# Appendix A

**Borehole Logs and Explanation Sheets**

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# Engineering Log - Borehole

| | |
|---|---|
| Borehole No. | ***BH1*** |
| Sheet | 1 of 4 |
| Project No: | ***GEOTALST01597AB*** |
| Client: ***CHAMPIONS QUARRY*** | Date started: ***12.10.2007*** |
| Principal: | Date completed: ***12.10.2007*** |
| Project: ***RESOURCE ESTIMATE*** | Logged by: ***ALB*** |
| Borehole Location: ***NEAR EXISTING QUARRY*** | Checked by: |

drill model and mounting: PIONEER 160 4wd ISUZU | Easting: 531336 | slope: -90° | R.L. Surface: 29.3

hole diameter: 100 mm | Northing 6798300 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetrometer kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | CM | | | 29 | | | SC | **TOPSOIL:** Sandy Clay, medium plasticity, dark brown, sand is fine to medium grained<br>pp=80kPa | M | F | × | TOPSOIL/COLLUVIUM |
| | | | | D | | 1 | | CH | **Silty CLAY:** medium plasticity, pale orange<br>pp=150kPa | | St | × | RESIDUAL SOIL |
| | | | | | 28 | 2 | | | Borehole BH1 continued as cored hole | | | | |
| | | | | | 27 | 3 | | | | | | | |
| | | | | | 26 | 4 | | | | | | | |
| | | | | | 25 | 5 | | | | | | | |
| | | | | | 24 | 6 | | | | | | | |
| | | | | | 23 | 7 | | | | | | | |
| | | | | | 22 | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil
C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown
water inflow
water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

BOREHOLE GEOTCOFH01597AB.GPJ COFFEY.GDT 22.1.08

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# Engineering Log - Cored Borehole

Borehole No. **BH1**

Sheet 2 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***12.10.2007***

Principal:

Date completed: ***12.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NEAR EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531336 | slope: -90° | R.L. Surface: 29.3

hole diameter: 100 mm Drilling fluid: | Northing: 6798300 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 29 | 1 | | Continued from non-cored borehole | | | | | | |
| NMLC | | | 28 | 2 | | **Silty CLAY:** high plasticity, brown to pale grey, with traces of fine grained sand, very stiff to hard<br>pp=310kPa<br>pp=600kPa | RS | | | | | |
| | | | | | | **SANDSTONE:** fine to medium grained, orange/red to pale grey, distinctly bedded fining upwards | EW<br>HW | | D 0.28 A 0.37 | 65 | | PT, 20°, PL, RO, CO, Clay<br>PT, 20°, PL, RO, CN |
| | | | 27 | 3 | | | | | | | | |
| | | | 26 | 4 | | | | | D 0.21 A 0.18 | | | |
| | | | 25 | 5 | | Colour change to pink | MW | | | | | SM, 60°, PL, SO, Clay, 150 mm |
| | | | 24 | 6 | | | | | D 0.52 A 0.54 | 92 | | |
| | | | 23 | 7 | | colour change to pale orange | | | | | | |
| | | | 22 | 8 | | Colour change to pale grey at 6.5 m. | | | D 0.79 A 0.65 | 75 | | JT, 65°, PL, RO, CN |
| | | | | | | | | | D A | | | |

General: PT, 20°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH1**

Sheet 3 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***12.10.2007***

Principal:

Date completed: ***12.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NEAR EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531336 | slope: -90° | R.L. Surface: 29.3

hole diameter: 100 mm | Drilling fluid: | Northing: 6798300 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular | general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 21 | | | **SANDSTONE:** fine to medium grained, orange/red to pale grey, distinctly bedded fining upwards *(continued)* | MW | M | 0.49 0.39 | 78 | | SM, 85°, IR, SO, Clay, 8 mm | |
| | | | | | | | | | | | | SM, 81°, IR, SO, Clay, 5 mm | |
| | | | | | | **SILTSTONE:** grey, indistinctly bedded | | L | | | | | |
| | | | | 9 | | **SANDSTONE:** fine to medium grained, pale grey, distinctly bedded | | M | | | | | |
| | | | 20 | | | Colour change to orange/red from 9.2 to 10.5 m. | | | D A 0.5 0.58 | | | | |
| | | | | 10 | | | | | | 84 | | | General: PT, 20°, PL, RO, CN |
| | | | 19 | | | | | | | | | JT, 64°, PL, RO, CN | |
| | | 3.30PM 12/010/07 | | 11 | | | | | D A 0.1 0.12 | | | | |
| | | | 18 | | | | | | | | | | |
| | | | | 12 | | | | | | 62 | | | |
| | | | 17 | | | | | | D A 0.07 0.09 | | | | |
| | | | | 13 | | | | | | | | | |
| | | | 16 | | | | | | | 98 | | | |
| | | | | | | Biotite pn parting faces from 13.7-14.8 m. | | | | | | PT, 13°, PL, RO, CO BIOTITE | |
| | | | | 14 | | | | | D A 0.64 0.74 | | | PT, 15°, PL, RO, CO, BIOTITE | |
| | | | 15 | | | Colour change to orange at 14.3 m. | | | | | | JT, 78°, PL, RO, CN | General: PT, 12-17°, PL, RP, CN |
| | | | | 15 | | | | | | | | | |
| | | | 14 | | | | | | D A 0.23 0.21 | 86 | | | |
| | | | | 16 | | | | | | | | | |

**method**
DT diatube; AS auger screwing; AD auger drilling; RR roller/tricone; CB claw or blade bit; NMLC NMLC core; NQ, HQ, PQ wireline core

**core-lift**
casing used; barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material; no core recovered

**water**
10/1/98 water level on date shown; water inflow; partial drill fluid loss; complete drill fluid loss; water pressure test result (lugeons) for depth interval shown (25)

**weathering**
FR fresh; SW slightly weathered; MW moderately weathered; HW highly weathered; XW extremely weathered; DW distinctly weathered (covers MW and HW)

**strength**
VL very low; L low; M medium; H high; VH very high; EH extremely high

**defect type**
JT joint; PT parting; SM seam; SZ sheared zone; SS sheared surface; CS crushed seam

**planarity**
PL planar; CU curved; UN undulating; ST stepped; IR irregular

**roughness**
VR very rough; RO rough; SO smooth; SL slickensided

**coating**
CN clean; SN stained; VN veneer; CO coating

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# Engineering Log - Cored Borehole

Borehole No. **BH1**

Sheet 4 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***12.10.2007***

Principal:

Date completed: ***12.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NEAR EXISTING QUARRY***

Checked by:

drill model & mounting:PIONEER 160 4wd ISUZU | Easting: 531336 | slope: -90° | R.L. Surface: 29.3

hole diameter: 100 mm Drilling fluid: | Northing: 6798300 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 13 | 17 | | **SANDSTONE:** fine to medium grained, pale grey, distinctly bedded *(continued)* | MW / HW | | D 0.02 A 0.04 | 86 | | |
| | | | 12 | | | | | | | | | |
| | | | | 18 | | **NO CORE=0.90 m** | | | | | | |
| | | | 11 | | | | | | | | | |
| | | | | 19 | | **SANDSTONE:** medium to fine grained, pale grey | HW / MW | | D 0.14 A 0.16 | 65 | | General: PT, 12-17°, PL, RP, CN |
| | | | 10 | | | | | | D 0.57 A 0.35 | | | |
| | | | | 20 | | | | | D 2.9 A 2.59 | | | |
| | | | 9 | | | | | | | | | |
| | | | | 21 | | BH1 terminated at 20.3 m due to limit of required investigation. BH1 terminated at 20.3m | | | | | | |
| | | | 8 | | | | | | | | | |
| | | | | 22 | | | | | | | | |
| | | | 7 | | | | | | | | | |
| | | | | 23 | | | | | | | | |
| | | | 6 | | | | | | | | | |
| | | | | 24 | | | | | | | | |

**method**
DT diatube; AS auger screwing; AD auger drilling; RR roller/tricone; CB claw or blade bit; NMLC NMLC core; NQ, HQ, PQ wireline core

**core-lift**
casing used; barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material; no core recovered

**water**
10/1/98 water level on date shown; water inflow; partial drill fluid loss; complete drill fluid loss; 25 water pressure test result (lugeons) for depth interval shown

**weathering**
FR fresh; SW slightly weathered; MW moderately weathered; HW highly weathered; XW extremely weathered; DW distinctly weathered (covers MW and HW)

**strength**
VL very low; L low; M medium; H high; VH very high; EH extremely high

**defect type**
JT joint; PT parting; SM seam; SZ sheared zone; SS sheared surface; CS crushed seam

**planarity**
PL planar; CU curved; UN undulating; ST stepped; IR irregular

**roughness**
VR very rough; RO rough; SO smooth; SL slickensided

**coating**
CN clean; SN stained; VN veneer; CO coating

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# Engineering Log - Borehole

Borehole No. **BH2**

Sheet 1 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***15.10.2007***

Principal:

Date completed: ***15.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NORTH OF EXISTING QUARRY***

Checked by:

drill model and mounting: PIONEER 160 4wd ISUZU | Easting: 531199 | slope: -90° | R.L. Surface: 28.7

hole diameter: 100 mm | Northing 6798403 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetro-meter kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | C | | | | | | SW | **TOPSOIL:** Sand, medium grained, orange/brown, with traces of CH clay and organics | M | L | | TOPSOIL/COLLUVIUM |
| | | | | | 28 | 1 | | SP | **SAND:** fine to medium grained, pale orange/brown, cobbles at 0.6 m with traces of medium plasticity clay | | MD | | RESIDUAL SOIL |
| | | | | | | | | | Borehole BH2 continued as cored hole | | | | |
| | | | | | 27 | 2 | | | | | | | |
| | | | | | 26 | 3 | | | | | | | |
| | | | | | 25 | 4 | | | | | | | |
| | | | | | 24 | 5 | | | | | | | |
| | | | | | 23 | 6 | | | | | | | |
| | | | | | 22 | 7 | | | | | | | |
| | | | | | 21 | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil

C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown

water inflow

water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

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# Engineering Log - Cored Borehole

Borehole No. **BH2**

Sheet 2 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***15.10.2007***

Principal:

Date completed: ***15.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NORTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531199 | slope: -90° | R.L. Surface: 28.7

hole diameter: 100 mm | Drilling fluid: | Northing: 6798403 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 28 | 1 | | Continued from non-cored borehole | | | | | | |
| NMLC | | | | | | **SAND:** fine to coarse grained, brown/orange | RS / XW | | | | | |
| | | | 27 | 2 | | **SANDSTONE:** fine grained, orange and pale grey, distinctly bedded, remoulds to SP-fine grained sand, with some medium plasticity clay<br>pp=240kPa | | | | 0 | | SM, 20°, PL, SO, Clay, 80 mm |
| | | | 26 | 3 | | | | | | | | |
| | | 8.50 AM 16/10/07 | | | | pp=160kPa | | | | | | |
| | | | 25 | 4 | | **SILTSTONE:** white, indistinctly laminated, remoulds to a low plasticity clayey silt, very stiff | | | | 10 | | PT, 7°, PL, SO, CN |
| | | | | | | **SANDSTONE:** fine to coarse grained, pale grey, remoulds to SW, sandstone | | | | | | |
| | | | 24 | | | **SILTSTONE:** pale grey, laminated | HW | | | | | PT, 3°, PL, SO, CN |
| | | | | 5 | | pp=250kPa<br>**SANDSTONE:** fine to coarse grained, pale orange, distinctly bedded, fining upwards | | | | | | |
| | | | | | | **NO CORE=0.10 m** | | | | | | |
| | | | 23 | | | **SANDSTONE:** fine to coarse grained, orange to pale grey, distinctly bedded | HW | | | | | SM, 6°, L, SO, Clay, 80 mm<br>SM, 4°, PL, SO, Clay, 20 mm |
| | | | | 6 | | pp=100kPa<br>Colour change to pale grey at 6.1 m. | MW | | D 0.79 A 1.9 | 62 | | SM, 5°, PL, SO, Clay, 80 mm |
| | | | 22 | | | | | | | | | |
| | | | | 7 | | | | | | | | PT, 5°, PL, RO, CN |
| | | | 21 | | | | | | D 0.18 A 0.17 | 95 | | |
| | | | | 8 | | | | | | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH2**

Sheet 3 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***15.10.2007***

Principal:

Date completed: ***15.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NORTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531199 | slope: -90° | R.L. Surface: 28.7

hole diameter: 100 mm Drilling fluid: | Northing: 6798403 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 20 | 9 | | **SANDSTONE:** fine to coarse grained, orange to pale grey, distinctly bedded *(continued)* | SW | | D 1.09 A 2.04 | 95 | | |
| | | | 19 | 10 | | Sandstone is medium to coarse grained from 10-12.25 m, fining upwards. | | | | | | |
| | | | 18 | | | | | | D 0.66 A 1.08 | | | |
| | | | | 11 | | | MW | | | 96 | | |
| | | | 17 | | | | | | | | | CS, 5°, IR, RO, 25 mm<br>PT, 6°, PL SO, CO, Fe |
| | | | | 12 | | | | | D 0.89 A 1.11 | | | |
| | | | | | | | SW | | | | | |
| | | | 16 | 13 | | | | | | | | |
| | | | 15 | | | | | | D 1.11 A 3.43 | 96 | | |
| | | | | 14 | | | | | | | | |
| | | | 14 | | | | | | | | | |
| | | | | 15 | | | | | D 1.32 A 3.07 | | | |
| | | | 13 | | | Colour change to orange from 15.6 to 16.05 m. | MW | | | 85 | | |
| | | | | 16 | | | | | | | | |

**method**
DT diatube
AS auger screwing
AD auger drilling
RR roller/tricone
CB claw or blade bit
NMLC NMLC core
NQ, HQ, PQ wireline core

**core-lift**
casing used
barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material
no core recovered

**water**
10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
25 water pressure test result (lugeons) for depth interval shown

**weathering**
FR fresh
SW slightly weathered
MW moderately weathered
HW highly weathered
XW extremely weathered
DW distinctly weathered (covers MW and HW)

**strength**
VL very low
L low
M medium
H high
VH very high
EH extremely high

**defect type**
JT joint
PT parting
SM seam
SZ sheared zone
SS sheared surface
CS crushed seam

**planarity**
PL planar
CU curved
UN undulating
ST stepped
IR irregular

**roughness**
VR very rough
RO rough
SO smooth
SL slickensided

**coating**
CN clean
SN stained
VN veneer
CO coating

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH2**

Sheet 4 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***15.10.2007***

Principal:

Date completed: ***15.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***NORTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531199 | slope: -90° | R.L. Surface: 28.7

hole diameter: 100 mm | Drilling fluid: | Northing: 6798403 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 12 | 17 | | **SANDSTONE:** fine to coarse grained, orange to pale grey, distinctly bedded *(continued)* Colour change to pale grey at 16.05 m. | HW / SW | | D 0.69 A 0.59 | 85 | | SM, 4°, PL, SO, Clay, 40 mm; CS, 5°, PL, RO, CN |
| | | | 11 | 18 | | | | | D 0.59 A 0.66 | | | |
| | | | 10 | 19 | | | | | | 100 | | General: PT, 3 to 8°, PL, RO, CN |
| | | | 9 | 20 | | **SILTSTONE:** dark grey, laminated coaliferous; **SANDSTONE:** fine to medium grained, grey; **SILTSTONE:** dark grey, laminated BH2 terminated due to limit of required investigation. BH2 terminated at 20.3m | | | D 0.79 A 1.26 | | | |
| | | | 8 | 21 | | | | | | | | |
| | | | 7 | 22 | | | | | | | | |
| | | | 6 | 23 | | | | | | | | |
| | | | 5 | 24 | | | | | | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Borehole

Borehole No. **BH3**

Sheet 1 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***16.10.2007***

Principal:

Date completed: ***16.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***EASTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model and mounting: PIONEER 160 4wd ISUZU | Easting: 531657 | slope: -90° | R.L. Surface: 36.2

hole diameter: 100 mm | Northing 6797945 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetro-meter kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | CM | | | 36 | | | SC | **TOPSOIL:** Clayey Sand, fine to coarse grained, dark brown, clay is medium plasticity, traces of rootlets and organics | M | L | | RESIDUAL TOPSOIL |
| | | | | | | | | SP | **SAND:** fine to medium grained, orange/brown, traces of very low strength sandstone | | D | | EXTREMELY WEATHERED ROCK |
| | | | | | | 1 | | | | | VD | | |
| | | | | | 35 | | | SP | **SAND:** fine to medium grained, pale orange/brown, with trace of medium plasticity clay | | | | |
| | | | | | | | | | Borehole BH3 continued as cored hole | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | 34 | | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | 33 | | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | 32 | | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | 31 | | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | 30 | | | | | | | | |
| | | | | | | 7 | | | | | | | |
| | | | | | 29 | | | | | | | | |
| | | | | | | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil

C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown

water inflow

water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

BOREHOLE GEOTCOFH01597AB.GPJ COFFEY.GDT 22.1.08

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# Engineering Log - Cored Borehole

Borehole No. **BH3**

Sheet 2 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***16.10.2007***

Principal:

Date completed: ***16.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***EASTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531657 | slope: -90° | R.L. Surface: 36.2

hole diameter: 100 mm Drilling fluid: | Northing: 6797945 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 36 | 1 | | | | | | | | |
| | | | 35 | | | Continued from non-cored borehole | | | | | | |
| NMLC | | | | 2 | | **SANDSTONE:** fine to medium grained, pale orange to pale grey and red, indistinctly bedded | HW | | D 0.02 A 0.03 | 97 | | PT, 14°, PL, RO CO, Fe |
| | | | 34 | | | | | | | | | |
| | | | | 3 | | | | | | | | PT, 16°, PL, RO, CN |
| | | | 33 | | | | | | | | | |
| | | | | 4 | | **SILTSTONE:** pale grey, interbedded with 100 mm width sandstone interbedded, fine grained | | | D 0.02 A 0.03 | | | |
| | | | | | | **SANDSTONE:** fine to medium grained, white and pink to pale grey, distinctly bedded | MW | | | | | PT, 3°, PL, RO, CN; PT |
| | | | 32 | | | | | | | | | |
| | | 17/10/2007 | | 5 | | Colour change to pale grey from 5.0m | SW | | | 86 | | PT |
| | | | 31 | | | | | | D 2.56 A 3.96 | | | JT, 39°, CU,, RO, CO, Fe |
| | | | | 6 | | | | | | | | |
| | | | 30 | | | | | | | | | JT, 2°, PL, RO, CO, Fe |
| | | | | 7 | | | | | D 2.56 A 2.91 | | | |
| | | | 29 | | | | | | D 3.75 A 3.7 | 100 | | |
| | | | | 8 | | | | | | | | |

General: PT, 10-15°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH3**
Sheet 3 of 4
Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY*** Date started: ***16.10.2007***
Principal: Date completed: ***16.10.2007***
Project: ***RESOURCE ESTIMATE*** Logged by: ***ALB***
Borehole Location: ***EASTERN EXTENT OF PROPOSED QUARRY*** Checked by:

drill model & mounting:PIONEER 160 4wd ISUZU Easting: 531657 slope: -90° R.L. Surface: 36.2
hole diameter: 100 mm Drilling fluid: Northing: 6797945 bearing: datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 28 | 9 | | **SANDSTONE:** fine to medium grained, white and pink to pale grey, distinctly bedded *(continued)* | SW | | D 4.25 A 5 | 100 | | |
| | | | 27 | | | | | | | | | |
| | | | | 10 | | **SANDSTONE:** fine to medium grained, banded orange-brown and red-brown | HW | | D 2.23 A 2.15 | | | |
| | | | 26 | | | | | | | | | |
| | | | | 11 | | | | | | 94 | | |
| | | | 25 | | | Fine to coarse grained from 11.5 m. | | | | | | |
| | | | | 12 | | | | | D 2.23 A 3.13 | | | |
| | | | 24 | | | | | | | | | |
| | | | | 13 | | | | | D 0.87 A 1.06 | 0 | | |
| | | | 23 | | | | | | | | | |
| | | | | 14 | | | | | | | | |
| | | | 22 | | | | | | | | | |
| | | | | 15 | | | | | D 0.54 A 0.56 | | | |
| | | | 21 | | | | | | | | | |
| | | | | 16 | | | | | | 80 | | SM, 10°, PL, SO, Clay, 250 mm |

General: PT, 10-15°, PL, RO, CN

**method**
DT diatube
AS auger screwing
AD auger drilling
RR roller/tricone
CB claw or blade bit
NMLC NMLC core
NQ, HQ, PQ wireline core

**core-lift**
casing used
barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material
no core recovered

**water**
10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
25 water pressure test result (lugeons) for depth interval shown

**weathering**
FR fresh
SW slightly weathered
MW moderately weathered
HW highly weathered
XW extremely weathered
DW distinctly weathered (covers MW and HW)

**strength**
VL very low
L low
M medium
H high
VH very high
EH extremely high

**defect type**
JT joint
PT parting
SM seam
SZ sheared zone
SS sheared surface
CS crushed seam

**planarity**
PL planar
CU curved
UN undulating
ST stepped
IR irregular

**roughness**
VR very rough
RO rough
SO smooth
SL slickensided

**coating**
CN clean
SN stained
VN veneer
CO coating

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# Engineering Log - Cored Borehole

Borehole No. **BH3**

Sheet 4 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***16.10.2007***

Principal:

Date completed: ***16.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***EASTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531657 | slope: -90° | R.L. Surface: 36.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797945 | bearing: | datum: AHD

| drilling information | | | | | material substance | | | | | rock mass defects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
| NMLC | | | 20 | 17 | | **SANDSTONE:** fine to medium grained, banded orange-brown and red-brown *(continued)* | HW | M | D 0.74 A 0.75 | 80 | | SM, 10°, PL, SO, Clay, 25 mm |
| | | | 19 | 18 | | | | | | | | JT, 65°, UN, SO, CO, Clay |
| | | | 18 | | | Colour change to banded white and orange at 18.2 m. | | | D 0.15 A 0.84 | | | JT, 62°, UN, SO, CO, Clay |
| | | | | | | | | | | | | JT, 60°, UN, RO, CO, Fe |
| | | | 17 | 19 | | | | | D 3.41 A 2.27 | | | General: PT, 10-15°, PL, RO, CN |
| | | | 16 | 20 | | | | | | 77 | | JT, 72°, UN, RO, CO, Fe |
| | | | | | | | | | D 4.59 A 4.86 | | | |
| | | | 15 | 21 | | | | | | | | JT, 20°, IR, RO, CO, Fe |
| | | | | | | | | | D 1.89 A 1.97 | | | |
| | | | 14 | 22 | | BH3 terminated at 21.65 due to direction of client.<br>BH3 terminated at 21.65m | | | | | | |
| | | | 13 | 23 | | | | | | | | |
| | | | | 24 | | | | | | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 — water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Borehole

Borehole No. **BH4**

Sheet 1 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model and mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm | Northing 6797931 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetrometer kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | CM | | | 50 | | | SP | **TOPSOIL:** Sand, fine to coarse grained, dark brown, with traces of high plasticity clay, organics and rootlets | M | L | | TOPSOIL/RESIDUAL SOIL |
| | | | | | | 1 | | SP | **SAND:** fine to coarse grained, orange/brown | | D | | EXTREMELY WEATHERED SANDSTONE |
| | | | | | 49 | 2 | | | Borehole BH4 continued as cored hole | | | | |
| | | | | | 48 | 3 | | | | | | | |
| | | | | | 47 | 4 | | | | | | | |
| | | | | | 46 | 5 | | | | | | | |
| | | | | | 45 | 6 | | | | | | | |
| | | | | | 44 | 7 | | | | | | | |
| | | | | | 43 | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil
C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown
water inflow
water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

BOREHOLE GEOTCOFH01597AB.GPJ COFFEY.GDT 22.1.08

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# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 2 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 50 | 1 | | Continued from non-cored borehole | | | | | | |
| NMLC | | | 49 | 2 | | **SANDSTONE:** fine to medium grained, orange to pale grey | XW / HW | | | | | |
| | | | 48 | | | Becoming pale grey from 2.0m | MW | | D 0.15 A 0.13 | 52 | | SM, 88°, IU, SO Clay, 30 mm |
| | | | | | | pp=400kPa | | | | | | SM, 5°, IR, SO, Clay, 90 mm |
| | | | | 3 | | | | | | | | Sm, 86°, IR, SO, Clay, 15 mm |
| | | | 47 | | | | | | | | | |
| | | 8.30 AM 18/10/07 | | 4 | | | | | D 0.59 A 0.74 | | | |
| | | | 46 | | | Fine to coarse grained from 4.1 m. | | | | | | SM, 11°, L, SO, Clay, 40 mm |
| | | | | 5 | | | SW | | | | | |
| | | | 45 | | | | | | D 2.9 A 2.52 | 97 | | |
| | | | | 6 | | | | | | | | |
| | | | 44 | | | | | | | | | |
| | | | | 7 | | | | | D 1.89 A 2.75 | | | |
| | | | 43 | | | | | | | 90 | | |
| | | | | 8 | | | | | | | | |

General: PT, 8-15°, PL, RO, CN

**method**
DT diatube
AS auger screwing
AD auger drilling
RR roller/tricone
CB claw or blade bit
NMLC NMLC core
NQ, HQ, PQ wireline core

**core-lift**
casing used
barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material
no core recovered

**water**
10/1/98 water level on date shown
water inflow
partial drill fluid loss
complete drill fluid loss
water pressure test result (lugeons) for depth interval shown (25)

**weathering**
FR fresh
SW slightly weathered
MW moderately weathered
HW highly weathered
XW extremely weathered
DW distinctly weathered (covers MW and HW)

**strength**
VL very low
L low
M medium
H high
VH very high
EH extremely high

**defect type**
JT joint
PT parting
SM seam
SZ sheared zone
SS sheared surface
CS crushed seam

**planarity**
PL planar
CU curved
UN undulating
ST stepped
IR irregular

**roughness**
VR very rough
RO rough
SO smooth
SL slickensided

**coating**
CN clean
SN stained
VN veneer
CO coating

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 3 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log / core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular | general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | 8.30 10/10/2007 | 42 | 9 | | **SANDSTONE:** fine to medium grained, orange to pale grey *(continued)* | SW / MW | | D 0.64 A 0.78 | 90 | | SM, 10°, PL, SO, Clay, 10 mm | General: PT, 8-15°, PL, RO, CN |
| | | | 41 | | | | | | | | | | |
| | | | 40 | 10 | | Colour change to orange at 10.5 m. | HW | | D 0.21 A 0.23 | | | SO, SM, 10°, PL, SO, Clay, 50 mm | |
| | | | 39 | 11 | | | | | D 0.02 A 0.02 | 74 | | | |
| | | | 38 | 12 | | **SILTSTONE:** grey and pale grey, laminated with some 100 mm width interbeds of fine pale grey sandstone pp=550kPa | HW / DW | | D 0.31 A 0.66 | | | | General: PT, 3°, UN to PL, SO, CO, Clay |
| | | | 37 | 13 | | | | | D 0.17 A 0.75 | 98 | | | |
| | | | 36 | 14 | | | | | | | | | |
| | | | 35 | 15 | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded, fining upwards | SW | | D 0.34 A 0.93 | | | SM, 10°, PL, SO, Clay, 20 mm | |
| | | | | 16 | | | | | | 100 | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 4 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 34 | | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded, fining upwards *(continued)* | SW | | D 0.9 A 0.99 | | | |
| | | | 33 | 17 | | | | | | 100 | | SM, 15°, sandy clay 3mm |
| | | | | | | | | | D 3.24 A 4.36 | | | |
| | | | 32 | 18 | | | | | | | | |
| | | | | | | | | | D 3.75 A 4.66 | | | |
| | | | 31 | 19 | | | | | | | | |
| | | | | | | | | | | 100 | | |
| | | | 30 | 20 | | | | | | | | SM, 5°, PL, RO, Sand and Clay |
| | | | | | | | | | | | | |
| | | | 29 | 21 | | | | | | | | |
| | | | | | | | | | D 3.91 A 5.54 | | | |
| | | | 28 | 22 | | | | | D 3.91 A 2.75 | | | |
| | | | | | | | | | | 100 | | |
| | | | 27 | 23 | | | | | | | | |
| | | | | | | | | | D 2.56 A 2.86 | | | |
| | | | | 24 | | | | | | | | |

General: PT, 8-15°, PL, RO, CN

**method**
DT diatube; AS auger screwing; AD auger drilling; RR roller/tricone; CB claw or blade bit; NMLC NMLC core; NQ, HQ, PQ wireline core

**core-lift**
casing used; barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material; no core recovered

**water**
10/1/98 water level on date shown; water inflow; partial drill fluid loss; complete drill fluid loss; water pressure test result (lugeons) for depth interval shown (25)

**weathering**
FR fresh; SW slightly weathered; MW moderately weathered; HW highly weathered; XW extremely weathered; DW distinctly weathered (covers MW and HW)

**strength**
VL very low; L low; M medium; H high; VH very high; EH extremely high

**defect type**
JT joint; PT parting; SM seam; SZ sheared zone; SS sheared surface; CS crushed seam

**planarity**
PL planar; CU curved; UN undulating; ST stepped; IR irregular

**roughness**
VR very rough; RO rough; SO smooth; SL slickensided

**coating**
CN clean; SN stained; VN veneer; CO coating

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# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 5 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 26 | 25 | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded, fining upwards *(continued)* | SW | | | 100 | | |
| | | | 25 | 26 | | | | | D 3.24 A 4.68 | 98 | | SM, 7°, IR, RO, Clayey Sand, 40 mm |
| | | | 24 | 27 | | | FR | | D 2.9 A 3.46 | | | |
| | | | 23 | 28 | | Fine to medium grained from 28.05 m. | | | D 2.9 A 5.09 | 100 | | General: PT, 8-15°, PL, RO, CN |
| | | | 22 | 29 | | | | | | | | |
| | | | 21 | 30 | | | | | D 3.41 A 3.87 | | | |
| | | | 20 | 31 | | | | | | 100 | | |
| | | | 19 | 32 | | | | | D 3.24 A 4.91 | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 6 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness (particular / general) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 18 | 33 | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded, fining upwards *(continued)* | FR | | D 3.24 A 4.68 | 100 | | |
| | | | 17 | | | | | | | | | |
| | | | | 34 | | | MW | | | | | |
| | | | 16 | | | Colour change to orange-brown and grey from 33.9m to 37.7m. | | | D 3.41 A 3.83 | 95 | | |
| | | | | 35 | | | | | | | | JT, 67°, IR, RO, CO, Fe |
| | | | 15 | | | | | | | | | |
| | | | | 36 | | | | | D 4.93 A 7.85 | | | |
| | | | 14 | | | | | | | | | PT, 10°, UN, RO, CO, biotite |
| | | | | 37 | | | | | | | | PT, 10°, UN, RO, CO, biotite |
| | | | 13 | | | | | | D 2.9 A 5.51 | | | |
| | | | | 38 | | | FR | | | 96 | | |
| | | | 12 | | | | | | | | | |
| | | | | 39 | | | | | D 5.94 A 5 | | | |
| | | | 11 | | | | | | | | | |
| | | | | 40 | | | | | | 100 | | |

General: PT, 8-15°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH4**

Sheet 7 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***17.10.2007***

Principal:

Date completed: ***19.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTH OF EXISTING QUARRY***

Checked by:

drill model & mounting: PIONEER 160 4wd ISUZU | Easting: 531440 | slope: -90° | R.L. Surface: 50.2

hole diameter: 100 mm Drilling fluid: | Northing: 6797931 | bearing: | datum: AHD

| drilling information | | | | | material substance | | | | | rock mass defects | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength VL L M H VH EH | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm 30 100 300 1000 3000 | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
| NMLC | | | 10 | 41 | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded, fining upwards *(continued)* | FR | | D 3.91 A 5.27 | 100 | | General: PT, 8-15°, PL, RO, CN |
| | | | 9 | | | | | | | | | |
| | | | | 42 | | | | | D 4.59 A 6.19 | | | |
| | | | 8 | | | | | | | | | |
| | | | | 43 | | BH4 terminated at 42.3 due to limit of required investigation.<br>BH4 terminated at 42.3m | | | | | | |
| | | | 7 | | | | | | | | | |
| | | | | 44 | | | | | | | | |
| | | | 6 | | | | | | | | | |
| | | | | 45 | | | | | | | | |
| | | | 5 | | | | | | | | | |
| | | | | 46 | | | | | | | | |
| | | | 4 | | | | | | | | | |
| | | | | 47 | | | | | | | | |
| | | | 3 | | | | | | | | | |
| | | | | 48 | | | | | | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Borehole

Borehole No. **BH5**

Sheet 1 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model and mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Northing 6797994 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetrometer kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | | | | 47 | | | SP | **SAND:** fine to medium grained, red/brown to orange/brown, traces of fine to coarse grained gravel and medium plasticity clay | M | L | | RESDIUAL SOIL |
| | | | | | | 1 | | | Trace of rootlets to 0.9 m. | | | | |
| | | C | | SPT 10,25 N*=R | 46 | | | SC | **Clayey SAND:** fine to medium grained, orange/brown, clay is medium plasticity | | D | | EXTREMELY WEATHERED SANDSTONE |
| | | | | | | | | | Borehole BH5 continued as cored hole | | | | |
| | | | | | 45 | 2 | | | | | | | |
| | | | | | 44 | 3 | | | | | | | |
| | | | | | 43 | 4 | | | | | | | |
| | | | | | 42 | 5 | | | | | | | |
| | | | | | 41 | 6 | | | | | | | |
| | | | | | 40 | 7 | | | | | | | |
| | | | | | | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil

C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown

water inflow

water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

BOREHOLE GEOTCOFH01597AB.GPJ COFFEY.GDT 22.1.08

Form GEO 5.3 Issue 3 Rev.2

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# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 2 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness (particular / general) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 47 | 1 | | | | | | | | |
| | | | 46 | | | Continued from non-cored borehole | | | | | | |
| NMLC | | | | 2 | | **SANDSTONE:** fine to medium grained, orange/brown, remoulds to medium plasticity clayey sand, indistinctly bedded | XW | | D 0.02 A 0.02 | 0 | | |
| | | | 45 | | | | | | | | | |
| | | | | | | **SANDSTONE:** fine to medium grained, orange and pale grey, distinctly bedded | HW | | | | | |
| | | | | 3 | | | | | D 0.09 A 0.07 | 60 | | |
| | | | 44 | | | | | | | | | |
| | | | | 4 | | | | | | | | JT, 39°, IR, RO, CO, Clay |
| | | | 43 | | | | | | | | | |
| | | 8 AM 23/10/07 - 30 PM 23/10/07 | | | | | | | D 0.01 A 0.01 | 45 | | |
| | | | | 5 | | | | | | | | |
| | | | 42 | | | | | | | | | |
| | | | | 6 | | | | | D 0.09 A 0.15 | 84 | | SM, 61°, PL, SO, Clay, 10 mm |
| | | | 41 | | | | | | | | | SM, 10°, PL, SO, Clay, 50 mm |
| | | | | 7 | | | | | | | | |
| | | | 40 | | | | | | | | | |
| | | | | | | | | | D 0.14 A 0.13 | 100 | | |
| | | | | 8 | | | | | | | | |

General: PT, 5-13°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 3 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 39 | | | **SANDSTONE:** fine to medium grained, orange and pale grey, distinctly bedded *(continued)* | HW | | | 100 | | SM, 14°, PL, SO, Clay, 10 mm |
| | | | | 9 | | | | | | | | SM, 10°, PL, RO, Coal, 3 mm |
| | | | 38 | | | | | | D 0.02 A 0.03 | | | |
| | | | | 10 | | | | | | 96 | | SM, 5°, PL, SO, Clay, 5 mm |
| | | | 37 | | | | | | | | | |
| | | | | | | **SANDSTONE:** fine to coarse grained, orange/brown to pale grey, distinctly bedded, traces of coal and conglomerate interbeds to 12.9 m | | | D 0.34 A 0.29 | | | SM, 8°, UN, SO, Coal, 4 mm |
| | | | | 11 | | | MW | | | | | |
| | | | 36 | | | | | | | | | SM, 5°, UN, SO, Coal, 4 mm |
| | | | | | | | SW | | | | | |
| | | | | 12 | | | | | D 3.91 A 3.06 | | | |
| | | | 35 | | | 50 mm pyrite vein at 12.15 m. | | | | | | |
| | | | | | | 150 mm wide siltstone bed at 12.7 m. | | | | | | |
| | | | | 13 | | | | | | 98 | | SM, 10°, PL, SO, Clay, 80 mm |
| | | | 34 | | | **SANDSTONE:** fine to medium grained, pale grey, distinctly bedded | | | D 2.9 A 2.91 | | | |
| | | | | 14 | | | | | | | | |
| | | | 33 | | | | | | | | | |
| | | | | 15 | | | | | D 2.56 A 3.02 | | | |
| | | | 32 | | | | | | | 97 | | |
| | | | | 16 | | | | | | | | |

General: PT, 5-13°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 — water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 4 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness (particular / general) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 31 | | | **SANDSTONE:** fine to medium grained, pale grey, distinctly bedded *(continued)* | SW | | D 3.58 A 4.45 | 97 | | SM, 14°, PL, RO, Clay and sand, 60 mm |
| | | | 30 | 17 | | Fine to medium grained from 16.9 m. | FR | | | | | |
| | | | 29 | 18 | | | | | D 3.58 A 3.03 | | | |
| | | | 28 | 19 | | | | | D 2.56 A 2.48 | 100 | | General: PT, 5-13°, PL, RO, CN |
| | | | 27 | 20 | | | | | | | | |
| | | | 26 | 21 | | | | | D 3.58 A 3.33 | | | |
| | | | 25 | 22 | | | | | D 3.07 A 2.97 | 100 | | |
| | | | 24 | 23 | | | | | | | | |
| | | | | 24 | | | | | D A | 95 | | JT, 60°, IR, RO, CN |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 5 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log / core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 23 | 25 | | **SANDSTONE:** fine to medium grained, pale grey, distinctly bedded *(continued)* | FR | | 3.24 3.4 | | | |
| | | | 22 | | | | | | D A 0.04 0.47 | 95 | | SM, 5°, PL, RO, Sand, 150 mm |
| | | | 21 | 26 | | | | | | | | |
| | | | 20 | 27 | | 20 mm wide pyrite vein at 27.5 m. | | | D A 3.58 3.19 | 100 | | |
| | | | 19 | 28 | | **SILTSTONE:** dark grey to grey, laminated with some 20 mm to 100 mm wide fine grained sandstone interbeds, Anisotropic strength: VH strength perpendicular to bedding, L parrallel to bedding | SW | | D A 0.25 3.06 | 100 | | |
| | | | 18 | 29 | | | | | | | | |
| | | | 17 | 30 | | | | | D A 3.91 7.94 | 100 | | |
| | | | 16 | 31 | | **SANDSTONE:** fine to medium grained, grey to pale grey, distinctly bedded, with 20-100 mm wide siltstone interbeds | | | D A 3.91 2.82 | | | SM, 8°, PL, SO, Clay, 10 mm |
| | | | | 32 | | | | | | | | General: PT, 5-13°, PL, RO, CN |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 — water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 6 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness (particular / general) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 15 | | | **SANDSTONE:** fine to medium grained, grey to pale grey, distinctly bedded, with 20-100 mm wide siltstone interbeds *(continued)* | | | | 100 | | |
| | | | | | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded | | | | | | |
| | | | 14 | 33 | | | | | D 2.56 A 4.48 | | | |
| | | | | 34 | | | | | | 100 | | |
| | | | 13 | | | | | | D 3.58 A 3.65 | | | |
| | | | | 35 | | Colour change to pale orange and pale grey at 34.5-35.4 m. | MW | | | | | |
| | | | 12 | | | | | | | | | |
| | | | | 36 | | Colour change to pale grey at 35.4 m. | SW | | D 2.9 A 2.97 | | | JT, 65°, PL, RO, SN, Fe |
| | | | 11 | | | | | | | | | |
| | | | | 37 | | | | | | 100 | | |
| | | | 10 | | | | | | D 4.25 A 3.52 | | | |
| | | | | 38 | | | | | | | | |
| | | | 9 | | | | | | | | | |
| | | | | 39 | | | | | | | | JT, 17°, IR, RO, SN, Fe |
| | | | 8 | | | | | | D 1.33 A 2.63 | 99 | | |
| | | | | 40 | | | | | | | | |

General: PT, 5-13°, PL, RO, CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH5**

Sheet 7 of 7

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***WESTERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: P120 CANTER 4wd | Easting: 531105 | slope: -90° | R.L. Surface: 47.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797994 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log / core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 7 | 41 | | **SANDSTONE:** fine to coarse grained, pale grey, distinctly bedded *(continued)* | SW | | D 4.59 A 3.85 | 99 | | |
| | | | 6 | | | | | | D 3.91 A 4.82 | | | |
| | | | | 42 | | BH5 terminated at 41.6 due to limit of required investigation. BH5 terminated at 41.6m | | | | | | |
| | | | 5 | | | | | | | | | |
| | | | | 43 | | | | | | | | |
| | | | 4 | | | | | | | | | |
| | | | | 44 | | | | | | | | |
| | | | 3 | | | | | | | | | |
| | | | | 45 | | | | | | | | |
| | | | 2 | | | | | | | | | |
| | | | | 46 | | | | | | | | |
| | | | 1 | | | | | | | | | |
| | | | | 47 | | | | | | | | |
| | | | 0 | | | | | | | | | |
| | | | | 48 | | | | | | | | |

**method**
DT diatube; AS auger screwing; AD auger drilling; RR roller/tricone; CB claw or blade bit; NMLC NMLC core; NQ, HQ, PQ wireline core

**core-lift**
casing used; barrel withdrawn

**graphic log/core recovery**
core recovered - graphic symbols indicate material; no core recovered

**water**
10/1/98 water level on date shown; water inflow; partial drill fluid loss; complete drill fluid loss; water pressure test result (lugeons) for depth interval shown (25)

**weathering**
FR fresh; SW slightly weathered; MW moderately weathered; HW highly weathered; XW extremely weathered; DW distinctly weathered (covers MW and HW)

**strength**
VL very low; L low; M medium; H high; VH very high; EH extremely high

**defect type**
JT joint; PT parting; SM seam; SZ sheared zone; SS sheared surface; CS crushed seam

**planarity**
PL planar; CU curved; UN undulating; ST stepped; IR irregular

**roughness**
VR very rough; RO rough; SO smooth; SL slickensided

**coating**
CN clean; SN stained; VN veneer; CO coating

coffey geotechnics

Borehole No. **BH6**

Sheet 1 of 4

Project No: **GEOTALST01597AB**

# Engineering Log - Borehole

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTHERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model and mounting: JACRO 6WD | Easting: 531450 | slope: -90° | R.L. Surface: 29.2

hole diameter: 100 mm | Northing 6797729 | bearing: | datum: AHD

**drilling information** | **material substance**

| method | penetration 1 2 3 | support | water | notes samples, tests, etc | RL | depth metres | graphic log | classification symbol | material: soil type: plasticity or particle characteristics, colour, secondary and minor components. | moisture condition | consistency/ density index | pocket penetrometer kPa 100 200 300 400 | structure and additional observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCAD | | CM | | | 29 | 1 | | SP | **TOPSOIL:** Sand, fine to medium grained. grey to dark grey, with trace of organics and rootlets<br><br>Traces of clay from 0.8 m. | M | L | | TOPSOIL, COLLUVIAL |
| | | | | | 28 | 2 | | | Borehole BH6 continued as cored hole | | | | |
| | | | | | 27 | 3 | | | | | | | |
| | | | | | 26 | 4 | | | | | | | |
| | | | | | 25 | 5 | | | | | | | |
| | | | | | 24 | 6 | | | | | | | |
| | | | | | 23 | 7 | | | | | | | |
| | | | | | 22 | 8 | | | | | | | |

**method**

| | |
|---|---|
| AS | auger screwing* |
| AD | auger drilling* |
| RR | roller/tricone |
| W | washbore |
| CT | cable tool |
| HA | hand auger |
| DT | diatube |
| B | blank bit |
| V | V bit |
| T | TC bit |
| *bit shown by suffix e.g. | ADT |

**support**

M mud N nil

C casing

**penetration**

1 2 3 4 — no resistance ranging to refusal

**water**

10/1/98 water level on date shown

water inflow

water outflow

**notes, samples, tests**

| | |
|---|---|
| $U_{50}$ | undisturbed sample 50mm diameter |
| $U_{63}$ | undisturbed sample 63mm diameter |
| D | disturbed sample |
| N | standard penetration test (SPT) |
| N* | SPT - sample recovered |
| Nc | SPT with solid cone |
| V | vane shear (kPa) |
| P | pressuremeter |
| Bs | bulk sample |
| E | environmental sample |
| R | refusal |

**classification symbols and soil description**

based on unified classification system

**moisture**

| | |
|---|---|
| D | dry |
| M | moist |
| W | wet |
| Wp | plastic limit |
| $W_L$ | liquid limit |

**consistency/density index**

| | |
|---|---|
| VS | very soft |
| S | soft |
| F | firm |
| St | stiff |
| VSt | very stiff |
| H | hard |
| Fb | friable |
| VL | very loose |
| L | loose |
| MD | medium dense |
| D | dense |
| VD | very dense |

coffey geotechnics

# Engineering Log - Cored Borehole

Borehole No. **BH6**

Sheet 2 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTHERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: JACRO 6WD | Easting: 531450 | slope: -90° | R.L. Surface: 29.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797729 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 29 | 1 | | Continued from non-cored borehole | | | | | | |
| NMLC | | | 28 | 2 | | **SAND:** fine to medium grained, with some high plasticity clay and organics | RS | | | 0 | | Core has soil properties from 1 to 3.7 m. |
| | | | | | | **Sandy CLAY:** medium plasticity, orange and pale grey, very stiff, sand is fine to medium grained<br>pp=270kPa | HW | | | | | |
| | | | 27 | | | **SANDSTONE:** fine to medium grained, orange to grey, bedding masked by weathering, remoulds to medium plasticity clayey sand or sand with some clay | | | | 0 | | |
| | | | 26 | 3 | | **SANDSTONE:** fine to coarse grained, pale brown and orange to grey, distinctly bedded | | | | 0 | | |
| | | | 25 | 4 | | | | | D 0.02 A 0.03 | 65 | | |
| | | | 24 | 5 | | | MW | | D 0.1 A 0.01 | | | General: PT, 8-16°, PL, RO CN |
| | | | 23 | 6 | | | | | | 95 | | |
| | | | 22 | 7 | | | | | D 0.02 A 0.02 | | | SM, 12°, IR, RO, Sand and Clay, 40 mm |
| | | | | 8 | | | HW | | | | | |

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH6**

Sheet 3 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTHERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: JACRO 6WD | Easting: 531450 | slope: -90° | R.L. Surface: 29.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797729 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | $Is_{(50)}$ MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness — particular / general |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | | 21 | | | **SANDSTONE:** fine to coarse grained, pale brown and orange to grey, distinctly bedded *(continued)* | HW | | D 0.89 A 3.3 | 95 | | |
| | | | | 9 | | Colour change to orange, pale grey and pink at 8.2 m. | | | | | | |
| | | | 20 | | | | | | | | | |
| | | | | | | Some 100 mm width siltstone interbeds from 9.2 m to 11.2 m. | | | | | | |
| | | | | | | pp=400kPa | | | D 0.09 A 0.04 | | | |
| | | | | 10 | | | | | | 92 | | |
| | | | 19 | | | | | | | | | |
| | | | | | | | MW | | | | | |
| | | | | 11 | | | | | | | | |
| | | | 18 | | | Colour change to pale grey at 11.2 m. | SW | | D 4.25 A 5.04 | | | |
| | | | | 12 | | | | | | | | |
| | | | 17 | | | | | | | | | |
| | | | | | | | | | D 4.59 A 5.86 | 100 | | |
| | | | | 13 | | | | | | | | |
| | | | 16 | | | | | | | | | |
| | | | | 14 | | | | | | | | |
| | | | 15 | | | | | | D 5.27 A 4.74 | | | |
| | | | | 15 | | | | | | 100 | | |
| | | | 14 | | | | | | | | | |
| | | | | | | 50 mm width conglomerate bed at 15.3 m. | | | | | | |
| | | | | 16 | | | | | D 3.91 A 3.87 | | | |

General: PT, 8-16°, PL, RO CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# Engineering Log - Cored Borehole

Borehole No. **BH6**

Sheet 4 of 4

Project No: **GEOTALST01597AB**

Client: ***CHAMPIONS QUARRY***

Date started: ***22.10.2007***

Principal:

Date completed: ***22.10.2007***

Project: ***RESOURCE ESTIMATE***

Logged by: ***ALB***

Borehole Location: ***SOUTHERN EXTENT OF PROPOSED QUARRY***

Checked by:

drill model & mounting: JACRO 6WD | Easting: 531450 | slope: -90° | R.L. Surface: 29.2

hole diameter: 100 mm | Drilling fluid: | Northing: 6797729 | bearing: | datum: AHD

**drilling information** | **material substance** | **rock mass defects**

| method | core-lift | water | RL | depth metres | graphic log core recovery | material: rock type; grain characteristics, colour, structure, minor components | weathering alteration | estimated strength (VL L M H VH EH) | Is(50) MPa D- diametral A- axial | RQD % | defect spacing mm (30 100 300 1000 3000) | defect description: type, inclination, planarity, roughness, coating, thickness (particular / general) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMLC | | 10.30 AM 23/10/07 | 13 | 17 | | **SANDSTONE:** fine to coarse grained, pale brown and orange to grey, distinctly bedded *(continued)* | SW | | | 100 | | |
| | | | 12 | | | Colour change to orange at 17.2-17.9 m. | | | D 4.93 A 4.22 | | | |
| | | | | 18 | | | FR | | | 100 | | |
| | | | 11 | | | | | | | | | |
| | | | | 19 | | | | | D 4.59 A 3.52 | | | |
| | | | 10 | | | 2 x 60 mm width siltstone beds at 19.5 m and 19.8 m. | | | | | | |
| | | | | 20 | | | | | | | | |
| | | | 9 | | | | | | D 4.76 A 4.44 | | | |
| | | | | 21 | | | | | | 99 | | |
| | | | 8 | | | | | | | | | |
| | | | | 22 | | | | | D 3.24 A 4.58 | | | |
| | | | 7 | | | BH6 terminated at 21.95 m due to limit of required investigation.<br>BH6 terminated at 21.95m | | | | | | |
| | | | | 23 | | | | | | | | |
| | | | 6 | | | | | | | | | |
| | | | | 24 | | | | | | | | |

General: PT, 8-16°, PL, RO CN

**method**

| | |
|---|---|
| DT | diatube |
| AS | auger screwing |
| AD | auger drilling |
| RR | roller/tricone |
| CB | claw or blade bit |
| NMLC | NMLC core |
| NQ, HQ, PQ | wireline core |

**core-lift**

- casing used
- barrel withdrawn

**graphic log/core recovery**

- core recovered - graphic symbols indicate material
- no core recovered

**water**

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- water pressure test result (lugeons) for depth interval shown (25)

**weathering**

| | |
|---|---|
| FR | fresh |
| SW | slightly weathered |
| MW | moderately weathered |
| HW | highly weathered |
| XW | extremely weathered |
| DW | distinctly weathered (covers MW and HW) |

**strength**

| | |
|---|---|
| VL | very low |
| L | low |
| M | medium |
| H | high |
| VH | very high |
| EH | extremely high |

**defect type**

| | |
|---|---|
| JT | joint |
| PT | parting |
| SM | seam |
| SZ | sheared zone |
| SS | sheared surface |
| CS | crushed seam |

**planarity**

| | |
|---|---|
| PL | planar |
| CU | curved |
| UN | undulating |
| ST | stepped |
| IR | irregular |

**roughness**

| | |
|---|---|
| VR | very rough |
| RO | rough |
| SO | smooth |
| SL | slickensided |

**coating**

| | |
|---|---|
| CN | clean |
| SN | stained |
| VN | veneer |
| CO | coating |

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# **Soil Description** Explanation Sheet (1 of 2)

### DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

### CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

### PARTICLE SIZE DESCRIPTIVE TERMS

| NAME | SUBDIVISION | SIZE |
|---|---|---|
| Boulders | | >200 mm |
| Cobbles | | 63 mm to 200 mm |
| Gravel | coarse | 20 mm to 63 mm |
| | medium | 6 mm to 20 mm |
| | fine | 2.36 mm to 6 mm |
| Sand | coarse | 600 µm to 2.36 mm |
| | medium | 200 µm to 600 µm |
| | fine | 75 µm to 200 µm |

### MOISTURE CONDITION

**Dry** Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

**Moist** Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

**Wet** As for moist but with free water forming on hands when handled.

### CONSISTENCY OF COHESIVE SOILS

| TERM | UNDRAINED STRENGTH $s_u$ (kPa) | FIELD GUIDE |
|---|---|---|
| Very Soft | <12 | A finger can be pushed well into the soil with little effort. |
| Soft | 12 - 25 | A finger can be pushed into the soil to about 25mm depth. |
| Firm | 25 - 50 | The soil can be indented about 5mm with the thumb, but not penetrated. |
| Stiff | 50 - 100 | The surface of the soil can be indented with the thumb, but not penetrated. |
| Very Stiff | 100 - 200 | The surface of the soil can be marked, but not indented with thumb pressure. |
| Hard | >200 | The surface of the soil can be marked only with the thumbnail. |
| Friable | – | Crumbles or powders when scraped by thumbnail. |

### DENSITY OF GRANULAR SOILS

| TERM | DENSITY INDEX (%) |
|---|---|
| Very loose | Less than 15 |
| Loose | 15 - 35 |
| Medium Dense | 35 - 65 |
| Dense | 65 - 85 |
| Very Dense | Greater than 85 |

### MINOR COMPONENTS

| TERM | ASSESSMENT GUIDE | PROPORTION OF MINOR COMPONENT IN: |
|---|---|---|
| Trace of | Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component. | Coarse grained soils: <5%<br>Fine grained soils: <15% |
| With some | Presence easily detected by feel or eye, soil properties little different to general properties of primary component. | Coarse grained soils: 5 - 12%<br>Fine grained soils: 15 - 30% |

### SOIL STRUCTURE

| ZONING | | CEMENTING | |
|---|---|---|---|
| Layers | Continuous across exposure or sample. | Weakly cemented | Easily broken up by hand in air or water. |
| Lenses | Discontinuous layers of lenticular shape. | Moderately cemented | Effort is required to break up the soil by hand in air or water. |
| Pockets | Irregular inclusions of different material. | | |

### GEOLOGICAL ORIGIN

#### WEATHERED IN PLACE SOILS

| | |
|---|---|
| Extremely weathered material | Structure and fabric of parent rock visible. |
| Residual soil | Structure and fabric of parent rock not visible. |

#### TRANSPORTED SOILS

| | |
|---|---|
| Aeolian soil | Deposited by wind. |
| Alluvial soil | Deposited by streams and rivers. |
| Colluvial soil | Deposited on slopes (transported downslope by gravity). |
| Fill | Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils. |
| Lacustrine soil | Deposited by lakes. |
| Marine soil | Deposited in ocean basins, bays, beaches and estuaries. |

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# **Soil Description** Explanation Sheet (2 of 2)

## SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass) | | | | | | | USC | PRIMARY NAME |
|---|---|---|---|---|---|---|---|---|
| COARSE GRAIINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm | (A 0.075 mm particle is about the smallest particle visible to the naked eye) | GRAVELS More than half of coarse fraction is larger than 2.0 mm | CLEAN GRAVELS (Little or no fines) | Wide range in grain size and substantial amounts of all intermediate particle sizes. | | | GW | GRAVEL |
| | | | | Predominantly one size or a range of sizes with more intermediate sizes missing. | | | GP | GRAVEL |
| | | | GRAVELS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below) | | | GM | SILTY GRAVEL |
| | | | | Plastic fines (for identification procedures see CL below) | | | GC | CLAYEY GRAVEL |
| | | SANDS More than half of coarse fraction is smaller than 2.0 mm | CLEAN SANDS (Little or no fines) | Wide range in grain sizes and substantial amounts of all intermediate sizes missing | | | SW | SAND |
| | | | | Predominantly one size or a range of sizes with some intermediate sizes missing. | | | SP | SAND |
| | | | SANDS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below). | | | SM | SILTY SAND |
| | | | | Plastic fines (for identification procedures see CL below). | | | SC | CLAYEY SAND |
| FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm | | | IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm. | | | | | |
| | | SILTS & CLAYS Liquid limit less than 50 | **DRY STRENGTH** | **DILATANCY** | **TOUGHNESS** | | | |
| | | | None to Low | Quick to slow | None | | ML | SILT |
| | | | Medium to High | None | Medium | | CL | CLAY |
| | | | Low to medium | Slow to very slow | Low | | OL | ORGANIC SILT |
| | | SILTS & CLAYS Liquid limit greater than 50 | Low to medium | Slow to very slow | Low to medium | | MH | SILT |
| | | | High | None | High | | CH | CLAY |
| | | | Medium to High | None | Low to medium | | OH | ORGANIC CLAY |
| HIGHLY ORGANIC SOILS | | | Readily identified by colour, odour, spongy feel and frequently by fibrous texture. | | | | Pt | PEAT |

• Low plasticity – Liquid Limit $W_L$ less than 35%. • Modium plasticity – $W_L$ between 35% and 50%.

## COMMON DEFECTS IN SOIL

| TERM | DEFINITION | DIAGRAM |
|---|---|---|
| PARTING | A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed. |  |
| JOINT | A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length. |  |
| SHEARED ZONE | Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks. |  |
| SHEARED SURFACE | A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect. |  |

| TERM | DEFINITION | DIAGRAM |
|---|---|---|
| SOFTENED ZONE | A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere. |  |
| TUBE | Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter |  |
| TUBE CAST | Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented. |  |
| INFILLED SEAM | Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints. |  |

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# **Rock Description** Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

**DEFINITIONS:** Rock substance, defect and mass are defined as follows:

| | |
|---|---|
| **Rock Substance** | In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic. |
| **Defect** | Discontinuity or break in the continuity of a substance or substances. |
| **Mass** | Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects. |

## SUBSTANCE DESCRIPTIVE TERMS:

| | |
|---|---|
| **ROCK NAME** | Simple rock names are used rather than precise geological classification. |
| **PARTICLE SIZE** | Grain size terms for sandstone are: |
| Coarse grained | Mainly 0.6mm to 2mm |
| Medium grained | Mainly 0.2mm to 0.6mm |
| Fine grained | Mainly 0.06mm (just visible) to 0.2mm |
| **FABRIC** | Terms for layering of penetrative fabric (eg. bedding, cleavage etc. ) are: |
| Massive | No layering or penetrative fabric. |
| Indistinct | Layering or fabric just visible. Little effect on properties. |
| Distinct | Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric. |

## CLASSIFICATION OF WEATHERING PRODUCTS

| Term | Abbreviation | Definition |
|---|---|---|
| **Residual Soil** | **RS** | Soil derived from the weathering of 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 Material** | **XW** | Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible. |
| **Highly Weathered Rock** | **HW** | Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores. |
| **Moderately Weathered Rock** | **MW** | The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable. |
| **Slightly Weathered Rock** | **SW** | Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance. |
| **Fresh Rock** | **FR** | Rock substance unaffected by weathering. |

**Notes on Weathering:**

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

## ROCK SUBSTANCE STRENGTH TERMS

| Term | Abbrev-iation | Point Load Index, $I_S50$ (MPa) | Field Guide |
|---|---|---|---|
| **Very Low** | **VL** | Less than 0.1 | Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure. |
| **Low** | **L** | 0.1 to 0.3 | Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling. |
| **Medium** | **M** | 0.3 to 1.0 | Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty. |
| **High** | **H** | 1 to 3 | A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer. |
| **Very High** | **VH** | 3 to 10 | Hand specimen breaks after more than one blow of a pick; rock rings under hammer. |
| **Extremely High** | **EH** | More than 10 | Specimen requires many blows with geological pick to break; rock rings under hammer. |

**Notes on Rock Substance Strength:**

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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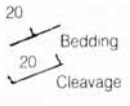
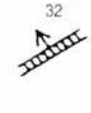
# **Rock Description** Explanation Sheet (2 of 2)

| COMMON DEFECTS IN ROCK MASSES<br>Term | Definition | Diagram | Map Symbol | Graphic Log (Note 1) |
|---|---|---|---|---|
| **Parting** | A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed. |  |  |  |
| **Joint** | A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed. |  |  |  |
| **Sheared Zone** (Note 3) | Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks. |  |  |  |
| **Sheared Surface** (Note 3) | A near planar, curved or undulating surface which is usually smooth, polished or slickensided. |  |  |  |
| **Crushed Seam** (Note 3) | Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties. |  |  |  |
| **Infilled Seam** | Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface. |  |  |  |
| **Extremely Weathered Seam** | Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place. |  |  |  |

| DEFECT SHAPE TERMS | |
|---|---|
| **Planar** | The defect does not vary in orientation |
| **Curved** | The defect has a gradual change in orientation |
| **Undulating** | The defect has a wavy surface |
| **Stepped** | The defect has one or more well defined steps |
| **Irregular** | The defect has many sharp changes of orientation |

**Note:** The assessment of defect shape is partly influenced by the scale of the observation.

| ROUGHNESS TERMS | |
|---|---|
| **Slickensided** | Grooved or striated surface, usually polished |
| **Polished** | Shiny smooth surface |
| **Smooth** | Smooth to touch. Few or no surface irregularities |
| **Rough** | Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper. |
| **Very Rough** | Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper. |

| COATING TERMS | |
|---|---|
| **Clean** | No visible coating |
| **Stained** | No visible coating but surfaces are discoloured |
| **Veneer** | A visible coating of soil or mineral, too thin to measure; may be patchy |
| **Coating** | A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein. |

| BLOCK SHAPE TERMS | |
|---|---|
| **Blocky** | Approximately equidimensional |
| **Tabular** | Thickness much less than length or width |
| **Columnar** | Height much greate than cross section |

**Notes on Defects:**

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.