Road Needs Study Report – 2021

D.M. Wills Project No. 4773

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Peterborough

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Prepared for:
The Township of Douro-Dummer

Executive Summary

The Township of Douro-Dummer (Township) retained the services of D.M. Wills Associates (Wills) to undertake a review of the Township's existing 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 260 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 151 km of gravel roads, 102 km of surface treated roads (low class bituminous (LCB)), and 7 km of hot mix asphalt paved roads (high class bituminous (HCB)).

Two (2) primary indicators of the relative health of a road are the structural adequacy and surface condition ratings. The current average structural adequacy rating for the Township's road network is 14.9/20. The current average surface condition rating for the Township's road network is 7.7/10.

3.3% (9 km) of the road network has a Structural "NOW" need, 3.8% (10 km) has a Structural "1-5" year need, and 13.1% (34 km) of the road network has a Structural "6-10" year need.

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 it 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.

Note that many "6-10" year reconstruction needs may be deferred by timely resurfacing, extending their service lives. As highlighted above, the Township has a portion of their roads (13%) with a" 6–10" Year Structural Need.

Resurfacing and 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 Township'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:

- 7.1 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 $100,800**: (0.4 km / year x $252,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 107.2 km of surface treated roads (LCB & ICB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 15.3 km / year.
- **Annual budget $348,075** (14.6 km / year x $22,750 / 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:

- 146.2 km of earth / gravel roads.
- 75 mm gravel every 5 years.
- Annual gravelling of 29.2 km.
- Granular A ($19,000 / km).
- **Annual budget $554,800** (48.7 km / year x $19,000 **G**) **.

** *Cost based on supply of Gravel from Township pit with application of gravel by external forces.*

The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at $1,003,675 per year.

Preservation techniques seal the surface as to prevent water infiltration into the granular base. 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:

Slurry Seal / Microsurfacing

- 7.1 km of paved roads (HCB).
- 107.2 km of surface treated roads (LCB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 16.1 km of road to preserve per year (0.4 km HCB and 15.7 km of LCB).
- **Annual budget $346,185** (15.7 km x $22,050 / km **Slurry Sealing / Microsurfacing**).

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

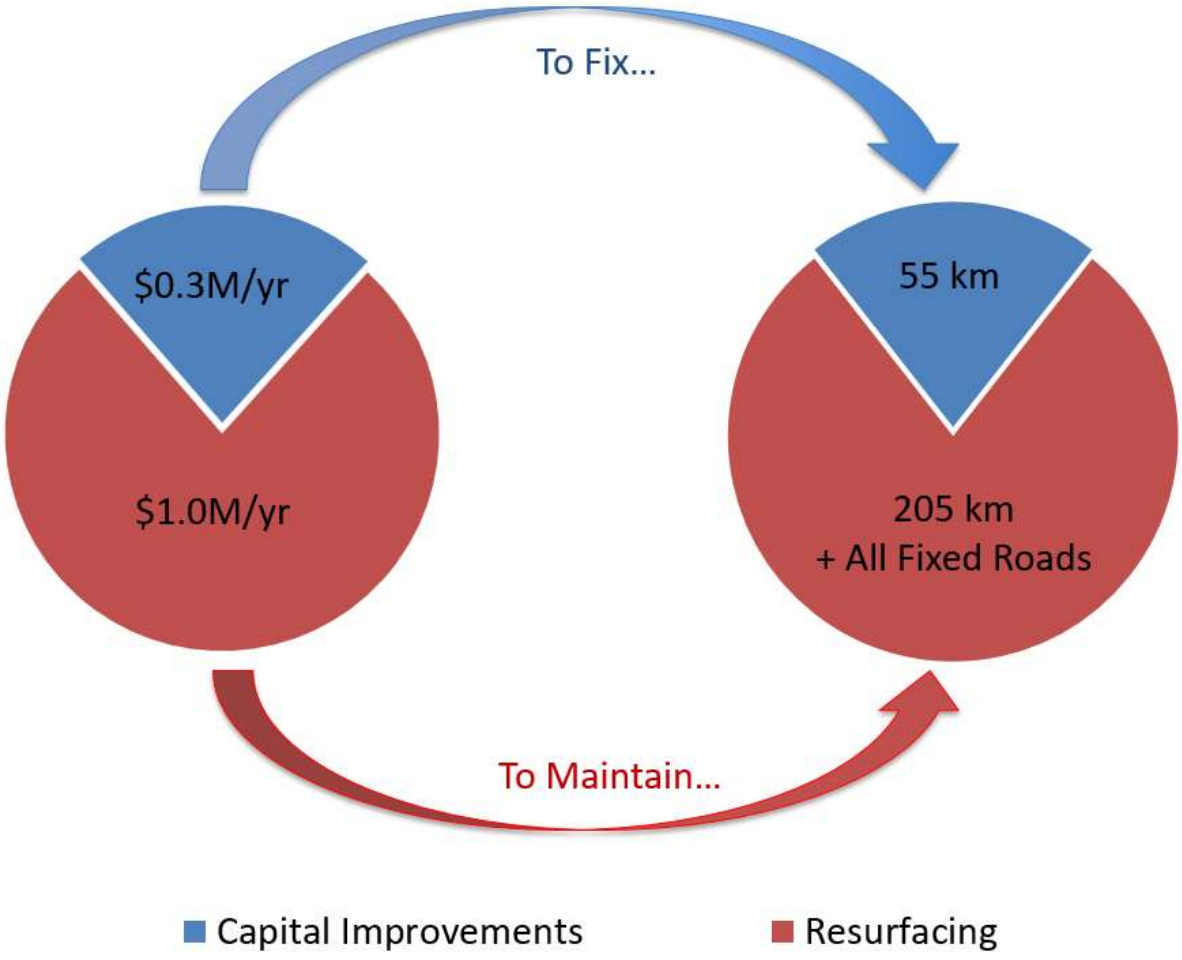
Capital Improvements

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", 1 – 5, or 6 - 10 year need have been included in the capital improvement plan for reconstruction.

A total length of 52.6 km of roads were identified as having structural needs in the "NOW", 1 – 5 or 6-10 year periods. The estimated cost to improve these roads is approximately $ 2.7 M.

It is important to highlight the network's average structural adequacy score of 14.9/20, as noted previously. A significant portion of the Township's roads are approaching a condition that will require reconstruction, as opposed to less costly resurfacing.

A fully funded 10 year plan following the recommendations in this report includes $1.0M/year for resurfacing needs and $2.7M ($0.3M/year) for the capital needs over ten years. Funding recommendations can be visualized in the graphic below.



Given that 80% of the Township's Road network has no structural need identified, Wills recommends that priority should be given to resurfacing and preservation over capital needs should funding fall short of ideal levels.

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1.0 Purpose, Background and Study Method

1.1 Purpose

The purpose of the 2021 Road Needs Study Report is to update the current road inventory and road condition assessments within the Township of Douro-Dummer (Township). 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 road network, and assess its physical condition as well as confirm various attributes. 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 Douro-Dummer is located in central-eastern Ontario within Peterborough County. The Township is largely rural with some scattered semi-urban developments. The communities of Warsaw, Donwood and Douro serve as the Township's main population centres.

In 2017, a Road Needs Study Report was completed to inventory and document the Township's existing assets. This current study (2021) utilizes and builds from the road asset information documented in the 2017 Road Needs Study Report.

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 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 in accordance with the Ministry of Transportation's Inventory Manual for Municipal Roads (February 1991).

Additionally, field reviews for the purpose of Pavement Condition Index (PCI) were undertaken in accordance with:

- MTO Manual for Condition Rating of Flexible Pavements, SP-024.
- MTO Manual for Condition Rating of Surface-Treated Roads, SP-021.

There are two (2) key observations when using PCI methods: the Ride Condition Rating (RCR), and the Distress Manifestation Index (DMI). RCR is a subjective measurement of how smooth a travelled surface is, rated from 0 to 10, with 10 representing excellent, new surfaces, and 0 representing an extremely rough, impassible road. DMI aggregates various forms of visible pavement distress into a rating from 0 to 10, with 10 representing a new surface and 0 representing a destroyed surface.

RCR and DMI are rated strictly independently. A rough road may have relatively few visible distresses while a fairly smooth road may display many distresses. In general, rough roads display associated visible distresses.

The combined approach facilitates comparing all the Township's roads, as the Inventory Manual prescribes the same rating system regardless of surface type, while also providing detailed descriptions of the types of distress encountered on surfaces as per the PCI ratings. This approach is compliant with O. Reg. 588/17. Wills undertook the field study in September 2021.

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.

1.4.1 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[1]
	Tolerable Range	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.

[1] Ministry of Transportation. Pavement Design and Rehabilitation Manual, Second Edition, 2013, Table 3.3.3 Structural Design Guidelines for Flexible Pavement – Secondary Highways

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.

Vehicle loading is one of the key considerations for pavement design and ultimately the decision between Hot Mix and 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**:

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 that no road section had an AADT greater than 5000 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 it 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 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 used in the 2017 Road Needs Study were brought forward to 2021 traffic volumes using a growth rate of 1.5%.

Table 3 summarizes the total road length in kilometres by surface type and road environment as of September 2021.

The existing road system consists of 260 km of roadway, 146 km of gravel roads, 107 km of surface treated roads (LCB) and 7 km of HCB (asphalt paved) roads; with all calculations being approximate and rounded to the nearest kilometre.

Table 3 - Road System Inventory

Township of Douro-Dummer		
Road System in Kilometres		
(As of September 2021)		
A.	**Surface Type**	**Totals***
	Earth	0
	Gravel (Loose Top Gravel)	146
	Surface Treatment (LCB & ICB)	107
	Hot Mix Asphalt (HCB)	7
	Total A	**260 km**
B.	**Roadside Environment**	
(i)	**Rural**	
	Earth	0
	Gravel (loose Top Gravel)	146
	Surface Treatment (LCB & ICB)	98
	Hot Mix Asphalt (HCB)	6
	Total Rural	**250 km**
(ii)	**Semi-Urban**	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	9
	Hot Mix Asphalt (HCB)	1
	Total Semi-Urban	**10 km**
(iii)	**Urban**	
	Gravel (loose Top Gravel)	0
	Surface Treatment (LCB)	0
	Hot Mix Asphalt (HCB)	0
	Total Urban	**0 km**
	Total B	**260 km**
**Estimated to the nearest centreline kilometre.*		

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 260 km of roads inventoried, a total of 80 km were found to be critically deficient in one (1) or more areas. Of the 80 km, approximately 50 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 road network, which is based upon the total road kilometres less the identified critically deficient ("NOW" needs) roads, is as follows:

$$\textbf{2021 System Adequacy} = \frac{\textbf{260 - (91 - 61)}}{\textbf{260}} \textbf{ x 100\% = 77\%}$$

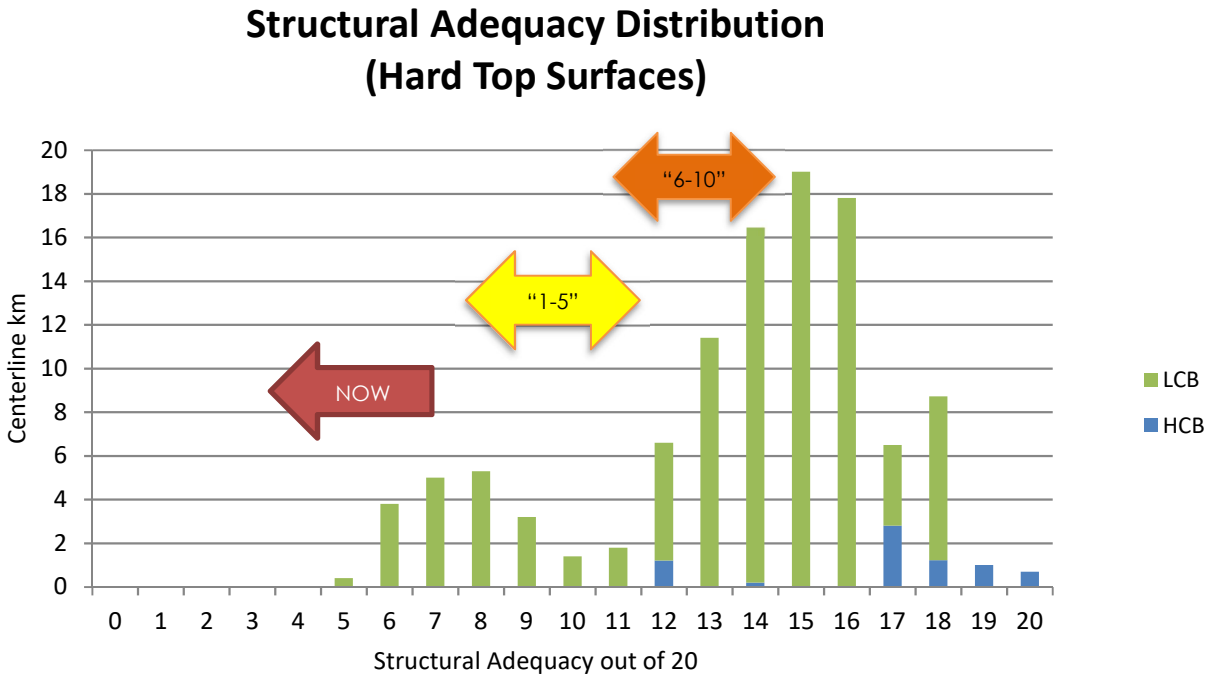
The majority of identified needs are related to surface widths. Ignoring critical deficiencies due to surface widths provides a modified System Adequacy as follows:

$$\textbf{2021 Modified System Adequacy} = \frac{260 - (8.8 - 0.7)}{260} \times 100\% = 97\%$$

The average surface condition rating of all roads is 7.7/10 while the average structural adequacy rating is 14.9/20. 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 hard top roads identifies a group of roads, 61 km, that 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 34 km, 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 19 km of hard top road network is well distributed over the very poor to poor range (structural adequacy from 5 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 to very good roads (61 km) from becoming capital reconstruction needs themselves.



3.2 Pavement Condition Index (PCI)

Pavement Condition Index (PCI) was calculated based on the same MTO PCI methodologies, using the following empirical formula:

$$\mathbf{PCI} = \mathbf{10} \times \sqrt{\frac{\mathbf{RCR}}{\mathbf{10}}} \times \mathbf{DMI} \times \mathbf{w_c}$$

Where DMI is the Distress Manifestation Index (0 to 10), calculated based on distress severity and density, RCR is the assigned Ride Condition Rating out of 10, $\boldsymbol{w_c}$ is the weighting constant to adjust for pavement bias (1.088 for HCB and 0.962 for LCB and gravel surfaces).

The overall weighted PCI for the Township's road network, which is based upon the section condition as weighted by AADT, is as follows:

$$\mathbf{Overall\ Weighted\ Condition} = \frac{\sum \mathbf{length} \times \mathbf{AADT} \times \mathbf{PCI}}{\sum \mathbf{length} \times \mathbf{AADT}} = \mathbf{74.7}$$

3.3 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:

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

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").

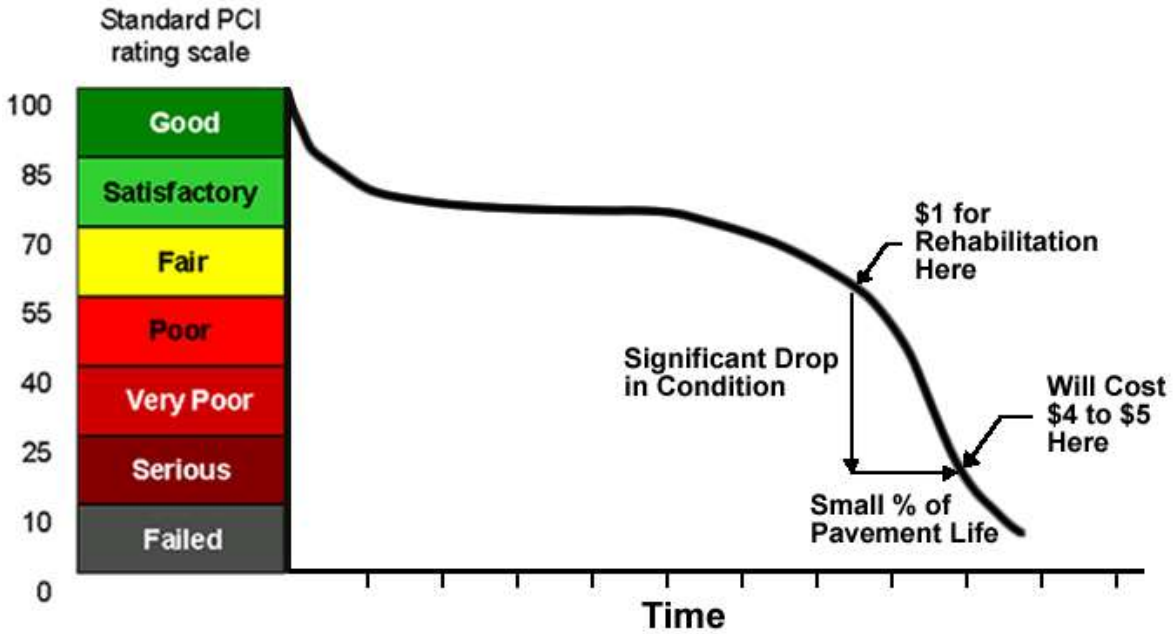
4.0 Roads Best Management Practices

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 **Section 4.1** 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

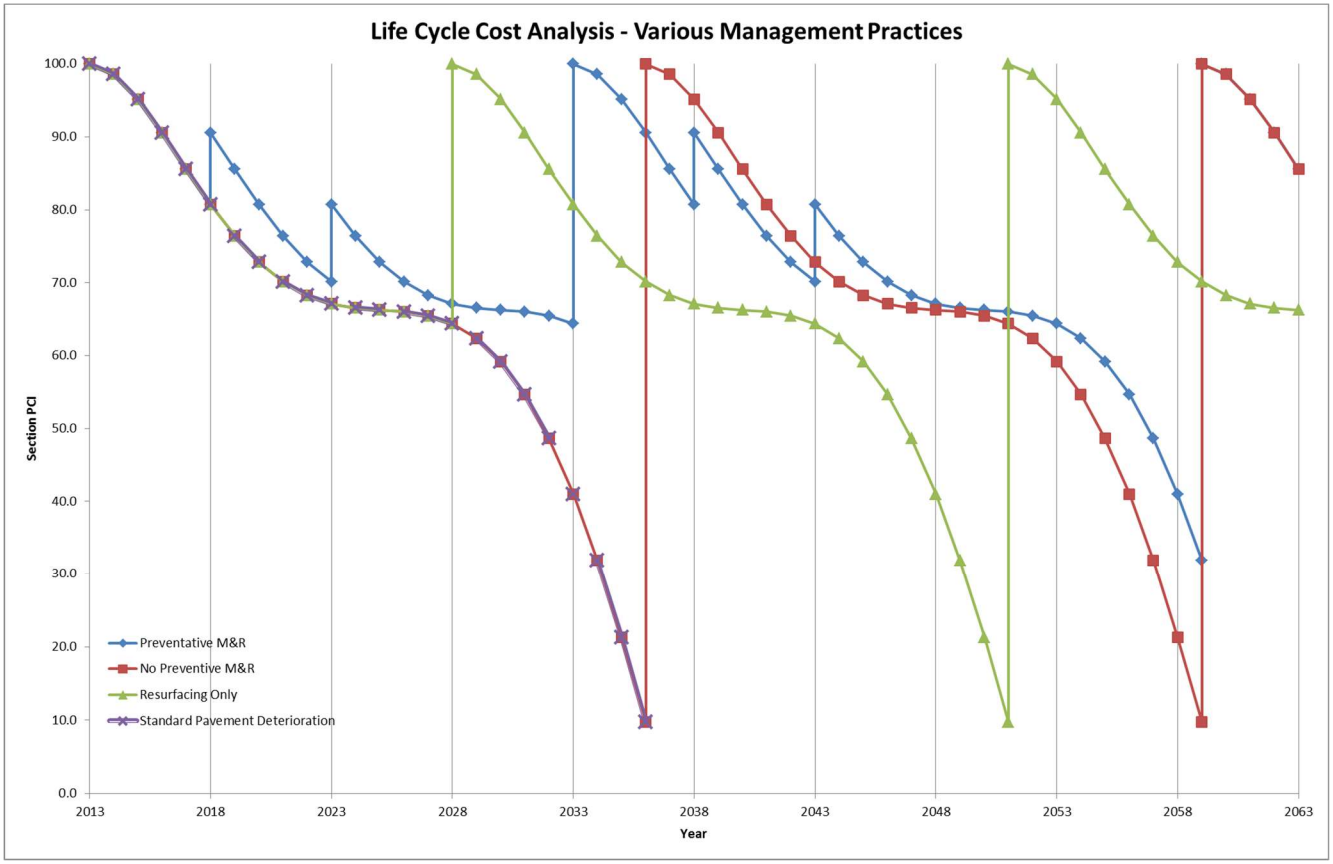
The following life cycle costs analysis compares three (3) different municipalities Municipality 1, Municipality 2 and Municipality 3; each with three (3) distinct approaches to pavement management. For this analysis we will assume each of the three (3) municipalities has 7000 m^2 of pavement, i.e. 1 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_q**	**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^2	$6.50	$45,500.00	**$35,544.53**
2033	**20**	**Surface Course**	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m^2	$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^2	$6.50	$45,500.00	**$21,691.79**
2048	**35**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	5%	m^2	$30.00	$10,500.00	**$4,424.40**
2053	**40**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$7,821.04**
2058	**45**	**Full Reconstruction**	32-100	Serious-Good					
		Remove Asphalt Full Depth			7000	m^2	$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**
		Final PCI in 2063:	**90**	**Good**				**Net:**	**$306,967.90**
								Residual Value:	**$85,346.08**
								Total Cost:	**$221,621.82**

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_q	Quantity	Unit	Unit Cost	Total Cost	Present Worth
2023	**10**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	5%	m^2	$30.00	$10,500.00	**$8,202.58**
2028	**15**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$14,499.78**
2030	**17**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	20%	m^2	$30.00	$42,000.00	**$27,602.19**
2036	**23**	**Full Reconstruction**	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m^2	$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^2	$30.00	$10,500.00	**$5,005.80**
2048	**12**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	10%	m^2	$30.00	$21,000.00	**$8,848.79**
2053	**17**	**Safety/Stopgap Maintenance - AC Patching/Leveling**	N/A	N/A	20%	m^2	$30.00	$42,000.00	**$15,642.09**
2059	**23**	**Full Reconstruction**	10-100	Poor-Good					
		Remove Asphalt Full Depth			7000	m^2	$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**
								Residiual 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.

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.

Resurfacing Only									
Year	**Age**	**Treatment**	**Δ PCI**	**PCI_q**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Present Worth**
2028	**15**	**Surface Course**	64-100	Poor-Good					
		Mill and Dispose of Surface Course			7000	m^2	$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^2	$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^2	$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**
								Residiual Value:	**$62,587.12**
								Total Cost:	**$260,037.55**

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.
Preservation Management Approach

4.1.1 Gravel Roads

The Township currently maintains approximately 146 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.

4.1.2 Surface Treated Roads

Surface treated roads have a hard wearing surface that must be preserved in order to be effective. The Township currently maintains 107 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
Single Surface Treatment	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.

4.1.3 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 7 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 brush clearing program to reduce shading of the roadbed and remove roots / vegetation from the road base.

4.2 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.

RO1 Resurfacing, Single-Lift Overlay.

RO2 Resurfacing, Double-Lift Overlay.

RMP1 Resurfacing, Mill and Pave 1-Lift.

RMP2 Resurfacing, Mill and Pave 2-Lifts.

PP1 Pulverize and Pave 1-Lift.

PP2 Pulverize and Pave 2-Lifts.

Recon 1R Excavate and Reconstruct Road and Pave 1-Lift – Rural.

Recon 1S Excavate and Reconstruct Road and Pave 1-Lift – Semi-Urban.

Recon 2S Excavate and Reconstruct Road and Pave 2-Lifts – Semi-Urban.

Recon 2U Excavate and Reconstruct Urban Road and Pave 2-Lifts – Urban.

SS Slurry Seal (Preventative Maintenance).

MS Microsurfacing (Preventative Maintenance).

RS 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

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

The design standards in **Table 8** were utilized for development of the benchmark cost estimates 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	600	100
Urban Local Industrial	9.0	-	150	600	100

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

6.0 Improvement Plan

In the following tables you will find three (3) columns being used to describe the condition of the road; Surface Condition, Structural Adequacy, and Condition Rating. To better understand the prioritization of the lists, descriptions of these ratings can be found below.

Surface Condition: Surface conditions relate to driving ease, comfort and safety. Inadequacies for paved surface include excessive or uneven crowns, washboarding, raveling and bumpiness because of cracking, sealing, and rough patching. Inadequacies on loose top surfaces do not include situations that can be readily corrected by maintenance blading. They do include unconsolidated surfaces due to poorly graded or clean aggregate and permanent roughness due to insufficient depth of aggregate or weak subgrade. The effects of surface inadequacies in ascending order of seriousness are noise, vibration, sway, excessive steering effort and reduced speed. *Rated on a scale of 1 to 10*.

Structural Adequacy: The Structural Adequacy point rating relates to the capability of the surface and base courses to support a load and to resist deformation or rupture. Soft spots and frost boils are structural adequacy distress signs for loose top roads. For paved surfaces, distress signs may be cracking, rutting, heaving, pot-holing, roughness, alligatoring, dishing, breakup, distortion, frost boils, etc. *Rated on a scale of 1 to 20*.

Condition Rating: A holistic rating that sums point ratings from alignment, surface condition, surface width, level of service, structural adequacy, drainage and maintenance demands. The condition rating is one of the major factors used to calculate the Priority Rating. *Rated on a scale of 1 to 100*.

6.1 Road Needs

The Township of Douro-Dummer's Capital Improvement Plan is included on the next page, **Table 9.** This table notes the recommended capital improvements based on priorities throughout the Township. AADT is based on traffic counts used in the 2017 Road Needs Study provided by the Township**. All costs are based on 2021 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 Douro-Dummer Capital Improvement Plan

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
NOW Needs										
045	Water Street	Ford Street	Mill Street	0.2	49	*ST2A - Double Surface Treatment with Granular A*	*$15*	5	6	63
046	Mill Street	West Limit	Peterborough Street	0.1	49	*ST2A - Double Surface Treatment with Granular A*	*$8*	4	5	48
048	Church Street	Mill Street	West Street	0.2	49	*ST2A - Double Surface Treatment with Granular A*	*$15*	5	6	65
049	West Street	County Road 4	West Limit	0.2	49	*ST2A - Double Surface Treatment with Granular A*	*$15*	5	7	68
052	Payne Line Road	County Road 4	Westerly	0.5	178	*ST2A - Double Surface Treatment with Granular A*	*$39*	5	7	69
063	Cooper Road	4th Line Road	Caves Road	1.8	172	*ST2A - Double Surface Treatment with Granular A*	*$139*	5	6	64
065	Caves Road	Cooper Road	County Road 4	1.6	142	*ST2A - Double Surface Treatment with Granular A*	*$124*	5	6	65
069	4th Line Road North Dummer	Sawmill Road	North Limit	3.1	371	*ST2A - Double Surface Treatment with Granular A*	*$240*	5	7	66
095	Division Road	County Road 4	Burnham Line 10	0.8	529	*ST2A - Double Surface Treatment with Granular A*	*$62*	6	7	67
162	Bradfield Road	County Road 4	300 m South	0.3	81	*ST2A - Double Surface Treatment with Granular A*	*$23*	4	5	62
1 - 5 Year Needs										
013	Division Road	Highway 28 (formerly Highway 134)	Indian River Line	5.3	833	*ST2A - Double Surface Treatment with Granular A*	*$410*	6	8	69
037	4th Line Road South Dummer	Clifford Road	County Road 8	3.2	127	*ST2A - Double Surface Treatment with Granular A*	*$248*	6	9	63
040	Banks Avenue	County Road 8	East Limit	0.2	49	*ST2A - Double Surface Treatment with Granular A*	*$15*	6	11	57
044	English Line (South)	County Road 4	South Limit	0.2	115	*ST2A - Double Surface Treatment with Granular A*	*$15*	6	10	70

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
157	Douro 7th Line Road	County Road 4	South Limit (Bradfield Road)	1.2	141	*ST2A - Double Surface Treatment with Granular A*	*$93*	6	10	71
6 - 10 Year Needs										
001	McCrackens Landing	County Road 6	North Limit (Stoney Lake)	1.7	532	*ST1 - Single Surface Treatment*	*$39*	7	13	63
002	Birchview Road	McCrackens Landing	Camp Line Road	5.2	325	*ST1 - Single Surface Treatment*	*$118*	7	13	77
014	Division Road	Indian River Line	Carlow Line	2.7	613	*ST2A - Double Surface Treatment with Granular A*	*$209*	7	12	75
043	Ford Street	East of South Street	Peterborough Street	0.2	1008	*RMP1 - Mill & Pave, 1 Lift*	*$50*	7	14	83
073	11th Line Road North Dummer	County Road 6	South Limit	1.2	265	*PP1 - Pulverize and Pave 1 Lift*	*$165*	7	12	75
100	Stenner Road	Highway 28	North Limit	0.5	159	*ST1 - Single Surface Treatment*	*$11*	7	14	78
105	Hilliard Way	Highway 28	West Limit	0.2	49	*ST1 - Single Surface Treatment*	*$5*	7	13	62
109	South Beach Road	Highway 28	East Limit	0.6	135	*ST1 - Single Surface Treatment*	*$14*	8	14	79
110	Douro 3rd Line Road	South Beach	Rishor Avenue	0.4	72	*ST1 - Single Surface Treatment*	*$9*	8	14	79
112	Birchview Road	Highway 28	Camp Line Road	6.4	733	*ST1 - Single Surface Treatment*	*$146*	8	14	80
122	Strickland Road	Highway 28 (formerly Highway 134)	Douro 5th Line	1.2	335	*ST1 - Single Surface Treatment*	*$27*	7	13	72
126	Lynch's Rock Road	Douro 5th Line	Douro 3rd Line	2.8	188	*ST1 - Single Surface Treatment*	*$64*	8	14	79
132	Douro 2nd Line Road	County Road 4	County Road 8	2	151	*ST1 - Single Surface Treatment*	*$46*	7	13	76
136	Douro 4th Line Road	County Road 4	County Road 8	1.5	324	*ST2A - Double Surface Treatment with Granular A*	*$116*	7	12	76
144	Ayotte Crescent	8th Line Road	East Limit	0.2	49	*ST1 - Single Surface Treatment*	*$5*	7	13	76
146	Nassau Road	9th Line	County Road 4	2.9	425	*ST1 - Single Surface Treatment*	*$66*	8	14	79

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
152	Douro 4th Line Road	Cooney Island Road	County Road 8	1.3	202	*ST1 - Single Surface Treatment*	*$30*	8	14	79
164	Douro 9th Line	County Road 4	Division Road	1.2	106	*ST2A - Double Surface Treatment with Granular A*	*$93*	7	12	75
166	Lonsberry Lane	County Road 4	East Limit	0.6	49	*ST1 - Single Surface Treatment*	*$14*	8	14	65
179	Galloway Drive	McCracken Landing	West Limit	0.1	49	*ST1 - Single Surface Treatment*	*$2*	6	13	58
102	Moodie Drive	Stenner Road	East Limit	0.8	96	*ST1 - Single Surface Treatment*	*$18*	7	13	63

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.*

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:

- 7.1 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 $100,800**: (0.4 km / year x $252,000 / ln **RMP1** x 2 lanes).

Surface Treated Roads:

- 107.2 km of surface treated roads (LCB & ICB).
- Degradation rate 0.625 / year (rating drops from 10 to 5, over a 7-year period).
- Annual resurfacing 15.3 km / year.
- **Annual budget $348,075** (14.6 km / year x $22,750 / 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:

- 146.2 km of earth / gravel roads.
- 75 mm gravel every 5 years.
- Annual gravelling of 29.2 km.
- Granular A ($19,000 / km).
- **Annual budget $554,800** (48.7 km / year x $19,000 **G**) **.

** *Cost based on supply of Gravel from Township pit with application of gravel by external forces.*

The total resurfacing program, (hot mix, surface treatment and gravel) is estimated at $1,003,675 per year.

Relative road preservation / resurfacing priorities for all roads not included in the previous Capital Improvement Plan are listed below in **Table 10,** Township of Douro-Dummer Priorities. Roads are listed in order of descending preservation priority.

Table 10 – Township of Douro-Dummer Resurfacing Plan

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
057	7th Line Road North Dummer	Centre Dummer	North Limit	1.2	49	*G - Gravel (75mm)*	*$23*	6	10	44
098	Strickland Street	Highway 28 (formerly Highway 134)	Westerly 500 m (Lakefield limits)	0.4	866	*Preventative Maintenance*	-	9	18	70
211	Television Road	County Road 4	North Limit	1.22	1163	*Preventative Maintenance*	-	9	18	72
173	Hickson Road	County Road 40	West Limit	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	52
027	Mill Line Road	Bridge	East Limit	1.7	127	*G - Gravel (75mm)*	*$32*	7	14	59
165	Douro 3rd Line Road	Division Road	County Road 8	3.3	200	*G - Gravel (75mm)*	*$63*	7	14	64
092	Maryvale Road	County Road 4	North Limit	0.4	123	*ST1 - Single Surface Treatment*	*$9*	7	15	61
026	Mill Line Road	County Road 40	Bridge (East End)	1.3	127	*G - Gravel (75mm)*	*$25*	7	14	61
156	Douro 5th Line Road	County Road 4	South Limit	0.01	49	*G - Gravel (75mm)*	*$0*	6	10	55
151	Douro 4th Line Road	Division Road	Cooney Island Road	1.8	128	*G - Gravel (75mm)*	*$34*	7	13	62
114	Henderson Road	Camp Line	West Limit	0.7	49	*G - Gravel (75mm)*	*$13*	6	12	56
116	Douro 2nd Line Road	County Road 6	South Limit	0.5	49	*G - Gravel (75mm)*	*$10*	6	12	56
148	Carlow Line Road	Division Road	County Road 8	3.4	117	*G - Gravel (75mm)*	*$65*	8	16	62

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
133	Douro 2nd Line Road	Cedar Cross Road	County Road 4	3.6	105	*G - Gravel (75mm)*	*$69*	7	14	62
115	Douro 1st Line Road	County Road 6	North Limit	1.3	52	*G - Gravel (75mm)*	*$25*	7	13	58
051	Payne Line Road	Oke Road	County Road 4	2	178	*G - Gravel (75mm)*	*$38*	8	16	67
039	Clifford Road	3rd Line Road South Dummer (west)	South Street	2	106	*ST1 - Single Surface Treatment*	*$46*	8	15	64
159	Old Douro Road	Highway 28 (formerly Highway 134)	County Road 8	0.5	49	*G - Gravel (75mm)*	*$10*	7	12	59
177	5th Line North Dummer	County Road 6	North Limit	0.1	49	*G - Gravel (75mm)*	*$2*	7	13	59
066	Rock Road	Cooper Road	Douglas	2	170	*ST1 - Single Surface Treatment*	*$46*	8	15	67
067	Rock Road	Rock Road	Douglas Road	0.5	170	*ST1 - Single Surface Treatment*	*$11*	8	15	67
007	6th Line North Dummer	County Road 6	End of Hawkins Lane	1.4	49	*G - Gravel (75mm)*	*$27*	6	12	60
089	Donwood Drive	County Road 4	Hillview Avenue	0.5	449	*Preventative Maintenance*	-	9	20	74
018	7th Line South Dummer	County Road 8	North Limit	0.8	49	*G - Gravel (75mm)*	*$15*	7	14	60
117	Douro 4th Line	County Road 6	South Limit	4	49	*G - Gravel (75mm)*	*$76*	7	13	60
119	Douro 4th Line Road	Highway 28 Intersection	Birchview Road	0.1	49	*G - Gravel (75mm)*	*$2*	7	13	60

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
129	Douro 1st Line Road	Cedar Cross Road	North Limit	0.3	49	*G - Gravel (75mm)*	*$6*	7	14	60
131	Douro 1st Line Road	County Road 4	South Limit	0.7	49	*G - Gravel (75mm)*	*$13*	7	14	60
134	Center Road	Douro 3rd Line	Douro 5th Line	2.9	49	*G - Gravel (75mm)*	*$55*	7	14	60
171	Douro 3rd Line Road	County Road 4	South Limit	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	60
175	3rd Line Road North Dummer	County Road 6	North Limit	0.2	49	*G - Gravel (75mm)*	*$4*	7	14	60
178	6th Line South Dummer	County Road 6	South Limit	0.2	49	*G - Gravel (75mm)*	*$4*	7	13	60
207	5th Line Douro	Highway No. 28	County Road 6	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	60
060	4th Line Road South Dummer	Cooper Road	North Limit	2.5	94	*G - Gravel (75mm)*	*$48*	8	18	64
138	Douro 5th Line Road	Center Road	County Road 4	1.8	109	*G - Gravel (75mm)*	*$34*	8	16	65
135	Douro 4th Line Road	County Road 4	North Limit	3.9	120	*G - Gravel (75mm)*	*$75*	8	15	66
168	Kerr Road	County Road 8	South Limit	0.1	49	*G - Gravel (75mm)*	*$2*	7	13	61
038	Clifford Road	4th Line South Dummer	3rd Line Road	1.3	106	*G - Gravel (75mm)*	*$25*	8	15	66
033	4th Line Road South Dummer	County Road 8	Division Road	3.1	105	*G - Gravel (75mm)*	*$59*	7	14	66
140	Center Road	Highway 28 (formerly Highway 134)	County Road 32	2.7	98	*G - Gravel (75mm)*	*$52*	8	16	65

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
030	7th Line Road Mid-Dummer	Webster Road	North Limit	0.2	49	*G - Gravel (75mm)*	*$4*	7	14	61
034	3rd Line Road South Dummer	Division Road	North Limit	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	61
056	Rusaw Lane	County Road 40	West Limit	1.4	49	*G - Gravel (75mm)*	*$27*	7	14	61
077	8th Line Road North Dummer	County Road 6	South Limit	0.6	115	*G - Gravel (75mm)*	*$11*	8	16	66
074	South Bay Road	County Road 6	North Limit	1	106	*ST1 - Single Surface Treatment*	*$23*	8	15	66
082	Clinton Avenue	Plati Avenue	Gifford Drive	0.4	192	*Preventative Maintenance*	-	9	18	70
176	Landfill Road	County Road 6	to Transfer Station	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	62
142	Douro 7th Line Road	Center Road	Hickey Road	1.2	33	*G - Gravel (75mm)*	*$23*	7	14	60
024	12th Line South Dummer	Forced Road Section	North Limit	6.3	106	*G - Gravel (75mm)*	*$120*	8	15	67
028	11th Line Road Mid Dummer	Mill Line Road	North Limit	0.9	49	*G - Gravel (75mm)*	*$17*	7	14	62
055	Dummer Centre Road	4th Line Road	County Road 40	7.9	49	*G - Gravel (75mm)*	*$151*	8	15	62
202	1st Line Road Douro	County Road 6	South Limit	0.9	49	*G - Gravel (75mm)*	*$17*	7	14	62
068	Sawmill Road	3rd Line Dummer	4th Line Dummer	2.3	222	*Preventative Maintenance*	-	9	17	71
139	Center Road	Douro 5th Line Road	Highway 28 (formerly Highway 134)	1.3	160	*G - Gravel (75mm)*	*$25*	8	16	70
137	Douro 5th Line Road	Center Road	North Limit	1.3	15	*G - Gravel (75mm)*	*$25*	7	13	58

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
147	Douro 9th Line	County Road 32	County Road 4	4.2	212	*G - Gravel (75mm)*	*$80*	7	14	72
071	McNaughton Lane	McNaughton Drive	North Limit	0.2	49	*G - Gravel (75mm)*	*$4*	7	14	63
072	McNaughton Drive	County Road 6	McNaughton Lane	0.4	49	*G - Gravel (75mm)*	*$8*	7	14	63
145	Douro 7th Line Road	County Road 4	North Limit	1.7	36	*G - Gravel (75mm)*	*$32*	7	14	62
084	Kingsdale Drive	County Road 4	North Limit	0.6	297	*Preventative Maintenance*	-	9	19	74
167	Canal Road	County Road 4	North Limit	0.7	172	*Preventative Maintenance*	-	9	18	71
209	Unnamed Road	McCracken's Landing Road	East Limit	0.1	49	*G - Gravel (75mm)*	*$2*	7	14	64
081	Plati Avenue	Kingsdale	Television Road	0.5	287	*Preventative Maintenance*	-	9	19	74
086	Coral Drive	Television Road	East Limit	0.3	143	*Preventative Maintenance*	-	9	18	70
153	Cooney Island Road	4th Line Road	East Limit	2.5	49	*G - Gravel (75mm)*	*$48*	8	16	64
172	10th Line of Dummer	Webster Road	Dummer-Asphodel Road	2.8	119	*G - Gravel (75mm)*	*$54*	8	16	70
012	White Lake Road West	County Road 6	South Limit	2.7	156	*Preventative Maintenance*	-	9	18	71
006	5th Line North Dummer	County Road 6	South Limits to include entrance to farm owned by Township	1.4	49	*G - Gravel (75mm)*	*$27*	8	16	65
062	Cooper Road	4th Line Road East	East Limit	1.4	49	*G - Gravel (75mm)*	*$27*	8	16	65
070	Batten Lane	4th Line	East Limit	0.2	49	*G - Gravel (75mm)*	*$4*	8	16	65
113	Douro 3rd Line Road	Birchview Road	South Limit	0.9	49	*G - Gravel (75mm)*	*$17*	8	15	65

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
174	English Line North	County Road 6	North Limit	0.9	49	*G - Gravel (75mm)*	*$17*	8	15	65
120	Douro 5th Line	County Rd #6	Lynch Rock Road	1.5	139	*G - Gravel (75mm)*	*$29*	8	20	71
149	Douro 1st Line	Division Road	County Road 8	3.7	66	*G - Gravel (75mm)*	*$71*	8	20	67
121	Douro 5th Line Road	Lynch Rock Road	Strickland Road	0.3	165	*ST1 - Single Surface Treatment*	*$7*	8	16	72
035	3rd Line Road South Dummer	County Road 8	South Limit	1.3	34	*G - Gravel (75mm)*	*$25*	8	20	64
031	6th Line Road South Dummer	Webster Road	North Limit	1.9	49	*G - Gravel (75mm)*	*$36*	8	16	66
085	Roxton Road	Kingsdale Drive	East Limit	0.1	49	*ST1 - Single Surface Treatment*	*$2*	7	16	66
210	Crowe's Landing Road	9th Line Dummer	Stony Lake	0.2	106	*Preventative Maintenance*	-	9	17	70
083	Gifford Drive	Television Road	Kingsdale	0.5	218	*Preventative Maintenance*	-	9	19	74
009	Howard Drive	County Road 6	South Limit	0.1	49	*G - Gravel (75mm)*	*$2*	8	16	66
163	Bradfield Road	Douro 7th Line Road	West 1.2 km	1.2	49	*G - Gravel (75mm)*	*$23*	8	16	66
050	Oke Road	County Road 4	Payne Line Road	1.4	64	*G - Gravel (75mm)*	*$27*	8	16	68
143	Douro 8th Line Road	County Road 32	County Road 4	3.9	212	*G - Gravel (75mm)*	*$75*	8	16	75
161	Douro 8th Line Road	County Road 4	250 m South	0.2	212	*G - Gravel (75mm)*	*$4*	8	16	75

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
203	12th Line Road south Dummer (forced road section)	Highway No. 7	12th Line Road South Dummer (road allowance)	2.2	212	*G - Gravel (75mm)*	*$42*	8	16	75
169	Douro 4th Line Road	Highway 28	North Limit	0.5	49	*G - Gravel (75mm)*	*$10*	8	16	67
020	Webster Road	County Road 40	10th Line South Dummer	1.3	64	*G - Gravel (75mm)*	*$25*	8	16	69
025	Simpson Road	12th Line	East Limit	0.9	106	*G - Gravel (75mm)*	*$17*	7	14	71
208	Dummer Asphodel Road	11th Line Dummer	East End	0.3	49	*G - Gravel (75mm)*	*$6*	8	15	68
108	Thelgar Road	Highway 28	West Limit	0.3	49	*ST1 - Single Surface Treatment*	*$7*	8	16	68
158	Douro 7th Line Road	Division Road	North Limit (Bradfield)	1.9	49	*G - Gravel (75mm)*	*$36*	8	16	68
170	Old Highway 28	South Beach Road	North Limit	0.3	49	*Preventative Maintenance*	-	9	17	68
127	Douro 3rd Line Road	Lynch's Rock Road	County Road 4	5.3	83	*G - Gravel (75mm)*	*$101*	7	14	71
204	12th Line Road South Dummer (road allowance)	Forced Road Section	Private Lane	0.2	49	*G - Gravel (75mm)*	*$4*	8	16	68
130	Douro 1st Line Road	Cedar Cross Road	County Road 4	3.1	80	*G - Gravel (75mm)*	*$59*	7	14	71
019	8th Line South Dummer	Webster Road	North Limit	3.6	157	*G - Gravel (75mm)*	*$69*	8	16	74
141	Hickey Road	7th Line Road	County Road 32	0.5	33	*G - Gravel (75mm)*	*$10*	8	16	67

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
087	Highland Avenue	County Road 4	North Limit	0.2	49	*Preventative Maintenance*	-	9	17	69
088	Valleyview Avenue	Highland Avenue	County Road 4	0.2	49	*Preventative Maintenance*	-	9	17	69
094	McNab Avenue	County Road	South Limit	0.1	49	*Preventative Maintenance*	-	9	18	69
008	Gilchrist Bay Road	County Road 6 (East)	County Road 6 (West)	1.3	49	*Preventative Maintenance*	-	9	18	69
128	Cedar Cross Road	Douro 3rd Line	Payne Line Road	4.2	149	*G - Gravel (75mm)*	*$80*	8	16	75
118	Douro 4th Line Road	County Road 6	Highway 28	1.6	380	*ST1 - Single Surface Treatment*	*$36*	8	16	79
059	4th Line Road South Dummer	Centre Dummer Road	Cooper Road	2	94	*G - Gravel (75mm)*	*$38*	8	16	73
029	Webster Road	County Road 40	County Road 8 (5th Line Road South Dummer)	5.6	414	*ST1 - Single Surface Treatment*	*$127*	8	15	80
093	Edgewood Avenue	County Road 4	South Limit	0.1	49	*Preventative Maintenance*	-	9	18	70
032	5th Line Road South Dummer	Webster Road	North Limit	2	71	*G - Gravel (75mm)*	*$38*	8	16	72
160	Douro 8th Line Road	Division Road	North Limit	1.9	106	*G - Gravel (75mm)*	*$36*	8	16	75
200	6th Line South Dummer	Webster Road	County Rd 8	3.1	106	*G - Gravel (75mm)*	*$59*	8	16	75
201	8th Line Dummer	Webster Road	County Rd. 8	2.9	106	*G - Gravel (75mm)*	*$55*	8	16	75
096	Division Road	Burnham Line 10	Douro 7th Line	4.2	505	*ST1 - Single Surface Treatment*	*$96*	8	16	82
058	4th Line Road South Dummer	Clifford Road	Centre Dummer Road	1.2	116	*G - Gravel (75mm)*	*$23*	8	16	76

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
011	Ivandale Road	Dummer Lake Road East	West Limit	0.4	49	*G - Gravel (75mm)*	*$8*	8	20	72
097	Division Road	Douro 7th Line	Highway 28 (formerly Highway 134)	1.3	475	*ST1 - Single Surface Treatment*	*$30*	8	16	82
076	Crowes Landing Road	County Road 6	North Limit	0.9	299	*ST1 - Single Surface Treatment*	*$20*	8	15	81
090	Hillview Avenue	Donwood Drive	Orchard Crescent	0.2	49	*Preventative Maintenance*	-	9	20	74
091	Orchard Crescent	Donwood Drive	Hillview Avenue	0.4	49	*Preventative Maintenance*	-	9	20	74
036	3rd Line Road South Dummer	County Road 8	Clifford Road	3	56	*G - Gravel (75mm)*	*$57*	8	20	75
064	3rd Line Road North Dummer	Caves Road	County Road 6	2.1	317	*ST1 - Single Surface Treatment*	*$48*	8	16	83
003	Camp Line Road	Birchview Drive	Henderson Road	2.7	188	*ST1 - Single Surface Treatment*	*$61*	8	15	81
004	Camp Line Road	Henderson Road	County Road 6	1.8	188	*ST1 - Single Surface Treatment*	*$41*	8	15	81
155	Douro 5th Line Road	Division Road	North Limit (County Road 8)	2.4	71	*G - Gravel (75mm)*	*$46*	8	20	78
053	Rock Road	South Street	Douglas	1.7	375	*Preventative Maintenance*	-	10	20	84
054	Douglas	Rock Road	4th Line Road	2	212	*Preventative Maintenance*	-	10	20	83
212	Indacom Drive	County Road 4	South Limit	0.2	49	*Preventative Maintenance*	-	10	20	78
150	Douro 2nd Line Road	Division Road	County Road 8	3.6	144	*ST1 - Single Surface Treatment*	*$82*	8	16	83

Sect. No.	Road Name	From	To	Length (km)	AADT	Preliminary Improvement Type Recommendation	Cost (x1000)	Surface Condition	Structural Adequacy	Condition Rating
015	Dummer Asphodel Road	Carlow Line	County Road 38	1.4	518	*Preventative Maintenance*	-	9	19	88
016	Dummer Asphodel Road	County Road 38	400 m East of 4th Line (at bridge)	3.3	509	*Preventative Maintenance*	-	9	19	88
017	Dummer Asphodel Road	Bridge	County Road 8	1.1	509	*Preventative Maintenance*	-	9	19	88
010	Dummer Lake Road East	County Road 6	South Limit (to start of Private road)	1.3	145	*Preventative Maintenance*	-	10	20	85
005	Golf Course Road	McCrackens Landing	Barnes Road	2.2	106	*Preventative Maintenance*	-	9	18	86
205	Little Lane	County Road 6	Gilcrest Bay	0.1	49	*Preventative Maintenance*	-	9	17	85
206	Ironwoods Drive	County Road 4	South Limit	0.4	49	*Preventative Maintenance*	-	9	17	85
079	Daleview Drive	County Road 4	Division Road	0.7	409	*Preventative Maintenance*	-	10	20	90
021	Dummer Asphodel Road	County Road 40	11th Line South Dummer	2.8	106	*Preventative Maintenance*	-	9	17	89
123	Block Road	Highway 28 (formerly Highway 134)	East Limit	0.1	49	*Preventative Maintenance*	-	10	19	90
023	11th Line South Dummer	Dummer-Asphodel Road	North Limit	0.9	212	*Preventative Maintenance*	-	10	19	93

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.*

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:

Slurry Seal / Microsurfacing

- 7.1 km of paved roads (HCB).
- 107.2 km of surface treated roads (LCB).
- Assume that slurry seal / microsurfacing will be applied, on average, once per resurfacing cycle.
- 16.1 km of road to preserve per year (0.4 km HCB and 15.7 km of LCB).
- **Annual budget $346,185** (15.7 km x $22,050 / 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 road infrastructure is approximately $42.7 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 O. Reg. 588/17 Reporting Requirements

This study meets the reporting requirements under Table 4 of O. Reg. 588/17. For convenience, all items required under Table 4 are presented below.

Table 11 - Road Class Density

Class	Lane-kilometres	Lane-kilometres / Municipal Area*
Arterial	0.0	0.00
Collector Roads	48.4	0.11
Local Roads	472.6	1.03

**Municipal area taken as 459 km²*

The average PCI for hard top surfaces in the Township is 74.7.

The average surface condition of unpaved roads is 7.7 as per the inventory Manual. This would broadly translate into a road with "good" rating.

Descriptions that illustrate the different levels of road class pavement condition are presented in the tables below

Table 12 - Qualitative Descriptions of PCI for HCB Roads[2]

PCI Range	Qualitative Description
90 - 100	Pavement is in excellent condition with few cracks. The Ride Condition Rating is excellent with few areas of very slight to slight distortion.
75 - 90	The pavement is in good condition with frequent very slight or slight cracking. The Ride Condition Rating is good with a few slightly rough and uneven sections.
65 - 75	The pavement is in fairly good condition with slight cracking, slight or very slight distortion and a few areas of slight alligatoring. The Ride Condition Rating is fairly good with intermittent rough and uneven sections.
50 - 65	The pavement is in fair condition with intermittent moderate and frequent slight cracking, and with intermittent slight or moderate alligatoring and distortion. The Ride Condition Rating is fair and the surface is slightly rough and uneven.
40 - 50	The pavement is in poor to fair condition with frequent moderate cracking and distortion, and intermittent moderate alligatoring. The Ride Condition Rating is poor to fair and the surface is moderately rough and uneven.
30 - 40	The pavement is in poor to fair condition with frequent moderate alligatoring and extensive moderate cracking and distortion. The Ride Condition Rating is poor to fair and the surface is moderately rough and uneven.

[2] Adapted from Table B-1 of the MTO's Manual for Condition Rating of Flexible Pavements, SP-024.

20 - 30	The pavement is in poor condition with moderate alligatoring and extensive severe cracking and distortion. The Ride Condition Rating is poor and the surface is very rough and uneven.
0 - 20	The pavement is in poor to very poor condition with extensive severe cracking, alligatoring and distortion. The Ride Condition Rating is very poor and the surface is very rough and uneven.

Table 13 - Qualitative Descriptions of PCI for LCB Roads[3]

PCI Range	Qualitative Description
80 - 100	Pavement is in excellent condition with just a few bumps or depressions from slight surface deformation. No surface defects such as streaking, potholes or cracking distresses. The Ride Condition Rating is very good.
60 - 79	Pavement is in good condtion with just a few bumps or depressions from slight to moderate surface deformation. Intermittent slight to moderate surface defects and/or cracking distresses. The Ride Condition Rating is good.
40 - 59	Pavement is in fair condition with intermittent to frequent bumps or depressions from slight to moderate surface deformation. Intermittent to frequent moderate surface defects and/or cracking distresses. The Ride Condition Rating is fair.
20 - 39	Pavement is in poor condition with frequent bumps or depressions from moderate surface deformation. Frequent moderate to severe surface defects and/or cracking distresses. Localized slight to moderate alligatoring may be present indicating pavement structural failure. The Ride Condition Rating is poor.
0 - 19	Pavement is in very poor condition with extensive bumps or depressions from moderate to sever surface deformation. Extensive to severe surface defects and/or cracking distresses. Frequent slight to moderate alligatoring may be present, indicating pavement structural failure. The Ride Condition Rating is very poor.

[3] Adapted from Table B-1 of the MTO's Manual for Condition Rating of Surface-Treated Roads, SP-021.

Table 14 - Qualitative Descriptions of Surface Condition for Gravel Roads[4]

Surface Condition	Qualitative Description
10	If the section affords a fully adequate standard of service, with no annoyance or discomfort. Gravel roads rarely score a "10" rating due to their inherent roughness.
7 - 9	If it is possible to maintain the lesser of the Minimum Tolerable Average Operating Speed or the legal Speed Limit with only a noticeable amount of annoyance to the driver due to sway, vibration or steering effort, but with no noticeable feeling of hazard.
4 - 6	If maintaining even the lesser of the Minimum Tolerable Average Speed or the legal Speed Limit results in either a "tug-of-war" with a too-steep crown, or a feeling that the car is taking undue punishment.
1 - 3	If the surface irregularities are so severe that a driver will tend to reduce speed considerably, possibly even steering an irregular course, or if the crown is to steep as to be hazardous in winter.

9.0 Sidewalk Assessment

As part of the 2021 Road Needs Study an inventory/assessment of all township sidewalk was undertaken. The completed sidewalk inventory/assessment included documenting of the following:

- Material type.
- Width.
- Location (Side of Road).
- Length.
- AODA compliance.
- Condition.

The Sidewalk Summary Table, **Table 15**, lists the condition, width and AODA compliance issues for all sidewalks in the Township.

[4] Adapted from Item 83 from the MTO's Ministry of Transportation's Inventory Manual for Municipal Roads (February 1991).

Table 15 - Sidewalk Summary Table

Road Section	Road Name	From	Length (m)	Side	Width (m)	Condition	Notes on AODA Compliance
44	English Line (South)	County Road 4 - School Crosswalk	50	Even	1.5	G	
45	Water Street	Mill Street to House 884	96	Even	1.2	P	Sidewalk is too narrow and lacks TWSI on curb ramps.
	County Road 4 (Water Street)	West Street – English Line	587	Odd	1.5	G	
	County Road 4 (Water Street)	Mill Street - West Street	270	Even	1.5	G	
	County Road 4 (Water Street)	Mill Street - West Street	270	Odd	1.5	G	
	County Road 4 (Mill Street)	Church Street - Water Street	80	Even	1.1	P	Sidewalk is too narrow and lacks TWSI on curb ramps.
	County Road 4 (Mill Street)	Church Street - Water Street	80	Odd	1.1	P	Sidewalk is too narrow and lacks TWSI on curb ramps.
	County Road 4	Ford Street - Mill Street	80	Even	1.1	P	Sidewalk is too narrow and lacks TWSI on curb ramps.
	County Road 38	Ford Street – Water Street	210	Even	1.3 - 1.5	F	Lacking TWSI at Curb Ramps
136	Douro 4th Line Road	County Road 8 to North End of Church	145	Even	1.5	G	
136	Douro 4th Line Road	County Road 8 to North End of Church	30	Odd	1.5	G	
	County Road 8	Douro Limits - Douro 4th Line	80	Even	1.1	F	Sidewalk is too narrow
	County Road 8	Douro Limits - Douro 4th Line	110	Odd	1.1	F	Sidewalk is too narrow

10.0 Storm Sewer Assessment

As part of the 2021 Road Needs Study, the township's existing storm sewer system was also reviewed.

The Township currently has two (2) storm sewer systems in their inventory, both located within the village of Warsaw. The first system is located along West Street and contains two (2) catch basins. This system includes a north inlet pipe and an outlet connecting to the County system at County Road No. 4. Although no material defects were observed, this system appears to be plugged with sediment. One catch basin appears to have been covered with asphalt and granulars. The other catch basin is nearly full of sediment.

The second system contains eight (8) catch basins and is located between Church Street and County Road 4. From the visual inspection undertaken by Wills, this system appears to be in good condition.

It should be noted that the Township has what may be considered a third storm sewer system on Crowe's Landing Road. This storm sewer is irregular in its composition: catch basins are merely grates attached to vertical CSP's, with horizontal pipes outletting downstream.

11.0 Summary

D.M. Wills Associates (Wills) undertook a review of the Township of Douro-Dummer (Township) existing 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 September of 2021. A visual assessment of each road within the Township was undertaken to assess the current condition of the road.

Two primary indicators of the relative health of a road are the structural adequacy and surface condition ratings. The current average structural adequacy rating for the Township's road network is 14.9/20. The current average surface condition rating for the Township's road network is 7.7/10.

3.3% (9 km) of the road network has a Structural "NOW" need, 3.8% (10 km) has a Structural "1-5" year need, and 13.1% (34 km) of the road network has a Structural "6-10" year need.

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 Township'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 $1,003,675 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 brush 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", 1 - 5 year, or 6 – 10 year need have been included in the capital improvement plan for reconstruction.

A total length of 52.6 km of roads were identified as having structural needs in the "NOW", 1 – 5 or 6-10 year periods. The estimated cost to improve these roads is approximately $ 2.8 M.

A fully funded 10 year plan following the recommendations in this report totals $1.3M/year, this includes $1.0M/year for resurfacing needs and $2.8M for the capital needs over ten years ($0.3M/year).

An additional length of approximately 71.6 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.

The time of inspection plays a significant role in assessing a road's condition. The field work for this study was carried out in September of 2021.

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,

Eric St. Pierre, P.Eng
Transportation Engineer

Turner Kuhlmeyer, E.I.T.
Transportation E.I.T.

TK/ESP/ms

Statement of Limitations

This report has been prepared by D.M. Wills Associates on behalf of the Township of Douro-Dummer. 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 document the 2021 Roads Needs Study Report findings 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 2021 Road Needs Study Report findings.

Appendix A

Unit Price Form

ROAD IMPROVEMENT COSTS
Township of Douro-Dummer

Unit Costs	Units	Unit Cost
Granular A	t	$16.55
Granular B	t	$10.00
Hot Mix	t	$130.00
Earth Excavation	m3	$12.00
Asphalt Removal	m2	$4.00
Asphalt Removal - Partial Depth	m2	$2.00
Removal of Concrete Curb & Gutter	m	$12.00
Concrete Curb & Gutter	m	$60.00
In-Place Full Depth Reclamation	m2	$1.50
Surface Treatment - Single	m2	$3.45
Surface Treatment - Double	m2	$5.40
Granular A Conversion	2.2	t/m3
Granular B Conversion	2	t/m3
Hot Mix Conversion	2.45	t/m3

Gravel (50mm)

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*		*Quantity*	*Unit Cost*	*Cost/km (x 1000)*
Granular A	7.0	75	2.2	t		1155	$16.55	$ 19
							G	**19**

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	$12.00	$ 4
Granular A	7.0	150	2.2	t		115.5	$16.55	$ 2
Granular B	8.0	650	2	t		520	$10.00	$ 5
							FT	**11**

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	$3.45	$ 24
							ST1	**24**

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	$5.40	$ 38
							ST2	**38**

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	$5.40	$ 38
Removal Asphalt Pavement	7.0	16		m2		7000	$4.00	$ 28
							ST2R	**66**

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	$5.40	$ 38
Granular A	7.0	150	2.2	t		2310	$16.55	$ 38
							ST2A	**76**

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	$5.40	$ 38
Granular A	7.0	150	2.2	t		2310	$16.55	$ 38
Pulverizing	7.0			m2		7000.0	$1.50	$ 11
Minor Items @ 25%								$ 3
							ST2PA	**89**

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	$5.40	$ 38
Granular A	7.0	150	2.2	t		2310	$16.55	$ 38
Pulverizing	7.0			m2		7000.0	$1.50	$ 11
Earth Excavation	2	450		m3		900	$12.00	$ 11
Granular B	1	450	2	t		900	$10.00	$ 9
Minor Items @ 25%								$ 8
							ST2PAW	**114**

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	$130.00	$ 57
Granular A	1.5	50	2.2	t		165	$16.55	$ 3
Minor Items @ 15%								$ 9
							RO1	**69**

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	$130.00	$ 95
Granular A	1.5	90	2.2	t		297	$16.55	$ 5
Minor Items @ 15%								$ 15
							RO2	**114**

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	$130.00	$ 68
Remove Curb and Gutter				m		200	$12.00	$ 2.40
Curb and Gutter - 20%				m		200	$60.00	$ 12.00
Milling	4.25			m2		4250	$2.00	$ 8.50
Minor Items @ 25%								$ 23
							RMP1	**113**

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	$130.00	$ 122
Remove Curb and Gutter				m		200	$12.00	$ 2.40
Curb and Gutter - 20%				m		200	$60.00	$ 12.00
Milling	4.25			m2		4250	$2.00	$ 8.50
Minor Items @ 25%								$ 36
							RMP2	**181**

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	$130.00	$ 48
Granular A	1.5	50	2.2	t		165	$16.55	$ 3
Pulverize	3			m2		3000	$1.50	$ 4.50
Minor Items @ 25%								$ 14
							PP1	**69**

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	$130.00	$ 86
Granular A	1.5	90	2.2	t		297	$16.55	$ 5
Pulverize	3			m2		3000	$1.50	$ 5
Minor Items @ 25%								$ 24
							PP2	**119**

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	600		m3		1200	$12.00	$ 14
Granular A	5	150	2.2	t		1650	$16.55	$ 27
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	8	50	2.45	t	196	1176	$130.00	$ 153
Milling	4			m2		4000	$2.00	$ 8
Minor Items @ 25%								$ 62
							RW1	**309**

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	$12.00	$ 14
Granular A	5	150	2.2	t		1650	$16.55	$ 27
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	8	90	2.45	t	353	2117	$130.00	$ 275
Milling	4			m2		4000	$2.00	$ 8
Minor Items @ 25%								$ 92
							RW2	**462**

Gravel Road Widening

Item	*Width - m*	*Depth - mm*	*Conversion Factor*	*Unit*	*Crossfall Correction*	*Quantity*	*Unit Cost*	*Cost/km (x 1000)*
Earth Excavation	2	600		m3		1200	$12.00	$ 14
Granular A	1	150	2.2	t		330	$16.55	$ 5
Granular B	1	450	2	t		900	$10.00	$ 9
Minor Items @ 25%								$ 7
							GW	**36**

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	600		m3		3000	$12.00	$ 36
Granular A	3	150	2.2	t		990	$16.55	$ 16
Granular B	5	450	2	t		4500	$10.00	$ 45
Minor Items @ 25%								$ 24
							Recon G	**122**

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	600		m3		3000	$12.00	$ 36
Granular A	4	150	2.2	t		1320	$16.55	$ 22
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	50	2.45	t		368	$130.00	$ 48
Minor Items @ 25%								$ 41
							Recon 1R	**203**

Semi-Urban: 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	600		m3		3000	$12.00	$ 36
Granular A	4	150	2.2	t		1320	$16.55	$ 22
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	50	2.45	t		368	$130.00	$ 48
Minor Items @ 25%								$ 41
							Recon 1S	**203**

Semi-Urban: Full Excavation and Reconstruction - 2 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	600		m3		3000	$12.00	$ 36
Granular A	4	150	2.2	t		1320	$16.55	$ 22
Granular B	5	450	2	t		4500	$10.00	$ 45
Hot Mix	3	90	2.45	t		662	$130.00	$ 86
Minor Items @ 25%								$ 50
							Recon 2S	**251**

Urban: Full Excavation and Reconstruction - 2 Lift

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)
Asphalt Removal - Full Depth	4.25			m2		4250	$4.00	$ 17
Earth Excavation	5.5	750		m3		4125	$12.00	$ 50
Granular A	4.5	150	2.2	t		1485	$16.55	$ 25
Granular B	5.5	600	2	t		6600	$10.00	$ 66
Hot Mix	4.25	90	2.45	t		937	$130.00	$ 122
Remove Curb and Gutter				m		1000	$12.00	$ 12.00
Curb and Gutter				m		1000	$60.00	$ 60.00
Minor Items @ 25%								$ 70
							Recon 2U	**421**

Rout and Seal

Item				Unit		Quantity	Unit Cost	Cost/km (x 1000)
Rout and Seal				m		1000	$4.00	$ 4
							RS	**4**

Slurry Seal

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)
Slurry Seal	7			m2		7000	$3.15	$ 22
							SS	**22**

Microsurfacing

Item	Width - m			Unit		Quantity	Unit Cost	Cost/km (x 1000)
Microsurfacing	7			m2		7000	$6.00	$ 42
							MS	**42**

Semi-Urban: Upgrade to Urban - 2 Lift

Item	Width - m	Depth - mm	Conversion Factor	Unit	Crossfall Correction	Quantity	Unit Cost	Cost/km (x 1000)
Asphalt Removal - Full Depth	4.25			m2		4250	$4.00	$ 17
Earth Excavation	5.5	600		m3		3300	$12.00	$ 40
Granular A	4.5	150	2.2	t		1485	$16.55	$ 25
Granular B	5.5	450	2	t		4950	$10.00	$ 50
Hot Mix	4.25	90	2.45	t		937	$130.00	$ 122
Curb and Gutter				m		1000	$60.00	$ 60.00
Minor Items @ 25%								$ 63
							Recon 2U	**376**

Rural: Full Excavation and Reconstruction with 700mm grade raise - 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	$12.00	$ 27
Granular A	4	150	2.2	t		1320	$16.55	$ 22
Granular B	6	1000	2	t		12000	$10.00	$ 120
Minor Items @ 25%								$ 42
							Recon G	**211**