2016 Hard Surface Road Assessment and Ten-Year Capital Plan

Rural Municipality of St. Clements

Stantec

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Stantec

Sign-off Sheet

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Prepared by ______________________________
(signature)

Reviewed by ______________________________
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Approved by ______________________________
(signature)

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Executive Summary

Units and Conversion Rates

Linear Measure

Metre	m
Millimetre	mm
Kilometre	km

Area

Square metre	m^2
Hectare	ha

Volume

Cubic metre	m^3
Litre	L

Mass

Kilogram	kg
Tonne	t

Conversion Rates

50mm Limestone Sub-base	1 m^3 = 2.35 tonnes
20mm Limestone Base	1 m^3 = 2.24 tonnes
Hot Mix Asphalt Concrete	1 m^3 = 2.42 tonnes

1.0 INTRODUCTION

1.1 OVERVIEW

The intent of the *2016 Hard Surface Road Infrastructure Assessment and Ten-Year Capital Plan* report is to provide the R.M. of St. Clements with updated information as to the current state of the existing roadway infrastructure and to prioritize repairs of the existing roadway network for future consideration of roadwork budgets.

1.2 SCOPE OF WORK

The scope of work is limited to a visual assessment and a photographic log of the surface conditions of specific reaches of the road network, including hot mix asphalt and chip seal roads as identified by the R.M. of St. Clements. Cross-sections of specific roads included rural designs with varying pavement widths and pavement cross-sections.

The scope of the report includes:

- Complete detailed visual assessments of the existing road pavements.
- Complete a photographic log of existing conditions.
- Identify/confirm lengths and widths of pavement.
- Classification of the road section.
- Rating of the surface pavement.
- Identification of probable causes of distresses or failures of the road surface.
- Identification of immediate needs for repairs.
- Identification of projected future needs for repairs.
- Identification of 2016 costs for repairs.
- Projection of future rehabilitation needs.
- Projection of project costs to 2026 for consideration in future Capital Plan projects.

The assessments did not review or evaluate the drainage characteristics, nor was the assessment to include identification of pavement structure (i.e. borehole, past records). It is important to note that the condition ratings were based on visual assessments and that no geotechnical data was collected.

The capital plan identifies funding that will be required in each of the next 10 years to maintain or improve the existing road inventory and does not consider additional inventory over time with the construction of new commercial and industrial properties, nor does it consider the required drainage improvements for both existing and future conditions.

The Opinions of Probable Costs included in the plan are based on industry trends, discussions with qualified contractors and recent contract awards for similar work. Costs are expressed in 2016 dollars with a "Class C" level of accuracy. This Class "C" Opinion of Cost is then extended up to 2020 using a compound annual interest rate determined in future sections of this report.

The Class "C" Opinion of Probable Cost is defined as follows:

- ***Class "C"***
  Project cost estimate, prepared with limited site information, based on probable conditions affecting the project. It represents the summation of all identifiable project component costs. It is used for program planning, establishing a more specific definition of client needs, and to obtain approval in principle. In general terms, the Class "C" Opinion of Probable Cost envelope can range from 35% project overrun to 20% project underrun.

There are three other classes of Opinions of Cost commonly used during the design and implementation of road surface projects. Class D, B and A. Class "D" is used for preliminary estimates with little or no site specific information. Class B and A can be developed in the future as the preliminary and detailed designs are completed (not within the scope of this report). As more information is gained the cost estimates will become progressively more accurate in the following order:

- ***Class "D"***
  This is a preliminary/conceptual project cost estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. The overall cost may be derived from lump sum or unit costs for a similar project. It may be used to obtain approval in principle and for discussion purposes. In general terms, the Class "D" Opinion of Probable Cost envelope can range from 50% project overrun to 35% project underrun.
- ***Class "B" Qualified***
  Project cost estimate prepared after site investigations and studies have been completed and the concept designs developed to illustrate and define all major systems, including outline specifications of each. It is based on a project brief and preliminary design. In general terms, the Class "B" Opinion of Probable Cost envelope can range from 20% project overrun to 15% project underrun.
- ***Class "B" Control***
  Detailed project cost estimate based on quantity take-offs from final drawings and specifications. It is used to evaluate tenders or as a basis of cost control during construction. In general terms, the Class "A" Opinion of Probable Cost envelope can range from 10% project overrun to 7% underrun.

To improve the cost estimates to Class "B" or better would require additional engineering assessment, field surveys and other investigations and is beyond the scope of this report.

2.0 FLEXIBLE PAVEMENT DISTRESS FORMS

This section is a summary of the major flexible pavement distresses. Each distress discussion includes pictures if available, a description of the distress, why the distress is a problem and typical causes of the distress. The discussion of each distress form is organized alphabetically.

2.1 ALLIGATOR CRACKING

Description: A series of interconnection cracks caused by fatigue failure of asphalt concrete surface under repeated traffic loading.

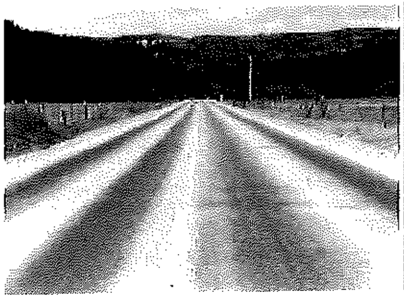
Problem: Allows moisture infiltration, increased roughness and decreased rideability, potential safety implications from debris.

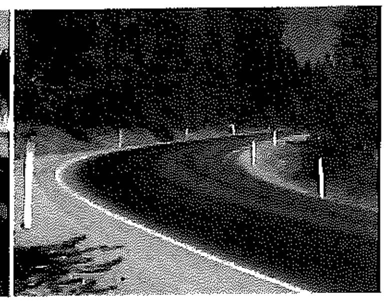
Possible Causes: Cracking begins at the bottom on the asphalt surface (base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel longitudinal cracks. After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 ft. (0.6m) on the longest side. Alligator cracking occurs only in areas subjected to repeated traffic loading, such as wheel paths. Alligator cracking is considered a major structural distress and is often accompanied by rutting and is highly anticipated to be a sub-grade mode of failure. This type of distress often will have two or three levels of severity often within one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately.

Repair: Strategies depend upon the severity and extent of the alligator cracking. However, once the cracking reaches the surface, the majority of the damage is complete and irreversible.

- *Low severity cracks (< 1/2 inch wide).* Crack seal to prevent (1) entry of moisture into the subgrade through the cracks and (2) further raveling of the crack edges. Hot mix asphalt can provide years of satisfactory service after developing small cracks if they are kept sealed.
- *High severity cracks (> 1/2 inch wide and cracks with raveled edges).* Remove and replace the cracked pavement layer with an asphalt overlay. There is a reasonably high probability that the underlying layers (i.e. stone and subgrade) are weak and may need full depth excavation for full support and long-term performance.

2.2 BLEEDING





Bleeding in wheelpaths **Bleeding in wheelpaths** **Bleeding from over-asphalting**

Description: A film of asphalt binder on the pavement surface. It usually creates a shiny, glass-like reflecting surface (as in the third photo) that can become quite sticky.

Problem: Loss of skid resistance when wet.

Possible Causes: Bleeding occurs when asphalt binder fills the aggregate voids during hot weather and then expands onto the pavement surface. Since bleeding is not reversible during cold weather, asphalt binder will accumulate on the pavement surface over time. This can be caused by one or a combination of the following:

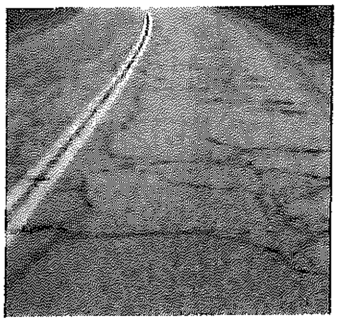
- Excessive asphalt binder in the hot mix asphalt (either due to mix design or manufacturing).
- Excessive application of asphalt binder during bituminous surface treatment application (as in the above figures).
- Low hot mix asphalt air void content (e.g., not enough room for the asphalt to expand into during hot weather).

Repair: The following repair measures may eliminate or reduce the asphalt binder film on the pavement's surface but may not correct the underlying problem that caused the bleeding:

- Minor bleeding can often be corrected by applying coarse sand to blot up the excess asphalt binder.
- Major bleeding can be corrected by cutting off excess asphalt with a motor grader or removing it with a heater planer. If the resulting surface is excessively rough, resurfacing may be necessary.

Flexible Pavement Distress Forms
November 1, 2016

2.3 BLOCK CRACKING



Description: Interconnected cracks that divide the pavement up into rectangular pieces. Blocks range in size from approximately 0.1 m^2 (1 ft^2) to 9 m^2 (100 ft^2). Larger blocks are generally classified as longitudinal and transverse cracking. Block cracking normally occurs over a large portion of pavement area but sometimes will occur only in non-traffic areas.

Problem: Allows moisture infiltration, increased roughness and decreased rideability.

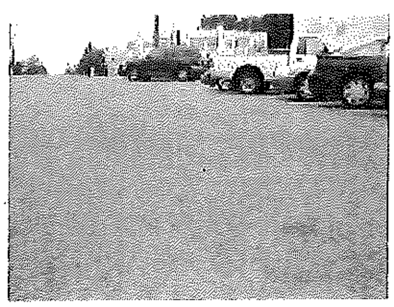
Possible Causes: hot mix asphalt shrinkage and daily temperature cycling. Typically caused by an inability of asphalt binder to expand and contract with temperature cycles because of:

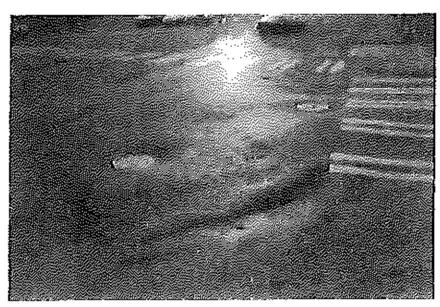
- Asphalt binder aging.
- Poor choice of asphalt binder in the mix design.

Repair: Strategies depend upon the severity and extent of the block cracking:

- *Low severity cracks (< 1/2 inch wide).* Crack seal to prevent (1) entry of moisture into the subgrade through the cracks and (2) further raveling of the crack edges. Hot mix asphalt can provide years of satisfactory service after developing small cracks if they are kept sealed.
- *High severity cracks (> 1/2 inch wide and cracks with raveled edges).* Remove and replace the cracked pavement layer with an asphalt overlay.

2.4 CORRUGATION AND SHOVING





Description: A form of plastic movement typified by ripples (corrugation) or an abrupt wave (shoving) across the pavement surface. The distortion is perpendicular to the traffic direction. Usually occurs at points where traffic starts and stops (corrugation) or areas where hot mix asphalt abuts a rigid object (shoving).

Problem: Roughness affected, rideability decreased

Possible Causes: Usually caused by traffic action (starting and stopping) combined with:

- An unstable (i.e. low stiffness) hot mix asphalt layer (caused by mix contamination, poor mix design, poor hot mix asphalt manufacturing, or lack of aeration of liquid asphalt emulsions)
- Excessive moisture in the subgrade

Repair: A heavily corrugated or shoved pavement should be investigated to determine the root cause of failure. Repair strategies generally fall into one of two categories:

- *Small, localized areas of corrugation or shoving.* Remove the distorted pavement and asphalt patch.
- *Large corrugated or shoved areas indicative of general hot mix asphalt failure.* Remove the damaged pavement and asphalt overlay.

2.5 DEPRESSION

Depression in left lane and shoulder

Description: Localized pavement surface areas with slightly lower elevations than the surrounding pavement. Depressions are very noticeable after a rain when they fill with water.

Problem: Roughness, depressions filled with substantial water can cause vehicle hydroplaning leading to safety concerns for the travelling public

Possible Causes: Frost heave or subgrade settlement resulting from inadequate compaction during construction.

Repair: By definition, depressions are small localized areas. A pavement depression should be investigated to determine the root cause of failure (i.e., subgrade settlement or frost heave). Depressions should be repaired by removing the affected pavement then digging out and replacing the area of poor subgrade. Asphalt patch over the repaired subgrade.

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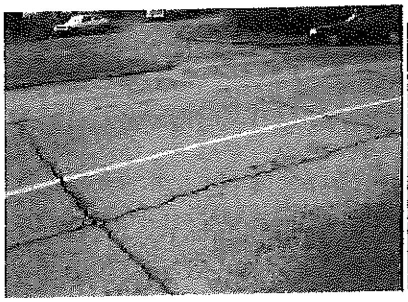
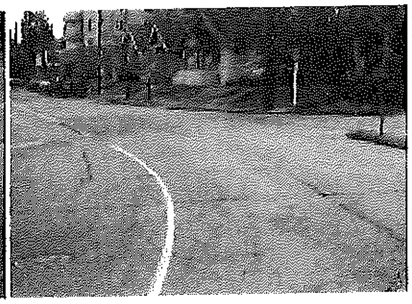
2.6 JOINT REFLECTION CRACKING



Joint reflection cracking on an arterial



Joint reflection cracking on an arterial

Joint reflection cracking close-up

Description: Cracks in a flexible overlay of a rigid pavement. The cracks occur directly over the underlying rigid pavement joints. Joint reflection cracking does not include reflection cracks that occur away from an underlying joint or from any other type of base (e.g., cement or lime stabilized).

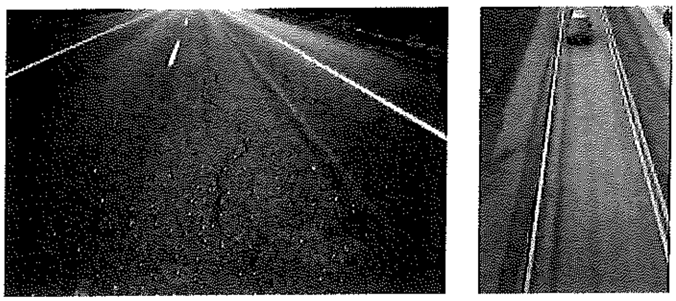
Problem: Allows moisture infiltration, decreased rideability

Possible Causes: Movement of the Portland cement concrete slab beneath the hot mix asphalt surface because of thermal and moisture changes. Generally not load initiated, however loading can hasten deterioration.

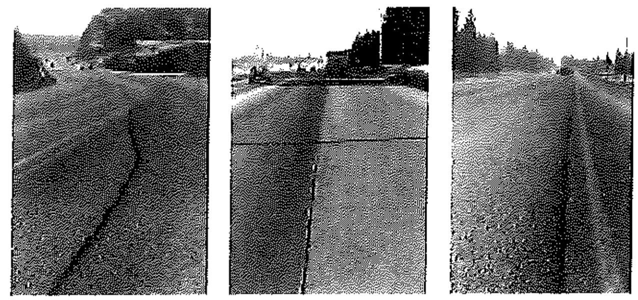
Repair: Strategies depend upon the severity and extent of the cracking:

- *Low severity cracks (< 1/2 inch wide and infrequent cracks).* Crack seal to prevent (1) entry of moisture into the subgrade through the cracks and (2) further raveling of the crack edges. In general, rigid pavement joints will eventually reflect through a hot mix asphalt overlay without proper surface preparation.
- *High severity cracks (> 1/2 inch wide and numerous cracks).* Remove and replace the cracked pavement layer with an asphalt overlay.

2.7 LONGITUDINAL CRACKING



Longitudinal cracking as the onset of fatigue cracking



Longitudinal cracking from poor joint construction

Description: Cracks parallel to the pavement's centerline or laydown direction. Usually a type of fatigue cracking.

Problem: Allows moisture infiltration, decreased rideability, indicates possible onset of alligator cracking and structural failure.

Possible Causes:

- Poor joint construction or location. Joints are generally the least dense areas of a pavement. Therefore, they should be constructed outside of the wheelpath so that they are only infrequently loaded. Joints in the wheelpath like those shown in third through fifth figures above, will general fail prematurely.
- A reflective crack from an underlying layer (not including joint reflection cracking).
- Hot mix asphalt fatigue (indicates the onset of future alligator cracking).
- Top down cracking.

Repair: Strategies depend upon the severity and extent of the cracking:

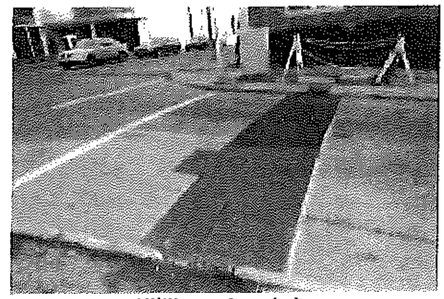
- *Low severity cracks (< 1/2 inch wide and infrequent cracks)*. Crack Seal to prevent (1) entry of moisture into the subgrade through the cracks and (2) further raveling of the crack edges. Hot mix asphalt can provide years of satisfactory service after developing small cracks if they are kept sealed.

High severity cracks (> 1/2 inch wide and numerous cracks). Remove and replace the cracked pavement layer with an asphalt overlay.

2.8 PATCHING


Failing patch


Patch over localized distress


Utility cut patch

Description: An area of pavement that has been replaced with new material to repair the existing pavement. A patch is considered a defect no matter how well it performs.

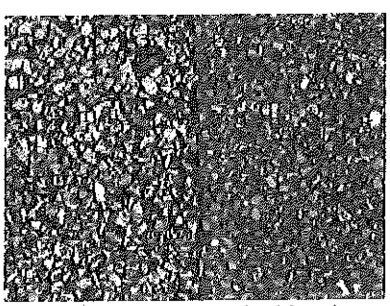
Problem: Roughness

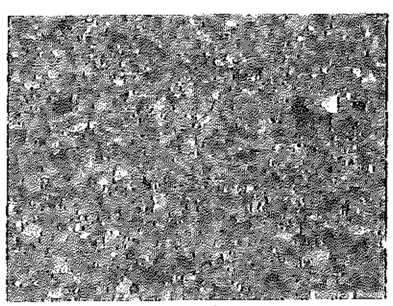
Possible Causes:

- Previous localized pavement deterioration that has been removed and patched.
- Utility cuts.

Repair: Patches are themselves a repair action. The only way they can be removed from a pavement's surface is by either a structural or non-structural overlay.

2.9 POLISHED AGGREGATE


SMAs at the NCAT test track


5 years of wear

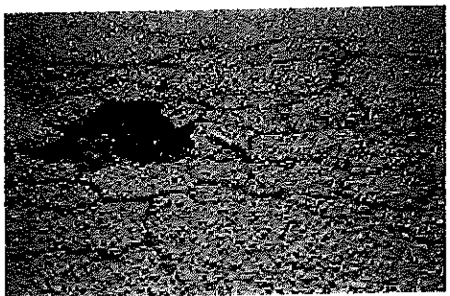
Description: Areas of hot mix asphalt pavement where the portion of aggregate extending above the asphalt binder is either very small or there are no rough or angular aggregate particles.

Problem: Decreased skid resistance.

Possible Causes: Repeated traffic applications. Generally, as a pavement ages the protruding rough, angular particles become polished. This can occur quicker if the aggregate is susceptible to abrasion or subject to excessive studded tire wear.

Repair: Apply a skid-resistant slurry seal, bituminous surface treatment or asphalt overlay.

2.10 POTHOLES



Pothole from fatigue cracking

Developing pothole

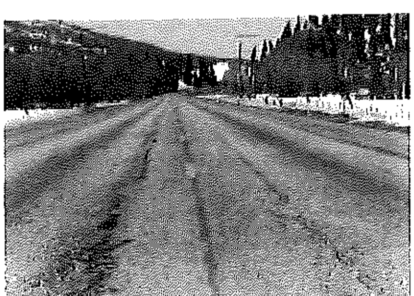
Description: Small, bowl-shaped depressions in the pavement surface that penetrate all the way through the hot mix asphalt layer down to the base course. They generally have sharp edges and vertical sides near the top of the hole. Potholes are most likely to occur on roads with thin hot mix asphalt surfaces (25 to 50 mm (1 to 2 inches)) and seldom occur on roads with 100 mm (4 inch) or deeper hot mix asphalt surfaces.

Problem: Roughness (serious vehicular damage can result from driving across potholes at higher speeds), moisture infiltration.

Possible Causes: Generally, potholes are the end result of alligator cracking. As alligator cracking becomes severe, the interconnected cracks create small chunks of pavement, which can be dislodged as vehicles drive over them due to friction of a tire, hydraulic action related to tire action or frost action in cold climates. The remaining hole after the pavement chunk is dislodged is called a pothole.

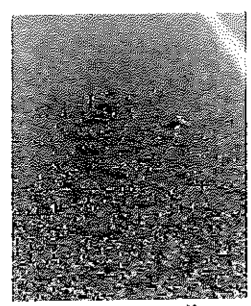
Repair: In accordance with patching techniques.

2.11 RAVELING



Raveling due to low density

Raveling from snowplow operations



From segregation

Description: The progressive disintegration of a hot mix asphalt layer from the surface downward as a result of the dislodgement of aggregate particles.

Problem: Loose debris on the pavement, roughness, water collecting in the raveled locations resulting in vehicle hydroplaning, loss of skid resistance.

Possible Causes: Several including:

- Loss of bond between aggregate particles and the asphalt binder as a result of:
  - A dust coating on the aggregate particles that forces the asphalt binder to bond with the dust rather than the aggregate
  - Aggregate segregation. If fine particles are missing from the aggregate matrix, then the asphalt binder is only able to bind the remaining coarse particles at their relatively few contact points.
  - Inadequate compaction during construction. High density is required to develop sufficient cohesion within the hot mix asphalt. The third figure above shows a road suffering from raveling due to inadequate compaction caused by cold weather paving.
- Mechanical dislodging by certain types of traffic (studded tires, snowplow blades or tracked vehicles). The third photo above show raveling most likely caused by snow plows.

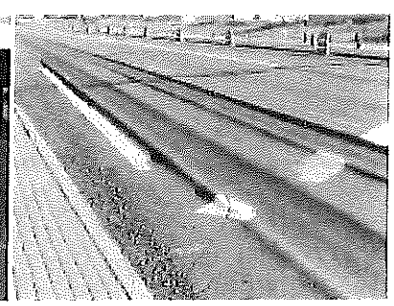
Repair: A raveled pavement should be investigated to determine the root cause of failure. Repair strategies generally fall into one of two categories:

- Small, localized areas of raveling. Remove the raveled pavement and patch.
- Large raveled areas indicative of general hot mix asphalt failure. Remove the damaged pavement and overlay.

2.12 RUTTING

Mix rutting

Mix rutting



Rutting from mix instability

Description: Surface depression in the wheelpath. Pavement uplift (shearing) may occur along the sides of the rut. Ruts are particularly evident after a rain when they are filled with water. There are two basic types of rutting: mix rutting and subgrade rutting. Mix rutting occurs when the subgrade does not rut yet the pavement surface exhibits wheelpath depressions as a result of compaction/mix design problems. Subgrade rutting occurs when the subgrade exhibits wheelpath depressions due to loading. In this case, the pavement settles into the subgrade ruts causing surface depressions in the wheelpath.

Problem: Ruts filled with water can cause vehicle hydroplaning, can be hazardous because ruts tend to pull a vehicle towards the rut path as it is steered across the rut.

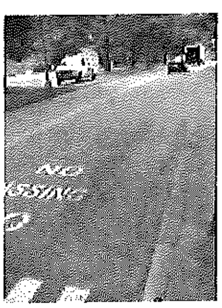
Possible Causes: Permanent deformation in any of a pavement's layers or subgrade usually caused by consolidation or lateral movement of the materials due to traffic loading. Specific causes of rutting can be:

- Insufficient compaction of hot mix asphalt layers during construction. If it is not compacted enough initially, hot mix asphalt pavement may continue to densify under traffic loads.
- Subgrade rutting (e.g., as a result of inadequate pavement structure).
- Improper mix design or manufacture (e.g., excessively high asphalt content, excessive mineral filler, insufficient amount of angular aggregate particles).

Ruts caused by studded tire wear present the same problem as the ruts described here, but they are actually a result of mechanical dislodging due to wear and not pavement deformation.

Repair: A heavily rutted pavement should be investigated to determine the root cause of failure (e.g. insufficient compaction, subgrade rutting, poor mix design or studded tire wear). Slight ruts (< 1/3 inch deep) can generally be left untreated. Pavement with deeper ruts should be leveled and overlaid.

2.13 SLIPPAGE CRACKING



Slippage cracking at a bus stop

Description: Crescent or half-moon shaped cracks generally having two ends pointed into the direction of traffic.

Problem: Allows moisture infiltration, roughness.

Possible Causes: Braking or turning wheels causes the pavement surface to slide and deform. The resulting sliding and deformation is caused by a low-strength surface mix or poor bonding between the surface hot mix asphalt layer and the next underlying layer in the pavement structure.

Repair: Removal and replacement of affected area.

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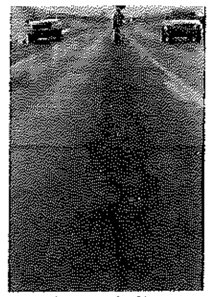
2.14 STRIPPING


Core hole showing stripping at the bottom


Stripping at bottom of hole


Fatigue failure from stripping

Description: The loss of bond between aggregates and asphalt binder that typically begins at the bottom of the hot mix asphalt layer and progresses upward. When stripping begins at the surface and progresses downward it is usually called raveling. The third photo shows the surface effects of underlying stripping.

Problem: Decreased structural support, rutting, shoving/corrugations, raveling, or cracking (alligator and longitudinal).

Possible Causes: Bottom-up stripping is very difficult to recognize because it manifests itself on the pavement surface as other forms of distress including rutting, shoving/corrugations, raveling, or cracking. Typically, a core must be taken to positively identify stripping as a pavement distress.

- Poor aggregate surface chemistry.
- Water in the hot mix asphalt causing moisture damage.
- Overlays over an existing open graded surface course. Based on past experiences, these overlays will tend to strip.

Repair: A stripped pavement should be investigated to determine the root cause of failure (i.e., how did the moisture get in?). Generally, the stripped pavement needs to be removed and replaced after correction of any subsurface drainage issues.

Flexible Pavement Distress Forms
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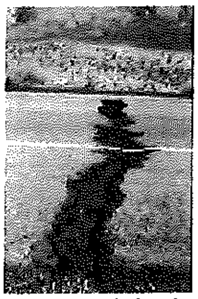
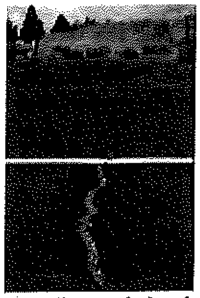
2.15 TRANSVERSE (THERMAL) CRACKING


Large patched thermal crack


Smaller patched thermal crack


Small thermal crack

Description: Cracks perpendicular to the pavement's centerline or laydown direction. Usually a type of thermal cracking.

Problem: Allows moisture infiltration, roughness.

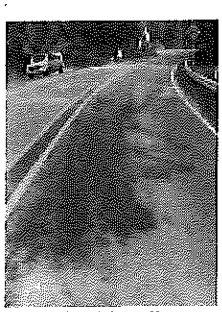
Possible Causes: Several including:

- Shrinkage of the hot mix asphalt surface due to low temperatures or asphalt binder hardening.
- Reflective crack caused by cracks beneath the surface hot mix asphalt layer.
- Top down cracking.

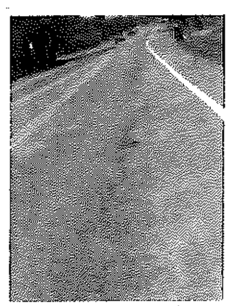
Repair: Strategies depend upon the severity and extent of the cracking:

- *Low severity cracks (< 1/2 inch wide and infrequent cracks).* Crack seal / reflective crack maintenance to prevent (1) entry of moisture into the subgrade through the cracks and (2) further raveling of the crack edges. Hot mix asphalt can provide years of satisfactory service after developing small cracks if they are kept sealed.
- *High severity cracks (> 1/2 inch wide and numerous cracks).* Remove and replace the cracked pavement layer with an overlay.

2.16 WATER BLEEDING AND PUMPING


Water bleeding


Water bleeding up close


CTB base pumping through HMA cracks

Description: Water bleeding (left two photos) occurs when water seeps out of joints or cracks or through an excessively porous hot mix asphalt layer. Pumping (right-most photo) occurs when water and fine material is ejected from underlying layers through cracks in the hot mix asphalt layer under moving loads.

Problem: Decreased skid resistance, an indication of high pavement porosity (water bleeding), decreased structural support (pumping).

Possible Causes: Several including:

- Porous pavement as a result of inadequate compaction during construction or poor mix design.
- High water table.
- Poor drainage.

Repair: Water bleeding or pumping should be investigated to determine the root cause. If the problem is a high water table or poor drainage, subgrade drainage should be improved. If the problem is a porous mix (in the case of water bleeding) a fog seal or slurry seal may be applied to limit water infiltration.

3.0 UNITS OF MEASUREMENT AND CONVERSION RATES

The units of measurement and conversion rates contained within this report are metric and metric usage is based upon SI units in accordance with CSA Standard CAN/CSA-Z234.1 Canadian Metric Practice Guide. In this report, all SI units are abbreviated in accordance with the metric units and abbreviations and a list of abbreviations and conversion rates used in this report are listed above.

4.0 ASSESSMENT CRITERIA

4.1 GENERAL

The hard surface roads to be included in this study were identified by the R.M. of St. Clements. Appendix "A" consists of various maps of the R.M. of St. Clements, indicating which streets were included within the scope of this report as well as a list of the affected streets including assessed length, road category and general location.

A detailed visual assessment of each road was performed. Appendix "B" includes the field notes prepared at the time of the visual inspections. Information gathered upon inspection included overall condition, observable distress, severity and extent of deterioration and dimensions of the assessed street. A photographic log was also kept and is included in Appendix "E".

4.2 ROAD CLASSIFICATIONS

In order to assist the R.M. of St. Clements in determining a repair strategy, each road was first classified as arterial, collector or local. These classifications were guided by the Transportation Association of Canada, Geometric Design Guide for Canadian Roads (1999).

4.2.1 Arterial Roads

Arterial roads represent the major thoroughfares in St. Clements. Land access is a secondary consideration to traffic movement. Flow is generally uninterrupted except at major intersections and running speeds range from 60 to 100 km/h. Traffic consists of all types including heavy trucks. In St. Clements arterials typically consisted of former provincial roads with rural freeway cross sections.

4.2.2 Collector Roads

Collectors serve as the link between local and arterial roads. Traffic flow is typically of equal importance to land access. Traffic generally consists of light and mixed truck traffic with running speeds ranging from 50 to 90km/h. In this study, roads were considered to be collector based on the number and type of connections and running speeds. Collector roads in St. Clements consisted mainly of mile roads with a typical rural cross-section.

4.2.3 Local Roads

Locals in St. Clements consist of rural residential roads providing access to multiple individual lots and connections to other local or collector roads. Usage is generally limited to low volume, light traffic with running speed of 50 km/h or less. The locals involved in this study consisted of typical rural cross sections.

4.3 ROAD SURFACE TYPES

4.3.1 Chip Seal Surface

A Chip Seal Surface (CSS) is a pavement surface treatment that combines a layer(s) of asphalt with a layer(s) of fine aggregate. Chip seals are typically used on rural roads carrying lower traffic volumes, lower vehicle weights and the process is often referred to as "asphaltic surface treatment". It can keep good pavement in good condition by sealing out water, but provides no structural strength and will only repair minor cracks. While the small stones used as surface yield a relatively even surface without the edges of patches, it also results in a very rough surface that leads to significantly louder rolling noises of automobile wheels. Although chip seal is an effective low cost way to repair the road and eliminate dust, its major drawback is the intolerance of heavy volumes and heavy trucks which cause premature failures of the pavement. When properly implements, the life of chip-seal surface roads can be maintained for 5-7 years, but can extend to 10 years depending on site conditions and traffic loadings.

4.3.2 Hot Mix Asphalt

A hot mix asphalt pavement (HMA) refers to the bound layers of a flexible pavement structure. For most applications, asphalt concrete is placed as HMA, which is a mixture of coarse and fine aggregate, and asphalt binder.

HMA is mixed, placed and compacted at elevated temperatures, hence the name. Asphaltic pavements can also be placed at ambient air temperatures, but HMA is the primary placement method for major roads and highways. The HMA is typically applied with a total thickness of 75 – 150mm, with the lower layers acting to support the top layer, known as the surface or friction course. The aggregates in the lower layers are chosen to prevent rutting and failure, while the aggregates in the surface course are chosen for their friction properties and durability.

4.4 RATING AND ASSESSMENT METHODOLOGY

The rating methodology used in this report was based on the Pavement Surface Evaluation and Rating (PASER) system devised by the Transportation Information Center of the University of Wisconsin-Madison. This system utilizes a 10 level scale to rate individual road segments. The rating score is based on quantifiable characteristics of the road surface, namely the type, severity and extent of deterioration. After identifying and analyzing the surface characteristics, the likely causes of deterioration were deduced and the extent of needed repairs determined. Individual repair options were selected based on the most cost effective method of raising the rating score from its current condition to a score of 6 or higher. As explained in Table 1 below, a rating of 6 represents good overall condition. Signs of aging are present however the road is still structurally sound.

Assessment criteria
November 1, 2016

It is important to note that the rating scale represents the overall average condition of each road segment. This means that very small, localized areas of varying surface conditions within a given segment, will not greatly affect the overall road rating. In addition to averaging *within* road segments, the PASER system also compares road segments relative to each other. No road segments will be exactly the same therefore some road segments with identical scores may exhibit varying types and severities of deterioration, however the overall condition will be similar. By rating the road segments in proper relative order, we can ensure that a lower rating will always indicate a poorer overall condition. The following table demonstrates a simplified breakdown of rating value and typical associated visible surface deterioration, overall condition and possible repair strategies.

Table 1 PASER Rating Chart

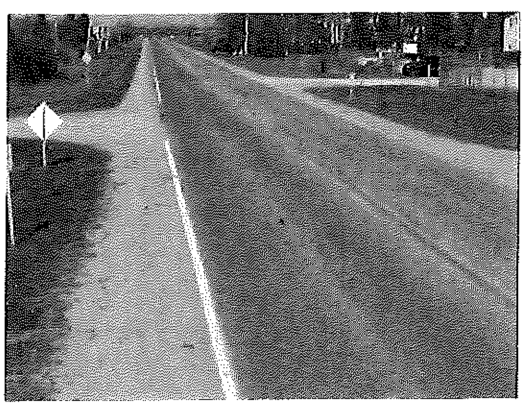
Road Score	Visible Distress	General Condition / Treatment Measures
10. Excellent	None	New Construction
9. Excellent	None	Recent overlay, like new.
8. Very Good	No longitudinal cracks, except reflection of paving joints Occasional transverse cracks, widely spaced (12m or greater).	Recent sealcoat or new road mix. Little or no maintenance required.
7. Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open 5mm) due to reflection or paving joints. Transverse cracks (open 5mm) spaced 3m or more apart, little or slight crack raveling No patching or very few patches in excellent condition	First signs of aging. Maintain with routine crack filling.
6. Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open 5-12mm) due to reflection of paving joints Transverse cracking (open 5-12mm) some spaced less than 3m apart. First signs of block cracking. Slight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging, sound structural condition. Could extend life with sealcoat or chip seal.
5. Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open 12mm) show first signs of slight raveling and secondary cracking. Firs signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface.	Surface aging, sound structural condition. Needs sealcoat or non-structural overlay.

Assessment criteria
November 1, 2016

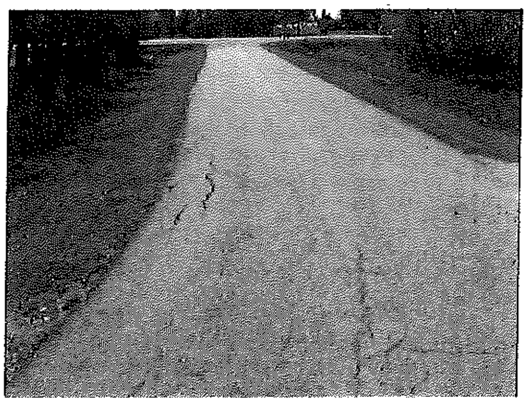
	Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	
4.Fair	Severe surface raveling. Multiple longitudinal and transverse cracks with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (12mm deep or less).	Significant aging and first signs of need for strengthening. Would benefit from recycling or overlay.
3. Poor	Closely spaced longitudinal and transverse cracks often showing reveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (25mm to 50mm deep). Occasional potholes.	Needs patching and major overlay or complete recycling.
2. Very Poor	Alligator cracking (over 25% of surface). Severe distortions (over 50mm deep). Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair.
1. Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

Asphalt PASER Manual, University of Wisconsin-Madison, Transportation Information Center, 2002

For purposes of demonstration, the following photos identify various classes of visual observations for the asphalt pavement distresses:



Road Score 9 – The asphalt pavement is smooth and generally free of distresses. Minor maintenance in the form of routing and sealing may be required, but no major work is currently required or projected within the next 10-years.



Road Score 5 – The asphalt pavement is moderate and the pavement surface is weathered. The pavement shows signs of structural damage. Immediate needs for the pavement may be continued maintenance in the form of routing and sealing and occasional localized patching. However, it is anticipated that the pavement will require some form of rehabilitation in the coming years.

Road Score 1 – The pavement surface is cracked and disintegrated. Structural damage is widespread. The ride has deteriorated to the point where traffic operations are affected as rideability is non-existent. Reconstruction is required as it is most probable that the pavement has exceeded its useful life and experiences sub-grade failure.

5.0 ROAD SURFACE ASSESSMENT

The following table contains all roads included in the assessment, organized alphabetically and by classification and includes surface type, road score and the estimated 2016 repair cost. The complete 10-Year Capital Plan can be found in Appendix "D".

Table 2 Road List

Road Component	Surface Type	Road Score	Estimated 2016 Cost
ARTERIAL			
Garson Rd.	Hot Mix Asphalt	6	$ 117,359.38
Grand Beach Rd	Chip seal	5	$ 98,087.50
Kirkness Rd	Chip seal	5	$ 1,513,187.50
COLLECTOR			
Church Rd.	Chip seal	3	$ 385,612.50
Donald Rd	Chip seal	2	$ 104,500.00
Dunning Rd - Henderson to Railway	Chip seal	2	$ 334,900.00
Dunning Rd - Railway to Rebeck	Hot Mix Asphalt	6	$ 87,562.50
Dunning Rd -Rebeck to PR202	Chip seal	7	$ 144,356.25
Dunning Rd East	Chip seal	8	$ -
Rebeck Rd - 202 to Ludwick	Hot Mix Asphalt	7	$ 18,000.00
Rebeck Rd. - Ludwick to Donald	Hot Mix Asphalt	4	$ 445,000.00
Rebeck Rd. - Donald to 400m North of Dunning	Chip seal	3	$ 436,875.00
Rebeck Rd. -400m North of Dunning to Dunning	Hot Mix Asphalt	6	$ 66,812.50
Rebeck Rd.-Dunning to McKay	Hot Mix Asphalt	7	$ -
Rebeck Rd -McKay to Coronation	Chip seal	6	$ 49,750.00
McKay Rd	Chip seal	2	$ 617,081.25
LOCAL			
Bison	Hot Mix Asphalt	7	$ 23,490.63
Boardwalk	Hot Mix Asphalt	9	$ -
Brickway	Chip seal	4	$ 9,100.00
Church Rd. East Selkirk	Chip seal	3	$ 439,125.00
Coronation Rd.	Chip seal	3	$ 291,387.50
Danko Dr.	Hot Mix Asphalt	8	$ -
Debra Ave.	Hot Mix Asphalt	6	$ 33,637.50
Ferry Rd	Chip seal	7	$ 191,750.00
Frank St	Chip seal	5	$ 422,237.50
Leah Ave.	Chip seal	4	$ 195,750.00

Marvin Gardens Rd	Hot Mix Asphalt	8	$ 900.00
Miller Creek Rd.	Hot Mix Asphalt	9	$ -
Nanton Rd.	Hot Mix Asphalt	8	$ -
Nicholas St	Chip seal	6	$ 283,562.50
Old Henderson Hwy.	Chip seal	5	$ 115,200.00
Old River Road	Hot Mix Asphalt	8	$ -
Parkview Ave	Chip seal	3	$ 199,400.00
Park Place	Chip seal	6	$ 33,000.00
Quarry Rd	Chip seal	6	$ 103,500.00
Readgan Dr.	Hot Mix Asphalt	9	$ -
Recreation Centre Rd -PR 212 to Strathcona Road	Hot Mix Asphalt	8	$ -
Rockhaven Rd.	Hot Mix Asphalt	5	$ 191,250.00
Roman Dr.	Chip seal	2	$ 146,000.00
Strathcona Rd.	Hot Mix Asphalt	4	$ 302,400.00
Wachal Dr.	Chip seal	6	$ 76,425.00

The above streets were further classified into near-, mid- and long-term priorities according to their rating score (indicative of overall condition), projected year of repair and road classification.

A road with a lower rating score would typically require maintenance/repair sooner than roads with higher scores. Note that this holds true except in cases where an individual road with a high overall score, has very limited areas of localized areas of deterioration which would need repair in the near future. This would result in a high scoring road being given a near-term priority. For the purposes of this report, near-term priorities are expected to need repairs within three years (2017-2019), mid-term priorities could expect repairs in the next 4-7 years (2020 -2022) and long-term priorities in the next 7-10 years (2023-2026). In cases where an individual street bridges the cut off between two categories the nearer priority is used.

In addition to the basic need for repair, priority ranking is also influenced by road category. Typically, arterial, collector and local roads are characterized respectively by decreasing traffic volumes and running speeds, increased traffic flow interruptions and an overall decrease in traffic movement. One must also take into account that driver's tend to expect a higher level of service from arterial and collector roads as compared to locals. Subsequently, arterial roads warrant a higher priority than collector and subsequently local streets. For example, a collector road with a similar or even slightly higher rating score as a comparable local street will warrant a higher priority for repair. In cases where streets within the same category have been given the same score, the one that services more residents and through traffic is given priority.

In general, the arterial roads scored in the good to high-fair range. They consist of former provincial roads with a typical rural highway cross-section. The subgrade material appears to be structurally sound and sufficient for current traffic loadings while the surface material shows signs of aging. According to their current condition, the arterial roads have been deemed mid to long-term priorities.

The collector roads demonstrated a wider range of road scores falling primarily into *either* the good or poor criteria. This disparity between scores can be attributed to relatively recent repair and/or reconstruction projects undertaken on several of these roads which have pushed these segments into the mid to long-term priorities category. Collectors deemed to be near-term priorities generally consist of aged chip seal in poor condition and showing signs of the need for subgrade strengthening and improved structural numbers.

The local roads of St. Clements exhibited the widest range of road scores. Roads scoring highest had benefitted from recent construction, namely asphalt overlays or chip seal treatments. These roads were subsequently graded as mid to long-term priorities. Again the near-term priorities consisted of severely aged chip seal and demonstrated a need for subgrade and structural strengthening.

The following tables provide an overview of the roads requiring near –term repairs. Table 3 is organized in order of descending priority and includes road score and projected project cost up to 2019. Table 4 provides a description of the roads included in table 3.

Table 3 Near-Term Repairs in Order of Priority (Note: values based on estimated 2016 cost plus 3% inflation)

Road Component	Road Score	2017	2018	2019
COLLECTOR				
McKay Rd	2	**$635,593.69**	**$654,661.50**	$674,301.34
Dunning Rd - Railway to Rebeck	6	**$90,189.38**	**$92,895.06**	$95,681.91
Dunning Rd - Henderson to Railway	2	$344,947.00	**$355,295.41**	**$365,954.27**
Rebeck Rd. - Donald to 400m North of Dunning	3	$449,981.25	$463,480.69	**$477,385.11**
Church Rd.	3	$397,180.88	$409,096.30	**$421,369.19**
Donald Rd	2	$107,635.00	$110,864.05	**$114,189.97**
LOCAL				
Roman Dr.	2	**$150,380.00**	**$154,891.40**	$159,538.14
Bison	7	**$24,195.34**	$24,921.20	$25,668.84
Coronation Rd.	3	**$300,129.13**	**$309,133.00**	$318,406.99
Church Rd. East Selkirk	3	$452,298.75	**$465,867.71**	**$479,843.74**
Parkview Ave	3	$205,382.00	**$211,543.46**	**$217,889.76**
Leah Ave.	4	$201,622.50	**$207,671.18**	**$213,901.31**
Frank St	5	$434,904.63	**$447,951.76**	**$461,390.32**

Old Henderson Hwy.	5	$118,656.00	$122,215.68	**$125,882.15**

Table 4 Description of Near-Term Repairs

Road Component	Road Score	Description
COLLECTOR		
McKay Rd	2	• Chip seal surface, poor condition • Major rutting throughout • Full depth reconstruction • 3-5 years
Dunning Rd - Railway to Rebeck	6	• Chip seal surface, poor condition • Multiple failed repairs between 2014 and 2016 repairs • Full depth HMA patching required to complete full major rehabilitation • Recommend widening existing road cross-section at Gunn's and Criste Creek to improve road side safety and embankment stability
Dunning Rd - Henderson to Railway	2	• Chip seal surface, poor condition • Multiple failed repairs • Full depth HMA reconstruction
Rebeck Rd. - Donald to 400m North of Dunning	3	• Chip seal surface, poor condition • Major areas of deterioration needing repair (50%) • Full depth patching and 0.08 HMA overlay • 2 pass chip seal or full depth HMA reconstruction 2-4 years
Church Rd.	3	• Chip seal surface, 0.3m gravel rounding • Poor condition • Recent 300m section of HMA repair • Full depth HMA reconstruction of chip seal sections
Donald Rd	2	• Chip seal surface, poor condition • Severe rutting and failures throughout • Full depth HMA reconstruction
LOCAL		
Roman Dr.	2	• Chip seal surface, poor condition • Multiple, HMA repairs of varying ages, with some failures • All roadway surrounding previous repairs has failed • Full depth HMA reconstruction
Bison	7	• HMA surface, 0.3 gravel rounding • Recent construction • Good condition with area of localized repairs needed • 15% full depth patching
Coronation Rd.	3	• Chip seal surface, fair to poor condition • Severe rutting, very poor condition

		middle to west end • HMA reconstruction on west half • Localized repair and 0.05 HMA overlay on east half • Full depth reconstruction in 2-4 years
Church Rd. East Selkirk	3	• Chip seal surface, 0.3m gravel rounding • Poor condition at ends • Major rutting • Fair condition in middle • Possible need for ditch grading on south side • Full depth HMA reconstruction 2-4 years
Parkview Ave	3	• Chip seal with section of recent HMA overlay • Chip seal section in very poor condition • HMA overlay already showing significant signs of deterioration • Full depth reconstruction
Leah Ave.	4	• Chip seal surface • Multiple HMA repairs in fair to good condition • South cul-de-sac up to Wachal St. in very poor condition • North section in fair condition • Full depth HMA patching with 0.08 HMA overlay • Reconstruct south section within 3 years • Reconstruct north in 5-8 years
Frank St	5	• Chip seal surface, poor to fair condition • Minor rutting • Two pass chip seal from PR 212 to first curve (480m) • Full depth reconstruction from first curve to Harold Ave. (820m) • Reconstruction in 1-3 years
Old Henderson Hwy.	5	• Chip seal surface, fair condition • Section of recent HMA rehabilitation • North end has wide paved parking shoulders • Several areas of recent HMA repairs • Full depth patching with 0.08 HMA overlay • Rehabilitation in 2 to 5 years • Reconstruction in 5-8 years

6.0 OPINIONS OF PROBABLE COST

Class "C" opinions of probable costs were developed for each road segment under the assumption of raising the overall street rating from its current condition to a score of 6 or greater. Appendix "C" contains the opinions of probable cost for each road. Each Class "C" opinion of probable cost is based on visual observations of each roadway, recording the extent and severity of the damages, estimates of work to be completed and use of current (i.e. 2016) unit rate costs.

Recorded on each Class "C" opinion of probable cost sheet is the following typical information:

- Road name
- Extent of road test section
- Type of road surface
- List of photos for each road segment (photos provided in Appendix D)
- Items of work
- Unit rate costs
- Anticipated work schedule (areas, volumes)
- General comments for each road segment, which are found on the bottom of each sheet.

Also included on the estimates are 15% contingencies and 10% engineering fees to develop the anticipated total project cost for purposes of infrastructure planning and future budgeting.

Please refer to Appendix "C" for detailed opinions of probable cost sheets.

7.0 TEN-YEAR CAPITAL PLAN

Based on the opinions of probable costs in Appendix "C" a 10-year capital plan including all road sections was developed and is included in Appendix "D". Appendix "D" also includes the 10-Year capital plan broken down into repair priority levels. This summary identifies the road, surface type, road score, 2016 project cost and the projection of project costs out to 2026. To develop the future Project Costs, a compound annual interest rate of 3.0% was implemented and was assumed to be representative, as an average, for the next 10 years. Also identified on this 10-year Capital Plan are projected costs in **BOLD** lettering for the anticipated years of the required rehabilitation or reconstructions.

8.0 CONCLUSIONS AND RECOMMENDATION

The current assessment and its projections were compiled with intent of improving and maintaining the serviceability of the hard surface roads of St. Clements to a safe and efficient system. Based on the opinions of probable cost provided in this report, the total 2016 cost for all repairs is estimated at 7.5 million dollars. This figure includes near-term as well as mid- and long-term priority streets. Further analysis showed an estimated $3.9 million dollars in near-term priority repairs as of 2017, $3.6 million dollars in mid-term priority repairs as of 2020 and $700,000 in long-term priority repairs as of 2023. A summary of these total repair costs is provided in Table 5 below.

Table 5 Total Repair Cost by Priority

	Total Cost		
	2017	2020	2023
Near-Term Priority (2016)	$3,900,000		
Mid-Term Priority (2020)		$3,600,000	
Long-Term Priority (2023)			$700,000

The estimates provided in this report can be balanced according to fiscal conditions and the needs of the R.M. and should be further refined based on future pavement assessments. Effective use of this planning document will require continual record updates, enabling the R.M. to identify which pavements continue to deteriorate at the expected rate, which pavements experience accelerated deterioration and which pavements demonstrate delayed deterioration. These deviations from the expected rate of road degradation would serve to push the projected repair schedule and therefore change future infrastructure and budget planning.

Stantec Consulting Ltd. recommends updating this document at least every 2 years in order to allow the R.M. of St. Clements the benefit of being able to be proactive and have the most up to date assessment of hard-surfaced roads and be able to budget for the anticipated needs over the next 10-years. We also recommend that St. Clements extend the reach of the assessment to incorporate any remaining hard surface roads, including those that as of 2016 have been recently repaired or reconstructed. This would assist in establishing a baseline for road deterioration typical to this area.

One proactive step that could be considered is to reassess existing truck haul routes and ensure compliance of weight restrictions by the commercial trucking industry. A large proportion of roadway damage is due to commercial trucking and the subsequent vehicle loadings which exceed the strength of the existing pavement and embankment structure. This is especially the case during spring thaw.

During the field inspections, routine maintenance was seen to have been implemented well, with crack sealing, spray patching and routing / sealing exercises complete for most of the roads. The R.M. is strongly advised to continue exercising diligent maintenance in the form of routing and sealing, continued monitoring of existing roads and proactive maintenance in the form of localized patching or applications of chip-seal to enhance the life-cycle of each road and delay the need for a major rehabilitation or reconstruction until the pavement reaches the end of its useful life. It is also imperative that this maintenance and the required rehabilitation and reconstruction projects continue annually as even minor delays can serve to compound future repairs thereby inflating future project costs

APPENDIX A – R.M. ST. CLEMENTS MAPS

APPENDIX B – FIELD NOTES

APPENDIX C – OPINIONS OF PROBABLE COST

APPENDIX D – 10 YEAR CAPITAL PLAN

APPENDIX E – 2016 ROAD PHOTOS