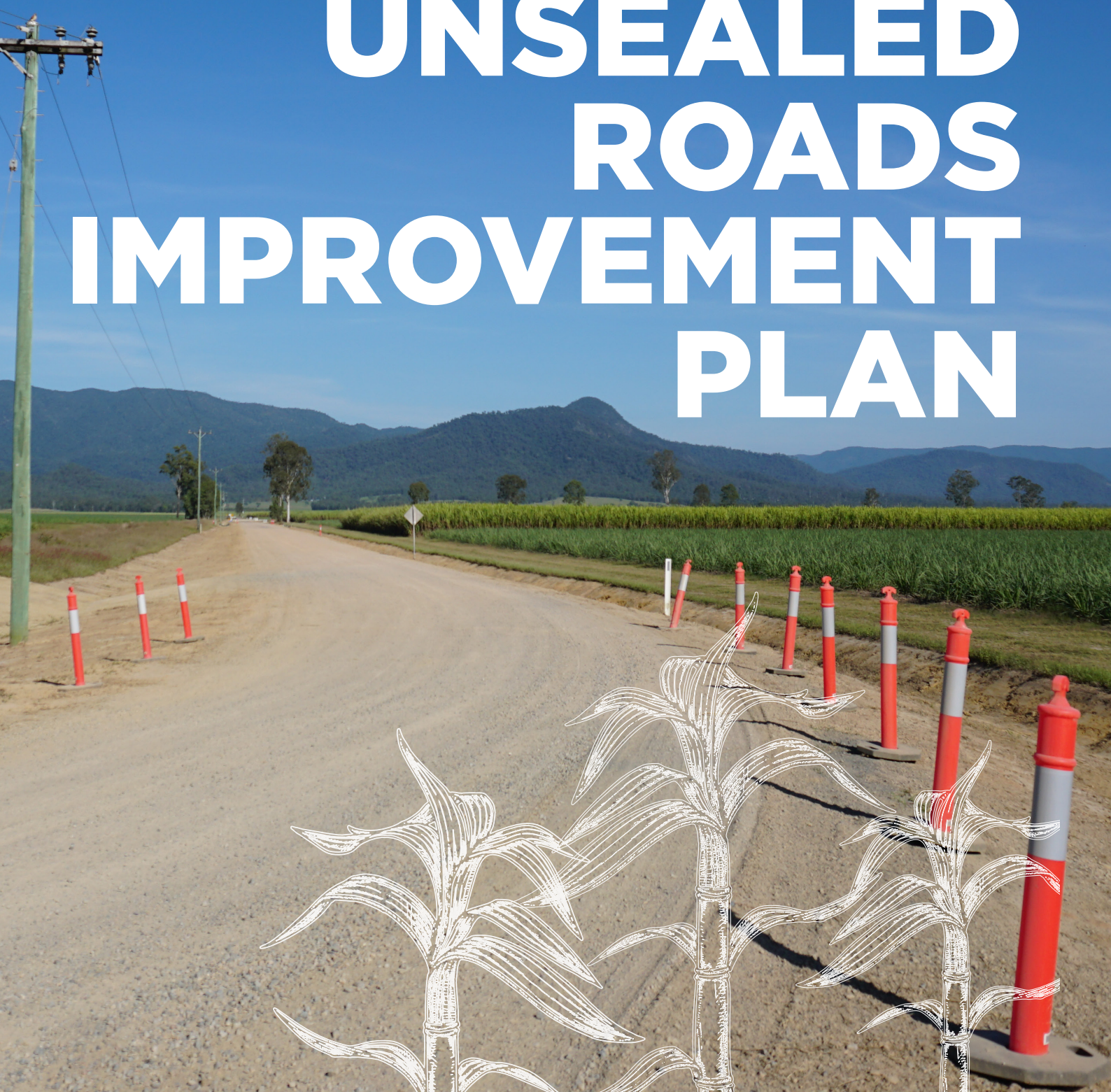
Cassowary Coast
REGIONAL COUNCIL

November 2022

UNSEALED ROADS IMPROVEMENT PLAN



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Background

Cassowary Coast Regional Council (CCRC) engaged Shepherd Services to review its unsealed road operational and management approaches in managing its unsealed road network. Darren Shepherd from Shepherd Services has worked with over 80 organisations across Australia assisting organisations to gain network performance improvements in both the operation and management of unsealed road networks.

In April 2022, Council asked our community to join the conversation and share feedback on what is important to residents and where Council should focus its attentions through the Cassowary Coast Community Scorecard. 1859 residents joined the conversation, sharing over one hundred thousand words to guide Council with its future priorities. The results were received in July and have been delivered through community workshops and the full survey results are posted on Council's website for all residents to access.

In response, Stage One of the Community Voice Action Plan outlines the priorities connection to Council's Corporate Plan 2021-2025 and features the following goal and priority action.

- Undertake public consultation on Council's Unsealed Roads Improvement Plan

Summary

The review identified that Council's operational grading techniques are largely in line with best practice and imported gravel material is largely in line with the Australian Road Research Board (ARRB) Unsealed Road Material Specifications, however numerous opportunities for improvement have been identified.

Short Term (by June 2023):

1. Adopt a standard procedure, including Quality Assurance (QA) auditing processes and increasing the frequency of testing of materials that go to site.
2. Adopt a strategy to communicate unsealed road management, including educational material should be developed.
3. Identify short unsealed road sections that are over-represented in our maintenance expenditure (hotspot) and recommend prioritised upgrades. Council has allocated $400K in the current capital budget.
4. Improve vegetation management to bolster maintenance productivity. Better programming of our grading program will allow for vegetation management prior to the grading team establishing on site. There are anticipated productivity and gravel loss benefits.
5. Consider the purchase of a water truck with greater carrying capacity. Effective grading is a water intensive activity and better access to water when required during the day is expected to improve productivity.
6. Develop a road enquiries flowchart and process document, that is internally focused to better provide clarity throughout the organisation on how unsealed roads are managed.

Medium Term (by June 2024):

7. Once item one (1) (above) is implemented publication and review of this data will provide opportunity for accountability to the Improvement Plan.
8. Providing opportunity to increase the skills of CCRC Day Labour Employees will provide improved succession planning and potential for significant improvements in utilisation of Council's plant.
9. Council consider the establishment of a separate Crew of minor plant (skid steer/ backhoe and truck) to complete high priority defects repairs (potholes etc.) so less pressure is applied to service whole segments of roads. This approach is anticipated to result in less over servicing and reduce costs.
10. Council currently uses the ARRB Unsealed Road Material Specification for unsealed road material. Consider amending specification that provides a less slippery surface while avoiding pavements that ravel and corrugate. Consider adding a requirement for a soaked CBR test to ensure material strength above 35 to avoid rutting when the material is wet.
11. Maintenance Crews quarterly review of current QA and productivity data and progress of the Improvement Plan and other initiatives.
12. Council use the newly developed deterioration modelling tools to help identify roads for grading and to ensure roads are maintained appropriately while in a locality. Council prioritises maintenance on a risk-based matrix based on condition and hierarchy.

Known condition is historical, with data often months old. Deterioration modelling will allow for highlighting of roads we should expect require grading now, and at set periods into the future.

13. There is significant community support for expanding the sealed road network. Developing a policy for prioritisation of sealing unsealed roads will allow for improvements in the network balanced with an understanding of whole-of-life costs.
14. Improve Drainage Management. The majority of Council's Maintenance Program is driven by roughness and associated safe driving speeds, however it is anticipated that a greater prioritisation on drainage management will have significant benefits to our pavements.

Longer Term (by June 2025):

15. Review road widths with classification as per QLD Functional Classification. Currently unsealed road widths in the Cassowary Coast are generally wider than accepted standards. A reduction in width of roads will provide significant opportunities for a reduction in costs.
16. Develop a map of current water locations to highlight areas of deficiency. As per item five (5) above, water is a key requirement to road maintenance. Long hauls from a water source can significantly impact on productivity of a standard grading team. This initiative will lead to identification of areas where new water access sites could provide significant productivity gains, or areas where it may be beneficial to engage an additional water truck to improve productivity.
17. A recommendation out of the review was to move to a heavy grading technique to improve road performance, by increasing the compaction through more depth of material and consistent moisture contents. This method has the potential to increase road performance efficiency by 20% over existing techniques. The concept is better quality grading that performs better over time, requiring less regular grading.
18. Improve quality of asset data, particularly with regard gravel depths. Will provide better benchmarking of gravel coverage and better inform gravel re-sheet capital programs.
19. Council currently classifies its unsealed roads into six classes from A through to F which is determined by traffic count. It has been identified however that many roads are deteriorating significantly faster than other roads in like classes. These roads should be identified to either conform or change classification.

Council's management techniques are in line with best practice of service level determination, monitoring and delivery. With the major service level being gravel coverage for wet weather access and surface smoothness for providing a safe running surface. Gravel coverage is provided via gravel re-sheeting and surface smoothness is maintained by Council's grading program and temporary repairs.

The assessment of these service levels by Shepherd Services was completed by using the following methodology:

1. International Roughness Index (IRI) measurements taken by Council that are used as the major measure of surface roughness;
2. The measure of wet weather accessibility was completed via analysis of Council expenditure data, in conjunction with benchmarking with other Councils. Note:- No Council in Australia maintains 100% gravel coverage across the network. The National funded average is 50% coverage;
3. Review of past expenditures for grading and resheeting and unit rates with the benchmarking with other Councils;
4. The benchmarking of surface roughness and gravel coverage with other Councils for comparison purposes.

The results provided by Shepherd Services concluded that:

- Current gravel resheeting long-term funding level of $2.8M/year is theoretically providing an average gravel pavement coverage of over 80% by length of the network (meaning the other 20% is not maintained with imported gravel). Council believe the network has better gravel coverage due to recent externally funded projects in recent years. The National average coverage is 50% by network length.
- Council is providing a very good service to the community compared to the National average. If Council wanted to fund a 100% coverage it would need to increase funding to $3.5M/year. Council should schedule its next survey of gravel coverage as a priority, as the current data is a number of years old.
- Council's current grading expenditure of $1.2M/year is providing an average network roughness index of 5.7 (adjusted) (modelled at $2M/year to maintain). Compared to the national average of 6.5, or in relationship to safe driving speed, over 85 km/hr, compared to the national average of 80km/hr.

Operational Techniques

Six Criteria for Successful Grade

Grading technique is the key to ensuring successful road performance after a grading practice. To ensure this, Council will utilise the following criteria for a grade:

1. Adequate removal of surface defects. i.e. blade or scarify to min depths for defect removal.
2. Existing material retrieval and adequate depth achieved. i.e. rile height indicator recommendation is knee height = 40mm depth over the road.
3. Adding correct amounts of water to the cut material to ensure that the moisture is consistent and adequate to enable good compaction to occur and clay activation. i.e. clay activation ensures particles hold together longer.
4. Correct compaction process used to ensure maximum cohesion of the material with optimised passes. i.e. brings material particles together to hold together as long as possible. Tyre roller is the most ideal roller.
5. Cross-fall of road minimum of 4% and a maximum of 6% i.e. ensures water gets off the road with less potholes occurring after rain.
6. Table and Diversion Drains and Cross Drainage. i.e. ensures water gets off the road.

Adhering to these criteria will ensure that Council is achieving longer performing roads after the grading process and value-for-money returns.

An overview of the different techniques observed, is shown on the following pages.

Items	Good	Fair	Poor	Comments
Adequate removal of surface defects	✕			Minimal defects in pavement for medium grade, defects removed adequately.
Existing material retrieval		✕		Small amount cut from batters; more could have been achieved but was adequate.
Adding adequate amounts of water/moisture.	✕			Adequate moisture and was consistent.
Compaction to ensure maximum cohesion.		✕		Compaction adequate for medium grade with amount of material retrieved.
Road Cross-fall		✕		Medium grade unable to achieve pavement desired shape with minimal amount of material recovered.
Table and diversion drains		✕		Minimal work required in table drains, adequate for medium grade.

Figure 2.1a: Medium Grading - material retrieval to ankle depth. Below is the rating of the process.

Items	Good	Fair	Poor	Comments
Adequate removal of surface defects	✕			A heavy cut removed the defects.
Existing material retrieval		✕		A bit more effort required to remove material from grass. However, depth is big improvement over medium. This will enable better compaction.
Adding adequate amounts of water/moisture.	✕			
Compaction to ensure maximum cohesion.	✕			Good use of multi-tyre roller.
Road Cross-fall		✕		More gravel enables a better chance to get cross-fall. However maybe more gravel could have been added to crown to achieve better cross fall.
Table and diversion drains		✕		Drains were in reasonable condition prior to grade minimal work required.

Figure 2.1b: Heavy Grading - material retrieval to knee depth. Below is the rating of the process.

Measuring performance of different grading techniques historically has been done by looking at $/km, yet this approach does not consider the performance of the road after grading.

Council will consider how long the road will last before it meets the intervention level again to know the true costs ($/week or $/month). Below is a chart to show this approach, heavy grades are the most cost-effective over time.

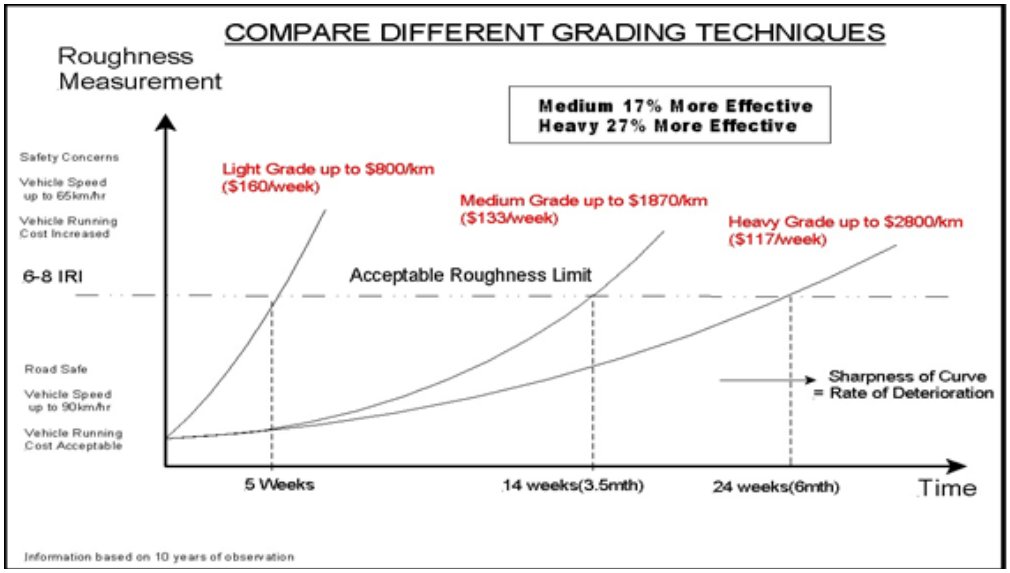

Figure 2.1c: Comparison of Grading Techniques Over Time

It is recommended that heavy grading via blading/scarifying to 50-75mm depth and focusing on adding correct amounts of moisture and then compacting, is the most effective technique.

				Class B Roads Normally 8 Months to Get to IRI 7-8		
	Daily Rate	km/day	$/km	Time Last in Months @ IRI 7	$/Month	% Saving
Medium Grade (*)	$ 3072	1.5	2048	8	384	0%
Heavy Grade	$ 3072	1	3072	10	307	20%

(*) this the most common technique now. Recommending moving to Heavy Grade, as better performance on roads for money spent. Yet coverage across the network will drop in total distance by up to 33%. The first year will be the hardest in making the change due to perception that we are doing less.

Figure 2.1d: Performance Comparison for Council's Different Grading Techniques

Outcomes

The major outcomes are:

- Heavy grading is the better technique to achieve longer performance (up to 20% improvement) by concentrating on the material rile to knee height in the cut process (40mm depth of cut) to get enough material for good compaction. (Note : Critical to ensure that pavement depth is sufficient. Mixing of sub-grade material with imported pavement would be detrimental to performance).
- Water is critical to operations, and we need to ensure that production in a day is based around adequate water supply. For a heavy grade, four loads of water/day = 0.75-1km graded/day and six loads/day = 1-1.5km graded/day.
- Agreement on the standards to ensure consistency among operators and procedure documentation produced is important.
- Vegetation control and drainage are also important factors in determining productivity and performance.

Material Quality

Material quality affects performance, gravel loss and road deterioration on unsealed roads. Over the last decade Council has been moving towards improved practices with the testing and selection of suitable material for unsealed roads.

The below chart is a well-recognised assessment chart used for unsealed road material selection. This is based on the Institute of Public Works Engineering Australasia, Queensland (IPWEAQ) Supervisors Handbook for the Construction & Maintenance of Infrastructure. This document has utilised the NSW Gangers Handbook, the Queensland Department of Main Roads 11AT document, documentation developed by Fitzroy and Sarina Shire Councils and the experience of a select group of highly experienced and well regarded infrastructure managers. It is also consistent with recommendations made by ARRB.

Historically (more than a decade ago) road treatments in our region consisted of either sand or conventional Department of Transport and Main Roads (DTMR) specification for pavements for sealed roads. This practice has been discontinued because while they perform well to reduce slipperiness of a road during rain their durability and their ability to resist raveling and corrugation has been shown to be significantly below the performance of current specification.

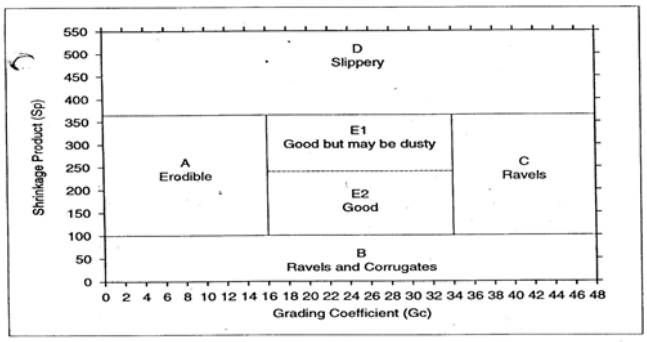

Figure 3
Performance based specification for gravel wearing courses

The horizontal axis, for the below chart, is calculated by:
Grading Coefficient = {(% Passing 26.5mm - % Passing 2.0mm)x(% Passing 4.75mm)/100}

The vertical axis, for the below chart, is calculated by:
Shrinkage Product = (Linear Shrinkage x % passing 0.425mm Sieve)

Figure 2.2a: Unsealed Road Material Assessment Chart

It is important to note that it is possible to blend materials either insitu or off-site to produce a better quality material. Council has had some success in insitu blending in the past, however success has been reliant on reasonably long sections of road with reasonably comparable materials.

The chart below is an example of how material type affects the deterioration of a road after grading. The example is the same road, graded at the same time yet the material quality is different on the two sections of the road. As you can see by the IRI chart, one section of the road is noticeably deteriorating with the poor material selection.

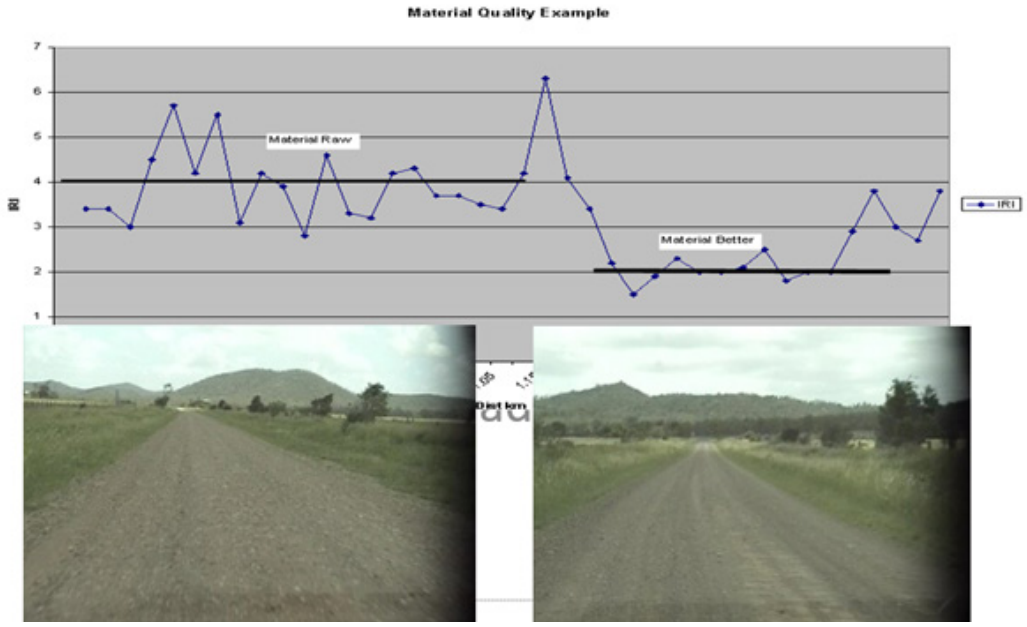

Figure 2.2d: IRI Chart Illustrating Effect of Material Quality on Road Deterioration

Below is sample of gravel quality data for eleven provided gravel pit samples. Both are in the good section result.

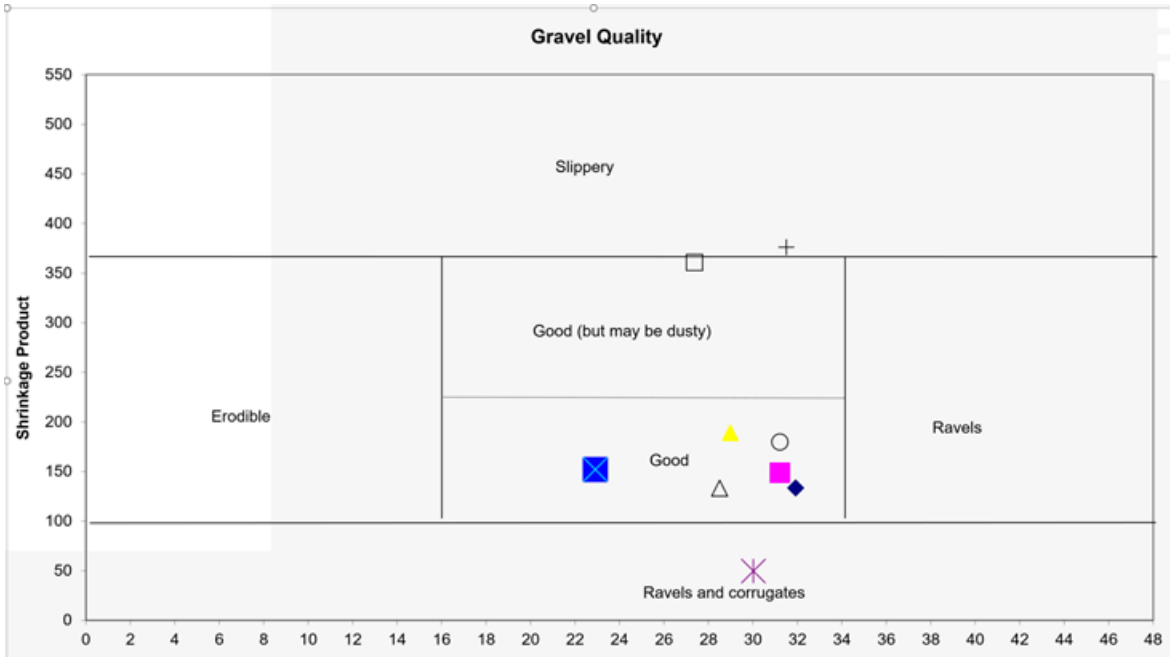

Figure 2.2e: Council Soil Test Results

Outcomes

A significant issue identified is that more testing of the material is required from pit to delivery to ensure quality is consistent. Council will consider post testing after it has been done to ensure material quality has not changed.

There is potential to further improve the quality of unsealed road pavements, potential specification modifications could be:

1. Consider making a lower acceptable “LS product”, considering the amount of annual rain the region receives.
2. Obtain soaked CBR tests and ensure they are minimum 35. (This will ensure there is strength in the material when wet.)

Management Techniques

Unsealed Roads Network

The Cassowary Coast Regional Council unsealed roads network is 527kms.

Below is the breakup by road hierarchy and historical grading frequency.

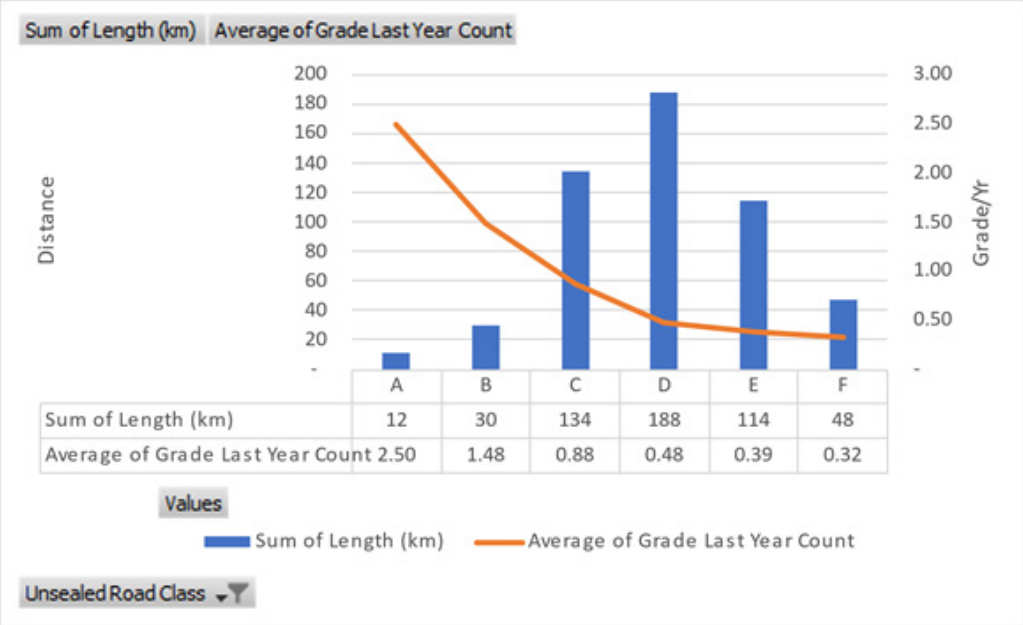

Figure 3.1a: CCRC Unsealed Roads Network Summary by Class and Historical Grade Frequency

It is important to note that road condition and hierarchy drives the CCRC maintenance program. It is often suggested that Council should simply have a grading program that is programmed by area and every road is graded at the same time. If this strategy was adopted, while there would be some benefit in productivity, the significant change would be that higher order roads with more traffic on them would be graded less and lower order roads with less traffic would be graded more.

Road Classification Review

Council currently classifies its unsealed roads into six classes from A through to F. This hierarchy is primarily driven by traffic counts, but is also influenced by the industry usage, school bus routes and access to National Parks.

Deterioration of the road surface is a function of many variables, however traffic volumes is considered to be a significant factor. It has been identified that many roads are deteriorating significantly faster or slower than other roads in that class. These roads should be identified and reviewed to confirm or otherwise if they are in the correct road class.

The revised road classes will assist with the planning and prioritisation of works and inspections.

Road Class	Estimate Traffic	Service	Function
A	> 120 ADT	> 15 Houses	Services high volumes of traffic Major movements between population centres Significant Industry Part of the primary network
B	75-120 ADT	11 -15 Houses May have less houses but connects to other roads	Roads that link to primary network Connecting local centres
C	40-75 ADT	7 - 10 Houses > 1 Industry	Minimum standard for school buses Minor roads
D	20-40 ADT	2 - 6 Houses 1 Industry	Provides access to low use areas (e.g. boat ramps) Few properties Some larger vehicles may be required to use these roads Min Standard access to National Park
E	8-20 ADT	1 - 2 Houses Small Industry	Provides access to properties Only 1-2 residences Very low use Access to minor tourism site
F	< 8 ADT	0 houses V Small to No Industry	Used for infrequent recreation Headland Equivalent May provide access to rivers or paddocks 4WD tracks

Wet Weather Access Provided by Gravel Coverage

Council's 2017 Assessment

Below is a summary of Council's last full survey of pavement depth ratings completed in 2017.

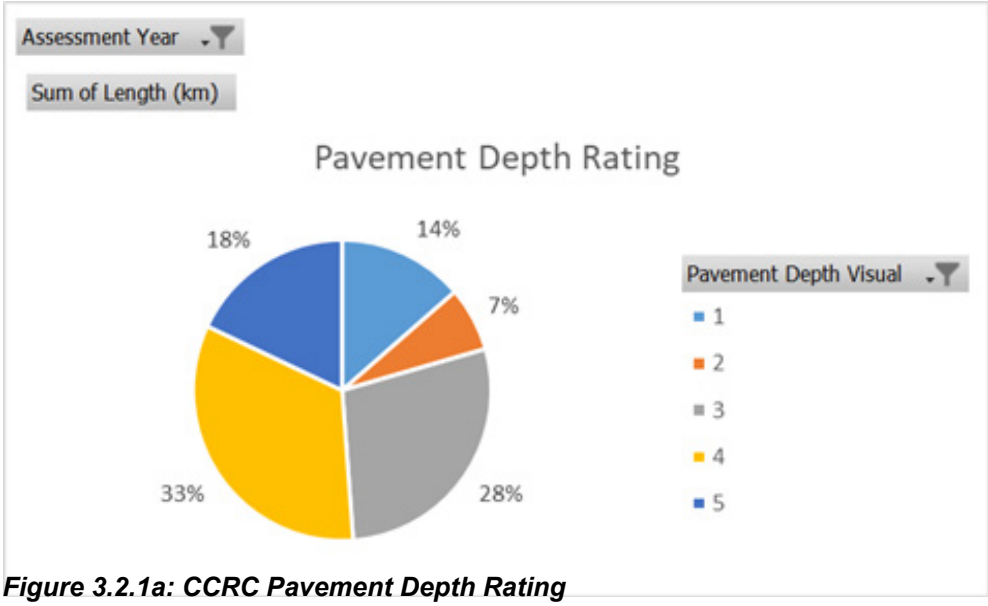

Figure 3.2.1a: CCRC Pavement Depth Rating

Gravel Coverage Determination

Council determines gravel coverage by using the following formula:

Gravel Coverage % = (Length of Pavement – Length of Sub-grade + Thinning) / Length of Road

Sub-grade exposure (no gravel). After rain event these sections will be become slippery and boggy.

Thin gravel. Normal 10 to 30mm. Likely deterioration within 1 to 2 years.

Pavement. Gravel material present >50mm

Figure 3.2.1b: Examples of Sub-grade, Thinning and Pavement

Unsealed Pavement Life

In order to determine the amount of funding required to maintain the network, the life of unsealed pavement needs to be determined.

Unsealed roads are not protected by a sealed surface so they are affected by the environment and traffic volumes. From recent gravel loss estimate surveys, average gravel loss can be in the range of 7 to 25mm a year. For this modelling we have used 10mm/year.

Financial Model – Gravel Coverage Service Level

Unit Rate Determination

Another variable required for the funding model is average unit rate for the depth of gravel used. Council's unit rate is $14/m2 or $100K/km for 150mm depth resheet. To benchmark this rate an adjustment was needed to convert the rate to a depth of 100mm, as this is the standard resheet depth. Council's adjusted rate is $9.34/m2.

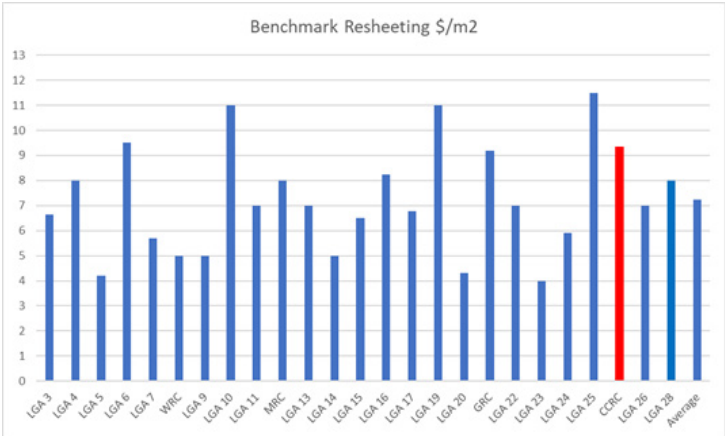

Figure 3.2.4a: Gravel Resheeting Unit Rates Benchmarking

While not the highest benchmarking rate, Council's unit rate is on the higher side for regional centres. Shepherd Services advise that over the last twenty years no Council has been able to maintain 100% imported gravel across the whole network, as it is not viable. The data below demonstrates the CCRC requirement for 100% coverage.

Determination of Gravel Coverage

Council spends about $2.8M/yr. on resheeting.
Network **= 527km**
Average pavement life (150mm depth/10mm) = **15years Unit rate $100k/km**
100% Gravel Coverage - Gross Replacement Cost = **527*$100K/km= 52.7M**
Annualised Replacement = $52.7M/15year = **$3.5M/yr.**

Below is a model chart for different gravel coverage and annualised expenditures.

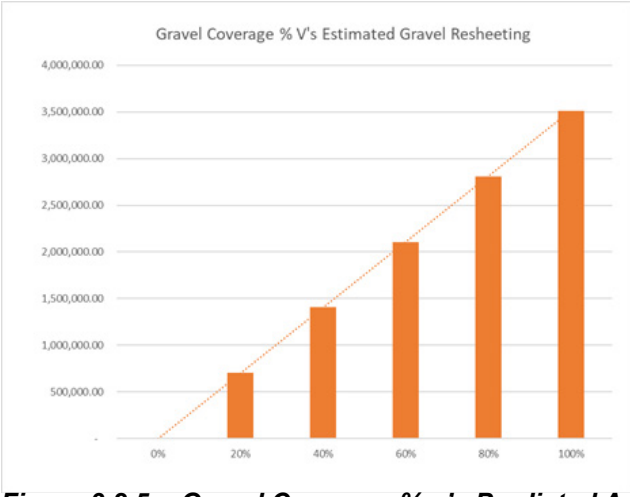

Figure 3.2.5a: Gravel Coverage % v's Predicted Annualised Expenditure

Based on the modelling, it is estimated that Council is funding about an 80% gravel coverage. However, Council are of the view that gravel coverage is higher and may be as high as 90%. The Queensland average funded (not actual on road) gravel coverage is around 50%. Council is funding a very good service level which is appropriate given our high rainfall environment.

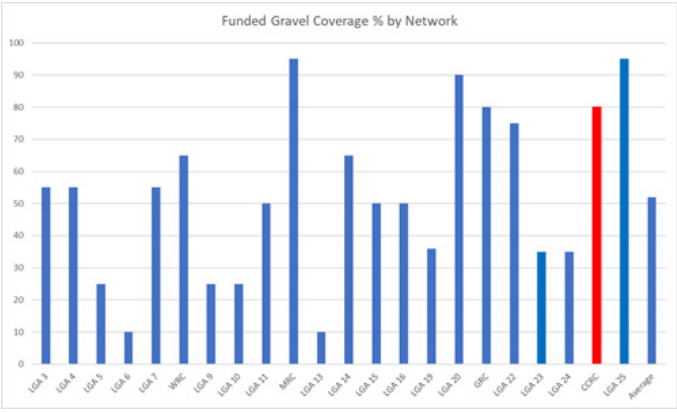

Figure 3.2.5b: Funded Gravel Coverage % by LGA Network

Gravel Coverage Financial Benchmarking Analysis

The financial model discussed above has many variables that if changed, a different result could be obtained (rate and gravel loss reduction will give better coverage results). However, another measure for comparison is a metric called $/km/network.

For a historical expenditure of $2.8M/yr the $/km/Network is $5,323. This has to be adjusted for 100mm depth of resheeting, as other Council rates are based on 100mm depths. The adjusted rate is a lot higher than the national average $1,441 and confirms that Council has been providing a very good service level.

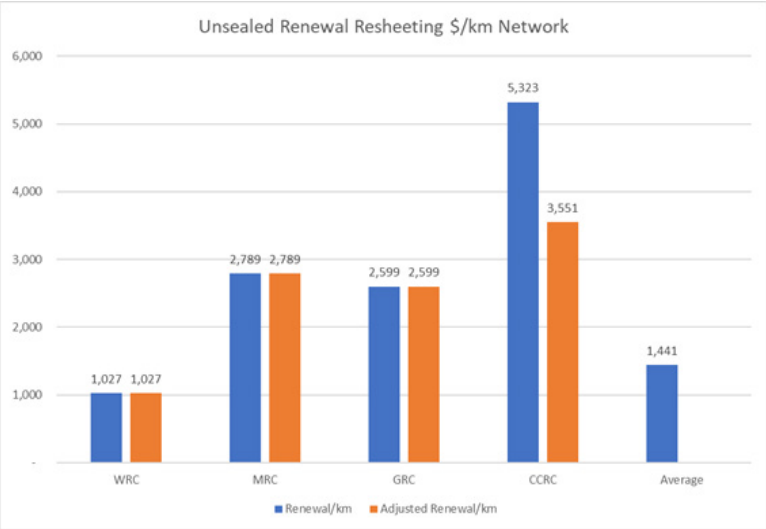

Figure 3.2.6a: CCRC's $/km/Network compared to other Councils and the National Average

Suggested improvements:

1. Adopt a formal policy for the prioritisation of sealing unsealed roads.
2. Review historical data to identify localized "hot spots" that are driving maintenance expenditure and consider:
    - What is the cause of accelerated deterioration?
    - Alternative treatment options to reduce whole of life costs

Outcomes

Council's estimated gravel coverage is over 80% and is a very good service level. Council should conduct a survey of gravel coverage this coming financial year. Potential gaps in funding might be present, if gravel coverage is greater than 80%.

In conjunction with the survey, Council should complete 100 depth potholes evenly across the network to determine the average pavement depth.

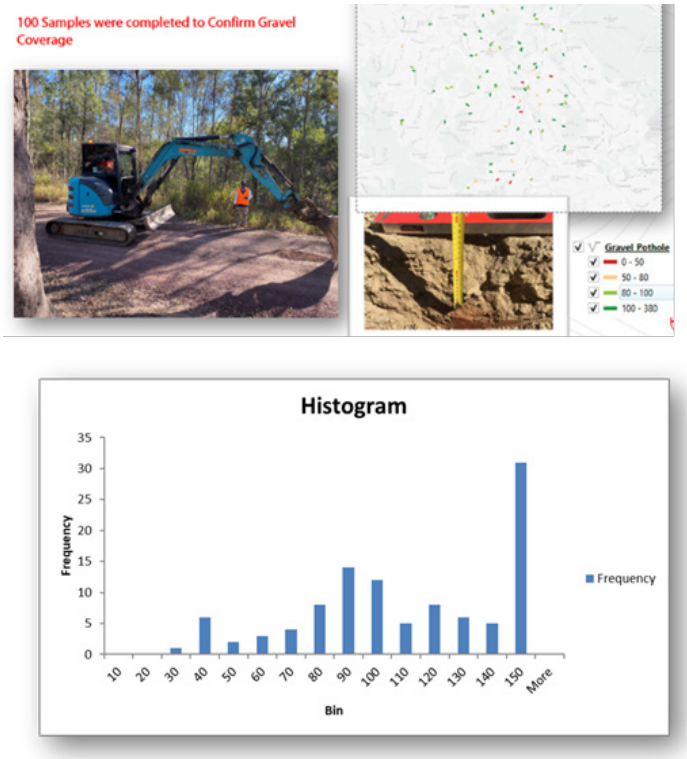

Figure 3.2.7a: Example Plot of Pavement Depths From Gravel Potholing

Lastly, Council will benefit from a detailed review of the $/m2 rate to determine why our costs might be on the higher side of the benchmark rates.

Smooth Running Surface Provided by Grading at a Target Roughness Level

A common phrase used by people reporting issues about an unsealed road is that it is rough. In more technical terms, they are feeling the response of the car as it drives over the bumps and imperfections caused by the road deterioration after grading.

Target Roughness Level

International Roughness Index (IRI) is a quantitative measure of surface roughness measured by actual deflection of a standard vehicle axle and recorded electronically. The below diagram shows an example of a vehicle system.

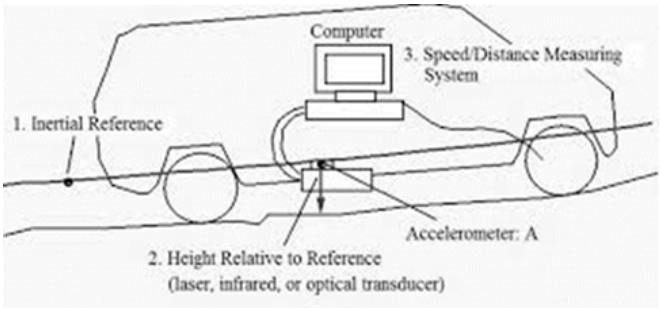

Figure 3.3.1a: How International Roughness Index (IRI) is Measured

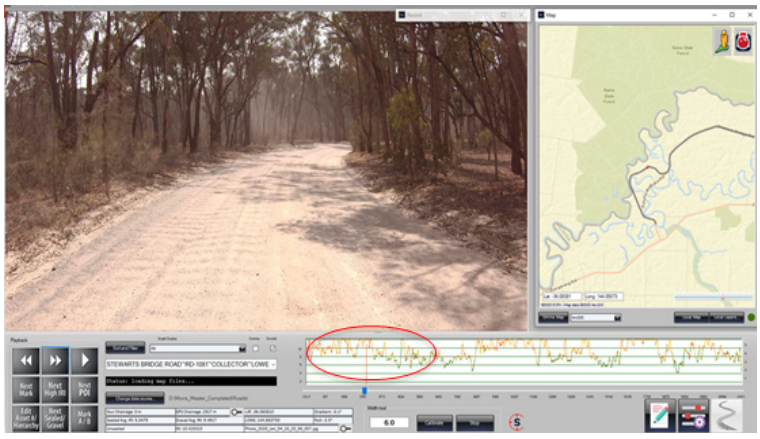

Figure 3.3.1b: IRI Chart Showing an Average 10 IRI Value for the Road

A roughness device registers the defects along the road as spikes on the IRI chart. See the chart (left) as an example circled in red, with corresponding corrugation on the screen.

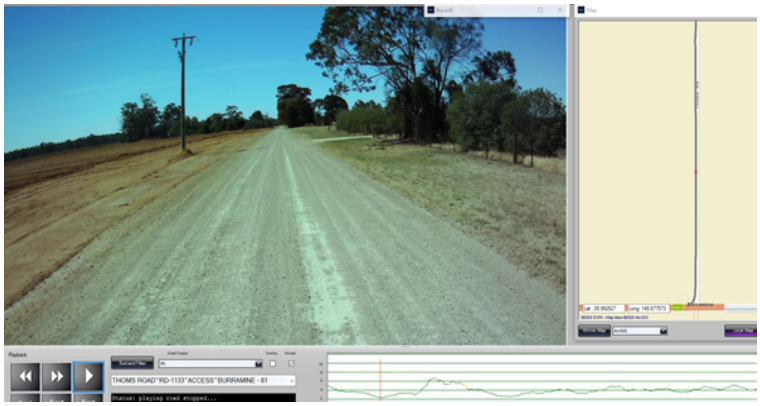

Figure 3.3.1c: IRI Chart of Freshly Graded Road

For reference, a freshly graded road typically has an IRI value of 3.5 to 4.

The network International Roughness Index results by road hierarchy are displayed below.

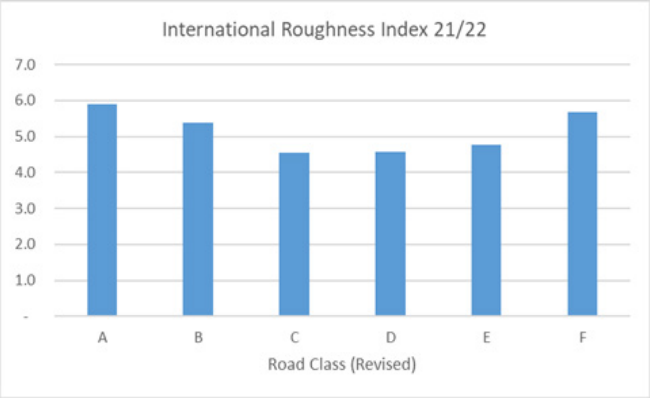

Figure 3.3.1d: International Roughness Index Results for CCRC Road Network

The basis of the CCRC statistical reporting is not consistent with how other Councils calculate their benchmark levels. It is considered that a reasonable adjustment to make CCRC data comparable would be to increase the reportable IRI by 20% this makes the comparison data for CCRC, 5.7 IRI. This compares well with many other Councils.

The average IRI value is 6.5. Council survey shows one of the best results seen amongst Councils.

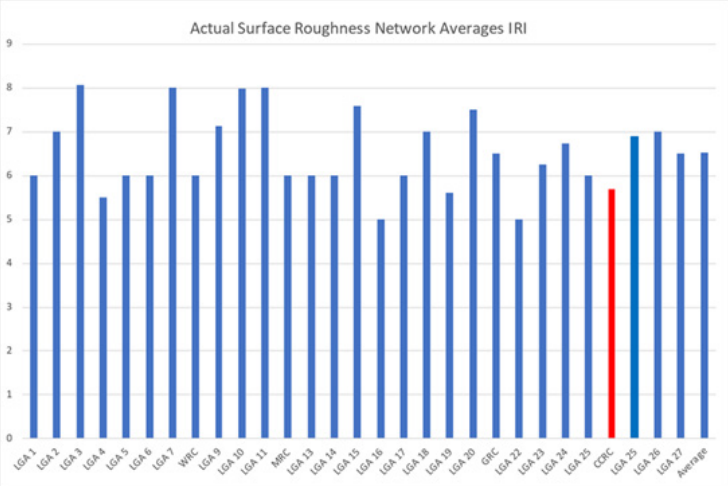

Figure 3.3.1e: Average IRI Values for Local Government Areas

Roughness Deterioration Modelling

Council has been using and collecting international roughness index values for many years now. This information with grade history enables Council to determine deterioration models for each class of road so that future values can be predicted and used for optimising works programs.

Deterioration models represent the gradient or movement that happens after the road is graded and is affected by traffic volumes, weather, material type and grading practice.

Below is an example of how different grading practices affect deterioration.

Figure 3.3.1a: Deterioration charts of medium grading and heavy grades

The next table is an example of how deterioration modelling can be used to predict the future IRI that assist when the road might be due for its next grade. This information is used when weather conditions have been consistent yet are reset when there has been a major rain event.

Road ID	Road Name	Section	Region	Class	Last Inspection	Roughness IRI	Degradation Faction (Average IRI/ Day)	Degradation Faction (Theory) IRI/ Day	Intervention Level	3 Month IRI	Program	Anticipated Grade Date 2
1228	Warrakin Rd	1	Silkwood	A	24/03/2022	7.1	0.02	0.03	8.8	9.8	Yes	10/06/2022
1222	Ranch Rd	2	Davidson	A	11/04/2022	5.7	0.03	0.03	8.8	8.4	No	17/07/2022
1224	Granadila Rd	2	El Arish	A	29/03/2022	4.4	0.05	0.03	8.8	7.1	No	2/07/2022
1221	Ranch Rd	1	Davidson	A	11/04/2022	4.2	0.04	0.03	8.8	6.9	No	31/07/2022
1224	Granadila Rd	3	El Arish	A	29/03/2022	3.9	0.03	0.03	8.8	6.6	No	25/08/2022
1220	Warrubulen Rd	1	Cowley	A	23/03/2022	3.0	0.03	0.03	8.8	5.7	No	13/09/2022
1226	Granadila Rd	4	El Arish	A	29/03/2022	4.1	0.02	0.03	8.8	6.8	No	28/10/2022
1227	Jackson Rd	2	El Arish	A	11/03/2022	4.1	0.02	0.03	8.8	6.8	No	29/11/2022
1223	Ranch Rd	3	Davidson	A	11/04/2022	3.3	0.03	0.03	8.8	6.0	No	7/10/2022
1263	Garners Beach Rd	1	Bingil Bay	A	16/03/2022	3.23	0.02	0.03	8.8	5.9	No	14/11/2022

Council Theorical Deterioration Model

Class	Deterioration IRI/ Day	Invention IRI	Associated Safe Driving Speed	Estimate Grades/ Year
A	0.030	7	75	3.1
B	0.020	7	75	2.1
C	0.017	8	70	1.3
D	0.010	8	70	0.8
E	0.007	9	65	0.4
F	0.007	11	55	0.3

Communicating Roughness Index to the Community

To help communicate what the International Roughness Index is, there is a direct relationship between IRI and safe driving speed (excluding geometric restraints).

Safe driving speed is sometimes an easier indicator to communicate to the community.

The chart provided by World Bank below, provides a comparison of IRI and speed with common defect descriptions.

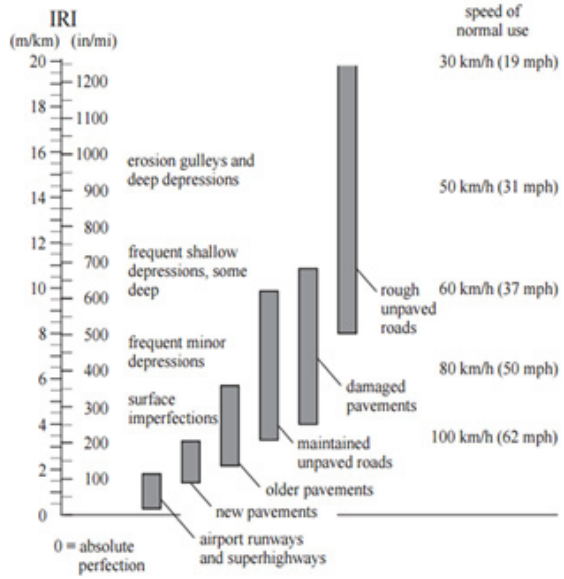

Figure 3.3.2a: Implications of IRI and Speed. Source: Research Chart from World Bank.

An International Roughness Index of 5.7 represents a safe driving speed of over 85km/hour (excluding geometric restraints).

Financial Model – Surface Roughness Service Level

To determine the funding required to maintain different roughness indexes for the network, a few things need to be considered.

The average of interventions for all road classes is currently IRI 7.5.

Below is a benchmark of International Roughness Index interventions of 20 other Councils.

The national average is an IRI of 8 or safe driving speed of 70km/hr.

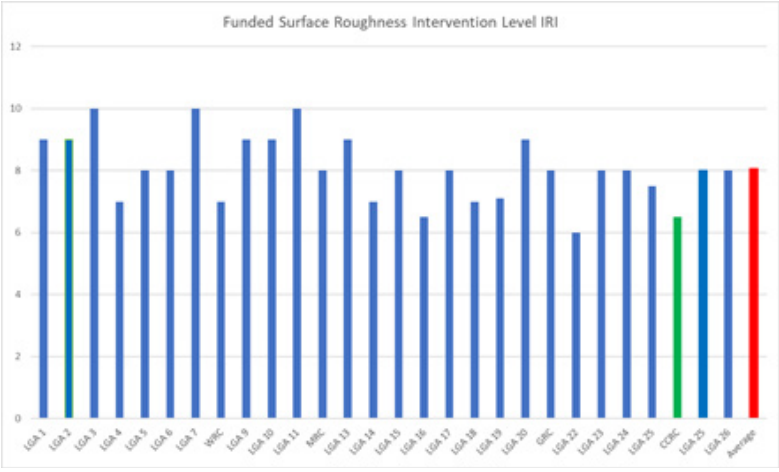

Figure 3.3.3a: Benchmark of IRI Inventions by Local Government Areas

Determination of Unit Rates

Council's average crew costs on a normal day are roughly $3,080/day and include a grader, roller, and water. The national average is between $2,800 and $5,000 (variations are based on plant rates/hr. used between Councils). Other regional Councils are at higher rates as they have either second rollers or additional equipment like water trucks.

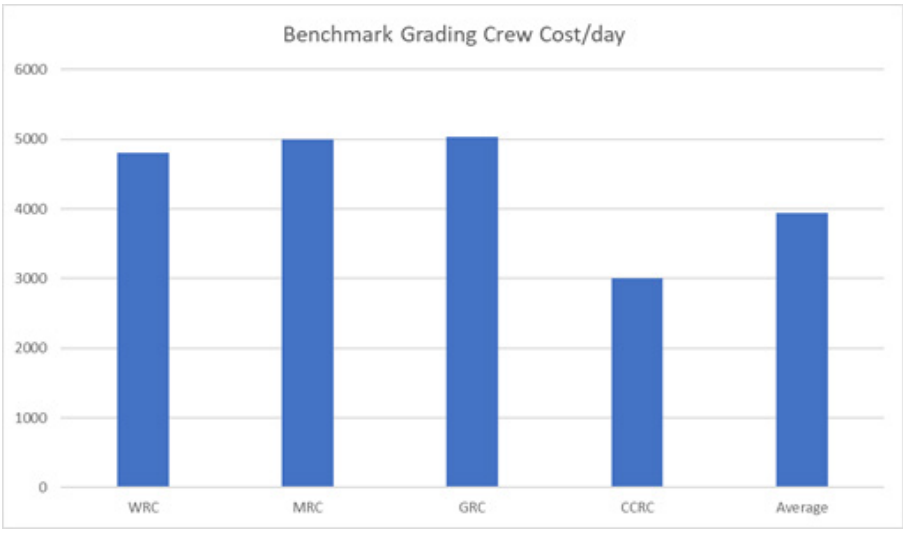

Figure 3.3.4a: Benchmarking Grading Crew Cost/ Day

Financial Model

There is a direct relationship between funding and roughness as per the analysis of different IRI values and expenditures required shown below. In terms of quality of our network, you get what you pay for. Our community may value improved performance of the unsealed road network through prioritisation of funds to this service or through the generation of additional revenue through general rates.

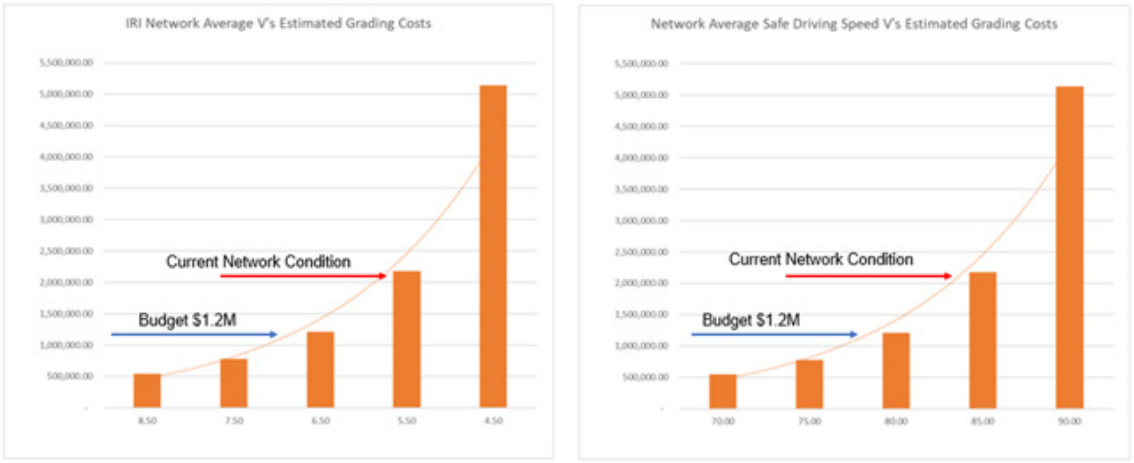

Figure 3.3.6a: IRI vs Estimated Grading Costs and Safe Driving Speed vs Estimated Grading Cost

Models for resources have also been developed for percentage of network graded as displayed below.

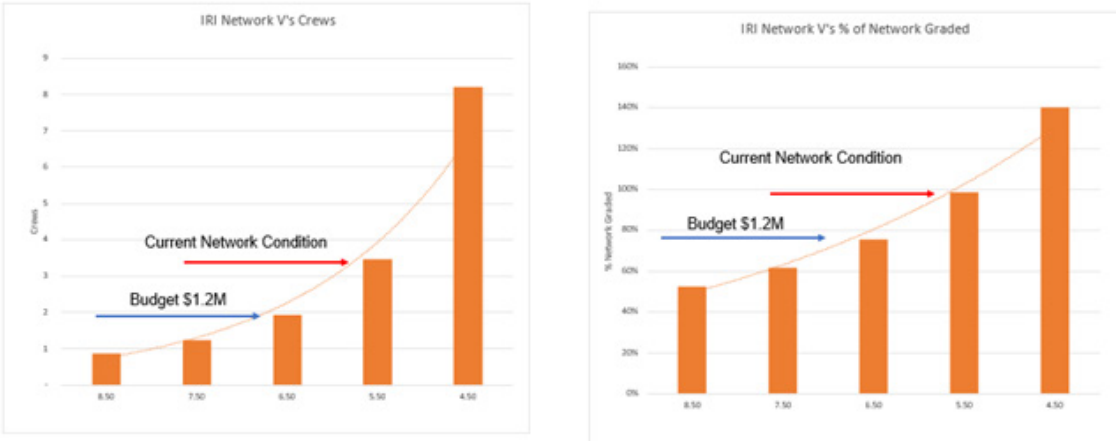

Figure 3.3.6b: Crews vs IRI and % of Network Graded vs IRI

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