**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

# BOREHOLE LOG

**Borehole No.** JK2 1/4

S 41° 13.120'
E 146° 19.774'

**Client:** CRADLE COAST WATER

**Project:** GEOTECHNICAL INVESTIGATION OF LANDSLIDE

**Location:** 9ML BIG KELCEY RESERVOIR, NEAR DEVONPORT, TASMANIA

**Job No.** 21508WH2 **Method:** SPIRAL AUGER HYDROPOWER SCOUT **R.L. Surface:** 111.56m

**Date:** 20-1-09 **Datum:** AHD

**Logged/Checked by:** A.J.H./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | N = 8 3,3,5 | 0 | | | FILL: Clayey silt/silty clay, low plasticity, brown mottled grey, with a trace of fine to medium grained angular XW siltstone gravel. | MC < PL | | 450<br>>600<br>>600 | GRASS COVER ROOT FIBRES TO 20mm DEPTH<br><br>APPEARS MODERATELY COMPACTED |
| | | | | | N = 10 4,5,5 | 1 | | | | | | 550<br>>600<br>>600 | APPEARS WELL COMPACTED |
| | | | | | N = 11 4,5,6 | 2 | | | as above, but brown, with a trace of ash. | | | >600<br>>600<br>>600 | |
| | | | | | N = 19 4,8,11 | 3 | | | as above, but brown mottled light grey, without ash, with a trace of shale cobbles (to 80mm size). | | | >600<br>>600<br>>600 | |
| | | | | | N = 12 5,6,6 | 4 | | | FILL: Silty clay, low plasticity, brown mottled grey, with fine to medium grained angular XW siltstone gravel. | | | 380<br>360<br>450 | |
| | | | | | N = 12 3,6,6 | 5 | | - | SILTSTONE: grey brown, with clay seams. | XW | EL | - | TOO FRIABLE FOR HP TESTING<br><br>INFERRED LANDSLIDE DEBRIS BELOW 6.0m DEPTH |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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# BOREHOLE LOG

**Borehole No.** JK2 2/4

S 41° 13.120'
E 146° 19.774'

**Client:** CRADLE COAST WATER

**Project:** GEOTECHNICAL INVESTIGATION OF LANDSLIDE

**Location:** 9ML BIG KELCEY RESERVOIR, NEAR DEVONPORT, TASMANIA

**Job No.** 21508WH2 **Method:** SPIRAL AUGER HYDROPOWER SCOUT **R.L. Surface:** 111.56m

**Date:** 20-1-09 **Datum:** AHD

**Logged/Checked by:** A.J.H./BRD.

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ■ | N = 8<br>3,4,4 | | | | SILTSTONE: grey brown, with clay seams. | XW | EL | | INFERRED LANDSLIDE DEBRIS |
| | | | | | | | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 8 | | | | | | | |
| | | | | | | 9 | | | | | | | |
| | | | | | | 10 | | | | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

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Borehole No. **JK2** 3/4

# CORED BOREHOLE LOG

**Client:** CRADLE COAST WATER

**Project:** GEOTECHNICAL INVESTIGATION OF LANDSLIDE

**Location:** 9ML BIG KELCEY RESERVOIR, NEAR DEVONPORT, TASMANIA

**Job No.** 21508WH2 **Core Size:** HQ **R.L. Surface:** 111.56m

**Date:** 20-1-09 **Inclination:** VERTICAL **Datum:** AHD

**Drill Type:** HYDROPOWER SCOUT **Bearing:** - **Logged/Checked by:** A.J.H./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH | DEFECT SPACING (mm) 500 300 100 50 30 10 | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | | START CORING AT 7.45m | | | | | |
| | | 8 | | SHALE: dark grey. No apparent bedding. Frequent clay seams and crushed seams. | XW | EL | | | INFERRED LANDSLIDE DEBRIS TO APPROXIMATELY 11.6m DEPTH<br>- L-M STRENGTH SEAM, 100mm.t<br>- 10mm SIZE QUARTZ GRAVEL INCLUSION |
| | | | | CORE LOSS 0.90m | - | - | | | |
| ▼ ON 21-1-09 | | 9 | | Shale and siltstone gravel, in a silty clay matrix. | DW | L-M | | | |
| | | | | CORE LOSS 0.80m | - | - | | | |
| 50% RET-URN | | 10 | | SILTSTONE: grey, fragmented. | DW | L-M | | | - POSSIBLE SHEAR PLANE, 60°, CLAY INFILL, 10mm.t<br>- CS, 80mm.t |
| | | 11 | | CORE LOSS 0.54m | - | - | | | |
| | | 12 | | SILTSTONE: light brown, bedded at 0-10°. | XW | EL | | | |
| | | | | SHALE: grey, fractured. | DW | VL | | | |
| | | | | SHALE: light grey. | XW | EL | | | |
| | | 13 | | SILTSTONE: light grey and grey, bedded at 0 to 5°. | DW | L | × | | - CS, 30mm.t<br>- CS, 25mm.t<br>- J, 55°, P, R |
| | | | | CORE LOSS 0.10m | | | | | |
| | | | | SILTSTONE: light grey and brown, bedded at 0-5°. | XW | EL | × | | - CS, 30mm.t |

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Borehole No. **JK2** 4/4

# CORED BOREHOLE LOG

**Client:** CRADLE COAST WATER

**Project:** GEOTECHNICAL INVESTIGATION OF LANDSLIDE

**Location:** 9ML BIG KELCEY RESERVOIR, NEAR DEVONPORT, TASMANIA

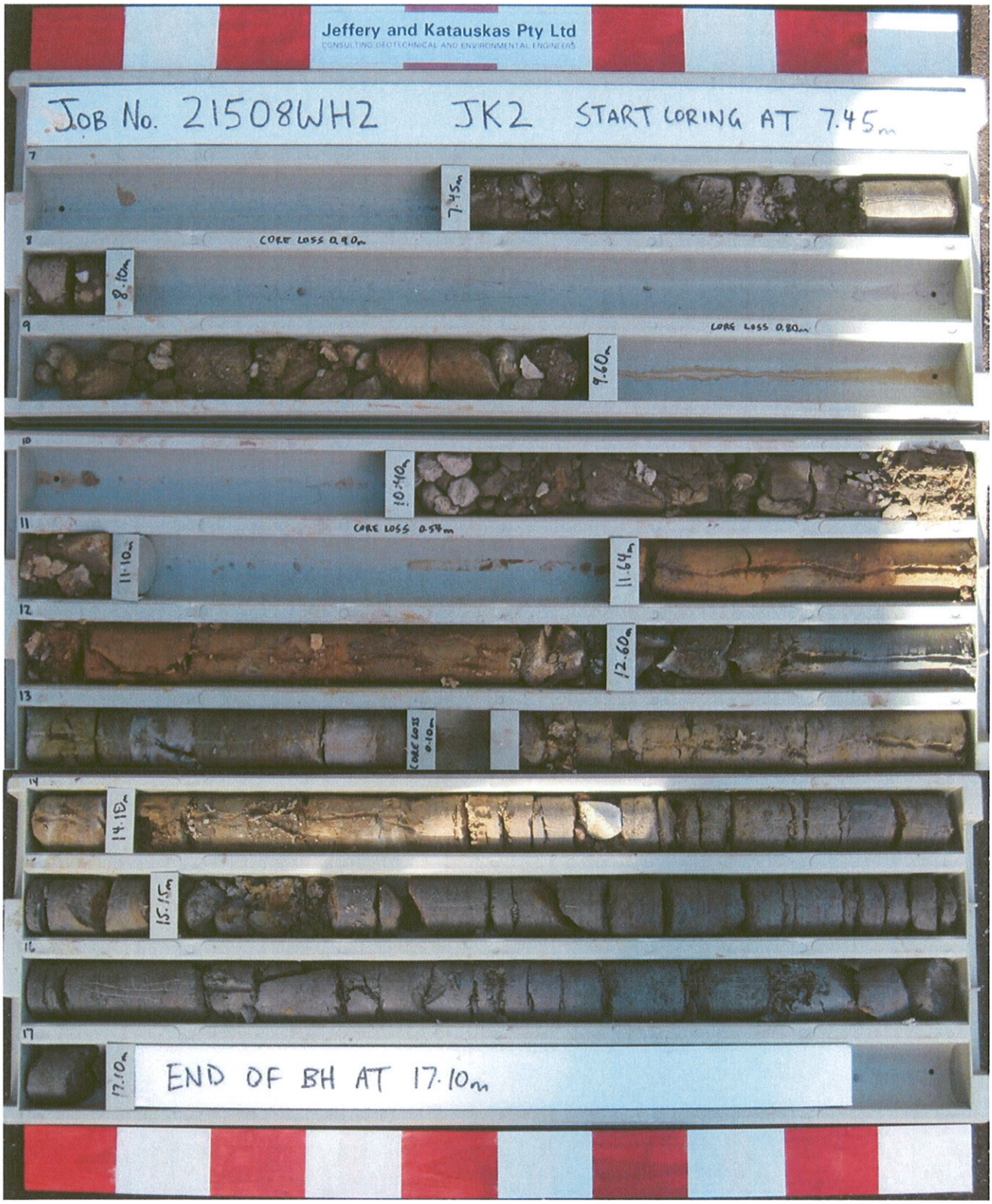
**Job No.** 21508WH2 **Core Size:** HQ **R.L. Surface:** 111.56m

**Date:** 20-1-09 **Inclination:** VERTICAL **Datum:** AHD

**Drill Type:** HYDROPOWER SCOUT **Bearing:** - **Logged/Checked by:** A.J.H./BPC.

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (EL VL L M H VH EH) | DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| 50% RET-URN | | 15 | | SILTSTONE: light grey and brown, bedded at 0-5°. | XW-DW | EL-VL | | | |
| | | | | INTERBEDDED SILTY CLAY: high plasticity, and SILTSTONE: light grey. | XW/MC<PL | EL/(H) | | | - CS, 20mm.t<br>- Cr, 50mm.t<br>- Cr, 0°, P, R, IS |
| | | | | SILTSTONE: light grey, bedded at 0-5°. | DW | L-M | | | - Cr, 200mm.t |
| | | 16 | | | SW | | | | - J, 30°, P, R, IS<br>- J, 40°, P, R, IS |
| | | 17 | | | | | | | - CS, 50mm.t<br>- J, 80°, P, R<br>- J, 50°, P, R<br>- XWS, 10mm.t<br>- Cr, 15mm.t<br>- J, 50°, P, R<br>- Cr, 30mm.t |
| | | | | END OF BOREHOLE AT 17.10m | | | | | BOREHOLE INCLINOMETER INSTALLED TO 16.0m DEPTH |
| | | 18 | | | | | | | |
| | | 19 | | | | | | | |
| | | 20 | | | | | | | |

Ref: 21508WH2
Borehole JK2



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# GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

## SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

## ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

## DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

## OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

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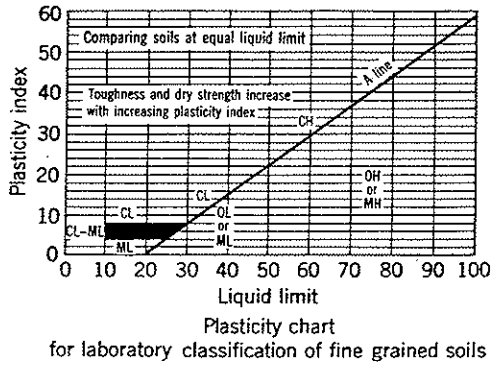
# UNIFIED SOIL CLASSIFICATION TABLE

| Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights) | | | | | | Group Symbols[a] | Typical Names | Information Required for Describing Soils | Laboratory Classification Criteria |
|---|---|---|---|---|---|---|---|---|---|
| Coarse-grained soils: More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye) | Gravels: More than half of coarse fraction is larger than 4 mm sieve size | Clean gravels (little or no fines) | Wide range in grain size and substantial amounts of all intermediate particle sizes | | | *GW* | Well graded gravels, gravel-sand mixtures, little or no fines | Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses<br>For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics<br>Example:<br>*Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*) | Use grain size curve in identifying the fractions as given under field identification<br>Determine percentages of gravel and sand from grain size curve<br>Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:<br>Less than 5% — *GW, GP, SW, SP*<br>More than 12% — *GM, GC, SM, SC*<br>5% to 12% — *Borderline* cases requiring use of dual symbols<br>$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | | *GP* | Poorly graded gravels, gravel-sand mixtures, little or no fines | | Not meeting all gradation requirements for *GW* |
| | | Gravels with fines (appreciable amount of fines) | Nonplastic fines (for identification procedures see *ML* below) | | | *GM* | Silty gravels, poorly graded gravel-sand-silt mixtures | | Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols |
| | | | Plastic fines (for identification procedures, see *CL* below) | | | *GC* | Clayey gravels, poorly graded gravel-sand-clay mixtures | | Atterberg limits above "A" line, with *PI* greater than 7 |
| | Sands: More than half of coarse fraction is smaller than 4 mm sieve size | Clean sands (little or no fines) | Wide range in grain sizes and substantial amounts of all intermediate particle sizes | | | *SW* | Well graded sands, gravelly sands, little or no fines | | $C_U = \frac{D_{60}}{D_{10}}$ Greater than 6<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | | *SP* | Poorly graded sands, gravelly sands, little or no fines | | Not meeting all gradation requirements for *SW* |
| | | Sands with fines (appreciable amount of fines) | Nonplastic fines (for identification procedures, see *ML* below) | | | *SM* | Silty sands, poorly graded sand-silt mixtures | | Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols |
| | | | Plastic fines (for identification procedures, see *CL* below) | | | *SC* | Clayey sands, poorly graded sand-clay mixtures | | Atterberg limits below "A" line with *PI* greater than 7 |
| Fine-grained soils: More than half of material is *smaller* than 75 μm sieve size | Identification Procedures on Fraction Smaller than 380 μm Sieve Size | | Dry Strength (crushing characteristics) | Dilatancy (reaction to shaking) | Toughness (consistency near plastic limit) | | | | |
| | Silts and clays: liquid limit less than 50 | | None to slight | Quick to slow | None | *ML* | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity | Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses<br>For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions<br>Example:<br>*Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*) | |
| | | | Medium to high | None to very slow | Medium | *CL* | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| | | | Slight to medium | Slow | Slight | *OL* | Organic silts and organic silt-clays of low plasticity | | |
| | Silts and clays: liquid limit greater than 50 | | Slight to medium | Slow to none | Slight to medium | *MH* | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | | |
| | | | High to very high | None | High | *CH* | Inorganic clays of high plasticity, fat clays | | |
| | | | Medium to high | None to very slow | Slight to medium | *OH* | Organic clays of medium to high plasticity | | |
| Highly Organic Soils | | | Readily identified by colour, odour, spongy feel and frequently by fibrous texture | | | *Pt* | Peat and other highly organic soils | | |




Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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## LOG SYMBOLS

| LOG COLUMN | SYMBOL | DEFINITION |
|---|---|---|
| Groundwater Record |  | Standing water level. Time delay following completion of drilling may be shown. |
| |  | Extent of borehole collapse shortly after drilling. |
| |  | Groundwater seepage into borehole or excavation noted during drilling or excavation. |
| Samples | ES | Soil sample taken over depth indicated, for environmental analysis. |
| | U50 | Undisturbed 50mm diameter tube sample taken over depth indicated. |
| | DB | Bulk disturbed sample taken over depth indicated. |
| | DS | Small disturbed bag sample taken over depth indicated. |
| | ASB | Soil sample taken over depth indicated, for asbestos screening. |
| | ASS | Soil sample taken over depth indicated, for acid sulfate soil analysis. |
| | SAL | Soil sample taken over depth indicated, for salinity analysis. |
| Field Tests | N = 17<br>4, 7, 10 | Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below. |
| | $N_c$ = 5<br>7<br>3R | Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment. |
| | VNS = 25 | Vane shear reading in kPa of Undrained Shear Strength. |
| | PID = 100 | Photoionisation detector reading in ppm (Soil sample headspace test). |
| Moisture Condition (Cohesive Soils) | MC>PL | Moisture content estimated to be greater than plastic limit. |
| | MC≈PL | Moisture content estimated to be approximately equal to plastic limit. |
| | MC<PL | Moisture content estimated to be less than plastic limit. |
| (Cohesionless Soils) | D | DRY - runs freely through fingers. |
| | M | MOIST - does not run freely but no free water visible on soil surface. |
| | W | WET - free water visible on soil surface. |
| Strength (Consistency) Cohesive Soils | VS | VERY SOFT - Unconfined compressive strength less than 25kPa |
| | S | SOFT - Unconfined compressive strength 25-50kPa |
| | F | FIRM - Unconfined compressive strength 50-100kPa |
| | St | STIFF - Unconfined compressive strength 100-200kPa |
| | VSt | VERY STIFF - Unconfined compressive strength 200-400kPa |
| | H | HARD - Unconfined compressive strength greater than 400kPa |
| | ( ) | Bracketed symbol indicates estimated consistency based on tactile examination or other tests. |
| Density Index/ Relative Density (Cohesionless Soils) | | **Density Index (Id) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** |
| | VL | Very Loose <15 0-4 |
| | L | Loose 15-35 4-10 |
| | MD | Medium Dense 35-65 10-30 |
| | D | Dense 65-85 30-50 |
| | VD | Very Dense >85 >50 |
| | ( ) | Bracketed symbol indicates estimated density based on ease of drilling or other tests. |
| Hand Penetrometer Readings | 300<br>250 | Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise. |
| Remarks | 'V' bit | Hardened steel 'V' shaped bit. |
| | 'TC' bit | Tungsten carbide wing bit. |
| | T 60 | Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers. |

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# LOG SYMBOLS

## ROCK MATERIAL WEATHERING CLASSIFICATION

| TERM | SYMBOL | DEFINITION |
|---|---|---|
| Residual Soil | RS | 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. |
| Extremely weathered rock | XW | Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water. |
| Distinctly weathered rock | DW | Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. |
| Slightly weathered rock | SW | Rock is slightly discoloured but shows little or no change of strength from fresh rock. |
| Fresh rock | FR | Rock shows no sign of decomposition or staining. |

## ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

| TERM | SYMBOL | Is (50) MPa | FIELD GUIDE |
|---|---|---|---|
| Extremely Low: | EL | 0.03 | Easily remoulded by hand to a material with soil properties. |
| Very Low: | VL | 0.1 | May be crumbled in the hand. Sandstone is "sugary" and friable. |
| Low: | L | 0.3 | A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling. |
| Medium Strength: | M | 1 | A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife. |
| High: | H | 3 | A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer. |
| Very High: | VH | 10 | A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer. |
| Extremely High: | EH | | A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer. |

## ABBREVIATIONS USED IN DEFECT DESCRIPTION

| ABBREVIATION | DESCRIPTION | NOTES |
|---|---|---|
| Be | Bedding Plane Parting | Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes) |
| CS | Clay Seam | |
| J | Joint | |
| P | Planar | |
| Un | Undulating | |
| S | Smooth | |
| R | Rough | |
| IS | Ironstained | |
| XWS | Extremely Weathered Seam | |
| Cr | Crushed Seam | |
| 60t | Thickness of defect in millimetres | |