

Using micropiles for long-term stabilisation of slopes

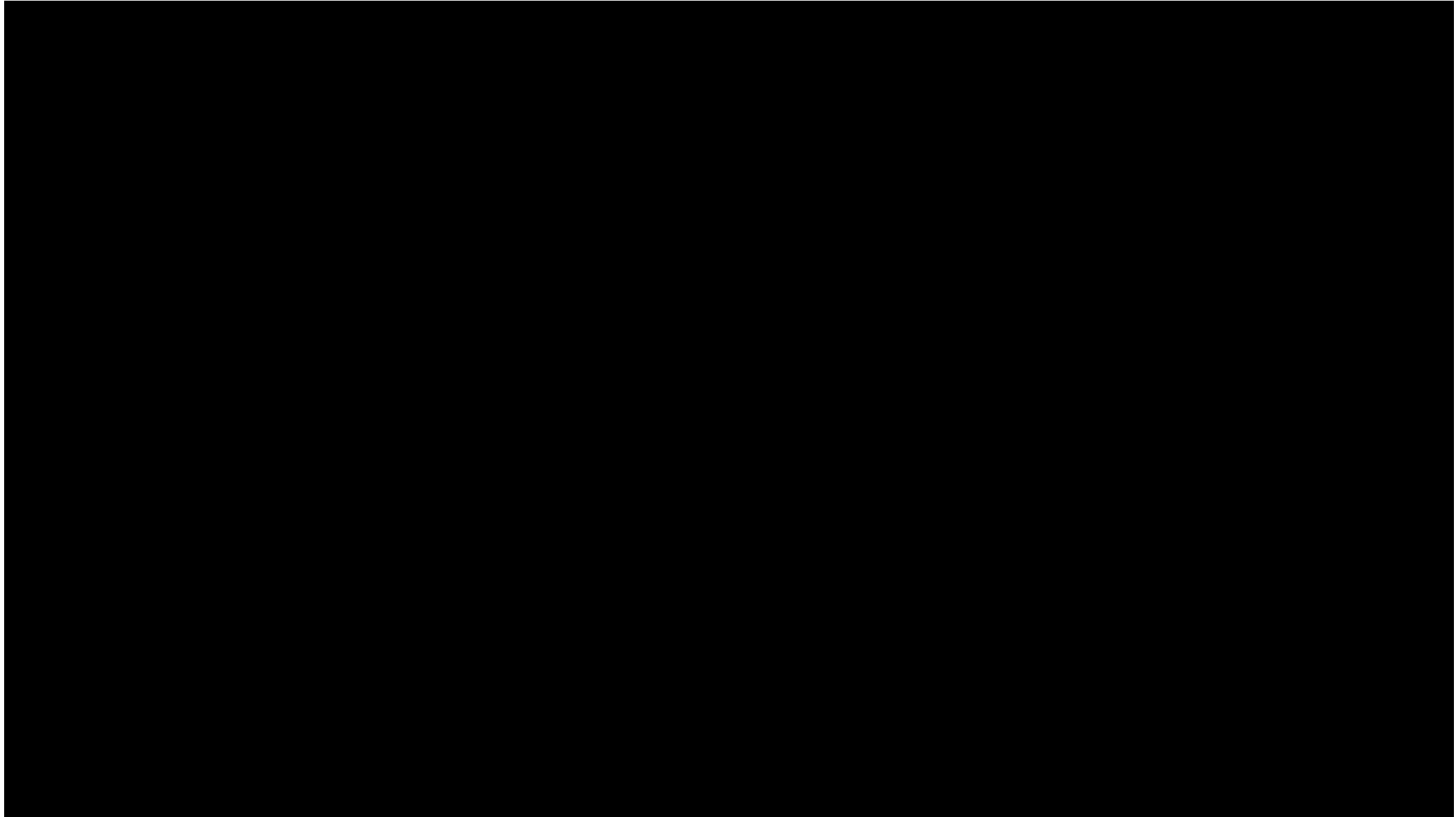
A Queensland Department of Transport and Main Roads Perspective

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About us





Queensland Government's objectives for the community

Agenda

1. Project overview
2. The problem
3. Approaches:
 - 'Ready to Use Tool Kit'
 - Alternative approach – Gatton-Clifton and Kin Kin Roads
4. Conclusions

Overview

- Multiple declared natural disasters between January 2010 and March 2013.
 - Multiple cyclones (Olga, Neville, Ului, Paul, YASI, tropical storms, low pressure systems and monsoon rains.
- 8,741km of state-controlled road network damaged.
- 3,100km of the rail network closed.
- Seven ports (two closed completely) and more than 50 navigation aids impacted.
- More than 27,000km of state-controlled road network closed or limited access.
 - 30m long section of the Gatton – Clifton Road located between chainages 203.1 to 203.4km.
 - 40m long section of the Kin Kin Road located between chainages 35.93 to 35.97km.
- Ex Tropical Cyclone Oswald – 2015.

Overview

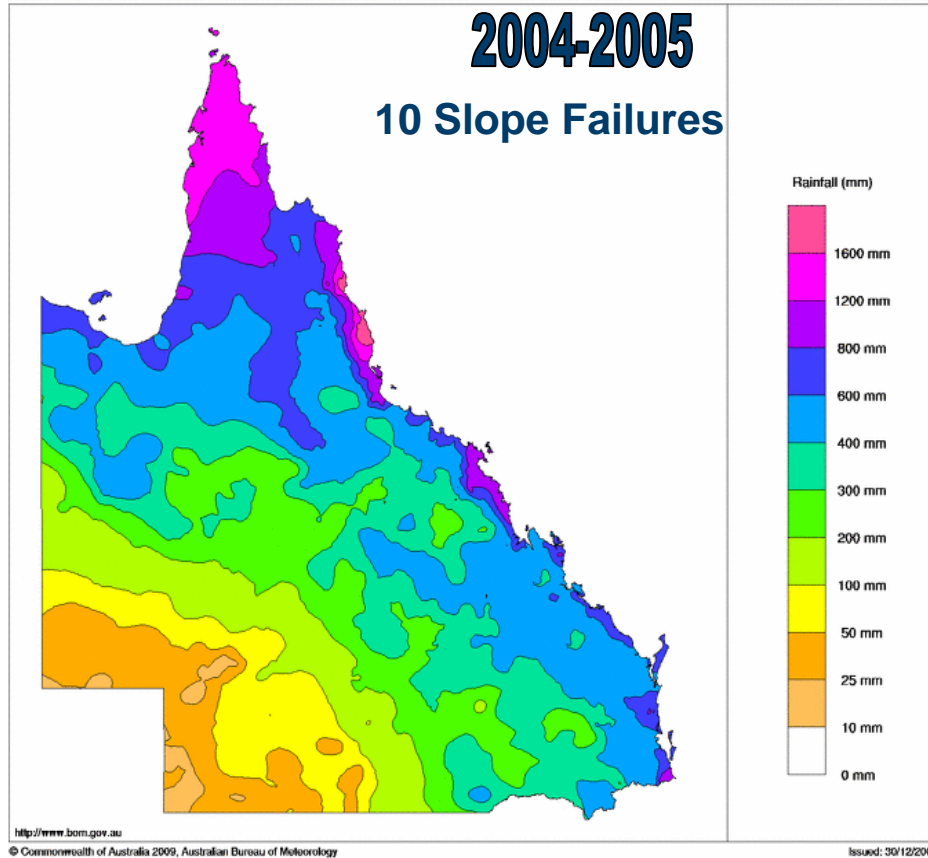
- About \$6b through Transport Network Reconstruction Program (TNRP) under the Australian Government Natural Disaster Recovery and Relief Arrangement (NDRRA).
- Ex Tropical Cyclone Debbie – 2017.
- ? (Are we done).



Extent of road reconstruction – Hinds (2015)

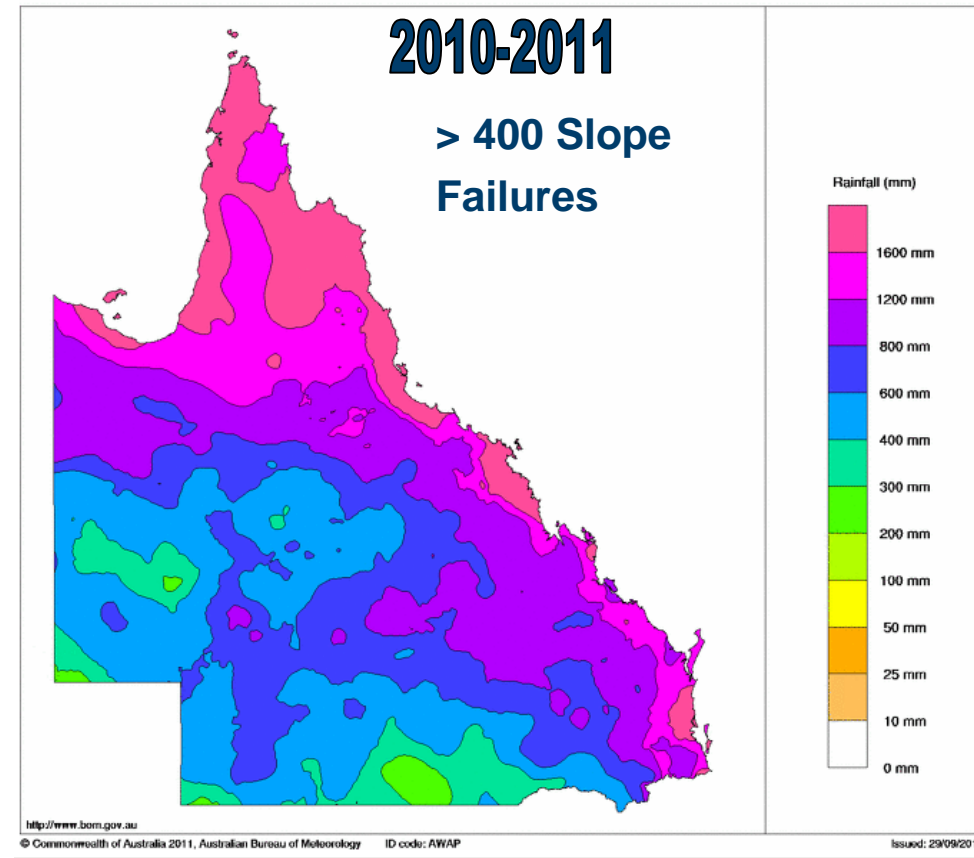
The problem – Extreme rainfall and instability

Queensland Rainfall Totals (mm) 1 October 2004 to 31 March 2005
Product of the National Climate Centre



Minimum rainfall total = 10mm

Queensland Rainfall Totals (mm) 1 October 2010 to 31 March 2011
Product of the National Climate Centre



Minimum rainfall total = 100mm



Kilcoy – Beerwah Road
Heavy rainfall – December 2008



Cunningham Highway
Rainfall/floods – ex Tropical Cyclone Yasi – Dec 2010/Jan 2011



Goodwood Road Bundaberg

Rainfall/floods – ex Tropical Cyclone Yasi – Dec 2010/Jan 2011



Springbrook Road – Gold Coast Hinterland, District

5 April 2009. Photo Source: Gold Coast Bulletin 6 April 2009



Geoff Fisher Bridge, Lockyer Valley, near Brisbane

Ex Tropical Cyclone Yasi – December 2010/January 2011





**Lockyer Creek,
Gatton-Esk Road**

Ex Tropical Cyclone Yasi
December 2010/January 2011



**Neerkol Creek,
near Rockhampton**

Ex Tropical Cyclone Oswald
January 2013



**Double Creek,
near Rockhampton**

Ex Tropical Cyclone Oswald
January 2013



Mt. Morgan – Burnett Highway
Ex Tropical Cyclone Oswald – January 2013



Sarina Range

Ex Tropical Cyclone Debbie – March 2017

Using micropiles | 24 August 2019

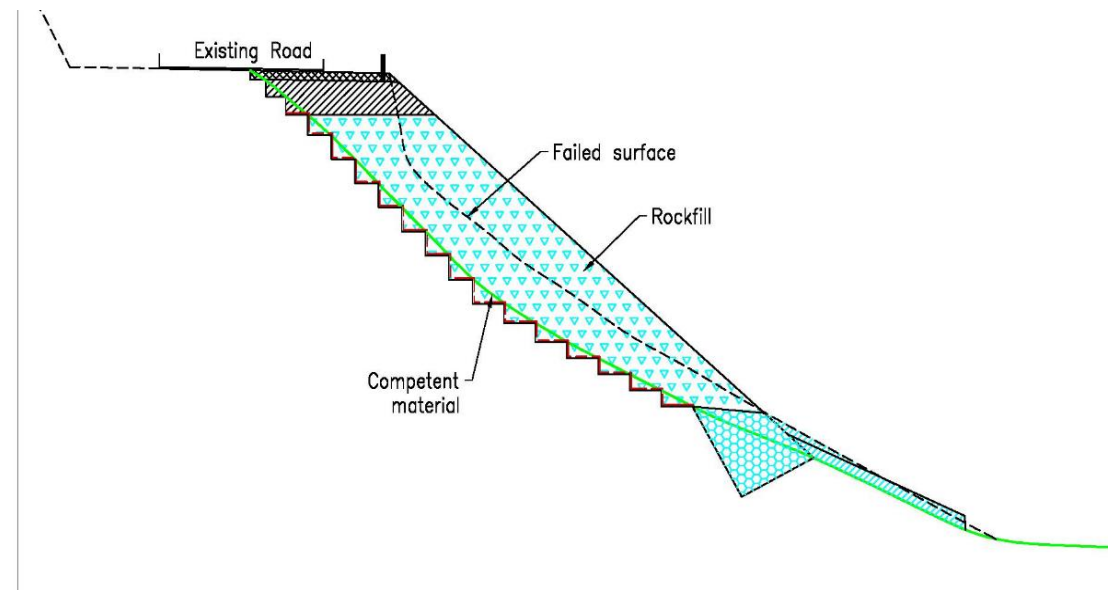


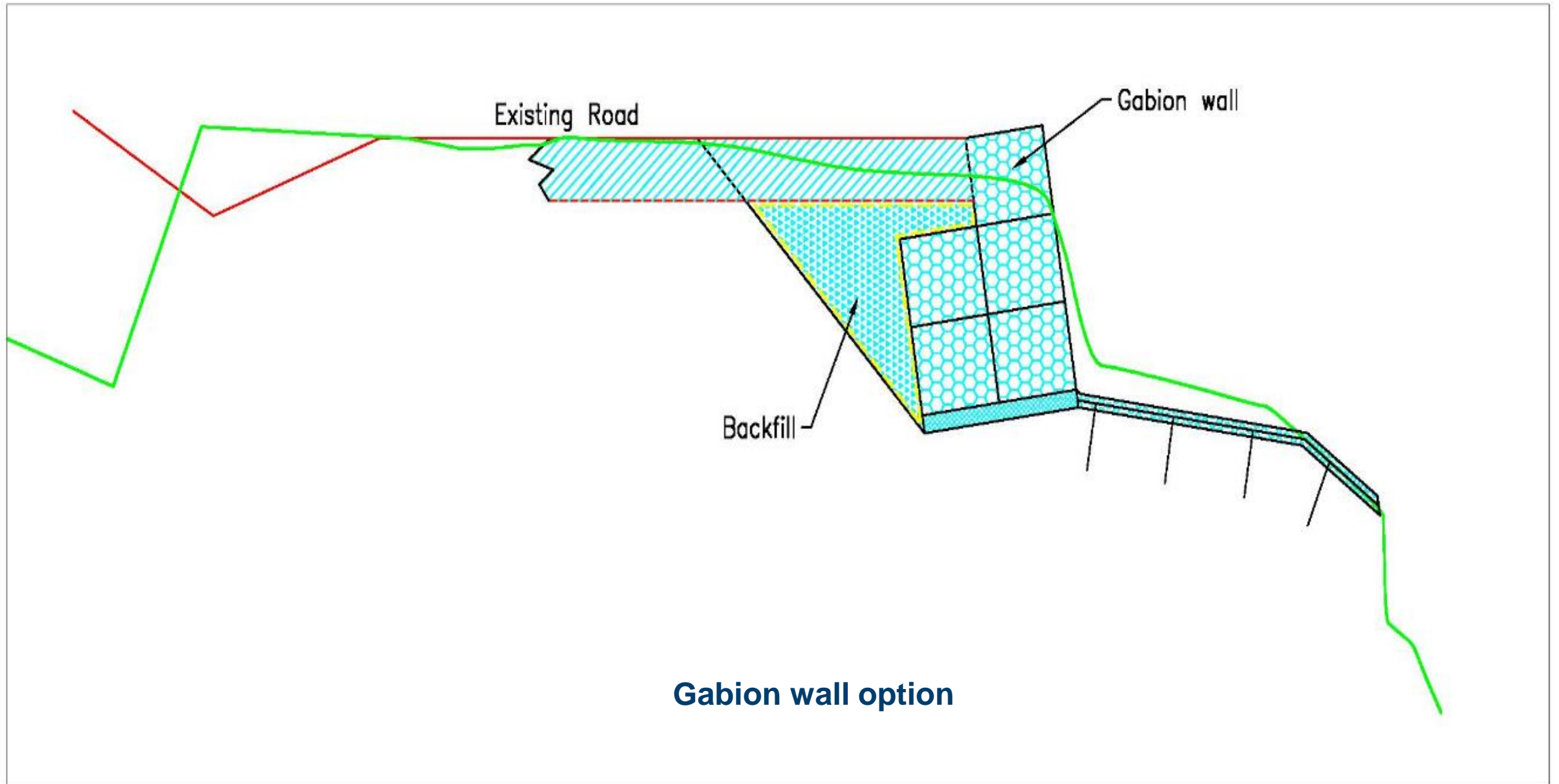
Hinchinbrook Passage, North Queensland

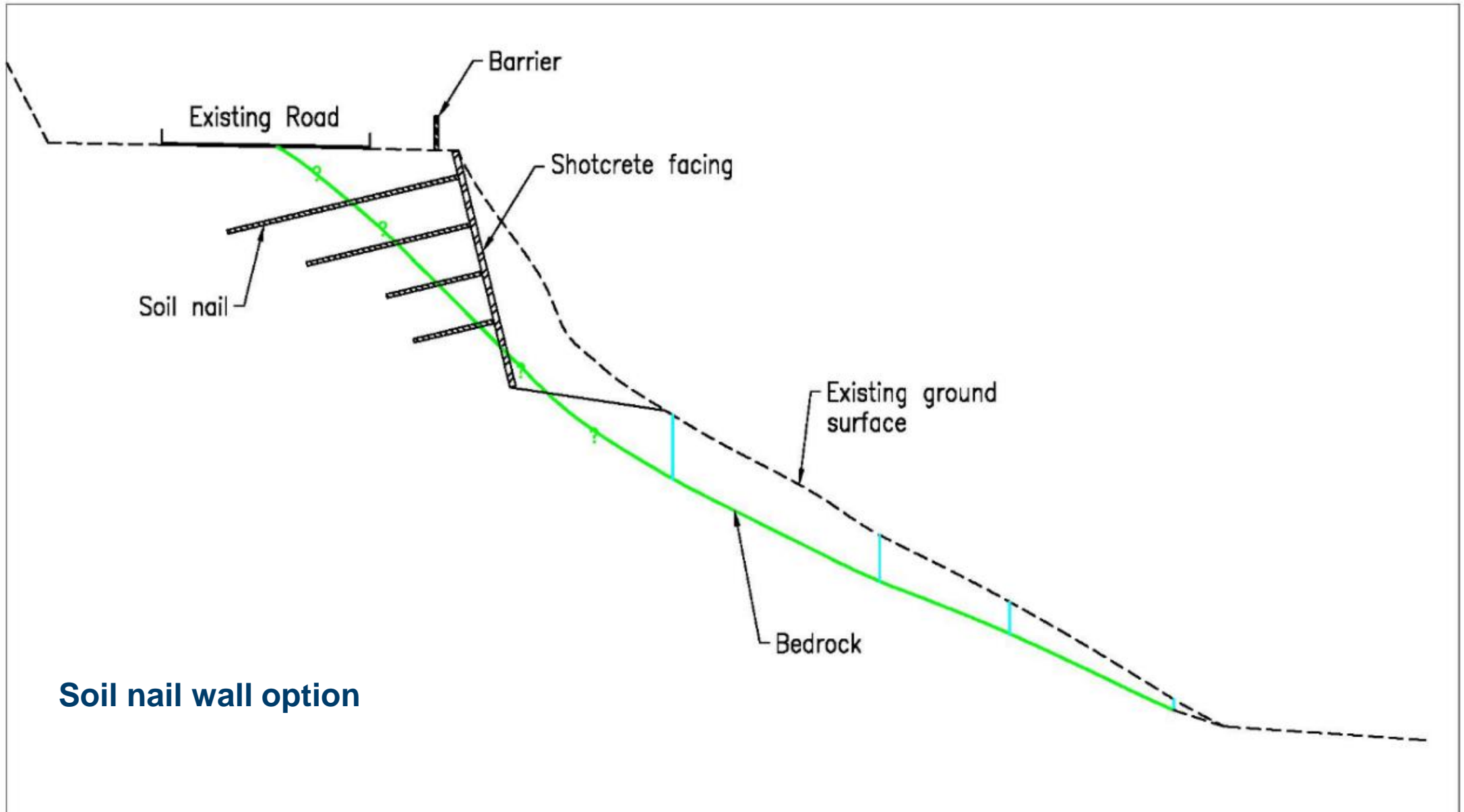
Ex Tropical Cyclone Yasi – December 2010/January 2011

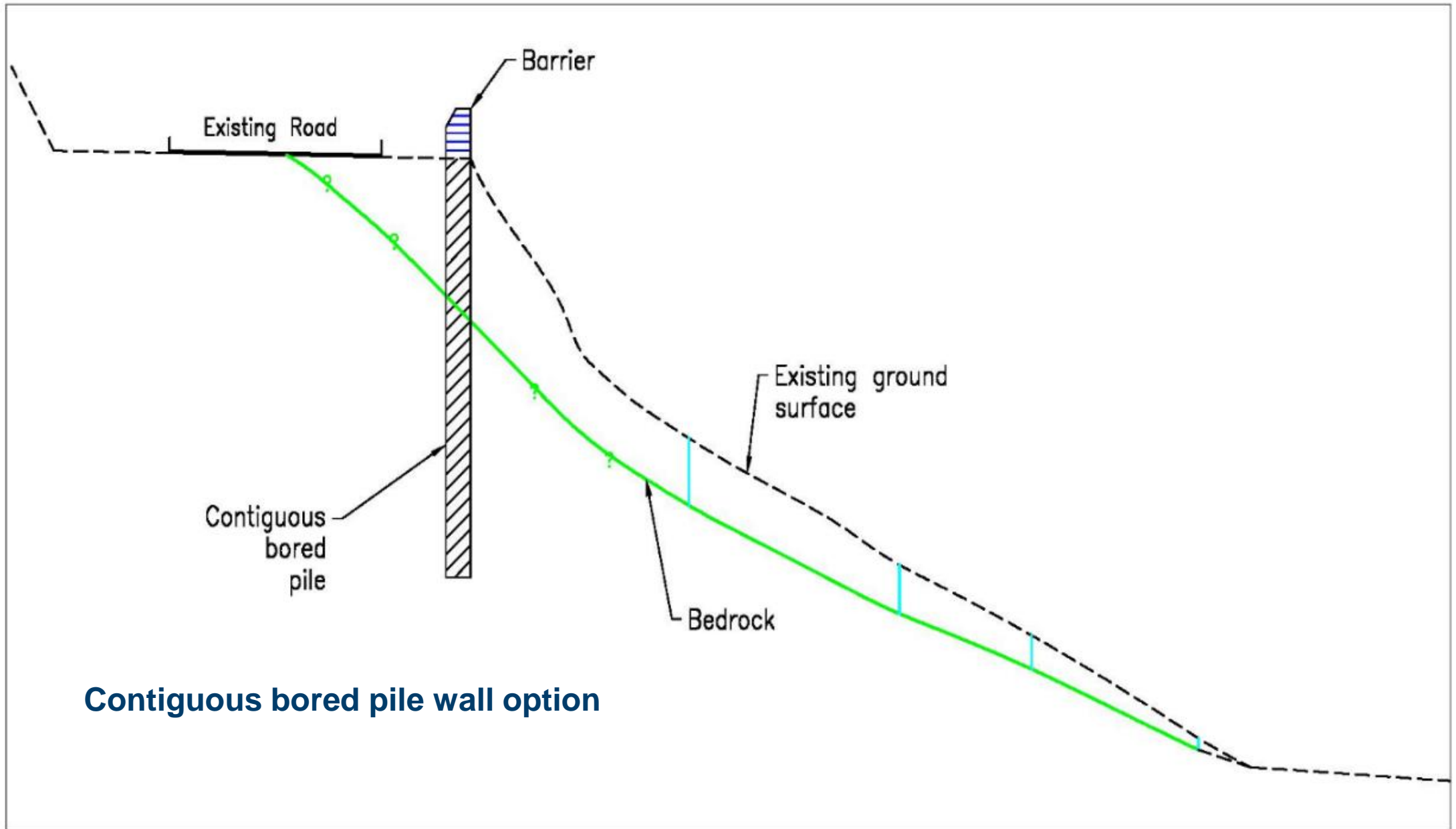
Approaches – ‘Ready to use tool kit’

- Department of Transport and Main Roads (TMR) has standard remedial measures ready to be used, including:
 - flattening or re-grading the slope by modifying the ground surface geometry
 - installing surface and subsurface drainage
 - retention using different types of walls.

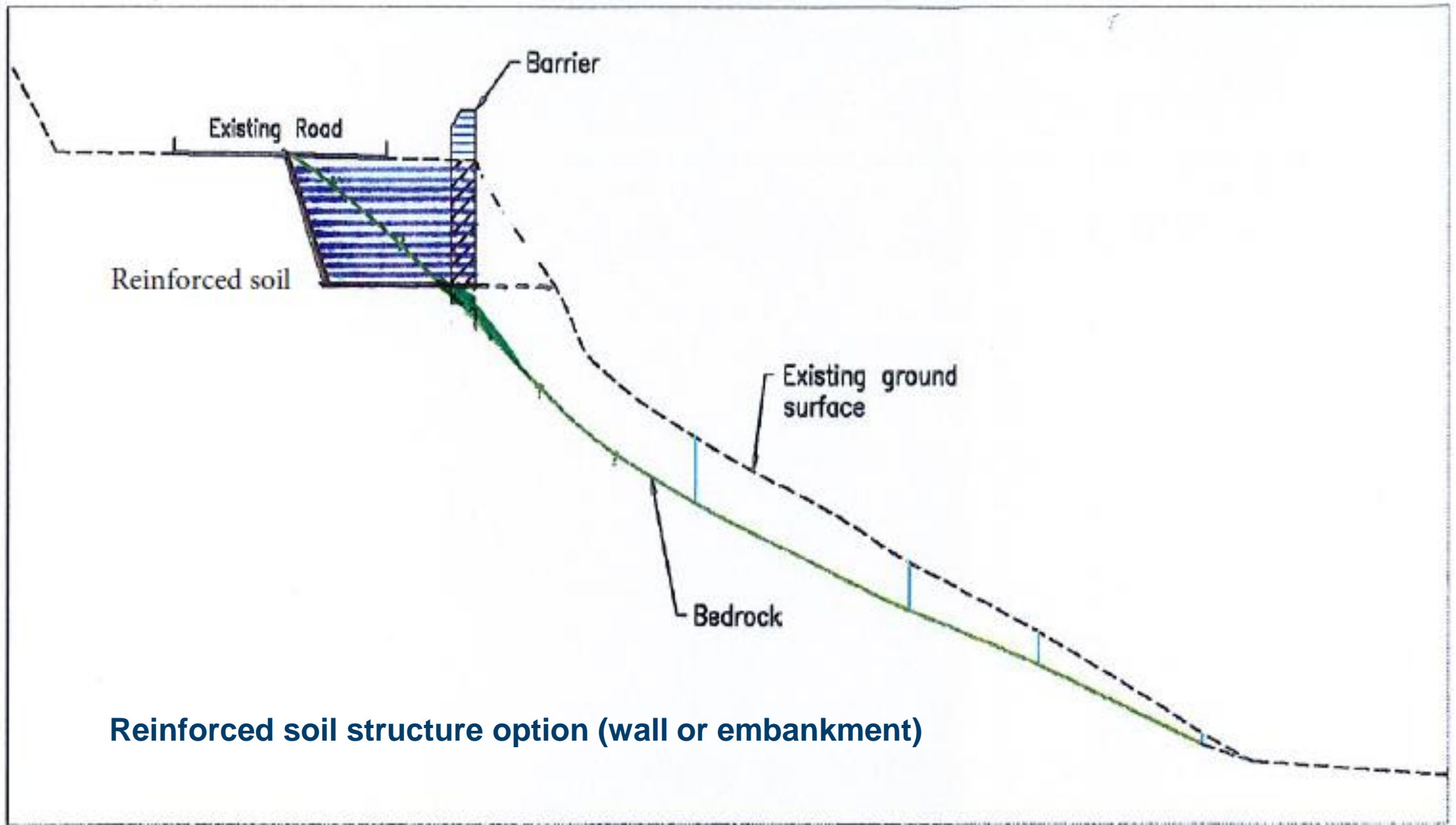








Contiguous bored pile wall option



Reinforced soil structure option (wall or embankment)

Alternative Approach – Gatton-Cliffton Road

- Affected section located just outside the township of Gatton close to Ma Ma Creek.
- 30m effected between chainage 203.1 and 203.4km.
- Available road width is less than 6.1m, rural, narrow and winding.
- The geometry consists of up-slope cuttings and down-slope sidelong embankment fills.
- The down-slope batter continues into a ravine meeting Ma Ma Creek.



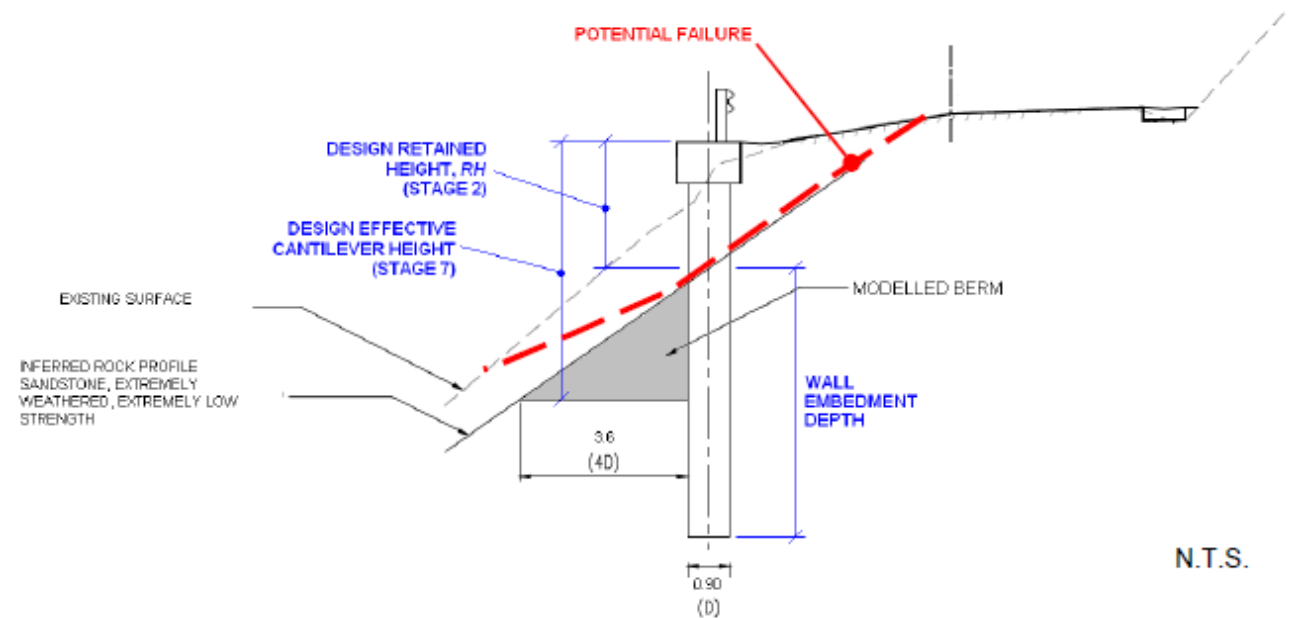
Alternative Approach – Kin Kin Road

- About 1.3km south of Kin Kin town centre.
- 40m effected between chainage 35.93 to 35.97km.
- Average Annual Daily Traffic = 2921 vehicles per day.
- Two lane undivided rural road with a 6m width.
- The road consists of up-slope cuttings and down-slope sidelong embankment fills.
- The down-slope batter continues in to Kin Kin Creek.



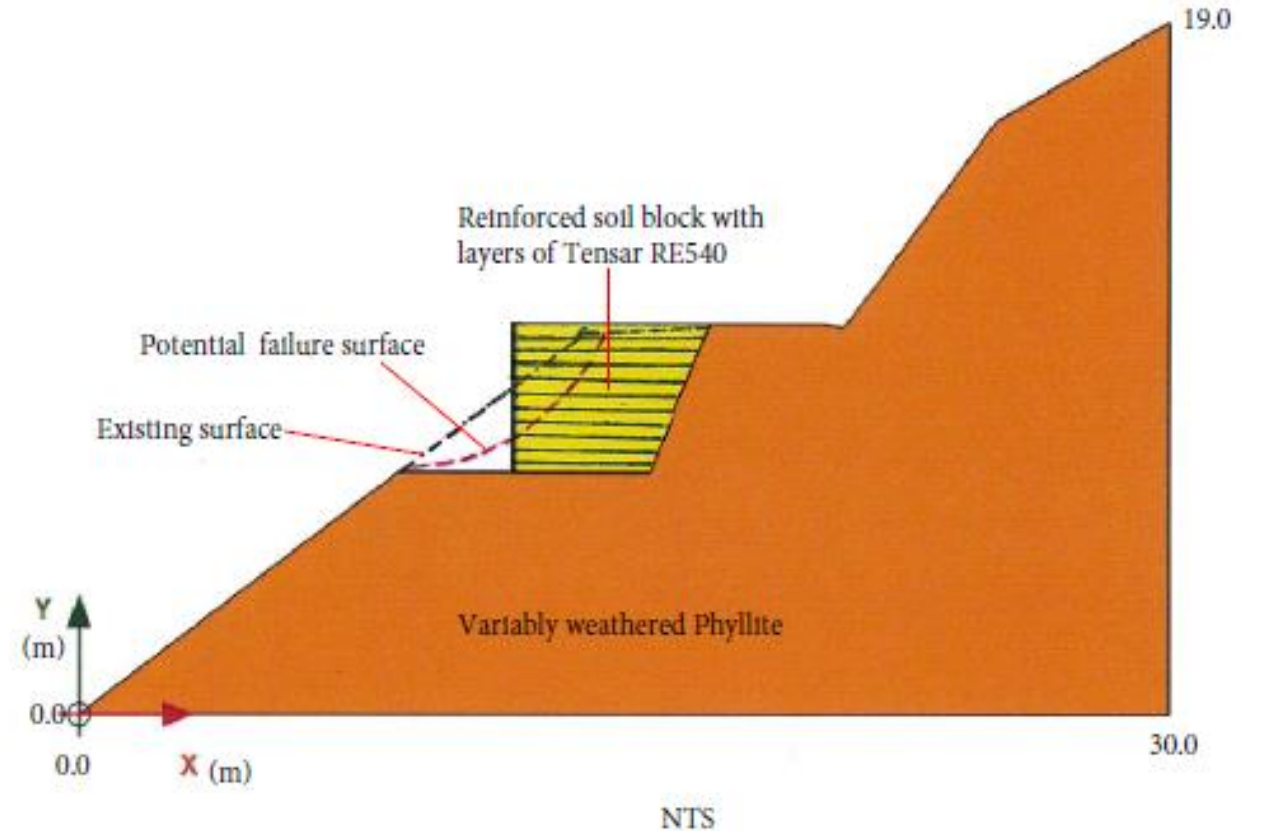
Alternative approach - Micropile

- Reference design at Gatton-Clifton Road:
 - contiguous pile wall.



Alternative approach - Micropile

- Reference design at Kin Kin Road:
 - reinforced soil structure.



Alternative approach - Micropile

The Micropile option was driven by:

- tight geometrical constraints.
- available road width (generally less than 6.1m).
- the steep down-slope batter profiles – inaccessibility of the toe of the failed batter.
- it provides construction access to the site.
- it maintains single lane traffic flow during construction.

Alternative approach - Micropile

Potential issues:

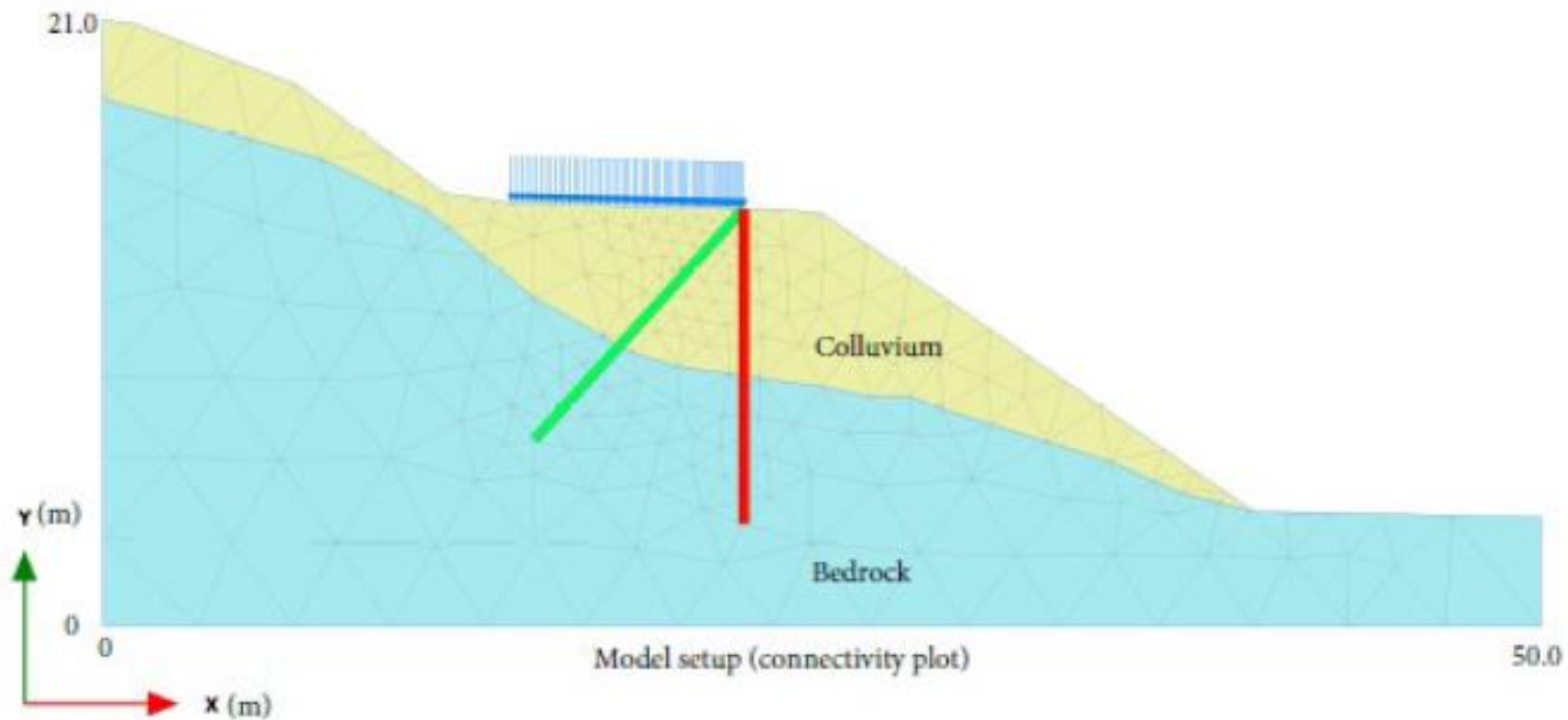
- Small axial and bending stiffnesses compared to their large diameter counterparts:
 - resiliency if soils are lost on passive side of the piles.
- Clause 2.2 of TMR Geotechnical Design Standard (GDS) – Not yet known if it can be satisfied.
- Long-term performance/durability not yet known.
- No pre-existing design method in TMR.

Alternative approach – Micropile trial

- Trial approved for the Gatton – Clifton and Kin Kin Roads.
- Full monitoring - gaining confidence in its use.
- Design:
 - to be carried out by a Geotechnical Design Consultant with a Level 3 experience.
 - Federal Highway Authority (FHWA) compliant - 12 steps in Micropile Design and Construction manual NHI-05-039 (FHWA, 2005).
 - must also address the two additional steps:
 - check for deflection levels
 - check for other forces that could be imposed on the Micropiles.

Alternative approach – Micropile trial

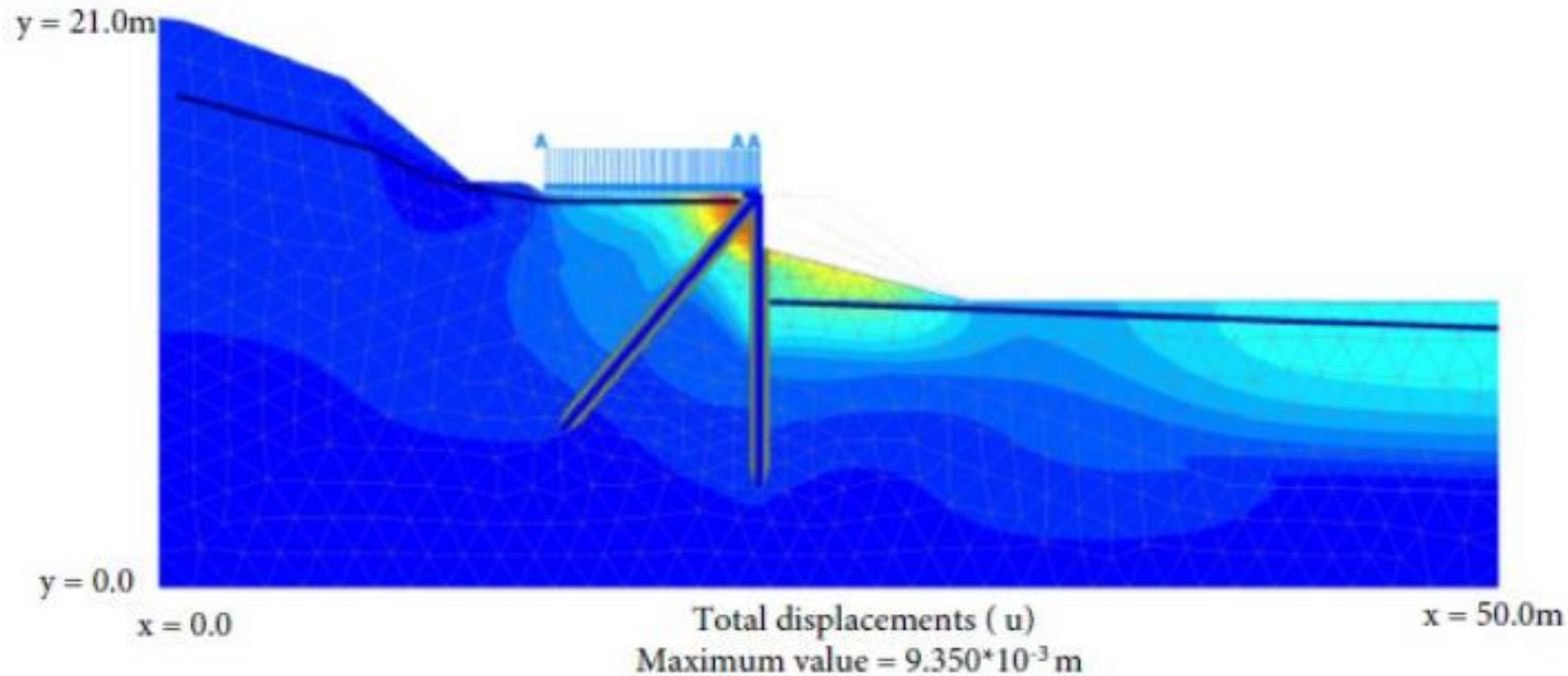
- Results of Ultimate Limit State (ULS) analyses for Step 12



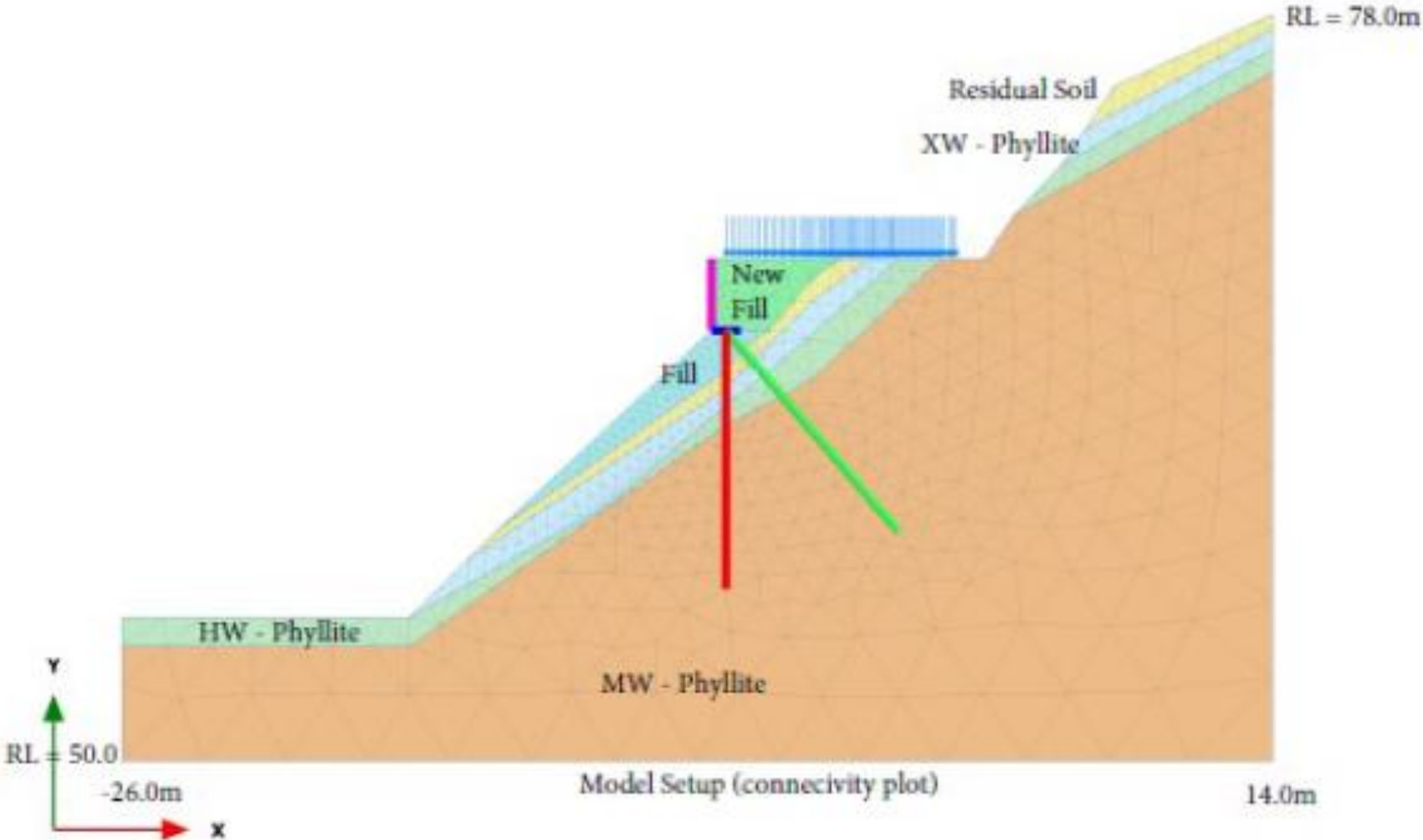
Geometry of the analysed problem at Section 6 on the Gatton-Clifton Road (Figure 3).

Alternative approach – Micropile trial

- Computed lateral displacement at the ULS condition – up to 2m loss of soil in front of the pile wall and groundwater table at ground surface.



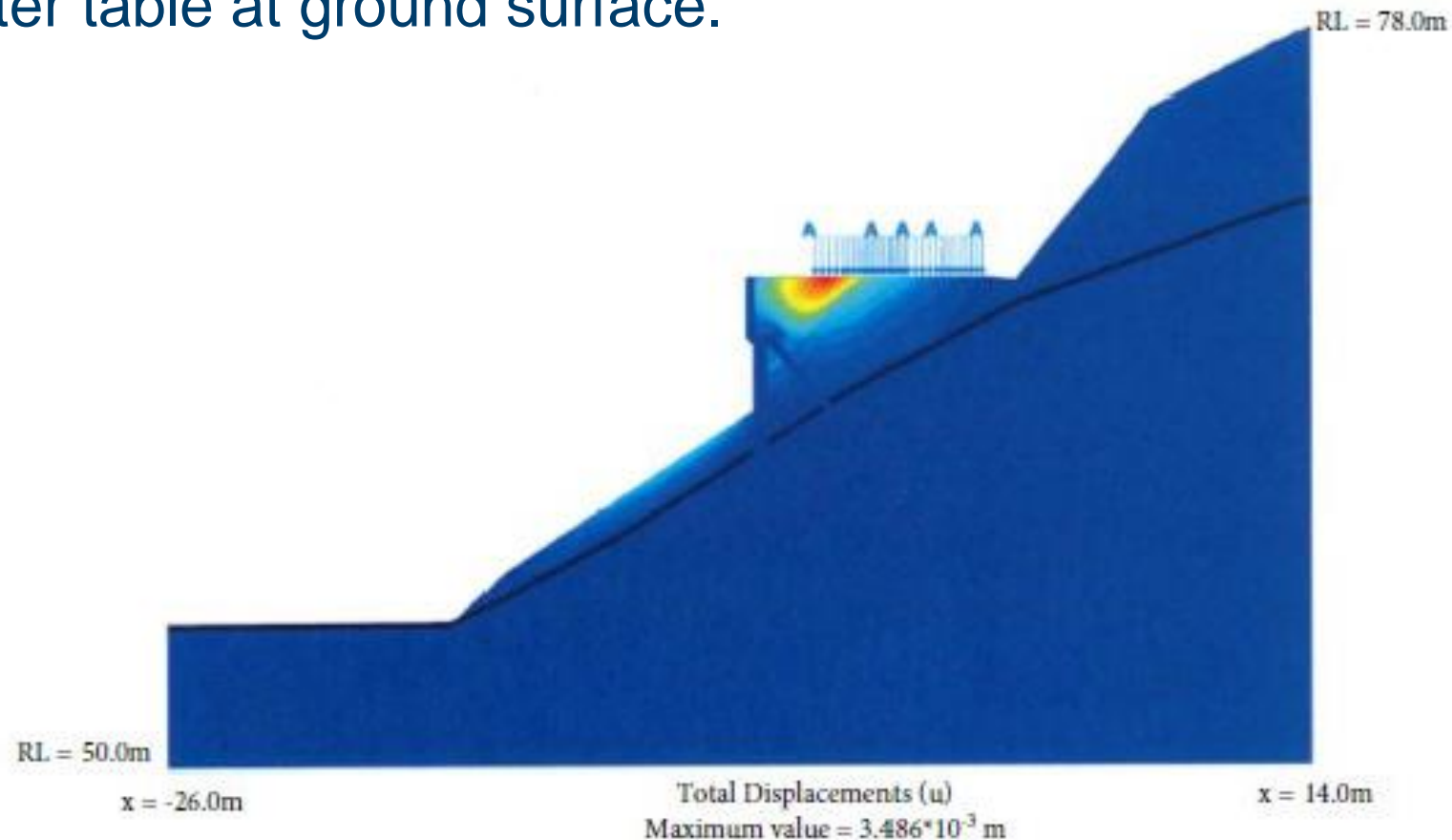
Alternative approach – Micropile trial



Geometry of the analysed problem at Kin Kin Road (Figure 5).

Alternative approach – Micropile trial

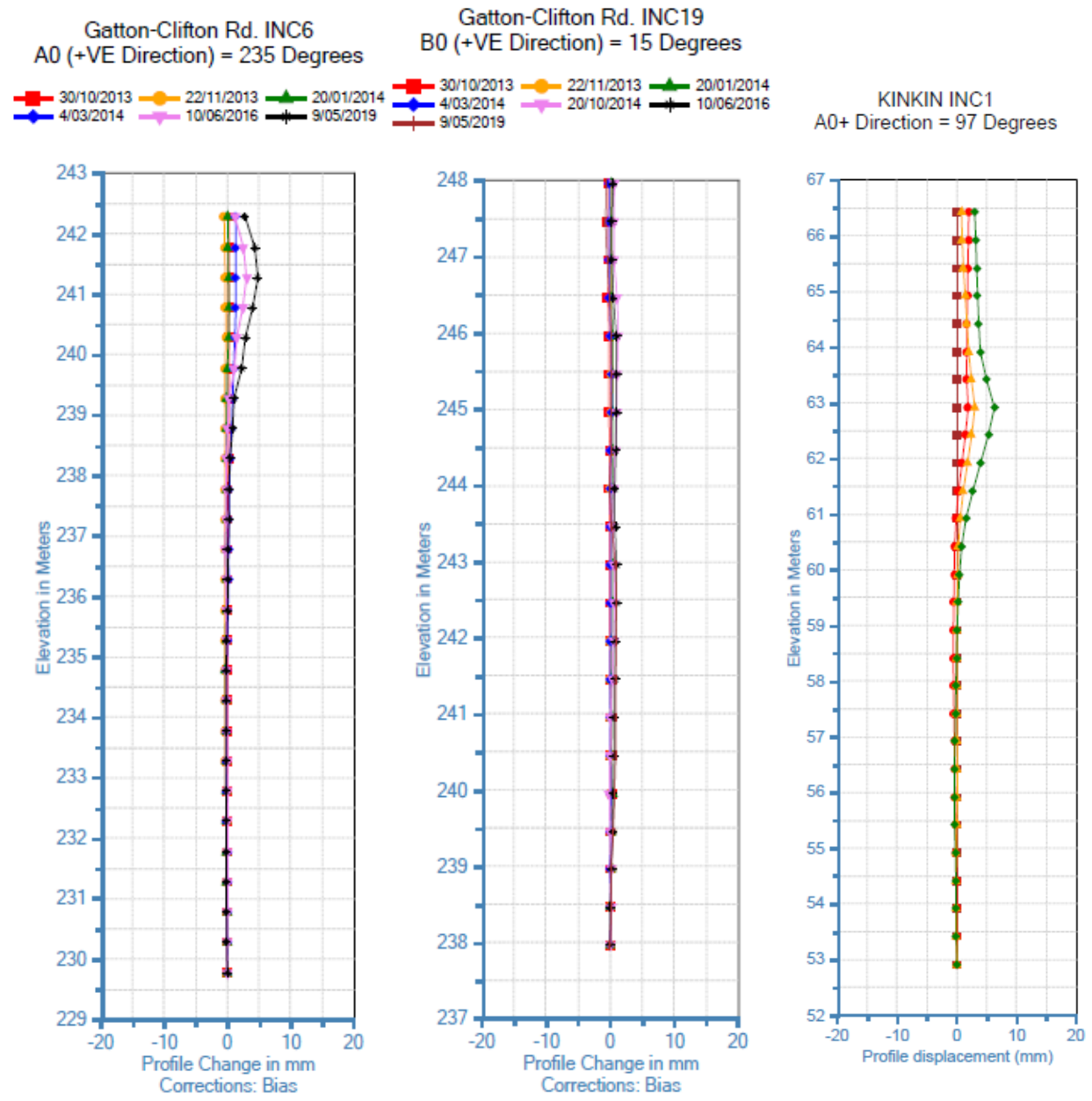
- Computed lateral displacement at the ULS condition – Up to 2m of soil loss in front of the pile wall plus additional load due to retaining wall and groundwater table at ground surface.



Micropile wall instrumentation, monitoring and results

Project area	Inclinometer Number (INC)	Date installed (Date of current reading)	Maximum displacement (mm)	Location of maximum displacement	Comments
Gatton-Cliffon Road	INC 1	30/10/13 (9/05/19)	5.0	Within top 1.5m from ground surface	Locally referred to as INC 6 (installed in Bay 6 of works). No distinct pattern of movement.
	INC 2	30/10/13 (9/05/19)	4.0	Within top 1.5m from ground surface	Locally referred to as INC 19 (installed in Bay 19 of works). No distinct pattern of movement.
Kin Kin Road	INC 1	28/04/15 (14/05/19)	6.0	At 3.5m from ground surface	Movement locus at 3.5m from ground surface.

Summary of results of monitoring



Plots of results of inclinometer monitoring

Conclusions

- Method used must follow the FHWA design manual, comply with the 12 steps and the extra 2 steps – loss of soil and additional loads.
- Minimal movements captured at the two trail sites.
- No loss of soil witnessed on the down-slope side of the piles – promising results.
- TMR will continue to monitor the sites and make further recommendations moving forward.

Thank you and stay connected



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