1983/20. Site investigation for a proposed stormwater line, Lampton Park, Prince of Wales Bay, Hobart.

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Abstract

Investigations along part of a proposed stormwater pipeline route at Prince of Wales Bay, Hobart, have shown that unrippable rock underlies the route at shallow depth, requiring expensive methods to reach the planned excavation depth of eight metres. The area is a former embayment of the River Derwent, subsequently used as a landfill site some 15 to 20 years ago.

Alternative pipeline routes are mainly underlain by unconsolidated materials consisting of fill, and sand and clay deposits; only minor blasting may be required for excavation. The indication of a water table at between three and four metres depth in an area close to the present shoreline may affect excavation stability.

INTRODUCTION

The Glenorchy City Council requested geological advice along the final section of a proposed route for a 2100 mm diameter stormwater line terminating at Prince of Wales Bay, Derwent Park [EN247574]. Advice was sought on the nature of materials and excavation conditions likely to be encountered to a depth of at least eight metres below the existing surface in the vicinity of the Lampton Park sports grounds.

The initial investigation involved a seismic refraction survey supplemented by an auger drilling programme to confirm the geophysical results. Based on these results, the Council proposed two alternative routes, designed to skirt around the basement high found to exist along a section of the original route. An additional drilling programme was undertaken to determine subsurface conditions along these routes.

SITE GEOLOGY

Lampton Park was formed as a result of the dumping of fill into the head reaches of Prince of Wales Bay some 15-20 years ago. The positions of the pre-fill shoreline and the more prominent morphological features of the original topography were obtained from interpretation of old aerial photographs (1947) and are depicted in Figure 1.

The Hobart sheet of the 1:50 000 Geological Atlas Series (Leaman, 1973) shows Tertiary basalt occupying the western shoreline of Prince of Wales Bay, with Jurassic dolerite on the eastern shoreline. The fill has since obscured the boundary relationship of these rocks, but it would appear that the pre-basaltic Tertiary silt and sand deposits in this area extend beneath the fill and abut the dolerite to the east. Recent alluvial deposits associated with the creek that originally entered the bay at this location are probably also present and underlie the fill.

Although the exact boundaries and thicknesses of the various rock types beneath the fill at Lampton Park are not known, the Council has records of the amounts of fill placed.

SEISMIC REFRACTION SURVEY

Survey details

Control for the survey was provided by a series of survey pegs marking the proposed route across Lampton Park.

Six seismic spreads were fired using a twelve-channel Nimbus seismograph. Both hammer and electrical firing methods (seismic boosters with electric detonators) were employed. All spreads were fired from both ends and in the middle. Geophone spacing was set at 5.0 m when using explosives, and 3.0 m for the hammer spreads. The locations of the spreads are shown on Figure 1.

Survey constraints

The major survey constraint was the limitation on the amount of explosive charge that could be used without unduly disturbing the surface of the hockey fields, yet acting as a sufficiently large energy source to attain a good seismic record. In most cases, this resulted in a compromise.

Depth determinations of velocity layers were calculated using a combination of critical distance, reciprocal, and time intercept methods. Due to the stepped nature and asymmetry of several of the velocity plots, there was some variation in depth at a particular point, depending upon the interpretation method used. Thus depth determinations should be regarded as approximate only.

The survey aimed only to provide seismic velocities as a general guide for the interpretation of the depths, and as a guide to the nature of the subsurface materials with respect to ease of excavation.

Interpretation of seismic velocities

Basically, only two velocity layers were distinguishable, although an intermediate velocity was recognised in some spreads. The time-distance (velocity) plots range from the highly asymmetrical case with stepped and inverted slope segments in the higher velocity layer, to an essentially symmetrical plot. The asymmetrical plots, with their correspondingly apparent velocity differences in the faster velocity layer, are due to the sloping and uneven interface of the bottom refractor (fig. 1).

The overall correlation of the depth and velocity ranges recorded on the sections of overlap, where both hammer and explosive methods were employed, was good.

The interpreted velocity section (fig. 1) shows a variable thickness of material with velocities of 350-450 m/s overlying a faster velocity layer averaging between 2800-4500 m/s. The lower velocity surface layer is considered to represent largely unconsolidated fill material; the higher velocity layer is interpreted as slightly weathered to fresh bedrock.

The suggestion of an intermediate velocity layer of 800-900 m/s in some spreads was based on information from two, or at the best, three geophone points only. The existence of such a layer, if real, probably represents the more consolidated sections of fill and/or extremely weathered bedrock.

DRILLING

Based on the interpretation of the seismic results, with the prospect that much of the final 100 m section of the proposed route would require blasting during excavation, it was decided to check the accuracy of the results by drilling a series of shallow auger holes either to the proposed excavation depth or to refusal on bedrock.

Nine holes were drilled; detailed descriptions of materials encountered in each hole are appended and their locations are shown in Figure 1.

Three auger holes (1, 2, and 5) proved sufficient to confirm the geophysical interpretation along the original proposed route; the depth correlation between the geophysical and drilling results was of the order of 1.0 m or better.

Two alternative routes (fig. 1) were then proposed by the Council in an attempt to avoid the necessity of having to blast during excavation. These routes, although longer, were chosen to skirt around the basement high by following the pre-fill basement shoreline (fig. 1), which would be at about the required final excavation depth. Drilling control was required to ensure that these routes did not extend too far beyond the pre-fill shoreline, where difficult excavation conditions associated with the underlying estuarine mudflats of the old bay might be encountered.

The drilling results suggest that very little blasting, if any, will be required during excavation if route 3 is adopted. Unfortunately, Hole 6 was unable to penetrate the fill, and with bedrock in Hole 4 being encountered some 2.5-3.0 m above the required excavation depth, some hard rock conditions may be encountered in this area. However, the pre-fill surface slopes to the south in this area, thus lowering the reduced level of the pre-fill basement.

From the results of Holes 2 and 9, between 1.0 m and 1.5 m of hard bedrock may also be encountered near where the pipeline finally terminates in Prince of Wales Bay.

The log of Hole 7 shows that estuarine mud and silt deposits may have been encountered at 6.0 m, suggesting that the pre-fill shoreline is in fact to the west of this location.

In contrast to the majority of holes, Tertiary sand and clay deposits were found underlying fill at 2.5 m in Hole 5. These materials are likely to persist further back along the route to the west.

EXCAVATION CONDITIONS

Much of the final 100 m section of the original proposed route would involve blasting, based on the fact that the upper seismic velocity limit of rippability for dolerite or basalt is of the order of 2000-2500 m/s.

With respect to routes 2 and 3, the drilling has confirmed that the proposed excavation would be predominantly in material comprising either fill or Tertiary sand and clay deposits. Seismically, these materials have low velocities and can be readily removed by bulldozer or traxcavator with little difficulty.

The ease of excavation of the basement rock that is anticipated to

occur along sections of the route will depend largely on the frequency and attitude of discontinuities in the material.

The design of the proposed cut will require consideration, for with a projected excavation depth of between 6.5 m and 8.5 m in largely unconsolidated materials, and with the prospect of a water table situated at about 3 m to 4 m depth (Holes 2 and 9; 3 and 8), stability problems could eventuate if water table conditions are not taken into account. Water was not recorded in other holes either during augering, or on completion of the hole.

CONCLUSIONS

Much of the final section of the original proposed route is underlain by rock at depths as shallow as 2.5 m below the existing surface, and would require extensive blasting to attain the required excavation depth of approximately eight metres.

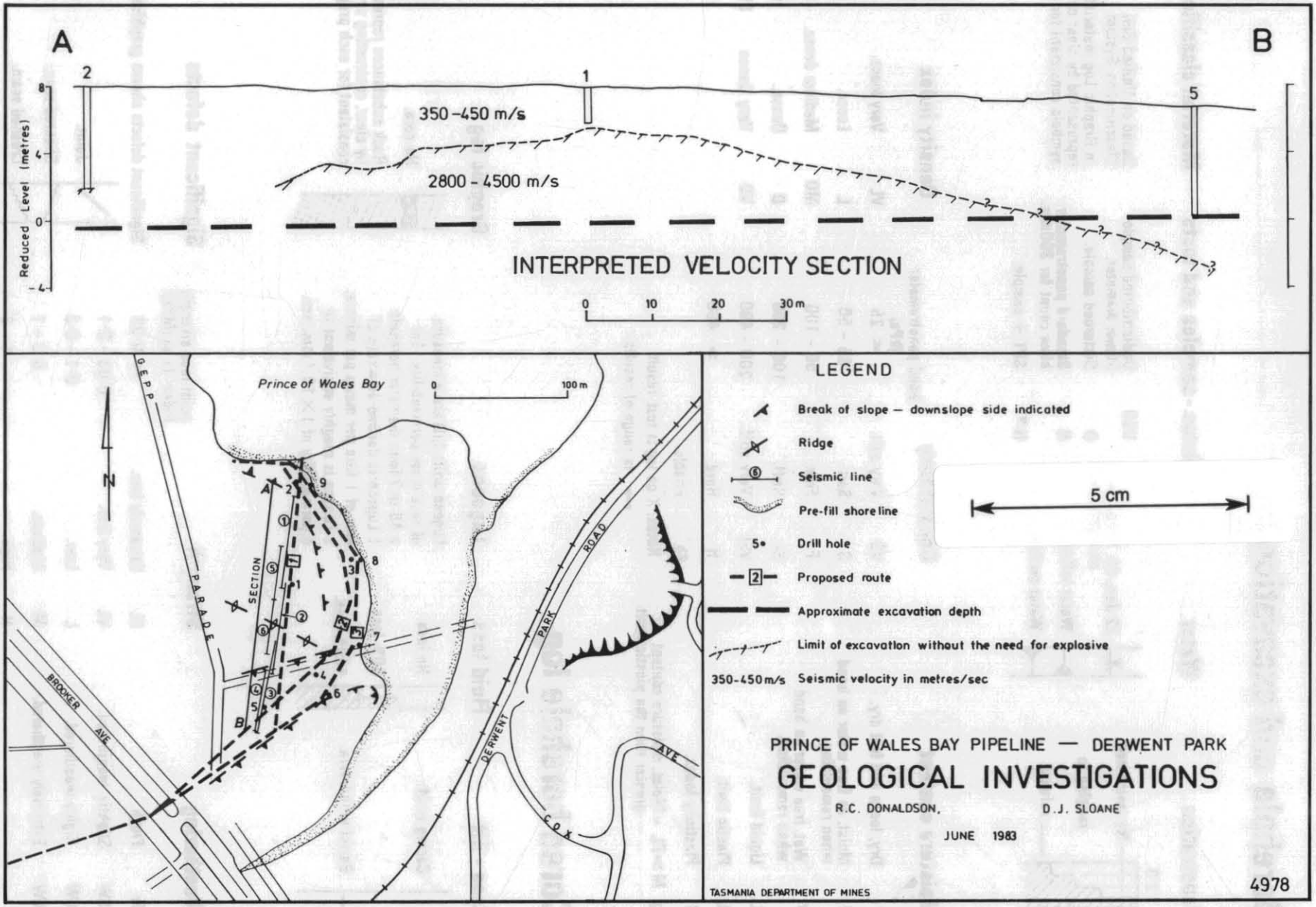
Excavation of alternative routes 2 and 3 should mainly be in unconsolidated materials comprising fill, and sand and clay deposits. Minor blasting may be necessary along small sections of these routes.

Standing water levels recorded in several of the drill holes indicate a water table at between 3 m to 4 m depth over the final section of the route; this will affect the stability of the excavation.

REFERENCE

LEAMAN, D.E. 1973. Geological atlas 1:50 000 series. Sheet 82 (8312S). Hobart. *Department of Mines, Tasmania*.

[1 June 1983]


A
B
2
1
5
8
4
0
-4
Reduced Level (metres)
350-450 m/s
2800 - 4500 m/s
INTERPRETED VELOCITY SECTION
0 10 20 30m
Prince of Wales Bay
0 100 m
N
GEPP
PARADE
SECTION
BROOKER AVE
DERWENT PARK ROAD
COX
AVE
LEGEND
Break of slope — downslope side indicated
Ridge
Seismic line
Pre-fill shoreline
Drill hole
Proposed route
Approximate excavation depth
Limit of excavation without the need for explosive
350-450 m/s Seismic velocity in metres/sec
5 cm
PRINCE OF WALES BAY PIPELINE — DERWENT PARK
GEOLOGICAL INVESTIGATIONS
R.C. DONALDSON, D.J. SLOANE
JUNE 1983
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4978

Figure 1.

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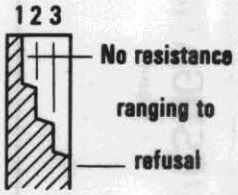
6/15

EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

5 cm

Penetration



Water

22 Jan, 80 Water level on date shown.

Water inflow.

Water outflow.

Notes - samples and tests

U50	Undistributed sample 50mm diameter.
D	Disturbed sample.
N	Standard penetrometer blow count for 300mm.
N*	SPT + sample.

Material classification

Based on Unified Soil Classification System.

In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

D	Dry, looks and feel dry.
M	Moist, no free water on hand when remoulding.
W	Wet, free water on hand when remoulding.
LL	Liquid limit.
PL	Plastic limit.
PI	Plasticity Index.

eg. M > PL – Moist, moisture content greater than the plastic limit.

Consistency

		hand penetrometer (kPa)
VS	Very soft.	< 25
S	Soft.	25 - 50
F	Firm.	50 - 100
St	Stiff.	100 - 200
VSt	Very stiff.	200 - 400
H	Hard.	> 400
Fb	Friable.	

Notes: X on log is test result

— is range of results.

Density index

		%
VL	Very loose.	0 - 15
L	Loose.	15 - 35
MD	Medium dense.	35 - 65
D	Dense.	65 - 85
VD	Very Dense	85 - 100

Cored borehole log

Case - lift

Casing used.

Barrel withdrawn.

Fluid loss

No loss

50% loss

100% loss.

Lugeons

Lugeon units (pL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log

No core.

Rock substances represented by clear, contrasting symbols consistent for each project.

Weathering

Fr	Fresh.
SW	Slightly weathered.
HW	Highly weathered.
EW	Extremely weathered.

Strength

		point load strength index $I_{s(50)}$ (MPa)
EL	Extremely low.	< 0·03
VL	Very low.	0·03 - 0·1
L	Low.	0·1 - 0·3
M	Medium.	0·3 - 1
H	High	1 - 3
VH	Very high.	3 - 10
EH	Extremely high.	>10

Note: X on log is test result.

Significant defects

Significant defects shown graphically.

Joint.

Sheared zone.

Crushed seam.

Infill seam.

Extremely weathered seam.

7/15

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 1

sheet 1 of 1

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1 drill type Triefus hole commenced 31 March 1983

drill method Auger hole completed 31 March 1983

R.L. 8.0 m drilled by B. Cox

inclination vertical drill fluid None logged by R. Donaldson

bearing - checked by D.J. Sloane

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							SM	Silty SAND - fine to medium, dark grey	M< PL			TOPSOIL
							CH	Sandy CLAY - high plasticity, mottled yellow-brown, sand fine to medium.	M > PL	F - St		FILL?
					1			gradational boundary				
		NONE					GC - CH	Clayey GRAVEL - gravelly CLAY: fine, green-grey, clay of high plasticity, some fine to medium sand. Gravel consists of fragments of weathered dolerite?	D	Fr		EXTREMELY WEATHERED BEDROCK
					2							
								DRILL REFUSED AT 2.3 m in S.W.-H.W. DOLERITE - fine-grained, green-grey, low-medium strength.				BEDROCK
					3							

8/15

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5 cm

borehole no. 2

sheet 1 of 1

ENGINEERING LOG – BOREHOLE

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1
R.L. 8.2 m
inclination vertical
bearing –

drill type Triefus
drill method Auger
drill fluid None

hole commenced 31 March 1983
hole completed 31 March 1983
drilled by B. Cox
logged by R. Donaldson
checked by D.J. Sloane

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
					1		GC	Clayey GRAVEL: fine to medium, grey-brown, rounded to sub-rounded clay of high plasticity, some fine to medium sand. Some cans, tin, wire, glass and timber.	M	MD		FILL
					2							
					3							
					4		GC – CH	Clayey GRAVEL - gravelly CLAY: fine, mottled green-grey, clay of high plasticity, some sand. Gravel consists of weathered rock and mineral fragments.	W	MD		EXTREMELY WEATHERED BEDROCK
					5							
					6				D			
								DRILL REFUSED AT 6.0 m IN H.W. DOLERITE - fine grained, green-grey, low strength.				BEDROCK

9/15

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 3

sheet 1 of 1

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1.
R.L. 7.9 m
inclination vertical
bearing -

drill type Triefus
drill method Auger
drill fluid None

hole commenced 31 March 1983
hole completed 31 March 1983
drilled by B. Cox
logged by R. Donaldson
checked by D.J. Sloane

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0		CH	Sandy CLAY: high plasticity, brown, sand fine to medium, some fine gravel.	M < PL			FILL
				1		CH	Gravelly CLAY: high plasticity, black and grey-brown, gravel fine to medium, some sand. Some metal, glass, rubber.	M > PL			
				2							
				3				W			
							N.B. Very little return beyond 3 m.				FILL?
				4							
				5							
				6							
				7			DRILL REFUSED AT 6.9 m.				

10/15

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5 cm

borehole no. 4

sheet 1 of 1

ENGINEERING LOG – BOREHOLE

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1
R.L. 6.8 m.
inclination vertical
bearing –

drill type Triefus
drill method Auger
drill fluid None

hole commenced 31 March 1983
hole completed 31 March 1983
drilled by B. Cox
logged by R. Donaldson
checked by D.J. Sloane

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				1		CH	Gravelly CLAY: high plasticity, grey to brown, gravel fine to medium, some sand, some metal, tree bark, wire, rubber.	M < PL			FILL
				2							
				3							
				4		GC – CH	Clayey GRAVEL - gravelly CLAY: fine, mottled green-grey, clay of high plasticity, some sand. Gravel consists of weathered rock fragments.				EXTREMELY WEATHERED BEDROCK
				5			DRILL REFUSED AT 4.8 m IN H.W. DOLERITE.				BEDROCK

11/15

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 5

sheet 1 of 1

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1
R.L. 6.6 m
inclination vertical
bearing –

drill type Triefus
drill method Auger
drill fluid None

hole commenced 31 March 1983
hole completed 31 March 1983
drilled by B. Cox
logged by R. Donaldson
checked by D.J. Sloane

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
					1		CH	CLAY: high plasticity, grey to brown, some sand and gravel, some metal, paper, wood fragments, bottles.	M			FILL
					2							
					3		SC	Clayey SAND: fine to medium, off-white, (quartz grains), clay of high plasticity.	M > PL	F		TERTIARY SAND AND CLAY DEPOSIT?
					4		CH	CLAY: high plasticity, mottled yellow-brown to grey-brown, some fine sand, becoming more clayey with depth.				
					5							
					6					VSt		
					7			HOLE TERMINATED AT 6.4 m - REQUIRED DEPTH.				

12/15

TASMANIA DEPARTMENT OF MINES

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 6

sheet 1 of 1

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1 drill type Triefus hole commenced 7 April 1983

drill method Auger hole completed 7 April 1983

R.L. – drilled by B. Cox

inclination vertical drill fluid None logged by R. Donaldson

bearing – checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								NINE ATTEMPTS WERE MADE TO AUGER THROUGH THE FILL, MOST HOLES TERMINATING AT DEPTHS OF 1.0 m OR LESS.				
								HOLE 6 FINALLY ABANDONED.				

13/15

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 7

sheet 1 of 1

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1.
R.L. 7.3 m.
inclination vertical
bearing –

drill type Triefus
drill method Auger
drill fluid None

hole commenced 7 April 1983
hole completed 7 April 1983
drilled by B. Cox
logged by R. Donaldson
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				1		GC	Gravelly CLAY: high plasticity, brown gravel fine to medium, some sand. Some metal, porcelain, textiles, etc.	M < PL			FILL
				3		CH – OH	CLAY: high plasticity, black, some fine to medium sand, some gravel, organic odour.	M > PL	F		
				6			Similar to above, except clay returns impregnated with oily substance.				PRE-FILL PRINCE OF WALES BAY, MUD FLATS?
				7			DRILL TERMINATED AT THE REQUIRED DEPTH OF 6.8 m.				

14/15

TASMANIA DEPARTMENT OF MINES

5 cm

borehole no. 8

sheet 1 of 1

ENGINEERING LOG – BOREHOLE

project PROPOSED STORMWATER PIPELINE location PRINCE OF WALES BAY, HOBART

co-ordinates Refer Figure 1 drill type Triefus hole commenced 7 April 1983

drill method Auger hole completed 7 April 1983

R.L. 7.8 m. drilled by B. Cox

inclination vertical drill fluid None logged by R. Donaldson

bearing – checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							SM	Silty SAND: fine to medium, brown	M< PL	L		TOPSOIL
					1		CH	Gravelly CLAY - high plasticity, black and grey-brown, gravel fine to medium, some sand, some bottles, paper, tin etc.	M > PL	St - VSt		FILL
					2							
					3			Similar to above, however, very little return below 3.0 m.	W			
					4							
					5							
					6							
					7							
							GC	Clayey GRAVEL - gravelly CLAY: fine, green-grey, clay of high plasticity, some fine to medium sand, gravel consists of fragments of weathered rock.				E.W.BEDROCK
					8			DRILL NEAR TO REFUSAL AT REQUIRED DEPTH OF 7.7 m IN EXTREMELY WEATHERED BEDROCK.				

TASMANIA DEPARTMENT OF MINES

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 9

sheet 1 of 1

project	PROPOSED STORMWATER PIPELINE		location	PRINCE OF WALES BAY, HOBART	
co-ordinates	Refer Figure 1	drill type	Triefus	hole commenced	7 April 1983
		drill method	Auger	hole completed	7 April 1983
R.L.	8.2 m			drilled by	B. Cox
inclination	vertical	drill fluid	None	logged by	R. Donaldson
bearing	-			checked by	

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
		7.4.83 ▼		1		GC	Clayey GRAVEL: fine-medium, grey-brown and black, clay of high plasticity, some fine to medium sand, some wood chips, metal, paper etc.	M > PL	MD		FILL
				2							
				3							
				4			Very little return below water table at 3.6 m.	W			
				5							
				6			RETURNS ADHERING TO AUGER FROM BOTTOM OF HOLE COMPRISED: CLAY: high plasticity, black, some fine to medium sand, trace gravel.				
				7			DRILL REFUSED AT 6.7 m ON BEDROCK?				BEDROCK?
				8							