BURNSIDE

Road Management Plan

Township of Melancthon
157101 Highway 10
Melancthon, ON L9V 2E6

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Melancthon, ON L9V 2E6

R.J. Burnside & Associates Limited
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Orangeville ON L9W 3R4 CANADA

October 2019
300043927.0000

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Record of Revisions

Revision	Date	Description
0	September 30, 2019	Initial Draft Submission to Township
1	October 11, 2019	Final Submission to Township

R.J. Burnside & Associates Limited

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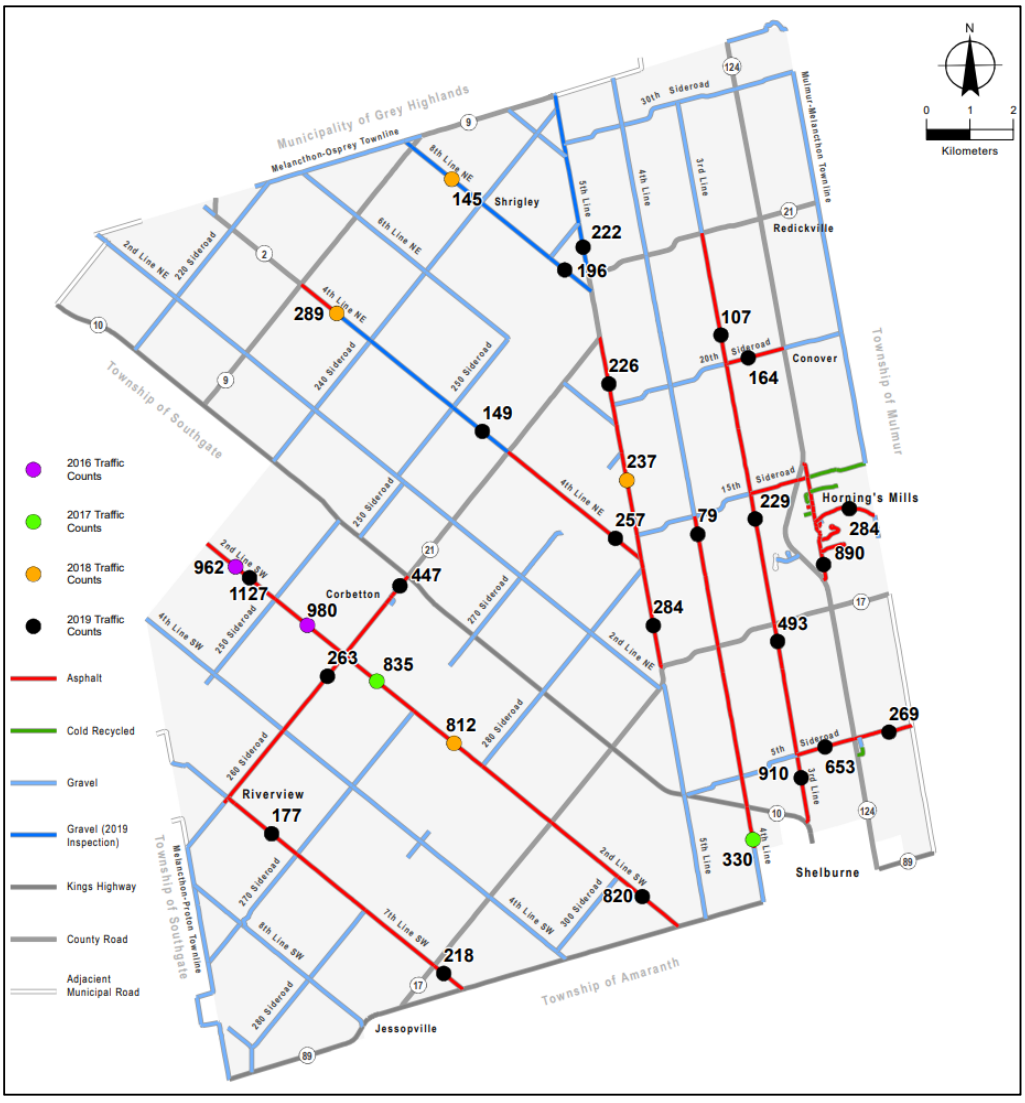
Executive Summary

R.J. Burnside & Associates Limited (Burnside) was retained by the Corporation of the Township of Melancthon (Township) to conduct a Road Management Plan (RMP). This RMP has addressed various road improvement, maintenance and management issues in the Township.

A total of 91 km (centerline) of roads were inventoried and reviewed in this RMP.

Burnside's sub-consultant Ontario Traffic Inc. (OTI) conducted a total of 22 Automatic Traffic Recorder (ATR) counts on roadways throughout the Township in Spring 2019. The traffic count volumes in vehicles per day (vpd), collected between 2016 and 2019, is summarized in Figure (i).

Figure (i): Traffic Count Volume Data



For each hardtop road section, Ride Comfort Rating (RCR), Distress Manifestation Index (DMI) and Pavement Condition Index (PCI) values were determined according to Ontario Good Roads Association (OGRA) criteria. In addition to PCI values, this RMP determined two more specific condition ratings for each hardtop road section: a Surface Condition Rating (SCR), which considers all surface-related deficiencies visible on a road section's surface, and a Base Condition Rating (BCR), which considers all base-related deficiencies visible on a road section's surface. The PCI value is out of 100, the SCR value is out of 10 and BCR value is out of 10.

Various improvement types (capital and maintenance) were considered and assessed in this study. For the 20-year budget sensitivity analysis, SCR and BCR post-treatment values (i.e., conditions) were determined in order to assist in the analysis, through the application of the SCR and BCR values within road degradation formulae. A Priority Guide Number (PGN) was developed in order to prioritize improvement needs.

A financial comparison was made to compare overall construction and maintenance costs of hardtop versus gravel roads under various conversion scenarios and structural base conditions. The results of the cost assessment indicate that, in general, gravel surface roads have reduced costs over hardtop roads (i.e., capital and maintenance costs), assuming a 60-year lifecycle and Annual Average Daily Traffic (AADT) volumes below 400 vpd. However, several other factors were also identified that can influence the decision on which surface type is preferable.

A methodology for establishing the relative merit of upgrading or downgrading road surface types was developed and applied against select roads within the network.

Geometric Deficiencies on the Roads

No horizontal alignment deficiencies were noted on the roads reviewed in this RMP. However, some vertical curve deficiencies have been identified where appropriate warning signage should be installed. Future road improvement projects at these locations should consider improving/reducing the magnitude of the vertical deficiency.

Minimum tolerable hardtop and gravel road widths (i.e., travel lanes) were assessed according to Transportation Association of Canada (TAC) and OGRA criteria. The few sections that were identified are not expected to change in many cases due to buildings built very close to the road and/or other planning related issues.

It is also important to maintain adequate shoulder widths along hardtop roads, to meet the requirements for pavement edge support and as a buffer between traffic and embankment slopes. Based on consultation with Township staff, it was noted that most of the hardtop roads provide acceptable shoulders, except for various segments of 3rd Line OS (which have limited shoulders).

It is recommended that when road sections which have deficient shoulder widths are rehabilitated or reconstructed, that where possible they be upgraded to meet minimum acceptable standards.

Road Maintenance Considerations

The Township undertakes brushing as part of their regular maintenance practices. Where road works are proposed, it is recommended that additional investigations be completed to determine drainage improvement requirements. However, it is also recognized that the practicality of achieving sufficient drainage outlets may constrain the opportunities to improve roads in areas with drainage issues.

Review of Road Upgrading/Downgrading Needs

Analysis of the gravel road sections reviewed in this study, including each road section's estimated existing (2019) AADT volume and calculated Gravel Upgrading Priority Index (GUPI) value was completed. The GUPI value considers factors such as traffic volumes, truck volumes, maintenance requirements and driveway densities.

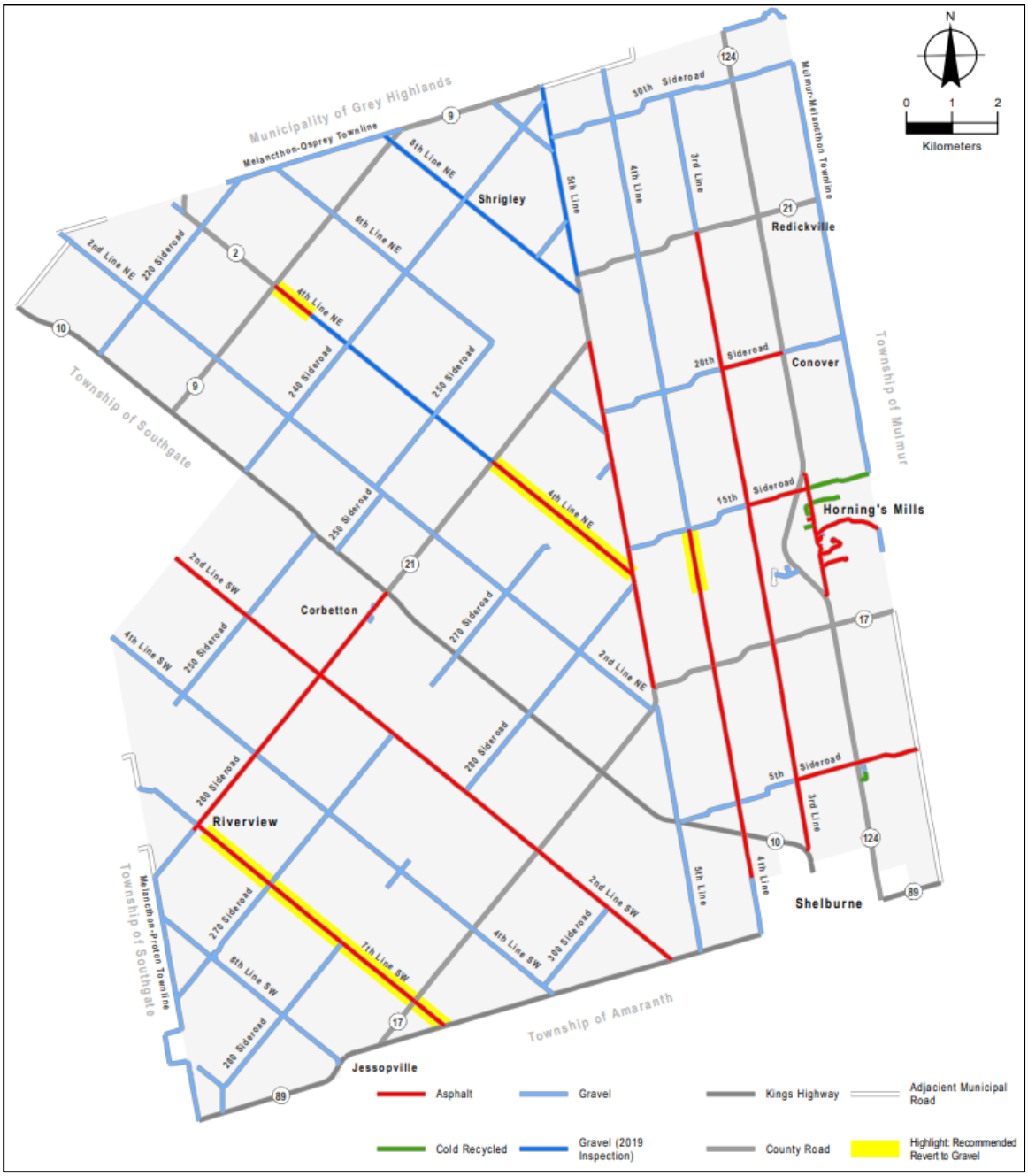
Based on this analysis, none of the existing gravel road sections are recommended for upgrading to a hardtop surface at this time.

This RMP has reviewed low volume rural hardtop roads for possible reversion back to gravel. Based on the analysis and the calculated GUPI values it is recommended that the following roads be reverted back to gravel when their asphalt surface has degraded and requires rehabilitation:

- 4th Line NE between 5th Line OS and Dufferin Road 21 (section ID #65).
- 4th Line NE between County Road 9 and 1 km north of Sideroad 240 (section ID #72).
- 7th Line SW between Highway 89 and 200 metres south of Sideroad 260 (section IDs #1489, 111, 142 and 143).
- 4th Line OS between the Strada Pit North Entrance and 15th Sideroad (section #95B)

The existing hardtop road sections recommended for consideration to downgrade to gravel surfaces are highlighted on Figure (ii).

Figure (ii): Hardtop Surface Downgrade Recommendations



Review of Hardtop Road Needs

It has been estimated that the total cost of current hardtop road improvement needs, based on existing road conditions and individual road section improvement needs on hardtop roads in the Township, is approximately $8 million. Table (ii) summarizes the hardtop road needs by improvement types.

Table (ii): Township of Melancthon Hardtop Road Needs

Improvement Need Type	Amount of Hardtop Road Needs		
	Cost (in CAD Dollars)	Length (in kilometres)	Percentage of Total Length
Routine Maintenance	$81,781	16.3	21.4%
Preventive Maintenance	$280,053	11.2	14.7%
Resurface	$191,658	2.0	2.6%
Rehabilitation	$4,994,751	37.7	49.4%
Reconstruction	$2,502,444	9.1	11.9%
Total	**$8,050,867**	**76.3**	**100.0%**

Table (iii) provides a qualitative condition summary based on the combined SCR plus BCR (out of 20) value ranges on all hardtop road sections in the Township.

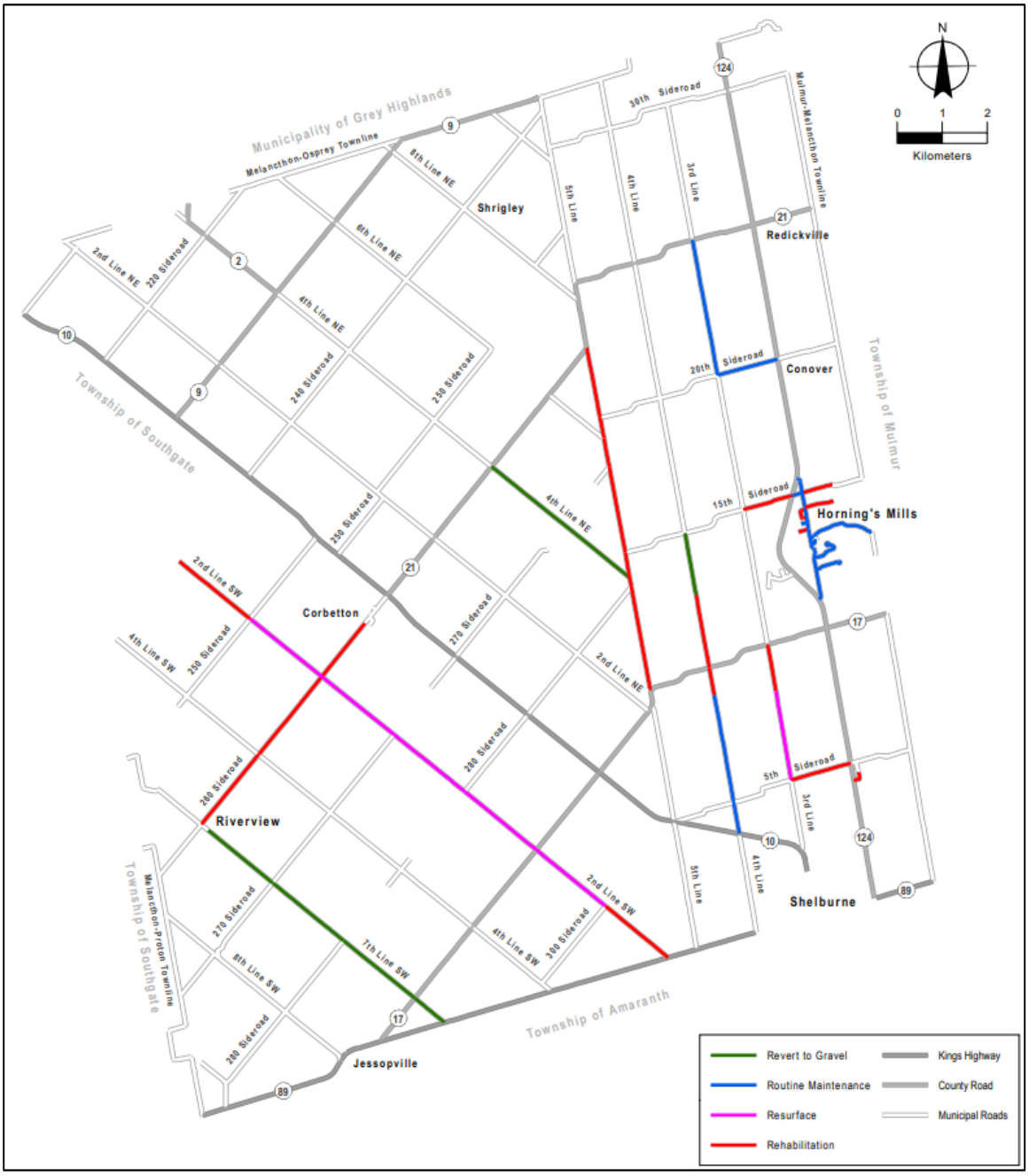
Table (iii): Qualitative Description of Hardtop Road Network

Combined (SCR + BCR) Value Range	Condition	Length of Road (Centerline km)	Percentage of Total Length
18 to 20	Excellent	22.3	29.2%
15 to 17.9	Good	7.9	10.3%
13 to 14.9	Fairly Good	12.1	15.9%
10 to 12.9	Fair	7.3	9.6%
Below 10	Poor	26.7	35.0%
Total	**-**	**76.3**	**100.0%**

Development of Ten-Year Hardtop Road Improvement Plan

A comprehensive ten-year (2020 to 2029) road capital and maintenance improvement plan is recommended, based on an average cost of $530,000 per year. This budget amount is higher than what the Township currently spends, however a significant budget increase is required over the next decade in order to reduce the existing capital need backlog. As a result of implementing the recommended ten-year improvement plan, it is forecast that the Township's overall hardtop road network condition will improve significantly from an "average" (6.2 out of 10) to "good" (8.7 out of 10) state by 2029.

Figure (iii): Ten-Year Road Improvement Plan



Review of Long-Term (20-year) Hardtop Road Budget Requirements

A sensitivity analysis was completed to determine the funding level required to sustain the Township's forecast "good" overall hardtop road network condition over a 20-year period. The cost to maintain a "good" hardtop road network condition level over the next 20 years (i.e., an overall hardtop network condition at or above 8 out of 10 through year 2039) is forecast to be approximately $315,000 per year (i.e., average over the 20-year period). The 20-year analysis assumes the aforementioned ten-year plan as a subset of the 20-year period, thus it can be concluded that the annual budget required to maintain the "good" network condition (after spending more than usual over the first ten years to reduce the capital need backlog and achieve a "good" overall network condition) is significantly less between years 11 to 20, when compared to the first ten year period. This reflects the shifting of focus from primarily costly capital improvements to more cost-effective maintenance treatments after a "good" overall condition state is reached, so that this condition state is sustainable over the long-term.

It is recommended that the Township increase their annual investment on hardtop roads over the next decade to try to meet the target average $530,000 per year amount, and that the Township continue to actively pursue all available capital grants and other funding sources for such work. As noted in the *Township of Melancthon Asset Management Plan*: "while the annual funding requirement may fluctuate, it is important for the Township to implement a consistent, yet increasing, annual investment in capital so that the excess annual funds accrue in capital reserve funds" (Burnside, May 2017). As identified above, it is anticipated that the annual average capital and maintenance investment in the Township's hardtop road network will be significantly less after the first decade, resulting in a 20-year average amount of about $315,000 per year.

The Township does not currently have an annual budget specific to routine and preventive maintenance treatments for hardtop roads (e.g., crack sealing, micro-surfacing, slurry sealing etc.). However, both the ten-year plan that was developed (at an average of $530,000 per year) and the 20-year sensitivity analysis (at an average of $315,000 per year) consider and include maintenance treatments. Best practice indicates that maintenance treatments applied on roads with good bases can provide extended life and are cost-effective in reducing the overall lifecycle expenditures on such roads. Therefore, it is recommended that the Township begin incorporating maintenance treatments on hardtop roads (within the aforementioned recommended budgets). Such maintenance treatments may be implemented as demonstration (i.e., test) projects initially, with ongoing monitoring to gauge their effectiveness.

Burnside gratefully acknowledges the assistance and contributions of Township staff and Roads Committee in the preparation of this study and Report.

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Disclaimer

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R.J. Burnside & Associates Limited makes no warranties, either express or implied, of merchantability and fitness of the documents and other instruments of service for any purpose other than that specified by the contract.

1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by the Corporation of the Township of Melancthon (Township) to conduct a Road Management Plan (RMP). This RMP has addressed various road improvement, maintenance and management issues in the Township, including a review of the following:

- all existing hardtop roads in the Township, in addition to Township-identified select gravel roads (via field data collection in Spring 2019);
- an analysis of the current road conditions;
- a review of potential surface type upgrades or downgrades for select roads;
- a ten-year road capital and maintenance improvement plan; and
- an analysis of long-term (20-year) capital and maintenance budget requirements.

The acronyms used throughout this report have been summarized in Appendix A.

2.0 Asset Management Plan Considerations

2.1 Road Management Plans as Input to Asset Management Plans

As an asset management practice, it is recommended that detailed condition and inventory information be obtained and analyzed on the Township's tangible capital assets regularly. To paraphrase, Ontario Regulation 588/17 specifies that each municipality's asset management plan should base current levels of service being provided on data from at most the two calendar years prior to the year in which the Asset Management Plan (AMP) is completed. Where detailed condition information is not available, AMPs typically use the age of an asset as a general indicator of where an asset is within its lifecycle and in assessing the risk associated with the needed improvements or replacements to this infrastructure. Ontario Regulation 588/17 requires that the following considerations be made:

- Options must be compared on lifecycle cost, including the cost of constructing, maintaining, renewing and operating an infrastructure asset through its service life.
- Other indirect benefits and costs associated with each option should be considered (e.g. user costs, safety, environmental, etc.).
- Each option must be evaluated based on its potential risk, using an approach that allows for comparative analysis. Risks associated with each option can be scored based on quantitative measures when reasonable estimates can be made of the probability of the risk event happening and the cost associated with the risk event.

Ontario Regulation 588/17 also requires that municipal governments have an adopted AMP for its core assets (i.e., which includes roads) by July 1, 2021. The AMP is to discuss current levels of service and the cost of maintaining those services. For roads, the regulation sets out the following qualitative descriptions and technical metrics that are to be reported in the AMP as an indication of the current levels of service being provided by the municipality:

- A description, which may include maps, of the road network in the municipality and its level of connectivity. The number of lane-kilometres of each of arterial roads, collector roads and local roads as a proportion of square kilometres of land area of the municipality;
- A description or images that illustrate the different levels of road class pavement condition. For paved roads in the municipality, the average pavement condition index value is to be provided. For unpaved roads in the municipality, the average surface condition (e.g., excellent, good, fair or poor) is to be provided.

The AMP is to provide an assessment of the lifecycle activities that would need to be undertaken to maintain the current levels of service, for each of the ten years following the year for which the current levels of service were established. By July 1, 2024, the AMP is to also include the establishment of the municipality's proposed levels of service,

the options for achieving these levels of service and the risks associated with those options to the long-term sustainability of the municipality.

The inventory and road needs assessment provided in this RMP are intended to provide a basis for the information requirements for the updating of the municipality's AMP, to meet the requirements of Ontario Regulation 588/17.

2.2 2017 Township of Melancthon Asset Management Plan

The *Township of Melancthon Asset Management Plan* (Burnside, May 2017) concluded that the Township's overall (i.e., weighted average) road surface and road base condition were both "average". It was also concluded that the overall risk of the Township's road surface and road base assets was "moderate".

The following specific recommendations were made in the Asset Management Plan with regards to the Township's roads:

- 2nd Line SW – change the posted speed limit from 80 km/h to 60 km/h.
- 2nd Line SW from 250 Sideroad to Melancthon/Southgate Boundary Line – grind the existing asphalt surface and add more gravel to stabilize the road base. Consider replacing the asphalt surface in a subsequent year, depending on traffic volume.
- 2nd Line SW from Highway 89 to 300 Sideroad – grind the existing asphalt surface and add more gravel to stabilize the road base. Consider replacing the asphalt surface in a subsequent year, depending on traffic volume.
- Road bases are not expected to be fully replaced, but rather improved in localized areas (i.e., by digging out and repacking). The following road sections may require additional road base support/stabilization:
  - 2nd Line SW from 250 Sideroad to Melancthon/Southgate Boundary Line;
  - 2nd Line SW from Highway 89 to 300 Sideroad; and
  - High Street in Horning's Mills (which has been completed at the time of this RMP).
- 4th Line NE from 240 Sideroad to County Road 9 – grind the existing asphalt surface and add more gravel to stabilize the road base. Consider replacing the asphalt surface in a subsequent year, depending on traffic volume. At the time of this RMP, part of this segment has been reverted to gravel.
- 5th Line OS (asphalt road segments) – indications of road base instability. Grind the existing asphalt surface and add more gravel to stabilize the road base. Consider replacing the asphalt surface in a subsequent year, depending on traffic volume.

The 2017 AMP estimated that the total 2016 replacement cost of road surfaces and bases in the Township were $6,460,483 and $105,612,196, respectively.

3.0 Inventory of Roads Considered in this RMP

All road section data contained in this RMP is based on a field review conducted in May 2019 by one Township staff member and one senior technical Burnside staff member. This RMP focuses primarily on the construction and maintenance needs of all hardtop roads in the Township, in addition to select gravel road sections (as confirmed via discussions between the Township and Burnside).

A total of 91 km (centerline) of roads were inventoried and reviewed in this RMP, consisting of 74 km High Class Bituminous (HCB) asphalt, 2 km cold recycled asphalt (CRA), and 15 km gravel surface (i.e., select gravel roads only, not the entire Township gravel road network). A map illustrating the existing surface type of roads in the Township is contained in Appendix B.

The road section inventory data collected in this RMP is summarized in Appendix C.

4.0 Traffic Counts and Annual Average Daily Traffic (AADT)

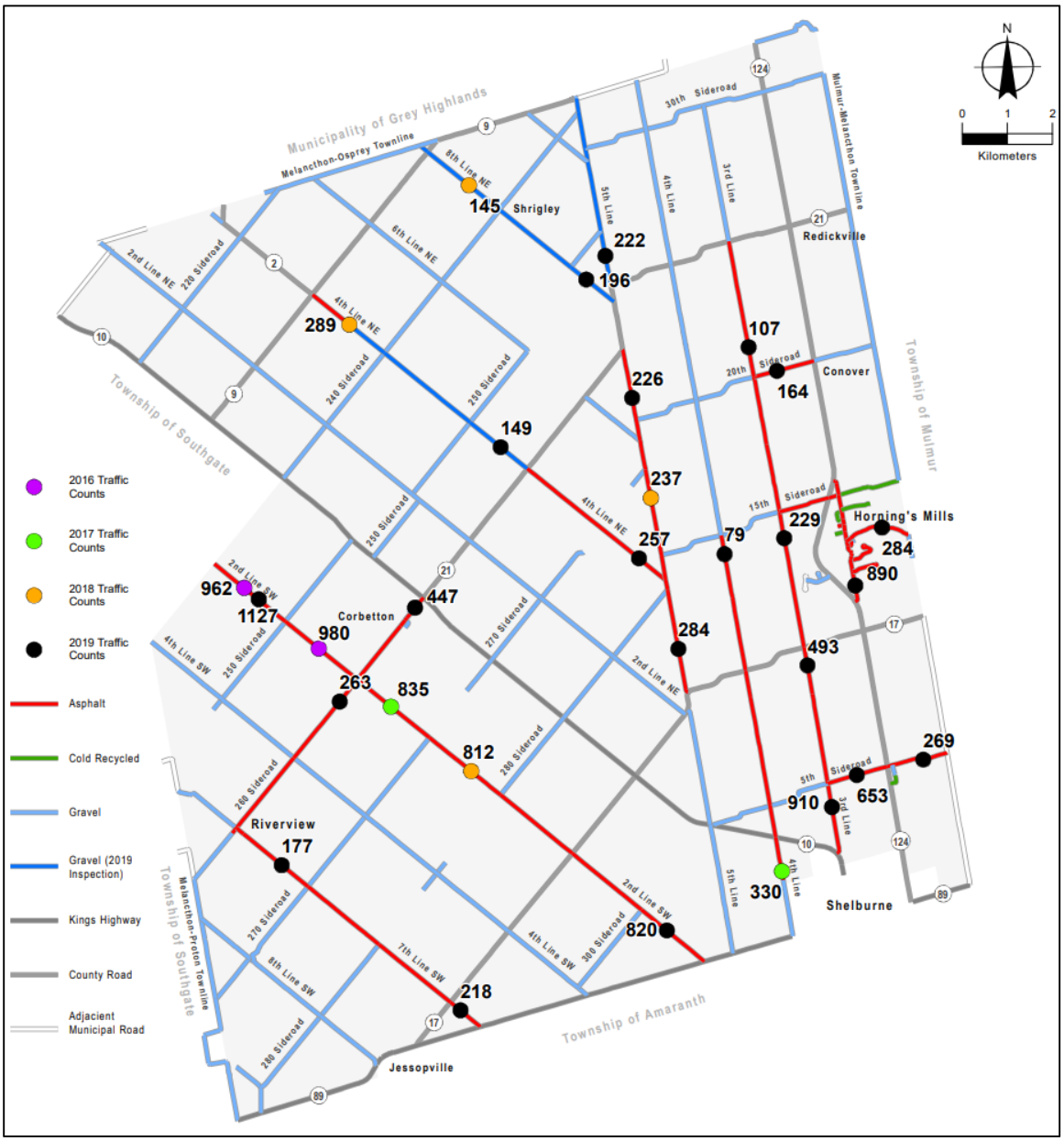
Burnside's sub-consultant, Ontario Traffic Inc. (OTI), completed a total of 22 Automatic Traffic Recorder (ATR) counts on roadways throughout the Township in the Spring of 2019. Factors that were considered in determining the optimal 22 ATR count locations included:

- gravel road sections that may be potential candidates for upgrading to hardtop surfaces;
- Hardtop road sections through the Township where it was deemed necessary to confirm the traffic and truck volumes to ensure that accurate data was incorporated into the road analysis work completed in this RMP.

All 22 ATR counts included both volume and vehicle classification data, collected over a 72-hour period between Thursday and Saturday, recorded in 15-minute intervals.

In addition to the above counts conducted by OTI, the Township provided Burnside with traffic volume/classification data from 2016, 2017, 2018, and 2019 on select roads. The Township collected more traffic counts in September to verify the counts on some of the higher traffic roads. The traffic count data collected in 2016, 2017, 2018 and 2019 is summarized in Figure 1.

Figure 1: Traffic Count Volume Data



The traffic volume/classification data was utilized, in conjunction with a general assessment of the road network and origin/destination considerations, in order to estimate Annual Average Daily Traffic (AADT) volumes and truck volumes on all road sections considered in this RMP. AADT volumes are one of the factors used in establishing potential improvement/upgrading requirements, as well as the formulation of improvement benchmark costs and road improvement priorities. For road segments where no traffic counts were available, traffic volume approximations were assigned based on the general traffic volume range forecasted, for use in the road assessments.

The location of various urban areas and developments throughout and adjacent to the Township were reviewed in conjunction with planning-level studies in order to make 10-year AADT forecasts on roads considered in this RMP. In the *Township of Melancthon Official Plan* (August 2014), it is stated that the population in 2031 is forecast to be 3,410, which would represent a 0.84% per annum growth rate from the Township's 2016 population of 3,008 (Statistics Canada). Also, population growth in the municipalities adjacent to Melancthon will impact traffic on some of the Township's roads. Growth in the Town of Shelburne is estimated to be approximately 2.2% per annum over the next 20 years, according to the *Town of Shelburne Official Plan* (December 2017 Consolidation). Growth in Southgate Township is estimated to be 0.61% per annum over the next 20 years (about 370 residential units, much of which will be in Dundalk), according to Grey County's *Growth Management Strategy Update* (Hemson Consulting Ltd, December 2015).

Based on the above considerations, the following traffic volume (i.e., AADT) growth rates were applied on roadways in this RMP, for the purpose of estimating 10-year (i.e., 2029) traffic volumes:

- A 2.0% Compound Annual Growth Rate (CAGR) was applied to AADT volumes on the following roadways:
  - 3rd Line OS between Highway 10 and County Road 21;
  - 4th Line OS between Shelburne Boundary and 15th Sideroad;
  - 5th Line OS between County Road 17 and County Road 21;
  - 5th Sideroad between 3rd Line and Mulmur/Melancthon Townline; and
  - 2nd Line SW (entire length).
- A 1.0% CAGR was applied to AADT volumes on all other roads considered in this RMP.

The AADT volume and range estimates for all road sections considered in this RMP is contained in Appendix C. The raw traffic count data collected by OTI has been provided to the Township digitally (Excel and PDF formats).

5.0 Methodology

5.1 Hardtop Road Condition Ratings

The Township's hardtop roads were reviewed in the field by Burnside with Township staff in May 2019 to determine their condition ratings. Specific pavement distress ratings were assigned for 15 distress types for all hardtop road sections in the Township, based generally on the "Flexible Pavement Condition Evaluation Form" developed by the Ontario Good Roads Association (OGRA), as illustrated in Figure 2. Weighting factors are assigned to each distress type as well as to the severity and density of the distress, as shown in Figure 1. The summation of all the various distress weightings, severities and densities for each road section provide a Distress Manifestation Index (DMI) for that section.

In addition to surface distresses, a Ride Comfort Rating (RCR) was also estimated for each road section. The RCR is a subjective measure of ride smoothness, measured on a 1 to 10 rating scale, with 10 representing a very good RCR (i.e., very smooth ride) and 1 representing a very poor ride, as delineated on Figure 1.

Pavement Condition Index (PCI) values were calculated for all hardtop road sections in the Township, according to the formula identified in Figure 2. The PCI, which is based on the DMI and RCR values for each road section, provides a rating out of 100, with higher PCI ratings reflecting better road pavement conditions.

Figure 2: Flexible Pavement Condition Evaluation Form (Generally Following Ontario Good Roads Association Methodology)

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Survey Date: _____ Evaluated by: _____

Road (Street) Name: _____ Section Length _____ km

Location from: _____ to: _____

Class of Road (circle both mtce. class & functional class) 1 2 3 4 5 6 Freeway Arterial Collector Local

Section # (if applicable)

Ride Comfort Rating (at posted speed)

10	9	8	7	6	5	4	3	2	1
Very Good		Good			Fair			Poor	Very Poor

					Severity of Distress (Si)					Density of Distress (Di)				
					Very Slight	Slight	Moderate	Severe	Very Severe	Few	Intermittent	Frequent	Extensive	Throughout
										<10	10-20	20-40	40-80	>80
Pavement				Wi	0.25	0.5	1	1.5	2	0.25	0.5	1	1.5	2
Surface Defects		Ravelling & loss of surface aggregate	1	1.5										
		Flushing	2	0.5										
Surface Deformations		Rippling and Shoving	3	1.0										
		Wheel Track Rutting	4	3.0										
		Distortion	5	3.0										
Cracking	Longitudinal Wheel Track	Single and Multiple	6	1.0										
		Alligator	7	3.0										
	Centreline	Single and Multiple	8	0.5										
		Alligator	9	2.0										
	Pavement Edge	Single and Multiple	10	0.5										
		Alligator	11	1.5										
	Transverse	Half, full and multiple	12	1.0										
		Alligator	13	3.0										
	Longitudinal – meander or mid-lane		14	1.0										
	Potholes/Patching		15	3.0										

Σ Wi x (Si + Di) (for all 15 distresses) = _____DMI

PCI = 100 – (DMI + (10 – RCR)) = _____

The establishment of a PCI value for each road section provides valuable information to identify, compare and prioritize road maintenance and improvement needs for the various road segments within the network. However, the provision of a single PCI number does not fully capture the causative factors of the observed distresses, nor whether such factors are indications of a surface condition need or a base condition need. One of the key challenges in utilizing performance-based decision making to manage road assets is a recognition that the road and base elements will have different lifecycles. To address these factors Burnside has further used the collected condition data to establish condition ratings that are specific to the surface or base components. A Surface Condition Rating (SCR) is established from the surface-related distresses that are visible on the road sections' surface. A Based Condition Rating (BCR) is established from the base-related distresses that are inferred from some of the distress types that are visible on the road sections' surface (i.e. in the absence of boreholes being completed to directly view the base). The distresses that are considered in the establishment of the SCR and BCR ratings are summarized in Table 5.1.

Table 5.1: Individual Hardtop Deficiency Types Relating to SCR and BCR Values

Deficiency Type		Considered in SCR (Yes/No)	Considered in BCR (Yes/No)
Surface Defects	Ravelling & loss of surface aggregate	Yes	No
	Flushing	Yes	No
Surface Deformations	Rippling & Shoving	Yes	No
	Wheel Track Rutting	No	Yes
	Distortion	No	Yes
Longitudinal Wheel Track Cracking	Single & Multiple	Yes	No
	Alligator	No	Yes
Centerline Cracking	Single & Multiple	Yes	No
	Alligator	No	Yes
Pavement Edge Cracking	Single & Multiple	Yes	No
	Alligator	No	Yes
Transverse Cracking	Single & Multiple	Yes	No
	Alligator	No	Yes
Longitudinal Cracking – meander or mid-lane		Yes	No
Potholes/Patching		No	Yes

The SCR and BCR ratings have been applied in the study to get more representative and specific data relative to the condition of road surfaces and bases, as well as to more precisely assess treatment need types. Each of the SCR and BCR ratings are on a scale out of 10, with 10 representing a very good condition.

To convert the condition data collected in the field (i.e., based on the severity and density of the distresses noted on the surface of the road) into SCR and BCR values, the conversion matrix shown in Table 2 was applied.

Table 5.2: Individual Deficiency Rating Conversion Matrix (to SCR & BCR Values)

Severity	Density				
	Few	Intermittent	Frequent	Extensive	Throughout
Very Slight	9	9	9	9	9
Slight	9	9	8	8	8
Moderate	8	7	6	5	5
Severe	8	7	4	3	2
Very Severe	8	7	3	2	1

* If a specific distress is not present (for any given road section), then the SCR and BCR values are both 10.

In order to obtain the overall SCR and BCR rating for each hardtop road section, the minimum SCR and BCR rating for any specific deficiency on any given road section was applied. For example, for a given road section, if the individual surface-related deficiencies have SCR's ranging from 3-10 and individual base-related deficiencies ranging from 4-7, then the overall SCR and BCR ratings for this road section would be 3 and 4, respectively.

The SCR, BCR, and PCI condition ratings for each road section inventoried are included in Appendix C.

5.2 Improvement Types

The hardtop road improvement types considered in this study are the following:

- Routine Maintenance (RM) – crack sealing.
- Responsive Maintenance - spot improvements/patching (asphalt surfaces).
- Preventive Maintenance (PM) – micro-surfacing or slurry seals.
  - Routine/Preventive Maintenance can help to delay the need for more extensive rehabilitation or reconstruction. Routine/preventive maintenance is typically done when a road is in good condition. Crack sealing, slurry sealing, and microsurfacing can prevent water from infiltrating through cracks to the road base, which ultimately helps to prevent further deterioration of the road base and increases the length of time before more extensive treatments are required.
- Resurface (R) – Hot Mix Asphalt (HMA) overlay (semi-urban and rural environments) or mill and replace surface course asphalt (urban environment).
  - Resurfacing treatments are typically done when a road is in fair condition. Given that the road is in fair condition, resurfacing treatments generally consist of replacing the surface of roadways, but minimal (if any) work is done to the base of the road. Resurfacing treatments mentioned in this RMP are not to be confused with microsurfacing treatments, which are considered a form of preventative maintenance which is applied to roads still in good condition with only minor amounts of cracking.
- Rehabilitation (REH) – pulverize, partial culvert replacement, addition of Granular A and one or two lifts of HMA (semi-urban and rural environments) or full depth asphalt

removal, catch basin/manhole adjustments, spot curb replacement and two lifts HMA (urban environments).
  - More extensive rehabilitation treatments are applied to pavements in poor condition which have deteriorated to a point where partial or full depth replacement of the pavement is required to protect the integrity of the underlying granular base and to delay more extensive reconstruction being required. Pavement rehabilitation extends the service life of a pavement and its load carrying capacity by enhancing its pavement structure. This is achieved by eliminating the age-related deterioration of the pavement and/or increasing the thickness of pavement layers, which returns the structural adequacy of the overall pavement to a value that is able to meet the loading requirements that it is designed to service.
- Reconstruction (REC) – full depth removal, total base replacement, total curb replacement and catch basin/manhole adjustments (urban environment), partial culvert replacement (rural or semi-urban environments), and one or two lifts HMA.
  - Reconstructions are typically done when a road is in very poor condition, or if work is being done to infrastructure beneath a road which require that the road be reconstructed. If pavements are left to deteriorate, they become weak and lose their structural integrity. As its structural capacity is weakened, a pavement will begin to disintegrate, resulting in extensive cracking, rutting and potholes being developed. At this point maintenance, resurfacing, or rehabilitation treatments will not be able to restore its structural integrity. Once a minimum condition level is reached (i.e., approximately PCI 20), the pavement and road base may require full reconstruction in order to reestablish the proper base support for the pavement. Applying a lesser degree of rehabilitation may result in premature failure of any newly applied pavement surface. Once the pavement degrades below a minimum recommended condition, ongoing maintenance (e.g., filling of potholes) will typically increase significantly and/or safety or user complaints may become a concern. Reconstruction is also required when the pavement needs to be improved, to cater to significant increases in projected traffic volumes or increased truck volumes or to accommodate road widening.

To determine improvement types that are warranted for certain road sections, the SCR and BCR ratings, determined from the distresses collected in the field, were assigned to the distress trigger value ranges set for different improvement types. The trigger value ranges set for each improvement type are summarized in Table 5.3, in addition to the effect that is anticipated from the improvement on road conditions (i.e., the net benefit to the SCR and BCR values after a certain improvement type). Specific details on what each improvement entails are included in Table 5.3, based on the distress trigger ranges, surface type, roadside environment, and traffic volumes. Estimated treatment costs (approximate) are also provided in Table 5.3, with the basis of these estimated bench mark costs provided in Appendix D.

Table 5.3: Template for Lifecycle Road Improvements

Improvement	Urban or Semi-Urban - Hardtop (Any AADT)				Rural - Hardtop (HCB/CRA)					Semi-Urban or Rural - Gravel			
	Post-Treatment Condition	High Class Bituminous (HCB)	Cold Recycled Asphalt (CRA)	Distress Triggers	Post-Treatment Condition	AADT>=400	400>AADT >=200	AADT<200	Distress Triggers	Post-Treatment Condition	AADT>=200	AADT<200	Distress Triggers
Routine Maintenance (RM)[1]	SCR=10	Crack Sealing [$0.75 per m^2]	N/A (Responsive Maintenance)	8.5<=SCR<9.5 **AND** BCR>=7.5	SCR=10	HCB – Crack Sealing [$0.75 per m^2] CRA – N/A (Responsive Maintenance)			8.5<=SCR<9.5 **AND** BCR>=7.5	N/A	Maintenance Gravel + Calcium Chloride [$0.80 per m^2]	Maintenance Gravel + Calcium Chloride [$0.80 per m^2]	N/A
Preventive Maintenance (PM)	SCR=10	Micro-Surfacing [$4 per m^2]		7.5<=SCR<8.5 **AND** BCR>=7.5	SCR=10	Micro-Surfacing [$4 per m^2]		Slurry Seal [$3 per m^2]	7.5<=SCR<8.5 **AND** BCR>=7.5				
Resurface (R)[2]	SCR=10 BCR=8	*Urban* - Mill + 50mm HL4 [$13 per m^2] *Semi-Urban* – 50mm HL4 + Shouldering [$10 per m^2]		5.5<=SCR<7.5 **AND** BCR>=6.5	SCR=10 BCR=8	60mm HL4 + Shouldering [$14 per m^2]	50mm HL4 + Shouldering [$10 per m^2]		5.5<=SCR<7.5 **AND** BCR>=6.5				
Rehabilitation (REH)[5, 9]	SCR=10 BCR=9	*Urban* - Full depth asphalt removal + 50mm HL8 + 40mm HL3 + 10% Curb/Gutter Replacement + Catch Basin/Manhole Adjustments [$26 per m^2] *Semi-Urban* – Pulverize + 60mm HL4 + Shouldering [$15 per m^2]		2<=SCR<5.5 **OR** 2<=BCR<6.5	SCR=10 BCR=9	Pulverize + PAD + 100mm Granular A + 60mm HL4 + 40mm HL3 + Shouldering [$29 per m^2] [7]	Pulverize + PAD + 100mm Granular A + 60mm HL4 + Shouldering [$20 per m^2] [8]	Pulverize + 60mm HL4 + Shouldering [$15 per m^2]	2<=SCR<5.5 **OR** 2<=BCR<6.5				
Reconstruction (REC)[6]	SCR=10 BCR=10	*Urban* – Full depth asphalt removal + + Total base replacement + 50mm HL8 + 40mm HL3+ 100% Curb/Gutter Replacement + Catch Basin/Manhole Adjustments [$68 per m^2] *Semi-Urban* – Full depth asphalt removal + Total base replacement + 60mm HL4 + Shouldering [$42 per m^2]		SCR<2 **OR** BCR<2 **OR** Requires underground infrastructure improvements	SCR=10 BCR=10	Full depth asphalt removal + Total base replacement + 50mm HL8 + 40mm HL3 + Shouldering [$51 per m^2]	Full depth asphalt removal + Total base replacement + 60mm HL4 + Shouldering [$42 per m^2]		SCR<2 **OR** BCR<2 **OR** Requires underground infrastructure improvements	SCR=10 BCR=10	Total base replacement + 60mm HL4 [3] + Shouldering [$37 per m^2]		Considers Surface Upgrade Criteria[4]

1. For crack sealing, in addition to the SCR, single/multiple cracking must be present on the road section (i.e., some cracking, such as alligator or block cracking, is more typically related to the road base and typically are not able to practically benefit from crack sealing).
2. Cracks over 0.25 inches wide should be sealed prior to application of an HMA Overlay treatment, to reduce the potential for reflective cracking. Contingencies have been excluded from the resurface unit cost estimates.
3. Boreholes should be taken at the design stage to determine the condition of a gravel road's base, and to confirm if asphalt is preferred (over Double Surface Treatment, recycled asphalt, etc.). Improvements to the road section's base and drainage are required prior to hardtopping the road's surface.
4. Refer to the gravel road upgrading policy outlined in Section 5.8 for all criteria that should be considered when determining if a gravel road section warrants upgrading to a hardtop surface, as well as an upgrading prioritization methodology. Note that simply adding a hardtop surface to a previously gravel road section (without ensuring that the road's alignments, width, drainage, etc. meet hardtop road standards) does not constitute as a reconstruction project.
5. Either a REH or REC treatment is applied at the end of the road's life, depending on the condition of the road base. Rehabilitation unit costs shown do not consider culvert replacement costs. Contingencies have been excluded from the rehabilitation unit cost estimates.
6. The unit cost applied in this study to revert an existing hard-top road to a gravel surface is $5.76 per m^2, and consists of pulverizing the existing hard-top road and adding 100mm of Granular A. Either a REH or REC treatment is applied at the end of the road's life, depending on the condition of the road base. Reconstruction unit costs shown do not consider culvert replacement costs. Contingencies have been excluded from the reconstruction unit cost estimates.
7. Additionally, the cost for a potential rehabilitation treatment on any segment of 2nd Line SW or 3rd Line OS (from Shelburne to County Road 17) was estimated at $29 per m^2, to account for high traffic volumes and the function of each road.
8. Additionally, the cost for a potential rehabilitation treatment on any segment of 5th Line OS was estimated at $34 per m^2 (instead of $20 per m^2), since 5th Line OS is in a swamp area and, therefore, a rehabilitation on 5th Line OS would include a 9 metre wide geogrid as well as additional granular A. The estimated existing (2019) traffic volume on all asphalt segments of 5th Line OS are between 200 and 400 vehicles per day (vpd).
9. The following sections have both an existing rehabilitation treatment need and vertical deficencies: 3rd Line OS between County Road 17 and 2 km north of 5th Sideroad (section #544) and 3rd Line OS between County Road 17 and 15th Sideroad (section #96). To account for the correction of the vertical deficencies on these two sections, an additional $30,000 and $150,000 were added to the total improvement need cost for sections #544 and #96, respectively.
10. Unit costs for specific road section improvements may have been adjusted, where required, to account for local road characteristics. Refer to the Inventory Table in Appendix C for the specific unit costs applied for each road section improvement need.

5.3 Improvement Costs

General improvement benchmark unit costs are for budget planning purposes and have been based on theoretical costs per square metre of hardtop surface for a recommended improvement standard. Improvement projects are generally completed through a combination of day labor and equipment rental, where required, or through contract work. While these unit costs are considered sufficient for planning purposes, actual costs may vary according to the following factors:

- site-specific requirements/constraints;
- fluctuations in input costs (such as the price of oil impacting asphalt costs); and
- budget constraints requiring consideration of lesser standards (such as maintaining vertical profiles to tolerable conditions or reducing overall improvements).

Benchmark improvement costs (per square metre) are outlined in Table 5.3 above and are based on available unit cost data from similar lower-tier Ontario municipalities (in terms of location, population, and climate) as well as some recent unit cost data provided by the Township**.** The improvement types/costs consider surface types, traffic volumes, road conditions, and roadside environments. Since the improvement benchmark costs are estimated on a square metre of hardtop road basis, the improvement costs for any particular road section will also capture individual road widths.

Note that the unit costs (per square metre) identified above have been used in years 11 to 20 of this study's 20-year budget sensitivity analysis. However, unit costs applied in this study's detailed ten-year improvement plan differ slightly from the unit costs outlined in Table 5.3 to account for some of the factors listed above, such as the addition of geogrid in swampy areas, correcting vertical deficiencies and network continuity, among others. It is recommended that standards be reviewed on a project specific basis as budgets are established and additional design details become available.

The breakdown of the unit costs applied in this RMP's 20-year budget sensitivity analysis are provided in Appendix D.

5.4 Improvement Prioritization

The Ministry of Transportation Ontario (MTO) has developed a Priority Guide Number (PGN) formula that can be used to prioritize road improvements based on condition ratings, improvement costs, and traffic volumes. To prioritize recommended hardtop road improvements in this study, Burnside has adjusted MTO's PGN formula, to reflect the adjusted condition rating methodology that has been developed for this study.

The PGN has built-in factors which account for asset management best practices, to strive to recommend the right treatment to the right road at the right time based on

where the road section lies within its lifecycle. As described in further detail in Section 5.5 of this RMP, to be most cost-effective, timely expenditures should be made using routine and preventive maintenance treatments, rather than allowing further degradation requiring much more costly rehabilitation or reconstruction treatments.

The PGN formula used in this RMP is as follows:

$$PGN = \frac{(20 - \text{SCR} - \text{BCR}) * \text{TF} * \text{LCF}}{10000 * Road\ Width * (cost\ per\ square\ metre)}$$

where:

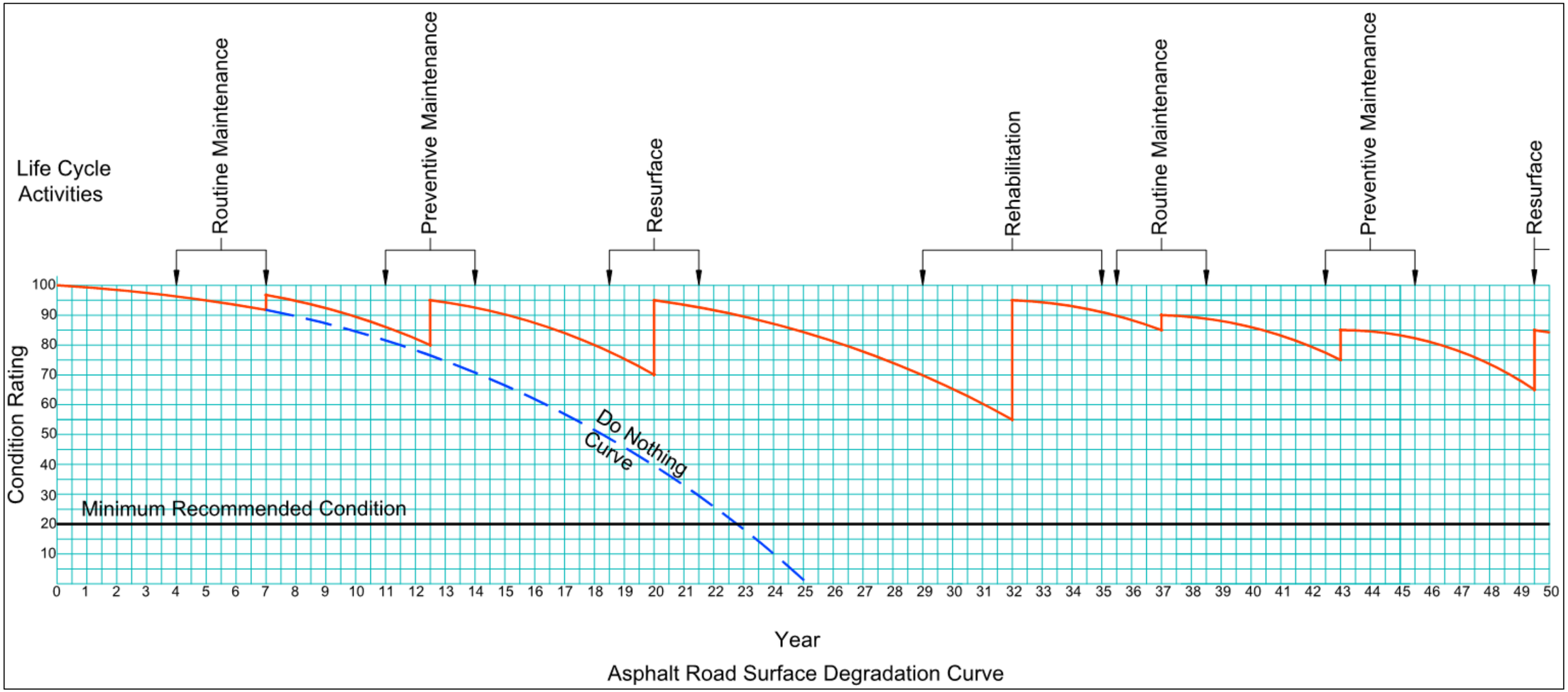
- SCR is the Surface Condition Rating (out of 10).
- BCR is the Base Condition Rating (out of 10).
- TF is the Traffic Factor, which is an estimate of the traffic served over the lifecycle of the improvement, as follows:
  - routine maintenance TF = (Existing AADT + Yr. 10 AADT) x 0.38
  - preventive maintenance TF = (Existing AADT + Yr. 10 AADT) x 0.42
  - resurfacing TF = (Existing AADT + Yr. 10 AADT) x 0.50
  - rehabilitation or reconstruction TF = Yr. 10 AADT
- LCF is the Lifecycle Factor, which is the typical number of days that is assumed to be added to the pavement life as a result of the treatment, as follows:
  - 1095 for routine maintenance treatments;
  - 1825 for preventive maintenance treatments;
  - 3650 for or resurfacing treatments; and
  - 7300 for rehabilitation and reconstruction treatments.
- Road Width is the hardtop width of a given road section (in metres).

The higher the PGN value, the higher the priority of the section relative to its condition, the traffic it is serving and the cost of improving the section to provide the most service to traffic for the dollar expended. This provides one measure of comparison between improvement requirements of any particular road section relative to other road sections.

5.5 Road Condition Deterioration

Typically, roadways with poor condition ratings are considered maintenance intensive. It is recognized that budget constraints often require that road sections be allowed to deteriorate before rehabilitation is scheduled. However, if routine and/or preventive maintenance is applied to a road section prior to the road base being significantly impacted, then the overall life of the road section can be extended, beyond what is achievable through a reconstruction/rehabilitation strategy alone, thus optimizing the use of the Township's resources. Figure 3 below illustrates how preventative maintenance modifies the typical degradation curve of pavements, thus extending the road's useful life while at the same time providing a higher level of service to the public.

Figure 3: Benefit of Applying Preventive Maintenance – Asphalt Surface Life



To account for the ongoing deterioration of roads in the Township, Burnside has developed formulas to estimate the future condition of a road section in any given year. The road condition degradation equations are described below for hardtop roads (HCB and CRA roads).

This study assumes that the surface of all hardtop roads in the Township will have a useful life of 20-25 years, and that the base of all hardtop roads will have a useful life of 60 years. Based on these assumptions, degradation formulae have been developed for an asphalt road's surface condition (i.e., SCR) and base condition (i.e., BCR), as follows:

$$SCR\ in\ Year\ Y = \ Current\ SCR - (e^{0.092*(Y)} - 1)$$

$$BCR\ in\ Year\ Y = Current\ BCR - (e^{0.038*(Y)} - 1)$$

where:

- Current SCR is the current year SCR value. The minimum SCR value is 1.0 in any given year.
- Current BCR is the current year BCR value. The minimum BCR value is 1.0 in any given year.
- Y is the year at which a road section's SCR or BCR value is being estimated (for example, Y would be 20 if a road section's SCR and BCR were being estimated 20 years into the future).

5.6 Remaining Useful Life

In general, the remaining useful life of a physical asset is the length of time an asset is forecast to function/operate providing acceptable level of service (i.e., remain "useful") before it needs to be replaced. As noted previously, this study assumes that the surface of all hardtop roads in the Township will have a useful life of 25 years, and that the base of all hardtop roads will have a useful life of 60 years.

The remaining useful life of hardtop road surfaces and bases in the Township as of 2019 have been estimated using the following formulae, which account for each road section's current condition:

$$Road\ Surface\ Remaining\ Useful\ Life\ (in\ Years) = 25 - \frac{Ln(11 - Current\ SCR)}{0.092}$$

$$Road\ Base\ Remaining\ Useful\ Life\ (in\ Years) = 60 - \frac{Ln(11 - Current\ BCR)}{0.038}$$

where:

- Current SCR is the current year SCR value (maximum 10, minimum 1).
- Current BCR is the current year BCR value (maximum 10, minimum 1).

5.7 Replacement Costs

The replacement cost of a physical asset is the amount it would cost to replace the existing asset with the same (or a similar) asset.

The benchmark improvement costs for "Reconstruction" improvements, as outlined in Table 5.3 (Section 5.2), were used to estimate the replacement cost for all hardtop roads in the Township. For the purposes of estimating the replacement cost of gravel road sections reviewed in this study, it is assumed that these roads will retain their gravel surface (i.e., rather than be upgraded to a hardtop surface). Thus, the cost to reconstruct an existing gravel road (back to gravel, including building-up the road) was estimated using a benchmark cost of $21.78 per m^2 (refer to Appendix D for unit cost breakdowns).

The estimated road replacement cost for all roads reviewed in this study (i.e., approximately 91 centreline km) are contained in the inventory table in Appendix C. In summary, the total 2019 replacement cost for all roads inventoried in this study is estimated to be $25.1 million.

5.8 Gravel Road vs Hardtop Roads

The Township's *2017 Asset Management Plan* estimated that there were 167.3 km of gravel surface roads within the Municipality at that time. Maintaining the condition of gravel roads is typically dealt with as ongoing maintenance work (such as ongoing grading, maintenance gravel, dust control, etc.), unless upgrading the gravel road to a hardtop surface. Thus, this RMP reviews the potential for the select gravel roads considered in this study to be upgraded to a hardtop surface. Similarly, considering the limited budgets for maintaining and improving the roads, consideration has been given to the potential for some existing hardtop roads to revert to a gravel surface, once improvements are required to such roads. The purpose of the following sections of this report is to review the most appropriate surface management strategy.

5.8.1 Financial Comparison Between Gravel and Hardtop Roads

To compare the overall construction and maintenance costs of hardtop versus gravel roads, the following data has been obtained from the Township and used in this analysis:

- Gravel Roads (200 to 400 vpd)
  - The cost for the supply of maintenance gravel is approximately $5,200/every 2 years ($10.40/tonne).
  - Gravel roads are typically graded 7 times per year (at 1.5 hours per kilometer at $150/hour).
- Hardtop Roads (<400 vpd)

- The cost for grinding asphalt, supply and place 700 tonne of gravel, grading and compacting is approximately $13,575/km.
- The cost for supply and place 50 mm depth of asphalt is approximately $70,000/km.

The cost comparison of gravel versus hardtop surfaces assumes that the road is being rehabilitated or reconstructed in Year 1 to respond to condition deficiencies. Therefore, the work required in Year 1 will reflect the existing base condition (i.e., good or poor base) and the intended surface to be implemented (i.e., gravel or hardtop). It is assumed that the resulting Year 1 base will be sufficient to accommodate a 60-year lifecycle, assuming that typical maintenance and improvement work is completed to address the surface distresses throughout this period. The assumed works and costs expended during the lifecycle, depending on the surface strategy and the existing base conditions, are summarized as follows:

- Existing Gravel to Future Gravel – Good Base
  - Year 1 – Dust control + grading 7 times = $2,175/km
  - Year 2 – 500 tonne maintenance gravel + dust control + grading 7 times = $7,375/km
  - Years 3 through 59, repeat Year 1 and Year 2 sequence.

- Existing Gravel to Future Gravel – Poor Base
  - Year 1 – Base strengthening + dust control + grading 7 times = $33,800/km
  - Year 2 – Dust control + grading 7 times = $2,175/km
  - Year 3 – 500 tonne maintenance gravel + dust control + grading 7 times = $7,375/km
  - Years 4 through 59, repeat Year 2 and Year 3 sequence.

- Existing Gravel to Future Hardtop – Good Base
  - Year 1 – 700 tonne gravel + 50 mm asphalt = $79,575/km
  - Year 5 – Crack sealing = $1,500/km
  - Year 10 – Patch repair = $22,500/km
  - Year 20 – Pulverize = 700 tonne gravel + 50 mm asphalt = $83,575/km
  - Repeat the Year 5, 10, 20 sequence for the remainder of the lifecycle.

- Existing Gravel to Future Hardtop – Poor Base
  - Year 1 – Base strengthening + 50 mm asphalt = $101,625/km
  - Year 5 – Crack sealing = $1,500/km
  - Year 10 – Patch Repair = $22,500/km
  - Year 20 – Pulverize + 700 tonne gravel + 50 mm asphalt = $83,575/km
  - Repeat the Year 5, 10, 20 sequence for the remainder of the lifecycle.

- Existing Hardtop to Future Hardtop – Good Base
  - Year 1 – Pulverize + 700 tonne gravel + 50 mm asphalt = $83,575
  - Year 5 – Crack sealing = $1,500/km
  - Year 10 – Patch Repair = $22,500/km
  - Year 20 – Pulverize + 700 tonne gravel + 50 mm asphalt = $83,575/km
  - Repeat the Year 5, 10, 20 sequence for the remainder of the lifecycle.

- Existing Hardtop to Future Hardtop – Poor Base
  - Year 1 - Pulverize + base strengthening + 50 mm asphalt = $105,626/km
  - Year 5 – Crack sealing = $1,500/km
  - Year 10 – Patch Repair = $22,500/km
  - Year 20 – Pulverize + 700 tonne gravel + 50 mm asphalt = $83,575/km
  - Repeat the Year 5, 10, 20 sequence for the remainder of the lifecycle.

- Existing Hardtop to Future Gravel – Good Base
  - Year 1 - Pulverize + 700 tonne gravel + dust control + grading 7 times = $15,750/km
  - Year 2 – Dust control + grading 7 times = $2,175/km
  - Year 3 – 500 tonne maintenance gravel + dust control + grading 7 times = $7,375/km
  - Years 4 through 59, repeat Year 2 and Year 3 sequence.

- Existing Hardtop to Future Gravel – Poor Base
  - Year 1 – Pulverize + Base Strengthen + dust control + grading 7 times = $37,800/km
  - Year 2 – Dust control + grading 7 times = $2,175/km
  - Year 3 – 500 tonne maintenance gravel + dust control + grading 7 times = $7,375/km
  - Years 4 through 59, repeat Year 2 and Year 3 sequence.

The lifecycle costs for the various scenarios noted above are summarized in the following table:

Table 5.4: Lifecycle Costs for Gravel Versus Hardtop

Scenario	Existing Base Condition	Present Value Cost Per Km of 60 Year Maintenance / Improvement Lifecycle*
Retain Existing Gravel	Good	$169,953
Retain Existing Gravel to Future Gravel	Poor	$198,184
Conversion of Existing Gravel to	Good	$216,996
Conversion of Existing Gravel to	Poor	$239,046
Retain Existing Hardtop	Good	$220,996
Retain Existing Hardtop	Poor	$243,096
Conversion of Existing Hardtop to	Good	$180,134
Conversion of Existing Hardtop to	Poor	$202,184

* Present Value is based on assumed 2% inflation rate and 4% discount rate.

The results of the cost assessment indicate that gravel surface roads may have reduced costs over hardtop roads (i.e., capital and maintenance costs), assuming a 60-year lifecycle and traffic volumes below 400 vpd. However, there are several other considerations that may also be considered and may influence the decision on which surface type to apply. Many of these other considerations are difficult to associate a value to or may not provide a direct benefit to the Township. Additional considerations may include:

- Location of any particular road section within the continuity of the overall hardtop road networks (i.e., both internal to the Township and beyond the Township boundaries).
- Potential for a hardtop road to redistribute traffic away from other gravel roads as road users preferentially select paved roads, reducing maintenance requirements.
- Potential for the hardtop road to result in increased traffic volumes and higher travel speeds.
- Hardtop roads effectively waterproof the road base, which can reduce the potential for load related damage.
- Hardtop roads reduce dust emissions.

- Hardtop roads provide for improved vehicular operational characteristics (smoother ride, less noisy, higher skid resistance, reduce vehicular maintenance costs and fuel costs).
- Impact on road maintenance requirements.
- Possible impact on real estate values for properties along the road.

5.8.2 Pre-Screening Criteria for Potential Gravel Road Upgrading or Hardtop Road Downgrading

In addition to the general network-level considerations (i.e., both economic and non-economic) that have been outlined in the previous section, it is recommended that roads being considered for surface type modifications should also be pre-screened to identify specific road-related criteria that may further inform the decision. Some of the primary factors that should be considered when considering surface type requirements are the following:

- traffic volumes (i.e., AADT volumes);
- traffic types (e.g., percentage of trucks)
- functional classifications (e.g., local or collector, residential or industrial/commercial);
- driveway densities;
- road platform widths;
- road structures;
- drainage;
- road conditions;
- road geometry (alignments); and
- maintenance requirements/frequency.

Based on the factors listed above, the framework in Table 5.5 has been developed for the Township, for use as a pre-screening to assist in assessing surface type requirements and priorities. The criteria listed in Table 5.5 are intended as guidelines to identify areas that may need to be further addressed prior to assessing the impacts of modifying the road surface type. The prescreening list is intended to be a guide and is not an exhaustive list of all criteria. Modifications to surface type will also be subject to the budget and level of service limitations set by the Township.

Table 5.5: Site-Specific Considerations in the Determination of Surface Type Associated with Road Improvements (Pre-Screening)

Item No.	Description	Criteria
1	Traffic Volume	Rural road standards *(Inventory Manual for Municipal Roads, MTO, 1991)* recommend hardtop surfaces for roads with AADT of 200 vpd or more. However, hardtop surfaces may be considered for lesser volumes, if warranted by other factors. Similarly, gravel roads may continue to be considered for higher volumes, depending on other factors.
2	Network Continuity	Hardtop network continuity, emergency detour routes etc.
3	Land Use	The typical Level of Service for urban, semi-urban or commercial land uses is a har- top surface.
4	Road Alignment	Substandard vertical and/or horizonal curves should be tolerable, to support operating speeds that are anticipated to occur under hardtop road conditions.
5	Road Width	Hardtop road sections should have a platform width of at least 7.0 metres and tolerable encroachment of vegetation into the clear zone within the right-of-way.
6	Drainage	Adequacy of drainage (e.g., flooding, saturated granular base, inadequate ditching etc.).
7	Road Structure*	The road base and subbase materials should be adequate to support the anticipated loading and environmental conditions, considering the surface type specified (e.g., absence of frost boils or soft spots, etc.).

* To confirm that a road section will be able to support a hardtop surface, boreholes should be obtained on candidate road sections to assess the existing base and subbase materials and condition. Construction and lifecycle costs should be considered when deciding on which hardtop surface type to construct.

The criterion noted in Table 5.5 is recommended to be assessed as part of the detailed design for improvement projects, with the tolerable levels of these criteria established as part of such designs.

For the purposes of this RMP, the Township has identified several roads for which an assessment of surface type has been completed, as outlined in a subsequent section of this report.

5.8.3 Gravel Road Upgrading Prioritization

For gravel roads that are identified for potential surface upgrading, it is recommended that all such gravel roads be prioritized based on a Gravel Upgrade Prioritization Index (GUPI), which is based on the following numerical formula:

$$GUPI = TF + TVF + MF + DF$$

where the factors are described as follows:

- GUPI is the Gravel Upgrade Priority Index, out of 100 points. The higher the GUPI, the higher the priority. Table 5.6 indicates how each GUPI relates to a road section's upgrading priority.

Table 5.6: Gravel Upgrade Priority Index (GUPI) Ranges

Gravel Upgrade Priority Index (GUPI)	Priority to Upgrade from Gravel to Hardtop Surface	Priority to Downgrade from Hardtop to Gravel Surface
0-49	Low	High
50-74	Medium	Medium
75-100	High	Low

- TF is the Traffic Factor. The TF is based on a road section's AADT range in vehicles per day (vpd). Table 5.7 indicates how a given road section's TF corresponds to its AADT range.

Table 5.7: Traffic Factor (TF) Ranges

AADT Range (vpd)	Traffic Factor (TF)
0-199	0
200-399	30
400 and above	50

- TVF is the Truck Volume Factor. The TVF is based on the total average annual daily truck volume on a given road section. Based on the vehicle classification definitions contained in the *Verification, Refinement, and Applicability of Long-Term Pavement Performance Vehicle Classification Rules* (U.S. Department of Transportation Federal Highway Administration, November 2014), all vehicles in classification groups 4 to 13 are considered trucks (i.e., motorcycles, passenger cars, and other two-axle four-tire single-unit vehicles are not considered trucks). Table 5.8 indicates how a given road section's TVF corresponds to its truck volume range.

Table 5.8: Truck Volume Factor (TVF) Ranges

Truck Volume Range (vpd)*	Truck Volume Factor (TVF)
0-9	0
10-19	5
20-49	10
50 and above	20

* Includes the summation of all vehicles on a road section in classification groups 4 to 13 of the *Verification, Refinement, and Applicability of Long-Term Pavement Performance Vehicle Classification Rules* (U.S. Department of Transportation Federal Highway Administration, November 2014).

- MF is the Maintenance Factor, which accounts for a road's condition and maintenance needs, as well as the financial benefit that may be achieved as a result of eliminating the gravel road maintenance need. Based on input from Municipal staff, a gravel road section under consideration for upgrading should be classified as "high maintenance" if the road section's surface has historically higher maintenance needs than other gravel roads in the municipality. Note that this assessment should be based strictly on the maintenance of a gravel road surface, and that the base condition of any gravel road should be sufficient to accommodate a hardtop surface. Table 5.9 summarizes how a given road section's MF relates to its maintenance needs.

Table 5.9: Maintenance Factor (MF) Characteristics

Existing Surface Type	Maintenance Level	Characteristics	Maintenance Factor (MF)
Gravel	Normal	Road section has average maintenance needs.	0
	High	Road section has above average maintenance needs, as confirmed by Municipal staff (compared to other gravel roads in the municipality). Examples of high maintenance gravel roads include roads with above average maintenance gravel needs, above average grading needs, and/or above average dust suppressant needs.	15
Hardtop (HCB or CRA)	Normal	Road section has average maintenance needs.	15
	High	Road section has above average maintenance needs, as confirmed by Municipal staff (compared to other hardtop roads in the municipality). Examples of high maintenance hardtop roads include roads with above average cold patching and/or crack sealing needs.	0

- DF is the Driveway Factor, which accounts for the driveway access density on gravel road sections. Residential, commercial, institutional, and industrial driveways are included in this classification. Table 5.10 summarizes the DF that should be assigned to a given road section according to the driveway density per kilometre.

Table 5.10: Driveway Factor (DF) Ranges

Number of Driveways per Kilometre	Driveway Factor (DF)
0-3	0
4-6	5
7-9	10
10 and above	15

Potential gravel roads that may be considered for upgrading of their surface type can be sorted according to their GUPI values, so that such projects may be prioritized (i.e., higher GUPI values have higher priority for upgrading) and incorporated within the municipality's capital improvement programs, subject to budget availability.

The above methodology can also be used as an initial tool when assessing if an existing hardtop road may warrant reversion to a gravel surface. Potential hardtop roads that may be considered for downgrading of their surface type may be assessed according to their GUPI values (i.e., lower GUPI values have higher priority for a downgrade).

6.0 Consideration of Other Needs for Establishing Road Network Improvements

In addition to the condition of roads, this study has considered several other road-related needs that trigger certain improvement requirements for any particular road section. The other needs considered in this RMP include the following:

- Surface type needs – based on the criteria outlined in Section 5.6.
- Geometric needs – including deficiencies in horizontal/vertical alignments or surface/platform widths.
- Drainage needs – based on the frequency of flooding on the roadway or the adequacy of roadside drainage (such as ditching and brushing).
- Maintenance considerations.
- Coordination with other projects (e.g., infrastructure replacement, bridge works, Development Charge works).
- Road network connectivity considerations.

It is recommended that these road needs be considered independently, rather than collectively. The benefits of this approach include the following:

- Allows for a better integration into a pavement management system, where road condition will form the primary trigger for improvements.
- Clarity in establishing the time of needs, reason for improvement, and appropriate response.

The standards associated with the above road needs are based on the criteria outlined in the *Inventory Manual for Municipal Roads* (MTO, February 1991).

6.1 Geometrics

6.1.1 Alignments

Road alignments are reviewed to determine the number of substandard horizonal/vertical curves and/or substandard stopping sight distances resulting from such curves.

Deficient alignments are defined as curves which do not meet design speeds of 10 km/h over posted speeds. However, the *Inventory Manual for Municipal Roads* (MTO, 1991) defines curves as tolerable when they meet design speeds of 5 to 15 km/h below the posted speeds.

No horizontal alignment deficiencies were noted on the roads reviewed in this RMP. Therefore, all horizontal curves are considered adequate for resurfacing projects.

Vertical curve deficiencies have been identified on the following road sections:

- 3rd Line OS - from Highway 10 to 5th Sideroad (Section 1507).
- 3rd Line OS - from 5th Sideroad to 2 km north of 5th Sideroad (Section 93).
- 3rd Line OS - from 2 km north of 5th Sideroad to County Road 17 (Section 544).
- 3rd Line OS - from County Road 17 to 15th Sideroad (Section 96).
- 3rd Line OS - from 15th Sideroad to 1.5 km south of 20th Sideroad (Section 1467).
- 3rd Line OS - from 1.5 km south of 20th Sideroad to 20th Sideroad (Section 102).

Appropriate warning signage should be provided at all vertical deficiency locations, and any future road improvement projects at these locations should consider improving/reducing the magnitude of the vertical deficiency. For projects requiring reconstruction, it is recommended that vertical curves be reviewed as part of any detailed design work, prior to implementation of such projects.

6.1.2 Road Widths

Minimum tolerable and recommended minimum road widths for hardtop roads have been assessed according to criteria outlined in the *Geometric Design Guide for Canadian Roads* (Transportation Association of Canada [TAC], June 2017). The surface (i.e., travel lanes) width requirements for hardtop roads are outlined below in Table 6.1.

Table 6.1: Tolerable & Recommended Surface Widths for Hardtop Roads (Based on Criteria in the TAC *Geometric Design Guide for Canadian Roads*)

Roadside Environment	Design Speed (km/h)	Road Surface Width (Two-Lane Roadways)			
		Tolerable Lower Limit	Recommended Lower Limit	Recommended Upper Limit	Tolerable Upper Limit
Rural or Semi-Urban[1]	60 or less	5.4 m	6.0 m	7.4 m	8.0 m
	70 to 100	6.5 m[2]	7.0 m	7.4 m	8.0 m
Urban	60 or less	5.4 m	6.0 m	7.4 m	8.0 m
	70 to 100	6.0 m	6.6 m	7.4 m	8.0 m

1. It is assumed that the Design Hour Directional Volume is less than or equal to 450 vehicles per direction per hour (vpdph) on all rural and semi-urban road sections in the Township.
2. For rural or semi-urban roadways with a design speed of 70 to 100 km/h, a minimum tolerable surface width of 3.25 metres per lane was applied, which is consistent with minimum width criteria for secondary highways with an AADT less than 1,000 vpd outlined in the *Geometric Design Standards for Ontario Highways* (Ministry of Transportation Ontario, 1989).

The minimum gravel road surface widths (i.e., platform width, including shoulders) have been assessed according to criteria outlined in the *Geometric Guidelines for Municipal Roads* (Ontario Good Roads Association [OGRA], 1998). The recommended minimum platform width requirements for gravel roads are outlined below in Table 6.2

Table 6.2: Recommended Minimum Platform Widths for Gravel Roads (Based on Criteria in the OGRA *Geometric Guidelines for Municipal Roads*)

Design Speed (km/h)	Minimum Platform Width for Varying AADT Traffic Volume Ranges (Vehicles per Day) [1]				
	<50 vpd	50 – 249 vpd	250 – 399 vpd	400 – 999 vpd	1,000 – 2,000 vpd
80	5.5 m	6.0 m	6.5 m	7.5 m	7.5 m
70				7.0 m	7.0 m
60				6.5 m	6.5 m
50				6.0 m	6.5 m
40				6.0 m	6.0 m

1. Widths outlined in the table exclude road rounding.

The hardtop road sections reviewed in this RMP which do not meet the minimum tolerable road widths outlined above are the following:

- High Street - from William Street to Main Street (Section 185).
- Church Street - from Main Street to end of road (Section 200).
- Addeson Street - from George Street to Lloyd Street (Section 186).
- Lloyd Street - from Addeson Street to Main Street (Section 187).
- George Street - from Addeson Street to Main Street (Section 188).
- Mill Lane - from Main Street to end of road (Section 195).

It is not expected that the Township will undertake the widening of the above roads due to building encroachment and planning related details from the past.

All of the gravel roads that were reviewed in this RMP were found to have acceptable widths, both as gravel roads and to support the potential upgrading of these roads to asphalt.

For rural hardtop roads, the provision of sufficient shoulder widths is necessary to ensure proper support for the pavement surface and to ensure a sufficient buffer between traffic and embankment slopes to maintain safety. For higher traffic volumes, a wider shoulder may also be provided to allow for space for disabled vehicles. MTO's desirable design standards for various traffic volumes are as follows:

- Traffic volumes < 1000 vpd – 1.5 m shoulders.
- Traffic volumes 1000 to 3000 vpd – 2.5 m shoulders.
- Traffic volumes >3000 vpd – 3.0 m shoulders.

A minimum shoulder width of 0.5 metres is required to meet the requirements for pavement edge support.

Based on consultation with Township staff, it was identified that various segments of 3rd Line OS have limited shoulder widths. It is recommended that widths be considered for

upgrading to meet tolerable standards for roads that are being rehabilitated or reconstructed, considering site-specific requirements.

6.2 Drainage

Historical and existing drainage issues (e.g., flooding, ponding) were identified based on discussions with Township staff. In general, the Township does not have a history of flooding on any of their roads. The Township undertakes brushing as part of their regular maintenance practices, which allows for roadside ditches to function and which promotes the drying of the roads and ditches.

Ditching was completed in 2018/2019 on the following road sections:

- 5th Line OS - from 20th Sideroad to County Road 21 (Section 161).
- 5th Line OS - from County Road 21 to Sideroad 250 (Section 1452).

Where road works are proposed, it is recommended that additional investigations be completed to determine the requirements for drainage improvements. It is recognized that the practicality of achieving sufficient drainage outlets may constrain the opportunities to improve roads in some areas with drainage issues. However, considering the importance of proper drainage in achieving the performance of the roads, effort should continue to be made to improving these outlets, possibly through mechanisms such as petitions under the Drainage Act.

6.3 Maintenance Considerations

Maintenance demands (e.g., low, average, high) is not a primary consideration in the prioritization of road sections for improvements, however is an additional item that may be considered by the Township when reviewing maintenance requirements.

In general, gravel roads in the Township maintain an adequate condition after they are graded and dust suppressant is applied.

Based on discussions with Township staff, the following road sections have above-average (i.e., high) maintenance demands, due to their current condition:

- Cold patching is required regularly on the following roads:
  - 5th Line OS between County Road 17 and County Road 21 (Sections 94, 101, 1492, 159, 1493, 160 and 161).
  - 3rd Line OS between Sideroad 15 and Sideroad 20 (Sections 1467 and 102).
- It is expected that a higher level of cold patch maintenance will be required on the following roads:
  - 260 Sideroad between Highway 10 and 7th Line SW (Sections 107, 26, 25, 24, 29,32 and 31).

- 7th Line SW between Highway 89 and Sideroad 260 (Sections 143, 142, 111 and 1489).

7.0 Road Improvement Needs

7.1 Gravel Road Needs and Review of Potential Gravel Road Upgrades to Hardtop Surfaces

A total of approximately 15 km of gravel roads were reviewed in this study, consisting of segments of 4th Line NE, 5th Line OS and 8th Line NE, as shown on the map in Appendix B.

Table 7.1 outlines the gravel road sections reviewed in this study, including each road section's estimated existing AADT volume and estimated GUPI value (according to the criteria and methodology outlined in Section 5.8.3). In addition, each gravel road section outlined in Table 7.1 has been sorted according to its estimated GUPI value, in order to demonstrate which sections have higher priority for upgrading to a hardtop surface (i.e., road sections with higher relative GUPI values have a higher perceived need for a hardtop surface).

Table 7.1: Gravel Road Sections, Sorted by Gravel Upgrade Priority Index (GUPI) Values

Section ID	Road Name	From	To	Existing AADT Volume (vpd)	Traffic Count Year	GUPI
1452	5th Line OS	County Road 21	30th Sideroad	222	2019	40
1519	5th Line OS	30th Sideroad	Sideroad 240	222	Estimate	40
1520	5th Line OS	Sideroad 240	County Road 9	222	Estimate	40
1511	8th Line NE	Sideroad 240	County Road 9	145	2018	15
1603	8th Line NE	County Road 9	Townline	125	Estimate	15
1440	8th Line NE	5th Line OS	Sideroad 250	196	2019	10
1441	8th Line NE	Sideroad 250	Sideroad 240	125	Estimate	10
1596	4th Line NE	Sideroad 240	1 km N of Sideroad 240	150	Estimate*	10
1594	4th Line NE	Sideroad 250	Sideroad 240	150	Estimate	5
1595	4th Line NE	County Road 21	Sideroad 250	149	2019	0

* This road section had a traffic count completed in 2018, however this was before the asphalt road surface was reverted to gravel. Thus, a post-2018 (gravel road) AADT estimate has been applied.

As shown in Table 7.1, all gravel roads reviewed in this study have GUPI values that reflect low priority for conversion to a hardtop surface, based on their traffic volumes, truck volumes, maintenance requirements and driveway densities. In addition, maintaining these as gravel roads is expected to reduce capital and maintenance costs over the long term. For the most part these gravel roads have good PCI ratings, good road structure, acceptable road alignment, road widths and drainage, which could accommodate their upgrading to hardtop roads, if required.

Note that for all existing gravel road sections analyzed below, a primary consideration / factor is that it is expected that maintaining these as gravel roads will reduce capital and maintenance costs over the long term, compared to a hardtop road surface.

5th Line OS: From a network continuity perspective, the paving of the gravel road sections of 5th Line OS (i.e., ID numbers 1452, 1519 and 1520) completes a north-south hardtop connection running parallel to Dufferin Road 124 between Grey Road 9 and

Dufferin Road 21, as well as to Dufferin Road 17 (i.e., via the existing paved sections of 5th Line OS). These sections currently have traffic volumes that exceed 200 vpd. The potential for this road attracting additional traffic as a result of upgrading to a hardtop surface may be limited, considering origin-destination considerations and alternate county road routes in this area. Given the limited budgets for upgrading the level of service of roads within the Township, the upgrade of these sections of the 5th Line OS is not recommended at this time.

4th Line NE: From a network continuity perspective, alternate asphalt roads exist in the vicinity of 4th Line NE that could accommodate traffic in this area, including Dufferin Road 21, Highway 10 and 5th Line OS. The existing gravel surface sections of 4th Line NE are sections #1594, 1595 and 1596 (between Dufferin Road 21 and 1 km north of Sideroad 240). Based on 2019 traffic volume data, the AADT on the existing gravel road section of 4th Line NE between County Road 21 and Sideroad 250 is only 149 vpd, which is relatively low. Also, it is likely that upgrading these sections of 4th Line NE would result in an increase in traffic volumes, since greater volumes of drivers would re-route to these road sections as a result of a new hardtop surface. However, ideally external drivers (i.e., drivers who do no reside on 4th Line NE or roads intersecting 4th Line NE) will utilize the upper-tier road network (i.e., county and provincial roads) in order to travel through the Township, rather than local roads under the Township's jurisdiction. Therefore, for the above reasons, it is recommended that sections #1594, 1595 and 1596 of 4th Line NE (between County Road 21 and 1 km north of Sideroad 240) remain gravel.

8th Line NE: From a network continuity perspective, the paving of the gravel surface 8th Line NE sections (i.e., ID numbers 1511, 1603 and 1440) would provide an additional connection between Dufferin Road 21 and Dufferin Road 9. However, this road currently has relatively low traffic volumes (less than 200 vpd). As noted previously, external drivers should use upper-tier hardtop roads to travel through the Township, rather than use 8th Line NE as a "shortcut" between Grey Road 9 and Dufferin Road 21. Therefore, the upgrade of these sections of the 8th Line NE is not recommended at this time.

Although none of the above road sections are recommended to be upgraded to hardtop surfaces at this time, it is recommended that traffic volumes and maintenance costs continue to be monitored in the future to reassess the cost-benefit of potential upgrading, as conditions change and subject to budget availability.

The surface type recommendations for the gravel roads reviewed are shown on the map in Appendix E.

7.2 Hardtop Road Needs and Review of Potential Hardtop Road Downgrades to Gravel Surfaces

Based on the existing road condition data collected in the field in Spring 2019, the hardtop road improvement needs were determined according to the improvement trigger criteria outlined in Table 5.3 (Section 5.2).

It has been estimated that the existing cost of hardtop road needs in the Township is approximately $8 million. Table 7.2 below summarizes the hardtop road needs by improvement types.

Table 7.2: Township of Melancthon Hardtop Road Needs

Improvement Need Type	Amount of Hardtop Road Needs		
	Cost (in CAD Dollars)	Length (in kilometres)	Percentage of Total Length
Routine Maintenance	$81,781	16.3	21.4%
Preventive Maintenance	$280,053	11.2	14.7%
Resurface	$191,658	2.0	2.6%
Rehabilitation	$4,994,751	37.7	49.4%
Reconstruction	$2,502,444	9.1	11.9%
Total	**$8,050,867**	**76.3**	**100.0%**

provides a qualitative condition summary based on the combined SCR plus BCR (out of 20) value ranges on all hardtop road sections in the Township.

Table 7.3: Qualitative Description of Hardtop Road Network

Combined (SCR + BCR) Value Range	Condition	Length of Road (Centerline km)	Percentage of Total Length
18 to 20	Excellent	22.3	29.2%
15 to 17.9	Good	7.9	10.3%
13 to 14.9	Fairly Good	12.1	15.9%
10 to 12.9	Fair	7.3	9.6%
Below 10	Poor	26.7	35.0%
Total	**-**	**76.3**	**100.0%**

Based on the criteria outlined in Section 5.8.1, all existing hardtop road sections in the Township have been reviewed in the context of potential reversion to a gravel road surface. One of the primary considerations in deciding whether a hardtop or gravel road surface is more appropriate for any given road section is the daily traffic volume that a road receives. Therefore, all existing rural hardtop road sections with AADT volumes less than 200 vpd have been listed in Table 7.4 below, for the purpose of outlining hardtop road sections in the Township which may warrant reversion to a gravel road surface. However, note that analyzing traffic volumes alone is not enough to conclude

whether or not any given section warrants a hardtop surface. Urban and semi-urban road sections with AADT volumes less than 200 vpd have not been included in Table 7.4, since the recommended surface type for such roadside environments is hardtop.

The road sections outlined in Table 7.4 provide direction to the Township on which roads may warrant reversion based on traffic volumes, in conjunction with a review of other factors such as truck volumes, widths, alignments, drainage, and road structures. In addition, each hardtop road section outlined in Table 7.4 has been sorted according to its estimated GUPI value, in order to demonstrate which sections may have higher priority for reversion to gravel surfaces (i.e., road sections with lower relative GUPI values have a lower perceived need for a hardtop surface).

Table 7.4: Hardtop Road Sections with AADT Volumes Less Than 200 vpd, Sorted by Gravel Upgrade Priority Index (GUPI) Values

Section ID	Road Name	From	To	Existing AADT Volume (vpd)	Traffic Count Year	GUPI
1489	7th Line SW	Sideroad 270	200m S of Sideroad 260	177	2019	5
95B	4th Line OS	Strada Pit North Entrance	15th Sideroad	79	2019	20
194	15th Sideroad	County Road 124	Main Street	125	Estimate	20
1345	20th Sideroad	3rd Line	County Road 124	164	2019	20
1490	3rd Line OS	20th Sideroad	County Road 21	107	2019	25
95A	4th Line OS	County Road 17	Strada Pit North Entrance	125	Estimate	25
1491	15th Sideroad	Main Street	East End of Hardtop	125	Estimate	25
176	15th Sideroad	3rd Line	County Road 124	125	Estimate	25

Maintaining these as gravel roads is expected to reduce capital and maintenance costs over the long term. In addition, based on qualitative information provided by Township staff, it is understood that most of the hardtop roads are assumed to have relatively poor road structure, for which it may be more cost-effective to maintain as gravel road surfaces.

Discussed below are existing hardtop roads (with any AADT volume) that have been assessed in further detail with regards to potential reversion to gravel surfaces.

4th Line NE: From a network continuity perspective, alternate routes exist in the vicinity of section #65 (4th Line NE between County Road 21 and 5th Line OS) that could

accommodate traffic in this area, including County Road 21 and 5th Line OS, which both consist of asphalt surfaces. Based on a traffic count collected in 2019, the existing AADT on section #65 is 257 vpd, which is relatively low. Also, it is likely that reverting section #65 to gravel would result in a reduction in traffic volumes, since greater volumes of drivers would re-route to the existing hardtop roads in the area. This is considered to be particularly true for section #65, since it appears to provide drivers with an alternate connection between County Road 21 and County Road 9 / County Road 2. However, ideally external drivers (i.e., drivers who do no reside on 4th Line NE or roads intersecting 4th Line NE) will utilize the upper-tier road network (i.e., county and provincial roads) in order to travel through the Township, rather than local roads under the Township's jurisdiction. Therefore, for the above reasons, it is recommended that section #65 of 4th Line NE (between County Road 21 and 5th Line OS) be considered for reversion to gravel once the existing hardtop surface deteriorates to a condition level where a gravel surface would be preferred. The estimated cost to downgrade section #65 of 4th Line NE is approximately $147,000 (assuming the road base is good).

Alternate routes exist in the vicinity of section #72 (4th Line NE between County Road 9 and 1 km north of Sideroad 240) that could accommodate traffic in this area, such as Highway 10 and County Road 9. The existing AADT is relatively low at 289 vpd. Therefore, it is recommended that this section be reverted to gravel once the existing hardtop surface deteriorates to a condition level where a gravel surface would be preferred. Based on the road sections current condition, it is expected that this may occur in the 2040-2045 horizon, assuming that appropriate treatments are applied to the road section at the appropriate time in its lifecycle. The estimated cost to downgrade section #72 of 4th Line NE is approximately $60,000 (assuming the road base is good).

7th Line SW: The sections of 7th Line SW between Highway 89 and 200 metres south of Sideroad 260 (i.e., section IDs #1489, 111, 142 and 143) have traffic volumes that are less than 220 vpd, which is relatively low. If these sections of 7th Line SW were to revert to gravel, it is probable that traffic volumes would reduce to less than 200 vpd. Alternate hardtop road routes exist for existing residents to get to/from the community of Riverview (i.e., Sideroad 260 via 2nd Line SW or Highway 10). Based on consultation with Township staff, it is expected that future growth in the community of Riverview will be minimal. The costs required to maintain the hardtop road condition to a tolerable state may outweigh the benefits, when compared to gravel road surface. Therefore, for the above reasons, it is recommended that sections #1489, 111, 142 and 143 of 7th Line SW (between Highway 89 and 200 metres south of Sideroad 260) be considered for reversion to gravel once the existing hardtop surface deteriorates to a condition level where a gravel surface would be preferred (expected within the next five years, considering the existing condition of 7th Line SW). The estimated total cost to downgrade the aforementioned sections of 7th Line SW (between Highway 89 and 200 metres south of Sideroad 260) is approximately $261,000 (assuming the road base is good).

4th Line OS: The sections of 4th Line OS between County Road 17 and 15th Sideroad (i.e., ID #95A from County Road 17 to Strada Pit North Entrance, and ID #95B from Strada Pit North Entrance to 15th Sideroad) provide connections to the Strada Pit. The north section (i.e., ID #95B) has relatively low traffic volumes (79 vpd according to a 2019 traffic count), only provides network connectivity to existing gravel road sections (beyond the Strada Pit North Entrance) and is currently in poor condition. Therefore, it is recommended that section #95B of 4th Line OS (between the Strada Pit North Entrance and 15th Sideroad) be considered for reversion to gravel, at the time of any future condition improvements (expected within the next few years, considering the road section's existing condition). The south section (i.e., ID 95A) should continue to be hardtop, to serve heavy truck traffic generated by the Strada Pit.

15th Sideroad: The sections of 15th Sideroad between County Road 124 and the east limit (i.e., ID #194 from County Road 124 to Main Street, ID #176 from 3rd Line to County Road 124, and ID #1491 between Main Street and the east limit) provide network connectivity between Horning's Mills, County Road 124 and 3rd Line. There is also residential growth along this segment of 15th Sideroad. Therefore, it is recommended that these sections remain hardtop.

20th Sideroad: The section of 20th Sideroad between 3rd Line and County Road 124 (i.e., ID #1345) provides network connectivity between the hardtop sections of 3rd Line and Dufferin Road 124. The Township has identified this section of 20th Sideroad to be the route that Downey Farms will use for trucking purposes. Therefore, it is recommended that this section remain hardtop.

3rd Line OS: The 3rd Line OS between County Road 21 and Highway 10 provides a significant connectivity benefit throughout the Township. Also, the traffic volumes on 3rd Line OS are some of the highest in the Township, ranging from 107 vpd to 910 vpd, based on 2019 traffic count data. Section #1507, which is 3rd Line OS between Highway 10 and 5th Sideroad, is estimated to have the highest average traffic volume of all roads under the Township's jurisdiction (910 vpd). Therefore, it is recommended that these sections remain hardtop.

The surface type recommendations are shown on the map in Appendix E.

8.0 Ten-Year Capital Hardtop Road Improvement Plan

A ten-year hardtop road capital plan was developed based on the current road improvement needs in the Township, in addition to a strategy that strives to significantly improve the Township's overall hard-top road network condition by year 2029.

The Township's existing hardtop road budget was estimated based on information provided by the Township on their asphalt budget over the last five-year period (i.e., 2014-2018 inclusive). The specifics of the Township's asphalt budget from 2014 to 2018 are detailed in Table 8.1.

Table 8.1: Township of Melancthon Asphalt Budget – 2014 to 2018

Year	Budget Amount		Funding Allocated
	Hardtop Resurfacing	Patch Paving	
2014	$250,000	$180,000	$180,000 Gas Tax
2015	$250,000	$175,000	$100,000 Gas Tax
2016	$0	$200,000	$0
2017	$0	$200,000	$0
2018	$170,000*	$30,000	$60,000 Gas Tax
Total	**$670,000**	**$785,000**	**$340,000 Gas Tax**
Average	**$134,000**	**$157,000**	**$68,000 Gas Tax**

* includes $50,000 that was budgeted for paving of the shoulders on Main Street in Horning's Mills.

As shown in Table 8.1, the combined hardtop resurfacing and patch paving budget was $1.455M over the five-year period from 2014 to 2018, or an average of $291,000 per annum. The maximum combined asphalt budget during the 2014-2018 period was $430,000 in 2014, and the minimum amount was $200,000 in 2016, 2017, and 2018. The Township has indicated that they will not undertake any road capital improvements in 2019, so they can review the details of this RMP report and ensure the best prioritization of capital projects can be delivered to the Township. Therefore, 2019 has been excluded from the above annual asphalt budget analysis to avoid skewing the annual averages (i.e., exclusion of the outlier).

The Township's existing overall hard-top road network condition was estimated to be 12.4 out of 20 (i.e., the weighted average SCR plus BCR value out of 20 was estimated to be 12.4 for the Township's hardtop road network, based on the existing condition data). The Township's existing hard-op road network condition of 12.4 out of 20 translates to a score of 6.2 out of 10. According to the *Township of Melancthon Asset Management Plan* (Burnside, May 2017), an infrastructure asset with a condition rating of 5 or 6 out of 10 represents an "average" condition. A condition score between 7 or 8 out of 10 is representative of a "good" road condition. Based on this criterion, it can be concluded that the Township's existing overall hardtop road network is in an "average" condition state.

In order to a improve the Township's overall hard-top road network condition to "good", a weighted average hardtop road network condition target of 16 out of 20 (i.e., 8 out of 10) was set for horizon year 2029. To achieve this target, a ten-year plan was developed that consists of both capital and cost-effective maintenance improvement recommendations. A table and map summarizing the details of the recommended ten-year hardtop road improvement plan is contained in Appendix F.

By utilizing the improvements highlighted in the ten-year plan in addition to the ongoing degradation of other road assets (as described previously in this report), the overall weighted average hardtop road network condition was estimated to be 17.4 out of 20 (i.e., 8.7 out of 10) at year 2029. Note that the value of 17.4 out of 20 increased slightly due to the recommended reversion of some hardtop roads to gravel in the ten-year plan. By reverting existing hardtop roads to gravel, such roads are excluded from the overall hardtop road network, which alters the overall hardtop road network conditon. Therefore, it can be concluded that the ten-year plan developed by Burnside, as outlined in Appendix F, has been forecast to improve the Township's overall hardtop road network condition from "average" in 2019 to "good" by 2029.

It is estimated that the total cost to implement the 10-year plan will be approximately $5.29M, or an average of approximately $529,000 per year. This reflects an increase of approximately $238,000 per year above the existing annual budget amount of $291,000, or an increase of approximately 82%. This budget is significantly higher than the Township's existing budget. However, a significant increase in budget is required in the next decade to reduce the existing capital need backlog.

The ten-year plan developed is forecast to significantly improve the hardtop road network condition by 2029. After the first decade, less capital will be required annually to maintain the Township's "good" overall hardtop road network condition, since the focus will shift towards incorporating more cost-effective maintenance treatments at the right times (in addition to some capital improvements) in order to sustain an overall "good" hardtop road network condition. Section 9.0 of this RMP includes a long-term (20-year) budget sensitivity analysis, which utilized the ten-year plan outlined above as a subset of the 20-year analysis to determine that an average annual budget of approximately $315,000 per year is required to maintain an overall "good" hardtop road network condition over the 20-year period.

8.1 Coordination with Bridge Projects

For budget allocation and phasing purposes, coordination with planned bridge and road improvement projects in the Township has been considered. Construction detours may also be a consideration in the scheduling / interface of road and bridge improvement projects. The preliminary recommendations for bridge rehabilitation or replacement, as set out in the Township's *2019 Municipal Bridge Inspection Report* (Burnside, 2019) is summarized in Table 8.2.

Table 8.2: Preliminary Bridge Improvement Plan

Structure No./Name	Road Name	Recommended Work	Estimated Construction Cost
2020			
2013	30th Sideroad	Replace	$474,500.00
2021			
013	260 Sideroad	Rehabilitate	$421,000.00
2022			
2023	4th Line NE	Rehabilitate	$187,000.00
007	7th Line SW	Rehabilitate	$255,000.00
006	4th Line SW	Rehabilitate (Waterproof & Pave)	$57,000.00
2023			
011	8th Line SW	Rehabilitate	$401,500.00
2024			
016	250 Sideroad	Rehabilitate	$339,000.00
		Total	**$2,151,800.00**

The following recommendations made in the ten-year road improvement plan were also made in the *2019 Municipal Bridge Inspection Report*:

- 4th Line NE – the section between 5th Line OS and Dufferin Road 21 is scheduled in year 2029 of the ten-year road improvement plan for reversion to gravel. Bridge 2023 on this road section is also recommended to be rehabilitated in 2022. There is significant time differential between these two improvement recommendations (i.e., eight years), and reverting the road to gravel is not anticipated to interfere with the bridge work, since the surface of the bridge will remain hardtop, and pulverizing the road section will terminate a certain distance from each of the bridge approaches. Therefore, coordination between the road and bridge improvements is not required.
- 260 Sideroad – the section between 4th Line SW and 7th Line SW is scheduled in year 2029 of the ten-year road improvement plan for a rehabilitation (hardtop surface). Bridge 013 on this road section is also recommended to be rehabilitated in 2021. There is significant time differential between these two improvement recommendations (i.e., eight years), and given the location of the bridge in the community of Riverview, it is believed that separating the road and bridge improvements in separate years is preferred since this will reduce temporary driveway access restrictions for residents of Riverview while the work is being undertaken. Therefore, coordination between the road and bridge improvements is not required.

- 7th Line SW – the section between Sideroad 270 and 200 metres south of Sideroad 260 is scheduled in year 2023 of the ten-year road improvement plan for reversion to gravel. Bridge 007 improvement recommendation (in year 2022) on 7th Line SW is not made on this road section, since the bridge is located only approximately 100 metres south of Sideroad 260 (i.e., approximately 100 metres north of the end of the aforementioned road section). Given the location of the bridge in the community of Riverview, it is believed that separating the road and bridge improvements in separate years is preferred since this will reduce temporary driveway access restrictions for residents of Riverview while the work is being undertaken. Also, note that the hardtop road reversion (to gravel) is recommended to terminate approximately 200 metres south of Sideroad 260, thus a hardtop surface will remain for approximately 100 metres south of the bridge. Therefore, coordination between the road and bridge improvements is not required.

Based on the above conclusions, any coordination would be limited to budget allocation between road and bridge projects in any particular year.

9.0 Long-Term (20-Year) Hardtop Road Budget Requirements

As concluded in Section 8.0, as a result of following Burnside's recommended ten-year hardtop road capital and maintenance improvement plan, it has been forecast that the Township's overall hardtop road network condition will improve from 12.4 (out of 20) in 2019 to 17.4 (out of 20) in 2029. Thus, the Township's overall hardtop road network condition is forecast to change from an "average" to "good" state after implementation of the ten-year plan.

Burnside has conducted a sensitivity analysis to estimate the annual budget in horizon years 11 to 20 (i.e., 2030 to 2039) required to sustain the Township's "good" overall hardtop network condition over the long-term. To do this, the sensitivity analysis assessed the annual budget required to maintain a rating above 16 out of 20 (or 8 out of 10) until the end of the 20-year period. It is understood that the combined condition value by year 2029 was forecast to be 17.4 out of 20 (i.e., 8.7/10) after completion of the ten-year plan outlined in Section 8.0, however it is believed that a combined condition target of 16 out of 20 (i.e., 8/10) is a realistic, attainable and sustainable long-term condition target for the Township, considering budgets and the existing condition of hardtop roads.

To summarize, the following steps were employed in conducting the 20-year budget sensitivity analysis:

1. Starting in year 2020, the SCR and BCR values for every hardtop road section in the Township were degraded based on the degradation formula outlined in Section 5.5. The ongoing degradation of road sections was considered until horizon year 2039 (i.e., for each year analyzed). For any road sections that were modelled to receive improvements, degradation formulae were applied to the road section's newly improved SCR and BCR values in the following analysis years.

2. Based on the degraded SCR and BCR values, a weighted average combined SCR plus BCR value was determined in every analysis year, based on the degraded SCR and BCR values.

3. The PGN value, improvement type need, and improvement need cost were all updated for each road section in any given year based on the degraded SCR and BCR values.

4. Road sections were sorted by their PGN values from highest to lowest.

5. The road sections with the highest PGN values had their respective improvement type needs and costs applied in the model. This includes the application of cost-effective maintenance treatments, which oftentimes had higher PGN values than other road sections with resurfacing or rehabilitation needs. After each

improvement type was applied to a given road section, the SCR and BCR values were increased by the amounts outlined in Table 5.3 (Section 5.2).

6. Repeat step 5 until the weighted average combined SCR plus BCR value for all hardtop roads in the Township equated (i.e., balanced) to at or above 16 out of 20 in each consecutive year (i.e., in each analysis year between 2030 and 2039). This was done to ensure that the weighted average combined SCR plus BCR value equated to 16 out of 20 (or 8 out of 10) in year 2039.

7. The cost of all treatments applied between 2020 and 2039 were added in order to obtain the total dollar amount spent to balance the weighted combined SCR plus BCR value of 16.0 in year 2039. This total dollar amount was divided by 20 in order to obtain the annual average amount required to sustain the weighted combined SCR plus BCR value of 16.0 in year 2039.

As identified previously, the Township spent an average of $291,000 per year between 2014 and 2018 (inclusive) on hardtop (asphalt) capital improvement projects. This amount excluded any funding towards cost-effective routine and preventive maintenance treatments.

Based on the above methodology, it was estimated that a 20-year annual average of approximately $315,000 per year, or a 20-year total amount of $6.3M, is required to achieve and sustain an overall hardtop road condition score of 8 out of 10 by year 2039. This amount includes the improvements outlined in the comprehensive ten-year plan outlined in Section 8.0 as a subset and combines both capital and maintenance improvements in order to simulate the largest benefits at the lowest costs. This represents an increase of approximately $24,000 per year above current hardtop road budget amounts, or 8.2% over the 20-year period. Therefore, it is forecast that the Township's current funding amount on hardtop road improvements will not be enough to meet the required road needs or close the funding gap.

It is recommended that the Township increase their annual investment on hardtop roads over the next decade to try to meet the target average $530,000 per year amount, and that the Township continue to actively pursue all available capital grants and other funding sources for such work. The first ten years of the recommended Road Management Plan will require the Township to access other funding sources to cover the costs of the remaining hardtop road improvements. This will get the Township back on appropriate levels of service and develop a sustainable hardtop road network.

Once into the horizon second half of the 20-year plan, it will be important for the Township to continue to set aside funds in road capital reserves to ensure that a similar backlog of road improvements does not occur. As identified in the *Township of Melancthon Asset Management Plan*: "while the annual funding requirement may fluctuate, it is important for the Township to implement a consistent, yet increasing,

annual investment in capital so that the excess annual funds accrue in capital reserve funds" (Burnside, May 2017).

The Township does not currently have an annual budget specific to routine and preventive maintenance treatments for hardtop roads (e.g., crack sealing, micro-surfacing, slurry sealing etc.). However, both the ten-year plan that was developed (at an average of $530,000 per year) and the 20-year sensitivity analysis (at an average of $315,000 per year) consider and include maintenance treatments. Best practice indicates that such treatments applied on roads with good bases can provide extended life and are cost-effective in reducing the overall lifecycle expenditures on such roads. Therefore, it is recommended that the Township begin incorporating maintenance treatments on hardtop roads (within the aforementioned recommended budgets). Such maintenance treatments may be implemented as demonstration (i.e., test) projects initially, with ongoing monitoring to gauge their effectiveness. Other Dufferin County municipalities are testing various maintenance treatments and can be contacted to pool resultant information.

10.0 Summary, Conclusions and Recommendations

The following primary conclusions and recommendations of this RMP are as follows:

- The updated inventory and road needs assessment in this RMP provides a basis for the updating of the Township's Asset Management Plan, as required by Ontario Regulation 588/17.
- Approximately 91 centreline kilometres of road were reviewed (approximately 76 km of hardtop roads and 15 km of gravel roads).
- Annual Average Daily Traffic (AADT) volumes and traffic growth estimates were updated for the roads reviewed.
- A field evaluation was completed on the condition of the roads, based on methodologies provided by the Ontario Good Roads Association (OGRA) and the Ministry of Transportation for Ontario (MTO). The following parameters were established for each road section: Pavement Condition Index (PCI), Ride Comfort Rating (RCR), Surface Condition Rating (SCR) and Based Condition Rating (BCR).
- Lifecycle improvement needs and costs were identified for each road section, based on their condition needs, traffic volumes, roadside environment and surface type.
- Priority Guide Numbers (PGN) were calculated for each road section, based on their condition, traffic volumes and improvement costs, to establish their relative priority for improvement (i.e., the strategy for applying the most cost-effective improvements, considering best practices for lifecycle improvements and budget limitations).
- Road degradation formulae was developed to assess the impacts on road conditions and long-term budget implications.
- For roads with less than 400 vpd, it was concluded that gravel roads may have present worth cost reductions in the order of $40,000 to $50,000 per km over hardtop roads (i.e., capital and maintenance costs), assuming a 60-year lifecycle. However, other factors such as network connectivity, dust control, and traffic diversion should also be considered when assessing potential surface type conversions.
- A Gravel Upgrade Priority Index (GUPI) was calculated to compare the relative priority of gravel roads to be upgraded to hardtop surfaces, or priority of hardtop roads to be downgraded to gravel surfaces, based on traffic volumes, truck volumes, maintenance requirements, and driveway densities.
- Vertical curve deficiencies have been identified on the following road sections:
  - 3rd Line OS - from Highway 10 to 5th Sideroad (Section 1507).
  - 3rd Line OS - from 5th Sideroad to 2 km north of 5th Sideroad (Section 93).
  - 3rd Line OS - from 2 km north of 5th Sideroad to County Road 17 (Section 544).
  - 3rd Line OS - from County Road 17 to 15th Sideroad (Section 96).
  - 3rd Line OS - from 15th Sideroad to 1.5 km south of 20th Sideroad (Section 1467).
  - 3rd Line OS - from 1.5 km south of 20th Sideroad to 20th Sideroad (Section 102).
- Appropriate warning signage should be applied at all vertical deficiency locations, and any future road improvement projects at these locations should consider reducing the magnitude of the vertical deficiency.

- In general, the Township does not have flooding issues on their roads. However, as part of the design for any future improvements, it is recommended that detailed investigations be completed to determine drainage requirements.
- A number of roads were identified to have high maintenance demands (i.e., cold patching requirements), including part of 5th Line OS, 3rd Line OS, Sideroad 260 and 7th Line SW.
- None of the existing gravel road sections that were reviewed in this RMP are recommended for upgrading from gravel surface to hardtop at this time.
- It is recommended that the Township consider reverting the following existing hardtop road sections to gravel, once the existing hardtop surfaces deteriorate to a point where rehabilitation is required:
  - 4th Line NE between 5th Line OS and Dufferin Road 21 (section ID #65).
  - 4th Line NE between County Road 9 and 1 km north of Sideroad 240 (section ID #72).
  - 7th Line SW between Highway 89 and 200 metres south of Sideroad 260 (section IDs #1489, 111, 142 and 143).
  - 4th Line OS between the Strada Pit North Entrance and 15th Sideroad (section #95B).
- Approximately 55% of the Township's hardtop roads were found to be in fairly good to excellent condition, 10% in fair condition and 35% in poor condition. The existing cost of hardtop road improvement needs, based on condition, is estimated to be approximately $8M.
- A comprehensive ten-year (2020 to 2029) road capital and maintenance improvement plan was recommended, using an average cost of $529,000 per year. A significant budget increase is required over the next decade in order to reduce the existing capital need backlog. As a result of implementing the recommended ten-year improvement plan, it is forecast that the Township's overall hardtop road network will improve significantly from an "average" (6.2 out of 10) to "good" (8.7 out of 10) condition state by 2029. Details regarding the ten-year improvement plan can be found in Appendix F.
- A sensitivity analysis was completed to determine the funding level required to sustain the Township's forecast "good" overall hardtop road network condition over a 20-year period. The cost to maintain a "good" condition level over the next 20 years (i.e., an overall hardtop network condition at or above 8 out of 10 through year 2039) is forecast to be approximately $315,000 per year. The 20-year analysis assumes the aforementioned ten-year plan as a subset of the 20-year period, thus it can be concluded that the annual budget required to maintain the "good" network condition (after spending more than usual over the first ten years to reduce the capital need backlog and achieve a "good" overall network condition) is significantly less between years 11 to 20, when compared to the first ten year period. This reflects the shifting of focus from primarily costly capital improvements to more cost-effective

maintenance treatments after a “good” overall condition state is reached, so that this condition state is sustainable over the long-term.

- The Township does not currently have an annual budget specific to routine and preventive maintenance treatments for hardtop roads (e.g., crack sealing, micro-surfacing, slurry sealing etc.). However, both the ten-year plan that was developed (at an average of $530,000 per year) and the 20-year sensitivity analysis (at an average of $315,000 per year) consider and include maintenance treatments. Best practice indicates that maintenance treatments applied on roads with good bases can provide extended life and are cost-effective in reducing the overall lifecycle expenditures on such roads. Therefore, it is recommended that the Township begin incorporating maintenance treatments on hardtop roads (within the aforementioned recommended budgets). Such maintenance treatments may be implemented as demonstration (i.e., test) projects initially, with ongoing monitoring to gauge their effectiveness.

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Appendix A

Acronyms

AADT – Annual Average Daily Traffic

AMP – Asset Management Plan

ATR – Automatic Traffic Recorder

BCR – Base Condition Rating (value out of 10)

CRA – Cold Recycled Asphalt

DF – Driveway Factor – driveway access density

DMI – Distress Manifestation Index

GUPI – Gravel Upgrade Priority Index

HCB – High Class Bituminous asphalt

HMA – Hot mix asphalt

LCF – Lifecycle Factor – typical number of days that is assumed to be added to the pavement life as a result of a treatment

MF – Maintenance Factor

MTO - Ministry of Transportation Ontario

OGRA – Ontario Good Roads Association

OTI – Ontario Traffic Inc.

PCI – Pavement Condition Index (value out of 100)

PGN – Priority Guide Number

PM – Preventative Maintenance (such as microsurfacing or slurry seals)

R – Resurface – Hot mix asphalt overlay or mill and pave

RCR – Ride Comfort Rating

REC – Reconstruction – full depth removal, total base replacement, curb and storm water assets, and one or two lifts of asphalt

REH – Rehabilitation – pulverize, add some base improvements as required and one or two lifts of asphalt

RM – Routine Maintenance

RMP – Road Management Plan

SCR – Surface Condition Rating (value out of 10)

TAC – Transportation Association of Canada

TF – Traffic Factor – is an estimate of the traffic served over the lifecycle of the improvement

TVF – Truck Volume Factor – total average annual daily truck volume

vpd –vehicles per day (daily traffic volume)

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Appendix B

Existing Road Surface Types Map

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Map Title

ROAD MANAGEMENT PLAN

EXISTING SURFACE TYPE

Client

TOWNSHIP OF MELANCTHON

Drawn	Checked	Date	Figure No.
PS	CR	2019/10/30	B
Scale		Project No.	
H 1:120,000		300043927	

File Path: \\ELMO\Shared Work Areas\043927 (Melancthon RNS 2019)\043927 Surface Type.mxd Print Date: 2019/10/30 Time: 09:57 AM

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Appendix C

Road Inventory Table

Township of Melancthon Road Management Plan
Road Inventory Table
All Hardtop Roads and Select Gravel Roads

Line No.	Asset ID	Road Name	Road From	Road To	Length of Road (m)	Road Width (m)	Road Material	Road Environment	Road Surface Remaining Useful Life	Estimated Road Replacement Costs	Existing AADT Volume (vpd)	Existing AADT Range (vpd)	Count Year	Percent Trucks	10-Year Percent Traffic Growth	Year 10 AADT Volume (vpd)	Ride Comfort Rating (RCR)	Pavemenet Condition Index (PCI)	Surface Condition Rating (SCR)	Base Condition Rating (BCR)	Existing (2019) Improvement Need (Based on Treatment Matrix Criterion)	Total Improvement Cost	Priority Guide Number (PGN)	Vertical Deficiencies ?	Deficient Width?	Field Notes	Construction History - Treatment(s)
1	1491	15th Sideroad	Main St.	East	691	6.5	Cold Recycled	Rural	3	$190,125	125	50-199	Estimate	Unknown	10.46%	138	3	56.8	10	2	Rehabilitation	$68,406	8.1			Significant patching	
2	194	15th Sideroad	County Rd. 124	Main St.	227	6.5	Asphalt	Rural	24	$62,458	125	50-199	Estimate	Unknown	10.46%	138	9	98.5	9	10	Routine Maintenance	$1,107	2.2				
3	176	15th Sideroad	3rd Line	County Rd. 124	1142	6.5	Asphalt	Rural	3	$314,216	125	50-199	Estimate	Unknown	10.46%	138	7	80.3	5	5	Rehabilitation	$113,052	10.2				
4	1345	20th Sideroad	3rd Line	County Rd. 124	1378	6.5	Asphalt	Rural	24	$379,150	164	50-199	2019	8.20%	10.46%	181	10	99.0	9	10	Routine Maintenance	$6,718	2.9				Chip Seal (1991), Asphalt Resurfacing (1997)
5	31	260 (Main St.)	4th Line SW	7th Line SW	2013	6.5	Asphalt	Rural	6	$553,867	250	200-399	Estimate	Unknown	10.46%	276	5	63.0	5	2	Rehabilitation	$263,653	20.0				Asphalt Resurfacing (1999)
6	32	260 (Main St.)	2nd Line SW	4th Line SW	2228	6.5	Asphalt	Rural	6	$613,023	263	200-399	2019	4.70%	10.46%	291	5	63.0	5	2	Rehabilitation	$291,812	21.1				Asphalt Resurfacing (1999)
7	29	260 (Main St.)	Geirson	2nd Line SW	1526	6.5	Asphalt	Rural	5	$508,349	450	400-999	Estimate	Unknown	10.46%	497	5	63.0	5	2	Rehabilitation	$289,932	24.8				Asphalt Resurfacing (1999)
8	24	260 (Main St.)	Manitoba	Geirson	159	8	Asphalt	Urban	11	$86,076	450	400-999	Estimate	Unknown	10.46%	497	6	90.8	9	8	Routine Maintenance	$954	19.7				Asphalt Resurfacing (1999)
9	25	260 (Main St.)	Poulton	Manitoba	74	8	Asphalt	Urban	11	$40,061	450	400-999	Estimate	Unknown	10.46%	497	6	90.8	9	8	Routine Maintenance	$444	19.7				Asphalt Resurfacing (1999)
10	26	260 (Main St.)	Shook	Poulton	153	8	Asphalt	Urban	11	$82,828	450	400-999	Estimate	Unknown	10.46%	497	6	90.8	9	8	Routine Maintenance	$918	19.7				Asphalt Resurfacing (1999)
11	107	260 (Main St.)	Hwy. 10	Shook	418	8	Asphalt	Semi-Urban	11	$171,380	447	400-999	2019	5.50%	10.46%	494	6	90.8	9	8	Routine Maintenance	$2,508	19.6				Asphalt Resurfacing (1999)
12	82	2nd Line SW	250	North Limit	2350	6.5	Asphalt	Rural	2	$646,591	1127	1000-1999	2019	4.97%	21.90%	1374	2	57.5	6	2	Rehabilitation	$307,791	91.9			Average 0.5m shoulder	
13	81	2nd Line SW	260	250	2054	6.6	Asphalt	Rural	15	$573,842	980	400-999	2016	3.82%	21.90%	1195	7	95.0	9	10	Routine Maintenance	$10,167	18.3				
14	1509	2nd Line SW	270	260	2045	6.6	Asphalt	Rural	15	$691,721	835	400-999	2017	2.03%	21.90%	1018	7	95.0	9	10	Routine Maintenance	$10,123	15.6				
15	117	2nd Line SW	280	270	2028	6.5	Asphalt	Rural	15	$675,578	812	400-999	2018	7.74%	21.90%	990	8	96.9	9	10	Routine Maintenance	$9,887	15.4				Repave (Asphalt, 2006)
16	1278	2nd Line SW	County Rd. 17	280	2051	6.5	Asphalt	Rural	15	$683,239	812	400-999	Estimate	Unknown	21.90%	990	6	87.8	5	9	Rehabilitation	$389,680	22.8				Repave (Asphalt, 2009)
17	1351	2nd Line SW	300	County Rd. 17	1981	6.7	Asphalt	Rural	12	$680,226	812	400-999	Estimate	Unknown	21.90%	990	9	98.3	7	10	Resurface	$191,658	10.2			0.5m shoulder	
18	147	2nd Line SW	Hwy. 89	300	1799	6.8	Asphalt	Rural	2	$626,952	820	400-999	2019	2.50%	21.90%	1000	5	61.3	3	3	Rehabilitation	$357,576	51.4			1m shoulder	
19	1490	3rd Line OS	20th Sideroad	County Rd. 21	3055	6.5	Asphalt	Rural	23	$840,568	107	50-199	2019	8.40%	21.90%	130	9	97.0	8	10	Preventive Maintenance	$59,573	1.9				Chip Seal (1991), Asphalt Resurfacing (2000)
20	102	3rd Line OS	1.5 km S of 20th Sideroad	20th Sideroad	1522	6.5	Asphalt	Rural	7	$418,771	200	200-399	Estimate	Unknown	21.90%	244	6	79.3	5	8	Rehabilitation	$199,344	9.5	Yes			Asphalt (1999)
21	1467	3rd Line OS	15th Sideroad	1.5 km S of 20th Sideroad	1523	6.5	Asphalt	Rural	7	$419,046	200	200-399	Estimate	Unknown	21.90%	244	6	79.3	5	8	Rehabilitation	$199,475	9.5	Yes			Asphalt (1999)
22	96	3rd Line OS	County Rd. 17	15th Sideroad	3052	6.5	Asphalt	Rural	8	$839,743	229	200-399	2019	4.60%	21.90%	279	6	79.3	5	8	Rehabilitation	$399,736	10.9	Yes			Asphalt (1999)
23	544	3rd Line OS	2km N of 5th Sideroad	County Rd. 17	1048	6.5	Asphalt	Rural	8	$349,115	493	400-999	2019	3.50%	21.90%	601	8	89.3	8	9	Preventive Maintenance	$27,248	9.7	Yes			Chip Seal (1996), Asphalt Resurfacing (1998), Repaved (2008)
24	93	3rd Line OS	5th Sideroad	2 km N of 5th Sideroad	2011	6.5	Asphalt	Rural	12	$669,914	493	400-999	2019	3.50%	21.90%	601	8	89.3	8	9	Preventive Maintenance	$52,286	9.7	Yes			Chip Seal (1996), Asphalt Resurfacing (1998), Repaved (2007)
25	1507	3rd Line OS	Hwy. 10	5th Sideroad	1650	6.5	Asphalt	Rural	15	$549,656	910	1000-1999	2019	3.30%	21.90%	1109	8	96.5	8	10	Preventive Maintenance	$42,900	11.9	Yes			Chip Seal (1988), Asphalt Resurfacing (1999)
26	72	4th Line NE	1 km N of Sideroad 240	County Rd 9/2	1300	8	Asphalt	Rural	23	$440,232	289	200-399	2018	6.29%	10.46%	319	9	95.3	8	10	Preventive Maintenance (Reversion to Gravel Recommended Once Road is in Rehabilitation Need)	$41,600	2.9				Asphalt (1994), Repaved (2002)
27	1596	4th Line NE	Sideroad 240	1 km N of Sideroad 240	1000	8	Gravel	Rural	N/A	$174,240	289	200-399	2018	6.29%	10.46%	319	N/A	N/A	N/A	N/A							Asphalt (1994), Repaved (2002)
28	1594	4th Line NE	Sideroad 250	Sideroad 240	2443	8	Gravel	Rural	N/A	$425,668	150	50-199	Estimate	Unknown	10.46%	166	N/A	N/A	N/A	N/A							Asphalt (1995), Repaved (2002)
29	1595	4th Line NE	County Rd. 21	Sideroad 250	1634	8	Gravel	Rural	N/A	$284,708	149	50-199	2019	5.80%	10.46%	165	N/A	N/A	N/A	N/A							
30	65	4th Line NE	5th Line OS	County Rd. 21	3937	6.5	Asphalt	Rural	15	$1,083,246	257	200-399	2019	5.50%	10.46%	284	7	68.8	6	5	Rehabilitation	$515,649	14.2				Repaved (Asphalt, 2007)
31	95B	4th Line OS	Strada Pit North Entrance	15th Sideroad	1400	6.5	Asphalt	Rural	3	$385,203	79	50-199	2019	6.60%	21.90%	96	6	54.3	1	1	Reconstruction	$385,203	4.6				Asphalt (2000)
32	95A	4th Line OS	County Rd. 17	Strada Pit North Entrance	1651	6.5	Asphalt	Rural	3	$454,264	125	50-199	Estimate	Unknown	21.90%	152	6	80.5	8	5	Rehabilitation	$163,441	7.8			Strada pit responsible for paving	Asphalt (1997)
33	1494B	4th Line OS	Lot 9/10	County Rd. 17	750	6.5	Asphalt	Rural	3	$206,359	300	200-399	Estimate	Unknown	21.90%	366	5	69.5	3	2	Rehabilitation	$98,231	30.6				Asphalt (1997)
34	1494A	4th Line OS	5th Sideroad	Lot 9/10	2438	6.5	Asphalt	Rural	24	$670,804	300	200-399	Estimate	Unknown	21.90%	366	9	98.3	9	10	Routine Maintenance	$11,885	5.7				Asphalt (1997)
35	1495	4th Line OS	Hwy. 10	5th Sideroad	713	6.5	Asphalt	Rural	24	$196,178	300	200-399	Estimate	Unknown	21.90%	366	9	98.3	9	10	Routine Maintenance	$3,476	5.7				Asphalt (1997)
36	1274	4th Line OS	Abandon Rail	Hwy. 10	956	6.5	Asphalt	Rural	17	$263,039	330	400-999	2017	10.51%	21.90%	402	7	88.3	5	9	Rehabilitation	$125,212	13.4				Chip Seal (1995), Asphalt Resurfacing (1998), Repaved (2009)
37	1520	5th Line OS	Sideroad 240	County Rd. 9	351	8	Gravel	Rural	N/A	$61,158	222	200-399	Estimate	Unknown	10.46%	245	0	90.0	10	10							
38	1519	5th Line OS	30th Sideroad	Sideroad 240	816	8	Gravel	Rural	N/A	$142,180	222	200-399	Estimate	Unknown	10.46%	245	N/A	N/A	N/A	N/A							
39	1452	5th Line OS	County Rd. 21	30th Sideroad	3102	8	Gravel	Rural	N/A	$540,492	222	200-399	2019	8.70%	10.46%	245	0	90.0	10	10							
40	161	5th Line OS	20th Sideroad	County Rd. 21	1577	6.5	Asphalt	Rural	3	$433,904	226	200-399	2019	9.10%	21.90%	275	4	41.0	2	1	Reconstruction	$433,904	12.4				Chip Seal (1992), Asphalt Resurfacing (2000)
41	160	5th Line OS	6th Line NE	20th Sideroad	466	6.5	Asphalt	Rural	1	$128,218	230	200-399	Estimate	Unknown	21.90%	280	4	41.0	2	1	Reconstruction	$128,218	12.6				Chip Seal (1992), Asphalt Resurfacing (2000)
42	1493	5th Line OS	Sideroad 270	6th Line NE	654	6.5	Asphalt	Rural	1	$179,945	230	200-399	Estimate	Unknown	21.90%	280	4	41.0	2	1	Reconstruction	$179,945	12.6				Chip Seal (1992), Asphalt Resurfacing (2000)
43	159	5th Line OS	15th Sideroad	Sideroad 270	1930	6.5	Asphalt	Rural	1	$531,030	237	200-399	2018	26.54%	21.90%	289	4	41.0	2	1	Reconstruction	$531,030	13.0				Chip Seal (1992), Asphalt Resurfacing (2000)
44	1492	5th Line OS	4th Line NE	15th Sideroad	570	6.5	Asphalt	Rural	1	$156,833	250	200-399	Estimate	Unknown	21.90%	305	4	41.0	2	1	Reconstruction	$156,833	13.8				Chip Seal (1992), Asphalt Resurfacing (1998)
45	101	5th Line OS	Sideroad 280	4th Line NE	205	6.5	Asphalt	Rural	1	$56,405	284	200-399	Estimate	Unknown	21.90%	346	4	41.0	2	1	Reconstruction	$56,405	15.6				Chip Seal (1992), Asphalt Resurfacing (1998)
46	94	5th Line OS	County Rd. 17	Sideroad 280	2293	6.5	Asphalt	Rural	1	$630,907	284	200-399	2019	9.20%	21.90%	346	4	41.0	2	1	Reconstruction	$630,907	15.6				Chip Seal (1992), Asphalt Resurfacing (1998)
47	206	5th Sideroad	County Rd. 124	Townline	1367	6.5	Asphalt	Rural	7	$376,123	269	200-399	2019	3.90%	21.90%	328	4	64.8	5	5	Rehabilitation	$179,043	18.3				Asphalt (2000)
48	207	5th Sideroad	3rd Line	County Rd. 124	1371	6.5	Asphalt	Rural	8	$456,714	653	400-999	2019	3.40%	21.90%	796	6	86.8	8	8	Preventive Maintenance	$35,646	17.1				Chip Seal (1990)
49	1489	7th Line SW	Sideroad 270	Sideroad 260	2048	6.5	Asphalt	Rural	5	$563,497	177	50-199	2019	5.90%	10.46%	196	6	63.5	5	3	Rehabilitation	$202,742	17.3				Chip Seal (1992), Chip Seal Resurface (1996), Asphalt Resurfacing (2000)
50	111	7th Line SW	Sideroad 280	Sideroad 270	2033	6.5	Asphalt	Rural	5	$559,370	200	200-399	Estimate	Unknown	10.46%	221	6	63.5	5	3	Rehabilitation	$266,272	14.8				Chip Seal (1992), Chip Seal Resurface (1996), Asphalt Resurfacing (2000)
51	142	7th Line SW	County Rd. 17	Sideroad 280	2040	6.5	Asphalt	Rural	5	$561,296	200	200-399	Estimate	Unknown	10.46%	221	6	63.5	5	3	Rehabilitation	$267,189	14.8				Chip Seal (1992), Chip Seal Resurface (1996), Asphalt Resurfacing (2000)
52	143	7th Line SW	Hwy. 89	County Rd. 17	853	6.5	Asphalt	Rural	5	$234,699	218	200-399	2019	6.80%	10.46%	241	6	63.5	5	3	Rehabilitation	$111,722	16.1				Chip Seal (1992), Chip Seal Resurface (1996), Asphalt Resurfacing (2000)
53	1603	8th Line NE	County Rd. 9	Townline	228	8	Gravel	Rural	N/A	$39,727	125	50-199	Estimate	Unknown	10.46%	138	N/A	N/A	N/A	N/A							
54	1511	8th Line NE	Sideroad 240	County Rd. 9	2040	8	Gravel	Rural	N/A	$355,450	145	50-199	2018	15.70%	10.46%	160	N/A	N/A	N/A	N/A							
55	1441	8th Line NE	Sideroad 250	Sideroad 240	2033	8	Gravel	Rural	N/A	$354,230	125	50-199	Estimate	Unknown	10.46%	138	N/A	N/A	N/A	N/A							
56	1440	8th Line NE	5th Line OS	Sideroad 250	1219	8	Gravel	Rural	N/A	$212,399	196	200-399	2019	11.70%	10.46%	217	N/A	N/A	N/A	N/A							

Township of Melancthon Road Management Plan
Road Inventory Table
All Hardtop Roads and Select Gravel Roads

Line No.	Asset ID	Road Name	Road From	Road To	Length of Road (m)	Road Width (m)	Road Material	Road Environment	Road Surface Remaining Useful Life	Estimated Road Replacement Costs	Existing AADT Volume (vpd)	Existing AADT Range (vpd)	Count Year	Percent Trucks	10-Year Percent Traffic Growth	Year 10 AADT Volume (vpd)	Ride Comfort Rating (RCR)	Pavemenet Condition Index (PCI)	Surface Condition Rating (SCR)	Base Condition Rating (BCR)	Existing (2019) Improvement Need (Based on Treatment Matrix Criterion)	Total Improvement Cost	Priority Guide Number (PGN)	Vertical Deficiencies ?	Deficient Width?	Field Notes	Construction History - Treatment(s)
57	186	Addeson St.	George St.	Lloyd St.	155	4.5	Cold Recycled	Semi-Urban	4	$29,525	50	50-199	Estimate	Unknown	10.46%	55	3	76.3	10	5	Rehabilitation	$10,623	2.9		Yes		
58	201	Charles St. W	Main St.	End of Road	141	7	Asphalt	Semi-Urban	21	$41,780	30	0-49	Estimate	Unknown	10.46%	33	8	96.5	10	9							
59	200	Church St.	Main St.	North Limit	242	4	Cold Recycled	Semi-Urban	1	$40,975	60	50-199	Estimate	Unknown	10.46%	66	2	54.3	10	2	Rehabilitation	$14,743	6.3		Yes		
60	182	Fieldway Ct.	Main St.	End of Road	800	6.5	Asphalt	Semi-Urban	19	$220,116	120	50-199	Estimate	Unknown	10.46%	133	6	92.8	8	10	Preventive Maintenance	$20,800	1.5				
61	188	George St.	Addeson St.	Main St.	114	5.5	Cold Recycled	Semi-Urban	4	$26,541	50	50-199	Estimate	Unknown	10.46%	55	3	76.3	10	5	Rehabilitation	$9,549	2.4		Yes		
62	185	High St.	William St.	Main St.	170	5.3	Asphalt	Semi-Urban	24	$38,139	70	50-199	Estimate	Unknown	10.46%	77	9	98.8	9	10	Routine Maintenance	$676	1.5		Yes		
63	205	Hunter Pkwy.	County Rd. 124	Apartment Building	291	6.5	Cold Recycled	Semi-Urban	7	$80,067	100	50-199	Estimate	Unknown	10.46%	110	5	76.0	10	5	Rehabilitation	$28,808	4.1			Cold recycled south half	
64	187	Lloyd St.	Addeson St.	Main St.	110	4.5	Cold Recycled	Semi-Urban	4	$20,953	50	50-199	Estimate	Unknown	10.46%	55	3	76.3	10	5	Rehabilitation	$7,539	2.9		Yes		
65	183	Main St.	15th Sideroad	County Rd. 124	366	6.5	Asphalt	Rural	24	$121,924	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,784	16.2				
66	193	Main St.	Mill Ln.	15th Sideroad	355	6.5	Asphalt	Semi-Urban	24	$118,259	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,731	16.2				
67	1314	Main St.	George St.	Mill Ln.	212	6.5	Asphalt	Urban	24	$93,249	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,034	16.2				
68	1313	Main St.	Charles St.	George St.	126	6.5	Asphalt	Urban	24	$55,422	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$614	16.2				
69	1312	Main St.	Church St.	Charles St.	153	6.5	Asphalt	Urban	24	$67,298	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$746	16.2				
70	1310	Main St.	Mill St.	Church St.	214	6.5	Asphalt	Urban	24	$94,129	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,043	16.2				
71	1311	Main St.	High St.	Mill St.	120	6.5	Asphalt	Urban	24	$52,783	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$585	16.2				
72	1315	Main St.	Fieldway Ct.	High St.	323	6.5	Asphalt	Semi-Urban	24	$107,599	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,575	16.2				
73	1346	Main St.	Oldfield Ct.	Fieldway Ct.	277	6.5	Asphalt	Semi-Urban	24	$92,276	900	400-999	Estimate	Unknown	10.46%	994	9	98.8	9	10	Routine Maintenance	$1,350	16.2				
74	1347	Main St.	County Rd. 124	Oldfield Ct.	692	6.5	Asphalt	Rural	24	$230,523	890	400-999	2019	2.10%	10.46%	983	9	98.8	9	10	Routine Maintenance	$3,374	16.0				
75	195	Mill Ln.	Main St.	End of Road	655	5	Cold Recycled	Semi-Urban	4	$138,631	150	50-199	Estimate	Unknown	10.46%	166	3	66.3	10	4	Rehabilitation	$49,878	9.5		Yes		
76	196	Mill St.	Main St.	William St.	95	6.5	Asphalt	Semi-Urban	24	$26,139	300	200-399	Estimate	Unknown	10.46%	331	9	98.3	9	10	Routine Maintenance	$463	5.4				
77	184	Old Field Ct.	Main St.	End of Road	643	6.5	Asphalt	Semi-Urban	17	$176,918	150	50-199	Estimate	Unknown	10.46%	166	5	75.6	5	8	Rehabilitation	$63,654	8.6				
78	189	River Rd.	William St.	Townline	1401	7.5	Asphalt	Semi-Urban	24	$444,782	284	200-399	2019	3.90%	10.46%	314	9	98.3	9	10	Routine Maintenance	$7,881	4.4				
									Total:	$25,143,038												$8,049,945					

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Appendix D

Benchmark Cost Breakdown Tables

Item	Unit	Unit Cost
Granular A - 150mm	m2	$7.00
Granular B - 300mm	m2	$9.00
Granular B - 450mm	m2	$13.00
Earth Excavation	m3	$15.00
Milling	m2	$4.00
Pulverizing	m2	$2.00
Asphalt Removal	m	$32.00
Crack Sealing	m2	$0.75
Maintenance Gravel + Calcium Chloride*	m2	$0.80
Curb and Gutter Replacement	m	$120.00
Catch Basin/Manhole Adjustments	m	$14.85
Driveway Culvert Replacement	m	$375.00
Cross Culvert Replacement	m	$500.00
Tack Coat	m	$3.00
Shouldering (50mm Depth)	m	$5.00
PAD with 100mm Granular A	m	$32.00
50mm HL8	m	$80.00
50mm HL4	m	$67.00
60mm HL4	m	$80.00
40mm HL3	m2	$8.00
Geogrid (9m wide)	m	$45.00

* Maintenance gravel and calcium chloride are material costs only. Road preparation and grading are assumed to be by Township forces.

Urban Hardtop Resurfacing								
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**
Milling		8			m2		$4.00	$4.00
Tack Coat		8			m		$3.00	$0.38
50mm HL4		8			m		$67.00	$8.38
Shouldering (50mm Depth)		8			m		$5.00	$0.63
							Total =	$13.38
Rural or Semi-Urban (AADT>=400) Hardtop Resurfacing								
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**
Crack Sealing		6.5			m2		$0.75	$0.75
Tack Coat		6.5			m		$3.00	$0.46
60mm HL4		6.5			m		$80.00	$12.31
Shouldering (50mm Depth)	120%	6.5			m		$5.00	$0.92
							Total =	$14.44
Rural or Semi-Urban (AADT<400) Hardtop Resurfacing								
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**
Crack Sealing		6.5			m2		$0.75	$0.75
Tack Coat		6.5			m		$3.00	$0.46
50mm HL4		6.5			m		$67.00	$8.38
Shouldering (50mm Depth)		6.5			m		$5.00	$0.63
							Total =	$10.21

60mm depth

Urban Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Asphalt Removal		8			m		$32.00	$4.00	
50mm HL8		8			m		$80.00	$10.00	
Tack Coat		8			m		$3.00	$0.38	
40mm HL3		8			m2		$8.00	$8.00	
Curb and Gutter Replacement	10%	8			m		$120.00	$1.50	
Catch Basin/Manhole Adjustments	100%	8			m		$14.85	$1.86	33 structures per km at $450 each
							Total =	$25.73	
Semi-Urban Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		6.5			m2		$2.00	$2.00	
60mm HL4		6.5			m		$80.00	$12.31	
Shouldering (50mm Depth)	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$15.23	
Rural (AADT>=400) Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		6.5			m2		$2.00	$2.00	
PAD with 100mm Granular A		6.5			m		$32.00	$4.92	
60mm HL4		6.5			m		$80.00	$12.31	
Tack Coat		6.5			m		$3.00	$0.46	
40mm HL3		6.5			m2		$8.00	$8.00	
Shouldering (50mm Depth)	200%	6.5			m		$5.00	$1.54	100mm depth
							Total =	$29.23	
Rural (400>AADT>=200) Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		6.5			m2		$2.00	$2.00	
PAD with 100mm Granular A		6.5			m		$32.00	$4.92	
60mm HL4		6.5			m		$80.00	$12.31	
Shouldering (50mm Depth)	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$20.15	
Rural (400>AADT>=200) AND Swamp Area (e.g., 5th Line OS) Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		6.5			m2		$2.00	$2.00	
PAD with 100mm Granular A	250%	6.5			m		$32.00	$12.31	
60mm HL4		6.5			m		$80.00	$12.31	
Geogrid (9m wide)		6.5			m		$45.00	$6.92	
Shouldering (50mm Depth)	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$34.46	

Rural (AADT<200) Hardtop Rehabilitation									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		6.5			m2		$2.00	$2.00	
60mm HL4		6.5			m		$80.00	$12.31	
Shouldering (50mm Depth)	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$15.23	
Urban Hardtop Reconstruction									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Asphalt Removal		8			m		$32.00	$4.00	
Earth Excavation	100%	10	450		m3	4500	$15.00	$8.44	
Granular A - 150mm	100%	10			m2		$7.00	$8.75	
Granular B - 300mm	100%	10			m2		$9.00	$11.25	
50mm HL8		8			m		$80.00	$10.00	
Tack Coat		8			m		$3.00	$0.38	
40mm HL3		8			m2		$8.00	$8.00	
Curb and Gutter Replacement	100%	8			m		$120.00	$15.00	
Catch Basin/Manhole Adjustments	100%	8			m		$14.85	$1.86	33 structures per km at $450 each
							Total =	$67.67	
Rural or Semi-Urban (AADT>=400) Hardtop Reconstruction									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Asphalt Removal		6.5			m		$32.00	$4.92	
Earth Excavation	100%	8.5	450		m3	3825	$15.00	$7.17	
Granular A - 150mm	100%	8.5			m2		$7.00	$7.44	
Granular B - 300mm	100%	8.5			m2		$9.00	$9.56	
50mm HL8		6.5			m		$80.00	$12.31	
Tack Coat		6.5			m		$3.00	$0.46	
40mm HL3		6.5			m2		$8.00	$8.00	
Shouldering (50mm Depth)	180%	6.5			m		$5.00	$1.38	90mm depth
							Total =	$51.25	
Rural of Semi-Urban (AADT<400) Hardtop Reconstruction									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Asphalt Removal		6.5			m		$32.00	$4.92	
Earth Excavation	100%	8.5	450		m3	4500	$15.00	$7.17	
Granular A - 150mm	100%	8.5			m2		$7.00	$7.44	
Granular B - 300mm	100%	8.5			m2		$9.00	$9.56	
60mm HL4		6.5			m		$80.00	$12.31	
Shouldering	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$42.33	

Gravel Road Reconstruction - To HCB Surface (ASSUMING ROAD SECTION MEETS UPGRADING CRITERIA)									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Earth Excavation	100%	8.5	450		m3	3825	$15.00	$7.17	
Granular A - 150mm	100%	8.5			m2		$7.00	$7.44	
Granular B - 300mm	100%	8.5			m2		$9.00	$9.56	
60mm HL4		6.5			m		$80.00	$12.31	
Shouldering	120%	6.5			m		$5.00	$0.92	60mm depth
							Total =	$37.40	
Gravel Road Reconstruction - To Gravel Surface									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Earth Excavation	100%	8.5	300		m3	2550	$15.00	$4.78	
Granular A - 150mm	100%	8.5			m2		$7.00	$7.44	
Granular B - 300mm	100%	8.5			m2		$9.00	$9.56	
							Total =	$21.78	
Existing Hardtop Road Reconstruction - To Gravel Surface									
Item	**Amount**	**Width (m)**	**Depth (mm)**	**Conversion Factor**	**Unit**	**Quantity**	**Unit Cost**	**Cost/m2**	
Pulverizing		8.5			m2		$2.00	$2.00	
PAD with 100mm Granular A		8.5			m		$32.00	$3.76	
							Total =	$5.76	

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Appendix E

Map of Surface Upgrade or Downgrade Recommendations

BURNSIDE

Map Title

ROAD MANAGEMENT PLAN

SURFACE TYPE DOWNGRADE RECOMMENDATIONS

Client

TOWNSHIP OF MELANCTHON

Drawn	Checked	Date	Figure No.
PS	CR	2019/10/30	E
Scale		Project No.	
H 1:120,000		300043927	

File Path: \\ELMO\Shared Work Areas\043927 (Melancthon RNS 2019)\043927 Downgrade.mxd Print Date: 2019/10/30 Time: 09:58 AM

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Appendix F

Table and Map of Ten-Year Road Improvement Plan

BURNSIDE

Map Title

ROAD MANAGEMENT PLAN

TEN YEAR ROAD CAPITAL & MAINTENANCE IMPROVEMENT PLAN

Client

TOWNSHIP OF MELANCTHON

Drawn	Checked	Date	Figure No.
PS	CR	2019/10/30	F
Scale		Project No.	
H 1:120,000		300043927	

File Path: \\ELMO\Shared Work Areas\043927 (Melancthon RNS 2019)\043927 Ten Year Plan.mxd Print Date: 2019/10/30 Time: 09:56 AM

2019 Township of Melancthon Road Management Plan
Ten-Year Improvement Plan (2020 to 2029)

Line No.	Asset ID	Road Name	From	To	Road Length (m)	Road Width (m)	Road Material	Road Environment	Existing AADT Volume (vpd)	Existing AADT Range (vpd)	Count Year	Year 10 (2029) AADT Estimate (vpd)	Road Surface Remaining Useful Life	Pavement Condition Index (PCI)	Priority Guide Number (PGN)	Existing (2019) SCR	Existing (2019) BCR	Improvement Type	Improvement Benchmark Cost ($/m2) *	Total Improvement Cost	Proposed Improvement Year	Notes	Annual Cost Subtotal
1	147	2nd Line SW	Hwy. 89	300	1,799	6.8	Asphalt	Rural	820	400-999	2019	1,000	2	61.3	51.4	3	3	**Rehabilitation (Apply Base Asphalt Only)**	$20.08	$246,611	**2020**		
2	82	2nd Line SW	250	North Limit	2,350	6.5	Asphalt	Rural	1,127	1000-1999	2019	1,374	2	57.5	91.9	6	2	**Rehabilitation (Apply Base Asphalt Only)**	$20.08	$306,756	**2020**		**$561,192**
3	194	15th Sideroad	County Rd. 124	Main St.	227	6.5	Asphalt	Rural	125	50-199	Estimate	138	24	98.5	2.2	9	10	**Routine Maintenance**	$0.75	$1,107	**2020**		
4	1345	20th Sideroad	3rd Line	County Rd. 124	1,378	6.5	Asphalt	Rural	164	50-199	2019	181	24	99.0	2.9	9	10	**Routine Maintenance**	$0.75	$6,718	**2020**		
5	94	5th Line OS	County Rd. 17	Sideroad 280	2,293	6.5	Asphalt	Rural	284	200-399	2019	346	1	41.0	15.6	2	1	**Rehabilitation**	$24.62	$366,880	**2021**	Includes geogrid and additional gravel (swamp area).	
6	101	5th Line OS	Sideroad 280	4th Line NE	205	6.5	Asphalt	Rural	284	200-399	Estimate	346	1	41.0	15.6	2	1	**Rehabilitation**	$20.00	$26,650	**2021**		
7	1492	5th Line OS	4th Line NE	15th Sideroad	570	6.5	Asphalt	Rural	250	200-399	Estimate	305	1	41.0	13.8	2	1	**Rehabilitation**	$20.00	$74,100	**2021**		
8	95A	4th Line OS	County Road 17	Strada Pit North Entrance	1,651	6.5	Asphalt	Rural	125	50-199	Estimate	152	3	80.5	7.8	8	5	**Rehabilitation**	$20.00	$214,630	**2021**	Since the Strada Pit owner is responsible for paying for improvements to this section, the cost has been excluded from the "Annual Cost Subtotal".	**$534,939**
9	95B	4th Line OS	Strada Pit North Entrance	15th Sideroad	1,400	6.5	Asphalt	Rural	79	50-199	2019	96	3	54.3	4.6	1	1	**Revert to Gravel**	$5.76	$52,416	**2021**		
10	1490	3rd Line OS	20th Sideroad	County Rd. 21	3,055	6.5	Asphalt	Rural	107	50-199	2019	130	23	97.0	1.9	8	10	**Routine Maintenance**	$0.75	$14,893	**2021**		
11	147	2nd Line SW	Hwy. 89	300	1,799	6.8	Asphalt	Rural	820	400-999	2019	1,000	2	61.3	51.4	3	3	**Resurface (Top Asphalt Only)**	$9.15	$110,975	**2022**		
12	82	2nd Line SW	250	North Limit	2,350	6.5	Asphalt	Rural	256	200-399	2019	312	2	57.5	20.9	6	2	**Resurface (Top Asphalt Only)**	$9.15	$139,744	**2022**		
13	159	5th Line OS	15th Sideroad	Sideroad 270	1,930	6.5	Asphalt	Rural	237	200-399	2018	289	1	41.0	13	2	1	**Rehabilitation**	$20.00	$250,900	**2022**		**$644,304**
14	1493	5th Line OS	Sideroad 270	6th Line NE	654	6.5	Asphalt	Rural	230	200-399	Estimate	280	1	41.0	12.6	2	1	**Rehabilitation**	$30.77	$130,800	**2022**	Includes geogrid and additional gravel (swamp area).	
15	1494A	4th Line OS	5th Sideroad	Lot 9/10	2,438	6.5	Asphalt	Rural	300	200-399	Estimate	366	24	98.3	5.7	9	10	**Routine Maintenance**	$0.75	$11,885	**2022**		
16	143	7th Line SW	Hwy. 89	County Rd. 17	853	6.5	Asphalt	Rural	218	200-399	2019	241	5	63.5	16.1	5	3	**Revert to Gravel**	$5.76	$31,936	**2023**		
17	142	7th Line SW	County Rd. 17	Sideroad 280	2,040	6.5	Asphalt	Rural	200	200-399	Estimate	221	5	63.5	14.8	5	3	**Revert to Gravel**	$5.76	$76,378	**2023**		
18	111	7th Line SW	Sideroad 280	Sideroad 270	2,033	6.5	Asphalt	Rural	200	200-399	Estimate	221	5	63.5	14.8	3	3	**Revert to Gravel**	$5.76	$76,116	**2023**		
19	1489A	7th Line SW	Sideroad 270	200 m S Sideroad 260	1,848	6.5	Asphalt	Rural	177	50-199	2019	196	5	63.5	17.3	5	3	**Revert to Gravel**	$5.76	$76,677	**2023**		
20	161	5th Line OS	20th Sideroad	County Rd. 21	1,577	6.5	Asphalt	Rural	226	200-399	2019	275	3	41.0	12.4	2	1	**Rehabilitation**	$24.62	$252,320	**2023**	Includes geogrid and additional gravel (swamp area).	**$611,519**
21	160	5th Line OS	6th Line NE	20th Sideroad	466	6.5	Asphalt	Rural	230	200-399	Estimate	280	1	41.0	12.6	2	1	**Rehabilitation**	$30.77	$93,200	**2023**	Includes geogrid and additional gravel (swamp area).	
22	1495	4th Line OS	Hwy. 10	5th Sideroad	713	6.5	Asphalt	Rural	300	200-399	Estimate	366	24	98.3	5.7	9	10	**Routine Maintenance**	$0.75	$3,476	**2023**		
23	185	High St.	William St.	Main St.	170	5.3	Asphalt	Semi-Urban	70	50-199	Estimate	77	24	98.8	1.5	9	10	**Routine Maintenance**	$0.75	$676	**2023**		
24	201	Charles St. W	Main St.	End of Road	141	7	Asphalt	Semi-Urban	30	0-49	Estimate	33	21	96.5	0.5	10	9	**Routine Maintenance**	$0.75	$740	**2023**		
25	1494B	4th Line OS	Lot 9/10	County Rd. 17	750	6.5	Asphalt	Rural	300	200-399	Estimate	366	3	69.5	30.6	3	2	**Rehabilitation**	$20.00	$97,500	**2024**		
26	176	15th Sideroad	3rd Line	County Rd. 124	1,142	6.5	Asphalt	Rural	125	50-199	Estimate	128	3	80.3	10.2	5	5	**Rehabilitation**	$15.38	$114,200	**2024**		
27	1491	15th Sideroad	Main St.	East	691	6.5	Cold Recycled	Rural	125	50-199	Estimate	138	3	56.8	8.1	10	2	**Rehabilitation**	$20.00	$89,830	**2024**		
28	205	Hunter Pkwy.	County Rd. 124	Apartment Building	291	6.5	Cold Recycled	Semi-Urban	100	50-199	Estimate	110	7	76.0	4.1	10	5	**Rehabilitation**	$15.38	$29,100	**2024**		
29	184	Old Field Ct.	Main St.	End of Road	643	6.5	Asphalt	Semi-Urban	150	50-199	Estimate	166	17	75.6	8.6	5	8	**Routine Maintenance**	$0.75	$3,135	**2024**		
30	182	Fieldway Ct.	Main St.	End of Road	800	6.5	Asphalt	Semi-Urban	120	50-199	Estimate	133	19	92.8	1.5	8	10	**Routine Maintenance**	$0.75	$3,900	**2024**		
31	196	Mill St.	Main St.	William St.	95	6.5	Asphalt	Semi-Urban	300	200-399	Estimate	331	24	98.3	5.4	9	10	**Routine Maintenance**	$0.75	$463	**2024**		
32	189	River Rd.	William St.	Townline	1,401	7.5	Asphalt	Semi-Urban	284	200-399	2019	314	24	98.3	4.4	9	10	**Routine Maintenance**	$0.75	$7,881	**2024**		
33	200	Church St.	Main St.	North Limit	242	4	Cold Recycled	Semi-Urban	60	50-199	Estimate	66	1	54.3	6.3	10	2	**Rehabilitation**	$32.50	$31,460	**2024**		
34	188	George St.	Addeson St.	Main St.	114	5.5	Cold Recycled	Semi-Urban	50	50-199	Estimate	55	4	76.3	2.4	10	5	**Rehabilitation**	$18.18	$11,400	**2024**		
35	186	Addeson St.	George St.	Lloyd St.	155	4.5	Cold Recycled	Semi-Urban	50	50-199	Estimate	55	4	76.3	2.9	10	5	**Rehabilitation**	$22.22	$15,500	**2024**		
36	187	Lloyd St.	Addeson St.	Main St.	110	4.5	Cold Recycled	Semi-Urban	50	50-199	Estimate	55	4	76.3	2.9	10	5	**Rehabilitation**	$22.22	$11,000	**2024**		
37	195	Mill Ln.	Main St.	End of Road	655	5	Cold Recycled	Semi-Urban	150	50-199	Estimate	166	4	66.3	9.5	10	4	**Rehabilitation**	$20.00	$65,500	**2024**		**$480,869**
38	207	5th Sideroad	3rd Line	County Rd. 124	1,371	6.5	Asphalt	Rural	653	400-999	2019	796	8	86.8	17.1	8	8	**Rehabilitation (Apply Base Asphalt Only)**	$13.91	$123,986	**2025**		
39	93	3rd Line OS	5th Sideroad	2 km N of 5th Sideroad	2,011	6.5	Asphalt	Rural	493	400-999	2019	601	12	89.3	9.7	8	9	**Resurface**	$14.44	$188,752	**2025**		
40	544	3rd Line OS	County Rd. 17	2 km N of 5th Sideroad	1,048	6.5	Asphalt	Rural	493	400-999	2019	601	8	89.3	9.7	8	9	**Rehabilitation**	$31.54	$214,840	**2025**	Includes vertical deficiency correction of $30,000.	
41	1347	Main St.	County Rd. 124	Oldfield Ct.	692	6.5	Asphalt	Rural	890	400-999	2019	983	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$3,374	**2025**		
42	1346	Main St.	Oldfield Ct.	Fieldway Ct.	277	6.5	Asphalt	Semi-Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,350	**2025**		
43	1315	Main St.	Fieldway Ct.	High St.	323	6.5	Asphalt	Semi-Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,575	**2025**		
44	1311	Main St.	High St.	Mill St.	120	6.5	Asphalt	Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$585	**2025**		
45	1310	Main St.	Mill St.	Church St.	214	6.5	Asphalt	Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,043	**2025**		
46	1312	Main St.	Church St.	Charles St.	153	6.5	Asphalt	Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$746	**2025**		
47	1313	Main St.	Charles St.	George St.	126	6.5	Asphalt	Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$614	**2025**		
48	1314	Main St.	George St.	Mill Ln.	212	6.5	Asphalt	Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,034	**2025**		
49	193	Main St.	Mill Ln.	15th Sideroad	355	6.5	Asphalt	Semi-Urban	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,731	**2025**		
50	183	Main St.	15th Sideroad	County Rd. 124	366	6.5	Asphalt	Rural	900	400-999	Estimate	994	24	98.8	16.2	9	10	**Routine Maintenance**	$0.75	$1,784	**2025**		**$541,413**
51	1351	2nd Line SW	300	County Rd. 17	1,981	6.7	Asphalt	Rural	812	400-999	Estimate	990	12	98.3	10.2	7	10	**Resurface**	$14.44	$191,658	**2026**		
52	1278	2nd Line SW	County Rd. 17	280	2,051	6.5	Asphalt	Rural	812	400-999	Estimate	990	15	87.8	22.8	5	9	**Resurface**	$14.44	$192,507	**2026**		**$574,513**
53	117	2nd Line SW	280	270	2,028	6.5	Asphalt	Rural	812	400-999	2018	990	15	96.9	15.4	9	10	**Resurface**	$14.44	$190,348	**2026**		
54	1509	2nd Line SW	270	260	2,045	6.6	Asphalt	Rural	835	400-999	2017	1,018	15	95.0	15.6	9	10	**Resurface**	$14.44	$194,897	**2027**		
55	81	2nd Line SW	260	250	2,054	6.6	Asphalt	Rural	980	400-999	2016	1,195	15	95.0	18.3	9	10	**Resurface**	$14.44	$195,754	**2027**		**$444,895**
56	207	5th Sideroad	3rd Line	County Rd. 124	1,371	6.5	Asphalt	Rural	653	400-999	2019	796	8	86.8	17.1	8	8	**Resurface (Top Asphalt Only)**	$6.09	$54,244	**2027**		
57	32	260 (Main St.)	2nd Line SW	4th Line SW	2,228	6.5	Asphalt	Rural	263	200-399	2019	291	6	63.0	21.1	5	2	**Rehabilitation**	$20.00	$289,640	**2028**		
58	29	260 (Main St.)	Geirson	2nd Line SW	1,526	6.5	Asphalt	Rural	450	400-999	Estimate	497	5	63.0	24.8	5	2	**Rehabilitation**	$20.00	$198,380	**2028**		**$488,020**
59	31	260 (Main St.)	4th Line SW	7th Line SW	2,013	6.5	Asphalt	Rural	250	200-399	Estimate	276	6	63.0	20	5	2	**Rehabilitation**	$20.00	$261,690	**2029**		
60	65	4th Line NE	5th Line OS	County Rd. 21	3,937	6.5	Asphalt	Rural	257	200-399	2019	284	15	68.8	14.2	6	5	**Revert to Gravel**	$5.76	$147,401	**2029**		**$409,091**
																				$5,290,755			**$5,290,755**

* Benchmark costs in this Table may differ from the benchmark costs shown in the Treatment Matrix. This is to reflect road-section-specific unit cost estimates in the detailed ten-year plan. See the "Notes" field for any specific adjustments.

** Section #72 (4th Line NE between County Road 9 and 1 km north of Sideroad 240) is not recommended for reversion to gravel in the next ten-year period, however is anticipated to warrant reversion to gravel in the 2040-2045 time horizon.

R.J. Burnside & Associates Limited