GEOTECHNICAL INVESTIGATION INTERPRETIVE REPORT

Breakwater Wharf Extension, Eden, NSW

Report For Australasian Marine Associates
Report No. 15001-006-Rev1
15 June 2015
# Document Review

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1.0 INTRODUCTION

Tectonic Geotechnical Pty Ltd (Tectonic) has been commissioned by Australasian Marine Associates (AMA) to undertake a geotechnical investigation for the proposed extension to the Eden Breakwater Wharf as per AMA’s proposal to NSW Crown Lands, dated 12 December 2014.

The field investigation was conducted to:

- Provide geotechnical information for the design of berthing and mooring piles for the wharf.
- Provide geotechnical information for the dredging assessment, including dredgability of materials, slope stability analyses of the dredge banks, and potential destabilisation of existing structures.
- Provide data to calibrate the results of a geophysics investigation conducted by OEMG.

Following discussions with NSW Crown Lands, the scope of the Interpretive Report has been reduced from the initially proposed scope. This report includes a limited interpretation of the results of the fieldwork and laboratory testing undertaken for the geotechnical investigation for the proposed wharf extension. The revised scope of the Interpretive Report includes:

- An interpreted engineering geological model for the site (including likely ground profile, seabed features, and potential geohazards); and
- Recommended design soil parameters related to the proposed construction for the various strata encountered (upper and lower range).

The following tasks from the originally proposed scope have been omitted from this revised scope of reporting:

- Slope Stability Analysis,
- Dredge Batter Design,
- Stability Check of Adjacent Structures (post dredging),
- Dredgability Analysis, and
- Pile Drivability Analysis, including testing specifications.

The details of the fieldwork methodology are included in our report Geotechnical Fieldwork Report 15001-003-Rev0, dated 31 March 2015. Geotechnical Factual Report 15001-005-Rev0, dated 13 May 2015, details the subsurface profiles encountered at each borehole within the proposed wharf extension area.

Surface (sea bed) and near surface information obtained from the environmental (sediment contamination) assessment undertaken by AMA for the dredging works has been included in this assessment.
2.0 PROPOSED DEVELOPMENT

The Eden Breakwater Wharf is located in Snug Cove, Eden. Snug Cove includes three main marine structures, namely the Mooring Jetty, Multi-Purpose Jetty and Breakwater Wharf (Ref. Text Figure 1).

NSW Crown Lands has identified the need to extend the Eden Breakwater Wharf and dredge the approach channel and berth pocket to -10.5m Chart Datum (CD), to accommodate cruise ships of up to 300m in length. The current bathymetry is between -4m to -10m Australian Height Datum (AHD). At this site, CD is approximately 1.07m below AHD (equivalent to Lowest Astronomical Tide [LAT]).

The proposed wharf extension comprises lengthening the existing seawall (berthing area) approximately 45m further to the east (berth extension), backfilling between the new wall and existing breakwater to increase the wharf area, and installation of three breasting dolphins and one mooring buoy at the western end of the wharf.

3.0 SITE INVESTIGATION FIELDWORK

The investigation for the wharf extension (including the proposed dredge area) comprised a total of seven boreholes, being boreholes BHT1, BHT3 to BHT6, BHT9 and BHT10. The borehole locations are shown on Figures 1 and 2 (at the end of text).

Reports of Boreholes are presented in Appendix A, together with photographs of rock core. Photographs of soil samples taken from the boreholes are provided in Appendix B.
4.0 REGIONAL GEOLOGY

The 1:250,000 scale Bega-Mallacoota Geological Map (Sheet SJ/55-4 and Part Sheet SJ/55-8) indicates that the site of the proposed wharf redevelopment (Snug Cove), the adjacent Cattle Bay, and the southern side of Lookout Point, is underlain by the Cambrian to Early Silurian (Ordovician) age Adaminaby Group, which comprises undifferentiated sediments, turbidites; sandstone, mudstone and shale.

The northern part of the headland (Lookout Point) comprises Late Devonian age Boyd Volcanic Complex undifferentiated acid volcanics, basalts, quartz porphyries and minor sediments. The volcanic activity is reported to have caused some alteration of the sedimentary rocks of the Adaminaby Group, including folding, fracturing and/or strengthening by metamorphic processes.

On the mainland to the north, the geology comprises Late Devonian age Twofold Formation (of the Merimbula Group), comprising fluvial sandstone with mudrock and conglomerate.
5.0 LOCAL GEOLOGY

The local geology of the Snug Cove/Cattle Bay area comprises the following:

- The eastern side of the existing Eden breakwater wharf comprises sedimentary rocks (of the Adaminaby Group) that appear to have been altered (hardened and fractured) by the occurrence of later volcanic activity (Refer Text Figure 3 below). The rock type is generally *metasandstone* (or sandstone altered by metamorphic processes) of low to high strength and generally having a massive structure with joints typically spaced at greater than 1m.

*Text Figure 3: Rock outcrop on beach to the east of the breakwater*

*Text Figure 4: Rock outcrop to the north-east of the breakwater*
Eastern side of Cattle Bay comprises layered beds of *metasandstone* (possible *metasiltstone*) and *slate* dipping steeply (from about 60° up to near vertical) towards the south/southeast. The metasandstone is generally of low to medium strength, and has some jointing that forms blocks of about 0.3m to more than 1m. The slate is strongly laminated and foliated, forming thin layers about 10mm to 20mm thick, and is also extensively fractured by cross-cutting joints, which typically forms pieces less than 50mm in length. Individual pieces of slate are generally of very low strength and ranging up medium strength.

It is presumed that sandstone/siltstone and shale were initially deposited in a flat, near level environment (successive layering of sandstone/siltstone and shale) prior to being folded and altered to form the existing steeply dipping layers of metasandstone and slate (Refer Text Figure 5 and 6).
Steeply dipping interbedded turbidites and siltstone (layers up to about 0.5m thick) can be seen outcropping at the beachfront on the western side of Cattle Bay (Refer Text Figure 7). Numerous high strength (or stronger) quartz seams were noted throughout the siltstone layers (Refer Text Figure 8).

Text Figure 7: Interbedded turbidites and siltstone on western side of Cattle Bay

Text Figure 8: Quartz seams in siltstone
6.0 SEA BED CONDITIONS

AMA carried out an environmental (sediment contamination) assessment of the site alongside the geotechnical investigation. As part of that environmental assessment, AMA conducted vibrocoring (VC). A total of 15 VC locations were cored within the proposed dredge footprint. Samples were obtained from the VC locations at 0.5m intervals to 1m depth and then a compositing sample was collected from each borehole at >1m to the bottom of the core. Sediment samples were then forwarded to a NATA accredited laboratory for organic and inorganic contaminant and particle size distribution (PSD) analysis.

A summary of the results of the laboratory PSD analysis was forwarded to Tectonic to include in this geotechnical assessment (refer Appendix C). PSD testing indicated that the top 1m of the sea bed profile comprised predominantly sand with varying quantities of clay, silt, and gravel. The silt content was less than 5%, and the clay content varied from 1% to 8%. The gravel however, exhibited a greater variability in content ranging from 1% up to 32%. The sand content was 61% to 94%.

Due to the method of geotechnical drilling, the strength (density) at the surface of the sea bed was not able to be assessed. Anecdotal evidence suggests, from the ease in which the drill casing was pushed into the sea bed, that the surficial sea bed materials were very loose. SPT results at 1m depth below sea bed (BSB) from the geotechnical boreholes indicated N values less than 5, which is very loose to loose.

7.0 SUBSURFACE PROFILE

From the seven boreholes drilled in the proposed wharf extension and dredge area, four distinct subsurface profiles were identified.

- **Profile 1** - Boreholes BHT1 and BHT6 encountered shallow soil profiles over rock (although different rock types) at depths of about 1m to 2m BSB.
- **Profile 2** - Boreholes BHT4 and BHT9 encountered alluvial sands over a residual soil layer up to about 3m thick, with rock at depths of 6m to 7m BSB.
- **Profile 3** - Borehole BHT3 encountered deeper alluvial soils directly overlying rock at about 15.5m BSB.
- **Profile 4** - Boreholes BHT5 and BHT10 encountered deep alluvial soils extending to 31m to 35m BSB. Rock was encountered at borehole BHT10 at about 31m BSB. No rock was intersected in at borehole BHT5.

**Profile 1**

Borehole BHT1 encountered shallow soils (dense, fine to coarse sandy gravel) to a depth of about 2m, over low to medium strength tuffaceous metasandstone. The rock at this location was observed to be less fractured than the metasandstone from other boreholes at this site, as evidenced by the higher RQD (40% to 68% for most of the retrieved rock core at BHT1).

Borehole BHT6 encountered a similar soil profile as BHT1, however, the rock type is medium to high strength rhyolitic tuff (from about 1m BSB). This rock type is also significantly more fractured than the metasandstone from borehole BHT1, with a recorded RQD of 0%.

**Profile 2**

Boreholes BHT4 and BHT9 encountered loose to medium dense, fine to coarse grained sand/silty sand to depths of about 4m to 5m BSB, then firm to hard silty/sandy clay of low plasticity. The silty clay appears to be residual material formed by the weathering of the underlying parent rock.

The rock profile at borehole BHT4 comprises interbedded layers of steeply dipping extremely low to very low strength slate and medium to high strength metasandstone. The rock core from borehole BHT4 was extremely fractured, resulting in an RQD of 0%. Rock coring was not carried out at borehole BHT9 as this borehole was drilled to provide information for dredging purposes (borehole was drilled to about 2m below the depth of proposed dredging).
Profile 3
The general profile from borehole BHT3 was similar to BHT4 (Profile 2). However, the alluvial layer, comprising loose to dense, fine to coarse grained sand and medium dense, fine to medium grained silty sand, was found to be much deeper, extending to about 15.5m BSB. Also, no residual soil was encountered above the rock. The rock type at borehole BHT3 comprised metasandstone only (i.e. no interbedded slate layers).

The metasandstone grades from extremely low strength at about 15.5m BSB, becoming low to medium strength from about 18m BSB, then high strength below about 22m BSB. The rock also becomes less fractured with depth, as indicated by the increase of the RQD from 0% (18m to 22.1m BSB) to 100% (from about 22.1m BSB).

Profile 4
Boreholes BHT5 and BHT10 encountered a deeper alluvial soil profile comprising:

- mostly very loose to medium dense, fine to medium grained sand/silty sand, to depths of 7m (BHT5) and 10m (BHT10) BSB, over
- very soft to soft clayey/sandy silt of low liquid limit to depths of 12m and 18.5m BSB; then
- stiff to very stiff, high liquid limit clayey silt (BHT5) or high plasticity silty clay (BHT10) to depths of about 24m BSB; over
- black, stiff to very stiff, high liquid limit clayey silt (probable carbonaceous material), to the depth of borehole (BHT5); or
- medium dense to dense clayey and silty sand, fine to medium grained, with some very loose to loose clayey sand layers (BHT10) to a depth of 31.3m BSB.

At borehole BHT10, conglomerate rock was encountered, comprising cemented pieces of extremely low to very low strength sandstone and high strength rhyolitic rock.

Text Figure 9 on the following page presents a plot of SPT N values versus depth from boreholes BHT1, BHT3 to BHT6, BHT9 and BHT10. That figure further illustrates the four Profiles described above.

SPT N values of 0 were recorded at boreholes BHT5 at 8m BSB and borehole BHT10 between 10m and 17m BSB. At BHT5 (8m) and BHT10 (10m), the SPT penetrated the soil under the self-weight of the drill rods and the SPT hammer. The tests below 10m BSB in BHT10 penetrated the soil under the weight of the rods only. The soil type at those depths was clayey sandy silt (about 50% to 80% silt content).

Pocket penetrometer (PP) and shear vane (SV) testing was conducted on the samples returned from the SPT sampler. Undrained shear strengths ($c_u$) estimated from PP and SV testing were in the range 7.5kPa to 30kPa. The triaxial test conducted in the clayey silt from an undisturbed tube sample from borehole BHT10 at 14m BSB indicated $c_u$ of 26.5kPa.

At boreholes BHT5 and BHT10, the depth of water above sea bed was about 10m, and the distance from the top of drill casing to the water level was approximately 4.5m. The weight of HQ rods is approximately 11kg/m length. Therefore, for example, for an SPT at depth of 13m BSB, the total length of drill string is approximately 28.5m, and the total rod weight is approximately 300kg. It is due in part to the extra weight of the drill string (above sea bed level) that the SPT penetrates the soft clayey sandy silt under its self-weight. This reaction is common within very soft to soft marine or estuarine silts/clays.

Text Figure 10 presents a plot of undrained shear strengths ($c_u$) versus depth. The $c_u$ values were determined by PP testing on SPT samples, PP and SV testing on U50 tube samples, and triaxial testing (UU). The values from SPT samples may underestimate the strength for stiffer clays due to sampling effects.

Full soil and rock profiles are shown on the Reports of Boreholes in Appendix A and are presented in cross-sections in Figures 3 to 6 (at the end of this report). Photographs of the rock core are also presented in Appendix A, and photographs of soil samples obtained from SPT tests are shown in Appendix B.
Text Figure 9: SPT N value vs Depth
Text Figure 10: Cu value vs Depth

Note: Design Cu based on results from PP on U63 and SPT; shear vane (SV); SPTs; and UU triaxial tests.
8.0 GEOLOGICAL ASSESSMENT

Based on the findings of the boreholes and observations of the rock outcrops on the nearby shoreline, it appears that the original sedimentary rock formations (sandstone/siltstone, shale) have undergone significant folding and alteration, possibly as a result of volcanic (metamorphic) activity associated with the intrusion of the Boyd Volcanic Complex to form relatively massive tuffaceous metasandstone, and interbedded layers of metasandstone and slate.

Sedimentary rocks are typically formed as mostly horizontal layers by successive deposition of sediments (sand, silt, clay, gravel) in old river beds, marine/estuarine settings, etc.

The tuffaceous metasandstone as seen on the south-western side of the existing breakwater, and from borehole BHT1, appears to have been altered, but has not undergone significant folding or fracturing, and is observed as a more massive material than the layered metasandstone and slate.

The interlayered metasandstone and slate layers appear to have been folded to form troughs and peaks, as illustrated on Figures 3 to 6. It should be noted that there are likely to be additional peaks and troughs between the boreholes.

Following folding of the metasandstone/slate layers, the troughs may have formed steep sided gullies, with most of the residual clay layer being eroded and subsequently backfilled with alluvial sands (and silts/clays). This process is likely to have occurred when the sea levels were lower, and creeks or rivers were formed within the gullies (troughs).

The deeper soil profiles encountered at boreholes BHT5 and BHT10 are indicative of old paleo-channels. It appears that meandering rivers may have crossed this area, with variable deposition of fine soils (silt and clays) and coarse materials (sand and gravel) occurring over time. Fine soils are typically deposited within slow moving systems, whereby the fine sediments are able to settle over time.

Conglomerate rock encountered in borehole BHT10 comprises mostly very low to low strength sandstone and high strength rhyolite pieces. It is probable that the sandstone and rhyolite pieces accumulated at the bottom of a river channel and have become cemented to form the conglomerate as a result of geochemical processes together with long term consolidation due to the deposition of deep sediments above. This is likely to have occurred after the metamorphic processes described above, as there did not appear to be any alteration (hardening of the rock), and by the presence of the rhyolite which was possibly sourced from the Boyd Volcanics intrusions.
9.0 GEOHAZARDS

We understand that the proposed breakwater wharf structure will comprise a series of contiguous piles (piled wall), with compacted backfill placed behind the piled wall to extend the wharf floor area. Additional berthing and mooring dolphins are also proposed, comprising vertical and raked pile groups tied to a common headstock.

An outline of some potential geohazards associated with the proposed structures are summarised below. The designer and piling contractor must make their own assessments of geohazards at this site.

9.1 Lateral Variability in Subsurface Conditions

The soil/rock profile supporting the piles will be required to provide sufficient lateral and vertical resistance to counter the dynamic loads from ship berthing impacts, as well as wave and tidal actions. The presence of loose or soft soils in the upper soil profile will significantly reduce both the lateral and vertical loads able to be resisted by the soil profile.

At boreholes BHT3, BHT5 and BHT10, the upper soil profile comprised deep very loose to loose sand and very soft to soft sandy silt, which is expected to have low lateral resistance. Rock was encountered at depths of about 15.5m BSB at BHT3 and below 31m BSB at BHT10. Rock was not encountered in borehole BHT5.

Should the soil profile to the depth of piling comprise all very loose/loose or soft/firm soils, the lateral capacity of the supporting soil profile will be greatly reduced. In that case, additional piles per group or closer spaced pile groups may be required.

Piling methods will need to consider the sloping nature of the rock layers, and will require guides to maintain the verticality/raking angle of the piles.

9.2 Drillability of Rock

We understand that the piling methodology may comprise driving steel casings to the rock and then boring in the rock using open holed drilling. Generally, rock encountered in the boreholes is expected to be within the capacity of pile drilling equipment (e.g. tungsten tipped rock auger). However, the presence of very high strength quartz layers within lower strength metasandstone and slate may require rock cutting attachments (e.g. core barrels, mandrill cutting bits).

Driven piles may not be able to penetrate sufficiently deep into the rock layer to develop sufficient lateral capacity. Piles will need to comprise a combination of driven casings and bored (through rock) cast-in-place piles.

9.3 Uncontrolled Pile Penetration

Soft to firm and very loose to loose soils were encountered within the boreholes (particularly the very soft/soft sandy silt at boreholes BHT5 and BHT10). Driving of piles through very soft/soft soils, and possibly through very loose/loose sandy soils, may result in piles dropping uncontrollably. Attention to securing of piles while driving through such materials must be maintained by the piling contractor.

9.4 Dredging Impacts

The proposed dredging depth is -10.5m CD. At the eastern end of the dredge area, it is expected that dredging to that depth will extend into the underlying rock. We assume that the dredging within the soils will comprise mostly soil suction or excavator type methods. Within the rock, it is expected that specialised rock cutting methods will be required.

The high strength rhyolitic tuff encountered at borehole BH6 was found to be highly fractured, forming pieces typically less than 100mm. If this rock is less fractured, excessive wear on dredge cutting bits may occur. The angular (sharp) nature of the rhyolitic rock may also result in excessive wear and tear on flexible pipes.

The presence of knobs of metasandstone as observed in the beach to the south of the wharf (refer Text Figure 3) may cause damage or excessive wear on soil cutting/suction equipment. Rock pieces may also result in blockage of suction pipes.
9.5 Dredge Batters

**Breakwater Wharf**

We understand that dredging may extend to within about 6m of the existing wharf structure. The existing wharf is supported by a series of interlocked steel sheet pile walled caissons. Based on design and as-constructed plans from the NSW Department of Public Works (Drawing No.'s 7366-7 and EW-1) from about 1975, it appears that the sheet pile toe levels for the caissons are about 2m to 3m BSB.

Dredging depths near the existing wharf are expected to be about 4m BSB at the eastern end (i.e. near borehole BHT1), decreasing to about 1.5m at the western end of the wharf (and about 2.5m BSB at the location of borehole BHT3).

The rock profiles encountered in boreholes BHT1 and BHT6 comprised tuffaceous metasandstone and rhyolitic tuff, respectively. The tuffaceous metasandstone was noted to have few joints (except around a rhyolitic dyke), dipping at about 45° to 70° in an easterly direction. Near vertical batters were observed in similar rock to the southeast of the breakwater wharf (refer Text Figure 3 earlier in this report) and batters of 45° or steeper were noted at a cutting near the breakwater wharf (just to the right of the batter shown on Text Figure 4).

The rhyolitic tuff was noted to be highly fractured, forming rock pieces less than about 70mm. Rock cuttings in similar rock, although less fractured, adjacent to the road on the northern side of the mooring jetty were noted to be sloping at about 60° to near vertical.

At the eastern end of the wharf, dredging is expected to be mostly in rock (tuffaceous metasandstone and rhyolitic tuff), and batter slopes of about 1V:1H or steeper may be possible.

Heading westwards, the rock head becomes deeper (below sea bed), and dredging will mostly be within loose silty sand and sand. Maximum batter slope angles of about 1V:3H are anticipated within the loose sand/silty sand. Therefore, dredging to 2.5m depth could result in the crest of the batter being very close to the existing wharf. Consequently, the risk of dredging works undermining the existing wharf needs to be quantified and addressed as part of the detailed design.

**Multi Purpose Jetty**

The eastern end of the dredging works is expected to extend to within about 10m of the multi purpose jetty (MPJ), and to depths of about 2.5m BSB. The subsurface profile for the batter edge in this area is expected to be similar to either borehole BHT6 or BHT9. It should be noted that these boreholes are about 50 m and 100 m from the western end of the MPJ, respectively.

Borehole BHT6 encountered shallow rhyolitic tuff rock at about 1m BSB, and excavations in this material are expected to be stable at slopes of about 1V:1H (or steeper if the rock is less fractured).

The subsurface profile at borehole BHT9 comprised about 5m of loose sand over rock. Excavations in the loose sand are expected to be battered to a maximum of about 1V:3H, in which case, the crest of the batter may be close to the MPJ (within a few metres).

Historical information provided to Tectonic (Public Works Department, NSW, Drawing No. 82027-2, dated 1982/1983) indicates that the subsurface profile at the western end of the MPJ comprises sediments (silty sand/sand/gravelly sand) and extremely weathered rock to depths of about 13m to 15 BSB, then moderately weathered rock (possible rhyolite). That data does not indicate the density of the sand soils, but does indicate that rock may be deeper at the western end of the MPJ than encountered at boreholes BHT6 and BHT9.

Depending on the depth of piles supporting the MPJ, and the proximity of the dredging, the dredge excavations may destabilise the MPJ.
9.6 Seabed Debris
Debris such as discarded equipment from boats may be present on the seabed. We understand that there may be some large steel sheets (possibly from boat repair works) dumped around the proposed dredge area. Such items may cause obstructions to piling, particularly driven piles.

9.7 Liquefaction
The potential for liquefaction in sand (and sand-like soils [clay/silt with Plasticity Index, PI, < 7%]) or possible cyclic softening in clay/silt (PI ≥ 7%) to occur as a result of seismic activity may need to be considered, particularly where the soil profile comprises a deep sequence of very loose to loose sandy soils or very soft to firm silt and clay.

It should be noted that laboratory testing indicated clay and silt soils to have PI > 7%, with some samples indicating PI as low as 9%.

10.0 GEOTECHNICAL DESIGN PARAMETERS
Table C1 in Appendix C provides simplified soil and rock profiles and tabulated lists of geotechnical parameters based on the results of the boreholes and laboratory testing. The parameters include classification by the unified soil classification system (USCS), estimated shear strength parameters, and a range of pile design parameters, based on field and laboratory testing, and established empirical relationships.

11.0 LIMITATIONS
Your attention is drawn to the document “Report Limitations”, which is included in Appendix D of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks associated with the services provided by Tectonic for this project.
NOTE: AERIAL PHOTOGRAPHY TAKEN FROM GOOGLE EARTH.
FIGURE No
PROJECT No
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Australasian Marine Associates
Eden, NSW
Eden Breakwater Wharf Extension
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BHT9 is 33m off-set from centreline
Assumed starting depth was 0 m Chart Datum

DC14 is located 26m off-set from centreline (possible refusal in rock).

DC15 "end of probe" not rock

DC6 refusal may be due to shaft adhesion on outer rods rather than rock

DC refusal may be due to shaft adhesion on outer rods rather than rock

Inferred Seabed Level

Notes:
1. Base of DC11 to DC14 at "Outer Rods Refusal", indicative of possible rock
2. X series borholes are very difficult to read. Inferred rock at base of borehole
   
   Inferred rock head
   SPT N Value

LEGEND

NoW: Sinclair Knight and Partners (July 1984)
DC - Longworth and McKenzie CPT (October 1984)
BH - Longworth and McKenzie borehole (October 1984)
X Series - Department of Public Works (1975)
BHT - Tectonic borehole (2015)

MATERIAL GRAPHIC

Silty SAND
Silty CLAY
Sandy CLAY
Silty sandy CLAY
SANDSTONE
SAND
Gravely SILT
Clayey sandy SILT
Clayey SAND
Clayey GRAVEL
Clayey gravelly SAND
RHYOLITE
SAND
SLATE
CONGLOMERATE

NOTES

1. Base of DC11 to DC14 at "Outer Rods Refusal", indicative of possible rock
2. X series borholes are very difficult to read. Inferred rock at base of borehole

Inferred rock head
SPT N Value

BH - Longworth and McKenzie borehole (October 1984)
BH8
BH11
BHT1
BHT3
BHT4
BHT5
BHT9
BHT10
BHT11
BHT12
BHT13
BHT14
BHT15
BHT16
DC10
DC12
DC14
DC15
DC2
DC6
DC8
DC16
DC17
X5
X6
X7
X8
X9
X10
X11
X12
X13
X14
X15
X16
X17
X18
X19
X20
X21
X22
X23
X24
X25
X26
X27
X28
X29
X30
X31
X32
X33
X34
X35
X36
X37
X38
X39
X40
X41
X42
X43
X44
X45
X46
X47
X48
X49
X50
X51
X52
X53
X54
X55
X56
X57
X58
X59
X60
X61
X62
X63
X64
X65
X66
X67
X68
X69
X70
X71
X72
X73
X74
X75
X76
X77
X78
X79
X80
X81
X82
X83
X84
X85
X86
X87
X88
X89
X90
X91
X92
X93
X94
X95
X96
X97
X98
X99
X100

DISTANCE (m)

50
100
150
200
250
300
350
400

ELEVATION (m)

-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
45
50

-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60

Note: The diagram shows a geological section A-A' with various boreholes and their respective depths and materials. The legend includes different geological materials and their respective colors, such as Silty SAND, Silty CLAY, Sandy CLAY, Silty sandy CLAY, SANDSTONE, SAND, Gravely SILT, Clayey sandy SILT, Clayey SAND, Clayey GRAVEL, Clayey gravelly SAND, RHYOLITE, SAND, SLATE, and CONGLOMERATE. Notes on the diagram indicate specific observations and interpretations related to the boreholes and their materials, including the indication of refusal in rock and inferred rock levels. The diagram is signed and dated with relevant information on the scan.
LEGEND
NoW- Sinclair Knight and Partners (July 1984)
DC - Longworth and McKenzie CPT (October 1984)
BH - Longworth and McKenzie borehole (October 1984)
BHT - Tectonic borehole (2015)

MATERIAL GRAPHIC
Silty SAND
CLAY sandy SILT
CLAY SAND
SAND
SLATE
Silty gravelly SAND
GRAVEL
METASANDSTONE
Sandy CLAY
Gravely SAND

NOTES
1. Base of DC11 to DC14 at "Outer Rods Refusal". Indicative of possible rock
2. Inferred rock head
3. SPT N Value

Australasian Marine Associates
Eden, NSW
Eden Breakwater Wharf Extension
Geological Section B-B'
Refusal at DC3 likely to be something other than rock. DC4 and BH8 are located <10m from DC3.
MATERIAL GRAPHIC

- SAND
- Clayey silty SAND
- Silty gravelly SAND
- Clayey sandy SILT
- Silty SAND
- Sandy GRAVEL

NOTES
1. Base of DC9 to DC10 at "Outer Rods Refusal". Indicative of possible rock refusal on very dense gravelly sand.
2. Rock head level not able to be confidently assessed with this data.

'N' SPT N Value

LEGEND
NoW - Sinclair Knight and Partners (July 1984)
DC - Longworth and McKenzie CPT (October 1984)
BH - Longworth and McKenzie borehole (October 1984)
BHT - Tectonic borehole (2015)
APPENDIX A

Reports of Boreholes & Explanatory Notes

Rock core photos
### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples</th>
<th>Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SM</td>
<td>Gravely SILT, low liquid limit, black, grey, brown, fine to coarse sized gravel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GP</td>
<td>Clayey Sandy GRAVEL, fine to coarse sized, pale grey, brown, fine to coarse grained sand, medium plasticity clay fines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SC</td>
<td>Gravelly Clayey SAND, fine to coarse grained, pale grey, brown, medium plasticity clay fines, fine to coarse sized gravel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tending to extremely low strength metasandstone</td>
</tr>
</tbody>
</table>

Continued on cored borehole sheet

### Soil Description

- **Material Description**: soil type, plasticity or particle characteristics, secondary and minor components, colour
- **Consistency/Relative Density**: soil type, plasticity or particle characteristics, secondary and minor components, colour
- **Hand Penetrometer**: Standard Penetration Test (SPT) blow counts
- **DCP Test**: Dynamic Cone Penetration Test (DCP)

### Observations

- **RL Surface**: -3.70 m
- **Datum**: CD
- **Operator**: Wizard Drilling

### Additional Observations

- **Core recovery (hatching indicates material)**
- **Core loss**
### Engineering Log - Cored Borehole

**Project No.:** 15001  
**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW  
**Hole Position:** 758566.0 m E 5893021.0 m N  
**Commenced:** 24/02/2015  
**Completed:** 26/02/2015  
**Logged By:** DJQ  
**Checked By:** ACD  
**Operator:** Wizard Drilling  

#### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>TGR (%)</th>
<th>SCR (%)</th>
<th>ROD (%)</th>
<th>Graphic Log</th>
<th>Material Description</th>
<th>Rock Substance</th>
<th>Strength (tr(50))</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ3</td>
<td></td>
<td></td>
<td>100</td>
<td>40</td>
<td>68</td>
<td></td>
<td>rock type: grain characteristics, colour, structure, minor components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2Q3</td>
<td></td>
<td></td>
<td>100</td>
<td>40</td>
<td>68</td>
<td></td>
<td>TUFFACEOUS METASANDSTONE, fine to coarse grained, pale grey</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rock Mass Defects

<table>
<thead>
<tr>
<th>Defect Description/ Lab Results</th>
<th>Defect Spacing (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>JT 70° RF</td>
<td></td>
</tr>
<tr>
<td>JT 70° RF</td>
<td></td>
</tr>
<tr>
<td>JT 45° Fe RF cross-joints</td>
<td></td>
</tr>
<tr>
<td>JT 45° Fe RF cross-joints</td>
<td></td>
</tr>
<tr>
<td>JT 70° Clay RF</td>
<td></td>
</tr>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>JT 60° Fe RF</td>
<td></td>
</tr>
<tr>
<td>4.5m: CAI (HRC55)= 0.21</td>
<td></td>
</tr>
<tr>
<td>4.5m: CAI (HRC55)= 0.21</td>
<td></td>
</tr>
<tr>
<td>4.5m: CAI (HRC55)= 0.21</td>
<td></td>
</tr>
</tbody>
</table>

#### Rock Substance

- **Depth (m):** 4.7  
- **Graphic Log:** Continued from non-cored borehole sheet  
- **Rock Type:** TUFFACEOUS METASANDSTONE, fine to coarse grained, pale grey
### Engineering Log - Cored Borehole

**Cored Borehole No.:** BHT1  
**Project No.:** 15001

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW

- **Commenced:** 24/02/2015  
- **Completed:** 26/02/2015  
- **Logged By:** DJQ  
- **Checked By:** ACD  
- **Datum:** CD  
- **Operator:** Wizard Drilling

**Drill Model and Mounting:** Hydropower Scout-Floating Barge  
**Inclination:** -90°  
**BHT1**

#### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>SCR (%)</th>
<th>ROD (%)</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ3</td>
<td>100</td>
<td>68</td>
<td>66</td>
<td>65</td>
<td>-11.7</td>
<td>8</td>
<td>TUFFACEOUS METASANDSTONE, fine to coarse grained, pale grey (continued)</td>
</tr>
<tr>
<td>HQ3</td>
<td>96</td>
<td>65</td>
<td>-12.7</td>
<td>-11.7</td>
<td>7</td>
<td>TUFFACEOUS METASANDSTONE, fine to coarse grained, brown</td>
<td></td>
</tr>
<tr>
<td>HQ3</td>
<td>100</td>
<td>0</td>
<td>-15.7</td>
<td>-14.7</td>
<td>11</td>
<td>RHYOLITIC TUFF, fine grained, brown</td>
<td></td>
</tr>
<tr>
<td>HQ3</td>
<td>100</td>
<td>0</td>
<td>-15.7</td>
<td>-14.7</td>
<td>11</td>
<td>TUFFACEOUS METASANDSTONE, fine to coarse grained, pale grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hole Terminated at 13.25 m</td>
<td></td>
</tr>
</tbody>
</table>

#### Rock Substance

- **Material Description:**  
  - rock type: grain characteristics, colour, structure, minor components

#### Rock Mass Defects

- **Defect Description/ Lab Results:**  
  - thickness, type, inclination, planarity, roughness, coating/infilling, UCS, CAI

#### Water Graphic Log/Core Loss

- **Graphic Log/Core Loss:** Core recovered (hatching indicates material)  
- **Core Loss:** Complete Loss

#### Weathering

- **Fresh**  
- **Slightly Weathered**  
- **Definitely Weathered**  
- **Extremely Weathered**  
- **Residual Soil**

#### Strength

- **(indirect tensile strength)**  
- **EL - Extremely Low**  
- **VL - Very Low**  
- **L - Low**  
- **M - Medium**  
- **H - High**  
- **VH - Very High**  
- **EH - Extremely High**

---

**Commenced:** 24/02/2015  
**Completed:** 26/02/2015  
**Logged By:** DJQ  
**Checked By:** ACD  
**Datum:** CD  
**Operator:** Wizard Drilling

**Drill Model and Mounting:** Hydropower Scout-Floating Barge  
**Inclination:** -90°  
**BHT1**
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Proposed Breakwater Wharf Extension, Eden, NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td>15001</td>
</tr>
<tr>
<td>Date Drilled</td>
<td>24 to 26/2/15</td>
</tr>
<tr>
<td>Borehole No.</td>
<td>BHT1</td>
</tr>
<tr>
<td>No. of Boxes</td>
<td>3</td>
</tr>
<tr>
<td>Easting</td>
<td>758566</td>
</tr>
<tr>
<td>Start Depth (m, BSB)</td>
<td>3.00</td>
</tr>
<tr>
<td>Northing</td>
<td>5893021</td>
</tr>
<tr>
<td>Finish Depth (m, BSB)</td>
<td>13.25</td>
</tr>
<tr>
<td>Driller &amp; Rig</td>
<td>Wizard Hydrapower Scout</td>
</tr>
<tr>
<td>Core Size</td>
<td>HQ</td>
</tr>
<tr>
<td>Remarks</td>
<td>Mounted on floating barge</td>
</tr>
<tr>
<td>Prepared By</td>
<td>DJQ</td>
</tr>
</tbody>
</table>

![Image of core samples](image-url)
### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples</th>
<th>Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Soil Description</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT</td>
<td>8, 10.5</td>
<td>N=15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>ML</td>
<td>Sandy SILT, low liquid limit, black, fine to coarse grained sand, trace fine to coarse gravel, shells</td>
<td>VS</td>
</tr>
<tr>
<td>SPT</td>
<td>4, 6, 11</td>
<td>N=17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>SP</td>
<td>SAND, fine to coarse, grey, trace of fine to coarse sized gravel, shells</td>
<td></td>
</tr>
<tr>
<td>SPT</td>
<td>3, 3.4</td>
<td>N=7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>GP</td>
<td>Sandy GRAVEL, fine to coarse sized, grey and white, angular and rounded, fine to coarse grained sand.</td>
<td>MD</td>
</tr>
<tr>
<td>SPT</td>
<td>3, 3.2</td>
<td>N=5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td>SP</td>
<td>SAND, fine to coarse grained, grey, with fine to coarse sized gravel, minor shells</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.50</td>
<td>3% Fines</td>
<td>SP</td>
<td>becoming pale brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td>SP</td>
<td>some clayey sand nodules noted</td>
<td></td>
</tr>
</tbody>
</table>

### Soil Description

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Consistency/Relative Density</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Very Soft</td>
<td>Very Soft</td>
</tr>
<tr>
<td>Silt</td>
<td>Soft</td>
<td>Soft</td>
</tr>
<tr>
<td>Gravel</td>
<td>Firm</td>
<td>Firm</td>
</tr>
<tr>
<td>Clay</td>
<td>Very Stiff</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>Clayey sand</td>
<td>Hard</td>
<td>Hard</td>
</tr>
<tr>
<td>Nodules</td>
<td>Very Loose</td>
<td>Very Loose</td>
</tr>
<tr>
<td>Limestone</td>
<td>Loose</td>
<td>Loose</td>
</tr>
<tr>
<td>Shells</td>
<td>Medium Dense</td>
<td>Medium Dense</td>
</tr>
<tr>
<td>Shells</td>
<td>Dense</td>
<td>Dense</td>
</tr>
<tr>
<td>Shells</td>
<td>Very Dense</td>
<td>Very Dense</td>
</tr>
<tr>
<td>Shells</td>
<td>Timbering</td>
<td>Timbering</td>
</tr>
</tbody>
</table>

### Additional Observations

- No resistance ranging to refusal
- Inflow
- Partial Loss
- Complete Loss
- Level (Date)
- Inflow
- Partial Loss
- Complete Loss
- Undisturbed Sample
- Standard Penetration Test
- Disturbed Sample

### Moisture Condition

- Dry
- Moist
- Wet

### Clayey Sand

- Nodules
- Shells

### Plastic Limit

- Less than PL
- Equal to PL
- Greater than PL

### Classification Symbols

- Based on Unified Soil Classification System

### Core Recovered

- (Hatching indicates material)

### Core Loss

- (Hatching indicates material)
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.40</td>
<td>SAND, fine to coarse grained, pale grey, trace of fine to coarse sized gravel</td>
<td>L</td>
</tr>
<tr>
<td>9.40</td>
<td>Silty SAND, fine to medium grained, grey</td>
<td>W</td>
</tr>
<tr>
<td>11.40</td>
<td>SPT 9,16,19 N=35</td>
<td>D</td>
</tr>
<tr>
<td>11.40</td>
<td>SPT 15,15,19 N=34</td>
<td>D</td>
</tr>
<tr>
<td>11.40</td>
<td>SPT 12,13,22 N=35</td>
<td>D</td>
</tr>
<tr>
<td>11.40</td>
<td>SPT 6.3,7 N=10</td>
<td>D</td>
</tr>
<tr>
<td>11.40</td>
<td>SPT 7,12,15 N=27</td>
<td>D</td>
</tr>
</tbody>
</table>

**Soil Description**

- **SAND, fine to coarse grained, pale grey, trace of fine to coarse sized gravel**: Material Description, Consistency/Relative Density L
- **Silty SAND, fine to medium grained, grey**: Material Description, Consistency/Relative Density W
- **SPT 9,16,19 N=35**: Material Description, Consistency/Relative Density D
- **SPT 15,15,19 N=34**: Material Description, Consistency/Relative Density D
- **SPT 12,13,22 N=35**: Material Description, Consistency/Relative Density D
- **SPT 6.3,7 N=10**: Material Description, Consistency/Relative Density D
- **SPT 7,12,15 N=27**: Material Description, Consistency/Relative Density D

**Support**

- **T** = Timbering

**Core recovered (hatching indicates material)**

- **Core loss**

**Penetration and Support**

- **AS** = Auger Screwing
- **RR** = Rock Roller
- **WB** = Washbore
- **T** = Timbering

**Samples and Tests**

- **U** = Undisturbed Sample
- **D** = Disturbed Sample
- **SPT** = Standard Penetration Test

**Inflow**

- No resistance ranging to refusal

**Consistency/Relative Density**

- **VS** = Very Soft
- **S** = Soft
- **F** = Firm
- **VSt** = Very Stiff
- **H** = Hard
- **VL** = Very Loose
- **L** = Loose
- **MD** = Medium Dense
- **D** = Dense
- **VD** = Very Dense

**Moisture Condition**

- **D** = Dry
- **M** = Moist
- **W** = Wet

**Graphic Log/Core Loss**

- Core recovered (hatching indicates material)
- Core loss

**Additional Observations**

- **9.40**: 4% Fines
- **11.40**: 20% Fines
- **7.20**: 18% Gravel, 5% Fines

**Core recovered (hatching indicates material)**

- Core loss

**Method**

- **AS** = Auger Screwing
- **RR** = Rock Roller
- **WB** = Washbore

**Penetration and Support**

- **AS** = Auger Screwing
- **RR** = Rock Roller
- **WB** = Washbore

**Samples and Tests**

- **U** = Undisturbed Sample
- **D** = Disturbed Sample
- **SPT** = Standard Penetration Test

**Inflow**

- No resistance ranging to refusal

**Consistency/Relative Density**

- **VS** = Very Soft
- **S** = Soft
- **F** = Firm
- **VSt** = Very Stiff
- **H** = Hard
- **VL** = Very Loose
- **L** = Loose
- **MD** = Medium Dense
- **D** = Dense
- **VD** = Very Dense

**Moisture Condition**

- **D** = Dry
- **M** = Moist
- **W** = Wet
**Engineering Log - Borehole**

**Project No.: 15001**

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Commenced:** 02/03/2015  
**Hole Location:** Eden, NSW  
**Completed:** 04/03/2015  
**Logged By:** DJQ  
**Datum:** CD  
**Checked By:** ACD  

**Drill Model and Mounting:** Hydrapower Scout-Floating Barge  
**Inclination:** -90°  
**RL Surface:** -8.40 m  
**Bearing:**  
**Operator:** Wizard Drilling  

### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples</th>
<th>Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Soil Description</th>
<th>Consistency/Relative Density</th>
<th>Moisture Condition</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
<td>6,7,11</td>
<td>N=18</td>
<td></td>
<td></td>
<td>15</td>
<td>16.0-16.5m</td>
<td>SM</td>
<td>Silty SAND, fine to medium grained, grey (continued)</td>
<td></td>
<td>W</td>
<td>MD</td>
</tr>
<tr>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
<td>9,10,16</td>
<td>N=26</td>
<td></td>
<td></td>
<td>16</td>
<td>16.0-16.5m</td>
<td>SM</td>
<td>trace of low plasticity clay</td>
<td></td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td></td>
<td></td>
<td></td>
<td>16.0-16.5</td>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
<td>METASANDSTONE, extremely weathered, grey, brown, extremely low strength, laminated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
<td>23, 30/50mm</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td>becoming low strength</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continued on cored borehole sheet

**Moisture Condition**

- W - Wet
- M - Moist
- D - Dry

**Consistency/Relative Density**

- LS - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- DD - Very Dense

**Penetration**

- No resistance ranging to refusal
- No flow
- Partial Loss
- Complete Loss

**Support**

- Core recovered (hatching indicates material)
- Core loss

**Graphic Log/Core Loss**

- AS - Auger Screwing
- RR - Rock Roller
- WB - Washbore

**Water**

- Level (Date)
- Inflow
- Partial Loss
- Complete Loss

**Samples and Tests**

- U - Undisturbed Sample
- D - Disturbed Sample
- SPT - Standard Penetration Test

**Plastic Limit**

- < PL
- = PL

**Classification Symbols and Soil Descriptions**

- Based on Unified Soil Classification System
### Engineering Log - Cored Borehole

**Project No.:** 15001

**Client:** Australasian Marine Associates

**Project Name:** Eden Breakwater Wharf Extension

**Hole Location:** Eden, NSW

**Commenced:** 02/03/2015

**Completed:** 04/03/2015

**Hole Position:** 758481.0 m E 5892972.0 m N

**Logged By:** DJQ

**Checked By:** ACD

---

#### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>SCR (%)</th>
<th>ROD (%)</th>
<th>RL (m)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

#### Rock Substance

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Grain Characteristics, Colour, Structure, Minor Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>METASANDSTONE, fine grained, dark brown</td>
<td></td>
</tr>
<tr>
<td>Fractured METASANDSTONE, pieces &lt;30mm, with some clay</td>
<td></td>
</tr>
<tr>
<td>METASANDSTONE, fine grained, grey brown</td>
<td></td>
</tr>
<tr>
<td>Crushed METASANDSTONE, with some clay seams</td>
<td></td>
</tr>
<tr>
<td>METASANDSTONE, grey brown, fractured into pieces 20-50mm</td>
<td></td>
</tr>
</tbody>
</table>

### Rock Mass Defects

<table>
<thead>
<tr>
<th>Defect Description/ Lab Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, type, inclination, planarity, roughness, coating/infilling, UCS, CAI</td>
</tr>
</tbody>
</table>

---

**Graphic Log/Core Loss**

**Material Description**

- Core recovered (hatching indicates material)
- Core loss

**Support**

- Timbering

**Defect**

- Axial Spacing (mm)

**Strength**

- Indirect tensile strength

---

**Defect Description/ Lab Results**

- Thickness, type, inclination, planarity, roughness, coating/infilling, UCS, CAI
METASANDSTONE, grey brown, fractured into pieces 20-50mm (continued)

METASANDSTONE, fine grained, pale grey, quartz veins approximately 5-10mm thick

Hole Terminated at 23.15 m
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Proposed Breakwater Wharf Extension, Eden, NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td>15001</td>
</tr>
<tr>
<td>Date Drilled</td>
<td>2 to 4/3/15</td>
</tr>
<tr>
<td>Borehole No.</td>
<td>BHT3</td>
</tr>
<tr>
<td>No. of Boxes</td>
<td>2</td>
</tr>
<tr>
<td>Easting</td>
<td>758481</td>
</tr>
<tr>
<td>Start Depth (m, BSB)</td>
<td>18.00</td>
</tr>
<tr>
<td>Northing</td>
<td>5892972</td>
</tr>
<tr>
<td>Finish Depth (m, BSB)</td>
<td>23.15</td>
</tr>
<tr>
<td>Driller &amp; Rig</td>
<td>Terra Test Explora 50</td>
</tr>
<tr>
<td>Core Size</td>
<td>HQ</td>
</tr>
<tr>
<td>Remarks</td>
<td>Mounted on Jack up barge</td>
</tr>
<tr>
<td>Prepared By</td>
<td>DJQ</td>
</tr>
</tbody>
</table>

![Core Photo](image1)

![Core Photo](image2)
### Engineering Log - Borehole

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW  
**Hole Position:** 758397.0 m E 5892920.0 m N  
**Commenced:** 10/03/2015  
**Completed:** 11/03/2015  
**Logged By:** DJQ  
**Checked By:** ACD

### Drilling Information

**Method:** Explora 50-Floating Barge  
**Hole Diameter:** 100 mm  
**Inclination:** -90°  
**RL Surface:** -9.30 m  
**Bearing:**  
**Datum:** CD  
**Operator:** Terratest

### Soil Description

| Material Description | Classification Symbol | Moisture Condition | Consistency/Relative Density | Hand Penetrometer UCS (kPa) | DCP Test (Depth/Blows/100mm)/Structure
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Silty SAND, fine to coarse grained, black, with some fine to coarse sized gravel, with some shells</td>
<td>SM</td>
<td>VL</td>
<td>2.00: 6% Fines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAND, fine to coarse grained, brown, trace of fine to coarse sized gravel, with some shells</td>
<td>SP</td>
<td>L</td>
<td>3.00: 18% Silt, 2% Clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAND, fine to coarse grained, grey, trace of shells</td>
<td>SP</td>
<td>MD</td>
<td>4.00: PP &lt;50kPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silty SAND, fine to coarse grained, grey, trace of shells</td>
<td>SM</td>
<td>W</td>
<td>5.00: 39% Fines, 17% Gravel, PP= 100kPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy CLAY, low plasticity, grey and pale yellow, fine to coarse grained sand, trace of fine to coarse sized quartz gravel</td>
<td>CL</td>
<td>M</td>
<td>5.65: PP= 200-300kPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLATE, grey and brown, extremely low strength, extremely weathered, laminated</td>
<td></td>
<td>H</td>
<td>7.00: PP= 300-450kPa, 47% Fines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Observations

- Continued on cored borehole sheet

---

**Method**
- AS - Auger Screwing
- RR - Rock Roller
- WB - Washbore

**Penetration**
- No resistance ranging to refusal
- Partial Loss
- Complete Loss

**Support**
- T - Timbering

**Samples and Tests**
- Undisturbed Sample
- Standard Penetration Test

**Moisture Condition**
- D - Dry
- M - Moist
- W - Wet

**Consistency/Relative Density**
- VS - Very Soft
- S - Soft
- F - Firm
- VSt - Very Stiff
- H - Hard
- VL - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- VD - Very Dense

**Plastic Limit**
- PL

**Graphic Log/Core Loss**
- Core recovered (hatching indicates material)
- Core loss

**Classification Symbols and Soil Descriptions**
- Based on Unified Soil Classification System
## Engineering Log - Cored Borehole

### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>SCR (%)</th>
<th>ROD (%)</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ3</td>
<td></td>
<td>40</td>
<td>0</td>
<td></td>
<td>-1.3</td>
<td>-1.3</td>
<td></td>
</tr>
</tbody>
</table>

Continued from non-cored borehole sheet

### Rock Substance

- **Material Description**
  - rock type: grain characteristics, colour, structure, minor components

- **Slate**, fine grained, grey brown, laminations (<10mm), extremely fractured

### Core Mass Defects

<table>
<thead>
<tr>
<th>Strength (IS50)</th>
<th>Defect Spacing (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Defect Description/ Lab Results**
  - thickness, type, inclination, planarity, roughness, coating/infilling, UCS, CAI

### Rock Mass Defects

- **BP 70° laminations, bedding planes every 10-20mm**

---

**Graphic Log/Core Loss**

- Core recovered (hatching indicates material)
- Core loss
- Complete Loss

**Support**

- **T** - Timbering

---

**Weathering**

- Fresh
- Slightly Weathered
- Definitely Weathered
- Extremely Weathered
- Residual Soil

**Strength**

- (indirect tensile strength)
- EL - Extremely Low
- VL - Very Low
- L - Low
- M - Medium
- H - High
- VH - Very High
- EH - Extremely High

---

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW  
**Hole Position:** 758397.0 m E 5892920.0 m N  
**Commenced:** 10/03/2015  
**Completed:** 11/03/2015  
**Logged By:** DJQ  
**Checked By:** ACD  
**Method:** Explora 50-Floating Barge  
**BHT4**  
**Commenced:** 10/03/2015  
**Completed:** 11/03/2015  
**Logged By:** DJQ  
**Checked By:** ACD  
**RL Surface:** -9.30 m  
**Datum:** CD  
**Operational:** Terratest
**Engineering Log - Cored Borehole**

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW  
**Hole Position:** 758397.0 m E 5892920.0 m N  
**Project No.:** 15001  
**Commenced:** 10/03/2015  
**Completed:** 11/03/2015  
**Logged By:** DJQ  
**Checked By:** ACD

**Drill Model and Mounting:** Explora 50-Floating Barge  
**Inclination:** -90°  
**Barrel Type and Length:** Bearing: Datum: CD Operator: Terratest

### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>SCR (%)</th>
<th>TCR (%)</th>
<th>RO (%</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ3</td>
<td>90</td>
<td>62</td>
<td>0</td>
<td>0</td>
<td>2.13</td>
<td>12</td>
<td>METASANDSTONE, fine grained, brown pieces approximately 50-100mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>SLATE, fine grained, grey brown, laminations (&lt;10mm), extremely fractured</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>METASANDSTONE, fine grained, brown pieces approximately 50-100mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>CORE LOSS</td>
<td></td>
</tr>
<tr>
<td>Hole Terminated at 16.55 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Rock Substance

- **METASANDSTONE, fine grained, brown pieces approximately 50-100mm**
- **SLATE, fine grained, grey brown, laminations (<10mm), extremely fractured**
- **METASANDSTONE, fine grained, brown pieces approximately 50-100mm**
- **CORE LOSS**

### Rock Mass Defects

- **BP 50 - 60° bedding laminations**
- **coarse gravel pieces**
- **JT 60 - 70° many joints, cross cutting**
- **13.3m: TS= 0.638MPa**
- **laminations mostly closed, 10-20mm bedding**
- **15.5m: UCS= 0.79MPa**
- **JT 80° Fe RF (90 degrees of bedding)**
- **15.9m: TS= 0.123MPa**
- **JT 20° Fe RF (same as bedding dip)**
- **JT 20° Fe RF (same as bedding dip)**

### Water

- **Level (Date)**
- **Inflow**
- **Partial Loss**
- **Complete Loss**

### Support

- **T** - Timbering

### Strength

- **(indirect tensile strength)**
  - **EL** - Extremely Low
  - **VL** - Very Low
  - **L** - Low
  - **M** - Medium
  - **H** - High
  - **VH** - Very High
  - **EH** - Extremely High

### Weathering

- **Fresh**
- **Slightly Weathered**
- **Dilutely Weathered**
- **Extremely Weathered**
- **Residual Soil**

### Defect Description/ Lab Results

- **thickness, type, inclination, planarity, roughness, coating/infilling, UCS, CAI**
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Proposed Breakwater Wharf Extension, Eden, NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td>15001</td>
</tr>
<tr>
<td>Date Drilled</td>
<td>10 &amp; 11/3/15</td>
</tr>
<tr>
<td>Borehole No.</td>
<td>BHT4</td>
</tr>
<tr>
<td>No. of Boxes</td>
<td>3</td>
</tr>
<tr>
<td>Easting</td>
<td>758397</td>
</tr>
<tr>
<td>Start Depth (m, BSB)</td>
<td>9.00</td>
</tr>
<tr>
<td>Northing</td>
<td>5892920</td>
</tr>
<tr>
<td>Finish Depth (m, BSB)</td>
<td>16.55</td>
</tr>
<tr>
<td>Driller &amp; Rig</td>
<td>Terra Test Explora 50</td>
</tr>
<tr>
<td>Core Size</td>
<td>HQ</td>
</tr>
<tr>
<td>Remarks</td>
<td>Mounted on floating barge</td>
</tr>
<tr>
<td>Prepared By</td>
<td>DJQ</td>
</tr>
</tbody>
</table>

![Core Photo](image-url)
**Engineering Log - Borehole**

**Borehole No.: BHT5**

**Project No.: 15001**

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Position:** 758313.0 m E 5892867.0 m N  
**Drill Model and Mounting:** Explora 50-Jack Up Barge  
**Drill Diameter:** 100 mm  
**Commenced:** 12/03/2015  
**Completed:** 14/03/2015  
**Logged By:** DJQ  
**Checked By:** ACD  
**Datum:** CD  
**Operator:** Terratest  
**Level (Date):**  
-11.6  
-13.6  
-15.6  
-17.6  
**Support Material Description**  
- Primary and minor components, colour  
- Soil type: plasticity or particle characteristics, secondary and minor components, colour  
- Classifications:  
  - SM - Silty SAND, fine to coarse grained, black, with some fine to coarse sized gravel, with some shells  
  - SP - SAND, fine to medium sized, grey, trace of shells  
  - SP - SAND, fine grained, grey  
  - SP - SAND, fine to medium grained, grey, trace of shells  
  - SM - Silty SAND, fine grained, grey, (possible sandy silt)  
  - ML - Sandy SILT, low liquid limit, grey  

**Method:** AS - Auger Screwing  
**Penetration:** SR - Standard Penetration  
**Water:** No resistance ranging to refusal  
**Samples and Tests:**  
- U - Undisturbed Sample  
- D - Disturbed Sample  
- SPT - Standard Penetration Test  
**Moisture Condition:**  
- D - Dry  
- M - Moist  
- W - Wet  
**Consistency/Relative Density:**  
- VS - Very Soft  
- S - Soft  
- F - Firm  
- VSt - Very Stiff  
- H - Hard  
- VL - Very Loose  
- L - Loose  
- MD - Medium Dense  
- D - Dense  
- VD - Very Dense  

**Additional Observations:**  
- 3.00: 6% Fines  
- 8.00: 37% Sand, 55% Silt, PP= 30-40kPa
**Engineering Log - Borehole**

**Client:** Australasian Marine Associates  
**Project Name:** Eden Breakwater Wharf Extension  
**Hole Location:** Eden, NSW  
**Hole Position:** 758313.0 m E 5892867.0 m N

**Drill Model and Mounting:** Explora 50-Jack Up Barge  
**Hole Diameter:** 100 mm  
**Inclination:** -90°  
**RL Surface:** -9.60 m  
**Datum:** CD  
**Operator:** Terratest

### Drilling Information

<table>
<thead>
<tr>
<th>RL (m)</th>
<th>Recovery</th>
<th>Samples Tests Remarks</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
<th>Material Description</th>
<th>Hand Penetrometer UCS (kPa)</th>
<th>Consistency/Relative Density</th>
<th>DCP Test (Depth B/100mm)</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td>ML</td>
<td>Sandy SILT, low liquid limit, grey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td></td>
<td></td>
<td>SM</td>
<td>Silty SAND, fine to medium grained, pale brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td></td>
<td></td>
<td>ML</td>
<td>Clayey Sandy SILT, low liquid limit, pale brown, fine to medium grained sand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td></td>
<td></td>
<td>SM</td>
<td>Silty SAND, fine grained, brown</td>
<td></td>
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</tr>
<tr>
<td>4.8</td>
<td></td>
<td></td>
<td>MH</td>
<td>Clayey SILT, high liquid limit, pale brown and pale grey</td>
<td></td>
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<td></td>
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<tr>
<td>6.8</td>
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<tr>
<td>7.9</td>
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<td>8.9</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Soil Description

- **Consistency/Relative Density**
  - **ML:** Very Soft  
  - **S:** Soft  
  - **VS:** Very Soft  
  - **VS:** Very Stiff  
  - **S:** Stiff  
  - **F:** Firm  
  - **H:** Hard  
  - **L:** Loose  
  - **D:** Dense  
  - **VD:** Very Dense

- **Moisture Condition**
  - **D:** Dry  
  - **M:** Moist  
  - **W:** Wet  
  - **U:** Undisturbed Sample

- **Samples and Tests**
  - **SPT:** Standard Penetration Test  
  - **RL:** Rock Roller  
  - **AS:** Auger Screwing  
  - **WB:** Washbore

- **Graphic Log/Core Loss**
  - Core Loss  
  - Core recovered (hatching indicates material)

**Additional Information**

- **Core Loss**
- **Samples Tests**
- **U63**
- **LL:** Plastic Limit
- **PI:** Plastic Index
- **Vs63**
- **Cp:** Compressibility

**Other Notes**

- **Support**
  - **T:** Timbering  
  - **O:** Ordinary

**Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **D:** Dense  
  - **VD:** Very Dense

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **M:** Medium Dense  
  - **V:** Very Dense

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **D:** Dense  
  - **VD:** Very Dense

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **M:** Medium Dense  
  - **V:** Very Dense

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **D:** Dense  
  - **VD:** Very Dense

**Graphic Log/Core Loss**

- **Core Loss**
- **Core recovered (hatching indicates material)**

**Classification Symbols and Soil Descriptions**

- **L:** Loose  
  - **D:** Dense  
  - **VD:** Very Dense
### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples Tests Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
<th>Material Description</th>
<th>Soil Type</th>
<th>Plasticity or Particle Characteristics, Secondary and Minor Components, Colour</th>
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</thead>
<tbody>
<tr>
<td>SPT</td>
<td>5.7</td>
<td>N=12</td>
<td></td>
<td></td>
<td></td>
<td>22</td>
<td>22</td>
<td>MH</td>
<td>X</td>
<td>Clayey SILT, high liquid limit, pale brown and pale grey (continued)</td>
<td>MH</td>
<td></td>
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<tr>
<td>SPT</td>
<td>1.6</td>
<td>N=15</td>
<td></td>
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<td>24</td>
<td>24</td>
<td>M</td>
<td>x</td>
<td>becoming grey</td>
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<tr>
<td>U63</td>
<td>23-23.45m</td>
<td>N=12</td>
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<td></td>
<td></td>
<td>26</td>
<td>26</td>
<td>MH</td>
<td>x</td>
<td>Clayey SILT, high liquid limit, black</td>
<td>MH</td>
<td></td>
</tr>
<tr>
<td>SPT</td>
<td>1.7</td>
<td>N=13</td>
<td>LL=57%</td>
<td>P=31%</td>
<td>C</td>
<td>28</td>
<td>28</td>
<td>MH</td>
<td>x</td>
<td>Clayey SAND, fine to medium grained, dark grey</td>
<td>MH</td>
<td></td>
</tr>
</tbody>
</table>

### Soil Description

<table>
<thead>
<tr>
<th>Moisture Condition</th>
<th>Consistency/Relative Density</th>
<th>Hand Penetrometer UCS (kPa)</th>
<th>DCP Test (Depth:Blows/100mm)/Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VL</td>
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<td></td>
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<tr>
<td>VL</td>
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<td></td>
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<tr>
<td>MD</td>
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<td>D</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Support

- **T** - Timbering
- **AS** - Auger Screwing
- **RR** - Rock Roller
- **WB** - Washbore

### Core recovered (hatching indicates material)

- **SC** - Clayey SAND, fine to medium grained, dark grey
- **MH** - Clayey SILT, high liquid limit, black

### Observations

- 20:00: PP= 100-120kPa
- 21:00: PP= 100-120kPa
- 22:00: PP= 80-100kPa
- 23:00: Shear Vane (SV) Bottom: Peak 150kPa, Res 30kPa, Top: Peak 120kPa, Res 30kPa, PP= 150-200kPa, 63% Silt, 35% Clay, UU Cu= 119kPa
- 24:00: PP testing conducted every 200mm on solid core
- 24.10: 98% Fines
- 25.00: PP= 80-100kPa
- 25.40: 98% Fines
- 26.00: PP= 100-150kPa
- 27.00: PP= 100-150kPa
- 27.40: 63% Silt, 30% Clay
- 27.60: UU Cu= 92kPa

### Additional Observations

- Water Recovery
- Moisture Condition: M - Moist, D - Dry, W - Wet
- Inflow
- Partial Loss
- Complete Loss
- Core recovered (hatching indicates material)
- Core loss

### Tectonic 1.01.1 LIB.GLB  Log  IS AU BOREHOLE 1  15001- TERRATEST.GPJ  <<DrawingFile>>  13/05/2015 14:02  8.30.004  Datgel Lab and In Situ Tool - DGD | Lib: Tectonic 1.01.1 2015-01-19 Prj: Tectonic 1.01.1 2015-01-19
### Soil Description

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Moisture Condition</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>M</td>
<td>VS</td>
</tr>
<tr>
<td>34</td>
<td>M</td>
<td>VSI</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>VSI</td>
</tr>
<tr>
<td>38</td>
<td>M</td>
<td>VSI</td>
</tr>
</tbody>
</table>

- **MH**: Clayey SILT, high liquid limit, black (continued)

#### Hand Penetrometer

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Moisture Condition</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.00</td>
<td>M</td>
<td>VS</td>
</tr>
<tr>
<td>30.55</td>
<td>M</td>
<td>VSI</td>
</tr>
<tr>
<td>31.00</td>
<td>M</td>
<td>VSI</td>
</tr>
<tr>
<td>32.00</td>
<td>M</td>
<td>VSI</td>
</tr>
</tbody>
</table>

- **30.00**: PP = 180-210kPa
- **30.55**: UU Cu = 132kPa
- **31.00**: PP = 200-250kPa
- **32.00**: PP = 200-250kPa

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

- **MH**: Clayey SILT, high liquid limit, black (continued)
- **CL**: Clayey Silt
- **ML**: Very dense mud
- **ML**: Loose mud
- **SM**: Clayey Sand
- **CM**: Very dense clay
- **ML**: Loose clay

**Samples and Tests**

- **U**: Undisturbed Sample
- **D**: Disturbed Sample
- **SPT**: Standard Penetration Test

**Moisture Condition**

- **D**: Dry
- **M**: Moist
- **W**: Wet

**Consistency/Relative Density**

- **VS**: Very Soft
- **S**: Soft
- **F**: Firm
- **VSt**: Very Stiff
- **H**: Hard
- **VL**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

**Support**

- **T**: Timbering

---

**Observations**

- **Hole Terminated at 35.50 m**

---

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

- **MH**: Clayey SILT, high liquid limit, black (continued)
- **CL**: Clayey Silt
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- **ML**: Loose mud
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- **D**: Disturbed Sample
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- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

**Support**

- **T**: Timbering

---

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

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- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

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---

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

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- **CL**: Clayey Silt
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- **ML**: Loose mud
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- **CM**: Very dense clay
- **ML**: Loose clay

**Samples and Tests**

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- **D**: Disturbed Sample
- **SPT**: Standard Penetration Test

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- **M**: Moist
- **W**: Wet

**Consistency/Relative Density**

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- **H**: Hard
- **VL**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

**Support**

- **T**: Timbering

---

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

- **MH**: Clayey SILT, high liquid limit, black (continued)
- **CL**: Clayey Silt
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- **D**: Disturbed Sample
- **SPT**: Standard Penetration Test

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- **W**: Wet

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- **H**: Hard
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- **L**: Loose
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- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

**Support**

- **T**: Timbering

---

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

- **MH**: Clayey SILT, high liquid limit, black (continued)
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- **H**: Hard
- **VL**: Very Loose
- **L**: Loose
- **MD**: Medium Dense
- **D**: Dense
- **VD**: Very Dense

**Plastic Limit**

- **<**
- **=**
- **>**

**Support**

- **T**: Timbering
### Drilling Information

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Recovery</th>
<th>Samples</th>
<th>Tests</th>
<th>Water</th>
<th>Support</th>
</tr>
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<tbody>
<tr>
<td>1.0</td>
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<td>2.0</td>
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</tr>
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<td>3.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Soil Description

- **Clayey GRAVEL, fine to coarse sized, grey, brown, with some black silt, shells**

### Observations

- Continued on cored borehole sheet

### Graphical Log

```
Depth RL
0.0
1.0
2.0
3.0
4.0
5.0
6.0
```

### Support

- **T** - Timbering

### Notes

- Moisture Condition: W MD
- Consistency/Relative Density: Very Soft
- DCP Test (Depth: Bows/100mm):

### Additional Observations

- Soil Description Observations
- Drilling Information
- Inflow
- Level (Date)
- Partial Loss
- Complete Loss

### Method

- **AS** - Auger Screwing
- **RR** - Rock Roller
- **WB** - Washbore

### Water

- No resistance ranging to refusal

### Samples and Tests

- **U** - Undisturbed Sample
- **D** - Disturbed Sample
- **SPT** - Standard Penetration Test

### Moisture Condition

- D - Dry
- M - Moist
- W - Wet

### Consistency/Relative Density

- VS - Very Soft
- S - Soft
- F - Firm
- VSt - Very Stiff
- H - Hard
- VL - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- VD - Very Dense

### Plastic Limit

- < PL
- = PL
- < PL
### Engineering Log - Cored Borehole

**Project No.:** 15001

**Client:** Australasian Marine Associates

**Project Name:** Eden Breakwater Wharf Extension

**Hole Location:** Eden, NSW

**Hole Position:** 758539.0 m E 5893071.0 m N

**Commenced:** 27/02/2015

**Completed:** 01/03/2015

**Logged By:** DJQ

**Checked By:** ACD

**Drill Model and Mounting:** Hydrapower Scout-Floating Barge

**Inclination:** -90°

**RL Surface:** -5.80 m

**Datum:** CD

**Operator:** Wizard Drilling

**Barrel Type and Length:** HQ3

**Shoe Depth:** 8.50 m

### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Support</th>
<th>Water</th>
<th>SCR (%)</th>
<th>ROD (%)</th>
<th>RL (m)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-11.8</td>
<td>0.09</td>
</tr>
<tr>
<td>WB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-10.8</td>
<td>0.0</td>
</tr>
<tr>
<td>HQ3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-9.8</td>
<td>0.1</td>
</tr>
<tr>
<td>HQ3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

### Rock Substance

- **Material Description:**
  - RHYOLITIC TUFF, fine grained, brown

- **Defects:**
  - 1.45m: CAI (HRC55) = 1.85
  - 2.05m: CAI (HRC55) = 2.36
  - 2.55m: CAI (HRC55) = 2.47

- **Defect Description/ Lab Results:**
  - fractured into pieces 20mm to 70mm, numerous joints at up to 70° and horizontal crossbedding

- **Hole Terminated at 4.50 m**

### Rock Mass Defects

- **Method:**
  - AS - Auger Screwing
  - WB - Washbore
  - HQ3 - HQ3 Core Barrel

- **Support:**
  - T - Timbering

- **Water:**
  - Level (Date)
  - Inflow
  - Partial Loss
  - Complete Loss

- **Graphic Log/Core Loss:**
  - Core recovered (hatching indicates material)

- **Weathering:**
  - Fresh
  - Slightly Weathered
  - Dullly Weathered
  - Extremely Weathered
  - Residual Soil

- **Strength:**
  - (indirect tensile strength)
  - EL - Extremely Low
  - VL - Very Low
  - L - Low
  - M - Medium
  - H - High
  - VH - Very High
  - EH - Extremely High

**Log Method and Drawings:**

- TECTONIC 1.01.1 2015-01-19
- Lib: Tectonic 1.01.1 2015-01-19
- Dat: Tectonic 1.01.1 2015-01-19
- DGD | Lib: Tectonic 1.01.1 2015-01-19

**Datum:** CD Operator: Wizard Drilling

**Barrel Type and Length:** HQ3

**Shoe Depth:** 8.50 m
<table>
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<tr>
<th>Description</th>
<th>Details</th>
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<tr>
<td>Project No.</td>
<td>15001</td>
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<tr>
<td>Date Drilled</td>
<td>27/2 &amp; 1/3/15</td>
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<tr>
<td>Borehole No.</td>
<td>BHT6</td>
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<tr>
<td>No. of Boxes</td>
<td>2</td>
</tr>
<tr>
<td>Easting</td>
<td>758539</td>
</tr>
<tr>
<td>Start Depth (m, BSB)</td>
<td>1.05</td>
</tr>
<tr>
<td>Nortthing</td>
<td>5893071</td>
</tr>
<tr>
<td>Finish Depth (m, BSB)</td>
<td>4.50</td>
</tr>
<tr>
<td>Driller &amp; Rig</td>
<td>Wizard Hydрапower Scout</td>
</tr>
<tr>
<td>Core Size</td>
<td>HQ</td>
</tr>
<tr>
<td>Remarks</td>
<td>Mounted on floating barge</td>
</tr>
<tr>
<td>Prepared By</td>
<td>DJQ</td>
</tr>
</tbody>
</table>
### Drilling Information

- **Method:** Explora 50-Jack Up Barge
- **Borehole Diameter:** 100 mm
- **Inclination:** -90°
- **RL Surface:** -7.50 m
- **Datum:** CD
- **Operator:** Terratest

### Soil Description

<table>
<thead>
<tr>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Material Description</th>
<th>Temperature</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>Silty SAND, fine to coarse grained, black, some fine to coarse sized gravel, with some shells</td>
<td>VL</td>
<td>4.00: 2% Fines</td>
</tr>
<tr>
<td>3.5</td>
<td>6</td>
<td>SAND, fine to coarse grained, grey, with some fine to coarse sized rounded gravel, with some shells</td>
<td>VL</td>
<td>4.00: 2% Fines</td>
</tr>
<tr>
<td>3.5</td>
<td>6</td>
<td>Silty CLAY, low plasticity, pale grey, pale yellow brown, trace of fine to coarse sized quartz gravel</td>
<td>F</td>
<td>4.00: 2% Fines</td>
</tr>
<tr>
<td>3.5</td>
<td>6</td>
<td>SLATE, grey, brown, extremely low strength, extremely weathered, laminated (&lt;20mm)</td>
<td>ST</td>
<td>4.00: 2% Fines</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Hole Terminated at 5.95 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Additional Observations

- **Penetration Method:** Standard Penetration Test
- **Water Samples and Tests:** No resistance ranging to refusal
- **Level (Date):** U - Undisturbed Sample
- **Inflow:** D - Disturbed Sample
- **Partial Loss:** SPT - Standard Penetration Test
### Engineering Log - Borehole

**BHT10**

**Project No.:** 15001

**Client:** Australasian Marine Associates

**Project Name:** Eden Breakwater Wharf Extension

**Commenced:** 18/03/2015

**Hole Location:** Eden, NSW

**Completed:** 19/03/2015

**Logged By:** DJQ

**Datum:** CD

**Checked By:** ACD

**Operator:** Terratest

**RL Surface:** -10.60 m

**Hole Diameter:** 100 mm

<table>
<thead>
<tr>
<th>Drilling Information</th>
<th>Soil Description</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RL</strong> (m)</td>
<td><strong>Depth (m)</strong></td>
<td><strong>Classification Symbol</strong></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>SPT 3,3</td>
<td>2</td>
<td>SM</td>
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<td>SPT 1,0,2</td>
<td>2</td>
<td>SP</td>
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<tr>
<td>SPT 2,5,7</td>
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</tr>
<tr>
<td>SPT 7,7</td>
<td>4</td>
<td>SP</td>
</tr>
<tr>
<td>SPT 8,11,15</td>
<td>6</td>
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<tr>
<td>SPT 1,3,8</td>
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<tr>
<td>SPT 11,12,10</td>
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</tr>
<tr>
<td>SPT 2,3,1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>SPT 3,4,2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Support**

- **T** - Timbering
- **D** - Disturbed Sample
- **U** - Undisturbed Sample
- **SPT** - Standard Penetration Test
- **RL** - Water Recovery

**Samples and Tests**

- **Level (Date)**
- **Depth**
- **Inflow**
- **Partial Loss**
- **Complete Loss**

**Plastic Limit**

- **< PL**
- **= PL**
- **> PL**

**Penetration**

- **AS** - Auger Screwing
- **RR** - Rock Roller
- **WB** - Washbore

**Penetration Method**

- **No resistance ranging to refusal**

**Consistency/Relative Density**

- **VS** - Very Soft
- **S** - Soft
- **F** - Firm
- **VSt** - Very Stiff
- **H** - Hard
- **VL** - Very Loose
- **L** - Loose
- **MD** - Medium Dense
- **D** - Dense
- **VD** - Very Dense

**Graphic Log/Core Loss**

- **Core recovered (hatching indicates material)**
- **Core loss**

**Classification Symbols and Soil Descriptions**

- Based on Unified Soil Classification System

**Additional Observations**

- 5.00: 5% Fines
- 8.00: 17% Silt, 4% Clay

**Drill Model and Mounting:** Explora 50-Jack Up Barge

**Inclination:** -90°

**Borehole Depth:** 100 mm

**N**

- **3**
- **12**
- **26**
- **4**
- **6**
- **14**
- **22**
- **26**

**Remarks**

- Partial Loss
- Complete Loss

**Remarks**

- Core loss

**Remarks**

- Core loss
### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples</th>
<th>Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL</th>
<th>Depth</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT</td>
<td>1.0</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ML</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td>Clayey Sandy Silt, low liquid limit, grey, fine grained sand, organic (sulphur) odour, with some silty sand lenses</td>
</tr>
<tr>
<td>UWH</td>
<td>UWH, UWH,</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>Clayey Sandy Silt, low liquid limit, grey, fine grained sand, organic (sulphur) odour, with some silty sand lenses</td>
</tr>
<tr>
<td>UWR</td>
<td>UWR, UWR,</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td>Silty Clay, high plasticity, pale brown, pale grey</td>
</tr>
<tr>
<td>U63</td>
<td>14-14.45m</td>
<td>LL=51%,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U58</td>
<td>15-16.56m</td>
<td>LL=43%,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UWR</td>
<td>UWR, UWR,</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CH</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPT</td>
<td>5, 10, 13</td>
<td>N=23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Water Recovery Details

- **Depth (m):**
  - 12
  - 14
  - 16
  - 18

- **Moisture Condition:**
  - ML: Clayey Sandy Silt, low liquid limit, grey, fine grained sand, organic (sulphur) odour, with some silty sand lenses
  - W: Silty Clay, high plasticity, pale brown, pale grey

### Observations

- **11:00:** UWH - SPT falling under weight of hammer; 36% Sand, 51% Silt
- **12:00:** UWR - SPT falling under weight of rods
- **13:00:** PP = 15kPa
- **14:00:** Shear Vane (SV) Bottom: Peak 30kPa, Res 6kPa, Top: Peak 32kPa, Res 6kPa, 4% Sand, 83% Silt, 13% Clay, PP = 30-50kPa, UU Cu = 26.5kPa
- **17:00:** 68% Sand, 23% Silt, 8% Clay
- **19:00:** no sample returned; pale grey/brown clay on SPT split spoon
**Engineering Log - Borehole**

**Project No.** 15001

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples</th>
<th>Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
<th>Material Description</th>
<th>Consistency/Relative Density</th>
<th>Hand Penetrometer UCS (kPa)</th>
<th>DCP Test (Depth/Bows/100mm)/ Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB</td>
<td></td>
<td></td>
<td></td>
<td>SPT</td>
<td>8,11</td>
<td>N=19</td>
<td></td>
<td></td>
<td></td>
<td>CH</td>
<td>Silty Clay, high plasticity, pale brown, pale grey (continued)</td>
<td></td>
<td></td>
<td></td>
<td>21.00: 97% Fines, PP= 250kPa</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VS</td>
<td></td>
<td></td>
<td></td>
<td>22.50: PP= 400-500kPa</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SPT</td>
<td>5,16,30</td>
<td>N=46</td>
<td></td>
<td></td>
<td></td>
<td>SM</td>
<td>Silty SAND, fine to medium grained, brown, grey, medium plasticity clay fines</td>
<td></td>
<td></td>
<td></td>
<td>24.00: 67% Sand, 23% Silt, 10% Clay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SPT</td>
<td>UWR,UWR,UWR</td>
<td>N=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SC</td>
<td>Clayey SAND and Sandy CLAY , fine to medium grained, medium plasticity, grey, brown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SPT</td>
<td>15,11,19</td>
<td>N=30</td>
<td></td>
<td></td>
<td></td>
<td>SC</td>
<td>Clayey SAND, fine to coarse grained, brown, high plasticity clay fines, trace of gravel</td>
<td></td>
<td></td>
<td></td>
<td>29.00: 27% Fines</td>
</tr>
</tbody>
</table>

**Support**
- T - Timbering

**Graphic Log/Core Loss**
- Core recovered (hatching indicates material)
- Core loss

**Penetration**
- AS - Auger Screwing
- RR - Rock Roller
- WB - Washbore

**Water**
- No resistance ranging to refusal
- Complete Loss

**Samples and Tests**
- U - Undistributed Sample
- D - Disturbed Sample
- SPT - Standard Penetration Test

**Moisture Condition**
- D - Dry
- M - Moist
- W - Wet

**Consistency/Relative Density**
- VS - Very Soft
- S - Soft
- F - Firm
- VS - Very Stiff
- H - Hard
- VL - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- VD - Very Dense

**Plastic Limit**
- < PL
- = PL
### Engineering Log - Borehole

**Borehole No.:** BHT10

**Project No.:** 15001

**Client:** Australasian Marine Associates

**Commenced:** 18/03/2015

**Completed:** 19/03/2015

**Hole Location:** Eden, NSW

**Logged By:** DJQ

**Checked By:** ACD

**Drill Model and Mounting:** Explora 50-Jack Up Barge

**Inclination:** -90°

**Hole Diameter:** 100 mm

**Bearing:**

**Datum:** CD

**Operator:** Terratest

**Hole Position:** 758263.0 m E 5892817.0 m N

---

### Drilling Information

<table>
<thead>
<tr>
<th>Method</th>
<th>Penetration</th>
<th>Support</th>
<th>Water</th>
<th>Samples Tests</th>
<th>Remarks</th>
<th>Recovery</th>
<th>RL (m)</th>
<th>Depth (m)</th>
<th>Graphic Log</th>
<th>Classification Symbol</th>
<th>Material Description</th>
<th>Moisture Condition</th>
<th>Consistency/Relative Density</th>
<th>DCP Test (Depth: Blows/100mm): Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
<td>15,10,12</td>
<td>N=22</td>
<td></td>
<td></td>
<td></td>
<td>SC</td>
<td>Clayey SAND, fine to coarse grained, brown, high plasticity clay fines, trace of gravel (continued)</td>
<td>W</td>
<td>MD to D</td>
<td></td>
<td>30.50: 23% Fines</td>
</tr>
</tbody>
</table>

---

**Support:**

- T - Timbering

**Graphic Log/Core Loss:**

- Core recovered (hatching indicates material)
- Core loss

**Classification Symbols and Soil Descriptions:**

- Based on Unified Soil Classification System

**Penetration Methods:**

- AS - Auger Screwing
- RR - Rock Roller
- WB - Washbore

**Drilling Support:**

- T - Timbering

---

**Samples and Tests:**

- U - Undisturbed Sample
- D - Disturbed Sample
- SPT - Standard Penetration Test

**Penetration Test:**

- No resistance ranging to refusal
- Inflow
- Partial Loss
- Complete Loss

**Water:**

- Water Recovery

**Inflow:**

- Level (Date)

**Support:**

- Core recovered (hatching indicates material)

---

**Additional Observations:**

Continued on cored borehole sheet

---

**Support:**

- Core recovered (hatching indicates material)

---

**Core Loss:**

- Core recovered (hatching indicates material)

---

**Core Loss:**

- Core loss

---

**Classification Symbols and Soil Descriptions:**

- Based on Unified Soil Classification System

**Penetration Test:**

- No resistance ranging to refusal
- Inflow
- Partial Loss
- Complete Loss

**Water:**

- Water Recovery

**Inflow:**

- Level (Date)
SANDSTONE, fractured into coarse gravel sized pieces

CONGLOMERATE, fine to coarse grained, pale grey and purple, extremely/very low and high strength layering, comprised of extremely to distinctly weathered sandstone and slightly weathered rhyolite clasts

Hole Terminated at 34.30 m
### Table: Borehole Data

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Proposed Breakwater Wharf Extension, Eden, NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project No.</td>
<td>15001</td>
</tr>
<tr>
<td>Date Drilled</td>
<td>18 &amp; 19/3/15</td>
</tr>
<tr>
<td>Borehole No.</td>
<td>BHT10</td>
</tr>
<tr>
<td>No. of Boxes</td>
<td>1</td>
</tr>
<tr>
<td>Easting</td>
<td>758263</td>
</tr>
<tr>
<td>Start Depth (m, BSB)</td>
<td>31.30</td>
</tr>
<tr>
<td>Northing</td>
<td>5892817</td>
</tr>
<tr>
<td>Finish Depth (m, BSB)</td>
<td>34.30</td>
</tr>
<tr>
<td>Driller &amp; Rig</td>
<td>Terra Test Explora 50</td>
</tr>
<tr>
<td>Core Size</td>
<td>HQ</td>
</tr>
<tr>
<td>Remarks</td>
<td>Mounted on jack-up barge</td>
</tr>
<tr>
<td>Prepared By</td>
<td>DJQ</td>
</tr>
</tbody>
</table>
**TERMS USED ON LOGS**

<table>
<thead>
<tr>
<th>DRILLING/EXCAVATION METHOD</th>
<th>DRILLING/EXCAVATION METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD* Auger Drilling</td>
<td>RD Rotary Blade or Drag bit</td>
</tr>
<tr>
<td>*V V-Bit</td>
<td>RT Rotary Tri-cone bit</td>
</tr>
<tr>
<td>*T TC-Bit</td>
<td>RA Rotary Air</td>
</tr>
<tr>
<td>HA Hand Auger</td>
<td></td>
</tr>
<tr>
<td>ADH Hollow Auger</td>
<td></td>
</tr>
<tr>
<td>HA Hand Auger</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WATER</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUNDWATER NOT OBSERVED</td>
<td>The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.</td>
</tr>
<tr>
<td>GROUNDWATER NOT ENCOUNTERED</td>
<td>The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLING AND TESTING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT Standard Penetration Test to AS1289.6.3.1-2004</td>
<td></td>
</tr>
<tr>
<td>5,4,10 N=14 5,4,10 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating</td>
<td></td>
</tr>
<tr>
<td>30/65mm Where practical refusal occurs, the blows and penetration for that interval are reported</td>
<td></td>
</tr>
<tr>
<td>RW Penetration occurred under the rod weight only</td>
<td></td>
</tr>
<tr>
<td>HW Penetration occurred under the hammer and rod weight only</td>
<td></td>
</tr>
<tr>
<td>HB Hammer double bouncing on anvil</td>
<td></td>
</tr>
<tr>
<td>DS Disturbed sample</td>
<td></td>
</tr>
<tr>
<td>BDS Bulk disturbed sample</td>
<td></td>
</tr>
<tr>
<td>FV Field vane shear test expressed as uncorrected shear strength ( s_v = \text{peak value}, s_r = \text{residual value} )</td>
<td></td>
</tr>
<tr>
<td>PP Pocket penetrometer test expressed as instrument reading in kPa</td>
<td></td>
</tr>
<tr>
<td>U50 Thin walled tube sample - number indicates nominal sample diameter in millimetres</td>
<td></td>
</tr>
<tr>
<td>DCP Dynamic cone penetration test</td>
<td></td>
</tr>
<tr>
<td>CPT Electronic cone penetration test</td>
<td></td>
</tr>
<tr>
<td>CPTu Electronic cone penetration test with pore pressure ( u ) measurement</td>
<td></td>
</tr>
</tbody>
</table>

Rev0

October 2013
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and rock is classified and described in borehole and test pit logs using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

### Particle Size

<table>
<thead>
<tr>
<th>Major Division</th>
<th>Sub Division</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOULDERS</td>
<td></td>
<td>&gt; 200 mm</td>
</tr>
<tr>
<td>COBBLES</td>
<td></td>
<td>63 to 200 mm</td>
</tr>
<tr>
<td>GRAVEL</td>
<td>Coarse</td>
<td>20 to 63 mm</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>6.0 to 20 mm</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>2.0 to 6.0 mm</td>
</tr>
<tr>
<td>SAND</td>
<td>Coarse</td>
<td>0.6 to 2.0 mm</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.2 to 0.6 mm</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>0.075 to 0.2 mm</td>
</tr>
<tr>
<td>SILT</td>
<td></td>
<td>0.002 to 0.075 mm</td>
</tr>
<tr>
<td>CLAY</td>
<td></td>
<td>&lt; 0.002 mm</td>
</tr>
</tbody>
</table>

### Plasticity Properties

#### MOISTURE CONDITION

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Dry</td>
<td>Sands and gravels are free flowing. Clays &amp; Silts may be brittle or friable and powdery.</td>
</tr>
<tr>
<td>M</td>
<td>Moist</td>
<td>Soils are darker than in the dry condition &amp; may feel cool. Sands and gravels tend to cohere.</td>
</tr>
<tr>
<td>W</td>
<td>Wet</td>
<td>Soils exude free water. Sands and gravels tend to cohere.</td>
</tr>
</tbody>
</table>

#### CONSISTENCY AND DENSITY

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Undrained Shear Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS</td>
<td>Very Soft</td>
<td>0 to 12 kPa</td>
</tr>
<tr>
<td>S</td>
<td>Soft</td>
<td>12 to 25 kPa</td>
</tr>
<tr>
<td>F</td>
<td>Firm</td>
<td>25 to 50 kPa</td>
</tr>
<tr>
<td>St</td>
<td>Stiff</td>
<td>50 to 100 kPa</td>
</tr>
<tr>
<td>VSt</td>
<td>Very Stiff</td>
<td>100 to 200 kPa</td>
</tr>
<tr>
<td>H</td>
<td>Hard</td>
<td>Above 200 kPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Density Index %</th>
<th>SPT &quot;N&quot; #</th>
</tr>
</thead>
<tbody>
<tr>
<td>VL</td>
<td>Very Loose</td>
<td>Less than 15</td>
<td>0 to 4</td>
</tr>
<tr>
<td>L</td>
<td>Loose</td>
<td>15 to 35</td>
<td>4 to 10</td>
</tr>
<tr>
<td>MD</td>
<td>Medium Dense</td>
<td>35 to 65</td>
<td>10 to 30</td>
</tr>
<tr>
<td>D</td>
<td>Dense</td>
<td>65 to 85</td>
<td>30 to 50</td>
</tr>
<tr>
<td>VD</td>
<td>Very Dense</td>
<td>Above 85</td>
<td>Above 50</td>
</tr>
</tbody>
</table>

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material. # SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.
### Method of Rock Description Used on Logs

#### Strength

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Point Load Index, $I_{50}$ (MPa)</th>
<th>Field Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL</td>
<td>Extremely Low</td>
<td>&lt; 0.03</td>
<td>Easily remoulded by hand to a material with soil properties.</td>
</tr>
<tr>
<td>VL</td>
<td>Very Low</td>
<td>0.03 to 0.1</td>
<td>Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.</td>
</tr>
<tr>
<td>L</td>
<td>Low</td>
<td>0.1 to 0.3</td>
<td>Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.</td>
</tr>
<tr>
<td>M</td>
<td>Medium</td>
<td>0.3 to 1</td>
<td>Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.</td>
</tr>
<tr>
<td>H</td>
<td>High</td>
<td>1 to 3</td>
<td>A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.</td>
</tr>
<tr>
<td>VH</td>
<td>Very High</td>
<td>3 to 10</td>
<td>Hand specimen breaks with pick after more than one blow; rock rings under hammer.</td>
</tr>
<tr>
<td>EH</td>
<td>Extremely High</td>
<td>&gt;10</td>
<td>Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.</td>
</tr>
</tbody>
</table>

Relationship between $I_{50}$ and UCS (unconfined compressive strength) will vary with rock type and strength, and should be determined on a site-specific basis. UCS is typically 10 to 30 x $I_{50}$, but can be as low as 5.

#### Rock Material Weathering

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Field Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>Residual Soil</td>
<td>Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.</td>
</tr>
<tr>
<td>EW</td>
<td>Extremely Weathered</td>
<td>Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.</td>
</tr>
<tr>
<td>DW</td>
<td>Distinctly Weathered</td>
<td>Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.</td>
</tr>
<tr>
<td>SW</td>
<td>Slightly Weathered</td>
<td>Rock is slightly discoloured but shows little or no change of strength relative to fresh rock.</td>
</tr>
<tr>
<td>FR</td>
<td>Fresh</td>
<td>Rock shows no sign of decomposition or staining.</td>
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#### Abbreviations for Defect Types and Descriptions

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<tr>
<th>Defect Type</th>
<th>Coating or Infill</th>
<th>Roughness</th>
<th>Planarity</th>
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<td>B</td>
<td>Bedding parting</td>
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<td>X</td>
<td>Foliation</td>
<td>S</td>
<td>Un</td>
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<td>C</td>
<td>Contact</td>
<td>SL</td>
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<td>L</td>
<td>Cleavage</td>
<td>S</td>
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<td>J</td>
<td>Joint</td>
<td>RF</td>
<td>St</td>
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<td>SS/SZ</td>
<td>Sheared seam/zone</td>
<td>VR</td>
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<td>DS/DZ</td>
<td>Decomposed seam/zone</td>
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<td>IS/IZ</td>
<td>Infilled seam/zone</td>
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<td>S</td>
<td>Schistocity</td>
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<td>V</td>
<td>Vein</td>
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<td>Cn</td>
<td>Clean</td>
<td>V</td>
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<td>Sn</td>
<td>Stain</td>
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<tr>
<td>Vr</td>
<td>Veneer</td>
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<td>Ct</td>
<td>Coating or Infill</td>
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<td>Clay</td>
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<td>Fe</td>
<td>Iron oxide</td>
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<td>Qz</td>
<td>Quartz</td>
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<td>POL</td>
<td>Polished</td>
<td>S</td>
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<td>SL</td>
<td>S</td>
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<td>Slickensided</td>
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<td>RF</td>
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<td>Very rough</td>
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<td>Stepped</td>
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APPENDIX B

Photos – Soil Samples
BOREHOLE BHT1

Material from 0.0m to 0.5m (black gravelly silt) and 0.5m to 1.0m (brown clayey sandy gravel)

Samples from SPT testing
BOREHOLE BHT3

Samples from SPT testing
BOREHOLE BHT3 CONTINUED

Samples from SPT testing
BOREHOLE BHT4

Samples from SPT testing

BOREHOLE BHT5

15 June 2015
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Samples from SPT testing

BOREHOLE BHT5 CONTINUED
Samples from SPT testing
BOREHOLE BHT5 CONTINUED

Samples from soil coring
Samples from soil coring
BOREHOLE BHT9

Samples from SPT testing
BOREHOLE BHT10

Samples from SPT testing

BOREHOLE BHT10 CONTINUED
Samples from SPT testing

Samples from soil coring
BOREHOLE BHT10 CONTINUED

Samples from SPT testing
APPENDIX C

Table C1 - Geotechnical Design Parameters
### TABLE C1 – SOIL AND ROCK PROPERTIES

#### BHT1

<table>
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<tr>
<th>Depth (m, BSB)</th>
<th>Soil/Rock Type</th>
<th>Density / Consistency</th>
<th>Ave N</th>
<th>USCS</th>
<th>Density (kN/m²)</th>
<th>cₑ (kPa)</th>
<th>Ø (degrees)</th>
<th>Ø’ (degrees)</th>
<th>E (MPa)</th>
<th>Poisson’s Ratio</th>
<th>kₛ (MN/m²)</th>
<th>fₛ (kPa)</th>
<th>qᵤ (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<tbody>
<tr>
<td>0.0 – 0.5</td>
<td>Clayey Silt</td>
<td>Very soft</td>
<td>-</td>
<td>ML</td>
<td>&lt;1.4</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;2</td>
<td>0.3-0.35</td>
<td>&lt;5</td>
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<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
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<td>0.5 – 1.3</td>
<td>Clayey Sandy Gravel</td>
<td>Dense</td>
<td>100</td>
<td>GP</td>
<td>1.8-2.0</td>
<td>35-40</td>
<td>0</td>
<td>35-40</td>
<td>160-320 (127)</td>
<td>0.2-0.3</td>
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<td>50</td>
<td>N/A</td>
<td>N/R</td>
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<td>1.3 – 3.0</td>
<td>Gravelly Clayey Sand</td>
<td>Dense</td>
<td>180</td>
<td>SC</td>
<td>1.8-2.0</td>
<td>35-40</td>
<td>0</td>
<td>35-40</td>
<td>160-320 (&gt;200)</td>
<td>0.2-0.3</td>
<td>200-400</td>
<td>100</td>
<td>N/A</td>
<td>N/R</td>
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<td>3.0 – 13.25</td>
<td>Metasandstone</td>
<td>LS – MS</td>
<td>-</td>
<td>-</td>
<td>1.9-2.1</td>
<td>4,000 (UCS)</td>
<td>&gt;10</td>
<td>&gt;37</td>
<td>2.5 GPa</td>
<td>0.2-0.3</td>
<td>&gt;500</td>
<td>200</td>
<td>4,000</td>
<td>Class III to IV</td>
<td>45-55 (Fair)</td>
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<td>13.25 End of Borehole</td>
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#### BHT3

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<th>Density / Consistency</th>
<th>Ave N</th>
<th>USCS</th>
<th>Density (kN/m²)</th>
<th>cₑ (kPa)</th>
<th>Ø (degrees)</th>
<th>Ø’ (degrees)</th>
<th>E (MPa)</th>
<th>Poisson’s Ratio</th>
<th>kₛ (MN/m²)</th>
<th>fₛ (kPa)</th>
<th>qᵤ (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<td>0.0 – 0.5</td>
<td>Sandy Silt</td>
<td>Very Soft</td>
<td>-</td>
<td>ML</td>
<td>&lt;1.4</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>&lt;2</td>
<td>0.3-0.35</td>
<td>&lt;5</td>
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<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
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<td>0.5 – 5.0</td>
<td>Sand</td>
<td>Medium Dense</td>
<td>16</td>
<td>SP</td>
<td>1.7-1.9</td>
<td>32-35</td>
<td>0</td>
<td>32-35</td>
<td>30-50 (15)</td>
<td>0.3-0.35</td>
<td>100-200</td>
<td>30</td>
<td>N/A</td>
<td>N/R</td>
<td>N/R</td>
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<td>5.0 – 7.2</td>
<td>Sand</td>
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<td>6</td>
<td>SP</td>
<td>1.7-1.9</td>
<td>29-32</td>
<td>0</td>
<td>29-32</td>
<td>10-30 (10)</td>
<td>0.3-0.35</td>
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<td>10</td>
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<td>N/R</td>
<td>N/R</td>
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<td>7.2 – 11.0</td>
<td>Sand</td>
<td>Dense</td>
<td>40</td>
<td>SP</td>
<td>1.8-2.0</td>
<td>35-37</td>
<td>0</td>
<td>35-37</td>
<td>50-80 (27)</td>
<td>0.2-0.3</td>
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<td>50</td>
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<td>N/R</td>
<td>N/R</td>
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<td>11.0 – 15.7</td>
<td>Silty Sand</td>
<td>Medium Dense</td>
<td>18</td>
<td>SM</td>
<td>1.7-1.9</td>
<td>30-33</td>
<td>0</td>
<td>30-33</td>
<td>30-50 (17)</td>
<td>0.3-0.35</td>
<td>100-200</td>
<td>30</td>
<td>N/A</td>
<td>N/R</td>
<td>N/R</td>
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<td>15.7 – 18.0</td>
<td>Metasandstone</td>
<td>ELS</td>
<td>180</td>
<td>-</td>
<td>1.9-2.1</td>
<td>1,000 (UCS)</td>
<td>-</td>
<td>5-10</td>
<td>37-40</td>
<td>1-2 (GPa)</td>
<td>0.2-0.3</td>
<td>200-500</td>
<td>50</td>
<td>1,000</td>
<td>Class V</td>
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<td>18.0 – 22.1</td>
<td>Metasandstone</td>
<td>LS – MS</td>
<td>-</td>
<td>-</td>
<td>1.9-2.1</td>
<td>5,000 (UCS)</td>
<td>-</td>
<td>10-30</td>
<td>38-42</td>
<td>5-10 (GPa)</td>
<td>0.2-0.3</td>
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<td>250</td>
<td>5,000</td>
<td>Class V</td>
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<td>22.1 – 23.15</td>
<td>Metasandstone</td>
<td>HS</td>
<td>-</td>
<td>-</td>
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<td>10,000 (UCS)</td>
<td>-</td>
<td>10-20</td>
<td>38-42</td>
<td>&gt;200 (GPa)</td>
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</table>

### Notes:

1. E – Young’s Modulus of Elasticity (values in brackets estimated from Table 5-5 “Foundation Analysis & Design”, Bowles, 1996, 4th ed. based on average SPT N values)
2. kₛ – lateral modulus of subgrade reaction (typical range from Table 9-1 “Foundation Analysis & Design”, Bowles, 1996, 4th ed.)
3. fₛ = ultimate skin friction; qᵤ = ultimate base bearing capacity.
5. N/R – material parameter not relevant to soil.
6. N/A – founding at this level is not considered applicable.
7. ELS – extremely low strength; LS – low strength; MS – medium strength; HS – high strength.
**EDEN BREAKWATER WHARF EXTENSION – GEOTECHNICAL INVESTIGATION INTERPRETIVE REPORT**

**15 June 2015**

**Report No. 15001-006-Rev1**

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### BHT4

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<th>Density / Consistency</th>
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<th>USCS</th>
<th>Density (kN/m³)</th>
<th>c_u (kPa)</th>
<th>Ø (degrees)</th>
<th>c' (kPa)</th>
<th>Ø' (degrees)</th>
<th>E (MPa)</th>
<th>Poisson’s Ratio</th>
<th>k_s (MN/m³)</th>
<th>f_s (kPa)</th>
<th>q_u (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<tbody>
<tr>
<td>0.0 – 1.0</td>
<td>Sand/silty Sand</td>
<td>Very Loose/Loose</td>
<td>-</td>
<td>SM/SP</td>
<td>1.6-1.8</td>
<td>-</td>
<td>27-29</td>
<td>0</td>
<td>27-29</td>
<td>&lt;5 (2)</td>
<td>0.3-0.4</td>
<td>&lt;20</td>
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<td>N/A</td>
<td>N/R</td>
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<td>1.0 – 2.8</td>
<td>Sand</td>
<td>Medium Dense</td>
<td>14</td>
<td>SP</td>
<td>1.8-1.9</td>
<td>-</td>
<td>32-35</td>
<td>0</td>
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<td>30-50 (15)</td>
<td>0.3-0.35</td>
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<td>N/R</td>
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<td>5</td>
<td>SM</td>
<td>1.6-1.8</td>
<td>-</td>
<td>29-32</td>
<td>0</td>
<td>29-32</td>
<td>10-30 (10)</td>
<td>0.3-0.35</td>
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<td>N/A</td>
<td>N/R</td>
<td>N/R</td>
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<td>4.1 – 5.3</td>
<td>Sandy Clay</td>
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<td>CL</td>
<td>1.5-1.7</td>
<td>25</td>
<td>-</td>
<td>2-5</td>
<td>23-25</td>
<td>5-8 (5)</td>
<td>0.2-0.3</td>
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<td>N/R</td>
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<td>CL</td>
<td>1.7-1.9</td>
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<td>-</td>
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<td>N/R</td>
<td>N/R</td>
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<td>Slate</td>
<td>ELS - VLS</td>
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<td>3,000 (UCS)</td>
<td>-</td>
<td>&gt;10</td>
<td>&gt;37</td>
<td>1-5 GPa</td>
<td>0.2-0.3</td>
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<td>7,000</td>
<td>Class V</td>
<td>10-15 (Poor)</td>
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<td>10.8 – 14.8</td>
<td>Metasandstone</td>
<td>MS - HS</td>
<td>-</td>
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<td>2.0-2.2</td>
<td>7,000 (UCS)</td>
<td>-</td>
<td>&gt;10</td>
<td>&gt;37</td>
<td>1-5 GPa</td>
<td>0.2-0.3</td>
<td>&gt;500</td>
<td>250</td>
<td>7,000</td>
<td>Class V</td>
<td>15-20 (Poor)</td>
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<td>2.0-2.2</td>
<td>3,000 (UCS)</td>
<td>-</td>
<td>5-10</td>
<td>30-35</td>
<td>1-2 GPa</td>
<td>0.1-0.3</td>
<td>200-400</td>
<td>150</td>
<td>3,000</td>
<td>Class V</td>
<td>10-15 (Poor)</td>
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### BHT5

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<th>Soil/Rock Type</th>
<th>Density / Consistency</th>
<th>Ave N</th>
<th>USCS</th>
<th>Density (kN/m³)</th>
<th>c_u (kPa)</th>
<th>Ø (degrees)</th>
<th>c' (kPa)</th>
<th>Ø' (degrees)</th>
<th>E (MPa)</th>
<th>Poisson’s Ratio</th>
<th>k_s (MN/m³)</th>
<th>f_s (kPa)</th>
<th>q_u (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<td>0.0 – 0.5</td>
<td>Silty Sand</td>
<td>Very Loose</td>
<td>-</td>
<td>SM</td>
<td>&lt;1.5</td>
<td>-</td>
<td>25-27</td>
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<td>25-27</td>
<td>&lt;5 (2)</td>
<td>0.3-0.4</td>
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<td>N/R</td>
<td>N/R</td>
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<td>0.5 – 1.8</td>
<td>Sand</td>
<td>Loose</td>
<td>5</td>
<td>SP</td>
<td>1.7-1.8</td>
<td>-</td>
<td>29-32</td>
<td>0</td>
<td>29-32</td>
<td>10-30 (10)</td>
<td>0.3-0.35</td>
<td>50-100</td>
<td>10</td>
<td>N/A</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>1.8 – 2.7</td>
<td>Sand</td>
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<td>SP</td>
<td>&lt;1.5</td>
<td>-</td>
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<td>&lt;5 (2)</td>
<td>0.3-0.4</td>
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<td>N/R</td>
<td>N/R</td>
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<td>13</td>
<td>SP</td>
<td>1.8-1.9</td>
<td>-</td>
<td>32-35</td>
<td>0</td>
<td>32-35</td>
<td>30-50 (14)</td>
<td>0.3-0.35</td>
<td>100-200</td>
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<td>N/R</td>
<td>N/R</td>
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<td>6.8 – 11.9</td>
<td>Sandy Silt</td>
<td>Very Soft/Soft</td>
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<td>ML</td>
<td>1.4-1.6</td>
<td>&lt;15</td>
<td>-</td>
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<td>N/R</td>
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<td>Clayey Silt</td>
<td>Stiff</td>
<td>16</td>
<td>MH</td>
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<td>-</td>
<td>4-7</td>
<td>25-27</td>
<td>10-15 (7)</td>
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### BHT6

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<th>Depth (m, BSB)</th>
<th>Soil/Rock Type</th>
<th>Density / Consistency</th>
<th>Ave N</th>
<th>USCS</th>
<th>Density (kN/m³)</th>
<th>c_u (kPa)</th>
<th>Ø (degrees)</th>
<th>c' (kPa)</th>
<th>Ø' (degrees)</th>
<th>E (MPa)</th>
<th>Poisson’s Ratio</th>
<th>k_s (MN/m³)</th>
<th>f_s (kPa)</th>
<th>q_u (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<td>0.0 – 1.0</td>
<td>Clayey Gravel</td>
<td>Medium Dense</td>
<td>-</td>
<td>GC</td>
<td>1.8-2.0</td>
<td>-</td>
<td>32-35</td>
<td>0</td>
<td>32-35</td>
<td>50-100</td>
<td>0.2-0.3</td>
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<td>50</td>
<td>N/A</td>
<td>N/R</td>
<td>N/R</td>
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<td>Rhyolitic Tuff</td>
<td>MS - HS</td>
<td>&gt;180</td>
<td></td>
<td>2.0-2.2</td>
<td>10,000 (UCS)</td>
<td>-</td>
<td>10-20</td>
<td>38-42</td>
<td>&gt;200</td>
<td>0.1-0.3</td>
<td>&gt;500</td>
<td>300</td>
<td>10,000</td>
<td>Class V</td>
<td>25-30 (Fair)</td>
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**Notes:**

1. E – Young’s Modulus of Elasticity (values in brackets estimated from Table 5-5 “Foundation Analysis & Design”, Bowles, 1996, 4th ed. based on average SPT N values)
2. k_s – lateral modulus of subgrade reaction (typical range from Table 9-1 “Foundation Analysis & Design”, Bowles, 1996, 4th ed.).
3. f_s = ultimate skin friction; q_u = ultimate base bearing capacity.
5. N/R – material parameter not relevant to soil.
6. N/A – founding at this level is not considered applicable.
7. ELS – extremely low strength; LS – low strength; MS – medium strength; HS – high strength
### TABLE C1 – SOIL AND ROCK PROPERTIES (Cont.)

#### BHT9

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<th>Depth (m, BSB)</th>
<th>Soil/Rock Type</th>
<th>Density / Consistency</th>
<th>Ave N</th>
<th>USCS</th>
<th>Density (kN/m³)</th>
<th>c (kPa)</th>
<th>Ø (degrees)</th>
<th>c' (kPa)</th>
<th>Ø' (degrees)</th>
<th>E (MPa)</th>
<th>Poisson's Ratio</th>
<th>k_s (MN/m³)</th>
<th>f_s (kPa)</th>
<th>q_u (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<td>0.0 – 0.5</td>
<td>Silty Sand</td>
<td>Very Loose</td>
<td>-</td>
<td>SM</td>
<td>&lt;1.5</td>
<td>25-27</td>
<td>0</td>
<td>25-27</td>
<td>&lt;5 (2)</td>
<td>0.3-0.4</td>
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<td>N/R</td>
<td>N/R</td>
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<td>0.5 – 5.1</td>
<td>Sand</td>
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<td>6</td>
<td>SP</td>
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<td>29-32</td>
<td>0</td>
<td>29-32</td>
<td>10-30 (10)</td>
<td>0.3-0.35</td>
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<td>N/R</td>
<td>N/R</td>
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<td>Silty Clay</td>
<td>Firm to Stiff</td>
<td>3</td>
<td>CL</td>
<td>1.6-1.8</td>
<td>25-35</td>
<td>-</td>
<td>0-5</td>
<td>5-10 (6)</td>
<td>0.3-0.35</td>
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<td>N/R</td>
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<td>1.500 (UCS)</td>
<td>-</td>
<td>5-10</td>
<td>35-40</td>
<td>1-2 (GPa)</td>
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<th>Soil/Rock Type</th>
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<th>USCS</th>
<th>Density (kN/m³)</th>
<th>c (kPa)</th>
<th>Ø (degrees)</th>
<th>c' (kPa)</th>
<th>Ø' (degrees)</th>
<th>E (MPa)</th>
<th>Poisson's Ratio</th>
<th>k_s (MN/m³)</th>
<th>f_s (kPa)</th>
<th>q_u (kPa)</th>
<th>RMR</th>
<th>GSI</th>
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<td>Shells</td>
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<td>-</td>
<td>SM</td>
<td>1.6-1.8</td>
<td>27-29</td>
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<td>27-29</td>
<td>&lt;5 (4)</td>
<td>0.3-0.4</td>
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<td>2</td>
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<td>32-35</td>
<td>0</td>
<td>32-35</td>
<td>10-30 (16)</td>
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<td>17</td>
<td>SP</td>
<td>1.8-1.9</td>
<td>29-32</td>
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<td>29-32</td>
<td>10-30 (10)</td>
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<td>N/R</td>
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<td>-</td>
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<td>22-24</td>
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<td>18.5 – 22.5</td>
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<td>21</td>
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<td>5-10</td>
<td>30-35</td>
<td>10-20 (20)</td>
<td>0.3-0.35</td>
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<td>N/R</td>
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<td>N/R</td>
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<td>Hard</td>
<td>-</td>
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<td>1.7-1.9</td>
<td>200</td>
<td>200</td>
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<td>20-30 (40)</td>
<td>0.2-0.3</td>
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<td>25-27</td>
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<td>N/R</td>
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<td>30-50 (20)</td>
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<td>35-40</td>
<td>0.5-1 (GPa)</td>
<td>0.2-0.4</td>
<td>200-400</td>
<td>100</td>
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<td>Class V</td>
<td>10-15 (Poor)</td>
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**Notes:**

1. E – Young’s Modulus of Elasticity (values in brackets estimated from Table 5-5 “Foundation Analysis & Design”, Bowles, 1996, 4th ed. based on average SPT N values)
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7. ELS – extremely low strength; MS – medium strength; HS – high strength
APPENDIX D

Report Limitations
REPORT LIMITATIONS

This report has been prepared for the purpose outlined in Tectonic’s proposal and no responsibility is accepted for the use of this report, in whole or in part, for any other purpose.

The scope of Tectonic’s Services are as described in Tectonic’s proposal, and are subject to restrictions and limitations. Tectonic did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the report. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Tectonic in regards to it.

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Tectonic's opinions are based upon information that existed at the time that the study was performed. The passage of time, man-made or natural events, may alter the site conditions. It is understood that the Services undertaken allowed Tectonic to form an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

Any assessments made in this report are based on the conditions indicated from published sources and the findings of the investigation described. Actual subsurface conditions may differ from those indicated in the report (e.g. between boreholes or test pits). No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this report.

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