



THE CORPORATION OF THE TOWNSHIP OF KING
Report to Council

Monday, June 12, 2023

Public Works Department - Capital Division

Report Number PW-CAP-2023-006

10 Year Paving Strategy, Gravel Road Conversion Strategy and Pavement Management Plan Update

RECOMMENDATION(S):

The Director of Public Works respectfully submits the following recommendation(s):

1. Report Number PW-CAP-2023-006 be received; and
2. That the Roads Needs Study, including the 10 Year Paving Strategy and Pavement Management Plan Update and the new Gravel Conversion Program be approved by Council.

REPORT HIGHLIGHTS:

- Completion of the Road Needs Study
- 10 Year Paving Strategy and Pavement Management Plan Update
- New Gravel Conversions Program

PURPOSE:

The purpose of this report is for Council to approve the Road Needs Study, including the 10 year paving strategy and Pavement Management Plan Update, and the new Gravel Conversions Program, attached as Appendix 'A' to this report.

BACKGROUND:

In February 2020 Council endorsed the 2020 Transportation Master Plan. Within the Master Plan, one of the Short-Term Recommendations included the development of a 10 Year Paving Strategy and Pavement Management Plan. This included an implementation plan to prioritize and phase the recommended paving program. The 10-year Paving Strategy was approved at Council in December 2020. This document was to be updated throughout the life of the program every two years through a Road Needs Study.

The original Road Needs Study scope of work did not include developing a separate 10-Year Capital Plan for our Gravel Conversion Program.

In May 2022, Council requested that a new Gravel Road Conversion Program be created in order to take into consideration the unique nature and needs of our gravel road assets. The 10 Year Paving Strategy, Pavement Management Plan and Gravel Road Conversion Program all form part of the road needs assessment.

ANALYSIS:

In 2022, Public Works staff procured the services of RJ Burnside and Associates to conduct a Road Needs Study that included the 10 Year Paving Strategy and Pavement Management Plan Update and a new Gravel Conversion Program.

As part of the 2022 Road Needs Study completed by R.J. Burnside and Associates, the Gravel Roads Conversion Program, the Road Improvement Program and their respective prioritization lists have been updated. The 2022 Road Needs Study utilized the most recent traffic data, road usage information, and the results of a visual condition survey of the subject roads to determine the revised prioritization lists. Please see Appendix 'A' of this report for the 2022 Road Needs Study and revised prioritizations.

This Road Needs Study also assessed localized drainage, potential roadside safety improvements, traffic volumes, need for culvert replacements, and technical data from geotechnical investigations. As a result, the revised road improvement prioritization lists take a wholistic approach to each road segment incorporating these other important improvements into the recommendations. The result of these changes will provide broader, more comprehensive improvements to our road network over the cycle of implementation.

FINANCIAL CONSIDERATIONS:

The paving program is budgeted annually as part of the budget process for Council approval each year.

ALIGNMENT TO STRATEGIC PLAN:

The 2019-2022 Corporate Strategic Plan was formally adopted by Council on September 21, 2020 which emphasizes all of the ICSP Pillars (Financial, Economic, Socio-Cultural and Environmental) and is also aligned with the long-term vision defined in the Official Plan. The 2019-2022 Corporate Strategic Plan aims to ensure staff initiatives focus on current Term of Council priorities in support of the Township's long-term vision to 2031.

This report is in alignment with the CSP's Priority Area(s), associated Objective(s) and/or Key Action(s):



**Investing in
Infrastructure**

Connecting People and Places
• Improve Road Network

This Roads Needs Study including the new Gravel Conversions Program and Road Improvement Program establishes the physical condition of the road network and determines roads maintenance needs and costs. The prioritization lists are provided to help develop a multi-year capital plan and assist with asset management planning.

CONCLUSION:

It is recommended that Council approve the Roads Needs Study, including the 10 year paving strategy and Pavement Management Plan Update, and the new Gravel Conversions Program.

ATTACHMENTS:

[King Roads Needs Study](#)

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BURNSIDE

Township of King Road Needs Study

**Township of King
2585 King Road
King City ON L7B 1A1**

Township of King Road Needs Study

**Township of King
2585 King Road
King City ON L7B 1A1**

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**November 2022 (Revised June 2023)
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Township of King

Township of King Road Needs Study
November 2022 (Revised June 2023)

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Revision	Date	Description
0	November 2022	Initial Submission to Township of King
1	March 2023	Draft Submission to Township of King
2	March 2023	Final Submission to Township of King
3	June 2023	Updated Final Submission to Township of King

R.J. Burnside & Associates Limited

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Executive Summary

This Report is the Road Needs Study (RNS) which is comprised of the 10-year paving strategy update, pavement management update and new gravel road paving strategy. The RNS updates the Township of King's (the Township) road inventory, establishes the physical condition of the road network and determines the road maintenance and improvement needs and costs. A general prioritization of the road improvement needs is provided for the Township to help develop a multi-year capital plan that will assist the Township in asset management planning.

Inventory of Roads

Road inventory information was collected, and road condition ratings were established in April and July 2022 for all the assumed roads within the Township's road network. Approximately 350.608 km of roads are inventoried in this study which includes 330.210 km of roads that are assumed by the Township and 20.398 km of roads that have not yet been assumed by the Township. The assumed roads inventoried are comprised of:

- 58.629 km of gravel rural roads.
- 1.373 km of gravel semi-urban roads.
- 25.686 km of surface treatment rural roads.
- 6.714 km of surface treatment semi-urban roads.
- 121.489 km of asphalt rural roads.
- 29.441 km of asphalt semi-urban roads.
- 86.878 km of asphalt urban roads.

Maps of the overall surface types are presented in Appendix A, along with an Excel spreadsheet of the inventory and condition data.

Traffic volume ranges are estimated for the roads in this study, based upon traffic counts provided by the Township, taken at select locations from 2016 to 2021. Traffic volumes for a ten-year horizon period were also estimated, based on growth forecasts in the Township's Transportation Master Plan.

Assessment of Road Needs

A pavement condition index (PCI) was established for each road section, based on rating systems developed by the Ministry of Transportation (MTO). The PCI has been used to assess the improvement requirements for each segment within the road network. An improvement matrix has been developed by R.J. Burnside & Associates Limited (Burnside) for the Township that identifies the appropriate improvement type, considering the condition of the road, roadside environment, surface type, traffic volumes and recommended best practices for the life cycle management of road assets. The lifecycle improvements include routine maintenance, preventive maintenance,

resurfacing, rehabilitation and reconstruction. A Priority Guide Number (PGN) and a Priority Rating Number (PRN) were developed to prioritize improvement needs.

The primary conclusions and recommendations made in this RNS are as follows:

- 10 Year Paving Strategy Update.
- Gravel Road Paving Strategy.
- Conduct a Township-wide traffic count study prior to the next RNS.
- Existing gravel or Low Class Bituminous (LCB) roads that may warrant upgrading (i.e., to LCB or High Class Bituminous (HCB) surfaces) have been identified.
- Road sections with the following issues/deficiencies have been identified in this RNS:
 - Potential for deficient sightlines.
 - Less than tolerable (i.e., deficient) road widths
- The total road network needs (i.e., current, today needs) for hardtop roads was determined to be \$26.5 million, and the total need to upgrade the remaining gravel roads was determined to be \$9.7 million.
- It is recommended that the Township establish an annual allowance specifically for applying cost-effective routine and preventive maintenance treatments on existing hardtop roads. Typical crack sealing budgets for similar municipalities are approximately \$180 per centreline km of road, therefore the recommended crack sealing budget for King Township is \$41,000 per annum.
- It is recommended that the Township further review their road maintenance budget to maintain their roads at a higher level of service. The needs over the next five years require a budget of approximately \$4.2 million to make the necessary improvements.
- It is recommended the Township align the road needs study finding, as presented in this report, with its Asset Management Plan. O.Reg 588/17 requires that all municipalities establish a service level for their critical infrastructure by 2025. This will assist with prioritization of road improvements in the next RNS.
- Two intersections along the 8th Concession may have deficient sightlines. It is recommended that the Township complete a detailed sightline analysis study for the intersections of 15th Sideroad and 8th Concession as well as 17th Sideroad and 8th Concession.

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

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) was retained by the Township of King (the Township) to conduct a Road Needs Study (RNS) and develop a 10-year road improvement plan. The road improvement plan includes three categories, the 10 Year Paving Strategy update, the Pavement Improvement Plan and the new Gravel Road Paving Strategy. This RNS updates the Township's road inventory, establishes the physical condition of the road network and determines the road maintenance and improvement needs and costs. A general prioritization of the road improvement needs is provided for the Township to help develop a multi-year capital plan that will assist the Township in asset management planning.

A complete Road Management Plan (RMP) considers the full range of issues that may affect the ongoing maintenance, improvement, and management of a road network, culminating in the completion of a multi-year road improvement plan. Outlined in this report is the 10-year road improvement plan that has been developed by Burnside using the current road conditions, priority rating and traffic volumes of the Township's road network.

We gratefully acknowledge the assistance and contributions of the Township staff in the preparation of this Study.

1.1 Previous Road Needs Studies and Background Studies

The Township completed two Road Needs Studies in the past, including the 2011 Road Needs Study (2011 Study) and a 2016 Road Needs Study (2016 Study). The previous studies' methodologies were based on the Inventory Manual for Township Roads (Ministry of Transportation, 1991).

A Technical Memorandum (Draft) was completed in 2019 that summarized the results of a Gravel Road Improvement Study (2019 Gravel Study) that was completed for the Township. The 2019 Gravel Study provided an assessment of the costs to improve and resurface the Township's gravel roads.

The Township's 2020 Transportation Master Plan (2020 TMP), dated 2020, was also reviewed and projected growth was considered. In addition, as Burnside has completed various road reconstruction and bridge / culvert Capital Works projects in recent years, these projects were considered in the assessment.

2.0 The Road Study

2.1 Road Inventory

A total of 350.608 km of roads were inventoried as part of this RNS including 330.210 km of roads that have been assumed by the Township, and 20.398 km of roads that have not yet been assumed by the Township. Roads are identified by their road names and identification numbers and road segments have been identified by reference to their location, with respect to intersecting roads. The road database and road inventory mapping are provided in Appendix A for reference purposes.

The database and mapping are fully integrated within a geographic information system (GIS) and each section has been assigned a unique ID number and GIS reference number. Data related to the road sections are obtained through a field review of the overall road network including:

- Road ID, Name, From, To
- Length
- Road Width
- Boundary Road
- Roadside Environment: Rural, Semi-urban and Urban
- Functional Class
- Minimum Maintenance Class
- Annual Average Daily Traffic: Existing and Projected
- Number of Lanes
- Surface Type: Gravel, High and Low Class Bituminous (asphalt)
- Platform Width
- Surface Width
- Shoulder Width
- Speed Limit
- Structural Adequacy Rating of the Road
- Distress Manifestation Index (DMI): various types of road distress, with quantification of the density and severity of the distress
- Ride Comfort Rating (RCR): qualitative assessment of ride comfort
- Calculation of Pavement Condition Index (PCI): based on DMI and RCR, using the Ministry of Transportation (MTO) formulae

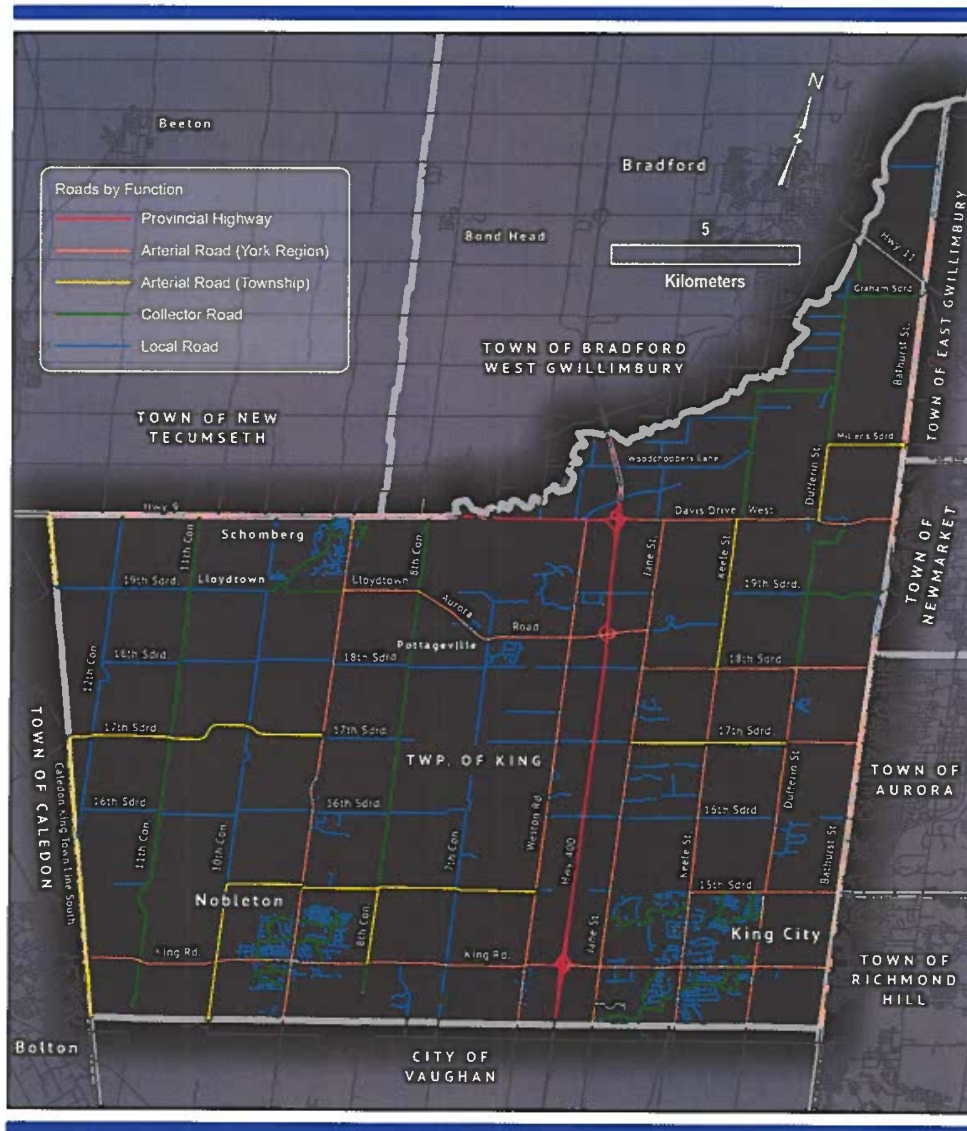
2.2 Functional Road Classifications

Based on the Township's Official Plan, the class of all roads within the Township are defined as follows:

- **Arterial Roads:** Includes both Regional and Township roads. Arterial roads serve higher volumes of intra-urban traffic at moderate to high speeds with limited private access. These roads also provide regional vehicular movement, goods movement, transit priority and active transportation. The planned right-of-way (ROW) width is up to 36 m and may include cycle tracks and multi-use paths.
- **Urban Collector:** These roads collect traffic from local roads and connect them to arterial roads. Urban collector roads are typically used by local traffic with limited through traffic. Private access and on-street parking can also be permitted. The roadway will accommodate pedestrian and cyclist traffic via the provision of sidewalk and cycling facilities. The planned ROW width is 26 m and elements within the cross section will vary depending on environment.
- **Rural Collector:** These roadways are typically located outside the urban areas. Rural collector roads serve regional and interregional vehicular movement at higher speeds. The planned ROW width is 26 m and includes features that assist in goods movement, farming supportive design measures, paved shoulders, and multi-use paths.
- **Urban Local:** Serves local traffic of typically low volumes. Private access is permitted on these roadways and intersections are typically stop or yield controlled. Cyclists may share the roadway with vehicles and pedestrian facilities may vary depending on environment. The planned ROW width is 20 m.
- **Rural Local:** These roadways are typically located outside villages and are similar to urban local roads. The planned right-of-way width is 20 m.

Figure 1 shows the existing generalized road classifications of the Township's roads as listed in Schedule F of the Township's Official Plan.

Figure 1: Existing Road Classification Map



2.3 Traffic Considerations

Traffic volume is an important consideration for determining the road improvement needs for any road segment within the road network. Traffic range estimates for Annual Average Daily Traffic (AADT) for each road section are included in the database in

Appendix A. the AADT volume ranges for this study are estimates based on historical traffic count work completed in 2016, 2020 and 2021 at select locations throughout the road network. Based on the Township's TMP, a growth rate of 2.1% compounded annually was applied for all segments with the exception of local roads from the base year traffic count to the existing year (2022). The estimated 2022 traffic volume ranges are shown graphically on the plan in Appendix B. The same growth rate was used to estimate the 2032 traffic volumes. The volume ranges for 2032 are presented graphically in Appendix B as well.

The lengths of roads that have been assumed by the Township in the various traffic volume ranges are summarized in Table 1.

Table 1: Length of Roads with Various AADT Traffic Ranges

AADT Traffic Range (vpd)	Length of Road in Traffic Range (km)	
	Existing (2022)	Year 2032
0 – 49	13.339	11.411
50 – 199	75.965	58.976
200 – 399	70.744	65.636
400 – 999	87.940	96.193
1,000 – 1,999	57.197	54.763
2,000 – 2,999	9.561	23.041
3,000 – 3,999	4.745	7.015
4,000 – 4,999	2.232	2.456
5,000 – 5,999	2.127	2.232
6,000 – 7,999	4.722	4.147
8,000 – 9,999	0	2.702
10,000 – 11,999	1.638	0
12,000 – 14,999	0	1.638
Total	330.210	330.210*

* Future AADT totals will vary based on growth within the Township and additional roads being assumed by the Township.

Traffic volumes and traffic types (auto, truck) are also important considerations in establishing the road surface needs for roads within the road network. Consideration may be given to upgrading gravel roads or surface treated roads to an asphalt surface, for roads experiencing high traffic volumes, high truck volumes or high truck loading, or where high maintenance is an ongoing issue.

Where traffic volumes exceed 200 vehicles per day (vpd), upgrading of gravel road surfaces to hard top road surfaces may be considered. Similarly, where traffic volumes exceed 400 vpd, upgrading of surface treatment roads to asphalt roads may be considered, per industry practice.

Truck volumes typically range from a low of 3% on low volume residential streets to a high of 15% or more on arterials and collector roads. Information on truck volumes on the Township's roads was not available for this current study. It is recommended that the Township develop a traffic counting program and release a Request for Proposal (RFP) a few months prior to their next RNS update to ensure that the AADT volumes being used are current. Also, it is recommended that any future traffic counting work in the Township distinguish vehicle classifications (i.e., heavy truck volumes) particularly if consideration is being made to upgrade the road's surface type. For low volume rural roads, this study recommends that surface upgrading may be economical to consider where the percentage of trucks exceed 10% of the AADT provided the absolute volume of truck traffic is over 30 trucks per day.

2.4 Roadside Environment and Surface Type

The roadside environment and surface type for each road section have been identified in the database in Appendix A, with the surface type also illustrated on the map. For the purposes of this study the roadside environment and surface type have been differentiated as follows:

Roadside Environment

- **Urban Environment:** Reasonably continuous development occurs along the roadway and the roadway design includes curbs and/or gutters and storm sewers.
- **Semi-Urban Environment:** Reasonably continuous development occurs along the roadway and the roadway design includes open ditches or swales and does not include curbs and/or gutters or storm sewers.
- **Rural Environment:** Rural roads which abut scattered rural development, farmland, or undeveloped land.

Surface Type

- Gravel
- Low Class Bituminous (LCB, Surface Treatment)
- High Class Bituminous (HCB, Asphalt)

The roadside environment and road surface types within the Township are summarized in Table 2.

Table 2: Roadside Environment Categorized by Surface Type

Surface Type	Roadside Environment	Length (km)	Percent of Total
Gravel	Rural	58.629	17.755%
	Semi-Urban	1.373	0.416%
LCB	Rural	25.686	7.779%
	Semi-Urban	6.714	2.033%
HCB	Rural	121.489	36.791%
	Semi-Urban	29.441	8.916%
	Urban	86.878	26.310%
Total		330.210	100%

Of the 330.210 km of roads inventoried, the roadside environments and surface types are summarized as follows:

- Roadside Environment: 205.804 km rural (62.325%), 37.528 km semi-urban (11.365%) and 86.878 km urban (26.310%).
- Road Surface Type: 60.002 km gravel (18.171%), 32.400 km LCB (9.812%), and 237.808 km HCB (72.017%).

3.0 Methodology

This study uses various Ministry of Transportation Ontario (MTO) procedures for the evaluation of the condition of the roads including the following:

- SP-024 Manual for Condition Rating of Flexible Pavements – Distress Manifestations, Ministry of Transportation, 1989.
- SP-021 Manual for Condition Rating of Surface-Treated Pavements – Distress Manifestations, Ministry of Transportation, 1989.
- SP-025 Manual for Condition Rating of Gravel Surface Roads, Ministry of Transportation, 1989.
- The Formulations to Calculate Pavement Condition Indices, Ministry of Transportation, 2007.
- Inventory Manual for Municipal Roads, Ministry of Transportation, 1991.

In addition to using the above manuals for condition evaluation, this study also uses the MTO prioritization methodology (Priority Rating and Priority Guide Number). This study uses the MTO methodology for all aspects of the project as these are the most commonly used methodologies for RNSs in Ontario and are based on technical inputs.

The inventory has also included the development of GIS mapping, and related database, for the Township's roads.

3.1 Hardtop Surface Paving Program and Pavement Management

3.1.1 Desktop Review

Burnside completed a desktop review of the background information provided by the Township to facilitate the field work and project setup prior to any field collection commencing. The following tasks were part of the desktop review to initiate this project.

The previous RNS reports (2011 Study & 2016 Study) were reviewed to determine the methodology used, tasks completed and the procedures that were used. Additionally, the previous reports were reviewed to determine how roads were identified (i.e., unique identifier for that study, Municipal ID, Road Name, etc.).

The 2020 Paving Strategy was reviewed to become familiar with the recommendations of the previous report and the 10-year capital improvement plan. The review of the 2020 study also allowed Burnside to become familiar with the Township's approach to road improvements and their progress over the previous 2 years.

The Township's 2020 Transportation Master Plan (TMP) was reviewed to determine the annual growth rate that is projected for the Township's roads.

Historical traffic volumes (AADTs) were reviewed to determine any areas of the Township's road network that was missing and would need attention (i.e., traffic volume forecasting/estimating or data collection). Based on the review of the 2020 TMP, a growth rate of 2.1% per annum (i.e., annual traffic growth) was determined.

The Township's Official Plan was also reviewed to determine the road classification descriptions as they apply to King, as well as to determine the existing road classification for each road segment within the Township.

Setup of a GIS linked field collection application that can be used on a tablet or phone using Arc GIS products (Survey 123, Field Maps, etc.). As part of this task, a GIS database for this study was created and the Township's road network was imported to determine what data was missing. This GIS application was created to link the data being collected in the field to the GIS database.

Review of relevant, and current road improvement cost data/information for Ontario was completed to determine unit costs for the components of the various types of improvements proposed in this study. This unit cost data was then used during detailed analysis of the proposed improvement types to determine a cost per m² for each improvement (i.e., cost per m² to reconstruct an asphalt road).

3.1.2 Visual Condition Survey

A visual assessment of the Township's hardtop road network took place in July 2022, to determine the condition rating of the road surface. Specific pavement distress ratings (i.e., Severity and Density) were assigned for 15 different distress types for hardtop road sections, based generally on the "Flexible Pavement Condition Evaluation Form" developed by the Ministry of Transportation.

The severity of a distress can be simply defined as how bad the distress is (i.e., slight cracking). The Severity of a distress is based on a scale of engineering judgement from previous experience and contains five levels. The five levels of severity are Very Slight, Slight, Moderate, Severe and Very Severe.

The density of the distress is also assigned which can be defined as the extent of the issues (i.e., how frequent the distress is present on the road). Like the severity, density is also based on engineering judgement from experience and contains five levels. The five levels of density are Few, Intermittent, Frequent, Extensive and Throughout.

As mentioned above, the review of hardtop roads requires 15 different distress types to be assigned to the road segment. The 15 distress types for hardtop roads consist of the following.

Distress 1: Ravelling and Loss of Surface Aggregate

Ravelling and surface aggregate loss is a surface defect and consists of the pavement surface breaking up with small pockmarks where the surface aggregate is lost from. This surface distress can be caused by a lack of bond between the asphalt and the underlying binder. Surface aggregate loss can also be caused by poor asphalt content and/or high air voids in the asphalt. Figure 2 below is an example of ID ORRD-0103 (10th Concession between 16th Sideroad and 2.05 km North) where very slight, intermittent surface aggregate loss was detected.

Figure 2: Ravelling and Aggregate Loss Example

**Distress 2: Flushing**

Flushing is a surface defect that consists of the asphalt cement (binding content in the asphalt mixture) on the asphalt surface. Flushing is most likely to occur in the wheel tracks during hot weather. Flushing can be caused by high asphalt cement content in the asphalt mix relative to the voids. During hot days, asphalt cements expand and fills any air voids present in the asphalt surface, is the air voids are too low and the road is prone to high traffic volumes, flushing is likely to occur. Figure 3 below is an example of ID ORRD-0053 (11th Concession between 16th Sideroad and 17th Sideroad) where slight, frequent asphalt cement flushing was detected.

Figure 3: Flushing Example**Distress 3: Rippling and Shoving**

Rippling and shoving is a surface deformation that consists of waves in the pavement surface. Rippling is where regular transverse waves are present, and shoving is where single or multiple waves are located transversely along the road. Rippling and shoving can be caused by poor construction practices, heavy traffic on steep grade changes (downgrade or upgrade), low stability in the asphalt mixture or an unstable granular base. Figure 4 below is an example of ID ORRD-0012 (19th Sideroad between King-Newmarket boundary and Old Bathurst Street) where severe, few rippling and shoving was detected.

Figure 4: Rippling and Shoving Example**Distress 4: Wheel Track Rutting**

Wheel track rutting is a surface deformation that can be defined as longitudinal depressions in the form of a single or double wheel in the wheel path of a lane. Wheel track rutting is a result of deformation due to frequent load combined with pavement material displacement. Some causes of wheel track rutting include, poorly compacted asphalt lifts, unstable granular base, unstable shoulder material or allowing traffic onto a hot asphalt mat before letting it cool. Figure 5 below is an example of ID ORRD-0053 (11th Concession between 16th Sideroad and 17th Sideroad) where severe, intermittent wheel track rutting was detected.

Figure 5: Wheel Track Rutting Example**Distress 5: Distortion**

Distortion is also a surface deformation and can be defined as any deviation of the pavement surface from its original shape (other than described under rippling or shoving). Usually distortions result from settlement, slope failure or volumes changes due to moisture change. Some of the possible causes of distortion include, Lack of subgrade support, roadside embankment slope failure, improper maintenance or culvert failures. Figure 6 below is an example of ID ORRD-0194 (8th Concession between 17th Sideroad and 17th Sideroad) where severe, few distortions were detected.

Figure 6: Distortion Example

Distress 6: Longitudinal Wheel Track Cracking (Single or Multiple)

Longitudinal wheel track cracking can be defined as cracks that follow a path approximately parallel to the centre line of the road and located near or at the centre of the wheel path. Possible causes of longitudinal wheel track cracking are overloaded vehicles while the pavement is at the weakest (early spring) and/or fatigue failure of thin asphalt. Figure 7 below is an example of ID ORRD-0055 (17th Sideroad between 12th Concession and Caledon King Townline South) where severe, frequent wheel track cracking was detected.

Figure 7: Wheel Track Cracking Example**Distress 7: Longitudinal Wheel Track Cracking (Alligator)**

Longitudinal wheel track alligator cracking can be defined as, as network of polygon cracks in the form of an alligator pattern that follow a path approximately parallel to the centre line of the road and located near or at the centre of the wheel path. Possible causes of longitudinal wheel track alligator cracking are, insufficient bearing support and/or poor base drainage and stiff or brittle asphalt mixes at cold temperatures. Figure 8 below is an example of ID ORRD-0103 (10th Concession between 16th Sideroad and 2.06 km North) where severe, few wheel track alligator cracking was detected.

Figure 8: Wheel Track Alligator Cracking Example**Distress 8: Centreline Cracking (Single or Multiple)**

Centreline cracking can be defined as single or multiple cracks that have occurred in the pavement surface that are located at or near the centreline of the roadway. Some possible causes of centreline cracking are, poor longitudinal joint construction, variable granular depths due to constructing lanes separately and/or moisture changes. Figure 9 below is an example of ID BRRD-0001 (Kettleby Road between Keele Street and Lorne Avenue) where moderate, intermittent centreline cracking was detected.

Figure 9: Centreline Cracking Example**Distress 9: Centreline Cracking (Alligator)**

Centreline alligator cracking can be defined as a network of polygon cracks that have formed the pattern of alligator skin and are located at or near the centreline of the roadway. Some possible causes for centreline alligator cracking are insufficient bearing support and/or poor base drainage and stiff or brittle asphalt mixes at cold temperatures. Figure 10 below is an example of ID ORRD-0103 (10th Concession between 16th Sideroad and 2.06km North) where severe, few centreline alligator cracking was detected.

Figure 10: Centreline Alligator Cracking Example**Distress 10: Pavement Edge Cracking (Single or Multiple)**

Pavement edge cracking can be defined as cracks that are parallel to extending out from the pavement lane edge. Pavement edge cracks can either be fairly continuous/straight or consist of crescent shaped cracks. Possible causes of pavement edge cracking are frost action, insufficient bearing support and/or excessive traffic loading at the edge of the pavement, poor drainage along the road edge/shoulder, pavement edge line painted in the wrong place, allowing traffic to travel on the edge of the pavement/shoulder. Figure 11 below is an example of ID ORRD-0135 (Jane Street between Woodchoppers Lane and Edward Avenue) where slight, frequent pavement edge cracking was detected.

Figure 11: Pavement Edge Cracking Example**Distress 11: Pavement Edge Cracking (Alligator)**

Pavement edge alligator cracking can be defined as a network of polygon cracks that have formed the pattern of alligator skin and are located at or near the edge of the pavement surface. Some possible causes of pavement edge alligator cracking are insufficient bearing support and/or poor base drainage and stiff or brittle asphalt mixes at cold temperatures. Figure 12 below is an example of ID BRRD-0001 (Kettleby Road between Keele Street and Lorne Avenue) where severe, extensive pavement edge alligator cracking was detected.

Figure 12: Pavement Edge Alligator Cracking Example**Distress 12: Transverse Cracking (Half, Full or Single/Multiple)**

Transverse cracking can be defined as cracks that follow a course or path approximately at right angles to the pavement centreline and are often regularly spaced along the length of the road. Possible causes of transverse cracks are natural shrinkage caused by low temperatures, frost action, and/or low temperature susceptibility of asphalt cement in asphalt mixes. Figure 13 below is an example of ID ORRD-0055 (17th Sideroad between 12th Concession and Caledon King Townline South) where moderate, throughout transverse cracking was detected.

Figure 13: Transverse Cracking Example**Distress 13: Transverse Cracking (Alligator)**

Transverse alligator cracking can be defined as a network of polygon cracks that have formed the pattern of alligator skin and are located at right angles to the roadway centreline. Some possible causes of pavement edge alligator cracking are insufficient bearing support and/or poor base drainage and stiff or brittle asphalt mixes at cold temperatures. Figure 14 below is an example of ID ORRD-0165.1 (12th Concession between Caledon King Townline and 120m North of Caledon King Townline) where moderate, few transverse alligator cracking was detected.

Figure 14: Transverse Alligator Cracking Example

Distress 14: Longitudinal Meander or Mid-lane Cracking

Longitudinal meander or mid-lane cracking can be defined as cracking that is usually quite long in length and wanders from edge to edge of the pavement or a crack that is usually straight and parallel to the centreline of the road. Possible causes of longitudinal meander or mid-lane cracking are frost action (greater heave at the centreline than at the edges), poor construction practices and/or faulty construction equipment resulting in a weak plane that fails due to thermal shrinkage. Figure 15 below is an example of ID ORRD-0124 (Graham Sideroad between Bathurst Street and Pumphouse Road) where moderate, intermittent mid-lane cracking was detected.

Figure 15: Mid-lane Cracking Example**Distress 15: Potholing and Patching**

Potholing and patching can be defined as a section of a road segment that has had potholes occur and are currently there or have been patched. Potholes are voids in the roadway surface where pieces of the pavement have become dislodged. Potholes occur when the ground water expands and contracts after the water has entered into the road base. Figure 16 below is an example of ID ORRD-0234 (Bathurst Street between Queensville Sideroad West and Hochreiter Road) where moderate, intermittent potholing and patching was detected.

Figure 16: Potholing and Patching Example**Completed Hardtop Road Evaluation Page**

For the completion of the field collection of the condition data, the severity and density of each distress is assigned on the "Flexible Pavement Condition Evaluation Form" developed by the Ministry of Transportation. Below in Figure 17 is an example of a completed evaluation form for ID ORRD-0105 (19th Sideroad between Hodgson Avenue and Hodgson Avenue) which currently yields a PCI of 54 (poor condition) and warrants a rehabilitation improvement.

Figure 17: Completed Hardtop Evaluation Form**HARDTOP PAVEMENT CONDITION EVALUATION FORM**

Survey Date 2022-06-24 Section ID ORRD-0105
 Road (Street) Name 19th Sideroad Section Length 0.489 km
 Location from Hodgson Avenue to Hodgson Avenue
 Comments

Ride Comfort Rating
(at posted speed)

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

3.2 Gravel Paving Program and Management**3.2.1 Desktop Review**

Burnside completed a desktop review of the background information provided by the Township to facilitate the field work and project setup prior to any field collection commencing. The following tasks were part of the desktop review to initiate this project.

The previous RNS reports (2011 Study & 2016 Study) were reviewed to determine the methodology used, tasks completed and the procedures that were used. Additionally, the previous reports were reviewed to determine how roads were identified (i.e., unique identifier for that study, Municipal ID, Road Name, etc).

The 2020 Paving Strategy was reviewed to become familiar with the recommendations of the previous report and the 10-year capital improvement plan. The review of the 2020 study also allowed Burnside to become familiar with the Township's approach to road improvements and their progress over the previous 2 years.

The Township's 2020 Transportation Master Plan (TMP) was reviewed to determine the annual growth rate that is projected for the Township's roads.

Review of the Technical Memorandum (Draft) that was completed in 2019 to summarize the results of a Gravel Road Improvement Study (2019 Gravel Study) that was completed for the Township. The 2019 Gravel Study provided an assessment of the costs to improve and resurface the Township's gravel roads.

Historical traffic volumes (AADTs) were reviewed to determine any areas of the Township's road network that was missing and would need attention (i.e., traffic volume forecasting/estimating or data collection). Based on the review of the 2020 TMP, a growth rate of 2.1% per annum (i.e., annual traffic growth) was determined.

The Township's Official Plan was also reviewed to determine the road classification descriptions as they apply to King, as well as to determine the existing road classification for each road segment within the Township.

Setup of a GIS linked field collection application that can be used on a tablet or phone using Arc GIS products (Survey 123, Field Maps, etc). As part of this task, a GIS database for this study was created and the Township's road network was imported to determine what data was missing. This GIS application was created to link the data being collected in the field to the GIS database

Review of relevant, and current road improvement cost data/information for Ontario was completed to determine unit costs for the components of the various types of improvements proposed in this study. This unit cost data was then used during detailed analysis of the proposed improvement types to determine a cost per m² for each improvement (i.e., cost per m² to pave/convert a gravel road to an asphalt road).

3.2.2 Visual Condition Survey

A visual assessment of the Township's gravel road network took place in April 2022, to determine the condition rating of the road surface. Specific pavement distress ratings (i.e., Severity and Density) were assigned for 6 different distress types for gravel road

sections, based generally on the "Gravel Condition Evaluation Form" developed by the Ministry of Transportation.

The severity of a distress can be simply defined as how bad the distress is (i.e., slight cracking). The Severity of a distress is based on a scale of engineering judgement from previous experience and contains five levels. The five levels of severity are; Very Slight, Slight, Moderate, Severe and Very Severe.

The density of the distress is also assigned which can be defined as the extent of the issues (i.e., how frequent the distress is present on the road). Like the severity, density is also based on engineering judgement from past experience and contains five levels. The five levels of density are; Few, Intermittent, Frequent, Extensive and Throughout.

As mentioned above, the review of hardtop roads requires 6 different distress types to be assigned to the road segment. The 6 distress types for hardtop roads consist of the following.

Distress 1: Soft Spots

Soft spots occurring along a gravel road can be defined as areas of the road surface and/or subgrade that have been made weak due to poor drainage of the road surface and the road base. Figure 18 below is an example of ID ORRD-0144 (Elmpine Trail between Mill Road and West end) where moderate, few soft spots were detected.

Figure 18: Soft Spot Example



Distress 2: Spring Breakup

Spring breakup can be defined as extremely soft or muddy road surface conditions as a result of melting snow/ice and frost. Spring breakup is likely to occur in March and April but is subject to the winter conditions/thawing timeframe. Figure 19 below is an example of ID ORRD-0134 (Spruce Hill Road between 300m East of Jane Street and East end) where moderate, few spring breakup was detected.

Figure 19: Spring Breakup Example**Distress 3: Potholing**

Potholing can be defined as small depressions or voids in the road surface which are caused by excessive moisture content, poor drainage and/or poorly graded aggregate. Figure 20 below is an example of 12th Concession where severe, frequent potholes were detected.

Figure 20: Potholing Example**Distress 4: Washboarding**

Washboarding can be defined as a series of ridges and/or depressions across the road surface that are caused by lack of surface cohesion. The lack of surface cohesion can be a result of loss of fines in the road surface which usually result in very dry conditions within the road surface. Figure 21 below is an example of washboarding on a gravel road. This distress was not picked up severe enough in King Township for it to be clear/visible in photos, therefore this example photo will provide better context as to what washboarding is.

Figure 21: Washboarding Example (Photo from King Not Available)**Distress 5: Distortion**

Distortion is a surface deformation and can be defined as any deviation of the road surface from its original shape. Usually distortions result from settlement, slope failure or volumes changes due to moisture change. Some of the possible causes of distortion include, Lack of subgrade support, roadside embankment slope failure, improper maintenance or culvert failures. Figure 22 below is an example of ID ORRD-0200 (Lipchey Road between Keele Street and East end) where slight, intermittent distortion was detected.

Figure 22: Distortion Example**Distress 6: Rutting**

Rutting is a surface deformation that can be defined as longitudinal depressions in the form of a single or double wheel in the wheel path of a lane. Wheel track rutting is a result of deformation due to frequent load combined with surface material displacement. Some causes of wheel track rutting include poorly compacted road base material, unstable granular base or unstable shoulder material. Figure 23 below is an example of ID ORRD-0200 (Lipchey Road between Keele Street and East end) where severe, intermittent rutting was detected.

Figure 23: Rutting Example**Completed Gravel Road Evaluation Page**

For the completion of the field collection of the condition data, the severity and density of each distress is assigned on the "Gravel Condition Evaluation Form" developed by the Ministry of Transportation. Below in Figure 24 is an example of a completed evaluation from for ID ORRD-0239 (18th Sideroad from Jane Street to west end) which is currently scheduled to be upgraded to an asphalt surface in Year 1 of the 10 year plan (2023).

Figure 24: Completed Gravel Evaluation Form

GRAVEL CONDITION EVALUATION FORM

Survey Date: 2022-04-13 Section ID: ORRD-0239

Road (Street) Name: 18th Sideroad Section Length: 0.82 km

Location from: Jane Street to: West end

Comments: Severe rutting. To be upgraded from gravel in 2023

**Ride Comfort Rating
(at posted speed)**

10	9	8	7	6	5	4	3	2	1	Severity of Distress (Si)					Density of Distress (DI)				
Very Good	Good		Fair		Poor		Very Poor			Very Slight	Slight	Moderate	Severe	Very Severe	Few	Intermittent	Frequent	Extensive	Throughout
															<10	10-20	20-40	40-80	>80
Pavement										Rating									
Structural Adequacy (1-20)										<u>17</u>									
Soft Spots																			
Spring Breakup																			
Potholes																			
Washboarding																			
Distortion																			
Rutting																			
Drainage Adequacy (1-15)										<u>15</u>									

4.0 Analysis

4.1 Hardtop Surface Program and Pavement Management

4.1.1 Pavement Condition Index

Based on the distress types determined during the condition survey and using the Ministry of Transportation (MTO) formulae

The condition rating is based on a visual review of the severity, extent (density) and weighting of various distress types, as well as a Ride Comfort Rating, which reflects the rideability of the surface. A Distress Manifestation Index (DMI) is calculated, using MTO formulae, from the visual distress data collected in the field. The condition rating methodology follows the procedures developed by the MTO for flexible pavements and surface-treated pavements (MTO, 1989)

The calculation of the PCI follows the methods outlined by the MTO for such calculations (MTO, 2007). A PCI has been calculated for each road section according to the following formulae:

$$\text{Asphalt: PCI} = 13.75 + (9 \times \text{DMI}) - (7.5 \times e^{(8.5 - \text{RCR})/3.02})$$

$$\text{Surface Treatment: PCI} = 12.75 + (9 \times \text{DMI}) - (5.5 \times e^{(9.94 - \text{RCR})/3.46})$$

Where:

- DMI = Distress Manifestation Index, which is a systematic method of classifying and assessing the visible consequences of various surface distress mechanisms. The DMI classifies distress manifestations into various categories which are given a weighting factor (W), and which are classified according to their severity (S) and density (D). A summary of the factors considered is included in Appendix C. The total DMI is obtained by summation of the distress manifestations for the relevant factors and the following formulae:

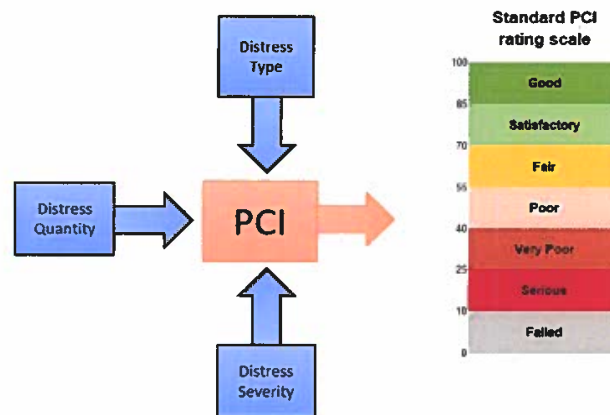
$$\text{Asphalt: DMI} = 10 \times (208 - \text{summation of } W \times (D+S))/208$$

$$\text{Surface Treatment: DMI} = 10 \times (135 - \text{summation of } W \times (D+S))/135$$

- RCR = Ride Comfort Rating, which is a subjective ride quality assessment as perceived by the traveling public and which has been determined by the field assessment of the roads.

The qualitative description of the various PCI ranges is shown in Figure 23.

Figure 25: Qualitative Description of PCI Ranges



Based on the above methodology/procedure, the updated PCI for each road segment is illustrated on a map in Appendix D and shown in the excel spreadsheets in Appendix A.

There are 22 hardtop roads in the township with poor condition Ratings (PCI<55), which currently require significant rehabilitation or full reconstruction. If sufficient budget is available to replace these roads, then these roads should be completed as soon as feasible as the roads currently sit in a state of disrepair that is not favoured by the level of service that should be provided. These roads (like the others) are subject to ongoing deterioration and will continue to degrade passed the state they are currently in. Table 3 below summarizes the 22 roads that have a poor condition rating and should be replace as soon as feasible.

Table 3: Hardtop Roads with Poor Condition Ratings (PCI<55)

Municipal ID	Road Segment	Surface Type	AADT (vpd)	PCI	Improvement Cost
KRRD-0032	McKellar Lane, from Kingscross Drive to End (Cul-de-Sac)	HCB	0-49	36	\$102,744.00
KRRD-0105	Kingsworth Road, from Westgate Circle to Blueberry Lane	HCB	200-399	40	\$270,864.00
SRRD-0053	Magnum Drive, from Proctor Road to End (Cul-de-Sac)	LCB	1,000-1,999	41	\$200,925.00
ORRD-0195	Holancin Road, from Highway 9 to 2nd Concession	LCB	50-199	42	\$721,656.00
KRRD-0148	Station Road, from Burton Grove to West Street	HCB	1,000-1,999	44	\$64,440.00
ORRD-0236	16th Sideroad, from Highway 400 Overpass to Weston Road	HCB	1,000-1,999	47	\$504,525.00
KRRD-0005	Manitou Drive, from Kingscross Drive to Fork	HCB	50-199	47	\$299,088.00
KRRD-0073	Westgate Boulevard, from Jane Street to Westgate Circle	HCB	200-399	48	\$112,320.00
ORRD-0128	Strawberry Lane, from Keele Street to Aileen Avenue	HCB	400-999	49	\$570,899.00
KRRD-0093	Chelsea Lane, from Fork to End (West Cul-de-Sac)	HCB	0-49	50	\$140,832.00
ORRD-0025	16th Sideroad, from 8th Concession to Trainor Court	HCB	400-999	51	\$415,961.00
KRRD-0043	Westgate Circle, from Kingsworth Road to Westgate Boulevard	HCB	400-999	51	\$6,272.00
KRRD-0031	Blueberry Lane, from Kingsworth Road to End (Cul-de-Sac)	HCB	50-199	52	\$122,976.00
KRRD-0047	Chelsea Lane, from Kingscross Drive to Fork	HCB	0-49	52	\$66,600.00
ORRD-0098	Hilda Road, from Diana Drive to End (Cul-de-Sac)	HCB	50-199	52	\$164,016.00
ORRD-0178	16th Sideroad, from Trainor Court to Highway 27	HCB	400-999	53	\$236,670.00
KRRD-0060	Keri Court, from Kingscross Drive to End (Cul-de-Sac)	HCB	0-49	53	\$49,220.00

Municipal ID	Road Segment	Surface Type	AADT (vpd)	PCI	Improvement Cost
BRRD-0001	Kettleby Road, from Keele Street to Lorne Avenue	HCB	1,000-1,999	53	\$461,531.00
ORRD-0105	19th Sideroad, from Hodgson Avenue to Hodgson Avenue	LCB	400-999	54	\$127,764.00
ORRD-0065	Rupke Road, from Highway 9 to End (Canal)	LCB	200-399	54	\$127,788.00
KRRD-0059	Chelsea Lane, from Fork to End (East Cul-de-Sac)	HCB	50-199	55	\$120,096.00
KRRD-0077	Kingsworth Road, from Blueberry Lane to Watch Hill Road	HCB	200-399	55	\$137,816.00
Total Cost					\$5,025,003.00

4.1.2 Surface Type Needs

The surface type of a roadway should be appropriately designed to accommodate the volume and type of traffic. According to the MTO guidelines (*Inventory Manual for Municipal Roads, Ministry of Transportation, 1991*), upgrading of surface treated roads to asphalt may be considered for roads experiencing high truck volumes or high truck loading, AADT values higher than 400 vpd or where high maintenance is an issue. For low volume rural roads, it is suggested that surface upgrading may be economical where the percentage of trucks exceed 10% of the AADT and is over 30 trucks per day.

Gravel roads are typically suitable for low truck traffic and AADT values of less than 200 vpd. Typically, surface treated roads are recommended for roadways that have an AADT between 200 and 400 vpd, with asphalt recommended for roads with AADTs higher than 400 vpd.

Truck volumes typically range from a low of 3% on low volume residential streets to a high of 15% or more on arterials and collector roads. Information on truck volumes on the Township's roads was not available for this current study.

Based on the above surface type considerations, a review of the data in Appendix A indicates that there are a number of roads in the Township that presently meet these surface type criteria, as summarized in Table 4.

Table 4: Existing Surface Treated Roads That May Warrant Upgrading

Road	Road Length (m)	AADT (vpd)	Rationale for Upgrade
LCB with AADT > 1,000 vpd			
11th Concession, from 16th Sideroad to 17th Sideroad	2012	1534	Traffic Volume
17th Sideroad, from Highway 27 to 10th Concession	2053	3000	Traffic Volume

Road	Road Length (m)	AADT (vpd)	Rationale for Upgrade
17th Sideroad, from 10th Concession to 1.4 km W. of 10th Concession	1441	2898	Traffic Volume
17th Sideroad, from 1.4 km W. of 10th Concession to 11th Concession	839	2898	Traffic Volume
17th Sideroad, from 11th Concession to 12th Concession	2090	2743	Traffic Volume
Magnum Drive, from Proctor Road to End (Cul-de-Sac)	367	1092	Traffic Volume
8th Concession, from 15th Sideroad to 16th Sideroad	2054	1010	Traffic Volume

Where budgets allow, it is recommended that surface types be upgraded to meet the minimum desirable levels of service for surface types. However, where budget is the limiting factor, surface type standards may be reduced to tolerable standards, assuming that the road base has been properly designed and constructed and appropriate maintenance is applied. Where this lower standard surface type is used, a corresponding reduction in useful life is likely. In some areas, other constraints (e.g., ROW widths, horizontal or vertical curve deficiencies, etc.) may preclude the upgrading of such road sections without first addressing those factors.

4.1.3 Road Widths

The existing widths for the roads in the network are shown in the inventory in Appendix A. The surface widths shown represent the hard top width (excluding shoulders) for hard top roads. Recommended lane widths generally vary with traffic volume and traffic speed for higher volume roads, and according to the type of use for lower volume roads.

Minimum tolerable and recommended minimum road widths for hard-top 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., through lane) width requirements for hard-top roads are outlined below in Table 5.

Table 5: Tolerable and Recommended Surface Widths for Hardtop Roads (Based on Criteria in TAC)

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	60 or less	5.4 m	6.0 m	7.4 m	8.0 m
	70 to 100	6.5 m	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

Roadside Environment	Design Speed (km/h)	Road Surface Width (Two-Lane Roadways)			
		Tolerable Lower Limit	Recommended Lower Limit	Recommended Upper Limit	Tolerable Upper Limit
	70 to 100	6.0 m	6.6 m	7.4 m	8.0 m

Note: 1. For rural or semi-urban roadways with a design speed of 70 to 100 km/h, a minimum tolerable surface width of 3.25 m 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 hardtop roads in the Township, that have been identified to have widths that currently do not meet the recommended lower width limit, are summarized in Table 6.

Table 6: Summary of Hardtop Roads with Deficient Widths

Road	Road Length (m)	Posted Speed (km/h)	AADT (vpd)	Width (m)
Spring Street, from Weston Road to End (West)	65	50	26	3.5
Lorne Avenue, from Kettleby Road to 165 m N. of Kettleby Road	167	40	94	4.0
Laskay Lane, from Weston Road to End (East)	147	50	26	4.2
Old Church Road, from Weston Road to End (East)	194	50	26	4.5
Rebellion Way, from Queen Street to End (North)	102	50	22	4.5
Victoria Street, from Queen Street to End East	133	50	81	4.5
16th Sideroad, from Bathurst Street to End (West)	753	40	25	5.0
19th Sideroad, from Hodgson Avenue to Weston Road	167	50	244	5.0
Queen Street, from Rebellion Way to 10th Concession	247	50	231	5.0
Centre Street, from Rebellion Way to End (West)	211	50	23	5.0
Edwards Mill Lane, from Church Street to End (North)	54	50	15	5.0
7th Concession, from Lloyd's Lane to 19th Sideroad	376	50	126	5.1
7th Concession, from Lloydtown/Aurora Road to Lloyd's Lane	1023	50	727	5.1
Dearbourne Avenue, from Keele Street to End (West)	747	40	113	5.1
Centre Street, from Church Street to Rebellion Way	351	50	53	5.2

The roads identified in the above table are low speed roadways that are experiencing low traffic volumes. While the widths in the above noted road segments are less than ideal, these width deficiencies are not considered critical in the short term. It is recommended that the widths on these roads be increased to meet recommended standards as part of any future improvement works.

4.1.4 Road Safety Review

During the field inspection, it was observed that two intersections along 8th Concession currently may have deficient sightlines. The intersection of 15th Sideroad and 8th Concession, as well as the intersection of 17th Sideroad and 8th Concession were determined to have possible sightline obstructions resulting in safety concerns. It is recommended the Township should complete a detailed sightline analysis study for both intersections.

4.1.5 Improvement Types

The different improvement types that are proposed in this study are listed below. These improvement types cover the full lifecycle of the road assets and require the Township to keep up with the road maintenance to prevent leaving the roads until they slip into a more extensive category like Rehabilitation or Reconstruction.

Routine Maintenance (RM):

Routine maintenance for hardtop roads consists of crack sealing. Routine maintenance (i.e., crack sealing) decreases further crack deterioration by preventing moisture damage to the pavement structure and it often adds approximately 3 to 5 years to the lifespan of a roadway. Routine maintenance can help delay the need for more extensive rehabilitation or reconstruction and Routine/preventive maintenance is typically done when a road is in good condition but is starting to show slight deficiencies.

Preventive Maintenance (PM):

Preventive maintenance for hardtop roads consists of the application of slurry seal or micro surfacing. Preventive Maintenance can help to delay the need for more extensive rehabilitation or reconstruction. Preventive maintenance is typically done when a road is in good condition but is starting to show slight deficiencies. Micro-surfacing or slurry seal can prevent water from infiltrating through cracks to the road base, which ultimately helps prevent further deterioration of the road base and increases the length of time before more extensive treatments are required.

Resurfacing (R):

For urban roads or semi urban/rural roads with higher traffic volumes, this study proposes that the resurfacing improvement consist of milling and paving (shave and

pave). For semi urban/rural roads that experience low traffic volumes, the resurfacing improvement proposed in this study is full depth removal + 1 (50mm) lift of hot mix asphalt (HMA). During the planning process, it should be determined if the low-speed semi urban/rural roads that are being planned currently have one or two lifts of asphalt. If it is determined that the low-speed semi urban/rural roads have more than one lift of asphalt, milling and paving may be chosen as this is a cheaper alternative than removing all the existing asphalt.

For this study, the resurfacing category has been split into two subcategories, 6 to 10 years and 1 to 5 years. This timeline is to indicate how long the Township has before significant rehabilitation is required (i.e., sufficient budget is not available). To represent this difference in the costing shown in the improvement matrix, the resurface 1 to 5 year indicates full depth removal as the pavement distresses have most likely made it through to the road base. It should be noted that this more expensive resurfacing does not include all actions that would be taken under rehabilitation, therefore repairing the road while it still warrants this category will allow the Township to save money.

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, aside from patching where required. Resurfacing treatments mentioned in this RNS are not to be confused with micro-surfacing treatments, which are considered a form of preventative maintenance, which is applied to roads still in good condition with only very minor amounts of cracking.

Rehabilitation (REH):

For urban roads, rehabilitation consists of full depth removal + 2 (50 mm) lifts of HMA and spot curb replacements. For semi urban or rural roads, rehabilitation consists of pulverizing the existing surface and spreading a thin lift of granular A over the pulverized base to add stability to the road base and then installing 2 (50mm) lifts of HMA.

More extensive rehabilitation treatments are applied to pavements in poor condition which have deteriorated to a point where full depth replacement of the pavement surface 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 or increasing the thickness of pavement layers to address increases in traffic volume.

Reconstruction (REC):

For urban roads, reconstruction consists of full depth removal, full depth base replacement (dig out and replace) + 2 (50 mm) lifts of HMA and full curb replacement.

For semi urban/rural roads, reconstruction consists of full depth removal, full depth base replacement (dig out and replace) + 2 (50 mm) lifts of HMA and nominal shoulder/ditch repairs.

Reconstructions are typically done when a road is in very poor condition, or if work is being done on infrastructure beneath a road which will 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, the pavement and road base may require full reconstruction to reestablish the proper base support for the pavement. Applying a lesser rehabilitation treatment 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 to accommodate road widening.

Determining Improvement Needs:

To determine the improvement types that are warranted for certain road sections, the PCI values 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 7 along with estimated benchmark treatment costs. In addition, the forecasted improvement effects resulting from the various life cycle treatments are shown in Table 7 (i.e., the net benefit to the PCI values after a certain improvement type is implemented). The net benefit that is presented as a result of implementing a given improvement type is to represent that maintaining the condition of roads and performing routine and preventive maintenance will lengthen the lifecycle of a road segment (i.e., performing crack sealing with help extend the useful life of a road segment).

Table 7: Hardtop Road Improvement Matrix

Improvement	Urban – Hard Top (HCB)		Semi-Urban or Rural – Hard Top (HCB/LCB)		Distress-Triggers	Post-Treatment Condition	Distress-Triggers	Post-Treatment Condition	Distress-Triggers	Distress-Triggers
	Post-Treatment Condition	Any AADT	AADT > 1000	1000 > AADT >= 400						
Routine Maintenance (RM)	PCI + 5	Crack Sealing (\$0.75 per m ²)	HCB – Crack Sealing (\$0.75 per m ²) LCB – N/A (Responsive Maintenance)	AADT < 400	95 > PCI >= 80	PCI + 5	95 > PCI >= 80	PCI + 5	95 > PCI >= 80	95 > PCI >= 80
Preventive Maintenance (PM)	PCI + 10	Micro Surfacing and Minor Patching (\$6 per m ²)	Micro-Surfacing (\$6 per m ²)	Slurry Seal (\$4 per m ²)	90 > PCI >= 80	PCI + 10	90 > PCI >= 80	PCI + 10	90 > PCI >= 80	90 > PCI >= 80
Resurface 6 to 10 Year (R, 6-10)	PCI + 15	Mill + 1 HMA (50 mm)	Mill + 1 HMA (50 mm) Overlay + Patching + Nominal Shoulder Repair (\$23 per m ²)	Full Depth Removal + 1 HMA (50 mm) Overlay + Patching (\$22 per m ²)	80 > PCI >= 70	PCI + 15	80 > PCI >= 70	Full Depth Removal + 1 HMA (50 mm) Overlay + Patching (\$22 per m ²) Patching (\$24 per m ²) (If asphalt thickness allows for milling \$20 per m ²)	80 > PCI >= 70	80 > PCI >= 70
Resurface 1 to 5 Year (R, 1-5)	PCI + 20	Full Depth Removal + 2 HMA (50 mm each) (\$40 per m ²)	Pulverize + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$39 per m ²)	Pulverize + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$39 per m ²)	70 > PCI >= 60	PCI + 20	70 > PCI >= 60	Pulverize + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$39 per m ²)	70 > PCI >= 60	70 > PCI >= 60
Rehabilitation (REH)	PCI + 40	Full Depth Removal + 2 HMA (50 mm each) + Spot Curb Replacement (\$45 per m ²)	Pulverize + Granular A + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$49 per m ²)	Pulverize + Granular A + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$49 per m ²)	60 > PCI >= 40	PCI + 40	60 > PCI >= 40	Pulverize + Granular A + 2 HMA (50 mm each) + Nominal Shoulder Repair (\$49 per m ²)	PCI < 40	PCI < 40
Reconstruction (REC)	PCI = 100	Full Depth Removal + 2 HMA (50mm each) + Total Base and Curb Replacement + Total Curb Replacement + Nominal Storm Sewer Adjustment (\$95 per m ²)	Full Depth Removal + 2 HMA (50 mm each) + Total Base Replacement + Nominal Shoulder/Ditch Repair (\$75 per m ²)	Full Depth Removal + 2 HMA (50 mm each) + Total Base Replacement + Nominal Shoulder/Ditch Repair (\$75 per m ²)	PCI < 40	PCI = 100	PCI < 40	Full Depth Removal + 2 HMA (50 mm each) + Total Base Replacement + Nominal Shoulder/Ditch Repair (\$72 per m ²)	PCI < 40	PCI < 40

4.1.6 Improvement Costs

The general improvement benchmark unit costs (costs per square metre) are for budget planning purposes and have been based on recent costing experience for the applicable recommended improvement standard. Improvement projects are generally completed through a combination of day labour 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).
- Budget constraints requiring consideration of lesser standards (such as maintaining vertical profiles to tolerable conditions, rather than design standards, or reducing overall improvements).

It is recommended that standards be reviewed on a project specific basis as budgets are established.

Benchmark improvement costs (per square metre) are outlined in Table 7 above as well as in the unit cost breakdowns in Appendix F and are based on recent data provided from the Township. The improvement types/costs consider surface types, traffic volumes, road conditions and roadside environments. Given that the improvement benchmark costs are estimated on a square metre basis, the improvement costs for any particular road section will also capture individual road widths.

4.1.7 Improvement Prioritization

For the prioritization of improvements proposed in this study, the MTO prioritization methodology was used. The MTO has developed a Priority Rating (PR) formula (in the *Inventory Manual for Municipal Roads*, 1991) that can be used to prioritize road improvements based on condition ratings, improvement costs, and traffic volumes.

The Priority Rating formula used for the improvement prioritization in this RNS is as follows:

$$PR = 0.2 (100 - CR) \times (AADT + 40)^{1/4}$$

The higher the PR value, the higher the priority of the road section improvement relative to its condition and the traffic it is serving. This MTO formula will help prioritize improvements that are priority driven by road conditions and high traffic volumes.

In addition to condition related prioritization formulas, the road improvement needs can be prioritized based on non-condition related triggers such as drainage, road width, platform width, surface type, local input from Township staff, maintenance demand, etc.

If a road is determined to have a road width and/or platform width that is less than ideal, then that road should be reviewed to determine if the current width is suitable for the current surface type and can wait for widening treatment until upgrade, or if it should be widened as soon as possible (i.e., a current surface treated road has a road width that is less than the recommended minimum for surface treated roads but given the site specific geometrics and traffic, the road width can continue to remain as is but will need to be widened prior to the road being upgraded to an asphalt surface).

4.1.8 Road Budget Consideration

Based on the 2022 and the 2023 Budget and Business Plan, the Township has allocated \$1.72 million per annum for hardtop Roads and Related Infrastructure improvement. The Township does not currently have a separate budget established for routine/preventive maintenance efforts.

As part of the recommendations of this study, it is recommended that the Township establish this routine/preventive maintenance budget to help maintain their roads at a higher level of service and prevent them from slipping into a more extensive improvement category. Typical crack sealing budgets in Ontario account for approximately \$180 per centre line kilometer of road. Based on \$180 per centreline km of road, a target crack sealing budget for King Township would be \$41,000 per year.

4.1.9 Hardtop Road Improvement Needs

Based on the analysis of the road condition data and review of the prioritization triggers previously outlined in the report for the Township's hardtop roads, a 10-year road improvement plan has been developed. The 10 year plans in the following three sections have been established using the MTO prioritization methodology outlined in this report, as well as the budget targets that have been established using the current operational budget.

A total of approximately 270.208 km of hardtop roads were reviewed as part of this study. Based on the priority rating number, traffic volumes, condition and geographic location the improvement of hard top roads was prioritized based on the previously outlined budget target of \$1.72 million. Degradation curves for LCB/HCB roads were used to estimate a deterioration rate for each roadway based on its current improvement category. The deterioration rate was then used to determine the estimated PCI and improvement cost at the time of upgrade. The early years of the 10-year plan were utilized to improve any road segments that are in poor condition based on the surrounding land use. For example, any roads with a PCI of <40, or any rural highspeed roads with a PCI of <50 were prioritized in the early years to prevent these roads from requiring a more extensive improvement type. A full spreadsheet version of the 10-year plans, along with an enlarged map can be found in Appendix H.

4.1.9.1 Preventive Maintenance Plan

As part of this road study, Burnside completed analysis to determine a list of roads within the Township that should receive crack sealing in the next three years if sufficient budget is available. The recommended preventive maintenance plan considers all hardtop roads with a PCI between 90 to 95 which would warrant crack sealing. The implementation of the crack sealing has been prioritized based on the PR which accounts for traffic and condition of each road. Table 8 and Figure 26 outline the roads that have been proposed for routine and/or preventive maintenance.

Figure 26: Preventive Maintenance Plan (2024-2027)

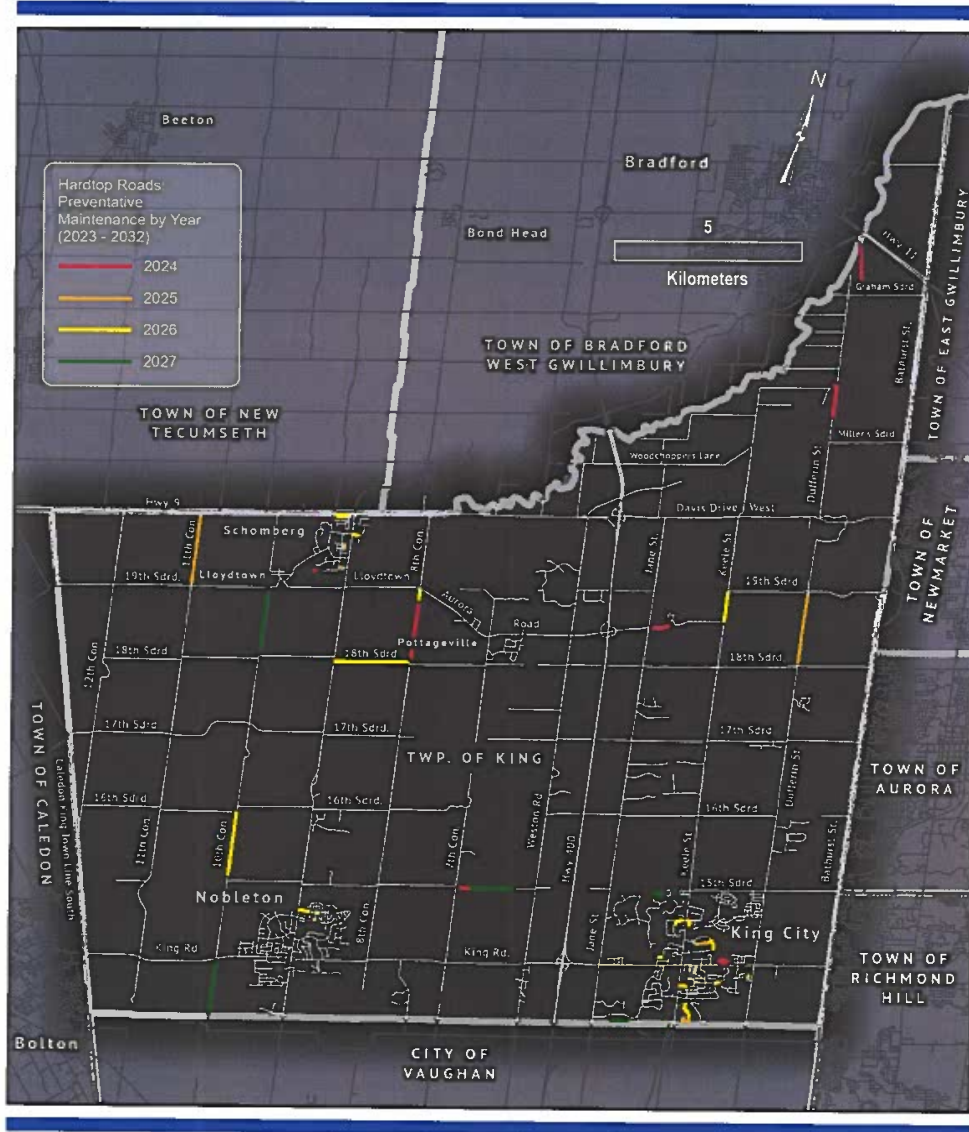


Table 8: Preventive Maintenance Plan (2024-2027)

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
2024					
SRRD-0041	Main Street from Ben Boy Avenue to Greco Ridge Lane	92	141	Crack Sealing (Routine Maintenance)	\$1,058.00
ORRD-0031	Pumphouse Road from Graham Sideroad to End	91	1438	Crack Sealing (Routine Maintenance)	\$7,010.00
ORRD-0185	8th Concession from 18th Sideroad to 1.7 km N. of 18th Sideroad	90	1705	Crack Sealing (Routine Maintenance)	\$7,800.00
SRRD-0060	Roselena Drive from Quaker House Lane to End	90	225	Crack Sealing (Routine Maintenance)	\$1,434.00
BRRD-0002	Kettleby Road from Lorne Avenue to Jane Street	91	693	Crack Sealing (Routine Maintenance)	\$3,378.00
KRRD-0022	Kingscross Drive from Carmichael Crescent to McKellar Lane	91	136	Crack Sealing (Routine Maintenance)	\$683.00
KRRD-0054	Warren Road from Cadden Court to Alex Campbell Crescent	92	69	Crack Sealing (Routine Maintenance)	\$424.00
ORRD-0086	Keele Street from Woodchoppers Lane to 110 m N. of Woodchoppers Lane	91	107	Crack Sealing (Routine Maintenance)	\$642.00
ORRD-0266	Dufferin Street from 630 m N. of Miller's Sideroad to King Street	92	995	Crack Sealing (Routine Maintenance)	\$5,149.00
KRRD-0099	Kingscross Drive from Keri Court to Chelsea Lane	92	172	Crack Sealing (Routine Maintenance)	\$864.00
ORRD-0272	15th Sideroad from 1.8 km E. of Weston Road to 7th Concession	90	382	Crack Sealing (Routine Maintenance)	\$2,063.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
ARRD-0005	King Street from Dufferin Street to King Street Fork	92	234	Crack Sealing (Routine Maintenance)	\$1,071.00
KRRD-0009	Patton Street from Hollingsworth Drive to Kingslynn Drive	93	104	Crack Sealing (Routine Maintenance)	\$624.00
KRRD-0037	Bennet Drive from Banner Lane to Forde Crescent	90	90	Crack Sealing (Routine Maintenance)	\$473.00
KRRD-0083	Chuck Ormsby Crescent from Richard Serra Court to Ron Coles Lane	91	327	Crack Sealing (Routine Maintenance)	\$2,085.00
KRRD-0108	Alex Campbell Crescent from Alex Campbell Crescent (Loop) to King Road	92	447	Crack Sealing (Routine Maintenance)	\$2,682.00
KRRD-0129	Alex Campbell Crescent from King Road to Alex Campbell Crescent (Loop)	92	190	Crack Sealing (Routine Maintenance)	\$1,140.00
NRRD-0113	Skyline Trail from Bluff Trail to Aspen King Road	91	104	Crack Sealing (Routine Maintenance)	\$624.00
NRRD-0127	Woodhill Avenue from Gilbert Fuller Drive to Hawthorne Valley Road	92	62	Crack Sealing (Routine Maintenance)	\$372.00
NRRD-0177	Parkheights Trail from Middlehead Trail to Kettle Valley Trail	92	145	Crack Sealing (Routine Maintenance)	\$1,196.00
NRRD-0179	Parkheights Trail from Kettle Valley Trail to Blueberry Run Trail	92	80	Crack Sealing (Routine Maintenance)	\$660.00
2024 Total Length (km)			7.846	2024 Total Cost	\$41,433.00
2025					
NRRD-0233	Northcott Way from New Scotland Court to End	91	58	Crack Sealing (Routine Maintenance)	\$348.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
NRRD-0243	Wellar Avenue from Cross Avenue to 90 m N. of Cross Avenue	90	87	Crack Sealing (Routine Maintenance)	\$522.00
ORRD-0059	Fairfield Drive from Eden Vale Drive to Eden Vale Drive	91	207	Crack Sealing (Routine Maintenance)	\$1,242.00
ORRD-0227	Dufferin Street from 18th Sideroad to 19th Sideroad	93	2062	Crack Sealing (Routine Maintenance)	\$11,135.00
SRRD-0030	Maynard Drive from Cutler Court to Moore Park Drive	92	133	Crack Sealing (Routine Maintenance)	\$848.00
SRRD-0037	Jessop Avenue from Cooper Drive to Cooper Drive	90	273	Crack Sealing (Routine Maintenance)	\$1,740.00
KRRD-0065	Carmichael Crescent from Keele Street to Curran Court	92	89	Crack Sealing (Routine Maintenance)	\$534.00
KRRD-0072	Kingslynn Drive from Patton Street to End	91	165	Crack Sealing (Routine Maintenance)	\$804.00
KRRD-0086	Patricia Drive from McBride Crescent to Elizabeth Grove	91	295	Crack Sealing (Routine Maintenance)	\$1,549.00
KRRD-0132	Chuck Ormsby Crescent from Ron Coles Lane to Ron Coles Lane	92	353	Crack Sealing (Routine Maintenance)	\$2,118.00
KRRD-0135	Findlay Avenue from Burns Boulevard to Dennis Drive	91	193	Crack Sealing (Routine Maintenance)	\$1,230.00
KRRD-0150	Fisher Street from King Road to End	91	201	Crack Sealing (Routine Maintenance)	\$1,206.00
KRRD-0179	Humber Valley Crescent from East Humber Drive to East Humber Drive	92	618	Crack Sealing (Routine Maintenance)	\$3,708.00
KRRD-0244	Warren Road from Patton Street to 120 m E. of Patton Street	93	121	Crack Sealing (Routine Maintenance)	\$662.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
NRRD-0013	Woodhill Avenue from Farmcrest Court to Gilbert Fuller Drive	93	130	Crack Sealing (Routine Maintenance)	\$780.00
NRRD-0168	Parkheights Trail from Blueberry Run Trail to Parkeight Trail (Traffic Circle)	93	67	Crack Sealing (Routine Maintenance)	\$553.00
ORRD-0102	11th Concession from 19th Sideroad to Highway 9	94	2045	Crack Sealing (Routine Maintenance)	\$13,344.00
2025 Total Length (km)			7.097	2025 Total Cost	\$42,323.00
2026					
ORRD-0129	18th Sideroad from 8th Concession to Highway 27	91	2037	Crack Sealing (Routine Maintenance)	\$9,167.00
ORRD-0225.2	10th Concession from 90 m N. of 15 th Sideroad to 16th Sideroad	91	1756	Crack Sealing (Routine Maintenance)	\$7,902.00
ORRD-0271	8th Concession from 1.7 km N. of 18 th Sideroad to Lloydtown/Aurora Road	93	310	Crack Sealing (Routine Maintenance)	\$1,558.00
SRRD-0018	Dillane Drive from Sproule Street to Dr. Kay Drive	93	180	Crack Sealing (Routine Maintenance)	\$1,215.00
SRRD-0033	Waterlily Trail from Mapleton Mills Drive to Mapleton Mills Drive	91	463	Crack Sealing (Routine Maintenance)	\$2,986.00
NRRD-0160	Fairmont Ridge Trail from Bighorn Trail to Fairmont Ridge Trail (Traffic Circle)	95	81	Crack Sealing (Routine Maintenance)	\$529.00
NRRD-0181	Fairmont Ridge Trail from Kettle Valley Trail to Highway 27	95	303	Crack Sealing (Routine Maintenance)	\$1,932.00
ORRD-0014	Keele Street from Kettleby Road to 19th Sideroad	95	831	Crack Sealing (Routine Maintenance)	\$3,802.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
KRRD-0026	Patton Street from King Road to Hollingsworth Drive	94	269	Crack Sealing (Routine Maintenance)	\$1,614.00
KRRD-0036	Melrose Avenue from Martin Street to Charles Street	92	141	Crack Sealing (Routine Maintenance)	\$899.00
KRRD-0090	Curran Court from Carmichael Crescent to End	91	174	Crack Sealing (Routine Maintenance)	\$1,044.00
KRRD-0096	Warren Road from Patricia Drive to Lavender Valley Road	94	151	Crack Sealing (Routine Maintenance)	\$963.00
KRRD-0111	McClure Drive from Pellatt Grove to Curtis Crescent	91	59	Crack Sealing (Routine Maintenance)	\$376.00
KRRD-0126	Nicort Road from Lilly Valley Crescent to Terry View Drive	94	53	Crack Sealing (Routine Maintenance)	\$318.00
KRRD-0134	Chuck Ormsby Crescent from Ron Coles Lane to Richard Serra Court	93	416	Crack Sealing (Routine Maintenance)	\$2,496.00
KRRD-0145	Elizabeth Grove from Keele Street to McBride Crescent	94	213	Crack Sealing (Routine Maintenance)	\$1,118.00
KRRD-0162	McClure Drive from Curtis Crescent to Auckland Lane	91	205	Crack Sealing (Routine Maintenance)	\$1,230.00
KRRD-0177.2	Dennison Street from 610 m E. of Valleycrest Drive to East Humber Drive	90	271	Crack Sealing (Routine Maintenance)	\$1,626.00
2026 Total Length (km)			7.913	2026 Total Cost	\$40,773
2027					
KRRD-0181	East Humber Drive from Dennison Street to End	94	97	Crack Sealing (Routine Maintenance)	\$582.00
KRRD-0184	Melrose Avenue from John Street to Martin Street	92	147	Crack Sealing (Routine Maintenance)	\$937.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
KRRD-0190	Sir Henry Court from Elmers Lane to End	93	129	Crack Sealing (Routine Maintenance)	\$774.00
KRRD-0195	15th Sideroad from Cairns Gate to Elmers Lane	93	265	Crack Sealing (Routine Maintenance)	\$1,391.00
KRRD-0226	Scott Crescent from Collard Drive to Collard Drive	91	699	Crack Sealing (Routine Maintenance)	\$3,355.00
KRRD-0230	Sir Henry Court from Lake Marie Trail to Elmers Lane	93	247	Crack Sealing (Routine Maintenance)	\$1,482.00
KRRD-0231	Elmers Lane from Lake Marie Trail to Sir Henry Court	93	315	Crack Sealing (Routine Maintenance)	\$1,890.00
KRRD-0241	Hambly Avenue from Humber Crescent to 50 m S. of Humber Crescent	92	50	Crack Sealing (Routine Maintenance)	\$263.00
NRRD-0014	Ellis Avenue from Wellington Street to Robinson Road	94	314	Crack Sealing (Routine Maintenance)	\$2,002.00
NRRD-0021	Parkheights Trail from Parkheights Trail (Traffic Circle) to West Coast Trail	94	144	Crack Sealing (Routine Maintenance)	\$1,188.00
NRRD-0030	Royal Avenue from King Road to Lynwood Crescent	91	217	Crack Sealing (Routine Maintenance)	\$977.00
NRRD-0072	Ellis Avenue from Robinson Road to Faris Avenue	94	114	Crack Sealing (Routine Maintenance)	\$727.00
NRRD-0086	Northcott Way from Westbrooke Boulevard to Skyline Trail	93	161	Crack Sealing (Routine Maintenance)	\$966.00
NRRD-0110	Skyline Trail from Westbrooke Boulevard to Piper Court	93	96	Crack Sealing (Routine Maintenance)	\$576.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
NRRD-0111	Parkheights Trail from James Bowan Court to Parkheights Trail (Traffic Circle)	94	111	Crack Sealing (Routine Maintenance)	\$916.00
NRRD-0156	Paradise Valley Trail from West Coast Trail to Anderson Cove Trail	93	61	Crack Sealing (Routine Maintenance)	\$398.00
ORRD-0051	10th Concession from Huntington Road to King Road	93	1574	Crack Sealing (Routine Maintenance)	\$7,909.00
ORRD-0061	15th Sideroad from 0.53 km E. of Weston Road to 1.8 km E. of Weston Road	93	1225	Crack Sealing (Routine Maintenance)	\$6,615.00
ORRD-0074	Fairfield Drive from Eden Vale Drive to Norcliffe Drive	93	114	Crack Sealing (Routine Maintenance)	\$684.00
ORRD-0161	10th Concession from 18th Sideroad to 19th Sideroad	91	2000	Crack Sealing (Routine Maintenance)	\$9,750.00
2027 Total Length (km)			8.411	2027 Total Cost	\$43,381.00

4.1.9.2 Resurfacing Plan

Burnside completed analysis to determine a list of roads within the Township that should receive resurfacing over the next 10 years, as the Township's budget will allow for. The recommended resurfacing plan considers all hardtop roads that will warrant resurfacing or rehabilitation over the next 10 years. The implementation of the resurfacing improvements has been prioritized based on the PR which accounts for traffic and condition of each road. Table 9 and Figure 27 outline the roads that have been proposed for routine and/or preventive maintenance.

Figure 27: 10 Year Resurfacing Plan (2023-2032)

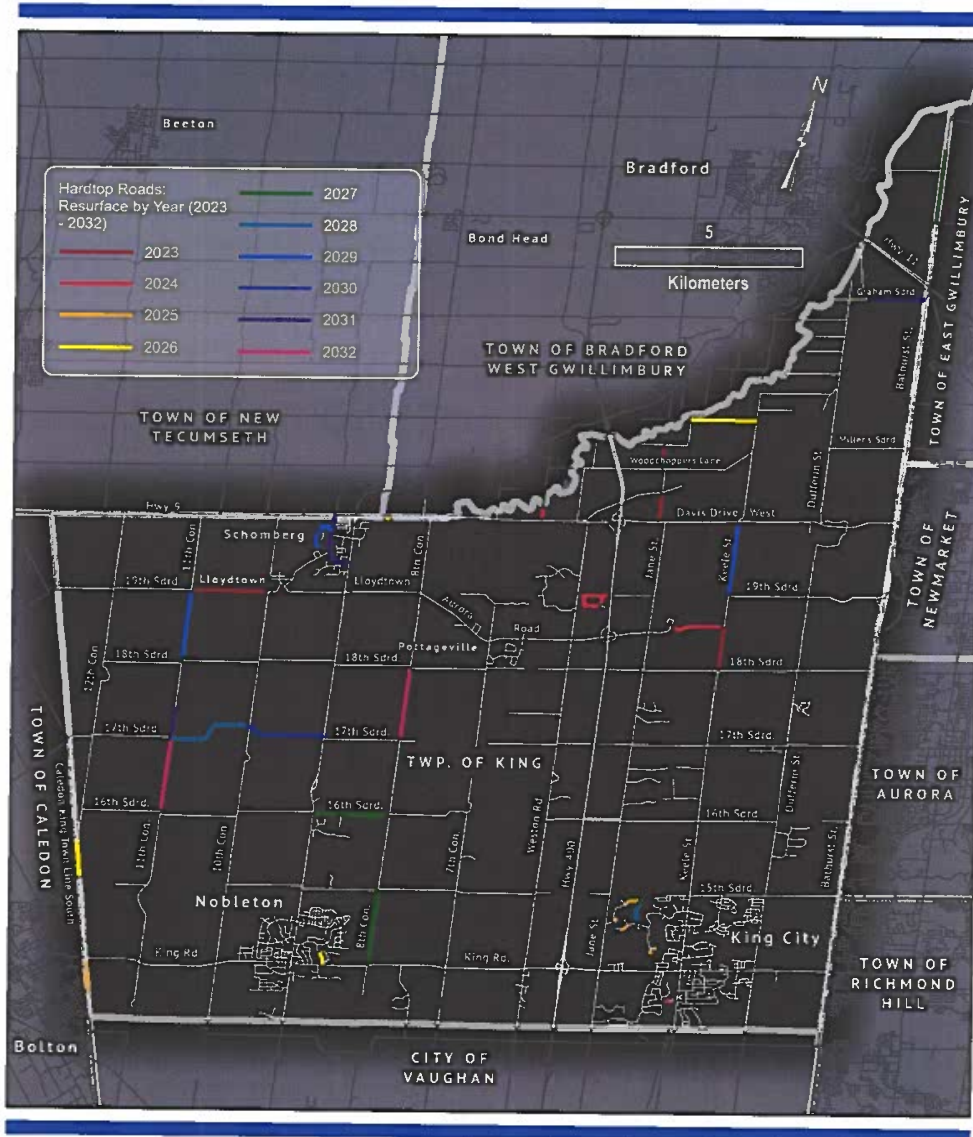


Table 9: 10 Year Resurfacing Plan (2023-2032)

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
Year 1 (2023)					
ORRD-0020	Keele Street from Lloydtown/Aurora Road Traffic Circle to Kettleby Road	65	1365	Pulverize + 2 HMA (Resurfacing)	\$356,655.00
ORRD-0250	Jane Street from Davis Drive West to South Canal Bank Road	68	818	Pulverize + 2 HMA (Resurfacing)	\$267,969.00
ORRD-0135	Jane Street from Woodchoppers Lane to Edward Avenue	83	681	Pulverize + 2 HMA (Resurfacing)	\$175,305.00
ORRD-0137	19th Sideroad from 10th Concession to 11th Concession	95	2049	Pulverize + 2 HMA (Resurfacing)	\$479,466.00
Year 1 Length (km)			4.913	Year 1 Cost	1,279,395.00
Year 2 (2024)					
ORRD-0105	19th Sideroad from Hodgson Avenue to Hodgson Avenue	54	489	Pulverize + 2 HMA (Resurfacing)	127,764.00
ORRD-0065	Rupke Road from Highway 9 to End	54	448	Pulverize + 2 HMA (Resurfacing)	\$108,342.00
ORRD-0158	Hodgson Avenue from William's Court to 19th Sideroad	66	719	Pulverize + 2 HMA (Resurfacing)	\$187,863.00
ORRD-0002	19th Sideroad from End (Cul-de-Sac) to Hodgson Avenue	70	228	Pulverize + 2 HMA (Resurfacing)	\$59,592.00
ORRD-0048	Hodgson Avenue from 19th Sideroad to William's Court	77	264	Resurface	\$68,991.00
ORRD-0109	19th Sideroad from Hodgson Avenue to Weston Road	77	167	Pulverize + 2 HMA (Resurfacing)	\$32,565.00
KRRD-0148	Station Road from Burton Grove to West Street	44	139	Full depth asphalt removal + 2 HMA + Spot curb replacement (Rehabilitation)	\$64,440.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
BRRD-0001	Kettleby Road from Keele Street to Lorne Avenue	53	1495	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$461,531.00
KRRD-0204	Station Road from West Street to Burns Boulevard	68	284	Full depth asphalt removal + 2 HMA (Resurfacing)	\$111,320.00
Year 2 Length (km)			4.233	Year 2 Cost	\$1,241,854.00
Year 3 (2025)					
KRRD-0043	Westgate Circle from Kingsworth Road to Westgate Boulevard	51	16	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$6,272.00
KRRD-0067	Westgate Circle from Kingscross Drive to Kingsworth Road	58	58	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$22,736.00
ORRD-0056	16th Sideroad from Jane Street to Highway 400 Overpass	62	983	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$308,259.00
KRRD-0080	Westgate Circle from Westgate Boulevard to Kingscross Drive	66	54	Pulverize + 2 HMA (Resurfacing)	\$12,636.00
KRRD-0087	Manitou Drive (East Cul-de-Sac) from Fork to End	60	173	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$53,314.00
KRRD-0081	Manitou Drive (South Cul-de-Sac) from Fork to End (Cul-de-Sac)	64	159	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$48,990.00
ORRD-0118	Albion Vaughan Road from Old King Road to 72m N. of Old King Road	77	71	Milling + Patching + 1 HMA (Resurfacing)	\$11,109.00
ORRD-0226	Albion Vaughan Road from 340 m N. of Queensgate Boulevard to Old King Road	80	852	Milling + Patching + 1 HMA (Resurfacing)	\$143,060.00
KRRD-0077	Kingsworth Road from Blueberry Lane to Watch Hill Road	55	454	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$137,816.00

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
KRRD-0018	Kingscross Drive from Cranberry Lane to Snowberry Lane	67	285	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$111,720.00
ORRD-0094	Albion Vaughan Road from 72 m N. of Old King Road to Caledon King Town Line South	84	175	Milling + Patching + 1 HMA (Resurfacing)	\$24,150.00
Year 3 Length (km)		3.280		Year 3 Cost	\$880,062.00
Year 4 (2026)					
ORRD-0128	Strawberry Lane from Keele Street to Aileen Avenue	49	1739	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$570,899.00
ORRD-0202	Caledon King Town Line South from Columbia Way to Mt. Pleasant Road	70	240	Pulverize + 2 HMA (Resurfacing)	\$34,164.00
ORRD-0203	Caledon King Town Line South from Mt. Pleasant Road to 12th Concession	74	783	Pulverize + 2 HMA (Resurfacing)	\$111,462.00
NRRD-0237	Greenside Drive from King Road to 35 m N. of King Road	72	35	Pulverize + Granular A + 2 HMA (Resurfacing)	\$13,377.00
NRRD-0141	Greenside Drive from Noblewood Drive to Noblewood Drive	73	261	Pulverize + Granular A + 2 HMA (Resurfacing)	\$99,762.00
NRRD-0121	Greenside Drive from 35 m N. of King Road to Noblewood Drive	74	40	Pulverize + Granular A + 2 HMA (Resurfacing)	\$15,288.00
ORRD-0132	Showa Court from Highway 9 to End (Cul-de-Sac)	65	67	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$85,358.00
Year 4 Length (km)		3.165		Year 4 Cost	\$930,310.00
Year 5 (2027)					
ORRD-0025	16th Sideroad from 8th Concession to Trainor Court	51	1306	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$415,961.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
ORRD-0178	16th Sideroad from Trainor Court to Highway 27	53	743	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$236,670.00
ORRD-0234	Bathurst Street from Queensville Sideroad West to Hochreiter Road	62	1443	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$459,620.00
ORRD-0224	8th Concession from King Road to 15th Sideroad	60	2092	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$666,302.00
ORRD-0060	Bathurst Street from Hochreiter Road to King – Bradford Boundary	64	576	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$183,456.00
Year 5 Length (km)		6.160		Year 5 Cost	\$1,962,009.00
Year 6 (2028)					
KRRD-0053	Watch Hill Road from Champlain Crescent to Kingsworth Road	59	734	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$237,356.00
ORRD-0024	17th Sideroad from 10th Concession to 1.4 km W. of 10th Concession	72	1441	Pulverize + Granular A + 2 HMA (Resurfacing)	\$488,943.00
ORRD-0157	17th Sideroad from 1.4 km W. of 10th Concession to 11th Concession	76	839	Pulverize + Granular A + 2 HMA (Resurfacing)	\$284,661.00
Year 6 Length (km)		3.014		Year 6 Cost	\$1,010,960.00
Year 7 (2029)					
ORRD-0026	11th Concession from 18th Sideroad to 19th Sideroad	70	1967	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$626,514.00
ORRD-0151	11th Concession from 18th Sideroad to 18th Sideroad	71	71	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$22,638.00
ORRD-0096	Keele Street from 19th Sideroad to Davis Drive West	71	2045	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$671,349.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
SRRD-0015	Western Avenue from Brownsville Court to Main Street	69	491	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$204,526.00
SRRD-0014	Western Avenue from Elmwood Avenue to Brownsville Court	68	562	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$234,073.00
Year 7 Length (km)		5.136		Year 7 Cost	\$1,759,100.00
Year 8 (2030)					
ORRD-0039	17th Sideroad from Highway 27 to 10th Concession	77	2053	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$673,995.00
KRRD-0079	Kingscross Drive from Snowberry Lane to Westgate Circle	71	231	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$90,552.00
Year 8 Length (km)		2.284		Year 8 Cost	\$764,547.00
Year 9 (2031)					
ORRD-0268	11th Concession from 17th Sideroad to 0.8 km N. of 17th Sideroad	75	787	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$258,377.00
SRRD-0051	Main Street from Cooper Drive to Church Street	80	441	Milling + Patching + 1 HMA (Resurfacing)	\$101,430.00
PRRD-0013	Archibald Road from Cook Drive to Cutting Crescent	70	169	Full depth asphalt removal + 2 HMA + Spot curb replacement (Rehabilitation)	\$64,665.00
ORRD-0124	Graham Sideroad from Bathurst Street to Pumphouse Road	76	1568	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$553,210.00
SRRD-0067	Main Street from Dr. Kay Drive to Western Avenue	82	152	Milling + Patching + 1 HMA (Resurfacing)	\$34,960.00
SRRD-0013	Main Street from Greco Ridge Lane to Highway 9	85	71	Milling + Patching + 1 HMA (Resurfacing)	\$16,330.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
SRRD-0004	Main Street from Western Avenue to Ben Boy Avenue	86	144	Milling + Patching + 1 HMA (Resurfacing)	\$33,120.00
SRRD-0041	Main Street from Ben Boy Avenue to Greco Ridge Lane	92	141	Milling + Patching + 1 HMA (Resurfacing)	\$32,430.00
SRRD-0058	Main Street from Church Street to Dr. Kay Drive	84	484	Milling + Patching + 1 HMA (Resurfacing)	\$111,320.00
SRRD-0045	Main Street from Highway 27 to Cooper Drive	86	236	Milling + Patching + 1 HMA (Resurfacing)	\$54,280.00
Year 9 Length (km)		4.193		Year 9 Cost	\$1,260,122.00
Year 10 (2032)					
ORRD-0194	8th Concession from 17th Sideroad to 17th Sideroad	73	19	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$6,223.00
ORRD-0159	8th Concession from 17th Sideroad to 18th Sideroad	83	1987	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$652,337.00
ORRD-0114	8th Concession from 18th Sideroad to 18th Sideroad	98	60	Milling + Patching + 1 HMA (Resurfacing)	\$8,844.00
ORRD-0053	11th Concession from 16th Sideroad to 17th Sideroad	78	2012	Pulverize + Granular A + 2 HMA (Rehabilitation)	\$660,520.00
Year 10 Length (km)		4.078		Year 10 Cost	\$1,327,924.00

4.1.9.3 Reconstruction Plan

In addition to the preventive maintenance and resurfacing plan, Burnside completed analysis to determine a list of roads within the Township that should receive full reconstruction over the next 10 years, as the Township's budget will allow for. The recommended reconstruction plan considers all hardtop roads with a PCI less than 40, which would warrant reconstruction. The implementation of the reconstruction improvements has been prioritized based on the PR which accounts for traffic and condition of each road. Table 10 and Figure 28 outline the roads that have been proposed for routine and/or preventive maintenance.

Figure 28: 10 Year Reconstruction Plan (2023-2032)



Table 10: 10 Year Reconstruction Plan (2023-2032)

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
Year 1 (2023)					
No Proposed Reconstructions					
Year 2 (2024)					
ORRD-0236	16th Sideroad from Highway 400 Overpass to Weston Road	47	1004	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$504,525.00
Year 2 Length (km)			1.004	Year 2 Cost	\$504,525.00
Year 3 (2025)					
SRRD-0053	Magnum Drive from Proctor Road to End (Cul-de-Sac)	41	367	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$200,925.00
KRRD-0073	Westgate Boulevard from Jane Street to Westgate Circle	48	260	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$112,320.00
KRRD-0005	Manitou Drive from Kingcross Drive to Fork	47	620	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$299,088.00
KRRD-0105	Kingsworth Road from Westgate Circle to Blueberry Lane	40	570	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$270,864.00
Year 3 Length (km)			1.817	Year 3 Cost	\$883,197.00
Year 4 (2026)					

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Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
ORRD-0195	Holancin Road from Highway 9 to 2nd Concession	42	1496	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$721,656.00
KRRD-0032	McKellar Lane from Kingcross Drive to End (Cul-de-Sac)	36	213	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$102,744.00
Year 4 Length (km)			1.709	Year 4 Cost	\$824,400.00
Year 5 (2027)					
No Proposed Reconstructions					
Year 6 (2028)					
ORRD-0076	Caledon King Town Line South from 12th Concession to 17th Sideroad	62	2702	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$744,750.00
Year 6 Length (km)			2.702	Year 6 Cost	\$744,750.00
Year 7 (2029)					
ORRD-0093	Loch Erne Lane from Nobleton Lakes Drive to Hilliard Grove	66	168	Full depth asphalt removal + Total base replacement + Total curb replacement + 2 HMA (Reconstruction)	\$127,680.00
Year 7 Length (km)			0.168	Year 7 Cost	\$127,680.00
Year 8 (2030)					
ORRD-0258	Aileen Avenue from Edward Avenue to Strawberry Lane	65	702	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$352,725.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
ORRD-0150	Edward Avenue from Aileen Avenue to Jane Street	67	613	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$289,650.00
KRRD-0031	Blueberry Lane from Kingsworth Road to End	52	234	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$122,976.00
KRRD-0048	Kingscross Drive from Champlain Crescent to Cranberry Lane	69	255	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$153,000.00
Year 8 Length (km)			1.804	Year 8 Cost	\$918,351.00
Year 9 (2031)					
ORRD-0192	Loch Erne Lane from Hilliard Grove to End (Cul-de-Sac)	63	312	Full depth asphalt removal + Total base replacement + Total curb replacement + 2 HMA (Reconstruction)	\$237,120.00
KRRD-0059	Chelsea Lane from Fork to End (Cul-de-Sac)	55	249	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$120,096.00
KRRD-0093	Chelsea Lane from Fork to End (West Cul-de-Sac)	50	292	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$140,832.00

Municipal ID	Road Segment	PCI	Length (m)	Improvement Type	Improvement Cost
KRRD-0047	Chelsea Lane from Kingscross Drive to Fork	52	138	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$66,600.00
Year 9 Length (km)			0.991	Year 9 Cost	\$564,648.00
Year 10 (2032)					
ORRD-0041	Cavell Avenue from Fog Road to End (West)	68	310	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$151,125.00
ORRD-0098	Hilda Road from Diana Drive to End (Cul-de-Sac)	52	340	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$164,016.00
NRRD-0142	Lynwood Crescent from King Road to Royal Avenue	68	110	Full depth asphalt removal + Total base replacement + 2 HMA (Reconstruction)	\$57,750.00
YRRD-0001	Laskay Mills Drive from Weston Road to Rolling Court	64	107	Full depth asphalt removal + Total base replacement + Total curb replacement + 2 HMA (Reconstruction)	\$81,320.00
Year 10 Length (km)			0.867	Year 10 Cost	\$454,211.00

4.2 Gravel Paving Program and Management

4.2.1 Gravel Condition Rating

Similar to the condition rating system developed for hardtop roads, Burnside developed the "Gravel Condition Evaluation Form". The Form incorporates rating schema from the Inventory Manual for Municipal Roads (Ministry of Transportation Ontario [MTO], 1991), such as the Structural Adequacy and Drainage Rating. The various distress types shown in the Form have been collected in the field to support the overall Structural Adequacy Rating (scale between 1 to 20). The gravel road condition review also included establishing a Ride Comfort Rating (scale between 1 and 10) and a Drainage Rating (scale between 1 to 15), as well as providing comments on the specific distress observations (if any) on each gravel road section.

Based on the distress types determined during the condition survey and using the Ministry of Transportation (MTO) formulae

The Gravel Condition Rating (GCR) is determined based on a visual review of the severity, extent (density) and weighting of various distress types, as well as a Ride Comfort Rating, which reflects the rideability of the surface. A Distress Manifestation Index (DMI) is calculated, using MTO formulae, from the visual distress data collected in the field. The condition rating methodology follows the procedures developed by the MTO for gravel surface roads (MTO, 1989)

The calculation of the GCR follows the methods outlined by the MTO for such calculations (MTO, 2007). A GCR has been calculated for each road section according to the following formulae:

$$\text{Gravel Surface: } \text{GCR} = 12.75 + (9 \times \text{DMI}) - (5.5 \times e^{(9.94 - \text{RCR})/3.46})$$

Where:

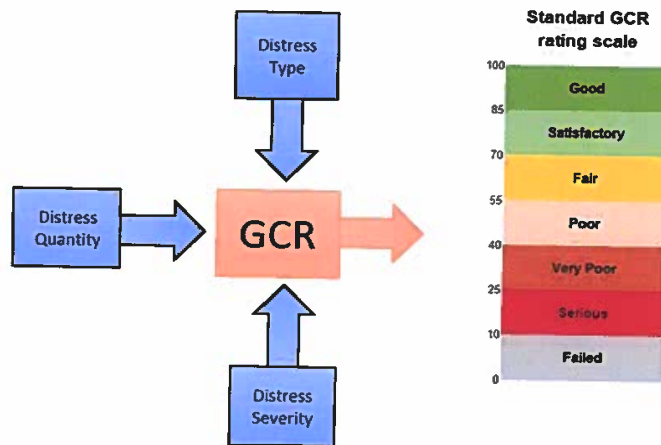
- DMI = Distress Manifestation Index, which is a systematic method of classifying and assessing the visible consequences of various surface distress mechanisms. The DMI classifies distress manifestations into various categories which are given a weighting factor (W), and which are classified according to their severity (S) and density (D). A summary of the factors considered is included in Appendix C. The total DMI is obtained by summation of the distress manifestations for the relevant factors and the following formulae:

$$\text{Gravel Surface: } \text{DMI} = 10 \times (135 - \text{summation of } W \times (D+S))/135$$

- RCR = Ride Comfort Rating, which is a subjective ride quality assessment as perceived by the traveling public and which has been determined by the field assessment of the roads.

The qualitative description of the various GCR ranges is shown in Figure 24.

Figure 29: Qualitative Description of GCR Ranges



Based on the above methodology/procedure, the updated GCR for each road segment is illustrated on a map in Appendix D and shown in the excel spreadsheets in Appendix A.

There are two gravel roads in the township with poor condition Ratings ($GCR < 55$), which currently require significant rehabilitation or full reconstruction. If sufficient budget is available to replace these roads, then these roads should be completed as soon as feasible as the roads currently sit in a state of disrepair that is not favoured by the level of service that should be provided. These roads (like the others) are subject to ongoing deterioration and will continue to degrade passed the state they are currently in. Table 11 below summarizes the two roads that have a poor condition rating and should be replace as soon as feasible.

Table 11: Gravel Roads with Poor Condition Ratings ($GCR < 55$)

Road Segment	Surface Type	AADT (vpd)	GCR
Lipchey Road, from Keele Street to End (East)	Gravel	50-199	15
South Canal Bank Road, from Jane Street to End (East)	Gravel	50-199	43

4.2.2 Surface Type Needs

The surface type of a roadway should be appropriately designed to accommodate the volume and type of traffic. According to the MTO guidelines (*Inventory Manual for*

Municipal Roads, Ministry of Transportation, 1991), The surface type requirements are as follows:

- Gravel roads are typically suitable for traffic volumes of less than 200 vehicles per day (vpd), however, upgrades to hardtop may be considered if roadside environment is semi-urban or for road network connectivity/hardtop continuity, subject to budget constraints and desired Level of Service. To minimize maintenance concerns, it is suggested that roads that have traffic volumes exceeding 200 vpd may be considered for a hard top surface (i.e., surface treatment for roads with 200 to 400 vpd AADT and asphalt for roads with over 400 vpd AADT).
- Asphalt roads may be considered where there is a high percentage of truck traffic, to maximize the road life.

Upgrading of gravel roads to asphalt may be considered for roads experiencing high truck volumes or high truck loading, AADT volumes higher than 200 or where high maintenance is an issue. For low volume rural roads, it is suggested that surface upgrading may be economical where the percentage of trucks exceed 10% of the AADT and is over 30 trucks per day.

Truck volumes typically range from a low of 3% on low volume residential streets to a high of 15% or more on arterials and collector roads. Information on truck volumes on the Township's roads was not available for this current study and it is recommended that future traffic counting work in the Township also delineate truck volumes, particularly if consideration is being made to upgrade the road's surface type. For low volume rural roads, this study suggests that surface upgrading may be economical to consider where the percentage of trucks exceed 10% of the AADT and is over 30 trucks per day.

Based on the above surface type considerations, a review of the data in Appendix A indicates that there are 18 gravel roads in the Township that presently meet these surface type criteria, as summarized in Table 12.

It is acknowledged that the Township plans to upgrade most, if not all, of its gravel roads, as the budget allows, to improve the overall Level of Service provided by its road network. Roads that are planned for upgrading should be reviewed at the detailed design stage, to ensure that the geotechnical conditions and design conditions (e.g., widths, cross section geometry, vertical and horizontal alignments, etc.) are conducive to such upgrading and / or increase the benchmark costs established in this study, to account for any related upgrading required to support the upgraded surface type.

Table 12: Existing Gravel Roads That May Warrant Upgrading

Road Segment	Length (m)	AADT (vpd)	Rationale for Upgrade
Semi-Urban Gravel Road			
Lipchey Road, from Keele Street to End (East)	886	60	Land use/ Environment
Elmpine Trail, from Mill Road to End (West)	487	153	Land use/ Environment
2nd Concession from Davis Road to Hanemaayer Lane	631	421	Traffic Volume
2nd Concession from Hanemaayer Lane to Holancin Road	205	421	Traffic Volume
19th Sideroad from 11th Concession to 12th Concession	2075	425	Traffic Volume
10th Concession from 165 m S. of 15 th Sideroad to 15th Sideroad	166	436	Traffic Volume
10th Concession from 145 m N. of King Road to 165m S. of 15th Sideroad	1834	436	Traffic Volume
Davis Road from 160 m N. of South Canal Bank Road to 2nd Concession	794	437	Traffic Volume
16th Sideroad from 7th Concession to 8 th Concession	2113	444	Traffic Volume
Dufferin Street from 1.4 km N. of 19th Sideroad to Davis Drive West	1129	494	Traffic Volume
Dufferin Street from 400 m N. of 19th Sideroad to 1.4 km N. of 19th Sideroad	998	494	Traffic Volume
12th Concession from 120 m N. of Caledon King Townline to 16th Sideroad	823	517	Traffic Volume
Mill Road from King – Vaughn Boundary to Elmpine Trail	422	566	Traffic Volume
Mill Road from Humber Trail to King Road	900	566	Traffic Volume
Mill Road from Elmpine Trail to Humber Trail	376	566	Traffic Volume
19th Sideroad from 230 m W. of Dufferin Street to 1.86 km W. of Dufferin Street	1635	865	Traffic Volume
19th Sideroad from 1.86 km W. of Dufferin Street to Keele Street	282	865	Traffic Volume
Caledon King Town Line North from Halls Lake Sideroad to Highway 9	1978	1690	Traffic Volume

Where budgets allows, it is recommended that surface types be upgraded to meet these minimum desirable levels of service for surface types. However, where budget is the limiting factor, surface type standards may be reduced to tolerable standards, assuming that the road base has been properly designed and constructed and appropriate maintenance is applied. Where this lower standard surface type is used, a corresponding reduction in useful life is likely. In some areas, other constraints (e.g., ROW widths, horizontal or vertical curve deficiencies, etc.) may preclude the upgrading of such road sections without first addressing those factors.

4.2.3 Road Width

The minimum gravel road surface widths (i.e., platform width, travel width plus 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 13.

Table 13: Recommended Minimum Platform Widths for Gravel Roads (Based on OGRA)

Design Speed (km/h)	Minimum Platform Width for Varying AADT Traffic Volume Ranges (vpd)				
	<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

There are ten gravel roads in the Township that have been identified to have widths that currently do not meet the recommended lower width limit and are summarized in Table 9.

Table 14: Summary of Gravel Roads with Deficient Platform Widths

Road	Road Length (m)	Posted Speed (km/h)	AADT (vpd)	Width (m)
Burrows Road from Weston Road to Weston Road	512	80	8	3.3
Elmpine Trail, from Mill Road to End (West)	487	50	153	5.0
Toll Road, from Bathurst Street to Highway 11	2051	60	74	5.0
17th Sideroad from Jane Street to End (West)	921	80	245	5.5
Emma Road from Dufferin Street to End (West)	975	80	253	6.10
Graham Sideroad, from Dufferin Street to End (West)	393	50	253	6.1

Road	Road Length (m)	Posted Speed (km/h)	AADT (vpd)	Width (m)
Wilhelmina Road from Dufferin Street to End (Canal)	758	80	253	6.1
Juliana Road from Dufferin Street to End (East)	1090	80	253	6.1
19th Sideroad, from 1.86 km W. of Dufferin Street to Keele Street	282	60	865	6.1
12th Concession from 120 m N. of Caledon King Townline to 16th Sideroad	823	80	517	7.3

Some of the gravel roads with deficient platform widths are located on roads with low traffic volumes (i.e., less than 400 vpd), and therefore may not be considered critical (i.e., not justifying widening to address the width deficiency). For the higher volume/higher speed roads, the magnitude of the width deficiencies is generally not that significant. However, consideration may be given to completing some widening of these roads as part of future maintenance work (i.e., maintenance gravel for gravel roads or surface treatment / asphalt resurfacing maintenance for hardtop roads). While none of the platform width deficiencies are considered critical in the short term, it is recommended that widths be upgraded to meet minimum acceptable standards when, or if, such sections are rehabilitated or reconstructed to address condition needs.

4.2.4 Improvement Types

The different improvement types that are proposed in this study are listed below. These improvement types cover the full lifecycle of the road assets and require the Township to keep up with the road maintenance to prevent leaving the roads until they slip into a more extensive category like Rehabilitation or Reconstruction.

Routine Maintenance (RM):

Routine maintenance for gravel roads consists of grading and application of dust suppressants (calcium). Routine maintenance can help delay the need for more extensive rehabilitation or reconstruction and often adds a few years to the lifespan of a roadway. Routine/preventive maintenance is typically done when a road is in good condition but is starting to show slight deficiencies.

Preventive Maintenance (PM):

Preventive maintenance for gravel roads consists of the application of maintenance gravel (gravel top-up). Preventive Maintenance can help to delay the need for more extensive rehabilitation or reconstruction. Preventive maintenance is typically done when a road is in good condition but is starting to show slight deficiencies.

Resurfacing (R):

Resurfacing for gravel roads, as proposed in this study consists of upgrading the gravel surface to a hardtop surface. Through discussion with Township staff, it is understood that the preferred surface type is Hot Mix Asphalt (HMA) and where applicable, roads should be upgraded to a HMA surface. This study proposes that the resurfacing improvement consists of nominal base strengthening (i.e., adding a thin lift of granular A to the existing surface) + two (50 mm) lifts of HMA.

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 upgrading the surface of gravel roads, but minimal work is done to the base of the road, aside from patching where required.

Rehabilitation (REH):

Rehabilitation for gravel roads, as proposed in this study consists of upgrading the gravel surface to a hardtop surface. Through discussion with Township staff, it is understood that the preferred surface type is Hot Mix Asphalt (HMA) and where applicable, roads should be upgraded to a HMA surface. This study proposes that the rehabilitation improvement consists of partial base strengthening (i.e., excavating part of the existing base and replacing the material with new granular A material) + two (50 mm) lifts of HMA.

More extensive rehabilitation treatments are applied to roads in poor condition which have deteriorated to a point where full depth replacement of the road surface is required to protect the integrity of the underlying granular base and to delay more extensive reconstruction being required. Rehabilitation extends the service life of a pavement and its load carrying capacity by enhancing the road structure. This is achieved by eliminating the age-related deterioration of the pavement or increasing the thickness of pavement layers to address increases in traffic volume.

Reconstruction (REC):

Reconstruction for gravel roads, as proposed in this study consists of upgrading the gravel surface to a hardtop surface. Through discussion with Township staff, it is understood that the preferred surface type is Hot Mix Asphalt (HMA) and where applicable, roads should be upgraded to a HMA surface. This study proposes that the

reconstruction improvement consists of full base strengthening (i.e., excavating all the existing base and replacing the material with new granular A and granular B material) + two (50 mm) lifts of HMA.

Reconstructions are typically done when a road is in very poor condition. If roads are left to deteriorate, they become weak and lose their structural integrity. As its structural capacity is weakened, a road 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, the surface and road base may require full reconstruction to reestablish the proper base support for the road surface. Applying a lesser rehabilitation treatment may result in premature failure of any newly applied surface material. Once the road 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 road needs to be improved, to cater to significant increases in projected traffic volumes or to accommodate road widening.

Determining Improvement Needs:

To determine the improvement types that are warranted for certain road sections, the GCR values 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 15 along with estimated benchmark treatment costs. In addition, the forecasted improvement effects resulting from the various life cycle treatments are shown in Table 15 (i.e., the net benefit to the GCR values after a certain improvement type is implemented). The net benefit that is presented because of implementing a given improvement type is to represent that maintaining the condition of roads and performing routine and preventive maintenance will lengthen the lifecycle of a road segment (i.e., performing crack sealing with help extend the useful life of a road segment).

Table 15: Gravel Road Improvement Matrix

Improvement	Post-Treatment Condition	Semi-Urban or Rural - Gravel			Distress Triggers
		AADT >= 400	400 > AADT >= 200	AADT < 200	
Routine Maintenance (RM)	N/A	N/A	N/A	Grading + Dust Suppressants	GCR >= 60
Preventive Maintenance (PM)	N/A	N/A	N/A	Maintenance Gravel (once every three years) + Calcium Chloride [\$0.55 per m ²]	
Resurface (R)	N/A	2 HMA + Nominal Base Strengthening + Nominal Ditch Repair [\$45 per m ²]	2 HMA + Nominal Base Strengthening + Nominal Ditch Repair [\$40 per m ²]	2 HMA + Nominal Base Strengthening + Nominal Ditch Repair [\$40 per m ²] (Policy Upgrade)	
Rehabilitation (REH)	N/A	2 HMA + Partial Base Strengthening + Nominal Ditch Repair [\$51 per m ²]	2 HMA + Partial Base Strengthening + Nominal Shoulder/Ditch Repair [\$49 per m ²]	2 HMA + Partial Base Strengthening + Nominal Shoulder/Ditch Repair [\$49 per m ²]	60 > GCR >= 40
Reconstruction (REC)	PCI=100	2 HMA + Total Base Replacement + Nominal Shoulder/Ditch Repair [\$70 per m ²]	2 HMA + Total Base Replacement + Nominal Shoulder/Ditch Repair [\$70 per m ²]	2 HMA + Total Base Replacement + Nominal Shoulder/Ditch Repair [\$70 per m ²]	GCR < 40

4.2.5 Improvement Costs

General improvement benchmark unit costs (costs per square metre) are for budget planning purposes and have been based on recent costing experience for the applicable recommended improvement standard. Improvement projects are generally completed through a combination of day labour 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); and
- Budget constraints requiring consideration of lesser standards (such as maintaining vertical profiles to tolerable conditions, rather than design standards, or reducing overall improvements)

It is recommended that standards be reviewed on a project specific basis as budgets are established.

Benchmark improvement costs (per square metre) are outlined in Table 15 above as well as unit cost breakdowns in Appendix F and are based on recent data provided from 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 basis, the improvement costs for any particular road section will also capture individual road widths.

4.2.6 Improvement Prioritization

For the prioritization of the gravel upgrades proposed in this study, non-condition related triggers were used. Local Township staff knowledge regarding road functionality, stability (i.e., condition during freeze/thaw season), maintenance demand and drainage were used to determine the order of prioritization for upgrade of the Township's gravel roads.

If a road is determined to have a road width and/or platform width that is less than ideal, this road should be reviewed to determine if the current width is suitable for the current surface type and can wait for widening treatment until upgrade, or if it should be widened as soon as possible (i.e., a current gravel road has a road width that is less than the recommended minimum for gravel roads but given the site specific geometrics and traffic, the road width can continue to remain as is but will need to be widened prior to the road being upgraded to an asphalt surface).

4.2.7 Road Budget Consideration

The Township has adopted a policy to upgrade/pave all of the gravel roads in the network. As part of this policy, the township has allocated an annual budget for gravel

road upgrade. Based on the 2022 and the 2023 Budget and Business Plan, the Township has allocated \$0.8 million per annum for gravel road conversion/paving.

4.2.8 Gravel Conversion Plan

A total of approximately 60.002 km of gravel roads was reviewed as part of this study. Since most of the Township's gravel roads are in good condition ($GCR > 60$), the remaining roads were prioritized based on non-condition related triggers such as local knowledge of condition deterioration, maintenance demand and functionality as well as proximity to the surrounding hardtop network. Occasionally roads were not recommended for upgrading due to specific issues that may arise if the road is provided with a hard top surface. These issues could consist of significant horizontal/vertical alignment upgrading, roadside encroachment, as well as type of traffic utilizing the road. Providing a hardtop surface on roads where speeding is currently an issue, or the focus of a road is to serve access for local residents, upgrading to a hard top surface and attracting other network traffic would not be considered a benefit. Table 16 and Figure 30 below outline the proposed roads to be upgraded as part of the 10-year plan. A full spreadsheet version of the 10-year plan, along with an enlarged map can be found in Appendix G.

Figure 30: 10 Year Gravel Upgrade Plan

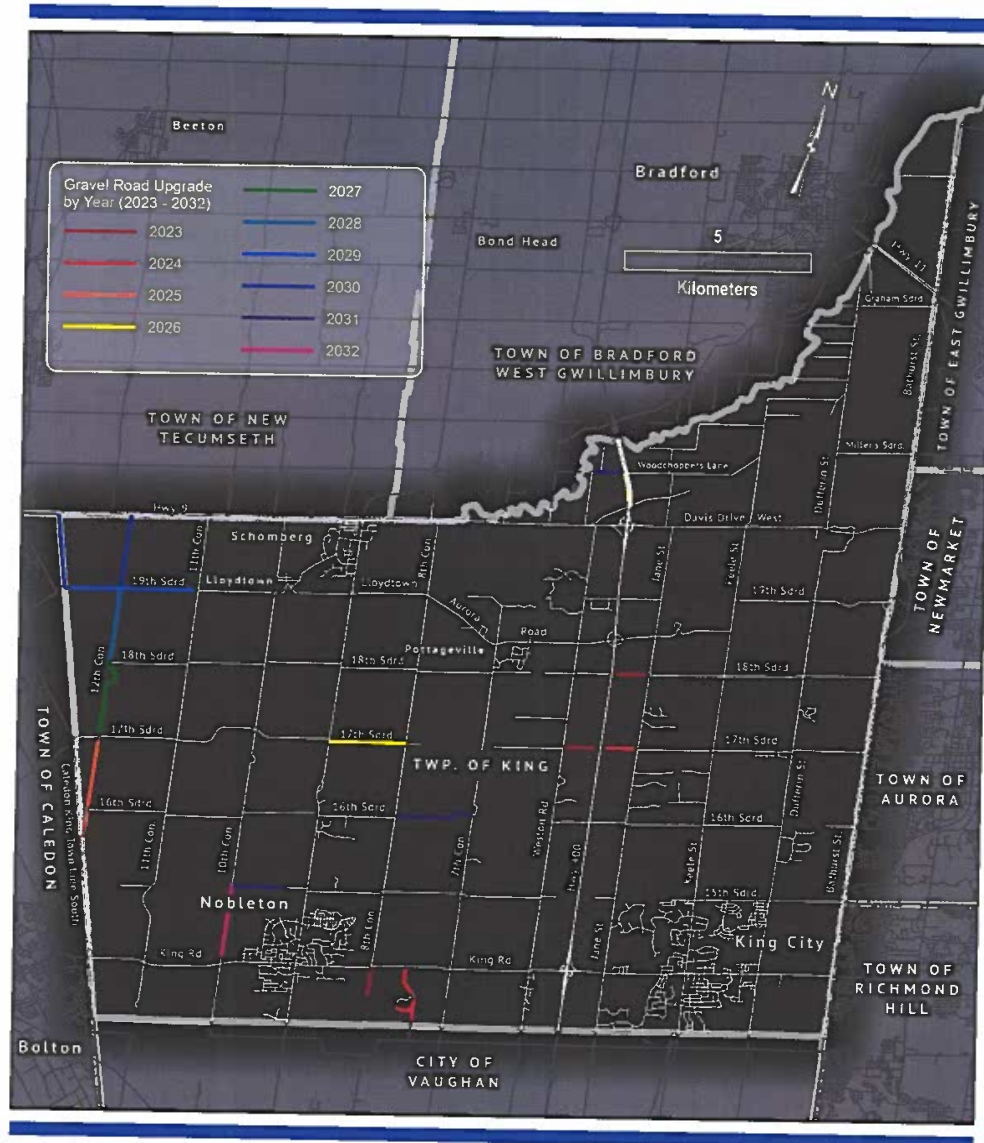


Table 16: Gravel Road Conversion 10 Year Plan

Municipal ID	Road Segment	Length (m)	Improvement Cost
Year 1 (2023)			
ORRD-0016	17th Sideroad from Weston Road to East end	946	\$253,520.00
ORRD-0092	8th Concession from South end to King Road	799	\$194,960.00
ORRD-0239	18th Sideroad from Jane Street to West end	952	\$255,120.00
ORRD-0244	Toll Road from Bathurst Street to Highway 11	2051	\$410,200.00
Year 1 Total (km)		4.748	\$1,113,800.00
Year 2 (2024)			
ORRD-0175	Mill Road from King – Vaughn Boundary to Elmpine Trail	422	\$138,645.00
ORRD-0156	Mill Road from Elmpine Trail to Humber Trail	376	\$123,525.00
ORRD-0052	Mill Road from Humber Trail to King Road	900	\$295,650.00
ORRD-0144	Elmpine Trail from Mill Road to West end	487	\$97,400.00
ORRD-0251	17th Sideroad from Jane Street to West end	921	\$202,640.00
Year 2 Total (km)		3.106	\$857,860.00
Year 3 (2025)			
ORRD-0165.2	12th Concession from 120 m N. of Caledon King Townline to 16th Sideroad	823	\$270,360.00
ORRD-0212	12th Concession from 16th Sideroad to 17th Sideroad	2029	\$592,480.00
Year 3 Total (km)		2.852	\$862,840.00
Year 4 (2026)			
ORRD-0196	17th Sideroad from 8th Concession to Highway 27	2042	\$547,240.00
ORRD-0040.2	Davis Road from 160 m N. of South Canal Bank Road to 2nd Concession	794	\$282,285.00
Year 4 Total (km)		2.836	\$829,525.00
Year 5 (2027)			
ORRD-0147	12th Concession from 17th Sideroad to 1.5 km N. of 17th Sideroad	1504	\$493,320.00
ORRD-0081	12th Concession from 1.5 km N. of 17th Sideroad to 2.2 km N. of 17th Sideroad	660	\$216,480.00
ORRD-0062	12th Concession from 2.2 km N. of 17th Sideroad to 18th Sideroad	118	\$38,720.00
Year 5 Total (km)		2.282	\$748,520.00

Municipal ID	Road Segment	Length (m)	Improvement Cost
Year 6 (2028)			
ORRD-0207	12th Concession from 18th Sideroad to 19th Sideroad	2031	\$674,280.00
Year 6 Total (km)		2.031	\$674,280.00
Year 7 (2029)			
ORRD-0148	19th Sideroad from 12th Concession to Caledon King Townline North	1505	\$439,480.00
ORRD-0209	19th Sideroad from 11th Concession to 12th Concession	2075	\$681,660.00
Year 7 Total (km)		3.580	\$1,121,140.00
Year 8 (2030)			
ORRD-0119	12th Concession from 19th Sideroad to Highway 9	2045	\$736,200.00
ORRD-0230	Caledon King Townline North from 19th Sideroad to Halls Lake Sideroad	51	\$8,680.00
ORRD-0077	Caledon King Townline North from Halls Lake Sideroad to Highway 9	1978	\$378,293.00
Year 8 Total (km)		4.074	\$1,123,173.00
Year 9 (2031)			
ORRD-0013	15th Sideroad from 0.55 km E. of Highway 27 to 10th Concession	1465	\$427,800.00
ORRD-0180	16th Sideroad from 7th Concession to 8th Concession	2113	\$694,125.00
ORRD-0160	2nd Concession from Davis Road to Hanemaayer Lane	631	\$212,985.00
ORRD-0073	2nd Concession from Hanemaayer Lane to Holancin Road	205	\$69,210.00
Year 9 Total (km)		4.414	\$1,404,120.00
Year 10 (2032)			
ORRD-0256.2	10th Concession from 145 m N. of King Road to 165 m S. of 15th Sideroad	1834	\$652,005.00
ORRD-0257	10th Concession from 165 m S. of 15th Sideroad to 15th Sideroad	166	\$58,995.00
ORRD-0225.1	10th Concession from 15th Sideroad to 90 m N. of 15th Sideroad	142	\$51,120.00
Year 10 Total (km)		2.142	\$762,120.00

5.0 Asset Management and Capital Planning Considerations

The needs outlined in this study are determined to be the current (2023) needs and are subject to ongoing deterioration. The current needs of the Township roads equate to \$26.5 million for hardtop and \$9.7 million to upgrade the remaining gravel roads. The current needs are subject to ongoing deterioration, which may require future improvements to be more extensive (i.e., a current resurface need with a PCI of 65 that is being pushed for 3 years until enough budget is available, might require rehabilitation in 3 years rather than resurfacing). If the Township's goal is to maintain a certain level of service and keep up with the road needs, the current budgets will need to be reviewed and increased to a level where the Township is comfortable with the expenditures and level of service for all the roads.

The previous Road Needs Studies have provided general considerations for establishing a capital improvement plan for the road network, based on the condition, needs, and other factors. As part of this study, a 10-year road improvement plan has been developed to assist the township in the development of a multi-year capital project plan. It is understood that the Township intends to use the updated condition rating data as input to their ongoing Asset Management and Capital Planning work. The updated GIS database, Excel spreadsheets and mapping will assist in this ongoing future work by the Township. Such future work may also require updating traffic data, confirming the maintenance / improvement needs and costs based on project-level review and completing a risk analysis to establish project priority within budget limitations.

To maintain a current database for asset management and capital planning purposes, it is recommended that the Township complete regular updates every 2 years to update the condition ratings of their road network, to assess ongoing deterioration rates and resulting improvement requirements.

The 2021 Asset Management Plan for the township presented a need to invest \$3.7M per year, on average, for all township road assets. The current allocation for maintenance is less than this amount, leaving a shortfall per year. Over time, this shortfall tends to increase disproportionately, as the deterioration of roads follows an increasing exponential deterioration curve (as opposed to linear) and the gap could increase to a point of never being able to "catch up". Therefore, it is recommended the township align its road maintenance needs with its Asset Management Plan to ensure an effective and efficient roadway network. To illustrate this point, a calculation of the actual road needs for the next five years versus the planned allocated budget, reveals a need for approximately \$4.2 million versus the current allocation of \$2.52 million. This is also reflected in Appendix E where some roads requiring maintenance are not in the 10-year program, as those in the program reflect a greater need and are prioritized within the budget constraints that exist.

Figure 31: Asset Management Plan Budget Needs Table**Table 4-1: Summary of 100-year Average Annual Funding Need and Average Annual Funding in 10-year Capital Plan by Asset Class (2021\$)**

Asset Class	100-year Average Annual Funding Required	Average Annual Expenditures in Current 10-year Capital Plan	Average Expenditures as a Percentage of Funding Required
Tax Supported			
Roads	\$3,740,000	\$2,680,000 ⁽¹⁾	67%
Bridges and Structural Culverts	\$1,820,000	\$1,430,000	79%
Stormwater	\$3,120,000	\$490,000	16%
Sub-total: Tax Supported	\$8,680,000	\$4,600,000	53%
Rate Supported			
Water	\$1,150,000	\$1,780,000	155%
Wastewater	\$1,100,000	\$850,000	77%
Sub-total: Rate Supported	\$2,250,000	\$2,630,000	117%
Total	\$10,930,000	\$7,240,000	66%

Source: King Township Asset Management Plan (2021)

Should the Township increase their annual road improvement budget to eliminate/keep up with the needs of the network, it is recommended that the Township adopt a life cycle approach to allocate budgets towards road improvement needs. Project improvements, using a lifecycle management approach may be prioritized using a Priority Guide Number (PGN). Burnside has slightly adjusted MTO's PGN formula, to reflect the condition rating methodologies 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 life cycle. As described in this RNS, to be most cost-effective, timely expenditures should be made using routine maintenance, preventive maintenance, and resurfacing treatments, rather than allowing further degradation requiring much more costly rehabilitation or reconstruction treatments.

The PGN formula used in this RNS is as follows:

$$PGN = \frac{(100 - \text{Condition Rating}) * TF * LCF}{10000 * \text{Road Width} * (\text{cost per square metre})}$$

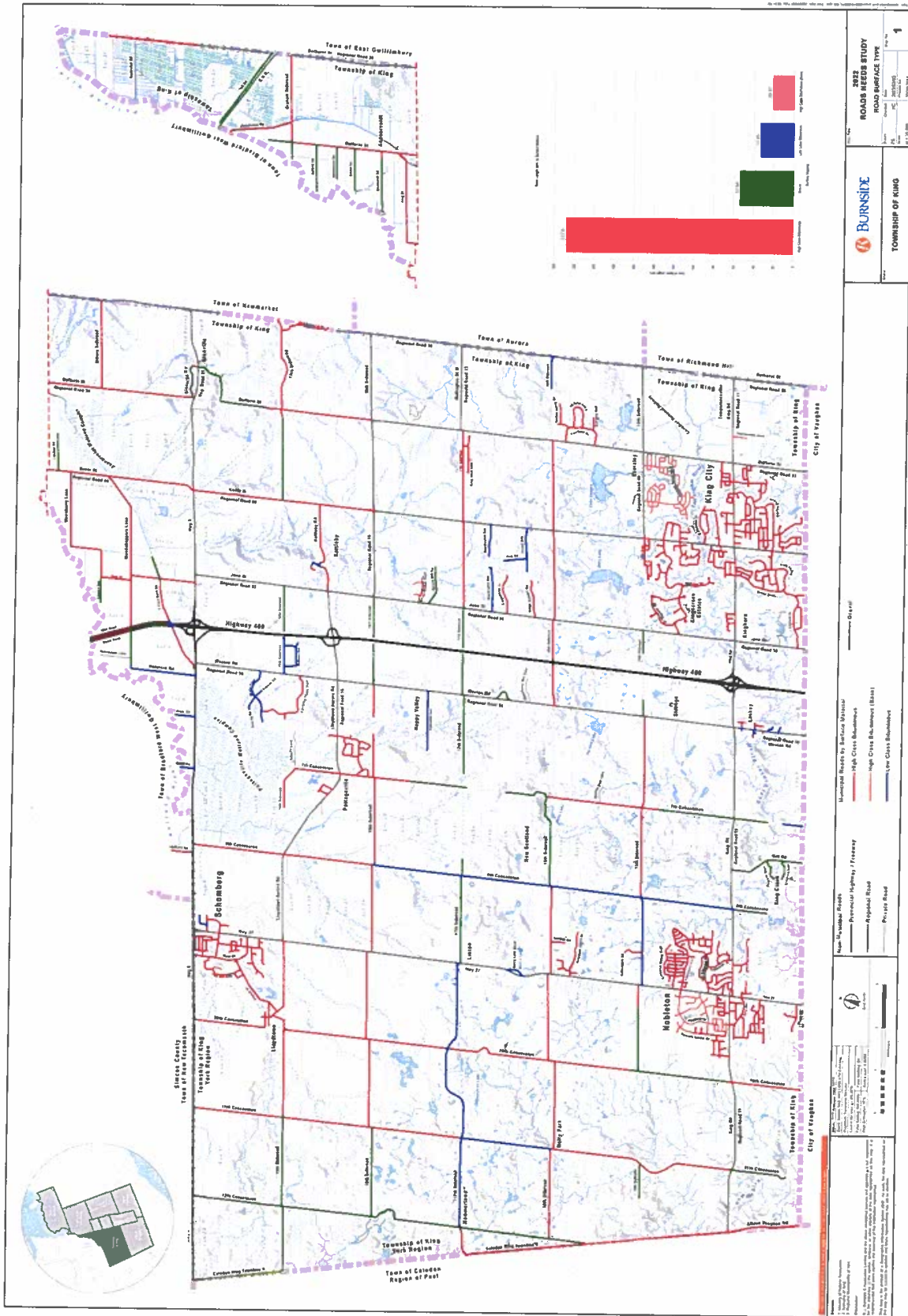
where:

- PGN is the Priority Guide Number
- Condition Rating is the Pavement Condition Index of the selected road segment
- TF is the Traffic Factor, which is an estimate of the traffic served over the life cycle of the improvement based on the warranted improvement type, the existing AADT and the 10-year projected AADT presented in Table 1 and is 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 0.5
 - rehabilitation or reconstruction TF = Yr. 10 AADT
- LCF is the Life Cycle 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:
 - 0 for routine maintenance treatments
 - 1095 for preventive maintenance treatments
 - 3650 for or resurfacing treatments
 - 7300 for rehabilitation and reconstruction treatments
- Road Width is the surface width of a given road section (in metres)

The higher the PGN value, the higher the priority of the road section improvement 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 a measure of comparison between improvement requirements of any road section relative to other road sections. The PGN value is summarized in Appendix A.

Appendix A

Road Inventory Maps and Table



Appendix A - Road Inventory Database (Sorted by Road Name)

[illegible]

Appendix A - Road Inventory Database (Sorted by Road Name

[illegible]

Appendix A - Road Inventory Database (Sorted by Road Name)

[illegible]

Appendix A - Road Inventory Database (Sorted by Road Name)

[illegible]

Appendix A - Road Inventory Database (Sorted by Road Name

[illegible]



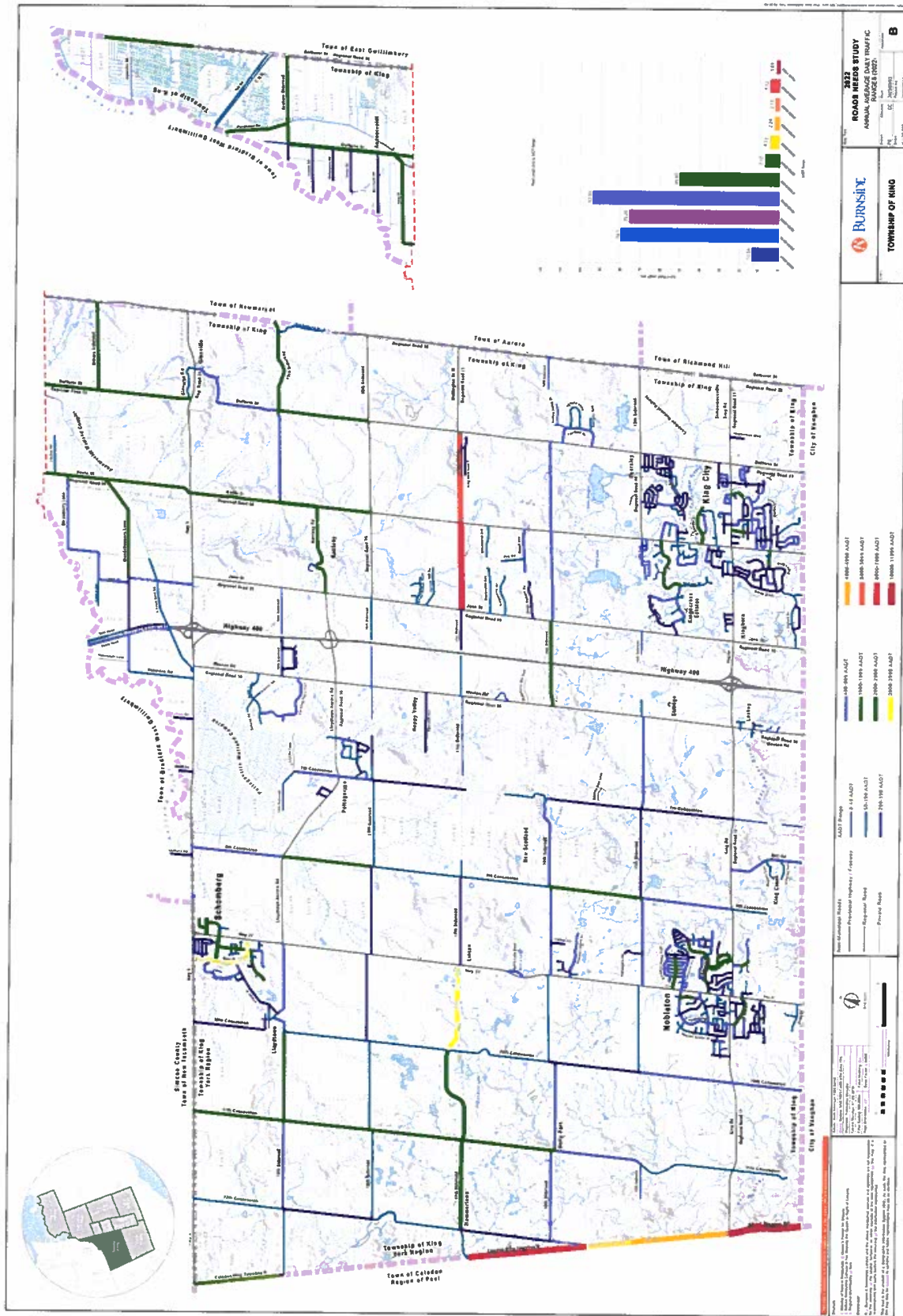
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Appendix B

AADT Map

Appendix B





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Appendix C

Distress Factors for Road Conditions Assessment

Appendix C

APPENDIX C
Distress Factors for Road Condition Assessment
Calculation of Distress Manifestation Index (DMI) and Pavement Condition Index (PCI)

Weighting Factors

Distress Manifestation For Asphalt Roads	Weighting Factor (W)	Distress Manifestation For Surface Treated Roads	Weighting Factor (W)	Distress Manifestation For Gravel Roads	Weighting Factor (W)
Flaveling and coarse aggregate loss	3.0	Cover Aggregate Loss	3.0	Flat/reverse crown	2.0
Flushing	1.5	Flushing	2.0	Loose gravel	1.5
Rippling and showing	1.0	Rippling and Showing	2.0	Dust	0.5
Wheel track rutting	3.0	Wheel track rutting	3.0	Break-up	3.0
Distortion	3.0	Distortion	3.0	Washboarding	1.0
Longitudinal wheel track - single/multiple cracking	1.5	Stracking	1.0	Rutting	3.0
Longitudinal wheel track - alligator cracking	3.0	Alligator Cracking	3.0	Distortion	3.0
Centerline - single/multiple cracking	0.5	Edge Cracking	1.0	Potholes	2.0
Centerline - alligator cracking	2.0	Edge Break	2.0		
Pavement edge - single/multiple cracking	0.5	Transverse Cracking	0.5		
Pavement edge - alligator cracking	1.5	Longitudinal Cracking	1.0		
Transverse - single/multiple cracking	1.0	Potholing	1.0		
Transverse - alligator cracking	3.0				
Longitudinal, meander and midlane cracking	1.0				
Random cracking	0.5				

Density Factors

Density of Distress Asphalt or Gravel Roads	Density Factor (D)	Severity of Distress (Asphalt or Gravel Roads)	Severity Factor (S)	Ride Condition Rating (RCR)	Factor
Few (<10%)	0.5	Very Slight	0.5	Very Poor	1
Intermittent (10 to 20%)	1.0	Slight	1.0	Poor	2 to 3
Frequent (20 to 40%)	2.0	Moderate	2.0	Fair	4 to 6
Extensive (40 to 80%)	3.0	Severe	3.0	Good	7 to 9
Throughout (>80%)	4.0	Very Severe	4.0	Very Good	10

Severity Factors

Empirical Formulas For Calculation of Distress Manifestation Index (DMI)

Surface Type	Formulae For Distress Manifestation Index (DMI)
Asphalt	$DMI = 10 \times (208 - \text{sum of } W \times (D \times S)) / 208$
Surface Treatment or Gravel or Earth	$DMI = 10 \times (135 - \text{sum of } W \times (D \times S)) / 135$

Empirical Formulas For Calculation of Pavement Condition Index (PCI)

Surface Type	Formulae For Pavement Condition Index (PCI)
Asphalt	$PCI = 13.75 + (9 \times DMI) - (7.5 \times e^{(0.838692 \times DMI)})$
Surface Treatment or Gravel or Earth	$PCI = 12.75 + (9 \times DMI) - (5.5 \times e^{(0.838692 \times DMI)})$



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Appendix D

Pavement Condition Rating Map

Appendix D



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Appendix E

Road Condition Improvement Needs, Map and Table

Appendix E

Appendix E - Road Improvement Needs (Sorted by PCI)

[illegible]

Appendix E - Road Improvement Needs (Sorted by PCI)

Project ID	Route	Project Description	Project Type	Project Length (mi)	Project Width (ft)	Project Depth (ft)	Project Area (sq ft)	Project Volume (cu yd)	Project Weight (tons)	Project Cost (\$ mil)	Project Status
00000001	State Route 1	1.00 mi of SR 1	SR 1	1.00	100	10	10000	10000	10000	10000	Completed
00000002	State Route 2	2.00 mi of SR 2	SR 2	2.00	100	10	20000	20000	20000	20000	Completed
00000003	State Route 3	3.00 mi of SR 3	SR 3	3.00	100	10	30000	30000	30000	30000	Completed
00000004	State Route 4	4.00 mi of SR 4	SR 4	4.00	100	10	40000	40000	40000	40000	Completed
00000005	State Route 5	5.00 mi of SR 5	SR 5	5.00	100	10	50000	50000	50000	50000	Completed
00000006	State Route 6	6.00 mi of SR 6	SR 6	6.00	100	10	60000	60000	60000	60000	Completed
00000007	State Route 7	7.00 mi of SR 7	SR 7	7.00	100	10	70000	70000	70000	70000	Completed
00000008	State Route 8	8.00 mi of SR 8	SR 8	8.00	100	10	80000	80000	80000	80000	Completed
00000009	State Route 9	9.00 mi of SR 9	SR 9	9.00	100	10	90000	90000	90000	90000	Completed
00000010	State Route 10	10.00 mi of SR 10	SR 10	10.00	100	10	100000	100000	100000	100000	Completed
00000011	State Route 11	11.00 mi of SR 11	SR 11	11.00	100	10	110000	110000	110000	110000	Completed
00000012	State Route 12	12.00 mi of SR 12	SR 12	12.00	100	10	120000	120000	120000	120000	Completed
00000013	State Route 13	13.00 mi of SR 13	SR 13	13.00	100	10	130000	130000	130000	130000	Completed
00000014	State Route 14	14.00 mi of SR 14	SR 14	14.00	100	10	140000	140000	140000	140000	Completed
00000015	State Route 15	15.00 mi of SR 15	SR 15	15.00	100	10	150000	150000	150000	150000	Completed
00000016	State Route 16	16.00 mi of SR 16	SR 16	16.00	100	10	160000	160000	160000	160000	Completed
00000017	State Route 17	17.00 mi of SR 17	SR 17	17.00	100	10	170000	170000	170000	170000	Completed
00000018	State Route 18	18.00 mi of SR 18	SR 18	18.00	100	10	180000	180000	180000	180000	Completed
00000019	State Route 19	19.00 mi of SR 19	SR 19	19.00	100	10	190000	190000	190000	190000	Completed
00000020	State Route 20	20.00 mi of SR 20	SR 20	20.00	100	10	200000	200000	200000	200000	Completed
00000021	State Route 21	21.00 mi of SR 21	SR 21	21.00	100	10	210000	210000	210000	210000	Completed
00000022	State Route 22	22.00 mi of SR 22	SR 22	22.00	100	10	220000	220000	220000	220000	Completed
00000023	State Route 23	23.00 mi of SR 23	SR 23	23.00	100	10	230000	230000	230000	230000	Completed
00000024	State Route 24	24.00 mi of SR 24	SR 24	24.00	100	10	240000	240000	240000	240000	Completed
00000025	State Route 25	25.00 mi of SR 25	SR 25	25.00	100	10	250000	250000	250000	250000	Completed
00000026	State Route 26	26.00 mi of SR 26	SR 26	26.00	100	10	260000	260000	260000	260000	Completed
00000027	State Route 27	27.00 mi of SR 27	SR 27	27.00	100	10	270000	270000	270000	270000	Completed
00000028	State Route 28	28.00 mi of SR 28	SR 28	28.00	100	10	280000	280000	280000	280000	Completed
00000029	State Route 29	29.00 mi of SR 29	SR 29	29.00	100	10	290000	290000	290000	290000	Completed
00000030	State Route 30	30.00 mi of SR 30	SR 30	30.00	100	10	300000	300000	300000	300000	Completed
00000031	State Route 31	31.00 mi of SR 31	SR 31	31.00	100	10	310000	310000	310000	310000	Completed
00000032	State Route 32	32.00 mi of SR 32	SR 32	32.00	100	10	320000	320000	320000	320000	Completed
00000033	State Route 33	33.00 mi of SR 33	SR 33	33.00	100	10	330000	330000	330000	330000	Completed
00000034	State Route 34	34.00 mi of SR 34	SR 34	34.00	100	10	340000	340000	340000	340000	Completed
00000035	State Route 35	35.00 mi of SR 35	SR 35	35.00	100	10	350000	350000	350000	350000	Completed
00000036	State Route 36	36.00 mi of SR 36	SR 36	36.00	100	10	360000	360000	360000	360000	Completed
00000037	State Route 37	37.00 mi of SR 37	SR 37	37.00	100	10	370000	370000	370000	370000	Completed
00000038	State Route 38	38.00 mi of SR 38	SR 38	38.00	100	10	380000	380000	380000	380000	Completed
00000039	State Route 39	39.00 mi of SR 39	SR 39	39.00	100	10	390000	390000	390000	390000	Completed
00000040	State Route 40	40.00 mi of SR 40	SR 40	40.00	100	10	400000	400000	400000	400000	Completed
00000041	State Route 41	41.00 mi of SR 41	SR 41	41.00	100	10	410000	410000	410000	410000	Completed
00000042	State Route 42	42.00 mi of SR 42	SR 42	42.00	100	10	420000	420000	420000	420000	Completed
00000043	State Route 43	43.00 mi of SR 43	SR 43	43.00	100	10	430000	430000	430000	430000	Completed
00000044	State Route 44	44.00 mi of SR 44	SR 44	44.00	100	10	440000	440000	440000	440000	Completed
00000045	State Route 45	45.00 mi of SR 45	SR 45	45.00	100	10	450000	450000	450000	450000	Completed
00000046	State Route 46	46.00 mi of SR 46	SR 46	46.00	100	10	460000	460000	460000	460000	Completed
00000047	State Route 47	47.00 mi of SR 47	SR 47	47.00	100	10	470000	470000	470000	470000	Completed
00000048	State Route 48	48.00 mi of SR 48	SR 48	48.00	100	10	480000	480000	480000	480000	Completed
00000049	State Route 49	49.00 mi of SR 49	SR 49	49.00	100	10	490000	490000	490000	490000	Completed
00000050	State Route 50	50.00 mi of SR 50	SR 50	50.00	100	10	500000	500000	500000	500000	Completed
00000051	State Route 51	51.00 mi of SR 51	SR 51	51.00	100	10	510000	510000	510000	510000	Completed
00000052	State Route 52	52.00 mi of SR 52	SR 52	52.00	100	10	520000	520000	520000	520000	Completed
00000053	State Route 53	53.00 mi of SR 53	SR 53	53.00	100	10	530000	530000	530000	530000	Completed
00000054	State Route 54	54.00 mi of SR 54	SR 54	54.00	100	10	540000	540000	540000	540000	Completed
00000055	State Route 55	55.00 mi of SR 55	SR 55	55.00	100	10	550000	550000	550000	550000	Completed
00000056	State Route 56	56.00 mi of SR 56	SR 56	56.00	100	10	560000	560000	560000	560000	Completed
00000057	State Route 57	57.00 mi of SR 57	SR 57	57.00	100	10	570000	570000	570000	570000	Completed
00000058	State Route 58	58.00 mi of SR 58	SR 58	58.00	100	10	580000	580000	580000	580000	Completed
00000059	State Route 59	59.00 mi of SR 59	SR 59	59.00	100	10	590000	590000	590000	590000	Completed
00000060	State Route 60	60.00 mi of SR 60	SR 60	60.00	100	10	600000	600000	600000	600000	Completed
00000061	State Route 61	61.00 mi of SR 61	SR 61	61.00	100	10	610000	610000	610000	610000	Completed
00000062	State Route 62	62.00 mi of SR 62	SR 62	62.00	100	10	620000	620000	620000	620000	Completed
00000063	State Route 63	63.00 mi of SR 63	SR 63	63.00	100	10	630000	630000	630000	630000	Completed
00000064	State Route 64	64.00 mi of SR 64	SR 64	64.00	100	10	640000	640000	640000	640000	Completed
00000065	State Route 65	65.00 mi of SR 65	SR 65	65.00	100	10	650000	650000	650000	650000	Completed
00000066	State Route 66	66.00 mi of SR 66	SR 66	66.00	100	10	660000	660000	660000	660000	Completed
00000067	State Route 67	67.00 mi of SR 67	SR 67	67.00	100	10	670000	670000	670000	670000	Completed
00000068	State Route 68	68.00 mi of SR 68	SR 68	68.00	100	10	680000	680000	680000	680000	Completed
00000069	State Route 69	69.00 mi of SR 69	SR 69	69.00	100	10	690000	690000	690000	690000	Completed
00000070	State Route 70	70.00 mi of SR 70	SR 70	70.00	100	10	700000	700000	700000	700000	Completed
00000071	State Route 71	71.00 mi of SR 71	SR 71	71.00	100	10	710000	710000	710000	710000	Completed
00000072	State Route 72	72.00 mi of SR 72	SR 72	72.00	100	10	720000	720000	720000	720000	Completed
00000073	State Route 73	73.00 mi of SR 73	SR 73	73.00	100	10	730000	730000	730000	730000	Completed
00000074	State Route 74	74.00 mi of SR 74	SR 74	74.00	100	10	740000	740000	740000	740000	Completed
00000075	State Route 75	75.00 mi of SR 75	SR 75	75.00	100	10	750000	750000	750000	750000	Completed
00000076	State Route 76	76.00 mi of SR 76	SR 76	76.00	100	10	760000	760000	760000	760000	Completed
00000077	State Route 77	77.00 mi of SR 77	SR 77	77.00	100	10	770000	770000	770000	770000	Completed
00000078	State Route 78	78.00 mi of SR 78	SR 78	78.00	100	10	780000	780000	780000	780000	Completed
00000079	State Route 79	79.00 mi of SR 79	SR 79	79.00	100	10	790000	790000	790000	790000	Completed
00000080	State Route 80	80.00 mi of SR 80	SR 80	80.00	100	10	800000	800000	800000	800000	Completed
00000081	State Route 81	81.00 mi of SR 81	SR 81	81.00	100	10	810000	810000	810000	810000	Completed
00000082	State Route 82	82.00 mi of SR 82	SR 82	82.00	100	10	820000	820000	820000	820000	Completed
00000083	State Route 83	83.00 mi of SR 83	SR 83	83.00	100	10	830000	830000	830000	830000	Completed
00000084	State Route 84	84.00 mi of SR 84	SR 84	84.00	100	10	840000	840000	840000	840000	Completed
00000085	State Route 85	85.00 mi of SR 85	SR 85	85.00	100	10	850000	850000	850000	850000	Completed
00000086	State Route 86	86.00 mi of SR 86	SR 86	86.00	100	10	860000	860000	860000	860000	Completed
00000087	State Route 87	87.00 mi of SR 87	SR 87	87.00	100	10	870000	870000	870000	870000	Completed
00000088	State Route 88	88.00 mi of SR 88	SR 88	88.00	100	10	880000	880000	880000	880000	Completed
00000089	State Route 89	89.00 mi of SR 89	SR 89	89.00	100	10	890000	890000	890000	890000	Completed
00000090	State Route 90	90.00 mi of SR 90	SR 90	90.00	100	10	900000	900000	900000	900000	Completed
00000091	State Route 91	91.00 mi of SR 91	SR 91	91.00	100	10	910000	910000	910000	910000	Completed
00000092	State Route 92	92.00 mi of SR 92	SR 92	92.00	100	10	920000	920000	920000	920000	Completed
00000093	State Route 93	93.00 mi of SR 93	SR 93	93.00	100	10	930000	930000	930000	930000	Completed
00000094	State Route 94	94.00 mi of SR 94	SR 94	94.00	100	10	940000	940000	940000	940000	Completed
00000095	State Route 95	95.00 mi of SR 95	SR 95	95.00	100	10	950000	950000	950000	950000	Completed
00000096	State Route 96	96.00 mi of SR 96	SR 96	96.00	100	10	960000	960000	960000	960000	Completed
00000097	State Route 97	97.00 mi of SR 97	SR 97	97.00	100	10	970000	970000	97		

[illegible]

Appendix E - Road Improvement Needs (Sorted by PCI)

[illegible]

[illegible]

[illegible]

[illegible]



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix F

Benchmark Unit Cost Breakdown

Unit Costs	Units	Unit Cost
Granular A	t	\$18.00
Granular B	t	\$14.40
Asphalt	t	\$120.00
50 mm HL8	m2	\$14.70
50mm HL4	m2	\$14.70
40mm HL3	m2	\$11.76
Earth Excavation	m3	\$15.00
Milling	m2	\$3.00
Pulverizing	m2	\$1.00
Asphalt Removal	m2	\$5.00
Microsurfacing	m2	\$6.00
Crack Sealing	m2	\$0.75
Catch Basin/Manhole Adjustments	m2	\$2.00
Crack Sealing + Patching	m2	\$1.50
Maintenance Gravel + Calcium Chloride*	m2	\$0.55
Curb and Gutter Replacement	m2	\$16.00
Tack Coat	m2	\$0.40
Gravel Shoulders (50mm Depth)	m2	\$1.35
Nominal Ditch Repairs	m2	\$0.50
FibreMat	m2	\$7.00
Single Surface Treatment	m2	\$5.00
Double Surface Treatment	m2	\$9.00
Triple Surface Treatment	m2	\$13.50
Improve Grades and Sightlines**	m2	\$85.00

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

** The extent of grade and/or sightline improvement requirements (if any) may vary widely from section-to-section. The unit cost shown is general, and any specific road section costs must be assessed at the project-level.

Urban HCB Resurfacing								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Milling					m2		\$3.00	\$3.00
Tack Coat					m2		\$0.40	\$0.40
HL4			50mm	0.12254/m2	m2		\$14.70	\$14.70
Contingencies	10%							\$1.81
							Total =	\$19.91

Semi-Urban or Rural HCB/LCB Resurfacing AADT>=1000								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Gravel Shoulders			50 mm		m2		\$1.35	\$1.35
Crack Sealing + Patching					m2		\$1.50	\$1.50
Milling			50mm		m2		\$3.00	\$3.00
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	10%							\$2.10
							Total =	\$23.05
Semi-Urban or Rural HCB/LCB Resurfacing 1000>AADT>=400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Crack Sealing + Patching					m2		\$1.50	\$1.50
Milling			50 mm		m2		\$3.00	\$3.00
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	10%							\$1.96
							Total =	\$21.56
Semi-Urban or Rural HCB Resurfacing AADT<400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Crack Sealing + Patching					m2		\$1.50	\$1.50
Asphalt Removal			50 mm		m2		\$5.00	\$5.00
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	10%							\$2.12
							Total =	\$23.32
Semi-Urban or Rural LCB Resurfacing AADT<400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Crack Sealing + Patching					m2		\$1.50	\$1.50
FibreMat					m2		\$7.00	\$7.00
Double Surface Treatment					m2		\$9.00	\$9.00
Contingencies	10%							\$1.75
							Total =	\$19.25

Urban HCB Rehabilitation								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Asphalt Removal			100 mm		m2		\$5.00	\$5.00
Curb and Gutter Replacement	15%				m2		\$16.00	\$2.40
Catch Basin/Manhole Adjustments					m2	30	\$2.00	\$2.00
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	15%							\$5.88
							Total =	\$45.08

30 structures per km at \$450 each

Semi-Urban or Rural HCB/LCB Rehabilitation AADT>=1000								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Granular A			150 mm		m2		\$9.36	\$9.36
HL8 Asphalt			50 mm		m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Contingencies	15%							\$6.43
					m2			
							Total =	\$49.29
Semi-Urban or Rural HCB/LCB Rehabilitation 1000>AADT>=400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Granular A			150 mm		m2		\$9.36	\$9.36
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Contingencies	15%							\$6.43
							Total =	\$49.29
Semi-Urban or Rural HCB Rehabilitation AADT<400								
Pulverizing					m2		\$1.00	\$1.00
Granular A			150 mm		m2		\$9.36	\$9.36
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	15%							\$6.02
							Total =	\$46.18
Semi-Urban or Rural LCB Rehabilitation AADT<400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Granular A			150 mm		m2		\$9.36	\$9.36
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	15%							\$6.02
							Total =	\$46.18

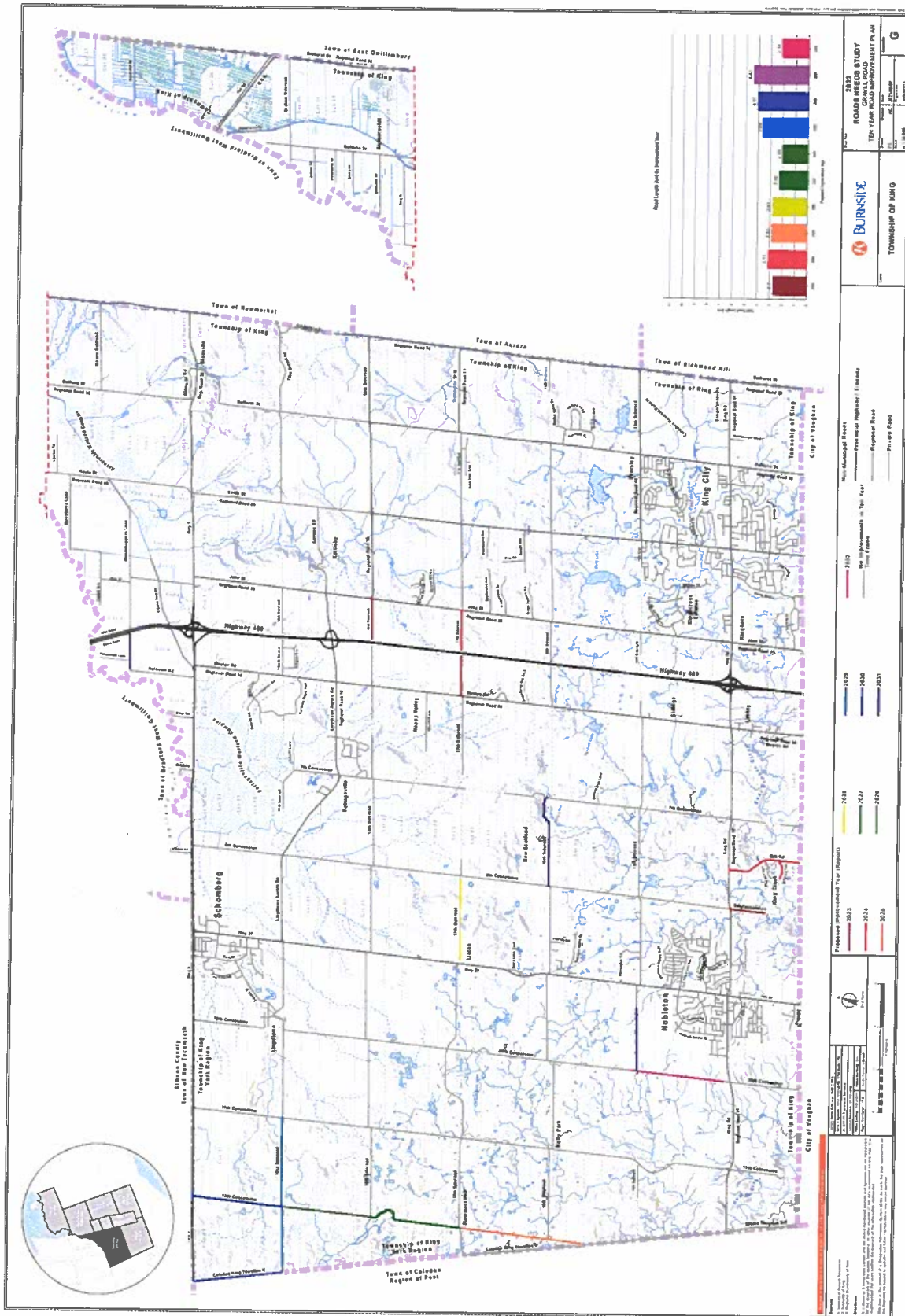
Urban HCB Reconstruction								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Asphalt Removal			100 mm		m2		\$5.00	\$5.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.29	\$7.29
Granular B			300 mm		m2		\$9.72	\$9.72
Curb and Gutter Replacement					m2		\$16.00	\$16.00
Catch Basin/Manhole Adjustments					m2	30	\$2.00	\$2.00
Drainage Improvements					m2		\$3.00	\$3.00
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies / Engineering	20%							\$15.91
Total =							\$95.47	

30 structures per km at \$450 each

Semi-Urban or Rural HCB/LCB Reconstruction AADT>=1000								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Asphalt Removal			100 mm		m2		\$5.00	\$5.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Contingencies	20%							\$12.48
							Total =	\$74.87
Semi-Urban or Rural HCB/LCB Reconstruction 1000>AADT>=400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Asphalt Removal			100 mm		m2		\$5.00	\$5.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Contingencies	20%							\$12.48
							Total =	\$74.87
Semi-Urban or Rural HCB/LCB Reconstruction AADT<400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Asphalt Removal			100 mm		m2		\$5.00	\$5.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Contingencies	20%							\$11.94
							Total =	\$71.63

Semi-Urban or Rural Gravel AADT>=400 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Earth Excavation			150 mm		m2		\$2.25	\$2.25
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt		6.7	50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Contingencies	5%							\$2.16
							Total =	\$45.33
Semi-Urban or Rural Gravel 400>AADT>200 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat							\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	5%							\$1.89
							Total =	\$39.61
Semi-Urban or Rural Gravel AADT<200 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat							\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Contingencies	5%							\$1.89
							Total =	\$39.61

Semi-Urban or Rural Gravel Rehabilitation AADT>400 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			150 mm		m2		\$2.25	\$2.25
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Contingencies	15%							\$6.63
							Total =	\$50.80
Semi-Urban or Rural Gravel Rehabilitation 400>AADT>200 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			150 mm		m2		\$2.25	\$2.25
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Gravel Shoulders			50 mm		m2		\$1.35	\$1.35
Contingencies	15%							\$6.42
							Total =	\$49.24
Semi-Urban or Rural Gravel Rehabilitation AADT<200 - To 2 HMA								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			150 mm		m2		\$2.25	\$2.25
Granular A			150 mm		m2		\$7.92	\$7.92
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Nominal Ditch Repairs					m2		\$0.50	\$0.50
Gravel Shoulders			50 mm		m2		\$1.35	\$1.35
Contingencies	15%							\$6.42
							Total =	\$49.24



Appendix G - Gravel Road 10 Year Conversion Plan

Map/Project ID	Name	Name From	Name To	Community	Boundary (Road)	ADIST	ADCE	PCE	PCE Class	Priority Road Rating (P/R)	Road Length (km)	Platform Width (m)	Surfaces Area (sqm)	Improvement Cost	Reconstruction Cost (Est.)	Comments	CRRI Category/Alt. Grades	
ORD-0018	17th Subdivided	Western Road	61st (East)	King Twp. (Rural)	No	126	19	48	Good Conditions	3	846	6.19	8258	153,520.00	540.00			
	ORD-0092	18th Subdivided	South and	King Twp. (Rural)	No	126	19	48	Good Conditions	3	846	6.19	8258	153,520.00	540.00			
	ORD-0218	18th Subdivided	West and	King Twp. (Rural)	No	62	8	82	Satisfactory Conditions	11	850	6.19	8318	156,120.00	540.00	Structures 1279		
											Total Length (km)							
											Total Length (km)	2.887						
ORD-0175	All Road	King - Vaughn Boundary	Empire Trail	King Twp. (Rural)	No	688	10	86	Good Conditions	5	422	6.00	7,30	5081	118,641.00	540.00		
	ORD-0092	Empire Trail	Northern Trail	King Twp. (Rural)	No	668	9	81	Good Conditions	8	276	6.00	7,30	2745	112,826.00	540.00		
	ORD-0144	Empire Trail	16th Road	King Twp. (Rural)	No	668	9	81	Good Conditions	15	800	6.00	7,30	5570	125,660.00	540.00	Structures 0071	
ORD-0152	16th Subdivided	16th Road	End (West)	King Twp. (Rural)	No	155	17	67	Good Conditions	11	877	6.19	8318	156,120.00	540.00			
	ORD-0144	16th Subdivided	End (West)	King Twp. (Rural)	No	155	17	67	Good Conditions	11	877	6.19	8318	156,120.00	540.00			
	ORD-0261	17th Subdivided	King Twp. (Rural)	No	243	8	87	Good Conditions	11	877	6.19	8318	156,120.00	540.00				
											Total Length (km)	3.168						
ORD-0162-1	12th Concession	12th N. of Caledon King Interchange	18th Subdivided	King Twp. (Rural)	No	317	8	84	Satisfactory Conditions	18	629	6.30	7,30	6059	135,320.00	540.00		
	ORD-0212	12th Concession	18th Subdivided	King Twp. (Rural)	No	317	8	84	Satisfactory Conditions	18	2079	6.00	7,30	14812	162,480.00	540.00		
	ORD-0212	12th Concession	18th Subdivided	King Twp. (Rural)	No	317	8	84	Satisfactory Conditions	18	2079	6.00	7,30	14812	162,480.00	540.00		
											Total Length (km)	3.882						
ORD-0185	8th Concession	8th Concession	Highway 77	King Twp. (Rural)	No	357	9	87	Good Conditions	12	2042	6.70	8,70	13081	167,240.00	540.00		
	ORD-0261-1	18th N. of Booth Caledon Road	2nd Concession	King Twp. (Rural)	No	437	9	84	Satisfactory Conditions	15	784	6.00	7,30	6773	132,260.00	540.00		
	ORD-0261-1	18th N. of Booth Caledon Road	2nd Concession	King Twp. (Rural)	No	437	9	84	Satisfactory Conditions	15	784	6.00	7,30	6773	132,260.00	540.00		
											Total Length (km)	3.894						
ORD-0187	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0202	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0202	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0202	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
											Total Length (km)	3.894						
ORD-0207	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	344	8	74	Satisfactory Conditions	24	2031	7.50	8,30	14607	164,280.00	540.00		Structures 0215
	ORD-0168	12th Concession	Caledon King Town Line North	King Twp. (Rural)	No	148	8	80	Satisfactory Conditions	18	1605	7.00	7,30	10087	1430,480.00	540.00		
	ORD-0209	11th Subdivided	11th Subdivided	King Twp. (Rural)	No	425	8	77	Satisfactory Conditions	21	2075	6.00	7,30	16148	1841,000.00	540.00		Structures 0214
											Total Length (km)	2.811						
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
	ORD-0261	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions	15	1604	7.20	8,20	13353	149,320.00	540.00		
ORD-0118	12th Concession	12th Subdivided	1st Subdivided	King Twp. (Rural)	No	127	9	78	Satisfactory Conditions									

Semi-Urban or Rural Gravel Reconstruction AADT>=400								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repair					m2		\$0.50	\$0.50
Contingencies	20%							\$11.68
							Total =	\$70.07
Semi-Urban or Rural Gravel Reconstruction 400>AADT>200								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repair					m2		\$0.50	\$0.50
Contingencies	20%							\$11.68
							Total =	\$70.07
Semi-Urban or Rural Gravel Reconstruction AADT<200								
Item	Amount	Width (m)	Depth (mm)	Conversion Factor	Unit	Quantity	Unit Cost	Cost/m2
Pulverizing					m2		\$1.00	\$1.00
Earth Excavation			450 mm		m2		\$6.75	\$6.75
Granular A			150 mm		m2		\$7.92	\$7.92
Granular B			300 mm		m2		\$9.72	\$9.72
HL8 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Tack Coat					m2		\$0.40	\$0.40
HL4 Asphalt			50 mm	0.1225t/m2	m2		\$14.70	\$14.70
Gravel Shoulders			100 mm		m2		\$2.70	\$2.70
Nominal Ditch Repair					m2		\$0.50	\$0.50
Contingencies	20%							\$11.68
							Total =	\$70.07



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Appendix G

Gravel Road 10-Year Road Improvement Plan

Appendix G

Modified ID	Name	Name From	Name To	Community	Boundary Road	ADOT ACIS Fee	Pd Class	Priority Rating	Need Within 1/2 Mi	Phase 1 (Within 1/2 Mi)	Barriers Area (sq ft)	Improvement Cost (\$/sq ft)	Backpack Cost (\$/sq ft)	Comments	OSM Cultural Affiliates	
ORSD-0018	17th Sideroad	Western Road	64th E and 10th Sideroad	Yes	No	186	19	85	Good Conditions	3	548	6.75	8.78	\$25,020.00	\$40.00	
ORSD-0052	8th Concession	South and 1st Street	10th Sideroad	Yes	No	186	19	85	Good Conditions	3	548	6.75	8.78	\$25,020.00	\$40.00	
ORSD-0238	18th Sideroad	1st Street	10th Sideroad	Yes	No	186	19	85	Satisfactory Conditions	11	550	8.25	9.74	\$116,880.00	\$40.00	Structure 2002
											Total Cost	\$725,688.88	\$40.00			
ORSD-0178	1st Road	10th Sideroad	18th Sideroad	Yes	No	668	10	98	Good Conditions	6	428	6.08	7.25	\$267,145.00	\$40.00	
ORSD-0002	10th Sideroad	1st Street	18th Sideroad	Yes	No	668	10	98	Good Conditions	6	428	6.08	7.25	\$267,145.00	\$40.00	
ORSD-0002	10th Sideroad	1st Street	18th Sideroad	Yes	No	668	10	98	Good Conditions	6	428	6.08	7.25	\$267,145.00	\$40.00	
ORSD-0144	10th Sideroad	1st Street	18th Sideroad	Yes	No	668	10	98	Good Conditions	6	428	6.08	7.25	\$267,145.00	\$40.00	Structure 0001
ORSD-0251	17th Sideroad	1st Street	10th Sideroad	Yes	No	668	10	98	Satisfactory Conditions	22	427	4.00	8.25	\$245,000.00	\$40.00	
											Total Cost	\$877,400.00	\$40.00			
ORSD-0182.2	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	248	6	17	Good Conditions	1	430	9.15	9.15	\$277,000.00	\$40.00	
ORSD-0012	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	248	6	17	Good Conditions	1	430	9.15	9.15	\$277,000.00	\$40.00	
ORSD-0185	17th Sideroad	1st Street	10th Sideroad	Yes	No	617	8	84	Satisfactory Conditions	18	425	8.25	7.25	\$376,860.00	\$40.00	
ORSD-0012	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	617	8	84	Satisfactory Conditions	18	425	8.25	7.25	\$376,860.00	\$40.00	
											Total Cost	\$725,688.88	\$40.00			
ORSD-0185	17th Sideroad	1st Street	10th Sideroad	Yes	No	337	8	87	Good Conditions	12	2642	8.25	8.25	\$227,010.00	\$40.00	
ORSD-0040.2	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	337	8	87	Satisfactory Conditions	15	1794	8.00	7.40	\$473,550.250.00	\$40.00	
											Total Cost	\$820,560.250.00	\$40.00			
ORSD-0147	17th Sideroad	1st Street	10th Sideroad	Yes	No	127	7	78	Satisfactory Conditions	15	1024	7.25	8.25	\$123,930.00	\$40.00	
ORSD-0002	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	127	7	78	Satisfactory Conditions	14	680	7.25	8.25	\$114,440.00	\$40.00	
ORSD-0002	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	127	7	78	Satisfactory Conditions	16	118	7.25	8.25	\$68,720.00	\$40.00	
											Total Cost	\$746,688.88	\$40.00			
ORSD-0002	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	334	8	74	Satisfactory Conditions	24	2023	7.25	8.25	\$188,571,200.00	\$40.00	Structure 0003
											Total Cost	\$674,888.88	\$40.00			
ORSD-0148	10th Sideroad	10th Concession	10th Concession	Yes	No	428	6	80	Satisfactory Conditions	15	1620	7.25	7.25	\$410,000.00	\$40.00	
ORSD-0209	10th Sideroad	10th Concession	10th Concession	Yes	No	428	6	80	Satisfactory Conditions	11	2075	8.00	7.25	\$1614,000.00	\$40.00	
											Total Cost	\$1,151,148.88	\$40.00		Structure 0214	
ORSD-0118	10th Sideroad	10th Concession	10th Concession	Yes	No	173	8	75	Satisfactory Conditions	19	2048	9.00	9.00	\$184,000.00	\$40.00	
ORSD-0239	10th Sideroad	10th Concession	10th Concession	Yes	No	173	8	75	Satisfactory Conditions	17	61	7.75	8.50	\$454,000.00	\$40.00	
ORSD-0077	10th Sideroad	10th Concession	10th Concession	Yes	No	173	8	75	Satisfactory Conditions	17	61	7.75	8.50	\$454,000.00	\$40.00	
											Total Cost	\$1,151,148.88	\$40.00			
ORSD-0013	18th Sideroad	0.5km E. of Highway 77	10th Concession	Yes	No	128	10	92	Good Conditions	8	1448	8.25	7.25	\$127,000.00	\$40.00	
ORSD-0180	10th Sideroad	10th Concession	10th Concession	Yes	No	444	9	45	Good Conditions	12	51	7.50	7.50	\$127,000.00	\$40.00	
ORSD-0273	10th Sideroad	10th Concession	10th Concession	Yes	No	444	9	45	Good Conditions	12	51	7.50	7.50	\$127,000.00	\$40.00	
											Total Cost	\$258,710.00	\$40.00			
ORSD-0248.2	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	428	6	78	Satisfactory Conditions	21	1324	8.00	7.25	\$652,000.00	\$40.00	
ORSD-0267	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	428	6	78	Satisfactory Conditions	13	185	8.50	7.90	\$58,880.00	\$40.00	
ORSD-0223.1	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	228	8	81	Satisfactory Conditions	12	127	8.00	7.25	\$11,780.00	\$40.00	
ORSD-0223.1	10th Concession	10th N. of 10th Sideroad	10th Sideroad	Yes	No	228	8	81	Satisfactory Conditions	12	127	8.00	7.25	\$11,780.00	\$40.00	



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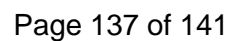
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Appendix H

Hard-Top Road 10-Year Road Improvement Plan

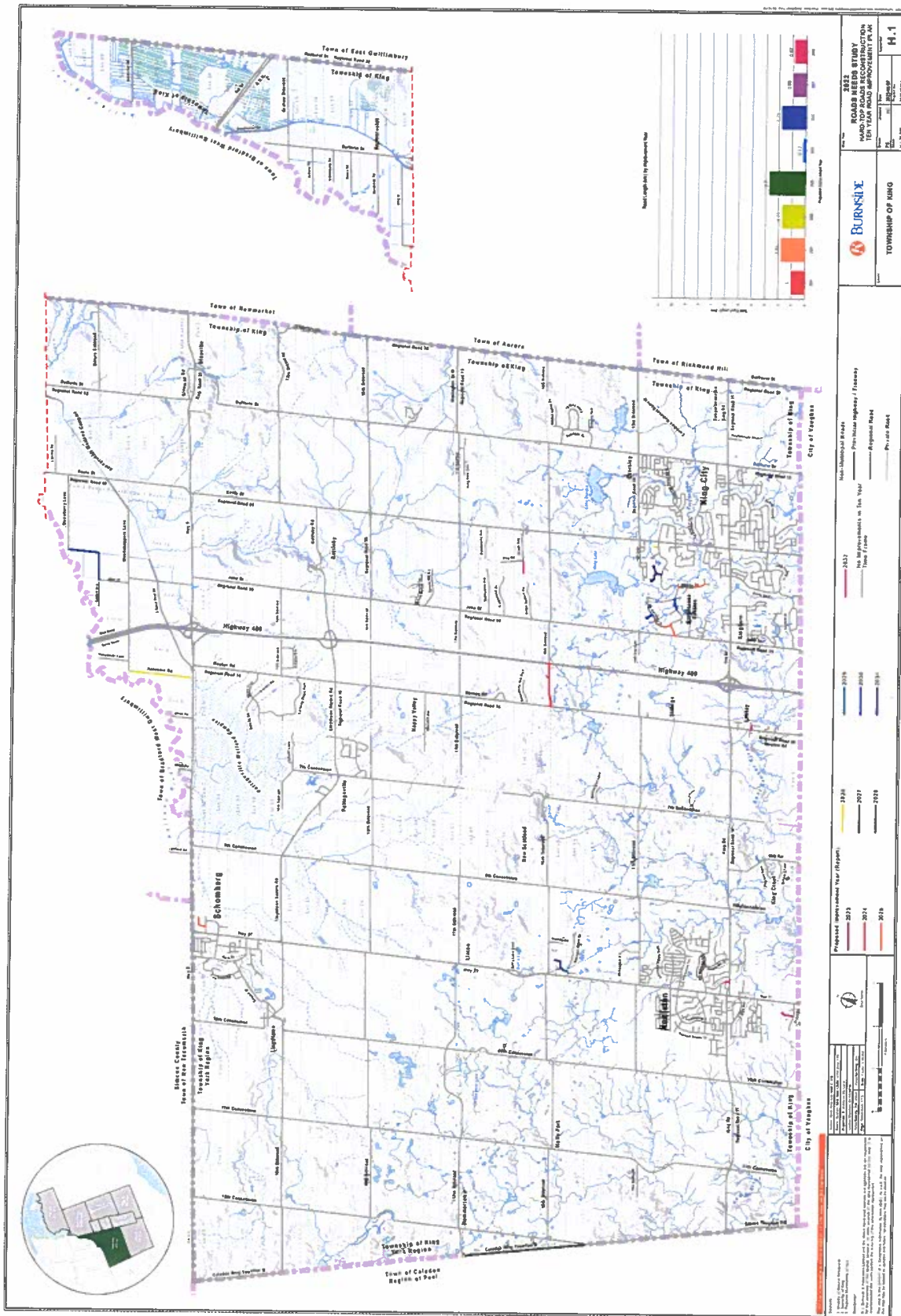
Appendix H

Managerial ID	Name	Name From	Community	Surface Material	AADT	PCI	PCI Class	Priority Rating (P/R)	Road Length (mi)	Road Width (ft)	Surface Area (sq ft)	Right-of-Way (ft)	Improvement Type	Improvement Cost	3225 Road Cost (\$/ft)
SRHD-0011	Main Street	Bay View Avenue	Schubert	High Class Bituminous	3600	92	Good Condition	13	141	10.00	1410	Urban	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75
SRHD-0012	Pennsylvania Road	18th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0013	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0014	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0015	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0016	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0017	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0018	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0019	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0020	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0021	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0022	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0023	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0024	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0025	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0026	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0027	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0028	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0029	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0030	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0031	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0032	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0033	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0034	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0035	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0036	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0037	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50	\$0.75	
SRHD-0038	18th St	17th St	High Class Bituminous	1715	81	Good Condition	12	143	5.00	947	Rural	Crack Sealing (Routine Maintenance)	\$1,037.50		



Appendix H - Hardtop Road Resurfacing 10 Year Plan

[illegible]



Shed No	Shed Name	Area (sq ft)	Year Built	Current Use	Future Use	Current Value	Future Value	Current Status	Notes
1	Shed 1	1000	2010	Storage	Storage	10000	10000	Good	
2	Shed 2	1200	2012	Storage	Storage	12000	12000	Good	
3	Shed 3	1500	2015	Storage	Storage	15000	15000	Good	
4	Shed 4	1800	2018	Storage	Storage	18000	18000	Good	
5	Shed 5	2000	2020	Storage	Storage	20000	20000	Good	
6	Shed 6	2200	2022	Storage	Storage	22000	22000	Good	
7	Shed 7	2500	2025	Storage	Storage	25000	25000	Good	
8	Shed 8	2800	2028	Storage	Storage	28000	28000	Good	
9	Shed 9	3000	2030	Storage	Storage	30000	30000	Good	
10	Shed 10	3200	2032	Storage	Storage	32000	32000	Good	
11	Shed 11	3500	2035	Storage	Storage	35000	35000	Good	
12	Shed 12	3800	2038	Storage	Storage	38000	38000	Good	
13	Shed 13	4000	2040	Storage	Storage	40000	40000	Good	
14	Shed 14	4200	2042	Storage	Storage	42000	42000	Good	
15	Shed 15	4500	2045	Storage	Storage	45000	45000	Good	
16	Shed 16	4800	2048	Storage	Storage	48000	48000	Good	
17	Shed 17	5000	2050	Storage	Storage	50000	50000	Good	
18	Shed 18	5200	2052	Storage	Storage	52000	52000	Good	
19	Shed 19	5500	2055	Storage	Storage	55000	55000	Good	
20	Shed 20	5800	2058	Storage	Storage	58000	58000	Good	
21	Shed 21	6000	2060	Storage	Storage	60000	60000	Good	
22	Shed 22	6200	2062	Storage	Storage	62000	62000	Good	
23	Shed 23	6500	2065	Storage	Storage	65000	65000	Good	
24	Shed 24	6800	2068	Storage	Storage	68000	68000	Good	
25	Shed 25	7000	2070	Storage	Storage	70000	70000	Good	
26	Shed 26	7200	2072	Storage	Storage	72000	72000	Good	
27	Shed 27	7500	2075	Storage	Storage	75000	75000	Good	
28	Shed 28	7800	2078	Storage	Storage	78000	78000	Good	
29	Shed 29	8000	2080	Storage	Storage	80000	80000	Good	
30	Shed 30	8200	2082	Storage	Storage	82000	82000	Good	
31	Shed 31	8500	2085	Storage	Storage	85000	85000	Good	
32	Shed 32	8800	2088	Storage	Storage	88000	88000	Good	
33	Shed 33	9000	2090	Storage	Storage	90000	90000	Good	
34	Shed 34	9200	2092	Storage	Storage	92000	92000	Good	
35	Shed 35	9500	2095	Storage	Storage	95000	95000	Good	
36	Shed 36	9800	2098	Storage	Storage	98000	98000	Good	
37	Shed 37	10000	2100	Storage	Storage	100000	100000	Good	
38	Shed 38	10200	2102	Storage	Storage	102000	102000	Good	
39	Shed 39	10500	2105	Storage	Storage	105000	105000	Good	
40	Shed 40	10800	2108	Storage	Storage	108000	108000	Good	
41	Shed 41	11000	2110	Storage	Storage	110000	110000	Good	
42	Shed 42	11200	2112	Storage	Storage	112000	112000	Good	
43	Shed 43	11500	2115	Storage	Storage	115000	115000	Good	
44	Shed 44	11800	2118	Storage	Storage	118000	118000	Good	
45	Shed 45	12000	2120	Storage	Storage	120000	120000	Good	
46	Shed 46	12200	2122	Storage	Storage	122000	122000	Good	
47	Shed 47	12500	2125	Storage	Storage	125000	125000	Good	
48	Shed 48	12800	2128	Storage	Storage	128000	128000	Good	
49	Shed 49	13000	2130	Storage	Storage	130000	130000	Good	
50	Shed 50	13200</							

