LG TRRIP
Local Government Transport & Roads
Research & Innovation Program

Considerations for Sealing Local Government Roads in WA

2 August 2023

Presenters & Team

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Welcome

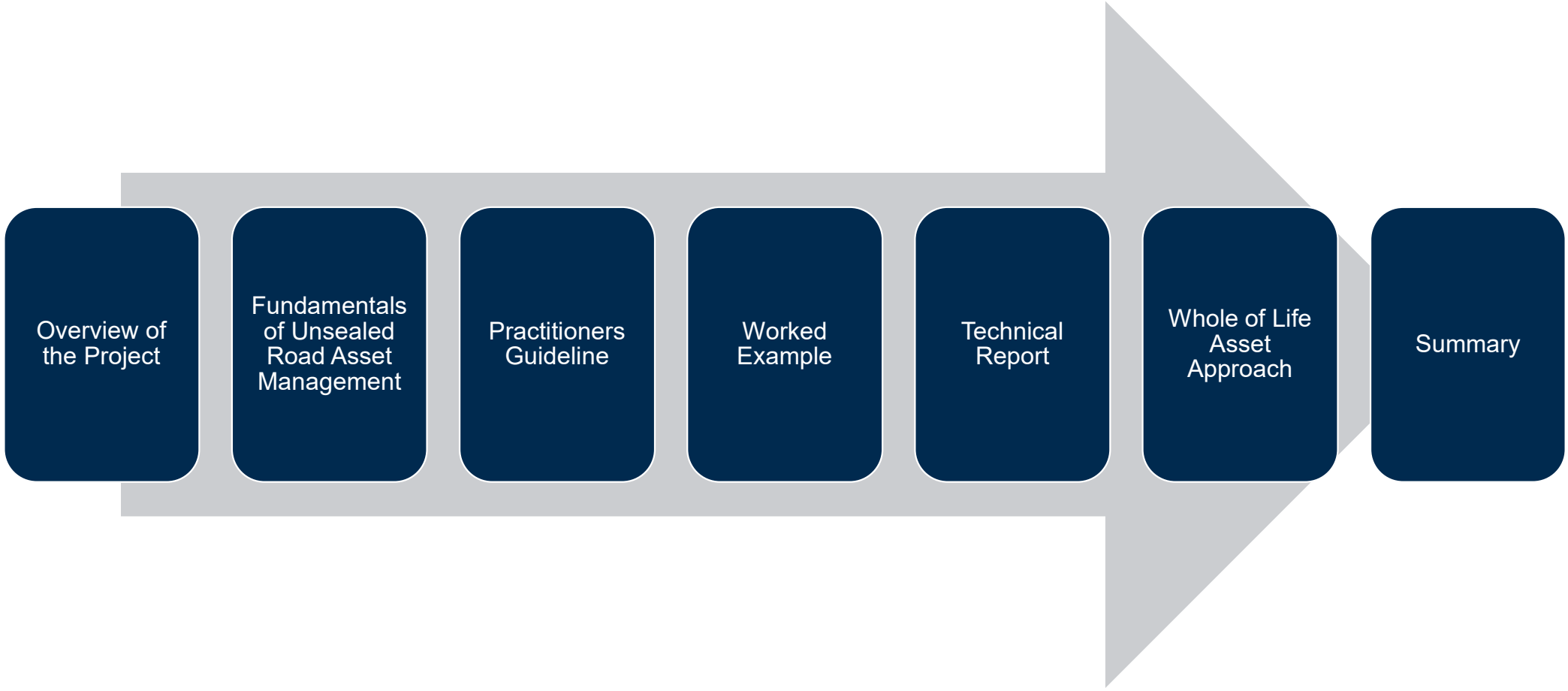
About LG TRRIP and WARRIP

LG TRRIP

The Local Government Transport and Roads Research and Innovation Program is a joint initiative between WALGA and Main Roads Western Australia.

LG TRRIP seeks to provide collaborative research that positively contributes to the design, construction and maintenance of safe, sustainable transport infrastructure for local government in Western Australia.

Agenda


Overview of the Project
Fundamentals of Unsealed Road Asset Management
Practitioners Guideline
Worked Example
Technical Report
Whole of Life Asset Approach
Summary

Overview

Georgia O’Connor

Background & Purpose

- **Purpose**
  - To equip local governments with the necessary information to make informed decisions about the sealing of unsealed roads within their jurisdiction.
  - Provide a comprehensive analysis of the potential benefits and drawbacks of sealing unsealed roads, taking into consideration:
    - the whole-of-life cost implications,
    - likely impacts of traffic generated by new developments, and
    - quantifiable safety benefits

ARRB Project Team

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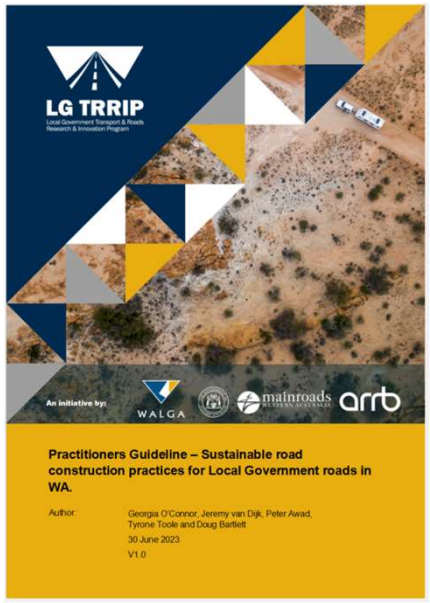
Structure of the Guidelines

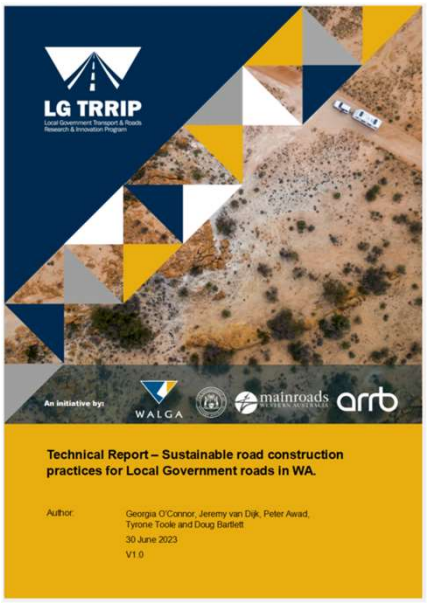


Practitioners Guideline

- User friendly
- Practical
- Links to the Technical Basis
- Provides a summarised Framework Flowchart of steps in the assessment
- Provides a Catalogue of Solutions
- Provides Worked Examples

Technical Report

- Full report with all background and research for the process and solutions development
- Supporting technical information for case studies and worked examples



Project Methodology

Literature Review to identify previous research, guidelines, and technical documents

Subject Matter Expert review

Consultation with local government to identify current practices and future needs

Application of a Whole-of-Life Asset Management Approach to Create a Catalogue of Solutions

Development of the Practitioner’s Guideline

The Issues

Increasing Traffic

- greater utilisation of unsealed local roads by more significant axle loads
- light traffic resulting from increased traffic from various sources

Accounting for all sources of costs

- typical costs and high costs reflecting location and fit for purpose treatments
- those which affect road users and crash costs
- other cost related factors to inform a more wholistic evaluation of upgrade options, e.g. road hierarchy and use related standards

Preservation & Renewal

- the condition of the unsealed road network
  - quality of materials and maintenance techniques
  - performance of the materials
  - whole-of-life costs
  - upgrade costs
- Climate and extreme weather events
  - how this can be expected to change over time

Levels of service

- intervention levels by road hierarchy
- vehicle operating costs
- travel time related costs related
- to community and industry use

Road safety

- potential changes in crash rates and crash severity by road type / cross section and condition / surface type

Environmental considerations

- soil reactivity and stability
- erosion and sedimentation
- roadside vegetation
- impacts on biodiversity and wildlife

(not costed but described)

The Role of Local Government

- **A vital role in the provision and management of Western Australia's road assets**
- **Responsible for more than three-quarters of the road network. Of the almost 185,654km long road network, approximately 69% is unsealed.**
- **Unsealed roads, even though often considered as lower-order roads, play a vital role in Western Australia in terms of:**
  - providing access to rural communities
  - the movement of primary and processed produce to markets
  - traffic movements within State forests and defence training areas
  - access to forests or fire management on public lands
  - haulage roads for the mining and timber industries
  - recreational, social and tourist pursuits (ARRB 2020).
- **Operates almost invariably under constant funding constraints and in many cases experiences a lack of both financial and human resources.**

Fundamentals of Unsealed Road Asset Management

Georgia O’Connor

Unsealed Roads

Unformed Road

- non-engineered roads
- consist of a track that is cleared of vegetation
- not all-weather roads
- carry very low traffic volumes
- seldom maintained
- may only be suited for four wheel drive vehicles

Formed Road

- desirably designed to the appropriate geometric standards
- adequate drainage is provided
- earth roads comprised of local materials sourced from the road reservation
- no imported gravel is used
- periodic maintenance of these roads should be carried out

Formed and Graveled Road

- designed to appropriate geometric standards
- adequate drainage provided
- a layer of imported granular material, compacted to the required thickness
- maintenance is carried out on a regular basis

Unsealed vs. Sealed

An unsealed road is a road that has been formed and constructed but is not sealed.

Unsealed

- providing access to rural communities
- the movement of primary produce to markets
- the movement within state forests and defence training areas, including fire management
- access to forests or fire management on public lands
- haulage roads for the mining and timber industries
- recreational, social and tourist pursuits

Sealed local roads have a pavement structure which, in many instances, has evolved over time rather than having been designed and upgraded according to systematic procedures.

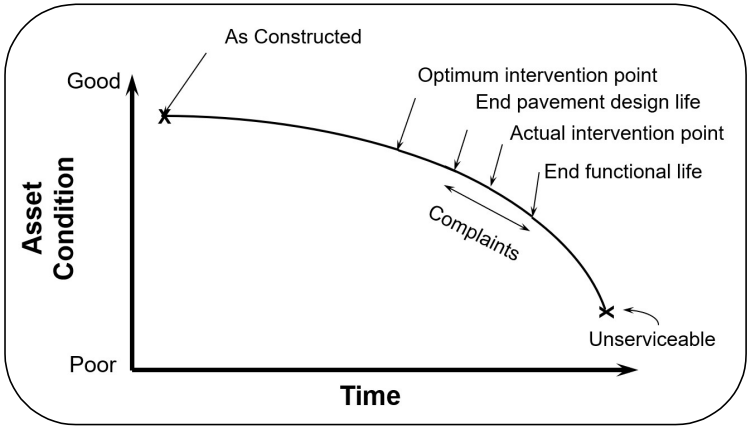
The main pavement structure is a flexible pavement consisting of unbound layers with a surface of a sprayed seal or asphaltic mix

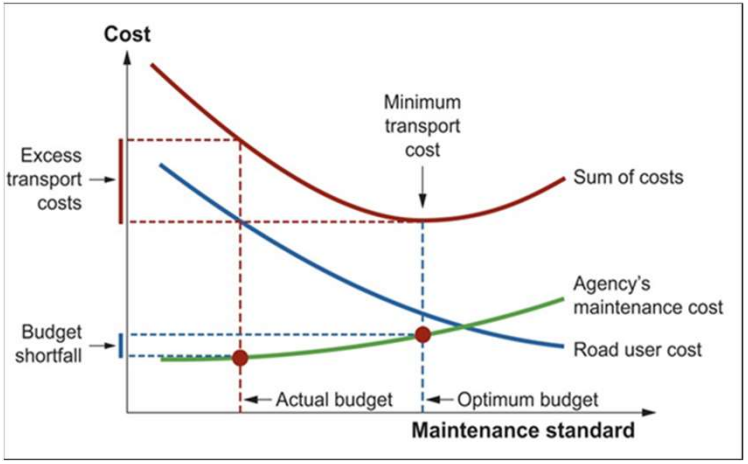
Sealed

- provide a safe, economical and durable all-weather surface
- protect lower layers of a pavement from moisture
- provide surface characteristics to reflect community expectations
- provide a dust-free surface
- extend the life of the pavement
- reduce vehicle operating and maintenance costs

Asset Management Principles

- **Preservation is better than cure**
  - Timely and effective interventions adopting the ‘Stitch-in-time’ principle
- **Minimise total transport costs (not just owner/agency costs)**
  - Seek the ‘Goldilocks’ solution (or sweet spot)
  - Accounts for community costs in a quantifiable manner
  - Total Transport Costs = sum of Agency costs of provision and upkeep, road user costs and crash costs, and other quantifiable costs / benefits
- **Metrics applied (behind the solutions)**
  - Net present value (NPV) of TTC (savings)
  - Marginal Benefit Cost Ratio (‘bang for the buck’)





Volume 1: Practitioners Guideline

Tyrone Toole

Framework Process

From Step 1 Road category	From Step 2 Climate zone	From Step 3 Cost level	From Step 4 Unsealed practice	Catalogue link	From Steps 5 & 6 AADT & HV%
Regional distributor	1	Typical	Typical	Figure A1	Select solution
			Good	Figure A2	Select solution
		High	Typical	Figure A3	Select solution
			Good	Figure A4	Select solution
	2	Typical	Typical	Figure A5	Select solution
			Good	Figure A6	Select solution
		High	Typical	Figure A7	Select solution
			Good	Figure A8	Select solution
	3	Typical	Typical	Figure A9	Select solution
			Good	Figure A10	Select solution
		High	Typical	Figure A11	Select solution
			Good	Figure A12	Select solution
	4	Typical	Typical	Figure A13	Select solution
			Good	Figure A14	Select
		High	Typical	Figure A15	Select
			Good	Figure A16	Select solution

NPV Optimum Upgrade Strategy

With crashes and additional SAFETY

		Optimum Upgrade Strategy_TYPICAL COST with crashes and additional SAFETY			
		Heavy Vehicle (%)			
		5	15	25	50
Typical Costs	AADT_50	Not Viable	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_100	Base Upgrade	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_175	Base Upgrade	Base Upgrade	Base Upgrade	Alt Upgrade
	AADT_250	Base Upgrade	Base Upgrade	Alt Upgrade	Alt Upgrade
	AADT_500	Alt Upgrade	Alt Upgrade	Alt Upgrade	Alt Upgrade

MBCR Upgrade Viability

With crashes and additional SAFETY

Seal + base maintenance

		Heavy Vehicle (%)			
		5	15	25	50
Typical Costs	AADT_50	Not Viable	Marginal	Viable	Viable
	AADT_100	Marginal	Viable	Viable	Viable
	AADT_175	Viable	Viable	Viable	Viable
	AADT_250	Viable	Viable	Viable	Viable
	AADT_500	Viable	Viable	Viable	Viable

Step 1
Determine your Road Category
(4 categories)

Step 2
Select your Climate Zone
(4 categories)

Step 3
Select your Cost Level
(2 categories)

Step 4
Select your Quality of Unsealed Practice
(2 categories)

Step 5
Obtain your Traffic Count Data and choose nearest AADT
(5 categories)

Step 6
Obtain your Heavy Vehicle % and choose the nearest HV%

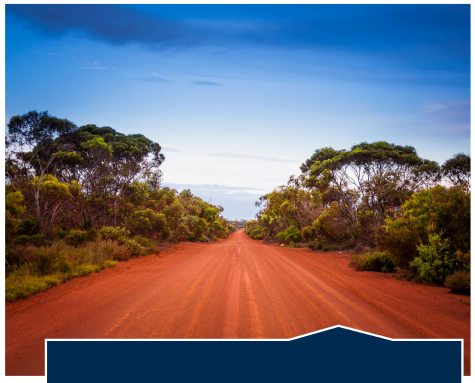
Step 7
Select Catalogue (see Table)

Step 8
Review Decision Matrix (see Table)

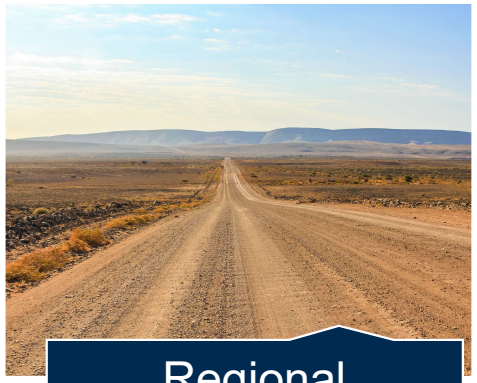
Step 1: Determine Road Category

- **Select from the list:**

Access Road



Local Distributor



Regional Distributor

District Distributor

Step 2: Select your Climate Zone

- **Select Climate Zone:**
  - 1. Hot humid summer
  - 2. Hot dry summer, mild winter
  - 3. Hot dry summer, cold winter.
  - 4. Warm summer, cold winter

Climate zones based on temperature and humidity

Projection: Lambert conformal with standard parallels 10°S, 40°S.

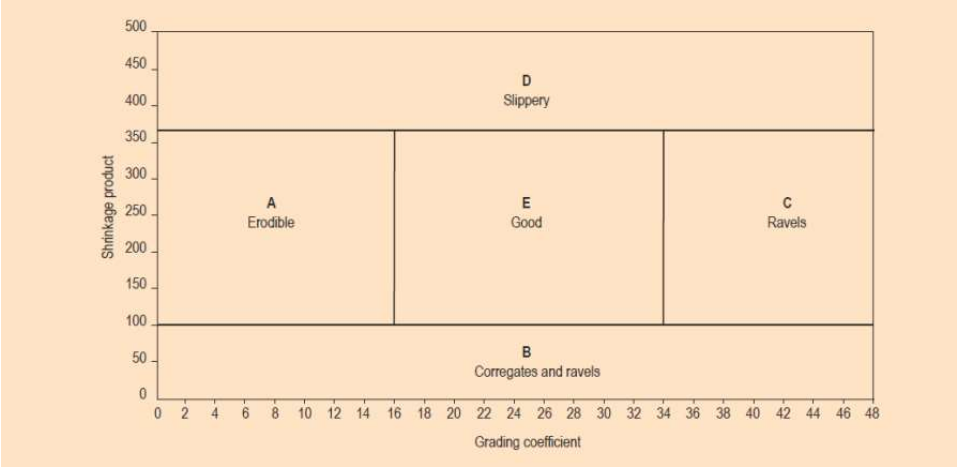
Based on a standard 30-year climatology (1961-1990)

Step 3: Select your Cost Level

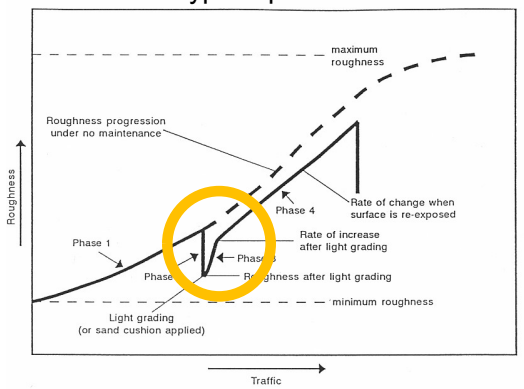
- Appropriate cost level must be selected from one of the categories listed
- Upgrade cost is a function of traffic level and HV%
- Required structural strength based on 20-year design period with single traffic growth rate
- A user may choose to interpolate or extrapolate solutions to account for the cost rates for upgrades in their Shire, or specific to the candidate project.

Step 4: Quality of Unsealed Practice

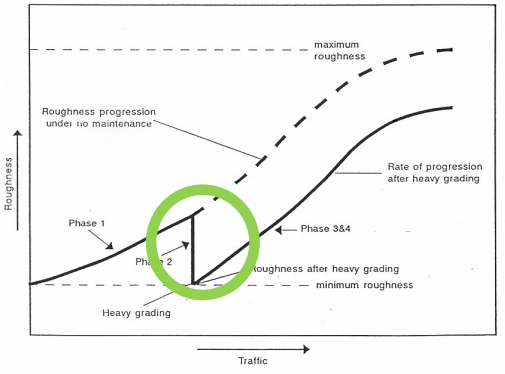
- **Compliance of gravel wearing course materials**
  - Compliant:
    - Low rate of material loss, typically less than 5 – 10 mm per year per 100 LVU (Light vehicle units),
  - Non-compliant:
    - High rate of material loss (> 20 – 40 mm per year per 100 LVU)
    - surface ravelling and corrugations common under traffic in drier conditions
- **Grading type and effectiveness**
  - Typical practice:
    - light grading involving minimal cutting and reshaping (< 50 mm depth) of the surface
    - respreading of loose material
    - applied in mainly dry conditions, in the absence of moisture
    - without any compaction applied
  - Good practice:
    - medium or heavy grading is applied
    - involving cutting and reshaping of the surface (> 50 mm depth)
    - under moist conditions
    - minimum of free-roller or traffic compaction, or mechanical compaction.



Typical practice



Good practice



Step 5&6: Traffic & HV%

5: Obtain your Traffic Count Data and Choose Nearest AADT

- Gain a good appreciation of the current level of traffic using the road by arranging traffic surveys or based on well-informed desk studies
- Any data collection should account for seasonal flows and concentrations of use, e.g. weekend or holiday use
- Select the nearest AADT level :
  - 50 veh/day
  - 100 veh/day
  - 175 veh/day
  - 250 veh/day
  - 500 veh/day

6: Obtain your Heavy Vehicle % and Choose the Nearest HV%

- Select a composition of heavy vehicles (by %) closest to the values below:
  - 5%
  - 15%
  - 25%
  - 50%
- The applied value should account for seasonal flows and concentrations of use and employ a value representative of the whole year.

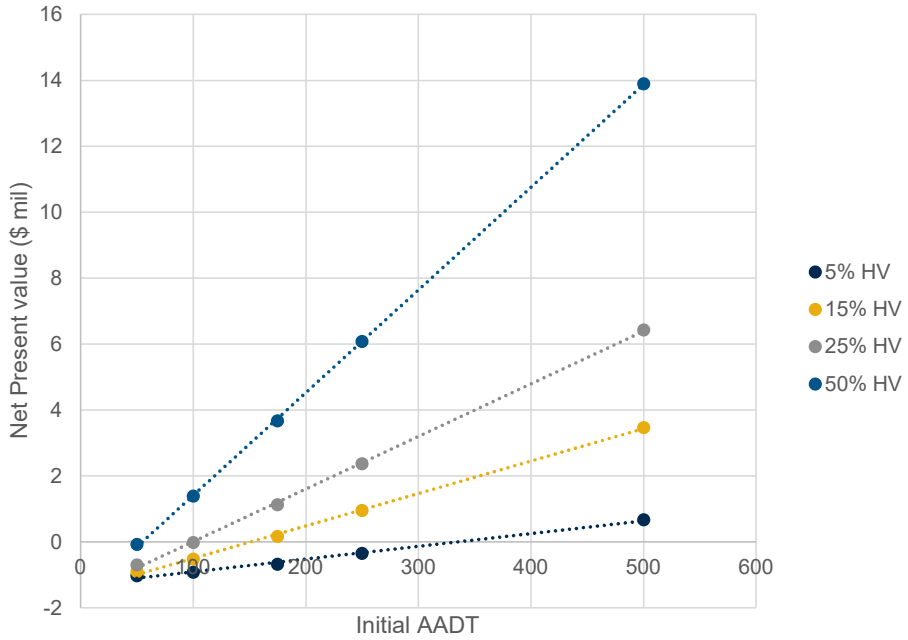
Step 7: Select Catalogue

- **Given the following data:**
  - Road Category - Regional Distributor
  - Climate zone - 1
  - Cost level – High
  - Quality of unsealed road maintenance practice – Good
- **Select Figure A.38 (Base) &/or Figure A.39 (Alternative) of this guideline**
  - See next slide

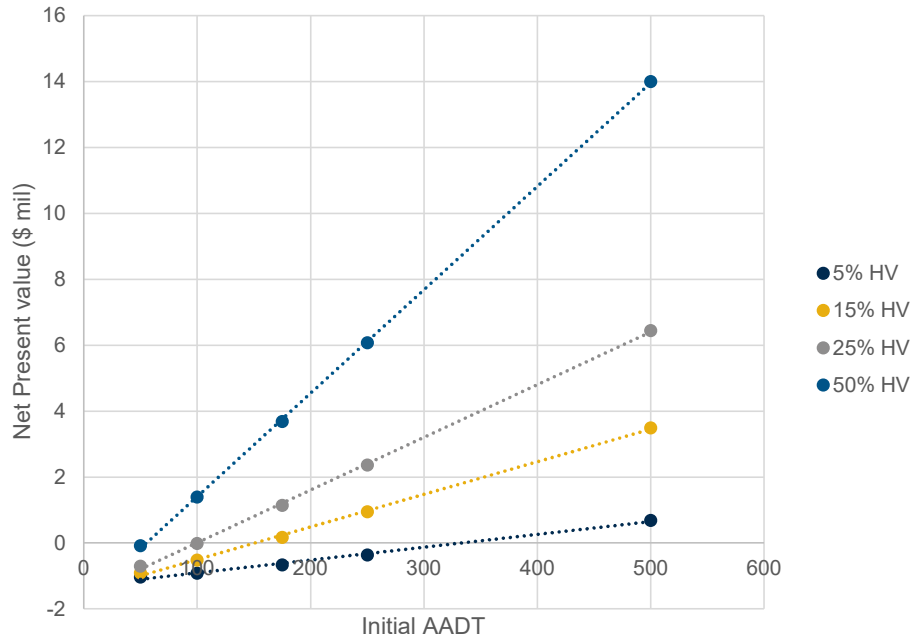
From Step 1 Road category	From Step 2 Climate zone	From Step 3 Cost level	From Step 4 Unsealed practice	Catalogue link	From Steps 5 & 6 AADT & HV% *
Regional distributor	1	Typical	Typical	TBA	Select solution
			Good	Figure A.36 & Figure A.37	Select solution
		High	Typical	TBA	Select solution
			Good	Figure A.38 & Figure A.39	Select solution
	2	Typical	Typical	TBA	Select solution
			Good	Figure A.40 & Figure A.41	Select solution
		High	Typical	TBA	Select solution
			Good	Figure A.42 & Figure A.43	Select solution
	3	Typical	Typical	TBA	Select solution
			Good	Figure A.44 & Figure A.45	Select solution
		High	Typical	TBA	Select solution
			Good	Figure A.46 & Figure A.47	Select solution
	4	Typical	Typical	TBA	Select solution
			Good	Figure A.48 & Figure A.49	Select solution
		High	Typical	TBA	Select solution
			Good	Figure A.50 & Figure A.51	Select solution

Step 7: Select Catalogue

A.38: Base Maintenance



A.39: Alternative Maintenance



Step 8: Review Decision Matrices

- Continuing the same example…
- Using these Tables select the applicable solution for the current AADT and HV:
  - Current AADT = 205 (Use 175 as nearest)
  - HV % = 23% (Use 25% as nearest)
  - Solution
    - NPV = Base Upgrade justified maintained to minimum intervention levels
    - MBCR = Both Base and Alternative are strongly Viable (MBCR >2)
    - Choose Alternative funds permitting

NPV Optimum Upgrade Strategy

With crashes and additional SAFETY

Climate Zone 1

		Optimum Upgrade Strategy_TYPICAL COST with crashes and additional SAFETY			
		Heavy Vehicle (%)			
		5	15	25	50
Typical Costs	AADT_50	Not Viable	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_100	Base Upgrade	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_175	Base Upgrade	Base Upgrade	Base Upgrade	Alt Upgrade
	AADT_250	Base Upgrade	Base Upgrade	Alt Upgrade	Alt Upgrade
	AADT_500	Alt Upgrade	Alt Upgrade	Alt Upgrade	Alt Upgrade

		Optimum Strategy_HIGH COST with crashes and additional SAFETY			
		Heavy Vehicle (%)			
		5	15	25	50
High Costs	AADT_50	Not Viable	Not Viable	Base Upgrade	Base Upgrade
	AADT_100	Not Viable	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_175	Base Upgrade	Base Upgrade	Base Upgrade	Base Upgrade
	AADT_250	Base Upgrade	Base Upgrade	Base Upgrade	Alt Upgrade
	AADT_500	Alt Upgrade	Alt Upgrade	Alt Upgrade	Alt Upgrade

MBCR Upgrade Viability

With crashes and additional SAFETY

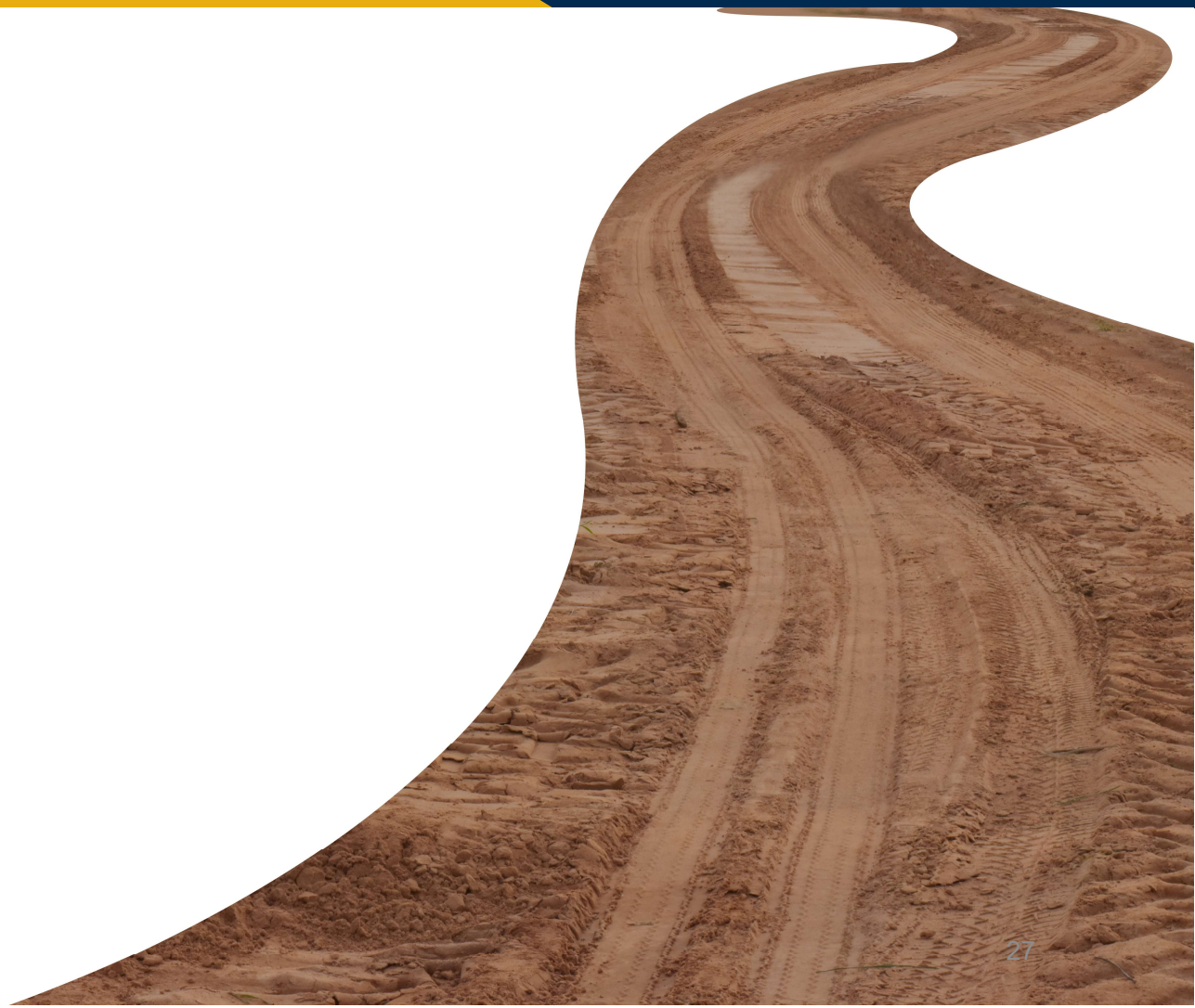
		Seal + base maintenance				Seal + preventative maintenance				
		Heavy Vehicle (%)					Heavy Vehicle (%)			
		5	15	25	50		5	15	25	50
High Costs	AADT_50	Not Viable	Not Viable	Marginal	Marginal	AADT_50	Not Viable	Not Viable	Marginal	Marginal
	AADT_100	Not Viable	Marginal	Marginal	Viable	AADT_100	Not Viable	Marginal	Marginal	Viable
	AADT_175	Marginal	Viable	Viable	Viable	AADT_175	Marginal	Viable	Viable	Viable
	AADT_250	Marginal	Viable	Viable	Viable	AADT_250	Marginal	Viable	Viable	Viable
	AADT_500	Viable	Viable	Viable	Viable	AADT_500	Viable	Viable	Viable	Viable

Volume 2: Technical Report

Georgia O’Connor / Tyrone Toole

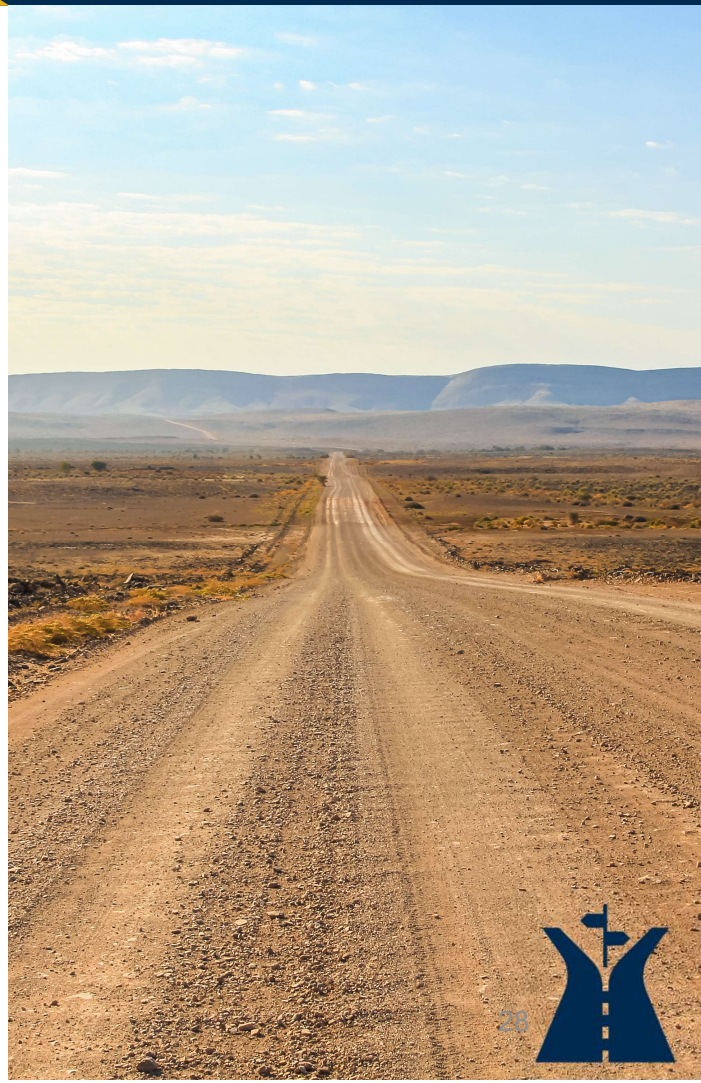
Key factors of decision-making

- Road Condition
- Materials
- Traffic
- Environmental Considerations
- Climate
- Whole-of-life Costs
- Road Safety
- Community expectations



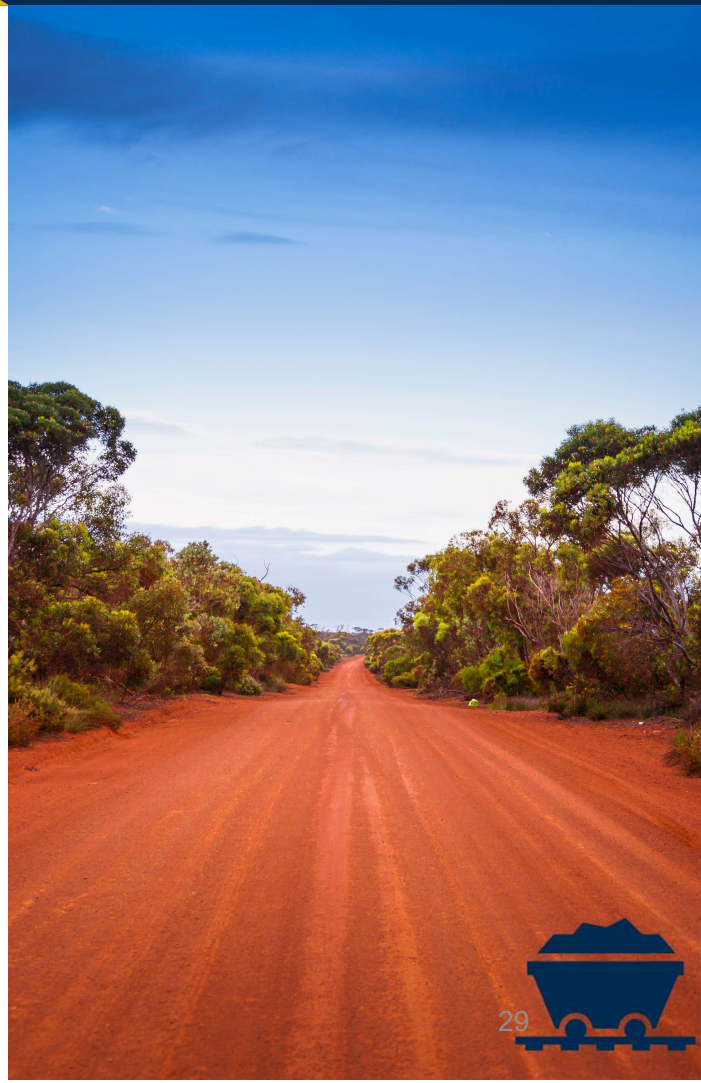
Road Condition

- Dry weather can cause wear and abrasion to road surfaces, leading to loose material, ruts, and concave shapes.
- Loss of surfacing material by dust and movement of loose material can cause corrugations and ravelling, resulting in increased roughness and material loss.
- In wet weather, environmental factors and traffic can cause erosion, wear and abrasion on road surfaces, leading to rutting, material loss, potholing, and roughness.
- These factors can result in increased deterioration of the road, affecting its shape and structural integrity.
- Wet weather can increase the risk of shear failure and deformation in the upper pavement when the surfacing layer is weak.
- When roadbed material is weak, wet weather can lead to over-stressing of the subgrade or roadbed, requiring protection and limiting deformation to acceptable levels.
- Locations with poor drainage and weak soils may experience accelerated deterioration.



Materials

- Choice of gravel material for unsealed roads is a compromise between high plasticity to minimize gravel loss in dry periods and low plasticity to prevent rutting and deformation in wet conditions.
- Specifications require a mechanically stable grading with a higher fines content for binding action to occur.
- Heavy vehicle loads applied to unsealed roads can cause ravels, corrugations, slippery surfaces, and material erosion.
- Finding the sweet spot, such as the that illustrated in reported case studies, can lead to optimal material choice and minimise material losses and the negative effects of heavy vehicle loads.



Traffic

- Vehicle use is a major contributor to road deterioration, particularly for unsealed roads, with increased traffic on unsealed roads leading to higher maintenance costs, which may result in the decision to seal the road
- Heavy vehicle axle loading has not been isolated as a specific parameter in most studies and based on the evidence provided, it is recommended to use the number of axle pairs to represent heavy vehicles when estimating traffic loading-based cost attribution parameters for unsealed roads.
- This approach has been found to provide more accurate cost attribution compared to other approaches such as assigning LVU factors or using PCU factors.

Environmental Considerations

- Unsealed roads affect:
  - waterways
  - the air
  - land and its biodiversity.
- The presence of moisture can cause several problems, including:
  - reduced traction
  - increased maintenance costs,
  - accelerated road deterioration.
- Proper cross fall and drainage techniques can effectively manage and remediate moisture issues.
- As road surfaces erode due to traffic and the environment, they need to be replaced.
- The replacement of gravel is both a financial and an environmental burden.

Climate Change & Extreme Weather Events

- Two main aspects through which climate change impacts the road network:
  - road infrastructure – pavements and structures impacted by flooding or cyclones, leading to possible severe damage, loss of function, or accelerated deterioration.
  - road use –temporary loss or reduced quality of access, with increased journey times on preferred routes or from diversions.
- Assuming normal weather patterns, surface type and material should ensure a reasonable service level in terms of accessibility.
- If not, consider upgrading to an all-weather, durable unsealed surface, or a sealed surface.

Whole of Life Costs

- Maintenance and sealing decisions must account for expected costs and benefits across the asset's service life.
- Upgrade and maintenance costs are offset by (generally) lower road user costs (cost savings), the greater the agency investment.
- Management decisions should target the "Goldilocks point" where lowest total transport costs (TTC) are achieved.
- Modelling and estimates for specific regions and roads are important as management and road user costs vary substantially due to traffic volumes, climate and weather, materials and remoteness, geology and topography, and more.

Road Safety

- Incorporation of the Safe System Approach into Road Asset Management Practices.
- The number of crashes on an unsealed road network is lower than that of sealed roads, but the probability of having a crash is at least double.
- When sealing an unsealed road, the road type and the road roughness will be improved.
  - Therefore, when a road is sealed the traffic along that road will travel at higher speeds.
  - In fact, on sealed roads, the travel speed can be nearly twice as much as that of unsealed roads.
- Along an unsealed road, due to lower speeds, roadside hazards are less of a concern.
  - Along a sealed road, where roadside hazard exist, consideration would need to be given to the removal of these hazards, or the installation of barriers to protect drivers from these hazards.

Community Expectations

- Public pressure may be based on a variety of reasons, such as:
  - the route being seen as a key throughfare for the community to access the goods and services they require,
  - the road may have consistent maintenance issues leading to customer complaints,
  - the road may have seen increasing traffic due to additional tourism, etc.
- Improvements or upgrades to the unsealed road network, particularly in regional areas, has a significant impact on the social well-being of the community.
- Customer complaints can be used to identify locations for routine, periodic and emergency maintenance and inspections.
  - Complaints could be entered into a complaints tracker in order to identify areas and issues that are repeatedly being reported, which can assist in improving ongoing maintenance schedules and actions.
- Community expectations can be measured using ‘Customer-based Levels of Service’ (CLOS).

Whole-of-life Asset Approach

Tyrone Toole

Whole-of-life Asset Approach

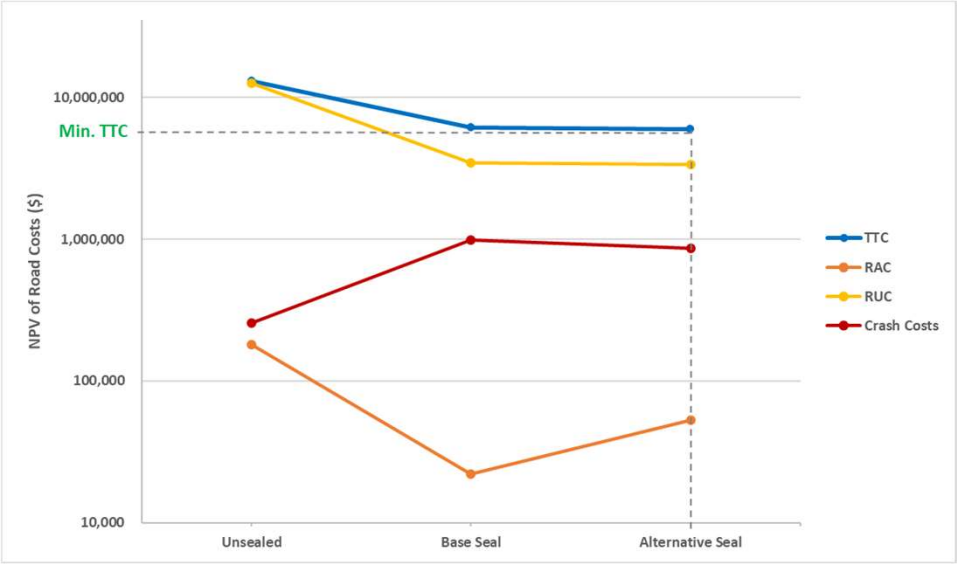
- A whole-of-life asset approach encourages road asset managers to consider all lifetime costs and benefits of road construction, maintenance, rehabilitation and upgrade decisions, to all relevant stakeholders, rather than limiting oneself solely to upfront, agency costs.
- This approach covers comparative assessments of the continuation (and potentially optimisation) of managing an unsealed road and alternative options for sealing the road to low and high standards.
- Such assessment follows a decision framework covering aspects of existing and forecast condition and use.
- Particularly, the following considerations are important:
    1. Existing Road Condition
    2. Initial and Forecast Traffic Levels
    3. Climate and Weather
    4. Environment and Geology
    5. Whole-of-Life Cycle Costs (WOLCC).
- Associated upgrade design standard and future maintenance strategy and intervention levels:
    - Sealed width by road hierarchy and traffic level / RAV classification, and corresponding costs
    - Future sealed road intervention levels considering base (or minimum standards) or alternative (desirable) standards, these affecting surfacing lives, cracking, rutting and roughness intervention levels and therefore timing
- The WOLCC analysis incorporates all of the other aspects, and we present here our WOLCC model that provides estimates for a range Western Australian-tailored climate, environmental and cost conditions.

Whole-of-life Asset Approach

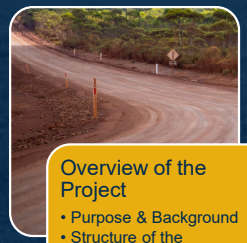
Breakeven AADT for sealing an unsealed road, by heavy vehicle percentage, cost level, strategy, climate zone

		Climate Zone	HV%			
			5	15	25	50
Typical Costs	Base Upgrade	1	221	100	66	36
		2	224	101	66	53
		3	216	98	65	52
		4	235	103	68	55
	Alternative Upgrade	1	219	100	66	36
		2	223	100	66	53
		3	217	100	66	53
		4	232	104	69	56
High Costs	Base Upgrade	1	335	151	100	55
		2	340	153	101	81
		3	328	149	99	79
		4	355	156	102	84
	Alternative Upgrade	1	333	151	100	55
		2	338	152	100	81
		3	328	151	100	80
		4	346	156	103	85

Road upgrade, maintenance and user costs by strategy, climate zone 3, initial AADT 500, 25% HV, typical costs, good practice



Summary

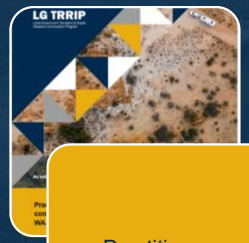


Overview of the Project

- Purpose & Background
- Structure of the Guidelines
- Project Methodology
- The issue
- The Role of Local Government

Fundamentals of Unsealed Road Asset Management

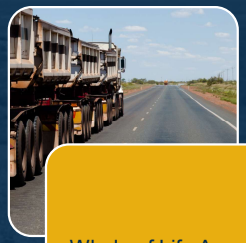
- Unsealed Roads
- Unsealed vs. Sealed



Practitioners Guideline

Worked Example

Technical Report



Whole of Life Asset Approach

LG TRRIP
Local Government Transport & Roads
Research & Innovation Program

Questions?