widening									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Earth Excavation	2	450		m3		900	\$29.00	\$ 26	
Granular A	1	150	2.4	t		360	\$20.00	\$ 7	
Granular B	1	300	2	t		600	\$14.00	\$ 8	
Minor Items @ 25%								\$ 10	
							<b>GW</b>	<b>52</b>	(widening one side)

Rural: Full Excavation and Reconstruction - Gravel (6 m surface width)									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Earth Excavation	5	450		m3		2250	\$29.00	\$ 65	
Granular A	3	150	2.4	t		1080	\$20.00	\$ 22	
Granular B	5	300	2	t		3000	\$14.00	\$ 42	
Minor Items @ 25%								\$ 32	
							<b>Recon G</b>	<b>161</b>	(per Lane Kilometre)

Rural: Full Excavation and Reconstruction - 1 Lift									
Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)	
Asphalt Removal - Full Depth	3			m2		3000	\$4.00	\$ 12	
Earth Excavation	5	500		m3		2500	\$29.00	\$ 73	
Granular A	4	150	2.4	t		1440	\$20.00	\$ 29	
Granular B	5	300	2	t		3000	\$14.00	\$ 42	
Hot Mix	3	50	2.45	t		368	\$150.00	\$ 55	
Minor Items @ 25%								\$ 53	
							<b>Recon 1R</b>	<b>263</b>	(per Lane Kilometre)

**Semi-Urban: Full Excavation and Reconstruction - 1 Lift**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Asphalt Removal - Full Depth	3			m2		3000	\$4.00	\$ 12	
Earth Excavation	5	500		m3		2500	\$29.00	\$ 73	
Granular A	4	150	2.4	t		1440	\$20.00	\$ 29	
Granular B	5	300	2	t		3000	\$14.00	\$ 42	
Hot Mix	3	50	2.45	t		368	\$150.00	\$ 55	
Minor Items @ 25%								\$ 53	
<b>Recon 1S</b>								<b>263</b>	(per Lane Kilometre)

**Semi-Urban: Full Excavation and Reconstruction - 2 Lift**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Asphalt Removal - Full Depth	3			m2		3000	\$4.00	\$ 12	
Earth Excavation	5	500		m3		2500	\$29.00	\$ 73	
Granular A	4	150	2.4	t		1440	\$20.00	\$ 29	
Granular B	5	300	2	t		3000	\$14.00	\$ 42	
Hot Mix	3	90	2.45	t		662	\$150.00	\$ 99	
Minor Items @ 25%								\$ 64	
<b>Recon 2S</b>								<b>318</b>	(per Lane Kilometre)

**Urban: Full Excavation and Reconstruction - 2 Lift**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Asphalt Removal - Full Depth	4.25			m2		4250	\$4.00	\$ 17	
Earth Excavation	5.5	500		m3		2750	\$29.00	\$ 80	
Granular A	4.5	150	2.4	t		1620	\$20.00	\$ 32	
Granular B	5.5	300	2	t		3300	\$14.00	\$ 46	
Hot Mix	4.25	90	2.45	t		937	\$150.00	\$ 141	
Remove Curb and Gutter				m		1000	\$19.00	\$ 19.00	
Curb and Gutter				m		1000	\$110.00	\$ 110.00	
Minor Items @ 25%								\$ 79	
<b>Recon 2U</b>								<b>524</b>	(per Lane Kilometre)

**Rout and Seal**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Rout and Seal				m		1000	\$2.40	\$ 2	
<b>RS</b>								<b>2</b>	(per Lane Kilometre)

**Slurry Seal**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Slurry Seal	7			m2		7000	\$2.00	\$ 14	
<b>SS</b>								<b>14</b>	(per Lane Kilometre)

**Microsurfacing**

<i>Item</i>	<i>Width - m</i>	<i>Depth - mm</i>	<i>Conversion Factor</i>	<i>Unit</i>	<i>Crossfall Correction</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Cost/km (x 1000)</i>	
Microsurfacing	7			m2		7000	\$2.00	\$ 14	
<b>MS</b>								<b>14</b>	(per Lane Kilometre)