5-Year Road Improvement Program

RECOMMENDATION:

THAT Council receive this report for information
AND THAT Council consider the proposed 5-Year Road Improvement Program outlined in this report during the 2018-2022 5-Year Financial Plan budget deliberations.

Report Summary:

In summer 2017, staff contracted Opus International Consultants Ltd. to conduct a pavement condition assessment covering the entire Sooke road network. The District has now received the report (Appendix A) which forecasts what will be required to reinstate and maintain the entire road network over the next 30 years.

Report:

2017 Pavement Condition Assessment

Earlier this year, staff contracted Opus International Consultants Ltd. to conduct a full-network pavement condition assessment, and summarize the data in a report. From this assessment, they have created a thirty-year budgeting model, which has been delivered with settings derived by Opus from analysis of the condition data and pavement life assumptions. Construction cost estimates used within the model were derived by Opus based on data obtained from various municipalities in the lower Vancouver Island area. To establish baseline values to populate the model, road sections are rated for roughness, cracking, rutting, raveling, and patching. The ratings for all criteria are compiled to form a Pavement Condition Index (PCI), which is the basis for determining when a section of road is due for remediation, and what form of remediation is recommended. Within the model, the road PCI deteriorates annually to coincide with the deterioration of the road.

Treatments include 40mm grind & pave, 80mm grind & pave, and full reconstruction. 'Trigger values', or 'treatment triggers' are the threshold PCI values which determine the recommended type of treatment. As a road naturally deteriorates, its PCI will eventually drop below the treatment trigger for a 40mm grind & pave. If treated promptly, the PCI will return back to that of a new road. If left untreated, the PCI (and road) will continue to deteriorate for a number of years, crossing the trigger value for an 80mm grind & pave, and then eventually again for full reconstruction. The estimated cost (based on data obtained from various surrounding municipalities) for an 80mm grind & pave is over double that for the 40mm equivalent ($38/square meter vs $18/square meter), and the cost of reconstruction is over double again ($80/square meter). This highlights the importance of promptly repairing the recommended roads before they deteriorate past the threshold of requiring more extensive treatments. The report determines that the

road network is heavily divided, with 56% of the network rating as very good to good(new developments), 20% rating as fair, and 23% rating as poor to failed (older roads).

Because of the high percentage of roads with PCI's already below the trigger values for treatment, the budget model is heavily loaded towards year one, with respective first-year works totaling an estimated $3.7 million of the total $8.0 million forecasted for the thirty-year cycle. With the heavy front-end cost, it is more practical from a budgetary and construction basis to stagger the work over five years. The total cost of the first five years of work as presented in the Opus report is approximately $4.06 million which translates to approximately $800,000 per year. After catching up with the massive 'backlog' in the first five years, the required works become maintenance-oriented, averaging closer to $170,000 per year over the remaining twenty-five years to keep the existing road network above the trigger PCI.

5-Year Road Improvement Program

Staff reviewed the Opus report, which is based entirely off raw condition data, and arranged it into a 5-Year Road Improvement Program which is practical and cost-effective from a construction perspective, as well as manageable from a budgetary perspective. Mobilization of equipment is expensive, so staff have split the road segments into groupings where cost of works in a small area totalled at least $100,000. A small number of segments are removed from the model because they are tied to larger issues and will be addressed with other projects, such as Charters Road with the embankment stabilization scheduled for 2019. Other segments are removed from the initial five-year program because they are adjacent to significant segments of road due for remediation in years five to ten. In these cases, it is more practical to delay for a year or two and complete the work all together. These modifications lower the total estimated cost of the Five-Year Road Improvement Program to $3,400,000, compared to the $4,060,000 forecast in the Opus report.

Another objective of dividing up the road segments is to balance the work in regard to dollar value across the five years. The total cost of all works recommended by staff for completion within the first five years is estimated at $3,400,000. Staff have divided this evenly into $700,000 segments over the first four years, with the final years' estimate summing $600,000. The detailed list of road segments and associated costs is attached as the Five-Year Road Improvement Program Breakdown (Appendix B). Colour-coded maps showing the geographic distribution of projects are attached as the Project Distrubution Maps (Appendix C).

In order to commence work on the 5-Year Road Improvement Program, staff will request to enter the first year with a budget of $800,000. Staff will be requesting $100,000 over the $700,000 estimate in order to have a buffer when establishing real costs vs. estimates. Although the cost estimates within the budgetary model include a contingency, there are unknowns within the estimates regarding transportation of personnel, equipment, and materials to Sooke, as compared to the communities from which the cost data was obtained. Leftover funds would become surplus which could be used to help fund the following year if Council so desires. The first year of works will

provide a much more accurate budgeting template moving onward to the second year and beyond, which will eliminate the need for such a large contingency.

If authorized to move forward with the first year of road remediation, staff would aim to tender the project over the winter so that work could begin in spring 2018, weather permitting.

Budget/Financial Impacts:

The 5-Year Road Improvement Program will require an $800,000 budget for the first year, and an estimated $700,000 per year for the remaining four years (subject to change based on real-world costs). Funding options will be discussed during the 2018 5-Year Financial Plan deliberations.

Frequently Asked Questions:

Q: How are the roads prioritized from year to year?
A: Roads are not individually prioritized per se. All segments in the list are determined by the model for remediation within the next five years (83% are already within trigger values for immediate remediation). Because there is similar importance between addressing a failed road, and addressing a road on the tipping point of failure (where delays lead to increased remediation costs), segments are treated with equal importance, and sorted based on establishing practical and cost-effective construction projects in a configuration that balances the required budget annually over five years. Essentially, all the year-one triggered segments are considered a year-one priority, but creating a realistic budget plan requires the one large $3.4 million project to be spread evenly over five years, with considerations for correlative DCC upgrades (sidewalks), and/or drainage projects.

Q: "X" section of "Y" road is in bad shape; why isn't it on the list?
A: The PCI rating is based on an average of all condition ratings over the entire segment of road. Some segments are as short as 24m, while others are over 1km. Within the larger segments it is likely that there are problem areas not reflected in the PCI. With approximately 90km of paved road, it would be a monumental task to plot and organize thousands of small segments, and unrealistic to arrange them into cost-effective construction projects, thus the reliance on average ratings.

Q: Are there any plans to address some of these problem sections before the entire segment as a whole comes up for remediation?
A: Staff will look for opportunities to apply treatments to these problem sections when there is a contractor in town for the respective year's works. Staff will propose plans for extra work to Council if there is budget remaining after the main works for the year are completed.

Q: What is the impact on holding off for a couple years before getting started?
A: In order to compare the difference between starting the works immediately, compared to waiting until the end of our 2018 5-Year Financial Plan to begin, staff

reconfigured the budget model to simulate what the first five years of road rehabilitation would look like if the roads were allowed to deteriorate at the standard rate for an additional 5 years before commencing works. To get an accurate comparison, staff forecasted the first ten years of works under the standard and modified copies of the model. Beginning the works immediately yields a sum of $4,450,206 for the first ten years of remediation works. Waiting five years to begin results in a ten-year sum of $5,684,966, a difference of over $1.2 million (not accounting for inflation). The reason for such a large discrepancy between the two is that the extra five years gives a number of roads time to deteriorate to the point of requiring a more intensive and expensive treatment type.This is shown in table and graph form in the 10-Year Outlooks (Appendix D).

Strategic Relevance:

1. Fiscal Sustainability
2. Community Planning
3. Community Livability
4. Good Governance

Neglecting the required remediation will lead to both an increase in the number of roads needing treatment, as well as an increase in the cost of remediation for the roads already under the trigger PCI threshold.

Attached Documents:

District of Sooke Pavement Management Report_210917_Final_v3 - Copy
Five-Year Road Improvement Program Breakdown
Project Distribution Maps
10-Year Outlooks

2017 Pavement Condition Assessment

District of Sooke

2017 Pavement Condition Assessment

Prepared By
Neil Forrest

Reviewed By
Raphaelle Cardyn

Approved for Release By
Carol Campbell P.Eng

Opus International Consultants (Canada) Limited
Victoria Office
Suite 310, 1207 Douglas Street
Victoria BC V8W 2E7
Canada

Telephone: +1 250 952 5640
Facsimile: +1 250 920 5620

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Status: Final

Contents

Executive Summary

Introduction

Municipalities across Canada, including the District of Sooke (the District), are challenged with maintaining aging infrastructure which demands substantial rehabilitation at a time of competing needs and budgetary constraints.

The District sought assistance from Opus International Consultants (Canada) Limited (Opus) to assess its 90 centreline kilometers of road network ranging from arterial collectors to local roads, report current condition, and assist in identifying maintenance and rehabilitation strategies.

Pavement Condition Assessment

A comprehensive pavement condition data collection program was undertaken for the District's entire road network in June 2017. The surveys consisted of the following data capture:

- Pavement Surface Distress;
- Pavement Rutting, and;
- Pavement Roughness.

Current Condition

Pavement condition can be reported in a number of ways. For the District, the condition is reported by defect, and as a Pavement Condition Index (PCI). The PCI is used to provide a quick reference to overall condition, and is calculated using the cracking, ravelling and pothole surface distresses, and pavement rutting. The results of the PCI analysis are shown as an average by road class below:

Collector Road Network – The Collector Road network has an average PCI value of 61.7, which equates to a "Fair" condition on the PCI scale;
Local Road Network – The Local Road network has an average PCI value of 75.9, which equates to a "Good" condition on the PCI scale;

As an example, the District's current pavement condition as a PCI has been spread across the seven bin system and shown as a percentage within each condition state is shown in Table 5 below.

Table 5: Percentage of Road Network (centreline km) by PCI Range and Condition States

	Condition States (PCI Range)						
	Very Good	Good	Fair	Poor	Very Poor	Serious	Failed
Roadway Class	**100-85**	**84-70**	**69-55**	**54-40**	**39-25**	**24-10**	**9 -0**
Collector Roads	**27%**	**23%**	**29%**	**10%**	**8%**	**1%**	**4%**
Local Roads	**47%**	**11%**	**18%**	**8%**	**7%**	**5%**	**5%**

The PCI results for the Collector Road network show that 50% of the network is in good or very good condition, 29% of the network is in fair condition, 18% of the network in poor and very poor condition, and the remaining 5% is in serious to failed condition.
In contrast, the Local Road network has 58% in good or very good condition, 18% in fair condition, 15% in poor and very poor condition, and the remaining 10% in serious to failed condition.

Rehabilitation Strategy

The foundational principal of preserving pavement assets is to ensure that they are protected from the damaging effects of water ingress into the pavement and underlying sub-grade layers. All forms of surface distress that will allow entry of water should be treated.

The Districts' road network is a network of two halves. Half of the network is in good condition overall due to being newer or recently repaved. However, the other half (older) of the network falls into the "Fair" to "Failed" condition state category. Based on the current pavement condition rating, the rehabilitation tactics recommended for this strategy are to;

- Identify road sections where the current pavement condition rating is at its lowest, and;
- Apply the most effective treatment that will maintain current service levels.

Budget and Treatments

A model has been developed to enable forecasting of network budgets for each of the next 30 years. The model does not contain any logic that caps total budgets or "smooths out" peak budget calculations across a number of years. The District's engineering staff will use the model outputs to forecast future budget requirements and as the basis for producing forward work programs.

The model calculates a budget cost for each of the selected treatments for each of the next 30 years.

Recommended Future Actions

- The budget model has been delivered with settings derived by Opus from analysis of the condition data and pavement life assumptions. These assumptions and settings will be adjusted by the user based on experience with the model, as described in Section 6.3.

- The Distress Triggers, Treatment Triggers, and Deterioration rates should be reviewed every two years.

- At the completion of future rehabilitation work, the PCI should be reset to 100.

- In the District's GIS System, each road should be assigned an overarching road number, and then split into sections (10, 20 etc.) at easily identifiable locations such as change in road classification, change from urban to rural or vice-versa, intersection to intersection, or where road widths substantially differ (more than 2 metres in width). This enables the District to add in new sections when changes in the roadway occur.

- Further attribute data should be created for all street sections including construction details such as depth, material type, and construction date for each pavement layer. Where this data

does not exist, consider making assumptions. Replace with factual information at time of treatments.

- Where assumed values exist in the database, Opus recommends validating the assumptions over a period of four years. A business process should be established that then updates this data over the next four years. Having this data enables the District to make informed decisions around planning and spending going forward.

- Condition data should be collected again in three to five years' time, firstly to provide an idea of actual deterioration rates against the assumed rates within this report, and secondly to assess the effectiveness of any maintenance work that has been completed. The suitability of the budget model should also be reviewed at the same time, as it may be that a more sophisticated deterioration and optimization model is appropriate.

Conclusions

- The District's road network is a network of two halves. The first being in good overall condition due to new developments. The other half of the network is older and has roads that are in very poor to failed condition.

- The new budgeting tool will assist the District of Sooke Engineering staff to identify long term budgeting requirements to maintain it at a defined level of service over the long term.

- The new budgeting tool will also assist the District in identifying potential candidate for treatment,

- This tool and the associated calibration and verification work should signal the commencement of a long term business process which has an objective of ensuring that a sustainable level of investment in pavement rehabilitation maintains the street network at an agreed level of service.

1 Introduction

Municipalities across Canada are challenged with maintaining aging infrastructure which demands substantial rehabilitation at a time of competing need and budgetary constraints. The District of Sooke (District) is faced with this predicament and requires an innovative and proactive approach to managing infrastructure assets to meet desired levels of service.

The District sought assistance from a consultant to evaluate its road network and assist in identifying maintenance and rehabilitation strategies. Opus International Consultants (Canada) Limited (Opus) were subsequently commissioned by the District to provide these pavement management services.

1.1 Purpose

The purpose of this report is to;

- Describe the Road Network;
- Describe the condition data collection process;
- Make observations on current network condition;
- Provide a list of prioritized sections with recommended treatments;
- Recommend a rehabilitation strategy and indicative long term budget;
- Document the development and workings of a simple spreadsheet based pavement budgeting model; and
- Recommend future actions the District could take to improve its network knowledge.

2 Network

The District of Sooke is a municipality situated on the southern tip of Vancouver Island, Canada. Located approximately 38 kilometres by road from the city of Victoria, Sooke is considered the westernmost of the "Western Communities". Sooke has gained increasing popularity as a scenic tourist destination due to its beaches, vibrant arts community, and world renowned regional and provincial parks including Whiffin Spit Park, Sooke Potholes Provincial Park, West Coast Trail and the Juan de Fuca Provincial Trail. Sooke is also a popular cycling route due to its access to Victoria via the Galloping Goose Regional Trail.

2.1 Network Hierarchy

The District's road network is accessed from Highway 14, a Provincial Highway. The road network is approximately 90 centreline kilometres in length. The District's road network is split into two hierarchical classifications; collector roads, and local roads. The length surveyed in each class is shown in Table 1 and mapped in Figure 1.

Table 1: District of Sooke Road Inventory (Road-km)

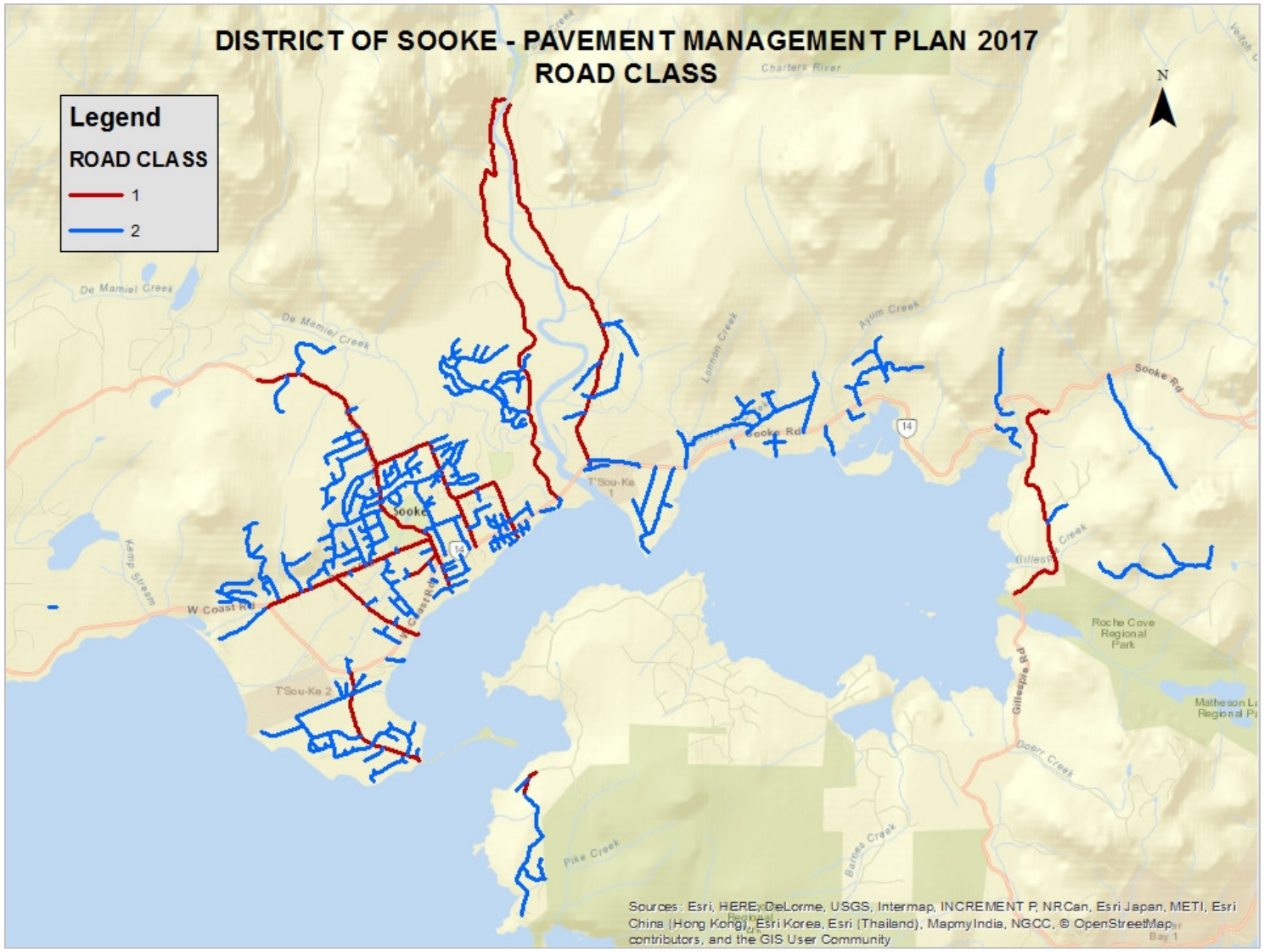
Road Class	Length (Km)
Collector Roads	21.521
Local Roads	67.058
Total Length	**88.579**

There are a number of road sections that were not surveyed due to various reasons. Table 2 shows the road sections, names, section lengths, and the reasons why they were not surveyed.

Table 2: District of Sooke – Roads not Surveyed (Road km)

Section ID	Road Name	Reason	Length (Km)
RD8	Croce Rd	no test - gravel	0.076
RD40	Penang Rd	no test - gravel	0.216
RD357	Atherly Close	no test - gravel	0.027
RD169	Lanark Rd	no test - gravel	0.042
RD147	Throup Rd	no test - gravel	0.171
RD2000012	Shepherds Way	no test - private	0.138
RD404	Medberry Close	no test - gravel	0.088
RD515	Sooke River Rd	no test - gated	0.073
RD496	Sooke River Rd	no test - gated	0.436
RD513	Sooke River Rd	no test - gated	0.205
RD397	Kirby Rd	no test - gravel	0.052
RD108	Gatewood Rd	no test - does not exist	0.077
RD109	Gatewood Rd	no test - does not exist	0.051
RD266	Coastal Heights	no test - does not exist	0.039
RD275	Blanchard Rd	no test - construction	0.05
Total Length			**1.741**

Figure 1: District of Sooke Road Classification Map



3 Data Collection

3.1 Pavement Condition Data Collection

MPE Siemens owns and operates an International Cybernetics Corporation (ICC) RT3000 data collection vehicle that simultaneously collects surface condition, roughness, rut, and GPS data streams. With the inclusion of the latest technology into the on-board systems, the data collection process has proven to be repeatable and extremely reliable. Details of this equipment can be supplied on request.

The District's road network comprises approximately 90 centreline kilometres of paved roads made up of suburban and rural arterial, collector, and residential roads. Surface distress, rutting and roughness testing was undertaken on the entire sealed network. Details of the Surface Condition Rating Methodology can be supplied on request.

A comprehensive pavement condition data collection program was undertaken for the District's streets during June 2017 by MPE Siemens as part of this study. The surveys consisted of the following data capture:

(a) ***Pavement Surface Condition*** – A detailed visual assessment of the pavement surface condition by experienced raters in accordance to ATSM D6433-11, a standardized rating methodology which is recorded in real time as the vehicle travels the road network. The focus areas in rating pavement distress include but are not limited to ravelling, cracking, potholes, bleeding, and distortion;

(b) ***Pavement Rutting*** – The transverse profile of the travel lane is measured on a continuous basis by laser sensors and used to calculate the average rut depths for each wheel path, and;

(c) ***Pavement Roughness*** – Longitudinal profile roughness measurements collected for each wheel path on a continuous basis using a Class II laser profiler (according to ASTM E950) to determine the pavement roughness as per the International Roughness Index (IRI).

4 Current Network Condition

4.1 Current Network Pavement Condition Index

The Pavement Condition Index (PCI) is a summary of pavement surface condition and was developed by the U.S. Army Corps of Engineers, and has become a recognized standard worldwide in the form of ATSM D6433-11. The index is based on the following surface defect types:

- Low ride quality
- Alligator cracking
- Bleeding
- Block cracking
- Bumps and sags
- Corrugations
- Depressions
- Edge cracking
- Joint reflections
- Lane/shoulder drop-off
- Longitudinal and transverse cracking
- Patching and utility cut patching
- Polished aggregate
- Potholes
- Rutting
- Shoving
- Slippage cracking
- Swelling
- Weathering and raveling

For the survey completed for the District in June 2017, each road was segmented into 10 metre segments and assessed for the defects listed above (where present). Each defect was recorded based on severity (low, medium, and high) and density (length or area of defect per segment).

The Pavement Condition Index (PCI) is a summary of overall pavement condition, and is calculated using the following equation:

PCI = 100 – TDV

The TDV (Total Deduction Value) is calculated using the defects listed above. Based on the severity and density of the defects, multipliers are used to "weight" the severity. The higher the severity of a defect, the higher the weighting to calculate the deduction value. Typically, deduction values are weighted as shown in Table 3 below:

Table 3: Typical Weighting of Defects by Severity

Defect Type	Severity	Weighting	Extent	Score	Deduction Value
Defect	Low	0.50	0-100%	0.50 x Extent	
	Moderate	0.75	0-100%	0.75 x Extent	
	High	0.90	0-100%	0.90 x Extent	

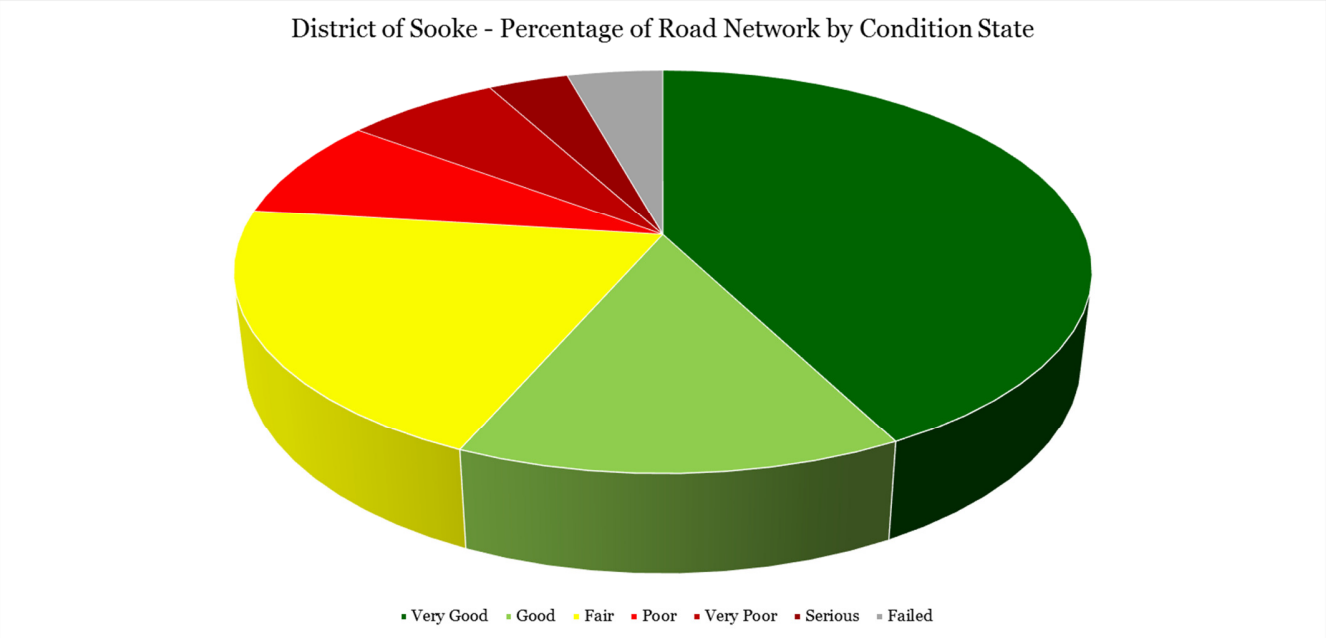
A condition state can be attributed to the PCI value, and can vary dependent on road class. For iterative purposes, table 4 below shows typical ranges of pavement condition rating values against corresponding condition states.

Table 4: Pavement Condition Rating and Corresponding Condition States

PCI Range	Condition State
100 - 85	Very Good
84 - 70	Good
69 - 55	Fair
54 - 40	Poor
39 - 25	Very Poor
24 - 10	Serious
9 - 0	Failed

Figure 2 shows the overall condition of the Districts' road network using the PCI values and corresponding condition states based on the PCI range above.

Figure 2: Percentage of Road Network by Condition State



The results in figure 2 show:

- 42% of the road network is in very good condition;
- 14% of the road network is in good condition;
- 20% of the road network is in fair condition;
- 8% of the road network is in poor condition;
- 7% of the road network is in very poor condition;
- 4% of the road network is in serious condition, and
- 4% of the road network is in failed condition.

Another output from the PCI analysis shows the average PCI by road class. This highlights road classes that the District may want to focus their efforts with regard to maintenance and rehabilitation activities.

A review of the current PCI analysis indicated the following:

Collector Road Network – The Collector Road network has an average PCI value of 61.7, which equates to a "Fair" condition on the PCI scale;

Local Road Network – The Local Road network has an average PCI value of 75.9, which equates to a "Good" condition on the PCI scale;

As an example, the District's current pavement condition as a PCI has been spread across the seven bin system and shown as a percentage within each condition state is shown in Table 5 below.

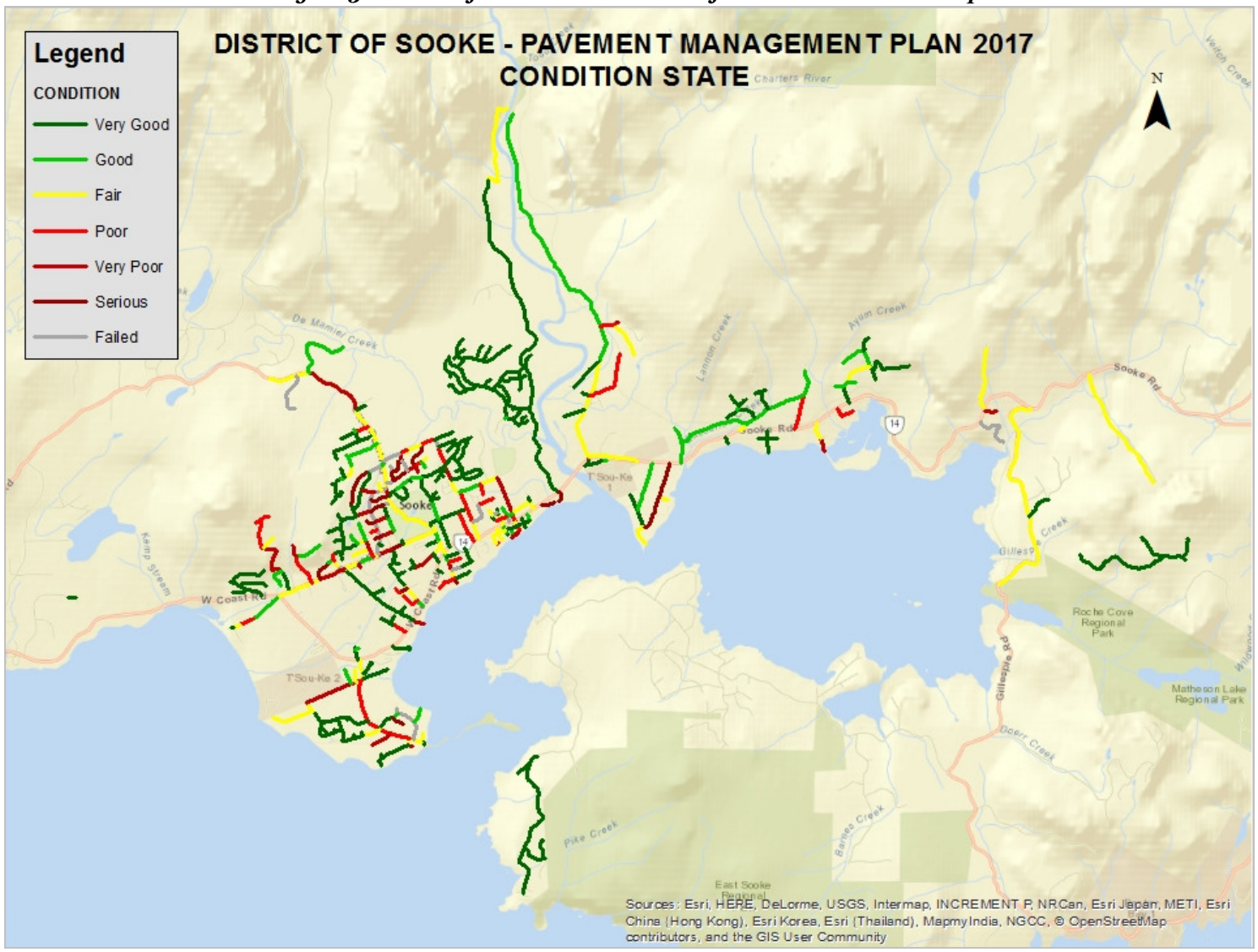
Table 5: Percentage of Road Network by PCI Range and Condition States

	Condition States (PCI Range)						
	Very Good	Good	Fair	Poor	Very Poor	Serious	Failed
Roadway Class	**100-85**	**84-70**	**69-55**	**54-40**	**39-25**	**24-10**	**9 -0**
Collector Roads	**27%**	**23%**	**29%**	**10%**	**8%**	**1%**	**4%**
Local Roads	**47%**	**11%**	**18%**	**8%**	**7%**	**5%**	**5%**

The PCI results for the Collector Road network shows that 50% of the network is in good or very good condition, 29% of the network is in fair condition, 18% of the network in poor and very poor condition, and the remaining 5% is in serious to failed condition.
In contrast, the Local Road network has 58% in good or very good condition, 18% in fair condition, 15% in poor and very poor condition, and the remaining 10% in serious to failed condition.

The PCI results have been mapped in Figure 3 below to illustrate road segments that fall into the condition states highlighted in Table 5.

Figure 3: District of Sooke – Pavement Surface Condition States Map



5 Causal Factors Affecting Current Condition

As the PCI is an index made up of various pavement defects, it is important to understand which modes of failure are responsible for the low PCI results and condition states.

This section highlights the current condition of the District's road network with regard to the following pavement condition parameters:

- Pavement Roughness;
- Cracking,
- Rutting;
- Ravelling, and;
- Patching and Utilities.

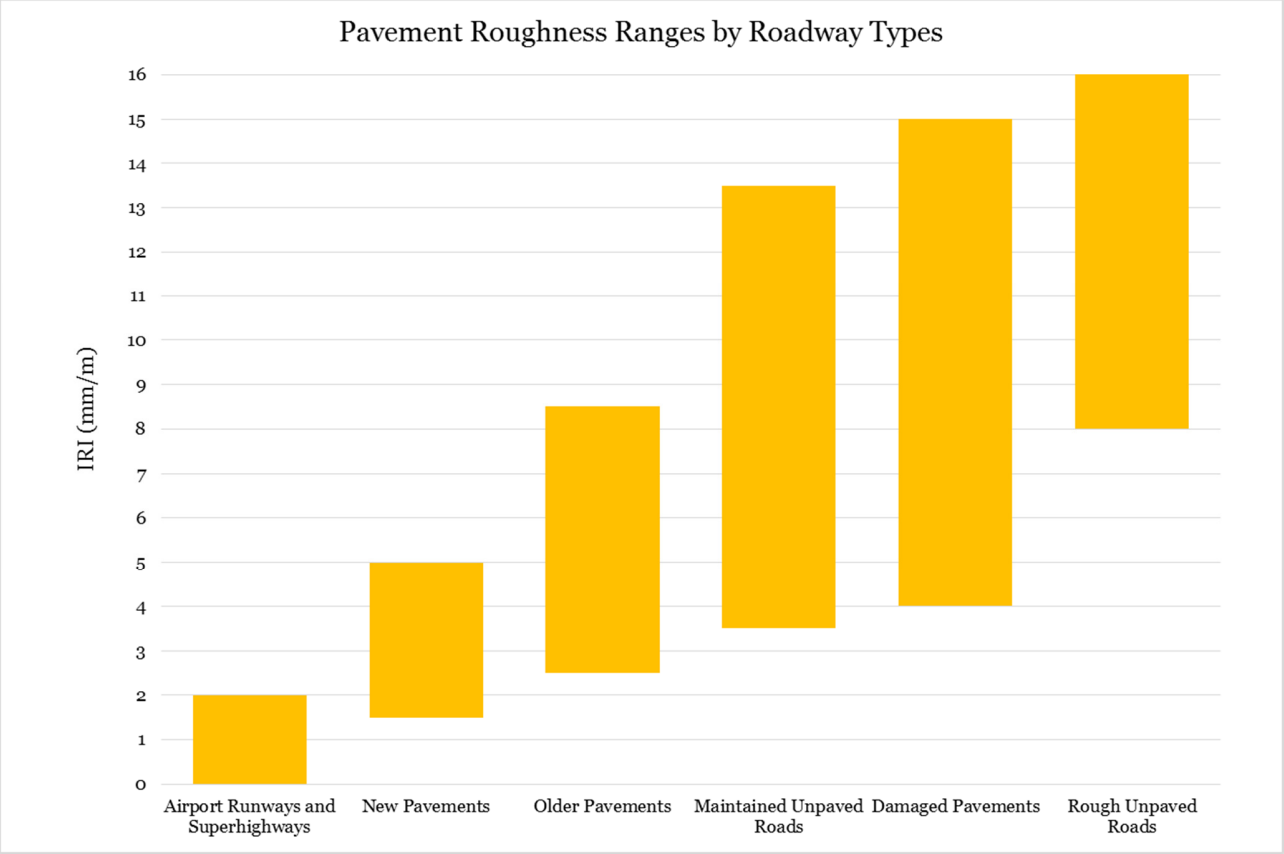
The data has been aggregated by road hierarchy and displayed as cumulative distributions for Collector, and Local Road classes. A cumulative distribution of each dataset shows the percentage of network length by road class that has a certain condition level or defect severity.

5.1 Current Network Pavement Roughness Condition

Pavement roughness is used to measure the longitudinal profile of highways, and is measured using the International Roughness Index (IRI), an internationally recognised measurement. Roughness equates to the difference in road surface level over a defined length.

Typical values in paved municipal environments would be between 1.5 for newly paved construction through 5-6 for deteriorated pavements. Values greater than 5-6 are often due to surface obstructions such as utility trenches or surface hardware (i.e. manhole covers, catch basins, etc.) located in the driving lanes. For clarification, the chart in Figure 4 shows the ranges that should be expected by roadway type.

Figure 4: Typical Pavement Roughness Ranges by Roadway Type

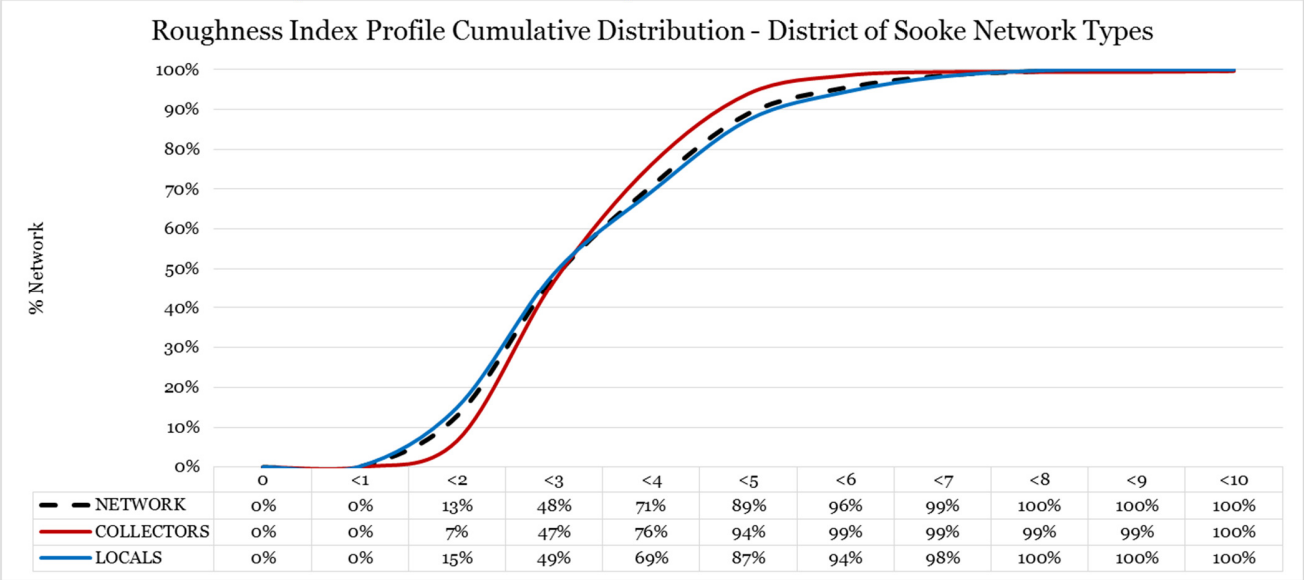


The cumulative distribution curves as shown in Figure 5 indicated very little difference in pavement roughness between the road classes as follows:

- **Collector Road Network** – the average IRI was 3.71 with 94% of the network having an IRI value of 5 or less. The remaining 6% of the network had an IRI between 5 and 10, which is expected for older pavements; and
- **Local Road Network** –the average IRI was 3.25 with 87% of the network having an IRI value of 5 or less. The remaining 13% of the network had an IRI between 5 and 8, which again falls within the threshold for older pavements.

The average condition of the District's road network with respect to roughness, are aligned with other similar municipalities within Greater Victoria that Opus is familiar with.

Figure 5: 2017 Pavement Roughness Cumulative Distributions



	0	<1	<2	<3	<4	<5	<6	<7	<8	<9	<10
NETWORK	0%	0%	13%	48%	71%	89%	96%	99%	100%	100%	100%
COLLECTORS	0%	0%	7%	47%	76%	94%	99%	99%	99%	99%	100%
LOCALS	0%	0%	15%	49%	69%	87%	94%	98%	100%	100%	100%

5.2 Current Network Pavement Cracking Condition

Cracking, if left untreated, enables the ingress of water into the underlying pavement layers and sub-grade, and can lead to increased rates of pavement deterioration.

The cumulative distribution curves for pavement cracking above are based on a crack index derived from the cracking defect types in Table 3, and calculated as per Table 4:

Table 3: Cracking Defect Types

Alligator Cracking	Longitudinal Cracking	Transverse Cracking
		

The crack index can range from 0 to 100, with 0 being no cracks and 100 being cracked throughout. It is derived by combining the severity and density ratios of each crack defect, then applying a weighting factor to each cracking type. The weighting factors are applied to each cracking type dependent on the failure mechanism. For example, alligator cracking has a higher weighting in the index as it is

considered to be the greatest factor to bring on rapid deterioration if not treated. Longitudinal and transverse cracking share the same, lesser weighting in the index as shown.

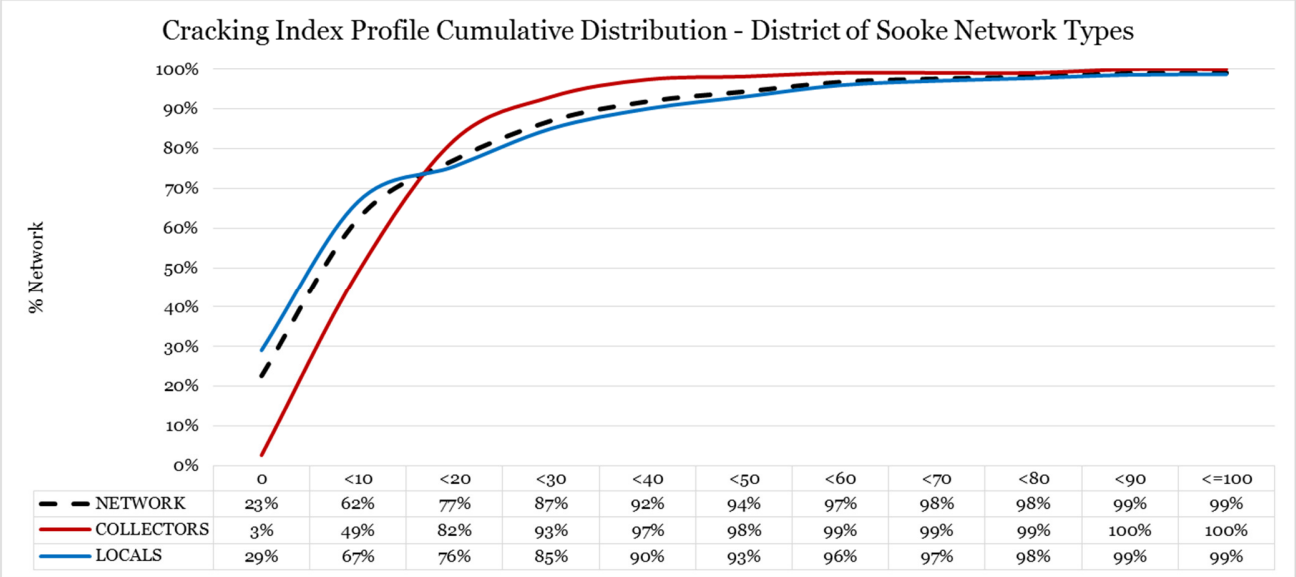
Table 4: Weightings and Calculations for Cracking Index

Cracking Type	Severity	Weighting	Extent	Score	Cracking Index Weighting
Transverse	Low	0.50	0-100%	0.50 x Extent	0.6
	Moderate	0.75	0-100%	0.75 x Extent	
	High	0.90	0-100%	0.90 x Extent	
Transverse Score = Sum of above					
Longitudinal	Low	0.50	0-100%	0.50 x Extent	0.6
	Moderate	0.75	0-100%	0.75 x Extent	
	High	0.90	0-100%	0.90 x Extent	
Longitudinal Score = Sum of Above					
Alligator	Low	0.50	0-100%	0.50 x Extent	1.0
	Moderate	0.75	0-100%	0.75 x Extent	
	High	0.90	0-100%	0.90 x Extent	
Alligator Score = Sum of Above					
Cracking Index = 0.6 x Transverse + 0.6 x Longitudinal + 1 x Alligator					

A review of the current pavement cracking condition cumulative distribution curves in Figure 4 indicated the following:

- **Collector Road Network** –the collector road network has more cracking throughout than the local road network, but the majority is of lower severity or density cracking. The breakdown is as follows: 3% of the network has no cracking present. 46% of the network has a cracking index of 10, 33% has a cracking index of 20, 11% has a cracking index of 30, 4% has a cracking index of 40, and the remaining 3% has a cracking index ranging between 50 and 80.
- **Local Road Network** – the local road network has less cracking throughout, but where cracking is present, the severity or density will be higher. The local roads results show 29% of the network having no cracking present. 38% of the network has a cracking index of 10, 9% of the network has a cracking index of 20, 9% of the network has a cracking index of 30, 5% of the network has a cracking index of 40, and the remaining 10% has a cracking index of ranging from 50 to 100.

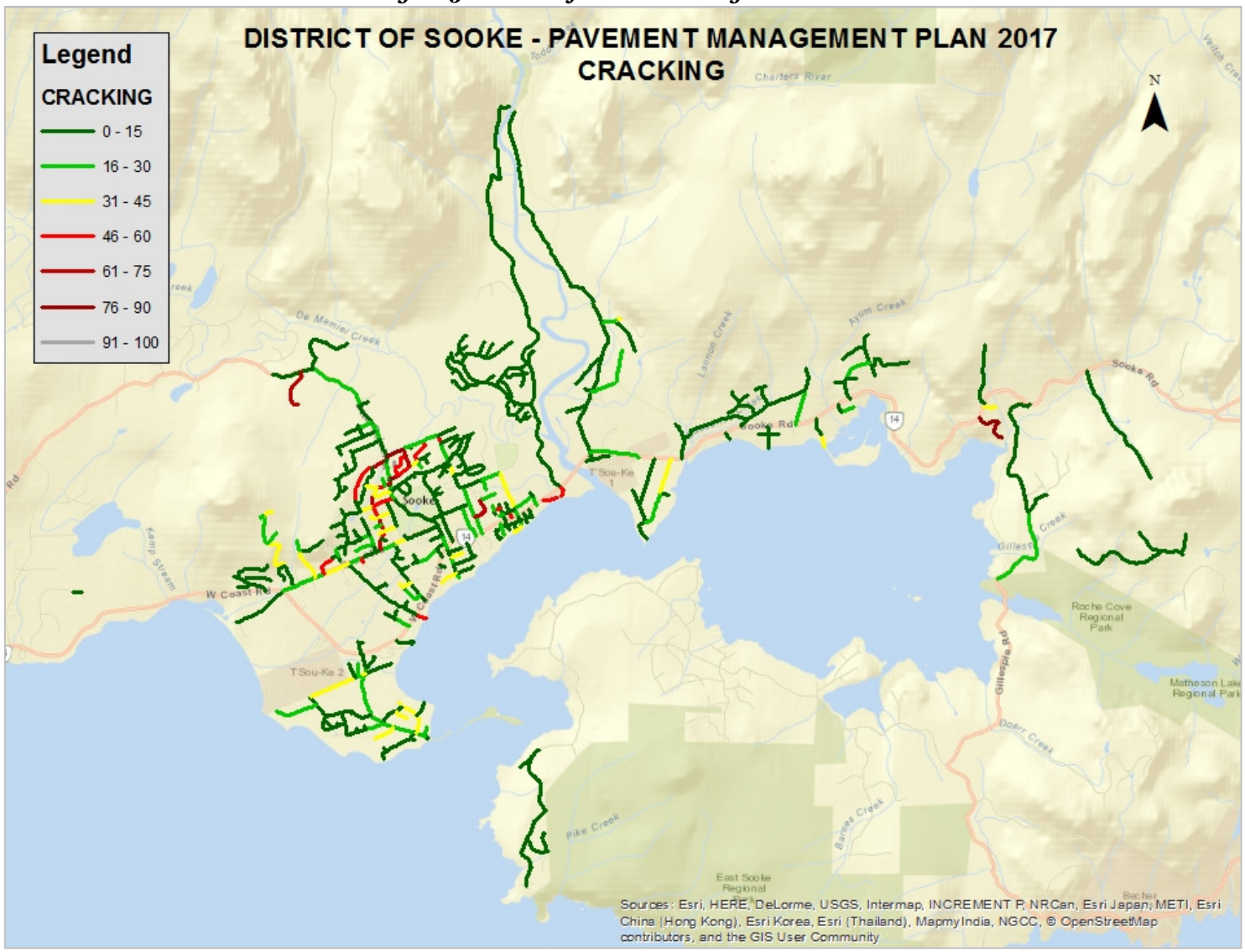
Figure 4: 2015 Pavement Cracking Cumulative Distributions



	0	<10	<20	<30	<40	<50	<60	<70	<80	<90	<=100
NETWORK	23%	62%	77%	87%	92%	94%	97%	98%	98%	99%	99%
COLLECTORS	3%	49%	82%	93%	97%	98%	99%	99%	99%	100%	100%
LOCALS	29%	67%	76%	85%	90%	93%	96%	97%	98%	99%	99%

The cumulative distribution chart provides a high level overview of the level of cracking present by road class, but does not provide the locational aspect. The cracking index results have been mapped to illustrate where the areas of high severity/density cracking exists as shown in Figure 5 below

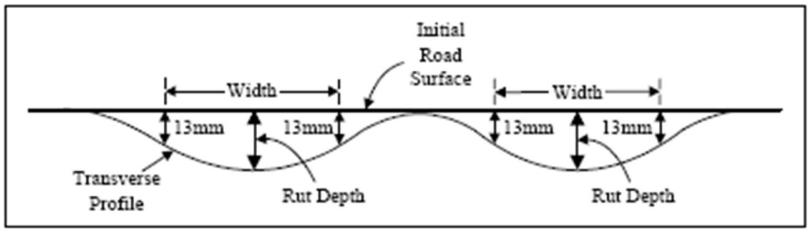
Figure 5: District of Sooke Cracking Index levels



5.3 Current Network Rutting Condition

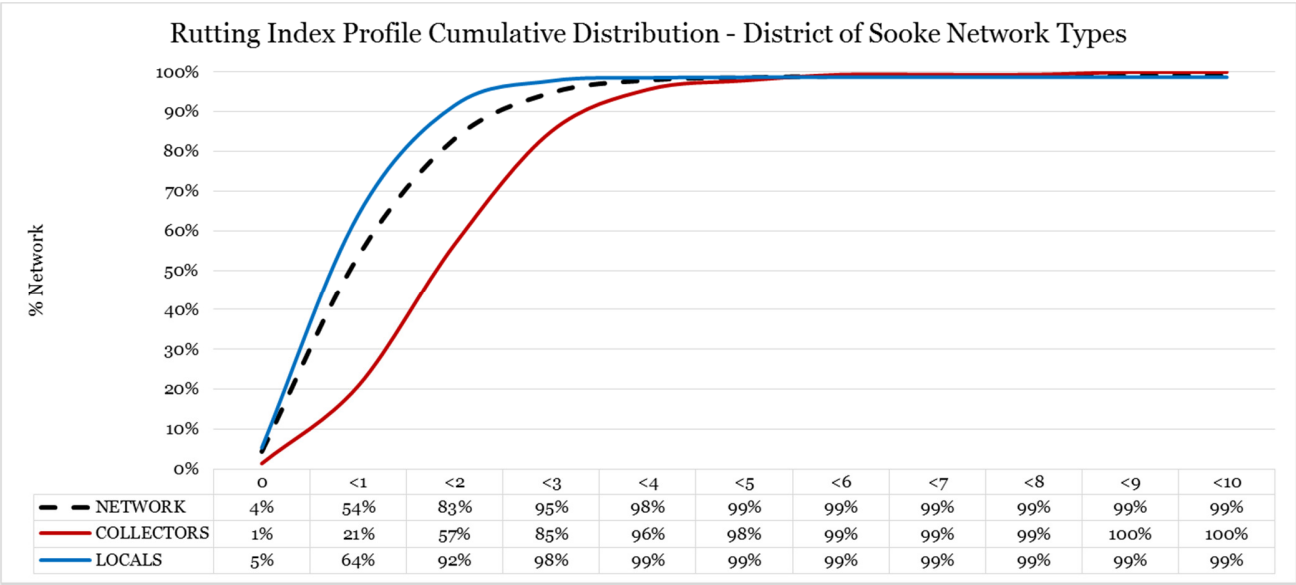
Rutting is the calculated average depth of rut in each wheel-path as measured from below a 2m straight edge. For this analysis the rut measurement for each 50m section was calculated as the average from the 10m collected survey data.

Overall, the level of rutting throughout the network by road segment was less than 10mm, and therefore not sufficient to warrant specific attention. The cumulative distribution curves as shown in Figure 6 indicate:



- **Collector Road Network** – The rutting levels on the collector road network are low with no rut levels above 8mm. 1% of the network has no rutting, 20% of the network has rutting of 1mm, 36% of the network has rutting less than 2mm, 28% of the network less than 3mm, 11% of the network has less that 4mm, and the remaining 3% of the network has rutting less than 8mm; and
- **Local Road Network** – The rutting levels on the local road network are lower to that of the collector road network due to less traffic loading. 5% of the network has no rutting, 58% of the network has rutting less than 1mm, 28% of the network with rutting less than 2mm, 6% of the network has rutting less than 3mm, and the remaining 1% of the local road network has rutting less than 10mm.

Figure 6: 2015 Rutting Cumulative Distributions



	0	<1	<2	<3	<4	<5	<6	<7	<8	<9	<10
NETWORK	4%	54%	83%	95%	98%	99%	99%	99%	99%	99%	99%
COLLECTORS	1%	21%	57%	85%	96%	98%	99%	99%	99%	100%	100%
LOCALS	5%	64%	92%	98%	99%	99%	99%	99%	99%	99%	99%

5.4 Current Network Ravelling Condition

Ravelling is the disintegration of the pavement from the surface downward due to the loss of aggregate particles. Ravelling usually occurs as a result of the aging of the asphalt binder, but can also be attributed to poor mixture quality, segregation, or insufficient compaction during construction. A ravelled surface enables the ingress of water into the underlying pavement and, if left untreated, can lead to increased rates of pavement deterioration.

Ravelling was collected similarly to cracking based on severity and extent with an overall index calculated as described in Table 5.

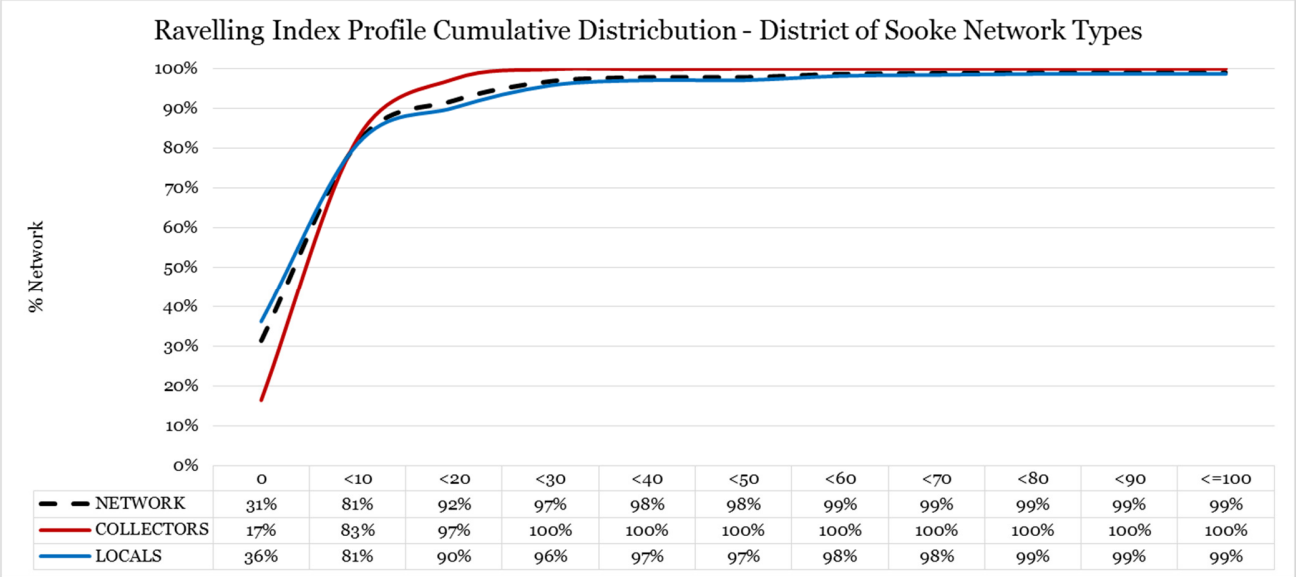
Table 5: Weightings and Calculations for Ravelling Index

Severity	Weighting	Extent	Score
Low	0.50	0-100%	0.50 x Extent
Moderate	0.75	0-100%	0.75 x Extent
High	0.90	0-100%	0.90 x Extent
			Ravelling Index = Sum of above

Looking at the results, the ravelling on the network is low with 31% of the network having no ravelling present. This is due to 31% of the network being newer or recently paved. The rest of the network has an equal amount of low and medium severity ravelling, with a smaller number of roads having high severity ravelling. The cumulative distribution curves as shown in Figure 7 showed that ravelling is a significant defect in older parts of the network, and that there was a noticeable difference between road classes as follows:

- **Collector Road Network** – The collector road network has a low level of ravelling present with 17% of the network having none. 66% of the network has 10% ravelling, 14% of the network has 20% ravelling, and the remaining 3% of the network has 30% ravelling; and
- **Local Road Network** – 36% of the network has no ravelling present, 45% of the network has 10% ravelling, 9% of the network has 20% ravelling, 6% of the network has 30% ravelling, 1% of the network has 40% ravelling, and the remaining 1% of the network has 50% to 100% ravelling.

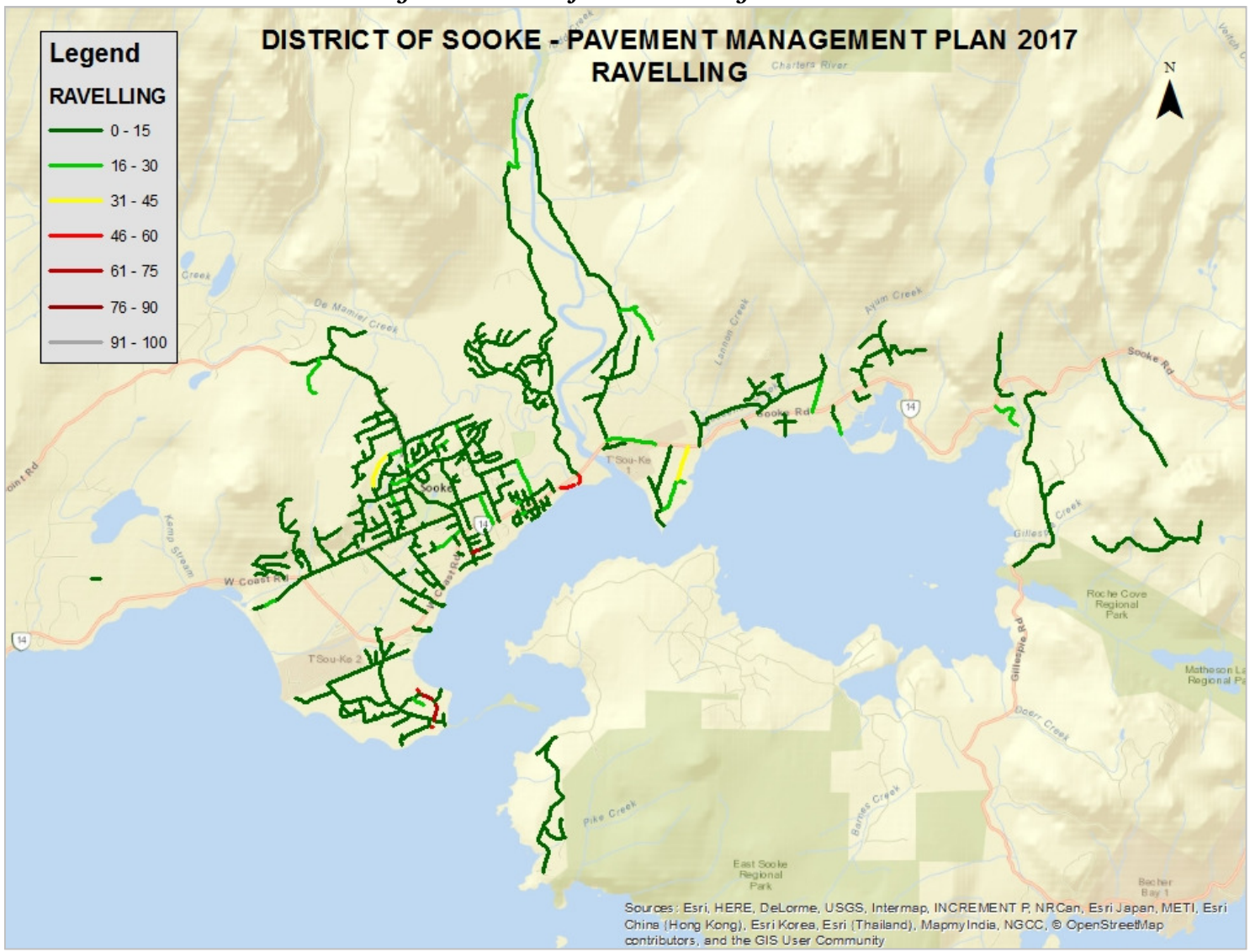
Figure 7: 2015 Ravelling Cumulative Distributions



	0	<10	<20	<30	<40	<50	<60	<70	<80	<90	<=100
NETWORK	31%	81%	92%	97%	98%	98%	99%	99%	99%	99%	99%
COLLECTORS	17%	83%	97%	100%	100%	100%	100%	100%	100%	100%	100%
LOCALS	36%	81%	90%	96%	97%	97%	98%	98%	99%	99%	99%

The cumulative distribution chart provides a high level overview of the level of ravelling present by road class, but does not provide the locational aspect. The results have been mapped to illustrate where the areas of high severity/density ravelling exists as shown in Figure 8 below.

Figure 8: District of Sooke Ravelling Index levels



5.5 Current Patching Condition

Patching can range in condition dependent on age, level of compaction at construction, joint permeability, and traffic volume. The condition of patching can also affect the overall road condition by enabling the ingress of water, which in turn can lead to increased rates of pavement deterioration. High severity patching can affect the overall ride quality of the roadway and also affect pavement roughness results. Furthermore, high severity patching can also lead to early damage of vehicles and increase fuel consumption.

Table 6: Weightings and Calculations for Patching Index

Low Severity Patching	Medium Severity Patching	High Severity Patching
		
Low severity patching has a condition range from brand new to slight aggregate loss and the opening of the sealed edges.	Medium severity patching has a condition range from slight aggregate loss and the opening of the sealed edges to cracking and aggregate loss throughout the patch, small depressions, and wider cracks at the edges.	High severity patching has a condition range from cracking and aggregate loss throughout the patch, small depressions, and wider cracks at the edges to aggregate loss that forms potholes, sinking and large depressions, and extensive higher severity cracking thoughout.

Patching was collected similarly to cracking based on severity and extent with an overall index calculated as described in Table 7.

Table 7: Weightings and Calculations for Patching

Severity	Weighting	Extent	Score
Low	0.50	0-100%	0.50 x Extent
Moderate	0.75	0-100%	0.75 x Extent
High	0.90	0-100%	0.90 x Extent
			Patching Index = Sum of above

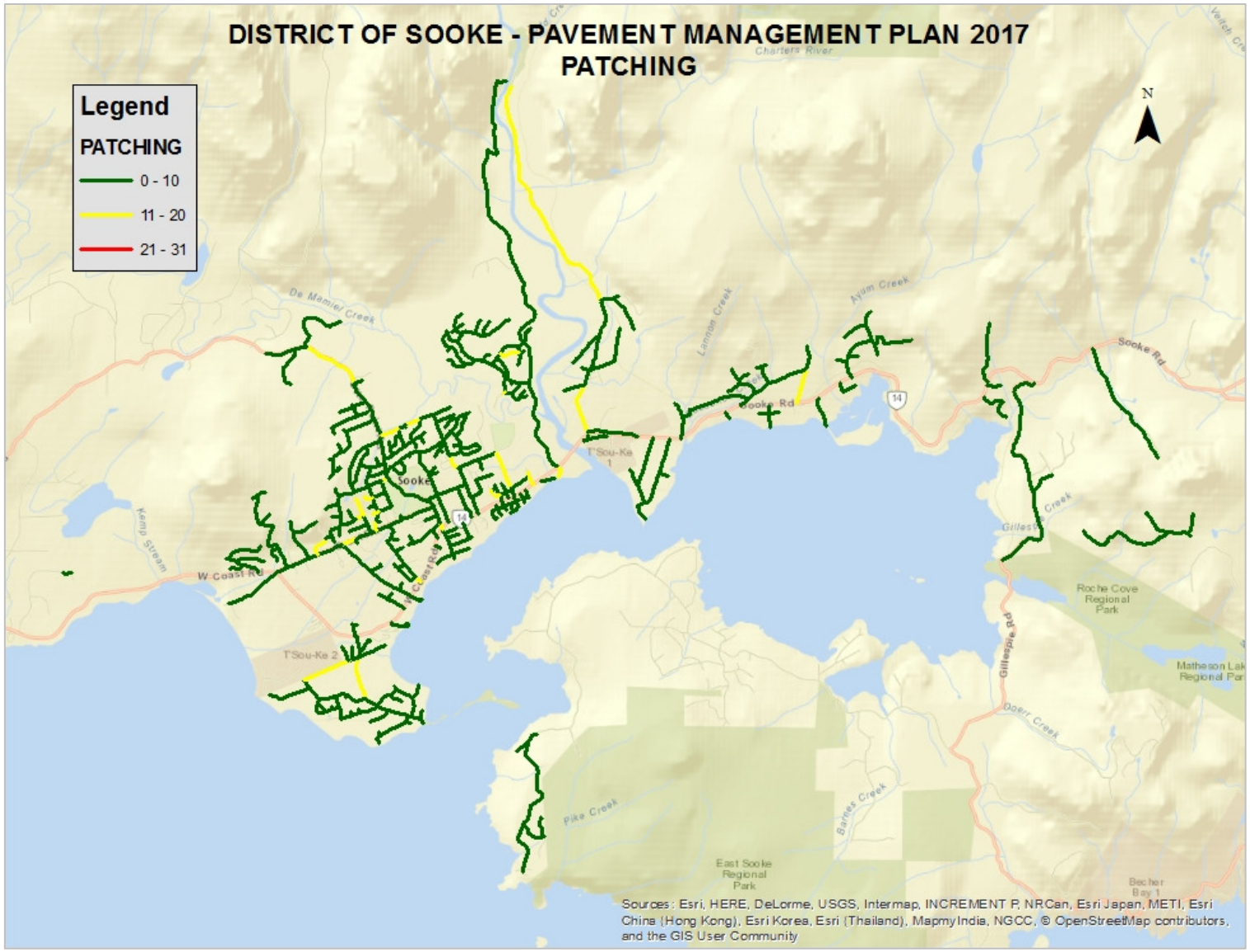
Patching is used in the derivation of the overall PCI Rating. Using the District's data, Table 8 shows how the patching index is derived, and provides a list of the roads that have a patching index greater than 10.

Table 8: Locations of High Patching Index Levels

Street	From	To	Class	Severity			Patch Index
				L	M	H	
Sooke River Rd	Sooke Road	Edward Milne Rd	1	0.0	24.4	0.0	18.3
Sooke River Rd	Edward Milne Rd	Soule Rd	1	12.2	1.7	10.5	16.9
Sooke River Rd	Meota Drive	2952m N of Meota Drive	1	21.9	1.4	1.4	13.2
Helgesen Rd	Otter Point Rd	Christan Dr	1	23.7	0.0	1.2	12.9
Helgesen Rd	Woodgrove Pl	Cedar Ridge Dr	1	24.6	0.0	0.0	12.3
Grant Rd W	Maple Ave S	Guardian Rd	1	24.3	0.0	0.0	12.2
Church Rd	Throup Rd	Church Hill Dr	1	23.8	0.0	0.0	11.9
Otter Point Rd	West Coast Rd	Eustace Rd	1	23.1	0.0	0.0	11.6
Otter Point Rd	Laronde Rd	Pascoe Rd	1	0.2	13.1	1.7	11.5
Whiffin Spit Rd	Francis Rd	Wright Rd	1	1.4	11.7	0.9	10.3
Solent Rd North	Harwick Lane	End	2	63.6	0.0	0.0	31.8
Demamiel Dr Cul De Sac	Demamiel Dr	End	2	38.8	0.0	0.0	19.4
Opal Pl	End	Pyrite Dr	2	0.0	24.3	0.0	18.3
Belvista Pl	End	Sooke Rd	2	0.0	1.5	18.0	17.3
Beaton Rd	Amethyst Way	Otter Point Rd	2	23.9	0.0	5.6	17.0
Larkspur Rd	Govenlock Pl	French Rd S	2	31.9	0.0	0.0	15.9
Drennan St	Sooke Rd	Golledge Ave	2	30.0	0.0	0.0	15.0
French Rd S	Larkspur Rd	End	2	28.3	0.0	0.0	14.1
Solent Rd North	End	Harwick Lane	2	27.9	0.0	0.0	13.9
Talc Pl	End	Pyrite Dr	2	26.9	0.0	0.0	13.5
Caldwell Rd	West Coast Rd	Powliuk Cres S	2	23.1	0.0	2.1	13.4
Pyrite Dr	Grant Rd W	Banner Rd	2	0.0	2.8	12.1	12.9
Winfield Dr	Grant Rd W	Rudd Rd	2	0.4	0.0	13.1	12.0
Golledge Ave	End	Dover St	2	23.5	0.0	0.0	11.7
Drennan St	Golledge Ave	End	2	20.9	0.0	0.0	10.4
Birchview Way	Willowpark Way	Snowden Pl	2	20.3	0.0	0.0	10.2

Figure 9 below, shows the areas where high severity patches exist.

Figure 9: District of Sooke – Locations of High Severity Patching



6 Rehabilitation Strategy and Budgets

6.1 Rehabilitation Strategy

The foundational principal of preserving pavement assets is to ensure that they are protected from the damaging effects of water ingress into the pavement and underlying sub-grade layers. All forms of surface distress that will allow entry of water should be treated.

The Districts' road network is a network of two halves. Half of the network is in good condition overall due to being newer or recently repaved. However, the other half (older) of the network falls into the "Fair" to "Failed" condition state category. Based on the current pavement condition rating, the rehabilitation tactics recommended for this strategy are to;

- Identify road sections where the current pavement condition rating is at its lowest, and;
- Apply the most effective treatment that will maintain current service levels.

6.2 Treatment Types and Budgets

The District's typical maintenance and rehabilitation treatments are Reconstruction for the most severely deteriorated road sections, and two Grind and Pave options; a 40mm single lift for lower severity defects and local roads, and an 80mm two-stage lift treatment for medium to high severity defects on collector roads. The District have also stated that the 80mm treatment will be used on local roads where traffic volumes have increased due to development or changes in traffic patterns.

Table 12 shows the costs of each treatment and the corresponding condition state most suited to these treatment types. The costs have been sourced from adjacent municipalities, and include shouldering, engineering, contingency, and Net GST.

Table 12: Treatment Costs

Treatment	Cost (m^2)	Condition State
Reconstruction	$80.00	Failed
Grind and Pave (80mm)	$38.00	Very Poor/Serious
Grind & Pave (40mm)	$18.00	Poor

6.3 Five Year Prioritized List of Segments and Treatments

In order to determine the prioritized list of segments, the model uses the current condition index as the deterioration parameter in the model. The deterioration rate for the network has been calculated by linearly regressing a PCI rating of 100 to achieve a typical service life of approximately 25 years.

Table 13 shows the deterioration rate and the treatment trigger values for each road class.

Table 13: Model Settings for Table 15 Output

Road Class	Collector Roads	Local Roads
	1	2
Annual Deterioration Rate	PCI 1.5	PCI 1.5
Treatment Trigger Values	40	40

Based on the results of the current and predicted condition index, the model output has identified a prioritized list of roads that require treatment for the next five years as shown in Table 14. The treatment identified for year 1 of the plan have been mapped in figure 10 below:

Table 14: Prioritized 5 Year Rehabilitation Program

Sect No.	Street	From	To	Class	PCI	Year				
						1	2	3	4	5
RD229	Helgesen Rd	Otter Point Rd	Christan Dr	1	0	RC				
RD134	Church Rd	Felderhof Rd	Helgesen Rd	1	5	RC				
RD110	Grant Rd W	Haywood Rd	Gatewood Rd	1	21	GP 80				
RD83	Maple Ave S	End	West Coast Rd	1	25	GP 80				
RD137	Church Rd	Church Hill Dr	Acreman Pl	1	27	GP 80				
RD106	Eustace Rd	Gatewood Rd (2000 Block)	Shields Rd	1	34	GP 80				
RD221	Otter Point Rd	Rhodonite Dr	Quartz Dr	1	35	GP 40				
RD234	Grant Rd W	Winfield Dr	Maple Ave S	1	35	GP 40				
RD111	Grant Rd W	Pyrite Dr	Haywood Rd	1	36	GP 40				
RD277	Otter Point Rd	Laronde Rd	Pascoe Rd	1	37	GP 40				
RD148	Charters Rd	Golledge Ave	Throup Rd	1	38	GP 40				
RD102	Murray Rd	Goodmere Rd	Lincroft Rd	1	39	GP 40				
RD292	Whiffin Spit Rd	Briarwood Pl	Deerlepe Rd	1	41		GP 40			
RD140	Church Rd	Country Rd	Throup Rd	1	41		GP 40			
RD79	Whiffin Spit Rd	Richview Dr	Briarwood Pl	1	42			GP 40		
RD2009Church	Church Rd	Acreman Pl	Felderhof Rd	1	43			GP 40		
RD228	Helgesen Rd	Christan Dr	Woodgrove Pl	1	45					GP 40
RD2009SookeRiver	Sooke River Rd	Sooke Rd	Edward Milne Rd	1	46					GP 40
RD434	Eakin Dr	Otter Point Rd	Kamaureen Pl	2	0	RC				
RD246	Pyrite Dr	Grant Rd W	Banner Rd	2	0	RC				

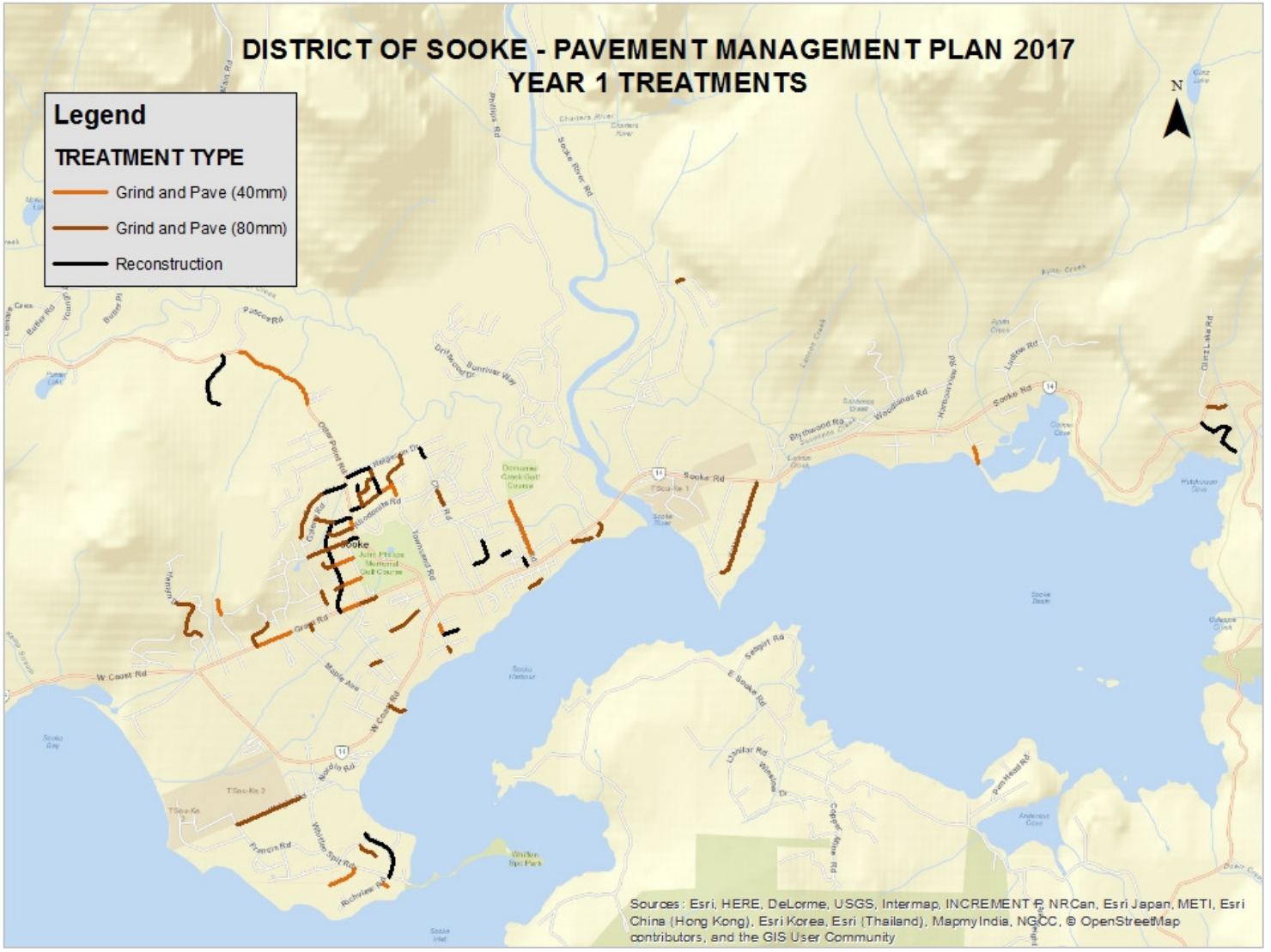
Sect No.	Street	From	To	Class	PCI	Year				
						1	2	3	4	5
RD255	Pyrite Dr	Cinnabar Pl	Talc Pl	2	0	RC				
RD258	Quartz Dr	Gatewood Rd	Otter Point Rd	2	0	RC				
RD26	Christan Dr	Eakin Dr	Rojean Dr	2	1	RC				
RD284	Pyrite Dr	Beaton Rd	Rhodonite Dr	2	1	RC				
RD142	Country Rd	Church Rd	Grant Rd East	2	1	RC				
RD247	Pyrite Dr	Banner Rd	Opal Pl	2	2	RC				
RD300	Dufour Rd	Possession Point Rd	Deerlepe Rd	2	2	RC				
RD298	Dufour Rd	Whiffin Spit Rd	Possession Point Rd	2	2	RC				
RD281	Sellars Rd	End	Otter Point Rd	2	2	RC				
RD257	Pyrite Dr	Talc Pl	Beaton Rd	2	3	RC				
RD208	Kamaureen Pl	Rojean Dr	End	2	3	RC				
RD152	Kennedy St North	End	Golledge Ave	2	3	RC				
RD301	Dufour Rd	Deerlepe Rd	End	2	5	RC				
RD176	Harwick Lane	Solent Rd North	Dover St	2	6	RC				
RD285	Pyrite Dr	Rhodonite Dr	Quartz Dr	2	7	RC				
RD259	Quartz Dr	Pyrite Dr	Gatewood Rd	2	8	RC				
RD447	Manzer Rd	Sooke Rd	End	2	8	RC				
RD251	Pyrite Dr	Opal Pl	Cinnabar Pl	2	8	RC				
RD253	Beaton Rd	Amethyst Way	Otter Point Rd	2	9	RC				
RD101	Goodmere Rd	Murray Rd	129 M East of Murray Rd	2	10	GP 80				
RD262	French Rd N	Galena Rd	Otter Point Rd	2	10	GP 80				

Sect No.	Street	From	To	Class	PCI	Year				
						1	2	3	4	5
RD237	Winfield Dr	Grant Rd W	Rudd Rd	2	10	GP 80				
RD184	Belvista Pl	Sooke Rd	End	2	11	GP 80				
RD445	Kamaureen Pl	Eakin Dr	Rojean Dr	2	12	GP 80				
RD254	Beaton Rd	Pyrite Dr	Amethyst Way	2	15	GP 80				
RD204	Cedar Ridge Dr	Eakin Dr	Helgesen Rd	2	15	GP 80				
RD245	French Rd N	176 M N of Maple Ave N	Galena Rd	2	16	GP 80				
RD207	Rojean Dr	Kamaureen Pl	Christan Dr	2	16	GP 80				
RD25	Christan Dr	Rojean Dr	Helgesen Rd	2	16	GP 80				
RD96	Powliuk Cres	Saunders Rd	Caldwell Rd N	2	17	GP 80				
RD99	Murray Rd	End	Horne Rd	2	17	GP 80				
RD458	O'Neill Rd	Deerlepe Rd	Cul de Sac	2	19	GP 80				
RD183	Belvista Pl	End	Sooke Rd	2	21	GP 80				
RD388	Kaltasin Rd	Seabroom Rd	Sooke Rd	2	22	GP 80				
RD209	Eakin Dr	Kamaureen Pl	Christan Dr	2	23	GP 80				
RD454	Talc Pl	End	Pyrite Dr	2	23	GP 80				
RD450	Opal Pl	End	Pyrite Dr	2	23	GP 80				
RD372	Kaltasin Rd	Glenidle Rd	Seabroom Rd	2	25	GP 80				
RD256	Rhodonite Dr	Pyrite Dr	Otter Point Rd	2	25	GP 80				
RD240	Guardian Rd	Grant Rd W	End	2	27	GP 80				
RD38	Henlyn Dr	Cedar Brook Pl	Alder Park Terr	2	27	GP 80				
RD167	Water St	End	Charters Rd	2	28	GP 80				
RD260	Quartz Dr	Galena Rd	Pyrite Dr	2	28	GP 80				

Sect No.	Street	From	To	Class	PCI	Year				
						1	2	3	4	5
RD321	Wright Rd	Francis Rd	Marathon Lane	2	28	GP 80				
RD29	French Rd S	Charval Pl	Larkspur Rd	2	28	GP 80				
RD392	Meota Dr	Brule Dr	End	2	28	GP 80				
RD30	Beaton Rd	French Rd N	Pyrite Dr	2	32	GP 80				
RD380	Polymede Pl	Sooke Rd	End	2	32	GP 80				
RD305	Briarwood Pl	End	Whiffin Spit Rd	2	36	GP 40				
RD203	Cedar Ridge Dr	End	Eakin Dr	2	38	GP 40				
RD436	Firwood Pl	Maple Park Terr	End	2	38	GP 40				
RD206	Eakin Dr	Christan Dr	Cedar Ridge Dr	2	38	GP 40				
RD248	Opal Pl	Pyrite Dr	Amethyst Way	2	39	GP 40				
RD250	Talc Pl	Pyrite Dr	Amethyst Way	2	39	GP 40				
RD307	Pears Point Rd	Richview Dr	Cul de Sac	2	39	GP 40				
RD439	Goodridge Rd	End	Medberry Close	2	39	GP 40				
RD47	Cedar Park Pl	Henlyn Dr	E End	2	40		GP 40			
RD97	Saunders Rd	Powliuk Cres	End	2	41		GP 40			
RD239	Firwood Pl	Grant Rd W	Maple Park Terr	2	42			GP 40		
RD94	Powliuk Cres	Caldwell Rd S	257 M N of Caldwell Rd	2	43				GP 40	
RD44	Tominny Rd	West Coast Rd	183 M NW of Hwy14	2	44				GP 40	
RD443	Horne Rd	Cul de Sac	Murray Rd	2	44				GP 40	
RD432	Cinnabar Pl	End	Pyrite Dr	2	44				GP 40	
RD516	Anna Marie Rd	Sooke Rd	378 M N of Sooke Rd	2	46					GP 40

Note: RC = Reconstruction, GP 80 = Grind and Pave (80mm), GP 40 = Grind and Pave (40mm)

Figure 10: District of Sooke – Locations of Rehabilitation Treatments in Year 1



7 The Budgeting Model

7.1 Purpose of the Model

The purpose of the model is to enable forecasting of network budgets for each of the next 30 years. The model does not contain any logic that caps total budgets or "smooths out" peak budget calculations across a number of years. The District's engineering staff have indicated they will use the model outputs to forecast future budget requirements and as the basis for producing forward work programs.

7.2 Road Sections

The network inventory supplied by the District has been used as the base for the model.

7.3 Model Deterioration Parameters

The results of the pavement condition surveys are used as the base figure to predict deterioration. The model uses the current pavement condition rating value and dependent on the typical service life of the pavement, is linearly regressed.

A road section without any cracking or ravelling will have an index of 100, with the index decreasing towards, but not reaching, zero as its condition worsens.

7.4 Deterioration Rate

The pavement deterioration rate of the PCI for each road section linearly regressed using the expected service life of treatments. The figure has then been averaged for each road class, and then projected each year until the PCI reaches a user set trigger level, at which time a treatment is scheduled.

The deterioration rate and the trigger levels, (see Section 5.6), work together to determine the average life for each treatment. The user can choose different deterioration rates for each class, in recognition that more heavily trafficked roads may tend to deteriorate faster.

The model will reset the condition rating to 100 once the initial treatment is triggered. The next rehabilitation treatment occurs when the calculated service life is reached.

7.5 Treatment Triggers and Selection

The user sets the level at which a treatment is triggered, which is called the Distress Trigger. Each road class can have its own trigger level, in recognition that a lower level of service may be acceptable for lower road classes. The condition index is reset to 100 after a treatment has been triggered.

7.6 Treatments

The condition of the highest priority street sections will require a default treatment based on road classification. As described in Section 5.2, these treatments range from reconstruction to grind and pave.

This model allows the choice of up to four treatments. Three have been used for the District's model which are:

- Reconstruction;
- Grind and Pave (80mm), and;
- Grind and Pave (40mm).

Based on the rule set for the treatment triggers and condition levels, the District's road network will only be treated with the most suitable treatment. The model will choose one of the more extensive treatments (reconstruction or the 80mm grind and pave) for the first treatment if the current condition is worse than the Distress Trigger. All subsequent treatments will be 40mm grind and pave.

The user sets an average $cost/m^2 for each treatment. These should be an average rate that reflects the achievable productivity and material costs for the range of construction locations and treatment variations likely to be encountered.

7.7 Model Outputs

The model calculates a budget cost for each of the selected treatments for each of the next 30 years.

The Dashboard sheet of the model shown in Figures 12 and 13, present a summary of model outputs in tables and graphs to enable visual assimilation of the overall modelled budget trends. More detailed outputs are in The Model spreadsheet provided separately.

The Dashboard results shown in Table 15, and Figure 12 below, are representative of the model settings included in the Table 13.

The model has identified a significant amount of treatments based on current condition, including $1.78M in reconstruction treatments, $1.48M in 80mm grind and pave treatments, and $415K in 40mm grind and pave treatments. This is a worst case scenario as only local roads that have seen increased traffic volumes or their classification has been elevated, will have the 80mm treatment applied.

Looking at the level of expenditure in subsequent years, it is recommended that the District consider a staged approach to tackling the "backlog" over the first 5 year period.

It should be noted that the dollar values are rounded to the nearest $1,000. Figure 13 shows the models output of condition index change over time.

Figure 12: Model Output of Annual and 5 Year Budgets Required

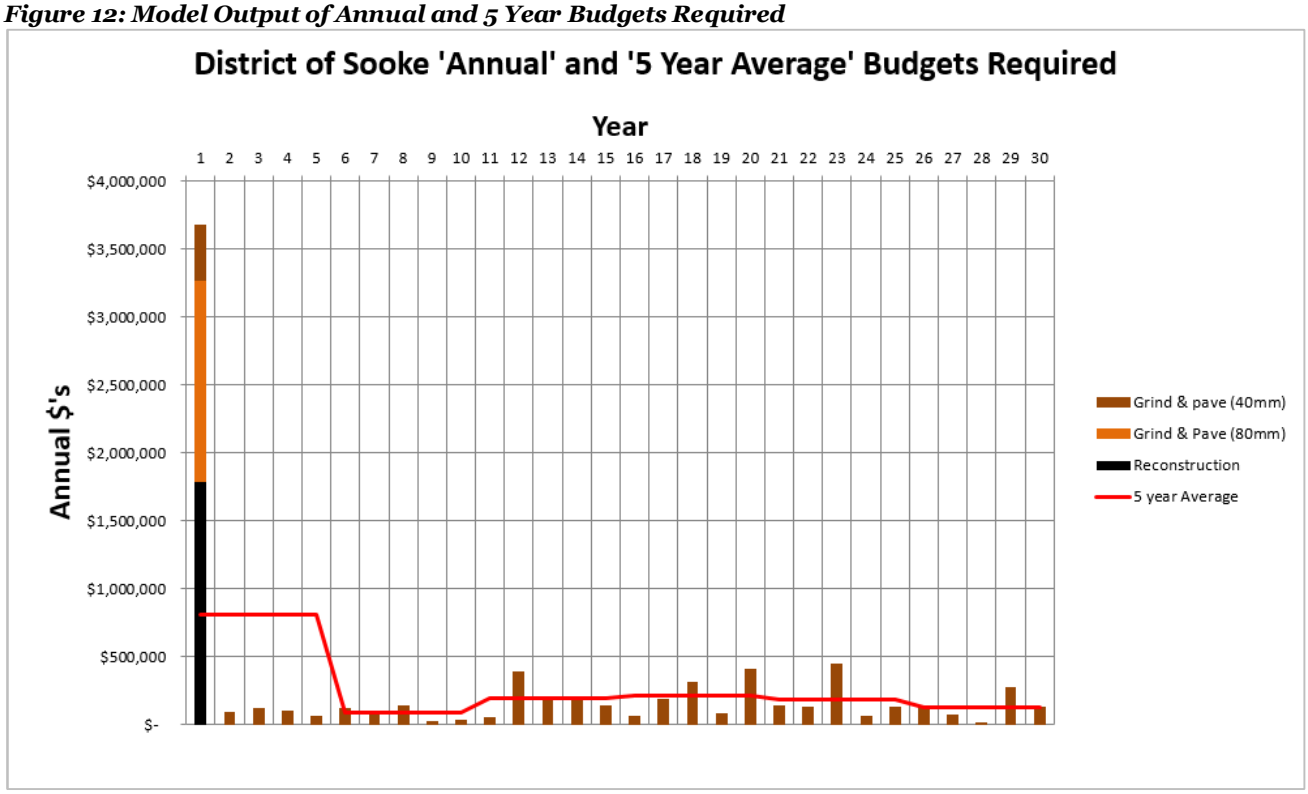


Figure 13: Model Output of Composite Index Change over Time

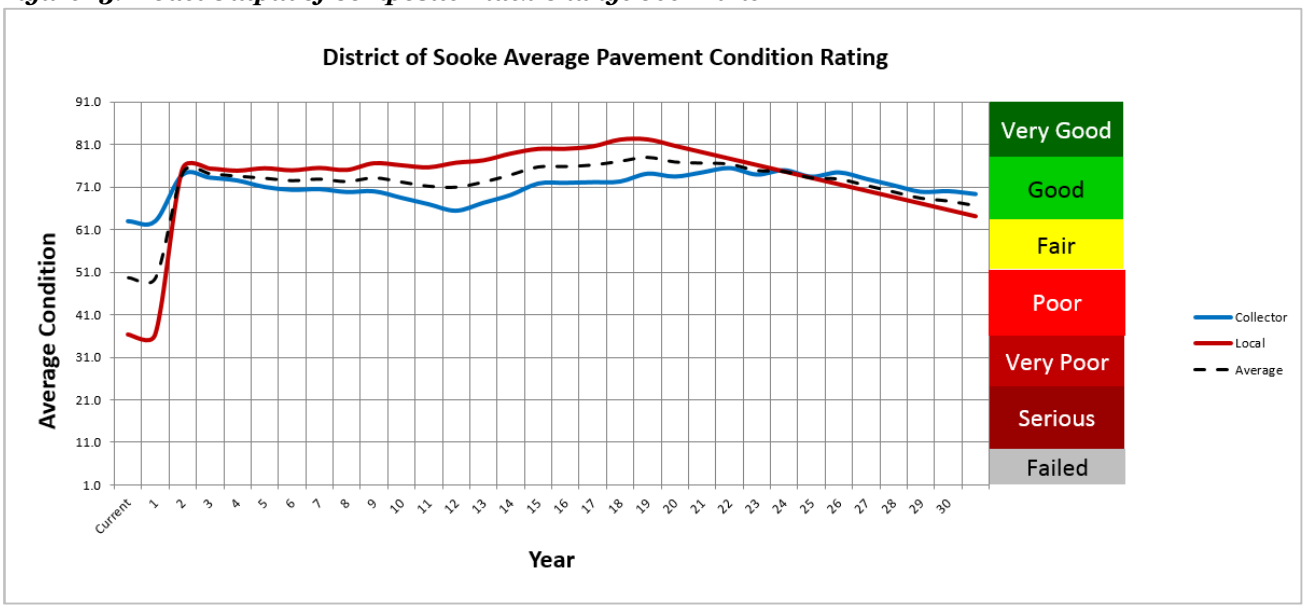


Table 15: Model Output of Five Yearly Block Budgets

Five Year Blocks	Block Budget
1-5	$4,058,645
6-10	$391,561
11-15	$999,277
16-20	$1,096,160
21-25	$919,591
26-30	$591,340

7.8 Overview of Model Operation

The model is operated as follows:

1. The user enters the latest condition data results into columns “A” to “J” in “The Model” tab.
2. The user can enter specific deterioration rates for each Class of road. These are used to linearly deteriorate the PCI values each year, for 30 years.
3. The Reset Value is left at 100. This is the value that the condition index is set to after a treatment has been scheduled.
4. Intervention Distress Trigger values are set by the user for each road classification. When the deteriorated index exceeds the set trigger value, the model schedules a treatment and resets the index to the reset value.
5. User entered Treatment Triggers for each Class/Surface Type/Treatment combination are used by the model to determine which treatment to schedule. This allows more extensive treatments to be scheduled for rehabilitating the initial backlog of street sections.
6. User entered unit rates for each treatment type are used by the model to calculate the cost of each scheduled treatment.
7. The model presents annual and summarised costs in tabular and graphic forms.

7.9 Model Calibration

The model requires calibration by engineering staff to meet the following requirements:

- Treatments are triggered in line with the District's levels of service – choosing the Distress Trigger and Deterioration rate; and
- The treatments used to treat the build-up of work are suited to the condition that triggers them – choosing the Treatment Triggers.

Distress Trigger and Deterioration Rate

Inspection should be made of a selection of street sections from each Class that engineering staff consider are approaching or well past requiring treatment and, preferably, for which the year of the last rehabilitation treatment is known. The average condition index of those sections that are considered to require treatment should be set as the Distress Trigger value for each Class. After determining the average rehabilitation life for each class, the Deterioration Rate/Year can be set so that the model's Resulting Average Life is as close as possible to this average found from inspection.

Treatment Triggers

The highest priority backlog street sections from each Class should be inspected, with a view to determining the values of the condition index that should be used to trigger Grind & Pave and Overlay treatments.

8 Recommended Future Actions and Conclusions

8.1 Recommended Future Actions

- The budget model has been delivered with settings derived by Opus from analysis of the condition data and pavement life assumptions. These assumptions and settings will be adjusted by the user based on experience with the model, as described in Section 6.3.
- The Distress Triggers, Treatment Triggers, and Deterioration rates should be reviewed every two years.
- At the completion of future rehabilitation work, the PCI should be reset to 100.
- In the District's GIS System, each road should be assigned an overarching road number, and then split into sections (10, 20 etc.) at easily identifiable locations such as change in road classification, change from urban to rural or vice-versa, intersection to intersection, or where road widths substantially differ (more than 2 metres in width). This enables the District to add in new sections when changes in the roadway occur.
- Further attribute data should be created for all street sections including construction details such as depth, material type, and construction date for each pavement layer. Where this data

does not exist, consider making assumptions. Replace with factual information at time of treatments.

- Where assumed values exist in the database, Opus recommends validating the assumptions over a period of four years. A business process should be established that then updates this data over the next four years. Having this data enables the District to make informed decisions around planning and spending going forward.

- Condition data should be collected again in three to five years' time, firstly to provide an idea of actual deterioration rates against the assumed rates within this report, and secondly to assess the effectiveness of any maintenance work that has been completed. The suitability of the budget model should also be reviewed at the same time, as it may be that a more sophisticated deterioration and optimization model is appropriate.

8.2 Conclusions

- The District's road network is a network of two halves. The first being in good overall condition due to new developments. The other half of the network is older and has roads that are in very poor to failed condition.

- The new budgeting tool will assist the District of Sooke Engineering staff to identify long term budgeting requirements to maintain it at a defined level of service over the long term.

- The new budgeting tool will also assist the District in identifying potential candidate for treatment,

- This tool and the associated calibration and verification work should signal the commencement of a long term business process which has an objective of ensuring that a sustainable level of investment in pavement rehabilitation maintains the street network at an agreed level of service.

Opus International Consultants (Canada) Limited
Suite 310, 1207 Douglas Street
Victoria BC V8W 2E7
Canada

t: +1 250 952 5640
f: +1 250 920 5620
w: www.opusinternational.ca

Five Year Road Improvement Program Break

Rehab Yr.	SECTION ID	STREET	FROM
1	RD434	Eakin Dr	Otter Point Rd
1	RD26	Christan Dr	Eakin Dr
1	RD208	Kamaureen Pl	Rojean Dr
1	RD262	French Rd N	Galena Rd
1	RD445	Kamaureen Pl	Eakin Dr
1	RD204	Cedar Ridge Dr	Eakin Dr
1	RD207	Rojean Dr	Kamaureen Pl
1	RD25	Christan Dr	Rojean Dr
1	RD209	Eakin Dr	Kamaureen Pl
1	RD203	Cedar Ridge Dr	End
1	RD206	Eakin Dr	Christan Dr
1	RD229	Helgesen Rd	Otter Point Rd
1	RD228	Helgesen Rd	Christan Dr
1	RD184	Belvista Pl	Sooke Rd
1	RD183	Belvista Pl	End
2	RD258	Quartz Dr	Gatewood Rd
2	RD284	Pyrite Dr	Beaton Rd
2	RD285	Pyrite Dr	Rhodonite Dr
2	RD259	Quartz Dr	Pyrite Dr
2	RD253	Beaton Rd	Amethyst Way
2	RD254	Beaton Rd	Pyrite Dr
2	RD245	French Rd N	176 M N of Maple Ave N
2	RD256	Rhodonite Dr	Pyrite Dr
2	RD260	Quartz Dr	Galena Rd
2	RD30	Beaton Rd	French Rd N
2	RD221	Otter Point Rd	Rhodonite Dr
2	RD237	Winfield Dr	Grant Rd W
2	RD436	Firwood Pl	Maple Park Terr
2	RD239	Firwood Pl	Grant Rd W
2	RD234	Grant Rd W	Winfield Dr
3	RD110	Grant Rd W	Haywood Rd
3	RD111	Grant Rd W	Pyrite Dr
3	RD246	Pyrite Dr	Grant Rd W
3	RD255	Pyrite Dr	Cinnabar Pl
3	RD247	Pyrite Dr	Banner Rd
3	RD257	Pyrite Dr	Talc Pl
3	RD251	Pyrite Dr	Opal Pl
3	RD454	Talc Pl	End
3	RD450	Opal Pl	End
3	RD29	French Rd S	Charval Pl
3	RD248	Opal Pl	Pyrite Dr
3	RD250	Talc Pl	Pyrite Dr
3	RD432	Cinnabar Pl	End

3	RD447	Manzer Rd	Sooke Rd
3	RD380	Polymede Pl	Sooke Rd
3	RD321	Wright Rd	Francis Rd
4	RD134	Church Rd	Felderhof Rd
4	RD137	Church Rd	Church Hill Dr
4	RD2009Church	Church Rd	Acreman Pl
4	RD300	Dufour Rd	Possession Point Rd
4	RD298	Dufour Rd	Whiffin Spit Rd
4	RD301	Dufour Rd	Deerlepe Rd
4	RD458	O'Neill Rd	Deerlepe Rd
4	RD305	Briarwood Pl	End
4	RD307	Pears Point Rd	Richview Dr
4	RD292	Whiffin Spit Rd	Briarwood Pl
4	RD79	Whiffin Spit Rd	Richview Dr
4	RD96	Powliuk Cres	Saunders Rd
4	RD97	Saunders Rd	Powliuk Cres
4	RD94	Powliuk Cres	Caldwell Rd S
4	RD44	Tominny Rd	West Coast Rd
4	RD106	Eustace Rd	Gatewood Rd (2000 Block)
5	RD142	Country Rd	Church Rd
5	RD143	Grant Rd East	Country Rd
5	RD140	Church Rd	Country Rd
5	RD101	Goodmere Rd	Murray Rd
5	RD443	Horne Rd	Cul de Sac
5	RD446	Lincroft Rd	Murray Rd
5	RD102	Murray Rd	Goodmere Rd
5	RD388	Kaltasin Rd	Seabroom Rd
5	RD372	Kaltasin Rd	Glenidle Rd
5	RD516	Anna Marie Rd	Sooke Rd
5	RD277	Otter Point Rd	Laronde Rd
TBD	RD281	Sellars Rd	End
TBD	RD240	Guardian Rd	Grant Rd W
TBD	RD439	Goodridge Rd	End
TBD	RD2009SookeRiver	Sooke River Rd	Sooke Rd

:down

TO	LENGTH	WIDTH	AREA	Trigger Year	PCI	Prescribed Treatment
Kamaureen Pl	102	7.0	714	1	0.00	Reconstruction
Rojean Dr	144	7.0	1008	1	0.54	Reconstruction
End	80	6.0	480	1	2.72	Reconstruction
Otter Point Rd	190	6.0	1146	1	9.82	Reconstruction
Rojean Dr	104	6.0	624	1	11.92	Grind & Pave (80mm)
Helgesen Rd	320	6.0	1926	1	15.25	Grind & Pave (80mm)
Christan Dr	200	5.0	1000	1	16.09	Grind & Pave (80mm)
Helgesen Rd	92	7.0	644	1	16.48	Grind & Pave (80mm)
Christan Dr	188	7.0	1316	1	22.75	Grind & Pave (80mm)
Eakin Dr	74	6.0	444	1	37.58	Grind & Pave (40mm)
Cedar Ridge Dr	116	7.0	812	1	38.43	Grind & Pave (40mm)
Christan Dr	198	8.0	1584	1	0.00	Reconstruction
Woodgrove Pl	103	8.0	824	5	44.58	Grind & Pave (40mm)
End	170	4.0	680	1	11.34	Grind & Pave (80mm)
Sooke Rd	120	4.0	484	1	21.15	Grind & Pave (80mm)
Otter Point Rd	66	8.5	561	1	0.00	Reconstruction
Rhodonite Dr	138	5.0	690	1	0.83	Reconstruction
Quartz Dr	99	5.0	495	1	6.88	Reconstruction
Gatewood Rd	97	5.0	485	1	7.91	Reconstruction
Otter Point Rd	96	5.0	480	1	8.74	Reconstruction
Amethyst Way	173	5.0	865	1	14.60	Grind & Pave (80mm)
Galena Rd	450	6.0	2700	1	16.06	Grind & Pave (80mm)
Otter Point Rd	209	8.0	1672	1	24.90	Grind & Pave (80mm)
Pyrite Dr	149	5.0	745	1	27.58	Grind & Pave (80mm)
Pyrite Dr	177	5.0	885	1	31.52	Grind & Pave (80mm)
Quartz Dr	94	8.0	752	1	34.96	Grind & Pave (80mm)
Rudd Rd	269	7.0	1883	1	10.30	Grind & Pave (80mm)
End	156	8.0	1248	1	38.10	Grind & Pave (40mm)
Maple Park Terr	356	8.0	2848	3	42.49	Grind & Pave (40mm)
Maple Ave S	320	8.0	2560	1	35.42	Grind & Pave (40mm)
Gatewood Rd	160	8.0	1280	1	20.71	Grind & Pave (80mm)
Haywood Rd	170	8.0	1360	1	36.25	Grind & Pave (40mm)
Banner Rd	110	5.0	555	1	0.00	Reconstruction
Talc Pl	100	5.0	500	1	0.00	Reconstruction
Opal Pl	99	5.0	495	1	1.89	Reconstruction
Beaton Rd	150	5.0	750	1	2.70	Reconstruction
Cinnabar Pl	92	5.0	460	1	8.16	Reconstruction
Pyrite Dr	149	5.0	745	1	22.84	Grind & Pave (80mm)
Pyrite Dr	90	5.0	450	1	23.37	Grind & Pave (80mm)
Larkspur Rd	115	5.0	575	1	28.26	Grind & Pave (80mm)
Amethyst Way	170	5.0	850	1	38.80	Grind & Pave (40mm)
Amethyst Way	170	5.0	850	1	38.85	Grind & Pave (40mm)
Pyrite Dr	100	6.0	600	4	43.75	Grind & Pave (40mm)

End	462	4.0	1848	1	8.05	Reconstruction
End	150	4.0	604	1	32.25	Grind & Pave (80mm)
Marathon Lane	580	6.0	3486	1	27.67	Grind & Pave (80mm)
Helgesen Rd	85	8.0	680	1	4.62	Reconstruction
Acreman Pl	139	8.0	1112	1	27.24	Grind & Pave (80mm)
Felderhof Rd	288	8.0	2304	3	42.73	Grind & Pave (40mm)
Deerlepe Rd	206	6.0	1236	1	2.10	Reconstruction
Possession Point Rd	210	6.0	1260	1	2.21	Reconstruction
End	48	6.0	288	1	5.24	Reconstruction
Cul de Sac	166	6.5	1079	1	19.04	Grind & Pave (80mm)
Whiffin Spit Rd	259	7.0	1813	1	36.35	Grind & Pave (40mm)
Cul de Sac	42	9.0	378	1	38.91	Grind & Pave (40mm)
Deerlepe Rd	120	6.0	720	1	40.81	Grind & Pave (40mm)
Briarwood Pl	255	6.0	1530	3	41.59	Grind & Pave (40mm)
Caldwell Rd N	95	11.0	1045	1	16.51	Grind & Pave (80mm)
End	68	11.0	748	2	41.27	Grind & Pave (40mm)
257 M N of Caldwell Rd	245	11.0	2695	4	43.21	Grind & Pave (40mm)
183 M NW of Hwy14	186	7.0	1302	4	43.57	Grind & Pave (40mm)
Shields Rd	299	8.0	2392	1	34.37	Grind & Pave (80mm)
Grant Rd East	270	5.0	1350	1	1.43	Reconstruction
End	195	7.0	1365	2	46.93	Grind & Pave (40mm)
Throup Rd	383	8.0	3064	1	40.96	Grind & Pave (40mm)
129 M East of Murray Rd	129	9.0	1161	1	9.77	Reconstruction
Murray Rd	205	6.0	1230	4	43.70	Grind & Pave (40mm)
Cul de Sac	148	5.4	799.2	2	46.77	Grind & Pave (40mm)
Lincroft Rd	89	7.0	623	1	38.59	Grind & Pave (40mm)
Sooke Rd	417	4.0	1668	1	21.66	Grind & Pave (80mm)
Seabroom Rd	413	4.0	1652	1	24.51	Grind & Pave (80mm)
378 M N of Sooke Rd	378	6.0	2268	5	45.89	Grind & Pave (40mm)
Pascoe Rd	766	8.0	6128	1	36.88	Grind & Pave (40mm)
Otter Point Rd	500	11.0	5511	1	2.42	Reconstruction
End	43	6.0	258	1	26.69	Grind & Pave (80mm)
Medberry Close	120	4.0	480	1	39.30	Grind & Pave (40mm)
Edward Milne Rd	24	7.0	168	5	45.84	Grind & Pave (40mm)

Cost	Year 1	Year 2	Year 3	Year 4	Year 5
$ 57,120.00	$ 57,120.00	$ -	$ -	$ -	$ -
$ 80,640.00	$ 80,640.00	$ -	$ -	$ -	$ -
$ 38,400.00	$ 38,400.00	$ -	$ -	$ -	$ -
$ 91,680.00	$ 91,680.00	$ -	$ -	$ -	$ -
$ 23,712.00	$ 23,712.00	$ -	$ -	$ -	$ -
$ 73,188.00	$ 73,188.00	$ -	$ -	$ -	$ -
$ 38,000.00	$ 38,000.00	$ -	$ -	$ -	$ -
$ 24,472.00	$ 24,472.00	$ -	$ -	$ -	$ -
$ 50,008.00	$ 50,008.00	$ -	$ -	$ -	$ -
$ 7,992.00	$ 7,992.00	$ -	$ -	$ -	$ -
$ 14,616.00	$ 14,616.00	$ -	$ -	$ -	$ -
$ 126,720.00	$ 126,720.00	$ -	$ -	$ -	$ -
$ 14,832.00	$ 14,832.00	$ -	$ -	$ -	$ -
$ 25,840.00	$ 25,840.00	$ -	$ -	$ -	$ -
$ 18,392.00	$ 18,392.00	$ -	$ -	$ -	$ -
$ 44,880.00	$ -	$ 44,880.00	$ -	$ -	$ -
$ 55,200.00	$ -	$ 55,200.00	$ -	$ -	$ -
$ 39,600.00	$ -	$ 39,600.00	$ -	$ -	$ -
$ 38,800.00	$ -	$ 38,800.00	$ -	$ -	$ -
$ 38,400.00	$ -	$ 38,400.00	$ -	$ -	$ -
$ 32,870.00	$ -	$ 32,870.00	$ -	$ -	$ -
$ 102,600.00	$ -	$ 102,600.00	$ -	$ -	$ -
$ 63,536.00	$ -	$ 63,536.00	$ -	$ -	$ -
$ 28,310.00	$ -	$ 28,310.00	$ -	$ -	$ -
$ 33,630.00	$ -	$ 33,630.00	$ -	$ -	$ -
$ 28,576.00	$ -	$ 28,576.00	$ -	$ -	$ -
$ 71,554.00	$ -	$ 71,554.00	$ -	$ -	$ -
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$ 51,264.00	$ -	$ 51,264.00	$ -	$ -	$ -
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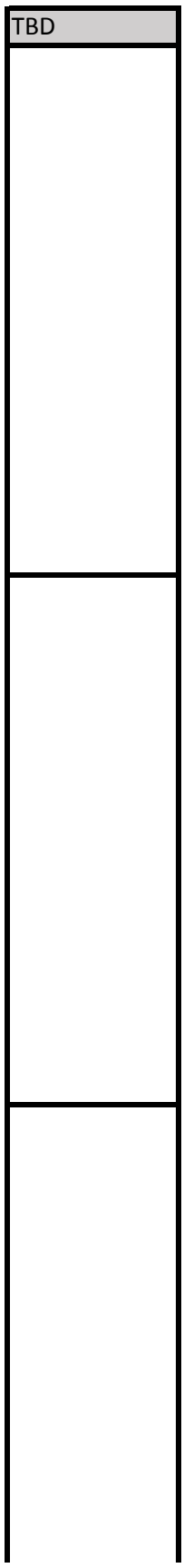
$ 110,304.00	$ -	$ -	$ -	$ -	$ 110,304.00
$ 440,880.00	$ -	$ -	$ -	$ -	$ -
$ 9,804.00	$ -	$ -	$ -	$ -	$ -
$ 8,640.00	$ -	$ -	$ -	$ -	$ -
$ 3,024.00	$ -	$ -	$ -	$ -	$ -
$ 3,854,997.60	$ 685,612.00	$ 697,764.00	$ 705,840.00	$ 697,804.00	$ 605,629.60
					$ 3,392,649.60


TBD

$ 440,880.00
$ 9,804.00
$ 8,640.00
$ 3,024.00
$ 462,348.00

District of Sooke

September 22, 2017
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Year 1
Year 2
Year 3
Year 4
Year 5

T'SOU-KE
NATION 2

0 500 1,000 2,000 ft
0 155 310 620 m

District of Sooke

September 22, 2017
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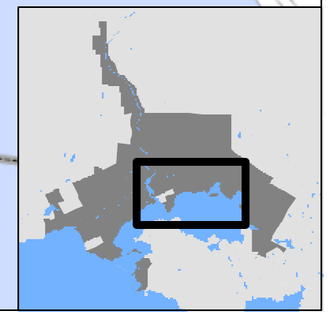
Year 1
Year 2
Year 3
Year 4
Year 5

T'SOU-KE NATION 1

Sooke Harbour

0 500 1,000 2,000 ft
0 165 330 660 m



Disclaimer: This map is an unofficial document of the District of Sooke and is consolidated for convenience purposes only and is not to be relied upon in making financial or other commitments. The District of Sooke does not warrant the accuracy of information on this map nor will it accept responsibility for errors or omissions. The District of Sooke reserves the right to alter or update this information without notice. This map is not intended for navigational purposes.

10-Year Outlook With No Delays (Start 2018)

This top part of the Dashboard contains all of the users inputs to The Model sheet, and below is a summary of the results

Green cells require user entered values

Pavement Condition Rating		
Deterioration / year	Class 1	1.5
	Class 2	1.5
	Class 3	2.0
	Class 4	2.0
	Class 5	2.0
Reset Value		100

Condition Distress Triggers		
Class	Distress Trigger	Resulting Average Life
1	40	27
2	40	27
3	70	35
4	70	35
5	70	35

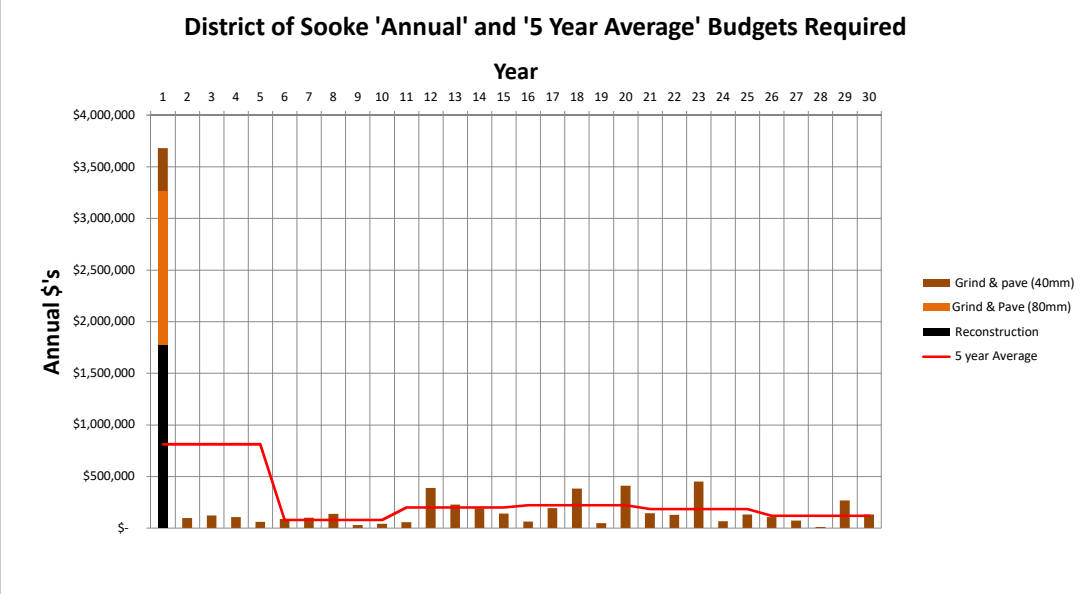
Sooke Treatment Selection	
Treatment	Unit Rate - $/m2
Reconstruction	$ 80.00
Grind & Pave (80mm)	$ 38.00
Grind & Pave (40mm)	$ 18.00

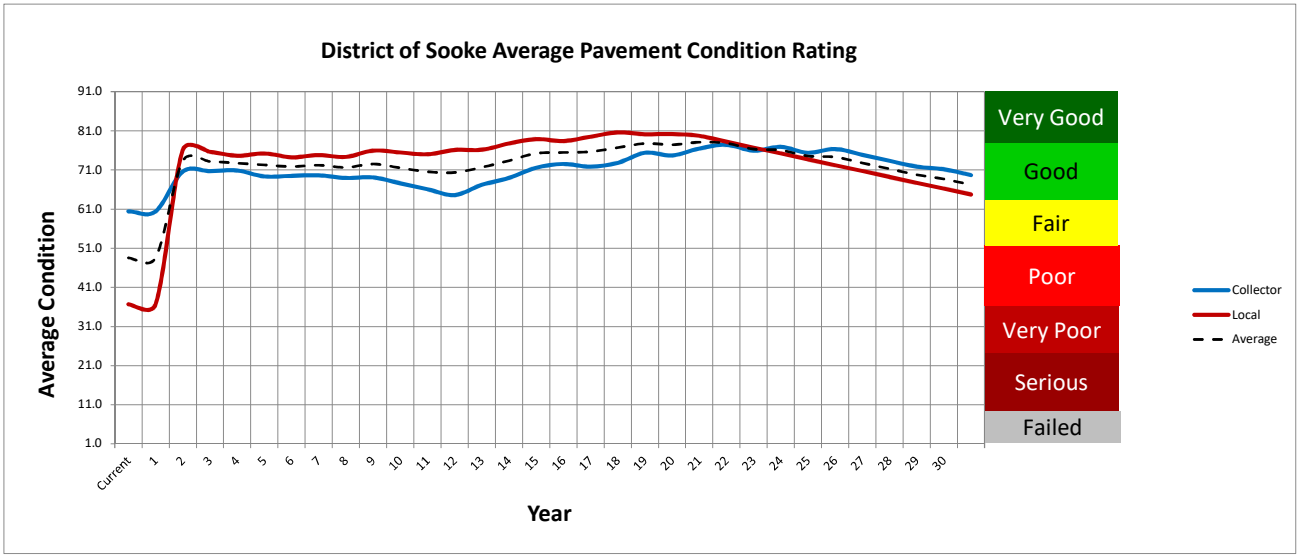
Total 5 Year block budget requirements

5 Yr Blocks	Reconstruction	Grind & Pave (80mm)	Grind & pave (40mm)	All treatments
1-5	1,780,800	1,483,163	794,682	4,058,645
6-10	-	-	391,561	391,561
11-15	-	-	999,277	999,277
16-20	-	-	1,096,160	1,096,160
21-25	-	-	919,591	919,591
26-30	-	-	591,340	591,340
Total	1,780,800	1,483,163	4,792,612	-

Average annual budget requirement

5 Yr Blocks	Reconstruction	Grind & Pave (80mm)	Grind & pave (40mm)	All treatments
1-5	356,160	296,633	158,936	811,729
6-10	-	-	78,312	78,312
11-15	-	-	199,855	199,855
16-20	-	-	219,232	219,232
21-25	-	-	183,918	183,918
26-30	-	-	118,268	118,268
Total	59,360	49,439	159,754	268,552





10-Year Outlook with 5-Year Startup Delay

This top part of the Dashboard contains all of the users inputs to The Model sheet, and below is a summary of the results

Green cells require user entered values

Pavement Condition Rating		
Deterioration / year	Class 1	1.5
	Class 2	1.5
	Class 3	2.0
	Class 4	2.0
	Class 5	2.0
Reset Value		100

Condition Distress Triggers		
Class	Distress Trigger	Resulting Average Life
1	47.5	32
2	47.5	32
3	70	35
4	70	35
5	70	35

Sooke Treatment Selection	
Treatment	Unit Rate - $/m2
Reconstruction	$ 80.00
Grind & Pave (80mm)	$ 38.00
Grind & Pave (40mm)	$ 18.00

Total 5 Year block budget requirements

5 Yr Blocks	Reconstruction	Grind & Pave (80mm)	Grind & pave (40mm)	All treatments
1-5	2,884,800	2,203,567	596,599	5,684,966
6-10	-	-	999,277	999,277
11-15	-	-	1,096,160	1,096,160
16-20	-	-	919,591	919,591
21-25	-	-	591,340	591,340
26-30	-	-	522,666	522,666
Total	2,884,800	2,203,567	4,725,634	-

Average annual budget requirement

5 Yr Blocks	Reconstruction	Grind & Pave (80mm)	Grind & pave (40mm)	All treatments
1-5	576,960	440,713	119,320	1,136,993
6-10	-	-	199,855	199,855
11-15	-	-	219,232	219,232
16-20	-	-	183,918	183,918
21-25	-	-	118,268	118,268
26-30	-	-	104,533	104,533
Total	96,160	73,452	157,521	327,133