Batemans Bay Bridge replacement

Soils and Geology Assessment

Roads and Maritime Services

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1 Introduction

1.1 Proposal identification

Roads and Maritime Services is proposing to construct a new bridge on the Princes Highway over the Clyde River at Batemans Bay. The Batemans Bay Bridge replacement (the proposal) would remove the existing bridge and provide a new bridge with two lanes in each direction, improving traffic flow along the Princes Highway in Batemans Bay.

This report supports the environmental assessment for the proposal. The proposal is subject to assessment under two planning pathways, a review of environmental factors (REF) under Part 5 of *Environmental Planning and Assessment Act 1979* (EP&A Act) and an environmental impact statement (EIS) under Part 4 of the EP&A Act.

1.1.1 Proposal location and setting

The proposal is located at the Princes Highway crossing of the Clyde River at Batemans Bay, generally between the Kings Highway and North Street (refer to Figure 1-1). Local roads including Clyde Street, Wharf Road and Old Punt Road would also be modified by the proposal.

The Batemans Bay Bridge is an important link for the Princes Highway. The Princes Highway is a classified State Highway (A1) and is the primary coastal route between Sydney and Melbourne. The Kings Highway, which is Canberra's primary road connection to the NSW south coast, intersects with the Princes Highway in the north of the proposal area. The crossing over the Clyde River is also an important local connection between the commercial centre of Batemans Bay and areas north of the river such as North Batemans Bay.

On the southern side of the bridge is Bateman Bay's main shopping and commercial area including a large supermarket and shopping mall. Key features adjacent to the proposal area on the south side of the bridge include holiday accommodation, commercial areas, river foreshore areas and facilities as well as an area mapped as a State Environmental Planning Policy 14 Coastal Wetlands (SEPP 14 wetland). On the northern side of the bridge are the suburbs of North Batemans Bay and Surfside. Other features near the proposal area include holiday accommodation, residences and commercial development.

1.1.2 Key features of the proposal

Key features of the proposal include:

- construction of a new bridge to the west (upstream) of the existing Batemans Bay Bridge across the Clyde River including:
  - bridge approaches generally between Wharf Road on the northern side and Clyde Street on the southern side
  - two traffic lanes in each direction (at least 3.5 metres wide)
  - a three-metre-wide shared use path on the eastern side of the new bridge connecting the Kings Highway to North Street
  - navigational clearance of about 12 metres from mean high water spring (MHWS) level
- no access to Clyde Street, which would pass under the new bridge
- upgrade of the Princes Highway generally between North Street and the Kings Highway
- upgrade of the Kings Highway / Princes Highway intersection
- local road adjustments at Clyde Street, Wharf Road and Old Punt Road
- earthworks, including cuttings and embankments and retaining walls to support the new bridge approaches
- temporary ancillary facilities during construction including water quality controls, site offices, construction / demolition compounds, batching plants and stockpile sites
- permanent operational water quality controls

- utility relocations including optic fibre, telecommunications, electrical, water, drainage and sewerage
- replacement of the T-wharf downstream of the existing bridge
- removal of the existing bridge following opening of the new bridge
- site rehabilitation and landscaping works.

The key features of the proposal are shown in Figure 1-1.

A number of temporary ancillary facilities and road diversions would be established for the proposal. These features would be removed and the relevant sites rehabilitated at completion of the proposal.

1.1.3 Proposal background

The Batemans Bay Bridge is located on the Princes Highway around 270 kilometres south of Sydney and 150 kilometres east of Canberra. The existing bridge over the Clyde River at Batemans Bay was constructed in 1956 with a central lift span used to allow boats up to 23 metres in height to pass underneath. The bridge was constructed to replace a vehicle ferry across the Clyde River. While water traffic was originally related to the local timber and fishing industries, this has increasingly changed to recreational and commercial water traffic. The lift span is generally raised twice each day for a local tourist ferry but also for private yachts and commercial and recreational vessels. As the lift span is raised however, traffic along the Princes Highway is disrupted.

The existing bridge is structurally in poor condition, and does not conform to modern safety standards. Major structural components of the trusses are vulnerable to vehicle strike and there is evidence of significant vehicle impacts to the bridge occurring in the past. Higher Mass Limit (HML) vehicles are not permitted to use the bridge due to poor structural condition and height limitations. Issues with the central lift span have closed the bridge on numerous occasions resulting in local and regional traffic and economic impacts. The existing bridge provides a single, narrow lane in each direction, which can result in substantial congestion especially in peak holiday periods. Where there is an incident on the bridge or where the lift span has failed, the detour for highway traffic is around 350 kilometres.

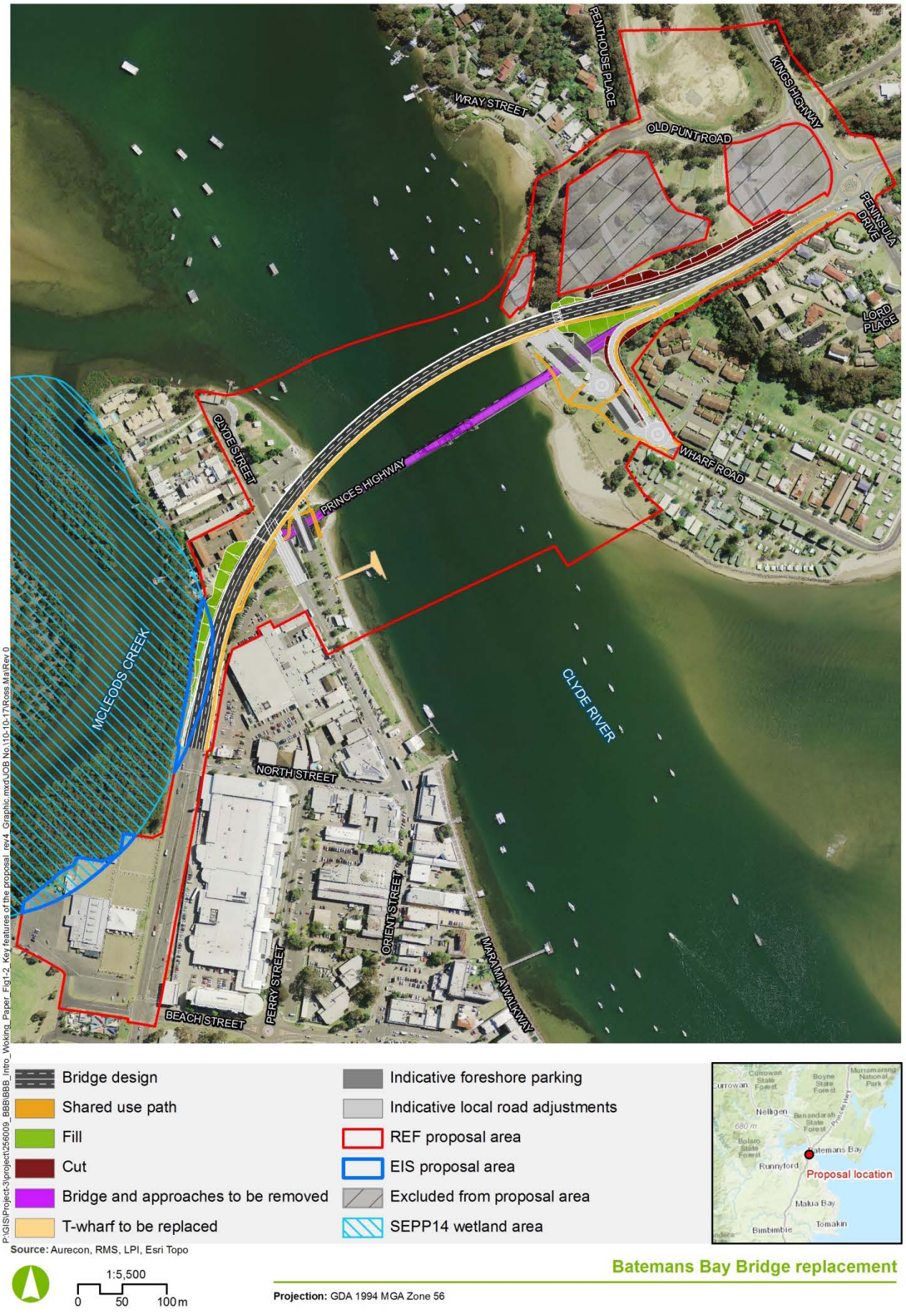

Figure 1-1: Key features of the proposal

1.2 Purpose of the report

This report has been prepared to support the REF and EIS for the proposal. This report has been prepared in accordance with relevant guidelines and the Secretary's Environmental Assessment Requirements (SEARs) for the EIS proposal.

The purpose of this report is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail environmental management measures to be implemented.

1.2.1 Secretary's Environmental Assessment Requirements

Part of the proposal is located within an area mapped as SEPP 14 wetlands. As such, an Environmental Impact Statement has been prepared and approval is being sought for that part of the proposal under a Part 4 of the EP&A Act. As part of this process, SEARs have been issued, which stipulate the requirements for the EIS. The requirements relevant to Soils and Geology Assessment Report are presented in Table 1-1.

Table 1-1 Secretary's environmental assessment requirements

Reference	Requirement	Where addressed
Soil and water quality	Detail the disturbance of soils and the associated impacts on: • Receiving waterways and wetlands, in particular the Batemans Marine Park	Operational Water Quality Assessment Preliminary Erosion and Sediment Management Report (Appendix D of this report)
	• Groundwater dependent ecosystems	Biodiversity Assessment
	• Surface and groundwater sources and quality	Sections 5 and 6.5 of this report Operational Water Quality Assessment
	• Occurrence of acid sulfate soils and likely disturbance of those soils	Sections 3.3 and 6.4 of this report

1.3 Scope of works

The soils and geology assessment includes the following scope of works:

- a review of existing literature available for the site, relating to information relevant to assessment of the soils, geology and hydrogeology for the site and surrounding area
- identification of potential impacts arising from the proposal associated with soils, geological and/ or hydrogeological considerations
- identification of suitable management measures to mitigate potential construction and operational impacts associated with the proposal
- conclusions and recommendations.

2 Existing environment – assessment methodology

2.1 Soils, geology and hydrogeology

The process of assessing the pedological (soil), geological and hydrogeological conditions affecting the site has included review and presentation of a range of information sources available for the area and existing literature available for the site. A summary of the information sources and existing proposal literature that has been reviewed in developing this report is presented in the following sections.

2.1.1 Soils

Information on soil characteristics, including acid sulfate soils was obtained through review of the following resources:

- NSW Office of Environment and Heritage (OEH) Soil Landscape Series Sheets
- Office of Environment and Heritage (OEH) eSPADE web application (accessed August 2017)
- Eurobodalla Shire Council GIS Mapping Tool (accessed August 2017)
- CSIRO Australian Soil Resource Information System (ASRIS) (accessed August 2017)
- Batemans Bay Bridge: Factual Geotechnical Report for Conceptual Design (Newcastle Geotech 2017)
- Batemans Bay Bridge replacement proposal: Phase 1 Contamination Assessment (Aurecon 2017a)
- Preliminary Erosion and Sediment Management Report – Batemans Bay Bridge replacement Proposal (Strategic Environmental and Engineering Consulting 2017; Appendix D).

2.1.2 Geology

Information on geological characteristics was obtained through review of the following resources:

- NSW Department of Planning and Environment – Resources and Energy (DPE – Resources and Energy) – Geological Series Sheets
- Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources 2016
- Water Sharing Plan for the South Coast Groundwater Sources 2016
- Batemans Bay Bridge: Factual Geotechnical Report for Conceptual Design (Newcastle Geotech 2017)
- Batemans Bay Bridge replacement Proposal: Phase 1 Contamination Assessment (Aurecon 2017a).

2.1.3 Hydrogeology

Information on hydrogeological characteristics was obtained through review of the following resources:

- Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources 2016
- Water Sharing Plan for the South Coast Groundwater Sources 2016
- NSW Department of Primary Industries (DPI) (Water) – Websites and databases containing groundwater bore and aquifer data
- Batemans Bay Bridge: Factual Geotechnical Report for Conceptual Design (Newcastle Geotech 2017)
- Groundwater Investigation at 21 Clyde Street, Batemans Bay, NSW (Environmental Earth Sciences Pty Ltd 2007)
- Batemans Bay Bridge replacement Proposal: Phase 1 Contamination Assessment (Aurecon 2017a).

2.1.4 Existing proposal literature

Geotechnical assessment

A geotechnical site investigation was carried out by Newcastle Geotech between April and May 2017 (Newcastle Geotech 2017), comprising drilling of 12 vertical exploratory boreholes, including:

- eight land-based boreholes (BBL1 to BBL8), advanced using a High Pressure Dilatometer (HPD) mounted drilling rig to an approximate maximum depth of 55.78 mbg (BBL8)
- six over-water boreholes (BBR1 to BBR6) advanced using a truck mounted scout drilling rig, secured to a barge, to an approximate maximum depth of 28mbgl (BBR1: -34.2mAHD).

The location of the geotechnical boreholes are presented in Figure 2-1 and summarised in Table 2-1.

Table 2-1 Geotechnical borehole details

Borehole ID	Approximate Location	Easting	Northing	Surface RL (mAHD)	Termination depth (mAHD)
Land based boreholes					
BBL1	Northern abutment, eastern (downstream) alignment	244897.221	6045461.785	2.22	-2.38
BBL2	Northern abutment, western (upstream) alignment	244861.805	6045484.729	2.22	-12.2
BBL3	Southern abutment, western (upstream) alignment	244556.142	6045302.809	2.02	-36.27
BBL4	Southern abutment, eastern (downstream) alignment	244576.820	6045251.332	1.83	-37.61
BBL5	Southern abutment, southern corner of Clyde Street	244531.096	6045233.506	1.83	-32.30
BBL6	Southern side about 400m from bridge on western side of Princes Highway about 70m south of North Street	244412.865	6044938.916	2.17	-21.11
BBL7	Southern abutment, approximately 30m south of intersection of Princes Highway and Clyde Street in front of residential property	244504.251	6045232.728	2.05	-32.15
BBL8	Near toe of road fill embankment and adjacent to mangroves on the western side of Princes Highway about 60m north of North Street	244461.090	6045136.493	1.02	-56.1
River boreholes					
BBR1	Southern borehole, eastern (downstream) alignment	244676.859	6045263.377	-6.22	-34.22
BBR2	Central, eastern (downstream) alignment	244758.410	6045282.712	-8.57	-26.57
BBR3	Northern, eastern (downstream) alignment	244821.285	6045385.225	-6.96	-22.96
BBR4	Southern, western (upstream) alignment	244626.854	244626.854	-5.45	-26.17
BBR5	Central, western (upstream) alignment	244677.976	6045461.021	-8.91	-23.91
BBR6	Northern, western (upstream) alignment	244724.819	6045481.194	-8.95	-21.88

The results from the geotechnical investigation works are summarised in the Batemans Bay Bridge Factual Geotechnical Report for Conceptual Design (Newcastle Geotech 2017).

Details on the soil and geological units encountered during geotechnical investigation works by Newcastle Geotech are discussed further in Sections 3 and 4 of this report. Aspects concerning groundwater are discussed in Section 5 of this report.

Contamination assessment

A Phase 1 Contamination Assessment was carried out for the proposal (Aurecon 2017a) comprising a desktop review of the physical environment (including soils, geology and groundwater issues) and identification of potential contaminated land risks. The findings from the Phase 1 Contamination Assessment have been reviewed and where appropriate integrated into the content of this assessment relating to the pedological (soil), geological and hydrogeological conditions affecting the site.

Legend

- Land boreholes
- River boreholes
- REF proposal area
- EIS proposal area
- Excluded from proposal area
- Ancillary facility
- Study area

Source: RMS, Aurecon, Esri Topo, RMS, Nearmap

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Projection: GDA 1994 MGA Zone 56

Batemans Bay Bridge replacement

FIGURE 2-1: Geotech Boreholes

3 Soils

3.1 Soils overview

Information obtained through the NSW Office of Environment and Heritage (OEH) indicate no soil mapping data is available for the Batemans Bay area. However, a review of information available through the OEH[1] and esPADE web app[2] indicates the North Batemans Bay portion of the proposal area is located within a zone of predominately Kurosol type yellow Podzolic Sands with minor Hydrosol / Vertosol type Humic Gleys. The portion of the proposal area within Batemans Bay town centre south of the Clyde River is predominately characterised by Rudosol type Siliceous Sands with minor Hydrosol / Vertosol type Humic Gleys.

3.2 Soil and fill materials

Recent investigations in 2017 by Newcastle Geotech identified a limited thickness of topsoil and man-made fill material present within the overall proposal area and surrounds, at land-based locations where exploratory boreholes were drilled (BBL1 to BBL8).

Table 3-1 provides a summary of the soil and fill materials encountered during the exploratory drilling programme, including soil descriptions and relative unit thicknesses and elevations at each of the borehole locations.

Table 3-1 Summary of topsoil and fill materials from geotechnical investigation

Borehole ID	Soil Type	Description	Unit surface (mAHD)	Approx. thickness (m)	Unit base (mAHD)
BBL1	FILL	Sand / Silty Clay	2.22	1.6	0.62
	FILL	Sand	2.02	0.6	1.82
BBL4	FILL	Silty Sand / Gravelly Sandy Clay	1.83	0.9	0.93
BBL6	FILL	Silty Sand / Sand	2.49	0.8	1.69
BBL8	FILL	Sand	1.02	0.7	0.37

Results from geotechnical drilling indicate topsoil is present in only one location (BBL2). Fill materials comprising sand, silty sand, gravelly silty sand and gravelly sandy clay were observed at variable depths, up to a maximum thickness of 1.6m. The base of fill material ranged from 2.02mAHD to 0.37mAHD.

No groundwater or perched water was observed in fill materials encountered during geotechnical drilling works. Aurecon (2017a) identified 15 active registered groundwater boreholes within 500 metres of the overall proposal area. Drillers' records for these boreholes indicate that fill materials range in thickness from approximately 0.2m to 2.0m in the surrounding area around Batemans Bay.

The Phase 1 Contamination Assessment report (Aurecon 2017a) also included a review of a contamination investigation undertaken for a site located at 21 Clyde Street Batemans Bay. This site was previously used as a service station and garage. Low level residual hydrocarbon contamination was identified within underlying soil material and within the underlying alluvial aquifer (this is discussed further in Section 5.2 of this report).

[1] http://data.environment.nsw.gov.au/dataset

[2] http://www.environment.nsw.gov.au/eSpadeWebApp/

The site may also be contaminated by potential asbestos containing material (ACM) in site soils. However, there was no obvious evidence of ACM based upon the site inspection undertaken for the Phase 1 assessment.

3.3 Acid sulfate soils

A review of information available through both the Australian Soil Resource Information System (ASRIS)[3] and OEH[4] on potential for acid sulfate soils indicates that the overall proposal area (particularly the south side of Clyde River) is located within a zone reported as generally having high probability for the presence of acid sulfate soils. Acid sulfate soils are less prevalent on the north side of the Clyde River (North Batemans Bay) giving way to low risk and unknown risk with regards to potential acid sulfate soils.

An acid sulfate soil risk map for the area is presented in Figure 3-1.

Review of the Eurobodalla Council Shire GIS dataset on distribution of acid sulfate soils, indicates that:

- the portion of the proposal area located within Batemans Bay is likely to be affected by Class 3 type acid sulfate soils, which are likely to affect "*works beyond 1 metre below natural surface*" and "*works below the watertable likely to be lowered beyond 1 metre below natural surface*". These are associated with Aeolian Sandplain deposits
- the portion of the proposal area located within the southernmost extent of North Batemans Bay is likely to be affected by Class 2 type acid sulfate soils, which are likely to affect "*Works below natural ground surface*" and "*Works by which the watertable is likely to be lowered*"
- the portion of the proposal area located within the central and northernmost extent of north Batemans Bay is unlikely to be affected by acid sulfate soils, with GIS data indicating low probability of acid sulfate soils.

In addition to the above, review of Department of Land and Water Conservation, Nelligen Acid Sulfate Soil Map (1997) indicates estuarine bottom sediments have a high probability of containing acid sulfate soils.

Based on the information reviewed, in conjunction with geomorphic observations, it is considered that the likelihood of encountering acid sulfate soils throughout the proposal area is high.

[3] ASRIS, http:www.asris.csiro.au

[4] http:www.environment.nsw.gov.au

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FIGURE 3-1: Acid Sulfate Soils

4 Geology

4.1 Geological overview

Information obtained through the DPE – Resources and Energy indicates that the following geological series sheets are available for the site:

- Ulladulla 1:250,000 Geological Series Sheet S1 56-13 (Geological Survey of NSW, 1996);
- Ulladulla 1:250,000 Metallogenic Map Sheet S1 56-13 (Geological Survey of NSW, 1974);
- Eurobodalla 1:100,000 and 1:25,000 Coastal Quaternary Geological Map Series (Geological Survey of NSW, 2013)

The area of Ulladulla 1:250,000 sheet covers part of the Molong – South Coast Anticlinorial Zone (a structural sub-division of the Lachlan Fold Belt) and the Southern Sydney Basin. The Anticlinorial zone consists of large, north-south elongate, cratonized block of Ordovician flysch sediments, overlain by Late Devonian rift volcanics and Late Devonian transitional and cratonic sediments.

A geological map of the local area is presented in Figure 4-1.

4.2 Quaternary Sediments

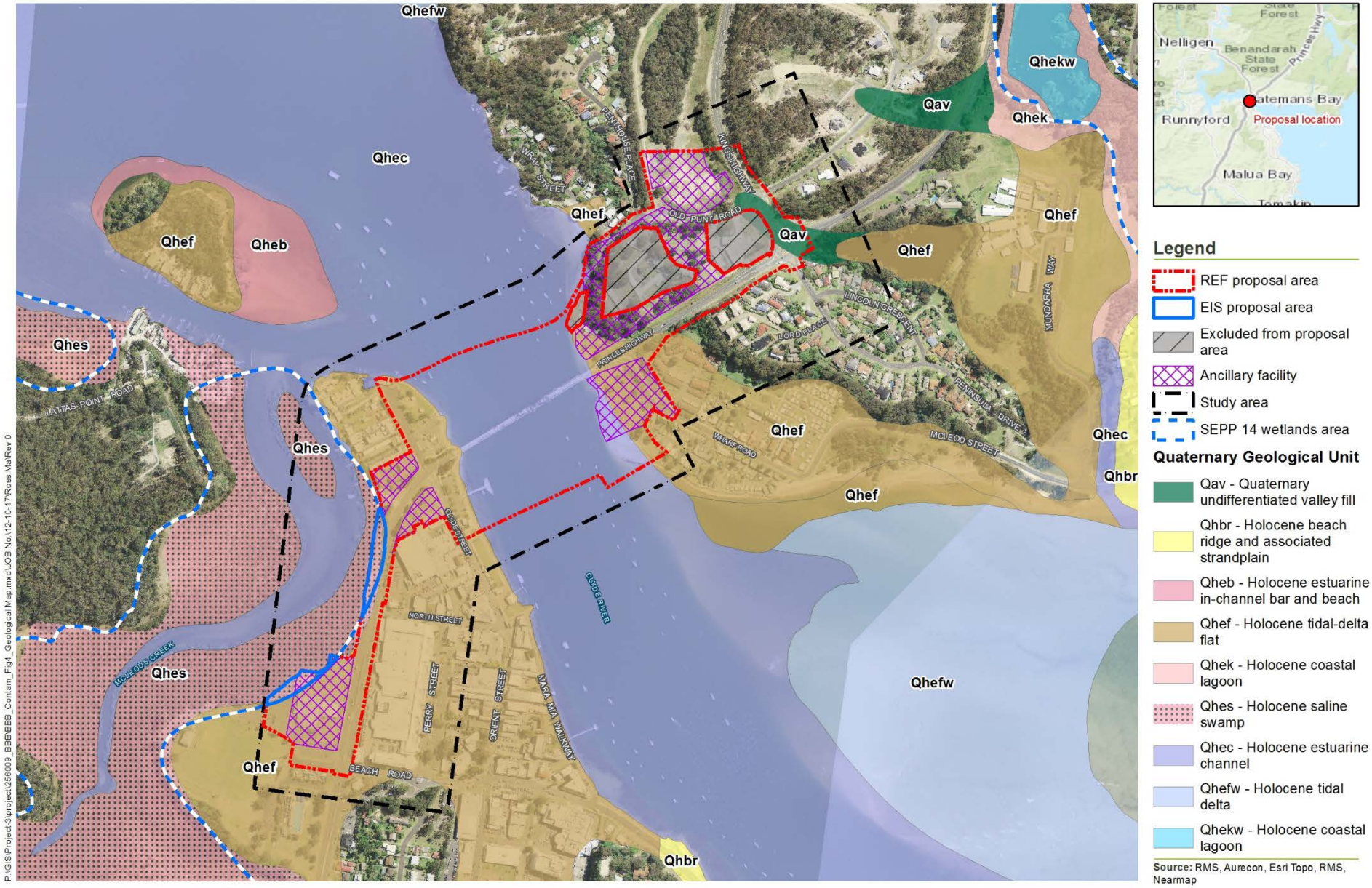
Reference to the Eurobodalla 1:100,000 and 1:25,000 Coastal Quaternary Geological Map Series and Ulladulla 1:250,000 Geological Series Sheet indicates that Quaternary sediments are present beneath the proposed bridge alignment, comprising the following units:

- Holocene age (Qhef) tidal-delta flat: marine sand, silt, clay, shell gravel at the northern and southern abutments of the proposed bridge
- Holocene age (Qhec) subaqueous estuarine channel marine sand, silt, clay, shell and gravel sediments within the river channel
- Holocene age (Qhec) saline swamp, organic mud, peat, clay, silt, marine sand and fluvial sand deposits within the SEPP 14 (Mcleods Creek) wetland area.

Quaternary sediments are underlain by the Ordovician age deposits of the Wagonga Formation.

Recent investigation in 2017 by Newcastle Geotech has identified variable thickness of alluvial sediments to be present within the proposal area and surrounds at both land-based and over-water locations, where exploratory holes have been drilled (BBL1 to BBL8 and BBR1 to BBR6).

Table 4-1 provides a summary of the alluvial sediments encountered during the exploratory drilling program, including a brief description and relative unit thicknesses / elevations at each of the borehole locations.



Legend

- REF proposal area
- EIS proposal area
- Excluded from proposal area
- Ancillary facility
- Study area
- SEPP 14 wetlands area

Quaternary Geological Unit

- Qav - Quaternary undifferentiated valley fill
- Qhbr - Holocene beach ridge and associated strandplain
- Qheb - Holocene estuarine in-channel bar and beach
- Qhef - Holocene tidal-delta flat
- Qhek - Holocene coastal lagoon
- Qhes - Holocene saline swamp
- Qhec - Holocene estuarine channel
- Qhefw - Holocene tidal delta
- Qhekw - Holocene coastal lagoon

Source: RMS, Aurecon, Esri Topo, RMS, Nearmap

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Projection: GDA 1994 MGA Zone 56

Batemans Bay Bridge replacement

FIGURE 4-1: Geological Map

Table 4-1 Summary of quaternary alluvial sediments from geotechnical investigation

Borehole ID	Sediment type	Description	Unit surface (mAHD)	Approx. thickness (m)	Unit base (mAHD)
Land Based Boreholes					
BBL2	Alluvium	Granular Soils (Sand, Silty Sand)	1.82	4	-2.18
BBL4	Alluvium	Granular Soils (Sand, Silty Sand) / Cohesive Soils (Silty Clay, Clayey Silt, Sandy Silt)	0.93	28.87	-27.94
BBL6	Alluvium	Granular Soils (Sand, Silty Sand) / Cohesive Soils (Silty Clay, Clayey Silt, Sandy Silt)	1.69	20.8	-19.11
BBL8	Alluvium	Granular Soils (Sand, Silty Sand) / Cohesive Soils (Silty Clay, Clayey Silt, Sandy Silt, Clays)	0.37	56+	-55.3+
BBR1	Alluvium	Granular Soils (Sand, Silty Sand) / Cohesive Soils (Silty Clay, Clayey Silt, Sandy Silt) / Gravel	-6.22	15.4	-21.62
BBR3	Alluvium	Granular Soils (Sand, Silty Sand)	-6.96	2.4	-9.36
BBR5	Alluvium	Granular Soils (Sand, Silty Sand)	-8.91	5.3	-14.21

Results from geotechnical drilling indicate alluvial materials generally comprising granular soils, cohesive soils and gravel to be present at both land-based and over-water locations.

Review of the borehole logs in the geotechnical report indicate sequences of granular soil are present at shallow depths, subsequently giving way to cohesive materials, which are in turn underlain by gravels. This is in general accordance with fining up and coarsening up sequences that are representative of an avulsing fluvial environment.

Alluvial sediments were observed underlying fill materials at land-based locations and from surface at over-water locations. Unit thicknesses and base elevations vary significantly, from approximately 0.3m to 32.5m thick and with base elevations between -2.58mAHD and -55.3mAHD. The greatest thickness of alluvial sediment was observed at the land-based location BBL8 (56+m), with the minimum thickness of alluvial sediment observed at the over-water location BBR6 (0.3m). Overall thickness and depth of alluvial sediments is generally greater at land-based locations than over-water locations.

4.3 Basement geology

Reference to the Ulladulla 1:250,000 Geological Series Sheet, Metallogenic Map Sheet and accompanying Explanatory Notes indicates that the site is located within an area dominated by Ordovician sediments of the Wagonga Formation, consisting of interbedded chert, black and grey siltstone, pelletal phosphatic siltstone and pelletal phosphorite, fine quartz sandstone, conglomerate and basic volcanics (including pillow lavas). The cherts and siltstones are thinly bedded, heavily jointed and contain pyrite and lenses of quartz sandstone. The amount of phosphatic material decreases southwards. Pebbles in the conglomerate consist

of schist and chert. Deposits of native gold or gold in sulfides are also present within the Ordovician sediments.

Recent investigations in 2017 by Newcastle Geotech has identified variable depth to the Ordovician bedrock units within the general proposal area and surrounds at both land-based and over-water locations, where exploratory holes have been drilled (BBL1-BBL8 and BBR1-BBR6).

Table 4-2 provides a summary of the details for residual and bedrock units encountered during the exploratory drilling programme, including a brief description and relative unit depths / elevations at each of the borehole locations.

Table 4-2 Summary of bedrock from geotechnical investigation

Borehole ID	Sediment type	Description	Unit surface (mAHD)	Approx. thickness (m)	Unit base / termination depth (mAHD)
Land based boreholes					
	Bedrock	Interbedded Argillite / Phyllite / Meta-Siltstone	-2.98	9.99	-12.97
	Bedrock	Interbedded Argillite / Phyllite / Meta-Siltstone	-2.38	9.82	-12.2
BBL4	Bedrock	Interbedded Argillite / Phyllite	-27.94	9.67	-37.61
BBL6	Residual	Silty Clay	-19.11	2	-21.11
BBL7	Bedrock	Meta siltstone and sandstone	-33.15	9+	-41.15
Over-water boreholes					
BBR2	Bedrock	Interbedded Argillite and Meta-Siltstone	-15.72	10.85	-26.57
BBR4	Bedrock	Interbedded Argillite and Meta-Siltstone	-17.55	8.62	-26.17
BBR6	Bedrock	Interbedded Argillite and Meta-Siltstone	-9.25	12.63	-21.88

Results from geotechnical drilling indicate bedrock geological materials generally comprising argillites, phyllites and meta-siltstones, which persist up to termination depth in each borehole and are present at both land-based and over-water locations.

Residual (weathered bedrock) material was encountered at several land-based locations (BBL1, BBL2, BBL6), and generally comprise clayey silty or silty clay ranging from between 0.2m and 2.0m thickness.

The top of bedrock geological units were encountered at variable depths, ranging from -2.38 mAHD (BBL2) to -33.15mAHD (BBL7). Variation in depth was more pronounced at land based locations than over-water locations where top of bedrock was generally encountered between -9.25 mAHD (BBR6) and -21.62 mAHD (BBR1). Bedrock was not reached at BBL8.

4.4 Summary

Information of geological setting, obtained through the DPE – Resources and Energy indicates the site is located within the Molong – South Coast Anticlinorial Zone, which consists of large, north-south elongate,

cratonized block of Ordovician flysch sediments, overlain by Late Devonian rift volcanics and Late Devonian transitional and cratonic sediments.

Geological mapping indicates that the site is located within an area underlain by both Ordovician sediments of the Wagonga Formation and Quaternary alluvium.

Results from the geotechnical investigation indicate that the site area at on-land based locations is generally characterised by a shallow thickness of man-made fill material (approximately 0.4-1.6m), overlying a variable thickness of Quaternary Sediments (approximately 0.3-32.5m), which in turn overlie the Ordovician bedrock.

Fill materials include silty sands and gravelly sandy clays. Quaternary sediments include granular sediments, cohesive sediments and gravels. Ordovician bedrock includes interbedded argillite, phyllite and meta-Siltstone.

Top elevations for geological units are highly variable across the site, with more pronounced variability at on-land locations than over-water locations. Ordovician bedrock elevations range from approximately -2.4mAHD to -31.4mAHD at over-land locations and from -9.25mAHD to -26.6mAHD at over-water locations.

Borehole logs prepared by Newcastle Geotech are presented in Appendix A. Table 4-3 presents a general summary of the units and the order in which they were encountered.

Table 4-3 Geotechnical investigation – summary of geological units encountered

Subsurface unit	Description
Man-Made Fill	Silty Sand
	Gravelly Sandy Clay
Quaternary Alluvium	Granular Soils (G) (Sand, Silty Sand)
	Cohesive Soils (C) (Silty Clay, Clayey Silt, Sandy Silt)
	Gravel (GR)
Residual Soil	Cohesive Soil
Ordovician Bedrock	Argillite
	Phyllite
	Meta-Siltstone

5 Hydrogeology

5.1 Hydrogeological overview

Information obtained through the NSW DPI (Water) indicates that groundwater within the site area, including Batemans Bay and the Clyde River are managed under the Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources (2016) and Water Sharing Plan for the South Coast Groundwater Sources (2016).

No specific information is available on physical properties or quality of alluvial or bedrock aquifers for the regional area, however it is understood that flow through alluvial sediments is through primary porosity, whilst fracture flow dominates the bedrock aquifer.

5.2 Quaternary alluvial sediments

Geological mapping has identified alluvial sediments underlying the proposal area. Information available in the Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources (2016) (under which alluvial water is managed) identifies the alluvial water sources as:

"*All water contained within all alluvial sediments below the surface of the ground within the boundaries of these water sources (these alluvial sediments) shown on the Plan Map*"

These water sources do not include any water that is:

- contained in any fractured rock or porous rock
- contained in all sand formations below the surface of the ground within the boundary of the South East Coastal Sands Groundwater Source shown on the Plan Map in the Water Sharing Plan for the South Coast Groundwater Sources 2016
- occurring in rivers, lakes estuaries and wetlands downstream of the mangrove limit.

The plan map for the Clyde River Unregulated and Alluvial Water Sources is presented in Appendix B. Quaternary alluvial water sources are considered unconfined aquifers within the area of Batemans Bay and the proposal area.

Review of borehole access data (Aurecon 2017a) and results from recent geotechnical investigations (Newcastle Geotech, 2017) indicate groundwater is present at shallow depths within alluvial sequences ranging between approximately 1.6 mbgl and 3.0 mbgl.

Two of the eight land-based exploratory boreholes (BBL2 and BBL4) drilled by Newcastle Geotech were installed as groundwater wells for the purpose of monitoring water levels and quality.

Four groundwater monitoring events were carried out (4 May, 24 May, 14 June and 15 June 2017) which reported generally stable groundwater depths of between 2.05 mbgl and 2.15 mbgl. It should be noted groundwater monitoring within areas close to the river and Batemans Bay, are likely to be affected by tidal influences and ranges in groundwater level may vary more significantly than indicated during peak ebb and flow periods.

Groundwater sampling carried out on 15 June 2017 for monitoring wells BBL2 and BBL4 reported total dissolved solids (TDS) concentrations of approximately 4,800 to 4,900 (mg/L) which would classify groundwater to be saline in nature (2,000-10,000 mg/l). No hydrocarbon contaminants were reported from samples collected.

An historic groundwater investigation was carried out by Environmental Earth Sciences Pty Ltd (EES 2007) in August 2007 for a property within the site area identified as 21 Clyde Street Batemans Bay. Results from the EES investigation identified water levels within the Quaternary alluvial sediments at depths between 1.2 and 1.8mbgl (0.25 to 0.39mAHD) with flow towards the west and the Clyde River. Subsequent aquifer testing by EES identified hydraulic conductivities within the alluvial sediments ranging from 3.3 to 5.8m/day.

Groundwater quality testing results identified low level hydrocarbon contamination in groundwater, no data on groundwater salinity was recorded.

5.3 Ordovician bedrock

Information available in the Water Sharing Plan for the South Coast Groundwater Sources indicates that the site is located within an area characterised by the Lachlan Fold Belt Coast Groundwater Source with localized pockets of the South East Coastal Sands Groundwater Source. The Lachlan Fold Belt Coast Groundwater Source is described as:

"All water contained in all fractured rock below the surface of the ground within the outcropped and buried areas within the boundary of the Lachlan Fold Belt Coast Groundwater Source, as shown on the Lachlan Fold Belt Coast Groundwater Source Plan Map."

And the South East Coastal Sands Groundwater Source is described as:

"*All water contained within all sand formations below the surface of the ground within the boundary of the South East Coastal Sands Groundwater Source shown on the Plan Map.*"

The plan map for the South Coast Groundwater Sources is presented in Appendix C. These groundwater sources do not include water contained in any alluvial sediments, and so will apply to Ordovician bedrock units in the vicinity of Batemans Bay.

Groundwater conditions were not recorded for Ordovician bedrock units by Newcastle Geotech during geotechnical investigation works, however it is highly likely that groundwater is present with significant flow within the fractured bedrock.

Borehole data available through the NSW DPI (Water). Groundwater indicates an historic borehole (licence cancelled) was advanced into the Ordovician bedrock for industrial purposes. Borehole information indicates a screened interval between 19.7 and 31.7mbgl with a standing water level of 3mbgl. Salinity data is not available for this borehole. Borehole yield is reported as 4.00 (possibly litres/second).

6 Potential impacts and management measures

6.1 Overview

Construction and operation of the proposal may lead to adverse impacts on soils, sediments and groundwater if appropriate management measures are not employed. Construction activities may expose soils and disturb sediments which increase the risk of erosion and sedimentation in the river. Operation could potentially lead to increased quantities of pollutants or accidental spills, which could discharge to underlying aquifers.

6.2 Soils

6.2.1 Construction impacts

The construction phase of the proposal would involve both land-based and water-based activities which may present a risk to soil, sediment and water quality if management measures are not implemented, monitored and maintained throughout the construction process.

The risks from land-based construction works are likely to arise during rainfall and wind events, where sediments or pollutants resulting from construction can flow or be blown to sensitive receiving environments. These may include:

- earthworks, including stripping of vegetation and topsoil, excavation or filling
- stockpiling of topsoil, vegetation and other construction materials
- transportation of cut or fill materials
- movement of heavy vehicles across exposed earth
- removal of riparian vegetation
- construction in any areas of highly erodible soils
- construction in any contaminated land or the construction of flow pathways to enable contaminated groundwater to flow into new areas – see section 6.3
- construction in any acid sulfate soils – see section 6.4.

These activities expose soils and without proper management may result in sediments and associated pollutants being washed during rainfall events or blown into downstream watercourses, with consequent potential degradation of water quality and / or groundwater quality. Care must be taken within the foreshore area to limit disturbance of estuary sediments which may result in generation of turbidity and other water quality impacts.

The water-based construction activities may cause disturbance of marine sediments. If unmitigated or inadequately managed, this could cause a decline in water quality and visual amenity adjacent to construction activities.

6.2.2 Construction management measures

A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks would be addressed during construction.

A site specific Erosion and Sediment Control Plan/s (ESCP) will be prepared and implemented as part of the SWMP. This plan will develop further on the Conceptual Erosion and Sedimentation Management Report located in Appendix D. The ESCP will include arrangements for managing wet weather events, and specific controls and follow-up measures to be applied in the event of wet weather.

The SWMP will be reviewed by a soil conservationist on the Roads and Maritime list of registered contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services.

6.2.3 Operation

During the operational phase of the proposal, pavements would be sealed, cleared areas rehabilitated and scour protection installed. No exposed topsoil would be present and therefore pose minimal risk of soil erosion and transport of eroded sediments to the river.

Stormwater treatment measures would be provided to treat runoff and capture spills from the overall proposal. This is further discussed in the Operational Water Quality Report (Aurecon 2017b).

6.3 Contamination

A Phase 1 Contamination Assessment was carried out for the proposal (Aurecon 2017a). The results of the contamination assessment identified the potential for significant widespread contamination to be present throughout the proposal area, as a result of past and present land use activities, is generally low. However, the report identified potential for legacy contamination issues associated with the vacant land at 21 Clyde Street (former service station "*Batemans Bay Motors*"), which is affected by residual low level hydrocarbon contamination and may also be affected by potential ACM in site soils (EEC 2007). However, there was no obvious evidence of ACM based upon the site inspection undertaken for the Phase 1 assessment (Aurecon 2017a).

The Phase 1 Contamination Assessment identified the requirement under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) to provide Eurobodalla Shire Council with an up to date assessment of site conditions (both soil and groundwater) at 21 Clyde Street to ensure that there has been no significant change to the previous (2012) reported conditions, and to provide opinion on the site's suitability for the proposal. Additional contamination assessments of 21 Clyde Street will be carried out to inform the management requirements for construction

6.3.1 Construction impacts

One ancillary facility site at 21 Clyde Street is potentially affected by residual contamination associated with its former use as a service station. If this site is not disturbed and used for activities such as spoil stockpiling or as a laydown area and storage, the risk of disturbing any remaining contamination is low. Works on and adjacent to the site which disturb soils (eg utility relocations) have the potential to encounter contamination from the previous land use and additional management measures would be required to minimise impacts.

Asbestos containing material may be present where imported fill has been used, where buildings constructed before 1997 are located or where asbestos has been previously dumped.

There is also potential for the proposal to generate contamination as a result of on-site activities (through leaks, spills, discharges, dumping), and through disturbance of unknown in-situ contaminated soils (such as asbestos, hydrocarbons or chemical impacted soils). These activities have potential to result in generation, spread and / or mobilisation of contamination to the environment.

6.3.2 Construction management measures

Environmental safeguards and management measures for potential contamination impacts include:

- Areas of known contamination to be managed under a contamination management plan prepared in accordance with the *Guideline for the Management of Contamination* (Roads and Maritime, 2013) and implemented during construction
- capture and management of any contaminated surface runoff
- further investigations required to determine the extent, concentration and type of contamination relevant to the proposal, including asbestos, lead and treated timber
- remediation and subsequent validation of identified contaminated land, including any certification required

- a procedure for the management of unexpected contamination identified during construction
- measures to ensure the safety of site personnel, local communities and the environment during construction
- Visual monitoring to identify potentially contaminated material or soils
- if it is confirmed that contaminated material or soils are identified on site and present an unacceptable risk to human health or the environment, an appropriate remedial action plan (RAP) will be developed and implemented.

6.3.3 Operational impacts

Operation of the proposal is unlikely to result in significant risks to human health or the environment. The stormwater treatment and spill containment measures would reduce any contamination risks from the overall proposal to acceptable levels.

6.3.4 Operational management measures

The design will consider the potential to create and mitigate preferential pathways for contaminants from offsite sources (such as septic tanks or sewers) to discharge to groundwater or surface water.

6.4 Acid sulfate soils

There is a high risk of encountering actual or potential acid sulfate soils as the overall proposal is located in an estuarine environment. Works on the southern bank and in the river including pier construction and utility relocation have been identified as having the highest risk of the encountering actual or potential acid sulfate soils.

Recent geotechnical investigation by Newcastle Geotech (2017) included limited testing of soils for acid sulfate soils. Soils from three depths at BBL 7 were analysed for the presence and strength of actual and potential acid sulfate soils (refer to Figure 2-1). The results suggest that low strength potential acid sulfate soils may be located in the area near BBL7 However more testing is required to confirm the presence and strength of actual and/or potential acid sulfate soils, which may be disturbed by the proposal.

6.4.1 Construction impacts

Excavation would be required for construction of the overall proposal and there is high likelihood that actual or potential acid sulfate soils would be encountered. If actual or potential acid sulfate soils are excavated they may impact the environment, groundwater or structures through generation of low pH (acidic) water or groundwater. It should be noted that the oxidation of the acid sulfate soils would not be instantaneous and would occur over a period of weeks or months.

Any dewatering, exposure or stockpiling of actual or potential acid sulfate soils over a prolonged period has the potential to generate low pH runoff and acidified soil. Appropriate management measures described in the following sections would minimise the risk of impacts.

6.4.2 Construction management measures

An Acid Sulfate Soils Management Plan will be developed and implemented during construction. This plan will be prepared in accordance with the *Roads and Maritime Guidance for the Management of Acid Sulphate Materials 2005* (RTA 2005a) and form part of the SWMP.

6.4.3 Operational impacts

Operation of the overall proposal will not result in a significant risk from acid sulfate soils.

6.4.4 Operational management measures

No management measures are likely to be required to manage acid sulfate soils during the operation of the proposal.

6.5 Groundwater

6.5.1 Construction impacts

Aquifers in the proposal area comprise unconfined units associated with Quaternary alluvium and fractured geology associated with the underlying Ordovician Meta-Sediments. Groundwater in the Quaternary alluvium is observed at a relatively shallow depth (1.6 m to 3.0 m) and with relatively saline quality (4,800 mg/L to 4,900 mg/L). The high salinity suggest that coastal and estuarine waters influence the salinity of the aquifer and typically these coastal aquifers have highly variable salinity with lower salinity after periods of heavy rainfall. The high and variable salinity would limit the use of the aquifer for drinking water, irrigation or other human uses. However, the aquifer would support groundwater dependent ecosystems and also provide structural stability for the overlying sandy soils.

Information relating to aquifer potential, productivity and groundwater conditions in the underlying Ordovician bedrock is generally unknown, however limited information obtained through the NSW DPI (Water) Groundwater databases indicates that groundwater may be encountered between 20 mbgl and 40 mbgl with a potential yield of 4.0l/s. Groundwater quality in the underlying Ordovician bedrock is unknown. However, impacts on this groundwater zone are unlikely given the typical depth of the groundwater zone below the surface and the relative depth of construction works.

Under the NSW Aquifer Interference Policy (NSW Office of Water, 2012), thresholds for key minimal impact considerations for both highly productive and less productive groundwater sources have been developed. Potential impacts include criteria for water table, water pressure and water quality. The risk of impact to groundwater from construction activities would be low as:

- no construction activities would potentially interfere with or meet the impact criteria for the underlying Ordovician aquifers
- apart from piling and utility relocation, no construction activities would potentially interfere with or meet the impact criteria for the Alluvium aquifer. Piling and utility relocation impacts are discussed below.
- groundwater flow appears to be towards the Clyde River and/or Batemans Bay. The proposal is down gradient of nearby groundwater bores and would be unlikely to decrease groundwater levels at these bores, which are located further away from the river
- as the proposal area is relatively small, it would have a relatively small underground cross-sectional area and therefore the proposal's potential to impact on groundwater flows would be minimal.

Piling and utility relocations may occur in areas where the Alluvium aquifer is present and close to the ground surface. These construction activities may require dewatering or have the potential to cause other impacts on the aquifer.

Typically no dewatering would be required for piling activities, however, there are many different construction options for piling and some of those do require dewatering. The REF proposes bored piling for land-based piling and this type of piling may require a metal sleeve or dewatering if groundwater inflow to the pile hole is substantial. Utilities are often located in the lowest point of the topography and consequently groundwater may be encountered during the excavation of service trenches. If the ingress of water into the services trench is substantial, the localised temporary dewatering of surrounding soils may be required to allow the utility construction to be completed. The need, location and type of dewatering activities would be determined during the detailed design and construction phases and appropriate management measures implemented. The need for any approvals under the *Water Management Act 2000* would be determined in consultation with DPI (Water).

The only other potential construction impact on groundwater would be the generation of preferential flow pathways (eg from piling, dredging or emplacement of supporting infrastructure) which could allow external sources of contamination (if present) to seep into the underlying quaternary or fractured bedrock aquifers.

Potential impacts would be mitigated through implemented of the management measures described in the following sections.

6.5.2 Construction management measures

The following management measure would be implemented:

- the design will consider the potential to create and mitigate preferential pathways for contaminants from offsite sources (such as septic tanks or sewers) to discharge to groundwater or surface water
- Further investigations will be undertaken during detailed design to confirm the depth of groundwater near the overall proposal and any potential impacts. If groundwater impacts are likely, a groundwater management plan will be developed and form part of the CEMP. If required, an approval under the *Water Management Act 2000* will also be obtained following consultation with the DPI Water.
- if dewatering is required, a dewatering management plan would be developed and relevant approval obtained in consultation with DPI (Water).

6.5.3 Operational impacts

Impacts to groundwater and underlying aquifers as a result of the operation of the proposal are considered unlikely.

6.5.4 Operational management measures

No mitigation measures are considered necessary for the operation of the proposal.

7 Conclusions

7.1 Soils

Review of the Eurobodalla Council Shire GIS dataset on distribution of acid sulfate soils, indicates that the REF and EIS proposal areas are likely to be affected by Class 2 and Class 3 type acid sulfate soils. Care should be taken during construction, in particular during excavation activities, to limit generation of acid sulfate soils which may impact the environment, groundwater or structures through generation of low pH water or groundwater. Management of these issues would be addressed through an appropriate acid sulfate soil management plan.

Activities which expose soils and without proper management may result in sediments and associated pollutants being washed during rainfall events or blown into downstream watercourses, with consequent potential degradation of water quality and / or groundwater quality.

A preliminary Erosion and Sediment Management Report has been prepared for the proposal (SEEC, 2017; Appendix D). The risks, impacts and management measures would be minimised through the implementation of the plan.

7.2 Contamination

A Phase 1 Contamination Assessment was carried out for the proposal (Aurecon 2017a). The report concluded a low potential for significant widespread contamination to be present throughout the proposal area. However, the report identified potential for legacy contamination issues associated with the vacant land at 21 Clyde Street (former service station "*Batemans Bay Motors*") which is impacted by residual low level hydrocarbon contamination and potential ACM in surface soils. The proposal could be affected by residual contamination associated with the relocation of utilities adjacent to 21 Clyde Street.

Asbestos containing material may be present where imported fill has been used, where buildings constructed before 1997 are located or where asbestos has been previously dumped.

There is the potential for the proposal to generate contamination as a result of on-site activities (leaks, spills, discharges, dumping), and through soil disturbance of in-situ contaminated soils (asbestos / hydrocarbon / chemical impacted soils). These activities may result in the generation, distribution and / or mobilisation of contaminates to the environment. No known areas of contamination occur within the EIS proposal area.

7.3 Groundwater

Aquifers in the REF and EIS proposal areas comprise unconfined units associated with Quaternary alluvium and fractured geology associated with the underlying Ordovician Meta-Sediments.

Groundwater within the alluvial aquifers is managed under the Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources (2016), whilst groundwater in the underlying fractured (Ordovician) bedrock is managed under the Water Sharing Plan for the South Coast Groundwater Sources (2016).

Groundwater in the Quaternary alluvium is observed at a relatively shallow depth (1.6 m to 3.0 m) and with relatively saline quality (4,800 mg/L to 4,900 mg/L). Information relating to aquifer potential, productivity and groundwater conditions in the underlying Ordovician bedrock is generally unknown.

The risk of impact to groundwater from construction activities would be low due to a number of factors, including the relatively small underground footprint of the proposed design and absence of activities likely to significantly interfere with groundwater. There is however potential for impacts to the groundwater resulting from construction activities through dewatering and the generation of preferential pathways for external sources of contamination to seep into the underlying aquifers. The potential impacts from these issues would be managed through the appropriate management and design measures. The need for any approvals under the *Water Management Act 2000* would be determined in consultation with DPI (Water).

8 References

- Aurecon Australasia Pty Ltd, 2017a: Phase 1 Contamination Assessment – Batemans Bay Bridge replacement, July 2017, Reference 256009-005-01, Prepared for Roads and Maritime Services
- Aurecon Australasia Pty Ltd, 2017b: Operational Water Quality Report – Batemans Bay Bridge replacement, September 2017, Prepared for Roads and Maritime Services
- Environmental Earth Sciences, 2007: Groundwater Investigation at 21 Clyde Street, Batemans Bay, New South Wales, Reference 107086, Environmental Earth Sciences Pty Ltd, New South Wales.
- Newcastle Geotech Pty Ltd, 2017: Batemans Bay Bridge Factual Geotechnical Report for Conceptual Design, Reference 326-2a, Newcastle Geotech Pty Ltd.
- Newcastle Geotech Pty Ltd, 2017: Clyde River Bridge Batemans Bay Factual Geotechnical Report for Conceptual Design Addendum 1, Reference 326-4a, Newcastle Geotech Pty Ltd
- New South Wales Government, 2017: Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources 2016.
- New South Wales Government, 2017: Water Sharing Plan for the South Coast Groundwater Sources 2016.
- New South Wales Department of Primary Industries, 2012: NSW Aquifer Interference Policy 2012.

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Appendices

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Appendix A
Newcastle Geotech Pty Ltd – Reproduced Borehole Logs

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EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

GENERAL

Information obtained from site investigations is recorded on log sheets. The "Cored Drill Hole Log" presents data from an operation where a core barrel has been used to recover material - commonly rock. The "Non-Core Drill Hole - Geological Log" presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

AS	Auger Screwing
AD/V	Auger Drilling with V-Bit
AD/T	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.


Standing water level measured in completed borehole


Level taken during or immediately after drilling

Samples/Tests

D	Disturbed
U	Undisturbed
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (* sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Test
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer

Angle/Orientation: Angle from horizontal and orientation to magnetic north.

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

	Description	Su	HP
	Very Soft	≤ 12kPA	< 25kPa
	Soft	12 - 25 kPa	25 - 50 kPa
	Firm	25 - 50 kPa	50 - 100 kPa
	Stiff	50 - 100 kPa	100 - 200 kPa
	Very Stiff	100 - 200 kPa	200 - 400 kPa
	Hard	≥ 200 kPa	≥ 400 kPa

Strength figures quoted are the approximate range of Unconfined Compressive Strength for each class.

Density Index (%) is estimated or is based on SPT results. Approximate N Value correlation is shown in right column.

	Description	Density Index	SPT Value
VL	Very Loose	< 15%	0 – 4
L	Loose	15 – 35%	4 – 10
MD	Medium Dense	35 – 65%	10 – 30
D	Dense	65 – 85%	30 – 50
VD	Very Dense	> 85%	> 50

MATERIAL DESCRIPTION - ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Description	**Spacing** (mm)
Thinly Laminated	< 6
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 -200
Medium Bedded	200 - 600
Thickly Bedded	600 - 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

F	**Fresh**	Rock substance unaffected by weathering
SW	**Slightly Weathered**	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
MW	**Moderately Weathered**	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
HW	**Highly Weathered**	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
EW	**Extremely Weathered**	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

	Rock Strength Class	**Point Load Strength Index, Is(50)** (MPa)
EL	**Extremely Low**	< 0.03
VL	**Very Low**	0.03 - 0.1
L	**Low**	0.1 - 0.3
M	**Medium**	0.3 - 1.0
H	**High**	1.0 - 3.0
VH	**Very High**	3.0 - 10.0
EH	**Extremely High**	≥ 10.0

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

- ○ Diametral Point Load Test
- ● Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects	————	Defects open in-situ or clay sealed
	- - - - - - - -	Defects closed in-situ
	.....	Breaks through rock substance

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Type	BP	Bedding Parting
	JT	Joint
	SM	Seam
	FZ	Fracture Zone
	SZ	Shear Zone
	VN	Vein
	FL	Foliation
	CL	Cleavage
	DL	Drill Lift
	HB	Handling Break
	DB	Drilling Break

Orientation - angle relative to the plane normal to the core axis.

Infilling	CN	Clean
	X	Carbonaceous
	Clay	Clay
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
	MS	Secondary Mineral
	MU	Unidentified Mineral
Shape	PR	Planar
	CU	Curved
	UN	Undulose
	ST	Stepped
	IR	Irregular
	DIS	Discontinuous
Roughness	POL	Polished
	SL	Slickensided
	S	Smooth
	RF	Rough
	VR	Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL1
FILE / JOB NO : SG0109
SHEET : 1 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - EAST SIDE

POSITION : E: 244897.221, N: 6045461.785 (56 MGA94) SURFACE ELEVATION : 2.221 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 19/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
HA	N/A			D	0.0			SAND: brown, fine to coarse grained sand, trace shells, roots.			FILL
				0.50m D			SW		M		
		E		1.00m D	1.0			1.00m SILTY CLAY: red-brown, low plasticity, charcoal.			
HW Casing							CL	SILTY CLAY: dark grey, fine to medium gravel (quartz), low plasticity			
				1.60m				1.60m	M - W		
				1.80m D				SILTY SAND: grey, brown, fine to coarse grained sand, trace shells.		VL	ALLUVIUM
			19/04/17	2.00m	2.0						
				2.50m SPT 2, 1, 1 N*=2				SILTY SAND: grey, brown, fine to coarse grained sand, trace shells			2.50: SPT Recovery: 0.45 m
				2.95m	3.0			3.10m: trace gravel			
		E-VE					SM				
Guar Gum									W		
				4.00m SPT 5, 5, 5 N*=10	4.0			SILTY SAND: grey, fine to coarse grained sand, with shells		L - MD	4.00: SPT Recovery: 0.45 m
AD/T				4.45m				4.80m			
		F			5.0		ML	CLAYEY SILT: green, brown, low plasticity		St	RESIDUAL SOIL
HQ Casing				5.20m SPT 18, 19, 22 N*=41				5.20m PHYLLITE: brown, grey, highly becoming moderately weathered.			BEDROCK 5.20: SPT Recovery: 0.45 m
				5.65m	6.0			6.00m Continued as Cored Drill Hole			
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL1
FILE / JOB NO : SG0109
SHEET : 2 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - EAST SIDE

POSITION : E: 244897.221, N: 6045461.785 (56 MGA94) SURFACE ELEVATION : 2.221 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 19/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	CORE LOSS (RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0							
				1.0							
				2.0							
				3.0							
				4.0							
				5.0							
				6.0		6.00m START CORING AT 6.00m					
NMLC	0% LOSS	0% LOSS				6.15m PHYLLITE: brown	HW				BP 70° S
						ARGILLITE: brown, fine to medium grained	MW				BP 70° S
						6.40m					
						6.55m PHYLLITE: brown	HW				
						ARGILLITE: brown, fine to medium grained	MW - SW				DB DB HB
		6.75		7.0		7.20m					
		0% LOSS	Is(50) d=0.53 MPa			META SILTSTONE (SANDY): grey some brown-orange, fine grained					VN 50° Qz JT 60° RF
	0% LOSS	0% LOSS	Is(50) d=0.44 MPa Is(50) d=0.33 a=0.31								
				8.0		8.00m					JT 50° RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL1
FILE / JOB NO : SG0109
SHEET : 3 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - EAST SIDE

POSITION : E: 244897.221, N: 6045461.785 (56 MGA94) SURFACE ELEVATION : 2.221 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 19/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING

PROGRESS: DRILLING & CASING; WATER; (CORE LOSS RUN %); DRILL DEPTH

SAMPLES & FIELD TESTS

DRILL DEPTH	(CORE LOSS RUN %)	SAMPLES & FIELD TESTS
	MPa	
8.25	0% LOSS	
	0% LOSS	
	0% LOSS	Is(50) d=0.22 MPa Is(50) d=0.08 MPa
9.50		
	0% LOSS	
	0% LOSS	Is(50) a=0.44 MPa Is(50) d=0.41 MPa
11.10		Is(50) d=0.58 MPa
	0% LOSS	Is(50) d=0.98 MPa
	0% LOSS	Is(50) d=0.65 MPa Is(50) a=0.51 MPa
12.64		Is(50) d=0.19 MPa
	0% LOSS	
	0% LOSS	Is(50) d=1.72 MPa Is(50) d=1.96 MPa
15.19		Is(50) d=2.06 a=1.65 MPa

NMLC

DEPTH (m): 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0

MATERIAL

GRAPHIC LOG

DESCRIPTION
ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)

Weathering

ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral
EL VL L M H VH EH
-0.03 -0.1 -0.3 -1 -3 -10

Depth	Description	Weathering
	META SILTSTONE: brown and grey	MW
8.41m		
8.55m	PHYLLITE: grey	
	ARGILLITE: brown, fine to medium grained, with bands metasiltstone (brown/grey).	MW - SW
9.00m		
	INTERBEDDED ARGILLITE AND META SILTSTONE /PHYLLITE: brown	
9.40m		
	ARGILLITE: brown, fine to medium grained	
12.40m		
	META SILTSTONE /PHYLLITE: brown, red, green	
13.40m		SW - F
	ARGILLITE: green, grey, fine grained	
15.19m		
	BOREHOLE BBL1 TERMINATED AT 15.19 m	
	Note: foliation: 80-85°, bedding: 70-75°	

FRACTURES

NATURAL FRACTURE (mm): 20, 40, 100, 300, 1000

VISUAL

ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other

- JT 25° S
- JT 75° S
- JT 75° S
- DB
- JT 10° S
- SM 75° highly weathered
- JT 45° Fe RF
- JT 55° Fe RF
- DB
- DB
- Fe SN silified
- SM 20° Clay 10 mm
- SM 20° Clay 20 mm
- SM 3° Clay
- DB
- DB
- DB
- FC 75°
- FC 75°
- JT 75° S
- JT 80° Fe RF

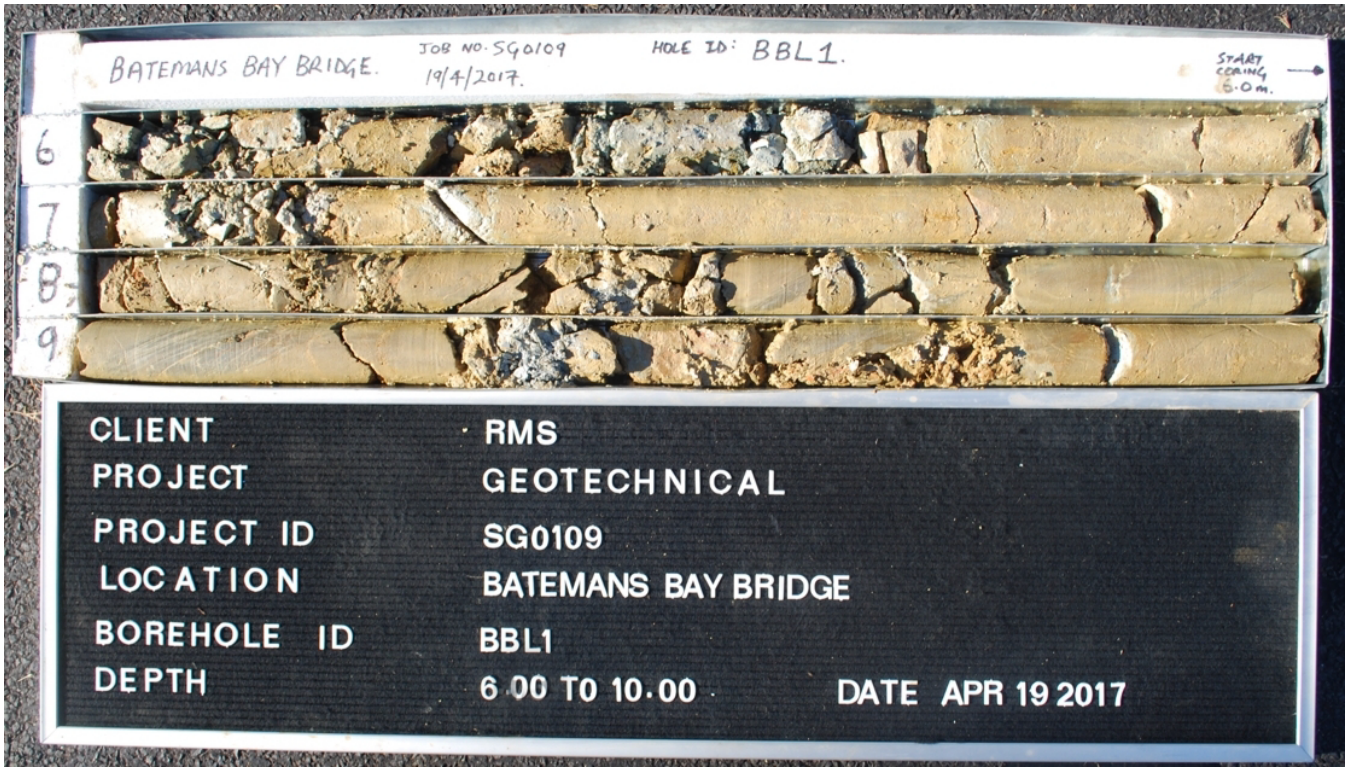
See Explanatory Notes for details of abbreviations & basis of descriptions.

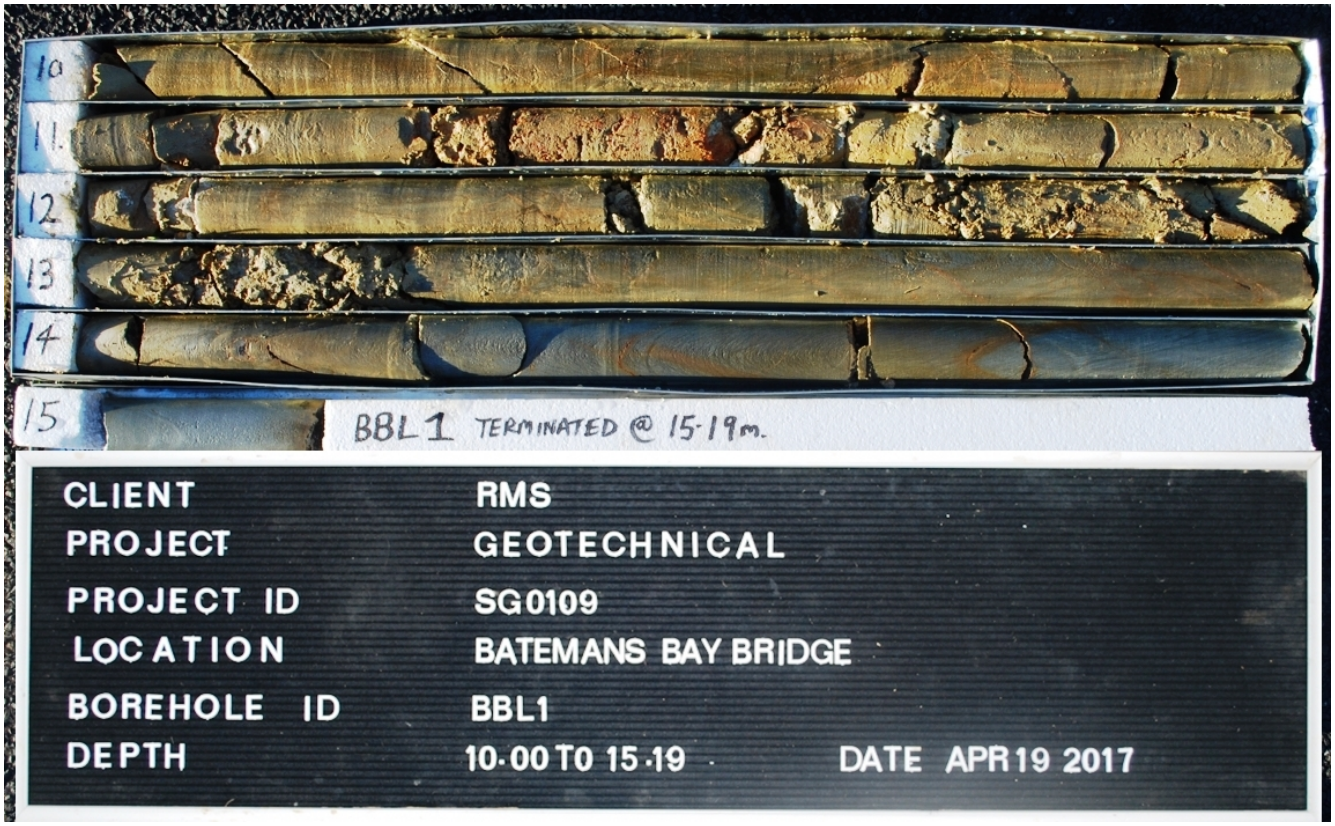
ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services NSW GOVERNMENT

File: SG0109 BBL1 3 OF 3

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:59 8.2.843 Datgel Tools





Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBL1**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL2
FILE / JOB NO : SG0109
SHEET : 1 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - WEST SIDE

POSITION : E: 244861.805, N: 6045484.729 (56 MGA94) SURFACE ELEVATION : 2.217 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 20/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
HA HW Casing	N/A			D	0.0		SM	SILTY SAND: dark brown, fine to coarse grained sand, roots.			TOPSOIL / FILL
								0.20m			
							SW	SAND: brown, fine to coarse grained sand, trace fine rounded quartz gravel, trace shells.			FILL
								0.40m			
				0.50m D				SAND: brown, fine to coarse grained sand, trace shells.			ALLUVIUM
				1.00m D	1.0				M		
				1.50m D							
									M - W		
				2.00m	2.0		SW				
AD/T HQ Casing	Guar Gum	VE	04/05/17	2.50m SPT 1, 2, 2 N=4				SAND: brown, fine to coarse grained, trace shells		VL - L	2.50: SPT Recovery: 0.45 m
				2.95m	3.0						
								3.40m			
								SILTY SAND: dark grey, fine to coarse grained sand, with shells.	W		
				3.90m SPT 0, 3, 3 N=6			SM				3.90: SPT Recovery: 0.45 m
				4.35m	4.0						
								4.40m			
		F-H		4.50m SPT 7, 14, 15 N=29			ML	CLAYEY SILT: green, low to medium plasticity		St	RESIDUAL SOIL 4.50: SPT Recovery: 0.45 m
								4.60m			
				4.95m	5.0			PHYLLITE: brown, green/grey, extremely to highly weathered.			BEDROCK
								5.13m			
								Continued as Cored Drill Hole			
					6.0						
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL2
FILE / JOB NO : SG0109
SHEET : 2 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - WEST SIDE

POSITION : E: 244861.805, N: 6045484.729 (56 MGA94) SURFACE ELEVATION : 2.217 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 20/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0							
				1.0							
				2.0							
				3.0							
				4.0							
				5.0		5.13m START CORING AT 5.13m					
NMLC	0% Water LOSS	0% LOSS 5.40	Is(50) d=0.34 MPa	6.0		PHYLLITE /METASILTSTONE WITH BANDS ARGILLITE: green, grey, brown	MW - SW				SM 75° Clay 20 mm SM 75° Clay 20 mm
		0% LOSS 6.85					EW - HW				SM Clay
		0% LOSS		7.0			MW - HW				VN 20° Qz VN 20° Qz
			Is(50) d=0.14 MPa			7.50m ARGILLITE: brown, fine grained	MW - SW				VN 45° Qz
			Is(50) d=0.52 MPa	8.0		8.00m					HB

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL2 2 OF 3

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:59 8.2.843 Datgel Tools

CORED DRILL HOLE LOG

HOLE NO : BBL2
FILE / JOB NO : SG0109
SHEET : 3 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : NORTHERN ABUTMENT - WEST SIDE

POSITION : E: 244861.805, N: 6045484.729 (56 MGA94) SURFACE ELEVATION : 2.217 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 20/04/17 DATE COMPLETED : 20/04/17 DATE LOGGED : 20/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING

PROGRESS: DRILLING & CASING; WATER

CORE LOSS / RUN %) / DRILL DEPTH

SAMPLES & FIELD TESTS

DEPTH (m)

MATERIAL

GRAPHIC LOG

DESCRIPTION
ROCK TYPE : Colour, Grain size, Structure
(texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)

Weathering

ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral
EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH

FRACTURES

NATURAL FRACTURE (mm) 20 40 100 300 1000

VISUAL

ADDITIONAL DATA
(joints, partings, seams, zones, etc)
Description, orientation, infilling or coating, shape, roughness, thickness, other

Depth (m)	Core loss / run % / drill depth	Samples & field tests	Description	Weathering	Additional data
8.0	0% LOSS		PHYLLITE: green some red	HW - MW	
8.33					
8.33m	87% LOSS		CORE LOSS 0.19m (8.33-8.52)		
8.52m			PHYLLITE		
8.70m			ARGILLITE: brown, fine to medium grained	HW - MW	VN 40° Qz
9.0		Is(50) d=0.34 MPa Is(50) d=0.23 MPa			
				EW	SM 75° Clay
9.80	0% LOSS			MW - SW	DB
10.0					SM 5° Clay 3 mm
		Is(50) a=0.73 MPa Is(50) d=1.24 MPa			
10.90m			ARGILLITE: green some brown, fine grained	SW	
11.0					JT 15° Fe RF DB BP 70° JT 45° Fe RF
11.50	0% LOSS	Is(50) d=1.64 MPa			
12.0					BP 70° Fe RF
13.0		Is(50) d=2.26 a=1.14 MPa Is(50) d=2.41 MPa			SM 10° Clay JT 15° RF
13.40m			META SILTSTONE: grey, green	F	VN 80° Qz
13.70m			ARGILLITE: green, grey	SW - F	VN 25° Qz
14.0		Is(50) d=0.38 MPa			
14.42		Is(50) d=1.69 MPa			
14.42m			BOREHOLE BBL2 TERMINATED AT 14.42 m		
15.0			Defect spacing: ~550mm		
			Piezometer installed - 50mm PVC - Screen 10.98 - 13.98m - 2mm sand backfill - Bentonite seal 0.27 - 0.60m - Concrete plug and roadcap 0.00 - 0.27m		
16.0					

NMLC

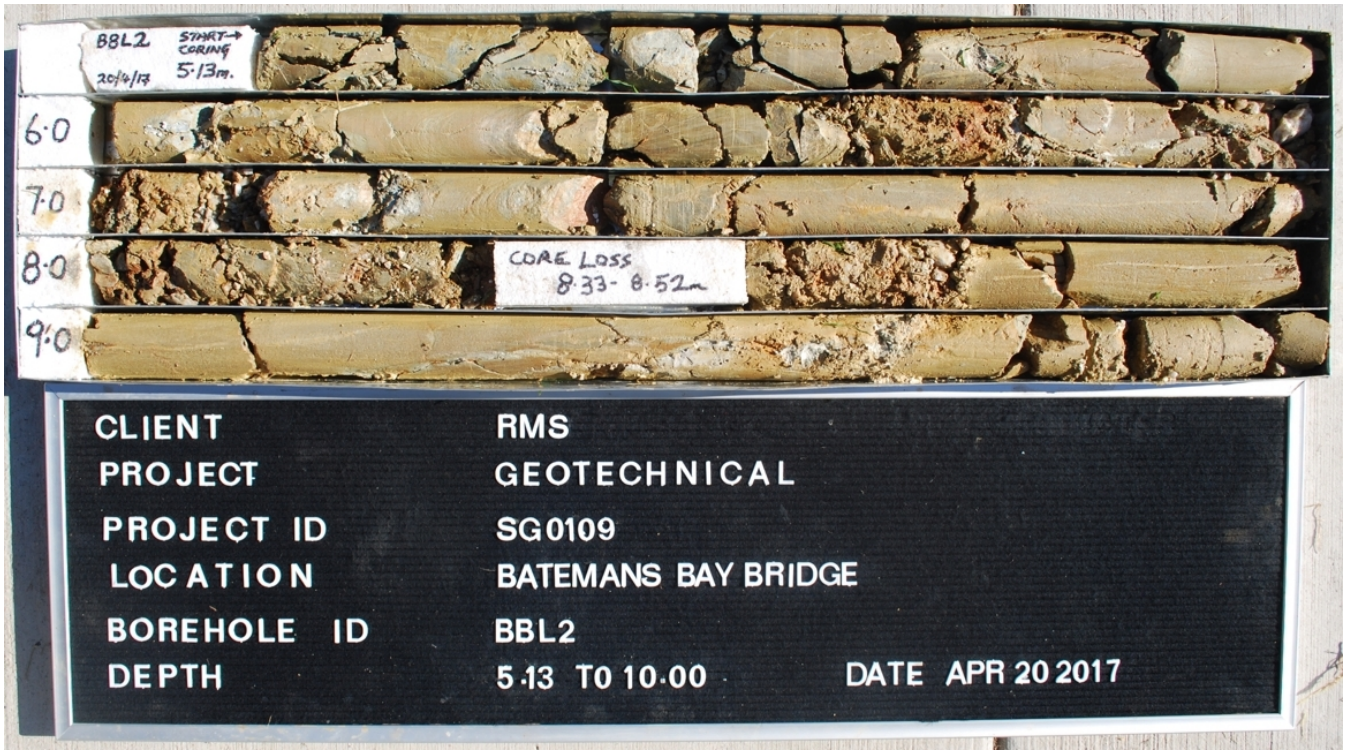
0% Water LOSS

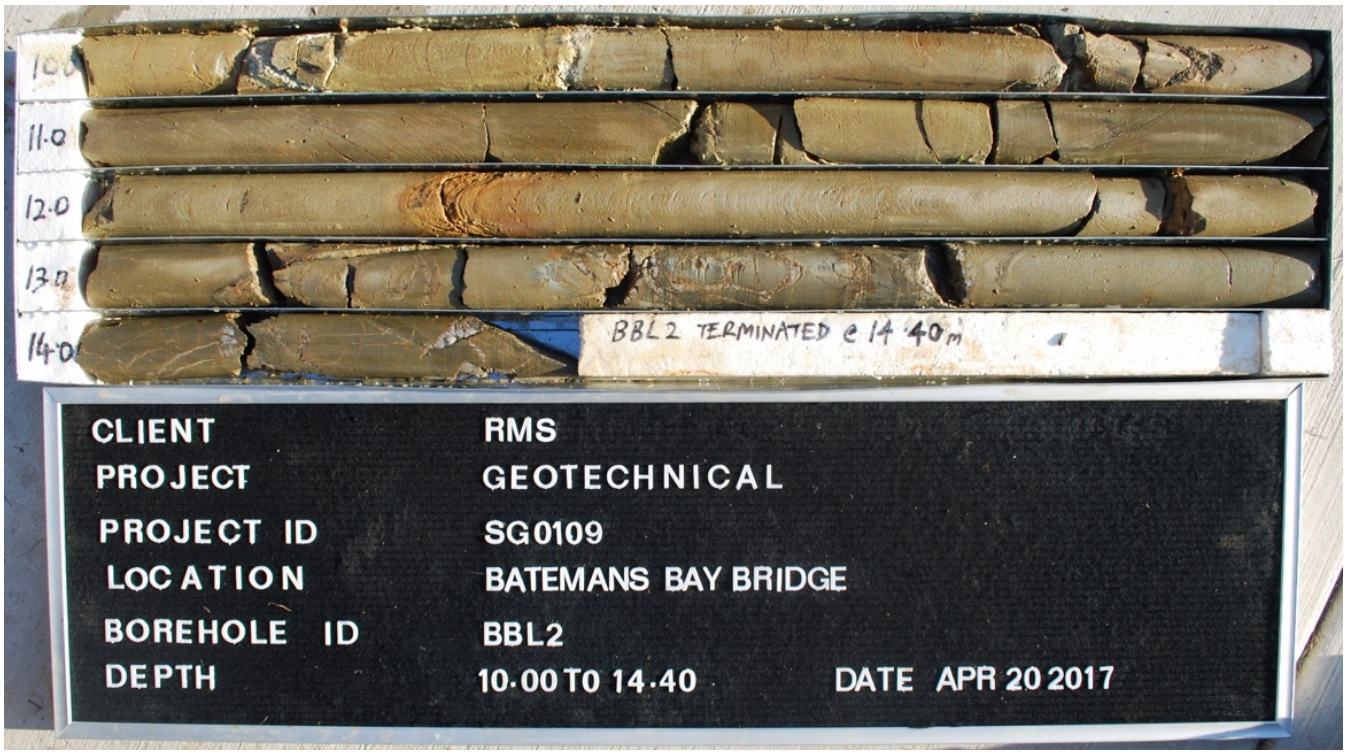
See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL2 3 OF 3





Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBL2**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 1 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
HA HW Casing	N/A	E		D	0.0		SM	SILTY SAND: brown, fine to medium grained sand, roots.		L	FILL
								0.20m GRAVELLY SILTY SAND: brown, fine to medium gravel, with clay			
		H		0.50m			SM		M	MD - D	
				0.80m				0.80m			
				D 1.00m	1.0		SM	SILTY SAND: dark brown, fine to medium grained sand			ALLUVIUM
				1.20m				1.10m SAND: brown, white, fine to medium grained sand, trace shells (1%).			
				D 1.50m					M - W		
			02/05/17	1.80m							
				D 2.00m	2.0						
				2.50m SPT 4, 4, 3 N=7				SAND: grey-brown, fine to medium grained, trace shells (1%)			2.50: SPT Recovery: 0.45 m
		E		2.95m	3.0		SP			L	
				4.30m SPT 1, 2, 3 N=5	4.0			SAND: dark grey, fine grained sand, trace silt, trace shells (1%)			4.30: SPT Recovery: 0.45 m
AD/T HQ Casing	Guar Gum			4.75m	5.0				W		
								5.50m SILTY SAND: dark grey, fine grained sand, trace shells (<1%).			
				5.80m SPT 2, 2, 1 N=3	6.0						5.80: SPT Recovery: 0.45 m
		VE		6.25m			SM			VL	
								6.90m SAND: grey, fine grained sand, trace silt, trace shells.			
				7.30m SPT HW/300mm, 0, 0, 1 N*=1	7.0		SP				7.30: SPT Recovery: 0.45 m
				7.75m	8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 2 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					8.0		SP	SAND: grey, fine grained sand, trace silt, trace shells. *(continued)*			ALLUVIUM
								8.30m SILTY SAND: dark grey, fine grained sand, with shells (5%).			
				8.80m SPT HW/450mm	9.0						8.80: SPT Recovery: 0.45 m
				9.25m							
					10.0						
				10.30m SPT HW/450mm							10.30: SPT Recovery: 0.45 m
				10.75m							
					11.0						
				11.80m SPT HW/450mm				SILTY SAND: dark grey, fine grained sand			11.80: SPT Recovery: 0 m; logged from small amount of material in catcher
AD/T HQ Casing	Guar Gum	VE		12.25m	12.0		SM		W	VL	
					13.0						
				13.30m SPT HW/450mm				SILTY SAND: dark grey, fine grained sand, with shells (3-5%)			13.30: SPT Recovery: 0.45 m
				13.75m							
					14.0			SILTY SAND: dark grey, fine grained sand, trace shells (<1%)			
				14.80m SPT HW/450mm							14.80: SPT Recovery: 0.45 m
				15.25m	15.0						
					16.0			16.00m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 3 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					16.0			SILTY SAND: dark grey, fine grained sand, trace shells.			ALLUVIUM
				16.30m SPT HW/450mm 16.75m							16.30: SPT Recovery: 0.45 m
					17.0		SM			VL	
				17.80m SPT HW/300mm, 0, 0, 1 N*=1 18.25m				SILTY SAND: dark grey, fine sand, trace shells			17.80: SPT Recovery: 0.45 m
					18.0			18.00m CLAYEY SILT: dark grey, low to medium plasticity, trace shells (4-5%).			
					19.0						
				19.30m SPT HW/450mm 19.75m				SANDY SILT: dark grey, low plasticity, fine grained sand, trace shells (<1%)			19.30: SPT Recovery: 0.45 m
AD/T HQ Casing	Guar Gum	VE			20.0				W		
				20.80m SPT HW/450mm 21.25m				SANDY SILT: dark grey, low plasticity, fine grained sand, trace clay, trace shells (<1%)			20.80: SPT Recovery: 0.45 m
					21.0		ML			S - F	
					22.0						
				22.30m SPT HW/450mm 22.75m				CLAYEY SILT: dark grey, low to medium plasticity, trace sand, fine grained sand, trace shells (<0.50%)			22.30: SPT Recovery: 0.45 m
					23.0						
				23.80m SPT HW/450mm							23.80: SPT Recovery: 0.45 m
					24.0			24.00m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 4 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum			SPT HW/450mm 24.25m	24.0			CLAYEY SILT /SILTY CLAY: dark grey, low to medium plasticity, trace shells (<0.50%).			ALLUVIUM 24.20: HP Samp = 35 - 45 kPa 24.40: HV Samp P: 15 kPa R: 12 kPa
				25.30m SPT HW/450mm 25.75m	25.0		ML	CLAYEY SILT: dark grey, low to medium plasticity, trace sand, fine			25.30: SPT Recovery: 0.45 m
					26.0			26.50m			
		VE		26.80m SPT 1, 0, 5 N=5 27.25m	27.0			INTERBEDDED SILTY SAND AND CLAYEY SILT: dark grey, fine sand, trace shells (1%).	W	S - F	26.80: SPT Recovery: 0.45 m
					28.0		SM	- minor bouncing, casing advancer, possible gravels in profile			
				28.30m SPT 0, 0, 1 N=1 **28.75m** U63				CLAYEY SILT: dark grey, low to medium plasticity, trace gravel			28.30: SPT Recovery: 0.45 m 28.80: Tube sample disturbed, possible gravel
					29.0			CLAYEY SILT: low to medium plasticity, trace gravel			29.00: HP Samp = 25 - 30 kPa
				29.40m				29.40m GRAVEL: grey, fine to coarse gravel, rounded, possible cobbles or larger.			29.40: Casing advancer in gravel
		H		29.80m SPT 25/150mm HB N=R 29.95m	30.0		GP	30.20m		MD - D	29.80: SPT Recovery: 0.45 m
								Continued as Cored Drill Hole			
					31.0						
					32.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 5 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : STEP FACE BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL >10 VL 10-3 L 3-1 M 1-0.3 H 0.3-0.1 VH 0.1-0.03 EH <0.03	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				24.0							
				25.0							
				26.0							
				27.0							
				28.0							
				29.0							
				30.0							
						30.20m START CORING AT 30.20m					
NMLC	0% LOSS	0% LOSS	Is(50) d=2.97 a=1.46 MPa	31.0		ARGILLITE: green, fine to medium grained	MW - SW				SM 5° Clay 40 mm
			Is(50) d=3.82 MPa				SW - F				JT 50° Fe RF SM 0° Clay 40 mm JT 70° Fe RF
		32.00		32.0		32.00m					

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL3
FILE / JOB NO : SG0109
SHEET : 6 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - WEST SIDE

POSITION : E: 244556.142, N: 6045302.809 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : JS

DATE STARTED : 02/05/15 DATE COMPLETED : 04/05/17 DATE LOGGED : 04/05/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : STEP FACE BIT CONDITION : GOOD

DRILLING				MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		32.0		ARGILLITE: green-grey, fine to medium grained, weak iron staining on joints, some bedding planes.	F				JT 45° Fe RF
			Is(50) d=2.46 MPa	33.0							SM 70° Clay 3 mm
			Is(50) d=3.91 a=1.23 MPa	34.0							
			Is(50) d=3.62 MPa	35.0							JT 85° Fe RF JT 30° Fe RF
		35.10									
		0% LOSS									
			Is(50) a=0.92 MPa	36.0							JT 50° Fe RF
											JT 85° Fe RF
			Is(50) d=4.29 MPa	37.0							
			Is(50) d=3.21 MPa								JT 35° Fe RF VN Qz JT 20° Fe RF
		38.10	Is(50) d=1.94 MPa	38.0		38.10m BOREHOLE BBL3 TERMINATED AT 38.10 m Fracture spacing: 720mm/profile					
				39.0							
				40.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

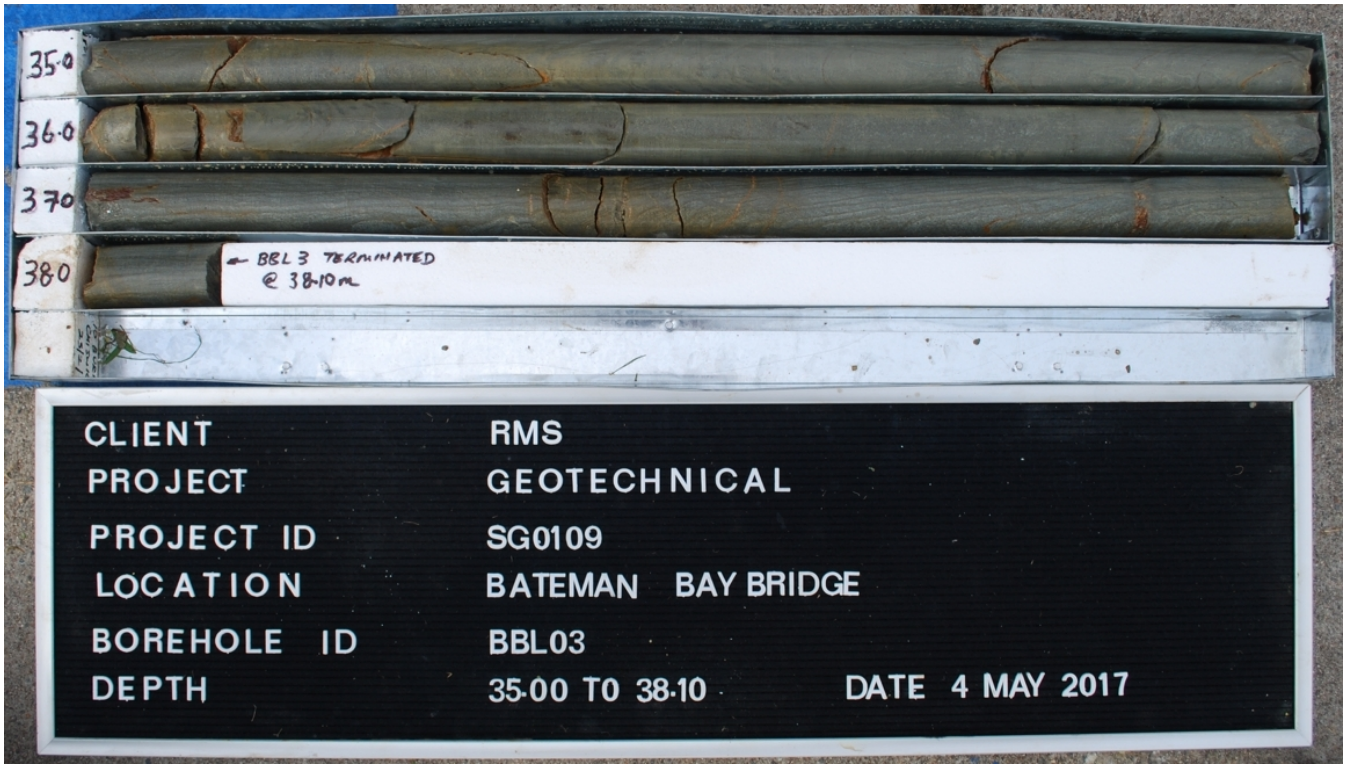
ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL3 6 OF 6

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:59 8.2.843 Datgel Tools


BBL ϕ3
3/5/17
START CORING 30.20m
31
32
33
34
CLIENT RMS
PROJECT GEOTECHNICAL
PROJECT ID SG0109
LOCATION BATEMAN BAY BRIDGE
BOREHOLE ID BBL03
DEPTH 30.20 TO 35.00
DATE 4 MAY 2017


35.0
36.0
37.0
38.0
BBL 3 TERMINATED @ 38.10m
CLIENT RMS
PROJECT GEOTECHNICAL
PROJECT ID SG0109
LOCATION BATEMAN BAY BRIDGE
BOREHOLE ID BBL03
DEPTH 35.00 TO 38.10
DATE 4 MAY 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 1 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
	N/A	E		D	0.0		SM	SILTY SAND: black, fine to coarse grained sand, roots.		L	FILL
								0.25m			
HA		H		0.50m D				GRAVELLY SANDY CLAY: brown, orange-brown, fine to medium rounded gravel		St - VSt	
				1.00m D	1.0			0.90m SAND: brown some black, fine to medium grained sand, trace silt, trace shells.	M		ALLUVIUM
HW Casing				1.50m D							
				2.00m	2.0				M - W		
			04/05/17							L - MD	
				2.50m SPT 1, 5, 6 N=11				SAND: brown, white, fine to medium grained sand, with silt, trace shells			2.50: SPT Recovery: 0.45 m
				2.95m	3.0		SP				
				4.00m SPT 2, 3, 3 N=6	4.0			SAND: grey-brown, grey, fine to coarse grained sand, with silt			4.00: SPT Recovery: 0.45 m
AD/T		E		4.45m						L	
					5.0				W		
HQ Casing				5.50m SPT 1, 1, 1 N=2				5.50m SILTY SAND: dark grey, fine to medium grained sand, trace shells.			5.50: SPT Recovery: 0.45 m
				5.95m	6.0		SM				
	Guar Gum							6.50m SAND: dark grey, fine to medium grained sand, with silt, trace shells.		VL	
				7.00m SPT 1, 1, 2 N=3	7.0		SP				7.00: SPT Recovery: 0.45 m
				7.45m							
					8.0			8.00m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 2 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					8.0			SAND: brown some black, fine to medium grained sand, trace silt, trace shells.		L	ALLUVIUM
				8.50m SPT 1, 0, 0 N=0 8.95m				SILTY SAND: dark grey, fine to coarse grained sand, with shells			8.50: SPT Recovery: 0.45 m
					9.0						
				10.00m SPT 1, 0, 0 N=0 10.45m	10.0			SILTY SAND: dark grey, fine grained sand, with shells (20%)			10.00: SPT Recovery: 0.45 m
					11.0						
				11.50m SPT HW/450mm 11.95m				SILTY SAND: dark grey, fine grained sand, with shells (5%)			11.50: SPT Recovery: 0.45 m
AD/T HQ Casing	Guar Gum	VE			12.0		SP		W	VL	
				13.00m SPT HW/450mm 13.45m	13.0			SILTY SAND: dark grey, fine grained sand, with shells (5%)			13.00: SPT Recovery: 0.45 m
					14.0						
				14.50m SPT HW/450mm 14.95m				SILTY SAND: dark grey, fine grained sand, trace clay, trace shells (<5%)			14.50: SPT Recovery: 0.45 m
					15.0						
				16.00m	16.0			16.00m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 3 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum	VE		SPT HW/450mm 16.45m	16.0			SILTY SAND: dark grey, fine grained sand, trace clay, trace shells (<1%).			ALLUVIUM 16.00: SPT Recovery: 0.45 m
					17.0			SILTY SAND: dark grey, fine grained sand, trace clay, trace shells (<1%)			
				17.50m SPT HW/450mm 17.95m							17.50: SPT Recovery: 0.45 m
					18.0						
				19.00m SPT HW/450mm 19.45m	19.0		SM	SILTY SAND: dark grey, fine grained sand, trace clay, trace shells (<1%)		VL	19.00: SPT Recovery: 0.45 m
				20.50m SPT HW/450mm 20.95m	20.0			SILTY SAND/SANDY SILT: dark grey, fine grained sand, low plasticity, trace shells (<1%)	W		20.50: SPT Recovery: 0.45 m
					21.0						
								21.50m SANDY SILT: dark grey, low plasticity, fine grained sand, trace shells (<2%).			
				22.00m SPT HW/450mm 22.45m	22.0		ML			S	22.00: SPT Recovery: 0.45 m
					23.0			23.00m CLAYEY SILT: dark grey, low plasticity, trace fine grained sand			
				23.50m SPT 0, 0, 2 N*=2 23.95m			ML			S - F	23.50: SPT Recovery: 0.45 m 23.60: HP Samp = 25 - 50 kPa
					24.0			23.80m SANDY SILT: dark grey, fine grained sand			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 4 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING | MATERIAL

PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic; Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T					24.0			SANDY SILT: dark grey, fine grained sand *(continued)*			ALLUVIUM
				25.00m SPT HW/450mm	25.0		ML	CLAYEY SILT/SILTY CLAY: dark grey, trace fine grained sand, low to medium plasticity			25.00: SPT Recovery: 0.45 m
				25.45m							
					26.0			26.00m SILTY CLAY: dark grey, medium to high plasticity			
HQ Casing		VE		26.50m SPT HW/450mm						S - F	26.50: SPT Recovery: 0.45 m
				26.95m U63	27.0				W		27.00: HP Samp = 25 - 30 kPa
				27.50m			CI-CH				27.60: HV Samp P: 20 kPa R: 10 kPa
				28.00m SPT HW/450mm	28.0			CLAYEY SILT/SILTY CLAY: dark grey, medium to high plasticity			28.00: SPT Recovery: 0.45 m
				28.45m U63							28.50: HP Samp = 25 - 30 kPa
	Guar Gum			**29.00m** SPT 17, 19, 10/320mm N=R	29.0			29.00m SILTY CLAY: green, low to medium plasticity, trace sand			RESIDUAL SOIL 29.00: SPT Recovery: 0.45 m
		F		29.62m			CL-CI	29.50m 29.55m ARGILLITE: green-brown, fine to medium grained, highly weathered.		F - St	BEDROCK
								29.77m ARGILLITE: green, fine to medium grained, highly weathered, estimated very low strength. Continued as Cored Drill Hole			
					30.0						
					31.0						
					32.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 5 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	RUN (CORE LOSS %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .03 VL .1 L .3 M 1 H 3 VH 10 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				24.0							
				25.0							
				26.0							
				27.0							
				28.0							
				29.0							
						29.77m START CORING AT 29.77m					
HQ Casing	0% LOSS	0% LOSS	Is(50) d=0.15 MPa	30.0		ARGILLITE: green, brown, fine to medium grained	HW - MW				DB BP 80°
						30.05m PHYLLITE: green-grey					
						30.40m ARGILLITE: green-brown, fine to medium grained	HW				BP 80°
NMLC	30.80			31.0							DB SM 45° Clay 30 mm SM 75° Clay 10 mm
	0% LOSS	0% LOSS	Is(50) d=0.14 MPa			31.70m PHYLLITE: green-grey, weak iron staining on joints, bedding.					SM 10° Clay 40 mm SM 10° Clay 30 mm
				32.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL4
FILE / JOB NO : SG0109
SHEET : 6 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : SOUTHERN ABUTMENT - EAST SIDE

POSITION : E: 244576.820, N: 6045251.332 (56 MGA94) SURFACE ELEVATION : 1.825 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 29/04/17 DATE COMPLETED : 02/05/17 DATE LOGGED : 02/05/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

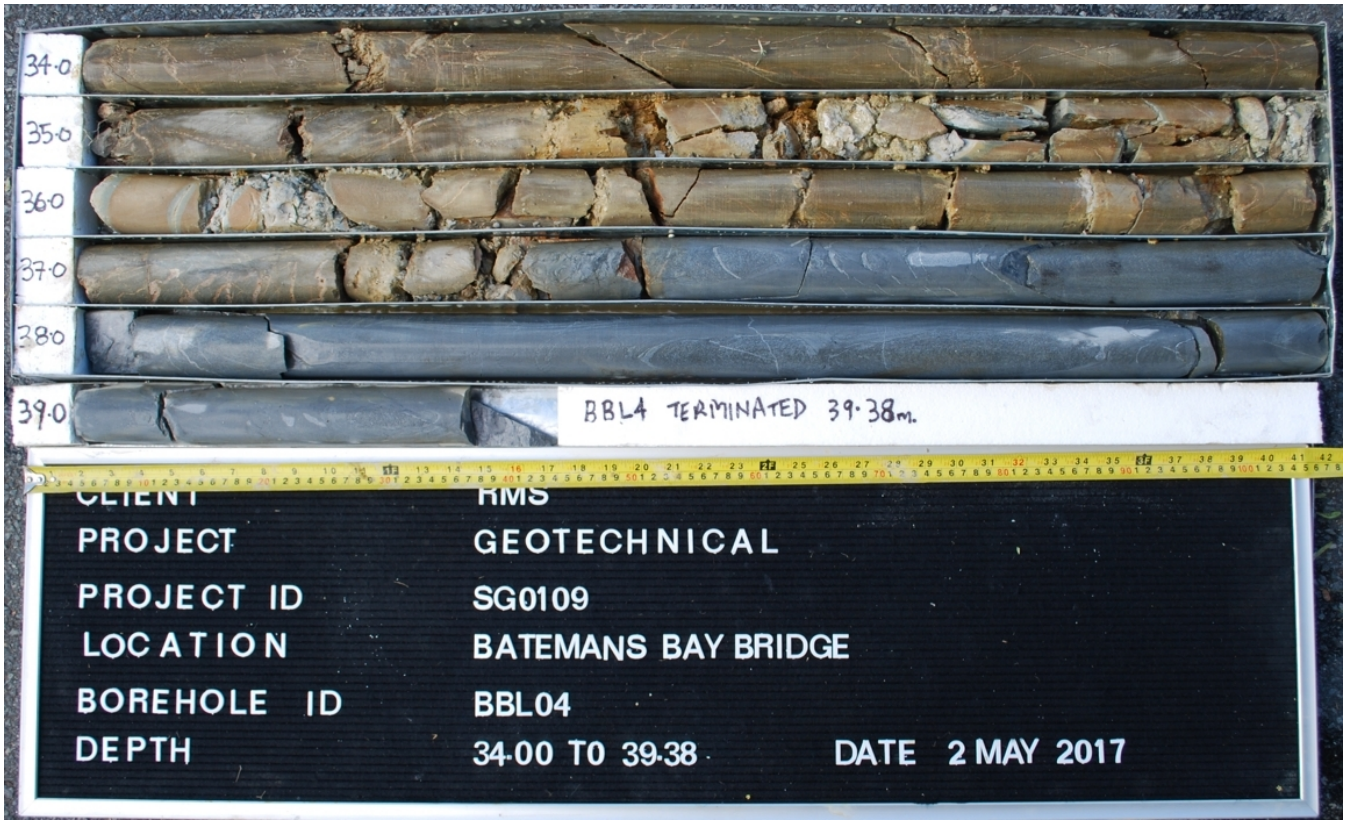
DRILLING					MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	PROGRESS: CORE LOSS (RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS 33.55	Is(50) d=0.56 MPa Is(50) a=0.3 MPa	32.0		PHYLLITE: green-grey, weak iron staining on joints, bedding. *(continued)*	HW - MW MW - SW	EL -0.03 VL -0.1 L -0.3 M -1 H -3 VH -10 EH	20 40 100 300 1000		BP 80° SM 0° Clay 20 mm SM 50° Clay 5 mm JT 15° Fe RF
	0% LOSS	0% LOSS 35.60	Is(50) d=1.23 MPa Is(50) d=1.25 MPa	33.0 34.0 35.0							DB BP 75° PR RF VN 60° Qz JT 47° Fe RF JT 45° Fe RF
	0% LOSS	0% LOSS 37.26	Is(50) d=2.57 MPa Is(50) d=2.47 MPa Is(50) d=5.44 a=1.74 MPa	36.0		- moderate to strong iron staining, 35.38 to 35.64m 36.90m INTERBEDDED ARGILLITE AND PHYLLITE: grey, green	SW F				VN 10° Qz VN 50° Qz SM 20° Clay DB SM Clay SM 40° Clay 20 mm SM 45° Clay 5 mm SM 70° Clay JT 55° SM 5° Clay 3 mm JT 5° JT 10°
	0% LOSS	0% LOSS 39.44	Is(50) d=3.99 MPa Is(50) d=3.21 MPa	37.0 38.0 39.0		39.44m BOREHOLE BBL4 TERMINATED AT 39.44 m Piezometer installed - 50mm PVC - Screen 6.10 - 9.10m - 2mm sand backfill - Bentonite seal 0.12 - 0.60m - Concrete plug and roadcap 0.00 - 0.12m					SM 10° Clay 25 mm JT 8° RF FL 80° 39.00: Fracture spacing: 377mm (30.00 - 37.80m) Fracture spacing: 1500mm (37.80 - 39.44m)
				40.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL4 6 OF 6



Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBL4**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 1 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
HA HW Casing	N/A	E	26/04/17, High tide	D 0.50m D 1.00m D 1.50m D 2.00m	0.0 1.0 2.0		CL	SILTY CLAY /SILTY SAND: orange-brown and brown, fine to medium grained sand, roots.	D - M	L - MD	FILL
							SM	0.35m 0.40m SILTY SAND /SANDY SILT: brown, fine to medium grained sand, trace fine gravel			
							SM	0.55m SILTY SAND: brown, fine to coarse grained sand, trace fine gravel (quartz, concrete).			
							SP	SAND: orange-brown, fine to coarse grained sand	M		
							SP	1.05m SAND: pale brown, fine to coarse grained sand, trace weakly cemented nodules.		L	ALLUVIUM
								1.45m SAND: brown, brown-white, fine to coarse grained sand, trace shell material.	M - W		
				2.40m SPT 9, 10, 10 N=20 2.85m						L - MD	2.40: SPT Recovery: 0.45 m
					3.0			SAND: dark grey, trace shells, fine to medium grained sand, with silt			
				3.90m SPT 3, 2, 3 N=5 4.35m	4.0		SP	SAND: dark grey, trace shells, fine to medium grained sand, with silt			3.90: SPT Recovery: 0.45 m
AD/T HQ Casing	Guar Gum	E							W	L	
				5.40m SPT 2, 2, 4 N=6 5.85m	5.0			SAND: dark grey, trace shells, fine to medium grained sand, with silt			5.40: SPT Recovery: 0.45 m
					6.0						
				6.90m SPT 3, 0, 0 N=0 7.35m				SAND: dark grey, trace shells, with silt			6.90: SPT Recovery: 0.45 m
		VE			7.0			7.00m SANDY SILT: dark grey, low plasticity, with shells.			
							ML			VS - S	
					8.0			8.00m			

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 2 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum	VE		8.40m SPT RW/450mm 8.85m	8.0			SILTY SAND: dark grey, fine grained sand, with shells.			ALLUVIUM 8.40: SPT Recovery: 0.45 m
				9.90m SPT RW/450mm 10.35m	9.0 10.0			SILTY SAND: dark grey, fine grained sand, trace shells			9.90: SPT Recovery: 0.45 m
				11.40m SPT RW/450mm 11.85m	11.0		SM	SILTY SAND: dark grey, fine grained sand, trace shells	W	VL	11.40: SPT Recovery: 0.45 m
				12.90m SPT RW/450mm 13.35m	12.0 13.0			SILTY SAND: dark grey, fine grained sand, trace shells			12.90: SPT Recovery: 0.45 m
				14.40m SPT 2, 2, 3 N=5 14.85m	14.0		ML	14.00m SILT: dark grey, low plasticity, trace sand and clay, trace shells.		F	14.40: SPT Recovery: 0.45 m
				15.90m	15.0 16.0		SM	15.40m SILTY SAND: dark grey, fine grained sand, trace clay, trace shells.		VL	15.90: SPT Recovery: 0.45 m

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 3 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
				SPT 0, 0, 2 N=2	16.0			SILTY SAND: dark grey, fine grained sand, trace clay, trace shells. *(continued)*			ALLUVIUM
				16.35m							
				17.40m	17.0		SM			VL	
				SPT HW/450mm				SILTY SAND: dark grey, fine grained sand, trace clay			17.40: SPT Recovery: 0.45 m
				17.85m							
		VE			18.0						
								18.50m CLAYEY SILT: dark grey, low to medium plasticity			
				18.90m							
				SPT HW/450mm	19.0						18.90: SPT Recovery: 0.45 m
				19.35m							19.42: HV Samp P: 70 kPa R: 40 kPa
					20.0				W		
				20.40m							20.40: SPT Recovery: 0.45 m 20.50: HP Samp = 50 - 60 kPa
				SPT 1, 3, 3 N=6						F	
				20.85m	21.0			CLAYEY SILT: dark grey, low to medium plasticity			21.03: HV Samp P: 95 kPa R: 60 kPa
							ML				
				21.90m							21.90: SPT Recovery: 0.45 m
		VE-E		SPT 0, 3, 3 N=6	22.0			CLAYEY SILT: dark grey, low to medium plasticity			
				22.35m 22.40m							22.40: HP Samp = 50 - 60 kPa
				U63							
				22.90m	23.0						
				23.40m				CLAYEY SILT: dark grey, low to medium plasticity		F	23.40: SPT Recovery: 0.45 m
				SPT 0, 0, 3 N=3							
				23.85m	24.0			24.00m			

AD/T
HQ Casing
Guar Gum

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 4 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL				
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum	VE		24.90m SPT HW/450mm 25.35m	24.0 25.0		CI-CH	SILTY CLAY: dark grey to black, medium to high plasticity			ALLUVIUM 24.90: SPT Recovery: 0.45 m 25.00: HP Samp = 25 - 30 kPa
				26.40m SPT HW/450mm **26.85m** U63	26.0			SILTY CLAY: dark grey, medium to high plasticity		S - F	26.40: SPT Recovery: 0.45 m 26.50: HP Samp = 25 - 30 kPa
				27.50m	27.0			27.00m CLAYEY SILT: dark grey, low to medium plasticity			27.00: HP Samp = 40 - 60 kPa
				27.90m SPT HW/450mm 28.35m	28.0				W		27.90: SPT Recovery: 0.45 m
				29.40m SPT 0, 1, 6 N=7 29.85m	29.0 30.0		ML	CLAYEY SILT: dark grey, low to medium plasticity		F	29.40: SPT Recovery: 0.45 m
				30.90m SPT 0, 2, 4 N=6 31.35m	31.0						30.90: SPT Recovery: 0.45 m
		E		32.00m	32.0		ML	31.50m CLAYEY SILT: low to medium plasticity, trace gravel, roots. 32.00m		D	31.50: Trace gravel noted during drilling

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 5 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum	H		SPT 19, 8, 20 N=28 32.45m	32.0		ML	SANDY GRAVELLY SILT: dark grey, fine to medium rounded gravel, fine grained sand			ALLUVIUM 32.00: SPT Recovery: 0.45 m
								32.60m GRAVEL: brown, fine to coarse gravel, rounded	W	D	32.70: Note: gravel sample recovered in consecutive core runs, fines probably lost
					33.0		GP	33.20m Continued as Cored Drill Hole			
					34.0						
					35.0						
					36.0						
					37.0						
					38.0						
					39.0						
					40.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL5
FILE / JOB NO : SG0109
SHEET : 6 OF 6

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - SOUTH BOUND - PRINCES HIGHWAY

POSITION : E: 244531.096, N: 6045233.506 (56 MGA94) SURFACE ELEVATION : 2.172 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP

DATE STARTED : 26/04/17 DATE COMPLETED : 28/04/17 DATE LOGGED : 28/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				32.0							
				33.0		33.20m START CORING AT 33.20m					
NMLC	80% LOSS	0% LOSS 33.80 0% LOSS 34.47	Is(50) d=2.43 MPa			GRAVEL (GP): brown, fine to coarse gravel, rounded (ALLUVIUM) 33.60m ARGILLITE: green-grey, fine to coarse grained, micaceous. 34.47m	F				33.60: BEDROCK DB VN Qz FL 85° JT 75° Clay
				34.0							
						BOREHOLE BBL5 TERMINATED AT 34.47 m Collapse of gravels occuring, 34.47m bedrock level confirmed Fracture spacing: 435mm					
				35.0							
				36.0							
				37.0							
				38.0							
				39.0							
				40.0							

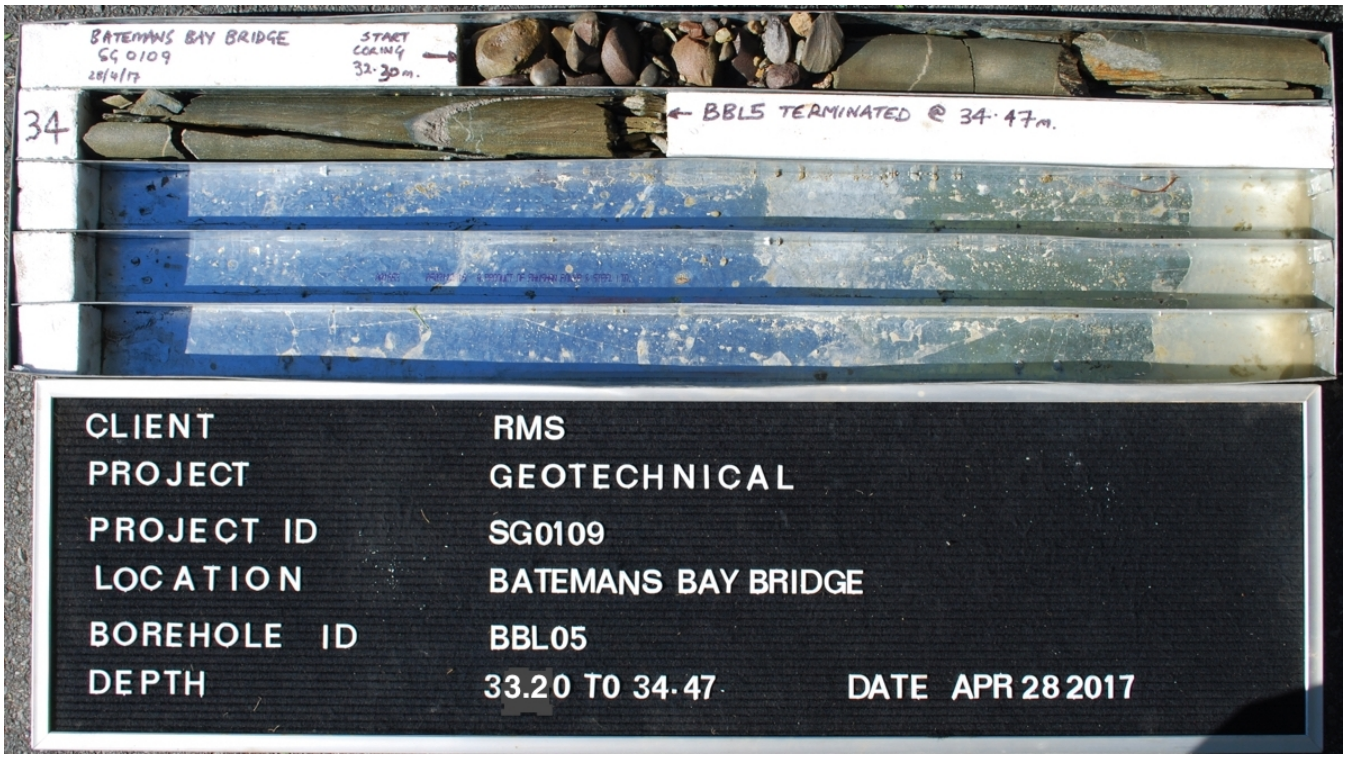
See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL5 6 OF 6

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:59 8.2.843 Datgel Tools



Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBL5**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL6
FILE / JOB NO : SG0109
SHEET : 1 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - NORTH BOUND - PRINCES HIGHWAY

POSITION : E: 244412.865, N: 6044938.916 (56 MGA94) SURFACE ELEVATION : 2.491 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 21/04/17 DATE COMPLETED : 22/04/17 DATE LOGGED : 22/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL						
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
	N/A				0.0		SM	SILTY SAND: brown, fine to coarse grained sand, roots.			FILL
								0.20m			
							SM	0.30m SILTY SAND: dark brown, fine to coarse grained sand, with shells.			
								SAND: red-brown, fine to coarse grained sand			
							SW				
								0.80m	M		
								SAND: brown, white, fine to coarse grained sand, trace shells.			ALLUVIUM
				1.00m D	1.0						
				1.50m D			SW		M - W		
			27/04/17								
				2.00m	2.0			2.00m			
								SILTY SAND: dark grey, fine to medium grained sand, trace shells.			
				2.50m SPT 5, 3, 2 N=5						L	2.50: SPT Recovery: 0.45 m
				2.95m	3.0						
		VE		4.00m SPT 1, 2, 2 N=4	4.0			SILTY SAND: dark grey, fine to coarse grained sand, trace shells			4.00: SPT Recovery: 0.45 m
				4.45m							
					5.0		SM		W		
				5.50m SPT 1, 0, 0 N=0				SILTY SAND: dark grey, fine grained sand, trace shells			5.50: SPT Recovery: 0.45 m
				5.95m	6.0					VL	
				7.00m SPT HW/450mm	7.0			SILTY SAND: dark grey, fine grained sand, trace shells			7.00: SPT Recovery: 0.45 m
				7.45m							
					8.0			8.00m			

HA — HW Casing — AD/T — HQ Casing — Guar Gum

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL6 1 OF 5

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL6
FILE / JOB NO : SG0109
SHEET : 2 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - NORTH BOUND - PRINCES HIGHWAY

POSITION : E: 244412.865, N: 6044938.916 (56 MGA94) SURFACE ELEVATION : 2.491 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 21/04/17 DATE COMPLETED : 22/04/17 DATE LOGGED : 22/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					8.0			SANDY SILT /SILTY SAND: dark grey, low plasticity, fine grained sand, trace shells.			ALLUVIUM
				8.50m SPT RW/450mm							8.50: SPT Recovery: 0.45 m
				8.95m	9.0		ML				
								9.50m SILT: dark grey, low plasticity, with fine grained sand, trace clay, trace shells.			
				10.00m SPT RW/450mm	10.0						10.00: SPT Recovery: 0.45 m
				10.45m							
					11.0						
				11.50m SPT RW/450mm							11.50: SPT Recovery: 0.45 m
AD/T HQ Casing	Guar Gum	VE		11.95m	12.0		ML	SILT: fine grained sand, low plasticity, with sand, trace clay	W	S	
				13.00m SPT RW/450mm	13.0			SILT: low plasticity, with fine grained sand, trace clay			13.00: SPT Recovery: 0.45 m
				13.45m							
								14.00m CLAYEY SILT: dark grey, low plasticity, trace shells.			
				14.50m SPT RW/450mm	14.0						14.50: SPT Recovery: 0.45 m
				14.95m			ML				
					15.0						15.07: HV Samp P: 48 kPa R: 27 kPa
											15.30: U75: No sample
								15.50m SILTY CLAY: dark grey, medium to high plasticity, trace shells.			
				16.00m	16.0		CI-CH			S - F	

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBL6
FILE / JOB NO : SG0109
SHEET : 3 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - NORTH BOUND - PRINCES HIGHWAY

POSITION : E: 244412.865, N: 6044938.916 (56 MGA94) SURFACE ELEVATION : 2.491 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 21/04/17 DATE COMPLETED : 22/04/17 DATE LOGGED : 22/04/17 LOGGED BY : MHK CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
AD/T HQ Casing	Guar Gum	VE		SPT 0, 0, 1 N=1 16.45m	16.0		CI-CH	SILTY CLAY: dark grey, medium to high plasticity, trace shells. *(continued)*		S - F	ALLUVIUM 16.00: SPT Recovery: 0.45 m 16.30: HP Samp = 50 - 60 kPa 16.64: HV Samp P: 57 kPa R: 37 kPa
					17.0			17.00m SILTY CLAY /CLAYEY SILT: dark grey, medium to high plasticity			
				17.50m SPT 0, 2, 3 N=5 17.95m						F	17.50: SPT Recovery: 0.45 m 17.60: HP Samp = 50 - 60 kPa
					18.0		CI-CH				
				19.00m SPT 0, 0, 1 N=1 19.45m	19.0			CLAYEY SILT: dark grey, medium to high plasticity, trace fine grained sand	W	S - F	19.00: SPT Recovery: 0.45 m
					20.0			20.00m SILTY SAND: dark grey, fine to medium grained sand, trace gravel			
				20.50m SPT 0, 0, 1 N=1 20.95m			SM			VL	20.50: SPT Recovery: 0.45 m
					21.0			21.60m SILTY CLAY: grey mottled green, with fine quartz gravel, with timber, charcoal.			RESIDUAL SOIL
		F-H		21.80m SPT 5, 8, 12 N=20 22.25m			CI			St	21.80: SPT Recovery: 0.45 m
					22.0			22.10m SILTY CLAY: green, low to medium plasticity, trace fine quartz gravel		VSt	
							CL-CI	22.43m Continued as Cored Drill Hole			
					23.0						
					24.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL6
FILE / JOB NO : SG0109
SHEET : 4 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - NORTH BOUND - PRINCES HIGHWAY

POSITION : E: 244412.865, N: 6044938.916 (56 MGA94) SURFACE ELEVATION : 2.491 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 21/04/17 DATE COMPLETED : 22/04/17 DATE LOGGED : 22/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL, VL, L, M, H, VH, EH; -0.03, -0.1, -0.3, -1, -3, -10)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				16.0							
				17.0							
				18.0							
				19.0							
				20.0							
				21.0							
				22.0							
						22.43m START CORING AT 22.43m					
NMLC	0% LOSS	0% LOSS 22.70		23.0		GRAVELLY SANDY CLAY (CL): orange-brown, low plasticity, fine quartz and highly weathered rock gravel	EW				
		0% LOSS				22.90m SANDY CLAY (CL): orange-brown, low plasticity, trace bands of highly weathered argillite and metasiltstone, thin bands of quartz. (RESIDUAL SOIL)					
		23.50				23.50m					BP 80°
		0% LOSS	Is(50) d=0.71 MPa			ARGILLITE: orange-brown, fine to coarse grained	HW				DB
				24.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBL6
FILE / JOB NO : SG0109
SHEET : 5 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : GRASS VERGE - NORTH BOUND - PRINCES HIGHWAY

POSITION : E: 244412.865, N: 6044938.916 (56 MGA94) SURFACE ELEVATION : 2.491 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : DT300 HPD MOUNTING : Track CONTRACTOR : SEA TO SUMMIT DRILLER : LP/JS

DATE STARTED : 21/04/17 DATE COMPLETED : 22/04/17 DATE LOGGED : 22/04/17 LOGGED BY : MHK CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : SERIES 2 IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% LOSS	0% LOSS		24.0		ARGILLITE: orange-brown, fine to coarse grained *(continued)*	HW	EL VL L M H VH EH -.003 -.01 -.03 -.1 -.3 -1 -10	20 40 100 300 1000		
		24.75				24.26m					
	0% LOSS					SANDY CLAY (CL): grey some orange, fine to coarse grained sand	EW				SM 80° Clay
						24.75m					
		0% LOSS	Is(50) d=1.42 MPa	25.0		ARGILLITE: orange-brown, fine to medium grained	HW - MW				BP 80° Clay FILLED
			Is(50) d=0.54 MPa								SM 40° Clay
											VN 70° Qz 50 mm
			Is(50) a=1.2 MPa	26.0							JT 30° Fe RF
			Is(50) d=1.54 MPa								JT 30° Fe RF
		26.60	Is(50) d=1.8 MPa			26.60m BOREHOLE BBL6 TERMINATED AT 26.60 m					SM 75° Clay 3 mm
				27.0		Defect spacing: 23.50 - 25.50m: 1000mm 25.50 - 26.50m: 200mm					
				28.0							
				29.0							
				30.0							
				31.0							
				32.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBL6 5 OF 5


BATEMANS BAY BRIDGE BBL6 START CORING →
PROJECT ID: SG0109 22/4/2017. 22.43m
23.0
24.0
25.0
26.0
← BBL6 TERMINATED @ 26.60m
CLIENT RMS
PROJECT GEOTECHNICAL
PROJECT ID SG0109
LOCATION BATEMANS BAY BRIDGE
BOREHOLE ID BBL6
DEPTH 22.43 TO 26.60 DATE APR 22 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR1
FILE / JOB NO : SG0109
SHEET : 1 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244676.859, N: 6045263.377 (56 MGA94) SURFACE ELEVATION : -6.220 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 18/05/17 DATE COMPLETED : 22/05/17 DATE LOGGED : 22/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING | MATERIAL

PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION (Soil Type, Colour, Plasticity or Particle Characteristic; Secondary and Minor Components)	MOISTURE CONDITION	CONSISTENCY / RELATIVE DENSITY	STRUCTURE & Other Observations
					0.0			SILTY SAND AND SHELLS: dark grey and black, fine and medium grained sand, non plastic, trace clay, shells and shell fragments predominantly <=10mm.			MARINE DEPOSITS
CASING	0% Bentonite LOSS (casing at 1.35m)	VE			1.0		SM				
				1.50m SPT 1, 0, 1 N*=1						VL	1.50: SPT Recovery: 0.25 m
				1.95m	2.0		SP	SAND WITH SOME SHELLS: grey, fine and medium grained sand, non plastic, trace silt, shells and shell fragments <=10mm.			
CASING	0% Bentonite LOSS (casing at 2.85m)							As above, some black silty sand pockets, trace of charcoal fragments			
								2.80m			
				3.00m SPT 2, 3, 5 N*=8	3.0		SP	SAND: grey, fine grained sand, non plastic, trace medium grained sand, trace silt, and shell fragments.		L	3.00: SPT Recovery: 0.3 m
CASING	0% Bentonite LOSS (casing at 4.35m)			3.45m							
DB					4.0			As above, with some shell layers, trace of sub-rounded and angular gravel <=20mm	W		
								4.25m			
				4.65m SPT 1, 0, 1 N*=1				SILTY SAND AND SHELLS: grey and dark grey, fine grained sand, non plastic, trace medium grained sand, shells and shell fragments <=10mm.			4.65: SPT Recovery: 0.3 m
		E		5.10m	5.0						
CASING	0% Bentonite LOSS (casing at 6.00m)						SM			VL	
				6.10m SPT 1, 1, 1 N=2	6.0			As above, trace of clay			6.10: SPT Recovery: 0 m
				6.55m							
					7.0						
								7.40m			
CASING	0% Bentonite LOSS (casing at 7.60m)			7.65m SPT 1, 0, 0 N*=0			ML	CLAYEY SANDY SILT AND SHELLS: grey and dark grey, low plasticity, fine grained sand, shells and shell fragments predominantly <=10mm throughout, organic (possibly).		S	7.65: SPT Recovery: 0.15 m
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR1 1 OF 5

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR1
FILE / JOB NO : SG0109
SHEET : 2 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244676.859, N: 6045263.377 (56 MGA94) SURFACE ELEVATION : -6.220 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 18/05/17 DATE COMPLETED : 22/05/17 DATE LOGGED : 22/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING							MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
				8.10m	8.0			CLAYEY SANDY SILT AND SHELLS: grey and dark grey, low plasticity, fine grained sand, shells and shell fragments predominantly <=10mm throughout, organic (possibly). *(continued)*			MARINE DEPOSITS
							ML				
								8.50m SANDY CLAYEY SILT AND SHELLS: grey and dark grey, low plasticity, fine grained sand, shells and shell fragments predominantly <=10mm throughout.	W		
				9.00m SPT HW/450mm	9.0		ML				9.00: SPT Recovery: 0.05 m
				9.45m							
								9.70m CLAYEY SILT AND SANDY CLAYEY SILT: grey, low plasticity, fine grained sand, some shell layers and bands.		S	
				10.55m SPT HW/450mm	10.0			As above, diminishing shell content, clayey silt with some sandy clayey silt			10.55: SPT Recovery: 0.55 m 10.65: HP Samp <=50 kPa
				11.00m	11.0						
		VE									11.45: HV Samp P: 84 kPa R: 27 kPa 11.50: Field vane results possibly higher due to presence of shells
				12.00m SPT 0, 0, 2 N*=2	12.0						12.00: SPT Recovery: 0.45 m
				12.45m			ML	As above, trace of fine grained silty sand bands, trace of wood fragments, some shells	VM - W		
					13.0					S - F	
				13.40m SPT 2, 0, 0 N*=0				As above, clayey silt, trace of sand, varying percentages of clay, silt, sand and shells			13.40: SPT Recovery: 0.4 m 13.50: HP Samp = 25 - 75 kPa
				13.85m	14.0						
				14.70m SPT 1, 5, 4 N*=9				As above, increase in shell content			
								14.80m SANDY GRAVEL AND SHELLS: grey and yellow-brown, fine to coarse gravel, angular, non plastic, fine and medium grained sand, some silt, meta siltstone gravel.			14.70: SPT Recovery: 0.2 m ALLUVIUM
				15.15m	15.0		GP		W	L	
		F						15.40m META SILTSTONE: yellow-brown, trace of quartz veins.	M		BEDROCK 15.40: Extremely and highly weathered bedrock
					16.0						

DB
CASING
0-20% Bentonite LOSS (casing at 7.60m)
CASING
0% Bentonite LOSS (casing at 11.10m)
HQ Casing
0% Bentonite LOSS (casing at 13.65m)

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR1
FILE / JOB NO : SG0109
SHEET : 3 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244676.859, N: 6045263.377 (56 MGA94) SURFACE ELEVATION : -6.220 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 18/05/17 DATE COMPLETED : 22/05/17 DATE LOGGED : 22/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
DB	▼	F			16.0			META SILTSTONE: yellow-brown, trace of quartz veins. *(continued)* 16.20m Continued as Cored Drill Hole	M		BEDROCK
					17.0						
					18.0						
					19.0						
					20.0						
					21.0						
					22.0						
					23.0						
					24.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR1
FILE / JOB NO : SG0109
SHEET : 4 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244676.859, N: 6045263.377 (56 MGA94) SURFACE ELEVATION : -6.220 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 18/05/17 DATE COMPLETED : 22/05/17 DATE LOGGED : 22/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL, VL, L, M, H, VH, EH)	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				16.0							
						16.20m START CORING AT 16.20m					
NMLC	0-10% Water LOSS (casing at 16.00m)	0% LOSS	Is(50) d=0.89 MPa			META SILTSTONE: yellow-brown and brown some brown-grey, 70-75° bedding, trace of fine grained argillite bands and quartz veins <=15mm.	HW - MW				JT 40° Clay PR RF DB JT 5° Fe PR RF JT 5° Fe PR RF
				17.0							JTs 5 - 45° Fe Clay IR RF BPs 70 - 75° Fe Clay PR RF S, trace clay pockets <=20mm
		17.20	Is(50) d=0.81 MPa								JT 5° Fe IR RF
		32% LOSS	17.35m ES								25 mm extremely weathered pocket JTs 45° Fe Clay IR RF DB
							HW				JTs 0 - 90° Fe Clay IR RF BPs 75° Fe Clay PR RF S
						17.69m CORE LOSS 0.40m (17.69-18.09)					Core loss probable position in EW bedrock
				18.0		18.09m					
						ARGILLITE AND META SILTSTONE: red-brown, brown and brown-grey, fine and medium grained sand, 70-80° bedding, trace of quartz veins <=10mm, thinly bedded to medium bedded layers.	HW				JTs 0 - 90° Fe Clay IR RF BPs 70 - 75° Fe Clay PR RF
		18.45									
		0% LOSS	Is(50) d=0.49 MPa				HW - MW				DB, JT 0° Clay CT PR RF JT 40° Clay PR RF
				19.0							
						19.17m					JTs 0 - 90° Fe Clay IR RF BPs 70 - 85° Fe Clay PR RF S
		19.25				ARGILLITE AND META SILTSTONE: as above , 85-90° bedding, quartz veins <=40mm at all angles.					
		0% LOSS									VN 0° Qz 30 mm JT 5° Clay PR RF
											JT 60° Fe Clay IR RF
				20.0							VN 70 - 90° Qz 40 mm
		20.25				20.26m					
		0% LOSS				ARGILLITE AND META SILTSTONE: as above , numerous quartz veins at 0-90° throughout, very thinly bedded.	HW				JTs 0 - 90° Fe Clay IR RF BPs 85 - 90° Fe Clay IR RF
						20.85m	MW				
						ARGILLITE: brown and grey-brown, fine grained sand, 85-90° bedding, trace of quartz veins <=3mm.					JT 5° Fe Clay Qz PR RF
			Is(50) d>0.92 MPa	21.0							JT 20° Fe Clay Qz PR RF DB
			Is(50) a=1.38 MPa								JT 5° Fe Clay PR RF
											JT 5° Fe IR RF
											SM 0° 20 mm extremely weathered seam DB JT 10° Fe Qz PR RF DBs HB
			Is(50) d=1.08 MPa	22.0							
		22.35				22.28m					
		0% LOSS				ARGILLITE: as above , numerous quartz veins <=20mm at all angles throughout.	MW - HW				SM 5° 25 mm extremely weathered seam JTs 0 - 90° Fe Clay Qz IR RF VNs 0 - 70° Qz <=20 mm DBs
							MW				
						23.00m					
				23.0		ARGILLITE: as above , brown and grey, 80-85° bedding, trace of quartz veins <=2mm.					
											JT 10° Fe Qz PR RF
		23.55									JT 5° Fe Clay PR RF
		0% LOSS	Is(50) a=1.64 MPa				SW - MW				JT 15° Fe PR RF
						23.85m					
				24.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR1
FILE / JOB NO : SG0109
SHEET : 5 OF 5

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244676.859, N: 6045263.377 (56 MGA94) SURFACE ELEVATION : -6.220 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 18/05/17 DATE COMPLETED : 22/05/17 DATE LOGGED : 22/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0-10% Water LOSS (casing at 16.00m)	0% LOSS DRILL DEPTH	Is(50) d=1.38 MPa	24.0		META SILTSTONE: grey and brown-grey, 80-85° bedding, trace of quartz veins <=5mm. *(continued)*	SW - MW				HB DB
						24.53m ARGILLITE: grey and brown-grey, fine grained sand, 80-85° bedding, trace of quartz veins <=10mm.					JT 5° Fe Qz PR RF JT 45° Fe Qz PR RF JT 0° Fe PR RF JT 20° Fe Clay IR RF JT 5° Fe PR RF
			Is(50) a=2.56 MPa	25.0			SW				
			Is(50) d=4.85 MPa	26.0							HB JT 10° Fe PR RF
		26.40 0% LOSS	Is(50) a=1.92 MPa								JT 10° Fe IR RF JT 5° Fe IR RF
						26.80m ARGILLITE AND META SILTSTONE: grey and dark grey, fine grained sand, 85-90° bedding, trace of quartz veins <=2mm.	SW - F				JT 55° Fe PR RF JT 5° Fe Qz IR RF BP 90° Fe PR RF
				27.0							BP 85 - 90° Fe IR RF DIS
		28.00		28.0		28.00m BOREHOLE BBR1 TERMINATED AT 28.00 m					DL
				29.0							
				30.0							
				31.0							
				32.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

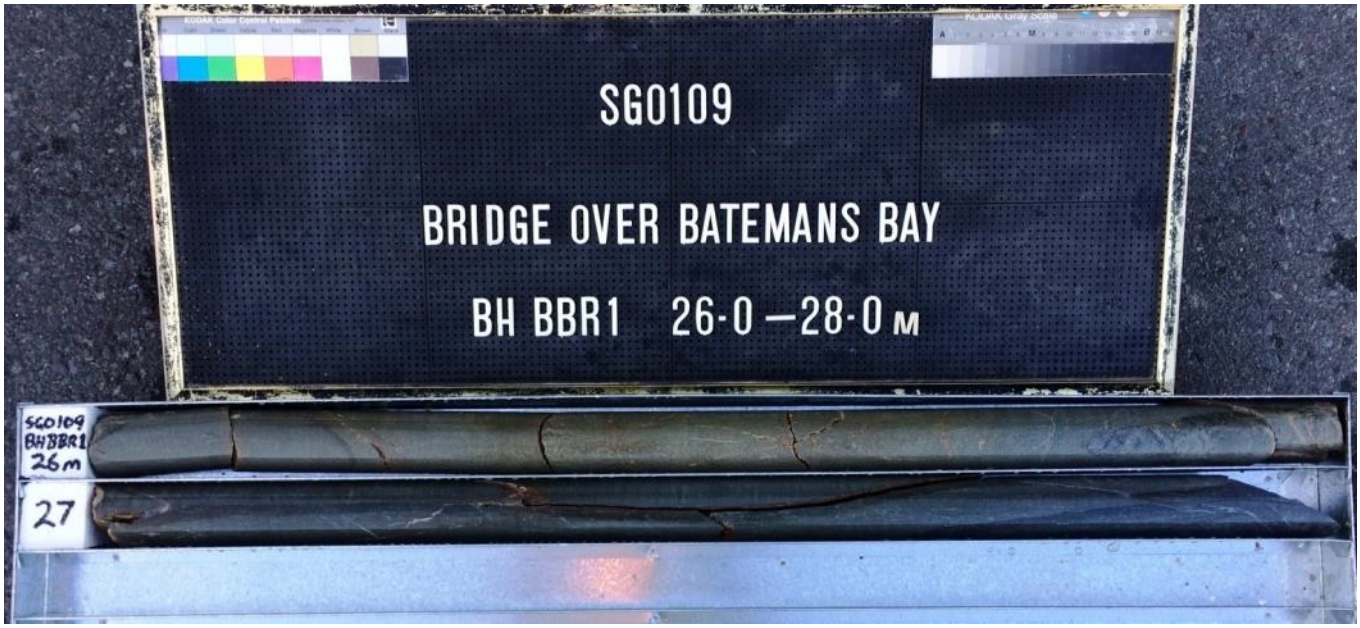
ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services NSW GOVERNMENT

File: SG0109 BBR1 5 OF 5

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:59 8.2.843 Datgel Tools

Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBRL1**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017



Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBRL1**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR2
FILE / JOB NO : SG0109
SHEET : 1 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244758.410, N: 6045282.712 (56 MGA94) SURFACE ELEVATION : -8.570 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 23/05/17 DATE COMPLETED : 25/05/17 DATE LOGGED : 25/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					0.0			SAND AND SHELLS: grey, fine and medium grained sand, non plastic, shells and shell fragments <=10mm.			MARINE DEPOSITS
CASING	0% Bentonite LOSS (casing at 1.30m)			1.45m SPT 1, 0, 1 N=1 1.90m	1.0		SP				1.45: SPT Recovery: 0 m
CASING	0% Bentonite LOSS (casing at 2.60m)				2.0			As above			
								2.50m SAND AND SILTY SAND: grey and dark grey, fine and medium grained sand, non plastic, trace of shells.			
CASING	0% Bentonite LOSS (casing at 4.00m)			2.75m SPT 0, 1, 1 N*=2 3.20m	3.0		SP-SM				2.75: SPT Recovery: 0.15 m
								3.30m SAND AND SHELLS: grey, fine and coarse grained sand, non plastic, trace fine angular gravel, shells and shell fragments <=10mm.			
DB		VE			4.0				W	VL	
CASING	0-20% Bentonite LOSS (casing at 5.50m)			4.15m SPT 2, 1, 2 N*=3 4.60m							4.15: SPT Recovery: 0.2 m
					5.0		SP	As above, fine shell fragments, varying percentages of sand and shells			
CASING	0% Bentonite LOSS (casing at 6.70m)			5.65m SPT 1, 3, 0 N=3 6.10m	6.0			As above, sand and shells <=10mm, trace of dark grey fine grained silty sand pockets			5.65: SPT Recovery: 0 m
								6.70m CLAYEY SILTY SAND AND SHELLS: dark grey and grey, fine and medium grained sand, non and low plastic, trace coarse grained sand, and silty clay pockets, shells and shell fragments <=10mm.			
HQ Casing	0% Bentonite LOSS (casing at 7.40m)			6.85m SPT 0, 0, 7 N*=7 7.30m	7.0		SC-SM				6.85: SPT Recovery: 0.35 m
								7.15m META SILTSTONE AND ARGILLITE: yellow-brown and brown, fine grained, trace of quartz veins.			BEDROCK 7.15: Extremely and Highly weathered bedrock
		F			8.0				M		

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR2
FILE / JOB NO : SG0109
SHEET : 2 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244758.410, N: 6045282.712 (56 MGA94) SURFACE ELEVATION : -8.570 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 23/05/17 DATE COMPLETED : 25/05/17 DATE LOGGED : 25/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
DB		F			8.0			8.20m META SILTSTONE AND ARGILLITE: yellow-brown and brown, fine grained, trace of quartz veins. *(continued)*	M		BEDROCK
								Continued as Cored Drill Hole			
					9.0						
					10.0						
					11.0						
					12.0						
					13.0						
					14.0						
					15.0						
					16.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR2
FILE / JOB NO : SG0109
SHEET : 3 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244758.410, N: 6045282.712 (56 MGA94) SURFACE ELEVATION : -8.570 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 23/05/17 DATE COMPLETED : 25/05/17 DATE LOGGED : 25/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION — ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL .003, VL .01, L .03, M .1, H .3, VH 1, EH 10)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				8.0		8.20m START CORING AT 8.20m					
NMLC	0% Water LOSS (casing at 7.40m)	58% LOSS				CORE LOSS 0.92m (8.20-9.12)					Core loss probable position in highly weathered and extremely weathered bedrock
				9.0		9.12m					
						META SILTSTONE: brown and grey-brown, 70° bedding, trace of quartz veins <=5mm.	HW				
						9.40m					JTs 0 - 90° Fe Clay IR RF BPs 70° Fe Clay PR RF S
						ARGILLITE: brown, fine grained sand, 70-90° bedding, trace of quartz veins <=1mm and meta siltstone bands.	MW - HW				
		9.80					HW - EW				Extremely weathered bedrock JTs 0 - 90° Fe Clay IR RF
		8% LOSS	9.90m AS Is(50) d=0.71 MPa Is(50) a=0.56 MPa	10.0			MW				JTs 10 - 45° Fe Clay CT IR RF HB JT 20° Fe Clay IR RF JT 5° Clay PR RF
											JT 30° Fe PR RF JT 5° Clay PR RF JT 15° Fe Clay IR RF
							HW - EW				5 - 60° 80 mm extremely weathered pocket JT 10° Clay PR S
				11.0		11.00m					30° 60 mm extremely weathered pocket
						11.18m CORE LOSS 0.18m (11.00-11.18)					Core loss probable position in extremely weathered bedrock
						ARGILLITE: as above , brown and red-brown with some grey-brown, 70° bedding.	HW - EW				JTs 0 - 90° Fe Clay IR RF S BPs 70° Fe Clay PR RF S
							MW				20° 40 mm extremely weathered pocket
						11.84m					JT 0 - 30° Fe IR RF
		12.00		12.0		META SILTSTONE: brown-grey with some brown, 70-80° bedding, trace of quartz veins <=2mm.	EW				BPs 70° Fe Clay PR RF S SM 0° 60 mm extremely weathered seam
		0% LOSS					MW				JTs 0 - 90° Fe Clay IR RF BPs 70 - 80° Fe Clay PR RF S
							MW - SW				
						12.81m					
			Is(50) d=1.56 MPa	13.0		ARGILLITE: grey with some brown-grey, fine grained sand, 80-85° bedding, trace of quartz veins <=2mm.					JT 5° Fe PR RF HB JT 15° Fe Clay IR RF DB JT 75° Fe PR RF JTs 5° Fe PR RF
		13.70					SW				DB DB DBs
		0% LOSS									
			Is(50) d=3.17 a=1.8 MPa	14.0							HB
						14.20m					
						ARGILLITE WITH SOME META SILTSTONE: grey with some brown-grey, fine grained sand, 80-90° bedding, trace of quartz veins <=5mm, laminated to medium bedded layers.					JT 80° Fe PR RF DIS BP 90° Fe IR RF DIS JT 30° Fe PR RF
				15.0							JT 45° Fe PR RF
											JT 50° Fe PR RF
				16.0		16.00m					JT 30° Fe PR RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services (NSW GOVERNMENT)

CORED DRILL HOLE LOG

HOLE NO : BBR2
FILE / JOB NO : SG0109
SHEET : 4 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244758.410, N: 6045282.712 (56 MGA94) SURFACE ELEVATION : -8.570 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 23/05/17 DATE COMPLETED : 25/05/17 DATE LOGGED : 25/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% Water LOSS (casing at 7.40m)	0% LOSS	Is(50) d=1.58 a=1.36 MPa	16.0		ARGILLITE AND META SILTSTONE: grey with some brown-grey, fine grained sand, 85-90° bedding, trace of quartz veins <=20mm, laminated to thinly bedded layers.	SW	EL VL L M H VH EH; -0.03 -0.1 -0.3 -1 -3 -10	20 40 100 300 1000		HB JT 5° Fe Clay PR RF JT 75° Fe Clay PR RF JT 25° Fe Clay PR RF JT 25° Fe Clay PR RF JT 20° Fe PR RF
		16.75									
		0% LOSS					MW				JT 20° Fe Clay PR RF DB JT 0° Fe Clay CT PR RF
				17.0		17.00m ARGILLITE AND META SILTSTONE: as above , grey.	SW - F				VN 20° Qz 20 mm
		18.00	Is(50) d=1.38 MPa			18.00m					JT 65° Fe PR RF
				18.0		BOREHOLE BBR2 TERMINATED AT 18.00 m					
				19.0							
				20.0							
				21.0							
				22.0							
				23.0							
				24.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR2 4 OF 4

Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBR2**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR3
FILE / JOB NO : SG0109
SHEET : 1 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244821.285, N: 6045385.225 (56 MGA94) SURFACE ELEVATION : -6.960 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 29/05/17 DATE COMPLETED : 30/05/17 DATE LOGGED : 30/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
DB	0% Water LOSS (casing at 1.70m)	VE-E			0.0		SP	SAND AND SAND WITH SOME SHELLS: brown, grey-brown and grey, fine and medium grained sand, non plastic, trace coarse grained sand, shells and shell fragments <=10mm.	W	VL	MARINE DEPOSITS
CASING					1.0						
					1.80m						
HQ Casing	0% Water LOSS (casing at 3.20m)			2.10m SPT 1, 1, 5 N*=6	2.0		SP	SAND AND SAND WITH TRACE OF SHELLS: grey, trace sub-rounded <=5mm gravel, trace silt, trace of yellow-brown meta siltstone extremely weathered fragments.			2.10: SPT Recovery: 0.3 m
					2.40m						
		F		2.55m				META SILTSTONE: green-grey becoming yellow-brown, trace of quartz veins.	M		BEDROCK 2.40: (Extremely and Highly weathered bedrock)
					3.0						
					3.30m			Continued as Cored Drill Hole			
					4.0						
					5.0						
					6.0						
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR3 1 OF 3

RMS 41.2 LIB.GLB Log RTA NON-CORE DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:54 8.2.843 Datgel Tools

CORED DRILL HOLE LOG

HOLE NO : BBR3
FILE / JOB NO : SG0109
SHEET : 2 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244821.285, N: 6045385.225 (56 MGA94) SURFACE ELEVATION : -6.960 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 29/05/17 DATE COMPLETED : 30/05/17 DATE LOGGED : 30/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral (EL, VL, L, M, H, VH, EH; -0.03, -0.1, -0.3, -1, -3, -10)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0							
				1.0							
				2.0							
				3.0							
						3.30m START CORING AT 3.30m					
NMLC	0% Water LOSS (casing at 3.20m)	9% LOSS	4.00m AS Is(50) d>0.17 MPa			CORE LOSS 0.17m (3.30-3.47)					
						3.47m ARGILLITE: brown and red-brown with some grey-brown and pale grey, fine grained sand, 70-80° bedding, trace of quartz veins <=5mm.	EW				Core loss probable position in extremely weathered bedrock
				4.0			HW - EW				5° 190 mm extremely weathered bedrock
											JTs 0 - 90° Fe Clay CT IR RF S with some <=50mm extremely weathered pockets, trace BPs
							MW				
						5.00m					
		5.20		5.0		ARGILLITE AND META SILTSTONE: brown, grey-brown and brown-grey, fine grained sand, 70-85° bedding, very thinly bedded to medium bedded layers.					HB DBs and HBs DL
		0% LOSS									JT 5° Fe CT PR RF
			Is(50) d=1.52 MPa	6.0							HB
						6.35m					DB on BP
						META SILTSTONE: brown and brown-grey, 80-85° bedding, trace of quartz veins <=20mm.	HW				JTs 0 - 90° Fe Clay IR RF S VN 60° Qz 20 mm
							MW				JT 5° Fe Clay PR RF HBs
		7.25		7.0							
		0% LOSS					HW				JTs 0 - 90° Fe Clay IR RF S BPs 80 - 85° Fe Clay PR RF S, with some quartz
							MW - SW				
				8.0		8.00m					

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services (NSW GOVERNMENT)

CORED DRILL HOLE LOG

HOLE NO : BBR3
FILE / JOB NO : SG0109
SHEET : 3 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244821.285, N: 6045385.225 (56 MGA94) SURFACE ELEVATION : -6.960 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 29/05/17 DATE COMPLETED : 30/05/17 DATE LOGGED : 30/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

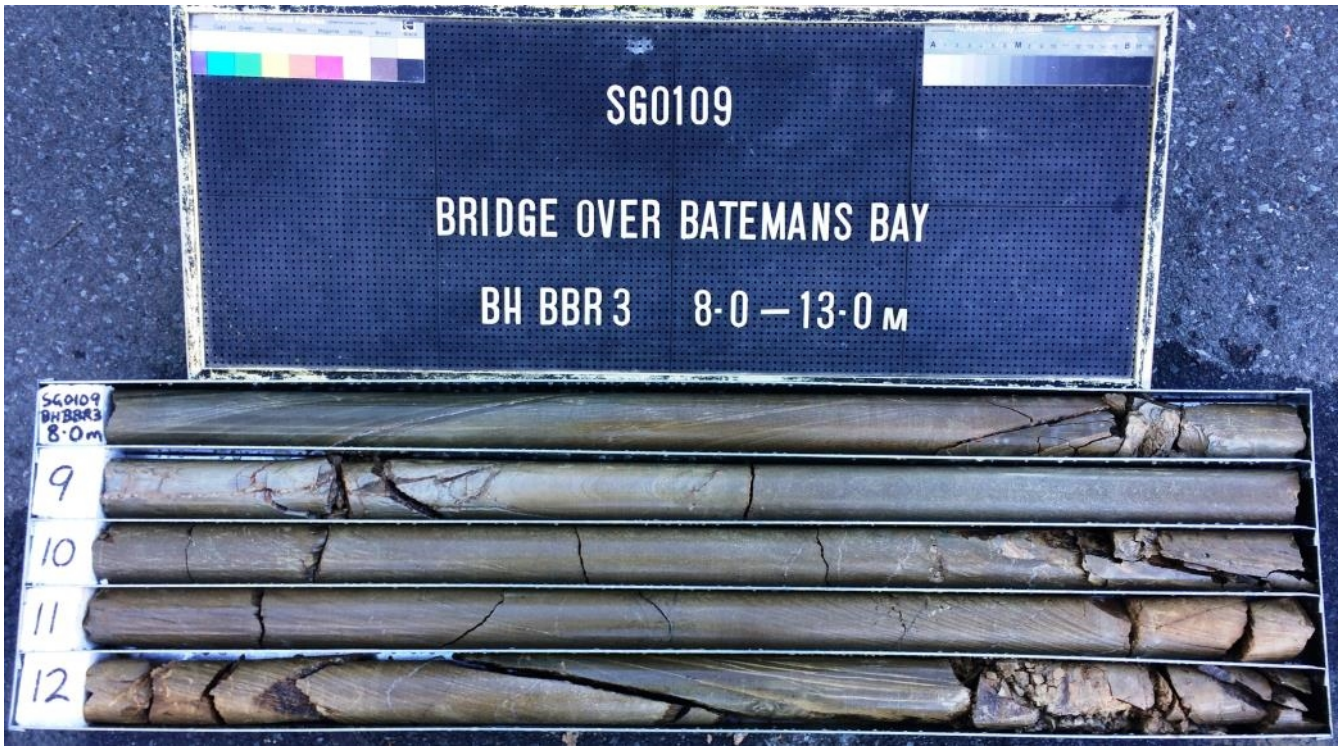
DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% Water LOSS (casing at 3.20m)	0% LOSS 8.95 0% LOSS 11.95 0% LOSS 13.35 0% LOSS 16.00	Is(50) d=1.99 MPa Is(50) d=1.09 MPa Is(50) d=3.23 MPa Is(50) d=2.46 MPa Is(50) d>1.22 MPa Is(50) d=2.07 MPa Is(50) d=3.73 MPa Is(50) d=3.41 MPa	8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0		ARGILLITE AND META SILTSTONE: brown and grey-brown, fine grained sand, 75-80° bedding, trace of quartz veins <=2mm, laminated to medium bedded layers. 9.54m ARGILLITE: brown with some grey-brown and red-brown, fine grained sand, 70-85° bedding, trace of quartz veins <=2mm and meta siltstone interbedding. 12.40m ARGILLITE AND META SILTSTONE: brown and grey-brown, fine grained sand, 80-85° bedding, trace of quartz veins <=5mm, laminated to thickly bedded layers. 15.58m META SILTSTONE: grey, as above. 16.00m BOREHOLE BBR3 TERMINATED AT 16.00 m	MW MW - HW MW EW - HW MW MW - SW SW			HB DBs, BP 80° Fe PR S HB DB, JT 20° Fe Clay Qz PR RF JT 45° Fe Qz PR RF JT 5° Fe IR RF HB JT 5° Fe IR RF JT 15° Fe PR RF JT 5° Fe PR RF JT 2° Fe PR RF JT 10° Fe PR RF DBs, BP 85° Fe PR RF HB JT 0° Fe PR RF JT 50° Fe PR RF JT 40° Fe IR RF JT 5° Fe IR RF JT 2° Fe Clay PR RF JT 30° Fe PR RF HB JT 5° Fe Clay PR RF JT 5° Fe IR RF JT 50° Fe IR RF BP 80° Fe Clay PR RF JTs 0 - 90° Fe Clay IR RF BPs 80 - 85° Fe Clay PR RF S, with extremely weathered pocket 70mm JT 5° Fe IR RF JT 5° Fe IR RF JT 15° Fe PR RF JT 30° Fe PR RF JT 70° Fe PR RF JT 2° Fe PR RF HB JT 5° Fe PR RF JT 0° Fe PR RF BP 80° Fe PR S DB DB

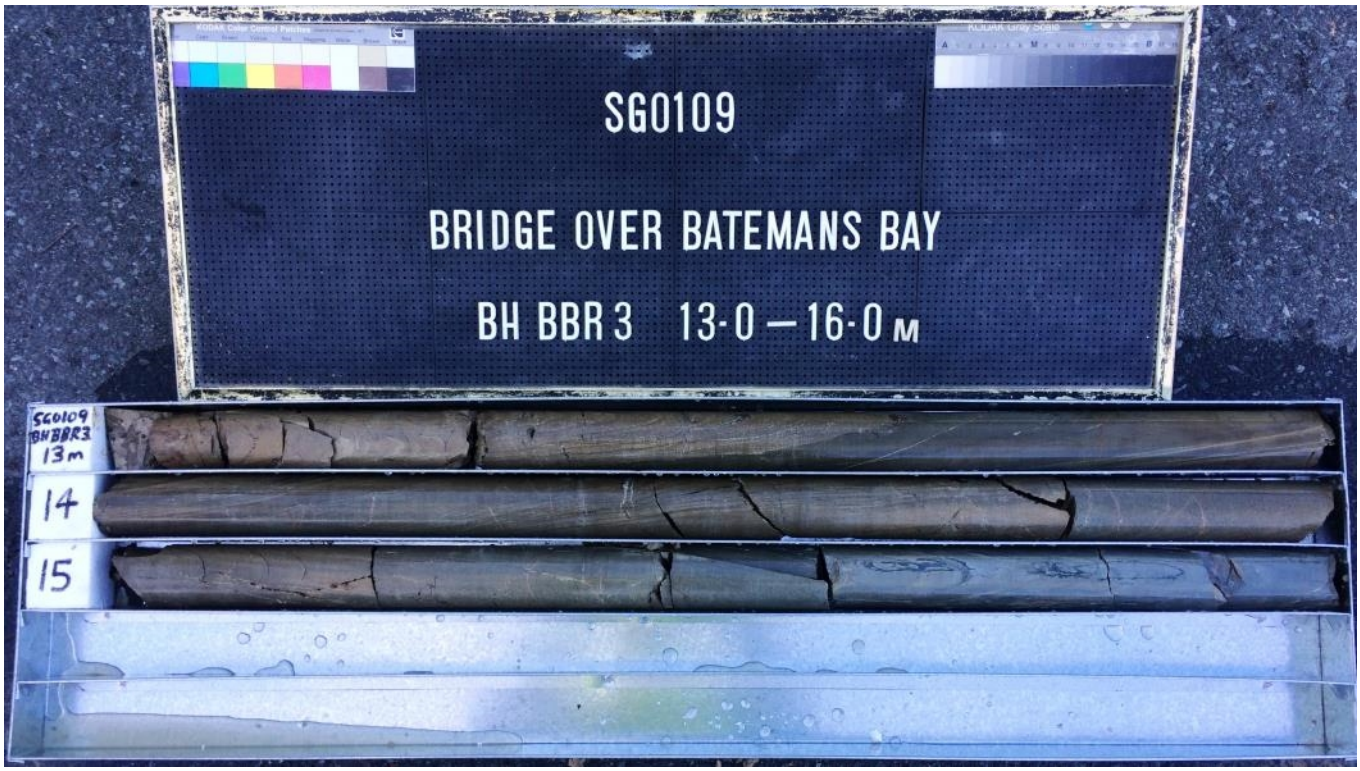
See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services NSW GOVERNMENT


SG0109
BRIDGE OVER BATEMANS BAY
BH BBR 3 3·30 – 8·0 M
SG0109.BHBBR3. START 3·30 m LOSS 0·17m
4
5
6
7


SG0109
BRIDGE OVER BATEMANS BAY
BH BBR 3 8·0 – 13·0 M
SG0109 BHBBR3 8·0m
9
10
11
12



Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBR3**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR4
FILE / JOB NO : SG0109
SHEET : 1 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244626.854, N: 6045428.501 (56 MGA94) SURFACE ELEVATION : -5.450 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 09/05/17 DATE COMPLETED : 11/05/17 DATE LOGGED : 11/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
CASING	0% Bentonite LOSS (casing at 1.50m)			1.50m SPT 5, 4, 6 N*=10 1.95m	0.0 1.0 2.0			SAND AND SHELLS: grey and brown-grey, fine to coarse grained sand, non plastic, shells and shell fragments predominantly <=10mm, little or no silt.		L - MD	MARINE DEPOSITS 1.50: SPT Recovery: 0.3 m
CASING	0% Bentonite LOSS (casing at 1.50m)			3.00m SPT 2, 3, 4 N*=7 3.45m	3.0		SP	As above, trace of sub-rounded gravel <=5mm			3.00: SPT Recovery: 0.1 m
DB CASING	0% Bentonite LOSS (casing at 3.00m)	E		4.00m SPT 3, 5, 3 N*=8 4.45m	4.0			SAND AND SHELLS, grey, fine and medium grained sand with shells, trace of coarse grained sand, varying percentages of sand and shells	W	L	4.00: SPT Recovery: 0.2 m
HW Casing	50% Bentonite LOSS (casing at 5.65m)			5.65m SPT 5, 3, 3 N*=6 6.10m	5.0 6.0			As above, trace of sub-rounded gravel <=20mm			5.65: SPT Recovery: 0.05 m
				7.25m SPT HW/450mm 7.70m	7.0 8.0		6.60m SC-SM	SILTY SAND , CLAYEY SAND AND CLAYEY SILT WITH SHELLS: grey and dark grey, fine and medium grained sand, non and low plastic, in layers and bands, shells and shell fragments predominantly <=10mm, trace of coarse grained sand.		VL - S	7.25: SPT Recovery: 0 m

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR4
FILE / JOB NO : SG0109
SHEET : 2 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244626.854, N: 6045428.501 (56 MGA94) SURFACE ELEVATION : -5.450 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 09/05/17 DATE COMPLETED : 11/05/17 DATE LOGGED : 11/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING | MATERIAL

PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
					8.0			SILTY SAND , CLAYEY SAND AND CLAYEY SILT WITH SHELLS: grey and dark grey, fine and medium grained sand, non and low plastic, in layers and bands, shells and shell fragments predominantly <=10mm, trace of coarse grained sand. *(continued)*			MARINE DEPOSITS
HW Casing							SC-SM		W	VL - S	
				9.05m SPT RW/450mm	9.0			9.00m CLAYEY SILT: dark grey, low plasticity, trace fine grained sand, with some low to medium plasticity clayey silt, some shells and shell bands, organic.			9.05: SPT Recovery: 0.45 m 9.15: HP Samp <25 kPa
				9.50m							
DB	0% Bentonite LOSS (casing at 9.05m)	E			10.0		ML-OL			VS	
				10.55m SPT HW/450mm					W - VM		10.55: SPT Recovery: 0.45 m 10.65: HP Samp <25 kPa
HQ Casing				11.00m	11.0			As above, trace of clayey sandy silt bands, low and low to medium plasticity bands, some medium plasticity silty clay bands			
								11.50m CLAYEY SAND AND SILTY SAND WITH SHELLS: dark grey and grey, fine to coarse grained sand, non and low plastic, trace gravel			
				12.00m			SC-SM			MD	12.00: SPT Recovery: 0.1 m
WB/RR				SPT 11/150mm HB N*=R 12.15m	12.0			12.10m META SILTSTONE AND ARGILLITE: green-grey, fine grained sand, sub-vertical bedding.			BEDROCK 12.10: Highly weathered and moderately weathered bedrock
		F-H						12.55m Continued as Cored Drill Hole	M		
					13.0						
					14.0						
					15.0						
					16.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR4 2 OF 4

CORED DRILL HOLE LOG

HOLE NO : BBR4
FILE / JOB NO : SG0109
SHEET : 3 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244626.854, N: 6045428.501 (56 MGA94) SURFACE ELEVATION : -5.450 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 09/05/17 DATE COMPLETED : 11/05/17 DATE LOGGED : 11/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	NATURAL FRACTURE (mm) 20, 40, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				8.0							
				9.0							
				10.0							
				11.0							
				12.0							
						12.55m START CORING AT 12.55m					
NMLC	0% Water LOSS (casing at 12.55m)	0% LOSS	13.16m AS Is(50) d=2.06 MPa	13.0		ARGILLITE: brown with some grey-brown, fine grained sand, 85-90° bedding, trace of quartz veins <=3mm.	MW				BPs 85° Fe Clay PR RF JT 5° Clay PR RF JT 5° Fe Clay Qz PR RF HB, JT 65° Fe Clay Qz PR RF HB JT 25° Fe Qz PR RF JT 30° Clay Qz PR RF JTs 0 - 75° Fe Clay PR RF IR, S BPs 90° Fe Clay PR RF
			Is(50) d=1.9 MPa	14.0							JT 2° Clay Qz PR RF DB, JT 75° Clay PR RF DBs, JTs 30° Fe Clay IR RF JT 75° Fe Clay IR RF DB BP 85 - 90° Fe Clay PR RF S JT 35° Fe Clay PR RF JT 40° Fe IR RF
		14.30 0% LOSS				14.46m ARGILLITE: as above , brown and grey-brown, fine and medium grained sand, trace of coarse grained sand.					
		15.07 0% LOSS	Is(50) d=3.59 MPa	15.0		15.43m ARGILLITE: as above , increase in quartz veins <=5mm.					HB DL JT 65° Fe PR RF JT 2° Clay PR RF JT 5° Fe Qz PR RF
				16.0		16.00m					

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR4
FILE / JOB NO : SG0109
SHEET : 4 OF 4

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244626.854, N: 6045428.501 (56 MGA94) SURFACE ELEVATION : -5.450 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 09/05/17 DATE COMPLETED : 11/05/17 DATE LOGGED : 11/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .03 VL .1 L .3 M 1 H 3 VH 10 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	0% Water LOSS (casing at 12.55m)	0% LOSS 18.07 0% LOSS 20.72	Is(50) d=2.37 a=1.64 MPa Is(50) d=2.84 MPa Is(50) d=2.04 MPa Is(50) d=2.09 MPa	16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0		ARGILLITE: brown and grey-brown, fine grained sand, with trace of medium grained sand, 80-90° bedding, trace meta siltstone bands and quartz veins <=10mm. 19.71m ARGILLITE: as above , some red-brown. 20.13m ARGILLITE AND META SILTSTONE: brown and grey-brown, fine grained sand, 80-90° bedding, trace of quartz veins <=2mm. 20.72m BOREHOLE BBR4 TERMINATED AT 20.72 m	MW EW MW MW - HW MW - SW				HB JT 20° Clay IR RF SM 10° Clay 90 mm extremely weathered seam DBs, JTs 60 - 10° Fe PR RF DB, JT 20° Clay IR RF HBs JT 70° Fe PR RF HB DB JT 15° Fe IR RF DB, JT 75° Clay Qz PR RF HB JT 10° CN PR RF JT 70° Clay PR RF JTs 40 - 70° Fe PR RF JT 5° Clay PR RF JT 15° Clay PR RF JT 55° Fe Clay IR RF HB JTs 45 - 50° Clay PR RF IR JTs 10 - 45° Clay PR RF IR DBs, JT 35° Clay PR RF DBs, JT 0° Clay CT PR RF JT 55° Clay CT PR S JT 20° Clay PR RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR4 4 OF 4

Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBRL4**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR5
FILE / JOB NO : SG0109
SHEET : 1 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244677.976, N: 6045461.021 (56 MGA94) SURFACE ELEVATION : -8.910 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 17/05/17 DATE COMPLETED : 17/05/17 DATE LOGGED : 17/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
DB	10% Water LOSS (casing at 1.80m)	VE		1.85m SPT 0, 1, 0 N=1 2.30m	0.0		SP	SAND AND SHELLS: grey, fine grained sand, non plastic, with shells and shell fragments throughout. shells predominantly <=10mm, little or no silt.	W	VL	MARINE DEPOSITS
CASING	10% Water LOSS (casing at 3.20m)				1.0						
					2.0			As above, predominantly shells and shell fragments with some fine and medium grained sand			1.85: SPT Recovery: 0 m
				3.25m SPT 1, 1, 1 N*=2 3.70m	3.0			As above, shells with some sand			3.25: SPT Recovery: 0.05 m
CASING	10% Water LOSS (casing at 4.75m)				4.0						
HQ Casing	10% Water LOSS (casing at 5.50m)	F		4.80m SPT 2, 2, 3 N*=5 5.25m	5.0		GM	4.70m SILTY SANDY GRAVEL AND SILTY GRAVELLY SAND AND SHELLS: grey and brown, fine to coarse gravel, angular, non plastic, fine to coarse grained sand, trace clay, meta siltstone and quartz gravel.	M - W	L	4.80: SPT Recovery: 0.05 m
								5.30m META SILTSTONE: yellow-brown, grey-brown, trace of quartz.	M		BEDROCK 5.30: Extremely and highly weathered bedrock
					6.0			5.95m Continued as Cored Drill Hole			
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR5
FILE / JOB NO : SG0109
SHEET : 2 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244677.976, N: 6045461.021 (56 MGA94) SURFACE ELEVATION : -8.910 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 17/05/17 DATE COMPLETED : 17/05/17 DATE LOGGED : 17/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .03 VL .1 L .3 M 1 H 3 VH 10 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0							
				1.0							
				2.0							
				3.0							
				4.0							
				5.0							
						5.95m START CORING AT 5.95m					
NMLC	0% Water LOSS	28% LOSS	Is(50) d=1.69 MPa	6.0		ARGILLITE: brown, fine grained sand, 85° bedding, trace of meta siltstone bands.	MW				HBs BP 85° Clay CT PR RF JT 10° Clay CT PR RF
						6.45m					JT 0° Clay PR RF
						CORE LOSS 0.55m (6.45-7.00)					Core loss probable position in extremely weathered bedrock
				7.0		7.00m					
	40% Water LOSS (casing at 5.50m)		7.15m AS Is(50) d=0.25 MPa			ARGILLITE: brown with some red-brown, fine and medium grained sand, 85-90° bedding.	HW - MW				DBs, JTs 40° Fe Clay CT PR RF JT 5° Fe Clay PR RF DBs, SM 0° Clay 70 mm
											JT 55° Clay PR RF SM 10° Clay 70 mm
						7.63m	EW				JTs 30 - 90° Fe Clay PR RF IR with clay pockets
		7.95				ARGILLITE: brown and grey-brown, fine grained sand, 85-90° bedding, trace of quartz veins <=1mm.	MW - SW				DBs, JTs 10 - 30° Clay IR RF
				8.0		8.00m					DL

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services NSW GOVERNMENT

CORED DRILL HOLE LOG

HOLE NO : BBR5
FILE / JOB NO : SG0109
SHEET : 3 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244677.976, N: 6045461.021 (56 MGA94) SURFACE ELEVATION : -8.910 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 17/05/17 DATE COMPLETED : 17/05/17 DATE LOGGED : 17/05/17 LOGGED BY : RH CHECKED BY : MGD

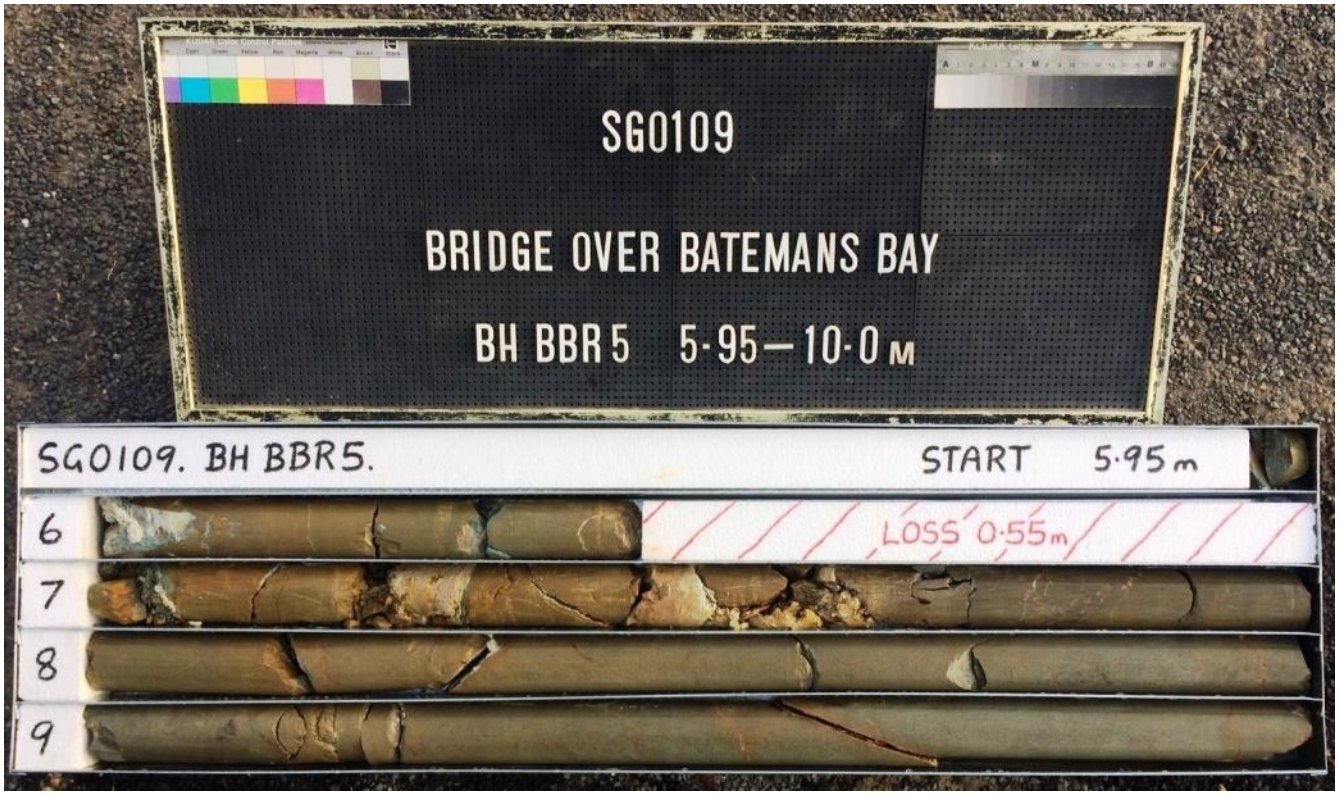
CASING DIAMETER : HQ BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

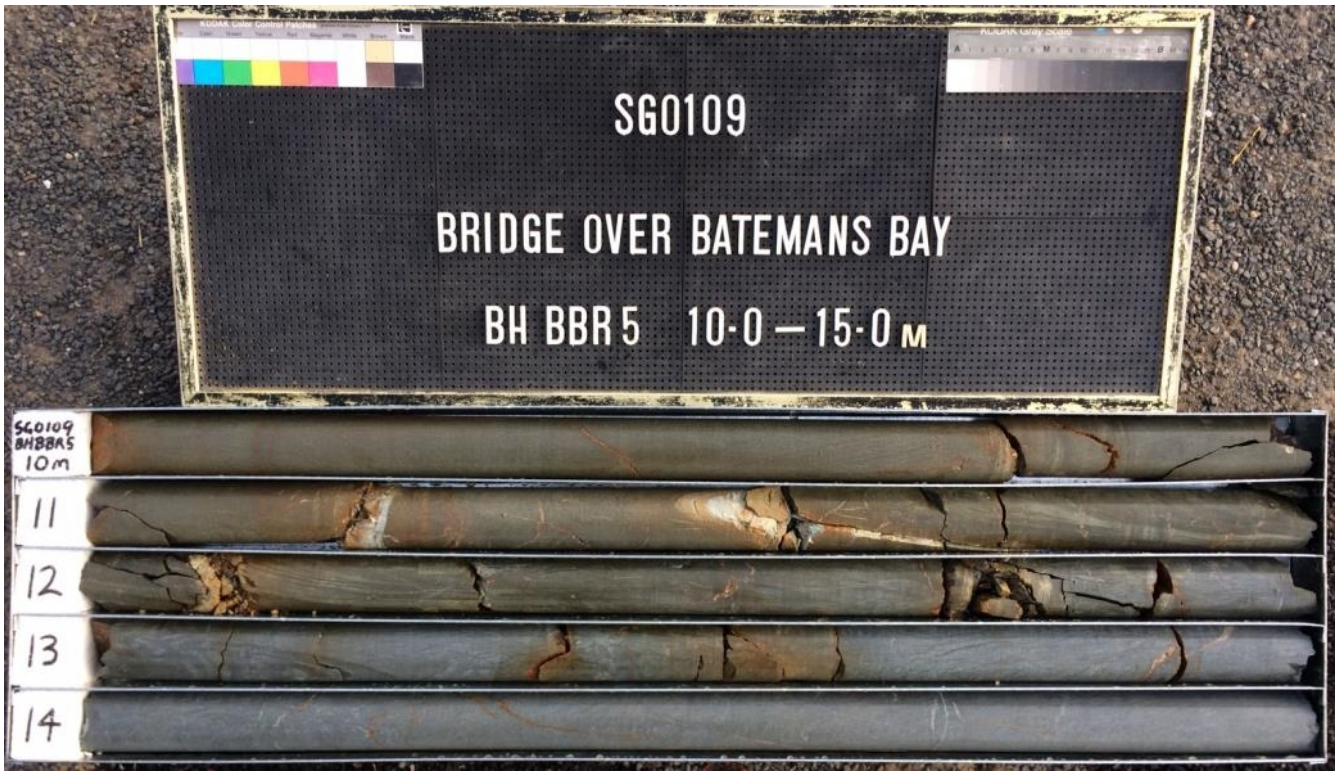
DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	40% Water LOSS (casing at 5.50m)	0% LOSS 10.95	Is(50) d=2.37 a=1.35 MPa	8.0		ARGILLITE: grey with some brown-grey, fine grained sand, variable 70-85° bedding, trace of quartz veins <=2mm and Fe sealed joints at 0-90°.	SW - MW	EL VL L M H VH EH -0.03 -0.1 -0.3 -1 -3 -10	20 40 100 300 1000		JT 30° Clay PR RF JTs 40° Clay CT PR RF JT 15° PR RF trace clay BP 70° Clay PR RF
			Is(50) d=3.5 MPa	9.0							HB JTs 0 - 45° Fe Clay PR RF
			Is(50) a=1.17 MPa								JT 65° Fe Clay Qz PR RF
				10.0		As above, grey with trace brown-grey, trace of medium grained sand					JT 55° Fe PR RF
		10.95 0% LOSS	Is(50) d>2.25 MPa	11.0							JT 15° Fe PR RF DB on sealed JT HBs SM 5° Clay 5-20mm JT 5° Fe Clay CT PR RF
			Is(50) a=1.05 MPa	12.0		11.65m META SILTSTONE: grey with some brown-grey and red-brown, 80-90° bedding, trace of quartz veins <=1mm and fine grained argillite laminations.	SW				JT 5° Clay CT PR RF BP 85° Fe Clay CT PR RF JT 5° Clay IR RF DB HB BPs 85° Fe PR RF SM 60° Clay 10 mm
		12.45 0% LOSS				12.45m ARGILLITE: grey with some red-brown, fine grained sand, 85-90° bedding, trace of meta siltstone bands and laminations, trace of quartz veins <=2mm.					JT 5° Clay CT PR RF JTs 0 - 45° Fe Clay PR RF IR BPs 80° Fe PR RF S JT 5° Fe PR RF
			Is(50) d>1.97 MPa	13.0							HB JT 5° Fe PR RF JT 5° Fe PR S
						13.55m ARGILLITE: grey, fine grained sand, with trace of medium grained, 85-90° bedding, trace of quartz veins <=2mm and Fe sealed joints at 0-90°.	SW - F				JTs 5 - 80° Fe Clay PR RF JTs 10 - 80° Fe PR RF IR JT 0° Fe PR RF
			Is(50) d=2.94 a=0.78 MPa	14.0							JT 5° Fe PR RF HB
		15.00		15.0		15.00m BOREHOLE BBR5 TERMINATED AT 15.00 m					
				16.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services





Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBR5**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BBR6
FILE / JOB NO : SG0109
SHEET : 1 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244724.819, N: 6045481.194 (56 MGA94) SURFACE ELEVATION : -8.950 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 15/05/17 DATE COMPLETED : 16/05/17 DATE LOGGED : 16/05/17 LOGGED BY : RH CHECKED BY : MGD

DRILLING					MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
DB HW Casing HQ Casing	0% Water LOSS (casing at 1.60m)	E			0.0		SP	SAND: grey, fine to coarse grained sand, non plastic 0.30m	W		MARINE DEPOSITS
		F-H			1.0			ARGILLITE: yellow-brown and red-brown, fine and medium grained sand, 80-90° bedding, trace of quartz veins, low becoming medium and high strength. 1.80m	M		BEDROCK 0.30: (Highly Weathered becoming Moderately Weathered bedrock)
								Continued as Cored Drill Hole			
					2.0						
					3.0						
					4.0						
					5.0						
					6.0						
					7.0						
					8.0						

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR6 1 OF 3

RMS 41.2 LIB.GLB Log RTA NON-CORE DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 17:54 8.2.843 Datgel Tools

CORED DRILL HOLE LOG

HOLE NO : BBR6
FILE / JOB NO : SG0109
SHEET : 2 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244724.819, N: 6045481.194 (56 MGA94) SURFACE ELEVATION : -8.950 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 15/05/17 DATE COMPLETED : 16/05/17 DATE LOGGED : 16/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral EL .003 VL .01 L .03 M .1 H .3 VH 1 EH 10	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
				0.0							
				1.0							
						1.80m START CORING AT 1.80m					
NMLC	0-5% Water LOSS (casing at 1.80m)	0% LOSS	Is(50) d>1.33 MPa	2.0		ARGILLITE: brown with some grey-brown, fine and medium grained sand, 80-85° bedding, trace of quartz veins <=13mm.	MW - HW				JT 5° Clay PR RF BP 85° Clay Qz PR RF DBs, JT 65° Clay Qz PR RF JT 45° Fe PR RF BP 85° Clay CN PR S trace mica
		2.55									
		0% LOSS									JT 15° Fe PR RF JT 5° Qz PR RF trace clay JTs 15 - 45° Qz PR RF trace clay
			Is(50) d>1.58 MPa	3.0							HBs JT 15° Fe Qz PR RF
						3.43m					JT 80° PR RF trace clay JT 35° Fe PR RF trace clay
			Is(50) d=0.8 MPa			META SILTSTONE: brown-grey and grey, 80-85° bedding, trace of quartz veins <=15mm, some phyllite interbedding.	SW - MW				
				4.0			HW				HB VNs 10° Qz 90 mm trace clay
							MW				BP 85° Fe PR RF VN 70° Qz 15 mm Fe
		5.05									
		0% LOSS	5.25m AS Is(50) d=0.86 MPa	5.0							JTs 60 - 90° Fe Clay IR RF JT 10° Fe PR RF DBs, JTs 5 - 50° Fe Clay PR RF
											BP 85° Fe PR RF trace clay JT 5° Clay PR RF HB DL and HBs
			Is(50) d=0.98 MPa	6.0			MW - SW				BP 85° Fe PR RF JT 70° Fe PR RF JTs 10 - 30° Fe Clay PR RF BPs 85° Fe PR RF S JT 15° Fe PR RF
	20% Water LOSS					6.35m ARGILLITE: brown-grey and grey-brown, fine with medium grained sand, 80-85° bedding, trace of meta siltstone bands and quartz veins <=10mm.					
		6.95									JT 5° Clay PR RF
		0% LOSS	Is(50) d=2.61 MPa	7.0							JT 15° Fe Clay PR RF HB JT 5° Fe Clay PR RF BP 80° Fe PR RF S
	50% Water LOSS										JT 5 - 30° Clay IR RF 20 mm clay clast JT 5 - 20° Fe PR RF JT 35° Fe Clay PR RF
				8.0		8.00m					

See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

CORED DRILL HOLE LOG

HOLE NO : BBR6
FILE / JOB NO : SG0109
SHEET : 3 OF 3

PROJECT : BATEMANS BAY BRIDGE
LOCATION : OVERWATER BOREHOLE

POSITION : E: 244724.819, N: 6045481.194 (56 MGA94) SURFACE ELEVATION : -8.950 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Hydrapower Scout MOUNTING : Truck on Barge CONTRACTOR : TOTAL DRILLING DRILLER : GLEN GARTSIDE

DATE STARTED : 15/05/17 DATE COMPLETED : 16/05/17 DATE LOGGED : 16/05/17 LOGGED BY : RH CHECKED BY : MGD

CASING DIAMETER : HQ/HW BARREL (Length) : 3.00 m BIT : IMPREG BIT CONDITION : GOOD

DRILLING				MATERIAL			FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	Weathering	ESTIMATED STRENGTH Is(50) ● - Axial ○ - Diametral	NATURAL FRACTURE (mm)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
NMLC	50-95% Water LOSS (casing at 1.80m)	0% LOSS 9.20 10.00 0% LOSS 12.93	Is(50) d=1.34 MPa Is(50) d=1.03 MPa Is(50) d>1.21 MPa Is(50) d=4.12 a=1.18 MPa Is(50) d=3.64 MPa Is(50) a=0.54 MPa	8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0		META SILTSTONE: grey, brown-grey and brown, 85-90° bedding, some fine and medium grained Argillite interbedding, trace of quartz veins <=15mm. 9.20m ARGILLITE: grey-brown and brown-grey, fine with medium grained sand, 80-85° bedding, trace of quartz veins <=15mm. 10.22m ARGILLITE: grey with some brown-grey, fine and medium grained sand, 80-85° bedding, trace of meta siltstone bands and quartz veins <=8mm. As above, grey predominantly fine grained sand, trace of quartz veins <=15mm 12.93m BOREHOLE BBR6 TERMINATED AT 12.93 m Note: probable rock outcrop on the river bed detected in the vicinity of this bore hole	MW - SW SW	EL VL L M H VH EH -0.03 -0.1 -0.3 -1 -3 -10	20 40 100 300 1000	HBs JT 0° Fe PR RF JT 80° Fe IR RF JT 5° Fe IR RF JTs 5 - 60° Fe Clay IR RF BPs 85 - 90° Fe Clay IR RF HB JT 45° Fe PR RF JTs 45° Fe Clay PR RF JT 50° Fe PR RF HBs JTs 30 - 55° Fe IR RF BPs 80° Fe PR RF JT 10 - 70° Fe IR RF JT 45° Fe PR RF HB DB HB, BP 85° Fe PR RF HB DB JT 25° Fe Qz IR RF JT 5° Fe PR RF VN 35° Qz 15 mm JT 15° Fe PR RF DBs, BP 80° Fe PR RF

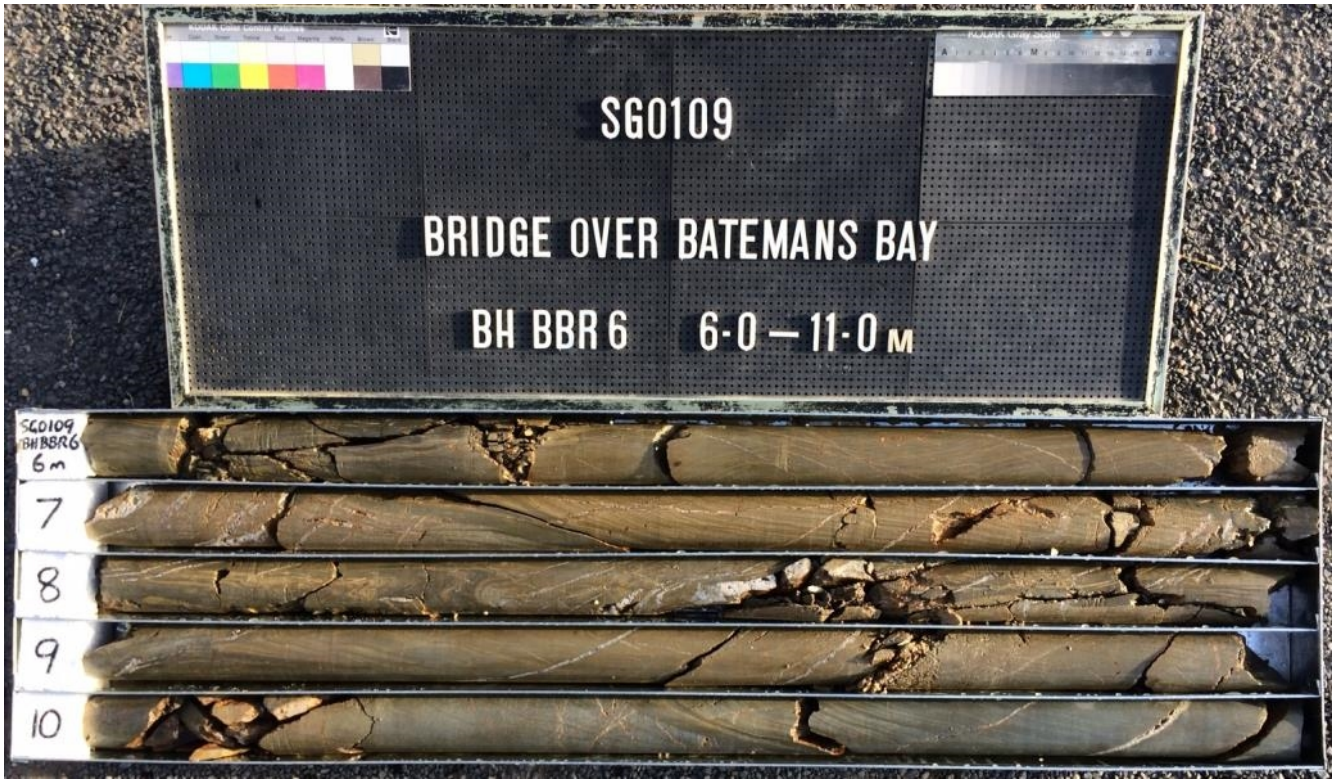
See Explanatory Notes for details of abbreviations & basis of descriptions.

ROADS AND MARITIME SERVICES, NSW

Transport Roads & Maritime Services

File: SG0109 BBR6 3 OF 3

RMS 41.2 LIB.GLB Log RTA CORED DRILL HOLE SG0109 BATEMANS BAY BRIDGE.GPJ <<DrawingFile>> 15/Jul/2017 18:00 8.2.843 Datgel Tools



Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBR6**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

Newcastle Geotech	**CORE PHOTOGRAPHS – BOREHOLE BBR6**	Job No: 326
	BATEMANS BAY BRIDGE	Date: June 2017

Appendix B
Clyde River Unregulated and Alluvial Water Sources Plan Map

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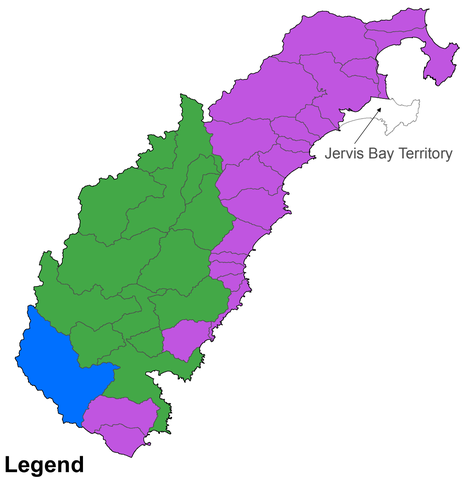
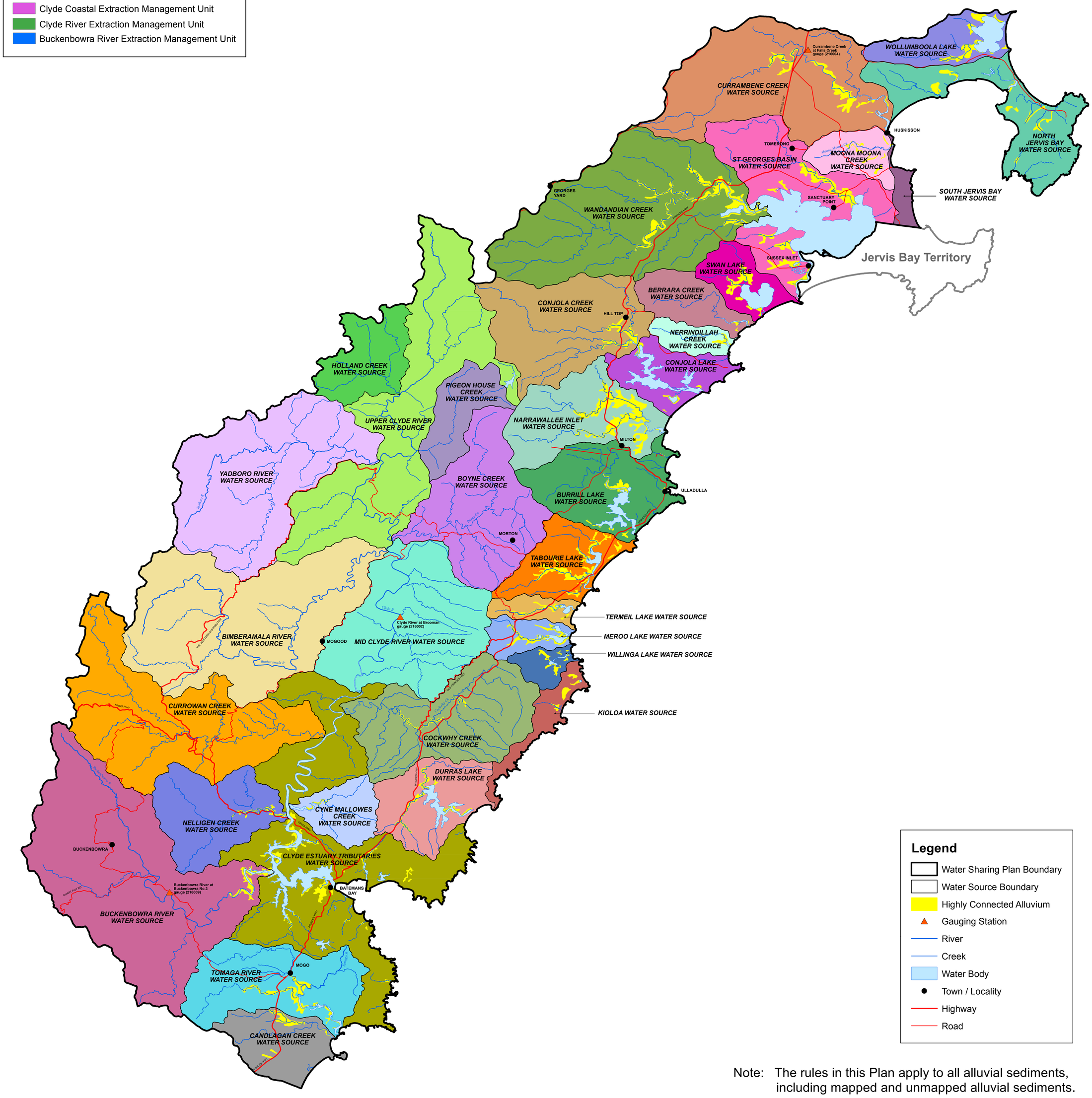
KEY TO EXTRACTION MANAGEMENT UNITS



Legend

- Clyde Coastal Extraction Management Unit
- Clyde River Extraction Management Unit
- Buckenbowra River Extraction Management Unit

LOCALITY MAP



Legend

- Water Sharing Plan Boundary
- Water Source Boundary
- Highly Connected Alluvium
- Gauging Station
- River
- Creek
- Water Body
- Town / Locality
- Highway
- Road

Note: The rules in this Plan apply to all alluvial sediments, including mapped and unmapped alluvial sediments.

N

0 5 10 20

Kilometres

Plan Map (WSP028_Version 1)

Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources 2016

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Appendix C
South Coast Groundwater Sources Plan Map

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Plan Map (WSP032_Version1)

WATER SHARING PLAN FOR THE SOUTH COAST GROUNDWATER SOURCES 2016

GROUNDWATER SOURCES

- Lachlan Fold Belt Coast
- South East Coastal Sands
- Sydney Basin - South Coast

- Alluvial and coastal sands groundwater sources covered by other water sharing plans
- Surface water features including lakes and rivers are shown on this map for context only. Groundwater extraction from fractured and porous rock sediments that underlie these surface water features are still included in the waters covered by this water sharing plan.

AUSTRALIAN CAPITAL TERRITORY

ACT

Tomerong
Huskisson
Sanctuary Point
Sussex Inlet
Yadboro Rv
Milton
Ulladulla
Bimberamala Rv
Clyde River
Buckenbowra Rv
Batemans Bay
Deua River
Moruya
Tuross Head
Bodalla
Tuross River
Narooma
Yowrie Rv
Cobargo
Bermagui
Brogo Rv
Murrah Rv
Bemboka Rv
Bega
Bega Rv
Tathra
Candelo
Bombala Rv
Towamba River
Pambula Rv
Merimbula
Pambula
Eden
Wonboyn Rv
Genoa River
Delegate Rv
Delegate
Bombala
Nimmitabel
Maclaughlin River
Snowy River
Berridale
Lake Jindabyne
Jindabyne
Thredbo Rv
Snowy River
Gungarlin Rv
Lake Eucumbene
Eucumbene Rv

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Kilometres

LOCATION WITHIN NSW

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Appendix D
Preliminary Erosion and Sediment Management Report

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SEEC

Strategic Environmental & Engineering Consulting

Preliminary Erosion and Sediment Management Report

Batemans Bay Bridge replacement

Prepared by:

Andrew Macleod

16 October 2017

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Andrew Macleod B.Sc (Hons) CPESC CPSS
Director and Principal Soil Conservationist
SEEC

16 October 2017

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Version Register

Version	Date	Author	Reviewer	Notes	Other
Draft A	04/08/17	AM	MP	Issued for review	
Rev 00	18/08/17	AM	Aurecon	Issued as Rev 00	
Rev 01	08/09/17	AM	RMS	Issued as Rev 01	
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Rev 04	03/10/17	AM	RMS	Issued as Rev 04	
Rev 05	16/10/17	AM	RMS	Issued as Rev 05	

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1 INTRODUCTION

1.1 Proposal Identification

Roads and Maritime Services is proposing to construct a new bridge on the Princes Highway over the Clyde River at Batemans Bay. The Batemans Bay Bridge replacement (the proposal) would remove the existing bridge and provide a new bridge with two lanes in each direction, improving traffic flow along the Princes Highway in Batemans Bay.

This report supports the environmental assessment for the proposal.

1.2 Proposal Location and Setting

The proposal is located at the Princes Highway crossing of the Clyde River at Batemans Bay, between the Kings Highway and North Street (refer to Figure 1). Local roads including Clyde Street, Wharf Road and Old Punt Road would also be modified by the proposal.

The Batemans Bay Bridge is an important link for the Princes Highway. The Princes Highway is a classified State Highway (A1) and is the primary coastal route between Sydney and Melbourne. The Kings Highway, which is Canberra's primary road connection to the NSW South Coast, intersects with the Princes Highway in the north of the proposal area. The crossing over the Clyde River is also an important local connection between the commercial centre of Batemans Bay and areas north of the river such as North Batemans Bay.

On the southern side of the bridge is Bateman Bay's main shopping and commercial area including a large supermarket and shopping mall. Key features adjacent to the proposal area on the south side of the bridge include holiday accommodation, commercial areas, river foreshore areas and facilities as well as an area mapped as a *State Environmental Planning Policy 14 Coastal Wetlands* (SEPP 14 wetland). On the northern side of the bridge are the suburbs of North Batemans Bay and Surfside. Other features near the proposal area include holiday accommodation, residences and commercial development.

1.3 Key Features of the Proposal

Key features of the proposal include:

- construction of a new bridge to the west (upstream) of the existing Batemans Bay Bridge across the Clyde River including:
    - bridge approaches generally between Wharf Road on the northern side and Clyde Street on the southern side
    - two traffic lanes in each direction (at least 3.5 metres wide)

  - a three-metre-wide shared use path on the eastern side of the new bridge connecting the Kings Highway to North Street
  - navigational clearance of about 12 metres from mean high water spring (MHWS) level
- no access to Clyde Street, which would pass under the new bridge;
- upgrade of the Princes Highway generally between North Street and the Kings Highway;
- upgrade to the Kings Highway / Princes Highway intersection;
- local road adjustments at Clyde Street, Wharf Road and Old Punt Road;
- earthworks, including cuttings and embankments and retaining walls to support the new bridge approaches;
- temporary ancillary facilities during construction including water quality controls, site offices, construction / demolition compounds, batching plants and stockpile sites;
- permanent operational water quality controls;
- utility relocations including optic fibre, telecommunications, electrical, water, drainage and sewerage;
- replacement of a wharf downstream of the existing bridge
- removal of the existing bridge following opening of the new bridge;
- site rehabilitation and landscaping works.

The key features of the proposal are shown in Figure 1.

A number of temporary ancillary facilities and road diversions would be established for the proposal. These features would be removed and the relevant sites rehabilitated at completion of the proposal.

1.4 Proposal Background

The Batemans Bay Bridge is located on the Princes Highway around 270 kilometres south of Sydney and 150 kilometres east of Canberra. The existing bridge over the Clyde River at Batemans Bay was constructed in 1956 with a central lift span used to allow boats up to 23 metres in height to pass underneath. The bridge was constructed to replace a vehicle ferry across the Clyde River. While water traffic was originally related to the local timber and fishing industries, this has increasingly changed to recreational and commercial water traffic. The lift span is generally raised twice each day for a local tourist ferry but also for private yachts and commercial and recreational vessels. As the lift span is raised however, traffic along the Princes Highway is disrupted.

The existing bridge is structurally in poor condition, and does not conform to modern safety standards. Major structural components of the trusses are vulnerable to vehicle strike and there is evidence of significant vehicle impacts to the bridge occurring in the past. Higher Mass Limit (HML) vehicles are not permitted to use the bridge due to poor structural condition and height limitations. Issues with the central lift span have closed the bridge on numerous occasions resulting in local and regional traffic and economic

impacts. The existing bridge provides a single, narrow lane in each direction, which can result in substantial congestion especially in peak holiday periods. Where there is an incident on the bridge or where the lift span has failed, the detour for highway traffic is around 350 kilometres.

1.5 Purpose of This Report

A Preliminary Erosion and Sedimentation Assessment for the proposal identified that it is inherently high risk due to:

- potential complexity;
- steep slopes on the north side of the existing bridge;
- working in and around an estuarine environment;
- the presence of sensitive coastal wetlands classified under State Environmental Planning Policy No.14 - Coastal Wetlands (SEPP 14);
- the Clyde River makes up part of the Batemans Marine Park;
- site constraints that limit the amount of available land during construction; and
- construction on low-lying or tidal lands with an inherent risk of acid sulfate soils.

This preliminary Erosion and Sedimentation Management Report (ESMR) was prepared in accordance with Roads and Maritime Procedure PN 143P.

The purpose of this report is to:

- Develop a concept for major erosion and sediment control measures such as up-gradient stormwater diversions, cross-drainage and sediment basins.

- Assess constraints to the installation and operation of major erosion and sediment controls during construction in accordance with Volumes 1 and 2D of the NSW Blue Book (Landcom, 2004 and DECC, 2008).

- Identify methods to eliminate, substitute or manage potential erosion and sediment control hazards during construction.

1.6 Scope and Limitations of This Report

Figure 1 shows the proposal area that this preliminary ESMR focuses on.

In preparing this preliminary ESMR, SEEC have reviewed:

- The proposal area including construction and operational areas;
- Existing drainage patterns (both overland and piped) that would impact on the construction area;
- Concept Drainage Drawings and Road Designs.

1.7 Structure of This Report

This report includes the following sections:

- Section 2 provides background regarding document preparation against Roads and Maritime procedural guidelines;
- Section 3 provides an assessment of the potential constraints and opportunities that might impact on construction-phase erosion and sediment control;
- Section 4 identifies design considerations for erosion and sediment control measures;
- Section 5 summarises a series of recommendations to manage or mitigate potential impacts relating to construction-phase erosion and sediment control.

Section 5 is accompanied by a series of Concept Erosion and Sediment Control Plans (ESCPs) in Appendix 3 showing the setup of key erosion and sediment control measures such as sediment basins.

Figure 1 –Proposal area (supplied by Aurecon and RMS).

2 DOCUMENTATION, REVIEW AND LIAISON

2.1 Design Documentation

The road and drainage design that makes up the basis for this preliminary ESMR and the Concept ESCP drawings are included in Appendix 3.

2.2 Review of Existing Design

As part of conducting this preliminary ESMR, SEEC conducted a review of:

- The concept road designs, to determine if any inherent design issues might impact on constructability and effective implementation of erosion and sediment controls; and
- The land available during construction to determine if space constraints were likely to impact on the effective implementation and establishment of erosion and sediment controls.

Comments regarding both of the above are included in Section 5 and on the Concept ESCP drawings in Appendix 3.

2.3 Site Inspection

A site inspection was conducted by Andrew Macleod from SEEC on 28 July 2017 to observe soil and topographical conditions and identify options for erosion and sediment control during construction.

2.4 Environmental Design and Compliance Checklist

Table 1 details the requirements for this preliminary ESMR as described in Section 2.3.2 of Roads and Maritime PS311 Specification (Environmental Design and Compliance) and where each is addressed.

Table 1 – Roads and Maritime Specification PS311 Compliance Checklist

Item reference	ESMR requirement	Location where this is addressed in this ESMR
2.3.2 (i)	Identify road corridor and surrounding catchments.	Section 3.5 and Appendix 3
2.3.2 (ii)	Identify road construction boundary catchments and their associated erosion hazard.	Appendix 3
2.3.2 (iii)	Identification of site constraints that limit the implementation of appropriate erosion and sediment control measures.	Section 3, Section 5.3 and Appendix 3
2.3.2 (iv)	Identification of any sensitive receiving environments that will receive stormwater discharge from the construction project, including but not limited to: (a) lands protected under environmental planning instruments such as SEPP 14 (Coastal Wetland) or SEPP 26 (Littoral Rainforest); and (b) land reserved or protected under nation parks legislation such as Marine Parks, National Park estates or State Forests.	Section 3.5
2.3.2 (v)	Major erosion and sediment control measures, including but not limited to: (a) Up-gradient stormwater diversion to ensure clean water does not enter the construction site; (b) Temporary cross drainage to transfer clean water through and/or around the site through all construction phases; (c) Sedimentation basins, as required, designed in accordance with the sizing criteria in Blue Book Vol 2D.	Section 5, Appendixes 2 and 3, and Section 3.12
2.3.2 (vi)	Water flow paths and direction for the construction area and adjacent property i.e. off site and on-site water flow	Appendix 3
2.3.2 (vii)	Calculation of work area and soil loss for each road catchment (Refer Department of Housing's Publication Managing Urban Stormwater - Soils and Construction).	Appendix 3 and Section 3.12
2.3.2 (viii)	Basin calculation for each road catchment that exceeds the soil loss equation in accordance with the Department of Housing's Publication Managing Urban Stormwater - Soils and Construction	Appendixes 2 and 3
2.3.2 (ix)	Construction basin location and measures to direct on site runoff into the basin	Appendix 3
2.3.2 (x)	A risk assessment of the effective installation, operation or maintenance of major controls, including but not limited to: (a) Timing of installation of the major controls, with reference to the construction staging of the project, including traffic and earthworks staging;	Section 5 and Appendix 3

	(b) Availability of land to install major controls, with reference to any property acquisition requirements or environmental restrictions on environmentally sensitive area.	
2.3.2 (xi)	Measures to mitigate or eliminate identified risks, through design changes, construction methodology and additional land acquisition and/or leasing. Where risks cannot be eliminated, mitigation measures for managing the specific sub-catchment must be designed and documented in a summary table.	Section 5, specifically Tables 7 and 8.

3 ASSESSMENT OF CONSTRAINTS AND OPPORTUNITIES

3.1 Climate

Bureau of Meteorology climatic statistics for Batemans Bay are contained in Table 2. Monthly average rainfall statistics are also shown in Figure 2. Data about rainfall intensity for various durations and recurrence is contained in Appendix 1. Table 2 and Figure 2 show that rainfall occurs throughout the year, although with more rain days during the summer months. Temperatures are warm in summer, and are mild in winter. Frost is not considered to be a risk for revegetation.

Rehabilitation would need to be sympathetic to the natural seasonal variations in temperature and rainfall, with species selection, watering regimes and ground preparation all influenced by the time of year. In particular, revegetation will need to be considerate of the risk of warm weather during summer months and the need for frequent watering.

The RUSLE R-Factor for this site is 3650, based on the 2-year, 6-hour storm event of 13.0mm/hr for Batemans Bay (Bureau of Meteorology, 2017).

Table 2 – Monthly climate averages for Batemans Bay (BoM station 069134) as at June 2017.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann-ual
Rainfall (mm)	88.0	97.9	78.8	67.6	58.4	83.4	43.6	70.3	59.0	90.2	94.2	73.1	923
Mean no of days with rain >1mm	8.8	9.0	7.9	6.8	5.3	6.0	4.9	4.9	7.0	8.0	9.3	8.9	86.8
Mean min temp (°C)	15.7	15.9	14.1	10.5	7.1	5.1	3.8	4.6	7.4	9.7	12.2	14.2	10.0
Mean max temp (°C)	25.9	25.5	24.5	22.3	19.8	17.4	17.0	18.3	20.4	22.1	23.1	24.6	21.7

As a coastal area, winds can be strong at any time of year. Prevailing summer winds are from the north-east, and from the south-west in winter.

The recommendations in Section 5 include management and mitigation options for climate-related constraints.

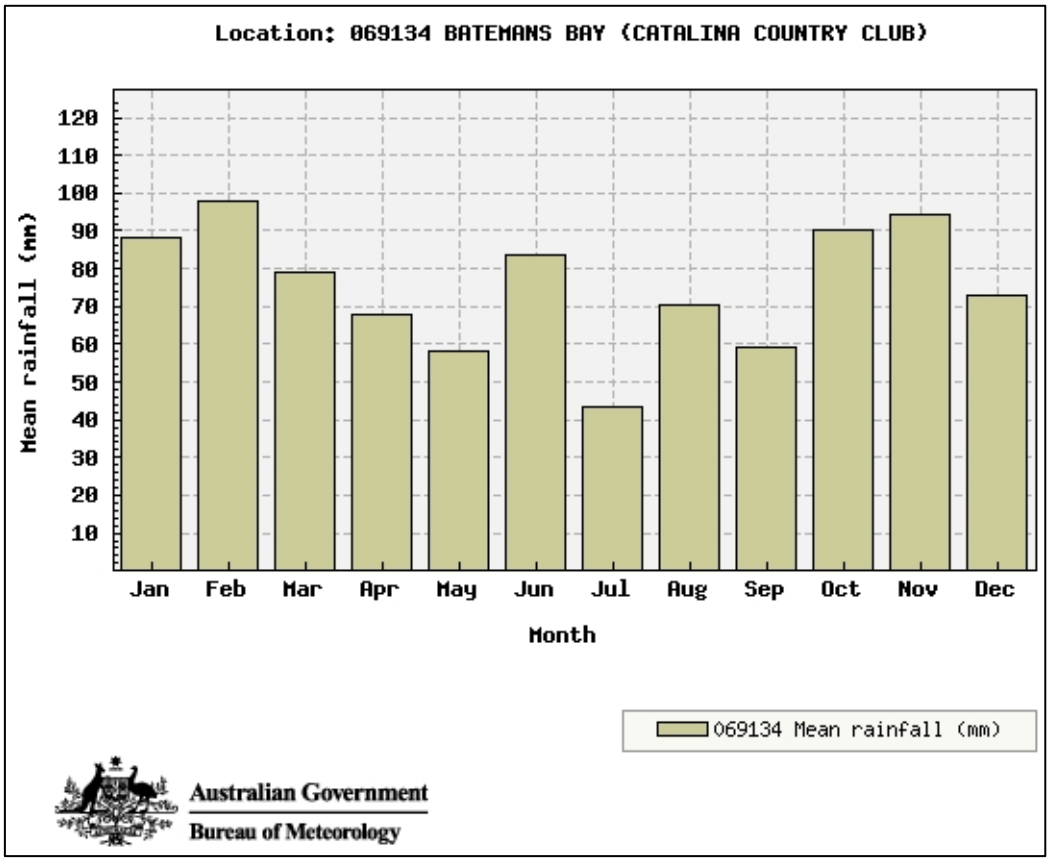


Figure 2 – Monthly average rainfall at Batemans Bay (station 069134). From Bureau of Meteorology, accessed June 2017.

3.2 Topography

Site topography is varied, with areas on the north side of the existing bridge being significantly steeper than areas south of the existing bridge.

South of the existing bridge lands are near-level, grading gently towards the north and west.

North of the existing bridge the existing Princes Highway cuts through a steep, low ridge (local elevation change is less than 25m) between the Kings Highway roundabout and the Wharf Road intersection. Existing cut faces range from about 15% to 200%. Cut faces are vegetated (south-east-facing cut batters) or mostly bare rock (north-west-facing cut batters).

Within the study area for the realigned bridge approaches, slopes north of the Clyde River are generally around 15 to 20% but include short (less than 20m long) sections up to 60%.

The Blue Book (Landcom, 2004) recommends slope lengths on bare ground be no greater than 80m whenever rain is falling or imminent. Slope breaks might need to be included during construction at 80m (maximum) intervals, or less on steep slopes.

The recommendations in Section 5 include management and mitigation options for topography-related constraints.

3.3 Soils - General

Soil Landscape Mapping has not been completed for this area although limited soil profile information is available from the Acid Sulfate Soils investigations (sourced from DLWC, 2007 and OEH eSpade web portal in August 2017). Soil investigations by SEEC identified several different soil types, depending on landscape position. Table 3 provides a summary of soil conditions and the locations where each soil type occurs.

Most of the soils along the proposed alignment have been disturbed as a result of urbanisation or as part of previous road construction, but are still mostly reminiscent of the natural soil materials.

Table 3 – Soils identified within the study area for the proposal.

Soil Unit	Ridges	Flats
Approximate percentage of proposal alignment (excludes over-water section)	40%	60%
Landscape description	Low, steep, convex (i.e. steeper at the base and more rounded at the top) ridge roughly parallel to the northern bank of the Clyde River. Slopes generally 15% to 60%, with slope lengths rarely exceeding 60m.	Near-level coastal flats associated with the Clyde River.
Observed soil types	Brown and yellow podzolic soils	Alluvial soils (sands, gravels, clays)
Erodibility	Estimated at 0.04 (moderate to high)	Estimated at 0.03 (moderate)
Key soil constraints and opportunities	High soil structural decline hazard Hardsetting surface soils. Moderate plant-available waterholding capacity. Moderately permeable soils. Low fertility. Localised dispersive (sodic) subsoils. Acidic soils. Highly erodible topsoils.	Potential Acid Sulfate Soils (PASS) (localised) Low fertility soils. Non-cohesive soils. Low plant-available waterholding capacity.

Several representative soil samples were investigated as part of SEEC site work to determine key constraints. Although in-house testing identified all samples as non-dispersive, soil dispersion is known to occur sporadically in south coast hillside clays.

The samples collected and the soil data in Table 3 indicate that:

- Subsoils (below 150mm depth) are potentially dispersible. This should be taken into account in the road and drainage design, and also for stormwater management during construction;
- Soils have low fertility and are nutrient-deficient, so would benefit from fertilizing to aid rehabilitation following construction;
- Soils are acidic so would benefit from the addition of lime or dolomite (plus gypsum);
- Ridge soils have moderate clay content, so are not likely to excessively leach any added nutrients to groundwater and should respond well to the addition of fertilizers or ameliorants.
- Alluvial soils have high permeability and would be likely to leach nutrients into groundwater.

A conservative K-factor of 0.04 is recommended based on typical soil textural data presented in IECA (2008).

The recommendations in Section 5 include management and mitigation options for soils-related constraints. Additional comments regarding Acid Sulfate Soils are also included in Section 3.4.

3.4 Acid Sulfate Soils

Acid Sulfate Soil Risk Mapping (DLWC, 1997) identified a high risk of encountering Potential Acid Sulfate Soils (PASS), mainly on the southern side of the Clyde River within the Study Area. Figure 3 shows the mapped extent and depth of PASS.

The recommendations in Section 5 include management and mitigation options for constraints relating to PASS.

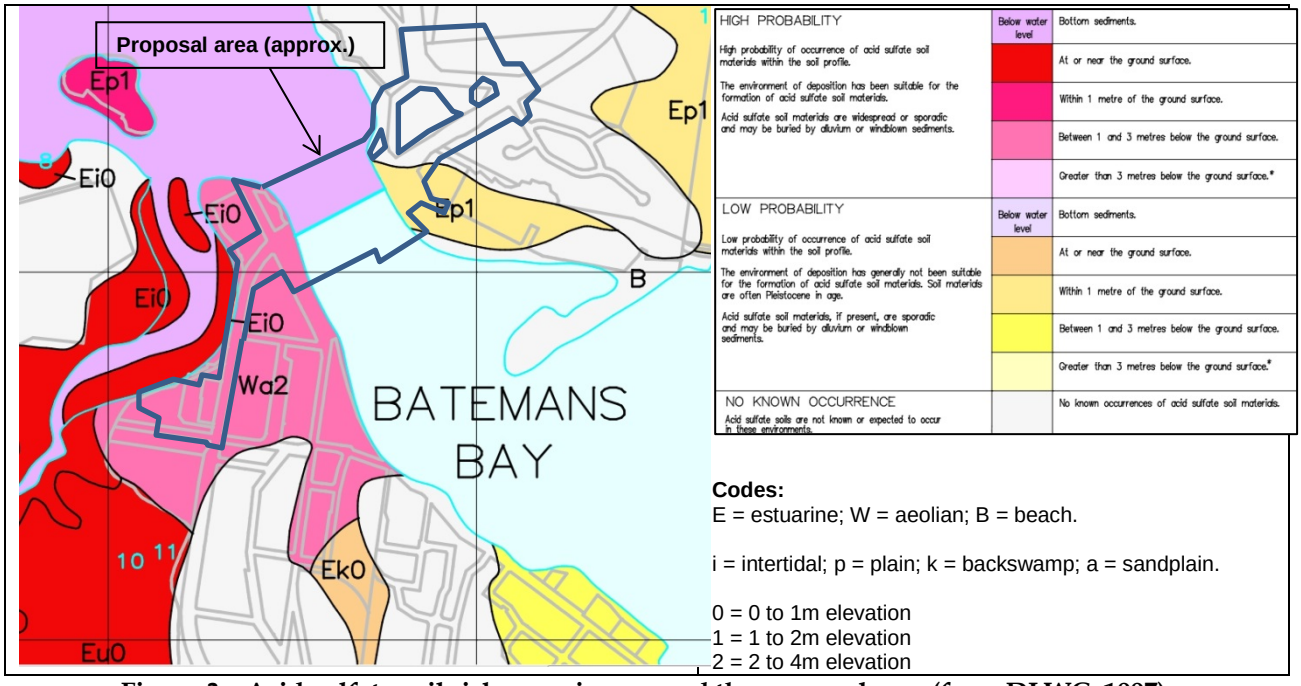


Figure 3 – Acid sulfate soil risk mapping around the proposal area (from DLWC, 1997).

3.5 Catchments and Receiving Waters

All drainage from the proposal site drains into the Clyde River, an open-intermediate tide-dominated valley estuary that flows into the Tasman Sea. At the proposal site, waters are tidal and saline. Although the Clyde River has been subject to human development along its shores, it is considered to be a sensitive receiving environment and is protected as part of the Batemans Marine Park. There are also numerous areas of SEPP14 wetlands near to or immediately adjacent to the project boundary. These are identified on the Concept ESCPs in Appendix 3.

The Clyde River is used for recreational activities including fishing, swimming, water skiing and boating. Commercial uses include oyster farms between Batemans Bay and Nelligen, plus tourism operators in and around Batemans Bay.

According to URS (2014), water quality in the Clyde River is generally within the acceptable limits of the Water Quality Objectives for Batemans Bay (NSW DECC, 2006) aside from slightly elevated turbidity values in the lower Clyde River between Nelligen and the Batemans Bay Bridge (WBM Oceanics Australia, 2004). The proposal site experiences good tidal flushing and is subject to strong currents.

The Blue Book (Landcom, 2004) suggests that water discharged from construction sites should not contain more than 50mg/L of suspended sediment. Although this concentration exceeds the recommended release criteria for stormwater flows into lowland seawater systems under ANZECC guidelines, a more stringent water quality requirement is not recommended because:

- The construction period is relatively short-term (estimated at 24 months) so long-term impacts are unlikely;
- The immediate receiving environment is saline, meaning that any sediment would rapidly settle; and
- A more stringent water quality requirement would add to the cost of site dewatering, and most likely couldn't be achieved within a reasonable timeframe using safe flocculants.

As such, we recommend that the water quality standard in Table 4 be adopted for any site dewatering. This is also included in Table 7 in Section 5.

Table 4 – Recommended water quality standard for site dewatering

Parameter	Recommended standard during construction
Total suspended solids (TSS)	50mg/L
pH	6.5 to 8.5
Oils and greases	None visible

The recommendations in Section 5 include management and mitigation options for constraints relating to management of stormwater quality.

3.6 Flooding and Tidal Influence

The Blue Book (Landcom, 2004) suggests that special erosion and sediment control measures should apply to any works below the 2-year average recurrence interval (ARI) flood level. This includes:

- Sediment controls should be placed above the 2-year ARI flood level (e.g. basins, sediment fences etc).
- Requirements to stabilise lands using temporary ground cover whenever rain is falling or imminent.
- Scheduling works for lower-risk times of year, based on historical rainfall figures.

The recommendations in Section 5 include management and mitigation options for drainage-related constraints.

3.7 Existing and Future Drainage

During construction, there is a risk of offsite (clean) and onsite (dirty) water mixing at various locations unless appropriate temporary drainage is provided.

Wherever possible, permanent cross-drainage (i.e. culverts) should be installed as early as possible to facilitate effective separation of offsite (clean) and onsite (dirty) water. In addition, temporary cross-drainage will be required in a number of locations to facilitate effective drainage control during construction. The locations for temporary drainage are noted on the Concept ESCPs in Appendix 3.

The recommendations in Section 5 include management and mitigation options for drainage-related constraints.

3.8 Ecology

Under the Roads and Maritime Biodiversity Guidelines (2011), avoiding or minimising ecological impacts is recommended. This can be considered in the selection and positioning of erosion and sediment control measures, especially those that typically involve disturbing land outside the earthworks footprint during construction (e.g. sediment basins).

Additional land outside of the earthworks footprint (but still within the proposal area) will be required for temporary structures such as sediment basins. Further comment on this is included in Section 3.10.

The recommendations in Section 5 include management and mitigation options for ecology-related constraints.

3.9 Existing Services

Site investigations identified numerous existing services that could constrain the ability to install and operate erosion and sediment control measures.

3.10 Land Availability

Land availability is a common constraint for major road projects during construction, especially for:

- Establishing stockpiles; and
- Constructing sediment basins.

Within the road construction industry, it is generally unacceptable to position temporary construction-phase sediment basins within the footprint of engineered fills because they can create geotechnical issues later during fill placement. As such, sediment basins are usually positioned outside the footprint of the engineered fill.

A series of concept ESCPs prepared by SEEC is included in Appendix 3; these identify where sediment basins and offsite (clean) and onsite (dirty) water drains might ideally be placed.

The recommendations in Section 5 include management and mitigation options for constraints relating to land availability.

3.11 Design and Construction Constraints

3.11.1 Tie-Ins and Interface

In preparing the concept ESCP drawings in Appendix 3, assumptions have been made regarding traffic staging and comments included where necessary to ensure erosion and sediment control is considered.

3.11.2 Sediment Tracking onto Surrounding Roads

The proposal includes interactions with existing live traffic on numerous local roads and, as such, sediment tracking could occur if adequate provisions were not made to minimise this.

Refer to Section 5 for management and mitigation options relating to sediment tracking.

3.12 Erosion Hazard

An evaluation of the erosion hazard was made using the approach in Chapter 4 of the Blue Book (Landcom, 2004). This process involves calculating the predicted annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) as follows:

$$A = R \times K \times LS \times P \times C$$

Table 5 details the above equation and the values used in assessing erosion hazard.

Table 5 – RUSLE definitions and assumptions

Parameter	Definition	Assumed or adopted value for this site
A	Total calculated soil loss (t/ha/yr)	Varies for each area.
R	Rainfall erosivity factor	3650 for this site (refer to Section 3.1).
K	Soil erodibility factor	0.04. Refer to Section 3.3.
LS	Slope length and gradient factor	Varies for each area. Both the existing and proposed slope length and gradient were assessed for each section and the maximum LS-factor adopted.
P	Conservation practice factor	Maximum of 1.3 assumed for this site.
C	Ground cover factor	Maximum of 1.0 assumed for this site.

The Concept ESCPs in Appendix 3 detail where the Erosion Hazard Assessment for each catchment triggers the requirement for a sediment basin under Blue Book (Landcom, 2004 and DECC, 2008) conditions. This is based on the assessment of prevailing and proposed slope/length conditions as shown in Table 6.

Table 6 – Slope gradient and length conditions; plus sediment basin triggers for each.

Site location	Slope gradient (%)	Slope length (m)	LS-factor	Predicted soil loss (RUSLE)	Minimum catchment size to trigger the need for a basin
South side of bridge (natural ground)	1	80	0.19	37 t/ha /yr	5.4 ha
North side of bridge – average slopes	10	60	2.31	438 t/ha/yr	0.46 ha
Proposed batters north and south side of the bridge	50	10	3.33	631 t/ha/yr	0.32 ha

4 DESIGN CONSIDERATIONS FOR EROSION AND SEDIMENT CONTROL

4.1 Sediment Basins

The Blue Book (Landcom, 2004 and DECC, 2008) notes that a sediment basin should be included in catchments where the erosion hazard exceeds 150 m^3/year (200 tonnes/year) of soil loss. It is standard practice that each affected catchment on a road construction project be assessed against this requirement.

Landcom (2004) also notes that sediment basins should not be positioned on lands prone to flooding, in locations where they might intercept PASS, or lands affected by high ground water tables (refer to Section 3.6).

Following on from the erosion hazard assessment in Section 3.12, an assessment of all catchments (existing catchments and future catchments once earthworks are complete) identified three sediment basins are required to comply with Blue Book criteria (Landcom, 2004 and DECC, 2008). However, given the high-risk nature of this project and its proximity to the Batemans Marine Park, four sediment basins have been included in the concept ESCP.

Conceptual sizing of basins is included in Appendix 2 and on the Concept ESCP drawings in Appendix 3. Note that, given the conceptual nature of this ESCP, these basins would most likely be subject to revision as part of the detailed design.

Sediment basins have been sized based on the following criteria (from Landcom, 2004):

- Design rainfall depth: 37.4 mm (5-day, 85th percentile for Batemans Bay);
- Basins designed for Type D (dispersible) sediment;
- Volumetric runoff coefficient (Cv): 0.64.

4.2 Onsite and Offsite Water Separation

The permanent design typically includes drainage to divert upslope ('offsite' or 'clean') water away from completed cut and fill batters. If possible, these drains should be installed early to aid efficient construction and minimise the risk of erosion, and this is noted on the Concept ESCPs in Appendix 3, with a recommendation that they be installed to the permanent design.

In addition, temporary drainage will be required in some locations to separate offsite (or 'clean') water from onsite (or 'dirty') water. This is also noted on the Concept ESCPs in Appendix 3.

Cross-formation culverts should ideally be installed early to assist with separating onsite (dirty) and offsite (clean) water during construction. In some locations, temporary cross-drainage will be required to achieve adequate separation due to the prevailing topography and design of the road. Those locations are marked on the Concept ESCPs in Appendix 3.

5 RECOMMENDATIONS

5.1 Recommendations for Road Design and Construction Phase

In preparing the Concept ESCP drawings in Appendix 3, a review was conducted of the road design to determine if the inherent design would impact on effective implementation of erosion and sediment control during construction. We conclude that there are no changes required to the design to effectively implement major erosion and sediment control measures such as sediment basins and temporary drainage. However, given the conceptual nature of this ESCP, sediment basin positioning and size would most likely be subject to revision as part of the detailed design.

Table 7 details recommended mitigation and management measures for the constraints identified in Section 3 and based on typical Blue Book methodologies for construction of major road projects. Where Table 7 identifies specific requirements that are high risk or outside of typical Blue Book practice, these are noted and summarised in Table 8 and also on the Concept ESCPs in Appendix 3.

Table 7 – Management and mitigation recommendations.

No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
Road Design, Planning and Roads and Maritime Specification Considerations – Prior to Construction			
1	• All cross-formation pipes, cross-formation culverts, excavated drains, constructed table drains, riprap, inlets and outlets should include a requirement for soil amelioration in, under and around the structure to address potential dispersion. Gypsum should be ripped into the underlying material at approximately 5 to 10t/ha (0.5 to 1kg/m^2) at the location where the structure is being placed.	• Without adequate soil amelioration there is a significant risk of undermining or tunneling under or around drainage structures due to dispersive soils.	Yes – Road design and specification issue. Refer to Table 8.
2	• Land will most likely need to be leased to allow for construction of sediment basins as shown on the Concept ESCPs in Appendix 3.	• In several locations there is insufficient space available within the road corridor to allow for construction of sediment basins.	Yes. Refer to Table 8.
3	• R178 specification should be modified to include requirements for soil amelioration to promote effective revegetation. This should include a requirement to lime-treat all topsoil and subsoil to increase calcium levels and raise the pH to 6.5, and gypsum-treat subsoils to address potential dispersion.	• To address inherent soil constraints that could limit the potential for successful revegetation.	Yes – Revegetation issue. Will require modification to R178 specification. Refer to Table 8.
4	• Traffic switching/staging and/or acid sulfate soils might impact on basin positioning. This should be taken into account as part of project planning.	• To minimise temporary traffic staging or acid sulfate soils from impacting on the feasibility for installing sediment basins.	Yes – this might impact on the design of temporary works. Refer to Table 8.
Construction-Stage Considerations			
5	• Sediment basins should be included at the lower end of larger or higher-risk catchments.	• To provide an end-of-line safeguard to capture and treat eroded sediment from steep areas.	No – standard practice. Include in G38. However, site constraints might impact on feasibility for basins.

No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
6	• Use efficient and reliable methods for batter stabilisation at the completion of works (e.g. compost blanket, hydromulching etc.). Refer to typical details in Section 5.2.	• To rapidly and progressively reduce the erosion hazard and reduce the potential for offsite pollution of waterways.	No – standard practice. Include in G38 and in R178.
7	• Progressively stabilise completed batters, rather than waiting until the end of works. Refer to typical details in Section 5.2.	• To rapidly and progressively reduce the erosion hazard and reduce the potential for offsite pollution of waterways.	No – standard practice. Include in G38.
8	• Slope breaks should be included during construction whenever rain is imminent or falling. Refer to typical details in Section 5.2 and the Concept ESCP in Appendix 3.	• To minimise the risk of erosion of long, bare slopes by controlling water velocities.	No – standard practice. Include in G38.
9	• Temporary drainage structures should be lined (e.g. geofabric).	• Lining of temporary drainage will help to reduce erosion.	No – standard practice. Include in G38.
10	• Any temporary drainage structures excavated into the subsoils should be gypsum-treated (at 0.5kg/m^2) prior to being lined.	• Gypsum treatment ameliorates the risk of soil dispersion and helps to minimise the risk of gully or tunnel erosion.	Yes – Refer to Table 8.
11	• Check dams should be used in drainage structures and table drains.	• Check dams help slow flow velocities, thereby reducing erosion.	No – standard practice. Include in G38.
12	• Ideally install cross-formation drainage early. Refer to typical details in Section 5.2.	• To promote separation of clean offsite water from dirty onsite water	No – standard practice. Include in G38.
13	• Install up-gradient clean (offsite) water drains early. Refer to typical details in Section 5.2 and the Concept ESCP drawings in Appendix 3.	• To divert clean water away from work areas.	No – standard practice. Include in G38.
14	• Use batter chutes and windrows on fills to control flows of dirty onsite water. Refer to typical details in Section 5.2.	• To control water and reduce the risk of erosion.	No – standard practice. Include in G38.

No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
15	• Establish a diversion across Old Punt Road as shown on the Concept ESCP drawings in Appendix 3.	• To divert clean offsite water away from the future work area at the bridge abutment.	Yes – Refer to Table 8.
16	• Use mulch bunds or clean rock filter bunds along the toe of the work area adjacent to McLeods Creek (i.e. in the SW corner of the study area).	• Acid sulfate soils (mangroves) limit the potential for establishing sediment controls such as basins or silt fences.	Yes – Refer to Table 8.
17	• Use sediment controls around the lower perimeter of all work areas to catch eroded sediment.	• To provide capture of as much sediment as possible given the available space.	No – standard practice. Include in G38.
18	• Use smaller sediment traps or sediment fences in those catchments where sediment basins are not triggered or are not feasible.	• To provide capture of as much sediment as possible given the available space.	No – standard practice. Include in G38.
19	• Position sediment controls above the 2-year flood level wherever possible.	• To meet Blue Book requirement for sediment control positioning.	No – standard practice. Include in G38.
20	• Identify potential stockpile locations prior to contract award.	• To minimise the risk of stockpile sites being created in ad hoc locations where they could cause or exacerbate environmental harm.	No – standard practice. Include in G38.
21	• Use chemical treatment (flocculation) in sediment basins to settle sediment out of turbid onsite water.	• To reduce the potential for offsite pollution of waterways.	No – standard practice. Include in G38.
22	• Gypsum-treat soils in, under and around permanent culverts, drainage structures and dissipaters.	• To ameliorate the risk of gully and tunnel erosion.	Yes – refer to Item 1.
23	• Lime-treat topsoils to bring pH into a relatively neutral range (around 6.5).	• To help promote revegetation outcomes.	Yes – refer to Item 3.
24	• Landscaping should include species adapted to typical conditions in this area.	• To promote better revegetation outcomes.	No – standard practice. Include in R178.

No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
25	• Employ construction practices that minimise damage to topsoils (e.g. avoid excessive compaction, avoid working topsoils when too wet or too dry).	• To improve the growing conditions and promote better revegetation outcomes.	No – standard practice. Include in G38.
26	• Use fertilizers or organic matter (compost, not mulch) to improve soil nutrient status.	• To improve growing conditions and promote better revegetation outcomes.	No – standard practice. Include in R178.
27	• Develop Progressive Erosion and Sediment Control Plans (PESCPs) for each stage/section of works. These should be based on the Concept ESCPs in Appendix 3 and the typical details in Section 5.2.	• To ensure erosion and sediment controls are adequately planned and integrated into each stage or section of work.	No – standard practice. Include in G38.
28	• Use water application to reduce dust.	• To reduce the risk of dust rise.	No – standard practice. Include in G38.
29	• Monitor dust generation.	• To check that dust suppression strategies are working.	No – standard practice. Include in G38.
30	• Monitor weather forecasts for high winds and hot, dry weather.	• To ensure preparedness when dust generation is likely.	No – standard practice. Include in G38.
31	• Use water carts or irrigation to promote growth of new revegetation.	• To improve the chances of successful revegetation.	No – standard practice. Include in G38.
32	• Select vegetation species for landscaping that are adapted to variable rainfall conditions.	• To promote better revegetation outcomes.	No – standard practice. Include in R178.
33	• Select vegetation species for landscaping that are appropriate to the time of year that sowing/planting will occur. Ensure any selected species are frost-tolerant.	• To promote better revegetation outcomes.	No – standard practice. Include in R178.
34	• Adopt a focus on minimising erosion from steep slopes by using temporary ground covers whenever rain is falling or imminent.	• To minimise the risk of erosion from high risk areas where the protective ground cover has been removed. • To demonstrate due diligence under the POEO Act, 1997.	No – standard practice. Include in G38.

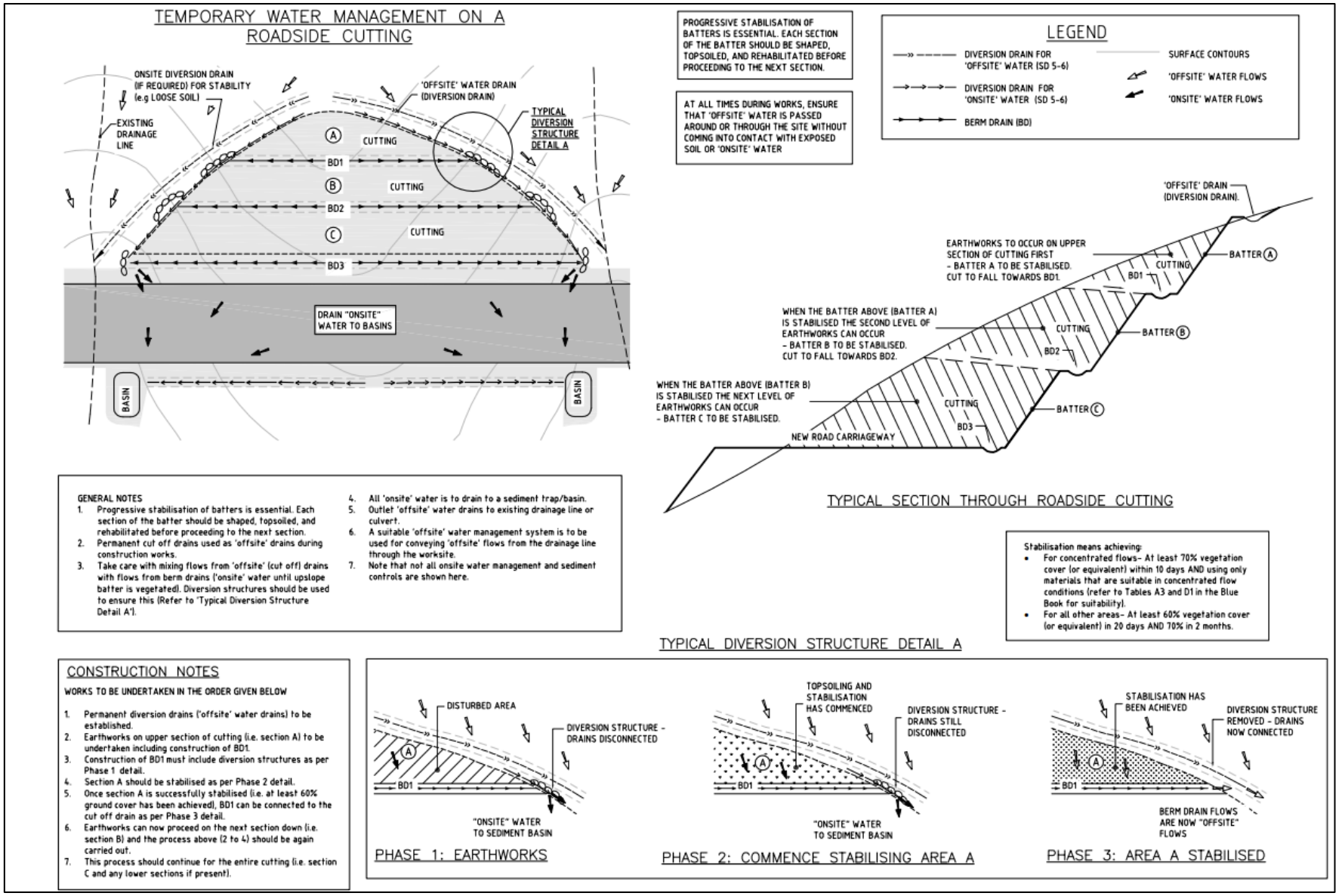
No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
35	• Adopt a practical but appropriate water quality standard for releases from sediment basins for all rainfall events up to and including the design rainfall depth of 37.4mm (over 5 days). This includes: 50mg/L TSS pH 6.5 to 8.5 Oils and greases: none visible.	• To ensure adequate water quality in releases from sediment basins. • To minimise the risk of contributing to degradation of downstream water quality. • To help achieve water quality objectives for the Murrumbidgee River.	No – standard practice. Include in G38.
36	• Use shakers, rumble grids, washdowns or similar at gates.	• To reduce the amount of sediment on vehicle wheels. • To reduce the risk of mud tracking onto local roads.	No – standard practice. Include in G38.
37	• Minimise traffic movements on and off public roads.	• To reduce the amount of sediment on vehicle wheels. • To reduce the risk of mud tracking onto local roads.	No – standard practice. Include in G38.
38	• Minimise traffic movements on and off site during rainfall.	• To reduce the amount of sediment on vehicle wheels. • To reduce the risk of mud tracking onto local roads.	No – standard practice. Include in G38.
39	• As much as possible, cover stockpiles to 60% grass cover (or equivalent) within 10 days of formation, as per Blue Book requirements.	• To minimise the risk of erosion from stockpiles.	No – standard practice. Include in G38.
40	• Position stockpiles so they have adequate sediment controls downslope.	• To contain any sediment that gets eroded from stockpiles.	No – standard practice. Include in G38.
41	• Monitor weather forecasts and prepare the site for imminent heavy rainfall.	• To ensure adequate preparedness for weather that is likely to cause erosion.	No – standard practice. Include in G38.

No.	Mitigation or management recommendations	Reasoning	High-risk OR outside of typical Blue Book practice for a major road project?
42	• Use temporary ground covers such as geofabric on the west-facing batter faces south of the bridge to provide erosion control whenever rain is falling or imminent.	• To minimise the risk of erosion from these batters, given that a sediment basin cannot be installed at the toe of this batter due to the presence of acid sulfate soils.	Yes – Refer to Table 8.
43	• Use well-anchored floating silt curtains around in-stream piling works.	• To contain any sediment plumes during piling works in the river.	Yes – Refer to Table 8.
44	• Use clean rock to establish any piling platforms in the river.	• To minimise the risk of introducing sediment into the river.	Yes – Refer to Table 8.
45	• Stabilise or rehabilitate completed surfaces to achieve a C-Factor of 0.05 or less (i.e. at least 70% cover) within 20 days of final shaping.	• To provide long-term erosion protection. • To comply with Blue Book requirements for rehabilitation.	No – standard practice. Include in R178 and/or G38.

5.2 Typical Details for Erosion and Sediment Control

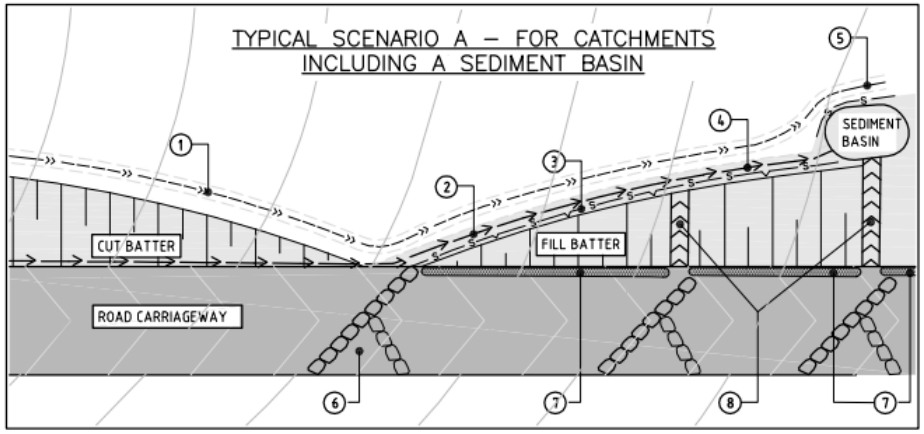
See following pages for typical details. These details show the typical setup for erosion and sediment control on major road projects such as this. The Concept ESCPs in Appendix 3 are based on these typical details.

These typical details should be used to help inform the preparation of Progressive ESCPs during construction.

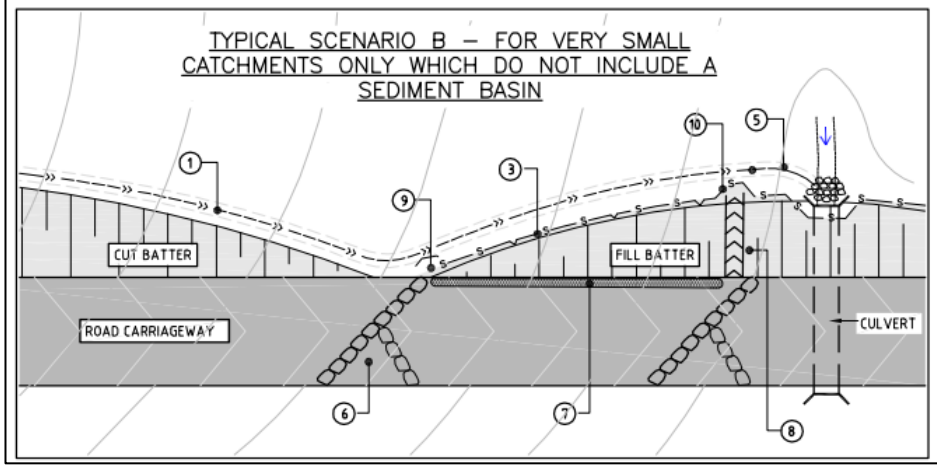

TEMPORARY WATER MANAGEMENT ON A ROADSIDE CUTTING
ONSITE DIVERSION DRAIN (IF REQUIRED) FOR STABILITY (e.g LOOSE SOIL)
EXISTING DRAINAGE LINE
'OFFSITE' WATER DRAIN (DIVERSION DRAIN)
TYPICAL DIVERSION STRUCTURE DETAIL A
A CUTTING
BD1
B CUTTING
BD2
C CUTTING
BD3
DRAIN "ONSITE" WATER TO BASINS
BASIN
BASIN
PROGRESSIVE STABILISATION OF BATTERS IS ESSENTIAL. EACH SECTION OF THE BATTER SHOULD BE SHAPED, TOPSOILED, AND REHABILITATED BEFORE PROCEEDING TO THE NEXT SECTION.
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER
LEGEND
DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
DIVERSION DRAIN FOR 'ONSITE' WATER (SD 5-6)
BERM DRAIN (BD)
SURFACE CONTOURS
'OFFSITE' WATER FLOWS
'ONSITE' WATER FLOWS
'OFFSITE' DRAIN (DIVERSION DRAIN).
EARTHWORKS TO OCCUR ON UPPER SECTION OF CUTTING FIRST - BATTER A TO BE STABILISED. CUT TO FALL TOWARDS BD1.
BATTER A
CUTTING
BD1
WHEN THE BATTER ABOVE (BATTER A) IS STABILISED THE SECOND LEVEL OF EARTHWORKS CAN OCCUR - BATTER B TO BE STABILISED. CUT TO FALL TOWARDS BD2.
CUTTING
BATTER B
BD2
WHEN THE BATTER ABOVE (BATTER B) IS STABILISED THE NEXT LEVEL OF EARTHWORKS CAN OCCUR - BATTER C TO BE STABILISED.
CUTTING
BATTER C
BD3
NEW ROAD CARRIAGEWAY
TYPICAL SECTION THROUGH ROADSIDE CUTTING
GENERAL NOTES
1. Progressive stabilisation of batters is essential. Each section of the batter should be shaped, topsoiled, and rehabilitated before proceeding to the next section.
2. Permanent cut off drains used as 'offsite' drains during construction works.
3. Take care with mixing flows from 'offsite' (cut off) drains with flows from berm drains ('onsite' water until upslope batter is vegetated). Diversion structures should be used to ensure this (Refer to 'Typical Diversion Structure Detail A').
4. All 'onsite' water is to drain to a sediment trap/basin.
5. Outlet 'offsite' water drains to existing drainage line or culvert.
6. A suitable 'offsite' water management system is to be used for conveying 'offsite' flows from the drainage line through the worksite.
7. Note that not all onsite water management and sediment controls are shown here.
Stabilisation means achieving:
- For concentrated flows- At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
- For all other areas- At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
TYPICAL DIVERSION STRUCTURE DETAIL A
CONSTRUCTION NOTES
WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW
1. Permanent diversion drains ('offsite' water drains) to be established.
2. Earthworks on upper section of cutting (i.e. section A) to be undertaken including construction of BD1.
3. Construction of BD1 must include diversion structures as per Phase 1 detail.
4. Section A should be stabilised as per Phase 2 detail.
5. Once section A is successfully stabilised (i.e. at least 60% ground cover has been achieved), BD1 can be connected to the cut off drain as per Phase 3 detail.
6. Earthworks can now proceed on the next section down (i.e. section B) and the process above (2 to 4) should be again carried out.
7. This process should continue for the entire cutting (i.e. section C and any lower sections if present).
DISTURBED AREA
DIVERSION STRUCTURE - DRAINS DISCONNECTED
A
BD1
"ONSITE" WATER TO SEDIMENT BASIN
PHASE 1: EARTHWORKS
TOPSOILING AND STABILISATION HAS COMMENCED
DIVERSION STRUCTURE - DRAINS STILL DISCONNECTED
A
BD1
"ONSITE" WATER TO SEDIMENT BASIN
PHASE 2: COMMENCE STABILISING AREA A
STABILISATION HAS BEEN ACHIEVED
DIVERSION STRUCTURE REMOVED - DRAINS NOW CONNECTED
A
BD1
BERM DRAIN FLOWS ARE NOW "OFFSITE" FLOWS
PHASE 3: AREA A STABILISED

CUT / FILL BATTER WATER MANAGEMENT

TYPICAL SCENARIO A – FOR CATCHMENTS INCLUDING A SEDIMENT BASIN



TYPICAL SCENARIO B – FOR VERY SMALL CATCHMENTS ONLY WHICH DO NOT INCLUDE A SEDIMENT BASIN



LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET/INLET (SD 5-8)
- CUT / FILL BATTER
- DIVERSION BERM (SD 5-5)
- CREEK / PIPE FLOW ROUTE
- SPILLWAY
- SEDIMENT FENCE (SD 6-8)

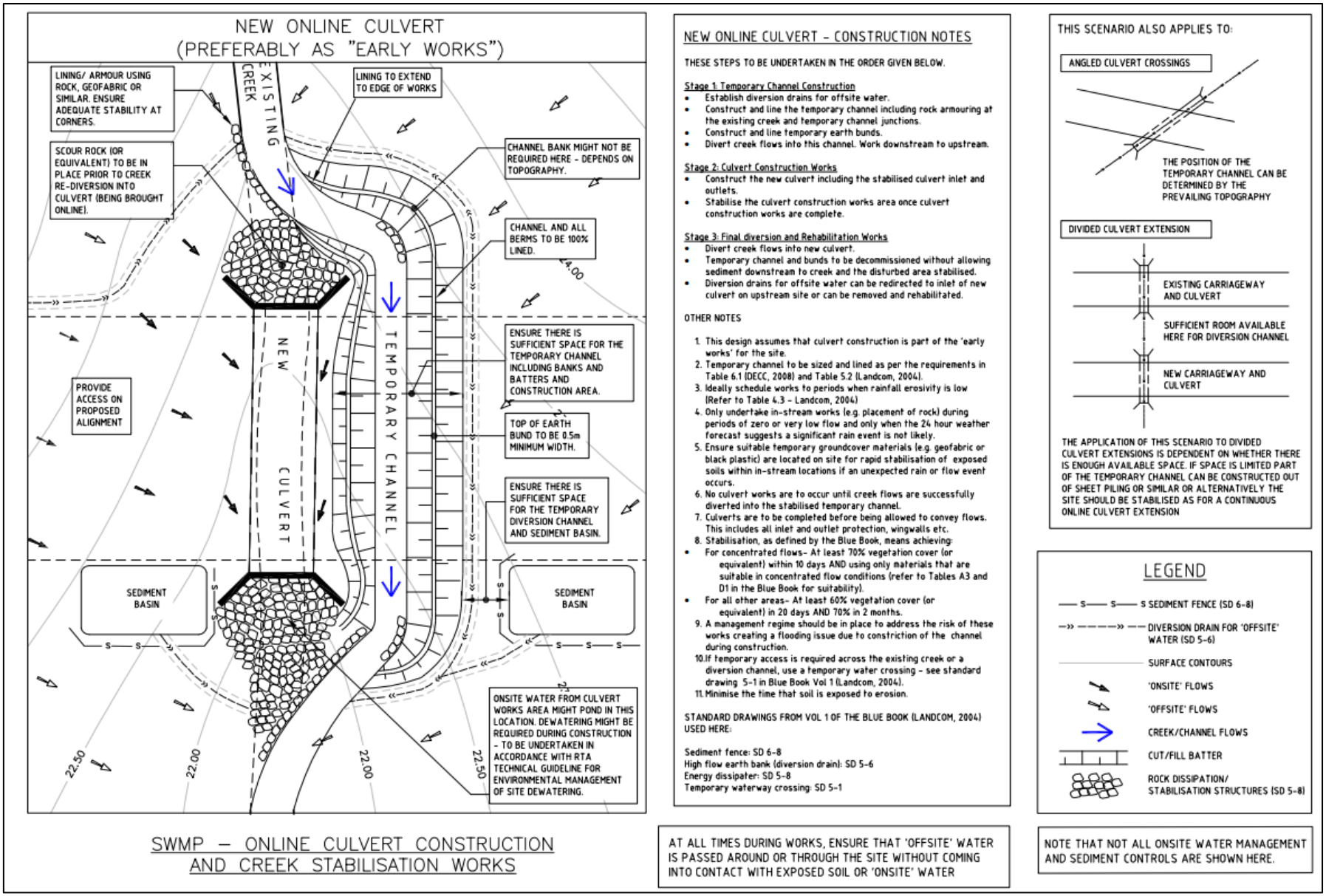
CONSTRUCTION NOTES

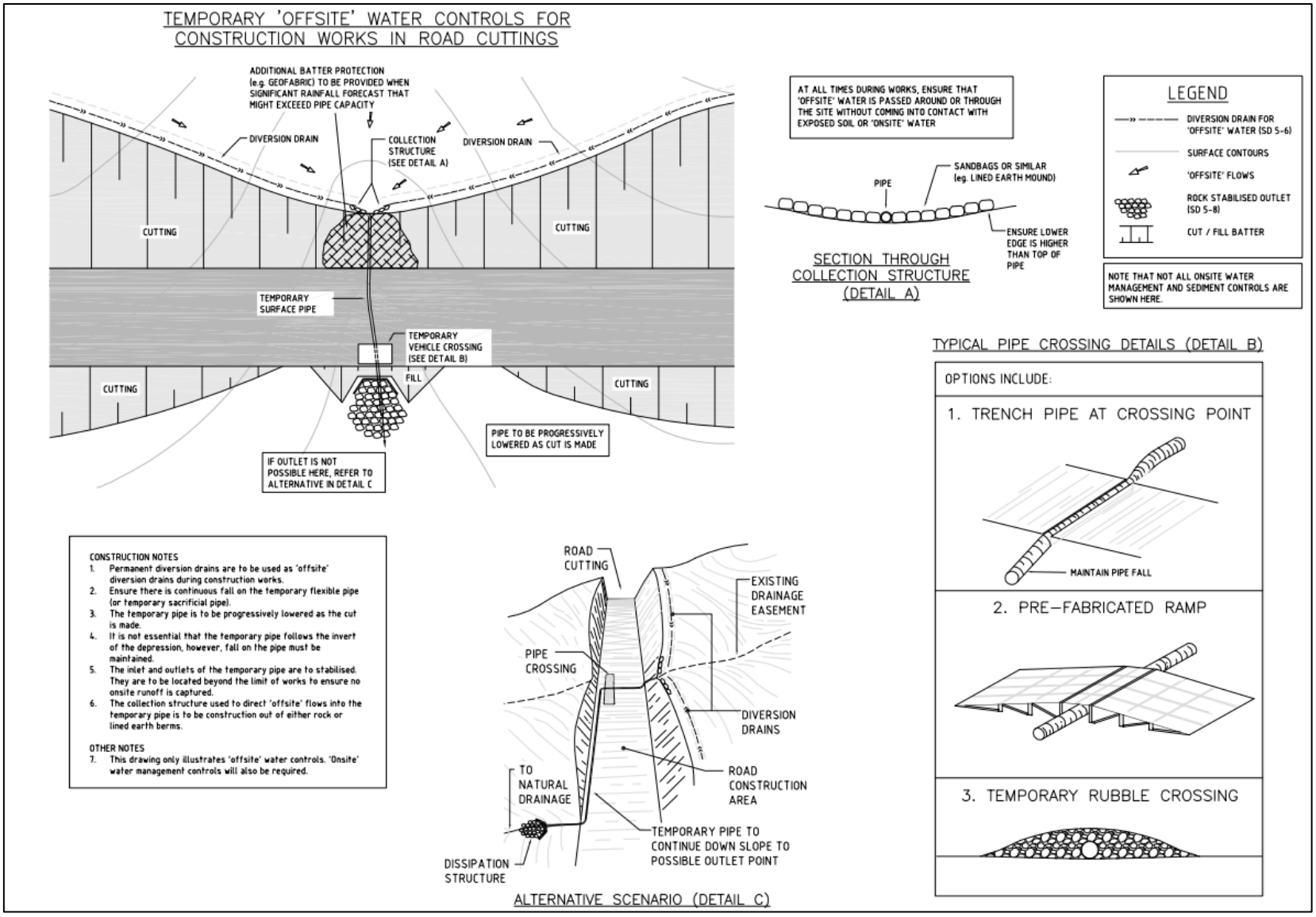
THE FOLLOWING WORKS ARE TO BE UNDERTAKEN AS SHOWN ON THE RELEVANT DIAGRAMS

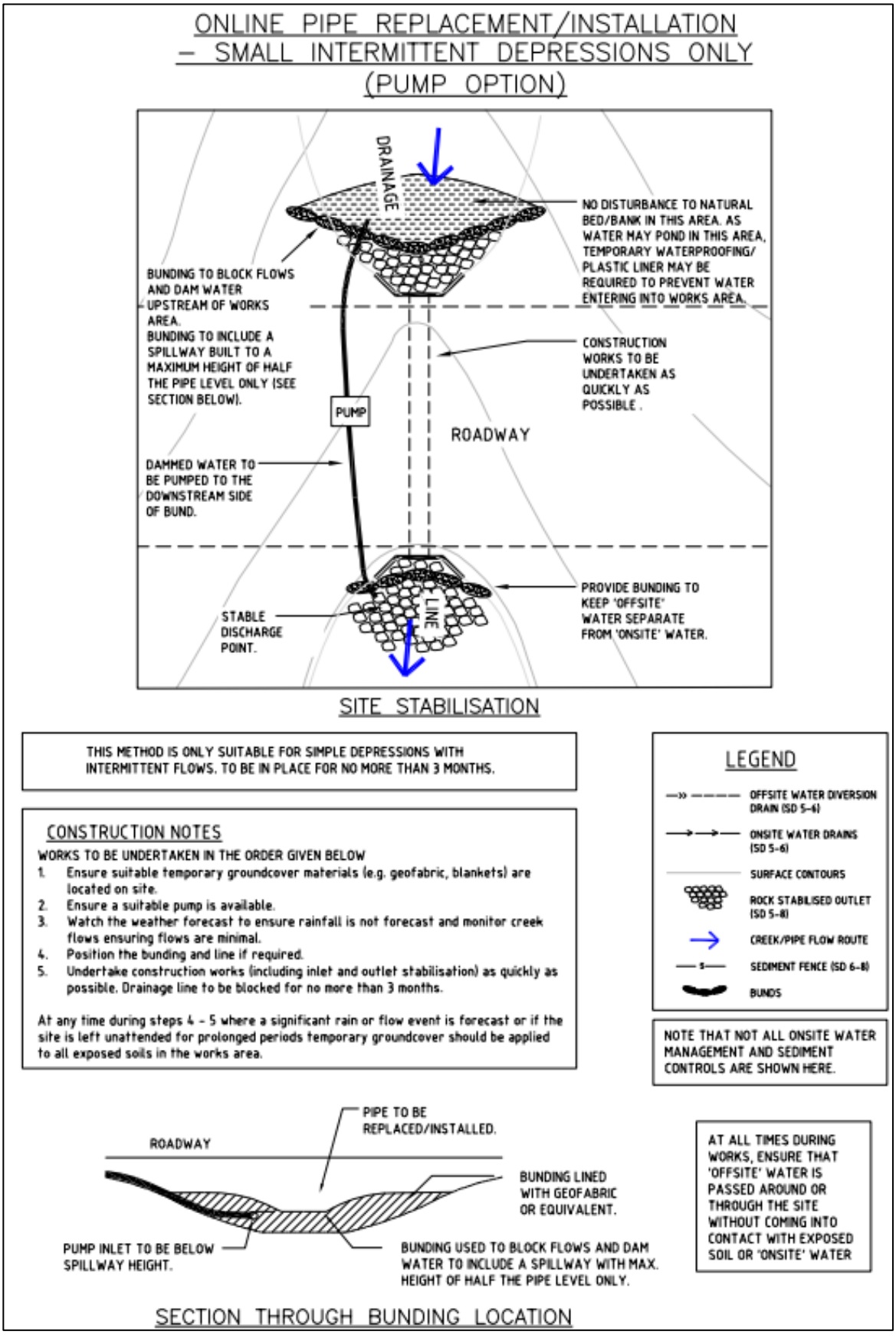
1. Lined permanent diversion drains to be used as 'offsite' water drains during construction. Must convey water all the way to a watercourse or depression and onto a stabilised outlet point.
2. Provide sufficient room between toe of fill and 'offsite' water drain for management of 'onsite' water. 'Onsite' water diversion (temporary drain) – to drain to sediment basin.
3. Sediment fence at toe of batter. Include returns at 20m intervals.
4. 'Onsite' water diversion (temporary drain) – to drain to sediment basin.
5. Ensure 'offsite' water drain extends all the way to drainage line and onto a stabilised outlet point.
6. Use earth bank or sandbags to divert runoff at cut / fill line to onsite drain or sediment trap. Do not mix with 'offsite' water in cut-off drain. Use arrowhead shape if water is being shed from both sides of formation. It is only required at end of day or when rain is imminent.
7. Earth or sandbag windrow for directing water into drop-down flume. To be installed at end of day or when rain is imminent.
8. Lined drop-down chute to carry 'onsite' water to basin or trap. Only required when rain is imminent.
9. Install sediment trap at cut/fill line if runoff is not flowing to a basin.
10. Install sediment trap at base of drop-down flume if runoff is not flowing to a basin. This can simply be formed as a section of the sediment fence with returns both sides.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

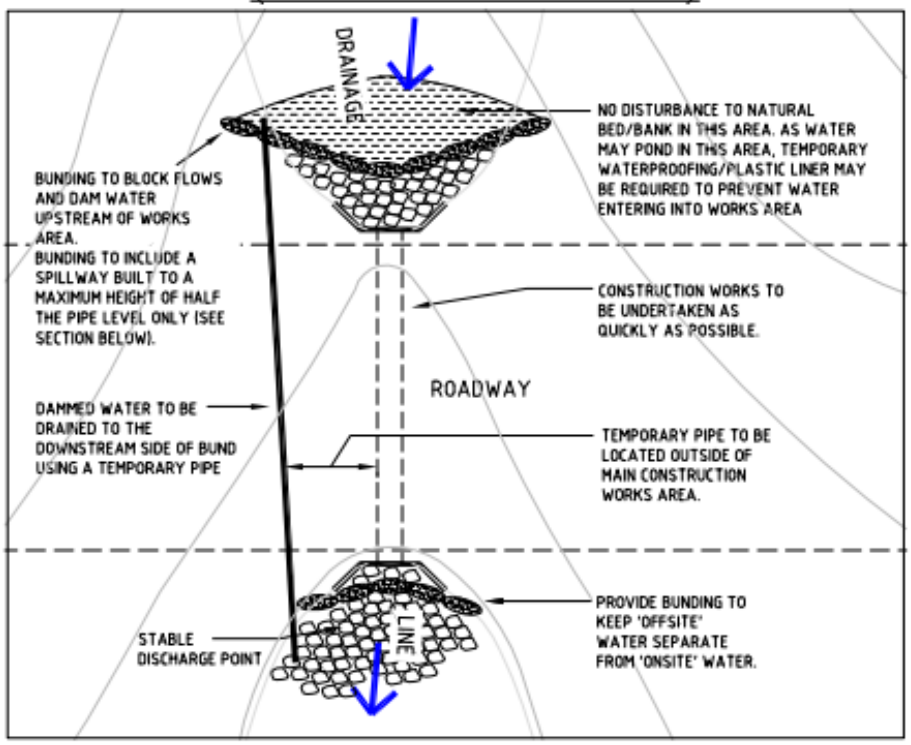
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.


NEW ONLINE CULVERT
(PREFERABLY AS "EARLY WORKS")
LINING/ ARMOUR USING ROCK, GEOFABRIC OR SIMILAR. ENSURE ADEQUATE STABILITY AT CORNERS.
SCOUR ROCK (OR EQUIVALENT) TO BE IN PLACE PRIOR TO CREEK RE-DIVERSION INTO CULVERT (BEING BROUGHT ONLINE).
EXISTING CREEK
LINING TO EXTEND TO EDGE OF WORKS
CHANNEL BANK MIGHT NOT BE REQUIRED HERE - DEPENDS ON TOPOGRAPHY.
CHANNEL AND ALL BERMS TO BE 100% LINED.
4.00
NEW CULVERT
TEMPORARY CHANNEL
ENSURE THERE IS SUFFICIENT SPACE FOR THE TEMPORARY CHANNEL INCLUDING BANKS AND BATTERS AND CONSTRUCTION AREA.
PROVIDE ACCESS ON PROPOSED ALIGNMENT
TOP OF EARTH BUND TO BE 0.5m MINIMUM WIDTH.
ENSURE THERE IS SUFFICIENT SPACE FOR THE TEMPORARY DIVERSION CHANNEL AND SEDIMENT BASIN.
SEDIMENT BASIN
SEDIMENT BASIN
S S
S S S
ONSITE WATER FROM CULVERT WORKS AREA MIGHT POND IN THIS LOCATION. DEWATERING MIGHT BE REQUIRED DURING CONSTRUCTION - TO BE UNDERTAKEN IN ACCORDANCE WITH RTA TECHNICAL GUIDELINE FOR ENVIRONMENTAL MANAGEMENT OF SITE DEWATERING.
22.50
22.00
22.00
22.50
SWMP – ONLINE CULVERT CONSTRUCTION AND CREEK STABILISATION WORKS
NEW ONLINE CULVERT – CONSTRUCTION NOTES
THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.
Stage 1: Temporary Channel Construction
• Establish diversion drains for offsite water.
• Construct and line the temporary channel including rock armouring at the existing creek and temporary channel junctions.
• Construct and line temporary earth bunds.
• Divert creek flows into this channel. Work downstream to upstream.
Stage 2: Culvert Construction Works
• Construct the new culvert including the stabilised culvert inlet and outlets.
• Stabilise the culvert construction works area once culvert construction works are complete.
Stage 3: Final diversion and Rehabilitation Works
• Divert creek flows into new culvert.
• Temporary channel and bunds to be decommissioned without allowing sediment downstream to creek and the disturbed area stabilised.
• Diversion drains for offsite water can be redirected to inlet of new culvert on upstream site or can be removed and rehabilitated.
OTHER NOTES
1. This design assumes that culvert construction is part of the 'early works' for the site.
2. Temporary channel to be sized and lined as per the requirements in Table 6.1 (DECC, 2008) and Table 5.2 (Landcom, 2004).
3. Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 – Landcom, 2004)
4. Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24 hour weather forecast suggests a significant rain event is not likely.
5. Ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
6. No culvert works are to occur until creek flows are successfully diverted into the stabilised temporary channel.
7. Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
8. Stabilisation, as defined by the Blue Book, means achieving:
• For concentrated flows– At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
• For all other areas– At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
9. A management regime should be in place to address the risk of these works creating a flooding issue due to constriction of the channel during construction.
10. If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing – see standard drawing 5-1 in Blue Book Vol 1 (Landcom, 2004).
11. Minimise the time that soil is exposed to erosion.
STANDARD DRAWINGS FROM VOL 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:
Sediment fence: SD 6-8
High flow earth bank (diversion drain): SD 5-6
Energy dissipater: SD 5-8
Temporary waterway crossing: SD 5-1
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER
THIS SCENARIO ALSO APPLIES TO:
ANGLED CULVERT CROSSINGS
THE POSITION OF THE TEMPORARY CHANNEL CAN BE DETERMINED BY THE PREVAILING TOPOGRAPHY
DIVIDED CULVERT EXTENSION
EXISTING CARRIAGEWAY AND CULVERT
SUFFICIENT ROOM AVAILABLE HERE FOR DIVERSION CHANNEL
NEW CARRIAGEWAY AND CULVERT
THE APPLICATION OF THIS SCENARIO TO DIVIDED CULVERT EXTENSIONS IS DEPENDENT ON WHETHER THERE IS ENOUGH AVAILABLE SPACE. IF SPACE IS LIMITED PART OF THE TEMPORARY CHANNEL CAN BE CONSTRUCTED OUT OF SHEET PILING OR SIMILAR OR ALTERNATIVELY THE SITE SHOULD BE STABILISED AS FOR A CONTINUOUS ONLINE CULVERT EXTENSION
LEGEND
S S S SEDIMENT FENCE (SD 6-8)
DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
SURFACE CONTOURS
'ONSITE' FLOWS
'OFFSITE' FLOWS
CREEK/CHANNEL FLOWS
CUT/FILL BATTER
ROCK DISSIPATION/ STABILISATION STRUCTURES (SD 5-8)
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.


TEMPORARY 'OFFSITE' WATER CONTROLS FOR CONSTRUCTION WORKS IN ROAD CUTTINGS
ADDITIONAL BATTER PROTECTION (e.g. GEOFABRIC) TO BE PROVIDED WHEN SIGNIFICANT RAINFALL FORECAST THAT MIGHT EXCEEED PIPE CAPACITY
DIVERSION DRAIN
COLLECTION STRUCTURE (SEE DETAIL A)
DIVERSION DRAIN
CUTTING
CUTTING
TEMPORARY SURFACE PIPE
TEMPORARY VEHICLE CROSSING (SEE DETAIL B)
FILL
CUTTING
CUTTING
PIPE TO BE PROGRESSIVELY LOWERED AS CUT IS MADE
IF OUTLET IS NOT POSSIBLE HERE, REFER TO ALTERNATIVE IN DETAIL C
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER
PIPE
SANDBAGS OR SIMILAR (eg. LINED EARTH MOUND)
ENSURE LOWER EDGE IS HIGHER THAN TOP OF PIPE
SECTION THROUGH COLLECTION STRUCTURE (DETAIL A)
LEGEND
DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
SURFACE CONTOURS
'OFFSITE' FLOWS
ROCK STABILISED OUTLET (SD 5-8)
CUT / FILL BATTER
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.
CONSTRUCTION NOTES
1. Permanent diversion drains are to be used as 'offsite' diversion drains during construction works.
2. Ensure there is continuous fall on the temporary flexible pipe (or temporary sacrificial pipe).
3. The temporary pipe is to be progressively lowered as the cut is made.
4. It is not essential that the temporary pipe follows the invert of the depression, however, fall on the pipe must be maintained.
5. The inlet and outlets of the temporary pipe are to stabilised. They are to be located beyond the limit of works to ensure no onsite runoff is captured.
6. The collection structure used to direct 'offsite' flows into the temporary pipe is to be construction out of either rock or lined earth berms.
OTHER NOTES
7. This drawing only illustrates 'offsite' water controls. 'Onsite' water management controls will also be required.
ROAD CUTTING
EXISTING DRAINAGE EASEMENT
PIPE CROSSING
DIVERSION DRAINS
TO NATURAL DRAINAGE
ROAD CONSTRUCTION AREA
TEMPORARY PIPE TO CONTINUE DOWN SLOPE TO POSSIBLE OUTLET POINT
DISSIPATION STRUCTURE
ALTERNATIVE SCENARIO (DETAIL C)
TYPICAL PIPE CROSSING DETAILS (DETAIL B)
OPTIONS INCLUDE:
1. TRENCH PIPE AT CROSSING POINT
MAINTAIN PIPE FALL
2. PRE-FABRICATED RAMP
3. TEMPORARY RUBBLE CROSSING


ONLINE PIPE REPLACEMENT/INSTALLATION
– SMALL INTERMITTENT DEPRESSIONS ONLY
(PUMP OPTION)
DRAINAGE
NO DISTURBANCE TO NATURAL BED/BANK IN THIS AREA. AS WATER MAY POND IN THIS AREA, TEMPORARY WATERPROOFING/ PLASTIC LINER MAY BE REQUIRED TO PREVENT WATER ENTERING INTO WORKS AREA.
BUNDING TO BLOCK FLOWS AND DAM WATER UPSTREAM OF WORKS AREA.
BUNDING TO INCLUDE A SPILLWAY BUILT TO A MAXIMUM HEIGHT OF HALF THE PIPE LEVEL ONLY (SEE SECTION BELOW).
CONSTRUCTION WORKS TO BE UNDERTAKEN AS QUICKLY AS POSSIBLE .
PUMP
ROADWAY
DAMMED WATER TO BE PUMPED TO THE DOWNSTREAM SIDE OF BUND.
PROVIDE BUNDING TO KEEP 'OFFSITE' WATER SEPARATE FROM 'ONSITE' WATER.
STABLE DISCHARGE POINT.
LINE
SITE STABILISATION
THIS METHOD IS ONLY SUITABLE FOR SIMPLE DEPRESSIONS WITH INTERMITTENT FLOWS. TO BE IN PLACE FOR NO MORE THAN 3 MONTHS.
CONSTRUCTION NOTES
WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW
1. Ensure suitable temporary groundcover materials (e.g. geofabric, blankets) are located on site.
2. Ensure a suitable pump is available.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding and line if required.
5. Undertake construction works (including inlet and outlet stabilisation) as quickly as possible. Drainage line to be blocked for no more than 3 months.
At any time during steps 4 - 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.
LEGEND
OFFSITE WATER DIVERSION DRAIN (SD 5-6)
ONSITE WATER DRAINS (SD 5-6)
SURFACE CONTOURS
ROCK STABILISED OUTLET (SD 5-8)
CREEK/PIPE FLOW ROUTE
SEDIMENT FENCE (SD 6-8)
BUNDS
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.
PIPE TO BE REPLACED/INSTALLED.
ROADWAY
BUNDING LINED WITH GEOFABRIC OR EQUIVALENT.
PUMP INLET TO BE BELOW SPILLWAY HEIGHT.
BUNDING USED TO BLOCK FLOWS AND DAM WATER TO INCLUDE A SPILLWAY WITH MAX. HEIGHT OF HALF THE PIPE LEVEL ONLY.
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER
SECTION THROUGH BUNDING LOCATION

ONLINE PIPE REPLACEMENT/INSTALLATION – SMALL INTERMITTENT DRAINAGE LINES (TEMPORARY PIPE OPTION)



SITE STABILISATION

THIS METHOD IS ONLY SUITABLE FOR SMALL CHANNELS WITH INTERMITTENT FLOWS.

TEMPORARY PIPE TO BE SIZED TO AT LEAST HALF THE PERMANENT PIPE.
e.g. – PERMANENT: 600ϕ
– TEMPORARY: MINIMUM 300ϕ

THIS METHOD (TEMPORARY PIPE SYSTEM) WILL NOT BE SUITABLE IN STEEP LOCATIONS WHERE TEMPORARY PIPE CANNOT BE LOCATED OUTSIDE OF WORKS AREA.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

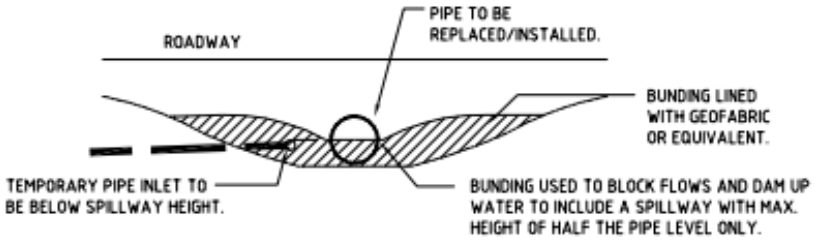
1. Ensure suitable temporary groundcover materials (eg. geofabric, blankets) are located on site.
2. Ensure a temporary pipe is available. Install temporary pipe to ensure flow, preferably by providing continuous fall.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding within the channel to secure the site.
5. Undertake construction works (including inlet outlet stabilisation) as quickly as possible.

At any time during steps 4 – 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET (SD 5-8)
- CREEK/PIPE FLOW ROUTE
- SEDIMENT FENCE (SD 6-8)
- BUNDS

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.



AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

5.3 High Risk Areas and Project-Specific Recommendations

Table 8 flags those areas that are considered high-risk or aspects of erosion and sediment control that are outside of typical best-practice for a major road construction project.

Table 8 – Summary of high-risk areas and recommendations.

Location	Reason for adoption as a high-risk area/aspect	Reference from Table 7	Recommended action(s)
Whole project	Moderate risk of gully or tunnel erosion around or under permanent drainage structures due to dispersive soils.	1 and 22	• All cross-formation pipes, cross-formation culverts, excavated drains, constructed table drains, riprap, inlets and outlets should include a requirement for soil amelioration in, under and around the structure to address potential dispersion. • Gypsum should be ripped into the underlying material at approximately 5 to 10t/ha (0.5 to 1kg/m^2) at the location where the structure is being placed.
Basins 1, 2, 3 and 4	Sediment basins are an essential part of the overall erosion and sediment control strategy, so space should be provided to allow for their inclusion during construction.	2	• Preliminary assessment indicates that sufficient land might not be available within the road corridor for construction of all basins. Land might need to be leased to allow for construction of these sediment basins as shown on the Concept ESCPs in Appendix 3. • If sufficient space is not available for construction of a sediment basin, an alternative is to use an undersized basin (i.e as big as possible but still not to the required size), and then augment the basin with enhanced erosion controls in the upslope catchment. Enhanced erosion controls mean that temporary ground covers must be employed over disturbed areas whenever heavy rain is imminent. This option is noted on the Concept ESCPs in Appendix 3. • The final positioning of Basins SB1, SB3 and SB4 (refer to Appendix 3) might be impacted by traffic staging, or by the presence of underground services or utilities (e.g. sewer). However, this is not considered to preclude the construction of sediment basins but a solution should be developed as part of project design and planning. Options to address this include: o The basins can be moved slightly if required to avoid utilities and the temporary dirty water diversion drains/berms can be extended to

Location	Reason for adoption as a high-risk area/aspect	Reference from Table 7	Recommended action(s)
			ensure site water flows to the basins; or o Underground utilities should be moved to allow for basin construction; or o Sit the basin on natural ground level to avoid excavating. This constraint is to be taken into consideration during project design and construction planning, and is not considered a justification for not installing basins.
Whole project	Risk of revegetation failures or poor growth due to inherent soil constraints.	3 and 23	• R178 specification should be modified to include requirements for soil amelioration and fertilizing to promote effective revegetation. • This should include a requirement to lime-treat all topsoil and subsoil to increase calcium levels and raise the pH to 6.5, and gypsum-treat subsoils to address potential dispersion.
Basins 1, 2, 3 and 4	Traffic switching/staging and/or acid sulfate soils might impact on basin positioning. This should be taken into account as part of project planning.	4	• To minimise the risk of temporary traffic staging from impacting on the feasibility for installing sediment basins, project planning should investigate potential traffic staging and ensure basin positioning is taken into account or alternative provisions made for basin(s). • To minimise the risk of acid sulfate soils from impacting on the feasibility for installing sediment basins, geotechnical investigations should include checking the locations where basins are proposed.
Whole project	High risk of gully or tunnel erosion under in and under temporary drainage structures due to inherent soil dispersion.	10	• Any temporary drainage structures excavated into the subsoils should be gypsum-treated (at 0.5kg/m^2) prior to being lined.
Old Punt Road	Runoff from Old Punt Road will follow existing concrete swale drains into the existing carpark. It will run into the work area for the bridge abutment.	15	• Prior to establishing the bridge abutment work area, create a concrete swale drain across Old Punt Road from north to south to divert all runoff towards the boat ramp and away from the proposed abutment work area. This concept is shown on the Concept ESCP drawings in Appendix 3.

Location	Reason for adoption as a high-risk area/aspect	Reference from Table 7	Recommended action(s)
Far southern portion of the alignment, adjacent to McLeods Creek	Sediment controls are required at the toe of the embankment works, which are hard against the mangroves (i.e. PASS).	16	• Use mulch bunds or rock filter bunds along the toe of the embankment immediately adjacent to the mangroves. These devices allow for sediment control but avoid the need for excavation or extensive ground disturbance of PASS. This is shown on the Concept ESCP drawings in Appendix 3.
West-facing batters, south of the bridge adjacent to McLeods Creek	As detailed above, a sediment basin will not be in place at the toe of the embankment on the west side (due to the presence of PASS material in the mangroves). To offset the lower level of proposed sediment control, additional erosion control measures should be adopted.	42	• Use temporary ground covers such as geofabric on the west-facing batter faces south of the bridge to provide erosion control whenever rain is falling or imminent. This will minimise the risk of erosion from these batters and offset the risk given that a sediment basin cannot be installed at the toe of this batter due to the presence of PASS. This is shown on the Concept ESCP drawings in Appendix 3.
Clyde River	Piling works will be required instream, creating the risk of sediment plumes when bottom sediments are stirred up.	43	• Use well-anchored floating silt curtains to contain any sediment plumes from piling.
Clyde River	Piling platforms might be constructed into the river (i.e. extended from shore). This creates a risk of sediment being washed or pushed into the river.	44	• Ensure clean rock is used to create any terrestrial-launched piling platforms in the river.

6 CONCLUSION

NSW Roads and Maritime propose to construct a new bridge for the Princes Highway over the Clyde River at Batemans Bay.

The purpose of this report is to determine management issues for construction-phase erosion and sediment control.

- Section 3 identifies potential constraints to construction-phase erosion and sediment control;
- Section 4 identifies design considerations for erosion and sediment control measures;
- Section 5 summarises a series of recommendations to manage or mitigate potential impacts relating to construction-phase erosion and sediment control.

Section 5 is accompanied by a Concept ESCP (in Appendix 3) showing the setup of key erosion and sediment control measures such as sediment basins. These Concept ESCPs identify four sediment basins that are recommended to help manage the potential for sediment runoff to SEPP14 wetlands and/or the Batemans Marine Park.

In preparing the Concept ESCP drawings in Appendix 3, a review was conducted of the road design to determine if the inherent design would impact on effective implementation of erosion and sediment control during construction. We conclude that there are no changes required to the design to effectively implement major erosion and sediment control measures such as sediment basins and temporary drainage. It is expected that the Concept ESCPs would be reviewed and incorporated as part of the detailed design for the proposal.

Providing the recommendations in Section 5 and Appendix 3 of this report are adopted during construction, the risk of pollution from erosion and subsequent sediment runoff can be minimised, in accordance with recognised best-practice in NSW.

Tables 7 and 8 (in Section 5) detail a series of erosion and sediment control recommendations, including those considered as "standard practice" for a road project, plus those that are outside of typical practice. For those high-risk areas or aspects that are detailed in Table 7 as being outside of typical practice, a potential strategy has been presented in Table 8 and on the Concept ESCPs in Appendix 3 to address the risk. Note that alternative options could feasibly be developed but should include expert consultation.

It is recommended that Roads and Maritime G38 specifications be modified to ensure that the recommendations in Tables 7 and 8 are incorporated and thus carry through to the construction-phase of the project.

7 REFERENCES

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8 APPENDICES

8.1 Appendix 1: IFD Table

From Bureau of Meteorology, 2017.

Intensity-Frequency-Duration Table

Location: 35.725S 150.200E NEAR.. Batemans Bay Issued: 6/6/2017

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

	Average Recurrence Interval						
Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	97.2	126	162	183	212	249	278
6Mins	91.0	118	152	172	199	235	262
10Mins	74.6	96.7	126	143	166	197	221
20Mins	54.8	71.4	94.4	108	127	151	170
30Mins	44.7	58.4	77.9	90.0	106	127	143
1Hr	30.3	39.8	53.8	62.5	73.7	88.9	101
2Hrs	19.9	26.1	35.5	41.3	48.8	59.0	67.1
3Hrs	15.4	20.2	27.4	31.9	37.8	45.7	51.9
6Hrs	9.86	13.0	17.6	20.4	24.2	29.2	33.1
12Hrs	6.35	8.36	11.3	13.2	15.6	18.9	21.5
24Hrs	4.09	5.40	7.42	8.69	10.3	12.6	14.3
48Hrs	2.57	3.42	4.78	5.65	6.77	8.31	9.54
72Hrs	1.90	2.54	3.57	4.24	5.10	6.28	7.22

(Raw data: 40.31, 8.41, 2.55, 88.74, 18.56, 6.18, skew=0.07, F2=4.25, F50=15.74)

8.2 Appendix 2: Sediment Basin Calculations

See overpage.

Site Name: **Batemans Bay Bridge**

Site Location: **Batemans Bay**

Precinct/Stage: **All**

Other Details: **Some basin catchments overlap, because water will flow to one basin initially, then a different basin once earthworks are complete.**

Site area	Sub-catchment or Name of Structure						Notes
	Basin 1	Basin 2	Basin 3	Basin 4			
Total catchment area (ha)	0.57	0.72	0.255	0.36			
Disturbed catchment area (ha)	0.57	0.72	0.255	0.36			

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D			From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D			Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5			See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85	85			
x-day, y-percentile rainfall event (mm)	37.4	37.4	37.4	37.4			
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	13	13	13	13			

RUSLE Factors

Rainfall erosivity (*R*-factor)	3650	3650	3650	3650			Auto-filled from above
Soil erodibility (*K*-factor)	0.04	0.04	0.04	0.04			
Slope length (m)	6	10	10	10			
Slope gradient (%)	50	50	50	50			RUSLE LS factor calculated for a high rill/interrill ratio.
Length/gradient (*LS*-factor)	2.18	3.33	3.33	3.33			
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2	2			Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.64	0.64	0.64	0.64			See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	414	631	631	631			
Soil Loss Class	4	5	5	5			See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	319	485	485	485			Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	30	58	21	29			See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	136	172	61	86			See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	166	230	82	115			

8.3 Appendix 3: Concept ESCP Drawings

See overpage.

LEGEND

- SEDIMENT FENCE (SD 6-8)
- DIRTY WATER DIVERSION BERM
- CLEAN WATER DIVERSION BERM
- MULCH BUND (OR ALTERNATIVE TYPE 2)
- PROPOSED STORMWATER
- EXISTING STORMWATER
- BATTER CHUTES
- EXISTING STORMWATER PIT
- PIT PROTECTION
- SEDIMENT BASIN (SB) - SEE PLAN FOR SIZING REQUIREMENTS.
- SEDIMENT TRAP/SUMP
- CONCRETE SWALE DRAIN
- HIGH PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- LOW PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- NO KNOWN OCCURANCE OF ACID SULFATE SOIL
- NOT ASSESSED FOR ACID SULFATE SOIL RISK
- SEPP14 WETLANDS
- EIS PROPOSAL BOUNDARY
- REF BOUNDARY

TOE OF EMBANKMENT EXTENDS INTO MANGROVES, WHICH IS POTENTIAL ACID SULFATE SOIL (PASS). BASINS AND DRAINS ARE NOT DESIRABLE. TO MINIMISE POTENTIAL IMPACTS ON MANGROVES AND TO AVOID EXCESSIVE DISTURBANCE TO PASS, USE A MULCH BUND OR CLEAN ROCK FILTER BUND ALONG THIS EDGE TO PROVIDE SEDIMENT CONTROL, AUGMENTED BY THE USE OF TEMPORARY GROUND COVERS (e.g. GEOFABRIC) ON THE FILL BATTER IMMEDIATELY ADJACENT WHEN RAIN IS IMMINENT.

EXISTING PIT AND PIPE TO BE DECOMMISSIONED AS PART OF EARTHWORKS.

PRINCES HWY

NORTH ST

INSTALL A NEW PIPE TO PROVIDE AN OVERFLOW FROM SEDIMENT TRAP.

A SEDIMENT BASIN IS NOT REQUIRED IN THIS LOCATION PROVIDING DIRTY ONSITE WATER FROM FILL CONSTRUCTION IS DIRECTED TO SEDIMENT BASIN 4 USING BATTER CHUTES (AS SHOWN). A SIMPLE SMALL EXCAVATED SEDIMENT TRAP WILL SUFFICE IN THIS LOCATION.

HOWEVER, IF SEDIMENT BASIN 4 CANNOT BE CONSTRUCTED TO THE REQUIRED SIZING, OR IF DIRTY WATER CANNOT BE DIRECTED TO SEDIMENT BASIN 4 USING BATTER CHUTES, THIS CATCHMENT WOULD NEED TO BE RE-ASSESSED AND A SEDIMENT BASIN MIGHT BE REQUIRED HERE INSTEAD OF THE SIMPLE SEDIMENT TRAP.

SEDIMENT SUMP SITS IN AN AREA IDENTIFIED AS HIGH PROBABILITY FOR PASS. GEOTECHNICAL TESTING SHOULD BE UNDERTAKEN TO CONFIRM/DENY. LIME-TREAT SUMP FLOOR AS A PRECAUTION.

USE TEMPORARY BATTER CHUTES TO CONVEY WATER OFF THE FILL AND INTO THIS DRAIN IF RAIN IS IMMINENT.

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
03	16/10/17	A.M.	L.O.	A.M.	FINAL ISSUE
02	03/10/17	A.M.	L.O.	A.M.	FINAL ISSUE
01	21/09/17	A.M.	L.O.	A.M.	FINAL ISSUE
00	08/09/17	A.M.	L.O.	A.M.	FINAL ISSUE
A	03/08/17	A.M.	L.O.	A.M.	DRAFT ISSUE – FOR CONSULTATION

DRAWING STATUS	
DESIGN BY	A.M.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	1:1000
FINAL	

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PROJECT TITLE

BATEMANS BAY BRIDGE REPLACEMENT PROPOSAL

DRAWING TITLE

EROSION AND SEDIMENT CONTROL PLAN SHEET 1 OF 4

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
17000162	P01	ESCP01	03

Plot Date: 16 October 2017 1:03:51 PM CAD File Name: P:\17000162 Batemans Bay Bridge\Drawings\17000162_P01_ESCP_REV03.dwg

INSTALL A NEW PIPE TO PROVIDE AN EMERGENCY OVERFLOW FROM BASIN 3. CONNECT INTO THE EXISTING STORMWATER PIT IN THE BOAT RAMP CARPARK.

SEDIMENT BASIN 3

CATCHMENT = 0.255 ha
TOTAL VOLUME = 82 m^3
SEDIMENT STORAGE = 21 m^3

BAFFLES MIGHT BE REQUIRED IF 3:1 (LENGTH:WIDTH RATIO) CANNOT BE ACHIEVED.

TEMPORARY DRAIN TO CONVEY DIRTY ONSITE WATER TO BASIN 3. CONSTRUCT IMMEDIATELY FOLLOWING DEMOLITION WORKS.

TRAFFIC STAGING IN THIS ZONE MIGHT DICTATE THE USE OF ALTERNATIVE EROSION AND SEDIMENT CONTROL MEASURES, OR COULD MAKE BASINS 3 OR 4 UNFEASIBLE.

LIKELY FUTURE PILING OR STAGING AREA FOR BRIDGE WORKS. USE CLEAN ROCK BUNDS OR SEDIMENT FENCES TO PROVIDE SEDIMENT CONTROL FOR ANY WORKS IN THIS AREA (i.e. LOCAL MANAGEMENT AREA).

IF PILING PLATFORMS WILL BE LAUNCHED INTO THE RIVER FROM THE BANK, USE CLEAN ROCK AND GRAVEL MATERIALS ONLY.

ANY MARINE PILING OR DREDGE WORK FROM BARGES SHOULD INCLUDE THE USE OF FIRMLY-ANCHORED SILT CURTAINS TO CONTAIN ANY BOTTOM SEDIMENTS THAT ARE STIRRED UP AND TO ALLOW FOR CLEANING OFF PILING HEADS INTO WATER.

BASINS 3 AND 4 SIT IN AN AREA IDENTIFIED AS HIGH PROBABILITY FOR PASS. GEOTECHNICAL TESTING SHOULD BE UNDERTAKEN TO CONFIRM/DENY. LIME-TREAT BASIN FLOORS AS A PRECAUTION.

PRINCES HWY

THE FINAL POSITIONING OF BASINS SB3 AND SB4 MIGHT BE IMPACTED BY UNDERGROUND SERVICES OR UTILITIES (e.g. SEWER). THE BASINS CAN BE MOVED SLIGHTLY IF REQUIRED AND TEMPORARY DIRTY WATER DIVERSION EXTENDED TO ENSURE SITE WATER FLOWS TO THE BASIN. ALTERNATIVELY, UNDERGROUND UTILITIES SHOULD BE MOVED TO ALLOW FOR BASIN CONSTRUCTION. THIS IS TO BE TAKEN INTO CONSIDERATION DURING CONSTRUCTION PLANNING.

SB3

SB4

SEDIMENT BASIN 4

CATCHMENT = 0.36 ha
TOTAL VOLUME = 115 m^3
SEDIMENT STORAGE = 29 m^3

BAFFLES MIGHT BE REQUIRED IF 3:1 (LENGTH:WIDTH RATIO) CANNOT BE ACHIEVED.

TEMPORARY DRAIN TO CONVEY DIRTY ONSITE WATER TO BASIN 4. USE TEMPORARY BATTER CHUTES TO CONVEY WATER OFF THE FILL AND INTO THIS DRAIN IF RAIN IS IMMINENT.

INSTALL A NEW PIPE TO PROVIDE AN EMERGENCY OVERFLOW FROM BASIN 4. CONNECT INTO THE BACK OF THE EXISTING STORMWATER PIT IN CLYDE ST.

USE TEMPORARY BATTER CHUTES TO CONVEY WATER OFF THE FILL AND INTO THIS DRAIN IF RAIN IS IMMINENT.

CLYDE ST

LEGEND

- SEDIMENT FENCE (SD 6-8)
- DIRTY WATER DIVERSION BERM
- CLEAN WATER DIVERSION BERM
- MULCH BUND (OR ALTERNATIVE TYPE 2)
- PROPOSED STORMWATER
- EXISTING STORMWATER
- BATTER CHUTES
- EXISTING STORMWATER PIT
- PIT PROTECTION
- SEDIMENT BASIN (SB) - SEE PLAN FOR SIZING REQUIREMENTS.
- SEDIMENT TRAP/SUMP
- CONCRETE SWALE DRAIN
- HIGH PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- LOW PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- NO KNOWN OCCURANCE OF ACID SULFATE SOIL
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PROJECT TITLE

BATEMANS BAY BRIDGE REPLACEMENT PROPOSAL

DRAWING TITLE

EROSION AND SEDIMENT CONTROL PLAN SHEET 2 OF 4

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
17000162	P01	ESCP02	03

AS PART OF INITIAL SETUP, CREATE A DIVERSION ACROSS OLD PUNT ROAD TO DIRECT WATER ON THE NORTHERN SIDE OF THE PAVEMENT ACROSS THE ROAD TO THE SOUTHERN SIDE. THIS WATER IS CLEAN, OFFSITE WATER SO SHOULD BE DIVERTED AWAY FROM WORK AREA.

RETAIN EXISTING ASPHALT CARPARK SURFACE TO PROVIDE A STABLE SITE ACCESS/EGRESS FOR CONSTRUCTION TRAFFIC TO BRIDGE ABUTMENT AREA FROM OLD PUNT ROAD.

IF PILING PLATFORMS WILL BE LAUNCHED INTO THE RIVER FROM THE BANK, USE CLEAN ROCK AND GRAVEL MATERIALS ONLY.

SEDIMENT BASIN 2

CATCHMENT = 0.72 ha
TOTAL VOLUME = 230 m^3
SEDIMENT STORAGE = 58 m^3

BAFFLES MIGHT BE REQUIRED IF 3:1 (LENGTH:WIDTH RATIO) CANNOT BE ACHIEVED.

THE OVERFLOW SPILLWAY FROM BASIN 2 CAN BE VIA A NEW PIPE, OR A ROCK-LINED CHANNEL, OR BY USING A SECTION OF THE EXISTING PIPE IN THIS LOCATION.

BASINS 1 AND 2 ARE OUTSIDE THE AREA IDENTIFIED AS HAVING A RISK OF INTERCEPTNG PASS.

THIS DRAIN WILL CONVEY DIRTY SITE WATER TO BASIN 2. IT WILL CAPTURE A SMALL AREA OF THE EXTERNAL CATCHMENT AS WELL, INCLUDING RUNOFF FROM THE EXISTING HIGHWAY AND BATTER. THIS IS ACCEPTABLE AND DOES NOT SIGNIFICANTLY IMPACT ON BASIN SIZING.

DURING SITE SETUP, INSTALL A DRAIN WARDEN (OR SIMILIAR IN-PIT SYSTEM) IN THE EXISTING STORMWATER DROP INLET IN THE CARPARK. ONCE THE BRIDGE ABUTMENT WORK AREA IS FULLY SETUP AND THE DIVERSION CREATED FOR OLD PUNT ROAD DRAINAGE, DECOMMISSION THE PIT AND ITS PIPE OUTLET.

THIS SECTION OF CONCRETE SWALE DRAIN WILL BECOME REDUNDANT ONCE THE NEW DIVERSION HUMP (OR SWALE) IS CREATED ACROSS OLD PUNT ROAD.

CLEAN OFFSITE WATER DIVERSION IS TO BE INSTALLED PRIOR TO EARTHWORKS, AND WILL CONVEY WATER INTO NEW DIVERSION ACROSS OLD PUNT ROAD.

MINOR DEPRESSION IN THIS LOCATION WILL EXPERIENCE CLEAN WATER RUN-ON FROM OFFSITE. THE UPSLOPE CATCHMENT IS SMALL AND SO IT IS CONSIDERED ACCEPTABLE TO ALLOW THIS OFFSITE WATER TO RUN INTO THE DIRTY ONSITE WATER SYSTEM - IT DOES NOT SIGNIFICANTLY IMPACT ON BASIN SIZING AND WOULD BE COSTLY AND IMPRACTICAL TO DIVERT IT UNDER THE EXISTING HIGHWAY (i.e. WOULD REQUIRE UNDERBORING).

DURING INITIAL STRIPPING AND EARTHWORKS ON THIS HILLSIDE, CREATE A DIVERSION BUND AT THE EDGE OF THE EXISTING HIGHWAY TO DIRECT DIRTY ONSITE RUNOFF TO BASIN 2.

AS EARTHWORKS PROCEED, WATER WILL FLOW NORTHWARDS DOWN THIS INCLINE AND INTO BASIN 1.

AS EARTHWORKS PROCEED, WATER WILL FLOW NORTHWARDS DOWN THIS INCLINE AND INTO BASIN 1.

SB2

PRINCES HWY

WHARF RD

WC

LEGEND

- SEDIMENT FENCE (SD 6-8)
- DIRTY WATER DIVERSION BERM
- CLEAN WATER DIVERSION BERM
- MULCH BUND (OR ALTERNATIVE TYPE 2)
- PROPOSED STORMWATER
- EXISTING STORMWATER
- BATTER CHUTES
- EXISTING STORMWATER PIT
- PIT PROTECTION
- SEDIMENT BASIN (SB) - SEE PLAN FOR SIZING REQUIREMENTS.
- SEDIMENT TRAP/SUMP
- CONCRETE SWALE DRAIN
- HIGH PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- LOW PROBABILITY OF ACID SULFATE SOIL OCCURANCE
- NO KNOWN OCCURANCE OF ACID SULFATE SOIL
- NOT ASSESSED FOR ACID SULFATE SOIL RISK
- SEPP14 WETLANDS
- EIS PROPOSAL BOUNDARY
- REF BOUNDARY

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
03	16/10/17	A.M.	L.O.	A.M.	FINAL ISSUE
02	03/10/17	A.M.	L.O.	A.M.	FINAL ISSUE
01	21/09/17	A.M.	L.O.	A.M.	FINAL ISSUE
00	08/09/17	A.M.	L.O.	A.M.	FINAL ISSUE
A	03/08/17	A.M.	L.O.	A.M.	DRAFT ISSUE - FOR CONSULTATION

DRAWING STATUS

DESIGN BY	A.M.
DRAWN BY	L.O.
FINAL APPROVAL	A.M.
SCALE: (on A3 Original)	1:1000

FINAL

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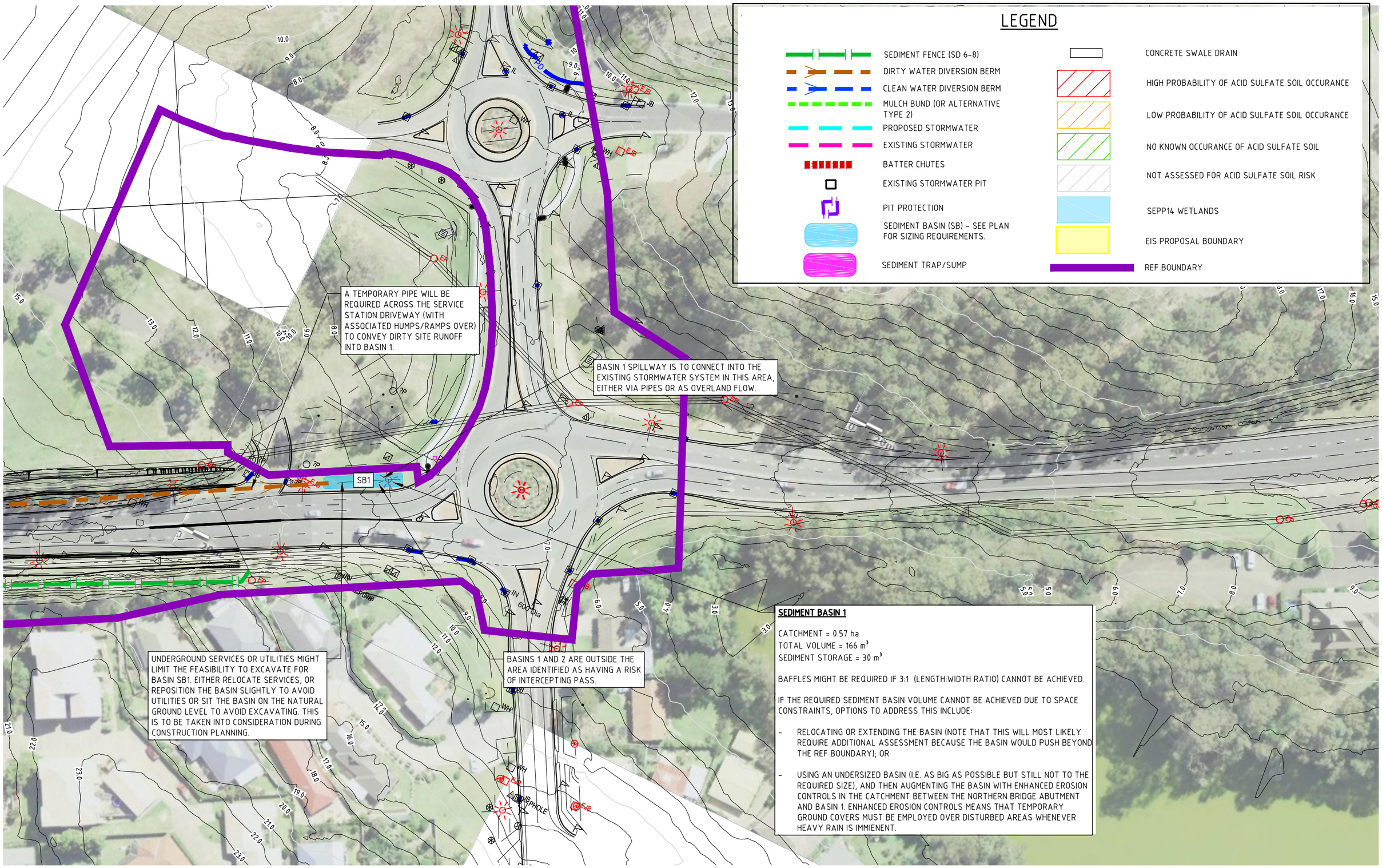
PROJECT TITLE: BATEMANS BAY BRIDGE REPLACEMENT PROPOSAL

DRAWING TITLE: EROSION AND SEDIMENT CONTROL PLAN SHEET 3 OF 4

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
17000162	P01	ESCP03	03



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PROJECT TITLE

BATEMANS BAY BRIDGE REPLACEMENT PROPOSAL

DRAWING TITLE

EROSION AND SEDIMENT CONTROL PLAN SHEET 4 OF 4

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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