Transport for NSW

Guide for Natural Disaster Slope Damage Restoration Requirements

September 2023

NSW GOVERNMENT

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Document Information

Title	Interpreting Natural Disaster Slope Damage Restoration Requirements
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Authorised by:	Joe Krsul

1. Introduction

The purpose of this document is to assist Transport for NSW and Local Government in complying with the Natural Disaster Framework of the Australian and New South Wales Governments as it relates to the restoration of slope damage impacting Essential Public Assets.

This document is not prescriptive and does not override or replace any of the Relevant Documents listed below.

2. Relevant Documents and Interpretation

The Disaster Recovery Funding Arrangements 2018 (hereafter DRFA) set out the arrangements for disaster funding between the Commonwealth and the States and Territories. These arrangements must be complied with to enable Commonwealth contribution to eligible reconstructions works.

The NSW Disaster Assistance Guidelines 2021 (hereafter DAG) set out how the broader DRFA applies to NSW and provides the process for the NSW Government providing financial assistance to councils that are impacted as a direct result of an eligible disaster.

The NSW Natural Disaster Essential Public Asset Restoration Guidelines 2018 (hereafter EPARG) describes the arrangements for the restoration of local council essential public assets that have been damaged as a direct result of eligible disasters.

The documents need to be read in conjunction with each other. However, in the event there is a conflict or inconsistency the following rules apply:

- For the Commonwealth, the DRFA takes precedence over all other documents.
- For NSW, the DAG prevails over the EPARG.

3. Application to Slope Restoration

From a road perspective, the overriding principle in all three (3) documents is to assist in the restoration of essential public assets to their pre-disaster function. The definitions and guiding principles defining an eligible disaster, essential public asset, pre-disaster function, etc can be found in the linked relevant documents above and will not be restated here.

The key component that directly describes the application of the relevant documents to slope failures is covered in Appendix E Eligibility Examples and Scenarios - Section 2.2.6 of the EPARG. It is restated below in full:

> *Road embankments and batter slopes are considered a part of the essential public asset of the road network.*

Following an eligible disaster, common forms of damage include scours, cut failures (shallow or deep) and embankment failures (shallow or deep). Where damage is sustained to road embankments and batters, an assessment is to be undertaken in line with the NSW RMS Guide to Slope Risk Analysis. This risk assessment provides a means for categorizing the risk, slope instability and prioritizing the risk management of the slope.

Investigative techniques (for example, geotechnical testing) are considered eligible for funding, where it is evident that an essential public asset has been directly damaged by an eligible disaster, and the investigative techniques are used as part of the reconstruction works (for example, to determine the extent of the damage and/or identify the reconstruction option).

The eligibility of the proposed treatment should be assessed on the basis that following the proposed treatment the Assessed Risk Level (ARL) of the embankment batter shall be the same ARL or one better than what existed pre-disaster – for example, if the ARL pre-disaster was a 3, the ARL following the treatment is to be either a 3 or a maximum of 4.

For specific reasons (e.g. cost benefit analysis and a site-specific evaluation of acceptable risk), if a council adopts a solution that does not bring the risk level to ARL4 or better (that is, where any residual risk exceeds ARL4 level), the council must provide a risk management plan for the asset.

For the assessment and repair of slopes, the minimum documentation required would be as follows:

- Slope Description Record contains section A, B and C together with sketches of slope features, geology, and failure mode.
- Slope Risk Analysis Summary showing the ARL rating of each upslope and downslope failure
- Photos of the damage.

It is important to recognise that the nature and types of batter failures are so diverse across the NSW road network that it is difficult to provide a standard restoration process or method that would suit all failures. Accordingly, the overriding principle is to restore the slope to its pre-disaster capacity, geometric layout or materials and the pre-disaster function. Where this is not possible, a range of options with the most suitable engineering and cost-effective option will need to be considered when determining the necessary restoration scope.

An overarching process flowchart to approach road slope failures following an eligible natural disaster is included in Attachment A.

3.1 Determining if the Function of the Asset has been Compromised.

The pre-disaster function of the essential public asset must be determined using the Essential Public Asset Function Framework (EPAFF), which is outlined in Section 6.3 of the DRFA.

The critical components directly relevant to slope restoration are 'category', 'sub-category and purpose', 'asset type', 'asset capacity', and 'asset layout and materials'. There is great variability in these components across the road network and the pre-disaster function is not always obvious without detailed knowledge of the road and its historical and current use.

There is a 2-step process with 5 considerations in the framework in defining the pre-disaster function of an asset.

The first step involves determining category, sub-category, and purpose of the asset. The essential asset 'category' for slopes is 'Transport' with sub-category of 'embankments and batters' with the asset's prime purpose of supporting the road formation.

The second step to defining the per-disaster function by considering the 'asset type', 'asset capacity' and 'asset layout and materials'.

The 'asset type' for slopes have been split into upslopes, downslopes and retaining structures with primary function to provide support for the road. For the council road network, these slope assets are located on Regional and Local roads with wide variations in traffic volumes and vehicle types.

The 'capacity' of the embankments and batters is to provide engineering support for the road to enable safe travel for the community for the pre-existing road traffic arrangement. The capacity of slopes is determined by the loss of batter materials that will compromise the integrity and support provided to the road and appropriate expertise is required to determine this based on geotechnical information provided.

The 'asset layout and materials' for slopes is largely determined from geotechnical advice based on the soil type, traffic loading and design requirements as well as risk analysis to determine the asset layout and materials to be used to repair the support provided for the existing road formation. If the asset layout for the slopes cannot be repaired using current materials to get an acceptable safe design in accordance with Geotechnical Technical Direction GTD 2018/001, then options for reinforcement of the slope can be achieved by considering a range of options including soil nails, shotcreting or piled walls. The provision of a safety barrier is eligible along the road where the treatment of the slope has resulted in a steeper slope than the pre-existing situation or where the design warrants the installation of safety barrier for the safety of the public.

Physical failure of the pavement surface is not required to impact the function of the road. Significant downslope batter failures can occur which, upon inspection and

assessment by a suitably qualified geotechnical engineer, has resulted in a failure of the downslope batter which is providing structural support to the road asset.

It is important to note that the assessment of a slope failure by an experienced geotechnical engineer will not always be required. It is expected that appropriately qualified and experienced council staff can inspect the damaged area in the first instance and determine if expert geotechnical advice is warranted due to concerns over impact to the pre-disaster function of the road.

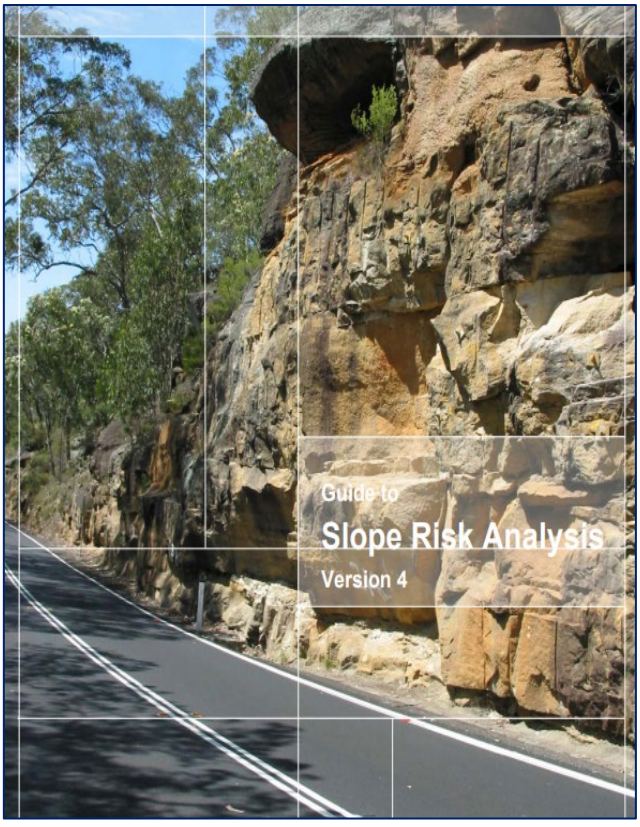
For damage to slopes that extend into private property, the damage must still be part of the essential slope asset up to a defined hinge point for upslopes and defined toe of downslope damage. Any natural disaster repair works in this scenario must have the agreement of the landowner for temporary and permanent works.

3.2 Adjustment of pre-disaster function to incorporate current engineering standards.

Where a decision has been made that functional restoration of slope failure is required and eligible, the EPARG references that a risk assessment can be undertaken for the slope and the appropriate geotechnical investigation is considered for identifying options for reconstruction. Geotechnical information and current engineering standards to be used to determine the most suitable cost-effective engineering option in restoring the slope.

The two documents below should be used by Transport for NSW and councils to guide their restoration.

Any exceptions to the guidelines, particularly regarding the factors of safety (as specified in Geotechnical Technical Direction GTD 2018/001) for restoration works adopted by councils need to be raised by the Natural Disaster Project Managers to the Senior Manager, Transport Technical Solutions for determination.



Transport – Roads and Maritime

Guide to Slope Risk Assessment Version 4

Transport – Roads and Maritime

Geotechnical Design for Remediation of Existing Slopes and Embankments

NSW GOVERNMENT

Technical Direction

Geotechnology

GTD 2018/001 | RMS 18.748 – 22 February 2018

Geotechnical Design for Remediation of Existing Slopes and Embankments

Summary:	Audience:
This technical direction specifies the minimum factor of safety in the design for remediation of existing soil slopes and fill embankments.	• Designers • Project Managers • Contract Managers

Background

For new infrastructure projects, typical Scope of Works and Technical Criteria (SWTC) requires slopes and batters to achieve an Assessed Risk Level (ARL) four or better. The ARL is assessed in accordance with the Roads and Maritime Services *Guide to Slope Risk Analysis* (Roads and Maritime, 2014). Furthermore, soil slopes and fill embankments shall be designed with a minimum long term Factor of Safety (FOS) of 1.5 and a minimum short term FOS of 1.2 to 1.3.

In contrast to new works, design for remediation of existing slopes and embankments only targets an ARL 3 or better in accordance with the *Slope Asset Management Policy PN 292*. This is less stringent than that of new works. If the design standard for new works is also adopted for remedial works, the associated repair costs could be unnecessarily high in many situations and might exceed the minimum ARL requirements. A rational approach is warranted to improve the cost effectiveness of slope remedial works in order to optimise network functionality and to be consistent with the strategy in slope management.

Approvals:

Owner:	Samuel Henwood Director Pavements & Geotechnical	**Review Date:**	No later than three years after effective date
Authorised by:	Chris Harrison Director of Engineering	**Effective Date:**	22 February 2018

GTD 2018/001 | RMS 18.748 – 22 February 2018 1
Version 1 UNCONTROLLED WHEN PRINTED

Based on the Essential Public Asset Function Framework (EPAFF), the asset types for the purposes of assessing slope failures have been split into upslope and downslope categories as the defined approaches are risk based and the risks associated with each category can differ.

The scope of repairs for any natural disaster impacted slopes that are rated at ARL4 or better need to be considered regarding the 'capacity' and 'asset layout and materials' when assessing treatment options to ensure a safe, cost-effective solution. This is explained in the following upslope and downslope sections with reference to examples.

3.3 Upslope failures

Upslope failures may produce minor landslips that simply need minor works to restore slope and road function. An example of this is given in Appendix B – Example 1 at Bumble Hill, where the slope is rated ARL 4 in terms of risk assessment. With a risk level of ARL4, no structural work would be warranted unless the material and structural integrity of the slope makes it unstable.

It is noted that the clearing of road drainage should be considered a critical activity, particularly when further inclement weather is forecast. Similarly, revegetation and restorative protective works should be carried out promptly to prevent further

progression of any failures, environmental damage, or the creation of new failures downslope due to erosion or uncontrolled water runoff.

Upslope failures may be so significant that they can create concern that the fundamental road function has changed resulting in partial or full closure of a road or limiting traffic due to the potential for further land slips. In these instances, the TfNSW Guide to Slope Risk Assessment should be used by the council to guide the necessary scope of slope restoration works.

It is important to note that upslopes need to be assessed in terms of risk and the proposed treatment of hazards within the slope and any underlying failures needs to be addressed to bring the Assessed Risk Level (ARL) of the slope to be the same ARL or one better than what existed pre-disaster.

An example of a significant upslope failure is shown in Appendix B – Example 2 Big Hill Slip on Kempsey to Armidale Road, where the rock slope is rated ARL 1 in terms of risk assessment. The slope was broken up into three geological areas for treatment with combination of rock anchors and mesh or matting.

3.4 Downslope failures

Embankments form part of the essential road asset and provide structural support for the road pavement. Downslope failures can undermine the structural integrity of the road formation depending on the extent of damage sustained during a natural disaster event.

Downslope failures may be minor slumping or topsoil scour that require no more than tidying and revegetation with some drainage considerations. For larger impacted downslope failures, appropriately skilled and experienced council or Transport staff consider that the slope failure has impacted the road function (eg loss of embankment asset or structural integrity) then a professional geotechnical assessment of the slope failure should be undertaken.

In circumstances where structural integrity of the batter has been compromised due to a downslope failure, councils are encouraged to have an experienced geotechnical engineer to provide options to reinstate the damaged asset embankment batter support for the roadway.

For restoration works undertaken on downslopes, the appropriate Factor of Safety (FoS) in accordance with TfNSW GTD2018/001 needs to be adopted for the works.

In assessing the downslope failures, appropriate treatments will need to be considered as well as the scope and length of the restoration works.

Some broad typical downslope restoration considerations based on the slope of the embankment include:

- Slope less than 40 degrees from horizonal (about 1 to 1 batter)
  Rebuilding of slope with rockfill or earthworks (reinforced or unreinforced) if suitable foundation available

- Slope steeper than 40 degrees
  Gravity retaining if suitable feasible foundation available, otherwise soil nails/rock anchors and /or in combination with mesh or shotcrete. An example of a downslope failure is shown in Appendix B – Example 3 Pee Dee Downslope Slip on Kempsey to Armidale Road, where the slope is rated ARL 1 in terms of risk assessment. The slope failure is very steep at 65 degrees and the toe of the downslope batter is around 130 metres down to the Macleay River. The solution to be adopted is for soil nails and shotcreting to recover existing road width of around 5 metres.
- Major movement of road with upslope and downslope failures
  In these situations, it is expected that piled walls will be the repair solution. An example of a downslope and upslope failures underlying the roadway is shown in Appendix B – Example 4 Naughton Gap Road slip where the slopes are rated as high risk (ARL 1).

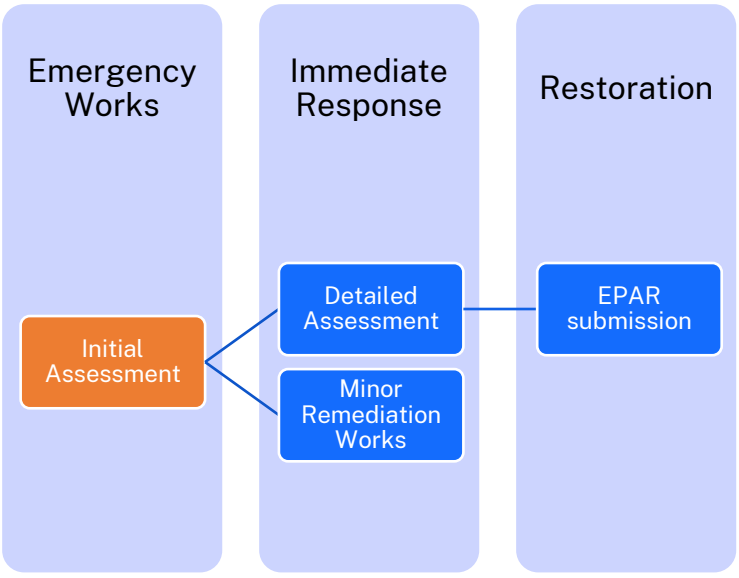
Each site needs to be considered individually based on a geotechnical advice and options to ensure a cost effective suitably engineered solution to address the failure.

For damage to riverbanks to be eligible, the bank needs to be providing downslope support for the public road asset.

Consideration can be given to minor road re-alignment if feasible and cost effective. Noting that this option can be more expensive if further requirement for soil nails and mesh to maintain the factor of safety of the upslope based on the Transport Technical Direction (TfNSW GTD2018/001). If any realignment is undertaken, also need to consider property boundaries and environmental approvals.

4.0 Slope Restoration in Practice

4.1 Initial Assessment – Emergency Response



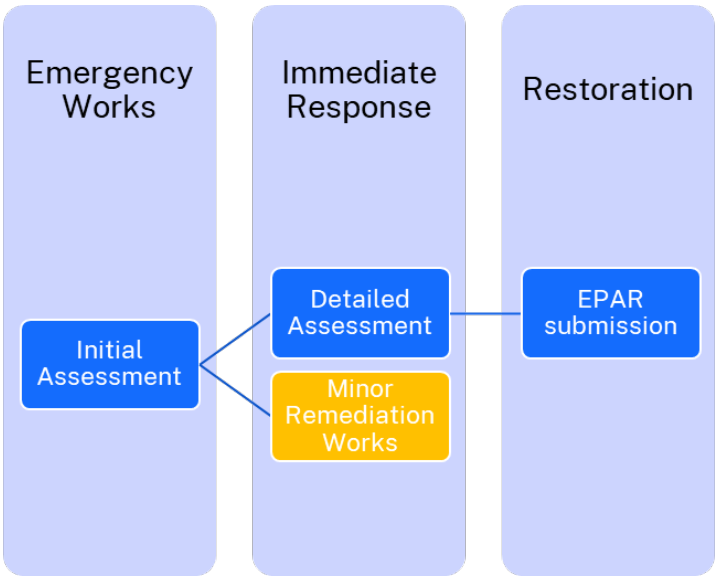
The initial assessment involves identifying those emergency actions that are required to:

- Make safe to a short-term standard.
- Restore access to primary place of residence (where possible).
- Determine if any further investigation or work is justified to restore the pre-disaster function of the essential public asset.

The initial assessment should be completed by a suitably skilled and experienced council staff and include:

- Detailed recording and photographic evidence of the assessment and findings.
- Assessment as to whether it is an essential public asset.
- Determination as to whether the damage can be rectified by minor restoration works.
- Determination as to any further geotechnical investigation or work that may be justified to restore the pre-disaster function of the essential public asset.

4.2 Minor Remediation Works – Immediate Response

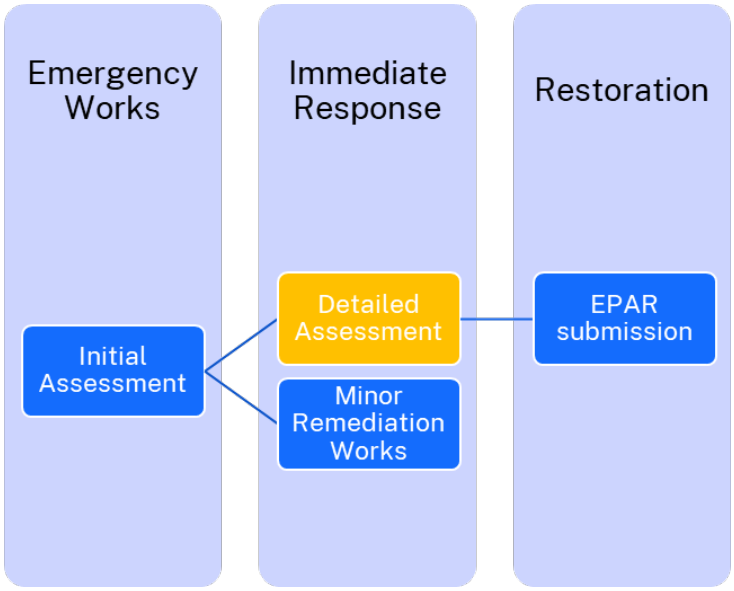


Minor remediation works are essentially non-structural repairs such as:

- Debris removal including scaling the slipped surface.
- Battering the scarp to remove undercut areas.
- Cleaning out table drains.
- Minor erosion or scour protection works.

These works can be time critical, particularly where further inclement weather is possible, as the drains and scour protection protect the asset from further damage during heavy rainfall events. It is noted that minor remediation works may still be required even where the decision has been made that more substantial investigations and/or restoration works need to be undertaken.

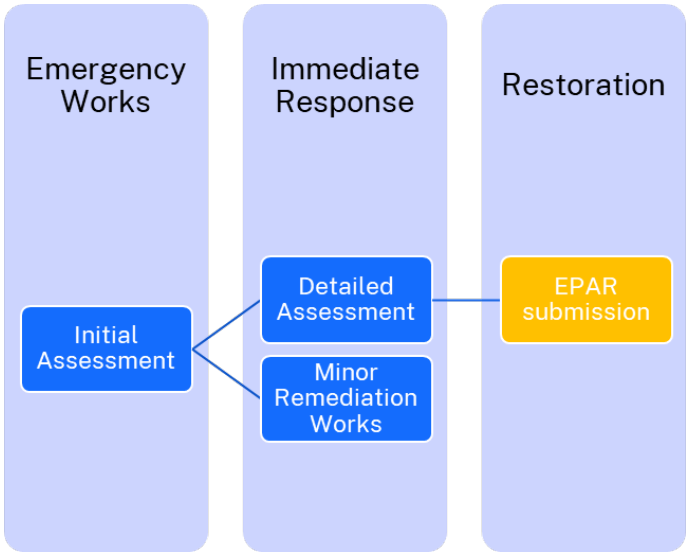
4.3 Detailed Assessment – Immediate Response



Detailed assessment is required where council has identified a more complex slope failure that does impact the pre-disaster function or asset structural integrity or asset geometry. Actions may include:

- Establish if major restoration works are required to restore the road function or asset structural integrity of the road embankments and batters.
- Establish if any downslope failure has impacted the road formation structural support function in accordance with section 3. This can be assessed by a geotechnical engineer or a suitably qualified engineer.
- Establish if the upslope has been damaged to the extent it requires intervention in accordance with the Guide to Slope Risk Assessment Version 4.
- Identify options for restoration and consult with the relevant TfNSW representative.

4.4 Preparation of EPARW Submissions



Once a slope has been shown to meet the requirements for funding.

1. Submit to TfNSW for Approval as an EPARW
2. Further Geotech investigation as required: that is, Boreholes, etc.
3. Options report (for major slope repairs)
4. Phase of Design (Strategic, Concept or Detail Design) and submit to TfNSW for comment.
5. Market Response
6. Submit to TfNSW for financial approval.
7. Construction

You must demonstrate that the proposed scope of work meets the Guidelines. As a minimum you must provide:

- Damage Evidence Photos
- Pre-Condition Evidence (ideally photos) or otherwise a Pre-condition certification by suitably qualified professional.
- For slopes, geotechnical report/ advice is also good to support pre-existing condition.
- Geotechnical information detailing the slope ARL, repair options and sketches to support repair claim.
- The proposed scope of work detailing the location, extent and expected repair method.
- Estimate of cost that is based on a P90 approach.
- Completed Form 306

5. Important Eligibility Considerations

Asset type	Scenario	Eligibility assessment
6. Embankment/ batters	A section of batter has slipped/eroded as a result of a flood event. This batter had some grass cover and natural vegetation on the slope prior to the *eligible disaster*. Geotechnical investigations is undertaken, investigating a range of treatment options and recommending an effective solution providing value for money. The engineering report demonstrates that soil nailing and a shotcrete protection to the batter is the only viable and cost-effective solution.	In circumstances where it is not possible to restore the *damaged essential public asset* to its pre-disaster capacity, layout or materials, the *pre-disaster function* and ultimately the *estimated reconstruction costs* may be adjusted to incorporate the most economically comparable alternative *reconstruction* option. In accordance with this provision, the cost of using soil nailing and shotcrete protection to stabilise the slop is eligible as it has been demonstrated to be the only viable and cost-effective solution.
7. Embankment/ batters	A mountain side washes out, depositing large amounts of debris and large rocks onto the road and beyond. A geotechnical assessment recommends the removal of loose rocks from the exposed face, placement of geotextile matting on the face and the installation of a rock catch fence to prevent future rock slides ending on the roadway.	Removal of debris, loose rocks and placement of matting is eligible for funding. The installation of a rock catch fence is considered to be complementary works and is ineligible for funding. If the council would like to install the fence, it would have to provide complementary funding to cover the additional cost.
8. Embankment/ batters	A local road is split level, with a steep embankment/cut between the two travel lanes for a length of about 100m. A 10m length of the batter slumps, washing away part of the higher roadway.	Only the treatment of the damaged section (10m) is eligible. If the council proposes constructing a retaining wall for the full 100m length it is considered to be complementary works and the treatment of the undamaged 90m is ineligible for funding. If the council would like to treat the undamaged 90m, it would have to provide complementary funding to cover the additional cost.
9. Embankment	A landslip undermines an off-road council carpark and deposits large amounts of debris onto a children's playground. The land on which the landslip occurs is not part of an *essential public asset*.	The cost of restoring the carpark is not eligible for funding because off-road carparks are not considered to be *essential public assets*. The cost of removing the debris from the playground, and restoration of damaged play equipment is not eligible for funding. This is because playgrounds and other recreational facilities are not considered to be *essential public assets*. The cost of restoring the landslip is not eligible for funding because the land is not part of an *essential public asset*.

Eligibility examples from the NSW EPAR Guidelines

It is vital that Transport and council satisfies the eligibility of the proposed works once information is known early stages of the EPARW based on the guidelines and sufficient supporting evidence. The Natural Disaster Program is subject to audits and ineligible expenses will not be funded.

Some examples of ineligible items are provided below.

5.1 Non-Council Assets

Not every asset on a road reserve is an Essential Public Asset.
Private retaining walls, fences and similar are not Essential Public Asset and are not eligible.
Specifically for the retaining wall shown, this was considered as ineligible and was not funded.
Refer example 9 from NSW EPAR Guidelines.

5.2 Slope Investigations

Council to provide Transport with information on slopes to be repaired before endorsement to proceed with geotechnical or design engagements.

Where the need for a detailed assessment has been appropriately determined, investigations should be completed in accordance with the recommendations in accordance with Transport Geotechnical Technical Direction GTD2018:001.

Transport may reject claims if the costs incurred are unreasonable or do not meet the guidelines.

Geotechnical assessment is not always warranted, and expensive investigations and assessments of minor batter slumping or weathering is not considered as representing value for money and may not be eligible under the EPAR Guidelines.

Assessment of failures that were present before the event are not eligible and may result in significant costs that will not be eligible for the Natural Disaster program.

Councils must follow the pre-condition evidence requirements detailed in the EPAR Guidelines.

5.3 Undercut Trees

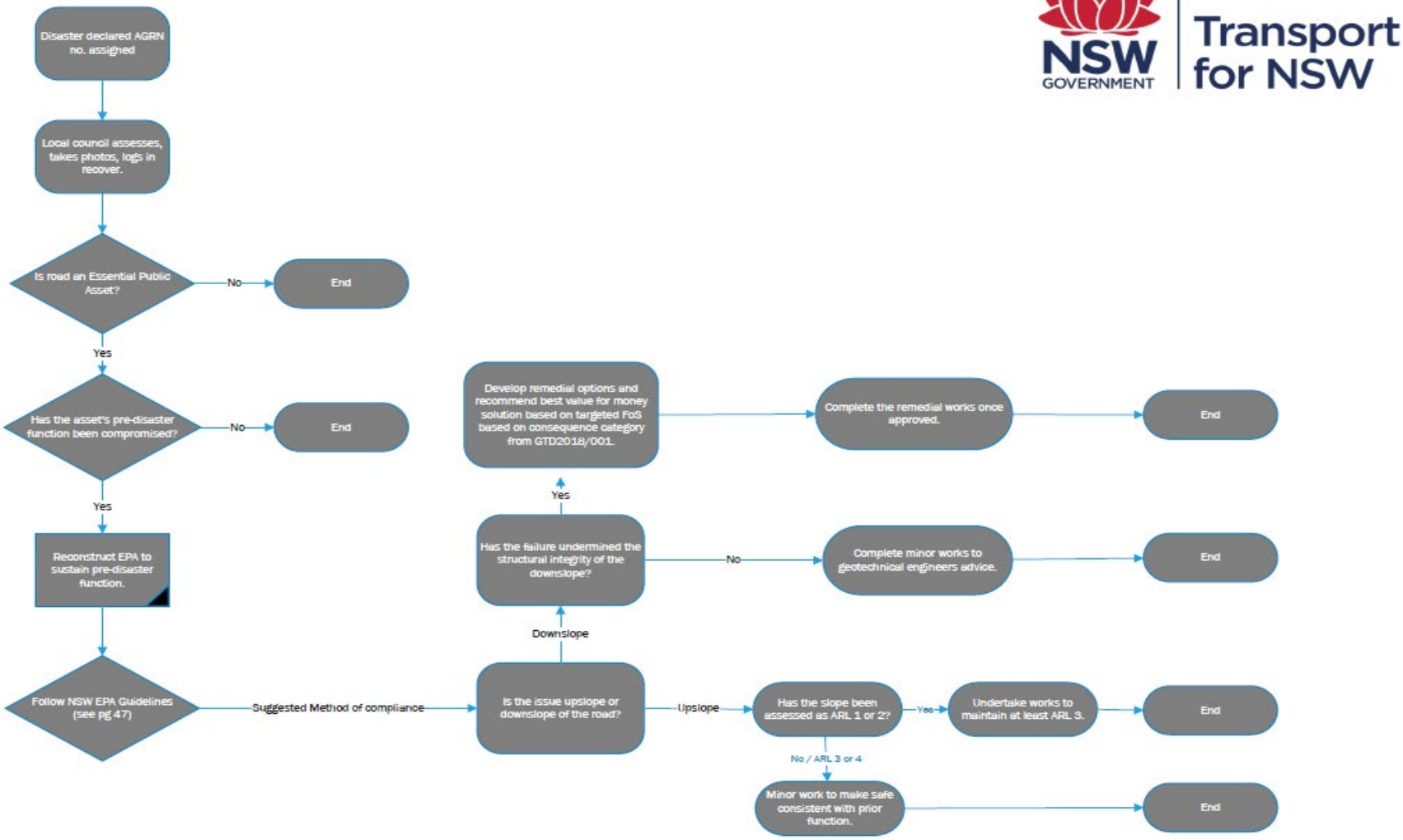
Trees on the batter need to have been affected by the event and subsequent undermining of the root system to be eligible. An arborist report is often more appropriate than a slope risk assessment for tree pruning or removal. This should also be accompanied by an engineer's assessment and an environmental review.

The report should consider the consequence of the tree falling on the asset function, eg:

- safety risk of tree falling
- what will impact the travel lanes.
- sight distance
- travel speed
- traffic volumes

Not all undercut trees are eligible for removal under the EPAR Guidelines.

Appendix A: Flowchart



Appendix B: Case Studies

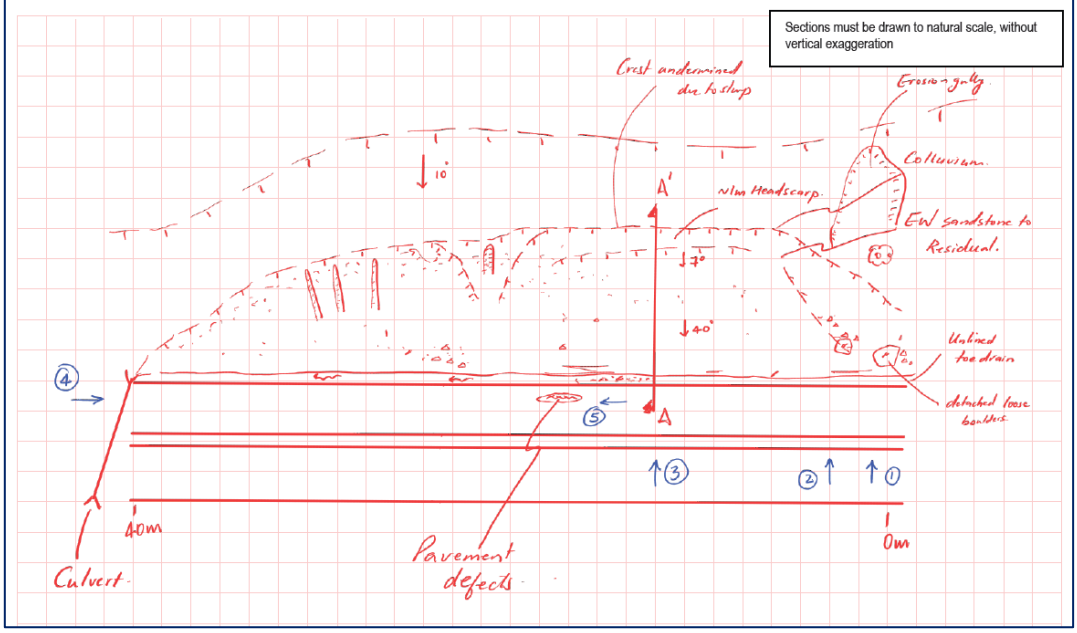
1. Bumble Hill – Central Coast

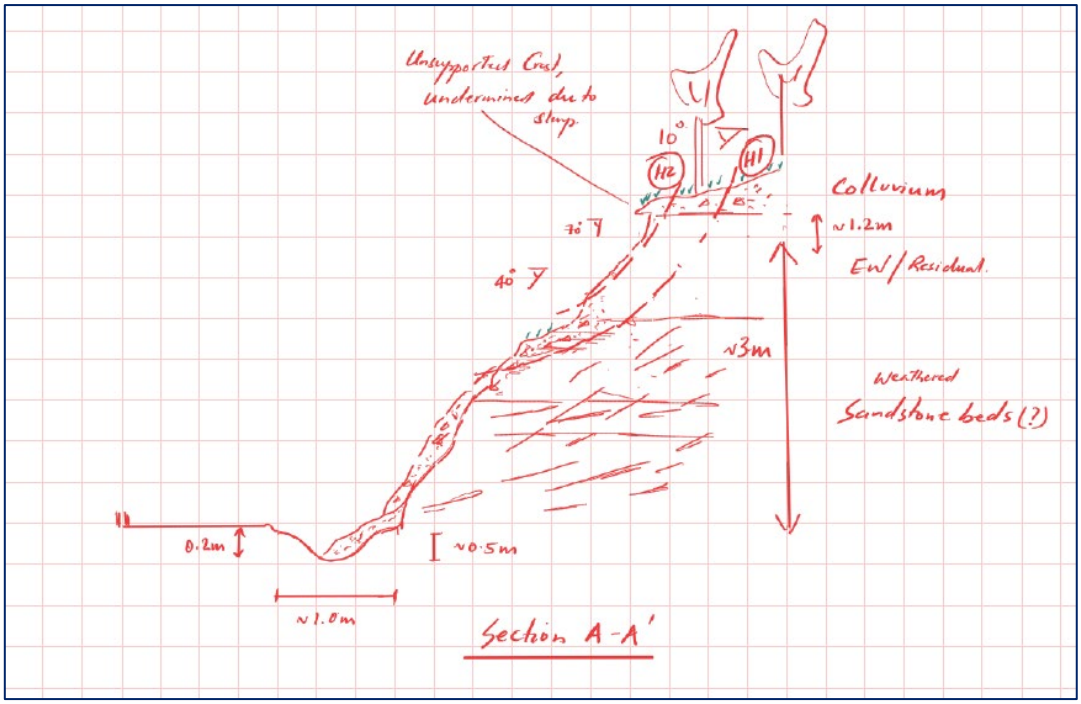
Site Details:

Traffic Volumes are 918 vehicles per day AADT (2019)

- Road connection between Yarramalong to Bumble Hill across the range
- Upslope assessed as ARL 4
- Slip material has been cleaned up.
- The proposed solution is soil nails and shotcrete – not warranted based on risk and geotechnical advice as upslope is ARL is 4 (low risk). Minor works are eligible as stated below.
- As the top of the batter is undermined by slip failure, suitable treatment would include the removal of the headscarp and associated trees to ensure safety for public.

C. SLOPE FEATURES, GEOLOGY & GEOMORPHOLOGY **Slope Identification No:** CH2500



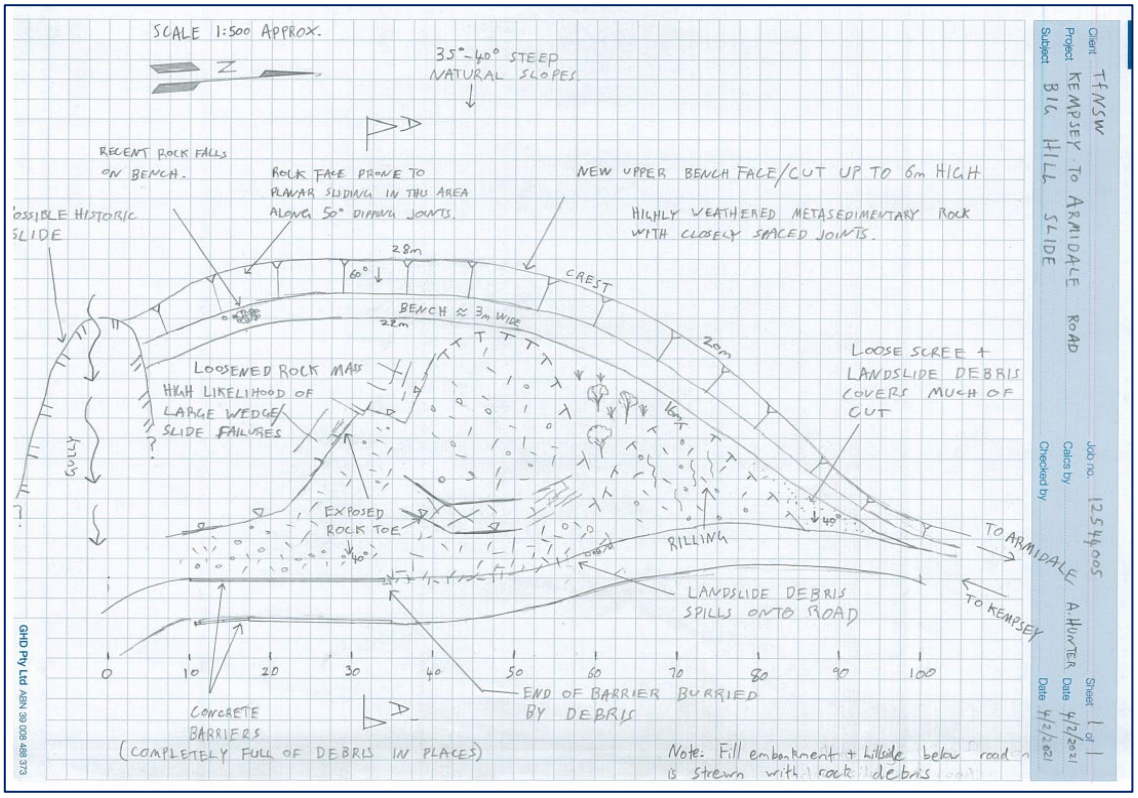


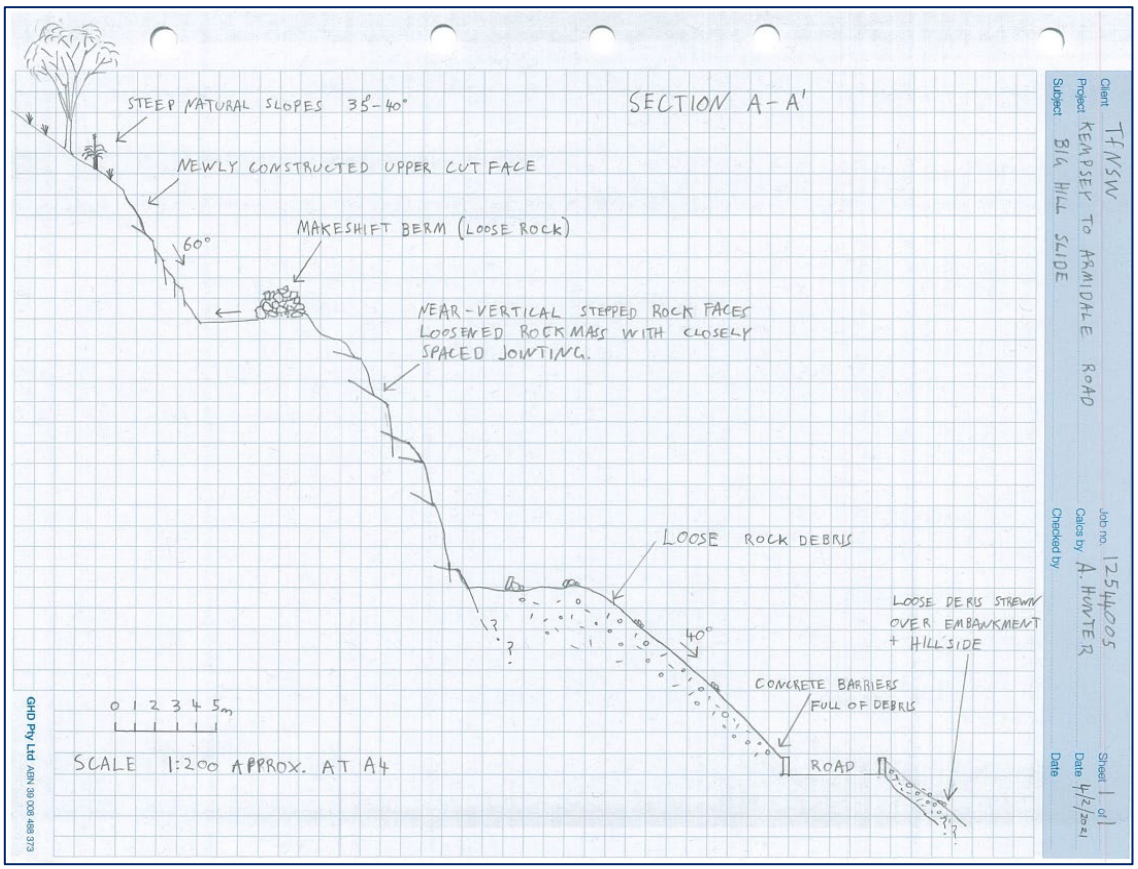
2. Big Hill Slip – Kempsey to Armidale Road

Site Details:

Traffic Volumes are around 50 vehicles per day

- Width of existing is about 5 metres.
- Road connection between Kempsey and Armidale
- Upslope assessed as ARL 1 and about 30 metres high.
- Slip containing debris and rock.
- The rock upslope is divided into 3 areas for treatment based on geological characteristics.
- Treatment includes a combination of rock anchors with mesh or matting.


SCALE 1:500 APPROX.
35°-40° STEEP NATURAL SLOPES
RECENT ROCK FALLS ON BENCH.
ROCK FACE PRONE TO PLANAR SLIDING IN THIS AREA ALONG 50° DIPPING JOINTS.
NEW UPPER BENCH FACE/CUT UP TO 6m HIGH
HIGHLY WEATHERED METASEDIMENTARY ROCK WITH CLOSELY SPACED JOINTS.
POSSIBLE HISTORIC SLIDE
28m
60°
CREST
BENCH ≈ 3m WIDE
22m
20m
16m
LOOSENED ROCK MASS
HIGH LIKELIHOOD OF LARGE WEDGE/SLIDE FAILURES
LOOSE SCREE + LANDSLIDE DEBRIS COVERS MUCH OF CUT
GULLY
EXPOSED ROCK TOE
40°
RILLING
TO ARMIDALE
TO KEMPSEY
LANDSLIDE DEBRIS SPILLS ONTO ROAD
0 10 20 30 40 50 60 70 80 90 100
END OF BARRIER BURRIED BY DEBRIS
CONCRETE BARRIERS (COMPLETELY FULL OF DEBRIS IN PLACES)
Note: Fill embankment + hillside below road is strewn with rock debris
Client TfNSW
Project KEMPSEY TO ARMIDALE ROAD
Subject BIG HILL SLIDE
Job no. 12544005
Calcs by A. HUNTER
Checked by
Date 4/2/2021
Sheet 1 of 1
GHD Pty Ltd ABN 39 008 488 373


SECTION A-A'
STEEP NATURAL SLOPES 35-40°
NEWLY CONSTRUCTED UPPER CUT FACE
MAKESHIFT BERM (LOOSE ROCK)
60°
NEAR-VERTICAL STEPPED ROCK FACES LOOSENED ROCK MASS WITH CLOSELY SPACED JOINTING.
LOOSE ROCK DEBRIS
LOOSE DEBRIS STREWN OVER EMBANKMENT + HILLSIDE
40°
CONCRETE BARRIERS FULL OF DEBRIS
ROAD
0 1 2 3 4 5m
SCALE 1:200 APPROX. AT A4
Client TfNSW
Project KEMPSEY TO ARMIDALE ROAD
Subject BIG HILL SLIDE
Job no. 12544005
Calcs by A. HUNTER
Checked by
Date 4/2/2021
Sheet 1 of 1
GHD Pty Ltd ABN 39 008 488 373

Big Hill Slip - Photo of rock bolts and mesh as well as bolts and matting (far right)

3. Downslope Slip – Pee Dee on Kempsey to Armidale Road

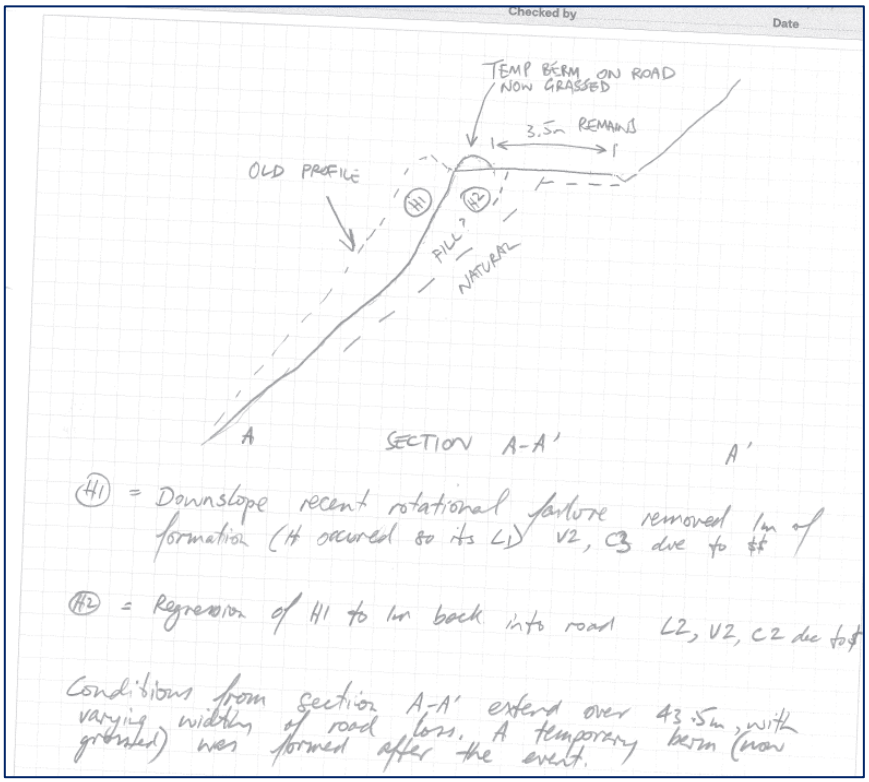
Site Details:

- Traffic Volumes are 50 to 100 AADT (estimated)
- Existing pre-disaster road width about 5 metres
- Downslope failure causing loss of structural integrity of batter resulting in reduction of road width.
- ARL risk rating of 1
- Steep terrain with no obvious foundation to build up from to recover missing downslope batter support.

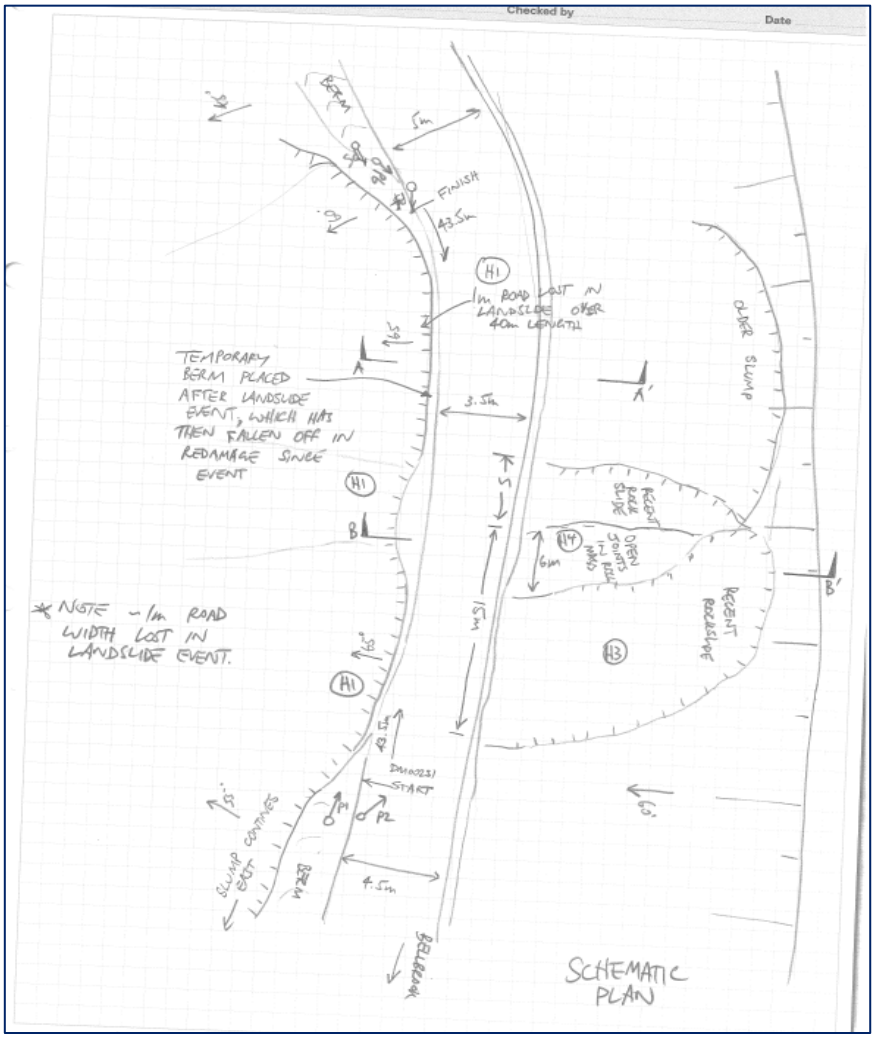
igure 4.1 DM00231 – Downslope failure extends >100m downslope

Photo of slip site

Geotechnical sketch of cross-section at slip site

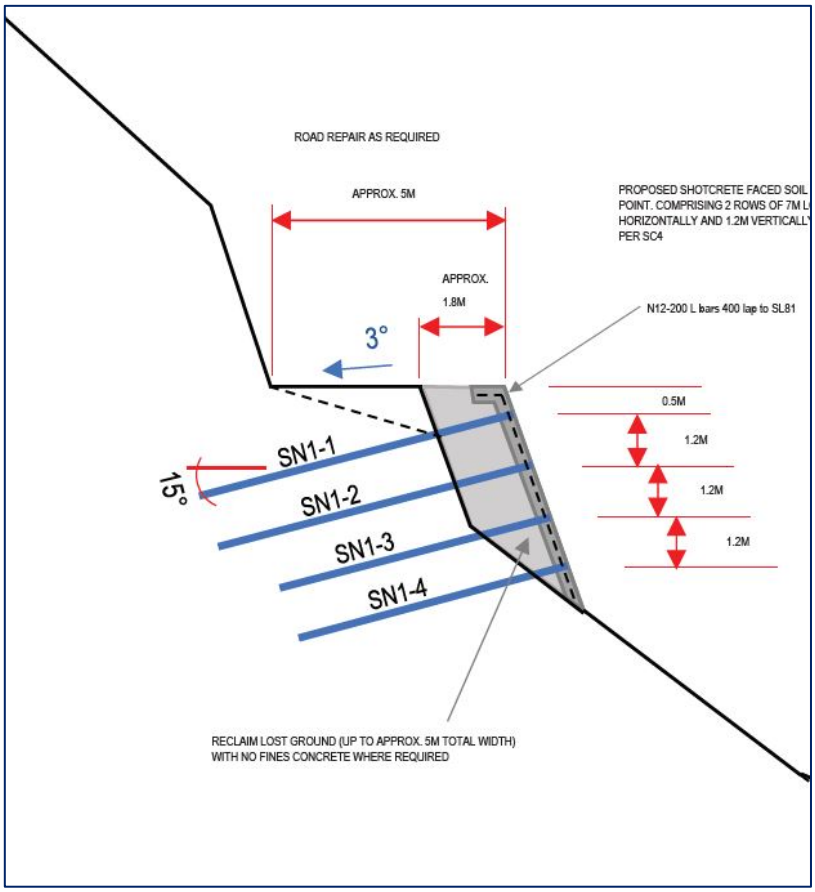


Geotechnical plan at slip site



Typical proposed solution of soil nails and shotcrete face

Typical design for steep slope repairs using soil nails and shotcrete



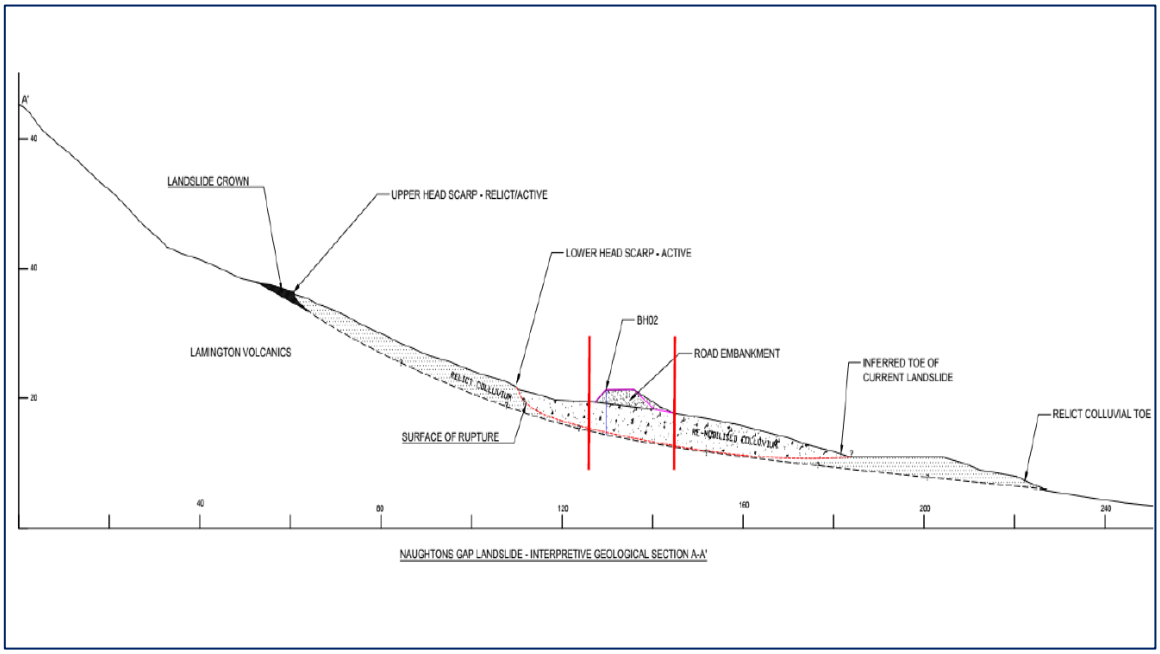
In this case, installation of guardrail is eligible as the repair work has provided a steeper vertical slope.

4. Downslope and upslope slips – Naughtons Gap Road

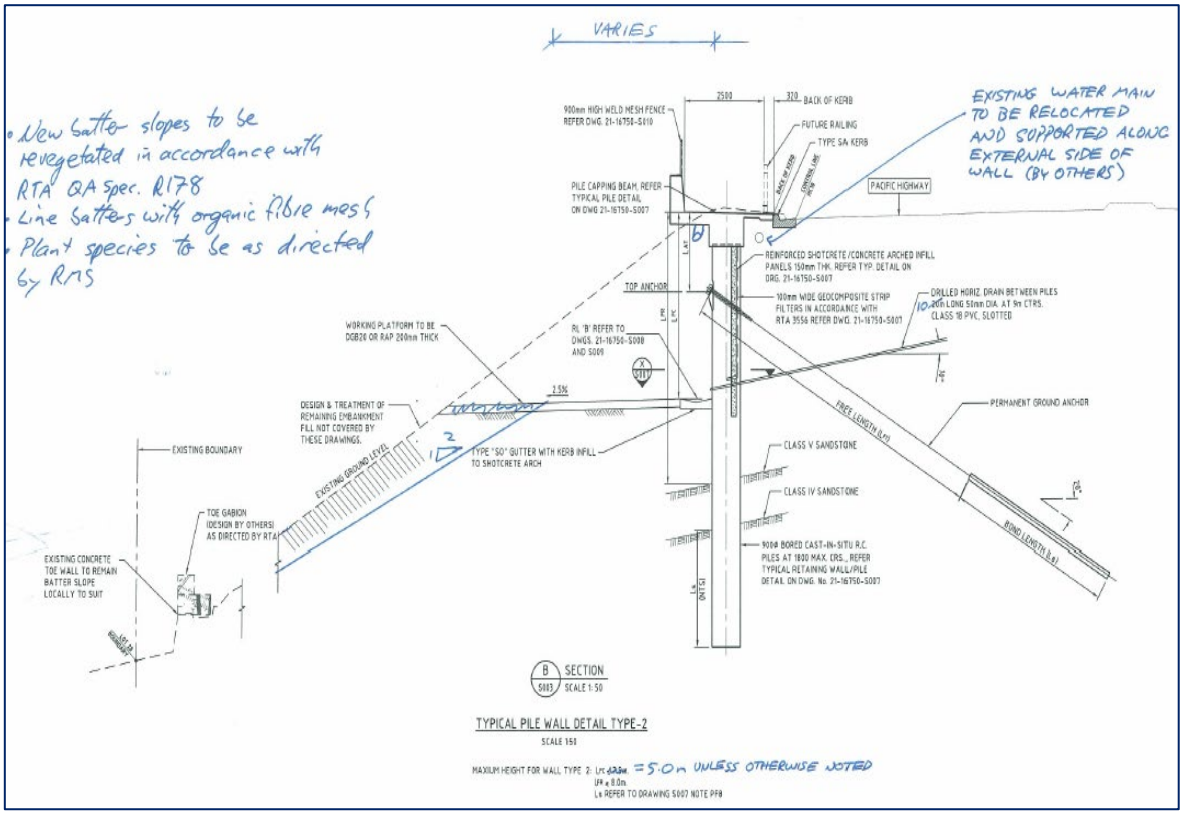
Site Details:

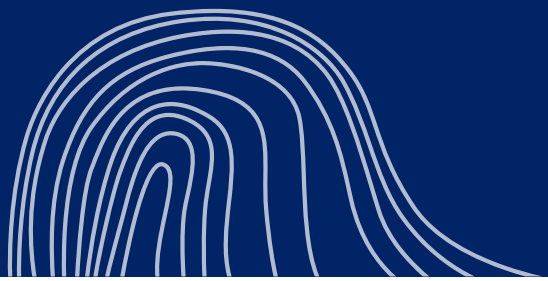
- Traffic Volumes are 1,500 vehicles per day AADT (estimated)
- Existing pre-disaster road width – two lanes total 7-8 metres
- Upslope and Downslope failures as well as translational movement of significant slip circle including road formation.
- Estimated ARL risk rating of 1
- Significant road damage from movement of slip circle under road.

Cross-section of Naughtons Gap Road showing slip circles



Typical piled solution – Pacific Highway Newcastle


VARIES
• New batter slopes to be revegetated in accordance with RTA QA Spec. R178
• Line batters with organic fibre mesh
• Plant species to be as directed by RMS
EXISTING WATER MAIN TO BE RELOCATED AND SUPPORTED ALONG EXTERNAL SIDE OF WALL (BY OTHERS)
900mm HIGH WELD MESH FENCE REFER DWG. 21-16750-S010
2500
370
BACK OF KERB
FUTURE RAILING
TYPE SA KERB
PILE CAPPING BEAM, REFER TYPICAL PILE DETAIL ON DWG 21-16750-S007
PACIFIC HIGHWAY
REINFORCED SHOTCRETE /CONCRETE ARCHED INFILL PANELS 150mm THK. REFER TYP. DETAIL ON DRG. 21-16750-S007
TOP ANCHOR
900mm WIDE GEOCOMPOSITE STRIP FILTERS IN ACCORDANCE WITH RTA 3556 REFER DWG. 21-16750-S007
DRILLED HORIZ. DRAIN BET WEEN PILES 10m LONG 50mm DIA. AT 9m CTRS. CLASS 18 PVC, SLOTTED
WORKING PLATFORM TO BE DGB20 OR RAP 200mm THICK
RL 'B' REFER TO DWGS. 21-16750-S008 AND S009
2.5%
DESIGN & TREATMENT OF REMAINING EMBANKMENT FILL NOT COVERED BY THESE DRAWINGS.
EXISTING BOUNDARY
EXISTING GROUND LEVEL
TYPE 'SO' GUTTER WITH KERB INFILL TO SHOTCRETE ARCH
PERMANENT GROUND ANCHOR
CLASS V SANDSTONE
CLASS IV SANDSTONE
FREE LENGTH (L.F.)
BOND LENGTH (L.B.)
TOE GABION (DESIGN BY OTHERS) AS DIRECTED BY RTA
EXISTING CONCRETE TOE WALL TO REMAIN BATTER SLOPE LOCALLY TO SUIT
900ø BORED CAST-IN-SITU R.C. PILES AT 1800 MAX. CRS., REFER TYPICAL RETAINING WALL/PILE DETAIL ON DWG. No. 21-16750-S007
B
5003
SECTION
SCALE 1:50
TYPICAL PILE WALL DETAIL TYPE-2
SCALE 1:50
MAXIMUM HEIGHT FOR WALL TYPE 2: LH 4.33m = 5.0m UNLESS OTHERWISE NOTED
LP = 8.0m
L= REFER TO DRAWING S007 NOTE PP8



NSW GOVERNMENT