Lorinna Road
Upgrade Assessment

Prepared for:	**Kentish Council**
Date:	**December 2013** **Rev 03**

transport infrastructure | community infrastructure | industrial infrastructure | climate change




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1. Introduction and Background

Lorinna Road provides access to the township of Lorinna. The road is narrow and located in steep mountainous terrain. It is cut into the steep hillside and supported by rock walls in many locations. The condition of the road, its suitability to provide access to Lorinna and concern for the safety of the rock walls and road has been considered in many reports over the last 20 years. In 2009 Council deemed the road to be unsafe and closed it between Cockatoo Road and the quarry north of Wilks Road (approximately 6.3km). The road has remained closed since 2009.

Lorinna is currently accessed from River Road. Kentish council is considering options for providing Lorinna with a fit for purpose long term access road.

pitt&sherry have been engaged by Kentish Council to assess the feasibility of repairing and maintaining Lorinna Road (the closed section) as a fit for purpose road. **pitt&sherry** has undertaken these specific tasks:

- Reviewed previous Lorinna Road reports
- Inspected the closed portion of Lorinna Road
- Reviewed published road standards
- In conjunction with the Lorinna Road Stakeholder Group determined the minimum requirements for Lorinna Road
- Provided to Council options for the minimum standard of Lorinna Road
- Researched rock walls used elsewhere in the world
- Geotechnical risk assessment of the threat to life from rock falls from above the road and collapse of rock walls below the road
- Identified the work required to make Lorinna Road safe and comply with the adopted road standard
- Prepared cost estimates for repair of Lorinna Road.

2. Previous Reports

Since 1996 there have been many reports prepared for Lorinna Road and alternative access routes to Lorinna. These reports cover the following subject areas:

- Inspection and assessment of specific issues
- Inspection and assessment of Lorinna Road between Cockatoo Road and Wilks Road
- Specifications for specific repair works
- Cost estimate for upgrading Lorinna Rd
- Safety assessments
- Assessment of alternative access to Lorinna
- Planning and environmental assessment for alternative access roads.

A list of all previous reports reviewed by **pitt&sherry** is attached at Appendix A. Also attached at Appendix A is a summary of each report.

It is difficult to summarise the reports concisely, but some key relevant points arising from these reports include:

- Lorinna Road was constructed between 1925 and 1935
- Lorinna Road has previously carried heavy vehicles – log trucks, a 21 seater school bus, cattle trucks and 10 yard trucks

- The road is narrow and has limited opportunity for widening due to rock walls and rock cuttings
- Drainage has been identified in most reports as necessary for protecting the pavement and rock walls
- The need to repair rock walls has been identified since 1996 but limited repair works have been undertaken
- Repairs to rock walls were first designed and specified in 2002
- Sometime in the early to mid 2000's a load limit of 5 tonnes was imposed. It is understood the load limit remained in place until the road was closed
- Concern for road safety has been raised many times. The road has been judged to be unsafe
- Safety Barrier should be considered
- Alternative alignments should be considered
- Lorinna Road can be returned to its former condition and provide a suitable access to Lorinna.

3. Site Inspections

The closed portion of Lorinna Road was inspected by David Hugo (**pitt&sherry**), Jonathan Magor (Council Engineer) and Bart Wisse (resident and Councillor) on 24 July 2012. During the inspection the following tasks were undertaken:

- The width of the road formation was measured every 100m
- The distance along the road was marked in yellow paint every 500m
- Reviewed the 2008 inspection records
- Took note of opportunities for passing bays
- Took note of whether the batters comprised rock, gravel or clay.

The width of the road formation is the width available for vehicles to travel on. This includes the lane and shoulders. The road formation width varied between 3.9 and 6.2m. The formation width was measured at approximately 70 locations and this provides a reasonable indication of the existing formation width.

Although much of the rock walls are now overgrown with vegetation, the condition of the rock walls is considered to be similar to the 2008 inspection record. The priority ranking for the rock wall repairs has not changed.

The locations where the road is greater than 5m wide were recorded as suitable for passing bays. These may have been used as passing bays in the past. Locations where the road could be widened relatively easily to greater than 6m wide and provide a passing bay were also recorded.

The closed portion of Lorinna Road was inspected by David Hugo (**pitt&sherry**) and Dan O'Toole (**pitt&sherry**) on 16 August 2012. During the inspection the following tasks were undertaken:

- General inspection of cut slopes and rock walls
- Recorded location of rock falls onto the road.

There are many sections of the road where there are large and small rocks above the road that may be at risk of falling onto the road. There are also locations where rocks have fallen onto the road. All these locations were recorded.

4. Local Knowledge

pitt&sherry have approached three people with local knowledge of Lorinna Road. The three people are:

- John Treloar of Treloar Transport. Treloar Transport is a Sheffield based Contractor who has undertaken works on Lorinna Road during the last 10 to 15 years
- Bart Wisse. Bart has lived in Lorinna for approximately 40 years
- Howard Mulvey. Howard has lived in Lorinna for approximately 36 years and drove the school bus along Lorinna Road for 20 years.

4.1 John Treloar

A telephone conversation was held with John Treloar and a summary of the conversation is as follows:

- Minor maintenance was required every year, usually in the form of replacing a few rocks at the top of the drystone walls that had been dislodged due to water runoff or vehicles
- Major repairs occurred every second year and usually consisted of a 5m section of wall and road that had started as a wash out due to poor road drainage. The road width would normally be restricted to less than 3m during these events
- 2 to 3 minor rock falls experienced each year (less that 0.5m dia.)
- Major falls usually occur around silver falls
- Significant debris and rock falls occurred after bushfire.

4.2 Bart Wisse

Bart Wisse responded to an email from David Hugo and a summary of Barts Wisses's email is as follows:

Rockfalls

- Rocks falling onto the road generally occur after prolonged rain
- Rocks falling generally land in the table drain or on the uphill side of the traffic lane
- Some rocks are quite large
- Rockfalls are generally about a trailer load or two of material
- Rockfalls have not closed the road.

Fire Events

- Following the fire in 2000 rocks fell onto the road for approximately 1 month after the event
- The rocks that fell onto the road were golf ball to soft ball size
- After about 1 month, vegetation started to regrow and the frequency of rock falls reduced.

Rock Walls

- In the late 1970's about one third of the roadway at White Rock Corner (approximate chg 1800) collapsed along with approximately 10m of rock wall. The road was not closed

- In 1999 a rock wall near Silver Falls Bridge (approximate chainage 900) collapsed. This affected approximately half of the road. Vehicles including the school bus continued to use the road
- Apparently in the early 2000's a rock wall collapsed and a machine had to be pulled back out of harms way. This incident has not been verified by Bart Wisse
- In 1969 a rock wall collapsed at approximate chainage 3300. The collapse was repaired with logs to support the road edge. The site experienced ongoing subsidence until the wall was destroyed in 2009 by a heavy rainfall event.

Road Closures

The road was closed at these times:

- In the late 1990's when Treloar replaced a deep culvert
- In 1999 when Treloar repaired a wall (assumed by **pitt&sherry** to be chainage 900)
- Other times by Kentish Council.

A copy of the email from Bart Wisse is attached at Appendix B.

4.3 Howard Mulvey

Howard Mulvey responded to an email from David Hugo and a summary of Howard's email is as follows:

Rockfalls

- Rocks fall onto the road at least once a month and sometimes weekly
- During Winter, rocks the size of a football would fall weekly
- During rainfall there were more rockfalls
- The size of rocks falls includes; wheel barrow loads, trailer loads and truck loads. The largest rock seen was over 2 metres high
- Rock falls closed the road several times; however the road was closed more times due to trees falling across the road. Some trees were huge and put deep dents in the road.

Rock Walls

- The tops of rock walls were damaged sometimes weekly and this was mainly due to fallen trees
- There were three major rock wall collapses
- Rock Wall failures closed the road at White Rock Corner, Silver Falls and Drybed Creek
- In 36 years there were maybe 6 rock wall failures
- Rockwalls were damaged during rainfall only if the drainage was poor.

General

- The fire burnt all the undergrowth, so following the fire, lots of smaller rocks fell from above the road
- Walls were also affected by tree falls due to the fire
- Trees are the main problem for Lorinna Road; they damage the rock walls, bring down rock and damage the road. If trees were cleared back a distance, the frequency of rock falls would be massively less.

A copy of the email from Howard Mulvey, including photographs, is attached at Appendix B.

5. Dry Stone Walls - Experience in the UK

pitt&sherry have undertaken a review of a number of UK publications on the topic of assessment of dry stone walls. The main publication referenced was CIRIA C676, 2009, *Drystone retaining walls and their modifications- condition appraisal and remedial treatment*.

5.1 Dry Stone Wall History

Dry stone walls are not a new structure type with some dating back to the early Stone Age. The walls became a common earth retaining structure in the 19th and 20th centuries throughout the United Kingdom (UK). In the UK many of the walls are still in use today throughout the road, rail and canal networks. Based on the 1987 UK senses of highway structures it is estimated that 4,500km of dry-stone wall is present throughout the whole of the UK.

Based on the number of walls across the United Kingdom the Department of Transport, Network Rail and Councils have in collaboration with Universities undertaken a significant amount of testing of walls to determine methods for condition appraisal and treatment.

5.2 Dry Stone Wall Stability

Like all structures a dry-stone wall has a limited life before replacement is required. To ensure the deterioration of the structure does not pose a risk to the public, regular inspections are required to assess the wall condition and structural capacity.

A dry stone wall is unique in that it has no tensile strength when subjected to ground loading and as a result its capacity to carry load is relatively low. As a result the following factors affect the stability of the wall:

- The presence of water behind the wall
- The properties of the ground that the wall supports and its interaction with the wall
- The geometry of the wall and construction material properties
- Stability of the founding material for the wall
- Vibration
- Surcharge loading on backfill behind the wall
- Affect of vegetation near and in the wall.

Walls can settle or move and in some cases the wall can gain strength in this process.

Based on the above elements a qualitative or quantitative assessment of the wall can be undertaken.

5.3 Qualitative Structural Review

The aim of a qualitative assessment is to use judgment to determine the condition and strength of the wall.

The UK Department of Transport, Design Manual for Roads and Bridges BD16/97 recommends that for highway bridges and structures that:

> *5.9, Assessment of dry-stone walls consists of regular visual inspection and a comparison with adjacent structures. Qualitative judgements are difficult since conditions will vary greatly with the quality of stone used, age, subsoil conditions, geometry, weathering factors and local expectations. Due attention should be given to local engineering experience.*

and

> *5.10, Where past movement or the condition of the structure raise doubts concerning stability, regular monitoring should be introduced. Decisions relating to structural safety and conditions often depend upon engineering instinct, although simple visual aids such as tell-tales can be useful to determine if the structure is moving or in a temporary equilibrium*

The manual goes on to provide notes on what is required in the assessment of dry-stone retaining walls.

In past reports and as part of this work **pitt&sherry** has undertaken a partial qualitative assessment of the rock walls and as a result classified defects with priority levels. The assessment **pitt&sherry** has undertaken is not strictly in accordance with the UK manual, however the critical elements have been considered.

5.4 Quantitative Structural Review

A quantitative assessment can be undertaken and this tries to determine the condition and strength of the wall based on numerical values as inputs into a formal stability analysis.

Recent work by Road Authorities and Universities in the UK has led to the development of a range of quantitative methods of stability assessment. These methods input a range of information into finite element software to arrive at a numerical solution.

By undertaking the analysis one is able to quantify the level of safety for users of the road way which is not possible with a qualitative analysis.

pitt&sherry has not attempted a quantitative assessment of the walls along Lorinna Road as there is insufficient data available to undertake the assessment. It is recommended that as part of future works this method of assessment be considered.

5.5 Strengthening Options

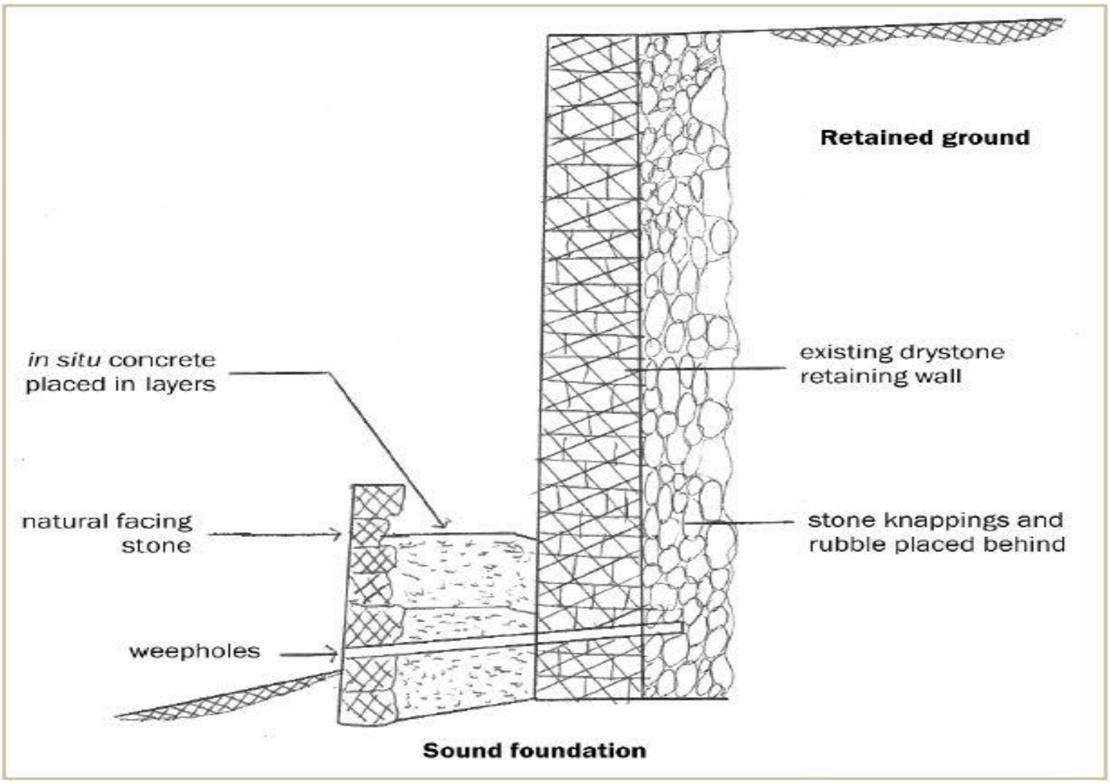
A range of strengthening options are published in the UK literature. The main methods include:

- Pointing
- Backfill Grouting
- Soil Nailing
- Thickening of Retaining Wall
- Buttressing.

The most appropriate treatment for Lorinna Road would be thickening of the walls at the base as it is accepted that by adding thickness to the bottom 1/6 of the wall height the safety factor will nominally increase by 60%, based on the wall being ‘just’ stable.

Critical to thickening of the wall would be ensuring an adequate founding as well as achieving a sufficient bond with the original wall. This is usually achieved with mass concrete and drainage pipes in it to manage water.

A typical sketch of a wall thickening is shown in Figure 1:



Note: knappings are pieces off the block of stone that is being dressed

Cross-section of construction of thickening to an existing drystone retaining wall

Figure 1

An example of buttressing of a dry stone wall is shown in Figure 2.

Figure 2

6. Road Standard

6.1 Road User Needs

The standard of a road is dependant on the needs of the road user. The needs of the road user were discussed with the stakeholder group at a meeting on 24 July 2012 and the agreed needs are shown in Table 1:

Primary road function	To provide residents with an all weather access to their properties in the Lorinna area.
Road surfacing	Unsealed and suitable for all weather conditions.
Number of Lanes	Single lane, two way road.
Passing Bays	Provision for passing bays, spacing of passing bays to be determined.
Vehicle Type	Light vehicles and heavy vehicles (up to 12.5m rigid body truck) such as 10 yard truck or cattle truck. Single axle steering and twin rear axle. Maximum vehicle load for 12.5m rigid truck is 22.5 tonne - (DIER Vehicle Mass for General Access Vehicles)[#1]
Vehicle speed	30km/h
Vehicle volume	Capable of taking 20 vehicles per day.

#1. Note an 8 tonne limit was subsequently adopted based on risk management considerations

Table 1

6.2 Published Road Standards

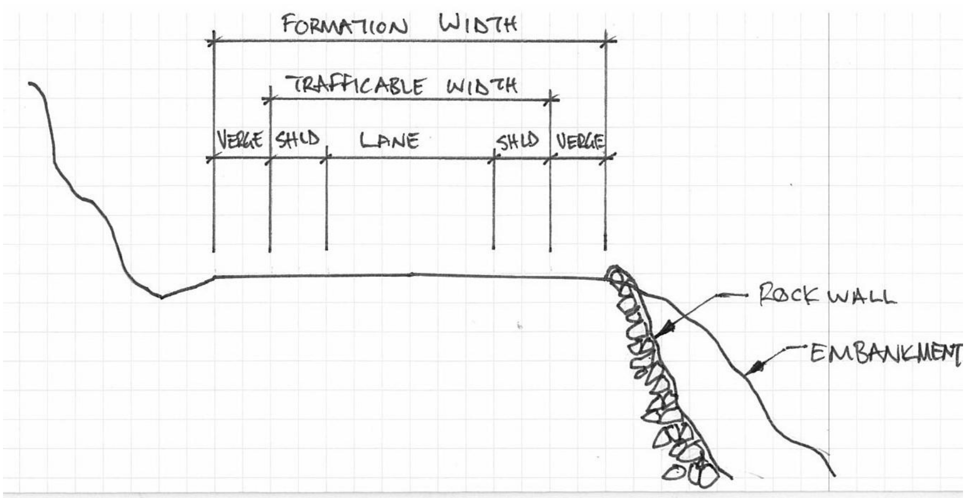
There are various published road standards applicable to low volume rural roads. The published road standards define the minimum requirements for:

- Lane and formation width
- Number of lanes
- Passing Bays
- Road surface
- Sight distance
- Road superelevation (camber)
- Curve radius and grade.

Some of the relevant published road standards include:

- Australian Road Research Board (ARRB) Unsealed Local Road Manual 2009
- ARRB Report ARR354 200. Road Classifications, geometric designs and maintenance standards for low volume roads
- Forestry Tasmania - Forest Practices Code – 2000
- Launceston City Council Rural Roads unsealed - drawing 7600/R-01 (Nov 2011)
- Victorian Forests Road Construction Specification.

The road width requirement for each standard is shown in Figure 3. This was previously provided to Council.



Relevant Road Cross section Standard		Trafficable Width			
	verge	shoulder	lane	shoulder	verge
ARRB Unsealed Local Road Manual 2009: Class 5c minor road - rolling terrain			7		
ARRB Report ARR354 2001: Class 4 c Access road - rolling terrain			5		
	1	1	3	1	1
ARRB Unsealed Local Road Manual 2009: class 5c minor road - mountainous terrain			6		
ARRB Report ARR354 2001: Class 4 c Access road - mountainous terrain			4		
	1	0.5	3	0.5	1
Forestry Tasmania - Forest Practices Code - 2000			*		
Class 4 road			4.9		
	*	0.6	3.7	0.6	*
Launceston City Council			*		
Rural Roads unsealed - drg 7600/R-01 (Nov 2011). Class US1			5		
No log trucks, no buses, AADT < 30, HV < 5%	*	0.5	4	0.5	*
Launceston City Council			*		
Rural Roads unsealed - drg 7600/R-01 (Nov 2011). Class US2			6		
AADT 30 to 100, HV < 5% (inc log trucks)	*	1	4	1	*
Lorinna Road			3.9 to 6.2, avg = 4.9		
			3.3 to 5.8, avg = 4.0		

Figure 3 *Verge not required

6.3 Traffic Volume

The number of vehicles travelling on the road influences the standard of the road. Council installed a traffic counter on River Road in October 2012 for 2 weeks and the traffic volumes were measured. The average number of vehicles recorded for week days was 24.8 and weekends were 22.5. Lorinna residents suggested to Council that these traffic volumes were high due to unusual circumstances in the Lorinna Community. It is possible that vehicles numbers over the next 10 to 20 years will increase. For the purpose of selecting a road standard the daily vehicle volume adopted is 30.

6.4 Vehicle Type and Load Limits

The vehicle type travelling on a road influences the standard of the road. Some of the road standards cater for heavy vehicles and others specifically exclude certain types of heavy vehicles. For example, the Launceston City Council Road Standard US1 is not appropriate for log trucks.

In the past heavy vehicles such as cattle trucks, 10yard trucks and log trucks have used Lorinna Road. However the narrow and winding nature of the road makes it difficult for some heavy vehicles to use the road.

Lorinna Road is supported by many rock walls and these have a limited structural capacity. Some of these walls need to be repaired. The capacity of the walls will influence the maximum mass of the vehicle using the road. The structural capacity has been partially assessed by engineering judgement in accordance with the methods described in section 5. On this basis it is considered that a load limit should be applied so that the rock walls are not overloaded. The Gross Vehicle Mass (GVM) should be limited to 8 tonnes. Vehicles permitted by this GVM include:

- Toyota Coaster 21 seater bus – GVM 5ton
- Hino 617 Tip truck with 2.5 tonne payload – GVM 4.5 tonne
- Hino 717 Tip Truck with 3.0 tonne payload – GVM 6.5 tonne
- Hino 917 Tip Truck with 4.5 tonne payload – GVM 8.0 tonne.

A common 10 yard truck has a GVM of 22.5 tonne. The GVM limit of 8 tonne is less than half the load imposed by a 10 yard truck.

pitt&sherry have considered the issue of construction vehicle loads greater than 8 tonne that might be required during remedial works and we believe this risk can be managed through:

- Conducting an on site pre-works inspection and risk assessment
- Limiting the number of sites under construction
- Repairing the most vulnerable sections first
- Limiting the number of vehicle movements required
- Reducing vehicle speeds for high load cases
- Not allowing vehicles to pass each other except at approved locations
- Nominating specific turn around sites
- Having spotters to assist large vehicles turning and reversing
- Construction phase monitoring.
- Considering these limitations during the design of repair works

Vehicles such as vibrating rollers should not be used on the road as these could be detrimental to the stability of rock walls.

Tasmanian Fire Service have been consulted regarding the proposed load limit and have indicated they can provide fire support within the proposed 8 tonne load limit.

6.5 Passing Bays

The ARRB Research Report ARR354 suggests that passing bays be provided every 300m and each bay is visible from each other.

The Tasmanian Fire Service "Guidelines for Development in Bushfire Prone areas of Tasmania" (TEN.063.001.0279) requires 20m long passing bays every 90m. The Tasmanian Fire Service has advised Council that where a bushfire safety area has been declared then exemptions from the Guidelines can be approved. Council has advised that Lorinna may be provided with a bushfire safety area.

In previous Lorinna Road reports passing bays located every 200m was proposed.

As Lorinna may be provided with a bushfire safety area, then **pitt&sherry** considers that provision of passing bays every 300m is a reasonable standard for Lorinna Road. An addition 9 to 12 passing bays will be required.

6.6 Road Safety Barrier

The *Austroads Guide to Road Design: Part 6 - Roadside Design and Safety Barriers* suggests that on low volume, low speed roads where there are road side hazards and these are consistent over the length of the road, then road safety barriers are not necessarily required. The guide also suggests that the need for safety barrier can be based on engineering judgement. The guide further suggests that installation of high standards of delineation (guide posts) and provision of a well maintained road surface are suitable mitigation measures where safety barrier cannot be justified. For a road to be judged *well maintained*, it has to be maintained in accordance with a recognised standard, such as the ARRB Unsealed Roads Manual. This manual provides guidance on maintenance requirements and also guidance on setting intervention levels for unscheduled maintenance (eg removal of loose material, fixing edge breaks or potholes).

In cases where the vehicle speed has to reduce significantly to negotiate a bend or a narrow section of road, and a hazard exists then safety barrier can be considered.

pitt&sherry recommends that the installation of safety barrier be based on judgement in accordance with the Austroads Guidelines. The alignment of the road, the width of the road, site distance and the location of high rock walls has been considered and it is judged that safety barrier will be needed at White Rock Corner and possibly at 5 other locations. The location of possible safety barrier is shown on site plan 2.

6.7 Road Standard Adopted

Council and the Stakeholder Group reviewed the road standards information provided by **pitt&sherry** and at a Council meeting decided the following:

> *"that Council approve a 4 metre wide pavement with ½ metre verges on both sides as a suitable road standard for Lorinna Road plus an inside verge drain and any requirements for guard rails or bunding be the adopted road standard to be used by Pitt & Sherry to assess Lorinna Road (it is possible that there may be a need for a small number of short 'pinch points' below this standard with associated localised treatment. Any need or recommendation for such will be furthered during the Pitt and Sherry assessment of Lorinna Road)"*

This is similar to the Launceston City Council (LCC) standard for unsealed rural roads - drg 7600/R-01 (Nov 2011). This LCC standard does not describe all the road standard requirements so the ARRB Research Report ARR354 standard for minor road has been used to assist defining the remaining standards. The standard adopted for Lorinna Road is summarised in table 2. The standard cross section is shown in figure 4.

Road Classification	LCC standard US1 (same as ARRB type minor road in mountainous terrain)
Carriageway	Single lane, two way
Road width	1 x 4m lane 2 x 0.5m shoulders 5m formation
Road surface	Gravel, unsealed
Passing Bays	To be located approximately 300m apart and to be visible from each other.
Safety Barriers	To be located where it is judged to be necessary in accordance with the Austroads Guide to Road Design : Part 6 - Roadside Design and Safety Barriers
Drainage	Drains to be provide at uphill side of the road
Traffic volume : ADT	Up to 30 vehicles per day average
Vehicle Type	Gross Vehicle Mass (GVM) – 8 tonne maximum. Construction vehicles and equipment shall comply with the conditions nominated at clause 6.4. Vibrating rollers are not allowed.
Vehicle speed	30km/h
Road geometry	Max grade – 8 to 12% Min horizontal curve - 15 to 60m
Site Distance	Meeting site distance 30m (min)

Table 2

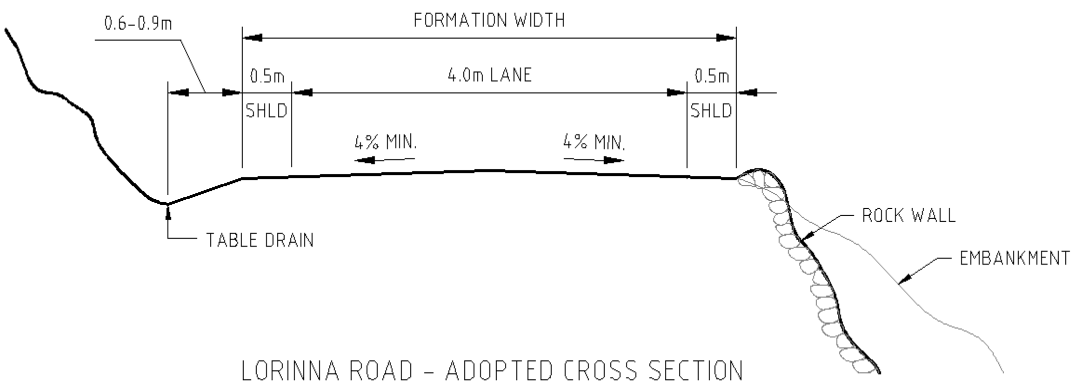


Figure 4

The steep mountainous terrain on Lorinna Road will make it very difficult for all sections of Lorinna Road to be upgraded and meet the requirements of the adopted road standard. Council has accepted there will need to be some "pinch points". Based on the information that **pitt&sherry** has, it is possible that pinch points will be needed at chg 2.7, 3.7, 4.0 and 4.8 to 4.9.

7. Site Plan and Road Data Diagram

Information contained in previous reports and information collected from the site inspections has been collated and presented on Site Plan 1 and also on a Road Data Summary Diagram.

Site plan 1 shows:

- Distance along the road
- Existing rock walls
- The sites that led to the closure of the road in 2009
- Failures of the road inspected in 1999 and 2001
- The location of rock wall repairs identified in 1996, 2002 and 2008
- Sight distance at some corners (This was estimated on site using a 30m tape)
- Radius of curves on the road (This was measured from a digital topographic map imported into AutoCAD.

The road data diagram shows:

- Distance along the road
- Geology along the road
- The width of the road formation
- The increase in road formation width required to meet the min standard
- Whether the batter is rock, clay or gravel
- Location and height of rock walls and repair sites
- The location of existing and possible passing bays
- Location of past inspections, issues and repairs required.

Site Plan 2 shows:

- Distance along the road
- The areas where road widening is required
- Rock wall repair sites with priority
- Existing passing bays and additional passing bays required.
- Location of possible safety barrier

Site Plans 1 and 2 are attached at Appendix C and the road data diagram is attached at Appendix D.

8. Geotechnical Risk Assessments

8.1 Introduction

The following geotechnical risks associated with travel along the 7km of Lorinna Road have been considered:

- Rock fall from the slope above the road
- Failure of embankment/rock walls below the road.

For each case, the following potential incidents have been considered:

- A vehicle is at the exact location where either event occurs

- A vehicle is within a distance from the event when it occurs that the driver is unable to stop before colliding with the event
- A vehicle collides with the event at some time after the event has occurred.

The risk level associated with each of the events listed above has been estimated. The overall geotechnical risk for the section of road is then determined by addition of individual risks for each event.

8.2 Loss of Life Risk Assessment - Rockfall

8.2.1 Vehicle being hit Directly by a Rock Fall

A method for assessing the risk of a vehicle being directly hit by a rock as it passes the rockfall along a section of road has been suggested by Australian Geomechanics Society (AGS) – Landslip Risk Management 2007[1]. It does not consider the risk of a rock falling in front of the vehicle and it being unable to stop.

The following parameters have been assumed for the Lorinna Road situation:

- Number of rock falls per year = 2 (this has been assumed based on the 5 rockfalls recorded in a recent survey after which the road had been closed for 3 years)
- Number of vehicles per day = 30
- Average length of vehicle = 6.0m
- Speed of vehicles = 30km/hr.

These parameters were partially verified by local knowledge.

Based on the above parameters the probability of one or more vehicles being hit in a year has been calculated and is 1.37×10^{-6} (this is equivalent to a chance of 1.37 in a million).

The AGS method goes on to recognise that not all rock that hits a car will result in serious injury or loss of life. Based on the Hong Kong vulnerability factors (Finlay *et al 1999*[2]) which estimates that 1 in 3 rock falls may result in the loss of a life the probability of a loss of life for the person most at risk as a result of vehicle being hit is 4.11×10^{-7} per year (this is equivalent to a chance of 0.41 in a million).

8.2.2 Rock Fall in Path of Moving Vehicle

pitt&sherry have modified the AGS method (described in section 8.2.1) to consider the event where the rock falls in front of the vehicle and it is unable to stop before colliding with the rockfall. This is in line with the recommendations of international rock fall guides. To undertake this **pitt&sherry** have determined the stopping sight distance for a car on a gravel road with a 2% slope to be 30.8m. This distance includes allowance for a 2 second reaction time.

Given that a car hitting a rock fall is less likely to result in loss of life than if a rockfalls directly onto the car, the vulnerability factor has been adjusted to reflect that 1 in 5 rocks falling into the path of a moving vehicle may result in a loss of life. The resulting probability of a loss of life for the person most at risk is 1.41×10^{-6} (this is equivalent to a chance of 1.41 in a million).

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[1] Landlside Risk Management Concepts and Guidelines, *Australian Geomechanics*, 2007

[2] Finlay, P.J., Mostyn, G.R. and Fell, R 1999 Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of persons. Proc 8th Australian New Zealand Conference on Geomechanics, Hobart, *Australian Geomechanics Society*, ISBN 1 86445 0029 Vol 1, pp105-113

8.2.3 Vehicle Colliding with Rock Fall at Some Time After the Event

After a rock fall has occurred, the next vehicle to travel the road will definitely be faced with the possibility of driving into the fallen rock. The potential for this to occur will depend on the Sight Stopping Distance available on the road which was assessed to be 30.8m. Based on a vehicle having sufficient sight distance to notice the rock this risk is deemed negligible.

However, from site inspections a number of areas/corners have been identified as having lesser sight distance. To manage these areas as on a normal road it is recommended corner advisory speed signs be installed to manage road users speed and as a result sight stopping distance.

8.3 Loss of Life Risk Assessment - Road Collapse Risk

Lorinna Road for a significant length is supported by dry stone walls. Dry stone walls while not common place today were extensively throughout the UK in the 18th and 19th centuries and still remain in service today.

From a site inspection and review of past reports of the condition of the wall 13 locations have been identified as requiring repair work. A priority level has been classified for each location identifying the urgency of the works. 3 Locations have been identified as high and need to be undertaken prior to the road opening.

Based on the other lower priority locations having not been treated, a review of the risk of loss of life has been undertaken.

As with the rockfall case three possible scenarios for incidents arising from road collapse risk have been assessed. The following assumptions have been made in the assessments of road collapse risk:

- Number of major wall collapses per year = 1 event every 10 years
- Number of minor/moderate wall collapses per year = 1 event every 2 years
- Typical length of major wall collapse = 20m
- Typical length of minor/moderate wall collapse = 5m.

Again, these parameters were partially verified by local knowledge.

As a point of measure if all of the defects with the walls and bulges are repaired then the number of road collapses per year is estimated to decrease to 1 wall collapse every 50 years.

Results from these assessments are summarised in section 8.4.

8.4 Loss of Life Risk Summary

A summary of annualised estimated probabilities of loss of life of the person most at risk is presented in Table 3. As expected and verified by local knowledge the majority/all recoded failures have occurred in the winter months as a result of rainfall. Based on this the probability of loss of life for a person travelling through winter increases and correspondingly decreases in the drier summer months. Table 4 presents the probabilities of loss of life during the winter months.

Event		Rockfall/land slide occurrence rate	Vulnerability*	Probability of loss of life
Rock fall	Rock fall directly onto passing car	2 per year	0.33 (1 in 3)	4.1×10^{-7} (0.41 in a million)
	Rock fall directly onto passing car	2 per year	0.2 (1 in 5)	1.4×10^{-6} (1.4 in a million)
			Total Risk (A)	**1.5×10^{-6}** (1.5 in a million)
Road collapse (without repair works)	As vehicle is passing (20m failure)	1 every 10 years	0.5 (1 in 2)	1.15×10^{-7} (0.115 in a million)
	As vehicle is passing (5m failure)	1 every 2 years	0.5 (1 in 2)	1.4×10^{-7} (0.14 in a million)
	In path of moving vehicle	1 every 10 years	0.1 (1 in 10)	5.9×10^{-8} (0.059 in a million)
			Total Risk (B)	**2.0×10^{-7}** (0.2 in a million)
Road collapse (with repair works)	As vehicle is passing (20m failure)	1 every 50 years	0.5 (1 in 2)	3.0×10^{-8} (0.03 in a million)
	In path of moving vehicle	1 every 50 years	0.1 (1 in 10)	1.2×10^{-8} (0.012 in a million)
			Total Risk (C)	**4.2×10^{-8}** (0.042 in a million)

*Vulnerability refers to the likelihood of death given the incident occurs

Table 3 – Summary of probabilities of loss of life for the person most at risk, annualised (Geotechnical Risks)

Total probable risk is the summation of the probability of each individual risk event occurring. This has been calculated in accordance with standard probability summation theory. Based on this the annualised geotechnical risk for the most at risk person using Lorinna Road is:

- Probability of loss of life without additional rock wall repairs = 1.7 x 10-6 (A+B)
- Probability of loss of life with rock wall repairs = 1.54×10^{-6} (A+C)

Event		Rockfall/land slide occurrence rate	Vulnerability*	Probability of loss of life
Rock fall	Rock fall directly onto passing car	2 per year	0.33 (1 in 3)	9.1×10^{-7} (0.91 in a million)
	Rock fall directly onto passing car	2 per year	0.2 (1 in 5)	2.8×10^{-6} (2.8 in a million)
			Total Risk (A)	**3.7×10^{-6}** (3.7 in a million)

Road collapse (without repair works)	As vehicle is passing (20m failure)	1 every 10 years	0.5 (1 in 2)	2.3×10^{-7} (0.23 in a million)
	As vehicle is passing (5m failure)	1 every 2 years	0.5 (1 in 2)	2.9×10^{-7} (0.29 in a million)
	In path of moving vehicle	1 every 10 years	0.1 (1 in 10)	7.1×10^{-8} (0.071 in a million)
			Total Risk (B)	**3.6×10^{-7}** (0.36 in a million)
Road collapse (with repair works)	As vehicle is passing (20m failure)	1 every 50 years	0.5 (1 in 2)	4.6×10^{-8} (0.046 in a million)
	In path of moving vehicle	1 every 50 years	0.1 (1 in 10)	1.4×10^{-8} (0.018 in a million)
			Total Risk (C)	**6.0×10^{-8}** (0.06 in a million)

*Vulnerability refers to the likelihood of death given the incident occurs

Table 4 – Summary of probabilities of loss of life for the person most at risk, during winter (Geotechnical Risks)

Total probable risk is the summation of the probability of each individual risk event occurring. This has been calculated in accordance with standard probability summation theory. Based on this the geotechnical risk for the most at risk person using Lorinna Road during winter is:

- Probability of loss of life without additional rock wall repairs = 4.06×10^{-6} (A+B)
- Probability of loss of life with rock wall repairs = 3.76×10^{-6} (A+C).

8.5 Risk Levels

Based on the above risks, acceptable and tolerable risk level needs to be set. The Health & Safety Directive (1989a) (referenced by AGS Landslide Risk Assessment procedure) states a dangerous dose equivalent to 0.33×10^{-6} (0.33 in a million) is an acceptable risk and a dangerous dose equivalent to 0.33×10^{-5} (33 in a million) is a tolerable risk. There are many published risk assessments that use various levels of acceptable risk, however, in general the limit to what is considered an acceptable risk is in the order of 10^{-06} (1 in a million).

Based on this it can be seen that the annualised risk of loss of life as a result of a rock fall event is only just greater than the acceptable level. It can be seen that the risk is increased during the winter months, however is still less than the tolerable risk level. Given the above analysis it can be seen that the greatest risk of loss of life to the users of Lorinna Road is from rock falls. Given this, it is recommended that the slopes above the roadway with a high rockfall risk be stabilised as part of the initial works to repair the 3 high priority areas of the dry stone wall.

If works were implemented to reduce the chance of rockfalls and road collapses and the likelihood of a rockfalls affecting vehicles was changed from twice a year to once every two years then the probabilities of loss of life reduce to:

- Probability of loss of life without rock wall repair = 6.03×10^{-7}
- Probability of loss of life with rock wall repair = 4.36×10^{-7}.

Both of these risks are now classified as acceptable under the Health & Safety Directive (1989a).

The probability of rock wall collapse can be further reduced if a load limit was imposed on the road.

8.6 Property Risk Assessment

It is possible to undertake a risk assessment on the financial impact associated with the estimated frequency of rock fall and/or road collapse and as a result asses the economic impact of such an event.

This has not been undertaken at this stage as the potential financial costs and frequency of events could not be adequately estimated at this time.

9. Lorinna Road - Fit for Purpose Assessment

In this report **pitt&sherry** has considered

- Previous Reports
- Local Knowledge
- Results of site inspections
- Dry stone wall experience in the United Kingdom
- The agreed road standard
- Risk Assessment.

pitt&sherry consider that Lorinna Road can be made fit for purpose provided the following actions are complied with:

- Carry out further Engineering work as identified in section 10
- Carry out roadworks identified in section 10
- Impose an 8 tonne GVM load limit on the road (Construction vehicles exempt, subject to implementing risk management conditions)
- Maintain a 30km/h speed limit.

During construction, vehicles with a GVM greater than 8 tonnes can be permitted to use the road. This is because during construction the road will be a controlled construction site and conditions on vehicles can be imposed that could not be applied to a public road. The details of these conditions would be developed during the engineering design stage and may include:

- Limiting the speed limit of heavy vehicles, particularly on corners with rock walls
- Limiting the location that heavy vehicles can travel
- Forcing heavy vehicles to travel with the wheels a minimum distance away from rock walls. This may require them to be hard up against the uphill side of the road.

10. Works Required to Upgrade Lorinna Road

Works are required to bring Lorinna Road up to the minimum agreed standard and these works are described below. The works required are based on the assessment conducted as part of this report and it has not included any detailed design or geotechnical subsurface investigations.

10.1 Further Engineering Requirements

Further Engineering work is required and includes:

- Dry stone wall assessment for all walls. The assessment would be in accordance with the qualitative methods identified by CIRIA C676, 2009, *Drystone retaining walls and their modifications- condition appraisal and remedial treatment*
- Design for repair of high priority rockwall sites. Chg 1050 -Silver Falls, chg 1800 - White Rock Corner and chg 3300 – Road currently impassable due to collapsed retaining wall
- Design for repair of a major culvert washed out at chg 3300
- Design for preventing rock falls from above the road at various locations
- Design for repair of medium priority sites. This includes rock walls and drainage at various locations
- Design for layout of an additional 9 to 12 passing bays
- Design for approximately 3200m of road widening. The widening required varies between 0.1 and 1.1m
- Design for safety barrier needs
- Design for pavement gravelling.

10.2 Lorinna Road Upgrade Work Requirements

Lorinna Road requires repair and upgrade. The works will be defined in more detail after further Engineering Work is undertaken but is likely to include the following:

Remove Vegetation and Trees

- Remove trees at risk of falling onto the road and rock walls
- Remove vegetation that impede sight distance
- Remove vegetation that is growing on the road formation and within 2m of the toe of rock walls.

High Priority Repairs

Chg 1000 - south of Silver Falls Bridge. Repair collapsed wall

- Excavation and removal of collapsed wall. Excavate to a sound foundation
- Construct a footing (concrete and bars drilled into rock if needed)
- Construct a gabion wall up to 4m high over 10m
- Backfill behind the gabion wall and up to road level.

Chg 1800 - White Rock Corner. Repair collapsed wall, increase the road width over 30m and install safety barrier

- Excavation and removal of collapsed wall. Excavate to a sound foundation. Benches will be required to gain access to lower levels of the slope
- Construct a footing (concrete and bars drilled into rock if needed)
- Construct a gabion wall up to 7m high. Over a length of 30m
- Backfill behind the gabion wall and up to road level
- Install a safety barrier.

Chg 3300 – Wall collapsed and road impassable

- Clear debris from foundation
- Construct a footing (concrete and bars drilled into rock if needed)
- Construct a gabion wall up to 6m high over a length of 10m
- Backfill behind the gabion wall and up to road level.

Chg 3300 – Culvert washed out and road impassable

- Clear debris from road and creek
- Install a precast concrete box culvert to the same width as the original bridge. This will include a cast insitu concrete floor slab
- Install wingwalls or other erosion protection.

Rock Stabilisation above the Road

Chg 1100 – south of Silver Falls Bridge

- Remove trees from above cutting
- Clear rock from the road
- Stabilise the rock. May include further excavation scaling, or bolting and netting.

Chg 1800 – White Rock Corner

- Scale loose rocks
- Stabilise rocks at risk of falling by bolting and netting.

Chg 1950 – south of White Rock Corner

- Remove trees from above and on cutting
- Clear rock from the road
- Stabilise the rock. May include further excavation scaling, or bolting and netting.

Medium Priority Repairs

- Repair rock walls at 6 sites. This could involve buttressing at the toe, grouting or reconstruction
- Clear blocked drains and culverts.

Widen Approximately 3.2km of Road

- Increase the width of the road by between 0.2 and 1.1m
- Some of this will be in terrain that can be excavated and much of it will be in rock
- In rock low impact blasting methods should be utilised. Low impact methods will involve carefully aligning drill holes to transfer blast energy out of the rock face rather than into the ground.

Place Gravel to the Road Surface

- Place gravel on the existing pavement to improve shape, rideability and drainage. The northern 3.5km of Lorinna Road requires at least 150mm of gravel placed on it. The southern section requires 75mm.

Passing Bays

- Construct an additional 9 to 12 passing bays
- This will require the formation width to be 7m minimum. The passing bay will have a 10m entrance, 20m passing bay and a 10m departure taper
- Some passing bays will be located in rock and some in material that can be excavated.

Install Safety Barrier at Selected Sites

- Safety barrier will be installed at sites selected on the basis of judgment as allowed by the Austroads Guide.

11. Estimated Cost of Lorinna Road Upgrade

The cost to upgrade Lorinna Road has been estimated. The estimate includes engineering design, construction and project management. There have been no survey or design work carried out and therefore the cost estimate is based on information collected from field inspections and also from experience and judgement.

A significant contingency of 50% was incorporated in our initial cost estimates presented in our draft report. The preliminary budget estimate including the contingency suggested the cost of the proposed works between $1.6 and $2.4million.

The services of an experienced civil contractor, Mr Louis Stevens Contracts Manager Gradco Pty Ltd, were retained by **pitt&sherry** to undertake an independent review of the cost estimate for the remedial works. A walk over inspection of the full length of the road was conducted by **pitt&sherry** with Mr Stevens to review the proposed remedial works.

The Gradco review found the following:

- Engineering $201,300 (Not assessed)
- Project Management $124,800 (Not assessed)
- Construction estimate $1,174,340
  - Considered a reasonable reflection of the scope required to repair the road and undertake prioritised repair work to ensure the road is repaired to an acceptable standard
  - Gradco assessed individual rates / allowances for clearing, excavation, foundation preparation, gabion construction, backfill, pavement works, box culverts, widening and found all rates / allowances to be reasonable
  - All aspects of the **pitt&sherry** estimate were reviewed and found to be an accurate assessment of the likely costs for the stated scope
  - Gradco consider $1,174,340 to be an adequate amount to undertake the scope as described.

Gradco indicated that it would be possible to stage the works over several campaigns without significantly impacting the budget.

Accordingly the project budget estimated has been revised with a reduced contingency of 10%.
The cost estimate is presented in table 5. The detailed cost estimate is attached at Appendix E.

	Estimated Cost
Engineering	
Drystone wall assessments	$39,700
Rock stabilisation above the road	$18,640
high priority repair sites	$57,160
moderate priority repair sites	$21,460
Road widening, site distance, passing bays, safety barrier	$36,440
Drawings, specification and Tender.	$31,320
subtotal	**$204,720**
Construction	
Clearing Vegetation	$55,800
Rockwall Repairs - High Priority Sites	$311,540
Rock stabilisation above the road	$57,000
Medium Priority Repairs	$ 43,300
General Repairs	$20,000
Road widening, drainage, site distance, passing bays, safety barrier	$686,700
subtotal	**$1,174,340**
Project Management	
Construction Supervision / Administration	**$124,800**
(26 weeks x 24 hrs / week x $200/hr)	
subtotal	**$1,503,860**
Contingency 10%	**$150,386**
Total	**$1,654,246**

Table 5

12. Ongoing Maintenance and Inspection Requirements

The drystone walls along Lorinna Road will need to be inspected and maintained in the future. After repairs are completed, the walls should have a general inspection every 2 years and a major inspection every 5 years. The general inspection can be conducted from ground level and the major inspection should be a close visual examination and involve measurements, detailed assessment, photographs and written reports. The inspection should be in accordance with CIRIA C676, 2009, *Drystone retaining walls and their modifications- condition appraisal and remedial treatment*.

The estimated cost to undertake the two yearly general inspections is between $5,000 (3 days work) and $8000 (5 days work). This includes time on site and time collating records.

Lorinna Road is a gravel road and will require ongoing maintenance and this should include:

- Routine maintenance – regular activities to maintain the riding surface and pavement integrity. Eg. Repairing pot holes, addressing loose material and clearing culverts.
- Periodic maintenance – undertake activities on as needs basis to keep the road at the standard adopted. Eg. Pavement resheeting, clearing vegetation for site distance and clearing drains

The ARRB Unsealed Local Road Manual 2009 provides detailed information and guidance on the management, planning and activities required for maintenance of unsealed roads. It is recommended that maintenance be undertaken in accordance with this manual or a similar equivalent.

The cost of ongoing maintenance has been estimated and is presented in the following table 6.

Routine Maintenance cost each year	**$3,767**
Potholing, loose gravel, drainage etc	
Periodic Maintenance Cost for 10 years	
Trees - remove fallen tree - twice each year	$46,800
Rockfalls – remove small rock fall twice each year	$15,120
Stone wall - minor repair - every second year	$51,850
Drainage - recut drains, clear blocked culvert - every third year	$18,581
Vegetation clearing - every second year	$22,500
Pavement - resheet every 5 years	$51,840
subtotal	**$206,691**
Annual cost / km for routine and periodic maintenance	**$3,593 / km / year**
Rock wall general inspection - every 2 years	**$8,000**

Table 6

Appendix A

Summary of Previous Reports

1_July 1996, Kentish Council, Lorinna Access Study

- Lorinna Road constructed between 1925 and 1935
- Assessment of rock walls by **pitt&sherry**
- Vertical alignment is satisfactory
- Horizontal alignment – SSD is as little as 15m in some places. Horizontal alignment cannot be significantly improved without blasting. Cannot upgrade to Council min standard. Install mirrors
- Geology: south of white rock corner – Cambrian Bull Creek Pyroclastics, white rock corner is Dolcoath Granite, north of white rock corner – Moina sandstone
- Road widening: will require blasting, should be limited to passing bays and improving site distance
- Recommended corners to be widened for site distance improvement – 2.1, 2.55, 4.2, 5.9, 7.5km
- At chg 6.4km (Sassafras Creek) outside of road needs building up and traffic barrier installed. Same at culvert at chg 3.15 and 3.5km
- Recommend selective removal of trees
- Drainage: pavement drainage improvements needed to protect gravel pavement, provide one way cross fall to protect rock walls
- Safety of road users is the main concern. Risk of collapsed wall reduced by implementing maintenance regime (see **pitt&sherry** report)
- Safety improvements: install some safety barrier – but difficult to install at rock walls, install 300 guide post, clear vegetation to improve site distance, install narrow signs
- Heavy vehicles: recommend load limit (especially log trucks) to minimize risk to road and rock walls
- This road is best option for all weather road.

1_July 1996, pitt&sherry, Assessment of rock retaining walls on Lorinna Road

- Typical x section provided
- Noted failure of rock wall at white rock corner from some 10 years ago (1986?)
- Noted some other failures in smaller walls which have been repaired but at a lower standard
- Site distance poor at white rock corner (chg 1.8) and at other locations – 0.5, 1.1, 2.74, 3.32
- Narrow road restricts speed and size of vehicle
- construction of walls – described
- structural integrity of walls – generally satisfactory, no reason to doubt future stability, but predicting when failure will occur or the time is right for repair is difficult to forsee
- drainage over walls causing damage
- traffic load and volume – widening the road may increase size of vehicle and load
- blasting may affect walls
- safety – risk of wall collapse and vehicle accident is low
- remedial works identified – improving structural integrity of walls
- improving general drainage.

2_October 1999, pitt&sherry, Rock wall collapse

- rock wall at chg 0.93 collapsed
- 20m long, one third of road collapsed
- Identified three repair options
- Recommended monitoring of slip, close road to heavy vehicles, develop strategy for repair , install signage.

3_February 2000, pitt&sherry, Post fire inspection

- Inspection of road following fire
- Massive loss of vegetation
- Erosion is an issue
- Rock fall while no vegetation is a risk.

4_August 2001, pitt&sherry, Pavement Slip Failure

- Two slips in the embankment below the road – chg 4.00 and 5.35. June 2002 report could not locate slip at chg 5.35 and noted chg 4.00 had not been repaired
- Wet and loose embankment.

6_June 2002, pitt&sherry, Lorinna Road condition assessment

- Comprehensive report
- Review of previous reports
- Road safety audit – requirement for safety barrier considered low risk, no provision for passing of large vehicles
- Earth slip failures noted at chg 3.3, 3.5 and 4.0km
- White rock corner (chg 1.78) – high priority repair site, medium priority site at chg 0.37, 0.39, 0.53, 1.38
- Consideration of crash history – one accident recorded on Lorinna Rd(within 7kmsection)
- Condition assessment
- Recommended works based on risk / priority
- Most repairs identified in 1996 have not been done.

7_June 2002, pitt&sherry, Lorinna Road specification for restoration works

- Specification for gabion wall repairs at chg 0.37, 0.57, 1.02, 1.38, 1.78, , 4.00
- Install post and cable safety barrier at chg 6.42
- Install guide posts.

8_April 2006, DIER, Safety Review Lorinna Road

- Comment on road width, geometry and mountainous terrain
- Road width further constricted by installation of safety barrier
- There are opportunities for widening / passing bays, but limited in higher risk mid section of road
- Limited forward site distance at many corners, difficult to improve
- There are adequate signage
- 85th percentile speed is 30km/h
- 5 ton load limit during school bus hours

- Cut batter provides delineation on lhs, but needs more guide posts on rhs
- Could consider safety barrier , however issues with installing posts
- Cost of improvements could be high and not greatly improve safety -????
- Alternative access should be considered.

9_September 2006, GHD, Lorinna Road – Route Options Assessment

- Identified issues for closing Lorinna Rd
- Identified issues against closing Lorinna Rd
- Load limit due to uncertainty of rock walls
- Crash history for past 5 years – 2 accidents – close to Lorinna township, low crash history reflective of narrow, slow winding road
- Stopping site dist for 20-30km/h = 17 to 28m. For two cars = 34 to 56m
- Assessment of road safety issues
- Lorinna Rd could continue to have sound safety performance, but rock walls are unpredictable and maintenance and construction have inherent risk to workers
- Lorinna road will not be able to provide safe passage for heavy vehicles
- Proposed that 2002 **pitt&sherry** remedial works are not guaranteed to provide certainty
- 2002 **pitt&sherry** actions mostly not addressed
- Identify safety concerns for workers on road
- The choice to change roads is a question of what risk Council is prepared to take.

11_November 2008, pitt&sherry, condition assessment update

- Reviewed condition assessment spreadsheet prepared in 2002
- Identified three sites requiring high priority repairs.

12_July 2008, CSE, Lorinna and River Roads, Upgrade Cost Assessment

- Set design criteria - , 4m min width, 6m wide passing bays at 200m min intervals, SSD for 20 to 30km/h = 14 (28) to 23 (46)m
- 5 ton load limit set to reduce risk of rock wall collapse
- Numerous wall failures noted
- Nominated area for guardrail – chg 0 to 5.5
- Bedding / dip angle of rocks at White Rock Corner of serious concern. Mining Engineer would not put miners below a face with rocks dipping at this angle
- Where site distance is substandard, provide two lanes.

14_February 2009, Kentish Council, Lorinna Road Closure Inspection

- Chg 914 – failure of repair made in 1999 considered highly probable
- Chg 1019 – section of rock wall showing evidence of worsening bulging and blow out – failure waiting to happen. Impact of failure on road users would be catastrophic
- Chg 3714 (chg 3314??) half circle evidence of subsidence. Site of previous failure. Presents unacceptable risk to road users
- Used emergency powers under the act to close the road.

Appendix B

Email from Bart Wisse and Howard Mulvey

David Hugo

From:	Bart Wisse [bart@lorinna.net]
Sent:	Monday, 4 March 2013 9:21 PM
To:	David Hugo
Cc:	Jonathan Magor
Subject:	Re: Lorinna Rd
Attachments:	bart.vcf
BeenAsked:	YES

Hi David and Jonathon,

Rock falls are not very common or problematic. They generally occur during times of prolonged rainfall and involve rocks loosening out of the road cutting and dropping down into the table drain or inside lane of the carriageway. Some rocks from this mode can be quite large, but I don't recall the road ever being closed by them. Amount of material from these events including soil and debris is about a trailer load or two, mostly in the table drain. Frequency about every two years.

After the fire of 2000, which burned along most of the length of Lorinna Road to Lorinna, there were dire predictions of massive rockfalls. For the year after, we would clear the road of stones when going to town. These were mostly from softball to golf ball size, with occasional larger. For the first month our weekly trips out would involve about 15 minutes stopping and starting to clean up the roadway. After the first flush of loose stones, the undergrowth re-established and rocks on the road reduced over the year to very occasional.

Rock wall failures are rare. One in the late 70's saw about a third of the roadway over about 10 metres fall away at White Rock Corner. Locals repaired it and we continued to use the road during the repair process. That was a medium on your scale. The other substantial failure was just before Silver Falls bridge and can be attributed to use of the vibrating roller and poorly maintained drainage with a pool of water lying in the table drain opposite the wall which ultimately failed. That was a major, and was in 1999. Even though almost half of the roadway was gone, locals - including the school bus - continued to use the road as the remaining roadway was on a solid dolerite cutting.

There was another top part of a wall which failed in the early 2000's and it was alleged that a road works machine had to be pulled back onto the road. I have never been able to verify this story and indeed the roadway itself was not compromised or closed in any way. That was small to medium.

They are the only actual failures I can recall in my 40 years experience. Other impacts on the walls have been from trees falling across the road or spearing down from higher up the slope, which have damaged the top sections of walls.

The other major failure was prior to my coming to Lorinna. The repair of that failure in 1969, using logs, led to the subsidence process which was ultimately the justification to close Lorinna Road. The washout of the repair in January 2010 exposed the solid rock foundation of the road and wall, and have clearly shown that there would have been water lubricating the rocks at the base of the wall. I recall a constant pool of water in the table-drain at that site, in the early days, due to the culvert just above the site being blocked and drainage to the bridge being graded incorrectly.

The only things that have closed the road are tree falls, a replacement of a deep culvert, by Treloar's, in the 1990's, the installation of a wire net and rock fill during Treloar's repair of the 1999 failure, and Kentish Council.

Regards

Bart

On 01/03/13 14:56, David Hugo wrote:

> Hi Bart

From previous reports and site inspections we have some data on rockfalls from above the road and rock wall failures. We have been in touch with John Trelour to try and develop a better understanding of the historical repair work on the road. He has provided us with some information.

Would you be able to provide us with some further local historical knowledge please? We are interested in:

- Frequency of rock falls from above the road.
- Size of rockfalls: wheel barrow load, trailer load or truck load
- Did any of these close the road

- Frequency of rock wall failures

  &a m p;nb
  sp;
  ;

  &a m p;nb sp;
- Type and size of wall failures: small - localized repair to top of wall
  medium – repair required to at least half of wall height
  major – reconstruction of section of wall with road closed.
- Did any of these close the road

Looking forward to hearing from you .

regards

David Hugo BEng (Civil)

Senior Civil Engineer

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A: 4th Floor, 113 Cimitiere Street, PO Box 1409, Launceston TAS 7250

David Hugo

Sent:	Friday, 15 March 2013 3:38 PM
To:	Simply Oarsome Aust P/L; David Hugo
Cc:	Bart Wisse; G de Burgh-Day; gerald@kentish.tas.gov.au
Subject:	Re: FW: Lorinna Road
Attachments:	Tree Down.jpg; Bus on Lorinna Road.jpg; Rock Wall Collapse.jpg
Follow Up Flag:	Filing Request by dhugo - HB12097 : 43P From Others
Flag Status:	Flagged

Hello Neil and David

As a long term resident of Lorinna (since 1977), my 20 years as a school bus driver from Lorinna to Sheffield and return (which, even if I only considered the travel from my home at 900 Lorinna Road to the sealed road at the end of the Cockatoo, amounts to over 100,000 kms), plus many years travelling Lorinna Road 4 times a day, I consider that I am qualified to answer the questions David Hugo has asked.

ROCKFALLS:
Frequency of rock falls from above the road: At least once a month, sometimes more, depending on the time of year - winter is worse. There would be small rockfalls, say a rock the size of a football, at least weekly.

Size (wheel barrow/trailer/truck): All of the above. The biggest one I have seen was over 2 metres high.

Did they close the road: Yes, several times. However the road was closed more times for fallen trees, which also bring the rocks down. Many of the trees were huge, so they put deep dents in the road as well.

ROCK WALLS:
Frequency of rock wall failures: In 36 years, maybe 6

Type and size:
Small: Small wall damage would have happen quite often, sometimes weekly. Damage to the top of walls mainly occurred due to trees falling on them.
Medium: Not really
Major: Three times that I know of

Did any close the road?: Yes, at White Rock Corner, Silver Falls and at Drybed Creek. Also the road was closed for 3 weeks because of fire damage above the road.

GENERAL:
Does rainfall influence rock walls and rock falls?: Yes, there are more rock falls during rain, but the walls only suffer if there is poor drainage, *ie* table drains.

How did the fire affect rockfalls and rock walls?: The fire burnt all the undergrowth that held the rocks in place, so lots of smaller rocks fell from above the road, and walls were affected by fallen trees.

Actually the trees were the main problem to Lorinna Road - they damage the rock walls, bring down rock falls and damage the road. If the trees were cleared back to a distance where they would have less impact on the road if they fell, the frequency of rock falls would have been massively less.

I have attached a couple of photos.

Yours sincerely

Howard Mulvey

On Thu, Mar 14, 2013 at 3:09 PM, Simply Oarsome Aust P/L <info@oarsome.com.au> wrote:

Hi Howard,

As I mentioned on the phone these are the questions from David Hugo re Lorinna Road. If you could also email your responses to David and myself and cc Bart and Geraldine, as well a copy to Gerald Monson as well that would be much appreciated. Gerald's email address is gerald@kentish.tas.gov.au.

Thanks again Howard

Neil

From: David Hugo [mailto:dhugo@pittsh.com.au]
Sent: Thursday, 14 March 2013 2:40 PM
To: info@oarsome.com.au
Cc: Jonathan Magor
Subject: Lorinna Road

To Neil Myers

As discussed at the meeting at Kentish Council on Tuesday, would you be able to find a member of the Lorinna Community who has lived there for some time and has long term knowledge of Lorinna Road. Would you be able to ask this person the following questions please?

Rockfalls

- Frequency of rock falls from above the road?
- Size of rockfalls: wheel barrow load, trailer load or truck load?
- Did any of these close the road?

Rock Walls

- Frequency of rock wall failures?
- Type and size of wall failures: small - localized repair to top of wall?

  medium – repair required to at least half of wall height?

major – reconstruction of section of wall with road closed?

- Did any of these close the road?

General

- How does rainfall events influence rock falls and rock walls?
- How did the fire affect rockfalls and rock walls?

regards

David Hugo BEng (Civil)
Senior Civil Engineer

pitt&sherry | **sustainable*thinking*®**

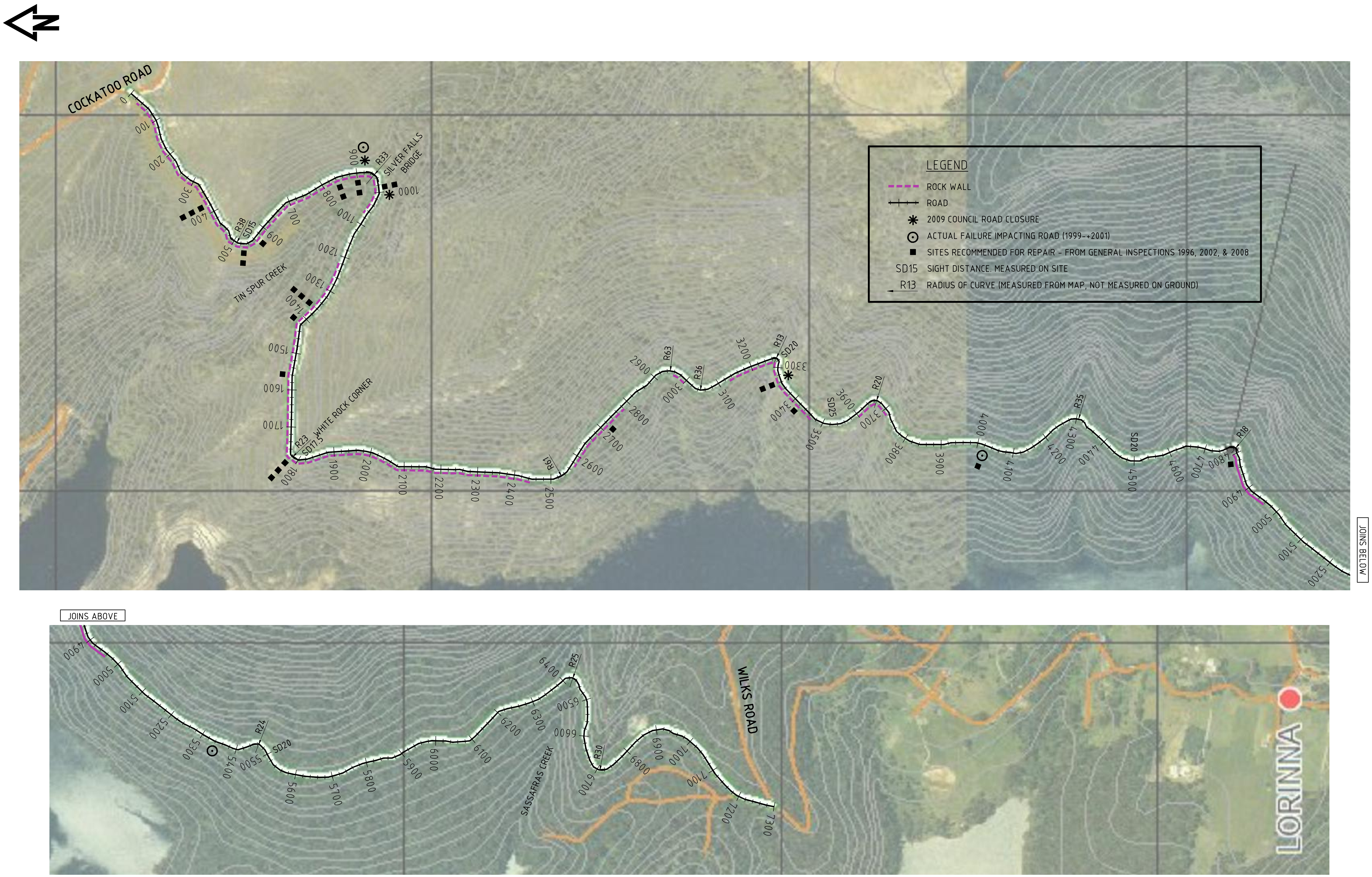
T: 03 6323 1900 | **F:** 03 6334 4651 | **M:** 0419 109 354

E: dhugo@pittsh.com.au | **W:** www.pittsh.com.au

A: 4th Floor, 113 Cimitiere Street, PO Box 1409, Launceston TAS 7250

Appendix C

Site Plan 1 and Site Plan 2



REFERENCE FILES ATTACHED:

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE	APPROVED
						ORIGINAL COPY ON FILE "e" SIGNED BY
						SIGNED
		AJS	DH	DH	18.07.12	DATE 18.07.12

SCALE (PLOTTED FULL SIZE) 1:5000 (A1) SHEET SIZE A1

REDUCED SCALE PLOT

CAUTION: THIS DRAWING MAY NOT COMPLY WITH AS1100 IF PLOTTED AT A REDUCED SCALE

PITT & SHERRY
ABN 77 009 586 083
pitt&sherry sustainable thinking
LAUNCESTON OFFICE
113 – 115 Cimitiere Street
Launceston
Tasmania 7250
Ph. (03) 6323 1900
Fax. (03) 63344 651
www.pittsh.com.au

CLIENT: KENTISH COUNCIL

PROJECT: LORINNA ROAD ACCESS STUDY

STATUS: **PRELIMINARY**

DRAWING TITLE: SITE PLAN 1

DATUMS: AHD / GDA PLANE

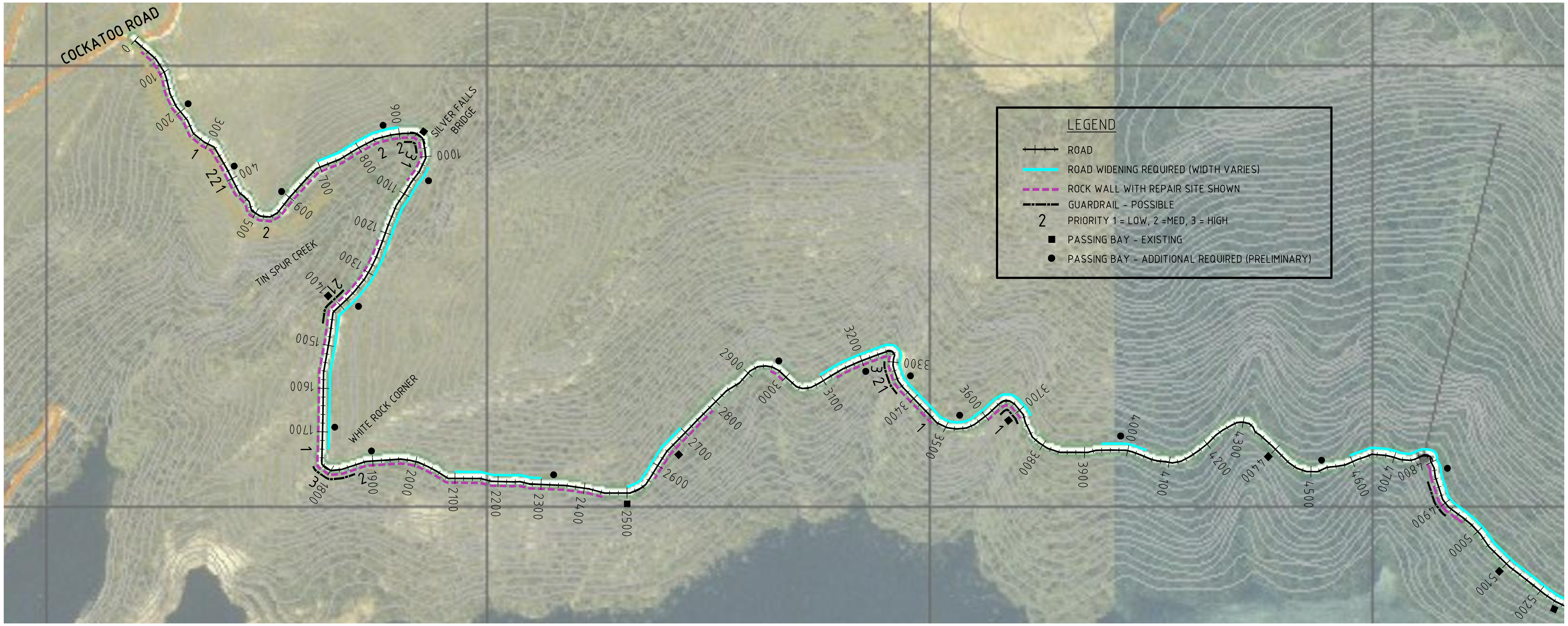
CLIENT No.

DRAWING No. HB12097-P1

REVISION

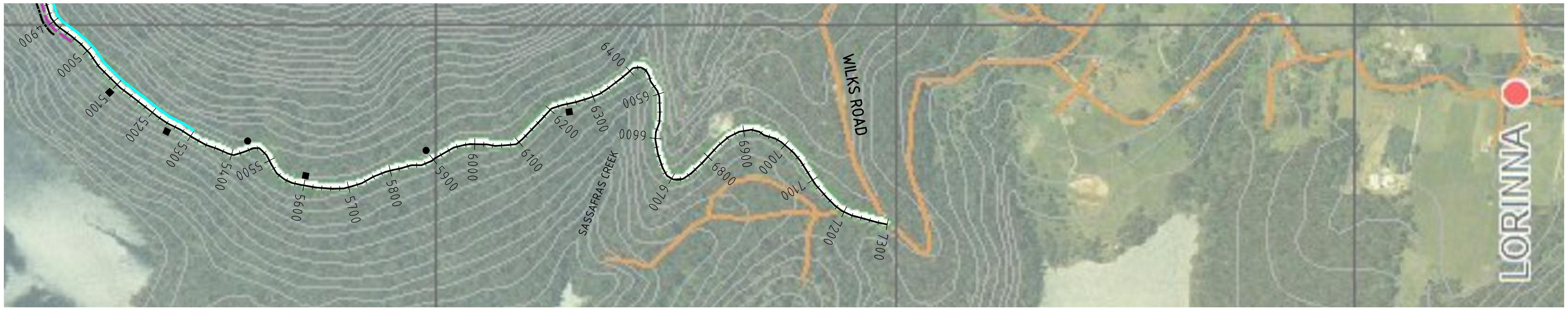
Mar. 8, 13 - 15:10:17 Name: HB12097-P1.dwg Updated By: Andrew Sluce

P&S FORM DRG-A1 REV 26



JOINS BELOW

JOINS ABOVE



REFERENCE FILES ATTACHED:

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
A	GUARDRAIL LOCATIONS INCLUDED	AJS	DH	DH	31.10.13
		AJS	DH	DH	14.02.13

APPROVED: ORIGINAL COPY ON FILE "e" SIGNED BY

SIGNED

DATE 18.07.12

SCALE (PLOTTED FULL SIZE) 1:5000 (A1)

SHEET SIZE **A1**

REDUCED SCALE PLOT

CAUTION: THIS DRAWING MAY NOT COMPLY WITH AS1100 IF PLOTTED AT A REDUCED SCALE

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Fax. (03) 63344 651
www.pittsh.com.au

CLIENT: KENTISH COUNCIL

PROJECT: LORINNA ROAD ACCESS STUDY

STATUS: **PRELIMINARY**

P&S FORM DRG-A1 REV 26

DRAWING TITLE: SITE PLAN 2

DATUMS: AHD / GDA PLANE

CLIENT No.

DRAWING No. HB12097-P2

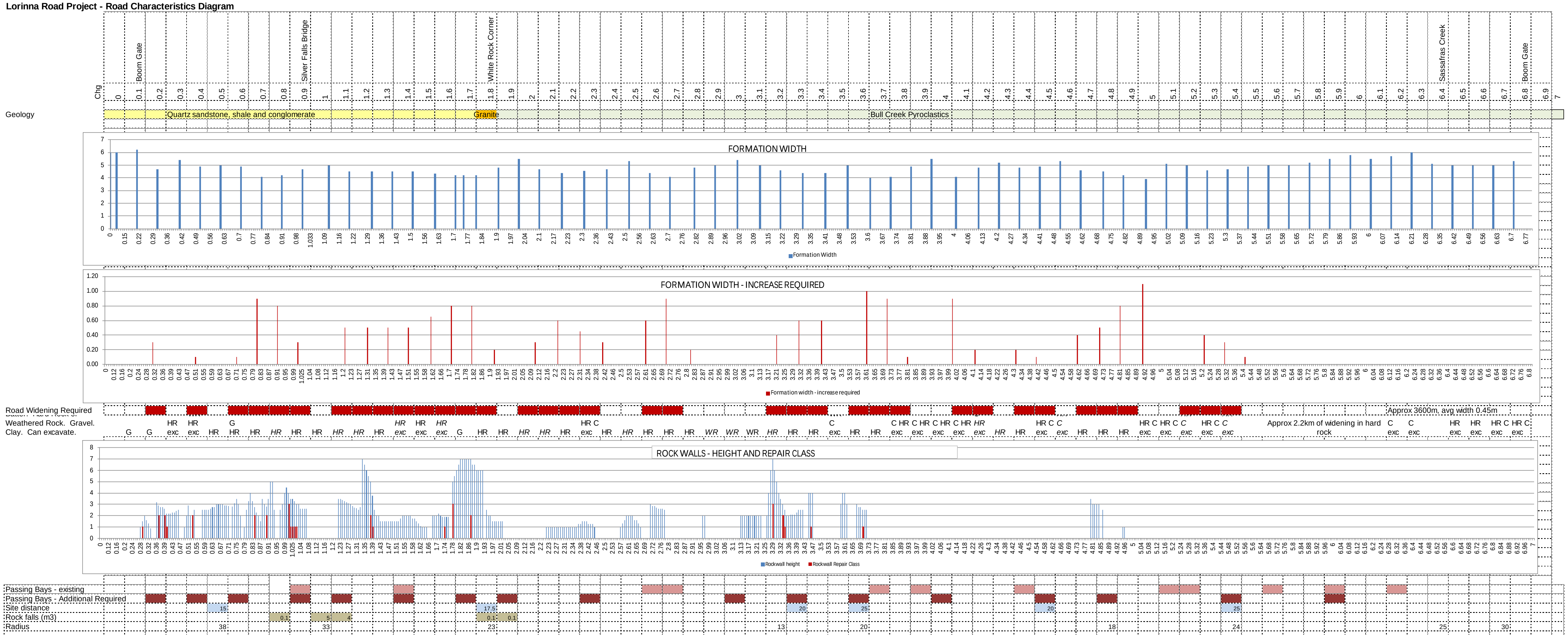
REVISION A

Oct. 31, 13 - 09:48:16 Name: HB12097-P2.dwg Updated By: Andrew Sluce

Appendix D

Road Data Diagram

Lorinna Road Project - Road Characteristics Diagram



Inspection of specific issues

October 1999: p&s L99132

- Chg 0.93: slip in outer western half of road

August 2001: p&s D01041

- chg 4: slip in downhill embankment
- chg 5.35: slip in downhill embankment

Kentish Council Road Closure Inspection

2009: Kentish Road Closure

- chg 0.914: major wall failure in Oct 99
- chg 1.019: worsening wall failure detected, number of sections showing significant bulging and a blow out.
- Chg 3.34 (incorrect chg by KC): half circle shaped evidence of walled road subsidence. Showed further cracking and subsidence.

General Inspections - Recommended Rep. 1 1 1

July 1996, p&s D6007

- chg 0.39. Drainage issue. repair wall 5m.
- chg 0.53. Drainage issue.
- chg 0.84. Draiange issue. Underpin wall 3m.
- chg 0.9 Wall bulge low pressure
- chg 1.36. Underpin wall 8m.
- chg 1.4 Drainage issue Rebuild wall 4m.
- chg 1.57. Bulge in wall. Grout.
- chg 1.78 White Rock Corner. Rebuild wall 60m2
- chg 2.74 wall damaged by falling log. Repair wall over 6m
- chg 3.34 Log ret wall failing. Rebuild wall 10m
- chg 3.4 Drainage issue. Reapir wall 5m.
- chg 4.8 Drainage issue Rebuild top of wall 10m

June 2002, p&s D02016.

- chg 0.37
- chg 0.57 Gabion Wall 4m
- chg 1.02 Gabion wall 10m
- chg 1.38 Gabion Wall 14m
- chg 1.78 - White Rock Corner. Gabion Wall 60m2
- chg4.0 Gabion wall 30m

Nov 2008, p&s LN08177

- chg 0.37 & 0.39 MED PRIORITY. Gabion Wall 5m
- chg 0.53. MED PRIORITY. Repair
- chg 0.84 MED PRIORITY. Underpin wall 3m.
- chg 0.89 MEDIUM PRIORITY
- chg 1.01. HIGH PRIORITY Gabion wall 8m
- chg 1.38 MED PRIORITY Underpin wall 8m
- chg 1.78 - White Rock Corner. HIGH PRIORITY. Gabion Wall 60m2
- Numerous low priority sites identified but have not been included here
- chg 3.3. HIGH PRIORITY. Repair wall 15m

Appendix E

Cost Estimate

Lorinna Road Upgrade Cost Estimate		
	Estimated Cost	
Engineering		
Drystone wall assessments	$	39,700
Rock stabilisation above the road	$	18,640
high priority repair sites	$	57,160
moderate priority repair sites	$	21,460
Road widening, site distance, passing bays, safety barrier	$	36,440
Drawings, specificaiton and Tender.	$	31,320
subtotal	$	204,720
Construction		
Clearing Vegetation	$	55,800
Rockwall Repairs - High Priority Sites	$	311,540
Rock stabilisation above the road	$	57,000
Medium Priority Repairs	$	43,300
General Repairs	$	20,000
Road widening, drainage, site distance, passing bays, safety barrier	$	686,700
subtotal	$	1,174,340
Project Management		
Construction Supervision / Administration	$	124,800
(26 weeks x 24 hrs / week x $200/hr)		
subtotal	$	1,503,860
contingency approx. 10%	$	150,386
Total	$	1,654,246
Routine Maintenance cost each year	$	3,767
Potholing, loose gravel, drainage etc		
Periodic Maintenacne Cost for 10 years		
Trees - remove fallen tree - twice each year	$	46,800
Rockfalls - small - clear twice each year	$	15,120
Stone wall - minor repair - every second year	$	51,850
Drainage - recut drains, clear blocked culvert - every third year	$	18,581
Vegetation clearing - every second year	$	22,500
Pavement - resheet every 5 years	$	51,840
subtotal	$	206,691
Yearly cost / km	$	3,593

Lorinna Road Upgrade
Engineering Works - Estimate of Fees

	Responsible Director	Project Manager	Geotechncial Engineer	Civil Engineer	Field Technician	AutoCAD draftsman	kilometres	Direct Costs		
	$ 300	$ 190	$ 180	$ 180	$ 140	$ 140	$ 0.90			
Geotechnical Engineering - Drystone wall assessment										
Project Management	2	4								
prepare for field			16							
field work	2	4	40	40			1200	1600	accomodation - 8 nights x $200	
collate field data		2	80			16				
sub-total hours	4	10	136	40	0	16	1200			
subtotal - cost	$ 1,200	$ 1,900	$ 24,480	$ 7,200	$ -	$ 2,240	$ 1,080	$ 1,600		$ 39,700 subtotal
Geotechnical Engineering - stability above the road										
Project Management	2	4	4							
visit site	2	4	10	10			600	400	accomodation - 2 nights x $200	
design	2	4	40			15				
sub-total hours	6	12	54	10	0	15	600			
subtotal - cost	$ 1,800	$ 2,280	$ 9,720	$ 1,800	$ -	$ 2,100	$ 540	$ 400		$ 18,640 subtotal
Geotechnical Engineering - three high priority rock walls										
Project Management	2	4	4					10000	survey inc accomodation	
visit site	2	4	10	10			600	400	accomodation - 2 nights x $200	
design	3	4	80	8		12		20000	Drilling	
sub-total hours	7	12	94	18	0	12	600			
subtotal - cost	$ 2,100	$ 2,280	$ 16,920	$ 3,240	$ -	$ 1,680	$ 540	$ 30,400		$ 57,160 subtotal
Geotechnical Engineering - moderate priority rock walls										
Project Management	2	4	4						survey inc accomodation	
visit site	2	4	20	10			600	400	accomodation - 2 nights x $200	
design	2	4	40	8		12				
sub-total hours	6	12	64	18	0	12	600			
subtotal - cost	$ 1,800	$ 2,280	$ 11,520	$ 3,240	$ -	$ 1,680	$ 540	$ 400		$ 21,460 subtotal
Civil Engineering - road widening, site distance, passing bays, safety barrier										
Project Management	2	4		4					survey inc accomodation	
visit site	2	4	10	10			600	400	accomodation - 2 nights x $200	
design	3	4	24	60		12		10000	survey inc accomodation	
sub-total hours	7	12	34	74	0	12	600			
subtotal - cost	$ 2,100	$ 2,280	$ 6,120	$ 13,320	$ -	$ 1,680	$ 540	$ 10,400		$ 36,440 subtotal
Drawings, specificaitons and Tender										
Project Management	4	16								
prepare documents	4	60	20	20		40	0			
						12				
sub-total hours	8	76	20	20	0	52	0			
subtotal - cost	$ 2,400	$ 14,440	$ 3,600	$ 3,600	$ -	$ 7,280	$ -	$ -		$ 31,320 subtotal
total hours	38	134	402	180	0	119			Total	$ 204,720

Lorinna Road Upgrade Construction Cost Estimate		unit	qty	rate	amount	comment
	Clearing Vegetation					
	Remove Trees - standing	no	70	500	$ 35,000	assume 10 trees / km
	Remove trees fallen	no	20	500	$ 10,000	approx 10 trees already fallen, likely more between now and construction - allow 20
	Clear vegetation from toe of wall and 2m beyond	item	1	3600	$ 3,600	wall - 3130m long. Slasher - 16hrsx125/hr = $2000+ chainsaw operator - 32hrsx$50/hr= $1600
	Clear vegetation from road formation and 2m beyond	item	1	7200	$ 7,200	6800m road length x 2 sides x 50%. Allow 2x item above
		Clearing Vegetation subtotal			$ 55,800	
	Rock Wall Repairs - high priority					
	chg 1000 - Silver Falls Bridge					
	Establishment	item	1	2000	$ 2,000	
	excavation, inc access to foundation	hrs	8	400	$ 3,200	10x2x4m excavation. Alow 1 day x exc, lab and 2 trucks$400/hr
	prepare footing and foundation	m2	20	200	$ 4,000	10m longx2m wide concrete, 0.5m thick avg, anchored to rock
	gabion wall and drainage	m3	60	400	$ 24,000	10x4mhighx1.5m avg wide = 60m3 gabion
	backfill	m3	33	40	$ 1,320	10x3 highx0.75m avg +50% for access = 33m3
					$ 34,520	
	ch 1800 - White Rock Corner - widen over 30m					
	Establishment	item	1	2000	$ 2,000	
	excavation, inc access to foundation	m3	50	550	$ 27,500	30x3x6m excavation plus 33% for benching / access. Allow 1 week 2 excavators and 2 trucks
	prepare footing and foundation	m2	60	200	$ 12,000	20m longx3m wide concrete, 0.5m thick avg, anchored to rock - $8250. Say $10,000 /(20x3m) = $166/m2, say $200/m2
	gabion wall and drainage	m3	180	400	$ 72,000	20x6mhighx1.5m avg wide = 180m2 gabion, only 20m because large rock takes up other 10m.
	backfill	m3	135	40	$ 5,400	20x6highx0.75m avg +50% for access = 135m3
	Remove rock to improve site distance	hrs	50	300	$ 15,000	assume 1 week - drill & blast and remove materials
		hrs	40	350	$ 14,000	rock breaker,+ 2 trucks
					$ 147,900	
	Chg 3300 - replace culvert and clear road					
	clear rock and debris from road	hr	8	500	$ 4,000	1 day work
	new box culvert - twin 1.8x1.8m x 6m	item	20	3250	$ 65,000	box culvert - 5mx3.6mx$3250/m2. Alt twin 2.1mdia pipes - 3x2.44mx2x$2500/m. Normal bridge rate is $2500/m2
	earthworks backfill etc	item	1	10000	$ 10,000	
					$ 79,000	
	chg 3300 - New gabion wall					
	Establishment	item	1	2000	$ 2,000	
	excavation, inc access to foundation	m3	40	50	$ 2,000	foundation already mostly exposed. Allow some work by hand. 2 lab x 20hr
	prepare footing and foundation	m2	29	200	$ 5,800	20m longx3m wide concrete, 0.5m thick avg, anchored to rock. $200/m2
	gabion wall and drainage	m3	90	400	$ 36,000	10x6mhighx1.5m avg wide = 90m3 gabion
	backfill	m3	108	40	$ 4,320	8x6mhighx1.5m avg wide = 72m3 fill + 50% for access
					$ 50,120	Rate = $50,000/ 90m3 gabions = $555/m3 gabion
		high priority sites subtotal			$ 311,540	
	Rock Stabilisation - above the road					
	chg 1100 - south of Silver Falls Bridge					
	Establishment	item	1	1000	$ 1,000	
	fall trees	no	5	500	$ 2,500	
	clear rock on road	hr	8	200	$ 1,600	allow 8 hrs - excavator and 1 truck
	Stabilise rocks - excavation...	hr	16	200	$ 3,200	allow 16 hrs - excavator and 1 truck, 2 days bolting and netting
	netting / bolting	item	1	5000	$ 5,000	labour, drilling and bolting, netting
					$ 13,300	
	ch 1800 - White Rock Corner					
	establishment	item	1	1000	$ 1,000	
	rock scaling	item	8	250	$ 2,000	allow 8hrs crane + lab
			8	200	$ 1,600	allow 8rs truck and excavator

	rock bolting and netting	hrs	30	300	$ 9,000	allow 30 hrs crane, 3x lab, equip
		item	1	10000	$ 10,000	450m2 of netting
					$ 23,600	
	chg 1950					
	Establishment	item	1	1000	$ 1,000	
	fall trees	no	5	500	$ 2,500	
	Scale loose rocks and clean up	hr	8	200	$ 1,600	allow 8 hrs - excavator and 1 truck
					$ 5,100	
	other sites	item	3	5000	$ 15,000	allow 3 other sites at $5000 each
	Rock stabilisation above road Subtotal				$ 57,000	
	Rock Wall Repairs - Medium Priority Sites					
	Repair / reconstruct walls. 6 sites. 60m3	m3	60	555	$ 33,300	allow 6 sites 10m3 gabions at each. Use $555/m3 for exc, gabs, reinstate
	drainage. Clear culvert inlets, unblock - allow 10	no	10	1000	$ 10,000	
				subtotal	$ 43,300	
	General Repairs - Low Priority					
	Drainage, guide posts, rock walls	item	1	20000	$ 20,000	
	Rock Wall Repairs - Medium Priority Sites - subtotal				$ 20,000	
	Road Widening, Drainage, Passing Bays, Gravel, Safety Barrier					
	Road Widening in rock - need blasting	m3	1620	80	$ 129,600	2200m long x 0.45m wide avg x 1.0m avg high = 1620m3. Based on ecavator to clear top of bank, dill and low impat blast, clean up. Production rates provided by Mining Engineer.
	road widening - by excavator	m4	990	40	$ 39,600	1400m long * 0.45m avg x 1.0m high = 990m3. allow 100hrs exc + 2 trucks + lab. 100hrx$400/hr=$40,000 = $40/m3
	Table Drains	m	3200	5	$ 16,000	Of the remaining 3200m, assume 50% of these drains needs cleaning out.
	Passing Bays in rock	no	900	80	$ 72,000	Need 12 extra. Allow 100m3 excavation. Assume 9 in hard rock
	Passing Bays in clay / rock excavatable	no	300	40	$ 12,000	Assume 6 in excavatable material.
	Gravel to resheet road	m3	3025	100	$ 302,500	2200m3 of gravel required for norhtern 3.5km, 825m3 material required for southern part
	Gravel in widened areas	m3	400	100	$ 40,000	3200mx0.45mx0.25m = 360m3, say 400m3
	Safety Barrier.	m	500	150	$ 75,000	allow 200m
	Road Widening, Drainage, Passing Bays, Gravel, Safety Barrier - subtotal				$ 686,700	
				TOTAL	$ 1,174,340	

Routine Maintenance Costs - annual	unit	qty	rate	amount
potholing. Truck + operator + lab - 2 days, 10 ton gravel				
truck	hr	9	90	$ 810
labourer	hr	9	50	$ 450
gravel	tonne	9	30	$ 270
supervision, profit overhead 35%				$ 536
				$ 2,066
drainage				
clear drains / culverts of isolated blockag or debris				
Truck + operator + labourer 1 day				
Truck	hr	9	90	$ 810
labourer	hr	9	50	$ 450
supervision and overhead 35%				$ 441
				$ 1,701
Annual Maintenacne Cost				$ 3,767
Annaul maintenance cost per kilometre (6.8km)	6.8			$ 554
Maintenance Cost for 10 years				$ 37,665

Periodic Maintenacne Cost for the next 10 years	unit	qty	rate	amount	fequency (per 10 year)	Cost for 10 years
Trees - remove fallen tree - twice each year						
truck	hr	9	90	$ 810	20	$ 16,200
labourer	hr	9	50	$ 450	20	$ 9,000
excavator & trailer behind truck	hr	9	120	$ 1,080	20	$ 21,600
supervision and overhead 35%				$ 819		$ 16,380
				$ 2,340		$ 46,800
Rockfalls - small - clear twice each year						
truck	hr	4	90	$ 360	20	$ 7,200
labourer	hr	4	50	$ 200	20	$ 4,000
supervision and overhead 35%				$ 196		$ 3,920
				$ 756		$ 15,120
Stone wall - minor repair -- every second year						
truck	hr	27	90	$ 2,430	5	$ 12,150
excavator - 7 ton	hr	27	120	$ 3,240	5	$ 16,200
labourer x2	hr	27	100	$ 2,700	5	$ 13,500
materials	item	1	2000	$ 2,000	5	$ 10,000
supervision and overhead 35%				$ 3,630		$ 18,148
				$ 10,370		$ 51,850
Drainage - recut drains, clear blocked culvert - every third year						
truck	hr	18	90	$ 1,620	3.33	$ 5,395
excavator - 7 ton	hr	18	120	$ 2,160	3.33	$ 7,193
labourer x2	hr	18	100	$ 1,800	3.33	$ 5,994
supervision and overhead 35%				$ 1,953		$ 6,503
				$ 5,580		$ 18,581
vegetation clearing - every second year						
slasher	hr	18	150	$ 2,700	5	$ 13,500
chainsaw operator x 2	hr	18	100	$ 1,800	5	$ 9,000
supervision and overhead 35%				$ 1,575		$ 7,875
				$ 4,500		$ 22,500
pavement - every 5 years						
grader	hr	27	140	$ 3,780	2	$ 7,560
roller	hr	18	100	$ 1,800	2	$ 3,600
water	hr	9	90	$ 810	2	$ 1,620
10 yard truck	hr	27	90	$ 2,430	2	$ 4,860
loader	hr	27	100	$ 2,700	2	$ 5,400
gravel. 1000m x 4m x 0.05m x 2.4t/m3	ton	480	30	$ 14,400	2	$ 28,800
supervision and overhead 35%				$ 9,072		$ 18,144
				$ 25,920		$ 51,840
Periodic Maintenance Cost for 10 years				$ 48,710		$ 206,691
total Maintenance Cost for 10 years						$ 244,356
Annual cost per kilometre						$ 3,593

Appendix F

DIER Crash History Report

Department of
Infrastructure,
Energy and Resources

Crash History from 01/01/2005 to 31/12/2008

Total Crashes: 2

Report Details:

Request Id:	44381262
Requested by:	T WALLACE
Date:	07/10/2013 11:31:44

Parameters Used:

DIER Road Carriageway:		Recipient Type:	Engineer
DIER Road End Chainage:		Release Delay:	0
DIER Road Start Chainage:		Retired Road:	Y
Dier Road Link:		Road Type:	
Dier Road No:		Show BAC:	N
End Date:	31/12/2008	Show Graph:	N
End Time:	23:59	Show Map:	Y
Intersection Name:		Start Date:	01/01/2005
Intersection Point	<spatial value>	Start Time:	00:00
LGA:	Kentish	Surface Condition:	
Light Condition:		Surface Type:	
List Road:	Lorinna Road	Visibility:	
Locality:		Weekend:	
No Units:		Crash Factor:	
Non Road:		DCA Ids:	
Police Attended:		DCA Sub Ids:	
Police District:		DCA Sub Sup Ids:	
Quality Assured:		Days Of Week:	
Radius (m):		Driver Town:	
Recipient Name:	Shivani Jordan	Entire State:	N

Parameters Used:

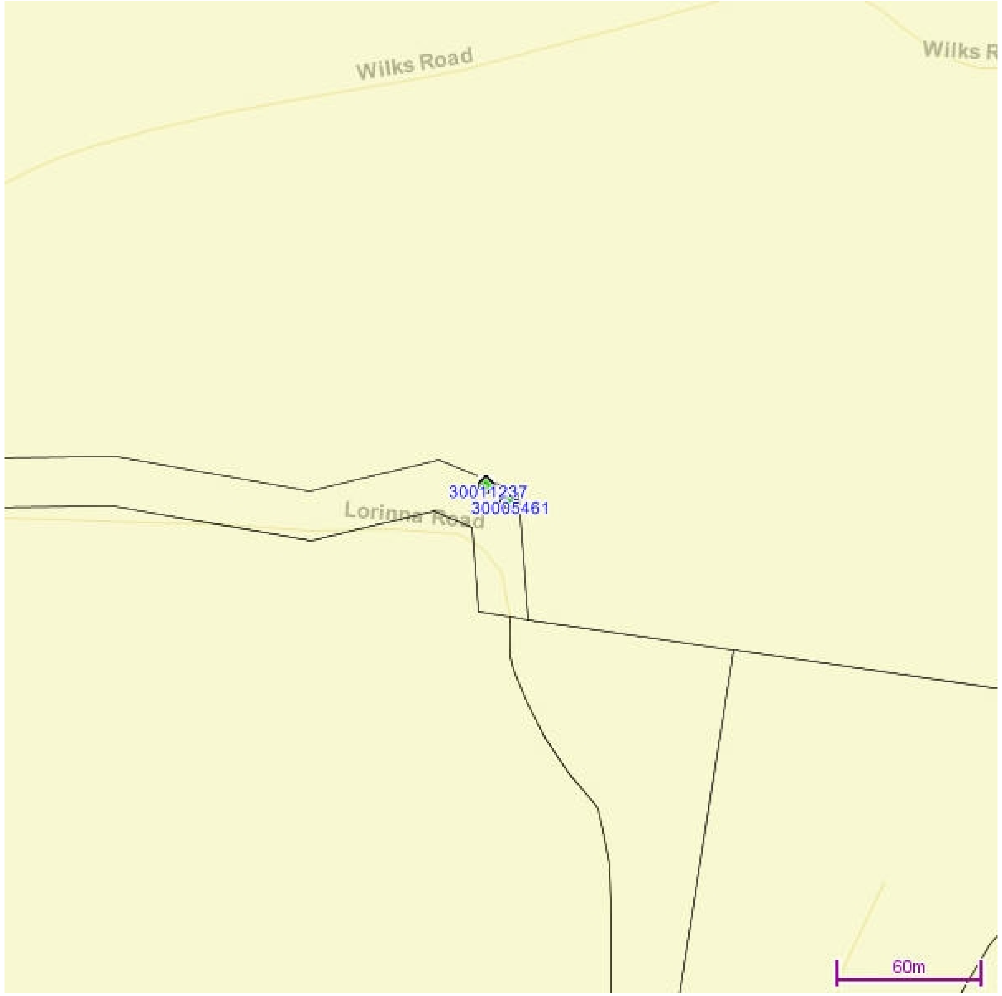
Severity:
Speed Zone:
Toxicology:
Traffic Control:
Unit Type:

Department of
Infrastructure,
Energy and Resources
Tasmania

Crash History from 01/01/2005 to 31/12/2008

Crash No	Crash Date Time	Severity	Description	Location	Visibility	Surface Type	Surface Condition	Light Condition	Speed Limit	Unit No	BAC*	Unit Type(s)	Traffic Control
30011237	27/08/2005 13:27 SAT	Property Damage Only	183 - Off left bend into object/parked vehicle	Lorinna Road, Lorinna, Kentish (427873.09,5401949.41) Trips Ref N/A	Clear	Unsealed	Dry	Daylight	100	1		Light Vehicle	Not controlled
30005461	28/04/2006 16:30 FRI	Property Damage Only	120 - Wrong side/other head on (not overtaking)	Lorinna Road, Lorinna, Kentish (427882.33,5401942.8) Trips Ref N/A	Clear	Unsealed	Dry	Daylight	100	1		Light Vehicle	Not controlled
										2		Light Vehicle	Not controlled

Crash History from 01/01/2005 to 31/12/2008



Requested by: T WALLACE Date: 07/10/2013 11:31:44
Request Id: 44381262 End Date: 31/12/2008 End Time: 23:59 Intersection Point <spatial value> LGA: Kentish List Road: Lorinna Road Recipient Name: Shivani Jordan Recipient Type: Engineer
Release Delay: 0 Retired Road: Y Show BAC: N Show Graph: N Show Map: Y Start Date: 01/01/2005 Start Time: 00:00 Entire State: N
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Department of
Infrastructure,
Energy and Resources
Tasmania

Crash History from 01/01/2005 to 31/12/2008

*******End of Report*******

Requested by: T WALLACE Date: 07/10/2013 11:31:44
Request Id: 44381262 End Date: 31/12/2008 End Time: 23:59 Intersection Point <spatial value> LGA: Kentish List Road: Lorinna Road Recipient Name: Shivani Jordan Recipient Type: Engineer
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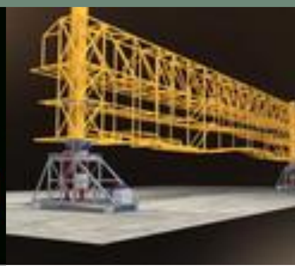
transport infrastructure | community infrastructure | industrial infrastructure | climate change



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