Safety Management Plan

Amity Point Flow Slide Barrier

Redland City Council

February 2019

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22 February 2019

Rod Powell
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Dear Rod

Safety Management Plan – Amity Point Flow Slide Barrier

Attached please find the Safety Management Plan with regard to undertaking future emergency works to the Flow Slide Barrier along the foreshore of Amity Point on North Stradbroke Island.

This Safety Management Plan has been prepared as part of the requirements of Section 166 of Queensland's *Planning Act 2016* for undertaking Emergency Tidal Works.

Yours sincerely

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1 INTRODUCTION

Proactive management is an effective strategy to address coastal hazards, however given the nature of flow slide events occurring at Amity Point appropriate mechanisms to facilitate emergency works are also required. The role of this Safety Management Plan (Safety Management Plan) is to outline the emergency event, legislative requirements, triggers and the roles and responsibilities for undertaking emergency works.

The objectives of the Safety Management Plan are to:

- Outline a process to facilitate property owners to undertake emergency works along the Amity Point foreshore; and
- Provide advice on the legislative requirements

Section 166 of Queensland's *Planning Act 2016* allows tidal works to be constructed without a development approval in the event of an emergency. Nevertheless, whilst such works can be initiated quickly, there are provisions in Section 166 to ensure that proper precautions and due diligence are exercised when installing the emergency works to ensure that they are safe.

Section 166 states that development offence provisions of the *Planning Act 2016* do not apply if a person or entity who carries out the emergency work:

i. Has made and complies with a Safety Management Plan for the emergency works;

ii. Takes reasonable precautions and exercises proper diligence to ensure the works or a structure to which the works relate are in a safe condition, including by engaging a registered professional engineer to audit the works or structure;

iii. Gives a copy of the plan to the enforcement authority as soon as reasonably practicable after starting the works.

This Safety Management Plan has been prepared by Paul O'Brien (RPEQ No. 5638) in fulfillment of item (i) of the above requirements when undertaking any emergency works to the Flow Slide Barrier along the foreshore of Amity Point on North Stradbroke Island.

The location of Amity Point within the Moreton Bay regional setting is illustrated on Figure 1-1.

Figure 1-1 Regional Setting

2 EMERGENCY EVENT RESPONSE

2.1 The Threat Requiring Emergency Works

The threat of shoreline erosion along the foreshore of Amity Point relates to the occurrence of *retrogressive flow slides* in the underwater side slopes of Rainbow Channel.

Retrogressive flow slides (also known as *retrogressive breach failures*) are natural events which occur in sandy deposits of many river, estuarine and coastal locations around the world. They can have a significant influence on the stability of river banks, as well as estuarine and coastal foreshores.

They have also been responsible for levee collapses along the lower reaches of the Mississippi River that have resulted in adverse flooding and damage to essential infrastructure. In the Netherlands, retrogressive flow slides have been recognised for many years as being a threat to the vital flood and sea defences along that country's coastline and riverbanks.

Due to their potentially catastrophic consequences, considerable research effort has been applied to understand retrogressive flow slides. Consequently, there is a significant body of technical literature available that describes the geomorphological mechanisms associated with retrogressive flow slide failures, as well as measures for either preventing their initiation or inhibiting their development to destructive scales.

Figure 2-1 shows images of a retrogressive flow slide underway at Amity Point[1].

The processes associated with a retrogressive flow slide can be summarised as follows:

- They occur on densely packed subaqueous sand slopes, such as those that exist along the underwater edge of tidal channels and river banks. At Amity Point they occur just offshore on the submerged side slopes of Rainbow Channel.
- A triggering mechanism develops a localised scour somewhere on the submerged slope, which can then progress to a shear failure should the disturbed area exceed the stable angle of repose for the sand.
- The sand grains remaining on the sheared face of the slope are unsupported, and will consequently move apart - increasing the void ratio (this is called *dilation*) which temporarily decreases pore pressures within the face of the slope. The lower pore pressures (compared to the surrounding hydrostatic water pressures) cause individual sand grains near the face to be "sucked" together for a short time. This enables the sand body to resist further collapse and for a near-vertical face to develop.
- The lower pore pressures at the near-vertical sand face are quickly dissipated - by the surrounding water infiltrating the voids. The unconfined grains at the face then detach and fall from the wall, generating a density current of entrained sand which carries the falling sand away into deeper water. The process continues on the newly exposed sand grains in the near-vertical face - increasing the momentum of the event.
- The density currents carry the removed sand away from the failure zone and beyond the immediate toe of the near-vertical face, allowing it to remain steep and high. This dispersion of sand away from the base of the breach can be further assisted by tidal currents flowing in the channel itself.

[1] Images in Figure 2-1 are reproduced from Beinssen, K., Neil D.T. and Mastbergen D.R. 2014. "*Field observations of retrogressive breach failures at two tidal inlets in Queensland, Australia".* Journal *Australian Geomechanics*. Vol. 49 No. 3, Sept 2014. pp55-63.

- In other words, the mechanism of flow slide development is driven by short-lived density currents that entrain sand off the near-vertical wall of a shoreward moving failure plane, causing sand grains to continually cascade off this advancing face. This process is classed as retrogressive breaching failure.

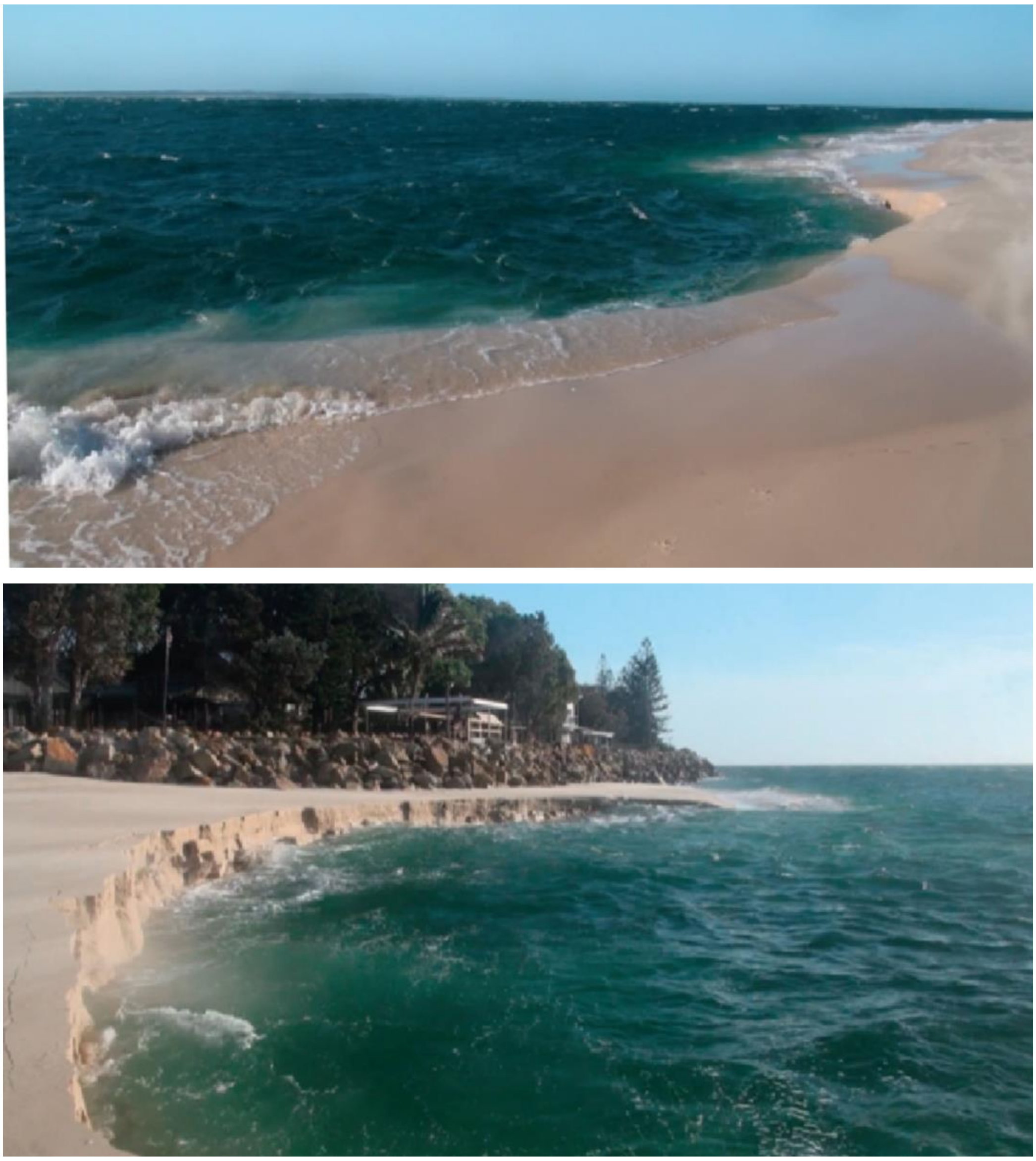


Figure 2-1 A Retrogressive Flow Slide Underway at Amity Point

- As the advancing sand wall grows in height, wedges of sand can also collapse off the vertical face - breaking up as they fall and mix with water, thereby enhancing the density current. Dilation in the sand face immediately behind the collapsing wedge temporarily stabilises the wall until retrogressive breaching restarts.
- Retrogression continues, creating a deep bowl-shaped scour feature in the submerged side slope of the tidal channel or river bank (as seen in Figure 2-1 above). Typically, as the event grows, this then becomes more of an amphitheatre-shaped characteristic with a narrower throat at its deeper offshore end.
- The base of the retrogressing sand wall propagates into the sand slope slightly upwards on an approximate angle of 1 vertical : 15 horizontal.

- The event ceases when the density current can no longer entrain sand from the retrogressing near-vertical face. This occurs either because there is no longer any sand available within the profile of the submerged slope to sustain the process; or the volume of sand being removed from the breaching face becomes so great as to "choke" the flow of entrained sand out of the bowl-shaped feature.
- Whilst they proceed entirely underwater, such events typically cannot be seen. It is only when they emerge above the waterline onto exposed beaches or sand banks that they can be detected by eye.

Investigations regarding the phenomenon of retrogressive flow slides at Amity Point have previously been undertaken[2]. They have included almost daily field monitoring for a period of 26 months of the at-risk beach and Rainbow Channel slope immediately to the north of the existing flow slide barrier.

Monitoring was carried out from July 2012 to August 2014. In that period, 52 retrogressive flow slides were recorded. This averages approximately one every fortnight. A summary of other findings are as follows:

- On no occasion was the approach of a subaqueous retrogressive flow slide evident on the surface of the water. Such events only became visible when they reached the beach.
- The morphology of each event was amphitheatre shaped as it progressed up the beach slope. Whilst sand grains could be seen cascading down the near-vertical face below the waterline, occasionally wedges of sand sheared off the top of the wall and sank vertically down its face.
- The speed of the retrogressing near-vertical sand face in all cases was approximately 0.8 metres / minute. However, this rate reduced as the event reached the upper beach area and began to diminish.
- The height of the subaqueous sand wall was measured on six occasions to be around 6m to 7m.
- Following each retrogressive flow slide event, the longshore littoral supply of sand from the north-west (from Amity Beach) filled the bowl-shaped erosion feature within one day to several weeks – depending upon the size of the retrogressive flow slide.
- Of the 52 events recorded, 48 were identified as having encroached onto the flow slide barrier - but none caused significant structural damage.

2.2 The Historical Response to the Threat of Flow Slides

It is apparent from the historical record that retrogressive flow slides have been occurring at Amity Point along the eastern edge of Rainbow Channel for over one hundred years, and probably longer.

Renowned local historian Thomas Welsby wrote in 1913 of his recollections[3] prior to that time of many "large slips" occurring at Amity Point which swept away "tons of sand". His observations dating back to the late 1800's indicate the occurrence of retrogressive flow slides and their adverse impacts on local foreshores and sand shoals at that time.

[2] Beinssen, K., and Neil D.T. 2015. "*Retrogressive Breach Failure Events at Amity Point, Australia and their Interaction with Built Defences".* Proceedings of the 25th International Ocean and Polar Engineering Conference. Hawaii, USA; June 21-26, 2015. Copyright the International Society of Offshore and Polar Engineers (ISOPE). pp 1325-1339. ISBN 978-1-880653-89-0; ISSN 1098-6189.

[3] Thomson, A.K. (Ed.) 1967. "*The Collected Works of Thomas Welsby ".* Jacaranda Press Pty Ltd., Brisbane.

Since then there have been numerous such events, many of which can be recalled by long-term residents[4] and are recorded in photographs dating back to the 1940's. Residents of Amity Point have historically (and still today) refer to retrogressive flow slides as "sink holes". There is wide-spread understanding in the local community that such events occur regularly at Amity Point and that they represent a threat - not only to foreshore properties, but potentially to the township itself.

The response of the local community to the threat of retrogressive flow slides have been varied over the years. These have included sea defences constructed of timber piles salvaged from an abandoned WW2 anti-submarine netting project, large ti-tree mats, and cement stabilisation (G. Litherland 2015 pers. comm.). Prior to the opening of a quarry on North Stradbroke Island in the 1970's, fill comprising large tree trunks, old car bodies and other such materials (including the *Bandicoot*, a decommissioned steam launch previously used as a dredge tender) were placed as emergency works by the community at locations of retrogressive flow slides.

Large rocks became available from the island's quarry around the mid-1970's. As a consequence, foreshore property owners have more recently used this material to armour their properties. Typically, this entails the placement of large volumes of rock into any areas of foreshore adversely affected by retrogressive flow slides. This occurs as soon as possible after each event. When a retrogressive flow slide undermines previously placed armour, those rocks slump or collapse into the eroded shoreline. Residents then place additional rocks to "top-up" the slumped armour. In effect this is progressively building a rock barrier to retrogressive flow slides, since each local undermining occurrence results in deeper foundations and a re-charging of the reserves of rock higher in the structure by residents.

Whilst there has been intermittent damage to the structure by deep retrogressive flow slides requiring placement of additional armour rocks to reinstate its alignment and effectiveness, this flow slide barrier has prevented any long-term recession of the shoreline alignment for more than 40 years. This is apparent from the historical foreshore surveys that have been undertaken since 1970.

As noted above, the mechanism of flow slide development is driven by short-lived density currents that entrain sand off the near-vertical wall of the shoreward moving failure plane, causing sand grains to cascade off the advancing failure face. Measures to prevent flow slides from being triggered on submarine sand slopes can be difficult and costly to implement, often with only limited effectiveness. Therefore, a significant focus of overseas research has been directed to identifying submarine sand slopes that are susceptible to flow slides; and to then devise the means to prevent them from developing into large scale failures.

For strategies that seek to prevent further development of an initiated flow slide, the primary objective is to disrupt or completely dissipate the density currents which entrain sand on the near-vertical failure plane. Blocking of flow slide development occurs when:

- The advancing near-vertical sand wall encounters non-erodible material within the sand body. In which case, there is no longer sand available to sustain the momentum of the density currents driving the growth of the flow slide event;
- Non-erodible layers present in the sand slope above the point of flow slide initiation become undermined and collapse in sufficient quantity down into the bowl-shaped failure area - thereby diffusing the density currents and armouring the near-vertical advancing sand wall.

There is a very large volume of rock (and other non-erodible material) placed by foreshore property owners over recent decades into the Amity Point foreshore. Even though Rainbow Channel has been migrating eastward towards Amity Point, resulting in deeper and steeper seabed slopes in front of the foreshore (with

[4] G. Litherland, 2015 pers. comm.; D. & E. Cilento 2015 pers. comm.; C. & M. McIllwain, 2015 pers. comm.; B. Hoare 2016 pers. comm.; J. & L. Walker 2016 pers. comm.; K. Norris 2016 pers. comm.; I. Panebianco 2016 pers. comm.

resulting greater vulnerability of the foreshore to flow slides), there have been fewer large failure events in recent years. This is very likely due to the blocking effect of the rock barrier that has been progressively reinforced by foreshore property owners.

In the past, whenever a flow slide event occurring on the submerged sand slopes of Rainbow Channel undermines any rocks placed previously, the buried rock mass slumps or collapses into the active flow slide region bringing the processes to an end. This typically manifests itself as a settling or dislodgement of rocks at the top of the slope. The response of local property owners is to then (and as soon as possible after the event) place additional rocks in the upper part of the collapsed rock slope.

Consequently, a flow slide barrier made of rock has been progressively built along the foreshore of the Central Reach over many years. Each undermining event caused by deep flow slides locates the foundations of the barrier deeper; whilst the reserve of rocks higher in the structure (to accommodate any future slumping) is recharged by local property owners.

The fundamental purpose of the flow slide barrier is to mitigate the development of flow slides to damaging proportions. This function will only be maintained if the current practice of recharging the upper reserves of rock in the structure occurs whenever there is local undermining of the barrier.

3 THE EMERGENCY TIDAL WORKS

The Emergency Tidal Works covered by this Safety Management Plan relate to the emergency placement of rocks to repair and reinstate the function of the existing flow slide barrier along the foreshores of Amity Point.

3.1 Trigger Event

Section 166 of the *Planning Act (2016)* defines emergency tidal works as being "…. *works, development or a use (an activity) carried out because an emergency endangers :*

i. a person's life or health; or

ii. a building's structural safety; or

iii. the operation or safety of infrastructure, other than a building; or

iv. *for tidal works – the structural safety of a structure for which there is a development permit for operational works that is tidal works*."

Given the physical characteristics of the existing flow slide barrier, in conjunction with the above definition of emergency tidal works, the trigger for implementation of this Safety Management Plan is when the flow slide barrier becomes damaged to the extent that people and houses adjacent to the structure are placed at significant risk.

Small movements and settlement of exposed rocks in the upper slope of the flow slide barrier can occur due to small retrogressive flow slides occurring near the buried toe of the barrier. This is acceptable from a structural integrity perspective. It is only when a deep retrogressive flow slide occurs which significantly undermines the barrier (causing significant slumping of the upper part of the barrier) is there a need to implement Emergency Tidal Works.

Such works should be triggered when:

- Excessive rock slumping : All visible rocks in the flow slide barrier above the prevailing tide level have slumped down below the waterline; or
- Excessive rock erosion : The extent of rock settlement during a single retrogressive flow slide event is such that the upper seaward-most corner of the barrier's front slope is eroded inland by 5 metres.

These two fundamental trigger actions are illustrated respectively in Figure 3-1 and Figure 3-2.

Figure 3-1 Emergency Tidal Works Trigger Event – Excessive Rock Slumping

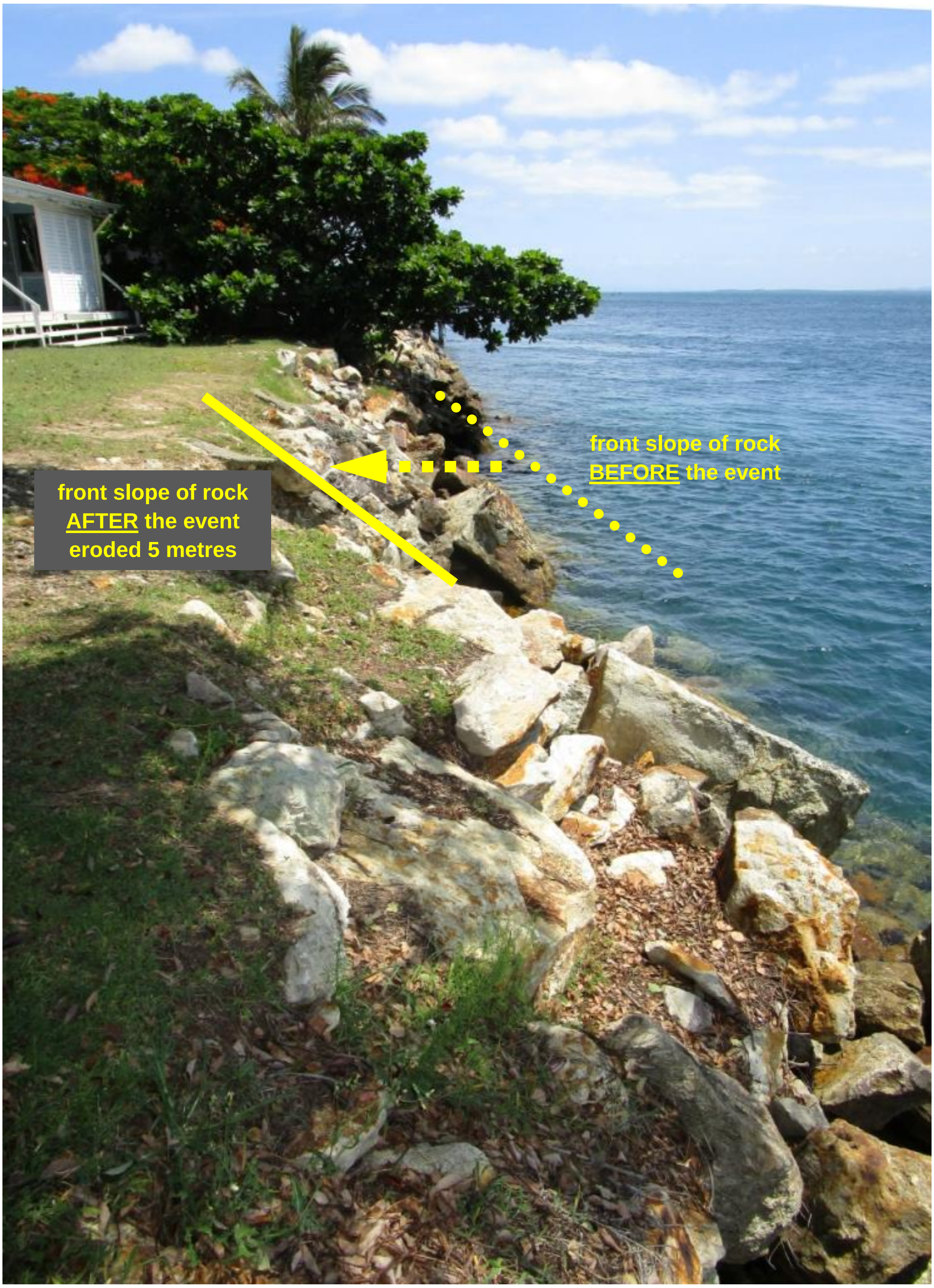


Figure 3-2 Emergency Tidal Works Trigger Event – Excessive Rock Erosion

3.2 Rock Placement Requirements

As part of obtaining development approval for the flow slide barrier, a Detailed Engineering Design will need to be undertaken. Repair works to that structure can then be done as approved works to reinstate the function of the flow slide barrier provided that they are in accordance with that Detailed Design.

However, if repair works to the existing flow slide barrier following a flow slide event are required prior to receiving development approval, then the works are to comply with the structural characteristics and requirements of the Concept Design prepared during the development of the Amity Point Shoreline Erosion Management Plan (SEMP). The Concept Design is shown overleaf on page 16.

In the event of damage to the flow slide barrier by a retrogressive flow slide, the effectiveness of structural repairs and the reinstatement of the barrier's primary function is significantly affected by the time between the occurrence of the damaging event and the commencement of the emergency tidal works.

It is important that repairs to the damaged flow slide barrier be initiated within only a few hours of the damaging event. Longer delays compromise the effectiveness of those repairs and the future effectiveness of the flow slide barrier in preventing the development of retrogressive flow slides to damaging proportions.

Repairs to the flow slide barrier can be effected by simply dumping rock armour (complying with the material specifications in Section 3.2) from conventional tip-trucks directly into the zone of the slumped/damaged barrier.

To ensure the safety of staff and equipment involved in the emergency work, it is essential that no dumping of rock occurs whilst a retrogressive flow slide is occurring. Rock placement should only be undertaken once the damaging flow slide event has ceased.

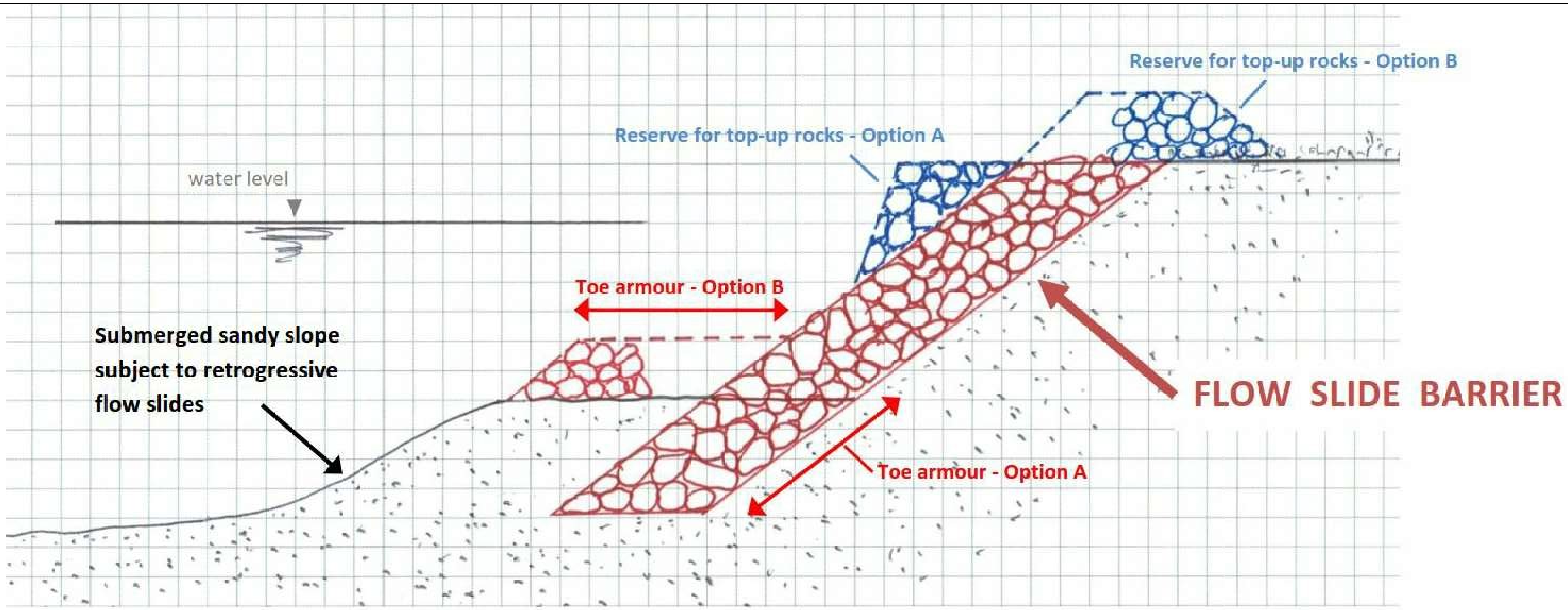
3.3 Material Specification

Rock material used to facilitate the emergency repairs to the damaged flow slide barrier shall be obtained from a stockpiled source maintained solely for that purpose. The material shall comply with the following specifications:

- All of the rocks used in the repair of the flow slide barrier are considered and referred to herein as "rock armour".
- All rock armour shall have a Specific Gravity of at least 2.60.
- Only rocks between the sizes of 50kg and 4tonnes shall be used for repair works on the flow slide barrier.
- All rock armour shall be well graded, clean, free from overburden, spoil, shale and organic matter.
- Individual rocks shall be slightly weathered to fresh; durable; sound; and suitable for use as armour in a marine environment.
- All rock armour must be free of any defects which would result in breakdown of individual stones in the foreshore environment of the works.
- Rocks displaying cleavage planes and weak seams shall not be used.

3.4 Notification

A requirement of Section 166 of the *Planning Act (2016)* is that a development approval is applied for as soon as "*reasonably practical*" after the Emergency Tidal Works are completed. It is also a requirement that the assessment manager for the application be given written notice of the emergency works and a copy of this Safety Management Plan.



NOTES :

1. All armour rocks used in the Flow Slide Barrier are to have a nominal weight designed to withstand tide/flood currents, storm tides and storm wave action– comparable to the design standards for rock-armoured seawalls in Queensland. This will include the determination of minimum and maximum weights of armour rocks to ensure tight interlocking of all rocks within the armour matrix.

2. The thickness of the Flow Slide Barrier is to be such as to prevent the unrestricted growth of any flow slide that develops on the adjacent seabed slope. The minimum thickness is to be at least ten times (x10) the dimension of the smallest allowable rock armour size.

3. The gradient of all exposed rock slopes are to be no steeper than 1 horizontal : 1.33 vertical.

4. Two options are shown as acceptable arrangements for the placement of rocks in the lower toe area of the Flow Slide Barrier. The intent is to ensure that there are adequate rocks in this toe area to provide protection for the maximum expected scour level of adjacent seabed/channel features. In the case of Option A, this is achieved by armouring down to at least the expected level of seabed scour/lowering. In the case of Option B, this is achieved by having an adequate volume of rock to self-armour the slope below in the event of undercutting of this reserve of rocks as the seabed level drops.

5. Two options are shown as acceptable arrangements for the placement of rocks in the upper area of the Flow Slide Barrier that provide a reserve of top-up rocks. Such reserves are to mitigate any slumping or structural damage to lower regions of the Barrier that may be initiated by a flow slide. The intent is to ensure that there is a sufficient volume of top-up rocks to reinstate the form and function of the Flow Slide Barrier following any such slumping/damage.

REVISIONS

REV.	DESCRIPTION	DATE	INIT.
01	INITIAL RELEASE	21/02/2019	PLO

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DRAWN	PLO	
CHECKED	ASX	
DESIGN	PLO	
CHECKED	AXS	
APPROVED	PLO	

AMITY POINT SEMP
CONCEPT DESIGN - FLOW SLIDE BARRIER

SHEET 1 of 1

Drawing No. 4193-01-D01
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JOB NO. 4193-01

SCALE: NTS

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