Report

Roadway Corridor Assessment

Prepared for:

District of Fort St. James

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1.0 INTRODUCTION

This report provides the rationale for and findings of a Road Corridor Assessment (RCA) designed to determine the existing field conditions and urgency of investment in the District's roadway assets. The purpose for this RCA is to inform the development of the District's short, medium and long-term capital plans.

The RCA identifies and assesses the functional and physical characteristics of the District's roadway corridors through standardized visual inspection. This is done to develop a surface condition rating as well as takes stock of other roadway components that directly affect the condition and lifespan of the road surface and cost of roadway improvements (maintenance, resurface, reconstruction). In addition to the road surface review, the RCA included an assessment of the sidewalks and drainage characteristics.

A surface condition review does not provide definitive road structural strength assessments as can be provided through load deflection testing. It also does not provide more detailed road structure composition information that could be determined through core sampling or test pits; however, surface conditions provide indications of underlying problems. It therefore can provide a general indication of road condition and, if assessments are completed over time, the rate of deterioration.

The inspection information is suitable for informing the District's annual road operations and maintenance programs and future Asset Management planning initiatives. Road renewal and improvement needs, priorities, and options can then be identified, and affordable levels of service and risk can be determined. More detailed geotechnical and road structure investigations may be warranted in some cases to help determine if alternative road rehabilitation methods would be appropriate i.e. full depth reclamation (pulverizing) or as part of design.

The roadway corridor assessment examined the roadway characteristics which included: road surface condition, road surface type of defect, roadway corridor drainage, safety concerns and collection of most characteristics of the roads cross section.

Most of the District's paved roads show signs of deterioration where major rehabilitation work (resurfacing, full depth reclamation, full depth reconstruction) could be justified, however, these rehabilitation methods come with a significant cost. It is recommended that priority be placed on regular and proactive road maintenance to stretch the useful life of the existing roads by reducing further deterioration. To get the most of the District's budget, roadwork should be aligned with subsurface utility and streetscape improvement projects. Independent road surface improvement projects should be prioritised to provide the best level of service possible. The intent of this assessment is not to specify rehabilitation of every road where it could be justified, but to balance and prioritize rehabilitation and maintenance repairs to provide a reasonable level of service while working within the District's budget.

All maps referred to in this report can be found in Appendix A.

2.0 BACKGROUND

Pavements will typically deteriorate over time at an ever-increasing rate in the absence of timely maintenance and rehabilitation actions as shown in

Figure **1**. As deterioration increases, so do the associated costs to repair them. Investments in effective and systematic maintenance and rehabilitation can slow or reverse this deterioration, extending its service life and reducing life cycle costs.

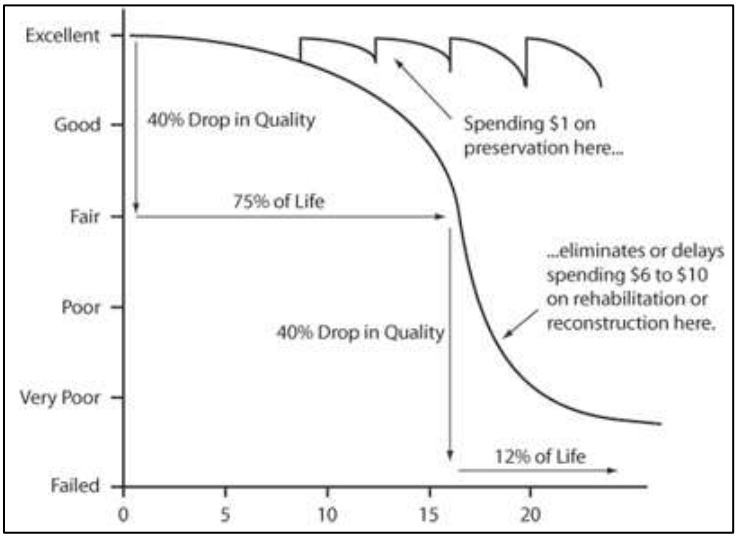


Figure 1: Typical Pavement Deterioration Curve

A typical pavement surface with a suitable base structure will deteriorate slowly for the first 75% of its life, after which it will lose the balance of its life very quickly. When the road surface is repaired regularly with maintenance interventions such as crack sealing, the useful life of the pavement can be extended dramatically. When it is no longer viable to extend the pavement life with maintenance, the road can be re-surfaced. Both timely actions (maintenance and resurfacing) can defer expensive re-construction, which includes the repair of the road base. It may be possible to get 3 or more resurfacings before reconstruction on a well-maintained and well-constructed roadway, depending on traffic loading. The road base provides the road strength, while the road surface provides a smooth, skid resistant waterproofing.

A community can reduce its long-term road repair and reconstruction costs by proactively managing the life cycle of the pavement surface. Figure 2 provides a generalized example of the financial benefits of being proactive when considering a theoretical 1.0 kilometer of roadway that is 7.0 meters wide. This example shows how the Uniform Annual Equivalent Cost savings is a factor of 2.6. To put this in monetary terms, for every $100,000 spent on the road in proactive road maintenance and surface repairs, a community could save in the order of $160,000. Results will vary based upon pavement design, construction quality, weather, traffic loading and drainage.

Well Maintained Road		
Treatment	**Age**	**Cost**
Construction	0	$ 700,000
Crack Seal	5	$ 2,000
Crack Seal & Patch	10	$ 3,000
Resurface	15	$ 300,000
Crack Seal	20	$ 2,000
Crack Seal & Patch	25	$ 3,000
Resurface	30	$ 300,000
Crack Seal	35	$ 2,000
Crack Seal & Patch	40	$ 3,000
Resurface	45	$ 300,000
Crack Seal	50	$ 2,000
Crack Seal & Patch	55	$ 3,000
Re-construct	60	
Total		**$ 1,620,000**
UAEC		**$ 27,000**

Poorly Maintained Road		
Treatment	**Age**	**Cost**
Construction	0	$ 700,000
Crack Seal	10	$ 5,000
Re-construct	20	$ 700,000
Total		**$ 1,405,000**
UAEC		**$ 70,250**

Cost Saving Ratio
$70,250/$27,000 = 2.6

***UAEC**: Uniform Annual Equivalent Cost*

Figure 2: Potential Life Cycle Cost Savings

It is also worth noting that some road condition investigations will rely on condensed ratings of roads expressed as Pavement Quality Index (PQI), Pavement Condition Rating (PCR) or other similar systems. These standardized values are useful for providing a broad overall measure of the state of a road network. There calculations typically combine the severity of pavement defects, the density of the defects (i.e. how much of the road surface includes those defects) and other considerations such as ride comfort.

The District has approximately 24 km of roads and lanes (20 km paved and 4 km unpaved). The road network is of a size that combining the measured field observations into a single rating for each road was not viewed as being necessary at this time. By considering the extent of each pavement distress type for each road it was possible to recommend rehabilitation works. The combination of standardized fieldwork, detailed inspection forms, photos and videos of each road segment allowed for site specific review and analysis for each road segment.

3.0 ROAD CORRIDOR ASSESSMENT

The field assessment was conducted during the period of July 22 – August 4, 2019 and included all 24 km of the District owned roads as identified by District staff. Generally, each of the District's roads were split into segments at intersections to facilitate the detailed assessment and documentation. The roads included in the RCA are shown in Map 1.

3.1 Road Corridor Inventory

Included in the inventory was the physical dimensions and materials of the roadway components including the road surface, parking, road shoulders, ditches, curbs and sidewalks.

As part of the assessment, the dimensions of the sidewalks, shoulders and paved lanes were measured and recorded. The ditch widths were also recorded but are approximate dimensions since ditches varied

in width over the length of the assessed segments. The road corridor dimensions are useful for calculating costs for rehabilitation efforts.

4.0 ROAD CORRIDOR RATINGS

Included in the condition assessment were the road and sidewalk distresses, and condition of the existing crack sealing, patches and drainage. The distresses and conditions were recorded using the Ministry of Transportation and Infrastructure Construction Branch's (MOTI) Pavement Surface Condition Rating Manual – Fifth Edition as a guide. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/highway-bridge-maintenance/pavement-marking/pavement-surface-condition-rating-manual.pdf

From the assessment we noted the recommended works to sustain or rehabilitate each road segment.

Road Surface

Pavement deteriorates for a broad number of reasons such as materials, thickness, base course, construction quality, design, loading, drainage, weather, and maintenance levels. This deterioration is exhibited through a variety of surface distresses. The District's RCA included recording both the severity and density of each distress type observed. Table 1 lists each distress type and provides a description of each severity level.

Table 1: Pavement Distress Rating System – Severity Levels

Pavement Distress Rating System – Severity Levels			
Distress Type	**Low Severity**	**Moderate Severity**	**High Severity**
Longitudinal Wheel Path Cracking (LWP)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Longitudinal Joint Cracking (LJC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Pavement Edge Cracking (PEC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Transverse Cracking (TC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Meandering Longitudinal Cracking (MLC)	Single cracks with no spalling; mean unsealed crack width < 5mm	Single or multiple cracks; moderate spalling; mean unsealed crack width 5-20mm	Single or multiple cracks; severe spalling; mean unsealed crack width >20mm; alligator
Alligator Cracking (AC)	Not rated	Interconnected cracks forming a complete block pattern; slight spalling and no pumping	Interconnected cracks forming a complete block pattern, moderate to severe spalling, pieces may move and pumping may exist
Rutting (RUT)	Less than 10mm	10 to 20mm	Greater than 20mm
Shoving (SHV)	Barely noticeable to noticeable	Rough ride	Very rough ride
Distortion (DST)	Not rated	Noticeable swaying motion; good car control	Fair to Poor car control
Bleeding (BLD)	Not rated	Distinctive appearance with free excess asphalt	Free asphalt gives pavement surface a wet look; tire marks are evident
Potholes (POT)	Less than 25mm deep and greater than 175cm2 in area. (~15cm Ø)	25 to 50mm deep and greater than 175cm2 in area. (~15cm Ø)	Greater than 50mm deep and greater than 175cm2 in area. (~15cm Ø)
Ravelling (RAV)	Not rated	Aggregate and/or binder worn away; surface texture rough and pitted; loose particles exist	Aggregate and/or binder worn away; surface texture is very rough and pitted

Source: MOTI Pavement Surface Condition Rating Manual – Fifth Edition

Table 2 describes the density rating for each distress type.

Table 2: Pavement Distress Rating System – Density Levels

Pavement Distress Rating System – Density Levels							
Distress Type	Units	None	Few	Intermittent	Frequent	Extensive	Throughout
Longitudinal Wheel Path Cracking (LWP)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Longitudinal Joint Cracking (LJC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Pavement Edge Cracking (PEC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Transverse Cracking (TC)	Number	0	1-2	3-4	5-7	8-10	>10
Meandering Longitudinal Cracking (MLC)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Alligator Cracking (AC)	Area	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Rutting (RUT)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Shoving (SHV)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Distortion (DST)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Bleeding (BLD)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%
Potholes (POT)	Number	0	1-2	3-4	5-6	7-9	>10
Ravelling (RAV)	Length	0%	< 10%	10-20%	20-50%	50-80%	80-100%

Source: MOTI Pavement Surface Condition Rating Manual – Fifth Edition

Table 3 provides a photo and description of each of the above road surface distresses. Most of the photos are of Fort St. James roads and the description and cause of the distress are from the MOTI Pavement Surface Condition Rating Manual – Fifth Edition.

Table 3: Pavement Distresses & Descriptions

DISTRESS	IMAGE	CAUSE
Longitudinal Wheel Path Cracking (LWP)		Cracks which follow a course predominantly parallel to the pavement centreline and are located at or near the centre of the wheel path. LWP cracking indicate fatigue failure from heavy vehicle loads. Cracks within one foot of the edge are caused by insufficient shoulder support, poor drainage, or frost action.
Longitudinal Joint Cracking (LJ)		Cracks running in the direction of traffic are longitudinal cracks. Centre line or lane cracks are caused by poor construction of longitudinal joint, frost action on adjacent lanes with variable granular depths, differential frost heave along the centreline caused by the insulating value of snow along pavement edges, moisture changes resulting in swelling and shrinkage.
Pavement Edge Cracking (PEC)		Cracks which occur parallel to and within 0.6 meters of the inside and/or outside of the fog line. Cracks may be crescent shaped cracks or other consistent cracks which intersect the pavement edge. Possible causes include: Frost action, inadequate pavement structural support at the pavement edge and/or excessive traffic loading, poor drainage at the pavement edge and shoulder, inadequate pavement width forces traffic too close to the pavement edge.

DISTRESS	IMAGE	CAUSE
Transverse Cracking (TC)		Cracks that are predominantly perpendicular to the pavement centreline and may extend fully or partially across the roadway. Possible causes include: surface shrinkage caused by low temperatures, high temperature susceptibility of the asphalt cement binder in asphalt mixes, frost action, reflection cracks and hardening of the asphalt with aging
Meandering Longitudinal Cracking (MLJ)		Cracks which wander from edge to edge of the pavement or run parallel to the centreline, situated near the middle of the lane. MLJ cracks are usually single cracks, but secondary cracks can develop in areas where transverse thermal cracks also exist. Possible causes include: Frost action with greater heave at the pavement centre than at the edges. This is more prevalent in mixes where asphalt stripping is extensive. Faulty construction equipment can cause weak planes in the mix, which can fail from thermal shrinkage
Alligator Cracking (AC)		Cracks which form a network of multi-sided blocks resembling the skin of an alligator. Block size can range in size which indicates the depth of failure taking place. The pattern of cracking is usually longitudinal, originating in the wheel paths, but can occur transversely due to frost heaves or settlement and along the centreline on narrow two-lane roads. Possible causes include: areas subjected to repeated traffic loadings. Insufficient bearing support due to poor quality base materials or saturated base with poor drainage, stiff or brittle asphalt mixes at cold temperatures.

DISTRESS	IMAGE	CAUSE
Rutting (RUT) *Photo not from Fort St. James		Longitudinal depressions left in the wheel paths after repeated loadings, combined with sideways shoving of the pavement material. Possible causes include: Poorly compacted structural layers, Heavy loadings of saturated unstable granular bases/sub-bases during spring thaw periods, unstable asphalt mixes due to high temperature or low binder viscosity, inadequate lateral support from unstable shoulder materials, permanent deformation of an overstressed subgrade
Shoving (SHV) *Photo not from Fort St. James as shoving was not observed		Longitudinal displacement of a localized area of the pavement surface generally caused by braking or accelerating vehicles and usually located on hills, curves or intersections. Possible causes include: Heavy traffic on steep downgrades or upgrades, low stability asphalt mix, lack of bond in asphalt surface and underlying layer, unstable granular base.
Distortion (DST)		Any deviation of the pavement surface from its original shape other than that described for shoving and rutting. Generally, distortions result from settlement, slope failure, volume changes due to moisture changes and to frost heaving, and from residual effects of frost heaving accumulating after each season. Possible causes: Differential frost heaves in poorly drained cuts, transitions and at pavement edges or centre. Reverse differential frost heave at culverts, differential settlement of subgrade or base

DISTRESS	IMAGE	CAUSE
		materials, lack of subgrade support, embankment slope failure.
Bleeding (BLD) **Photo not from Fort St. James as bleeding was not observed*		Excess bituminous binder on the pavement surface can create a shiny, glass-like, reflective surface that may be tacky to the touch. Bleeding quite often occurs in the wheel paths. Possible causes include: Mix design deficiencies where too high an asphalt content relative to voids results in excess asphalt forced to the surface by traffic, especially on hot days, paving over surfaces with severe bleeding or the application of a heavy prime or tack coat under a new pavement layer may result in excess primer bleeding through the pavement surface over a period of time, poor construction of surface seal coats.
Potholes (POT)		Bowl-shaped holes of various sizes in the pavement surface. Possible causes include: Thin spot in the asphalt layer, localized drainage problems such as water infiltration through poorly bonded pavement structural layers or segregated spots in the asphalt mix where coarse patches allow intrusion of water, asphalt mix design deficiencies.
Raveling (RAV)		The progressive loss of the pavement material from the surface downward, leaving a rough surface, vulnerable to weather deterioration. Possible causes include: poor adhesion of aggregates due to insufficient asphalt content, clay-coated aggregate, use of wet aggregates or stripping due to water action, fracture of aggregate particles by heavy loads or natural causes, the unbound particles are then removed by traffic, reducing the depth of the asphalt, poor compaction permits infiltration of water and salts which promote asphalt stripping,

DISTRESS	IMAGE	CAUSE
		segregated mix placed during construction, aging and weathering.
Tree Roots **Photo not from Fort St. James as root problems were not observed*		Surface failures caused by tree roots. Caused by tree roots growing between road base and asphalt surface. The force from the tree roots causes the localized swelling and cracking of the road surface.
Manholes		Cracking, swelling or settling of the road surface around manholes, catch basins or other infrastructure within the road surface. Possible causes include: poor compaction of materials around manholes, low spot or inadequate drainage allowing water to pool and weaken surface and surrounding base materials.

Photos taken by Urban Systems
Source: MOTI Pavement Surface Condition Rating Manual – Fifth Edition

Crack Sealing and Patches

In addition to the surface distresses noted above, the condition of crack sealing, patches and drainage were reviewed. The crack sealing and patch conditions were recorded as Level 1-3 described below:

Crack Sealing Condition:

- Level 1 - < 30% of cracks are sealed
- Level 2 - 30% to 60% of cracks are sealed
- Level 3 - > 60% of cracks are sealed

Patch Condition:

- Level 1 - Few small localized patches
- Level 2 - Several larger patches
- Level 3 - Full lane patching

For patch condition a condition rating was also added to take stock of the condition of the patches.

- 1 = Poor; patch ineffective and should be repaired as soon as possible;
- 2 = Fair; some patch defects, repair if funding available;
- 3 = Good; patch in good condition, no repair required.

Figure 3: Examples of the Condition of Patching and Crack Sealing

Level 3 Patch - In good condition

Level 3 crack seal condition

Base Failure

As part of the assessment, roads that appeared to show signs of base failure were flagged for further review. These roads are shown on Map 5. Since the RCA was a visual assessment of the road surface and associated road corridor components, we could not definitively determine if the roads have an adequate road base, the base condition or extent of any base failure. We recommend that the District have a geotechnical assessment done in key locations to better understand the condition of the road structure prior to overlaying or reconstructing the roads.

Drainage

Drainage is an important factor to help ensure the integrity and longevity of the District's roads. If water can penetrate the road structure it will weaken and fail prematurely. Any water needs to be kept below the road structure with the use of open ditches, culverts or other drainage infrastructure. For the RCA, the rating of the drainage condition for each road corridor segment was recorded as described in the Table 4. Significant low spots on the road, shoulder or around manholes or catch basis were also noted. Where drainage was determined to be an issue, a comment was recorded to provide further detail. Map 3 shows drainage condition ratings and general recommendations for drainage improvements.

Table 4: Road Corridor - Drainage Condition

ACCEPTABLE
✦ Cross section and drainage are fully adequate. ✦ Concealed underground storm drains in good repair. ✦ Open ditching with no free-standing water and no silt bottom layer or obstructed culverts, etc. ✦ Open ditching with free-standing water or bull rushes in the ditch and the fill height is greater than 1.5 metres.
BORDERLINE
✦ If the ditch grade line, cross-section elements and/or culvert and/or ditch capacity are somewhat below the standard that would be provided if the road and ditches were rebuilt. ✦ Roads with acceptable design characteristics, but poorly maintained ditching, requiring work to be brought up to an acceptable level. Work required should generally fall into a category that could be completed by gradual cleaning of ditches, grading of shoulder areas and minor culvert repair.
UNACCEPTABLE
✦ Free-standing water in ditches, grass and other debris, requiring more than minor work to be brought up to an acceptable standard; granular washout of shoulder areas, etc. ✦ Conditions could impede safe traffic movement. ✦ Areas with lack of grade could possibly flood. ✦ Catch basins are in a very poor state of repair with obvious pavement deterioration and free-standing water. ✦ Water channels onto driven portion of road. ✦ Road drains onto adjacent occupied properties

Source: MOTI Pavement Surface Condition Rating Manual – Forth Edition

Sidewalk Condition

A general condition of the sidewalks and curb were included using the following scale:

- 0 = Not Inspected;
- 1 = Poor; severe defects, should repair immediately;
- 2 = Fair; some defects, monitor for future repair, repair now if funding available;
- 3 = Good; some minor defects, monitor for future repair; and
- 4 = Excellent; no substantial defect, no repair required.

Specific issues that were found during the road assessment including hazards and safety concerns were recorded to provide further detail about the distresses, hazards, potential causes and recommended works to sustain, or rehabilitate that section of sidewalk.

Reporting Template

Data for each segment of road included in the assessment was picked up through a data collection app on a tablet. During the field inspections, a road inspection database was populated. Each road was also videoed with a high definition camera and distresses found were photographed. The photos are linked to the road segments within the database for further reference. The database of the field inspections was compiled in GIS format but provided in MS Excel for ease of reference. This table is attached to this report. All the found distresses informed an overall rating of the severity and density for each road segment.

5.0 ASSESSMENT FINDINGS

5.1 Road Surface

Although there are high severity distresses and roads needing attention, it should be noted that many of the road surface distresses can be addressed within a road maintenance program. As an initial review, roads with high severity and high density are likely candidates for reconstruction whereas roads with high severity but lower density are in many cases, candidates for priority patching.

The severity of distress observed during the RCA is summarized by length in Table 5. A severity score was assigned to each road as a way of summarizing the number and severity of the distresses. The score applies a weighting factor to those distresses, whereas the more severe distresses receive a higher weighting than the less severe distresses. The purpose of the weighting factor is to differentiate the roads with higher severity distresses from those with less. The score is simply used to help highlight candidate roads but then the actual field assessment of each road was considered in more detail to help recommend repair and reconstruction works.

Table 5: Surface Distress Overview

Surface Distress Overview			
Distresses Severity	**Severity Score**	**Length (m)**	**Percentage**
High	> 400	7455	37%
Moderate to High	> 299 & < 400	2599	13%
Moderate	> 199 & < 300	4308	21%
Low to Moderate	> 99 & < 200	2238	11%
Low	< 100	3713	18%

5.2 Crack Sealing and Minor Patching

Surface cracks allow water to penetrate and weaken the road structure. Once the road structure is weakened, the deterioration of the road surface increases. To prevent water from entering the road structure it is recommended that the District use a portion of the annual roads budget to establish an annual crack sealing and minor patching program. We recommend an increased focus on crack sealing and patching initially until the District has addressed most of the cracking. From our field assessment we estimate the District has approximately 30 km of surface cracks, and 20 km of those cracks currently need sealing. For the purpose of budgeting, we have used 30 km as the length of cracks to be sealed.

In addition to crack sealing, we estimate there is approximately 7,000 m^2 of alligator cracking requires attention. It is important to understand that surface patching of alligator cracking is a temporary fix since alligator cracking is often a sign of failure within the base, subbase, or subgrade; however, patching may lengthen the remaining life of that area temporarily until a proper fix can be completed.

To determine the costs for the District's crack sealing we contacted Peace River Projects. We were provided with a budget rate for rubberized crack sealing of normal sized cracking of $2.00 - $2.50 linear meter. We understand that spray patching has not been typically used in Fort St. James but this service could be available by other contractors out of Prince George. It may be useful for District Public Works staff to reach out to the City of Prince George who uses spray patching as part of their road maintenance program.

Table 6: Crack Sealing and Minor Patching Estimated Costs

Crack Sealing and Minor Patching				
Method	**Quantity**	**Unit**	**Unit Cost**	**Totals**
Crack Sealing of severe cracks (20%)	6000	m	$5.00	$30,000
Crack Sealing of normal cracking (80%)	24000	m	$2.50	$60,000
Spray patching for alligator cracking & potholes	7000	Sq.m.	$20.00	$140,000
Total				**$230,000**

It is important to note that the width and depth of pavement cracks vary. The above rate for crack sealing is based on an average crack width of 13mm, and depth of 25mm. Unit pricing per meter will vary based on the actual volume of sealant required to complete the crack filling. The price does not include routing, which may be required to seal some cracks.

The severity and size of some of the lineal cracks are such that spray patching would be required to fill them. We do not know that exact length of cracks that would require spray patching, but we would plan for up to 20% of the cracks to be filled using spray patching.

Based on the above costs and the approximate extent of patching and crack sealing, the cost of crack sealing and patching could be in the order of $90,000 and $140,000 respectively as shown in Table 6. The

District should also include an additional allowance for patching of new base failures that may arise prior to reconstruction or resurfacing as well as repair of some existing patches.

We recommend the District undertake as much crack sealing and patching as possible over the next two years as it will slow the deterioration of the existing roads.

5.3 Surface Treatments

There a several types of surface treatments that can be used to extend the life of a paved road. These include fog seals, seal coats, slurry seals and micro-surfacing. Each method is suitable for different road and traffic conditions, and hence, each road must be reviewed individually to determine if a surface treatment is appropriate to extend its life.

It was observed that much of the asphalt pavement within Fort St. James is oxidizing and raveling. Ravelling is deterioration of pavement by the loss of asphalt and rocks on the surface. If conditions are right and the road is structurally sound, a surface treatment may be a suitable option to mitigate further oxidation and raveling of the pavement. While we have not assessed each road segment for suitability for a surface treatment, we have highlighted roads where raveling is extensive (greater than 50% of the road area) as shown on Map 6. It is recommended the suitability for the various surface treatments on these roads be further reviewed to maximize the roads life before more major rehabilitation works are required.

5.4 Base Failure

During the RCA, roads that appeared to show signs of base failure were flagged for further review. Map 5 shows the result of the RCA and the roads with distresses indicating potential base failure. The distresses noted include:

- High severity longitudinal wheel path cracking;
- High severity distortion;
- High severity rutting;
- High severity pavement edge cracking;
- Alligator cracking.

Table 7 shows lengths of the road segments that contain a combination of the above distresses as shown in Map 5. Some of the lengths below for the various distress types and densities overlap on the same road segment. Map 5 illustrates where the distresses are overlapping.

Table 7: Roads with Potential Base Failure

Roads with Potential Base Failures		
High Severity Distress Type and Density	**Length (m)**	**Percentage of Total Paved Road Length**
High Density Rutting, Distortion, LWP	63	<1%
High Density Alligator, PEC	495	2%
Low Density Rutting, Distortion, LWP	3716	19%
Low Density Alligator, PEC	10304	52%

We recommend the District undertake the following to better understand the existence and condition of the road base prior to undertaking significant roadwork projects:

- Have a geotechnical assessment done (core testing or other load testing) along roads with distresses indicating potential base failure. The testing should be focused to the roads that are recommended for rehabilitation and reconstruction. This testing will help determine the condition and structural integrity of the existing road base as well as the condition of the existing asphalt material. This testing will help inform if full reconstruction is necessary or if there is adequate road base to justify mill and overlay of the roads. This testing will provide the District with greater confidence that the best result will be achieved for the money spent. To have this testing done, we recommend the District allocate $50,000 to cover the cost of this geotechnical assessment.
- If a road surface is deteriorating, but the road base is near to adequate, the District may be able to have the road reclaimed (pulverized), rather than reconstructing the whole road. Reclaiming includes pulverizing the existing road surface and mixing with additional crushed gravel and magnesium chloride forming a strengthened road base. The road is then graded and repaved. If reclaiming is determined to be appropriate, it could be a significant cost savings and enable the District to extend their roads program within the existing annual budget.

5.5 Drainage

Rainfall during the field inspection enabled Urban Systems to monitor roadway surface drainage and identify some areas where water ponding occurs. It is important to note that ponding of surface water that allows water to saturate the granular base and subgrade will negatively impact the life expectancy of asphalt and the structure of the road. The following drainage issues were noted during the road assessment:

- Roads with ponding on the surface;
- Roads where surface drainage improvements are needed;
    - Gravel and vegetation built up at the pavement edge causing water to pond on the pavement edge;
    - Lack of a crown or crossfall on the road directing drainage off the road;
    - Low spots
- Roads where ditching improvements are needed;

    - Vegetation growing in ditches;
    - Lack of ditching;
    - Damaged culverts or lack of culverts
- Roads requiring other drainage infrastructure

Drainage recommendations:

- **Gravel and vegetation built up at the pavement edge**
    - This was a common drainage issue observed throughout Fort St. James. This build up prevents surface water from draining off the road and enables water to saturate the base gravels of the shoulder and weaken the pavement edge. It is recommended that the District grade off the vegetation and gravels to ensure surface water can drain off the road surface. We understand that in some cases, residents may have put effort into their landscaping and may not wish to have their yard disturbed. The District may wish to handle these properties on a case by case basis.

- **Lack of a crown or crossfall on the road top**
    - This was a common drainage issue observed throughout Fort St. James. This may be caused by building the road top without a crown/crossfall, or loss of the crown/crossfall over time due to settlement. It is recommended that roads be graded to promote surface drainage when there is an opportunity to do so during rehabilitation works. When roads are built on clay, it is also important to ensure the clay subgrade is graded to promote subgrade drainage.
- **Vegetation growing in ditches**
    - It is recommended that the District clear out any debris or vegetation in existing ditches that prevents the ditch from effectively conveying water.
- **Roads requiring ditches or other drainage infrastructure**
    - During the field assessment it was found that there is a general lack of drainage ditching throughout Fort St. James, and that often road rights-of-way drain onto private properties. There are approximately 5 km of roads where ditches should be established or re-established.
    - While these ditching improvements are important and needed, we understand it is a large undertaking to execute, and recommend starting where ditching issues are evidently causing road base failures, causing flooding, or where road rehabilitation work is planned and ditching improvements are required.
    - Whenever making ditching improvements, it is advised to review the ultimate drainage path to ensure that runoff conveyed by the ditch system can continue downstream of the improved area to its ultimate destination.
    - The suitability of diching to handle runoff should be reviewed on a site-specific basis. It is important to consider the following:
        - Ultimate drainage path
        - Grade available to create positive drainage
        - Culverts

        - Soil type. An area high in gravels or permeable soils may not require ditching to allow runoff to drain.
    - Where ditching is not a suitable drainage solution, underground drainage infrastructure may be a consideration.
    - The intent of this assessment was to identify areas where drainage improvements were likely needed. It is recommended that the District investigate the existing drainage system in more detail to identify required improvements. A drainage master plan would assist the District in planning for and implementing drainage improvements.
    - Map 3 shows the noted drainage conditions and recommended drainage works.
- **Roads with ponding on road surface** – these roads will require re-grading of the road surface or patching to ensure the ponding water cannot penetrate the road surface and get into the road base.

Examples of some of the drainage issues found during the RCA are shown in Figure 7. It should be noted that signs of road base failure were often found where drainage issues were observed.

Ditch Vegetation and Ponding Water – Stones Bay Rd near Golf Course

Low Spot – 2 Ave W and Elm St W

Inadequate Drainage – Stuart Drive E Near Curling Rink

Surface Low Spot - Mason Street –

Figure 4: Examples of the Drainage Issues Found During the RCA

5.6 Sidewalk Condition

There are approximately 3.4 km of sidewalk in the District. During the field review it was found that approximately 24% (816 m) of the District's sidewalks are in good condition, 50% (1700 m) are in fair condition, and 26% (884 m) are in poor condition. Map 4 shows an inventory of the sidewalks and their recorded condition.

It is recommended that the District prioritize addressing the tripping hazards identified during the assessment and begin planning to replace the sidewalks in poor condition. The sidewalk along Douglas Avenue shows signs of extreme scaling. We recommend the District replace these sidewalks as soon as possible while ensuring budget is also put towards preventive road maintenance including crack sealing. There may be potential to align the sidewalk replacement with other infrastructure works along Douglas Avenue in the near future.

We provide the following budgetary costs for reference. Costs are for the concrete work only, and don't include base gravel work.

Table 8 – Sidewalk Rehabilitation Costs

Sidewalk Rehabilitation Costs		
Rehabilitation	**Unit**	**Cost**
Machine Placed MMCD Barrier Curb & Gutter - Long Sections	l.m.	$125
1.5m Wide Concrete Sidewalk 100mm Thick - Long Sections	Sq.m	$85
Handformed Barrier Curb & Gutter (Patches)	l.m.	$175
1.5m Wide Concrete Sidewalk 100mm Thick - Patches	Sq.m	$155
Mobilization	ea.	$17,000

Sidewalk scaling – Douglas Avenue

Tripping Hazards – Stuart Drive E

Sidewalk Cracking – Stuart Drive W

Figure 5: Examples of the Sidewalk Distresses Found During the RCA

5.7 Safety Concerns

There were no major safety concerns requiring immediate attention related to road surface condition that were noted during the RCA. However, one concern noted is the valve box within Stuart Drive E near Eagle Court. The valve box is protruding above the road surface, and there is a visible void forming around the valve box and under the pavement. It is recommended this be investigated and repaired accordingly to avoid a potential larger problem.

Protruding Valve Box and Loss of Surrounding Material – Stuart Drive E and Eagle Court

Figure 6: Safety Concerns Found During the RCA

6.0 COST ESTIMATES FOR PRIORITIZED ROADS

Class C cost estimates have been developed for the roads that have been identified for rehabilitation. Capital works have been identified as either fully reconstruct or mill and overlay roads depending on the severity and density of distresses and indications of potential base failure. Please note that it may be possible to do full depth reclamation (pulverizing) instead of the full reconstruction which would enable the District to save costs and extend the extents of the roads program. From our experience full depth reclamation costs approximately half of the cost of full reconstruction (if enough area of road undergoes reclamation to help offset the costs of mobilizing the reclamation equipment).

Costs for roadworks are impacted by the quantity. In general, as quantity goes up, unit costs go down. To our knowledge, there has not been any recent large-scale roadwork projects in Fort St. James recently to base cost from. Paving costs were provided for the 2018 patching work; however, these rates may not be reflective of larger scale paving projects where the asphalt quantity is considerably higher.

We reviewed roadwork pricing we had available in the area, including Quesnel, and Vanderhoof. The Class C cost estimate unit rates are generally based off Quesnel rates plus an additional 20% to provide an allowance for inflation and trucking.

6.1 Key Perspectives for Scheduling Works

The following perspectives were utilized to help establish priority road works that could be accommodated within the District's budget. When determining maintenance and rehabilitation work, we not only considered the condition of each road segment, but we considered the observed use of each road, traffic volume observed, connecting roads, and the number and type of properties that would benefit from the rehabilitation work.

For example, Lakeshore Drive could arguably be resurfaced/reconstructed for the 1.6 km length based on its general condition, however, there are few properties located along this road compared to the length, and traffic was observed to be lower since Stones Bay Road is the straight forward route for traffic to head west. To rehabilitate 1.6 km of roads within the more densely developed areas of Fort St. James would likely provide a benefit to more people than rehabilitating 1.6 km of Lakeshore Drive. Based on the above perspective, we recommended reconstructing portions of Lakeshore Drive where base failure is suspected or there is high traffic (such as the portion between Stuart Drive and the access to Cottonwood Park), and to seal and patch the remainder of the road. This way more budget can be allocated to areas of the District where there is a greater benefit for the dollars spent.

Concrete Sidewalk Improvements

Sidewalk improvements are scheduled for the first year to eliminate the tripping hazards identified. An allowance has been allotted to complete this work.

Crack Sealing and Minor Patching

Crack sealing and patching on all roads that are not candidates for full depth reconstruction should be considered as higher priority. The investment in this preventive maintenance work could help avoid or delay more extensive base failure. Crack sealing and minor patching works are therefore recommended over the first two years with further investments on a regular basis as new cracks occur. Cost per meter for crack sealing of normal cracks was provided by Peace River Projects and applied to the amount of surface cracking observed during the RCA.

Mill & Overlay

When planning maintenance and surface repair works, road condition, expected life, and traffic volume should be considered in prioritizing work. Generally, higher traffic roads are recommended to be higher priority investments than the lower traffic roads. Delaying that work may result in more expensive reconstruction work for some of the road segments. It is recommended that core sampling and Benkelman beam testing be done as part of a geotechnical assessment to confirm that further base work is not required since full depth reclamation could be used instead of a mill and overlay to add base structure to these roads and extend their useful life.

Shoulder, Ditch and Drainage Improvements

We have provided an allowance for shoulder repair, ditch work and drainage improvements that will enable the District to address many of the issue found during the RCA. It is anticipated that this work will include

the grading of the built-up shoulders as well as other shoulder rehabilitation, establishing ditches, installation of culverts and other drainage works. It would be beneficial for the District to develop a Master Drainage Plan to present details on the existing drainage system and aid in planning the drainage improvements; however, initially there is shoulder grading and maintenance that should occur as soon as possible.

Reconstruction

There are some roads where we recommend planning for reconstruction:

- Birch Street alongside the elementary school (Higher traffic and large vehicles like buses)
- Lakeshore Drive between Stuart Drive and the north access to Cottonwood Park (Higher traffic accessing the park)
- Heathmont Street from the Highway to 7 Avenue (local residential traffic)
- 7 Avenue between Fir Street and Grove Street (local residential traffic)
- A portion of Pineridge Road (local residential traffic)

These roads, particularly the lower traffic roads with less significant distress, should be delayed for as many years as possible, even if it requires some patching. This will make budget available to complete maintenance repairs and resurfacing. In many cases local roads that have some structural failure can still accommodate local traffic without major impacts to vehicles. The reduced level of service, compared to a reconstructed road, may be necessary until the priority overlays, crack sealing and reconstruction of the more severe condition roads is complete.

For the budgeting purposes, we have provided the estimates for the roads recommended for reconstruction. These cost estimates are provided to give the District an idea of the cost to reconstruct these roads. The cost per meter for these roads can be used to estimate other similar roads if the District wishes to undertake the reconstruction sooner or as part of other infrastructure works.

The specific selection of road reconstruction should be based on the ongoing annual inspection of those candidate roads. Some of the roads that require reconstruction may remain in somewhat stable condition for many years. Others may deteriorate very quickly, such as over a single winter season.

Coordination with Other Infrastructure Works

The priorities provided in this report may be impacted by other capital works in the community. Buried infrastructure construction or other roadway improvements may change road priority timings. For example, if the District plans to install a new watermain and services under a road that is expected to undergo road works, the District should seek to align the road works with the watermain installation.

It is understood that the District is planning to assess the condition of some of the sewer piping in the community. It is suggested that the District try to include the assessment of the sewer infrastructure within the roads where rehabilitation works are recommended.

6.2 Proposed Capital Works

Priority road works were identified using the above considerations. The recommended road works can be seen on Map 7. Table 9 summarizes the costs associated with these priority road works in 2019 dollars. It is important to note that Table 9 does not include costs for ongoing annual maintenance work that should be accounted for in the District's annual budgeting.

Table 9: Priority Road Project Considerations

Road Rehabilitation	Costs
Sidewalk Tripping Hazards	$15,000
Crack Sealing and Patching	$240,000
Drainage Improvements: Shoulder Grading	$20,000
Geotechnical Review	$50,000
Drainage Improvements: Ditching and Culverts	$150,000
Mill & Overlay	$1,400,000
Reconstruction	$1,100,000
Sidewalk Replacement	$300,000
Total	**$3,275,000**

Currently, the District does not have a defined road maintenance and repair program. The District advised that current budgeting has $200,000 per year allocated for road work for the next several years, however, there may be opportunity to increase this budget if deemed necessary. At an annual budget of $200,000, it would take approximately 16 years to complete the recommended work, which does not account for inflation, ongoing regular maintenance and future rehabilitation work as it arises.

The report does not include specific recommendations for setting the District's roads budget; however, we have mapped out the start of a multi-year budget for consideration. The intent is to outline the priority of the various work items, and approximate costs for budgeting. From there, priority and timing of specific work can be reviewed in more detail and budgets refined based on what the level of service the District is able to provide and what they can afford.

Table 10 - Budget Framework for Consideration in Planning & Moving Forward

Rehabilitation Method	2020	2021	2022	2023	2024 & Onward
Sidewalk Tripping Hazards	$15,000				
Initial Crack Sealing and Patching	$120,000	$120,000			
Drainage Improvements: Shoulder Grading	$20,000				
Geotechnical Review	$50,000				
Drainage Improvements: Ditching and Culverts	$50,000	$50,000	$50,000		
Mill & Overlay		$1,400,000*			
Reconstruction					$1,100,000*
Sidewalk Replacement					$300,000*
Annual Crack Sealing and Patching			$40,000	$40,000	$40,000

*Work completed as it can be afforded, with both condition, political, and other required infrastructure work in mind.

It is important to note that costs are provided in 2019 Canadian Dollars. Costs should be adjusted for annual budgeting to reflect inflation and market changes.

The detailed cost estimates for the roads identified for rehabilitation can be found in Appendix B.

7.0 SUMMARY OF RECOMMENDATIONS

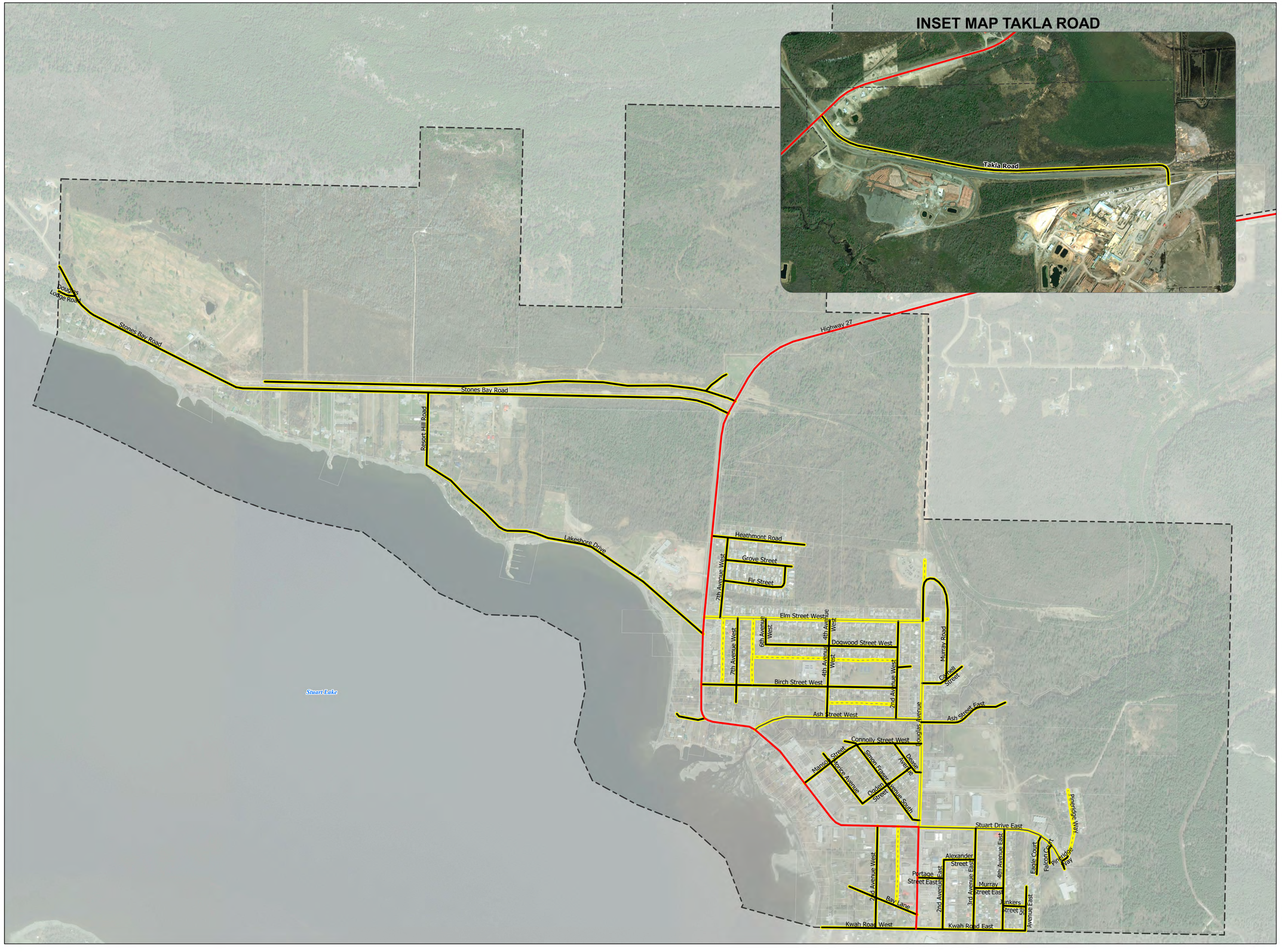
This RCA data, photos and videos taken during the field work will provide critical information to inform the District's roads capital program. This information will also be valuable when planning other infrastructure projects. Combining the transportation and other priority infrastructure works will ensure the District makes best use of their capital funds.

The District should consider the following short-term recommendations that will provide immediate benefits while also helping to enhance the District's ongoing road maintenance program:

1. Address identified safety concerns as soon as possible;
2. Replace sections of sidewalk to remove tripping hazards;
3. Allocate as much budget as possible over the next few years to crack sealing and minor patching. That work will be critical to slow the deterioration of the District's roads;
4. In the short term, grade road shoulders to remove built up gravel and vegetation to allow water to flow off the road surface;

5. Rehabilitate existing culverts and clear vegetation from ditches to prevent the pooling of water. Establish ditches and add culverts where necessary to convey storm water. The District may consider undertaking a drainage master plan to help guide drainage improvements.
6. Review and become familiar with the data collected from the RCA. There was a lot of information collected that can be used to help inform the District's capital program including establishing level of service and investment levels to sustain the District's roads. Information can be used to inform staff and Council decisions.
7. Have a Geotechnical review done for the roads to be rehabilitated;
8. Establish an annual road maintenance program for these maintenance activities;
9. Continue to monitor, track progress and update the RCA on a regular basis (annually or biennially), and focus on roads that are experiencing changes in conditions; and
10. Use the RCA database to assist in setting maintenance, rehabilitation and reconstruction priorities in conjunction with the priorities.
11. Establish and adhere to appropriate construction standards for backfilling of excavated areas to mitigate the chance of settlement that causes distortion of the roadway.

Appendix A: Maps



FORT ST JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Existing Road Classes & Roads Included in RCA

Legend

- Arterial
- Collector
- Local / Street
- Alleyway/Service
- Arterial/Highway/Expressway
- Roads Included in RCA

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 100 200 400 600 Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

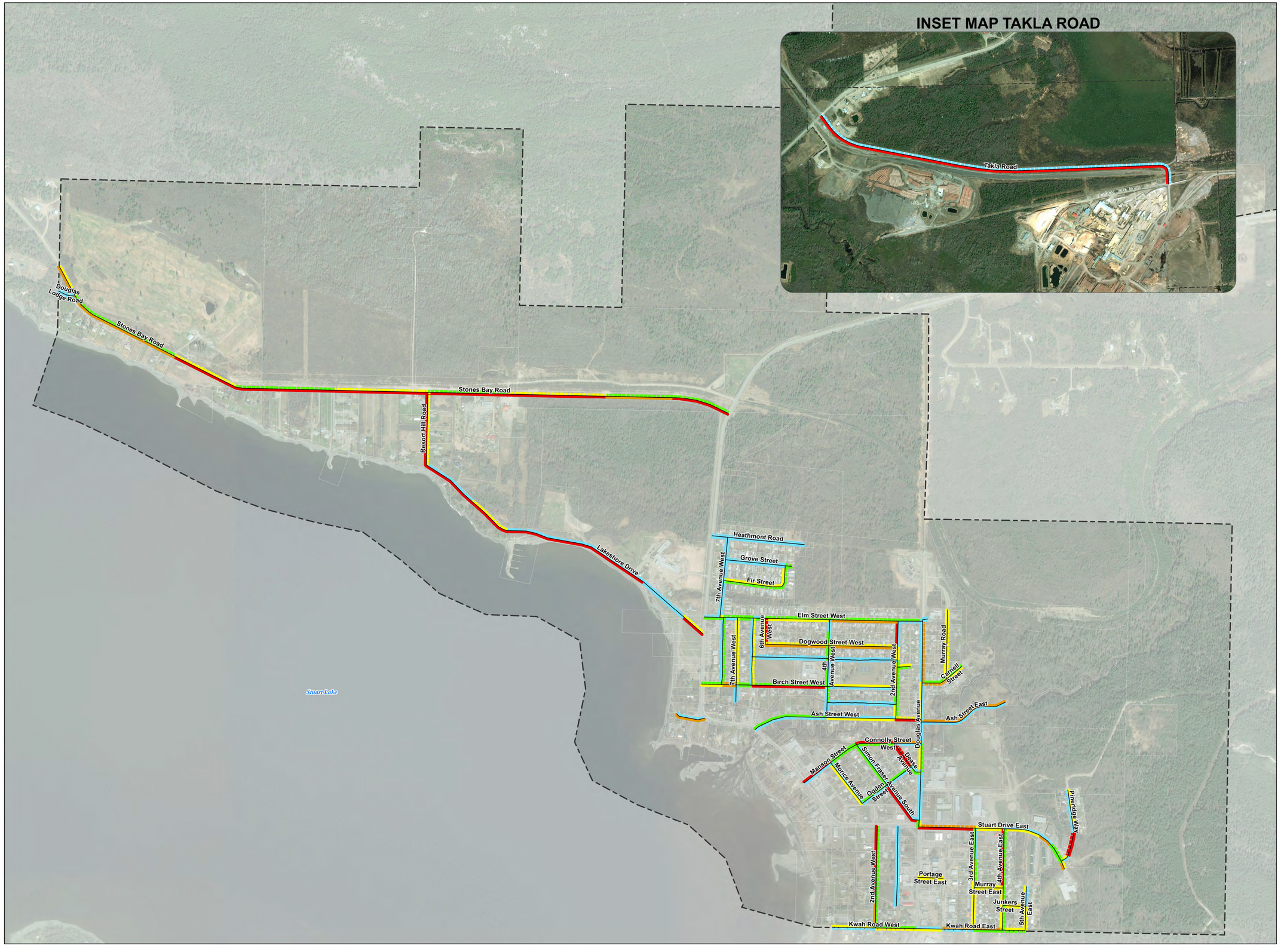
Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
Checked:	JH
Status:	Final
Revision:	A
Date:	2019 / 9 / 26

URBAN systems

FIGURE 1.0



FORT ST JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Paved Road Surface Distress Severity & Density Rankings

Legend

Severity Ranking	Density Ranking
1 - (0 - 100)	1 - (0 - 100)
2 - (101 - 200)	2 - (101- 200)
3 - (201 - 300)	3 - (201 - 300)
4 - (301 - 400)	4 - (301 - 400)
5 - (401 - 810)	5 - (401 - 550)

Note: The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not. This map includes distress severity and density ranking for paved roads only. Refer to field assessment forms for severity and density ranking of the gravel roads and lanes.

0 100 200 400 600
Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
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Status:	Final
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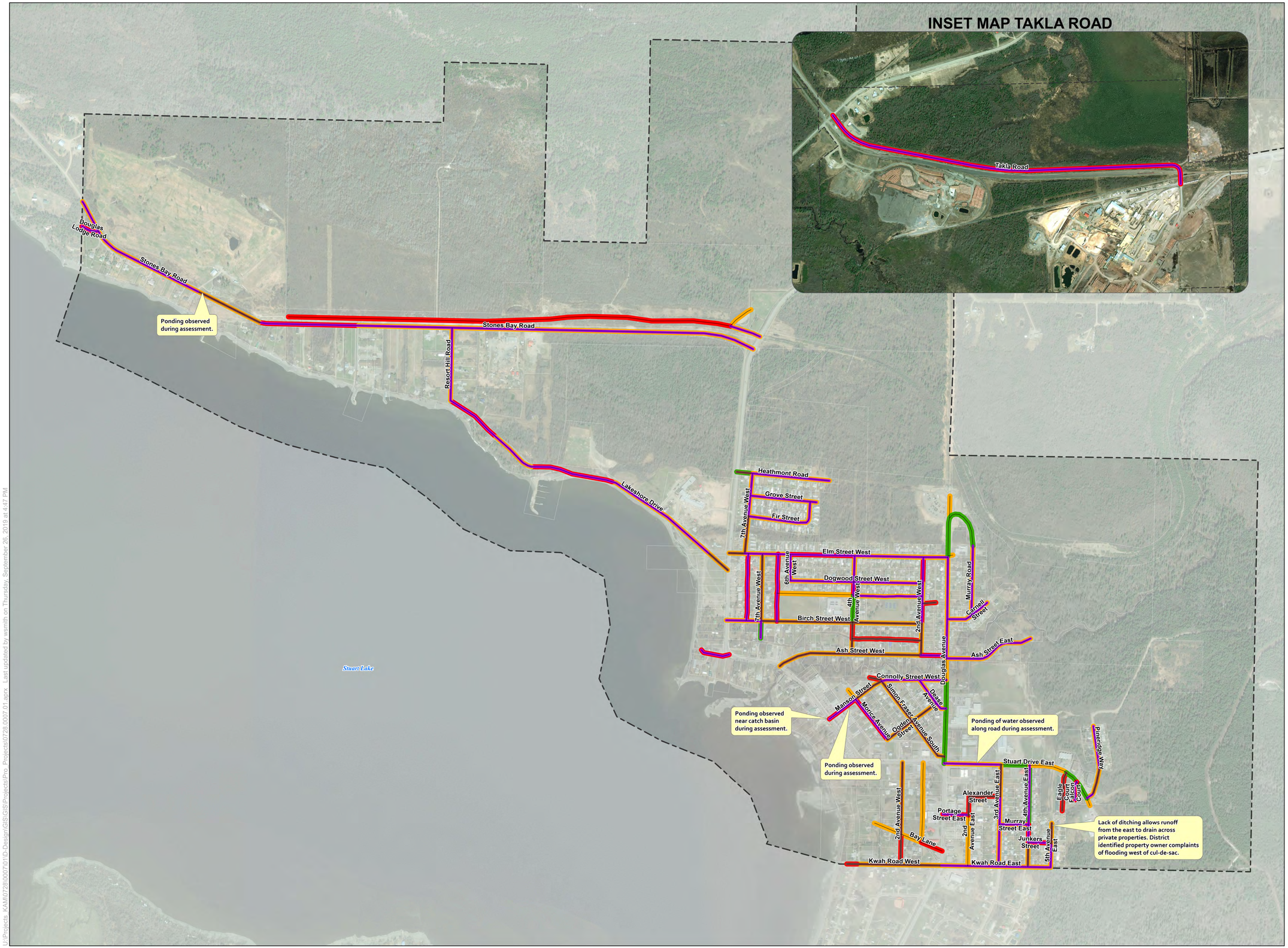
Date:	2019 / 9 / 26

URBAN systems

FIGURE 2.0



FORT ST JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Drainage Condition and Recommended Drainage Works

Legend

Recommended Drainage Works
- Establish/Rehab Ditches
- Establish/Rehab Surface Drainage

Drainage Condition
- Acceptable
- Borderline
- Unacceptable

0 50 100 200 300
Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

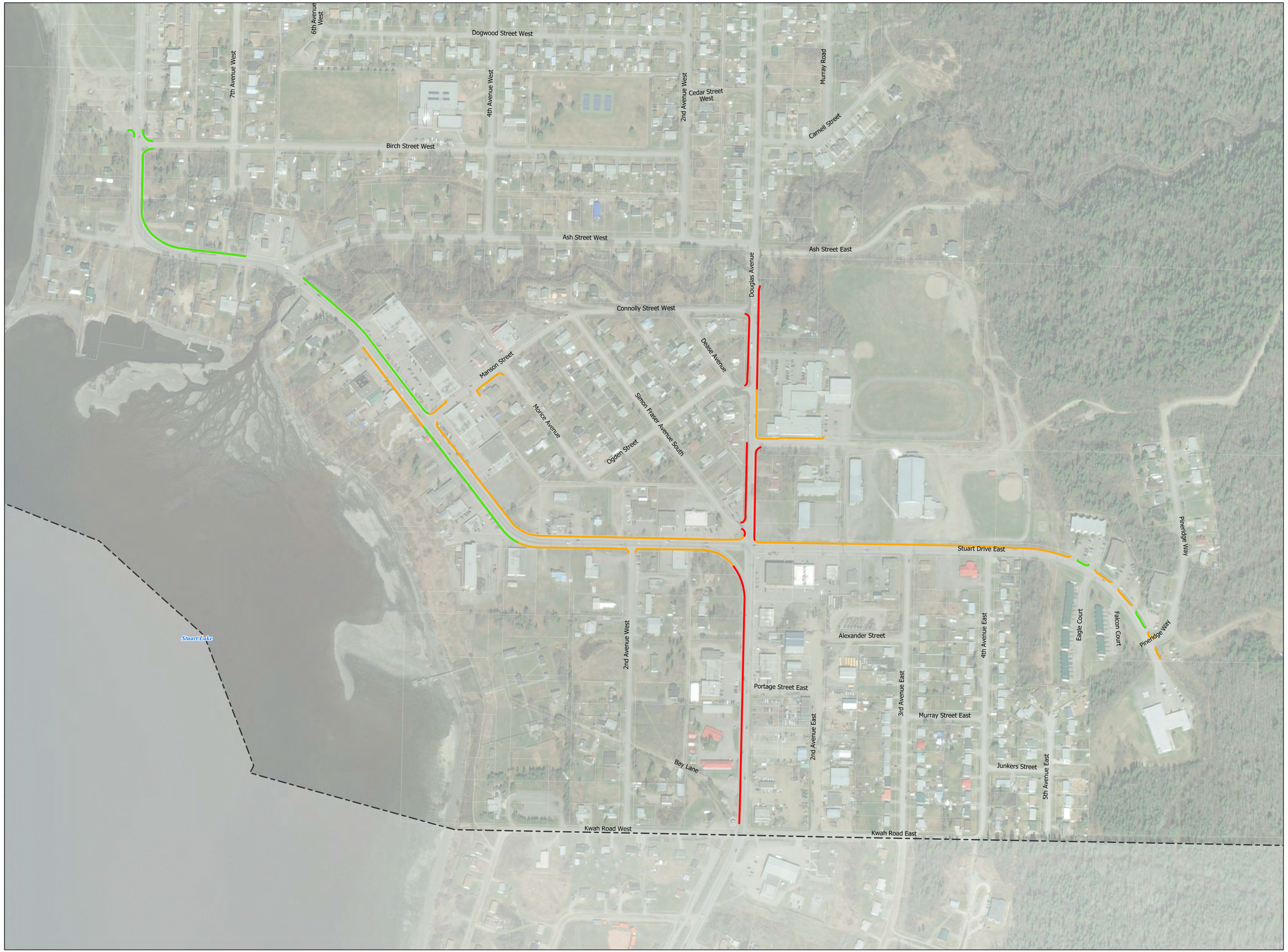
Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
Checked:	JH
Status:	Final
Revision:	A
Date:	2019 / 9 / 26

URBAN systems

FIGURE 3.0



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FORT ST JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Sidewalk Distress Severity

Legend

Condition Rating

- 1 - Poor
- 2 - Fair
- 3 - Good

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 25 50 100 150
Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

Scale:
1:2,500
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
Checked:	JH
Status:	**Final**
Revision:	A
Date:	2019 / 9 / 26

URBAN systems

FIGURE 4.0

FORT ST. JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Road Surface with High Severity Distresses Indicating Potential Base Failure

Legend

- High Density Alligator Cracking Pavement Edge Cracking
- High Density Rutting, Distortion Wheel Path Cracking
- Low Density Alligator Cracking, Pavement Edge Cracking
- Low Density Rutting Distortion Wheel Path Cracking

0 100 200 400 600 Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
Checked:	JH
Status:	Final
Revision:	A
Date:	2019 / 9 / 26

URBAN systems

FIGURE 5.0

FORT ST. JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Road Surface Ravelling Distress

Legend

Ravelling Over 50%

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 100 200 400 600
Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
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Status:	Final
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URBAN systems

FIGURE 6.0

FORT ST. JAMES DISTRICT

District of Fort St James

Road Corridor Assessment & Priority Ranking

Recommended Road Surface Works from Field Assessment

Legend

Recommended Surface Works

- Crack Seal & Minor Patching
- Crack Seal & Sections of Reconstruction
- Grade
- Mill & Overlay with Minor Base Repair
- Plan for Reconstruction

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 100 200 400 600
Metres

N

Coordinate System:
NAD 1983 UTM Zone 10N

Scale:
1:7,000
(When plotted at 22"x34")

Data Sources:
Roads provided by NRCAN
Municipal Boundary provided by DataBC

Project #:	0728.0007.01
Author:	WS
Checked:	JH
Status:	Final
Revision:	A
Date:	2019 / 9 / 26

URBAN systems

FIGURE 7.0

Appendix B: Cost Estimates

	Road ID		125465901		68848		236242, 154627		167472		134687	
			Lakeshore Drive		Pineridge Road		Birch Street W		7 Avenue W		Heathmont Street W	
	From		Stuart Lake Highway		310 Pineridge Road		7 Avenue W		Fir Street W		Stuart Lake Highway	
	To		160m West of Stuart Lake High		110m to the South		4 Avenue W		Grove Street W		7 Avenue W	
DESCRIPTION	**UNIT**	**UNIT PRICE**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**
Road Length	m		**160**		**110**		**360**		**85**		**65**	
Road Width	m		**7.1**		**7.0**		**7.0**		**7.0**		**7.0**	
Mobilization and Insurance Attributable to Road Works	L.S.	1	$5,700	$ 5,700	$3,100	$ 3,100	$12,700	$ 12,700	$2,400	$ 2,400	$13,000	$ 13,000
Sawcut Existing Asphalt	m	$ 11	14	$ 156	14	$ 154	14	$ 154	14	$ 154	14	$ 154
Asphalt Removal	Sq.m.	$ 8	1136	$ 9,088	770	$ 6,160	2520	$ 20,160	595	$ 4,760	455	$ 3,640
Pulverize, Stabilize and Shape Asphalt Top Gravels (Gravels shown below)	Sq.m.	$ 10		$ -		$ -		$ -		$ -		$ -
Milling (Skid-steer Mounted Machine)	Sq.m.	$ 5		$ -		$ -		$ -		$ -		$ -
Milling (Larger Areas)	Sq.m.	$ 4		$ -		$ -		$ -		$ -		$ -
Common Excavation and Disposal	Sq.m.	$ 8	1136	$ 9,088	770	$ 6,160	2520	$ 20,160	595	$ 4,760	455	$ 3,640
Remove and Replace Unsuitable Soils	Cu.m.	$ 30	114	$ 3,408	77	$ 2,310	252	$ 7,560	60	$ 1,785	46	$ 1,365
Base and Gravel Preparation												
.1 Subgrade Preparation	Sq.m.	$ 4	1136	$ 4,544	770	$ 3,080	2520	$ 10,080	595	$ 2,380	455	$ 1,820
.2 Geogrid (Tensar BX1100 or equivalent) and Non-Woven Geotextile	Sq.m.	$ 6		$ -		$ -		$ -		$ -		$ -
.3 Supply and Place Gravels (Large Areas)												
(i) Arterial Road Sub-base Gravel (450 mm)	Sq.m.	$ 30	1136	$ 34,080		$ -	2520	$ 75,600		$ -		$ -
(ii) Arterial Road Base Gravel or Extra Gravel When Pulverizing (75 mm)	Sq.m.	$ 17	1136	$ 19,312		$ -	2520	$ 42,840		$ -		$ -
(iii) Local Road Sub-base Gravel (400 mm)	Sq.m.	$ 27		$ -	770	$ 20,790		$ -	595	$ 16,065	455	$ 12,285
(iv) Local Base Gravel (65 mm)	Sq.m.	$ 14		$ -	770	$ 10,780		$ -	595	$ 8,330	455	$ 6,370
.4 Supply and Place Gravels (Small Areas / Patches)												
(i) Sub-base Gravel (450 mm)	Sq.m.	$ 48		$ -		$ -		$ -		$ -		$ -
(ii) Base Gravel (75 mm)	Sq.m.	$ 30		$ -		$ -		$ -		$ -		$ -
Asphalt												
.1 Prime Coating or Tack Coating	Sq.m.	$ 2	1136	$ 2,272	770	$ 1,540	2520	$ 5,040	595	$ 1,190	455	$ 910
.2 Arterial Asphalt Surface (100mm) for Areas Requiring Patching	Sq.m.	$ 54	1136	$ 61,344		$ -	2520	$ 136,080		$ -		$ -
.3 Local Asphalt Surface (65mm)	Sq.m.	$ 36		$ -	770	$ 27,720		$ -	595	$ 21,420	455	$ 16,380
.4 Level Course (not needed in all instances)	Sq.m.	$ 9		$ -		$ -		$ -		$ -		$ -
.5 Asphalt Overlay (50 mm)	Sq.m.	$ 27		$ -		$ -		$ -		$ -		$ -
Allowance for Adjustments, Tie-ins and Restoration Ditching, Culverts, Driveway tie-ins, Topsoil and Seeding, Utility Adjustements and Signage	ls	1	1	$ 22,349	1	$ 12,270	1	$ 49,557	1	$ 9,487	1	$ 8,935
SUB-TOTAL ROAD WORKS (Rounded)				**$ 171,000**		**$ 94,000**		**$ 380,000**		**$ 73,000**		**$ 68,000**
Comments			**Full Depth Reconstruction**		**Full Depth Reconstruction**		**Full Depth Reconstruction**		**Full Depth Reconstruction**		**Full Depth Reconstruction**	
SUMMARY												
SUB-TOTAL ROAD WORKS (Rounded)				$ 171,000		$ 94,000		$ 380,000		$ 73,000		$ 68,000
				$ 171,000		**$ 94,000**		**$ 380,000**		**$ 73,000**		**$ 68,000**
Other, Non-Standard Items				$ -		$ -		$ -		$ -		$ -
Survey, Geotechnical and Civil Engineering, Tendering, Contract Administration and Contingency			35%	$ 60,000	35%	$ 33,000	35%	$ 133,000	35%	$ 26,000	35%	$ 24,000
TOTAL (Rounded):				**$ 230,000**		**$ 130,000**		**$ 510,000**		**$ 100,000**		**$ 90,000**

	Road ID		158592		112704, 191908		109712		133750, 119784, 29504, 261182, 233560, 125168		50910	
			Stuart Drive E		Dease Avenue		Douglas Avenue		2 Avenue W		Heathmont Street W	
	From		Douglas Avenue		Douglas Avenue		Elm Street W		Elm Street W		7 Avenue W	
	To		3 Avenue E		Connolly Street		Carnell Street		Ash Street W		East End	
DESCRIPTION	**UNIT**	**UNIT PRICE**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**
Road Length	m		**225**		**165**		**245**		**390**		**305**	
Road Width	m		**10.8**		**6.2**		**7.0**		**6.7**		**7.0**	
Mobilization and Insurance Attributable to Road Works	L.S.	1	$5,800	$ 5,800	$3,800	$ 3,800	$4,200	$ 4,200	$6,400	$ 6,400	$5,200	$ 5,200
Sawcut Existing Asphalt	m	$ 11		$ -		$ -		$ -		$ -		$ -
Asphalt Removal	Sq.m.	$ 8	2430	$ 19,440	1023	$ 8,184	1715	$ 13,720	2613	$ 20,904	2135	$ 17,080
Pulverize, Stabilize and Shape Asphalt Top Gravels (Gravels shown below)	Sq.m.	$ 10		$ -		$ -		$ -		$ -		$ -
Milling (Skid-steer Mounted Machine)	Sq.m.	$ 5		$ -		$ -		$ -		$ -		$ -
Milling (Larger Areas)	Sq.m.	$ 4	2430	$ 9,720	1023	$ 4,092	1715	$ 6,860	2613	$ 10,452	2135	$ 8,540
Common Excavation and Disposal	Sq.m.	$ 8		$ -		$ -		$ -		$ -		$ -
Remove and Replace Unsuitable Soils	Cu.m.	$ 30	122	$ 3,645	153	$ 4,604	86	$ 2,573	131	$ 3,920	107	$ 3,203
Base and Gravel Preparation												
.1 Subgrade Preparation	Sq.m.	$ 4	243	$ 972	307	$ 1,228	172	$ 686	261	$ 1,045	214	$ 854
.2 Geogrid (Tensar BX1100 or equivalent) and Non-Woven Geotextile	Sq.m.	$ 6		$ -		$ -		$ -		$ -		$ -
.3 Supply and Place Gravels (Large Areas)												
(i) Arterial Road Sub-base Gravel (450 mm)	Sq.m.	$ 30		$ -		$ -		$ -		$ -		$ -
(ii) Arterial Road Base Gravel or Extra Gravel When Pulverizing (75 mm)	Sq.m.	$ 17		$ -		$ -		$ -		$ -		$ -
(iii) Local Road Sub-base Gravel (400 mm)	Sq.m.	$ 27		$ -		$ -		$ -		$ -		$ -
(iv) Local Base Gravel (65 mm)	Sq.m.	$ 14		$ -		$ -		$ -		$ -		$ -
.4 Supply and Place Gravels (Small Areas / Patches)												
(i) Sub-base Gravel (450 mm)	Sq.m.	$ 48	243	$ 11,664	307	$ 14,731	172	$ 8,232	261	$ 12,542	214	$ 10,248
(ii) Base Gravel (75 mm)	Sq.m.	$ 30	243	$ 7,290	307	$ 9,207	172	$ 5,145	261	$ 7,839	214	$ 6,405
Asphalt												
.1 Prime Coating or Tack Coating	Sq.m.	$ 2	2430	$ 4,860	1023	$ 2,046	1715	$ 3,430	2613	$ 5,226	2135	$ 4,270
.2 Arterial Asphalt Surface (100mm) for Areas Requiring Patching	Sq.m.	$ 54	243	$ 13,122	307	$ 16,573	172	$ 9,261	261	$ 14,110	214	$ 11,529
.3 Local Asphalt Surface (65mm)	Sq.m.	$ 36		$ -		$ -		$ -		$ -		$ -
.4 Level Course (not needed in all instances)	Sq.m.	$ 9	900	$ 8,100	660	$ 5,940	980	$ 8,820	1560	$ 14,040	1220	$ 10,980
.5 Asphalt Overlay (50 mm)	Sq.m.	$ 27	2430	$ 65,610	1023	$ 27,621	1715	$ 46,305	2613	$ 70,551	2135	$ 57,645
Allowance for Adjustments, Tie-ins and Restoration Ditching, Culverts, Driveway tie-ins, Topsoil and Seeding, Utility Adjustements and Signage	ls	1	1	$ 22,534	1	$ 14,704	1	$ 16,385	1	$ 25,055	1	$ 20,394
SUB-TOTAL ROAD WORKS (Rounded)				**$ 173,000**		**$ 113,000**		**$ 126,000**		**$ 192,000**		**$ 156,000**
Comments			**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**	
SUMMARY												
SUB-TOTAL ROAD WORKS (Rounded)				$ 173,000		$ 113,000		$ 126,000		$ 192,000		$ 156,000
				$ 173,000		**$ 113,000**		**$ 126,000**		**$ 192,000**		**$ 156,000**
Other, Non-Standard Items				$ -		$ -		$ -		$ -		$ -
Survey, Geotechnical and Civil Engineering, Tendering, Contract Administration and Contingency		30%		$ 52,000	30%	$ 34,000	30%	$ 38,000	30%	$ 58,000	30%	$ 47,000
TOTAL (Rounded):				**$ 230,000**		**$ 150,000**		**$ 160,000**		**$ 250,000**		**$ 200,000**

	Road ID		220411		244809		132953		11912		220411	
			Ash Street W		7 Avenue W		7 Avenue W		4 Avenue W		Ash Street W	
	From		2 Avenue W		Elm Street W		Grove Street W		Birch Street W		Douglas Avenue	
	To		Douglas Avenue		Fir Street W		Heathmont Street W		Lane		2 Avenue W	
DESCRIPTION	**UNIT**	**UNIT PRICE**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**	**Estimated Quantity**	**Amount**
Road Length	m		**100**		**150**		**90**		**65**		**100**	
Road Width	m		**7.0**		**7.0**		**7.0**		**6.5**		**6.7**	
Mobilization and Insurance Attributable to Road Works	L.S.	1	$2,100	$ 2,100	$2,600	$ 2,600	$1,500	$ 1,500	$1,000	$ 1,000	$2,100	$ 2,100
Sawcut Existing Asphalt	m	$ 11		$ -		$ -		$ -		$ -		$ -
Asphalt Removal	Sq.m.	$ 8	700	$ 5,600	1050	$ 8,400	630	$ 5,040	423	$ 3,380	670	$ 5,360
Pulverize, Stabilize and Shape Asphalt Top Gravels (Gravels shown below)	Sq.m.	$ 10		$ -		$ -		$ -		$ -		$ -
Milling (Skid-steer Mounted Machine)	Sq.m.	$ 5		$ -		$ -		$ -		$ -		$ -
Milling (Larger Areas)	Sq.m.	$ 4	700	$ 2,800	1050	$ 4,200	630	$ 2,520	423	$ 1,690	670	$ 2,680
Common Excavation and Disposal	Sq.m.	$ 8		$ -		$ -		$ -		$ -		$ -
Remove and Replace Unsuitable Soils	Cu.m.	$ 30	70	$ 2,100	53	$ 1,575	32	$ 945	21	$ 634	67	$ 2,010
Base and Gravel Preparation												
.1 Subgrade Preparation	Sq.m.	$ 4	140	$ 560	105	$ 420	63	$ 252	42	$ 169	134	$ 536
.2 Geogrid (Tensar BX1100 or equivalent) and Non-Woven Geotextile	Sq.m.	$ 6		$ -		$ -		$ -		$ -		$ -
.3 Supply and Place Gravels (Large Areas)												
(i) Arterial Road Sub-base Gravel (450 mm)	Sq.m.	$ 30		$ -		$ -		$ -		$ -		$ -
(ii) Arterial Road Base Gravel or Extra Gravel When Pulverizing (75 mm)	Sq.m.	$ 17		$ -		$ -		$ -		$ -		$ -
(iii) Local Road Sub-base Gravel (400 mm)	Sq.m.	$ 27		$ -		$ -		$ -		$ -		$ -
(iv) Local Base Gravel (65 mm)	Sq.m.	$ 14		$ -		$ -		$ -		$ -		$ -
.4 Supply and Place Gravels (Small Areas / Patches)												
(i) Sub-base Gravel (450 mm)	Sq.m.	$ 48	140	$ 6,720	105	$ 5,040	63	$ 3,024	42	$ 2,028	134	$ 6,432
(ii) Base Gravel (75 mm)	Sq.m.	$ 30	140	$ 4,200	105	$ 3,150	63	$ 1,890	42	$ 1,268	134	$ 4,020
Asphalt												
.1 Prime Coating or Tack Coating	Sq.m.	$ 2	700	$ 1,400	1050	$ 2,100	630	$ 1,260	423	$ 845	670	$ 1,340
.2 Arterial Asphalt Surface (100mm) for Areas Requiring Patching	Sq.m.	$ 54	140	$ 7,560	105	$ 5,670	63	$ 3,402	42	$ 2,282	134	$ 7,236
.3 Local Asphalt Surface (65mm)	Sq.m.	$ 36		$ -		$ -		$ -		$ -		$ -
.4 Level Course (not needed in all instances)	Sq.m.	$ 9	400	$ 3,600	600	$ 5,400	360	$ 3,240	260	$ 2,340	400	$ 3,600
.5 Asphalt Overlay (50 mm)	Sq.m.	$ 27	700	$ 18,900	1050	$ 28,350	630	$ 17,010	423	$ 11,408	670	$ 18,090
Allowance for Adjustments, Tie-ins and Restoration Ditching, Culverts, Driveway tie-ins, Topsoil and Seeding, Utility Adjustements and Signage	ls	1	1	$ 8,331	1	$ 10,036	1	$ 6,013	1	$ 4,057	1	$ 8,011
SUB-TOTAL ROAD WORKS (Rounded)				**$ 64,000**		**$ 77,000**		**$ 46,000**		**$ 31,000**		**$ 61,000**
Comments			**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**		**Mill & Overlay with Base Repair**	
SUMMARY												
SUB-TOTAL ROAD WORKS (Rounded)				$ 64,000		$ 77,000		$ 46,000		$ 31,000		$ 61,000
				$ 64,000		**$ 77,000**		**$ 46,000**		**$ 31,000**		**$ 61,000**
Other, Non-Standard Items				$ -		$ -		$ -		$ -		$ -
Survey, Geotechnical and Civil Engineering, Tendering, Contract Administration and Contingency			30%	$ 19,000	30%	$ 23,000	30%	$ 14,000	30%	$ 9,000	30%	$ 18,000
TOTAL (Rounded):			**$ -**	**$ 80,000**		**$ 100,000**		**$ 60,000**		**$ 40,000**		**$ 80,000**