MOTT MACDONALD

Aberdeen Donmouth Coastal Embankment

Risk Assessment

26 April 2017

Aberdeen City Council

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Issue and Revision Record

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A	24.02.17	S Eyers-Young	K Young	A Martin	Draft for Comment
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Contents

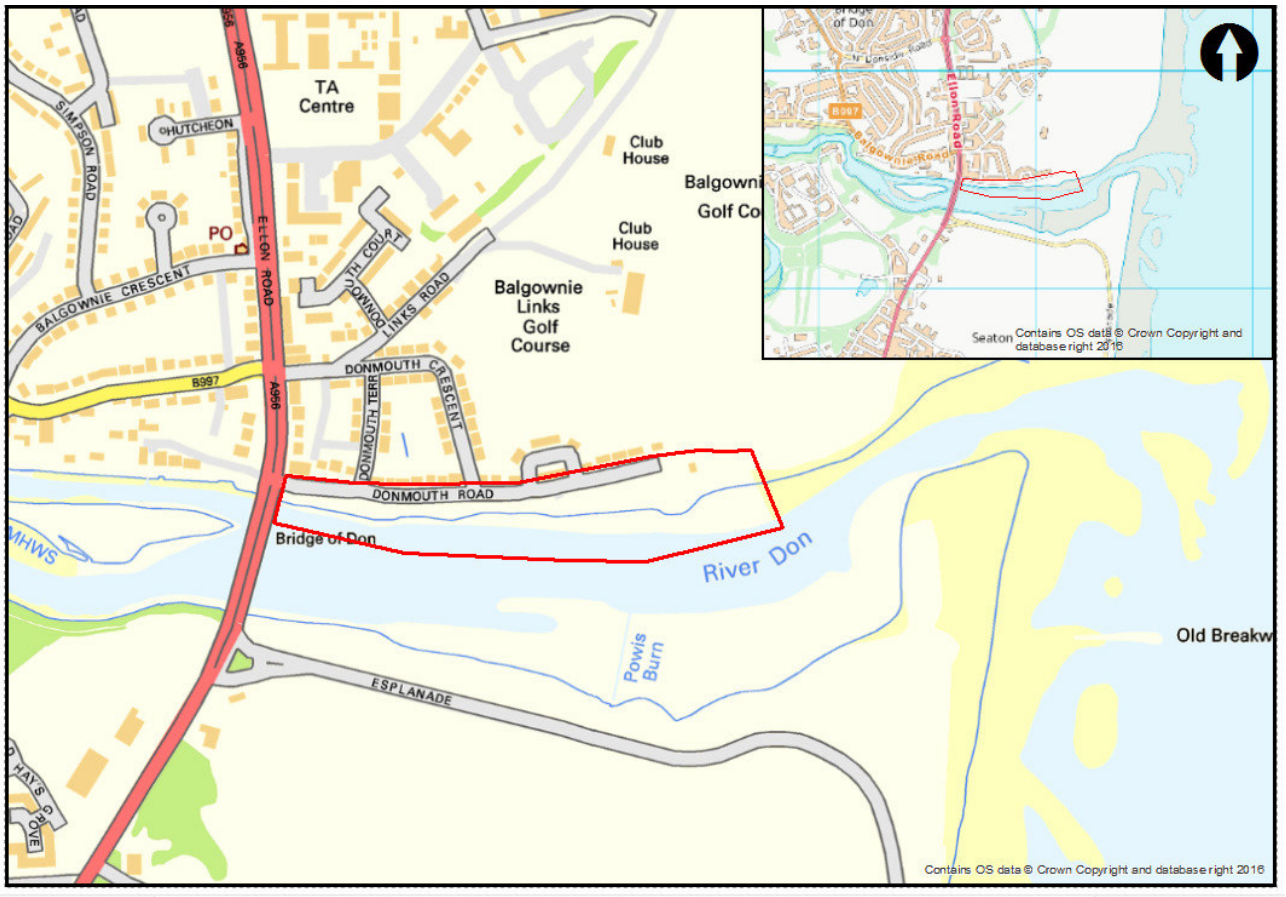
1 Introduction

1.1 Background and Scope

A site walkover survey was undertaken at the Donmouth coastal embankment site on the 24th January 2017 by two engineering geologists. The aims of the walkover surveys were to:

- Identify visual evidence of historical instability on the site associated with landslides;
- Identify potentially unstable areas and assess the risks these pose to adjacent roads and pathways and users;
- Highlight areas which require management / remediation.

Figure 1.1: Indicative Site Boundary



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The information gathered during the site walkover has informed a quantitative risk assessment, to classify the overall condition of the embankment and prioritise remedial actions required, with numbers assigned to risk level, impact, priority.

The objectives of this report are to:

- Summarise the findings of the site walkover and describe the baseline condition of the embankment, including locations of instability.
- Present the results of a slope stability risk assessment for the embankment, highlighting where management or remediation actions are required.
- Provide a priority level for remedial actions.
- Make recommendations for any immediate actions required.
- Make recommendations for a proposed strategy for continual monitoring of the embankment by Aberdeen City Council staff.

The results of the site walkover are presented in Appendix A.

1.2 Sources of Information

The following sources of information summarised below have been used to compile this report and are summarised in Section 2.

- MML Donmouth Desk Study (Ref.1)
- A guide to managing coastal erosion in beach/dune systems, SNH (Ref. 2)

2 Site Walkover Summary

2.1 Site Walkover Results

A Site Walkover was completed by MML on 24th January 2017. The results of the walkover are included in Appendix A.

The slopes are generally steep below Donmouth Road, being between 45 and 55 degrees, becoming shallower at 15 degrees towards the eastern end of the site. The slopes range in height from approximately 10m in the west to 4m in the east and are vegetated with grasses and occasional trees and bushes to the end of the road, with sand dunes beyond. There is some debris at the base of the slope, either from material tipped or failed from the crest of the slope or deposited during flood events.

The site has previously been remediated at the western end, with coarse rock fill placed on the slope and new surfacing on the pavement at the crest of the slope. The new surfacing shows cracks parallel to the slope. Additionally, there have been two historical slips towards the centre of the site, between 4 and 6m in length, <10m^3 material and with vegetated failed material on the slope and caught in trees at the base of the slope.

Evidence of flooding and deposition are present at the toe of the slope, with areas of erosion approximately 3m high into the toe of the slope visible towards the eastern end of Donmouth Road.

There are two culverts at the base of the slope, possibly associated with an historical burn. A large cracked concrete pipe is present at the eastern end of the site exposed within the river channel, possibly associated with the Sottish Water asset at the crest of the slope at the end of Donmouth Road.

A record geodatabase of each feature has been produced, including photographs, issued by CD. A plan showing the features at each site is included in Appendix A.

3 Slope Stability Risk Assessment Methodology

3.1 Strategy

Using published guidance (E. M. Lee and D. K. C. Jones, Landslide Risk Assessment, ICE 2014), the slopes have been assigned a category according to the level of risk to infrastructure and members of the public, by chainage groupings. The risk categories are from 1 to 5, with 1 being the lowest risk and 5 the highest.

This risk assessment method is quantitative, with the ratings based on engineering judgement. The risk assessment has been undertaken focusing on potential harm to users.

The following factors have been considered when assigning risk:

- Slope angle
- Consequence of failure
- Likelihood of failure
- Topography
- Groundwater
- Vegetative cover

Tables 1 and 2 demonstrate the ratings assigned to both likelihood of slope failure occurring and the consequences associated with failure.

The slopes have been assessed in terms of likelihood and consequence; these ratings are multiplied together to form a risk rating. The possible risk ratings are shown in the Risk Rating Matrix in Table 3, the ratings have been assigned a risk category from 1 to 5 indicated in Table 4. These risk categories inform prioritisation of any potential actions or remediation measures, with a High to Very High risk necessitating further investigation and a discussion of options / recommendations.

Table 1: Probability Ratings

Likelihood	Rating
Very unlikely	1
Unlikely	2
About as likely as not (Possible)	3
Likely	4
Very likely	5

Table 2: Consequence Ratings

Consequence	Rating
Minor: failed materials stop along the slope, no failure that would impact on infrastructure	1
Moderate: failed materials impact the foreshore, potential for failure to affect upslope footpaths	2
Serious: failure with debris/blocks reaching the foreshore, with the potential for damage to upslope footpaths / roads and injury to members of the public	3

Table 3: Risk Rating Matrix

		Likelihood				
		Very unlikely	Unlikely	Possible	Likely	Very Likely
Consequence		1	2	3	4	5
Minor: failed materials stop along the slope, no failure that would impact on infrastructure	1	1	2	3	4	5
Moderate: failed materials impact the foreshore, potential for failure to affect upslope footpaths	2	2	4	6	8	10
Serious: failure with debris/blocks reaching the foreshore, with the potential for damage to upslope footpaths / roads and injury to members of the public	3	3	6	9	12	15

Table 4: Risk Categories and Recommended Actions

Risk Category			Action
Very Low	1-2	Increasing Risk →	None required
Low	3-4		None required
Moderate	5-6		Management required
High	7-10		Remediation required
Very High	11-15		Remediation required

4 Slope Stability Risk Assessment Results

4.1 Risk Assessment Results

The results of the slope stability risk assessment are included in Table 5.

A prioritisation level has been applied to those areas requiring action (moderate to very high risk) of between 1 (highest priority) and 3 (lowest priority).

Table 5: Donmouth Slope Stability Risk Assessment

Chainage (m)	Description	Grid Reference (centre)	Associated Features (Appendix A)	Consequence Rating	Likelihood Rating	Risk Rating	Risk Category	Prioritisation
0 to 30	This area comprises steep (40-60 degrees) vegetated slopes adjacent to the road bridge abutment and area that has previously failed. It is considered a similar slip could potentially happen in this area and should be monitored.	NJ 9468 0949	1, 2, 3	3	2	6	Moderate	2
30 to 40	This area has previously been remediated due to a slip by placement of rockfill material. Cracks were visible in the new footpath surface at the crest of the slope. It is not known if these are as a result of ongoing instability or settlement of the new surface. It is considered that while a further slip is unlikely, any potential movement should be monitored.	NJ 9469 0949	30	3	2	6	Moderate	2
40 to 200	Vegetated slope with concrete blocks at base of slope, possible failed edge protection. The slopes in this area appear to be generally stable; however, they are of a similar steepness to the adjacent area that failed. There is a culvert at the base of the slope, possibly from a burn. It is considered that the slopes may fail in the future, affecting the road at the crest, and it is recommended that remedial measures are considered.	NJ 9478 0948	14, 15, 16, 28, 29	3	3	9	High	1
200 to 300	This area has experienced historical slips, with	NJ 9491 0948	11, 12, 13, 24, 25, 26	3	3	9	High	1

	deposition of material visible on slopes (vegetated) and against trees (<10m^3 volume). There is the potential for further failure in this area, potentially affecting Donmouth Road at the crest of the slope, and it is recommended that remedial measures are considered.							
300 to 400	This area has undergone erosion at the toe of the slope, potentially due to flooding scour. The height of the scour is 3m into a steep (50 degree) slope. It is considered that this area should be remediated to prevent deterioration of the slope, potentially affecting Donmouth Road above.	NJ 9500 0948	6, 7, 8, 9, 14, 21, 22, 23	3	3	9	High	1
400 to 496	The slopes in this area are relatively shallow (<15 degrees), grassy and sandy. There is no instability visible.	NJ 9511 0948	5, 20	1	2	2	Very Low	-
450	There is a cracked partially buried / submerged concrete pipe >1m diameter at this location. This is potentially a sewage pipe associated with the nearby Scottish Water asset.	NJ 9514 0946	4, 18, 19	N/A	N/A	N/A	N/A	-

4.2 Recommendations

It is recommended that potential mitigation and remedial measures are considered for those high risk areas to prevent damage to infrastructure. Management and monitoring measures are considered to mitigate potential risk for the identified moderate risk areas.

4.2.1 Immediate Actions

Immediate actions that may be undertaken at the site include setting up fixed monitoring points / tell tales on the pavement to allow measurement of the cracks that have formed.

It is recommended that the priority be to set up a monitoring routine / schedule to monitor those areas of slope that may fail and the toe of the slope that is showing current movement. This will allow an informed decision to be made as to the nature and extent of any remedial works.

4.2.2 Proposed Strategy for Continual Monitoring

It is considered that fixed monitoring points could be installed at various locations along the face of the slope to monitor for movement, either by traditional topographic survey methods or by aerial photogrammetry / point cloud survey, at regular intervals.

ACC may also wish to undertake a visual inspection at regular intervals to identify any slope changes, based on the photographs provided by MML and any subsequent ACC visits, as well as after any periods of extended heavy rainfall when slope instability and erosion at the toe of the slope due to scour / flooding are more likely.

5 References

1. MML Desk Study, 378926 Donmouth Phase I Desk Study, Rev B, March 2017
2. SNH, 'A guide to managing coastal erosion in beach/dune systems', dated October 2000. [online- http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/index.shtml]

A. Site Walkover Results

Figure A: Site Walkover Results

C:\Users\you59695\Desktop\Greyhope Results.mxd

Location Map

Key to Symbols

- Current Instability
- Historic Instability
- Observation
- Structure
- Chainage (m)
- Site Boundary

Reference Drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
A	17/02/2017	KY	Draft for Comment	SEY	AM

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Title

Aberdeen Coastal Embankments
Donmouth
Site Walkover Results

Designed	K Young		Eng Check	S Eyers Young	
Drawn	K Young		Coordination	K Young	
GIS Check	J Irons		Approved	A Martin	

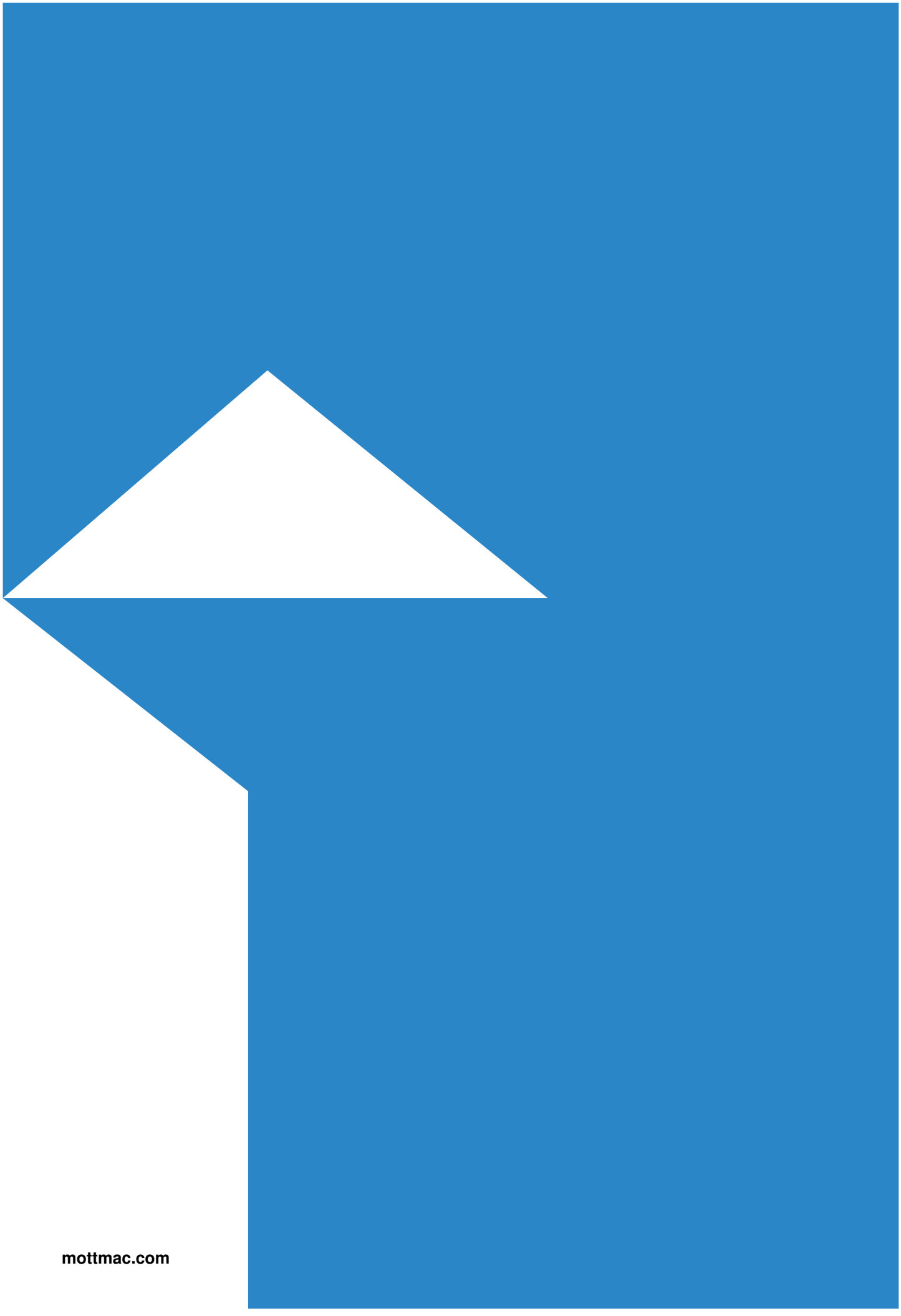
Scale at A1	Status	Rev	Security
1:1,000	DRA	A	STD

Drawing Number

378926-MMD-00-DM-GIS-001

Table A: Site Walkover Features

Number	Classification	Feature	Description	Comment
1	Observation	View from Bridge	Looking along coast, remediated areas visible	
2	Observation	North East Bridge Abutment		
3	Observation	View from Bridge	Looking east along coast at area previously remediated by coarse rock fill, 10m high slope at 55 degrees	
4	Structure	Concrete Pipe	See 18	
5	Observation	Vegetated Slopes		
6	Observation	Vegetated Slopes		
7	Observation	Vegetated Slopes	6.5m high 50 degree slope.	
8	Current Instability	Erosion	Erosion at base of slope, potentially caused by flooding scour	
9	Current Instability	Erosion	3m high erosion from flooding	
10	Observation	Vegetated Slopes	View looking east	
11	Observation	Vegetated Slopes	View looking west	
12	Historic Instability	Possible Old Slip	5m x 6m x 0.3m, 9m3 volume material, failed material vegetated	
13	Historic Instability	Historical Movement	3m x 4m x 0.5m, 6m3 volume material, failed material vegetated on slope and held by tree, 45 degree slope	
14	Structure	Culvert	450mm diameter	
15	Observation	Poorly Vegetated Slope	Possibly due to tree canopy	
16	Observation	Concrete Rubble	Concrete rubble at toe of slope	
17	Structure	Pipe/culvert	Silted up culvert, no flow evident	
18	Structure	Concrete Pipe	Cracked concrete pipe exposed in river channel, >1m diameter, rebar visible	Possibly sewage pipe from SW asset
19	Structure	Concrete Pipe	See 18	
20	Observation	Dunes & Beach	Approximately 4m high slopes at 15 degrees	
21	Observation	Vegetated Slope		
22	Observation	Vegetated Slope	Visible slope 6.4m high, 50 degree slope	
23	Current Instability	Toe erosion	3 m high instability at base of slope, sandy material visible in slope	
24	Observation	Vegetated Slopes	Views east and west	
25	Historic Instability	Historical Slip	See 12	
26	Historic Instability	Historical Slip	See 13	
27	Observation	Spring flowing over rock	Located at toe of slope	
28	Structure	Culvert	450mm diameter, possibly associated with historic burn	
29	Observation	End of Access	Tree at toe of slope, concrete rubble at toe	
30	Current Instability	Tension Cracks	Cracks in new tarmac in pavement	Previous instability remediated by coarse rock.



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