



APPENDIX A ENVIRONMENTAL REPORT



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Murdoch Mixed Use Precinct

Environmental Report

Prepared for
LandCorp
by Strategen

November 2015

Murdoch Mixed Use Precinct

Environmental Report

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

November 2015

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Client: LandCorp

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Appendix 1 Geotechnical report

1. Introduction

1.1 Background

The Murdoch Mixed Use Precinct (MUP) Project site (the site) is located approximately 12 km south of the Perth Central Business District (CBD) (Figure 1). The 9.6 ha site is located adjacent to Fiona Stanley Hospital (FSH) within the larger Murdoch Activity Centre (MAC) area. The site is planned for a mixture of uses including residential, offices, retail, commercial, civic uses and entertainment facilities.

The MAC is identified in the Western Australian Government's Directions 2031 strategic planning document for Perth and Peel as one of five Specialised Activity Centres (DoP & WAPC 2010). These centres are intended to be employment/community areas, leveraging off the existing institutions to create vibrant hubs which diversify Perth's employment opportunities (DoP & WAPC 2010).

This report has been prepared to support the local structure planning (LSP) process for submission to the City of Melville (City) and the Western Australian Planning Commission (WAPC). This report provides a summary of the existing environment and an assessment of environmental opportunities and constraints associated with the development of the Site.

1.2 Site description

1.2.1 Current site zoning and use

The site is zoned 'Urban' under the Metropolitan Region Scheme and 'Urban Development' under the City Community Planning Scheme No. 5.

The majority of the site is currently used as a public car park for the South Street train station and bus interchange (PTA car park), with an off-ramp connecting to the Kwinana Freeway (Figure 2). The site includes 0.89 ha of Conservation Area which is part of the Australian Government approval for the adjacent FSH Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Figure 2). The balance of the site has previously been cleared.

Outside the public car park, roads and public open space have been constructed as part of the FSH development (Figure 2). The existing PTA car parking facilities will remain in their current configuration and capacity as part of Stage 1 works (Figure 2). An alternative parking strategy will be required to implement Stage 2 of the development. The implementation of Stage 2 will consequently be subject to a future business case which will need to be assessed and approved by the State Government.

Land uses surrounding the site are:

- north: South Street and residential development
- east: Kwinana Freeway, South Street Railway Station and the Mandurah Railway
- south: FSH and drainage infrastructure
- west: St John of God Hospital and FSH (Figure 2).

1.2.2 Proposed local structure plan

The site is proposed to be developed for a range of key uses, including support for health and education activities, associated convenience retail and business uses, recreational, hospitality, entertainment, lifestyle and living opportunities (i.e. residential). The site is anticipated to be a high density, high rise area consisting of a series of 'superlots' each greater than 1500 m² in size which will be sold for development.

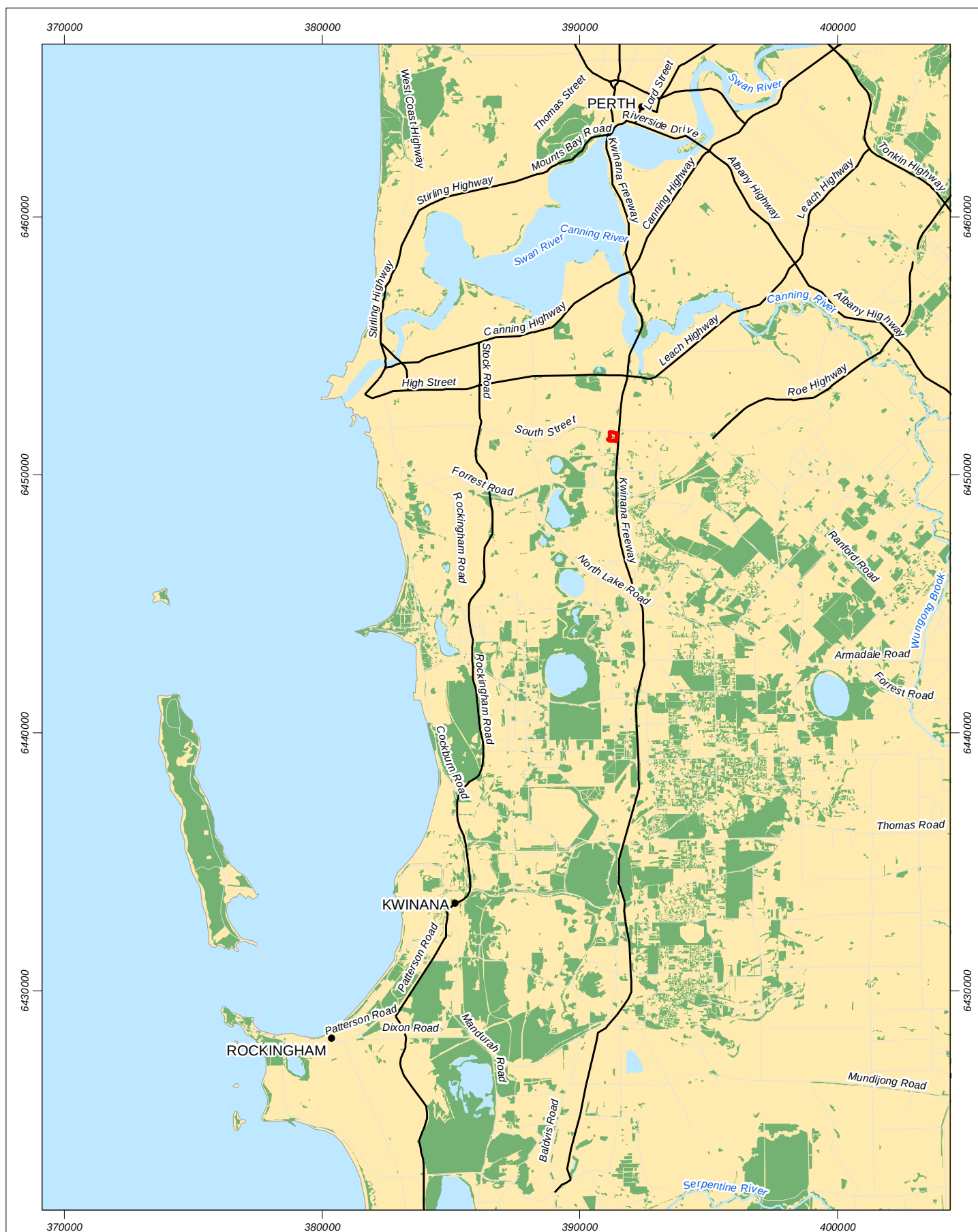


Figure 1: Regional location

Scale 1:200,000 at A4

0 1 2 3 4 5 km

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 24/09/2015

Author: JCrute

Source: Topography: Geoscience Australia 2011.



Legend

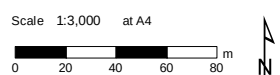
- Town
- Major road
- Minor road
- Major river
- Lakes
- Native vegetation
- Project boundary

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Figure 2: Site location



Coordinate System: GDA 1994 MGA Zone 50
 Note that positional errors may occur in some areas
 Date: 24/09/2015
 Author: JCrute
 Source: Aerial image: Landgate, flown March 2015. Project boundary & stages: ARM Architecture 2015.

Legend

- Project boundary
- Conservation Area
- Stage 1
- Stage 2

2. Geology, landforms and soils

The site lies between 20 and 26 metres Australian Height Datum (mAHD), and generally slopes in a north-easterly direction towards the Kwinana Freeway (DoW 2004) (Figure 3).

The site is located on the Swan Coastal Plain, and is situated on Bassendean Sands, which indicates that it provides good potential for stormwater infiltration, due to its sandy composition. There is, however, a possibility that coffee rock occurs on the site, which may reduce this potential for infiltration (GHD 2007). Preliminary geotechnical surveys indicate that an approximately two metre (m) thick lens of clay is present at a level of about 14 mAHD in and around the Conservation Area (Coffey 2008) (Figure 4, Appendix 1). This layer has some potential to represent a constraint to infiltration of stormwater and construction of buildings.

2.1 Acid sulfate soils

Land development activities such as sewer installation, which involve the excavation of saturated soil, have the potential to facilitate acid formation within ASS environments, resulting in harm to the surrounding environment and infrastructure. Dewatering for infrastructure (i.e. underground car parks or similar structures) can also cause acidification. Below ground infrastructure will be required as part of the MUP development, particularly in the Stage 2 area.

There is a 'low to moderate risk' of acid sulfate soils (ASS) occurring at a depth of 3 m from the surface within the site (DEC 2006) (Figure 4). Preliminary testing by Coffey (2008) indicated that such ASS was present at a depth of greater than 3 m at the site (Appendix 1). Sampling was also undertaken by Strategen in 2011 to depths of 4 metres below ground level as part of groundwater bore installation process. These tests did not find any additional ASS.

2.2 Potential for contaminated sites

A search of the DER Contaminated Sites Database indicates that no known contaminated sites are located within a 1 kilometre (km) radius of the site.

On the basis of the information available, the only known potentially contaminating past or current land use present within the site is the car park. The north-eastern part of the site is currently a car park, which, on the basis of aerial photograph analysis was constructed between 1985 and 1995. The car park may be a source of minor soil and groundwater contamination due to leakage of hydrocarbons and leaching of metals from parked vehicles.

2.3 Management response

ASS investigations will be required to be undertaken in a manner consistent with DER guidelines where dewatering or major earthworks are proposed. Such investigations are anticipated to be required as a condition of subdivision if dewatering or major earthworks are required. If ASS is encountered, management plans may be required to be developed prior to ground disturbing works. Where excavation is required for construction of on-lot car parks, the need for ASS investigations should also be considered.

Based on the current land uses, DER (2014) guidelines do not require a contamination investigation. As such, a Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) are not considered to be required for the redevelopment of the Project site.

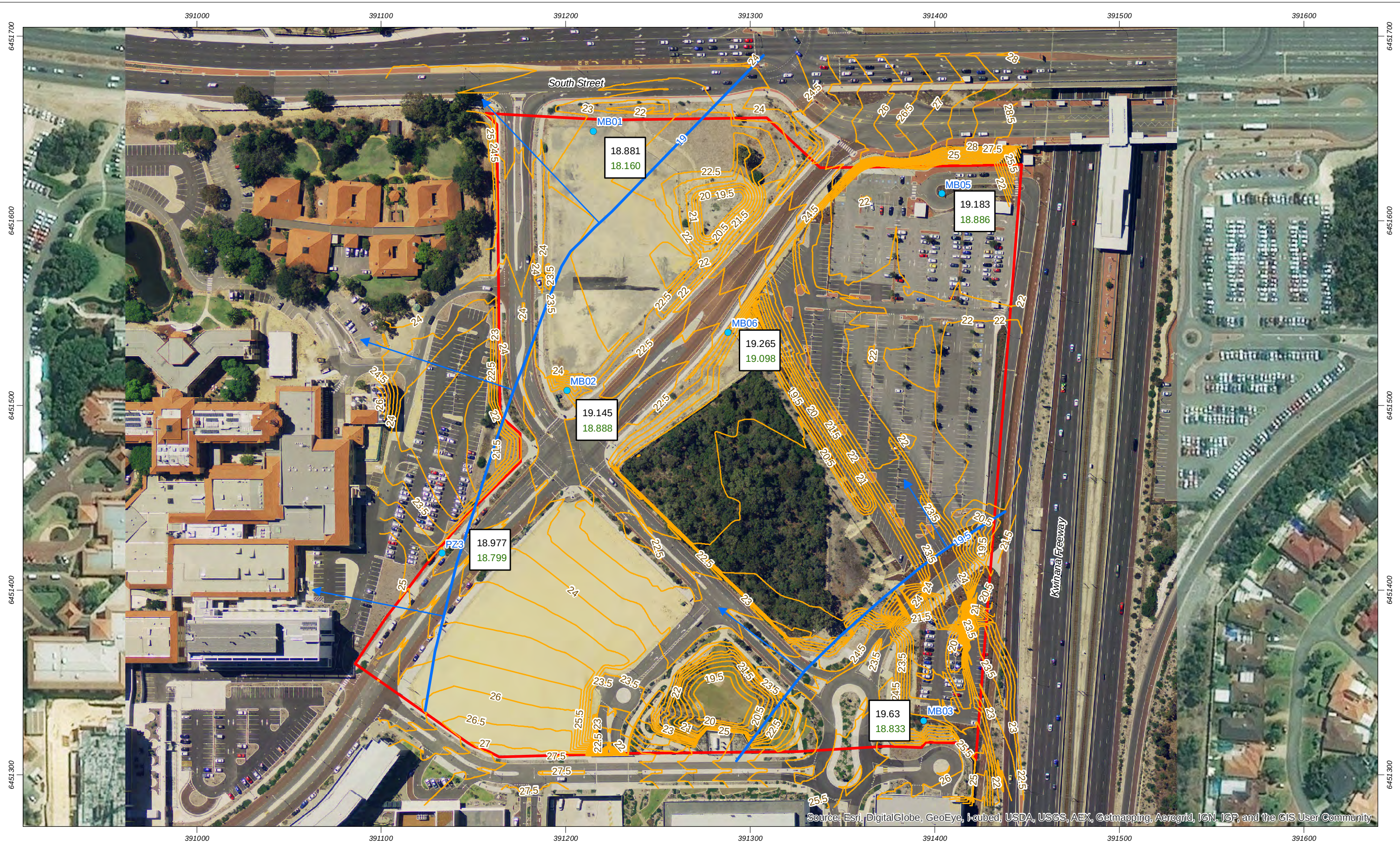


Figure 3: Topography and groundwater levels

Scale 1:1,902 at A3

0 20 40 60 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 24/09/2015

Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Background image: ESRI online, approx. 2014. Concept plan: Client 2015. Topography: Client 2011.

Path: Q:\Consult\2015\LANLAN15273\ArcMap_documents\R001\RevA\LAN15273_01_R001_RevA_F003_A3.mxd

Legend

- Groundwater bores
- AAMGL contour (mAHD)
- Surface elevation (mAHD)
- Project boundary
- AAMGL (mAHD)
- Maximum recorded level (mAHD)
- Groundwater flow direction

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Figure 4: Clay Soils and acid sulfate soils at the Project site

Scale 1:8,000 at A4

0 50 100 150 200 m



Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 24/09/2015
Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Background imagery: ESRI online, approx. 2012. Concept plan: Client 2015. ASS: DER 2014.

Legend



Project boundary



Clay soil zone



Conservation area

ASS risk category

High to moderate risk

Moderate to low risk

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3. Hydrology

3.1 Groundwater

Based on monitoring undertaken by Strategen, average annual maximum groundwater levels on the site are estimated at between 18.8 mAHD in the northwest and 19.6 mAHD in the southeast (Figure 3). Groundwater flows in a north-westerly direction (Figure 3).

Groundwater on the site is fresh and is considered suitable for irrigation purposes.

3.2 Surface water

3.2.1 Wetlands

No mapped permanent surface water bodies are present on the site.

Quenda Wetland, a Conservation Category Wetland (CCW) (DEC 2010), is located in the north-west corner of the Murdoch superblock, approximately 400 m east of the site, bordered by St John of God Hospital, South Street and Murdoch Drive (Figure 5). The wetland is defined as a sumpland (DEC 2010), and is seasonally inundated. The wetland is regarded as a significant wetland which has a high level of protection due to its fauna habitat and floristic diversity (GHD 2007).

Because of the distance between MUP and Quenda Wetland, the development is not anticipated to impact upon Quenda Wetland.

3.2.2 Drainage

There is no arterial drainage network in the broader Murdoch area. A drainage system was constructed for the FSH development. Existing infrastructure within the MUP site includes a road drainage network, an infiltration tank and an infiltration basin. All of the existing drainage is managed by infiltration on site.

3.3 Management Response

The drainage infrastructure and philosophy used for the FSH project is intended to continue on the Site. A Local Water Management Strategy has been prepared for the Site, consistent with *Better Urban Water Management* (WAPC and DPI 2008) outlining the proposed drainage system.



Figure 5: Wetlands

Scale 1:8,000 at A4

0 50 100 150 200 m



Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 24/09/2015

Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Background imagery: ESRI online, approx. 2012. Concept plan: Client 2015. Contours: DoW 2001. Wetlands: DPAW 2014.

Legend



Project boundary

Wetland category



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4. Vegetation and flora

4.1 Regional context

The site falls under the Perth subregion (SWA2) of the Swan Coastal Plain region under the Interim Biogeographic Regionalisation of Australia (Mitchell *et al.* 2002). The remnant native vegetation complexes may have comprised the Bassendean Complex – Central and South or the Karrakatta Complex – Central and South, outlined by Heddle *et al.* (1980) (Table 1). Other than the vegetation associated with the Conservation Area, vegetation is limited on site.

Table 1: Remnant vegetation complexes

Vegetation complex	Description
Bassendean complex – central and south	Vegetation ranges from woodland of <i>Eucalyptus marginata</i> – <i>Casuarina fraseriana</i> – <i>Banksia</i> spp. to low woodland of <i>Melaleuca</i> spp. and sedgelands on the moister sites. This area includes the transition of <i>E. marginata</i> to <i>E. tottiana</i> in the vicinity of Perth.
Karrakatta complex – central and south	Predominantly open forest of <i>E. gomphocephala</i> – <i>E. marginata</i> – <i>C. calophylla</i> and woodlands of <i>E. marginata</i> – <i>Banksia</i> spp.

Source: Heddle *et al.* 1980

The development of the Site will require the removal of isolated trees only.

4.2 Conservation Area

A vegetation and flora assessment of the site was undertaken for Stage 1 as part of the FSH project in 2005, prior to clearing (GHD 2006a).

Since the development of the FSH Project, the only remaining vegetation on Site (apart from a few scattered trees) is contained within this Conservation Area and another Conservation Area to the south of FSH. Vegetation within the Conservation Area is considered to be in Excellent condition (GHD 2006a).

The majority of the Conservation Area is representative of Marri-Banksia-Melaleuca Woodland (Figure 6) which was described as a 'small area, recently burnt, comprising an overstorey of *Corymbia calophylla* (Marri) and *Banksia attenuata*, with scattered *B. menziesii* and *Melaleuca preissiana*, over *Xanthorrhoea preissii*, *Hibbertia hypericoides*, *Patersonia*, and various herbs' (GHD 2006a). A small portion of the Conservation Area consists of Jarrah-Banksia Woodland, being *Banksia attenuata*, *B. menziesii* with scattered Jarrah (previously harvested), *Allocasuarina fraseriana*, over *Adenanthos cygnorum*, *Allocasuarina humilis*, *Melaleuca thymoides*, *M. systema*, *Beaufortia elegans*, *Hibbertia hypericoides*. Understorey varied, with mixed undershrubs, sedges and herbs, dominated by *Lepidosperma* species, *Burchardia umbellata*, *Patersonia occidentalis*, *Stirlingia latifolia*, *Briza maxima*, *Ehrharta calycina*, *Gladiolus caryophyllaceus*, *Hardenbergia comptoniana* (GHD 2006a). Subsequent surveys indicate that construction of the FSH project has not affected the composition or condition of the vegetation of the Conservation Area (Strategen 2013).

The retention of the Conservation Area and maintenance of the condition of the vegetation is a condition of the EPBC approval of FSH. Strategen understands the Conservation Area is currently managed by Serco as per their contractual arrangements with the Department of Health (DoH) for the operation of the FSH. Public access to the Conservation Area may be permitted with the approval of DoH and the Federal Department of the Environment (DoE). The proposed LSP design will not result in public access to the Conservation Area.

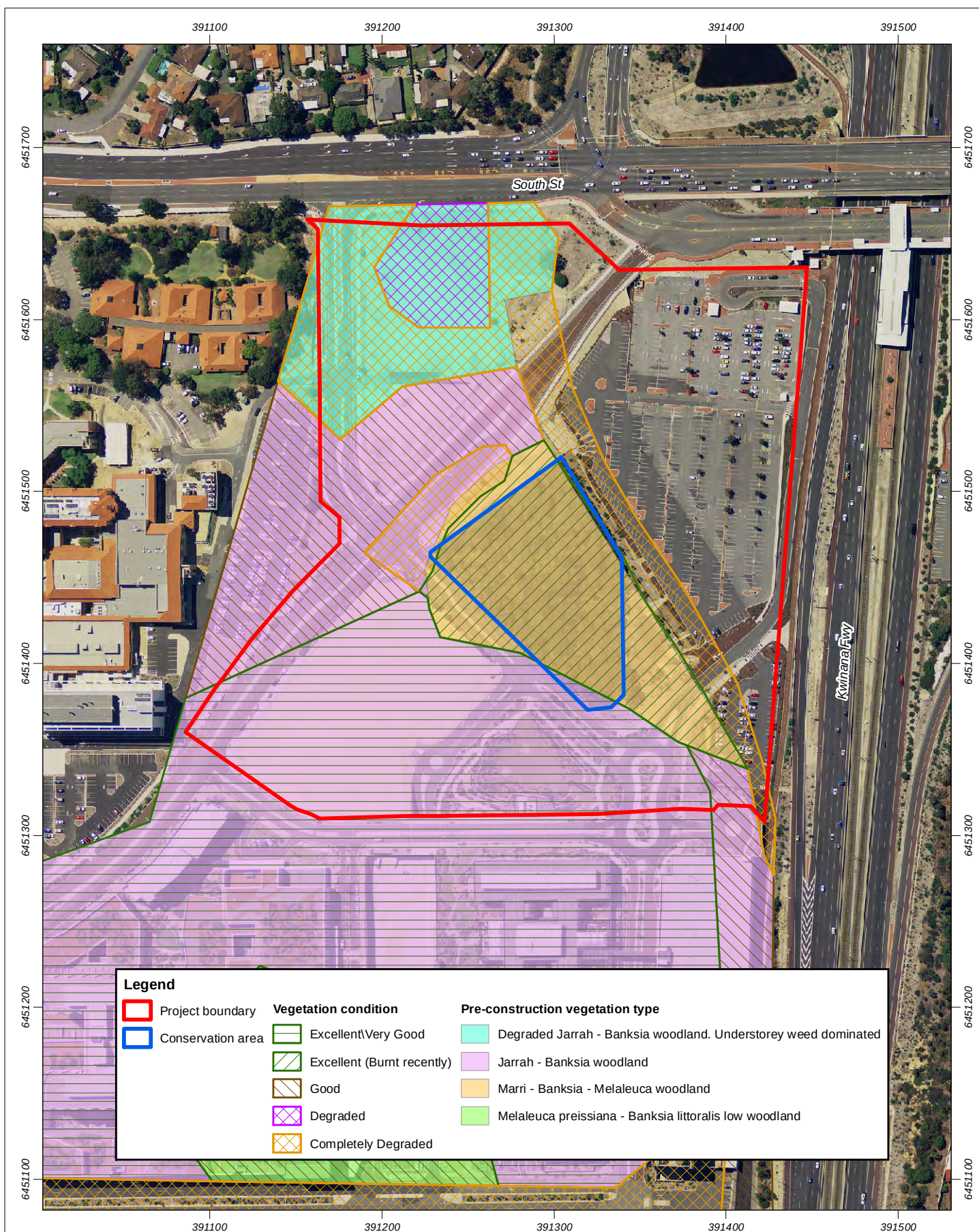
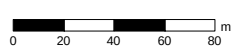


Figure 6 Vegetation complexes, type and fauna habitat

Scale 1:3,000 at A4



Coordinate System: GDA 1994 MGA Zone 50
 Note that positional errors may occur in some areas
 Date: 24/09/2015

Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Concept plan: Client 2015. Vegetation: GHD 2006.

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4.3 Dieback

A *Phytophthora cinnamomi* (dieback) assessment of the FSH Project area was undertaken by Glevan Consulting (2008). The southern part of the MUP area was considered generally to be dieback free, but the northern part of the Site was considered to be 'unmappable' as the high level of disturbance of vegetation made it difficult to determine if dieback was present (Glevan Consulting 2008). The Conservation Area was not identified as containing dieback (Glevan Consulting 2008).

Subsequent sampling was undertaken in 2013. While dieback was not identified in soil samples taken, deaths of *Xanthorrhoea preissii* (grass tree) were noted to be occurring in the area (Glevan Consulting 2013). Grass tree death is often an early sign of dieback presence. The cause of the grass tree deaths could not be identified (Glevan Consulting 2013). Glevan Consulting (2013) considered there was the potential that dieback may be present in the Conservation Area.

4.4 Commitments under Environment Protection and Biodiversity Conservation Act 1999

The clearing associated with the FSH Project included the clearing of the MUP Stage 1 area. This clearing was approved as part of the FSH EPBC Act action. The FSH Project was approved to be implemented subject to a number of conditions, as outlined in EPBC 2008/3970.

One of the on-site mitigation measures for the FSH Project was the retention, protection and management of the Conservation Area that is within the Murdoch MUP site. The Conservation Area is currently managed by Serco. The ongoing management of the Conservation Area is a matter for the DoH and is not a subject of the LSP.

Because MUP Stage 1 is located on land cleared under EPBC 2008/3970, the conditions of the approval must be honoured through the development. The following conditions are relevant to the Murdoch MUP site:

- "2. *The person taking the action must implement the Carnaby's Black-Cockatoo (*Calyptrorhynchus latirostris*) Management Plan (Attachment B) and undertake on-site landscaping consistent with the FSH Landscape Implementation Plan (Attachment C). This requires the person taking the action to:*
 - 2.1 *retain, protect and manage in perpetuity 0.89 hectares [the Conservation Area within MUP] and 2.18 hectares respectively within the two conservation areas, as identified in Attachment A.*
 - 2.2 *establish greenways planted with 100 percent native species...with 100 percent of the total number of trees planted and at least 70 percent of the understorey cover being either species found in the project area or other native species suitable for the Carnaby's Black-Cockatoo*
 - 2.3 *establish streetscapes planted with 100 percent native species, with at least 70 percent of trees planted being either species found in the project area or other native species suitable for the Carnaby's Black-Cockatoo....*
 - 2.4 *establish other areas of open space within Fiona Stanley Hospital including urban plazas, internal gardens and roof gardens planted with at least 70 percent native species, with at least 60 percent of trees planted and at least 60 percent of the understorey cover being either species found in the project area or other native species suitable for Carnaby's Black-Cockatoo.*

In all cases, the aforementioned targets exclude areas of turf and paving."

The landscaping requirements are relevant to streetscapes, however they also relate to connectivity of the two conservation areas established within the FSH site. Immediately south of the Conservation Area within the Murdoch MUP site, is a constructed wetland environment which is surrounded by and connected to external public space that is envisaged to be landscaped. Including the landscaping that is proposed around the two Conservation Areas relevant to FSH, there is connectivity throughout the site that was envisaged to provide some connectivity for fauna.

4.5 Management response

The MUP Site has been largely cleared. Clearing, beyond the removal of isolated trees, is not proposed as part of the MUP development. The impact of the proposal on existing flora and fauna is consequently minimal.

LandCorp will work with DoH to ensure that conditions relating to the retention and management of the Conservation Area and all landscaping requirements under the EPBC Act approval are met. This will include the preparation of a Construction Environmental Management Plan (CEMP) to ensure that construction works do not impact upon the Conservation Area as required by the conditions of the EPBC Act approval.

With implementation of these measures, the project is not anticipated to impact upon flora and vegetation within the project area.

5. Fauna

5.1 Fauna habitats

As described in Section 4, other than the Conservation Area the Project site supports limited vegetation and does not support other areas of potential fauna habitat such as wetlands. The site therefore provides little to no fauna habitat value.

5.2 Management response

As no additional clearing is proposed, the development of MUP is not anticipated to impact upon fauna present on the Site.

6. Social environment

6.1 Noise

The site is located adjacent to two primary freight roads under Main Roads jurisdiction, being Kwinana Freeway and South Street, as well as the Mandurah Rail Line (WAPC 2009). As such, the development is subject to the requirements of *State Planning Policy 5.4: Road and Rail Transportation Noise and Freight Considerations in Land Use Planning* (SPP 5.4) (WAPC 2009). This policy requires that new sensitive developments, including residential developments, located adjacent to primary road and rail routes demonstrate that the development meets the outdoor noise level requirements (Table 2). These requirements are to be met at 1 m from the most exposed habitable façade of the proposed building, at each floor level and at least one outdoor living area on each residential lot (WAPC 2009).

Table 2: Outdoor noise levels

Time of Day	Noise target	Noise limit
Day (6 am to 10 pm)	LAeq = 55 dB(A)	LAeq = 60 dB(A)
Night (10 pm to 6 am)	LAeq = 50 dB(A)	LAeq = 55 dB(A)

Source: WAPC (2009)

Where this noise limit is likely to be exceeded, a detailed noise assessment must be undertaken by the developer in line with the policy to demonstrate that indoor noise requirements can be met and that at least one outdoor living area on each residential lot can meet the noise target (WAPC 2009).

6.2 Light spill

Light spill from the Kwinana Freeway, FSH Project and South Street may also need to be managed to ensure that new residents are not affected by light. Light spill into the Conservation Area is not considered to be of concern as it is not anticipated to affect the growth of vegetation and the Conservation Area is not a known black cockatoo roosting site.

6.3 Fire management

Part of the maintenance of the Conservation Area will be fire management, in accordance with the *Bush Fires Act 1954*. The requirements for fire breaks and access to fire fighting facilities will need to be confirmed with the City of Melville, Fire and Emergency Services Association (FESA) and the Department for Planning to ensure requirements are incorporated into the design as it progresses.

6.4 Management response

Detailed design guidelines will be developed at the subdivision stage. These design guidelines will require developers to demonstrate that noise guidelines can be met and that new residents will not be affected by light spill.

Requirements for access and facilities for fire management will be considered as part of the design of the POS.

7. Recommendations and conclusions

An environmental evaluation of the terrestrial portion of the Site was undertaken, including an assessment of existing environmental characteristics of the Site and investigations undertaken to date. In summary, the outcomes of the environmental assessment were:

1. Geological investigations indicate that the soils are generally sandy, with a clay lens present in the vicinity of the Conservation Area. Acid sulphate soils have been found on the site at depth and further investigations may be required depending on the nature of ground disturbing works proposed on the site.
2. The site has been previously cleared as part of the FSH development. Apart from a few scattered trees, vegetation is limited to the Conservation Area, which will be retained. The impact of the MUP development on flora and fauna is considered to be negligible.
3. The FSH development was the subject of an EPBC Act approval that requires that certain criteria are met with respect to landscaping on the site, specifically the percentage of native species, and retention of the Conservation Area. As MUP is located within the boundary of this approval, these conditions are also binding on the MUP development.
4. Noise and light spill from South Street and Kwinana Freeway may potentially affect the amenity of future residents. Detailed design guidelines will be developed at the subdivision stage that will require developers to demonstrate that noise guidelines can be met and that new residents will not be affected by light spill.
5. Requirements for access and facilities for fire management will be considered as part of the design of the POS.

A Construction Environmental Management Plan (CEMP) will be required limit the impacts to adjacent land uses from noise, vibration, dust and traffic. The CEMP should also include management actions to prevent impacts to the Conservation Area.

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Appendix 1

Geotechnical report

**FIONA STANLEY HOSPITAL:
GEOTECHNICAL REPORT**

**BG & E
Murdoch**

GEOTHERD08304AB-AC (Rev A)
30 June 2008

30 June 2008

BG & E
484 Murray Street
Perth WA 6000

Attention: Donald MacMillan

Dear Sir

RE: Fiona Stanley Hospital: Geotechnical Report

This letter presents our report on a geotechnical investigation carried out at the above site. It revises our earlier draft GEOTHERD08304AB-AC dated 10 June 2007, following receipt of review comments from BG&E.

It should be noted that there are a number of ongoing tasks associated with our original brief. In addition however, we have recommended further studies to be undertaken during design and implementation of this project. Comments on further work are presented in Section 9 of the report.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact Mr Francesco Senatore or the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd



M.O. Hillman

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- 2 Groundwater Elevations
- 3 Rising Head permeability Testing
- 4 Geotechnical Model
- 5 General Definition of Site Classes
- 6 Soils Parameters Recommended for Design of Retaining Walls
- 7 Maximum Groundwater Levels (Current Conditions)

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- 1 Site Plan – Coffey Test Sites
- 2 Site Plan – All Test Sites
- 3 Extent of Clay Soils
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Appendices

- A Results of Field Investigation Boreholes (35 pages)
- B Results of Field Investigation Electric Friction Cone Penetrometer (86 pages)
- C Results of Field Investigation Test Pits (20 pages)
- D Rising Head Permeability Testing (4 pages)
- E Seismic profiling (35 pages)
- F Laboratory Test Data (83 pages)
- G Results of Finite Element Analysis of Rafts (FEAR) – (6 pages)
- H Acid Sulphate Soils (78 pages)

1 INTRODUCTION

This report presents the results of geotechnical and geophysical investigations carried out by Coffey Geotechnics Pty Ltd (Coffey) for BG&E on the proposed Fiona Stanley Hospital located at Murdoch.

This work was commissioned by Mr Donald MacMillan of BG&E on 11th April 2008 via a completed "Authorisation to Proceed" form enclosed with the Coffey proposal dated (Ref. GEOTHERD08304AB-P-AA).

This report is prepared and is to be read subject to the terms and conditions contained in our proposal dated 22nd February 2008 (Ref. GEOTHERD08304BA-P-AA). Our advice is based on the information stated and on the assumptions expressed herein. Should that information or the assumptions be incorrect then Coffey Geotechnics Pty Ltd shall accept no liability in respect of the advice whether under law of contract, tort or otherwise.

2 PROPOSED DEVELOPMENT

You have indicated that the development proposed for the site comprises of a new hospital development including a number of multi storey buildings, open areas and car-parking buildings. It is understood that a significant amount of bulk earth works including cuts up to approximately 10m and fill up to approximately 4m will be required.

3 OBJECTIVES

The objectives of the geotechnical investigation were to assess the following:

- A. Review of the following existing geotechnical reports and site investigation work carried out to date for the project:
 - o Report on Preliminary Geotechnical Investigations, prepared by GHD Geotechnics, September 2007, Revision 0.
 - o Preliminary Acid Sulphate Soil Investigation, prepared by GHD Geotechnics, 17 July 2007.
- B. Review of the Site Creation Tender (Bulk Earthworks). Report received during the week commencing 2 June 2008.
- C. Plan and implement as required an additional desk top study to establish geological setting, site history (development and prior land use), including review of existing aerial photographs general site conditions including adjacent structures and potential impacts of planned development.
- D. Plan and implement additional site investigation work as is required for engineering characterisation and items referred to in this scope. Planning is to take account of environmental requirements and specifically land clearing requirements.
- E. Assess soil and groundwater conditions, including likely seasonal variations, across the site including design water-table levels.
- F. Advise on short and long term groundwater control.

- G. Screening for presence of acid sulphate soils and assessment of water quality for construction dewatering.
- H. Review previous studies regarding possible site contamination and undertake additional studies where necessary, to identify possible contaminants, contaminant locations on the site and provide recommendation on additional studies required to determine the extent of such contaminants.
- I. Preparation of Acid Sulphate Soil Management Plan, as required.
- J. Assess ground stability and need for ground improvement or removal of unsuitable materials.
- K. Assess liquefaction potential.
- L. Advise on protection of foundation and service excavations and suitability of materials for structural fill.
- M. Advise on possible fines migration below stormwater compensation tanks and the possible settlement effects on tank structure and adjacent buildings/structures. Provide recommendations to manage effects of potential fines migration.
- N. Provide recommendations on site preparation requirements, including compaction criteria, possible effects on adjacent building / roadways.
- O. Provide recommendations and geotechnical design parameters for earth retaining structures including: bulk density, submerged density, angle of internal friction and coefficients of lateral earth pressure K_0 , K_a , and K_p .
- P. Provide recommendations for excavation and dewatering requirements for input to earthworks specification, including potential for acid sulphate soils.
- Q. Provide recommendations for slope batters.
- R. Provide a qualitative assessment of the potential for on-site disposal of stormwater including transmissive parameters.
- S. Assess the site classification in accordance with AS 2870 "Residential Slabs and Footings".
- T. Assess the appropriate seismic sub soil class in accordance with AS 1170.4 2007.
- U. Provide recommendations on suitable footing systems for the proposed development.
- V. Provide geotechnical design parameters for the recommended footing systems.
- W. Provide estimated total and differential settlements for the suitable footings.
- X. Provide a recommendation for CBR for pavement design.
- Y. Provide geotechnical advice as required during design.
- Z. Provide geotechnical advice as required during construction. Identify extent of involvement and associated costs.

4 INFORMATION SUPPLIED BY OTHERS

You have provided us with the following information:

- Your request for geotechnical consulting services dated 7 February 2008 (ref: P07037 : DM).
- Site Location plan (ref: Figures 1 and 2).
- Site Plans outlining the proposed structures and present surface elevations.
- Draft aerial view Master Plans.
- Architectural Elevations.
- Report on Preliminary Geotechnical Investigations, prepared by GHD Geotechnics, September 2007, Rev 0.
- Preliminary Acid Sulphate Soil Investigation, prepared by GHD Geotechnics, 17 July 2007.
- Construction Environmental Management Plan, prepared by Strategen, November 2007.
- Fiona Stanley Hospital Design Programme (dated 5 February 2008).
- Fiona Stanley Hospital Master Geotech Programme (dated 7 February 2008).
- Preliminary Road Layout Design Contours (ref: 6119514-C101 Rev B.pdf)
- Existing Sewer Pipes line (ref: Exist Sewer.pdf)

5 FIELDWORK

5.1 General

Fieldwork was carried out between 1st May 2008 and 15th May 2008 in the full time presence of personnel from Coffey. Fieldwork was undertaken following consultation with the environmental consultant, Stratogen, and was monitored by personnel representing aboriginal heritage issues. Environmental constraints precluded access to parts of the site, especially in the area of the main hospital.

Investigation locations were measured by GPS. Water level readings were made in the drill holes at times and under conditions stated on the borehole logs. It must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors.

Access at the site was moderate, with investigations being largely limited to existing sand access tracks as approval was not obtained for the clearing of vegetation. Tracks are loose boggy sands suitable for 4WD use only. For drilling access, an 8.5 tonne loader was required to tow the drilling rig and support truck to borehole locations BH103 and BH104.

Weather conditions at the time of fieldwork were mostly fine, with occasional showers.

Approximate investigation locations are shown in Figures 1 and 2.

5.2 Boreholes, Sampling and Testing

The fieldwork included the drilling of 4 boreholes (BH101 to BH104) to depths varying from nominally 24.1m to 25m below existing ground surface using a Jacro 200 Site Investigation Drilling Rig and mud flush techniques.

Sub-soil samples were taken at nominally 1m – 1.5m intervals and included Standard Penetration Tests (SPT's) and thin walled (62 mm diameter) tube samples. The SPT's were carried out on granular materials to estimate the density index at the test depth. The thin walled tube samples were taken in predominantly cohesive materials to provide "undisturbed" samples for laboratory examination and testing. From these samples, further sub samples were taken for acid sulphate soil testing.

Five samples of groundwater were obtained for chemical analyses.

The records of boreholes showing detailed descriptions of the major strata encountered, the depths at which the samples were taken, the depths at which the in situ tests were carried out, and the results of these tests are presented in Appendix A.

Borehole data collected by GHD 2007 is also enclosed in Appendix A for completeness.

5.3 Electric Friction Cone Penetrometer Testing

Electric Friction Cone Penetrometer Test (CPT) probes (CPT101 to CPT105) were carried out at five locations to depths varying from nominally 15m to 20m below the existing ground surface at the approximate locations shown on Figure 1.

Piezocene (CPTu) data collected by GHD 2007 is also enclosed in Appendix B for completeness.

The CPT is described in AS 1289-1999.6.5.1 and the results of these tests in the form of plots of Cone Resistance (q_c) Sleeve Friction (f_s) and Friction Ratio, together with a Technical Note on the application of the CPT to geotechnical investigations, are attached as Appendix B.

5.4 Test Pitting

A total of 19 test pits were excavated by backhoe to depths ranging from 1.5 m to 4m below the existing ground surface at the approximate locations shown on Figure 1.

Disturbed samples were taken from all locations of representative soil types for both environmental and geotechnical laboratory examination and testing.

The records of the test pit logs showing the major strata intersected, the depths at which the samples were taken, insitu tests carried out, and the results of these tests, together with Explanation Sheets defining the terms used, are presented in Appendix C.

5.5 Groundwater Monitoring

The groundwater was monitored by installing 5 piezometers to depths varying from nominally 7m to 25m below ground level using the boreholes described at Section 5.2. Each piezometer comprised 50mm diameter PVC with a 3m interval of slotted screen and fitted with PVC end caps. The slotted sections were gravel/sand packed and sealed with bentonite plugs.

A total of 5 groundwater samples were obtained for chemical analyses.

Rising head tests were carried out in the piezometers. The results of this testing are presented in Section 7.4, and analysis data is provided in Appendix D.

5.6 Seismic Testing

5.6.1 Introduction

The objective of the testing was to obtain laterally distributed information on subsurface geology and to provide in situ dynamic modulus values for the materials at this site to assist foundation design. Seismic testing was carried out along ten (10) lines on 6th and 7th May. Figure 1 shows the location of the seismic test lines plotted on the supplied site plan.

5.6.2 Methodology & Equipment

A combination of seismic testing methods were applied at this site i.e. the Seismic Refraction and Refraction Microtremor (ReMi) methods.

Seismic refraction testing is accepted practice for many problems in geotechnical engineering. This non-destructive test uses a linear array of closely spaced detectors on the earth's surface (from 1m to 10m) to identify first arrival seismic waves travelling through the earth from seismic sources placed at various locations. These data are digitally acquired, computer processed and interpreted to provide the subsurface distribution of seismic P-wave velocities and the locations of significant elastic interfaces.

ReMi testing is a relatively new seismic method for measuring in-situ shear-wave (S-wave) velocities in the subsurface. Testing is performed at the surface using the same conventional seismograph and vertical P-wave geophones used for refraction studies. The seismic source consists of ambient seismic "noise", or microtremors, which are constantly being generated by cultural and natural noise. Conventional seismic equipment is used to record data, and ambient noise is used as a seismic source.

5.6.3 Field Procedures

At this site, ten (10) intersecting seismic refraction lines and ReMi lines (Figure 1) were completed using length from 71m to 94m with geophones at 3m or 4m intervals. The seismic data were acquired using a Geometrics Geode 24-channel digital signal enhancement seismograph with a sample interval of 0.250 ms. The refraction seismic sources were summed hammer impacts on a metal plate placed at various locations in line with the geophone array on each seismic line.

The ReMi data were acquired with a sample interval of 2 milliseconds and record length of 30 sec. Low frequency geophones (4.5 Hz) were used and the seismic sources consists of ambient seismic "noise", or microtremors.

5.6.4 Results & Interpretation

All the acquired seismic data were stored on computer disk for later processing and have been archived in Coffey's database.

In general, data quality was adequate for geophysical analysis and interpretation. The seismic refraction data were interpreted using REFRACT software and the ReMi data analysis was completed using Optim software in accordance with accepted practice. The ReMi data was transformed by frequency-slowness method and surface wave phase velocity picked. Using a numerical Rayleigh wave modelling

procedure and linearised optimisation, layered S- wave velocity models were derived from the observed dispersion curves.

The Seismic results are summarised in Appendix E.

The interpreted refraction sections (Appendix E) show a two-layered subsurface with seismic P-wave velocities in the upper layer typically from 350 to 450 m/s that is typical of essentially dry sandy soils or uncompacted sand fills. The lower layer occurs near RL -4 to -10m and has P-wave velocities from about 1600 to 1700 m/s although beneath Line 9 the P-wave velocity increases to about 2000 m/s suggesting possible induration. This range of P-wave velocities in the lower layer may represent saturated soil materials or materials of increased density extending to the depth of investigation of the refraction testing

The ReMi analysis provided uniformly increasing S-wave velocities to about 27m depth ranging from 150 m/s near the surface to about 300 m/s at depth. These velocities are also consistent with sandy materials increasing in density with depth.

As no abrupt increase in S-wave velocity with depth was observed it is likely that the abrupt increase in P-wave velocity is mainly due to increased saturation.

On each line the averaged P and S – wave velocities obtained have been used to compute indicative dynamic and shear modulus values across the site to assist foundation design. An average density of 1.8 t/m^3 was assumed for the sandy materials that are believed to be present and the standard equations were applied. These modulus values are listed on Tables E1 to E10 in Appendix E.

6 DESCRIPTION OF LABORATORY TESTING

Laboratory testing was carried out in accordance with the general requirements of the latest edition of AS 1289 by the Coffey NATA registered soils laboratory.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Table 1.

Table 1 – Extent of Laboratory Testing

Type of Test	Number
Particle Size Distribution tests	10
Atterberg Limits, Percent Fines and Moisture Content tests	3
Unsoaked/Soaked CBR tests	2
Extended Water Analysis	5
Acid Sulphate Soil Field Screening	Approximately 400
Quantitative Acid Sulphate Soil Testing (S_{CR} and SPOCAS)	Up to 72

Test results for the above mentioned tests are attached in Appendix F.

7 SITE CONDITIONS

7.1 Surface Conditions

The site occupies an area of 11 ha and is bounded by South Street, Murdoch Drive and The Kwinana Freeway. St John of God Hospital is located to the north of the site. A Police Station and Fire Station are located on the western boundary, fronting Murdoch Drive. The site is situated in undulating topography with gentle slopes.

A sandy ridge crosses the site from north north-west to south-south-east, rising to elevations above 30m AHD. A now dry swamp (drained by the adjacent South Street/Kwinana freeway drainage) with ground level about 20m AHD extends to the north of the sandy ridge. A large low lying depression (elevations less than 21m AHD) extends to the south of the sandy ridge, and will underlie much of the proposed hospital. A pronounced west to east sandy track crosses the site through this depressed area, and marks the southern boundary of currently proposed building development for the hospital. Immediately south of the track is an open man-made water body. A second dunal ridge rising to over 30m AHD is evident south of this water body.

The site is well vegetated with mature native bushland consisting predominantly of Mari, Banksia and Casuarina. Paper bark is present in low lying areas.

Access into some areas of the site was not possible due to dense vegetation, therefore prior to design finalisation and/or commencement of construction further investigation of the vegetated areas will be required to identify appropriate measures for these areas of the site (see Section 9).

7.2 Subsurface Conditions

The 1:50,000 Environmental Geology (Fremantle) indicates that the surface geology is Bassendean Sands.

Based on the results of field testing, the Fiona Stanley Hospital site is within an area of deep sand soils. Topsoils are thin (typically less than 100mm), however thicker organics might be expected in the lower lying areas (swales). TP104 indicated a topsoil as much as 0.4m thick (in the former swamp site to the north of the main development).

Two distinct sand units may be present below the topsoils. The upper unit is dune sand, fine to medium grain size. The upper 4m of the soil profile irrespective of elevation, typically increases from a cone resistance of about 2MPa at ground surface, to in excess of about 10MPa at 4m depth. SPT test results were typically greater than 5 at 1m depth and greater than 12 at 3m depth. Taking into account the low overburden stress at 1m depth, these results suggest a medium dense sand condition in the upper 4m (density index 45% to 60%). Beyond about 4m depth, the soil profile is typically medium dense to dense, becoming very dense with greater depth.

At about +14m AHD in the northern portion of the site, a lense of up to 2m of fine grained typically low plasticity silt and clay (referred to in this report as the "clay" layer) was encountered. The lense appears to mark a disconformity separating the sands above, from deeper soils, also sands but possibly coarser grain size, and typically very dense to cemented.

The clay layer is very stiff. It is judged to comprise diatomaceous earths associated with a former swamp bed, and silts and clays of generally low plasticity. Its approximate extent based on testing undertaken, is illustrated on Figure 3.

The deeper sands may be Gngangara Formation. The seismic profiling work differentiates between an upper layer and deeper indurated sands, however the boundary identified in the seismic profiling appears higher than the unconformity marked by the presence of the clay layer. The seismic profiling identified the presence of the clay layer in Line 4.

The seismic profiling shows similar seismic velocities for all seismic lines in the sands at depth, suggesting uniform consistencies across the site.

Borehole testing has penetrated to an elevation of -7m AHD without intersecting bedrock. Bedrock in this area is likely to be of the order of -20m AHD (i.e. from 40m to 50m below ground surface) and comprise Kardinya Shale Member of the Osborne Formation (refer to Perth Groundwater Atlas 1997 and Davidson 1995).

7.3 Groundwater

7.3.1 Groundwater Levels

Groundwater levels measured during the course of the investigation are presented in Table 2.

Table 2 – Groundwater Elevations

Site No.	Screened Depth (m)	Depth to Groundwater (m) – May 2008	Water Table Level (mAHD) – May 2008
BH101	22 – 25m	9.7	16.9
BH102	22 – 25m	4.4	16.6
BH103	22 – 25m	14.0	17.7
BH104d	22 – 25m	5.2	17.7
BH104s	6 – 9m	5.1	17.8

It should be noted that groundwater levels are subject to variation due to the influence of rainfall and other seasonal affects, and to local drainage and changing land use.

7.3.2 Groundwater Quality

Groundwater quality is generally fresh to brackish. The salinity of BH104 Deep was comparatively high at 3200mg/L TDS. It is noted overlying water in BH104s is fresh. The pH was generally close to neutral for all sites, with BH104 Deep showing the lowest value at 6.35 pH units.

Appendix F presents a summary of analysis results. The water is not suitable for drinking, but would be suitable for earthworks purposes. Salinity in BH104 may be unsuitable for some plants for reticulation. Advice should be sought from the Landscape Architect, if it is intended to draw water from this site for landscaping purposes.

7.3.3 Rising Head Permeability Test Results

The permeability of the sands at the site was calculated as per BS5930:1999. Data was obtained using a Level Troll automatic logging device, which recorded water height above the tip of the instrument at 2 second intervals.

The range in average hydraulic conductivity (k) values obtained from the analysis is presented in the table below. The analysis data is presented in Appendix D.

The results of the analysis show that soil horizontal hydraulic conductivity (k) are consistent with the typical conductivity associated with clean sands, at close to 5m/d. A low permeability measured at BH103 can not be adequately explained by review of the borehole logs. It is lower than would be anticipated for sands with a fines content typically about 3% by weight, or that would be anticipated from region studies of this sand unit. The results for BH103 are more likely to reflect partial blockage of the piezometer slots than aquifer conditions.

Vertical permeability in these sands is expected to be similar to horizontal permeability.

Table 3 – Rising Head Permeability Testing

Test Location	Horizontal Conductivity (k)	
	(m/s)	(m/d)
BH101	$3.4 \times 10^{-5} - 8.9 \times 10^{-5}$	3 to 8
BH102	$5.2 \times 10^{-5} - 7.6 \times 10^{-5}$	4.5 to 6.5
BH103	$2.1 \times 10^{-6} - 4.0 \times 10^{-6}$	0.2 to 0.4**
BH104	$7.4 \times 10^{-5} - 1.3 \times 10^{-4}$	6 to 11

*** - This test result is significantly below expectations for this sand unit, and may reflect a problem with the piezometer, rather than site conditions, based on our review of particle size distributions. This result is ignored in subsequent analysis.*

7.4 Geotechnical Model

The geotechnical model for this site will depend on the final earthworks levels, and thickness and condition of engineered fill (or of cut). For design purposes, and based on CPT and borehole SPT interpretations, a model is proposed as set out in Table 4. A final floor level of about 23m AHD is applicable to most of the hospital. There is however a long tunnel, and an associated deeper basement which will be excavated to a final floor level of 18m AHD. The stiffness of the soil profile (elastic modulus) increases with depth, and the influence of geological surcharge loading (removed to achieve basement elevation) becomes greater. The analysis method used does not accommodate this difference in elevations, and therefore a “typical” elevation for the modelling has been adopted (nominally 20m AHD). The impact would be to overestimate settlements in the area of the deeper basement, and to underestimate settlements in the higher elevation areas.

It should also be noted the clay zone does not encroach to any significant extent into the currently proposed building envelopes, and the model therefore does not allow for its presence.

The bulk density assumed for the sand is 1.8t/m^3 . Effective friction angles of $\Phi' = 32^\circ$ to $\Phi' = 38^\circ$ have been adopted depending on the CPT cone resistance, and assuming earthworks are undertaken in accordance with this report.

Geotechnical design for this project is primarily related to the amount of settlement.

CPT data has been interpreted in terms of elastic modulus “E”. Fahey et al 2003 found that E is related to overburden stress, stress history, and the magnitude of strain generated by the applied load, and can not be interpreted solely from CPT cone resistance q. They proposed a relationship of the form shown in equation (1) .

$$E = C \times (q \times \sigma_v' \times p)^{0.333} \dots\dots\dots(1)$$

Where q_c = CPT cone resistance

σ_v' = effective vertical stress

p_{atm} = atmospheric pressure (100kPa)

C is a factor which is dependent on stress history, and magnitude of strain.

Units must be consistent (for instance all kPa)

Various test methods used to measure soil stiffness can be categorised in terms of the magnitude of strain imposed. The seismic testing is interpreted as a low level strain modulus. The Pressuremeter test unload-reload modulus provides a good estimate of settlements for foundations on the stiff clays and sands of the Perth area (Fahey et al 2003) and reflects an “intermediate strain” modulus. The Marchetti Dilatometer (DMT) testing presents a large strain modulus, oriented in a horizontal direction.

Fahey et al 2003 compared stiffness values from the above three test methods for three rafts in the Perth CBD, and found the stiffness derived from seismic cone testing to be 2 to 3 times higher than that for pressuremeter testing, whilst the stiffness for DMT testing was 2 to 3 times lower. The reason for this difference is the magnitude and direction of strain (elastic modulus is strain dependent), and this highlights the need for caution in the selection of a modulus value appropriate to the magnitude of movement anticipated.

Stress history also has a substantial impact on elastic modulus. Cocks et al 2004 found that the equivalent stiffness of deep Spearwood Sand over Guildford Alluvium at the Mortimer Road bridge crossing of Kwinana Freeway at low stress levels was about 3 times that measured at comparatively high stress levels. This may be attributable to historic preconsolidation levels or aging effects. Fahey et al 2003 showed in the results of Baldi 1979, that for the sands reported by Baldi 1979 at intermediate strain levels, the stiffness of an over consolidated sand was twice that of an aged normally consolidated sand, and 5 times that of a recent normally consolidated sand.

Fahey et al 2003 have proposed a relationship for the factor C for sands in Perth CBD from $C = 70$ for normally consolidated sands under large strain, (a ratio of settlement to footing width greater than 1%) to $C = 200$ for normally consolidated aged sands, and $C = 400$ for over-consolidated sands under intermediate strain (settlement/ footing width of 0.1%).

Cocks et al 2004 present a linear relationship between E and q based on back analysis from settlement monitoring with the ratio of E/q ranging from 12 at comparatively low stress levels (inferred as less than

preconsolidation levels) to 4 for stress levels greater than a threshold value (greater than preconsolidation levels). The threshold value for this bimodal relationship is likely to be dependent on the magnitude of any previous pre-loading or aging effect. For comparatively low loads (less than 150kPa), a value of $E=6 \times q_c$ could be adopted as an approximation of the bimodal relationship, however the multiplier will decrease below about 6 as loads increase. Based on the indicative loads for the major structure at Fiona Stanley, a multiplier of 5 is reasonable.

At Fiona Stanley Hospital, it was found that vertical strain would be greater than 0.5% of footing width without taking account of interference effects between adjoining footings, based on preliminary modelling.

Adoption of $C = 150$ for this level of strain is judged to be adequately conservative based on Figure 24 in Fahey et al 2003, taking into account that the sands can be expected to be aged, cemented and overconsolidated (but not to the extent of the proposed imposed load).

Table 4 presents modulus values for the sands at this site derived from equation 1 with $C = 150$.

The Modulus values derived from $C = 150$ in equation 1 are higher at shallow depths than values derived using Cocks et al 2004, but are comparable overall.

As a further check on elastic modulus, consideration has been given to an interpretation of elastic modulus from Standard Penetrometer Test (SPT) "N". Decourt (1982) proposed $E=3 \times N$ based on extensive investigations using the SPT Test. This value is judged reasonable for intermediate strain levels, but may be high where strains become large. Based on this model, modulus values in the upper 3 or 4 m (where $N < 10$ is recorded at a number of sites) would be underestimated relative to Fahey et al 2003, and modulus values at depth ($N \gg 50$) would be over estimated.

The model developed by Fahey et al 2003 draws heavily on the results of back analysis of settlement data recorded by Fraser 1975. It therefore represents an initial settlement plus some creep that has taken place up to the time of settlement monitoring (which may have been months after most of the load had been applied to the foundations). It does not identify whether further creep may be expected to occur under sustained load during the 100 year structure life. On the other hand the model of Cocks et al 2004 estimates an immediate settlement only, with further allowance being required for creep settlement.

Cocks et al 2004 monitored creep for about 25 days on similar sands, however this monitoring duration was not long enough to establish a model for predicting long term creep. Hillman et al 1999 observed significant creep settlement for large storage tanks under constant load over calcareous soils, and provided a model for assessing long term settlements of the tanks under cyclic loading. It is possible that the low strength of calcareous sand grains (leading to crushing) may make them more susceptible to creep than siliceous sands.

Schmertmann 1970 presents a model for assessment of creep settlement based on a logarithmic time scale, as follows:

$$s_t = s_i \times (1 + 0.2 \times \log(t/0.1)) \quad \dots\dots\dots(7)$$

where s_t = total settlement; s_i = immediate settlement; t = time in years.

The settlement attributable to creep over say a 50 year design life based on this equation is large, and there is little evidence in Perth or elsewhere of problems arising from long term creep settlements of major buildings. The Schmertmann 1970 model is judged to be excessively conservative.

For the Fiona Stanley Hospital it is judged prudent to allow for some creep settlement over and above settlements calculated based on Fahey et al 2003 approach. A further contribution of up to 25% of the settlement calculated using Fahey et al 2003 is proposed for total settlements based on a 50 year structure life.

The geotechnical model for “initial” settlement derived below is applicable to the area of the main structure. Some modification to the model would be required for the area illustrated on Figure 3 as encompassing the “clay” zone intercepted at about 15m AHD – however we understand no buildings are currently planned in that area.

Table 4 – Geotechnical Model

Depth From (m)	Depth To (m)	CPT q_c (MPa)	Friction Angle θ' (degrees)	E(MPa)	Poisson's Ratio
0	2	4	32	35	0.3
2	5	9	34	45	0.3
5	10	15	36	75	0.3
10	20	20	36	100	0.3
20	30	25	36	125	0.3
30	>30	>30	36	150	0.3

Bedrock is anticipated at about -20m AHD (some 40m below ground surface).

8 RECOMMENDATIONS

8.1 General

It should be noted that the ground encountered by the testpits, Electric Friction Cone Penetrometer (CPT's) and seismic testing represent the ground conditions at the location where the tests have been undertaken and as such are an extremely small proportion of the site to be developed. Accordingly, variations to the ground conditions are likely and allowance should be made for variability in the design and construction budgets. If conditions other than those described are encountered, further advice should be sought without delay.

Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, ground conditions including groundwater levels can change in a limited time or due to seasonal fluctuations. For example fill could be added to a site or surface materials removed from a site that will change the thickness of surface materials and depth to the underlying materials. The potential for change in ground conditions should be recognised particularly if this report is used after a protracted delay.

It is also recommended that any plans and/or specifications prepared which relate to the content of this report or amendments to original plans and specifications be reviewed by Coffey to verify that the intent of the recommendations contained in this report are properly reflected in the design.

8.2 Site Classification

Table 5 – General Definition of Site Classes

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay site, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include: Soft soils, such as soft clays or silts or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Australian Standard AS2870-1996 provides a system of site classification for residential slabs and footing design (see Table 5). Whilst this standard is not strictly applicable to commercial scale developments, it does provide guidance on what might be anticipated for lightly loaded structures. A site classification of Class A has been assigned, provided the site is prepared in accordance with the Tender documents for bulk earthworks and Section 8.6. As the proposed structures are generally significantly larger than assumed in AS2870, it is recommended that footings are designed in accordance with the site specific footing recommendations.

8.3 Foundations

8.3.1 General

The investigated ground conditions are suitable to support conventional shallow foundation systems comprising pad and strip footings. Settlement criteria rather than bearing capacity will govern foundation design, and consideration will need to be given to the loads and total and differential settlements before deciding whether to proceed with shallow foundations.

Settlement analysis for shallow foundations has been based on two scenarios:

- Isolated footings of different dimensions (supplied by the client) without interactions;

- Simplified model of interacting footings based on indicative loads (supplied by the client).

Copies of client provided footing layout drawings (Ref: Footing Layout and Sections Reference P07037 Dwg S1 to S10 received June 2008) have been provided together with column loads.

8.3.2 Isolated footing

Allowable bearing pressures and estimated settlements, including allowance for creep (50 years) are shown in Figure 4 (square footings). Allowable bearing pressures are based on the following assumptions:

- Load eccentricity is less than 10% of footing width
- Load inclination (H/V) is less than 10%
- Effective footing embedment exceeds 1.2m.
- The ground surface is horizontal
- There is no interaction between adjacent footings.

This chart should be used for sizing of individual footings within the building complex, and elsewhere across the site where earthworks have been completed, and the “clay zone” is not present.

8.3.3 Interacting Footings with Indicative Column load

If footings are closely spaced then there will be significant interaction between the stressed zones of the individual footings. Consequently, the “pressure bulb” will be greater and the theoretical footing settlements will be higher than those shown on Figure 4.

The client provided footing layout drawings illustrate the close proximity of individual footings to one another. Analysis of the footings with consideration of the interaction effects was undertaken using Finite Element Analysis of Rafts (FEAR). The structure was analysed using the client supplied column loading and the footing layout. The estimated elastic settlement is shown in Appendix G. The maximum elastic settlement of a footing as illustrated in the figure is approximately 80mm. This does not allow for long term creep effects.

Maximum settlement occurs in the “core” of the structure where the load is applied at a basement level some 5m lower than the surrounding structure. The numerical modelling did not take this into account. Based on the geotechnical model at Table 4, footings under load at this lower elevation would be expected to settle measurably less than footings under a similar load at the higher elevation. It is also worthwhile observing that whilst loads in this lower core are significantly higher than loads for the structures at higher elevation, the weight of soil removed to achieve this lower elevation in part offsets the higher structure loads.

The figure at Appendix G should be used to illustrate qualitatively where settlements are large or small across the site, but is judged to be conservative in assessing absolute settlements.

8.3.4 Initial and Total Settlements

The maximum initial settlement of a footing is assessed to be less than 80mm based on the above argument, reducing to nominally 20mm around the margins of the building.

It should be noted that 75% of this initial settlement will take place as the structure is constructed, and will therefore be difficult to accurately monitor. The remainder will occur as the “imposed loadings” are applied.

Section 7.4 discusses the need for an allowance for some on-going creep throughout the structure life. The model proposes an allowance for creep of 25% of initial settlement. This would result in total settlements at the heaviest load concentration areas of less than 100mm, with settlements at the edge of the structure nominally 25mm.

8.3.5 Differential Settlements

The Figure G-1 at Appendix G illustrates differential settlements across the building envelope. As discussed in Section 8.3.3, this settlement distribution is qualitative rather than quantitative. There are factors such as previous stress history, aging effects in the soil, cementation effects, and varying modulus with depth that are extremely difficult (and in most cases impractical) to measure, and therefore further numerical analyses is not proposed to improve these assessments. In addition, geotechnical modelling considers only the soil effects – and not the interaction of the structure that can result in partial transfer of load from areas settling, to areas not settling. This factor is particularly important when considering differential movement brought about by localised geotechnical factors.

The approach adopted to assessing the magnitude of differential settlement is to note the difference in long term settlement between building edge and building “core area” over a distance of in excess of 35m is likely to be less than about 75mm, equating to a differential settlement of the order of 1:500 for this structure.

8.3.6 Ground Improvement

The CPT cone resistance in the upper 2m of a great number of the test sites is comparatively low. Whilst this is in part due to the low overburden over this depth range, consideration has been given as to the extent to which ground improvement might be considered, and to the nature of the ground improvement.

The low cone resistance in the upper 2m is not likely to be an issue where depths of cut in excess of about 1.5m are anticipated. Under these circumstances, the low cone resistance zone is removed, and proof compaction of the cut surface ensures a suitable surface finish.

In areas where depth of cut is less than 1.5m, or where fill is to be placed, two options have been considered:

- The soil profile is excavated to within say 0.5m to 1m of the base of the low cone resistance zone and stockpile, the cut surface is proof compacted, and the stockpiled material then replaced as engineered fill. Under this scenario, the elastic modulus of the unexcavated portion of the low cone resistance zone would have been significantly improved, and the subsequent engineered fill will be comparatively high elastic modulus.
- The surface of the 2m layer is heavily compacted (15 tonne smooth drum vibratory roller or larger) resulting in the likely improvement of the upper 1m, with the remaining 1m barely improved or in its unimproved condition.

It should be noted that sensitivity analyses have been undertaken to assess the likely impact on settlement of the structure, if the elastic modulus for a 1m thick zone was up to half the modulus of the

compacted layer (in the event that localised deepening of the low cone resistance zone occurs). The results of the analyses suggest the likely increase in settlement (initial plus creep) for individual footings proposed for this project based on retention of 1m of unimproved profile is less than 5mm (whether considered in isolation or within a group of closely spaced footings). This is a small figure in the context of an overall settlement of up to 100mm. The main disadvantage therefore of retaining a zone that is lower modulus value, is that because it will not be continuous, it will exaggerate localised differential settlements.

Brief consideration has also been given to the possibility of using stone columns to improve the overall soil stiffness. Column spacing would need to be very close to significantly improve the soil/column overall stiffness, because the existing background stiffness is comparatively high (relative to the stiffness of the stone column). A very substantial amount of limestone would need to be sourced and brought into the site, and issues of noise, vibration, and site water management would be exaggerated. This option is not being pursued.

High Energy Impact Compaction (HEIC) has also been considered, but is unlikely to be suitable without some form of preparatory works such as the placement of a crushed limestone surface because of the sand subgrade, which does not provide a suitable surface on which to rotate the HEIC roller. Vibrations from operation of the HEIC are likely to be significantly greater than normal earthworks plant, and would need to be taken into account if using this compactor. This option is not being pursued.

We understand a decision has been made that the bulk earthworks contract is to be based on excavation of nominally 1m of the low cone resistance zone.

Comments on earthworks requirements are presented in Section 8.6

8.4 Earthquake Classification

The earthquake site sub-soil classification in accordance with Australian Standards (AS 1170.4-2007) is Class C_e – Shallow Soil.

8.5 Retention Systems

Earth retaining structures should be designed in accordance with the requirements of AS 4678-2002. The soil parameters recommended for the design of the retaining walls are presented in Table 6.

Table 6 - Soil Parameters Recommended for Design of Retaining Walls

Soil Type	Depth to Top of Layer (m)	Effective Cohesion (c', kPa)	Friction Angle, (φ' degrees)	Unit Weight (γ kN/m ³)	Active Pressure K _a	At Rest K _o	Passive Pressure K _p
Natural Sand	0 - 2	0	32	18	0.307	0.470	3.255
Natural Sand/ Fill	>2	0	34	18	0.283	0.441	3.537

Key: c' denotes undrained cohesion (kPa).
 Phi' denotes undrained friction angle (degrees)

K_a	fully mobilised coefficient of active earth pressure
K_p	fully mobilised coefficient of passive earth pressure
K_o	at rest earth pressure coefficient

8.6 Earthworks

8.6.1 General

Earthworks requirements for this project are set out in Tender Document “Fiona Stanley Hospital and Health precinct: Stage A Site Clearing and Bulk Earthworks”, which is currently in draft form. Coffey has contributed to the review and improvement of this document. Based on the geotechnical investigations, and the Tender Document as reviewed by Coffey, the following further advice can be given concerning the soils at this site.

8.6.2 Suitability of Cut for Use as Engineering Fill

Unsuitable soils including topsoils, soils with an organic content in excess of 2% by weight, building rubble, timber, mulch, contaminated soils, clay, silt (soils with fines content greater than 5% by weight finer than 0.075mm) and rubbish should be stripped from site. The sands remaining after stripping of unsuitable soils are suitable for use as engineered fill sands within this site.

The landscape architects advice should be sought as to their suitability for landscaping purposes.

8.6.3 Excavatability

Sands encountered at this site become very dense, and probably cemented at depth. Deep ripping may be required at depth to assist in excavation where CPT cone resistance is in excess of 20MPa. We would anticipate ripping to be comparatively easy for a D8 or equivalent dozer with single tyne ripper.

8.6.4 Earthworks Slopes

Excavated slopes will be in sand. It is recommended that temporary excavated slopes be constructed not steeper than 1V:1.8H. In the long term, slopes will require protection from erosion by either reducing slopes and vegetating them (slopes nominally no steeper than 1V:3H) or by stone pitching or other means. Slopes with structures or other surcharge closer to the crest than the height of the slope should be reviewed for stability. Slopes of sumps or immediately adjacent sumps should also be reviewed.

8.6.5 Heavy Proof Compaction in Areas to be Filled

Comparatively dense sands will be exposed in areas where more than say 2m of soil is to be cut. A semi-circular area exists encompassing low lying land north of the main access from Murdoch Road into the site, where filling is likely to take place, and as discussed in Section 8.3, this semi-circular area should be compacted as deeply as practical using a heavy vibratory roller. Guidelines for this work have been developed separately (see Section 8.6.1)

The area requiring heavy compaction for the major structures proposed for this project, is of the order of 100m from the nearest building, and whilst vibration monitoring will be required, the separating distance may be sufficient to maintain vibrations within current background levels for those buildings. Vibration monitoring trials are recommended (see Section 8.12.2).

8.7 Flexible Pavements

8.7.1 Subgrade CBR

A design subgrade 4 day soaked CBR of 10 is recommended based on a consideration of:

- CPT
- Correlations with soil classification tests;
- Regional experience;

The adoption of this design value is contingent upon strict compliance with the site preparation recommendations given in the Tender documents.

8.8 Groundwater

Coffey has previously (2004) examined groundwater elevations in the region immediately encompassing Kwinana Freeway south of South Street intersection. Data used in this assessment spanned the Fiona Stanley hospital site. Data sources that have been drawn on from this previous investigatory work, and from the site specific Fiona Stanley studies include the following:

- Main Roads Bore KW1 located in the south west quadrant of the intersection (and within the boundaries of the Fiona Stanley Hospital site) was monitored monthly from August 1988 to June 1990. Results of that monitoring showed:
 - a normal seasonal cycle of about 1.2m (from minimum to maximum groundwater level);
 - minimum groundwater level was in February 1990 at 18.47m AHD;
 - maximum groundwater level was in August 1988 at 19.54m AHD.
- Department of Environment and Conservation "WIN" database bores 3170 and 3171 located on Murdoch Drive, north of Bramanti Drive (and now abandoned). These bores were monitored from June 1973 to January 1993, and show:
 - a normal seasonal cycle of about 1.2m
 - the highest groundwater level recorded since 1974 was August 1988 – i.e. the time KW1 was being monitored.
- Department of Environment and Conservation "WIN" database bore 4487 located north of Leach Highway records water levels from 1974 to present. This bore also confirms that 1988 was the highest groundwater level recorded since the early 1970's, and that annual maximum levels are generally 0.3m or more below this level.
- Coffey installed a piezometer PZ7 in the west of the Kwinana Freeway at the southern end of the then park-and-bus facility (i.e immediately east of the Fiona Stanley site). Monthly water levels were recorded at that piezometer from June 2004 to November 2004, and showed a minimum groundwater level of 17.64m AHD in June 2004 and a maximum groundwater elevation 18.61m AHD in October 2004. This maximum level was over 0.9m lower than the maximum level recorded in KW81 (in comparatively close proximity) in August 1988.

The above results indicate groundwater levels have typically fallen since the early 1970's and more recently since 1988.

Piezometer levels for the current piezometers installed by Coffey BH101, 102, 103 and 104 (see Table 2) showed a maximum level in April 2008 (i.e. end of summer seasonal minimum) of 17.7mAHD near the boundary of the Fiona Stanley site and the Kwinana Freeway. This level is similar to the end of summer level recorded in PZ7 in June 2004.

In addition to the piezometer records at Table 2, earlier piezocone testing by GHD can be used to provide an approximate interpretation of groundwater elevations across the site at that time (June 2007). Indicative groundwater contours from that data show a predominantly east to west fall of about 1m across the site. A low lying area and associated man made swamp near the southern boundary influenced water contours, with levels not falling across this zone until about its western edge. There is some indication in both the GHD data and the piezometer results that groundwater levels may fall more steeply west of this man made swamp area, towards Murdoch Drive.

Based on the regional data sighted for this project (reinforced by observations elsewhere in urbanised areas of the Perth Coastal plain), groundwater levels have declined in recent decades. The fall is attributable to reduced rainfall, drainage works, and heavy groundwater consumption. There may be other causes. Given the similarity in end of summer water level records for PZ7, and for the bores in Table 2, we have adopted 17.7m AHD as representative of the Annual Average Minimum Groundwater Level, covering the eastern margin (say 100m from the eastern boundary) of the site. Annual Average Maximum Groundwater Level for this area is judged to be 18.9m AHD (allowing for 1.2m of seasonal rise and fall). The groundwater level recorded in KW81 was the highest level recorded since the early 1970's (i.e. a 30 year time frame) at 19.54m AHD. Given the probability that with falling regional groundwater levels, this elevation will not be exceeded, and given the location of this bore, we have adopted 19.6m AHD as a probable maximum groundwater level for this eastern margin.

The fall in groundwater elevations from BH103 and BH104 (eastern margin of the site) to BH101 was 0.8m in April 2008 (end of dry seasonal conditions). BH102 which is located between these sites was lower elevation than BH101, possibly reflecting some influence from the low lying interdunal swale immediately to the south. This observation contrasts with the GHD piezocone data which indicates comparatively high groundwater elevations adjacent the swamp. In order to be conservative in estimating maximum levels the low result from BH102 is ignored.

It is proposed that for design purposes, a fall in groundwater elevations of 0.5 be adopted for the estimates of maximum groundwater elevations, for a line through the eastern road for St John of God Hospital and the western boundary of the man made swamp area, with a further 0.5m fall to Murdoch Road. This distribution is illustrated on Figure 5.

Maximum current groundwater levels for this site are summarised in Table 7. It should be noted that with changing land use there will be some changes in these groundwater levels. For example clearing of trees can be expected to result in increased recharge, however collection of stormwater will direct the recharge into specific areas, rather than distributed across the site. The potential impact of the works on this site will need to be considered as an iterative process as design evolves. It is recommended that for current design purposes, the groundwater elevations presented in Table 6 be adopted.

It should be noted that when designing for water proofing of buried structures, an allowance for capillary rise of 0.6m over and above MPGL will be required.

Table 7 – Maximum Groundwater Levels (Current Conditions)

LOCATION	Annual Average Maximum Groundwater Elevation (AAMGL) - mAHD	Maximum Probable Groundwater Elevation (MPGL) - mAHD
Within 100m of Boundary with Kwinana Freeway	18.9	19.6
Line Coincident with Access Road East of St John of God Hospital	18.4	19.1
Murdoch Drive	17.9	18.6

Groundwater quality is discussed in Section 7.3.2 of this report

8.9 Subsoil Drains & Compensating Basins

Subsoil drainage will be required where the Maximum Probable Groundwater Level rises to within 0.6m of the underside of road base course or to within 0.6m of underside of footings for structures not provided with water proofing of foundations. It is understood that basement of some structures may extend below the water table, in which case the structures must be designed to resist buoyant uplift based on the MPGL plus a suitable Factor of Safety, and to be water proofed allowing for capillary rise.

Compensating or attenuation basins are proposed within this site, the effectiveness of such infrastructure to dispose runoff by infiltration will be limited where the water table is in close proximity to their underside. In addition, consideration will need to be given to the influence of rising groundwater elevations within such storage facilities, on adjoining structures. For design purposes, a permeability of 5m/d (average of the piezometer falling head test results – and a number suitable representative of sands in the region) and a specific yield of 0.20 may be adopted (again, suitably representative of these sands). Detailed design will require a drainage layout plan and design showing the retention/attenuation system details.

8.10 Acid Sulphate Assessment

8.10.1 Soil Sampling Methodology

An *in-situ* ASS soil sampling program was implemented on 1 May 2008 through to 14 May 2008, concurrent with the geotechnical investigations. Soil samples were collected from the 19 test pit locations to a maximum depth of 4m BGL (or pit collapse) and from the 4 borehole locations to 25m BGL. Soil samples were collected at 0.25m intervals from testpits, and 0.5m intervals from boreholes, and stored in ziplock bags with the air excluded and stored on ice. Samples were delivered to the laboratory at the end of each field day.

8.10.2 Sample Analysis

Field tests were conducted on all samples at ALS Laboratory in Malaga, WA. The results of the field tests were used to determine which samples required further laboratory analysis.

Based on the field test results, approximately 25% of the samples were analysed for Chromium Suite (S_{CR}) with approximately 25% of these also being analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS). Laboratory analysis was only carried out on samples which were in the potential zone of disturbance (up to 12m BGL) ALS Laboratory is NATA accredited for the analyses performed.

The S_{CR} and SPOCAS methods provide a standard approach provides measurements of field pH (pH_{KCL}), oxidation pH (pH_{OX} – SPOCAS only), chromium reducible sulphur (S_{CR}) or peroxide oxidisable sulphur (S_{pos}), total actual acidity (TAA), retained acidity (S_{NAS}) and an indication of buffering capacity via calcium, magnesium and sodium analyses before and after oxidation.

The results of the field tests and laboratory analyses are tabulated in Appendix H.

8.10.3 Results

The laboratory screening results for the pH_f and pH_{fox} for test pitting (typically the uppermost 3m) showed only slight reaction, suggesting the presence of acid sulphate soils to be unlikely at shallow depth. This is further confirmed by results from S_{CR} and SPOCAS laboratory testing, with net acidity values below the limit of reporting (i.e. <0.02% Sulphur).

Results from field tests for the boreholes at greater depths (i.e greater than 3m) show a large variability in the degree and severity of reactions, suggesting acid producing sediments may occur at depth, typically below the water table. Laboratory testing identified two samples with a net acidity greater than 0.03% sulphur in BH102. The net acidities did not significantly exceed values, with a net acidity of 0.03%S at 3.35m – 3.45m BGL and a net acidity of 0.04%S at 4.85m-4.95m BGL. These results appear to be associated with an oxidised sand zone around water table level, which is likely to continue throughout the low lying area and man made wetland adjacent to the borehole.

During bulk earthworks, only the upper soil profile will be disturbed in these low lying areas (topsoils, and the next metre). Testing did not encounter acid sulphur conditions in this aerated zone (above normal summer low groundwater elevations). The bulk earthworks therefore do not require an Acid Sulphate Soil Management Plan (ASSMP).

During the subsequent construction phase, the east west “tunnel” will extend below the aerated soil zone, and there is clearly a potential for at least low level acid sulphur conditions to be encountered.

An acid sulphate soil and dewatering management plan will need to be developed for this subsequent phase.

8.11 Dewatering

During bulk earthworks, there is a possibility that localised dewatering may be required, depending on seasonal groundwater conditions, the depth of cutting required in low lying areas, and the size of the earthworks “Lot” being worked at that time. It is unlikely that depths of dewatering required will be less than 1m (and possibly less than 0.5m), and in order to achieve this, the contractor may simply use open drains across the site to assist in lowering water levels to a low “sump” from where the draining water can be pumped into the existing man made wetland south of the main east-west access route. Dewatering rates of less than 5L/s are anticipated assuming the area of earthworks opened at any one time requiring dewatering is less than 4000m².

A licence application for this dewatering should be sought from the Department of Water at the earliest opportunity.

Final floor levels for most of the main structure are at about 23m AHD. This is well above the maximum probable groundwater level for the site. However there is a pronounced east west tunnel, and also an associated basement area – both at final floor level of 18m AHD - which will extend below annual average maximum groundwater levels. In order to construct these lower elevation areas it will be necessary to dewater to as low as 16m AHD (to allow for the foundation thickness plus an allowance to drain the soils on which the footing is cast).

In preliminary planning for the dewatering, it has been necessary to make a number of assumptions:

- Discharge of dewatering water to the low lying area to the north will not be permitted because of risks to the Kwinana Freeway/ South Street pavement and drainage system (there is a risk that significant recharge might overwhelm the drains);
- Discharge is likely to take place into the man made wetland to the south of the main east west access;
- The potential impact on the Police Station or Fire Station arising from elevated groundwater levels down gradient of the recharge area is assumed to be acceptable (but this will need to be confirmed);
- Some bunding around this wetland will be required, allowing it to flood to a level of 21m AHD;
- If the whole of the site is to be dewatered over a 150m length and up to 60m width (the zones encompassing the east and west “core areas” of the main building), with nominally 2.5m drawdown to 16m AHD (based on annual average maximum levels) then a hydraulic gradient between the recharge area and the tunnel of 5m over a distance of about 90m will be created;
- Preliminary analysis indicates dewatering rates of in excess of 2000kL/d must be anticipated based on a permeability of 5m/d. For design purposes (for example to allow for an underestimate of permeability), a discharge area based on 3000kL/d should be sized;
- Preliminary “sump” modelling indicates the wetland to the south of the main east west access, particularly if permitted to fill to a level of 21m AHD, will be able to drain water back into the water table at a sufficiently high rate that this dewatering can continue for a prolonged period.
- It will not be possible to cease dewatering in any one stage until measures have been taken to equalise uplift pressure under the structure that will arise as groundwater levels recover. An alternative approach is to allow the structure to temporarily flood (equalising water pressures), until further load is added;

Consideration may need to be given to dewatering in a series of stages (for example the eastern lobe with Core 1, 2, 3, 4 ; the western lobe with Core 1, 2, 3, 4; and the tunnel in possibly 3 further sections, making 5 sections in all), in order to reduce the dewatering impacts.

Issues associated with dewatering are potentially very significant given the above. A dewatering plan will need to be developed between structural designer, groundwater advisor and environmental consultant, and more detailed numerical analysis undertaken to establish dewatering rates and the adequacy of the recharge area for the duration of these works.

A dewatering approval will be required from the Department of Water prior to any dewatering, and it should be noted that such approval normally takes well over a month to obtain following lodgement of the application.

Dewatering will need to be undertaken in accordance with the Department of Waters guidelines on Dewatering, available through their web page. It is noted that disposal of water by recharge is the preferred approach by the Department. The water quality is judged suitable for disposal as proposed.

8.12 Construction Considerations

8.12.1 General

There are a number of activities that must be undertaken during construction to ensure compliance with design and to ensure the smooth running of the project. The following activities should be carried out during the contract.

8.12.2 Protection of Adjacent Structures

The existing St John of God Hospital in particular, but also the Police Station and the Fire Station need to be protected from vibrations generated at this site. An acceptable level of vibrations has not been investigated for the existing buildings. In laboratories or areas of specialised equipment, even small vibrations may pose a risk firstly to the work to which the equipment is being applied, and secondly to the equipment itself. Prior to commencing works, it is strongly recommended that investigations be undertaken to establish background peak particle velocities at critical locations in adjacent buildings (particularly the hospital), and use these background levels as “not to be exceeded” at the same locations if at all possible, by the construction equipment on the Fiona Stanley Hospital site, operating very much further away.

A specialist vibration consultant should be engaged for that work.

8.12.3 Preparation of Footing Bases in Sands

Foundations for the proposed structures will be founded in areas of cut over natural comparatively dense sands, or in areas of fill, where the subgrade was initially heavily proof compacted, and subsequent filling has been engineered. Nevertheless the site is a large one, and occasional loose sand pockets are possible in both natural and fill environments, or as a result of disturbance during excavation of the footing. It is recommended that the compaction at the base of footings be checked to confirm that it meets the minimum requirements for a Perth Sand Penetrometer of 7 blows over the test interval 150mm to 450mm and 10 blows over the test interval 450mm to 750mm. Further advice should be sought if these criteria are not achieved.

8.13 Construction Monitoring

8.13.1 Settlement Monitoring

The scale of this structure is particularly large, and the settlements assessed in this report are large. Whilst more than 50% of settlements are expected to take place as the structure is built, this still leaves a substantial amount of ongoing settlement as “imposed” loads are applied and as creep settlement takes place. It is strongly recommended a settlement monitoring programme be established on completion of bulk earthworks, and as part of the construction contract.

The settlement monitoring could be undertaken by casting survey “pins” at accessible locations on selected basement columns, and monitoring with survey accurate to nominally 1mm tolerance, x, y and z locations. Monitoring could proceed monthly throughout construction, and 6 monthly through the builders contracted maintenance period. The builder could be given the responsibility for establishing the pins and collecting the data.

8.13.2 Monitoring Water Levels

During the fieldwork stage of this investigation 5 standpipes were put in place to monitor the groundwater table. Where possible, these piezometers should be maintained and monitored monthly throughout the winter months to confirm seasonal conditions. On completion of construction the need for ongoing groundwater monitoring should be reviewed, particularly where the discharge of stormwater may have an adverse impact on the water table.

Depending on the location of stormwater disposal facilities, it may be necessary to establish additional piezometers so that the impact of stormwater disposal can be understood. This work could also be undertaken by the builder, with monitoring conducted monthly during construction, and about April and October of each year during post construction maintenance period.

8.13.3 Earthworks Monitoring

The tender documents set out the requirements for earthworks monitoring for this project. The Superintendent may wish to consider the appointment of a Geotechnical Testing Authority (as defined in AS3798-1996) to provide an independent check on earthworks activities and interpret the contractors quality assurance data on earthworks.

9 FURTHER STUDIES

An additional 3 CPT probes are recommended within the area of the central block of the hospital, where environmental constraints have prevented earlier testing (see Section 7.2). The need for a vibration monitoring study prior to major earthworks has been identified in Section 8.2.2. We have also recommended settlement monitoring, and groundwater level monitoring as outlined in Sections 8.13.1 and 8.13.2, and suggested consideration be given to engaging a Geotechnical Testing Authority during earthworks, in Section 8.13.3.

There are some tasks that formed the “objectives” of this study at Section 3, which have not been completed. These include further advice on Acid Sulphate management during construction of the tunnel (a management plan will be required – see item I in Section 3), and advice on the stormwater compensation system (see item M – at this stage we have not sighted concept drawings). On going advice will also be required under the current brief, for items Y (provide geotechnical advice during design) and Z (provide geotechnical advice during construction).

This report has identified that there may be a significant dewatering requirement for the east west tunnel and associated basement areas for the main building. The main issue is likely to be confirming the approach that is to be taken to dewatering, estimating the quantities and durations of dewatering, and establishing that the water can be disposed of without adverse impact on others/ the environment. Licencing for this dewatering will need to be sought, and adequate time allowed for the statutory processes in view of the likely size of the dewatering operation. The overall dewatering management plan (i.e taking into account disposal and relevant approvals) is beyond the scope of the original brief for this project.

10 IMPORTANT INFORMATION ABOUT YOUR COFFEY REPORT

The reader's attention is drawn to the important information about this report which follows the main text.

11 REFERENCES

The following standards and references were used in the preparation of this report.

AS 1170.4-2007 Structural design actions Part 4: Earthquake Actions in Australia.

AS 1289 Method of Testing Soils For Engineering Purposes.

AS 1726-1993 SAA Geotechnical Site Investigations.

AS 2870-1996 Residential Slabs and Footings.

AS 3798-1996 Guidelines on Earthworks for Commercial and Residential Developments

AS 4678-2002 Earth Retaining Structures

Cocks G.C., Simpson K and Hillman M.O. 2004 "Liquefaction and Settlement Assessment for the Mortimer Road Bridge, Perth", Australian Geomechanics Vol 38 No 4, January 2004

Davidson W.A. 1995 "Hydrogeology and Groundwater Resources of the Perth Region Western Australia", Bulletin 142 Geological Survey of Western Australia

Decourt L 1995 "Prediction of Load- Settlement relationships for Foundations on the Basis of the SPT Test" Ciclo de Conferencias Intern. "Leonardo Zeevaert" UNAM, Mexico 85-104

Fahey M, Lehane B and Stewart D 2003 "Stiffness for Shallow Foundation Design in Perth CBD" Australian Geomechanics Volume 38 No 3, September 2003

GHD Geotechnics 2007 "Fiona Stanley Hospital: Report on Preliminary Geotechnical Investigations" Report prepared for Department of Housing and Works, Revision 0, September 2007

GHD 2008 "Fiona Stanley Hospital – Stage 1 Land Development Technical Specification" document 61/19514/75587 dated May 2008 (in DRAFT form). Document to form part of "Fiona Stanley Hospital and Health Precinct: Stage A Site Clearing and Bulk Earthworks – Tender Document"

Hillman M.O., Cocks G.C., Szymakowski J.B. "Tank Settlements on Calcareous Soils, Kwinana, W.A." In Proceedings 8th Australian New Zealand Conference on Geomechanics: Consolidating Knowledge, Hobart

Water and Rivers Commission 1997 "Perth Groundwater Atlas"

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by

earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

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% 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% 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.

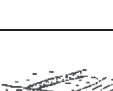
Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

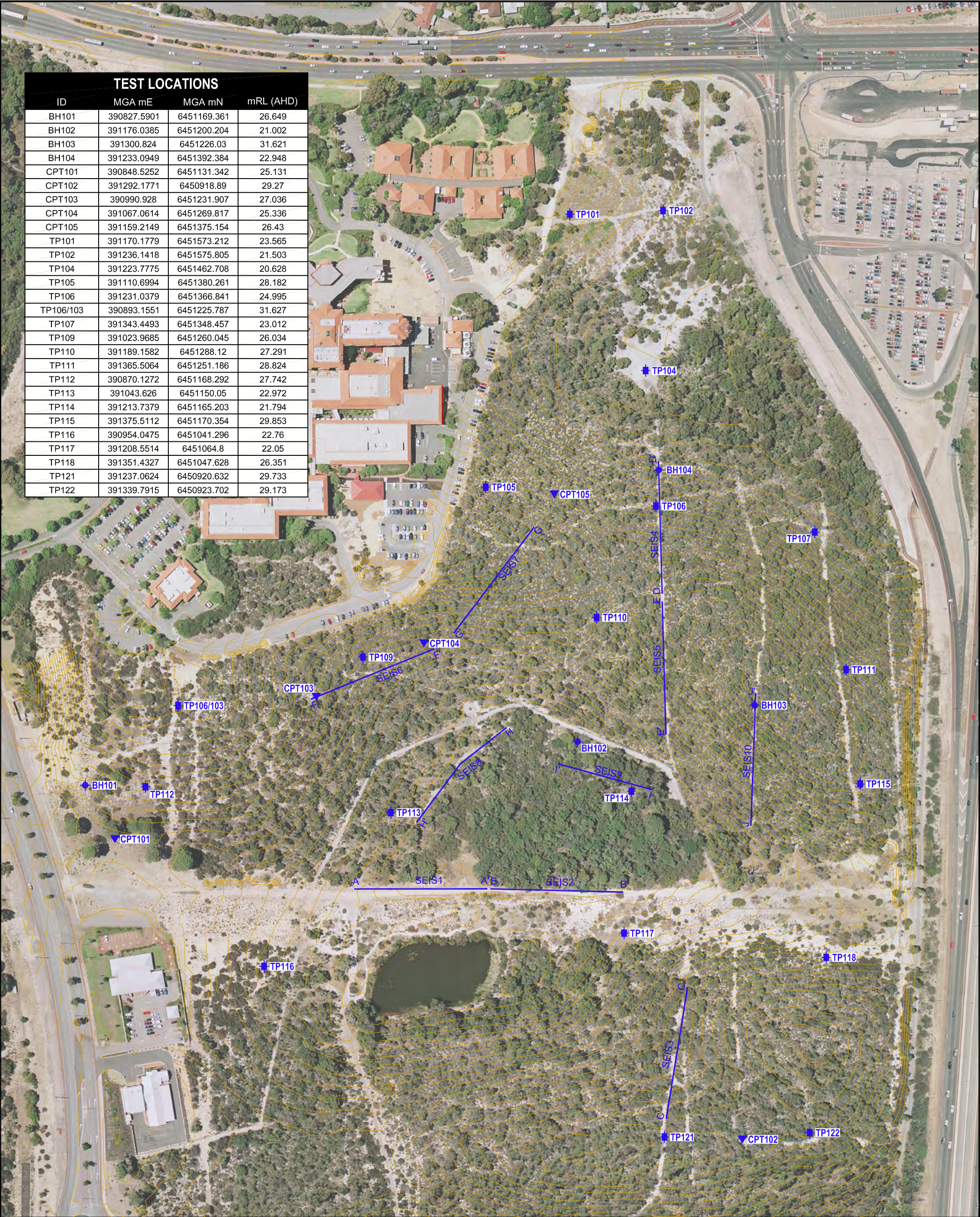
FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)					USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little 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 (A 0.075 mm particle is about the smallest particle visible to the naked eye)	SILTS & CLAYS Liquid limit less than 50	IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
		DRY STRENGTH	DILATANCY	TOUGHNESS		
		None to Low	Quick to slow	None	ML	SILT
		Medium to High	None	Medium	CL	CLAY
	SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		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%.						

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

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM	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.		SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
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.		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	
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.		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.	
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.		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.	

Figures



TEST LOCATIONS			
ID	MGA mE	MGA mN	mRL (AHD)
BH101	390827.5901	6451169.361	26.649
BH102	391176.0385	6451200.204	21.002
BH103	391300.824	6451226.03	31.621
BH104	391233.0949	6451392.384	22.948
CPT101	390848.5252	6451131.342	25.131
CPT102	391292.1771	6450918.89	29.27
CPT103	390990.928	6451231.907	27.036
CPT104	391067.0614	6451269.817	25.336
CPT105	391159.2149	6451375.154	26.43
TP101	391170.1779	6451573.212	23.565
TP102	391236.1418	6451575.805	21.503
TP104	391223.7775	6451462.708	20.628
TP105	391110.6994	6451380.261	28.182
TP106	391231.0379	6451366.841	24.995
TP106/103	390893.1551	6451225.787	31.627
TP107	391343.4493	6451348.457	23.012
TP109	391023.9685	6451260.045	26.034
TP110	391189.1582	6451288.12	27.291
TP111	391365.5064	6451251.186	28.824
TP112	390870.1272	6451168.292	27.742
TP113	391043.626	6451150.05	22.972
TP114	391213.7379	6451165.203	21.794
TP115	391375.5112	6451170.354	29.853
TP116	390954.0475	6451041.296	22.76
TP117	391208.5514	6451064.8	22.05
TP118	391351.4327	6451047.628	26.351
TP121	391237.0624	6450920.632	29.733
TP122	391339.7915	6450923.702	29.173

LEGEND

- SEISMIC LINE (COFFEY)
- BOREHOLE (COFFEY)
- CPT (COFFEY)
- TEST PIT (COFFEY)

drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	TEST LOCATION PLAN - COFFEY		
project no:	GEOTHERD08340AB	fig no:	FIGURE 1
rev:			

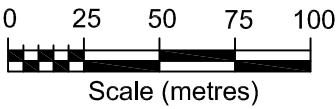
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REF:



LEGEND

- SEISMIC LINE (COFFEY)
- BH101 BOREHOLE (COFFEY)
- CPT101 CPT (COFFEY)
- TP101 TEST PIT (COFFEY)
- CPT02 CPT (OTHERS)
- BH3 BOREHOLE (OTHERS)



drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	TEST LOCATION PLAN - COFFEY & GHD		
project no:	GEOTHERD08340AB	fig no:	FIGURE 2
rev:			

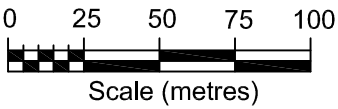
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REF:



LEGEND

- SEISMIC LINE (COFFEY)
- BH101 BOREHOLE (COFFEY)
- CPT101 CPT (COFFEY)
- TP101 TEST PIT (COFFEY)
- CPT02 CPT (OTHERS)
- BH3 BOREHOLE (OTHERS)



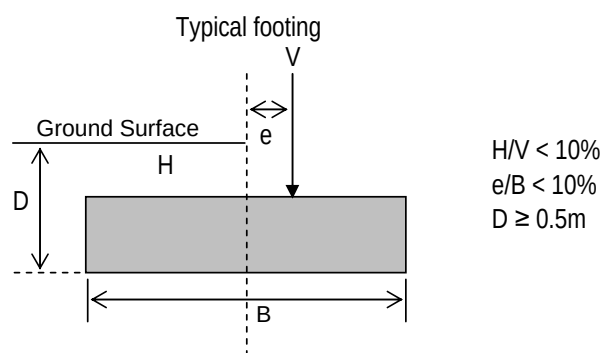
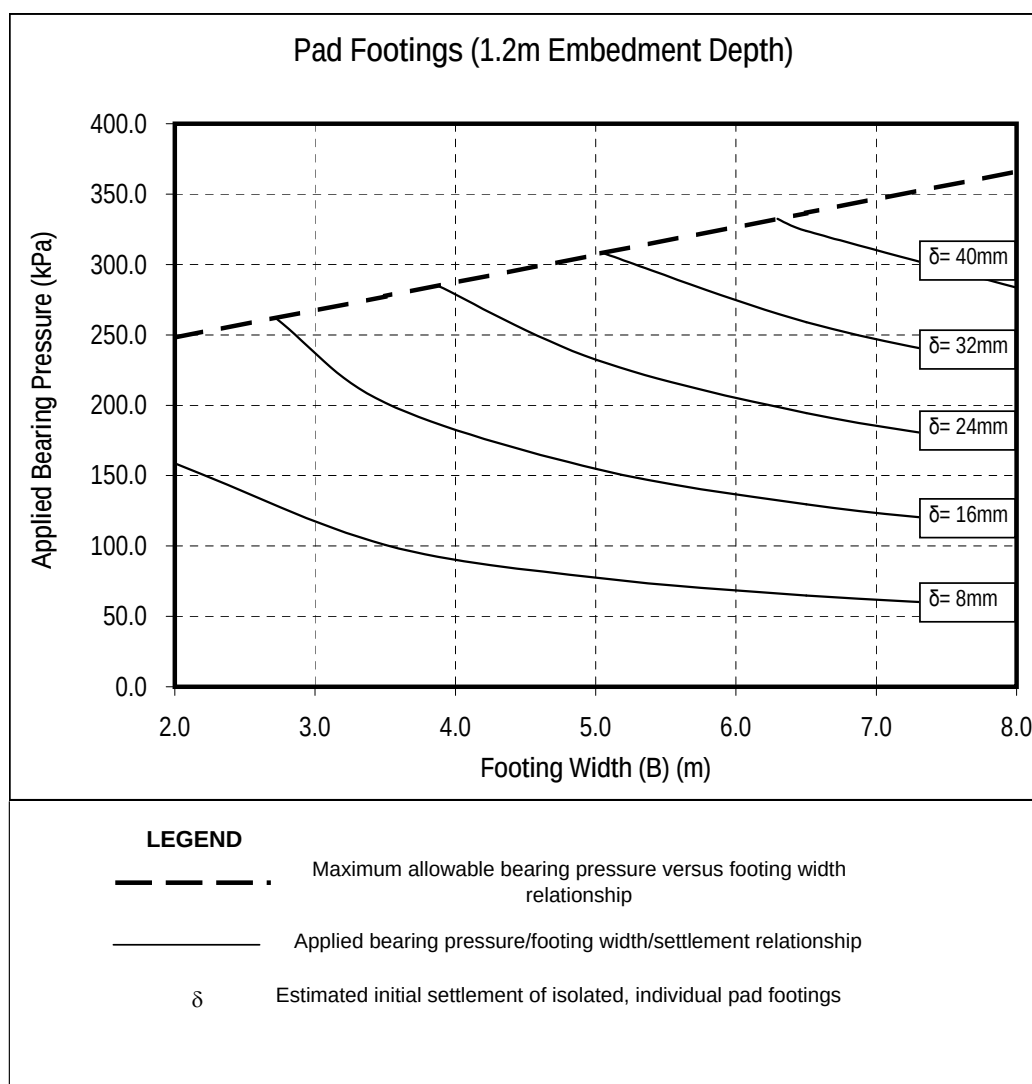
drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	APPROXIMATE EXTENT OF CLAY SOIL ZONE		
project no:	GEOTHERD08340AB	fig no:	FIGURE 3
rev:			

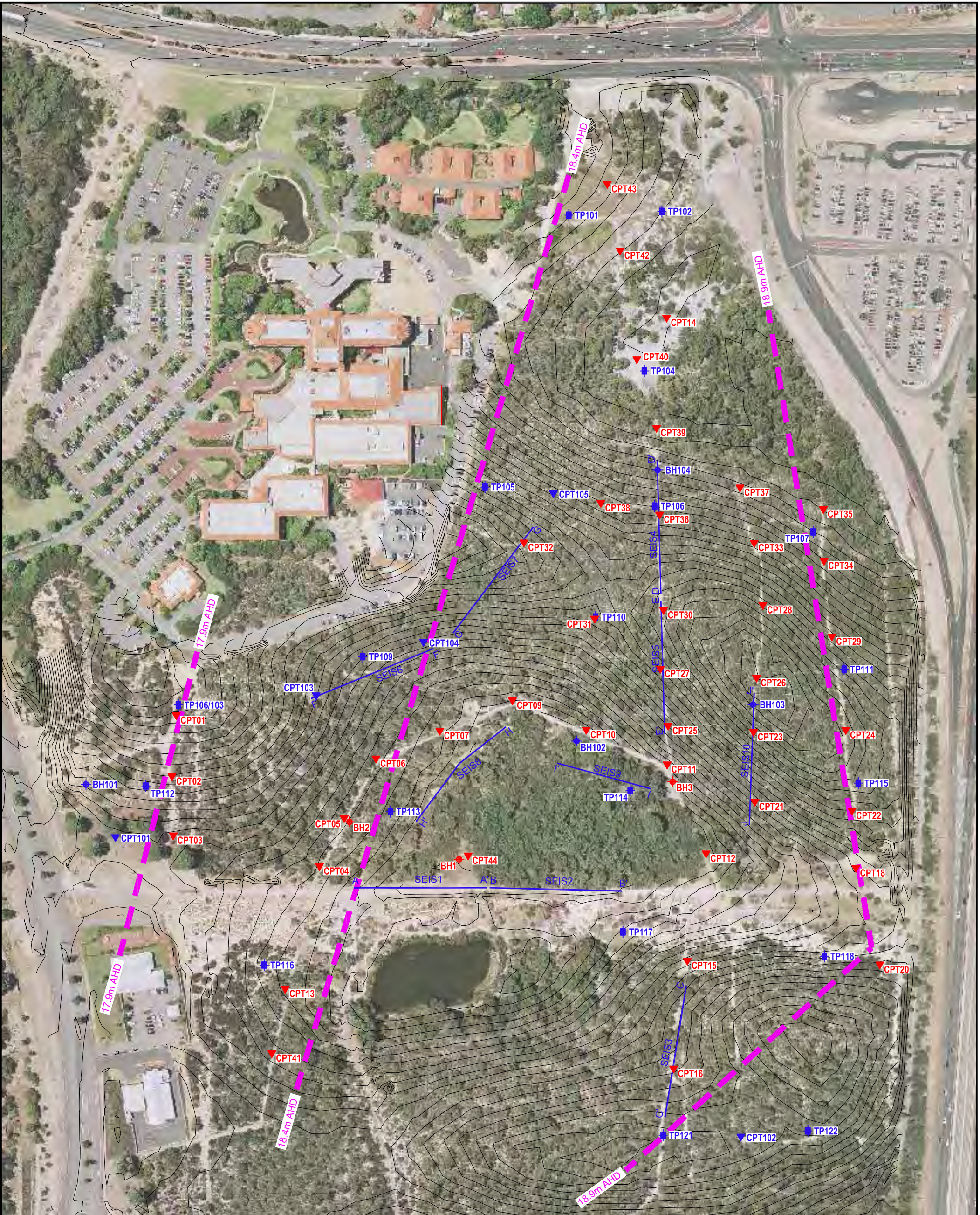
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REF:



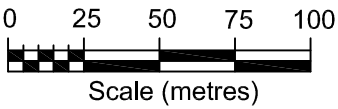
Note: This chart has been constructed assuming there is no interaction between footings.
Initial Settlement only, settlement does not include creep settlement.

drawn	PCW	 SPECIALISTS MANAGING THE EARTH	client:	BG & E	
approved			project:	Fiona Stanley Hospital	
date	30-May-08		title:	Allowable Bearing Capacities & Settlements for Pad Footings - 1.2m Embedment Depth	
scale	As Shown		project no:	GEOHERD08304AB	figure no: FIGURE 4
original size	A4				



LEGEND

- SEISMIC LINE (COFFEY)
- BH101 BOREHOLE (COFFEY)
- CPT101 CPT (COFFEY)
- TP101 TEST PIT (COFFEY)
- CPT02 CPT (OTHERS)
- BH3 BOREHOLE (OTHERS)



NOTE: AAMGL CAN BE SUSPECTED TO BE EXCEEDED ON AVERAGE EVERY TWO YEARS.

drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	ANNUAL AVERAGE MAXIMUM GROUNDWATER LEVELS (AAMGL)		
project no:	GEOTHERD08340AB	fig no:	FIGURE 5
rev:			

REF:
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Appendix A

Results of Field Investigation Boreholes

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH101**

Sheet No. 1 of 4

Project No. **GH08304AB**

Date started : **6/5/08**

Date completed **7/5/08**

Logged by : **CT**

Checked by :

Position : E: 390827.5901, N: 6451169.361 (50 MGA94) Surface Elevation : 26.649m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Track Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
					0.0			
					26.5			
					26.0			
				SPT 6, 10, 9 N=19	25.5	SAND, fine to medium grained, yellow	W	D
				1.45m				
					25.0			
				SPT 4, 7, 9 N=16	24.5	becoming orange		
				2.45m				
					24.0			
				SPT 4, 7, 9 N=16	23.5			
				3.45m				
					23.0			
				SPT 8, 10, 15 N=25	22.5	becoming pale yellow orange		
				4.45m				
					22.0			
				SPT 8, 13, 18 N=31	21.5			
				5.45m				
					21.0	becomes coarser with depth to fine - coarse grained		
				SPT 8, 11, 13 N=24	20.5			
				6.45m				
					20.0	SAND, sub-rounded, orange	W	D
				SPT 7, 12, 15 N=27	19.5			
				7.45m				
					19.0			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	 No Resistance 10 Oct., 73 Water Level on Date shown water inflow water outflow	U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH101**

Sheet No. 2 of 4

Project No. **GH08304AB**

Date started : **6/5/08**

Date completed **7/5/08**

Logged by : **CT**

Checked by :

Position : E: 390827.5901, N: 6451169.361 (50 MGA94) Surface Elevation : 26.649m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Track Casing Diameter : 50 mm

drilling information						material substance					
drilling method & casing	water	VE penetration		samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations
WB	06/05/08			SPT 11, 17, 23 N=40 8.45m	18.5	8.0		SAND, fine to medium grained, sub-rounded, white pale grey	W	VD	
					18.0						
				SPT 12, 20, 25 N=45 9.45m	17.5	9.0					
					17.0						
				SPT 10, 15, 19 N=34 10.95m	16.0	10.0				D	
					15.5						
				SPT 9, 17, 18 N=35 12.45m	14.5	12.0		becoming finer, fine grained dominant, pale orangy grey	D		
					14.0						
				SPT 11, 19, 26 N=45 13.95m	13.0	13.0					
					12.5						
				SPT 12, 21, 30 N=51 15.45m	11.5	15.0					
					11.0						

METHOD	penetration	samples & field tests	classification symbols & soil description Based on Unified Classification System	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	 No Resistance 10 Oct., 73 Water Level on Date shown water inflow water outflow	U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Hole No.	BH101
Sheet No.	3 of 4
Project No.	GH08304AB
Date started :	6/5/08
Date completed	7/5/08
Logged by :	CT
Checked by :	

Location : ***Murdoch***

Sheet No.	3 of 4
Project No.	<i>GH08304AB</i>
Date started :	<i>6/5/08</i>
Date completed	<i>7/5/08</i>
Logged by :	<i>CT</i>
Checked by :	

Position : E: 390827.5901, N: 6451169.361 (50 MGA94)										Surface Elevation : 26.649m (AHD)										Angle from horizontal : 90°																													
Rig type : Jacro										Mounting : Track										Casing Diameter : 50 mm																													
drilling information										material substance																																							
drilling method & casing		water		VE penetration		samples & field tests		RL (m)		depth (m)		graphic log		material description										moisture condition		consistency / relative density		structure and other observations																					
														SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components																																			
														SAND, fine to medium grained, sub-rounded, white pale grey (continued)										W		VD																							
						SPT 19, 40, 10 N*=50 16.95m		10.5		16.0																		SPT Recovery: 0.17 m																					
								9.5		17.0																																							
								9.0		18.0				SAND, fine to medium grained, sub-rounded, pale grey; well sorted, upper medium to lower coarse grained dominate														SPT Recovery: 0.28 m																					
						SPT 13, 23, 27 N*=50 18.45m		8.5		18.0																																							
								8.0		19.0				SAND, fine to medium grained, sub-rounded, pale orange grey; well sorted, fine grained dominate																																			
								7.5		19.0																																							
						SPT 26, 24, 0 N*=24 19.85m		7.0		20.0																		SPT Recovery: 0.24 m																					
								6.5		20.0																																							
								6.0		21.0																																							
						SPT 21, 29 N*=R 21.30m		5.5		21.0																		SPT Recovery: 0.27 m																					
								5.0		22.0																																							
								4.5		22.0																																							
						SPT 15, 26, 24 N*=50 22.95m		4.0		23.0				becoming coarser, slight odour (groundwater)														SPT Recovery: 0.15 m																					
								3.5		23.0																																							
								3.0																																									
METHOD										penetration										samples & field tests										classification symboles & soil description										consistency / relative density									
AS auger screwing*																				U50 - Undisturbed Sample 50mm diameter										Based on Unified Classification System										VS - Very Soft									
AD auger drilling*																				U63 - Undisturbed Sample 63mm diameter																				S - Soft									
RR roller/tricone																				D - Disturbed Sample																				F - Firm									
W washbore																				B - Bulk Disturbed Sample																				St - Stiff									
CT cable tool																				E - Environmental Sample																				VSt - Very Stiff									
HA hand auger																				MC - Moisture Content																				H - Hard									
DT diatube																				HP - Hand Penetrometer (UCS kPa)																													
* bit shown by suffix																				N - Standard Penetration Test (SPT)																				VL - Very Loose									
B blank bit																				N* - SPT - sample recovered																				L - Loose									
V V bit																				Nc - SPT with solid cone																				MD - Medium Dense									
T TC bit																				P - Pressuremeter																				D - Dense									
																																								VD - Very Dense									

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**
Principal :
Project : **Fiona Stanley Hospital**
Location : **Murdoch**

Hole No. **BH101**
Sheet No. 4 of 4
Project No. **GH08304AB**
Date started : **6/5/08**
Date completed **7/5/08**
Logged by : **CT**
Checked by :

Position : E: 390827.5901, N: 6451169.361 (50 MGA94) Surface Elevation : 26.649m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Track Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	SPT	depth (m)	material description	moisture condition	consistency / relative density
WB				38, 14, 0 N=14	2.5			
				24.45m		BOREHOLE BH101 TERMINATED AT 24.17 m		SPT Recovery: 0.17 m
					2.0			
					25.0			
					1.5			
					1.0			
					26.0			
					0.5			
					0.0			
					27.0			
					-0.5			
					-1.0			
					28.0			
					-1.5			
					-2.0			
					29.0			
					-2.5			
					-3.0			
					30.0			
					-3.5			
					-4.0			
					31.0			
					-4.5			
					-5.0			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 1 of 4

Project No. **GH08304AB**

Date started : **8/5/08**

Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE penetration	H	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
					RL (m)	SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components		structure and other observations
					0.0	SAND , fine to medium grained, sub-rounded, pale grey; medium grained dominate		MD Note: Paper bark trees nearby
					21.0			
					20.5			
					20.0			
					19.5			
				SPT 2, 4, 5 N=9	1.95m			
					19.0			
					18.5			
					18.0			
				SPT 5, 8, 10 N=16	3.45m	becoming slightly finer		D
					17.5			
					17.0			
					16.5	becoming orangey brown, slight odour		
				SPT 4, 6, 8 N=14	4.95m			
					16.0			
					15.5	becoming pale brownish grey		
					15.0			
				SPT 10, 14, 15 N=29	6.45m			
					14.5			
					14.0			
					13.5			
				SPT 12, 17, 26 N=43	7.95m			

METHOD

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

penetration

No Resistance
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
N - Standard Penetration Test (SPT)
N* - SPT - sample recovered
Nc - SPT with solid cone
P - Pressuremeter

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 2 of 4

Project No. **GH08304AB**

Date started : **8/5/08**

Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD)

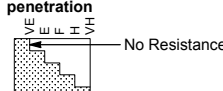
Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	graphic log	material description	moisture condition
					RL (m)		SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	consistency / relative density
					8.0			
					12.5			
					12.0			
				SPT 10, 16, 17 N=33	9.45m			
					11.5			
					11.0			
					10.5			
				SPT 14, 20, 24 N=44	10.95m			
					10.0			
					9.5			
					9.0			
				SPT 12, 21, 28 N=49	12.45m			
					8.5			
					8.0			
					7.5			
				SPT 18, 24, 26 N=50	13.95m			
					7.0			
					6.5			
					6.0			
				SPT 20, 20, 30 N*=50	15.45m			
					5.5			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing*		U50 - Undisturbed Sample 50mm diameter	Based on Unified Classification System	VS - Very Soft
AD auger drilling*		U63 - Undisturbed Sample 63mm diameter		S - Soft
RR roller/tricone		D - Disturbed Sample		F - Firm
W washbore		B - Bulk Disturbed Sample		St - Stiff
CT cable tool		E - Environmental Sample		VSt - Very Stiff
HA hand auger		MC - Moisture Content		H - Hard
DT diatube		HP - Hand Penetrometer (UCS kPa)	moisture	VL - Very Loose
* bit shown by suffix		N - Standard Penetration Test (SPT)	D - Dry	L - Loose
B blank bit		N* - SPT - sample recovered	M - Moist	MD - Medium Dense
V V bit		Nc - SPT with solid cone	W - Wet	D - Dense
T TC bit		P - Pressuremeter	W _P - Plastic Limit	VD - Very Dense
			W _L - Liquid Limit	

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 3 of 4

Project No. ***GH08304AB***Date started : **8/5/08**Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD)

Surface Elevation : 21.002m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance					
drilling method & casing	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations	
WB		VE F H		5.0	16.0		SAND, fine to medium grained, sub-rounded, pale grey; medium grained dominate(continued)		VD		
			SPT 19, 37, 17 N*=54 16.95m	4.5	17.0						SPT Recovery: 0.2 m
				4.0							
				3.5							
			SPT 35, 15 N*=R 18.30m	3.0	18.0						SPT Recovery: 0.2 m
				2.5							
				2.0	19.0						
			SPT 50, 0 N*=R 19.80m	1.5	20.0						SPT Recovery: 0.15 m
				1.0							
				0.5							
			0.0	21.0	trace of silt	SPT Recovery: 0.2 m					
			-0.5								
			-1.0	22.0							
			-1.5								
			SPT 27, 23 N*=R 22.80m	-1.5	23.0	SPT Recovery: 0.2 m					
			-2.0								
			-2.5								

METHOD AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	penetration water 10 Oct., 73 Water Level on Date shown water inflow water outflow	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet Wp - Plastic Limit WL - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**
Principal :
Project : **Fiona Stanley Hospital**
Location : **Murdoch**

Hole No. **BH102**
Sheet No. 4 of 4
Project No. **GH08304AB**
Date started : **8/5/08**
Date completed **9/5/08**
Logged by : **CT**
Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	graphic log	material description	moisture condition
WB				SPT 19, 31 N=R	24.0		SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	consistency / relative density
					24.30m			VD SPT Recovery: 0.27 m
					24.27		BOREHOLE BH102 TERMINATED AT 24.27 m	
					24.5			
					25.0			
					25.5			
					26.0			
					26.5			
					27.0			
					27.5			
					28.0			
					28.5			
					29.0			
					29.5			
					30.0			
					30.5			
					31.0			
					31.5			
					32.0			
					32.5			
					33.0			
					33.5			
					34.0			
					34.5			
					35.0			
					35.5			
					36.0			
					36.5			
					37.0			
					37.5			
					38.0			
					38.5			
					39.0			
					39.5			
					40.0			
					40.5			
					41.0			
					41.5			
					42.0			
					42.5			
					43.0			
					43.5			
					44.0			
					44.5			
					45.0			
					45.5			
					46.0			
					46.5			
					47.0			
					47.5			
					48.0			
					48.5			
					49.0			
					49.5			
					50.0			
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					73.0			
					73.5			
					74.0			
					74.5			
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					95.0			
					95.5			
					96.0			
					96.5			
					97.0			
					97.5			
					98.0			
					98.5			
					99.0			
					99.5			
					100.0			

METHOD	penetration	samples & field tests	classification symboles & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

[illegible]

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH103**

Sheet No. 2 of 4

Project No. **GH08304AB**

Date started : **12/5/08**

Date completed **12/5/08**

Logged by : **CT**

Checked by :

Position : E: 391300.824, N: 6451226.03 (50 MGA94) Surface Elevation : 31.621m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information						material substance					
drilling method & casing	water	VE	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations
WB	12/05/08			SPT 11, 21, 30 N=51	23.5	8.0		SAND, fine to medium grained, sub-rounded, orange yellow (continued)		VD	
				8.45m	23.0						
				SPT 15, 22, 28 N=50	22.5	9.0					
				9.45m	22.0						
					21.5	10.0					
				SPT 13, 24, 31 N=55	21.0	11.0					
				10.95m	20.5						
					20.0						
				SPT 19, 30, 20 N=50	19.5	12.0					
				12.45m	19.0						
					18.5	13.0					
				SPT 26, 24 N=R 13.80m	18.0	14.0					
	17.5										
	17.0										
	16.5	15.0		SAND, fine to medium grained, sub-rounded, grey		MD					
	15.45m	16.0									

METHOD	penetration	samples & field tests	classification symbols & soil description Based on Unified Classification System	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Hole No.	BH103
Sheet No.	3 of 4
Project No.	GH08304AB
Date started :	12/5/08
Date completed	12/5/08
Logged by :	CT
Checked by :	

Location : **Murdoch**

Checked by :

Casing Diameter : 50 mm

drilling information						material substance						
drilling method & casing	water	penetration VEFH			samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations
WB						15.5	16.0		SAND, fine to medium grained, sub-rounded, grey (continued)		MD	
					SPT 16, 29 21/0mm N=R 16.80m	15.0		VD		SPT Recovery: 0.25 m		
						14.5	17.0					
					SPT 20, 30 N=R 18.30m	13.5	18.0			SPT Recovery: 0.3 m		
						13.0						
					SPT 21, 33 N=R 19.80m	12.0	19.0			SPT Recovery: 0.3 m		
						11.5	20.0					
					SPT 30, 20 N=R 21.30m	10.5	21.0			SPT Recovery: 0.2 m		
						10.0						
					SPT 40, 10 N=R 22.80m	9.0	22.0			SPT Recovery: 0.19 m		
					8.5	23.0		becoming slightly coarse (medium grained dominate)				
					8.0							
METHOD					penetration		samples & field tests			classification symbols & solid description		consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit					 water 10 Oct., 73 Water Level on Date shown water inflow water outflow		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter			Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit		
												VS - Very Soft S - Soft F - Firm St - Stiff VS _t - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH103**

Sheet No. 4 of 4

Project No. **GH08304AB**

Date started : **12/5/08**

Date completed **12/5/08**

Logged by : **CT**

Checked by :

Position : E: 391300.824, N: 6451226.03 (50 MGA94) Surface Elevation : 31.621m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
WB				SPT 30, 20 N*=R 24.30m	7.5	SAND, fine to medium grained, sub-rounded, grey (continued)		SPT Recovery: 0.2 m
					7.0			
					25.0	BOREHOLE BH103 TERMINATED AT 25.00 m		
					6.5			
					6.0			
					26.0			
					5.5			
					5.0			
					27.0			
					4.5			
					4.0			
					28.0			
					3.5			
					3.0			
					29.0			
					2.5			
					2.0			
					30.0			
					1.5			
					1.0			
					31.0			
					0.5			
					0.0			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	10 Oct., 73 Water Level on Date shown water inflow water outflow	U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Hole No.	BH104
Sheet No.	1 of 4
Project No.	GH08304AB
Date started :	7/5/08
Date completed	8/5/08
Logged by :	CT
Checked by :	

Angle from horizontal : 90°
Nozzle Diameter : 50 mm

drilling information					material substance					
drilling method & casing	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description	moisture condition	consistency / relative density	structure and other observations
							SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components			
drilling method & casing WB	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	SAND, fine to medium grained, sub-rounded, pale yellow mottled orange		D	

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 2 of 4

Project No. ***GH08304AB***

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance				
drilling method & casing	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description	moisture condition	consistency / relative density	structure and other observations
WB		U63		8.0	8.0		CLAY, low plasticity, grey; (diatomite), sticky when wet, hard brittle when dry, traces of fine sand; no sulfur odour		H	Hard on surface (>600mm), note low SPT sample value 5 for 150mm
				14.5						
		U63		14.0	9.0		CLAY, low plasticity, dark green; becoming sandy with depth, spongy texture; slight odour			
				13.5						
				13.0	10.0	SAND, fine to medium grained, sub-rounded, pale brown grey; sulfurous odour odour		VD		
		SPT 15, 22, 28 N=50		12.5	11.0					
				12.0	11.0					
				11.5						
			SPT 16, 25, 28 N=53		11.0	12.0				
				12.45m	10.5					
			10.0	13.0						
			9.5							
		SPT 16, 37, 13 N*=50		9.0	14.0					SPT Recovery: 0.2 m
			13.95m							
			8.5							
			8.0	15.0						
		SPT 21, 30 N*=R 15.30m		7.5						SPT Recovery: 0.22 m
				-7.0						

METHOD

AS auger screwing*

AD auger drilling*

RR roller/tricone

W washbore

CT cable tool

HA hand auger

DT diatube

* bit shown by suffix

B blank bit

V V bit

T TC bit

penetration

No Resistance

water

10 Oct., 73 Water Level on Date shown

water inflow

water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter

U63 - Undisturbed Sample 63mm diameter

D - Disturbed Sample

B - Bulk Disturbed Sample

E - Environmental Sample

MC - Moisture Content

HP - Hand Penetrometer (UCS kPa)

N - Standard Penetration Test (SPT)

N* - SPT - sample recovered

Nc - SPT with solid cone

P - Pressuremeter

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry

M - Moist

W - Wet

W_p - Plastic Limit

W_L - Liquid Limit

consistency / relative density

VS - Very Soft

S - Soft

F - Firm

St - Stiff

VSt - Very Stiff

H - Hard

VL - Very Loose

L - Loose

MD - Medium Dense

D - Dense

VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 3 of 4

Project No. ***GH08304AB***

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information							material substance					
drilling method & casing	water	penetration			samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations
		VE	F	H								
WB							16.0		SAND , fine to medium grained, sub-rounded, pale brown grey; sulfurous odour odour <i>(continued)</i>		VD	
					SPT 28, 22 N*=R 16.80m	6.5		SPT Recovery: 0.28 m				
						6.0	17.0					
						5.5						
					SPT 26, 24 N*=R 18.30m	5.0	18.0	SPT Recovery: 0.25 m				
						4.5						
						4.0	19.0					
					SPT 30, 20 N*=R 19.80m	3.5		SAND , fine to coarse grained, sub-rounded, pale grey	SPT Recovery: 0.22 m			
						3.0	20.0					
						2.5		SAND , fine to medium grained, sub-rounded, pale brown grey				
					SPT 37, 13 N*=R 21.30m	2.0	21.0	SPT Recovery: 0.17 m				
						1.5						
						1.0	22.0					
					SPT 40, 10 N*=R 22.80m	0.5		SPT Recovery: 0.17 m				
						0.0	23.0					
						-0.5						
					-1.0							

METHOD		penetration		samples & field tests		classification symbols & soil description		consistency / relative density	
AS	auger screwing*			U50	- Undisturbed Sample 50mm diameter	Based on Unified Classification System		VS	- Very Soft
AD	auger drilling*			U63	- Undisturbed Sample 63mm diameter			S	- Soft
RR	roller/tricone			D	- Disturbed Sample			F	- Firm
W	washbore			B	- Bulk Disturbed Sample			St	- Stiff
CT	cable tool			E	- Environmental Sample			VSt	- Very Stiff
HA	hand auger			MC	- Moisture Content			H	- Hard
DT	diatube			HP	- Hand Penetrometer (UCS kPa)			VL	- Very Loose
* bit shown by suffix				N	- Standard Penetration Test (SPT)			L	- Loose
B	blank bit			N*	- SPT - sample recovered			MD	- Medium Dense
V	V bit			Nc	- SPT with solid cone			D	- Dense
T	TC bit			P	- Pressuremeter			VD	- Very Dense
						moisture			
						D - Dry			
						M - Moist			
						W - Wet			
						W _p - Plastic Limit			
						W _L - Liquid Limit			

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 4 of 4

Project No. **GH08304AB**

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance			
drilling method & casing	water	VE	E	H	SPT 50, 0 N*=R 24.30m	depth (m)	material description	moisture condition	consistency / relative density
WB						24.0	SAND, fine to medium grained, sub-rounded, pale brown grey (continued)		VD SPT Recovery: 0.15 m
						25.0	BOREHOLE BH104 TERMINATED AT 25.00 m		
						26.0			
						27.0			
						28.0			
						29.0			
						30.0			
						31.0			
						32.0			
						33.0			
						34.0			
						35.0			
						36.0			
						37.0			
						38.0			
						39.0			
						40.0			
						41.0			
						42.0			
						43.0			
						44.0			
						45.0			
						46.0			
						47.0			
						48.0			
						49.0			
						50.0			
						51.0			
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						77.0			
						78.0			
						79.0			
						80.0			
						81.0			
						82.0			
						83.0			
						84.0			
						85.0			
						86.0			
						87.0			
						88.0			
						89.0			
						90.0			
						91.0			
						92.0			
						93.0			
						94.0			
						95.0			
						96.0			
						97.0			
						98.0			
						99.0			
						100.0			

COFFEY_02.GLB Log NON CORED BOREHOLE GH08304AB - BOREHOLE.GPJ DWG14548.GDW 30/06/2008 10:35



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 1 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

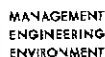
Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
0	12/09				0.2 [+20.7]		x x	SM	SILTY SAND Light brown, medium to coarse grained, sub- rounded quartz sand, with roots and minor organic material. SAND with SILT Dark grey blotched/mottled brown, medium to coarse grained sand, sub-angular. FILL With medium grained gravel (about 8%), probably imported limestone at 0.5m.	M	L				
1					1.0 [+19.8]			SP	SAND with SILT Light grey, medium grained, sub angular quartz sand. BASSENDEAN SAND With minor dark brown mottling at 1.8m, fine to medium grained. Becoming light brown grey becoming brown at 2.3m.	M	L	1.00 1.45	N	SPT: 3, 4, 5 [N=9]	1
2										D-M	L-MD				2
3										M	L	2.50 2.95	N	SPT: 2, 2, 4 [N=6]	3
4										W	L	4.00 4.45	N	SPT: 2, 3, 6 [N=9]	4
5															5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



Borehole No.: **BH1**

Sheet 2 of 4

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	13-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations					Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water											
6				Hollow Stem Auger		6.0 [+14.8]		[Pattern]	SP	SAND with SILT Light grey, medium grained, sub angular quartz sand. BASSENDEAN SAND Becoming predominantly fine grained from about 5.9m.	M	MD	5.50 5.95	N	SPT: 8, 11, 15 [N=26]	6
7	12/09 13/09							[Pattern]	SP	SAND Light brown, fine to medium grained, sub angular, quartz. BASSENDEAN SAND Light grey brown.			7.00 7.45	N	SPT: 6, 9, 13 [N=22]	7
8								[Pattern]		Contains occasional black, coarse grained sand, becoming medium grained.			8.00 8.45	N	SPT: 9, 14, 15 [N=29]	8
9				Wash Boring				[Pattern]		Becoming medium to coarse grained from about 9m.		VD	9.00 9.45	N	SPT: 7, 20, 24 [N=44]	9
10						10.0		[Pattern]				D- VD				10

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07

GENERAL LOG 611951401 GP.I GHDPER GDT 24/10/07



MANAGEMENT
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ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 3 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
						[+10.8]			SP	SAND Light grey brown, medium to coarse grained, occasional black, coarse grained particles. BASSENDEAN SAND	W	D- VD	10.00	N	SPT: 15, 34, * [N>50 (16 blows for 50mm third stage)]	
11										Becoming medium grained.			10.35			
													11.00	N	SPT: 20, 50, * [N>50 (300mm/450mm)]	
													11.30			
12												MD	12.00	N	SPT: 6, 8, 13 [N=21]	
													12.45			
13												VD	13.00	N	SPT: 9, 20, 31 [N=51]	
													13.45			
										With occasional (2% to 5%) fine limestone gravel and black fine (quartz?) gravel. GNANGARA SAND?		D	14.00	N	SPT: 8, 17, 28 [N=45]	
													14.45			
15						15.0										

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 4 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200
Flushing Fluid:
Hole Diameter (mm): 150

Inclination: Vertical

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
					15.6 [+5.6]				CORE LOST 15.0 - 15.m (Possibly blocked SPT)			15.00	N	SPT: 13, 34, * [N>50 (16 blows for 50mm third stage)]	
					15.5 [+5.3]			SP	SAND Light grey brown, fine to medium grained, quartz sand. GNANGARA SAND?	W	VD	15.35			
16									With minor (<5%) quartz gravel, black and clear (white), sub-angular to angular gravel up to 12mm from about 16m.			16.00	N	SPT: 12, 27, * [N>50 (23 blows for 50mm third stage)]	16
												16.40			
17												17.00	N	SPT: 8, 20, 35 [N=55]	17
												17.45			
18												18.00	N	SPT: 15, 27, * [N>50 (23 blows for 100mm third stage)]	18
												18.40			
1309					18.4 [+2.4]				Termination Depth = 18.4m						
19															19
20															20

GENERAL LOG 61/19514/01.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 1 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
1400									SP	SAND with SILT Dark grey, medium grained quartz sand (300/500mm return). TOPSOIL/SUBSOIL Becoming light orange brown. BASSENDEAN SAND Becoming fine to medium grained from about 1m.	M	L				1
1.5						(+21.7)										
2										CORE LOST 1.5 - 2.5m						2
2.5						(+20.6)			SP	SAND with SILT Light orange brown, fine to medium grained quartz sand. BASSENDEAN SAND						3
3																
4										Becoming light grey brown.						4
5																5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole No.: **BH2**

Sheet 2 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
6				Hollow Stem Auger				SP	SAND with SILT Light orange brown, fine to medium grained quartz sand. BASSENDEAN SAND	M-W	MD	5.00 5.45	N	SPT: 4, 7, 8 [N=15]	6
7										W					7
8												7.50 7.95	N	SPT: 7, 12, 14 [N=26]	8
9					9.0 [+14.1]				CORE LOST 9.0 - 9.5m		D	8.00 9.45	N	SPT: 3, 13, 25 [N=38] Changed to washbore drilling at 9.5m.	9
10				Wash Boring	9.5 [+13.6]			SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND						10

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 3 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
11				Wash Boring				SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND	W	VD	10.50 10.85	N	SPT: 17, 34, * [N>50 (16 blows for 50mm third stage)]	11
12												12.00 12.28	N	SPT: 25, 50, * [N>50 (50 blows for 150mm second stage)]	12
13												13.50 13.80	N	SPT: 22, 50, * [N>50 (50 blows for 150mm second stage)]	13
14															14
15											D-VD				15

GENERAL LOG 61/1951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 4 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
16					Wash Boring				SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND	W	D- VD	15.00	N	SPT: 16, 19, 30 [N=49]	16
													15.45			
													16.50	N	SPT: 13, 23, 24 [N=47]	
17													16.95			17
													18.00	N	SPT: 7, 12, 17 [N=29]	18
													18.45			
													19.50	N	SPT: 11, 24, 29 [N=53]	19
													19.95			
20						20.0										20

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
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BOREHOLE LOG

Borehole
No.:

BH2

Sheet 5 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

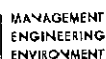
Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
				Wash Boring	23.1			SP	SAND Light orange brown, medium grained, quartz. BASSENDEAN SAND	W	VD				
21									Becoming light grey brown, fine to medium grained from about 21m.			21.00 21.20	N	SPT: 35, *, * [N>50 (15 blows for 50mm second stage)]	21
22									Becoming grey from about 21.5m. GNANGARA SAND?			22.50 22.70	N	SPT: 26, *, * [N>50 (24 blows for 50mm second stage)]	22
23															23
24												24.00 24.40	N	SPT: 16, 25, 25 [N=50]	24
25					25.0										25

GENERAL LOG 61/19514/01 GPJ GHDPER.GDT 24/10/07



Borehole No.: **BH2**

Sheet 6 of 7

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

[illegible]

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH2

Sheet 7 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
14.09						[-6.9] 30.2 [-7.1]			SP	GRAVELLY SAND with CLAY Light grey, medium grained sand, fine to medium grained sub-rounded quartz gravel, GNANGARA SAND? Termination Depth = 30.2m	W	VD	30.00 30.20	N	SPT: 23, *, * [N>50 (27 blows for 50mm second stage)]	
31																31
32																32
33																33
34																34
35																35



MANAGEMENT
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ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH3

Sheet 1 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
1509								SP	SAND with SILT Dark grey with light grey mottling, medium grained, quartz sand with roots and minor organic material. TOPSOIL / SUBSOIL Light grey brown from 0.4m, poorly graded sand with little or no organics and roots from 0.8m. BASSENDEAN SAND	M-W	L				
1															1
2									With orange mottling from 2.2m to 2.5m.			1.50	N	SPT: 2, 3, 4 [N=7]	2
												1.95			
3									Becoming medium dense with more orange (FeO) stained mottling from 3.0-3.45m.			3.00	N	SPT: 3, 4, 8 [N=12]	3
									With less iron oxide staining from 3.45m.			3.45			
4					3.8 [+18.7]			SP	SAND Light grey with minor orange mottling, medium grained, quartz sand BASSENDEAN SAND	W	L				4
5					5.0										5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH3

Sheet 2 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
				Hollow Stem Auger	17.5				CORE LOST 5.0 - 6.0m			5.00 5.45	N	SPT: 2, 1, 5 [N=6] Water sample taken.	
6					6.0 [+16.5]			SP	SAND Brown, medium grained quartz sand. BASSENDEAN SAND	W	D	6.50 6.95	N	SPT: 12, 14, 18 [N=32]	6
7									Becoming light grey brown, fine to medium grained from about 6.5m.						7
8				Wash Boring					Becoming light grey in colour from about 8m.			8.00 8.45	N	SPT: 9, 17, 17 [N=34]	8
9												9.50 9.95	N	SPT: 12, 21, 17 [N=38]	9
10					10.0										10

GENERAL LOG 61/19514/01.GPJ GHDPER GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH3

Sheet 3 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200

Inclination: Vertical

Logged: GB 15-Sep-07

Flushing Fluid:

Processed: WKN 24-Oct-07

Hole Diameter (mm): 150

Checked:

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
11					12.5			SP	SAND Light grey, fine to medium grained quartz sand. BASSENDEAN SAND						11
12															12
13									Becoming medium grained sand from about 12.5m.						13
14										VD					14
15					15.0										15

GENERAL LOG 61/19514/01.GPJ GHDPR.GDT 24/10/07

Wash Boring



SPT: 12, 20, 22 [N=42]

SPT: 13, 20, 24 [N=44]

SPT: 13, 27, * [N>50 (23 blows
for 100mm third stage)]



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH3

Sheet 4 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 15-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
16				Wash Boring	17.5			SP	SAND Light grey brown, medium grained quartz sand. BASSENDEAN SAND	W	VD	15.50 15.92	N	SPT: 12, 26, * [N>50 (24 blows for 100mm third stage)]	16
17									Light grey.			17.00 17.40	N	SPT: 13, 29, 21 [N=50]	17
18												18.50 18.75	N	SPT: 19, 50, * [N>50 (50 blows for 110mm second stage)]	18
19															19
20															20



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH3

Sheet 5 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
15.09						20.2 [+2.4]			SP	Termination Depth = 20.15m	W	VD	20.00 20.15	N	SPT: 50, * * [N>50 (50 blows for 150mm first stage)]	
21																21
22																22
23																23
24																24
25																25

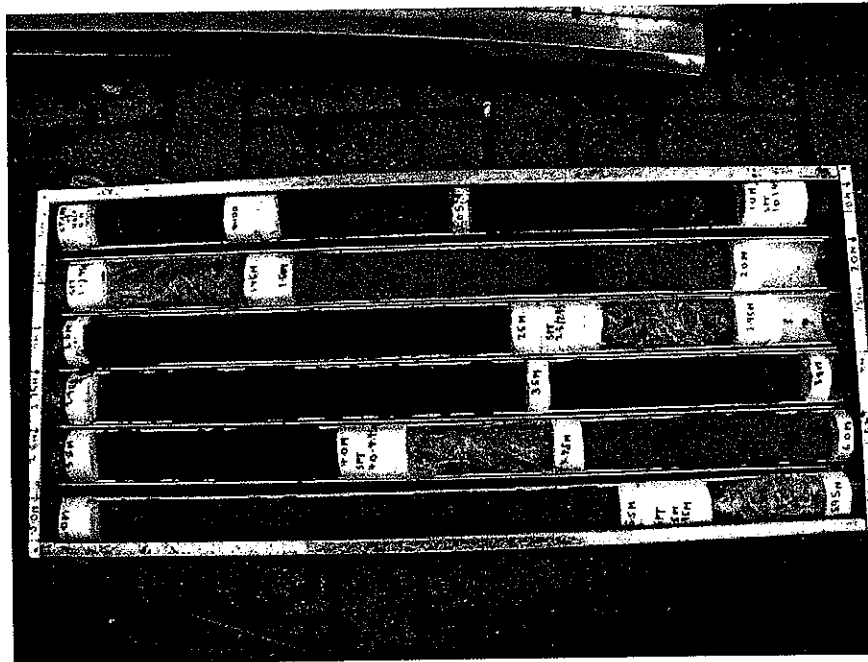


CORE PHOTOGRAPHS

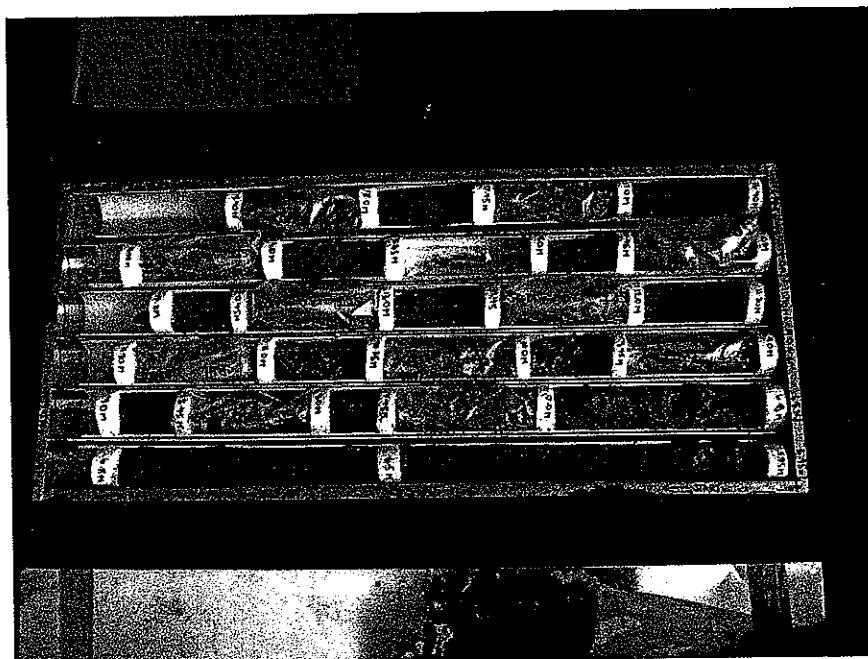
Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH1 – 0.0m to 5.95m



Description: BH1 – 5.95m to 18.4m



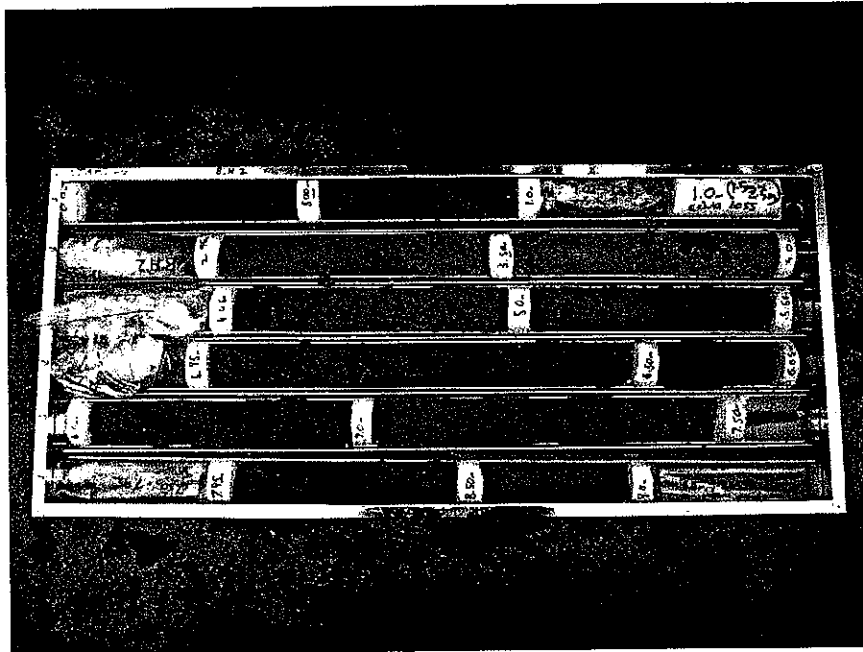


CORE PHOTOGRAPHS

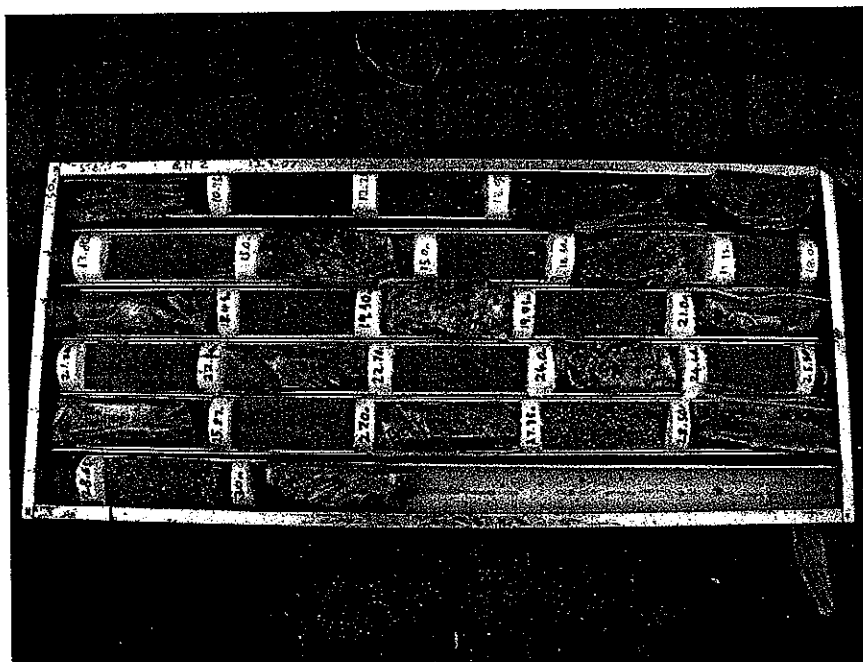
Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH2 – 0.0m to 9.45m



Description: BH2 – 9.45m to 30.45m



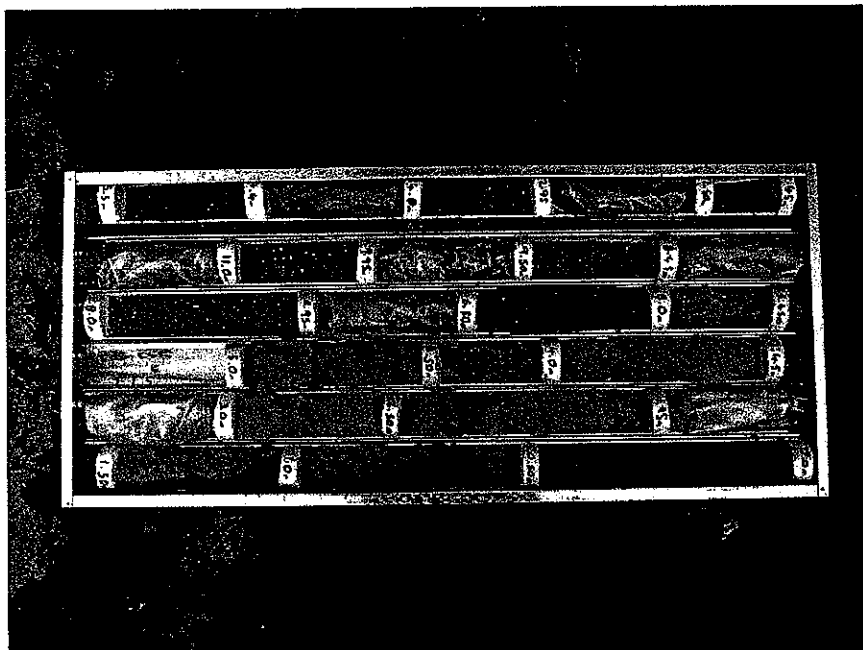


CORE PHOTOGRAPHS

Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH3 – 0m to 15.5m



Description: BH3 – 15.5m to 20.45m



Appendix B

Results of Field Investigation Electric friction Cone Penetrometer

Electric Friction Cone Penetrometer

Explanation Sheet

The Electric Friction Cone Penetrometer was developed from the original mechanical Dutch Cone Penetrometer. The test consists of advancing a 35mm diameter rod with penetrometer attached into the soil at a rate of approximately 20mm per second.

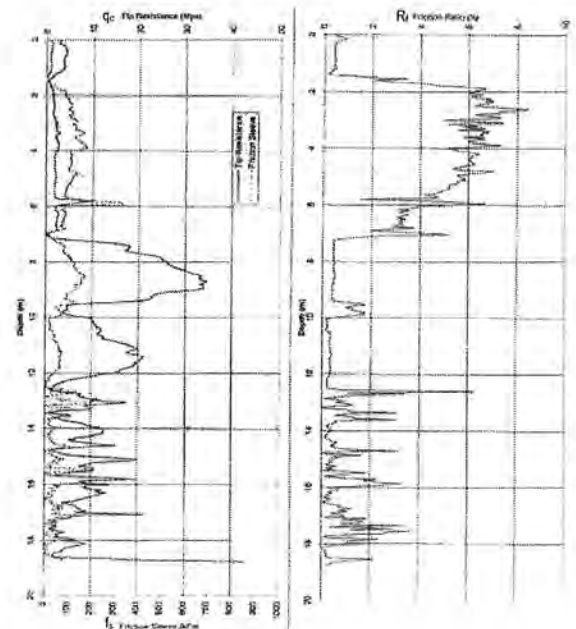
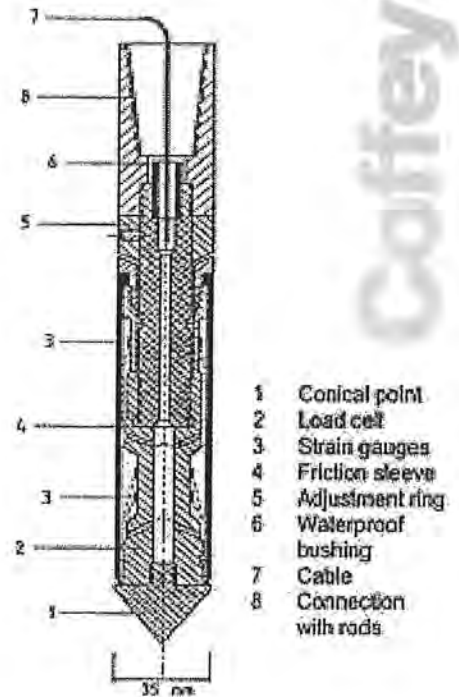
Reaction is provided by a purpose made truck or a conventional drilling rig. It is also possible to operate the penetrometer from a floating barge or a jack-up rig.

The penetrometer itself consists of a conically shaped tip and a separate cylindrical sleeve fitted immediately behind the tip. The maximum diameter of the tip corresponds to the sleeve diameter, and the cross sectional area is 1,000mm². The surface area of the sleeve is 15,000mm². Separate force transducers are attached to the tip and the sleeve permitting independent measurements of respective resistances. The transducer signals are transmitted by means of an electrical cable passing through the centre of the rods to an amplifier and display unit at the surface. The information is displayed digitally and on a computer display, and consists of:

- I. Cone Resistance, q_c . This is the end bearing resistance acting on the tip in MPa.
- II. Sleeve Resistance, f_s . This is the resistance acting on the sleeve in kPa.
- III. Friction Ratio, R_f . This is the ratio of sleeve resistance to cone resistance, expressed in percent.

The cone penetration test procedure is standardised in AS 1289.F5.1-1997, titled "Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Cone or a Friction-Cone Penetrometer".

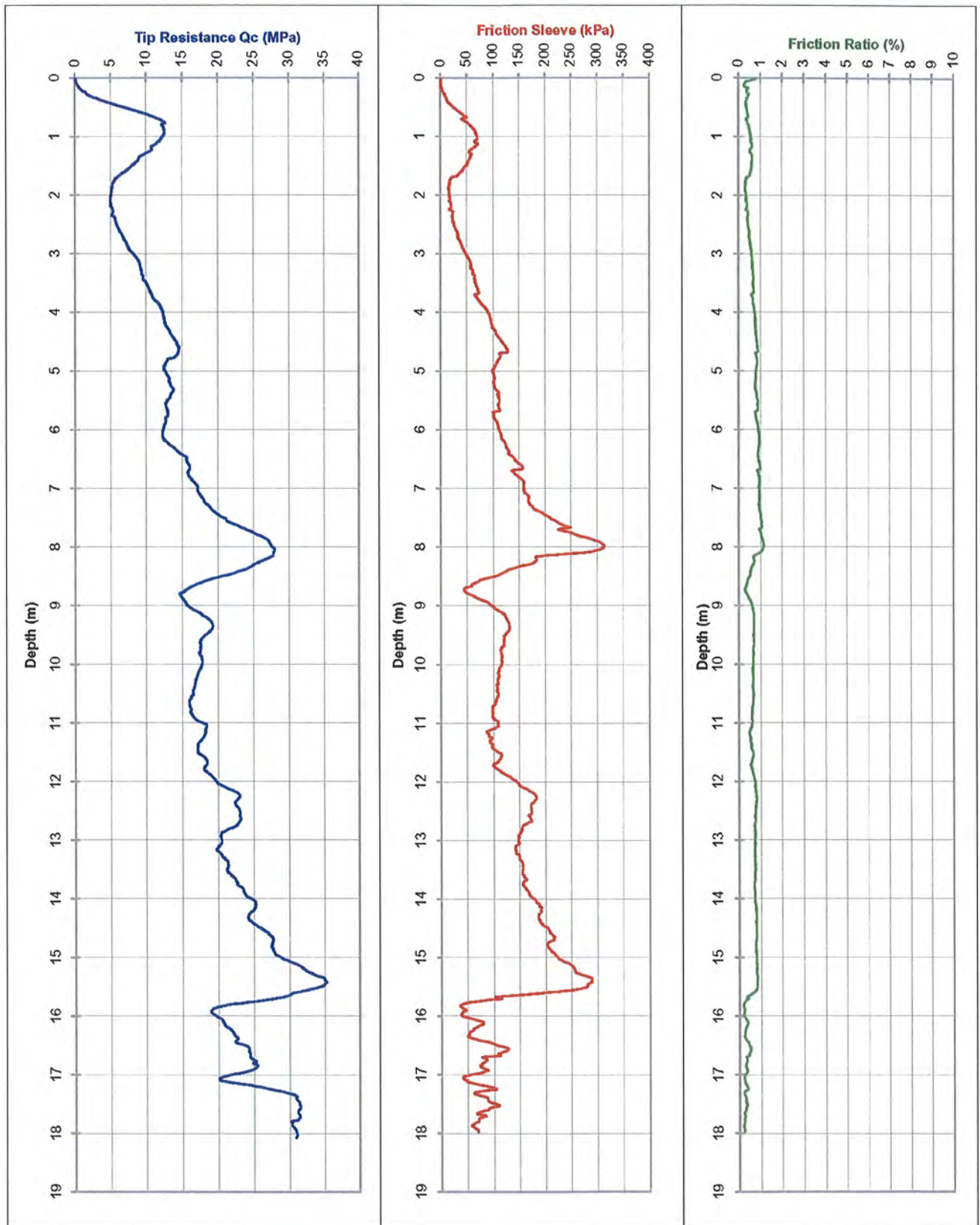
The cone penetrometer test has proven capable of providing data for design in most of the types of soil wherein the equipment can penetrate. Significant amount of gravel sized particles, however, can render the data very erratic and difficult to interpret quantitatively.



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Coffey Geotechnics
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch

Date: 15/5/08
Probe No.: CPT 101
Job Number: GEOTHERD-08304AB
Co-ordinates:



Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 33MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: CP0843M.txt

Dummy probe to (m):

Cone I.D. : EC23

12 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Coffey Geotechnics

Date: 15/5/08

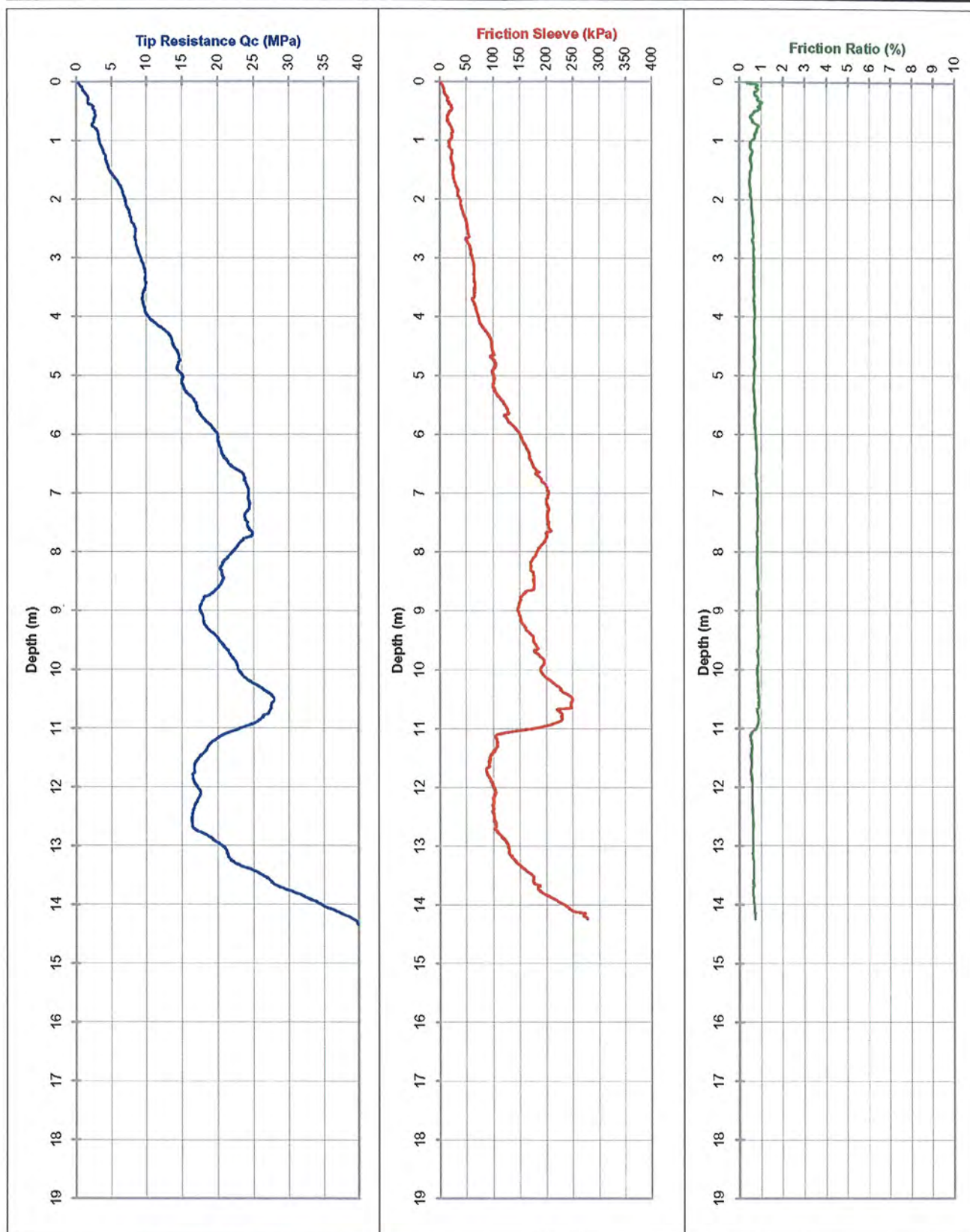
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 102

LOCATION: Murdoch

Job Number: GEOTHERD-08304AB

Co-ordinates:



Water (m): -

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

Refusal: 40MPa + R.F.

File: CP0844M.txt

Dummy probe to (m):

Cone I.D. : EC31

12 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Coffey Geotechnics

PROJECT: Fiona Stanley Hospital

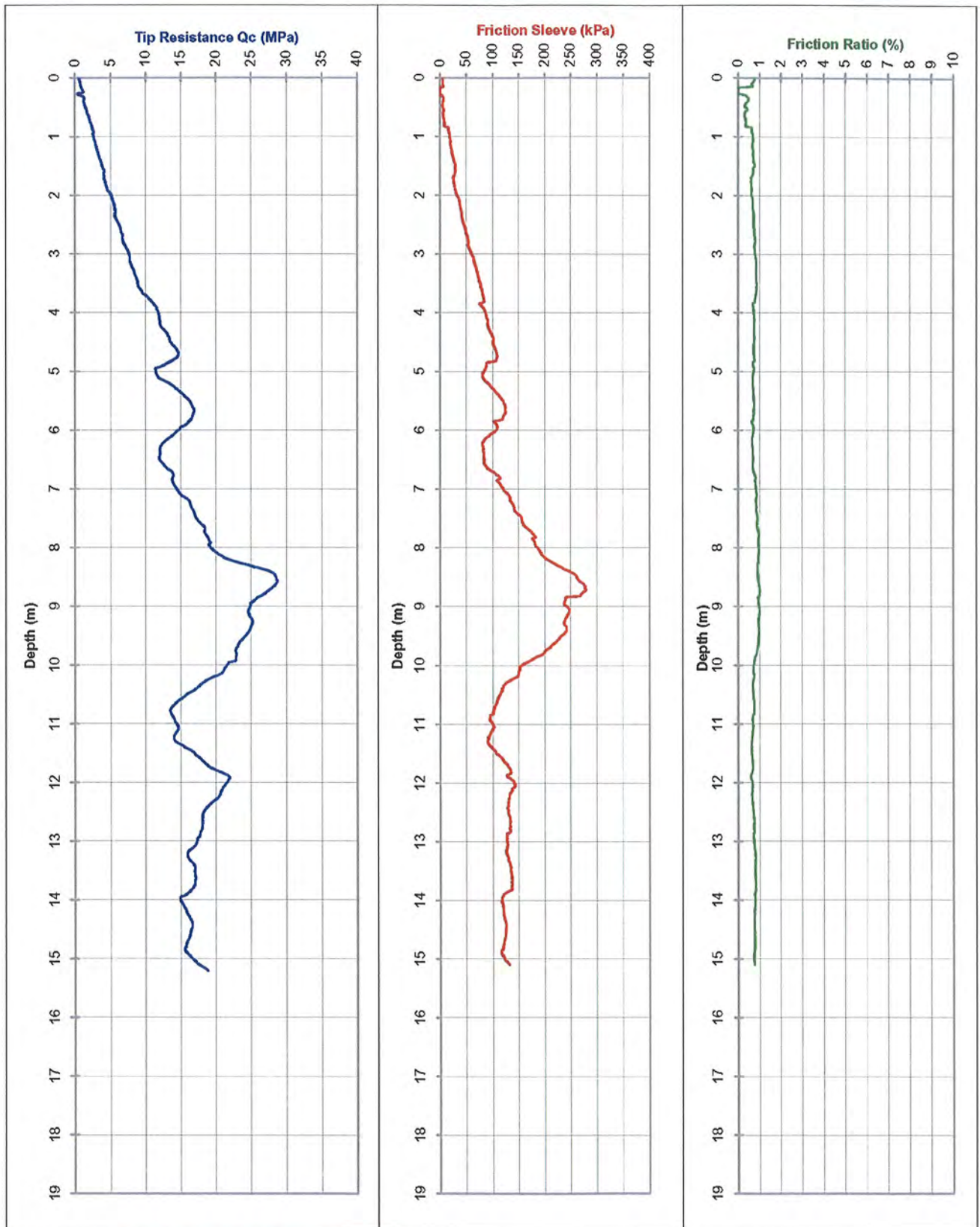
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 103

Job Number: GEOTHERD-08304AB

Co-ordinates:



Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: CP0845M.txt

Dummy probe to (m):

Cone I.D. : EC31

12 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Coffey Geotechnics

Date: 15/5/08

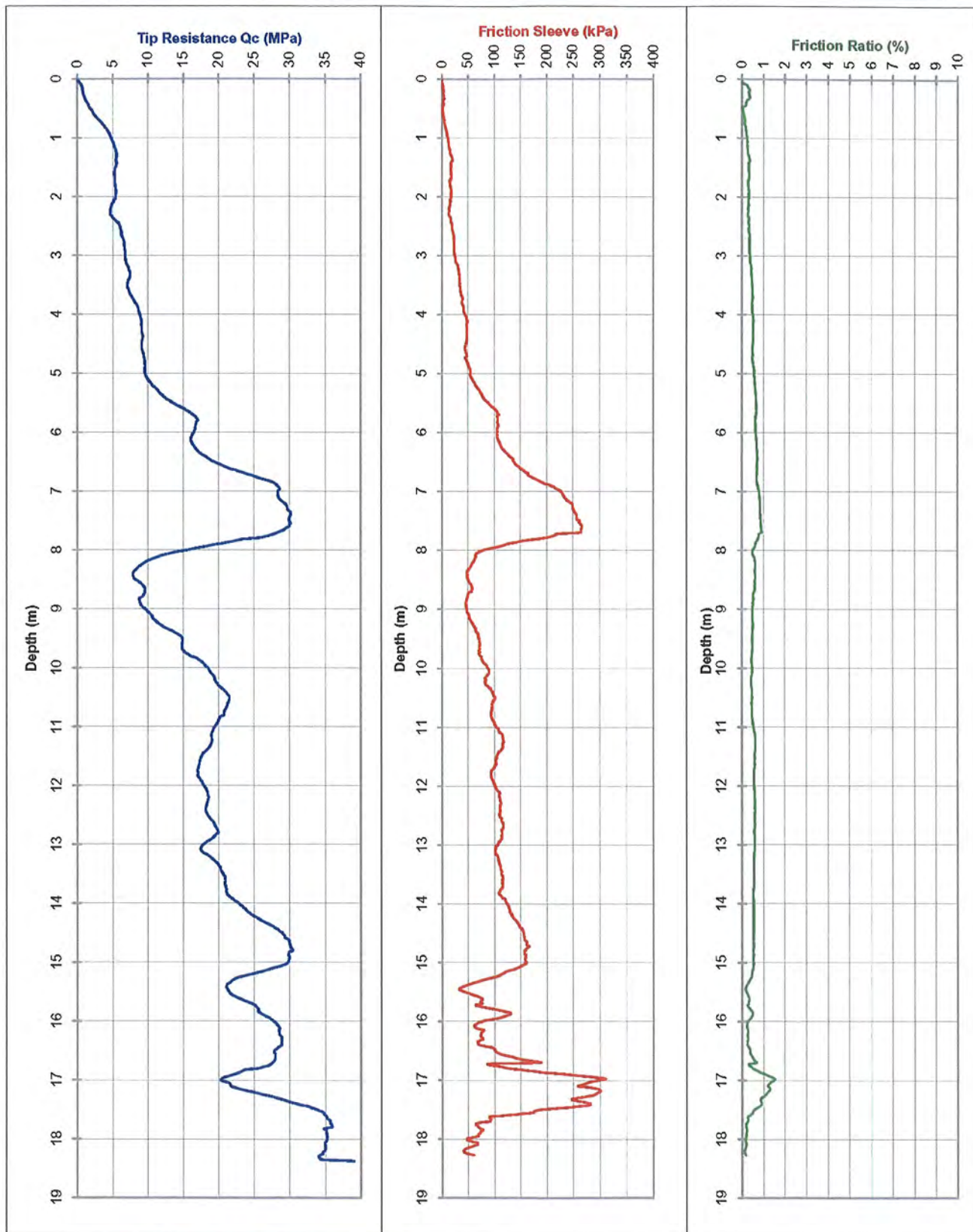
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 104

LOCATION: Murdoch

Job Number: GEOTHERD-08304AB

Co-ordinates:



Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 39MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: CP0846M.txt

Dummy probe to (m):

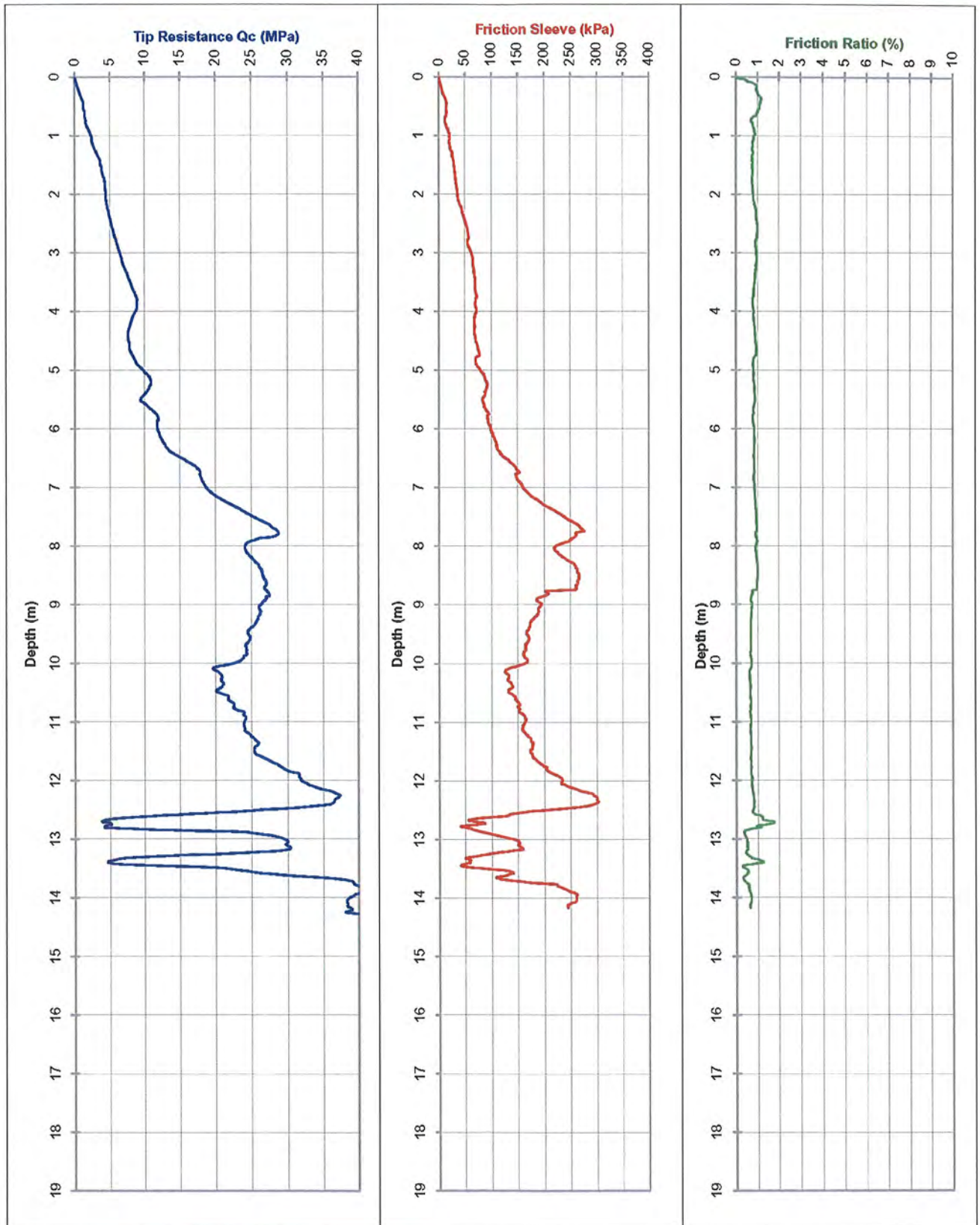
Cone I.D. : EC31

12 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Coffey Geotechnics
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch

Date: 15/5/08
Probe No.: CPT 105
Job Number: GEOTHERD-08304AB
Co-ordinates:



Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 40MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: CP0847M.txt

Dummy probe to (m):

Cone I.D. : EC31

12 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

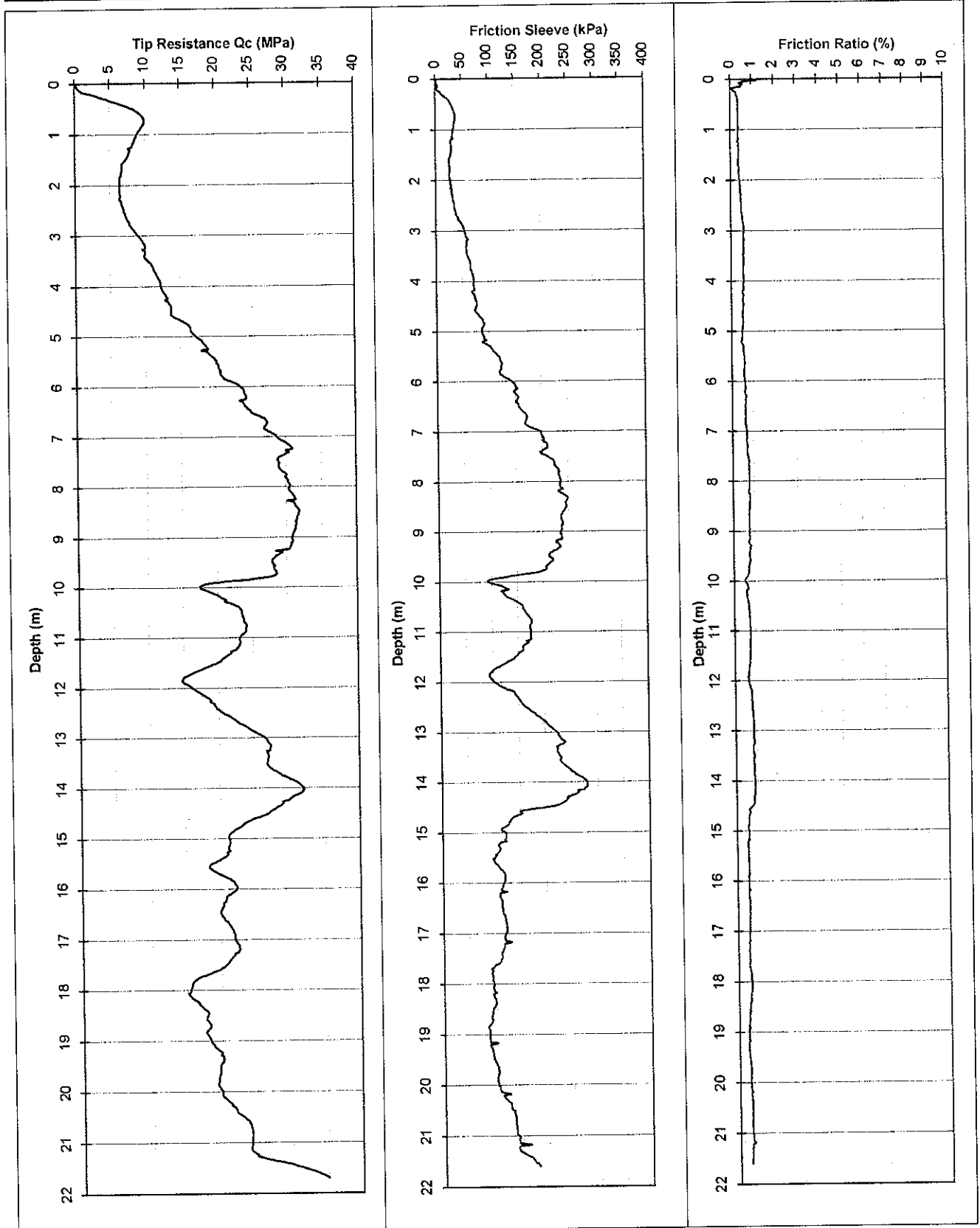
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 01 U

Job Number: 61/19514/01

Co-ordinates:



Ph. 9314 6611 Fax 9314 6699

Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

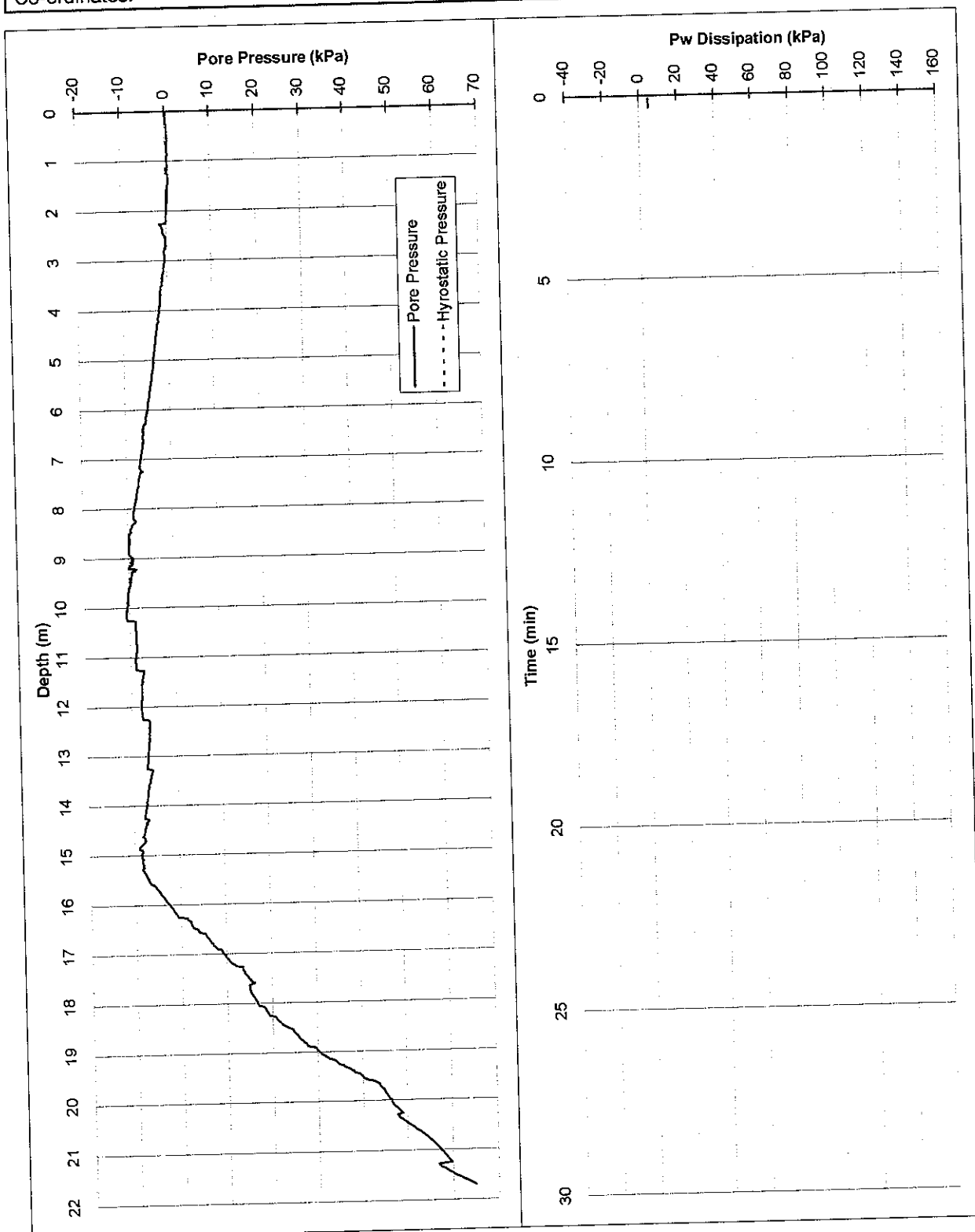
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 01 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

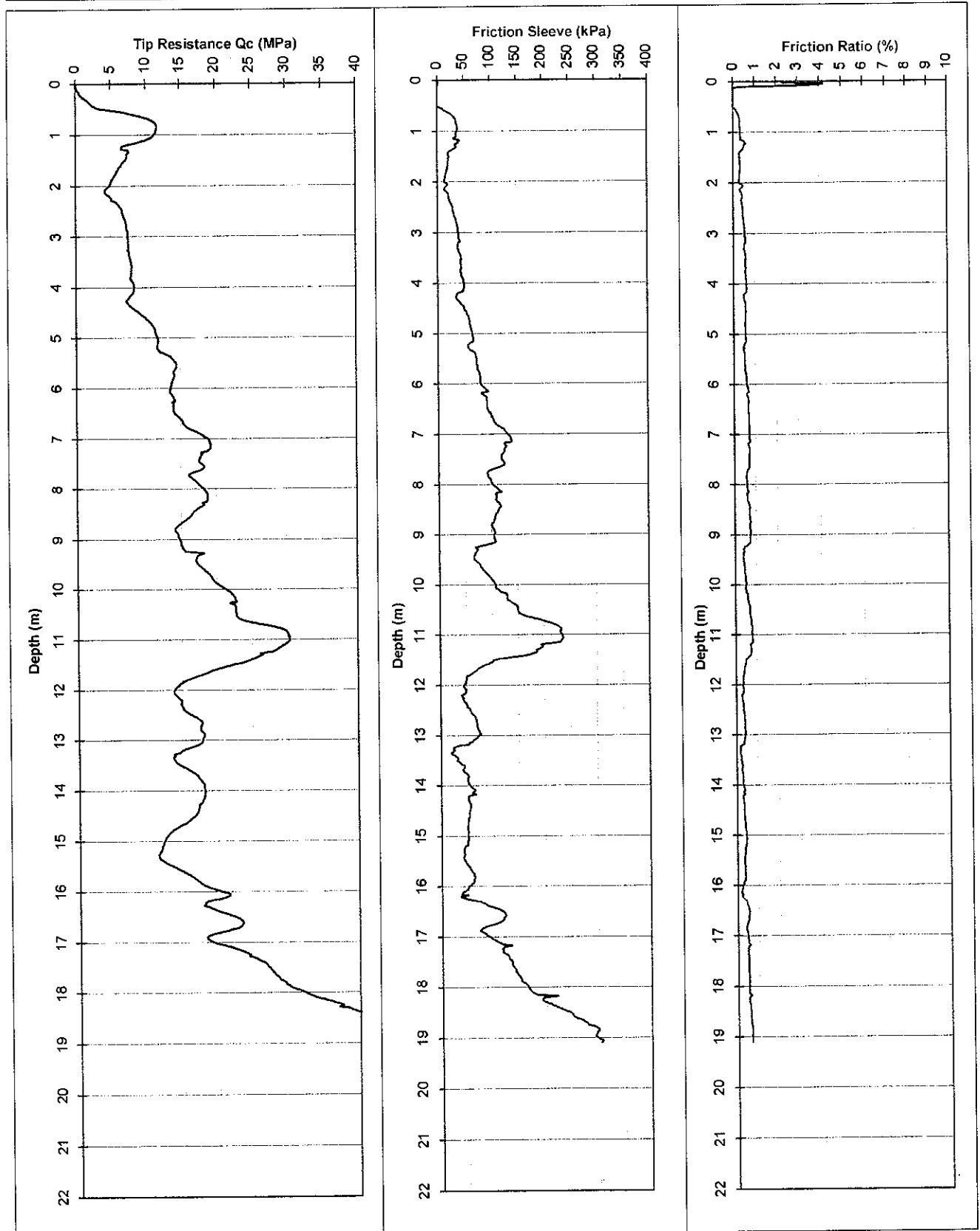
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 02 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

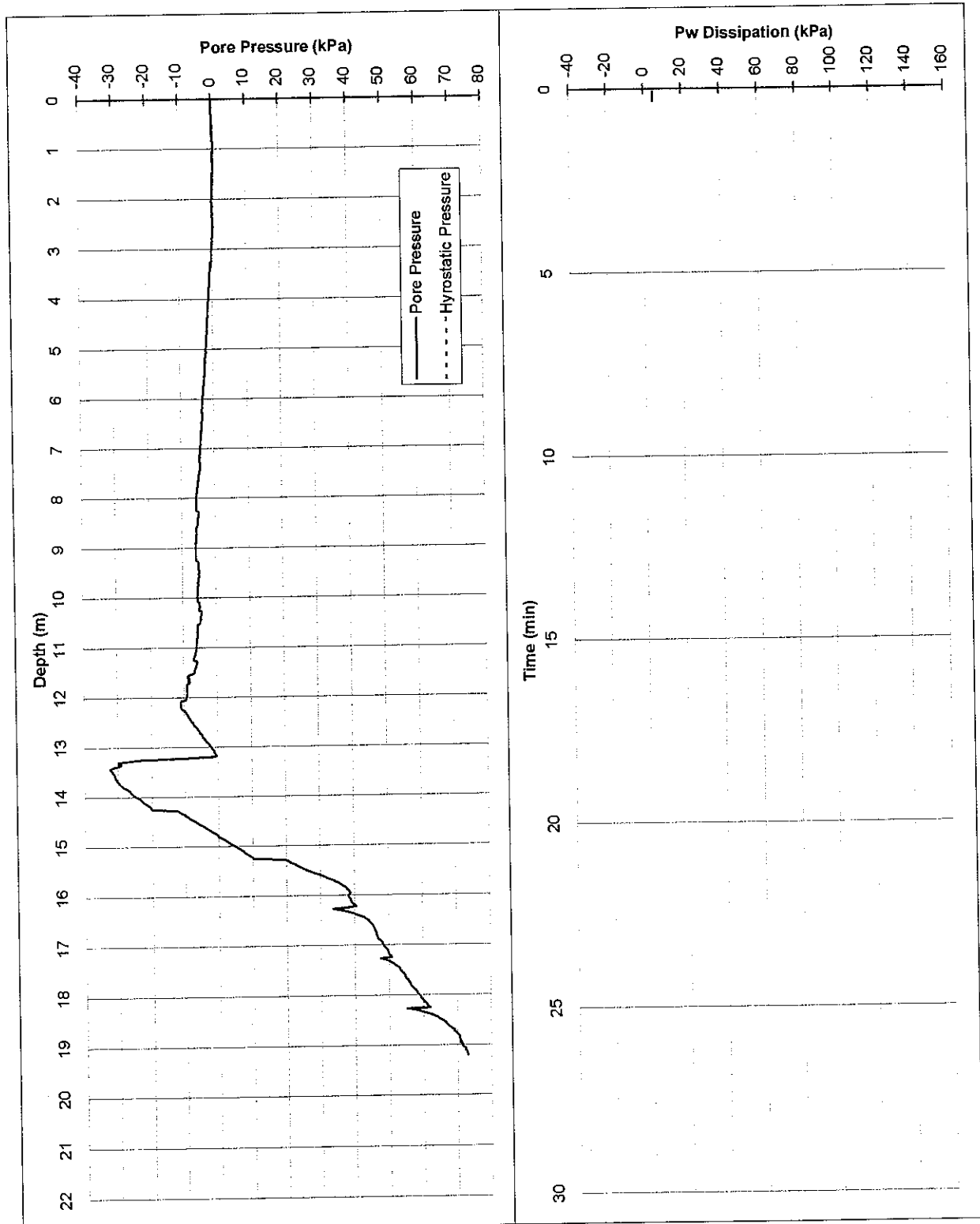
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 02 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 21/06/07

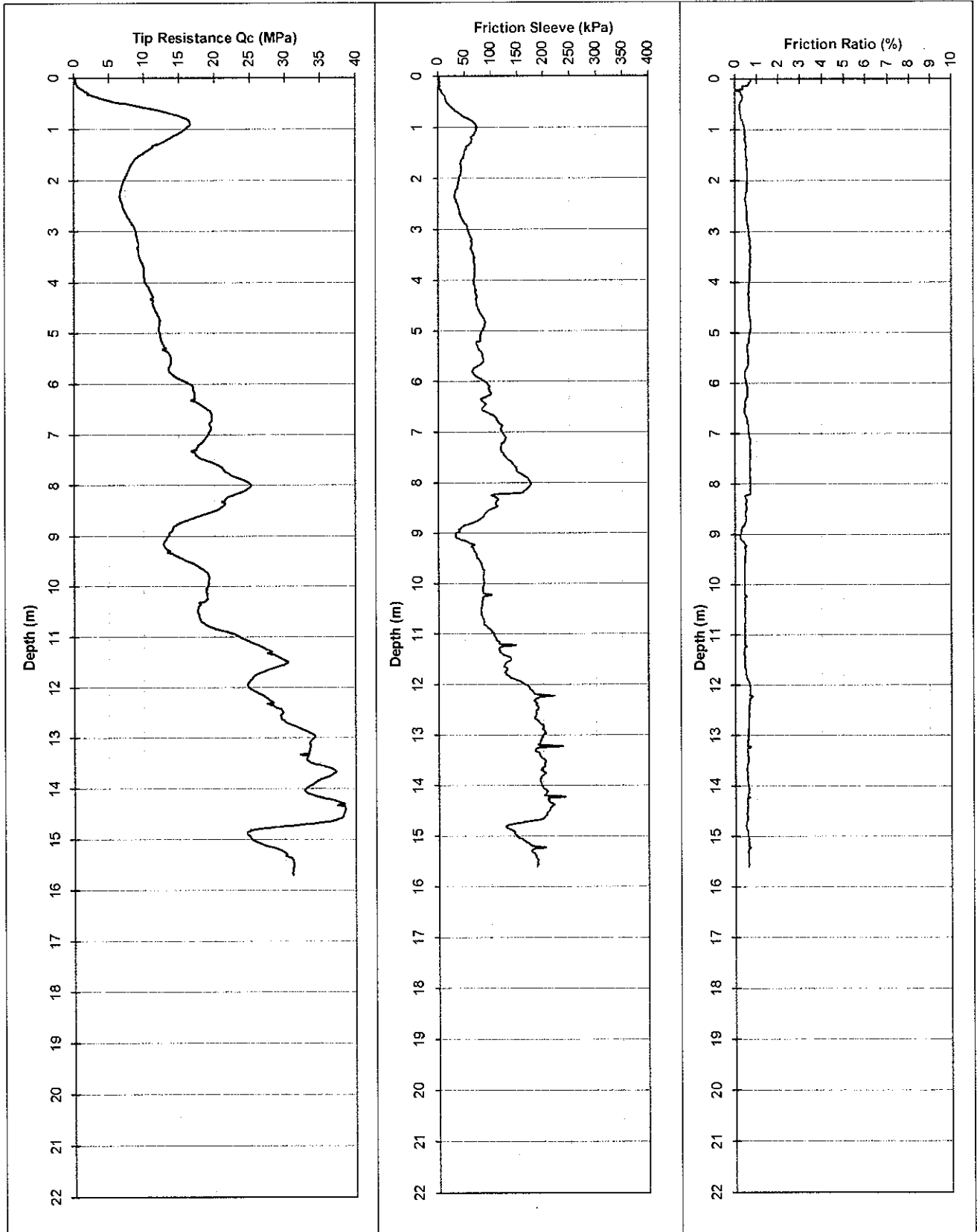
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 03 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 21/06/07

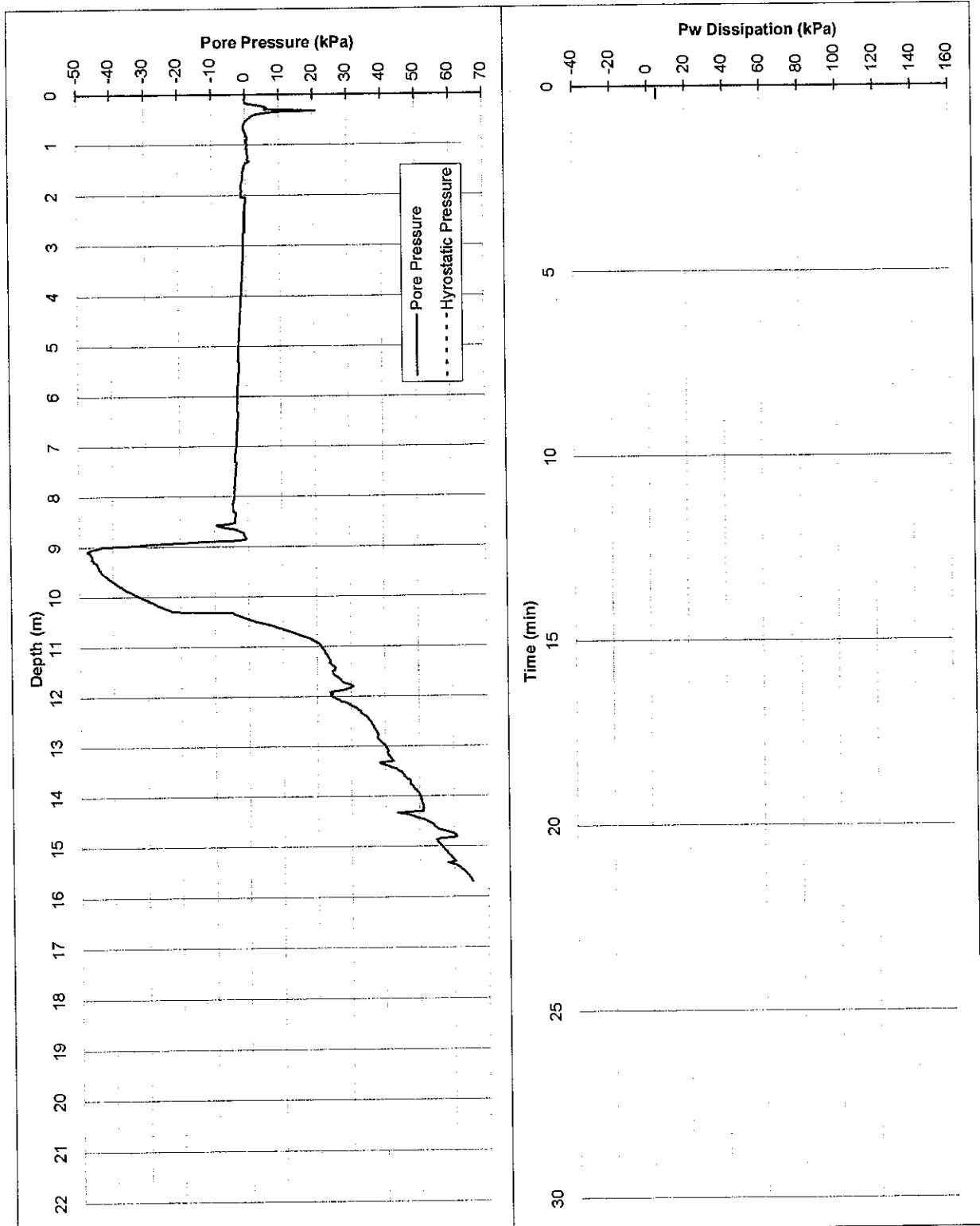
Project: Fiona Stanley Hospital

Probe No.: CPT 03 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 22/06/07

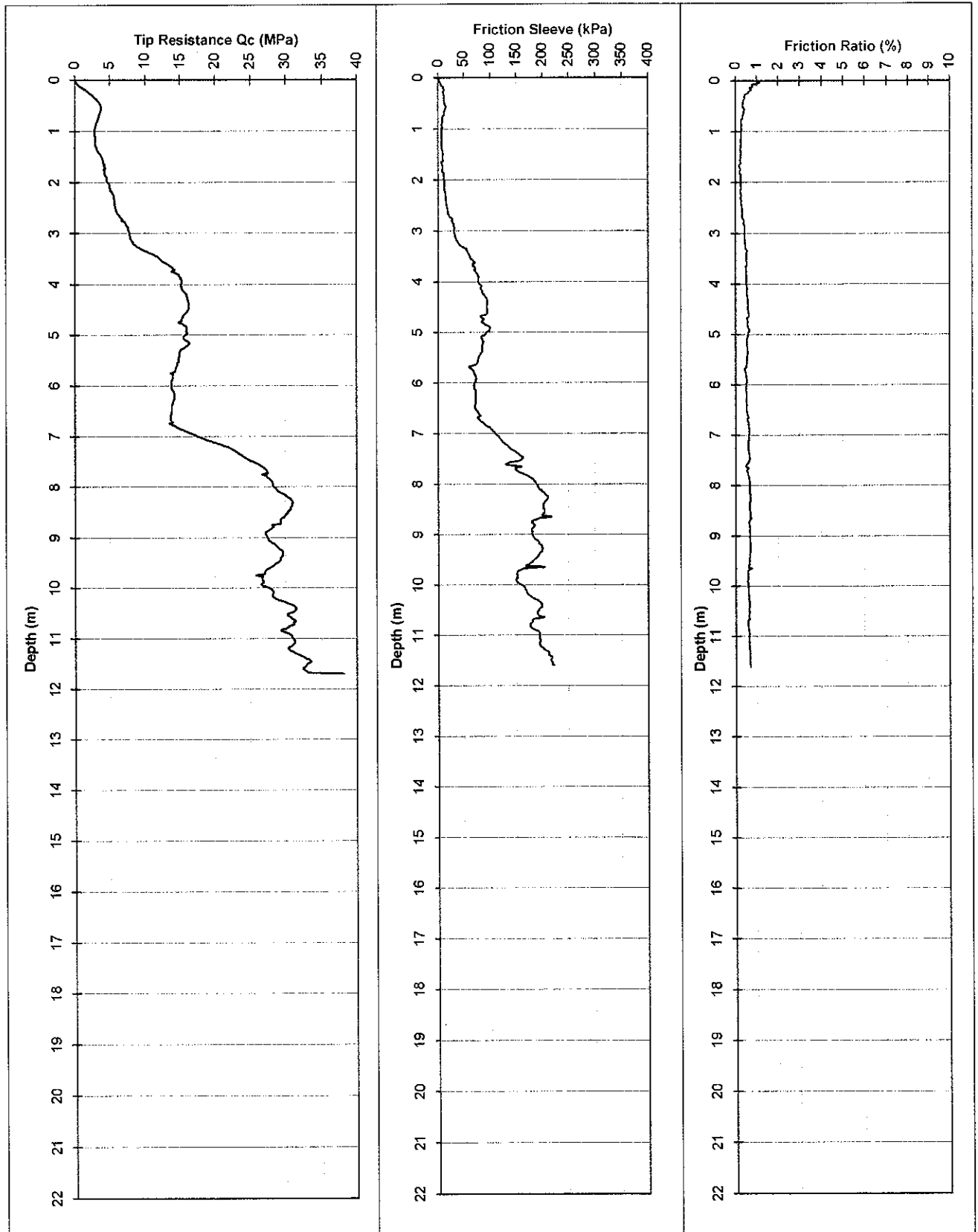
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 04 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Pl: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

Water (m): Dry to 5.4

Refusal: 38MPa

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 22/06/07

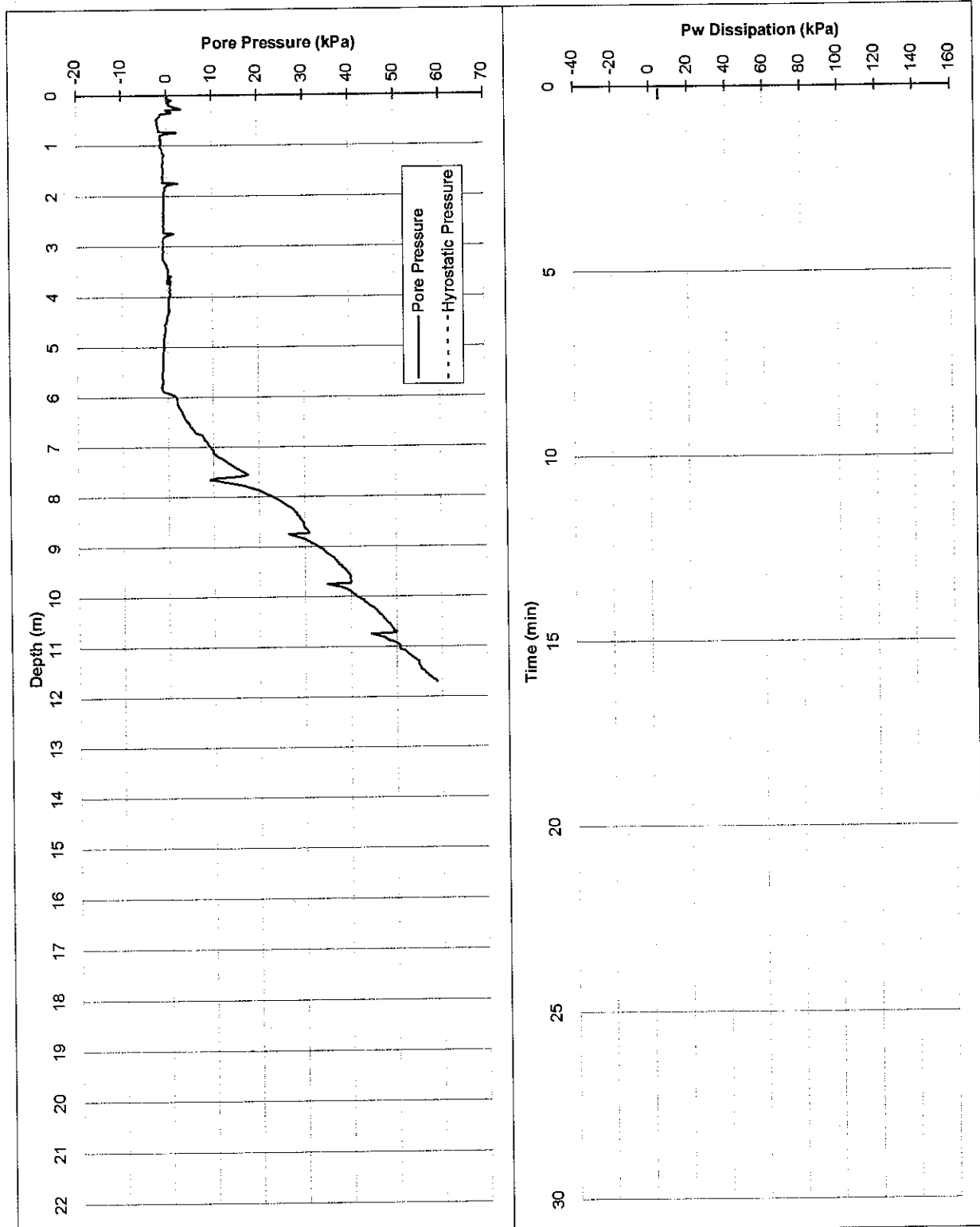
Project: Fiona Stanley Hospital

Probe No.: CPT 04 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

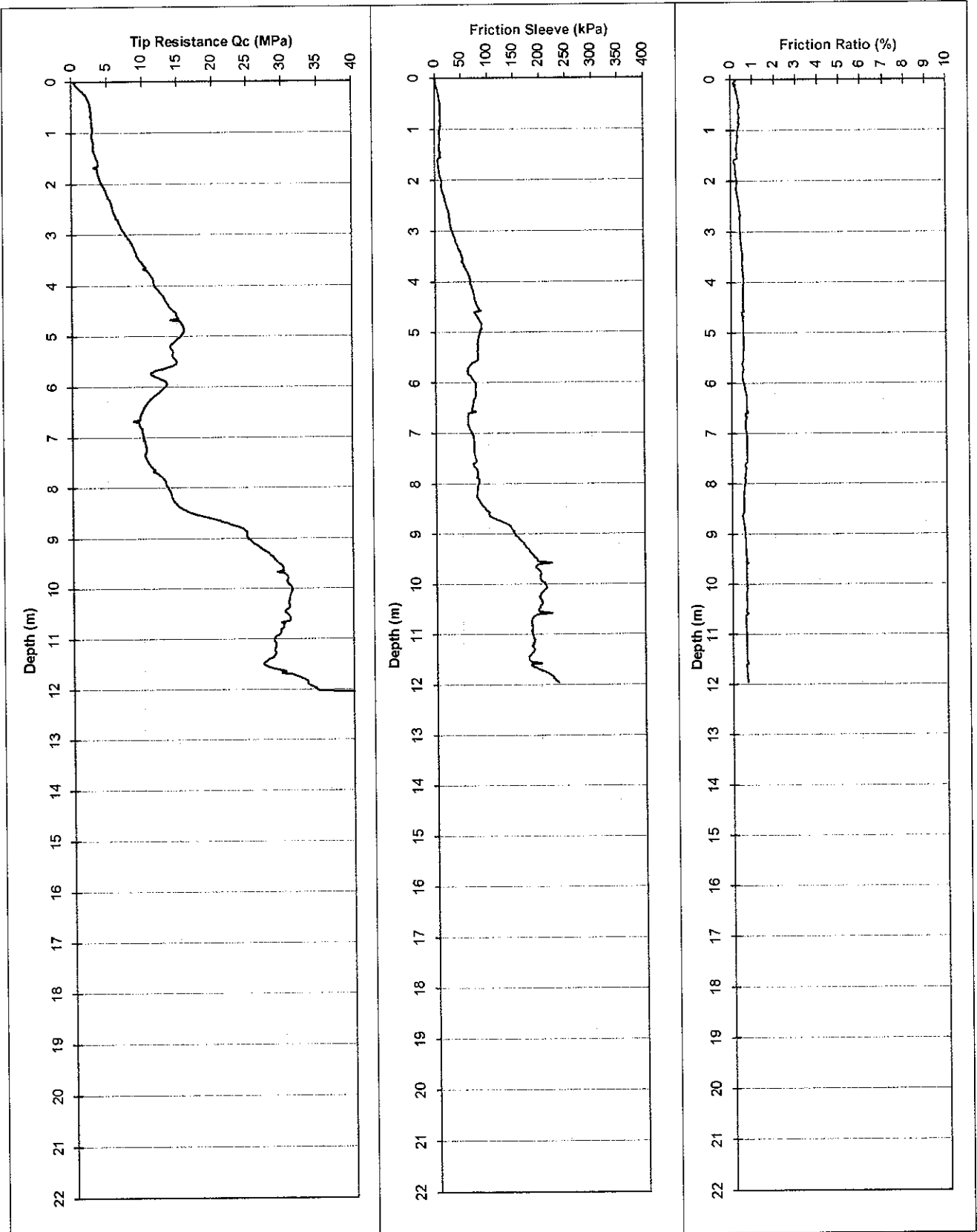
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 05 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 5.0

Refusal: 40MPa

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

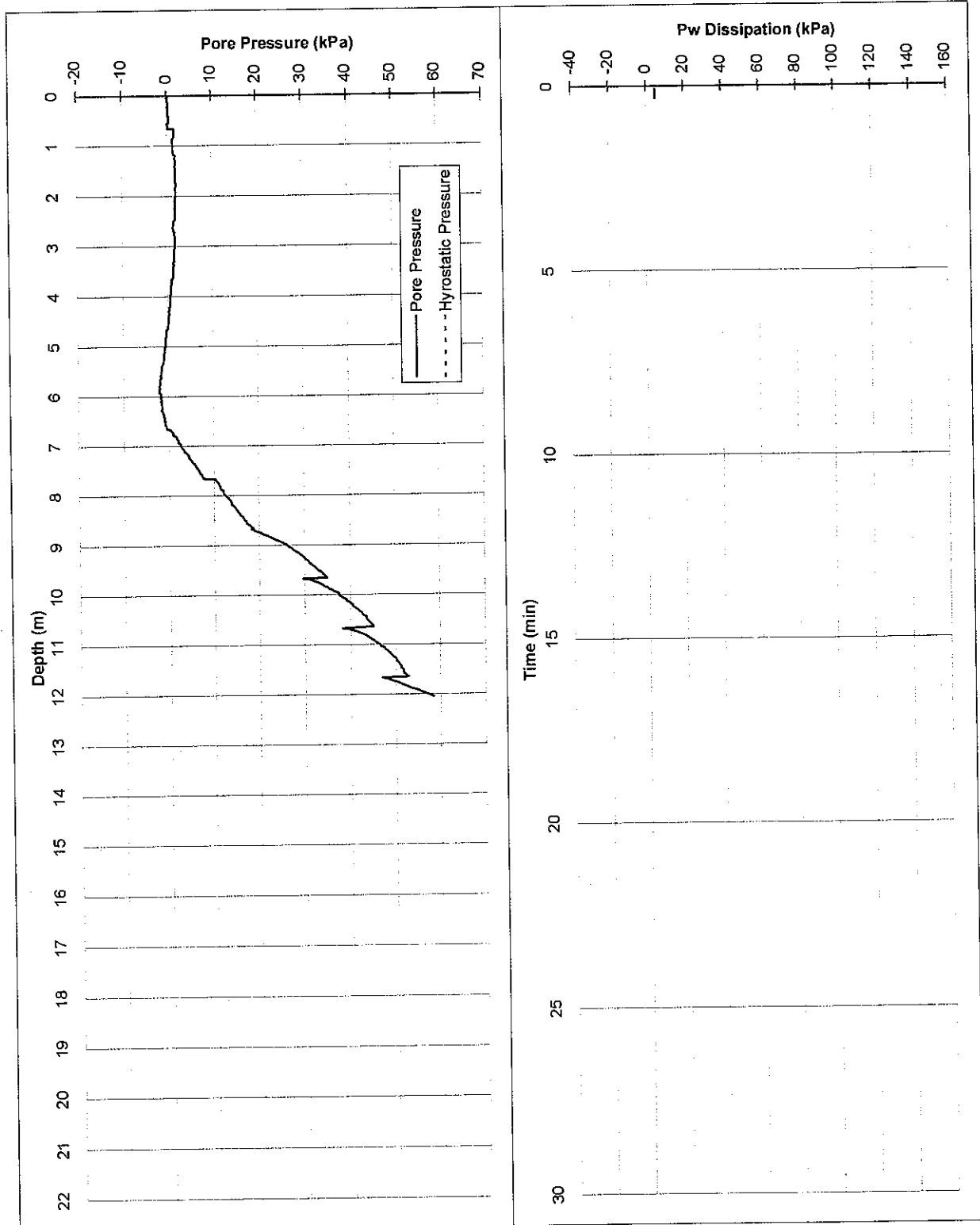
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 05 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 22/06/07

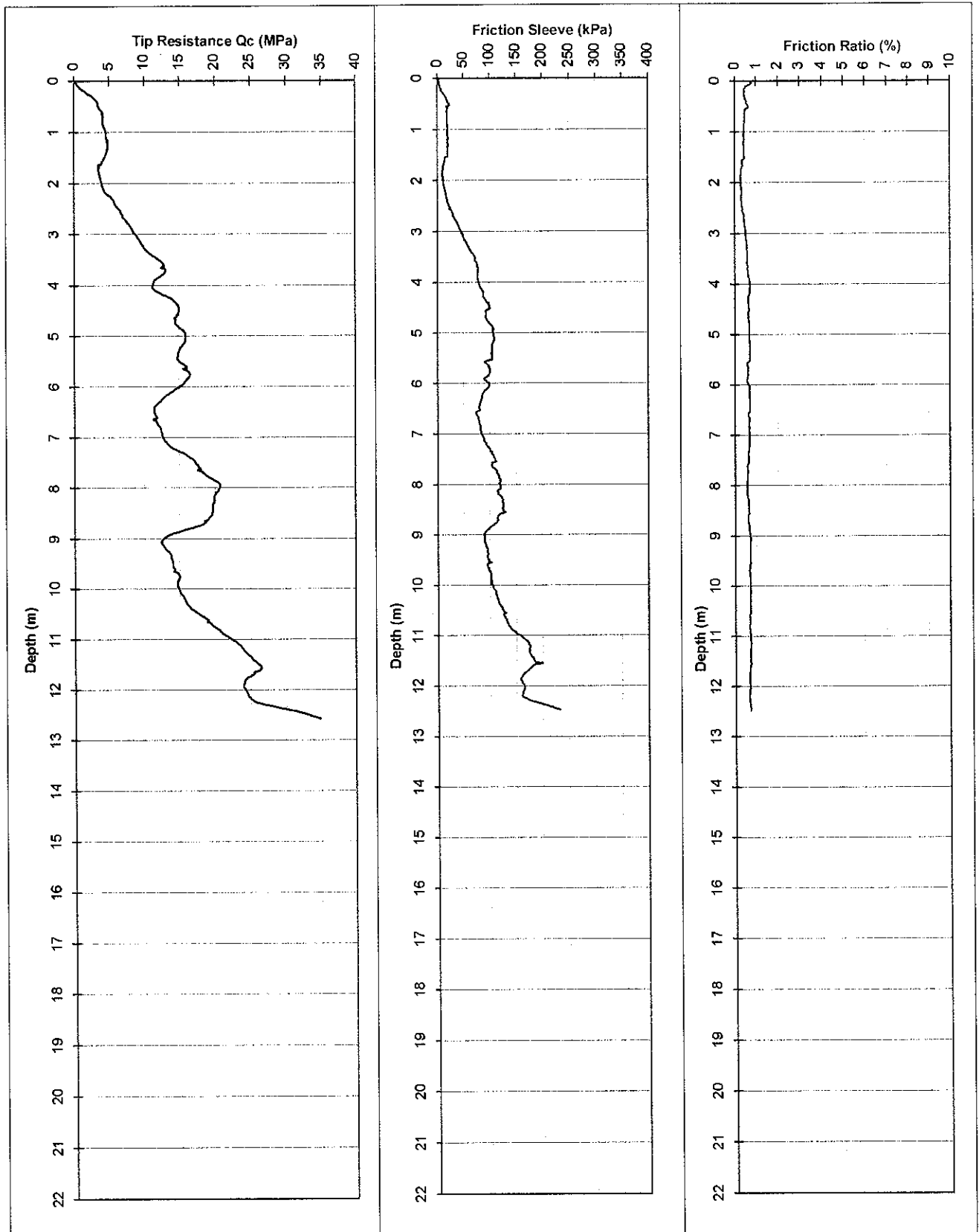
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 06 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 5.4

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

Refusal:

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

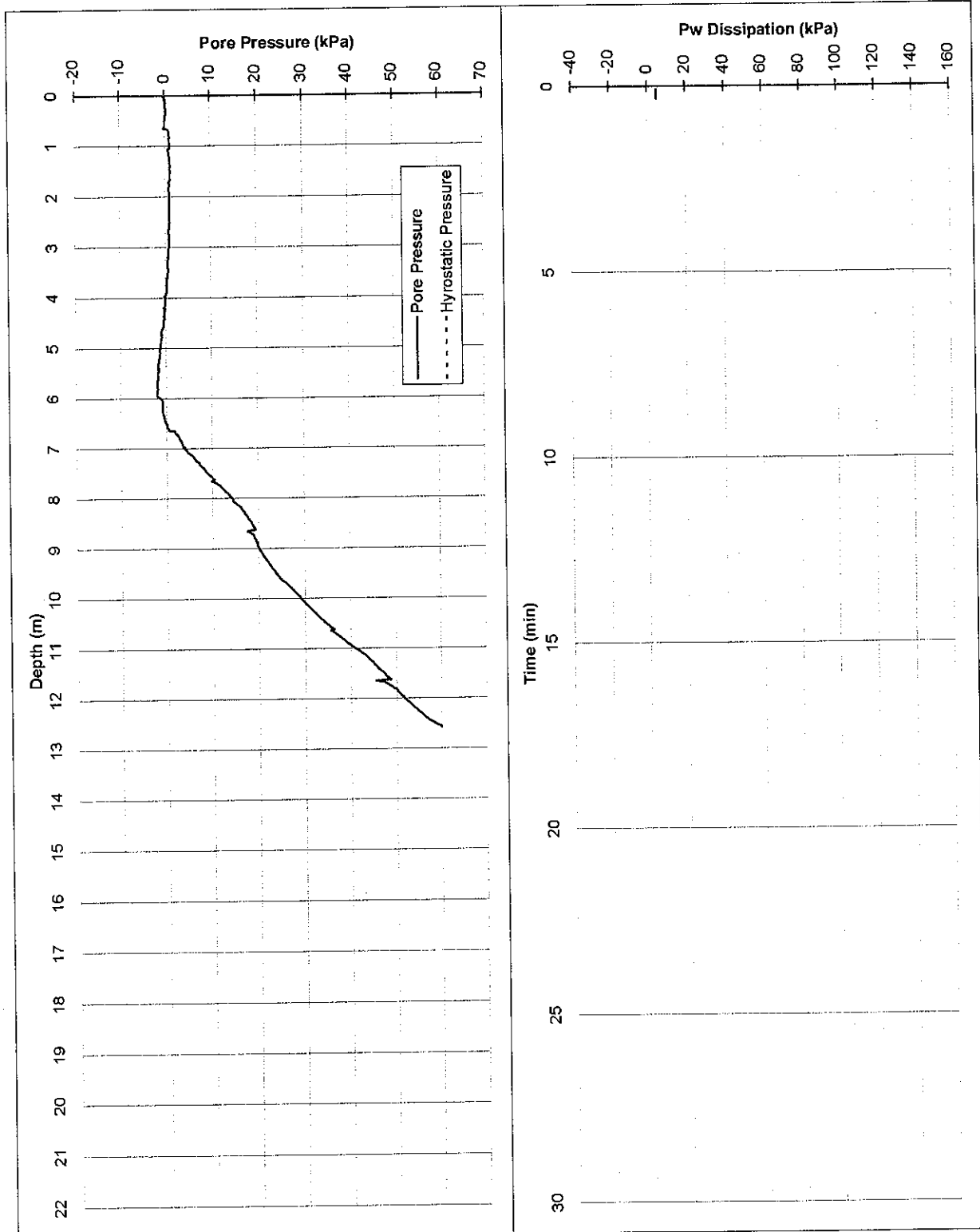
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 06 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

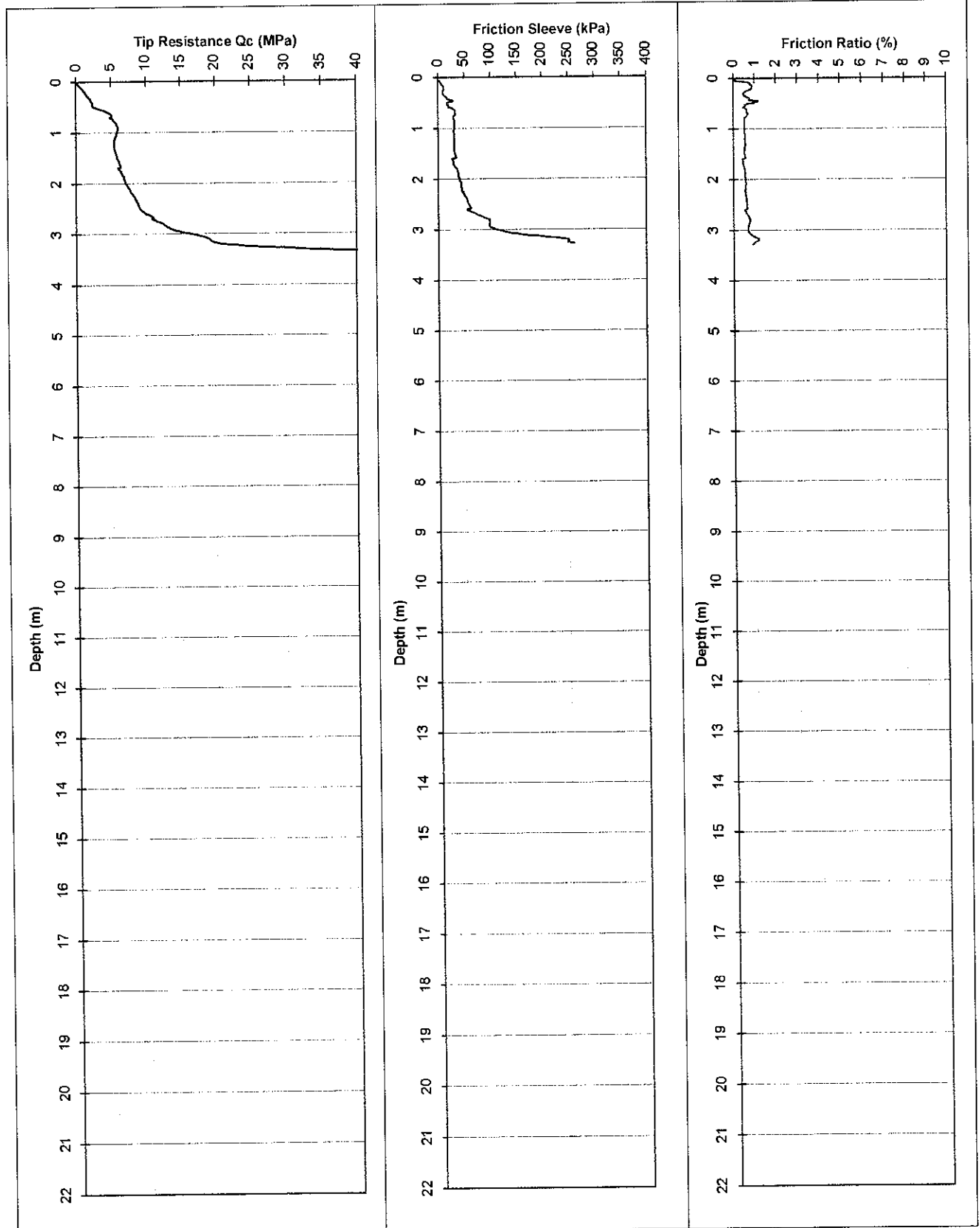
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 07 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 3.0

Refusal: 50MPa

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 22/06/07

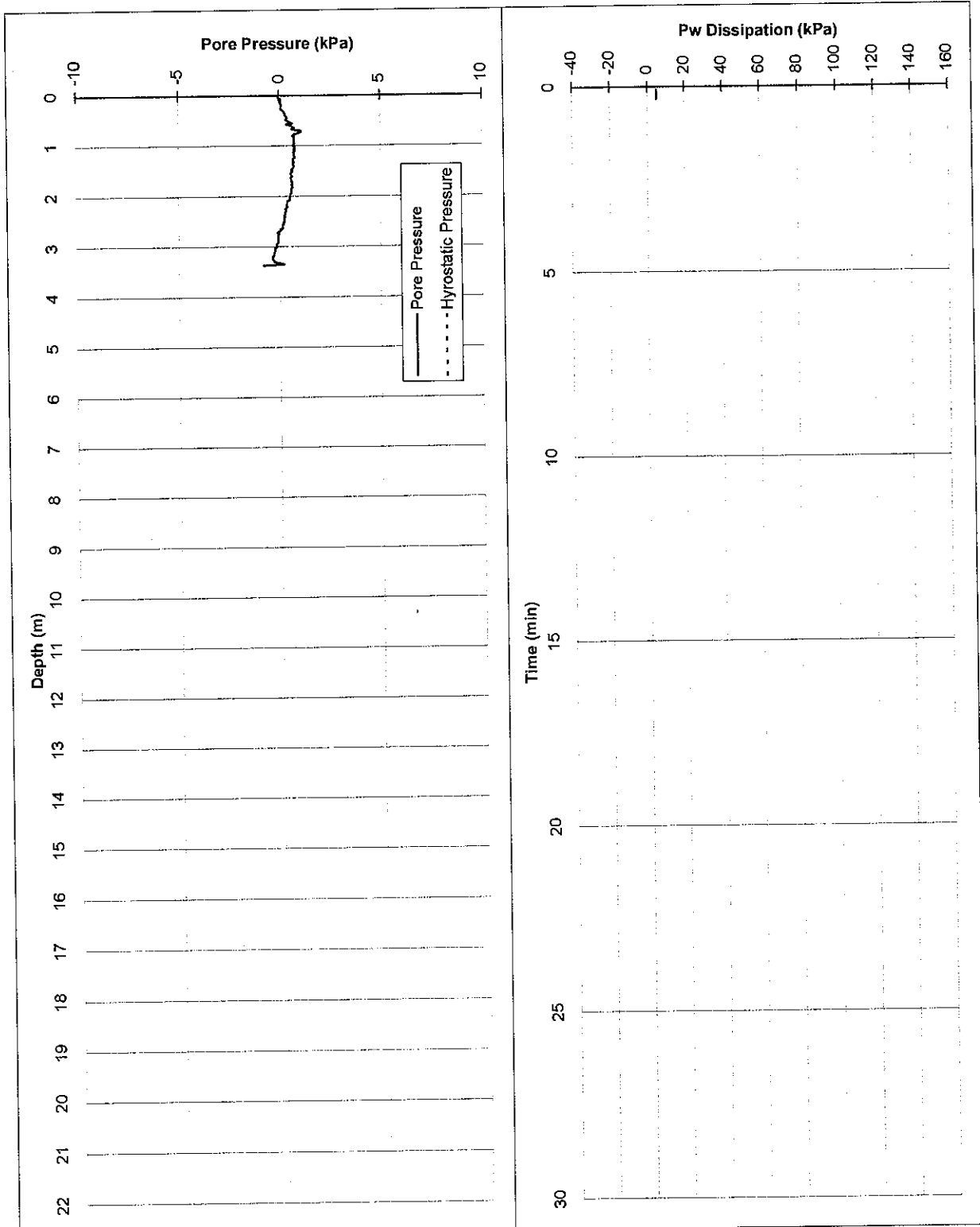
Project: Fiona Stanley Hospital

Probe No.: CPT 07 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

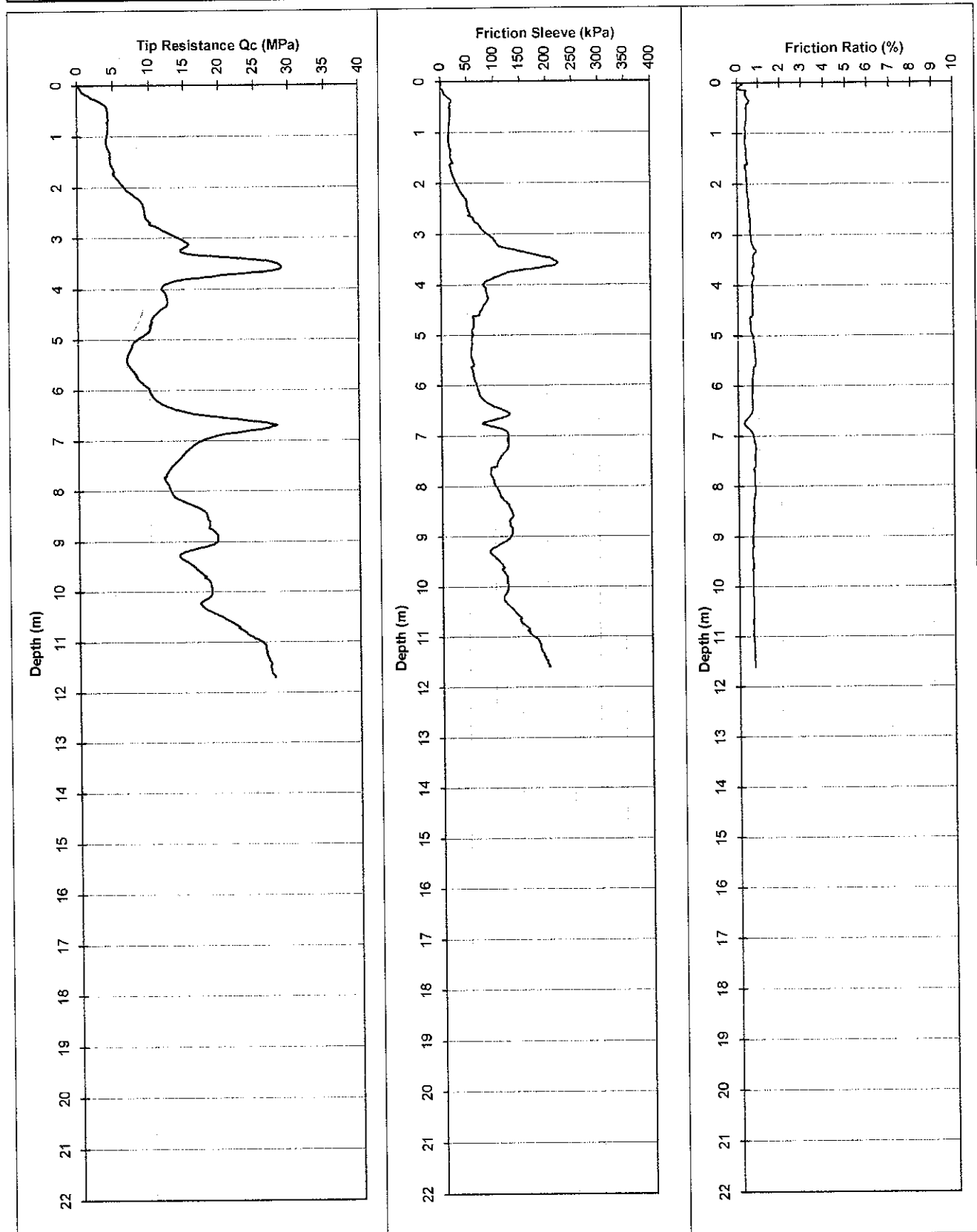
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 07 A U

Job Number: 61/19514/01

Co-ordinates:



Plt 9314 6611 Fax 9314 6699

GEOTECHNICAL SURVEY

Water (m): Dry to 5.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7441TT.txt

Dummy probe to (m):

Cone I.D. : EC29

7 tonne track mounted CPT Rig

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 22/06/07

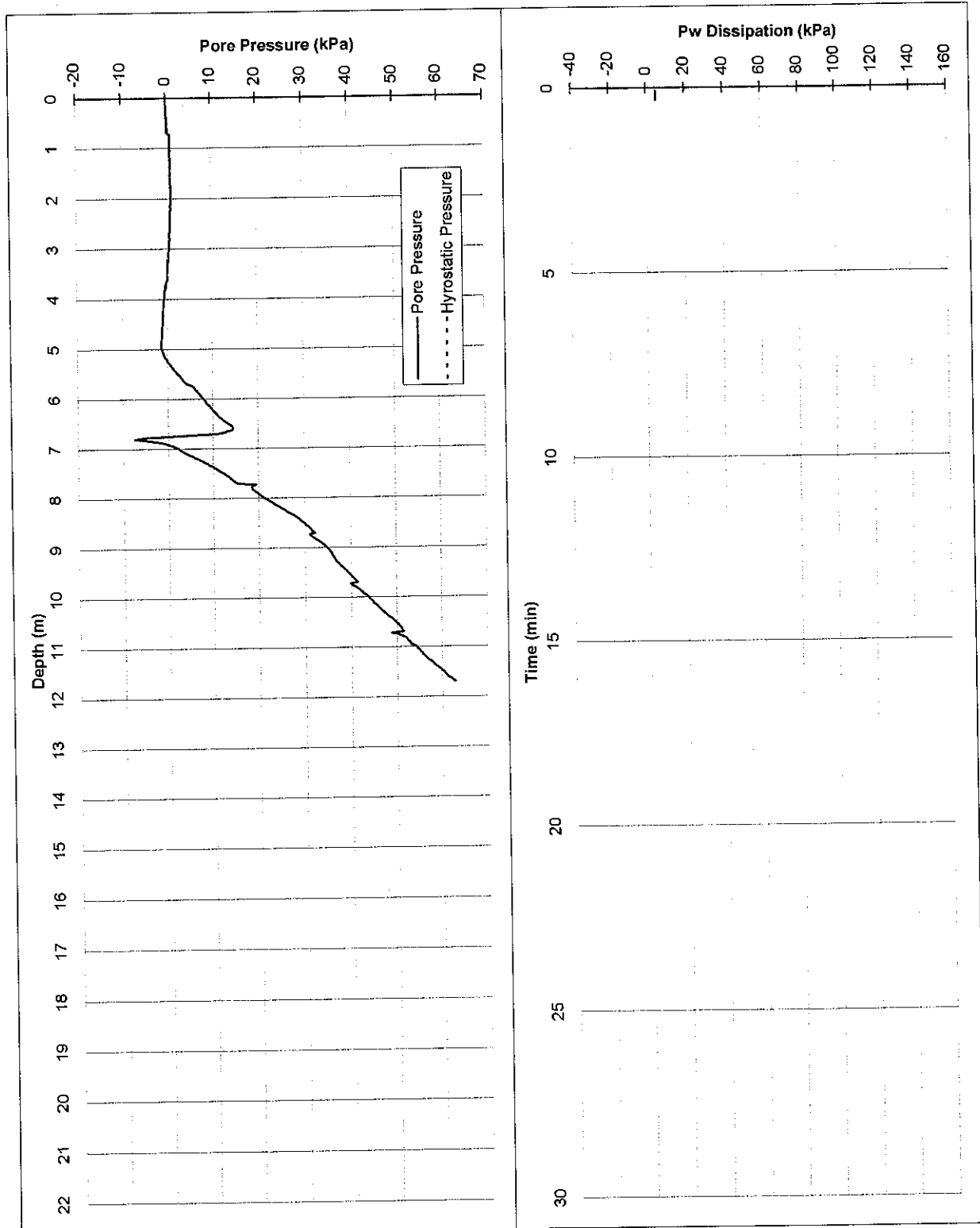
Project: Fiona Stanley Hospital

Probe No.: CPT 07 A U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

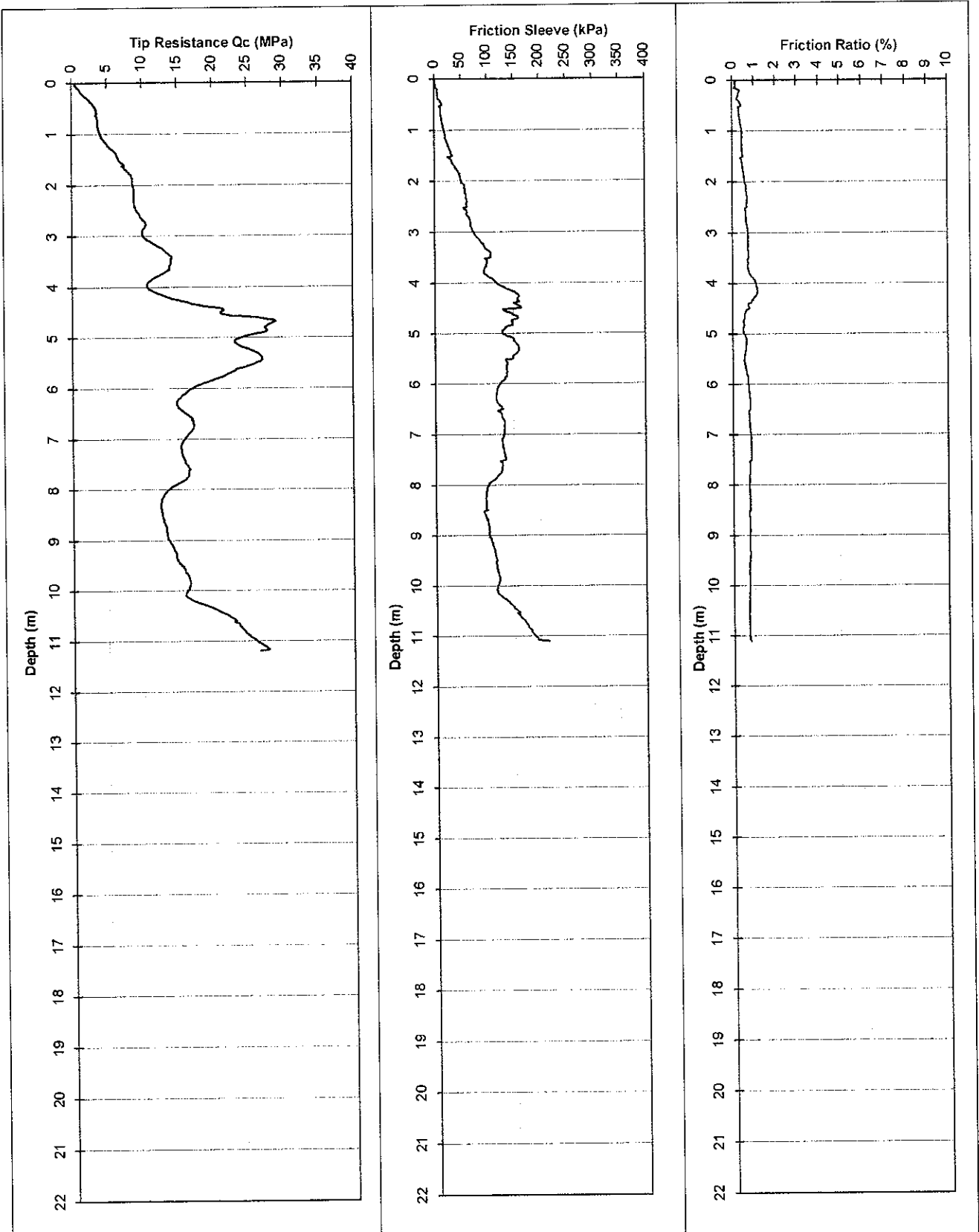
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 09 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 1.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 22/06/07

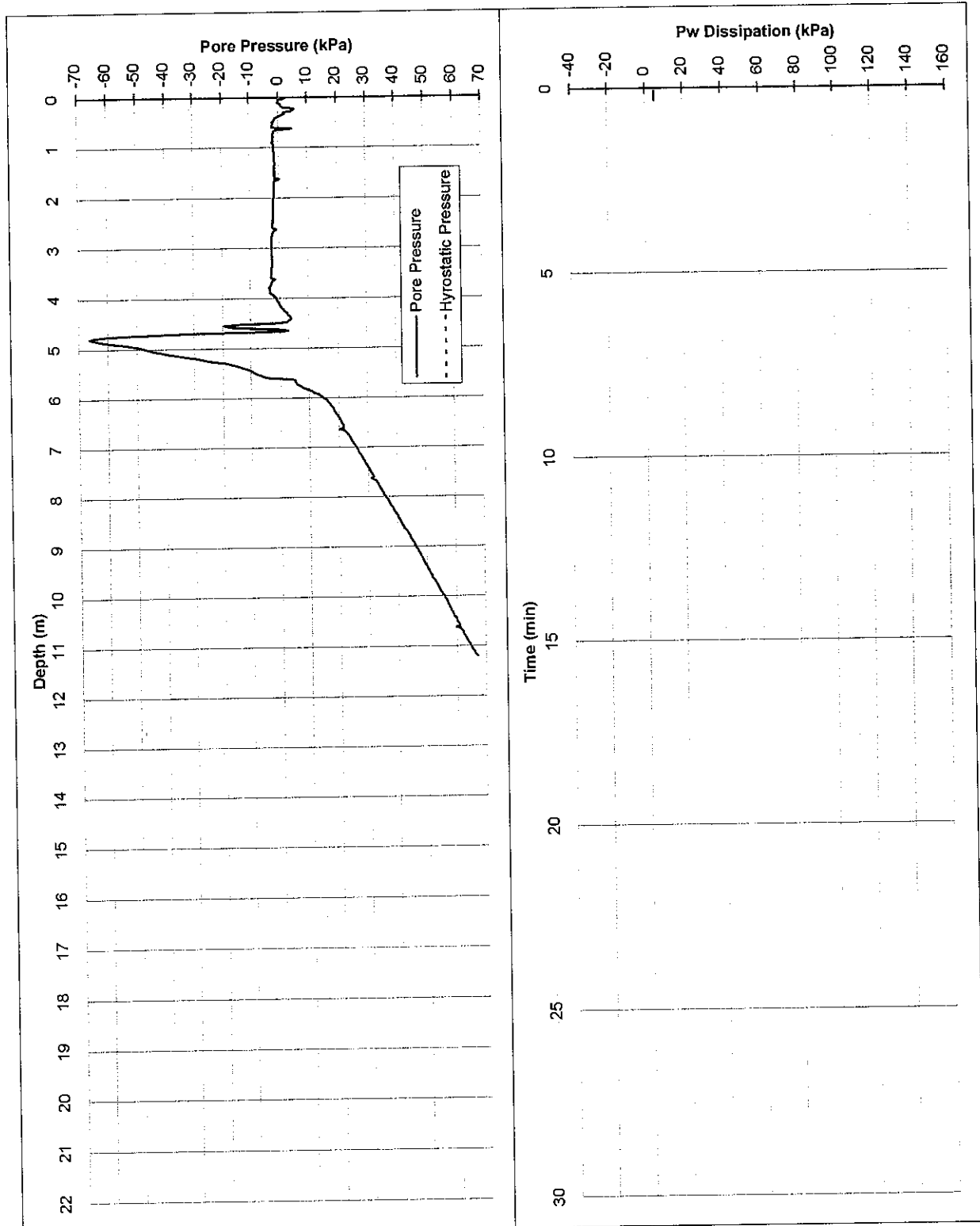
Project: Fiona Stanley Hospital

Probe No.: CPT 09 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 21/06/07

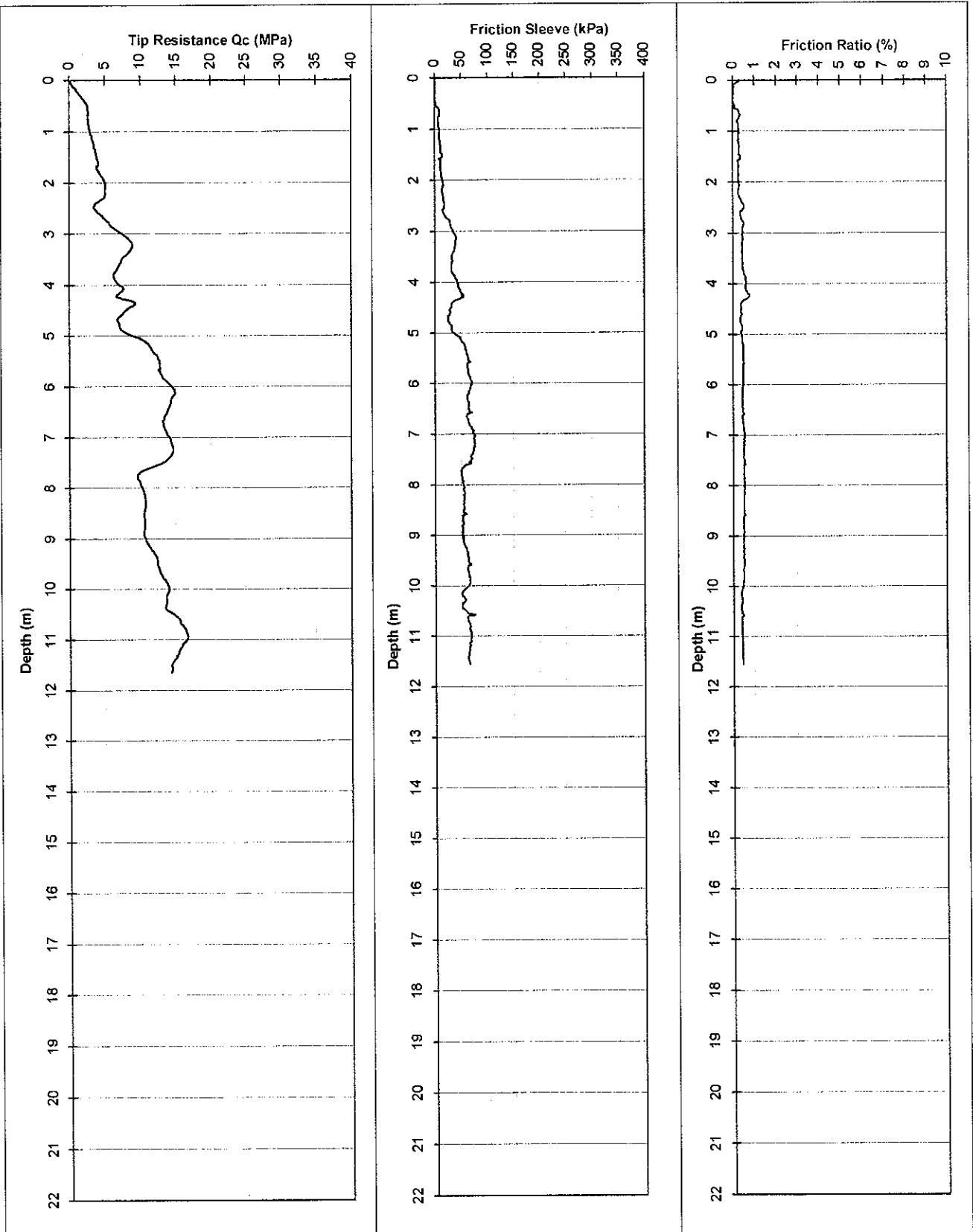
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 10 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

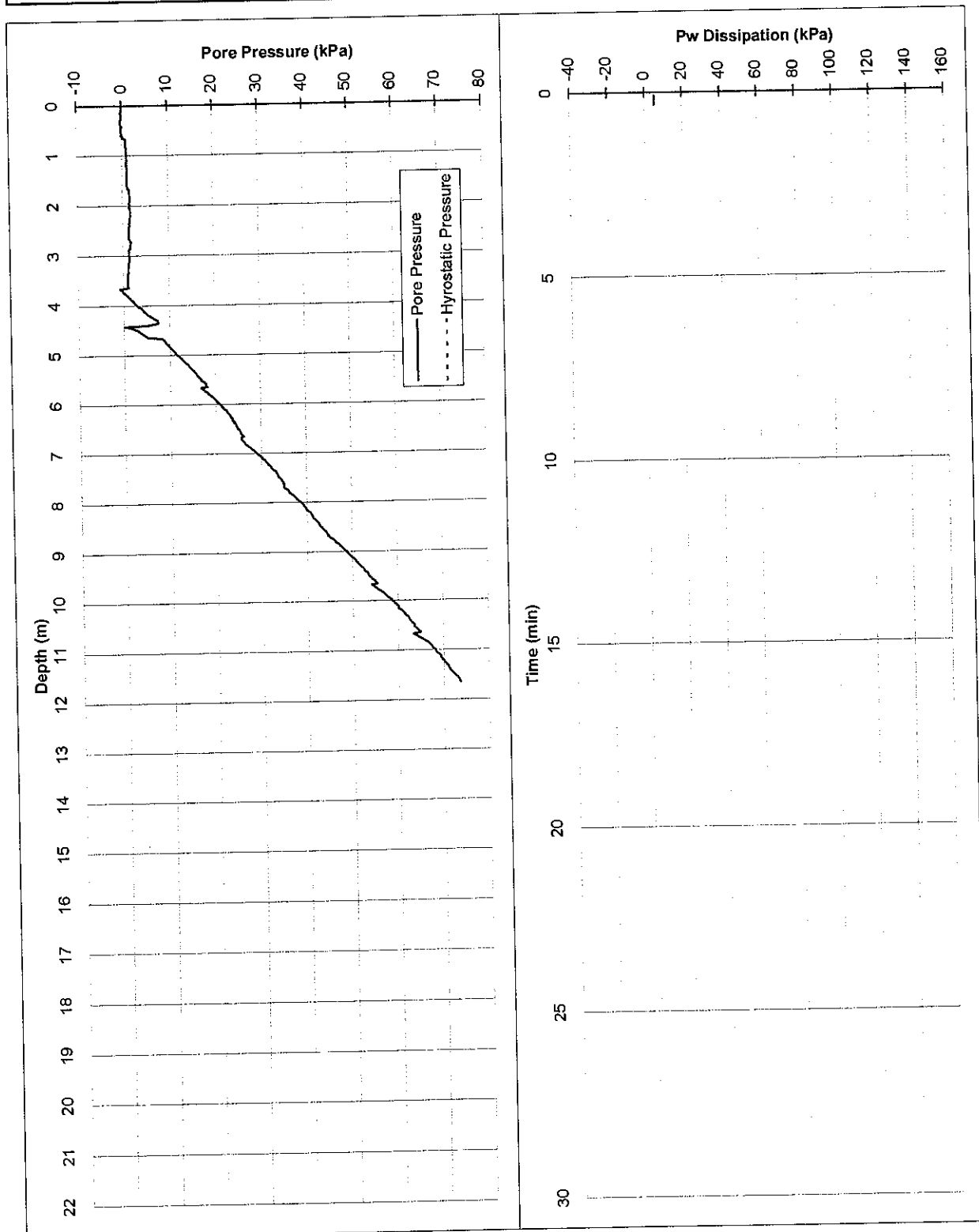
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 10 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

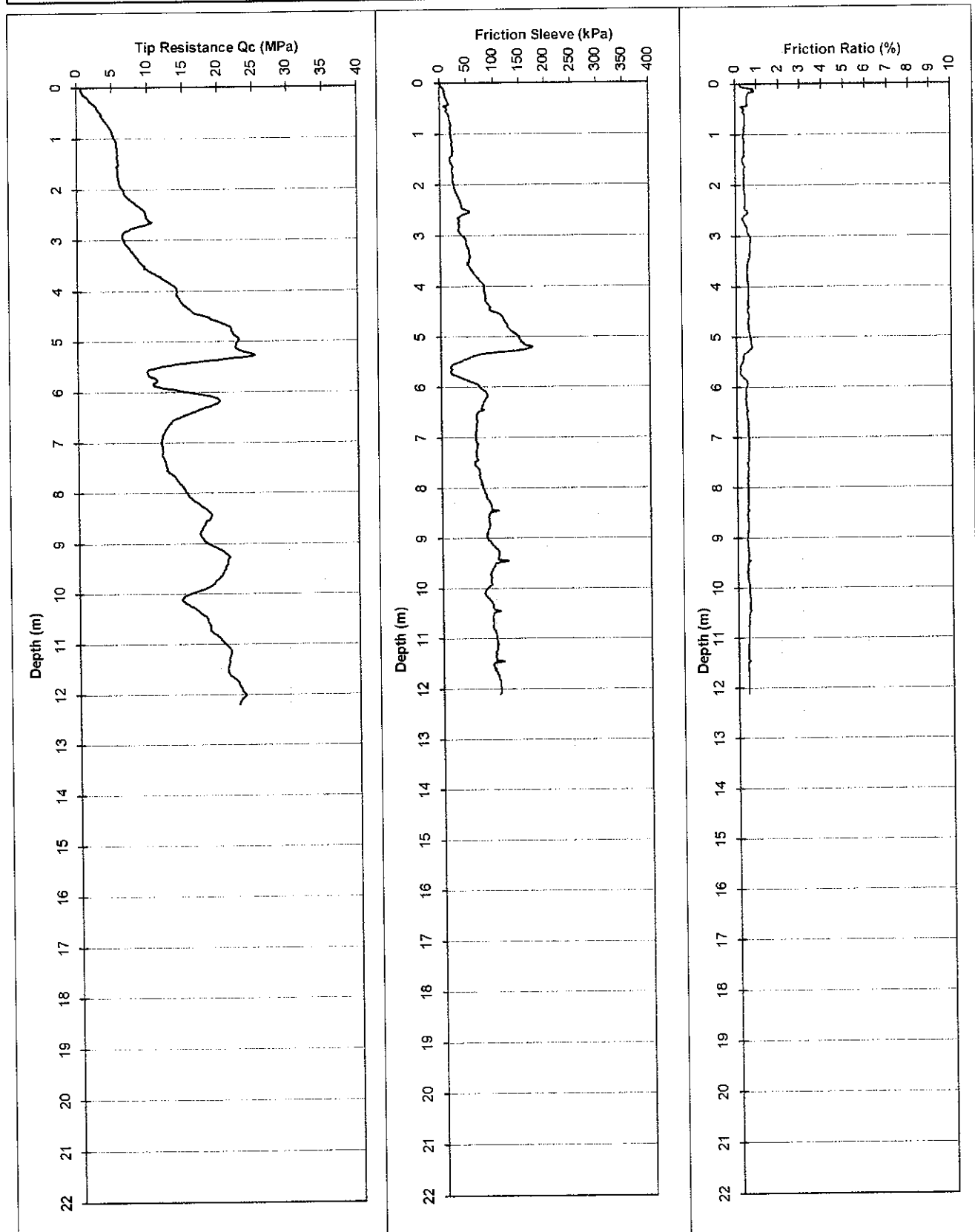
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 11 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 3.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7437TT.txt

Dummy probe to (m):

Cone I.D. : EC29

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

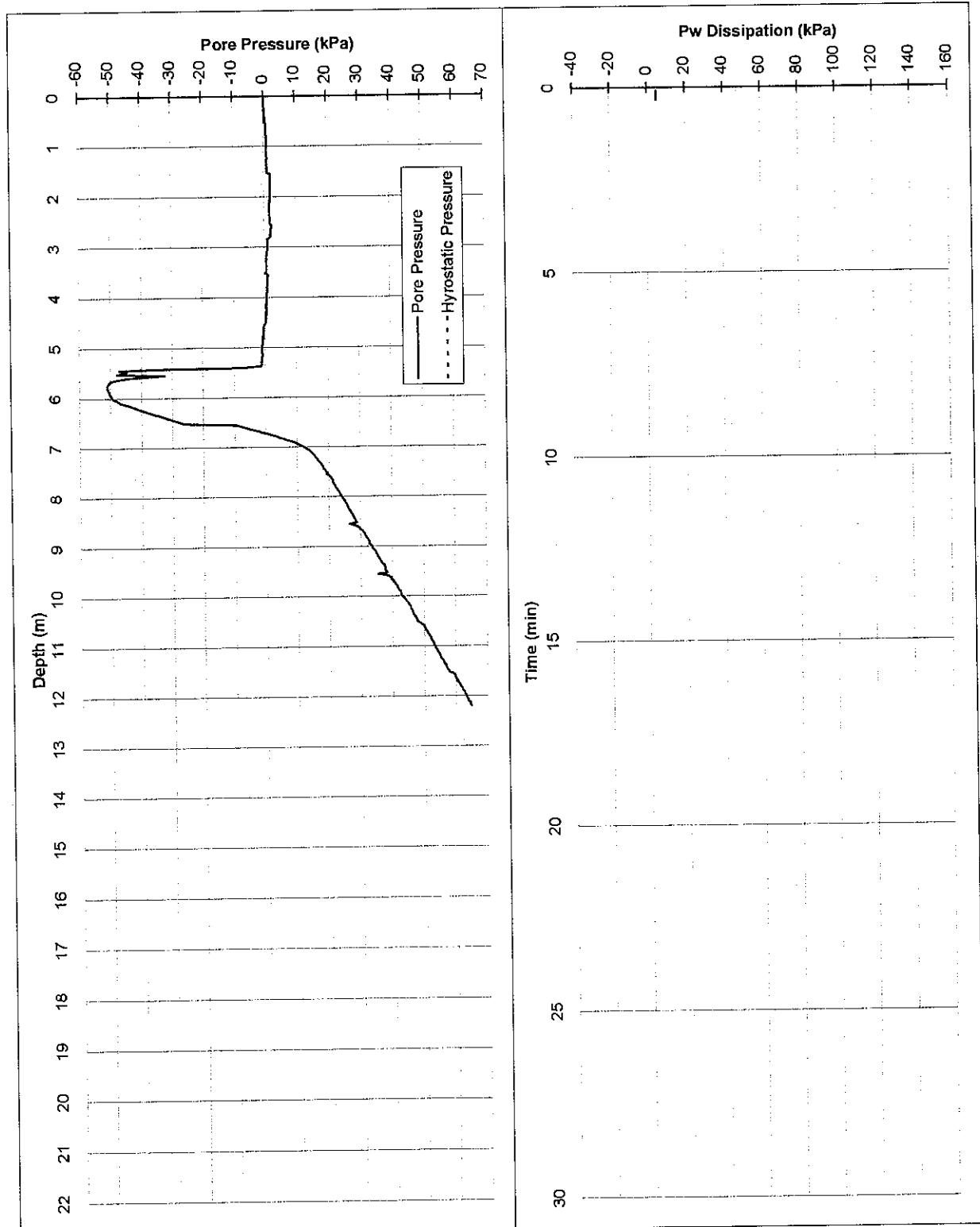
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 11 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

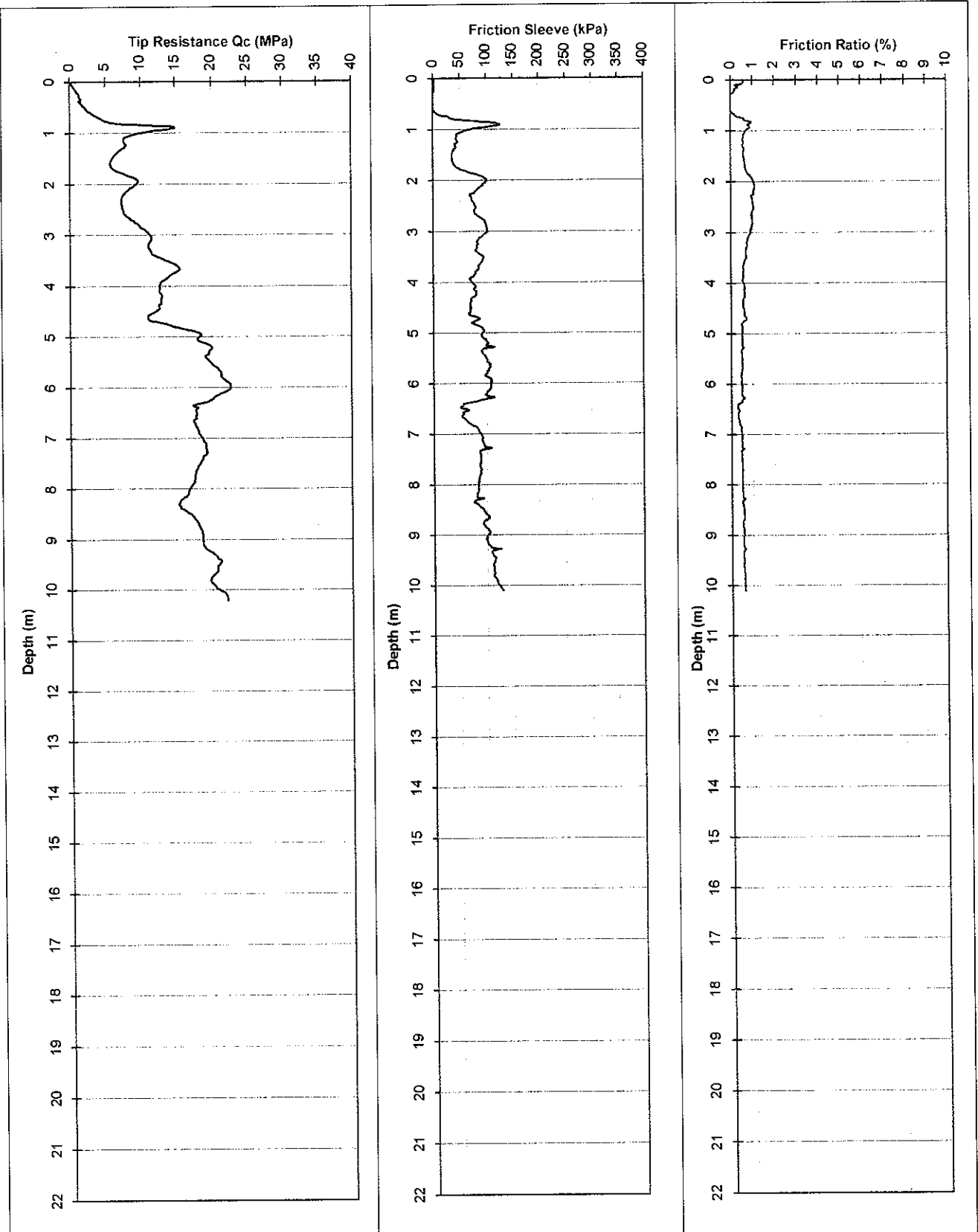
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 14 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): 3.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 18/06/07

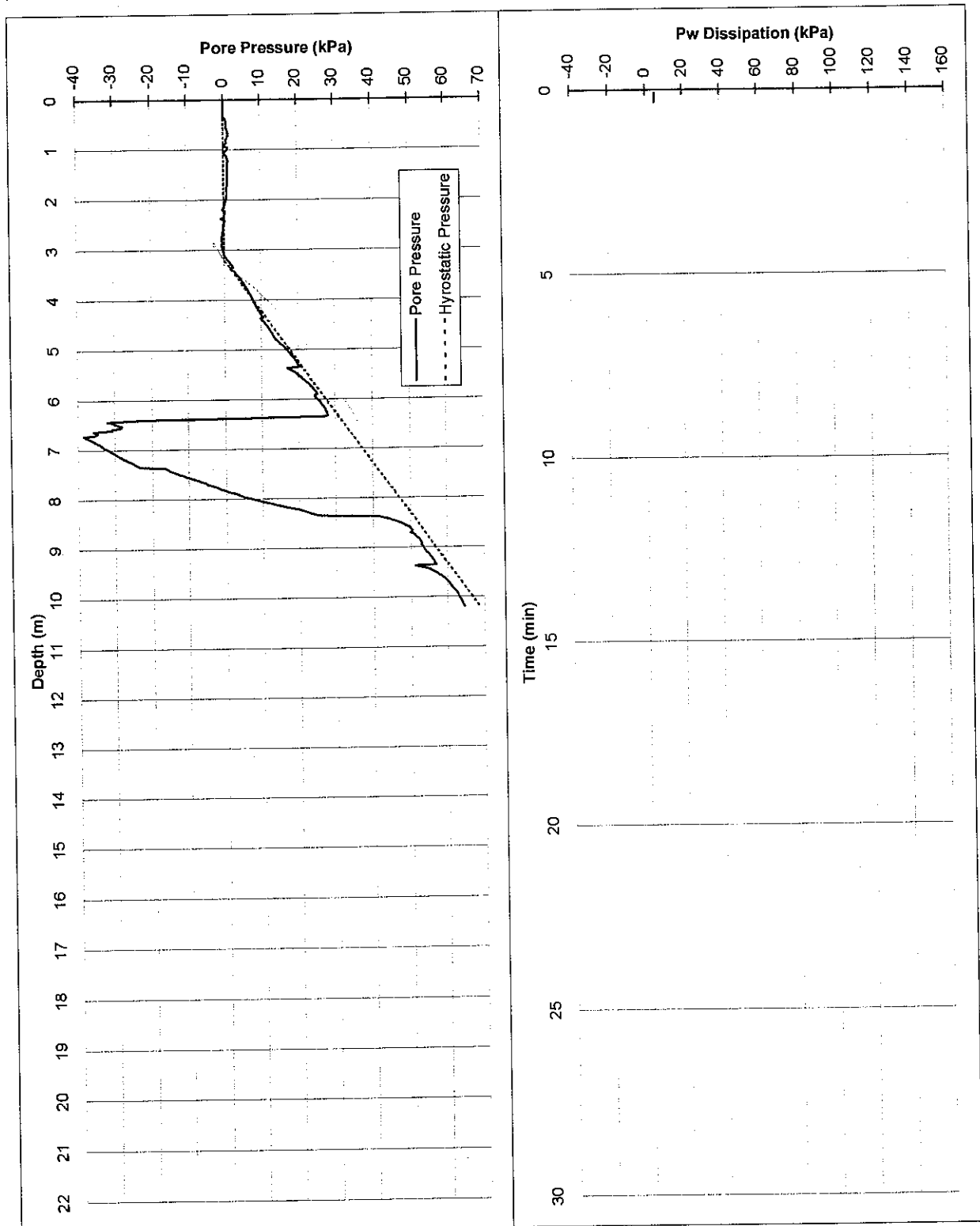
Project: Fiona Stanley Hospital

Probe No.: CPT 14 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

File: GH7407IT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

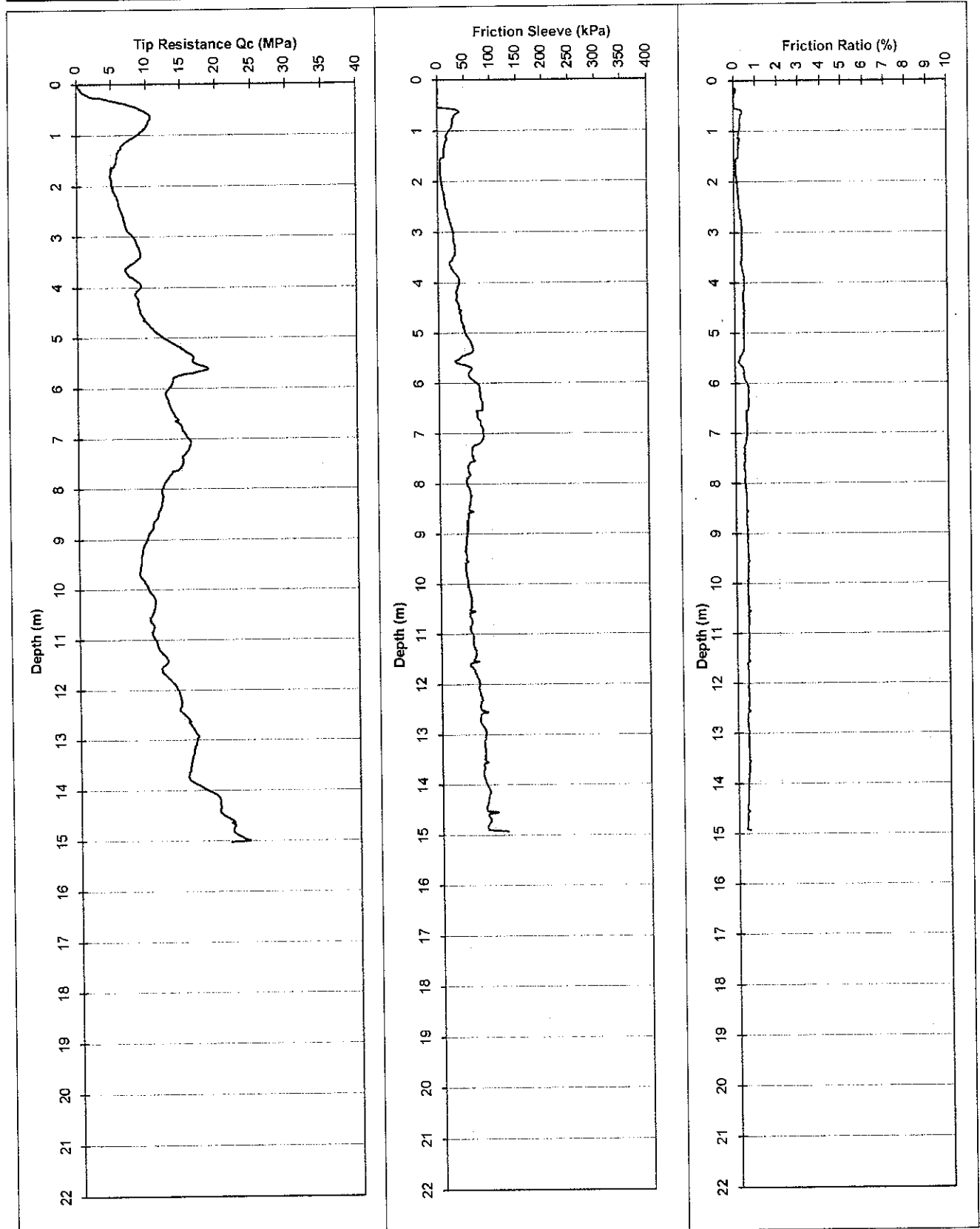
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 15 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 4.3

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7434TT.txt

Dummy probe to (m):

Cone I.D.: EC29

7 tonne track mounted CPT Rig

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

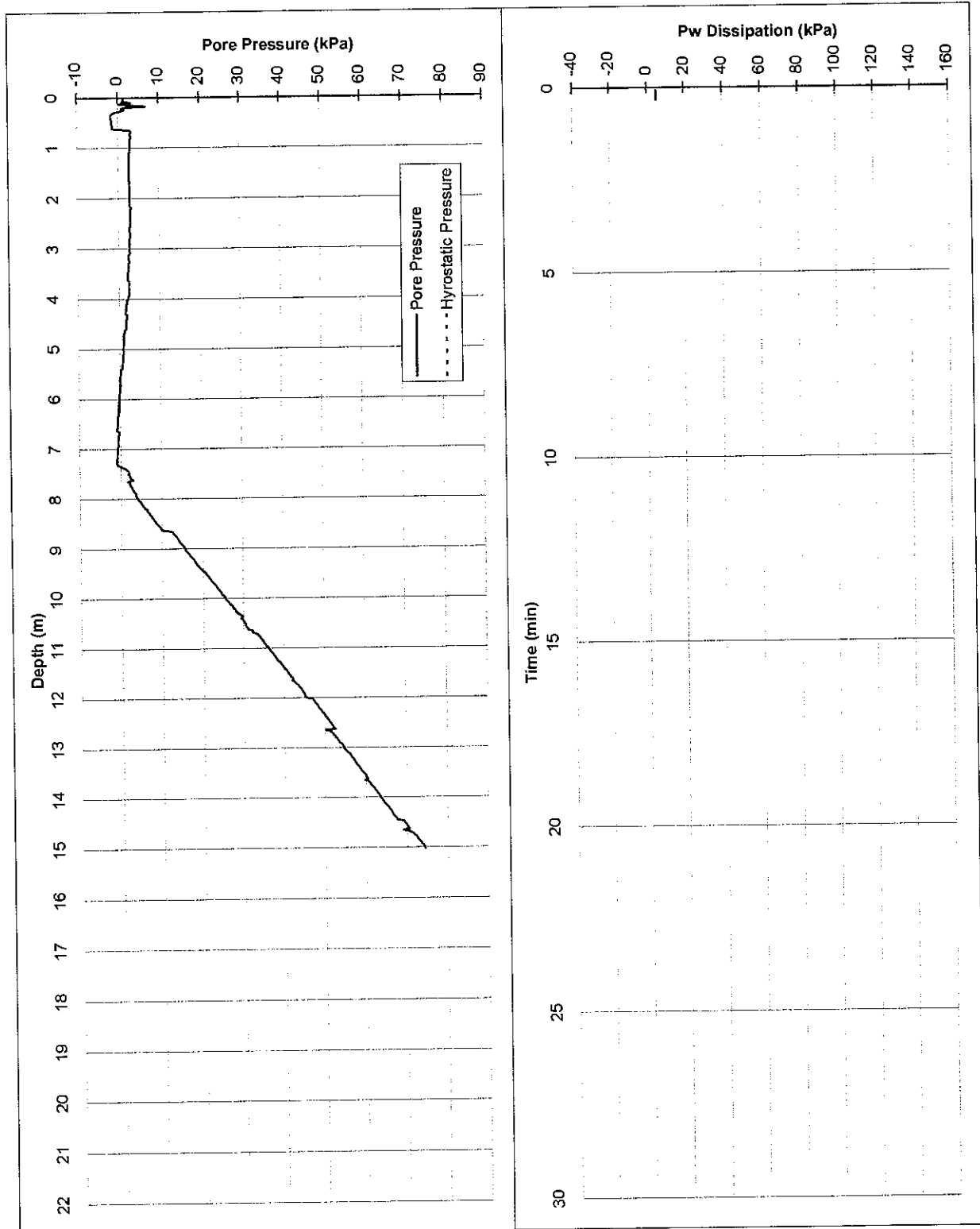
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 15 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

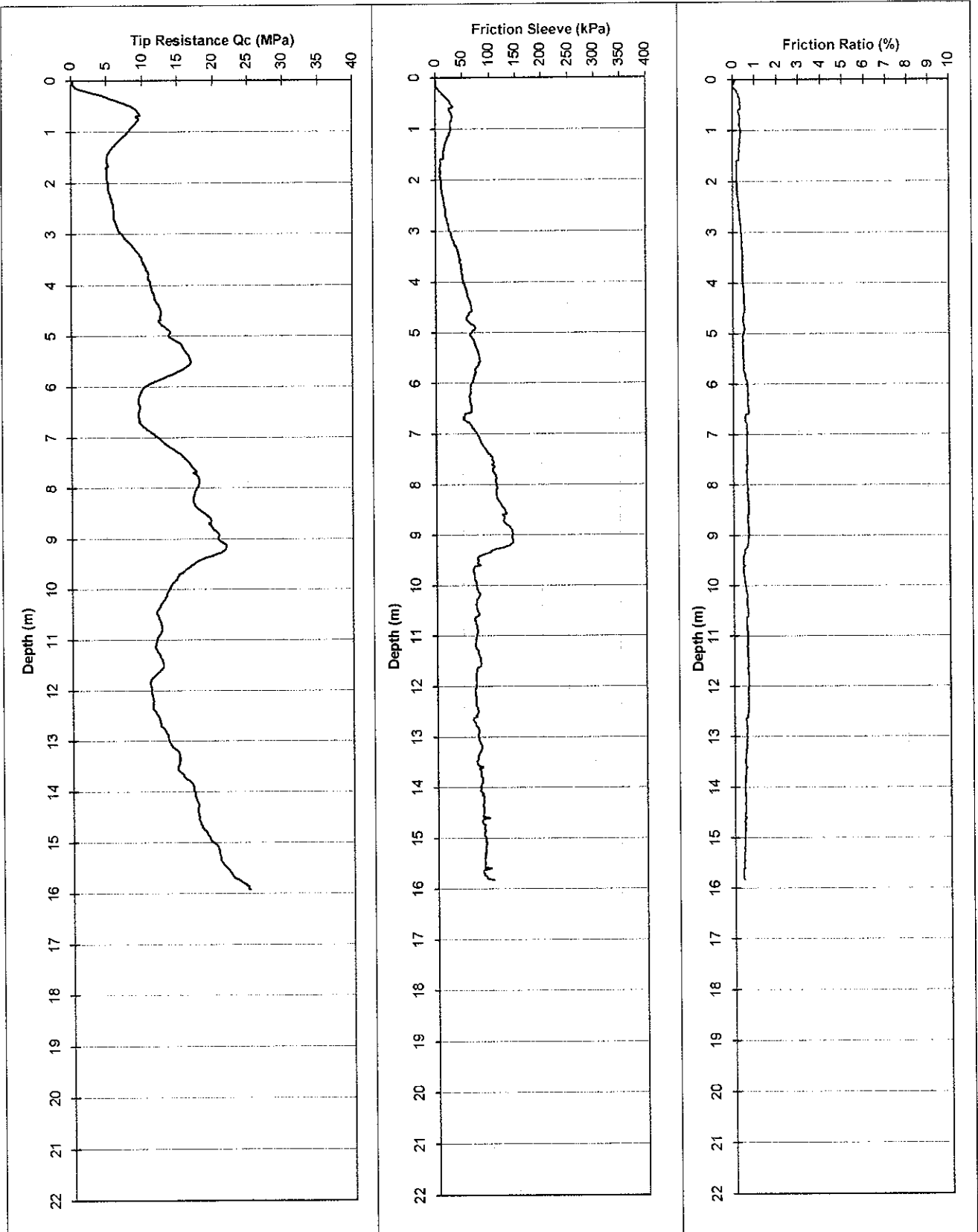
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 16 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 9.1

Refusal: 25MPa

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 21/06/07

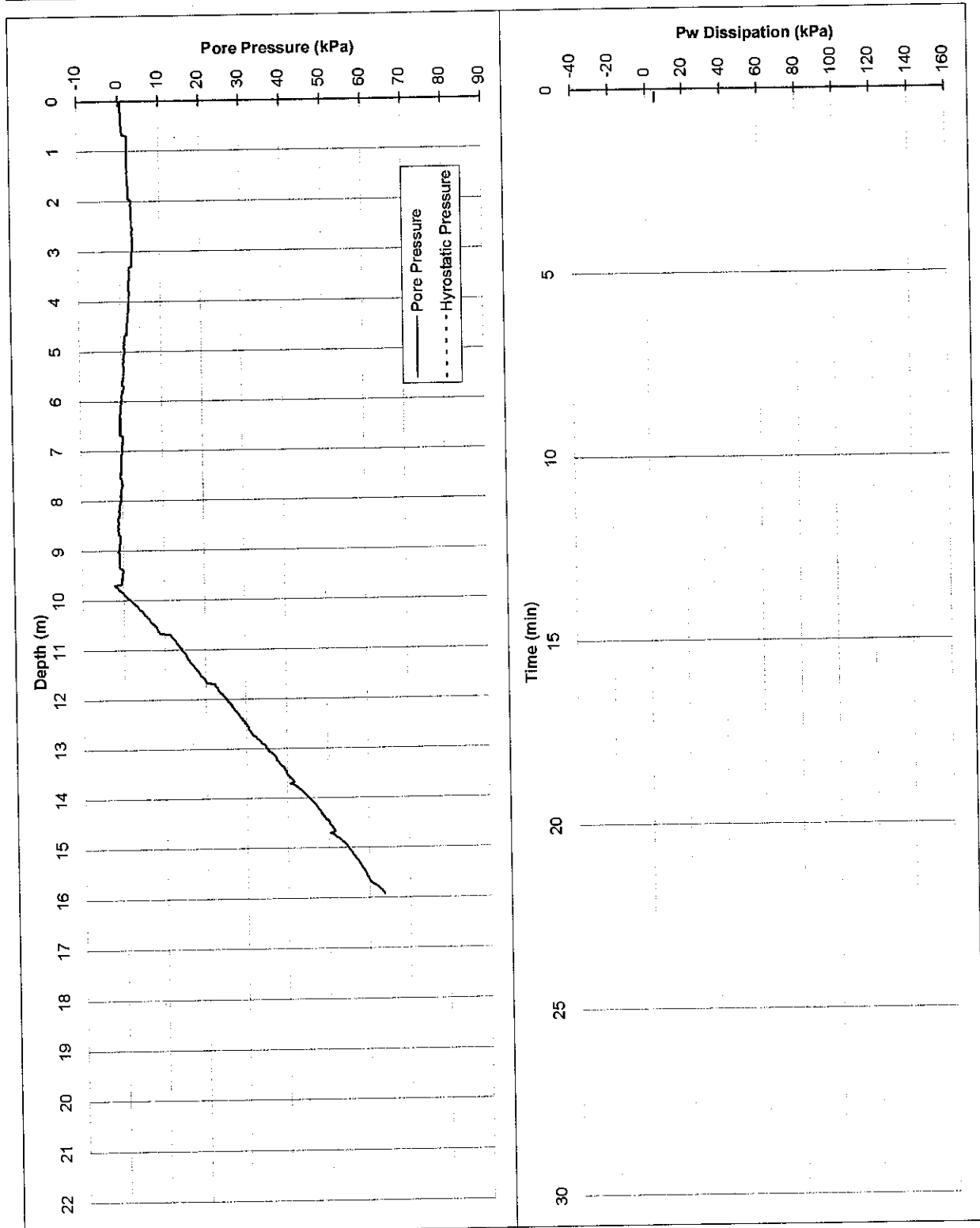
Project: Fiona Stanley Hospital

Probe No.: CPT 16 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 20/06/07

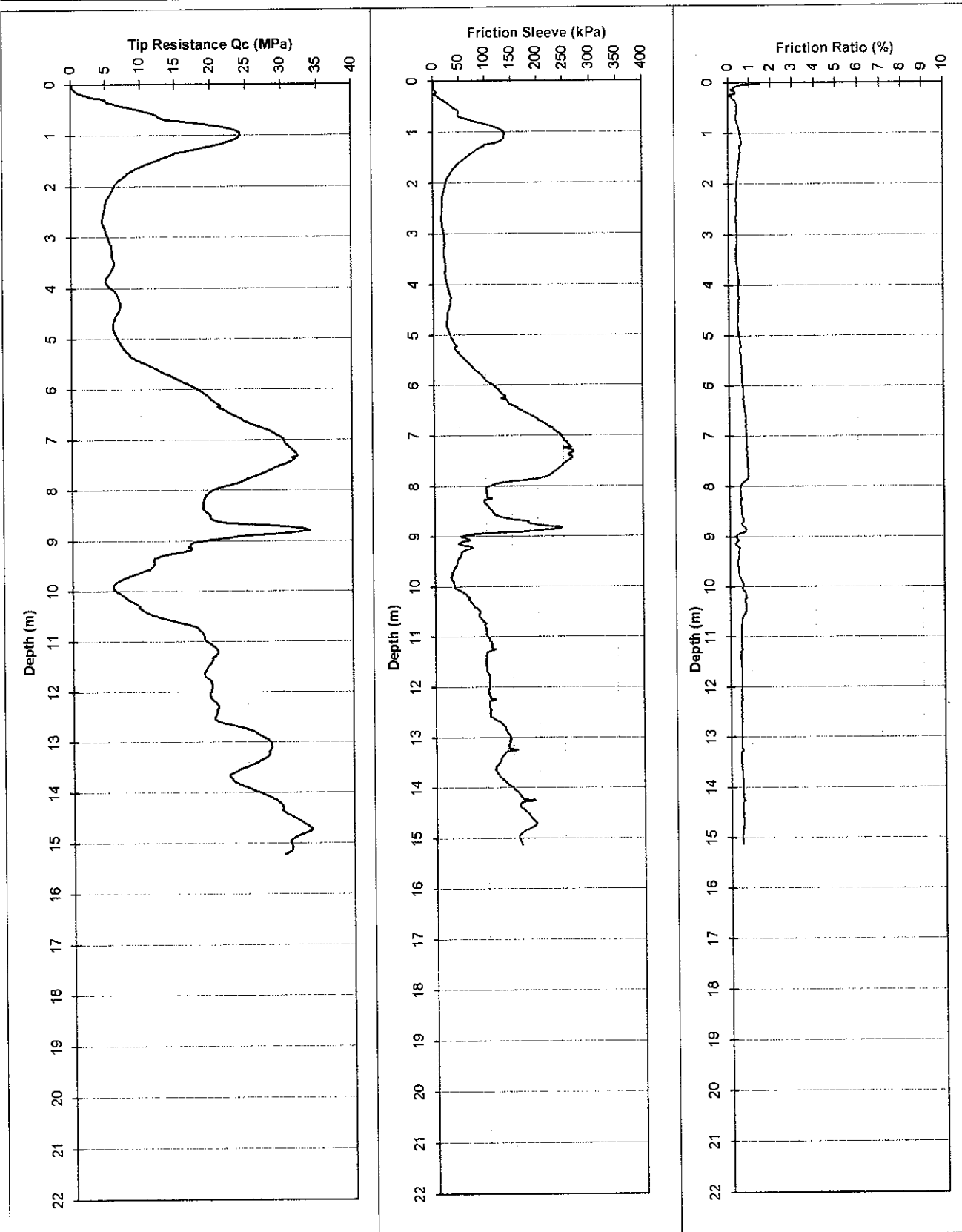
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 19 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 7.0

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

Refusal:

File: GH7427TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

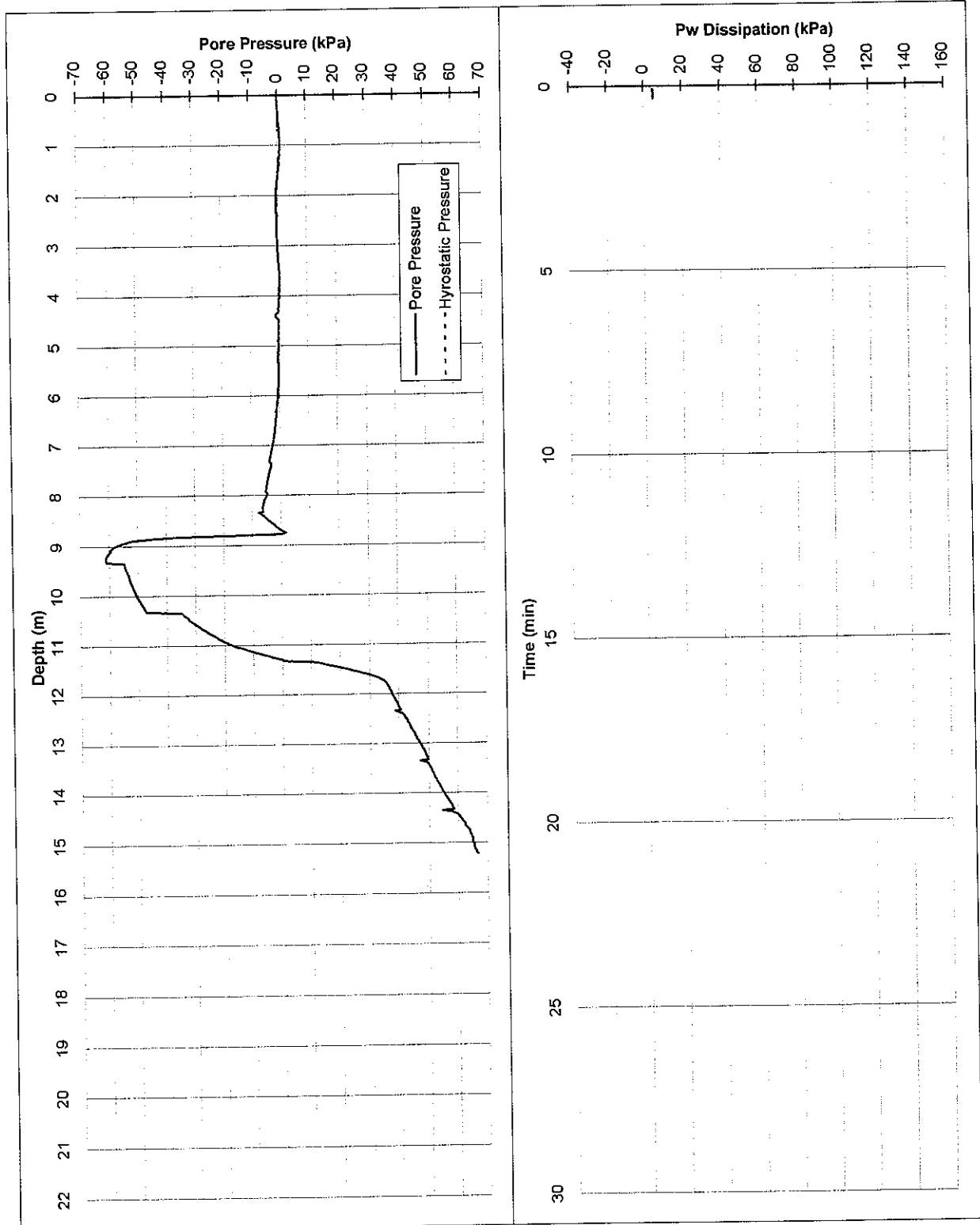
Project: Fiona Stanley Hospital

Probe No.: CPT 19 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

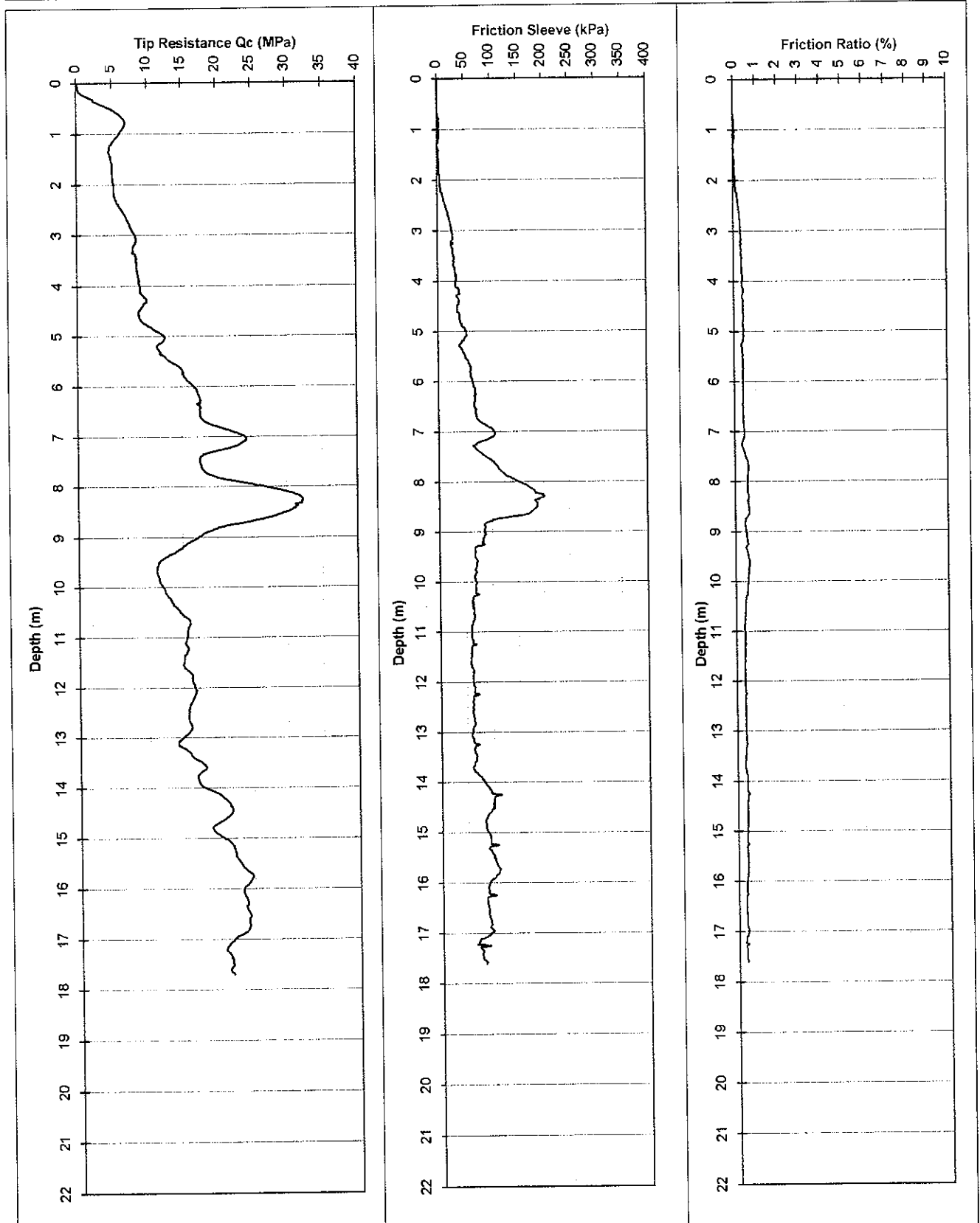
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 20 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 21/06/07

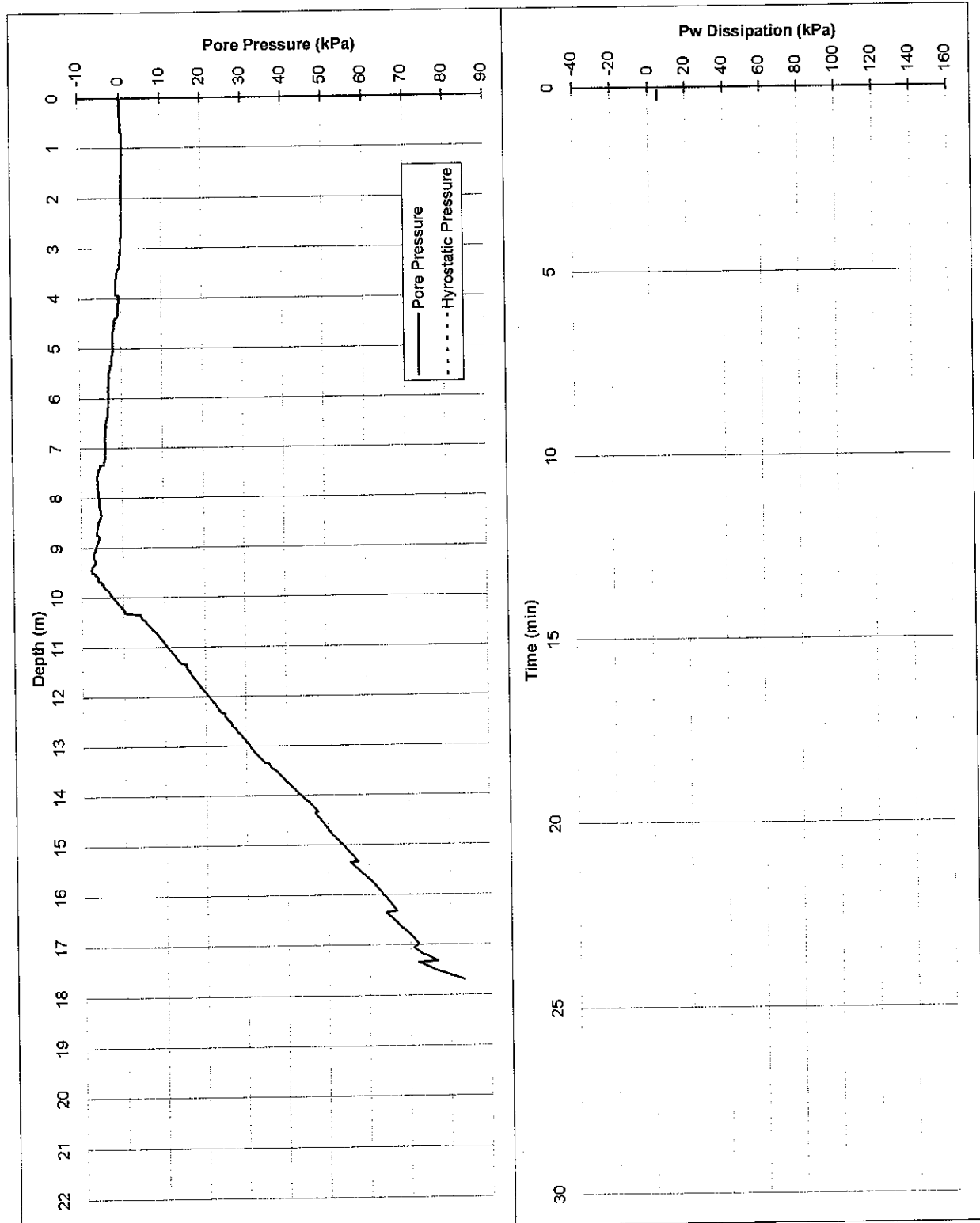
Project: Fiona Stanley Hospital

Probe No.: CPT 20 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

Date: 18/06/07

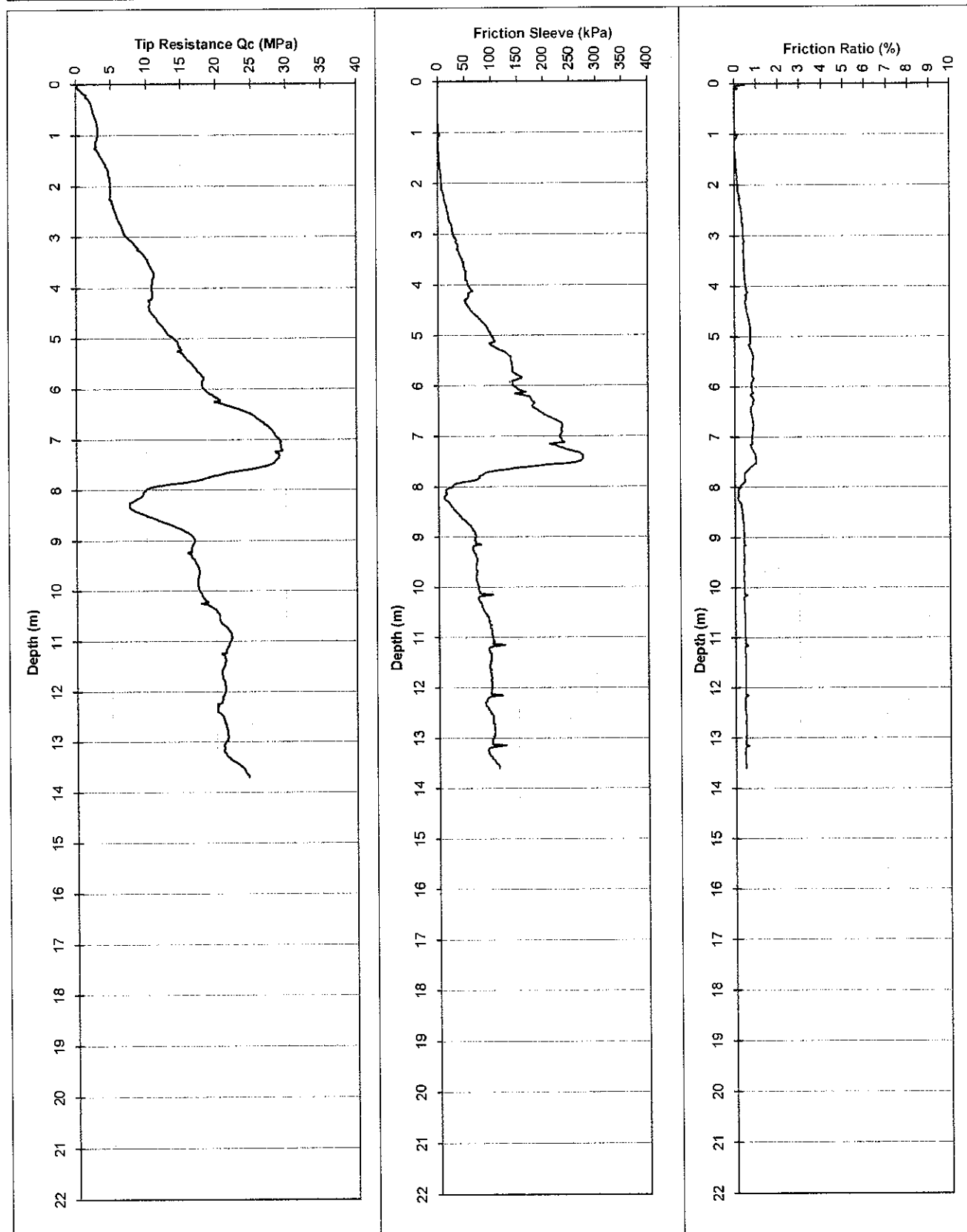
PROJECT: Fiona Stanley Hospital

Probe No.: CPT 21 U

LOCATION: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

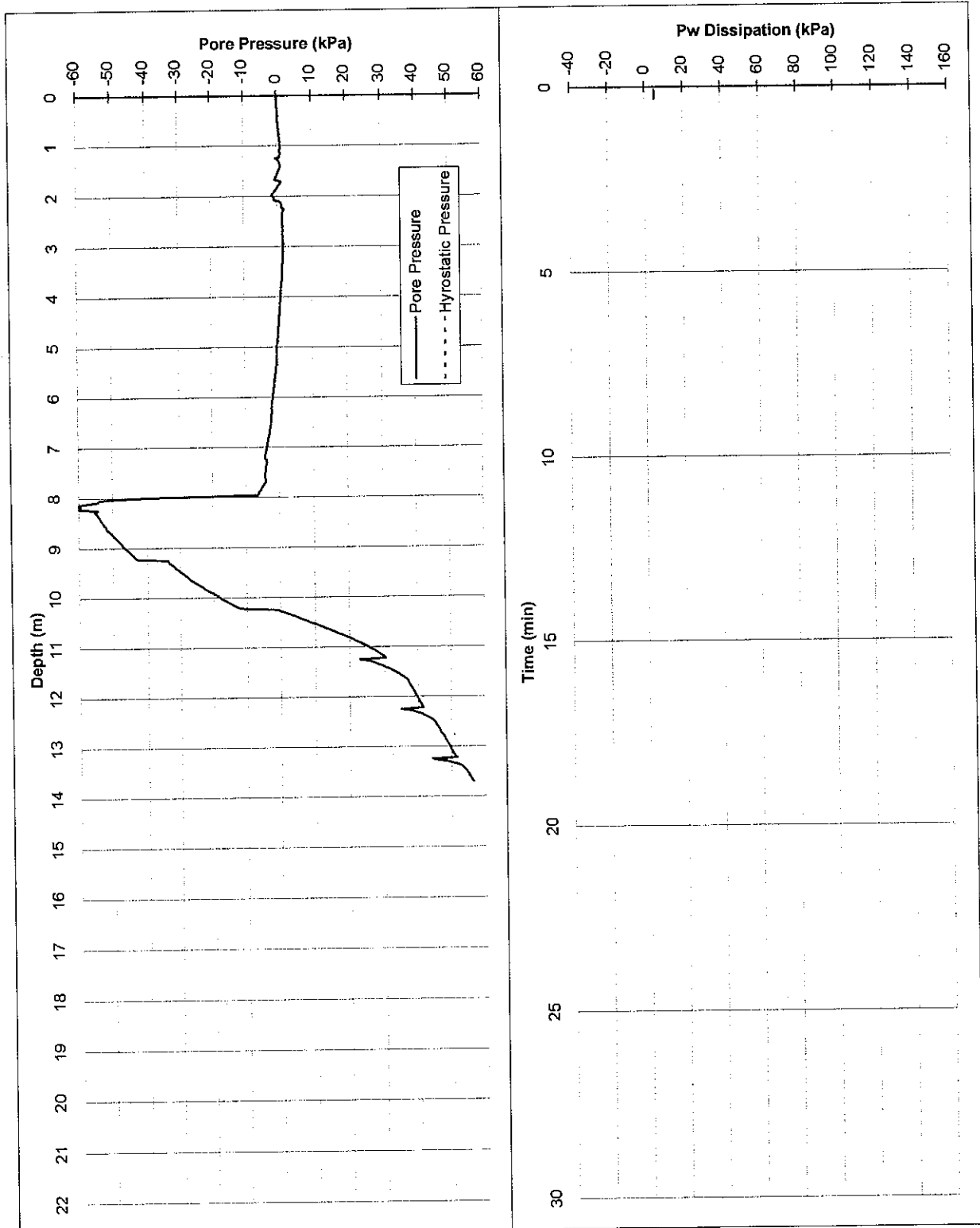
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 21 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

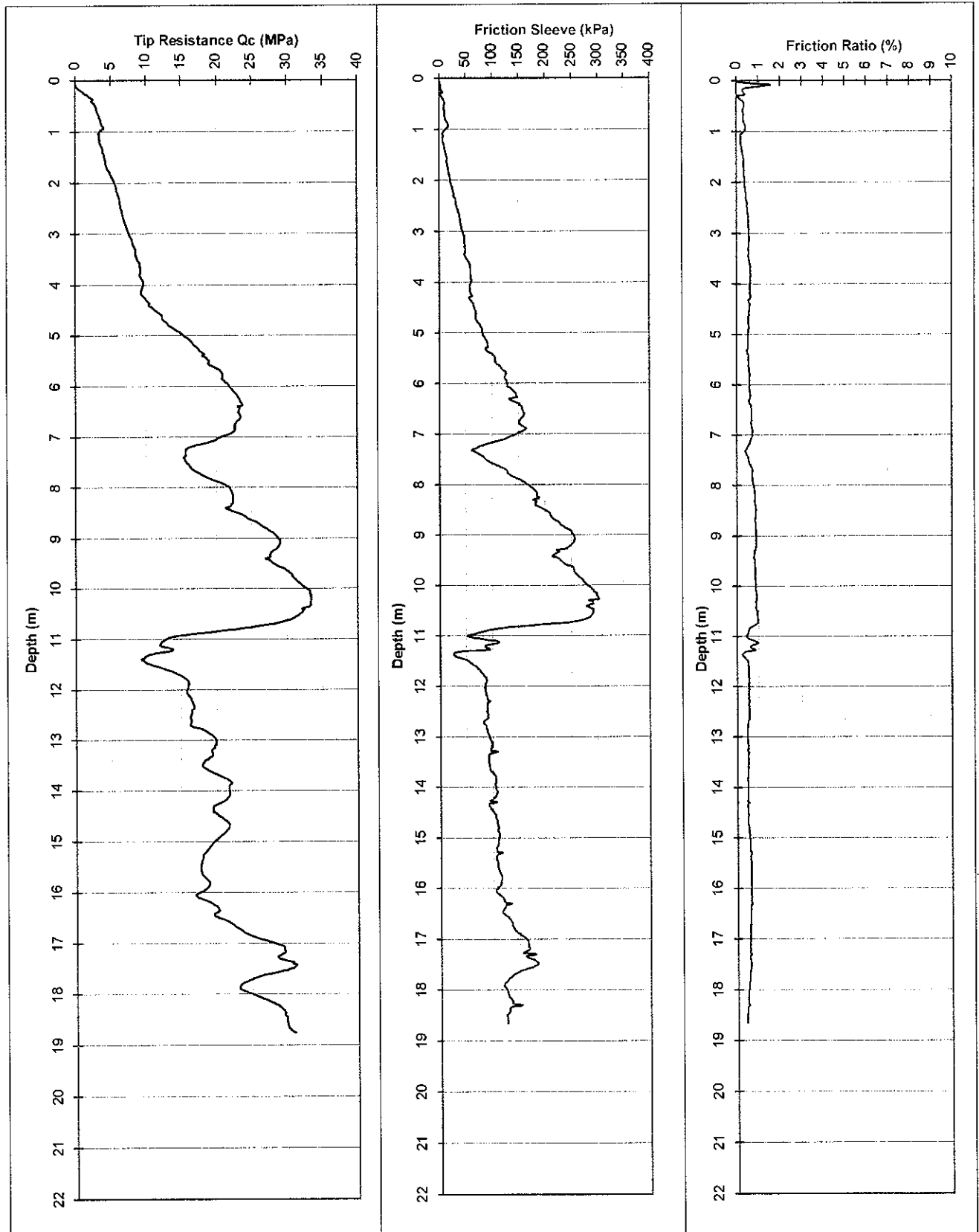
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 22 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 9.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

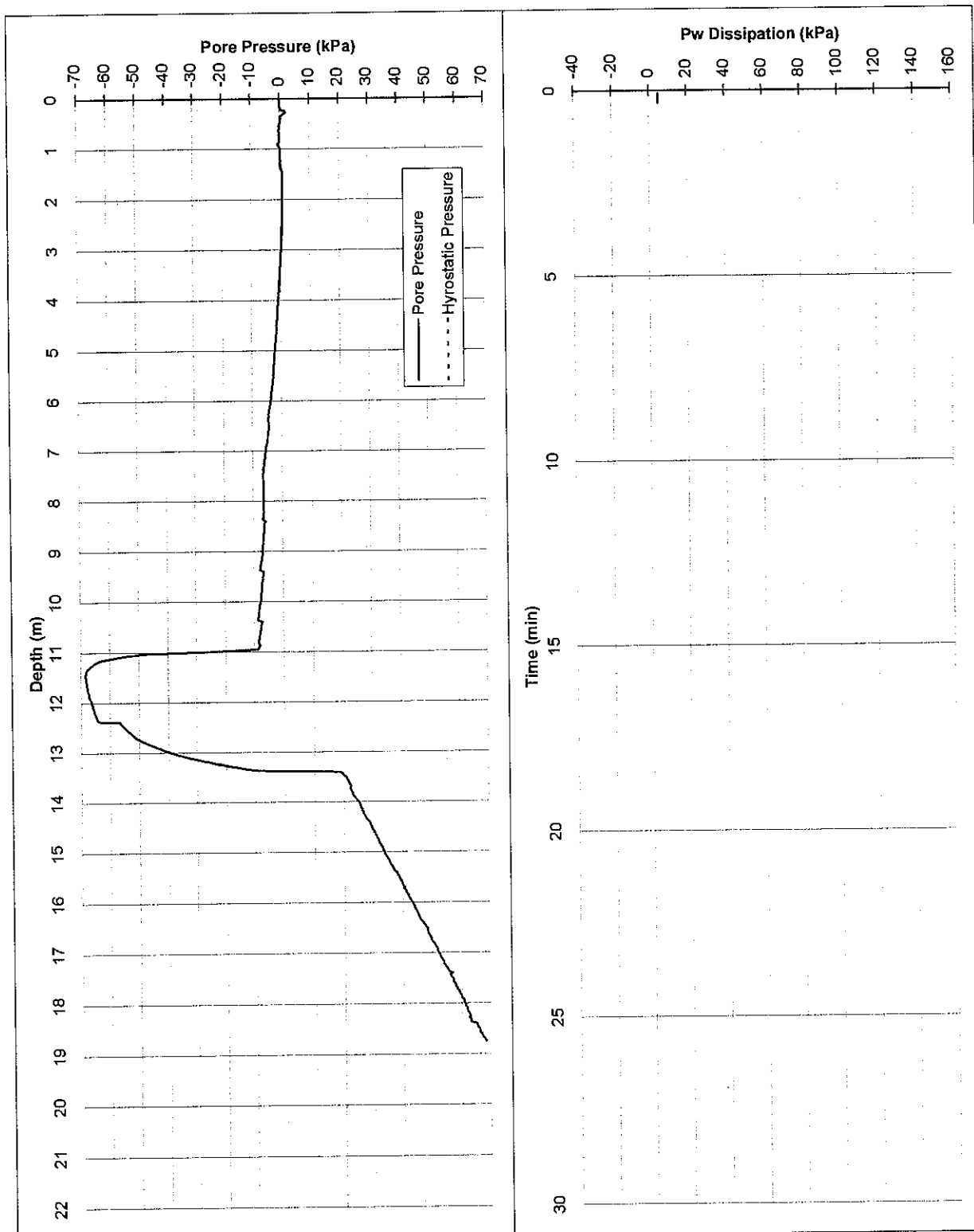
Project: Fiona Stanley Hospital

Probe No.: CPT 22 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

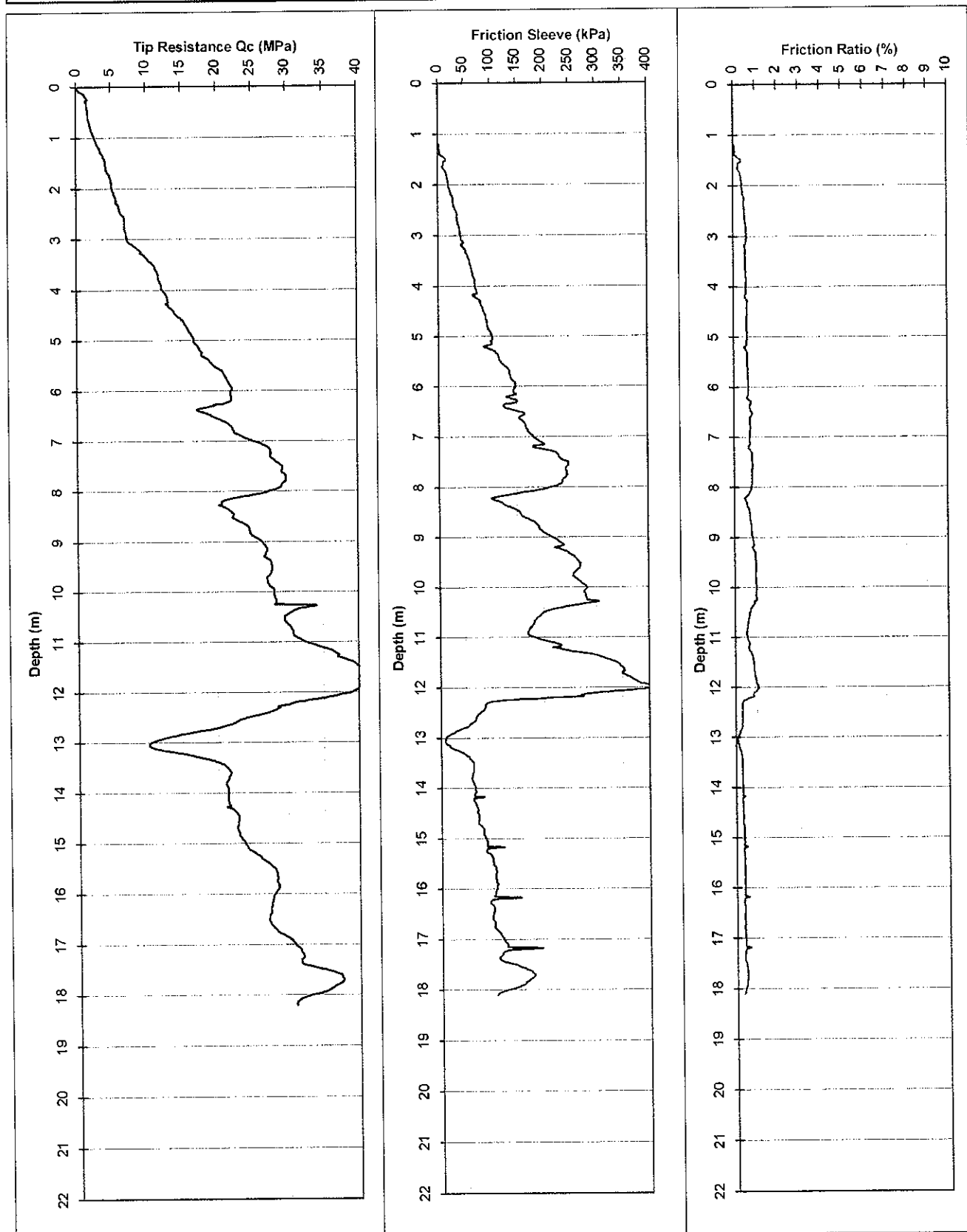
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 23 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 5.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 18/06/07

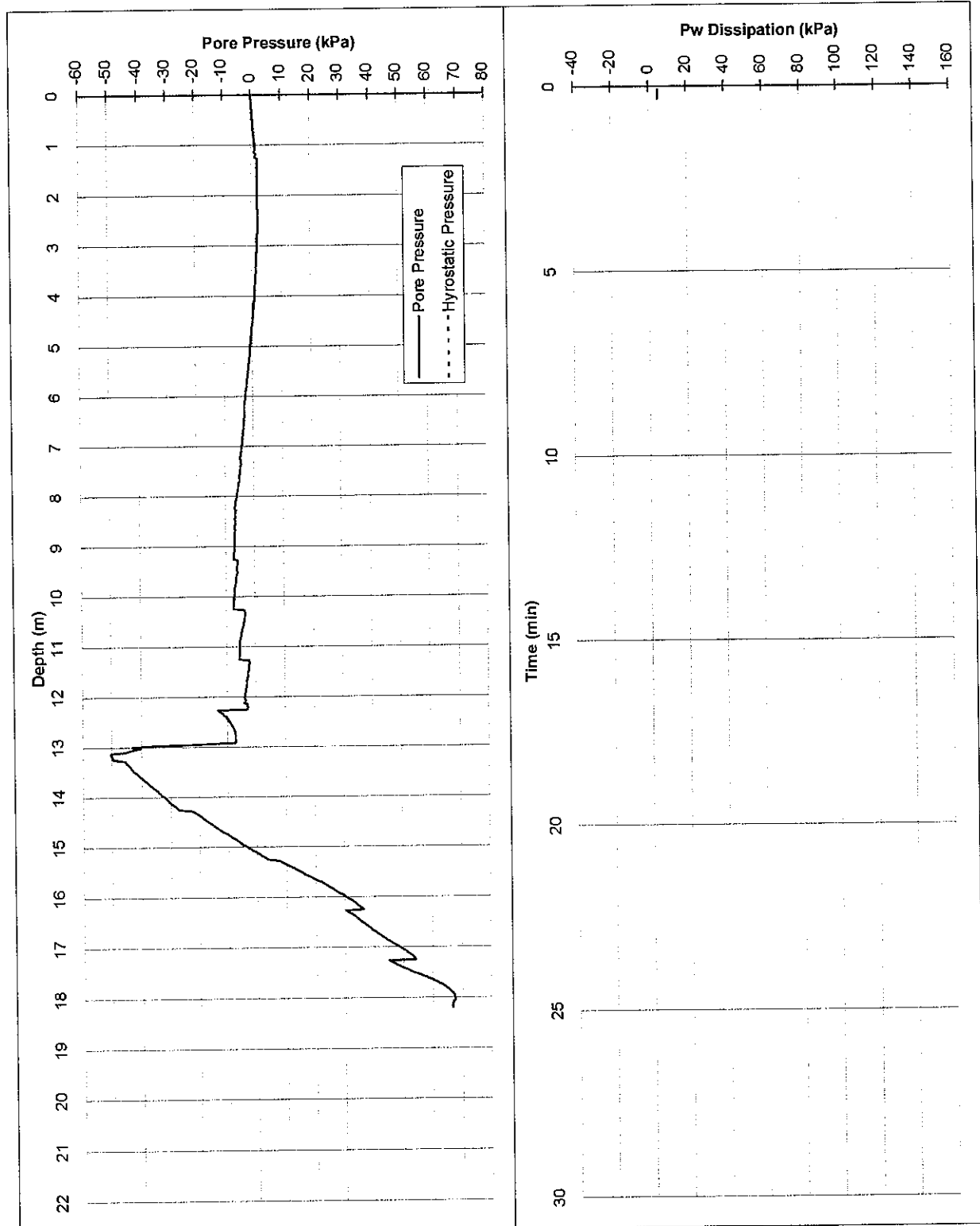
Project: Fiona Stanley Hospital

Probe No.: CPT 23 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

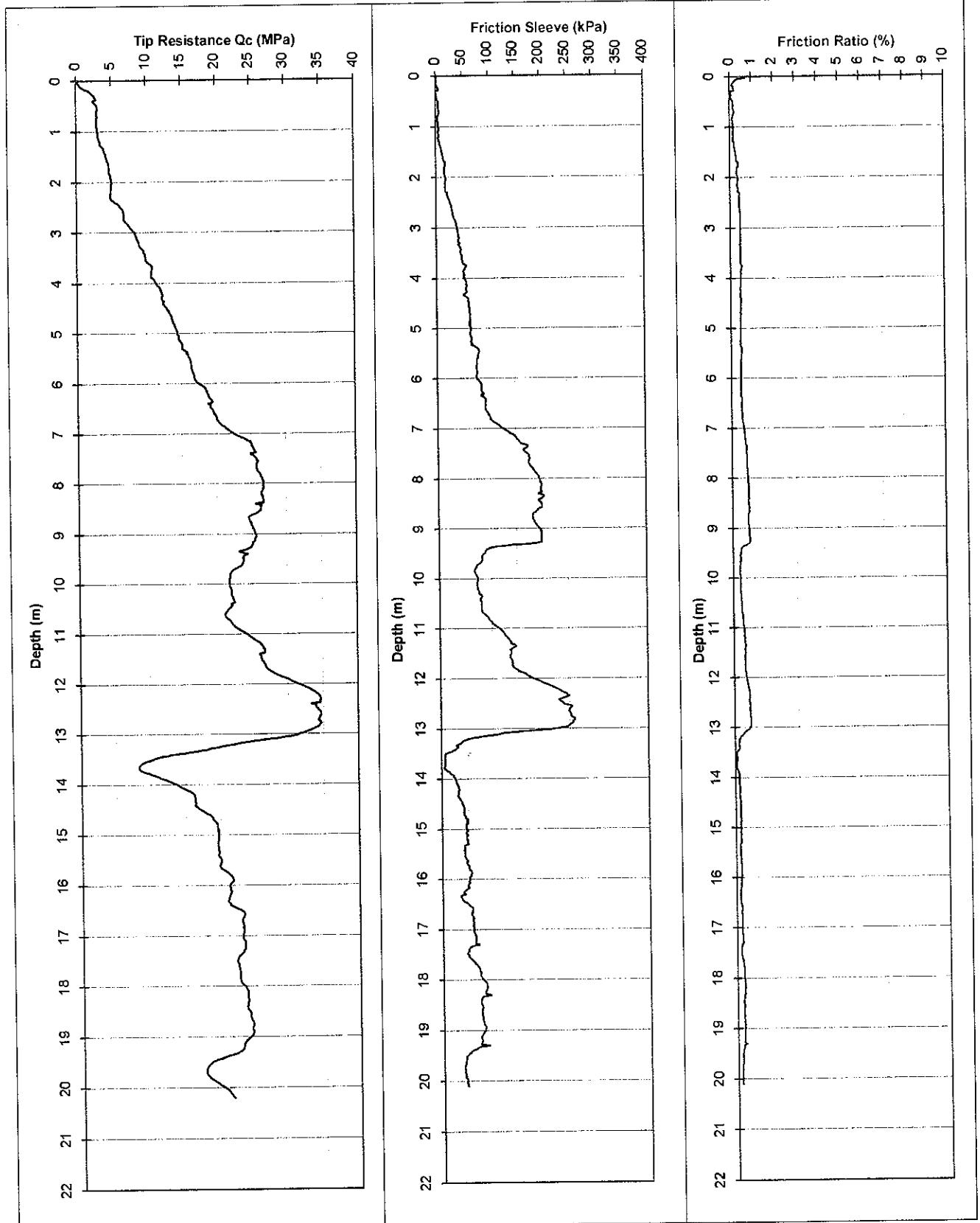
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 24 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 9.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

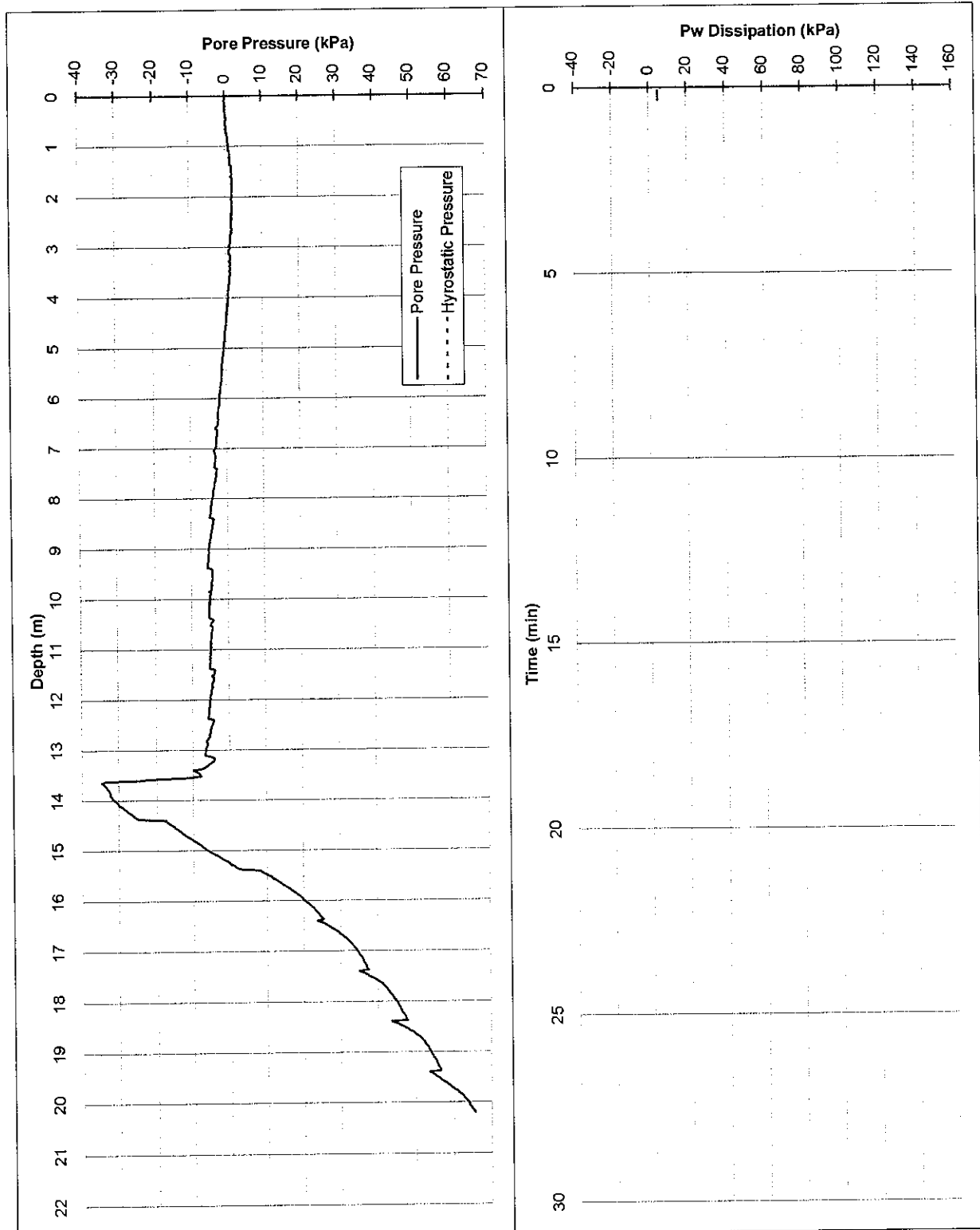
Project: Fiona Stanley Hospital

Probe No.: CPT 24 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

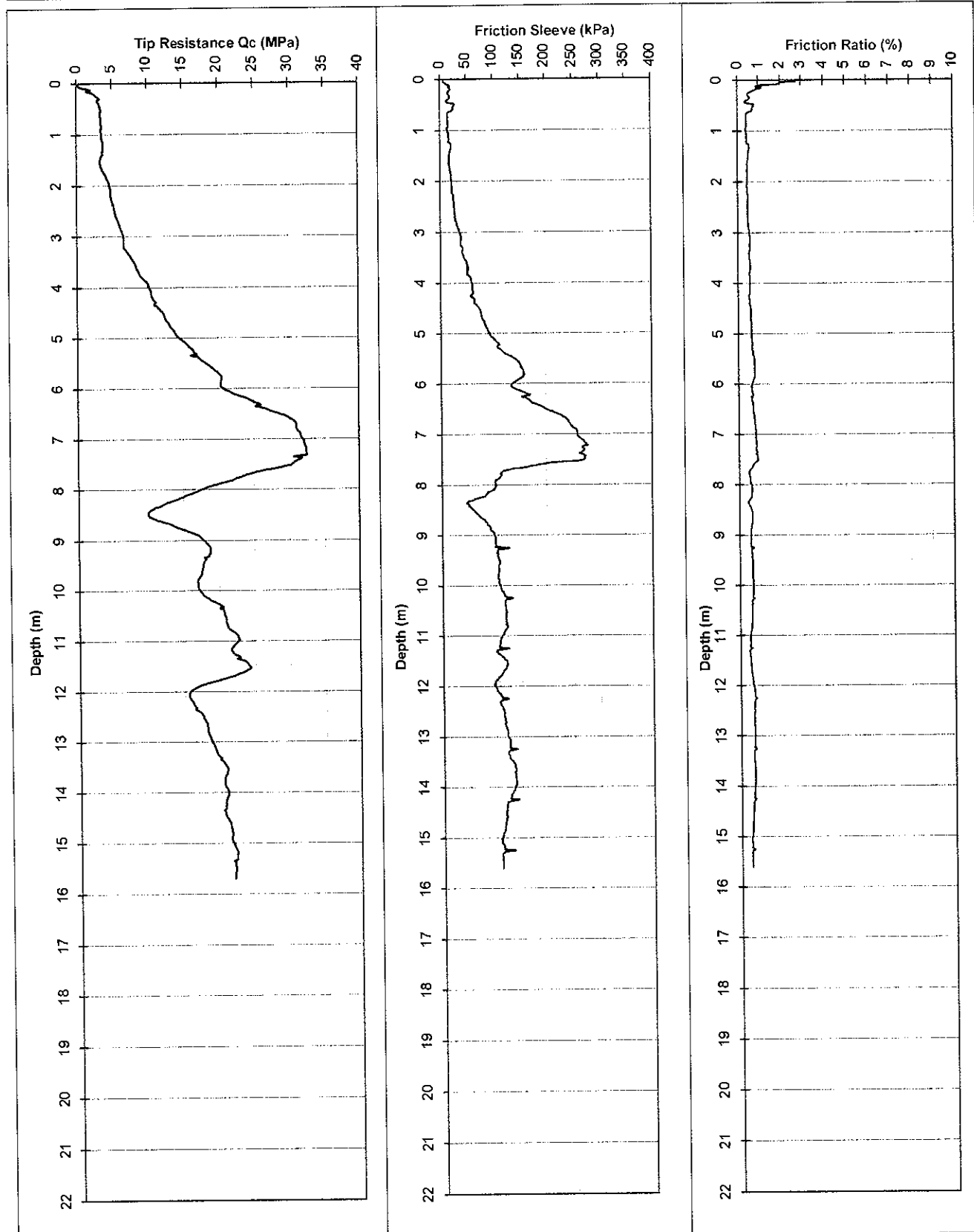
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 25 U

Job Number: 61/19514/01

Co-ordinates:



Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 10.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

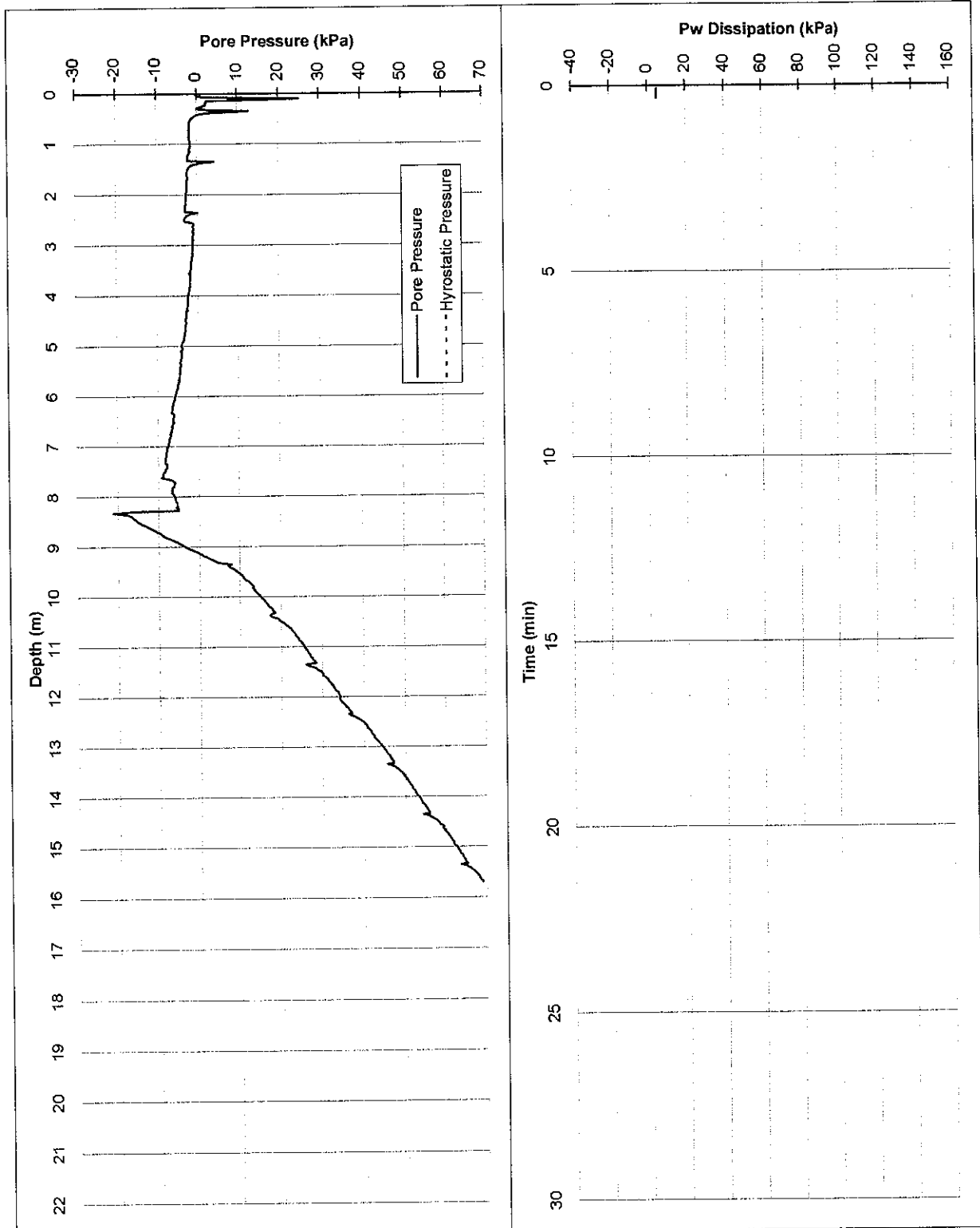
Project: Fiona Stanley Hospital

Probe No.: CPT 25 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

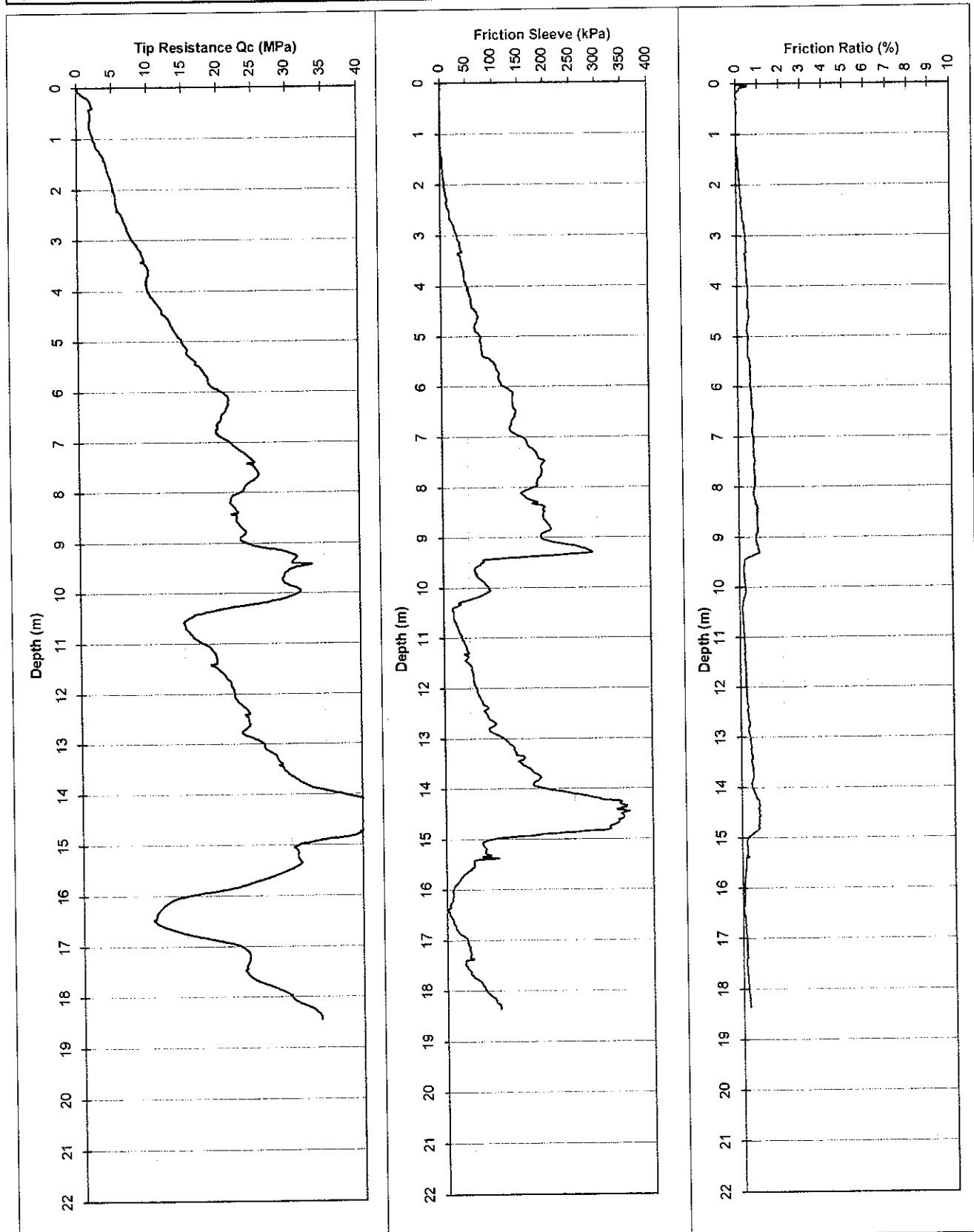
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 26 U

Job Number: 61/19514/01

Co-ordinates:



Pl: 9314 6611 Fax: 9314 6699

Water (m): -

Refusal: 40MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999
and IRT 2001 for friction reducer

File: GH7411TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

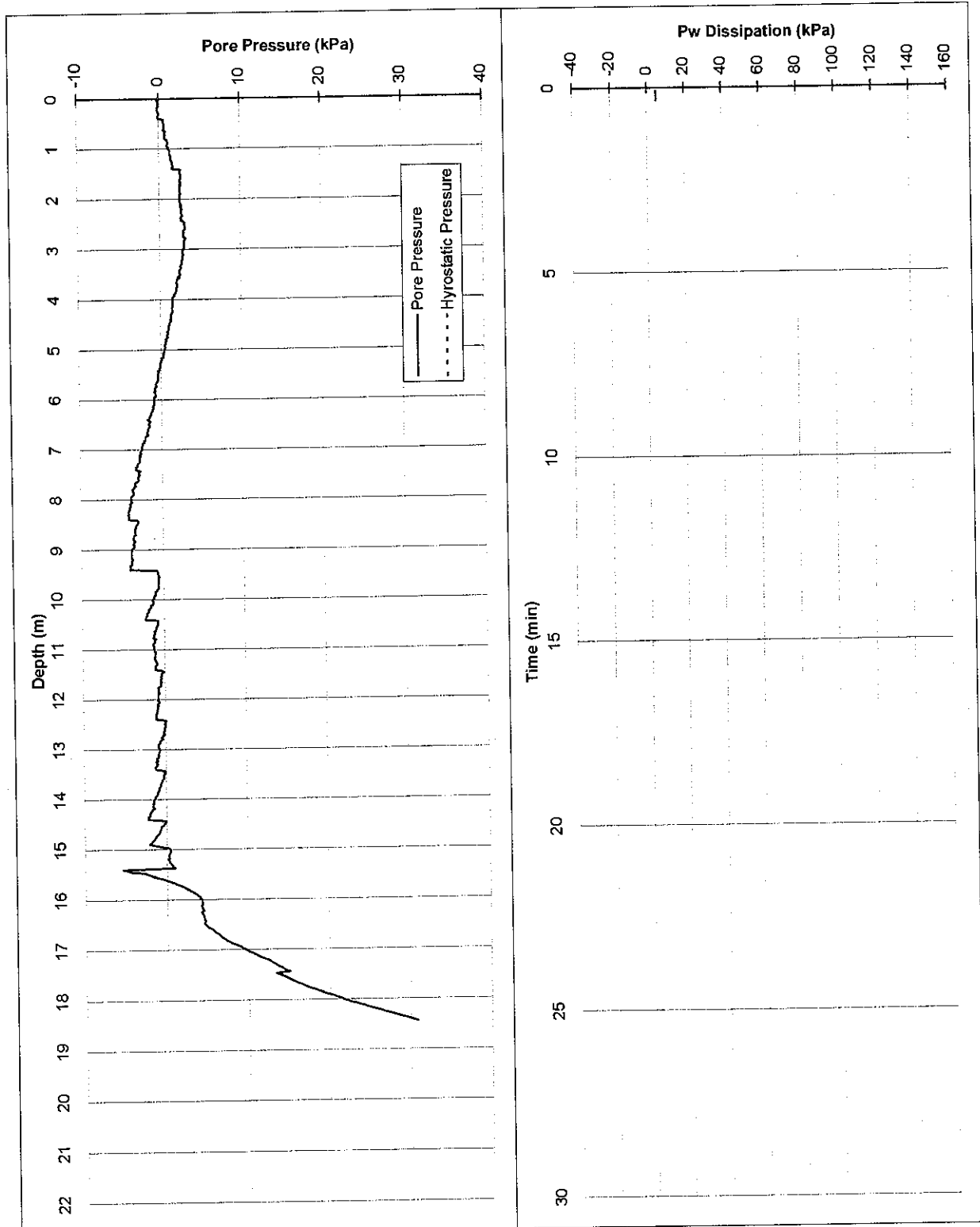
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 26 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

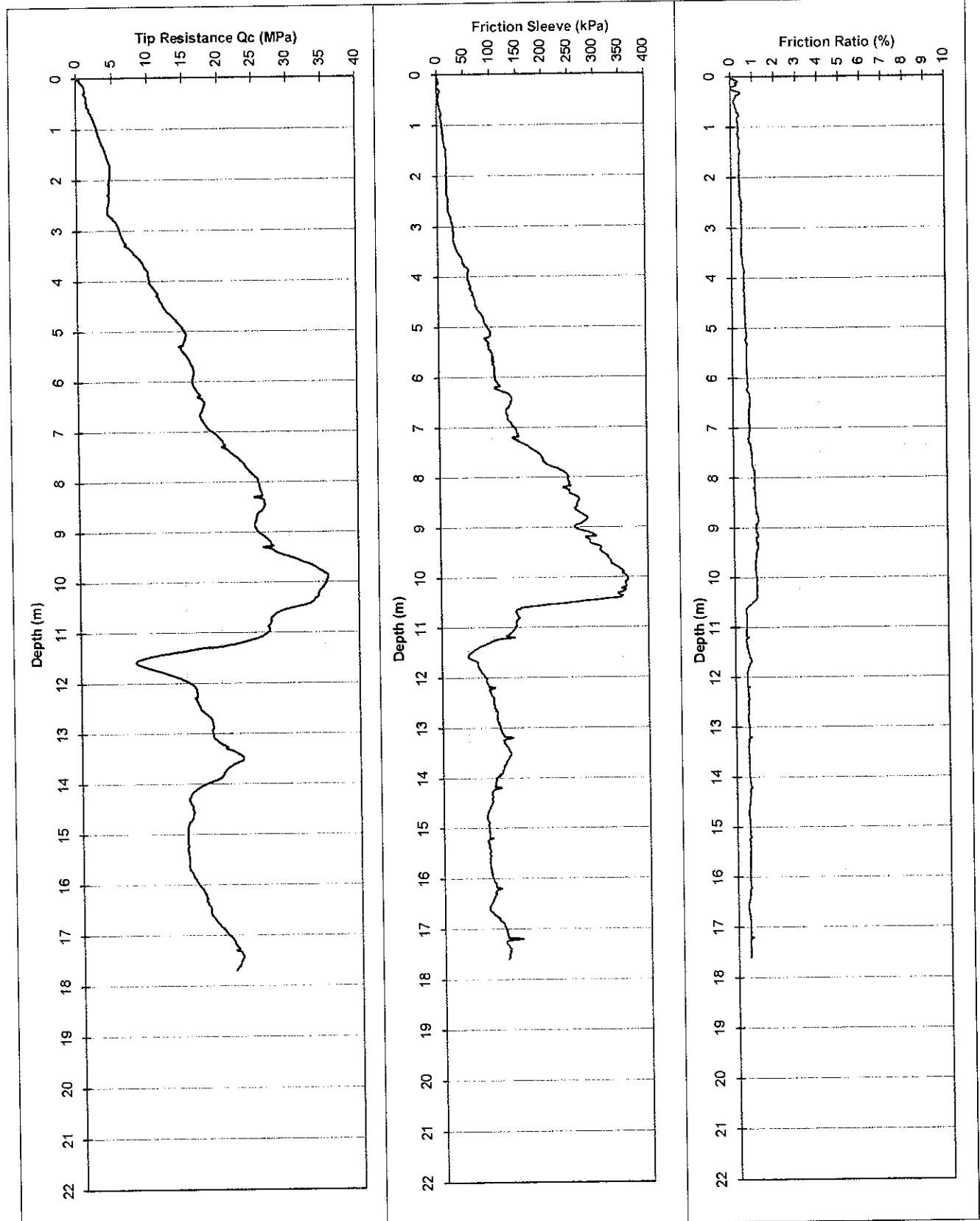
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 27 U

Job Number: 61/19514/01

Co-ordinates:



Ph. 9314 6611 Fax 9314 6699

Water (m): Dry to 10.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

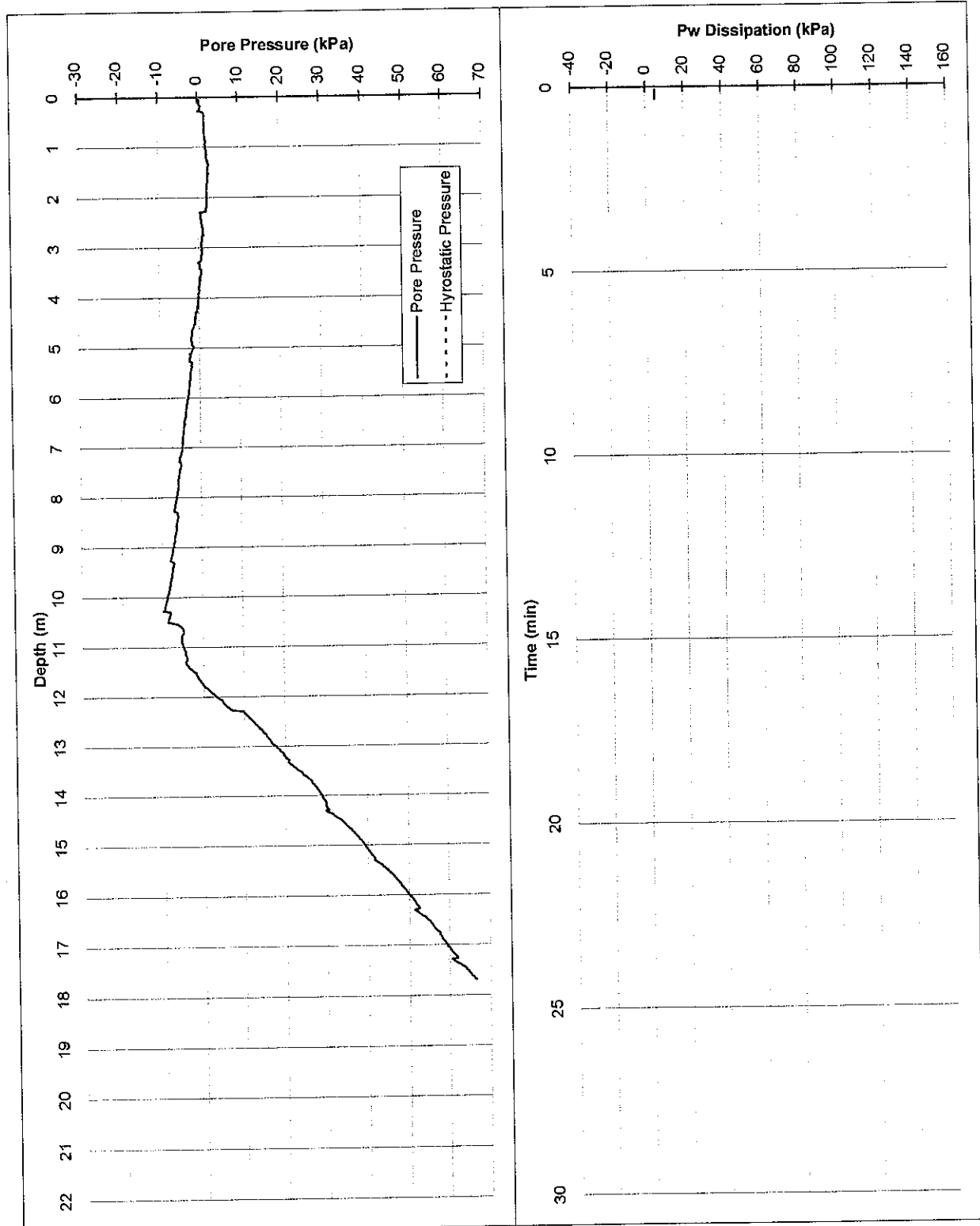
Project: Fiona Stanley Hospital

Probe No.: CPT 27 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

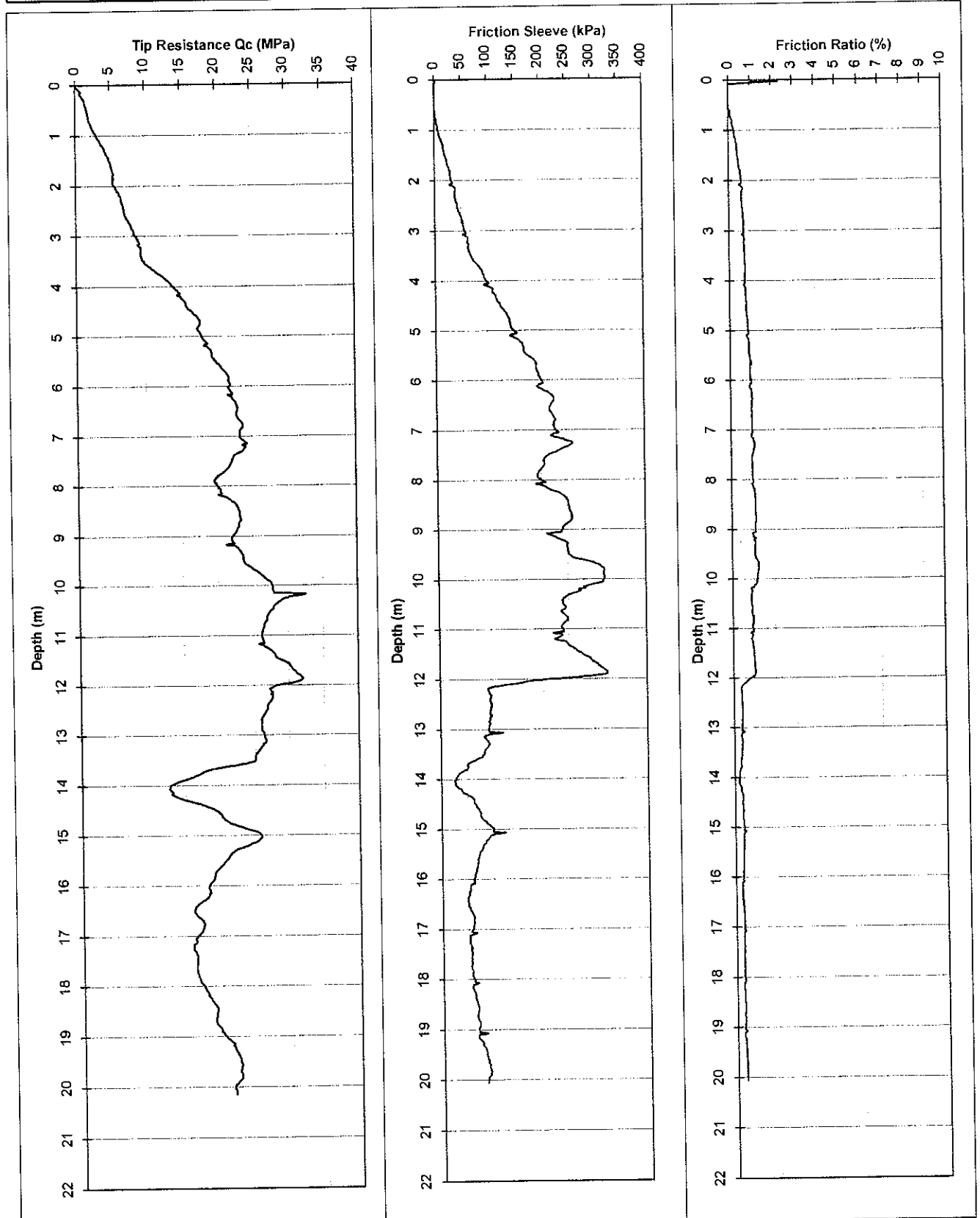
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 28 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 10.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

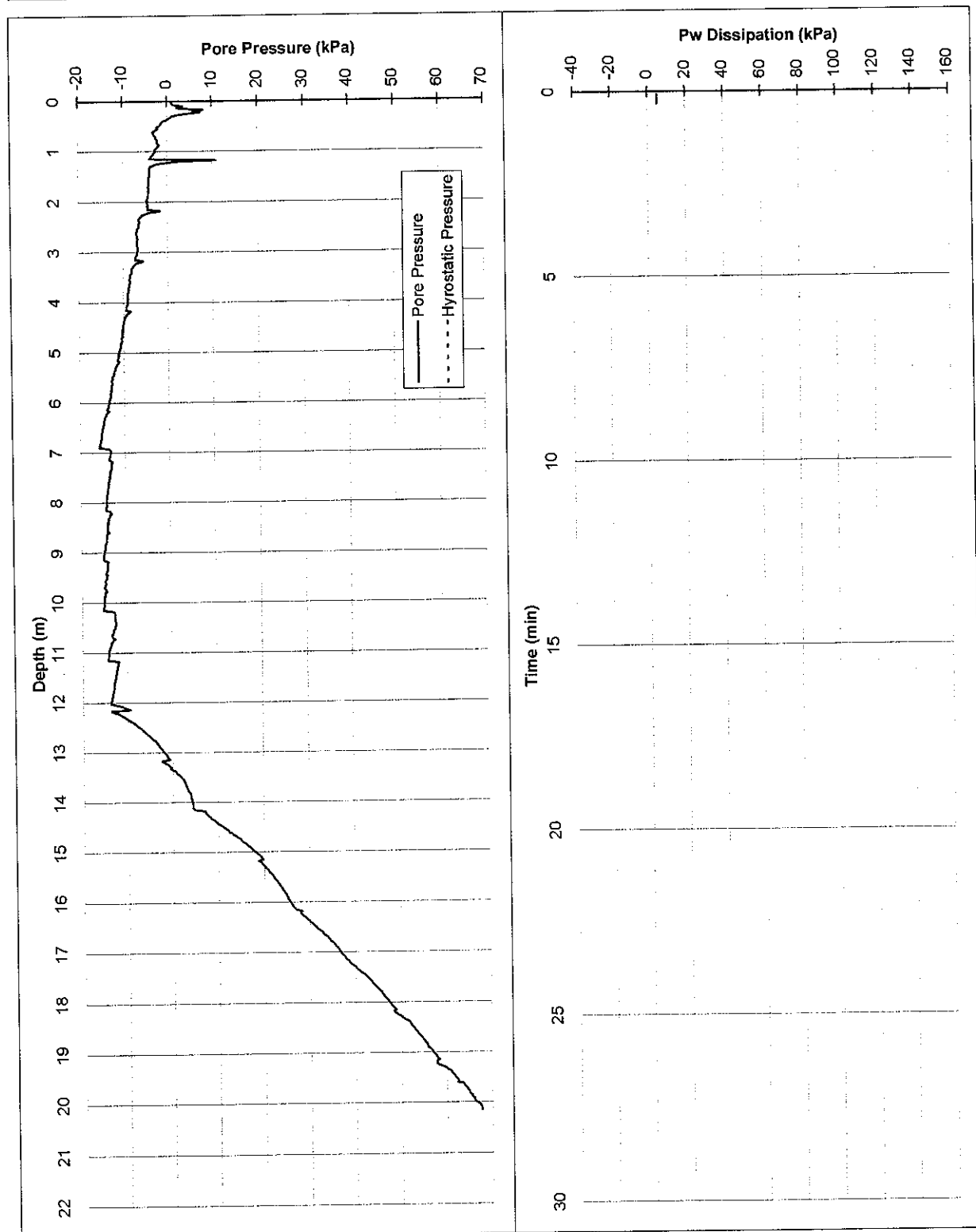
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 28 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

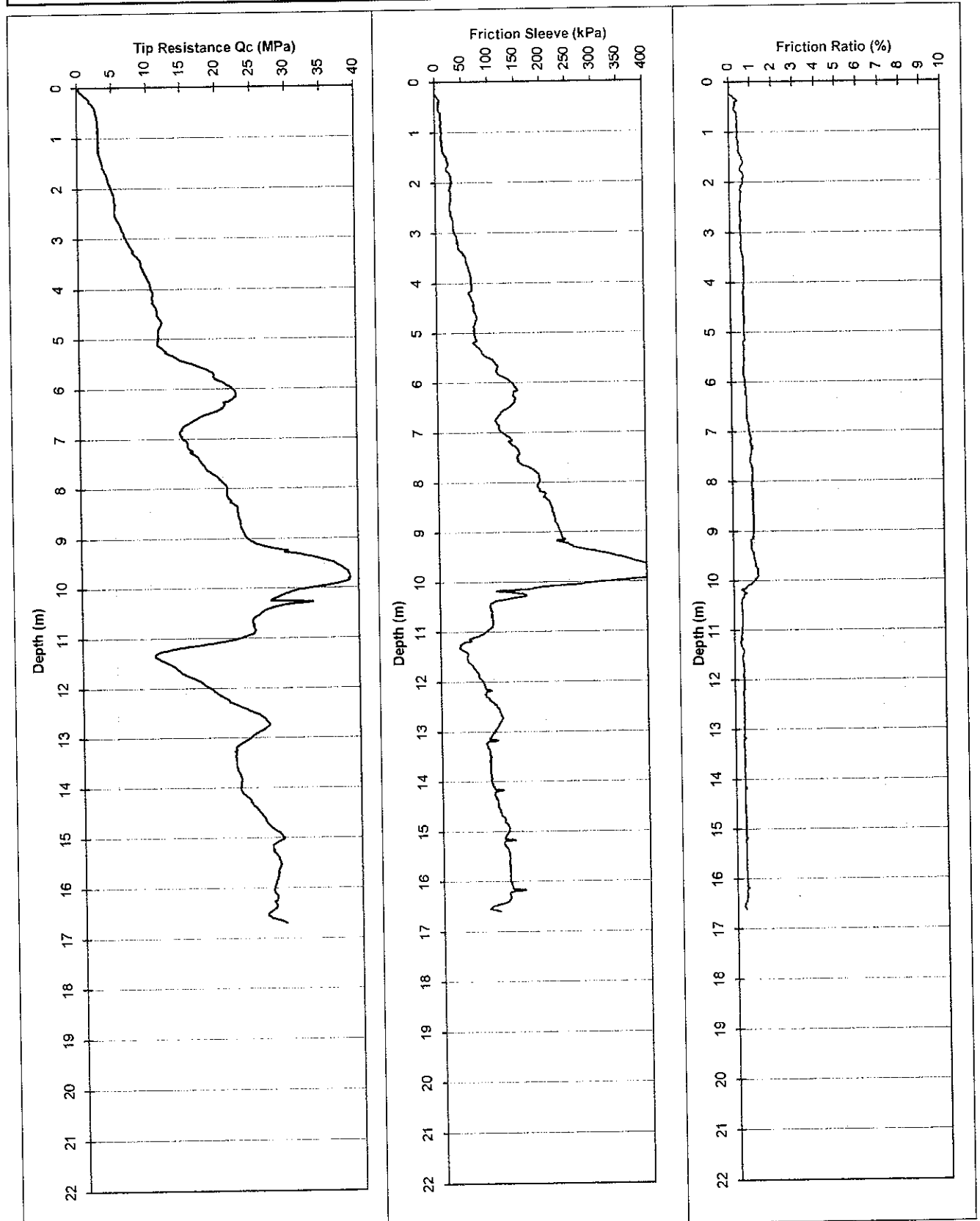
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 29 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 8.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

File: GH7424TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 20/06/07

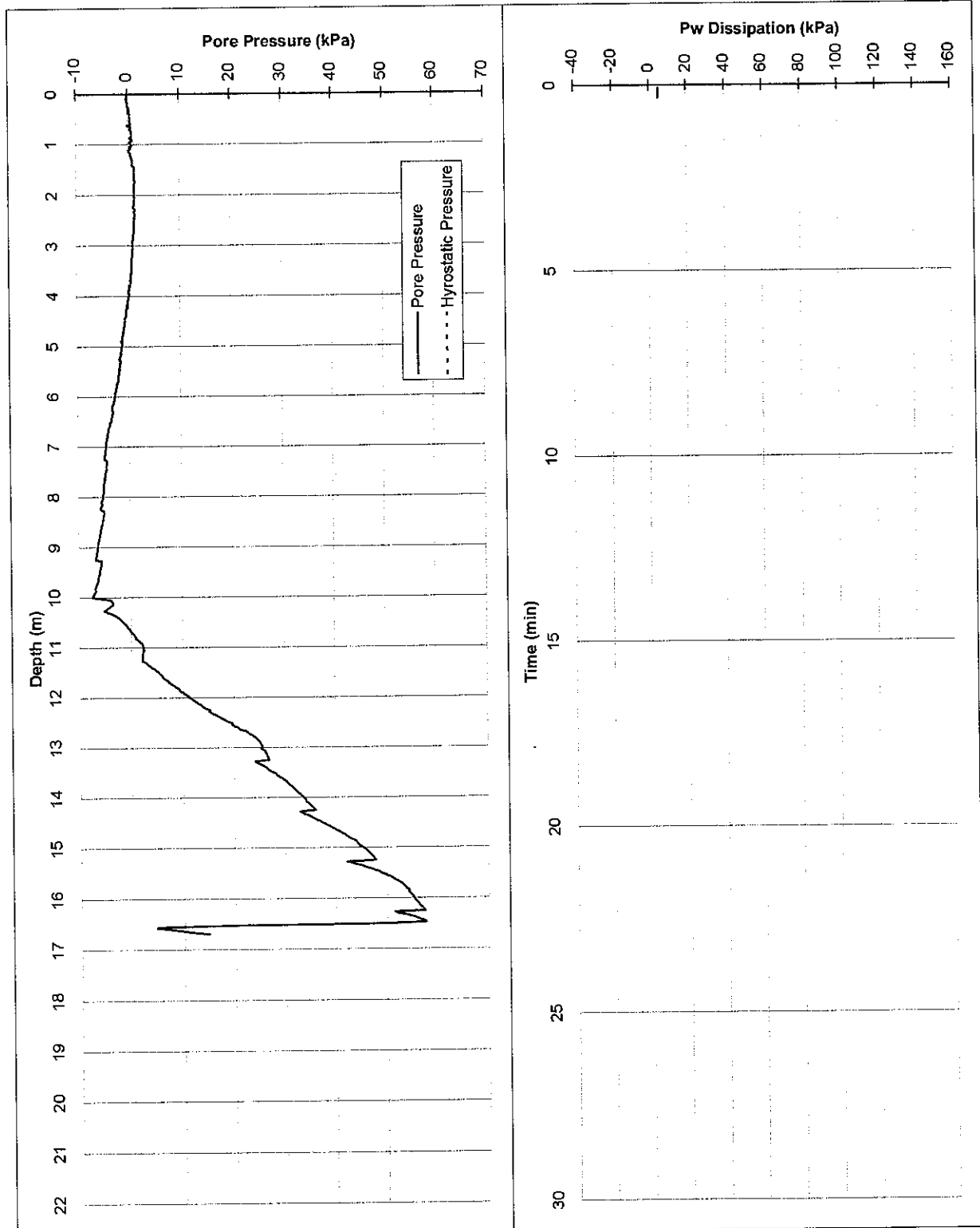
Project: Fiona Stanley Hospital

Probe No.: CPT 29-U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

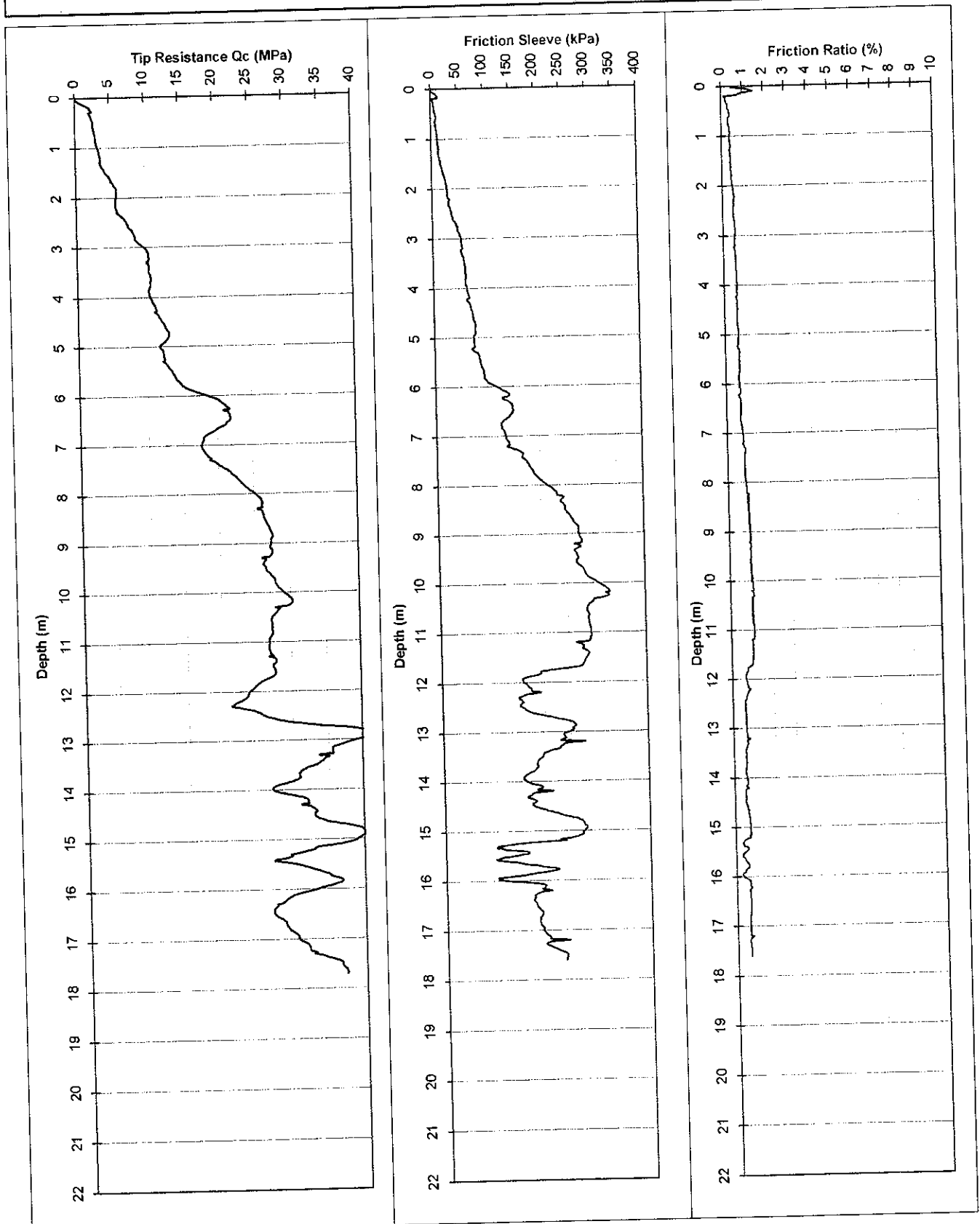
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 30 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 6.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH74221T.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

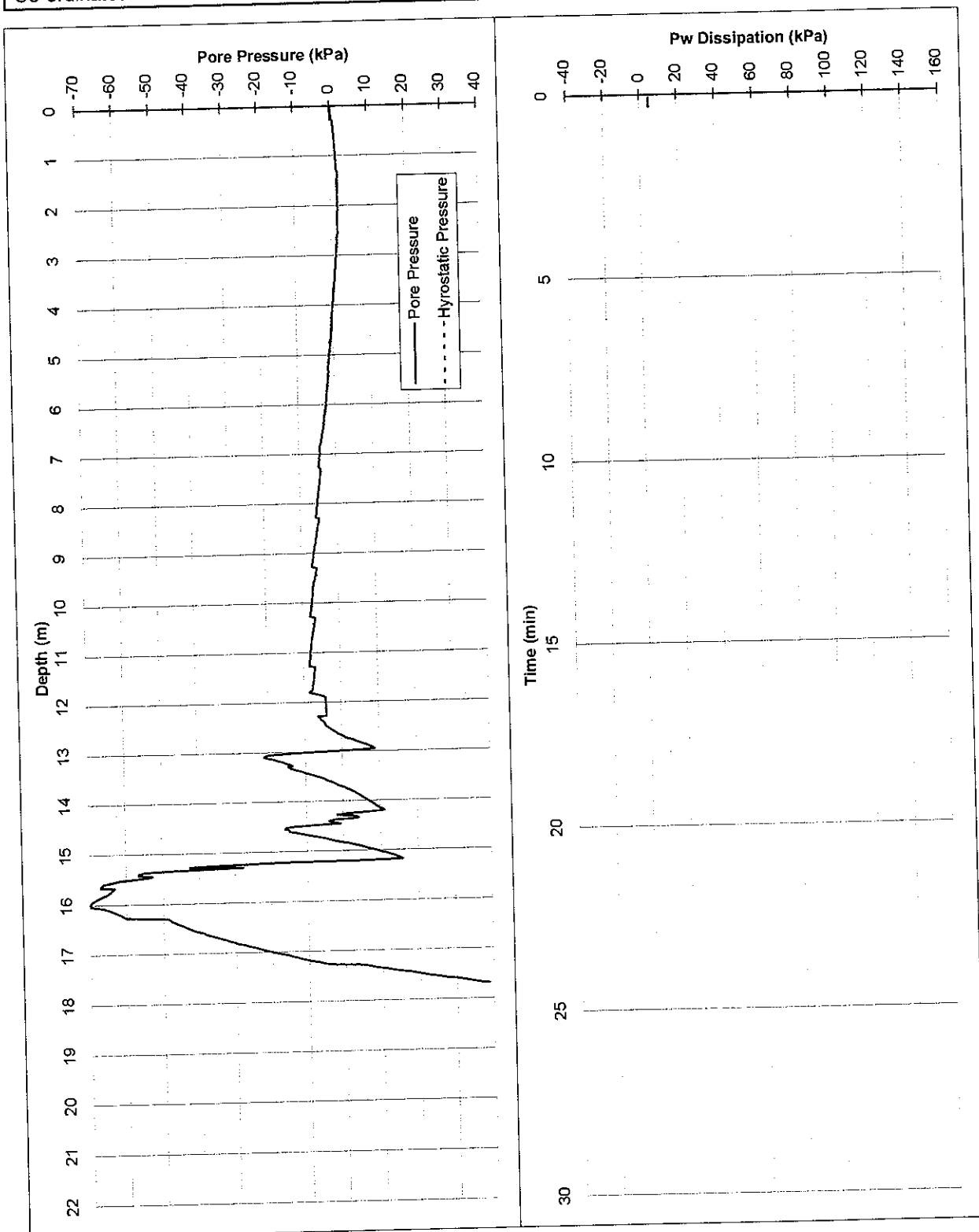
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 30 U

Job Number: 61/19514/01



Ph: 9314 6611 Fax: 9314 6699

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

22 tonne truck mounted CPT Rig.

File: GH7422TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

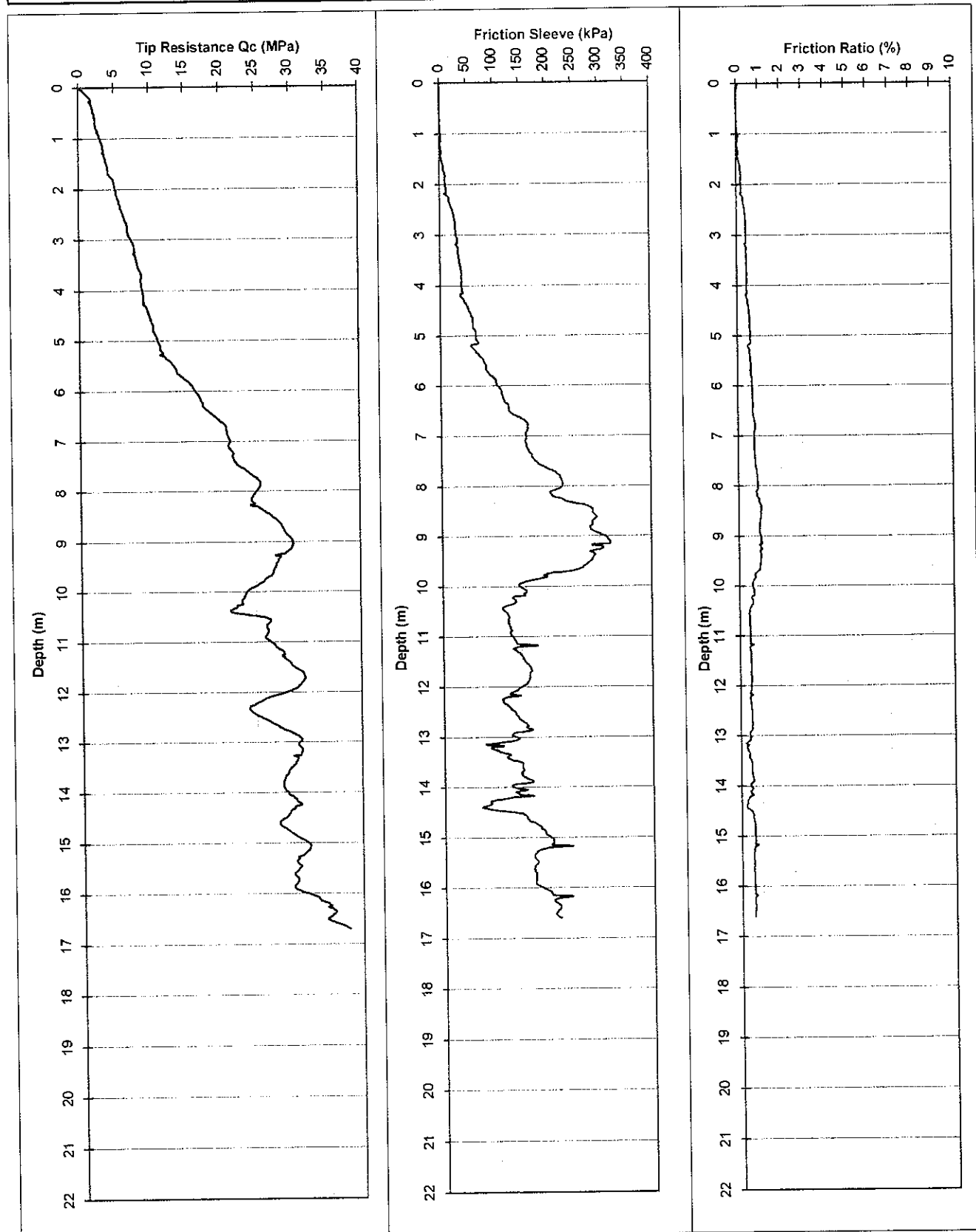
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 31 U

Job Number: 61/19514/01

Co-ordinates:



Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 4.6

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7417TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 19/06/07

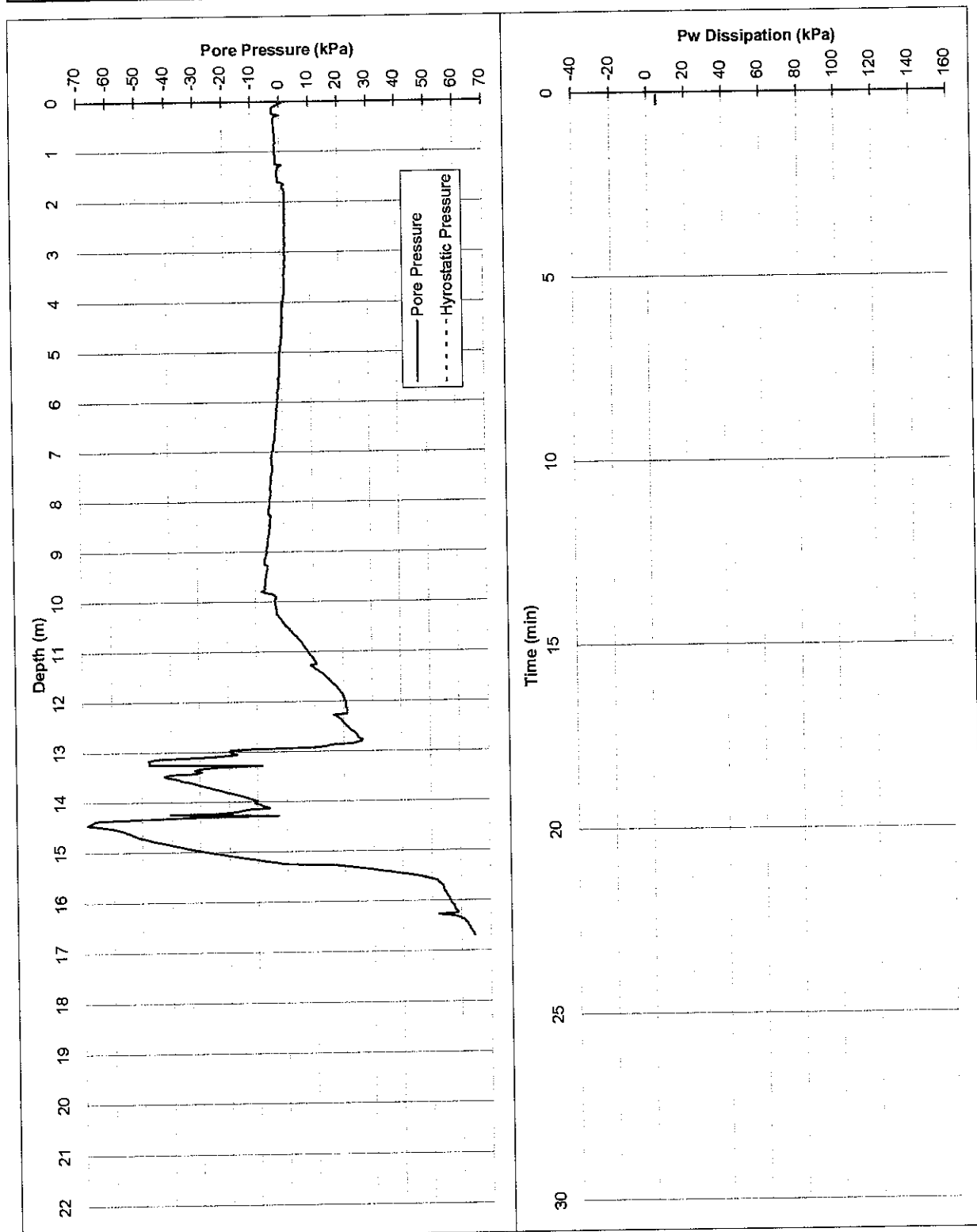
Project: Fiona Stanley Hospital

Probe No.: CPT 31 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

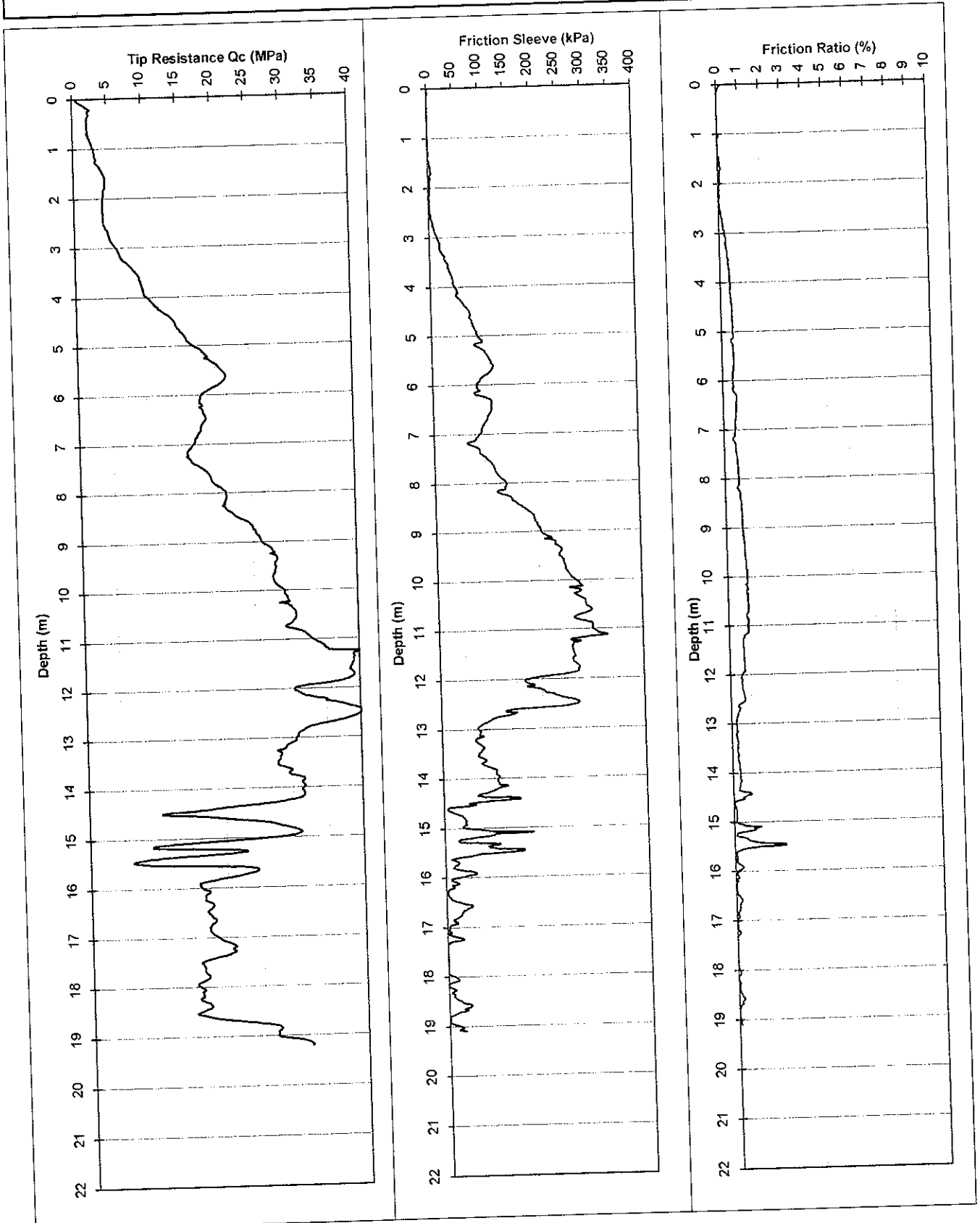
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 32 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

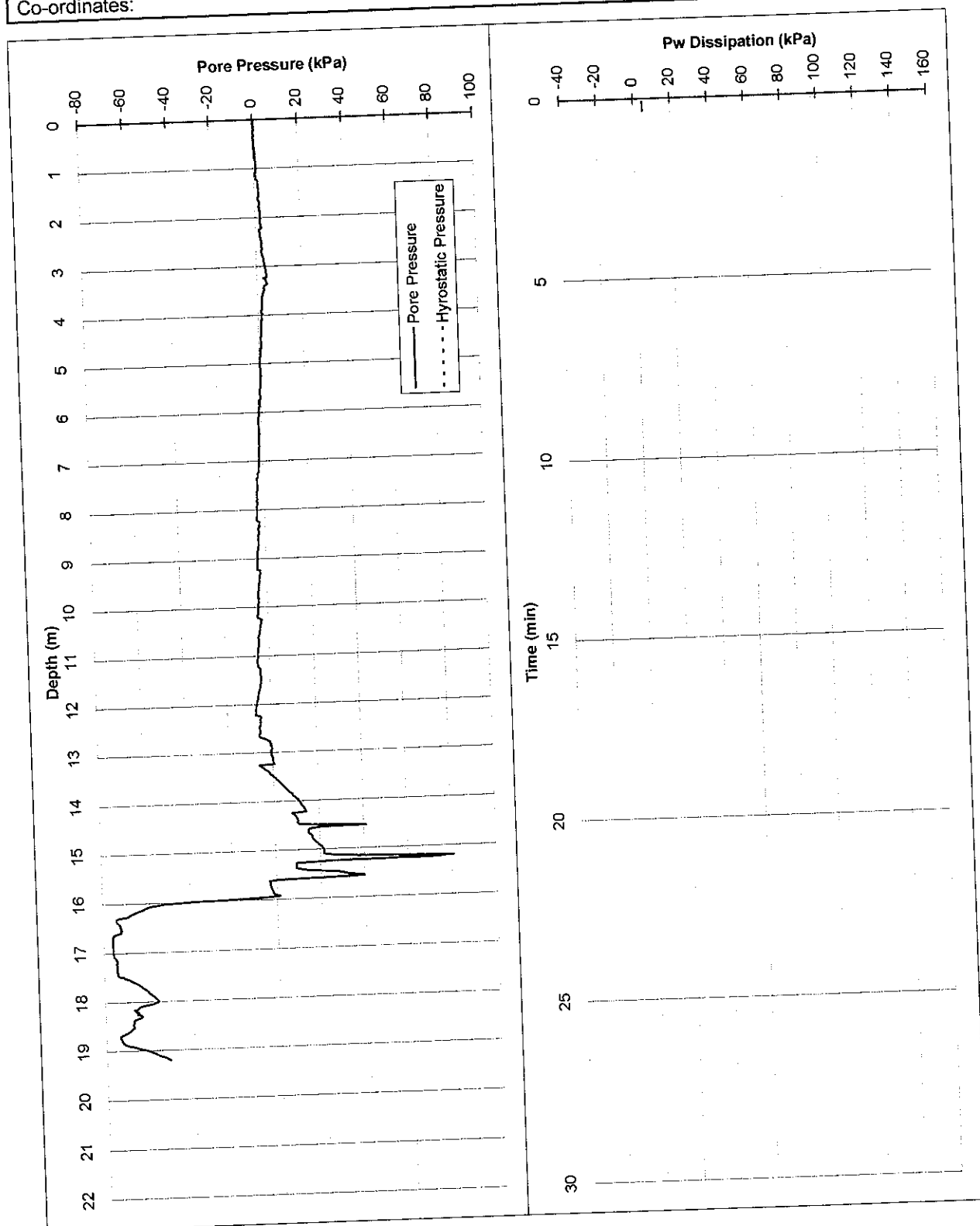
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 32 U

Job Number: 61/19514/01



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

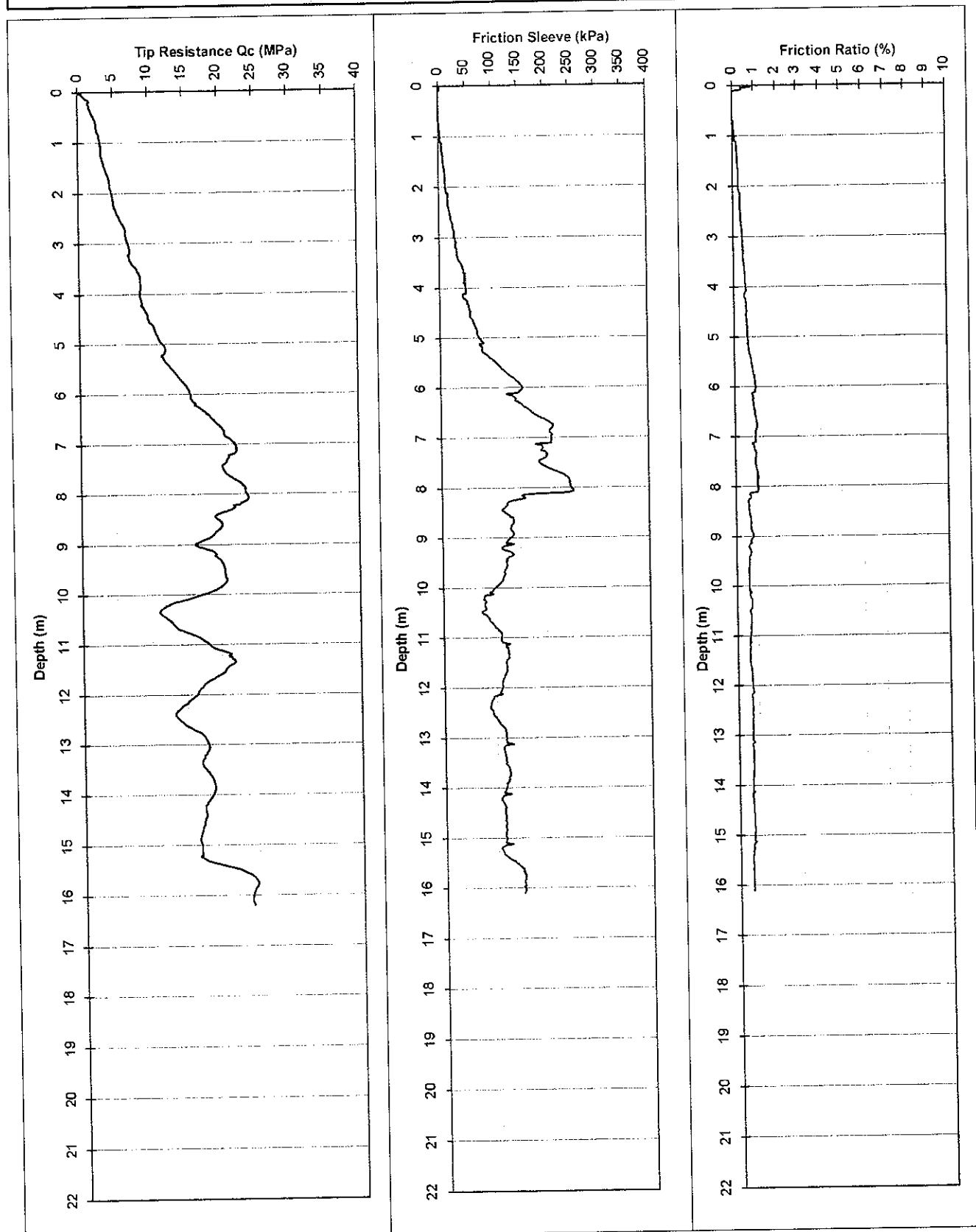
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 33 U

Job Number: 61/19514/01

Co-ordinates:



Pr: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

Water (m): Dry to 8.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

File: GH7413TT.txt

Dummy probe to (m):

Cone I.D.: EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

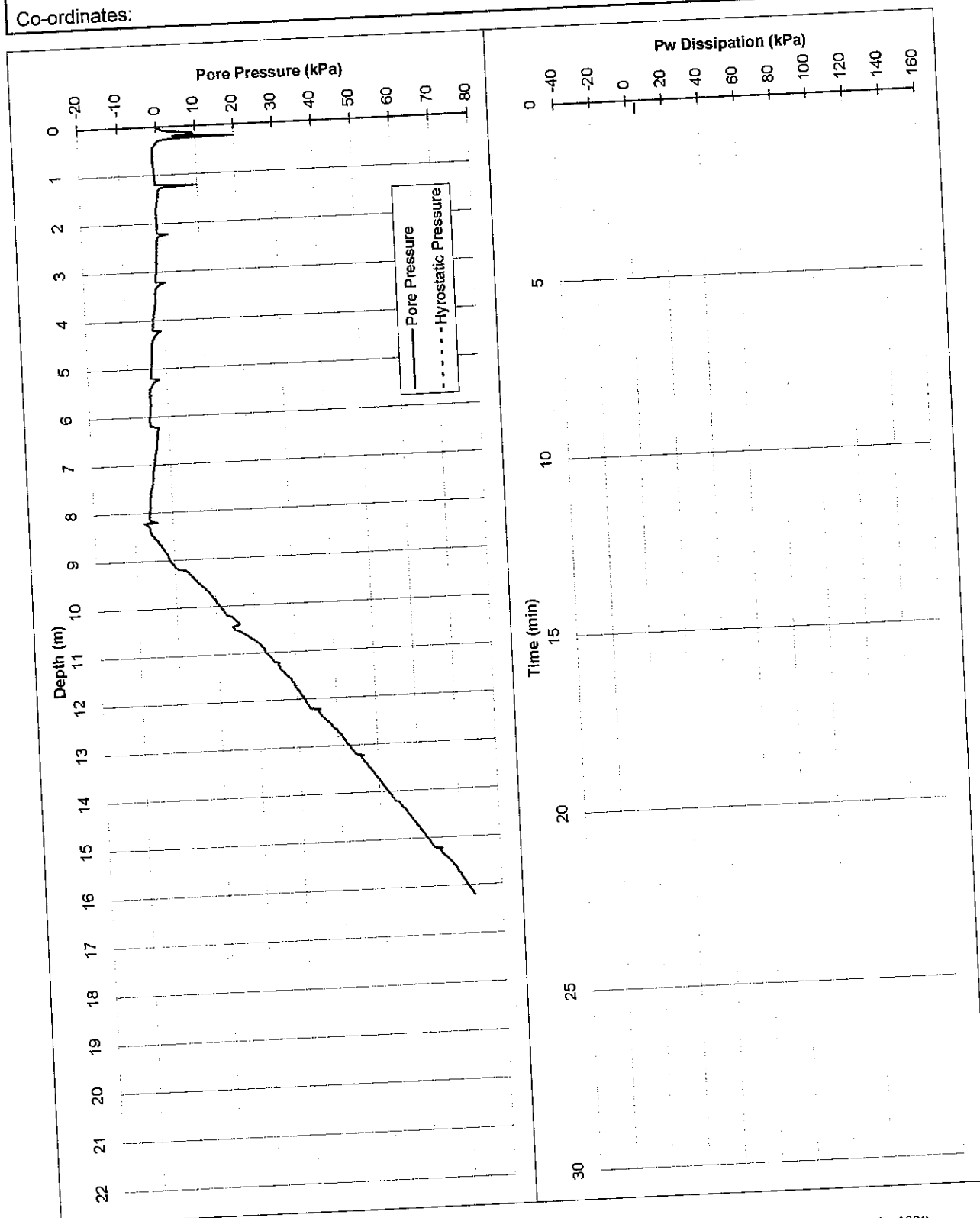
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 33 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

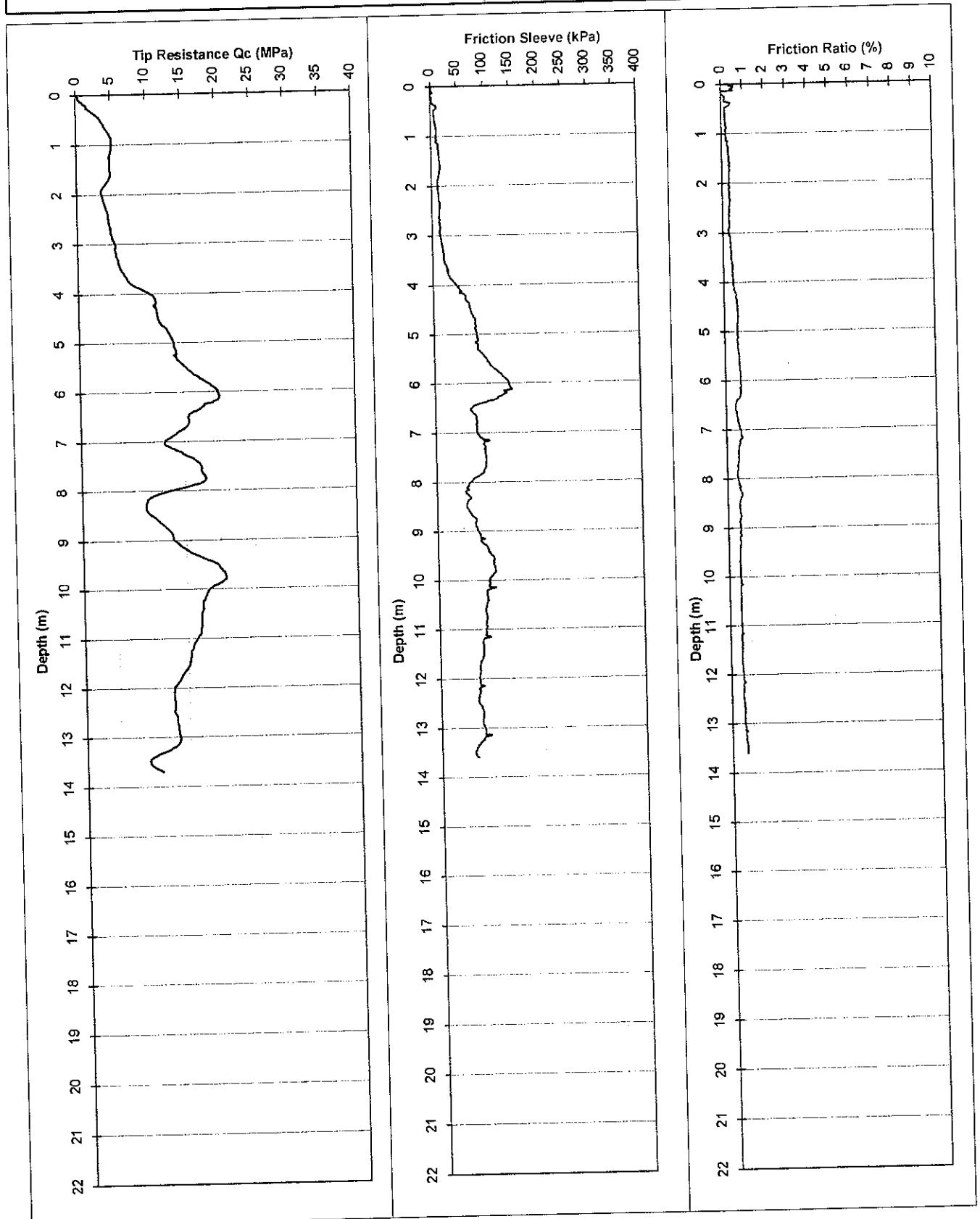
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 34 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 6.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

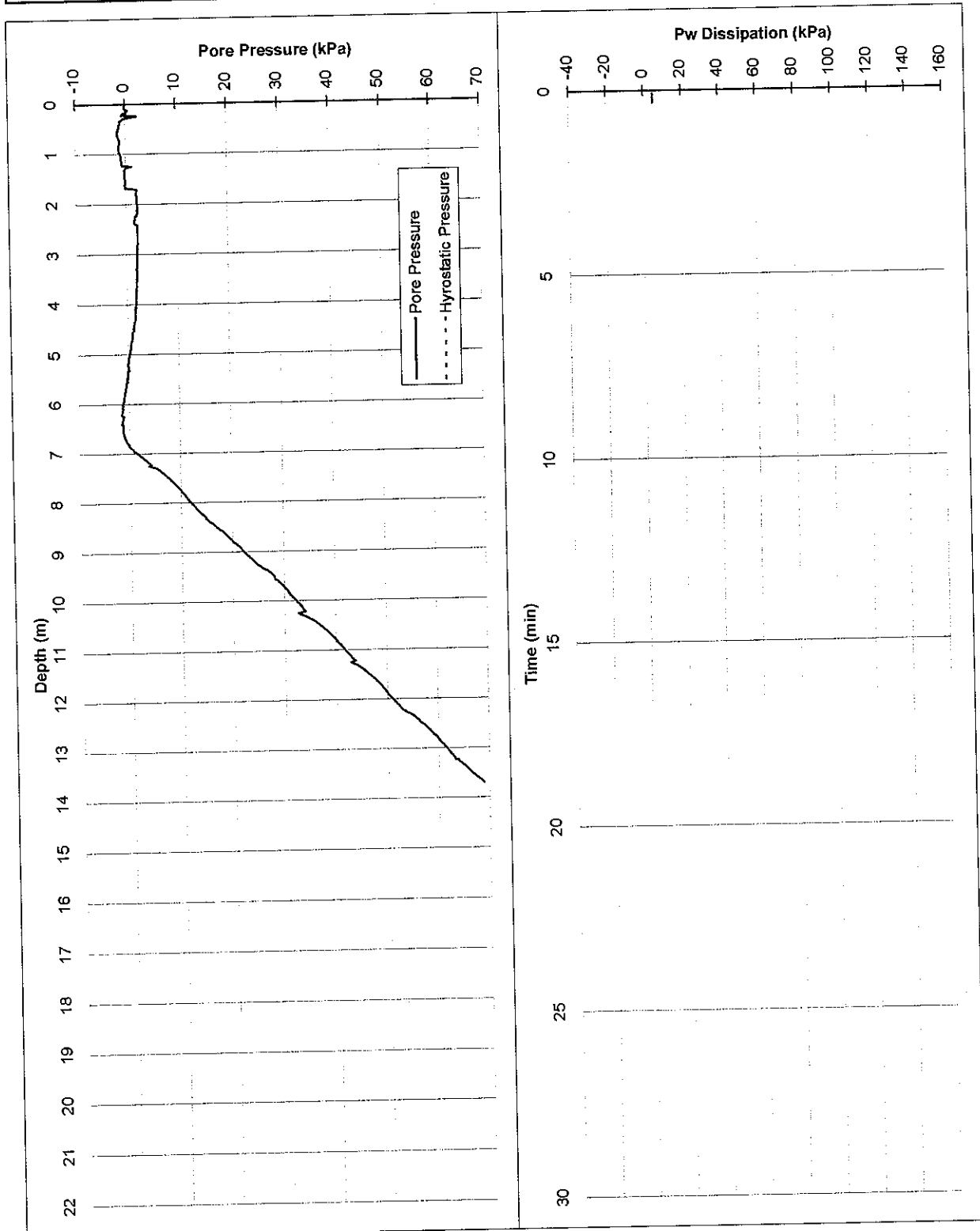
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 34 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

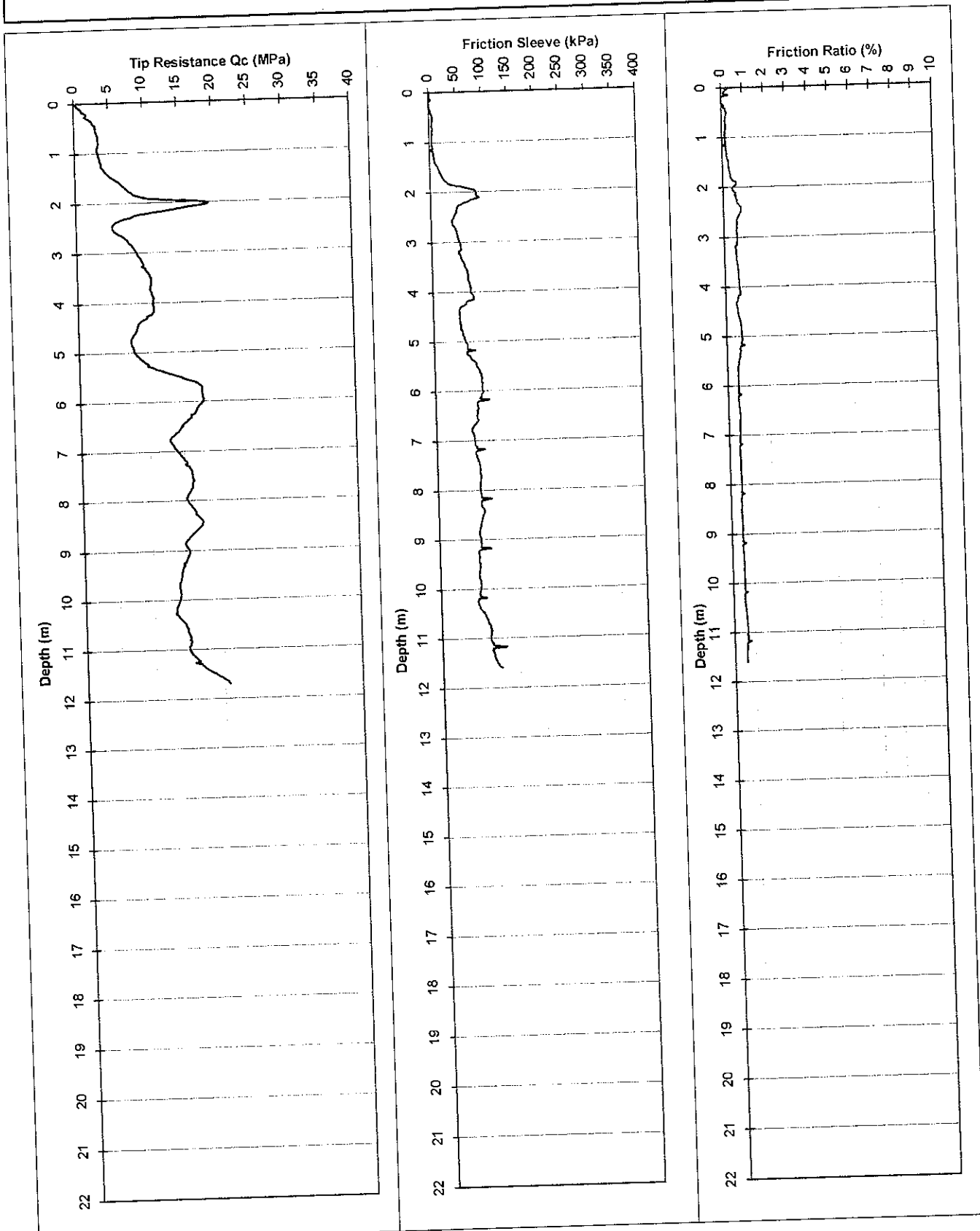
CLIENT: Department of Housing & Works
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 35 U

Job Number: 61/19514/01

Co-ordinates:



Plt 9314 6611 Fax 9314 6699

Water (m): Dry to 6.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

File: GH7428TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

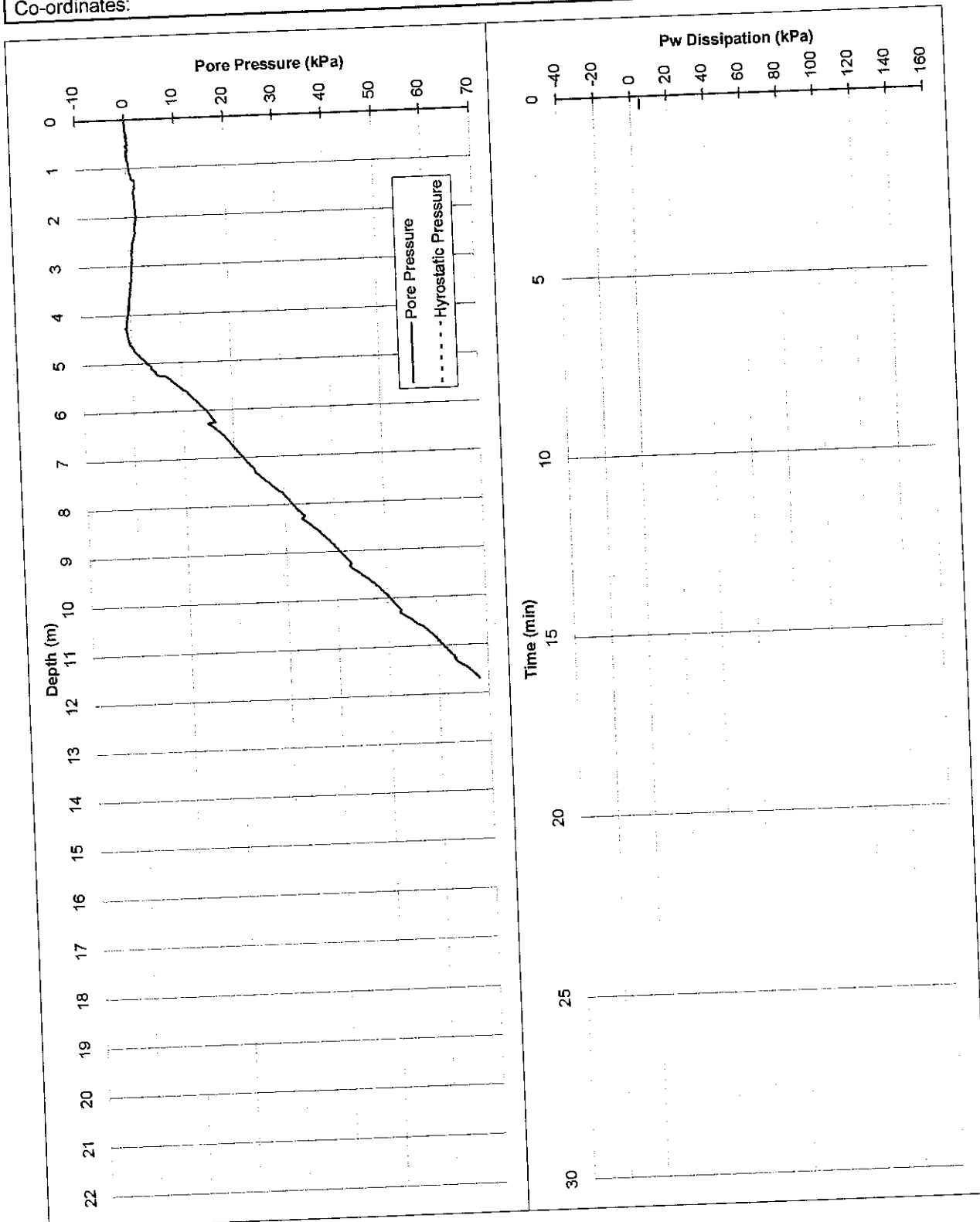
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 35 U

Job Number: 61/19514/01



Ph: 9314 6611 Fax: 9314 6699

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

22 tonne truck mounted CPT Rig.

File: GH7428TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

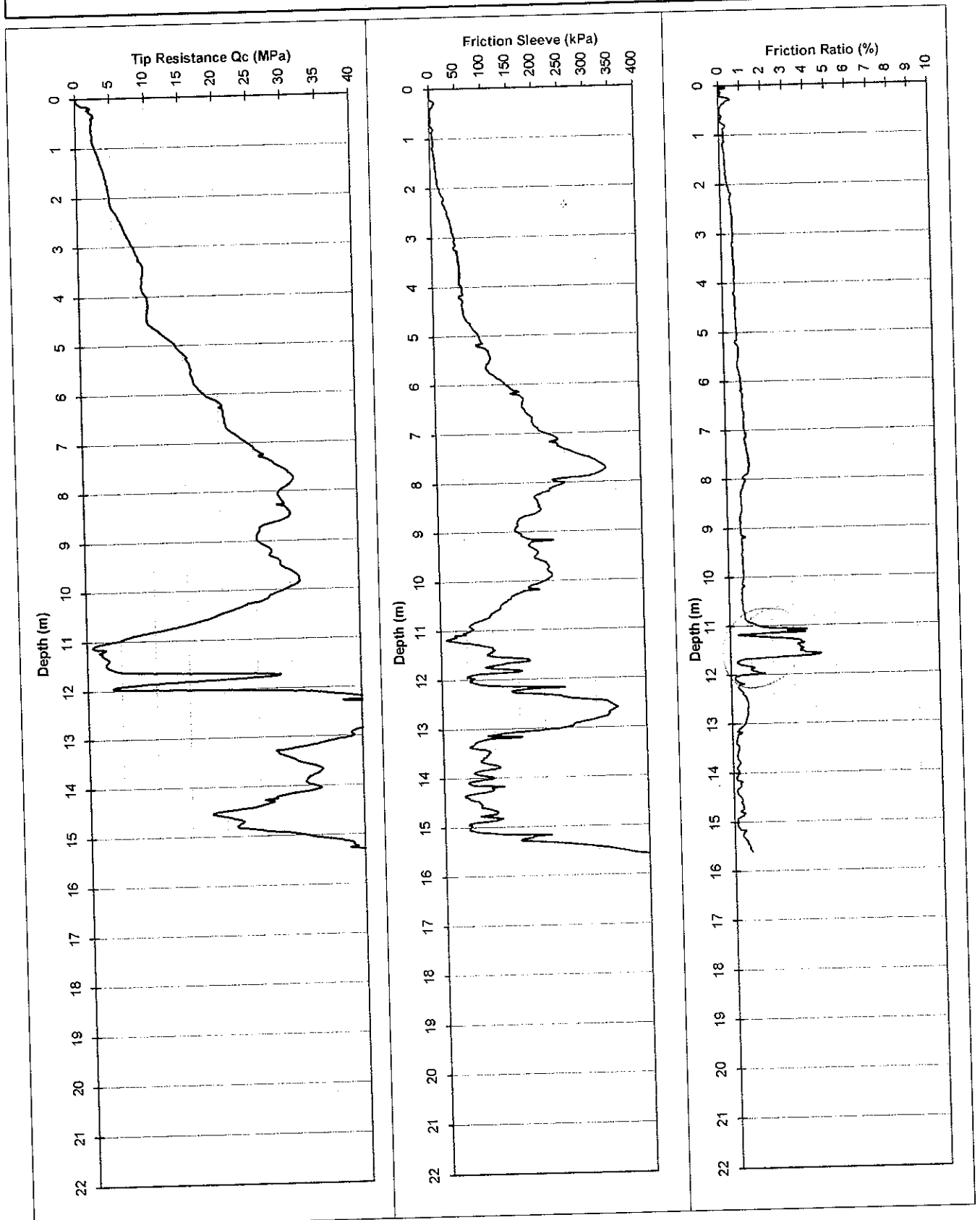
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 36 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7416TT.txt

Dummy probe to (m):

Cone I.D.: EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

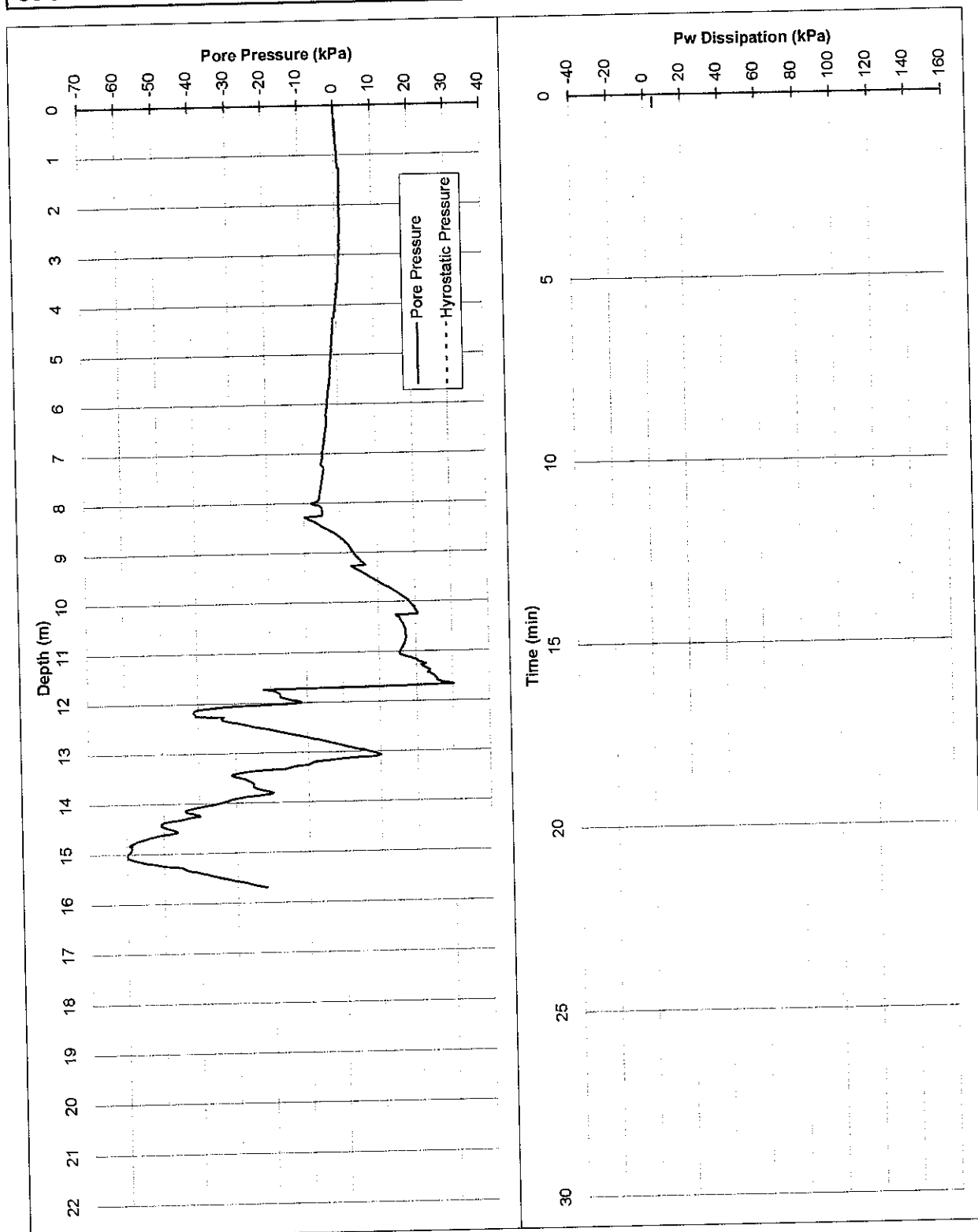
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 36 U

Job Number: 61/19514/01

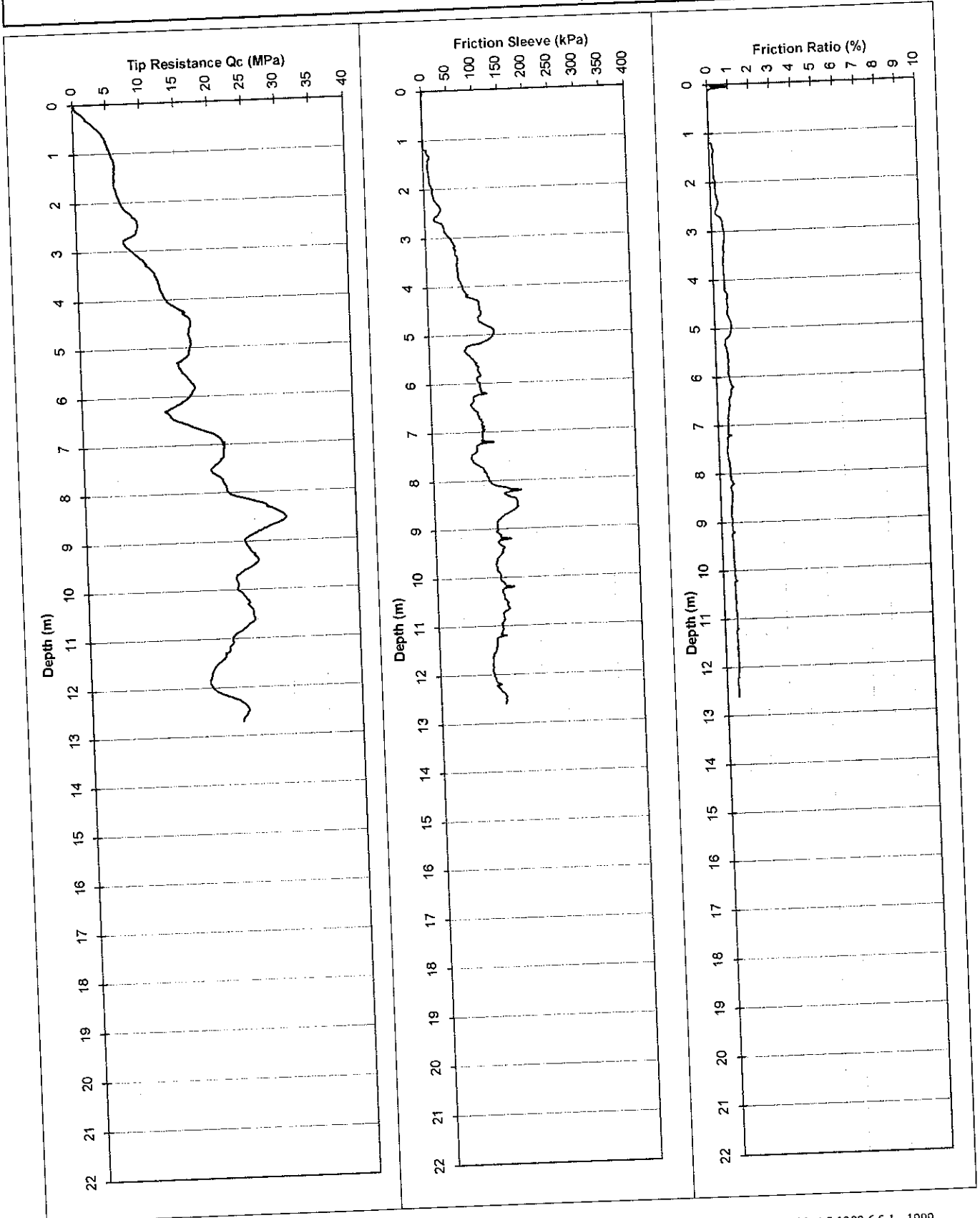


Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch

Date: 19/06/07
Probe No.: CPT 37 U
Job Number: 61/19514/01
Co-ordinates:



Water (m): Dry to 4.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

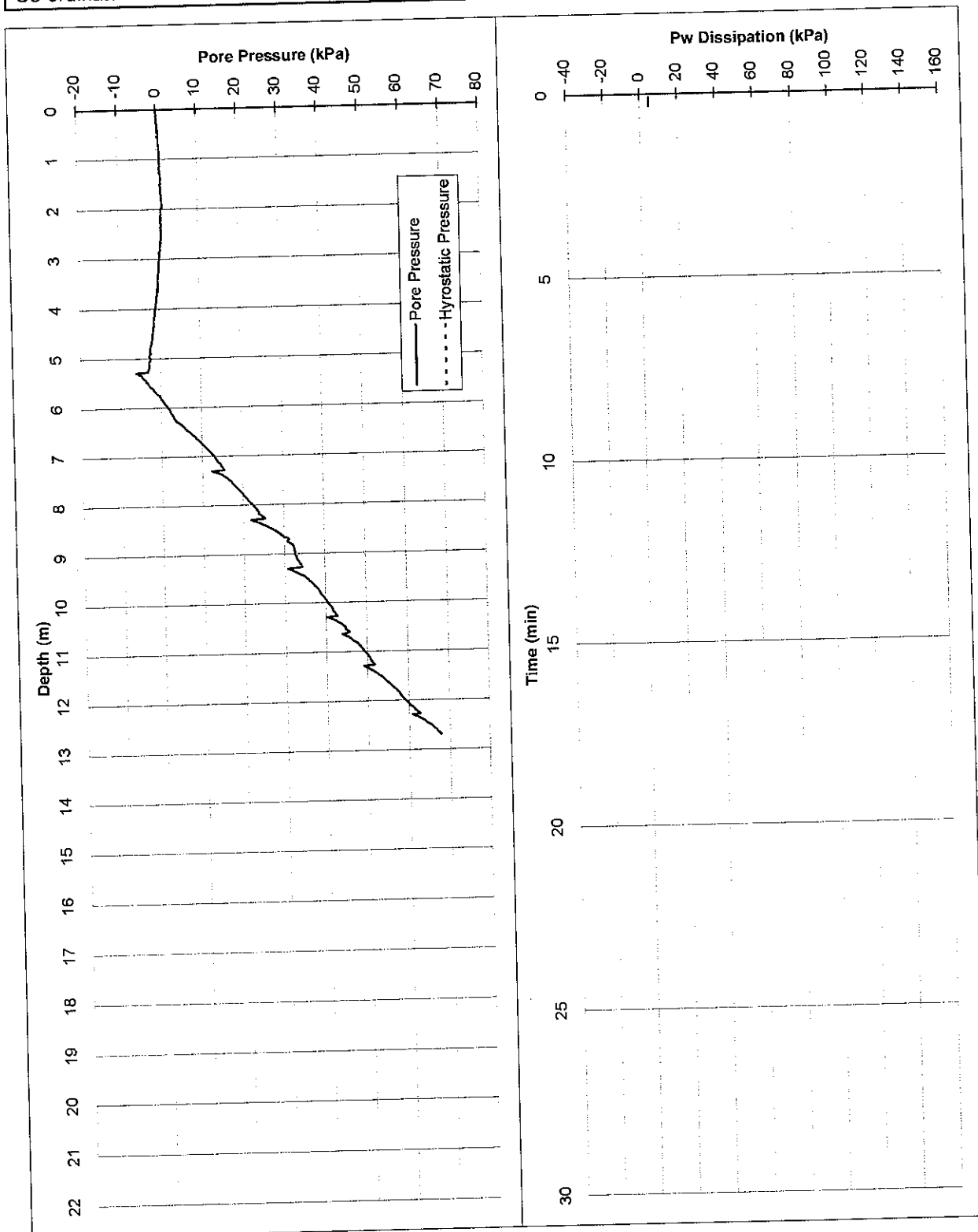
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 37 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

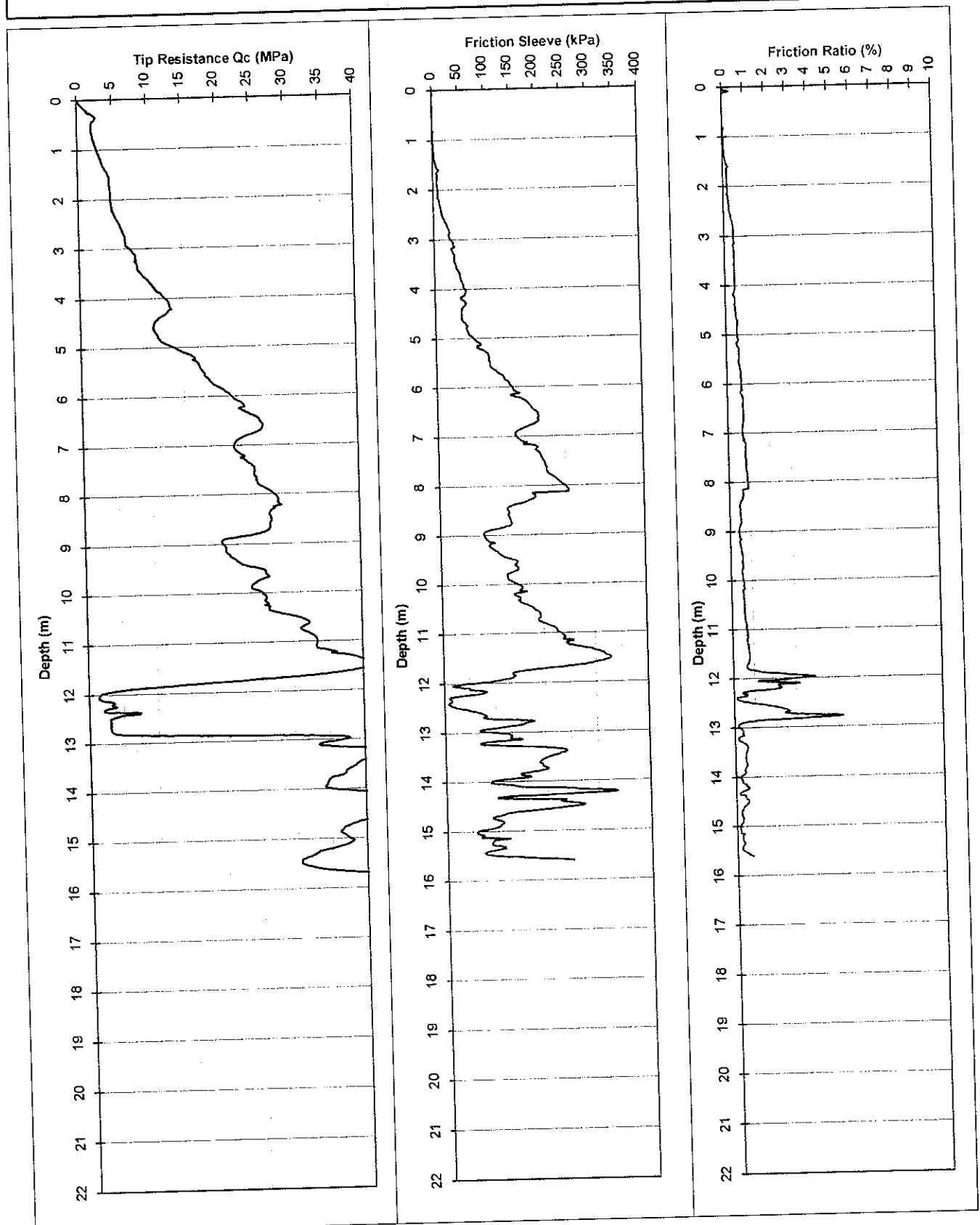
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 38 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 4.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7418TT.txt

Dummy probe to (m):

Cone I.D.: EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 19/06/07

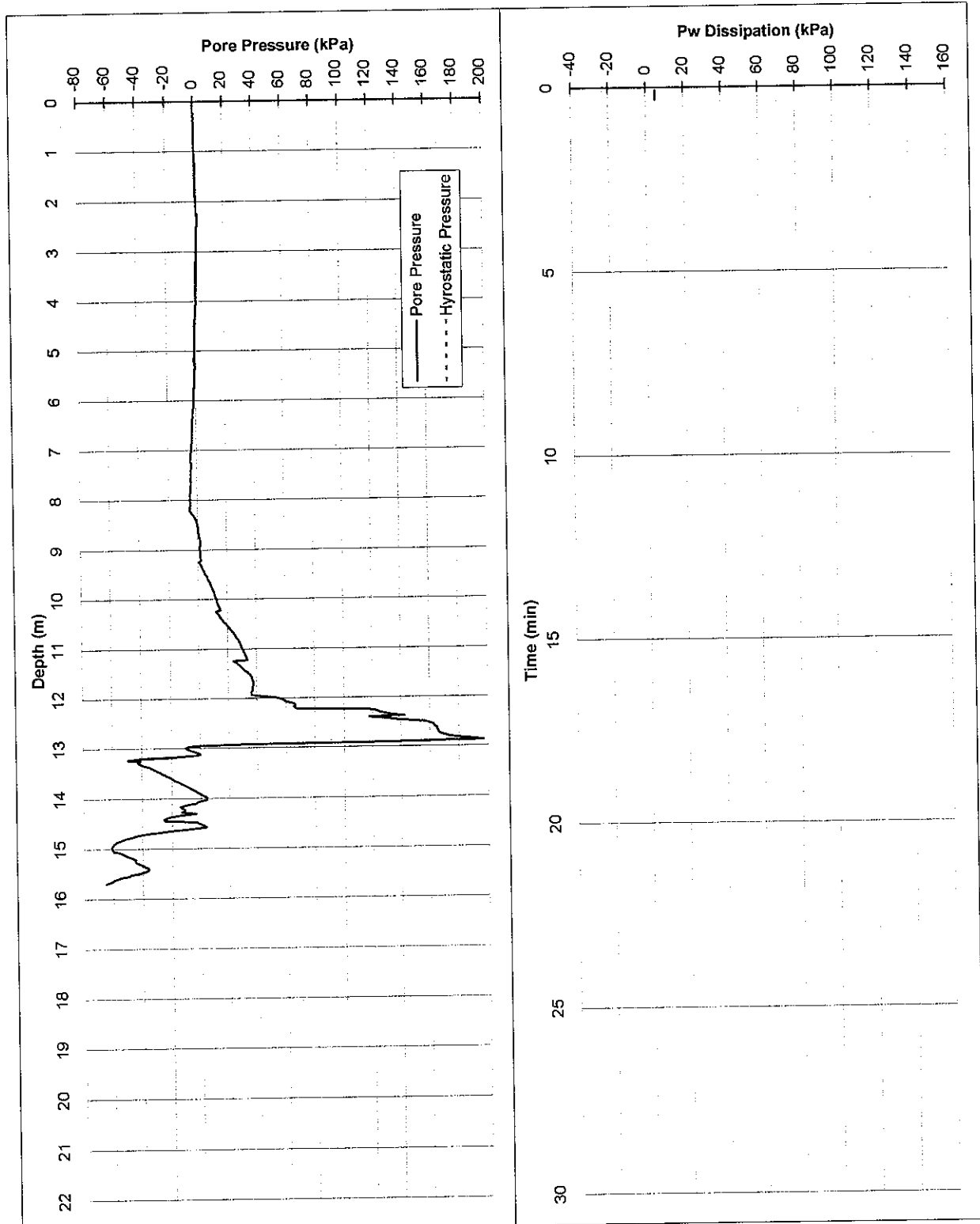
Project: Fiona Stanley Hospital

Probe No.: CPT 38 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

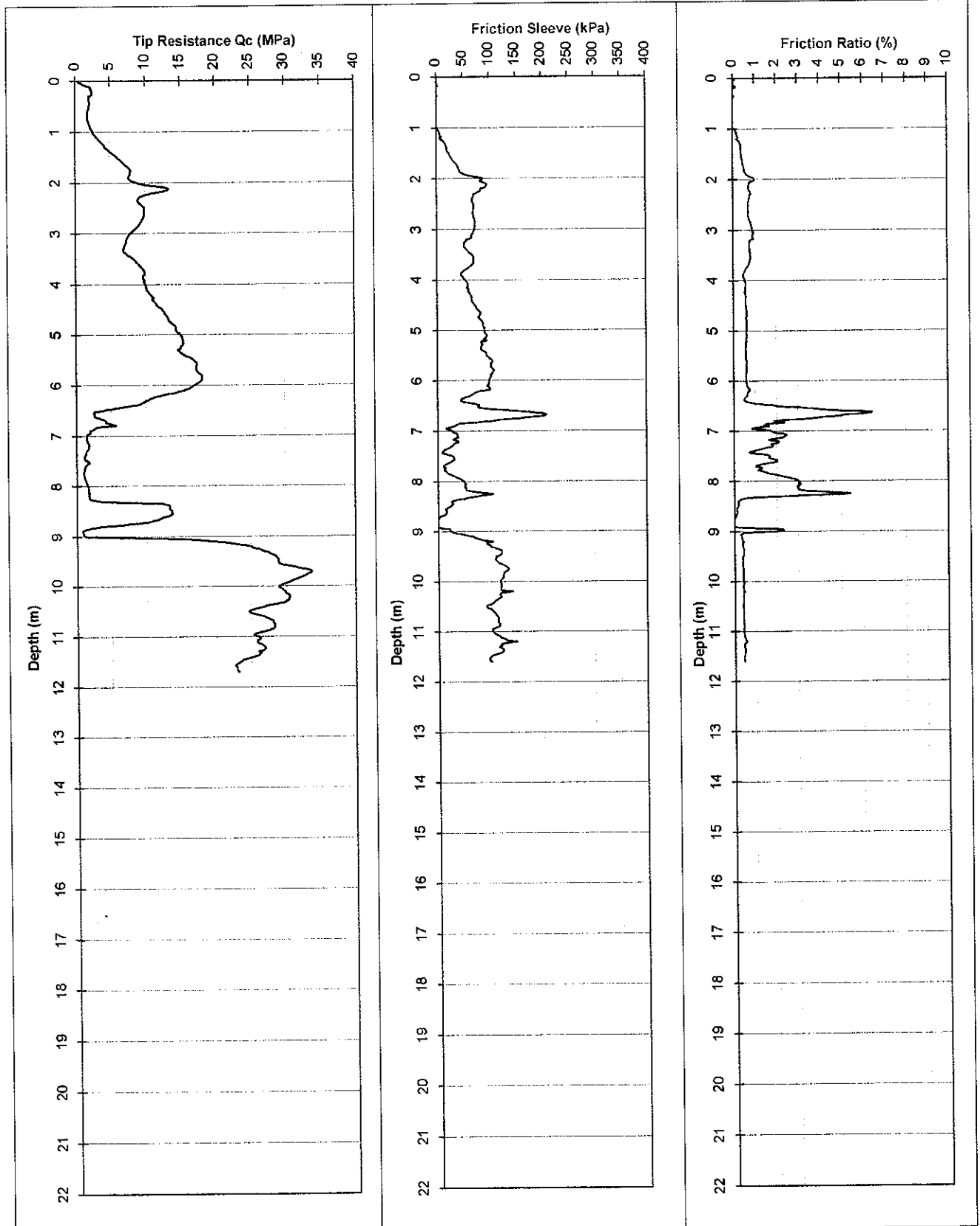
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 39 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 4.3

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

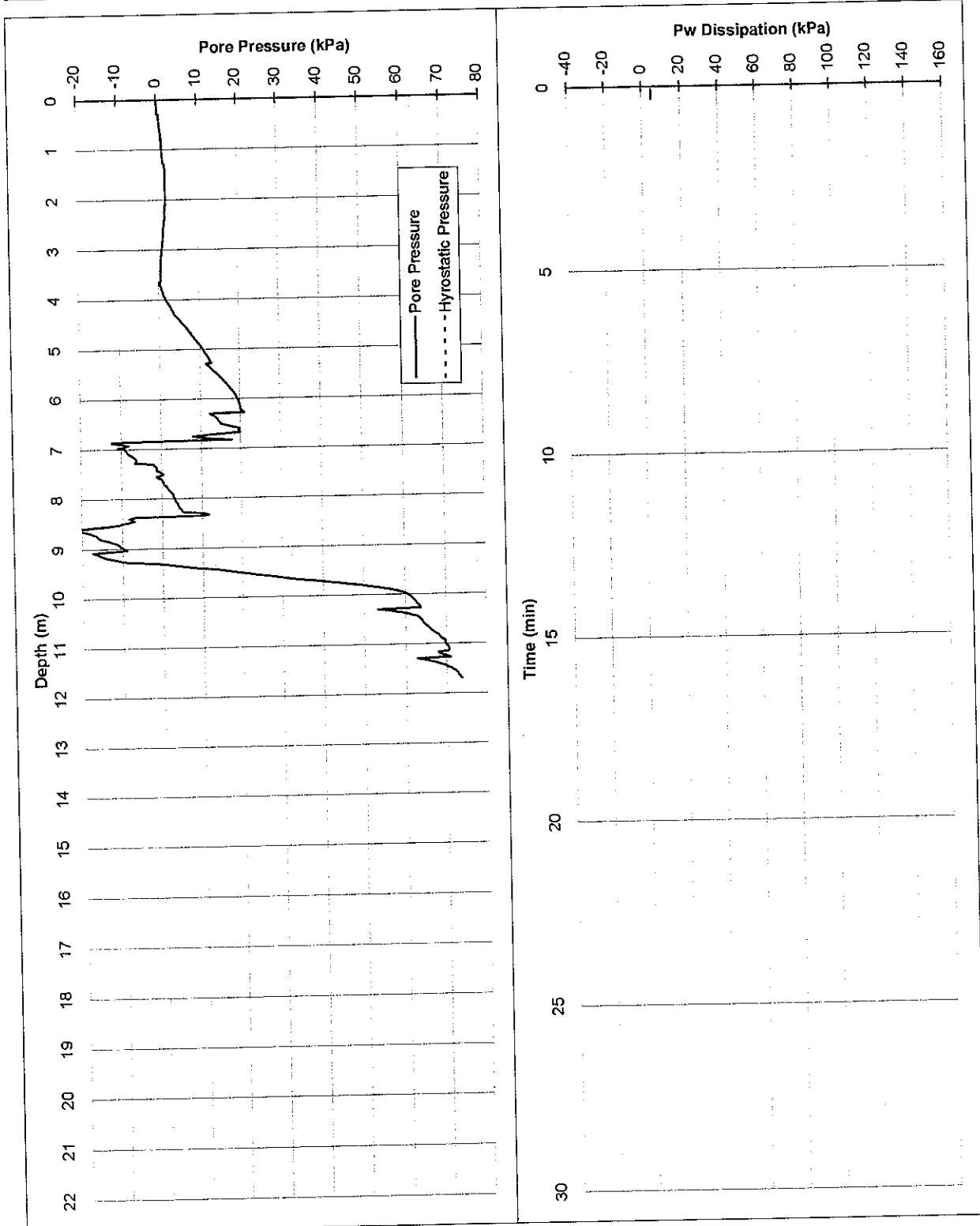
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 39 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

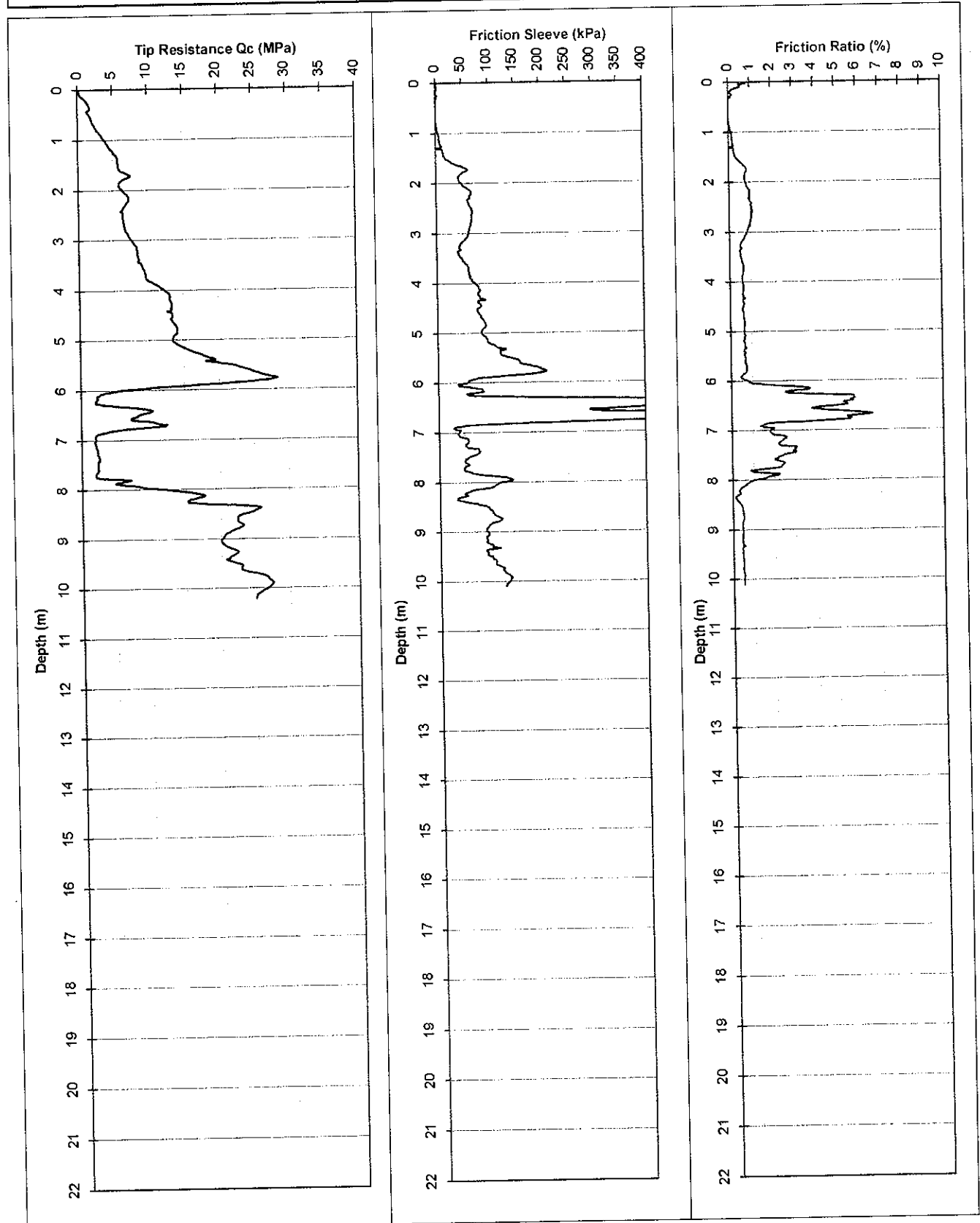
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 40 U

Job Number: 61/19514/01

Co-ordinates:



Ph: 9314 6611 Fax: 9314 6699

Water (m): 3.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

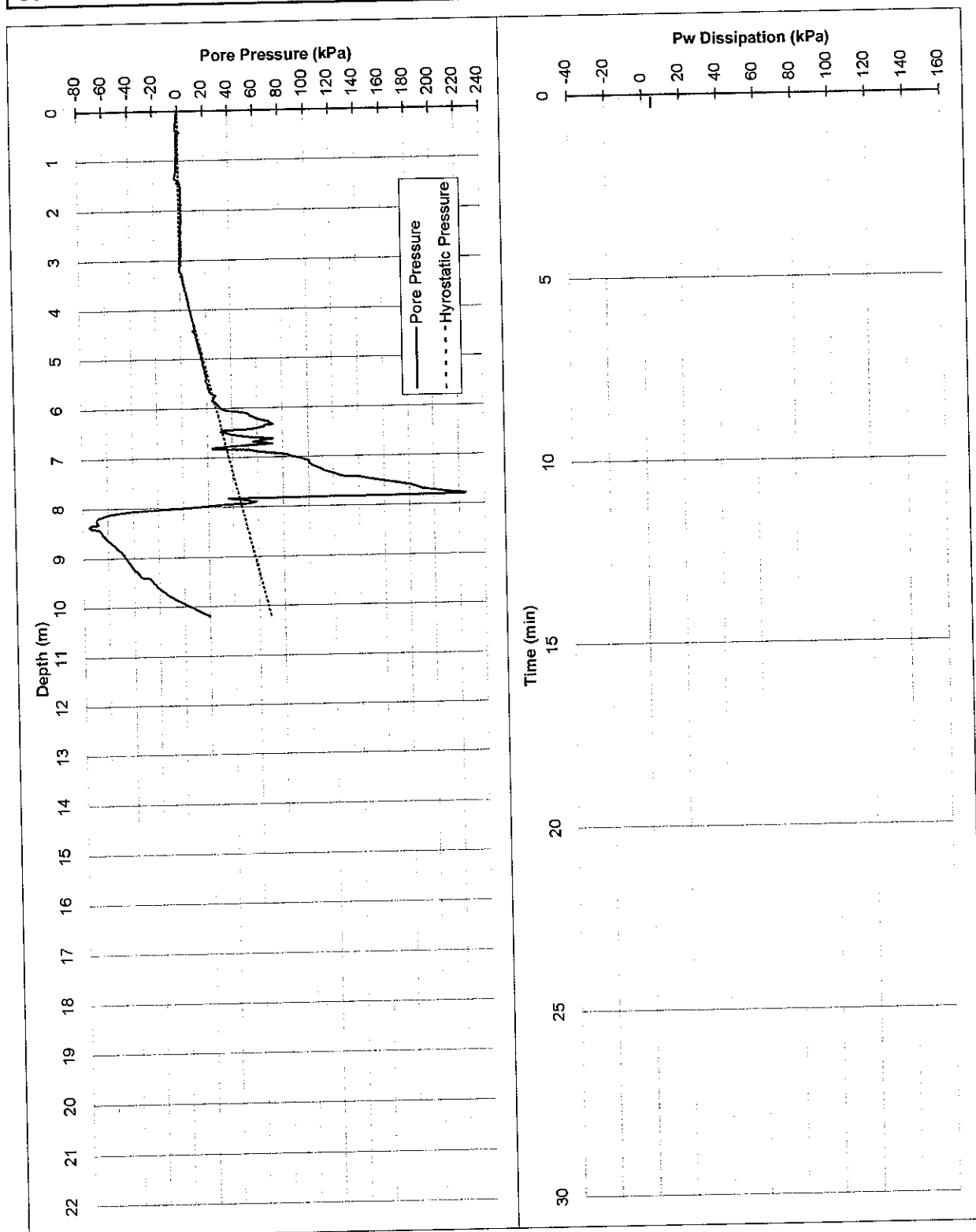
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 40 U

Job Number: 61/19514/01



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

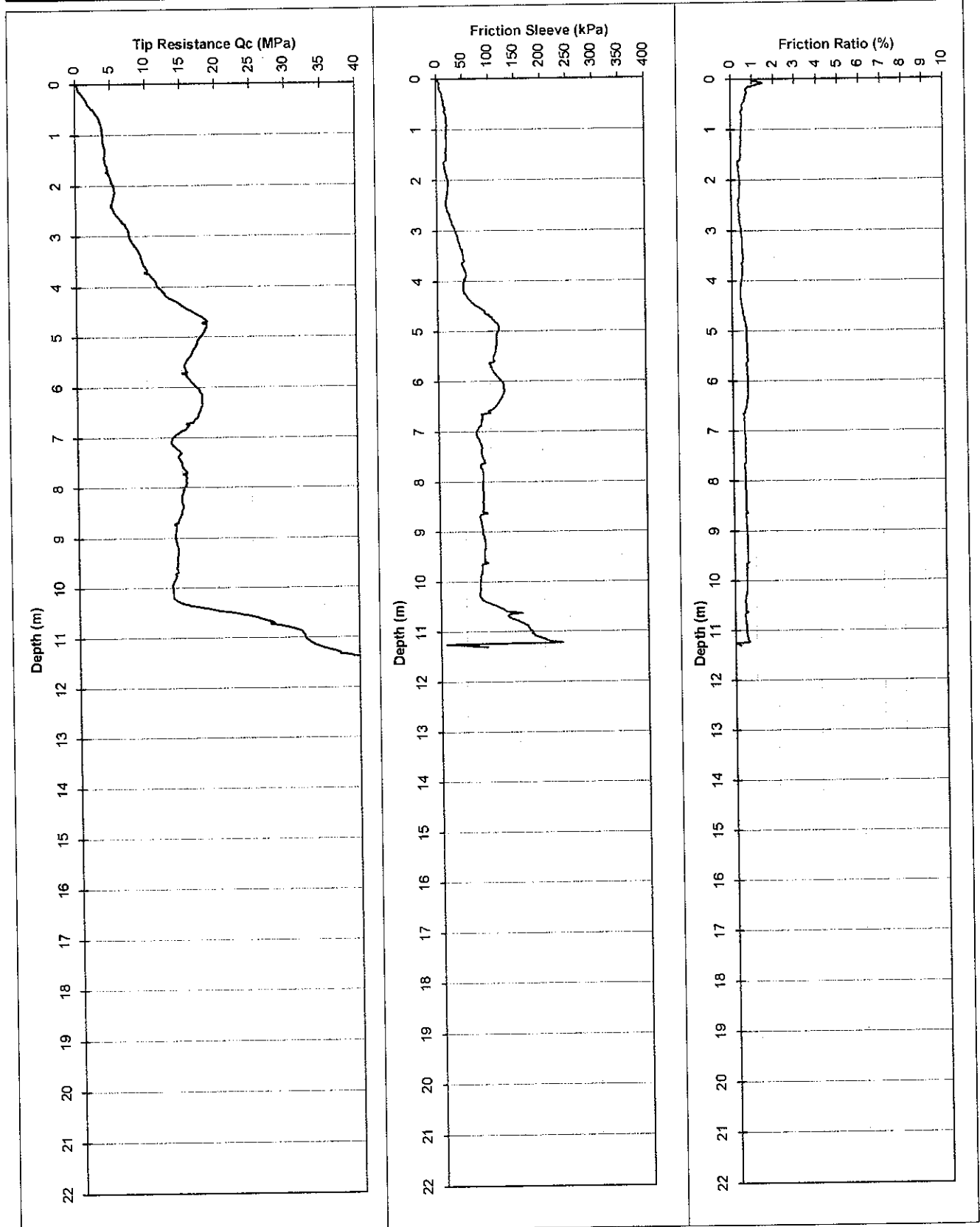
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 41 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): Dry to 4.4

Refusal: 44MPa

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Project: Fiona Stanley Hospital

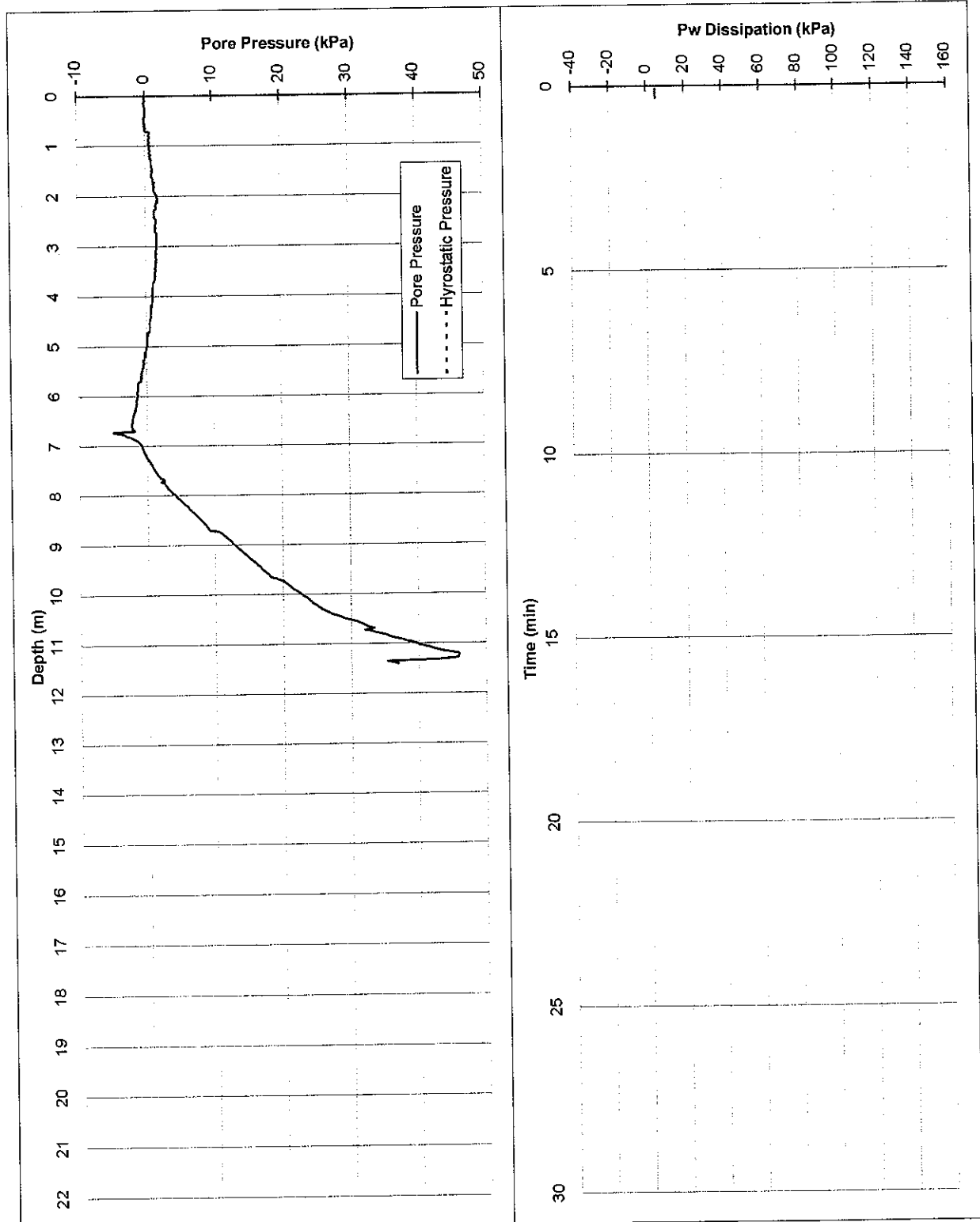
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 41 U

Job Number: 61/19514/01



Ph: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

7 tonne track mounted CPT Rig.

File: GH7446TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

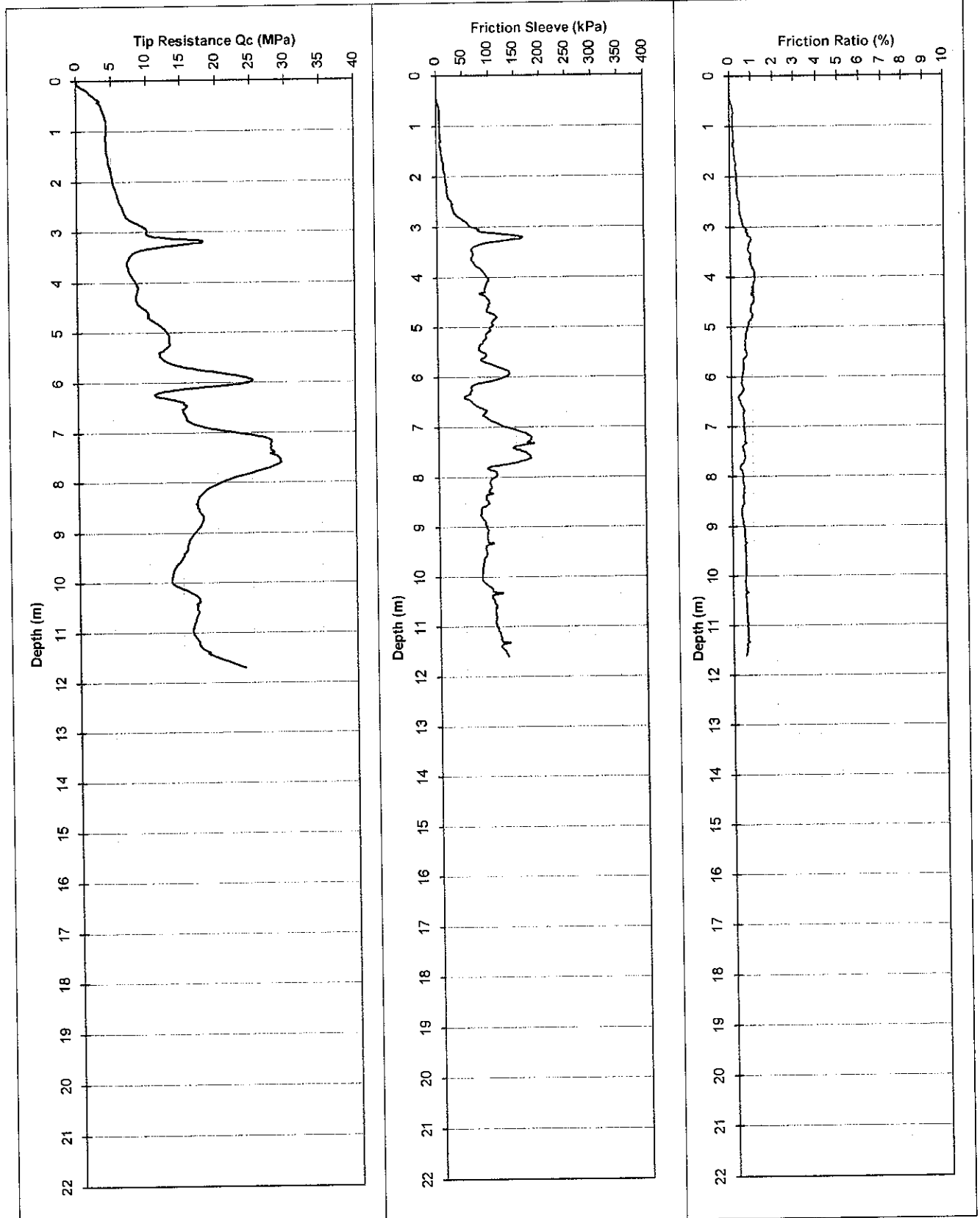
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 42 U

Job Number: 61/19514/01

Co-ordinates:



Ph 6314 6611 Fax 9314 6699

Water (m): 4.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

File: GH7406TT.txt

Dummy probe to (m):

Cone I.D. : EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 18/06/07

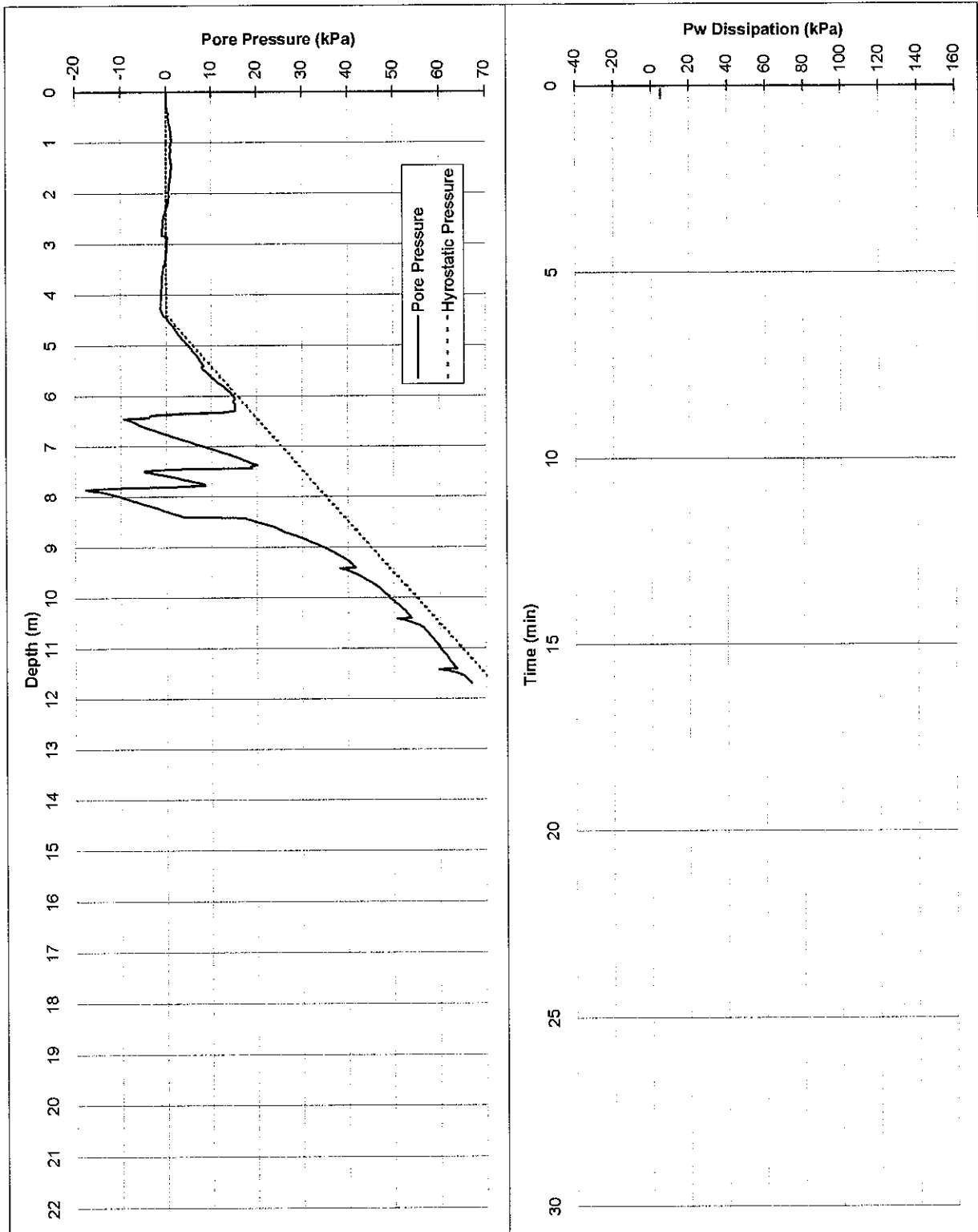
Project: Fiona Stanley Hospital

Probe No.: CPT 42 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Tested in accordance with AS 1289.6.5.1 - 1999
and IRTF 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

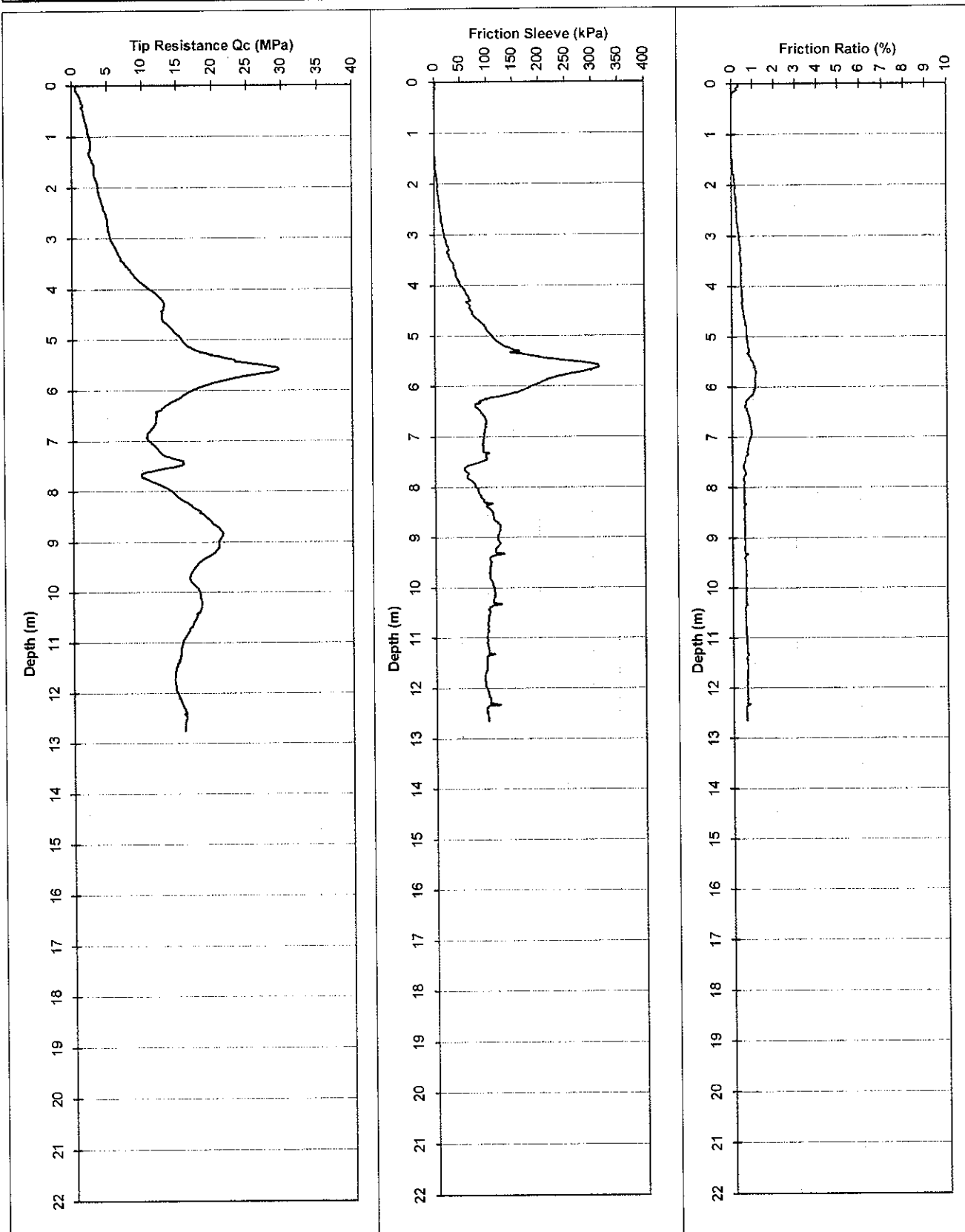
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 43 U

Job Number: 61/19514/01

Co-ordinates:



Pr: 9314 6611 Fax: 9314 6699

Water (m): -

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

File: GH7405TT.txt

Dummy probe to (m):

Cone I.D.: EC29

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 18/06/07

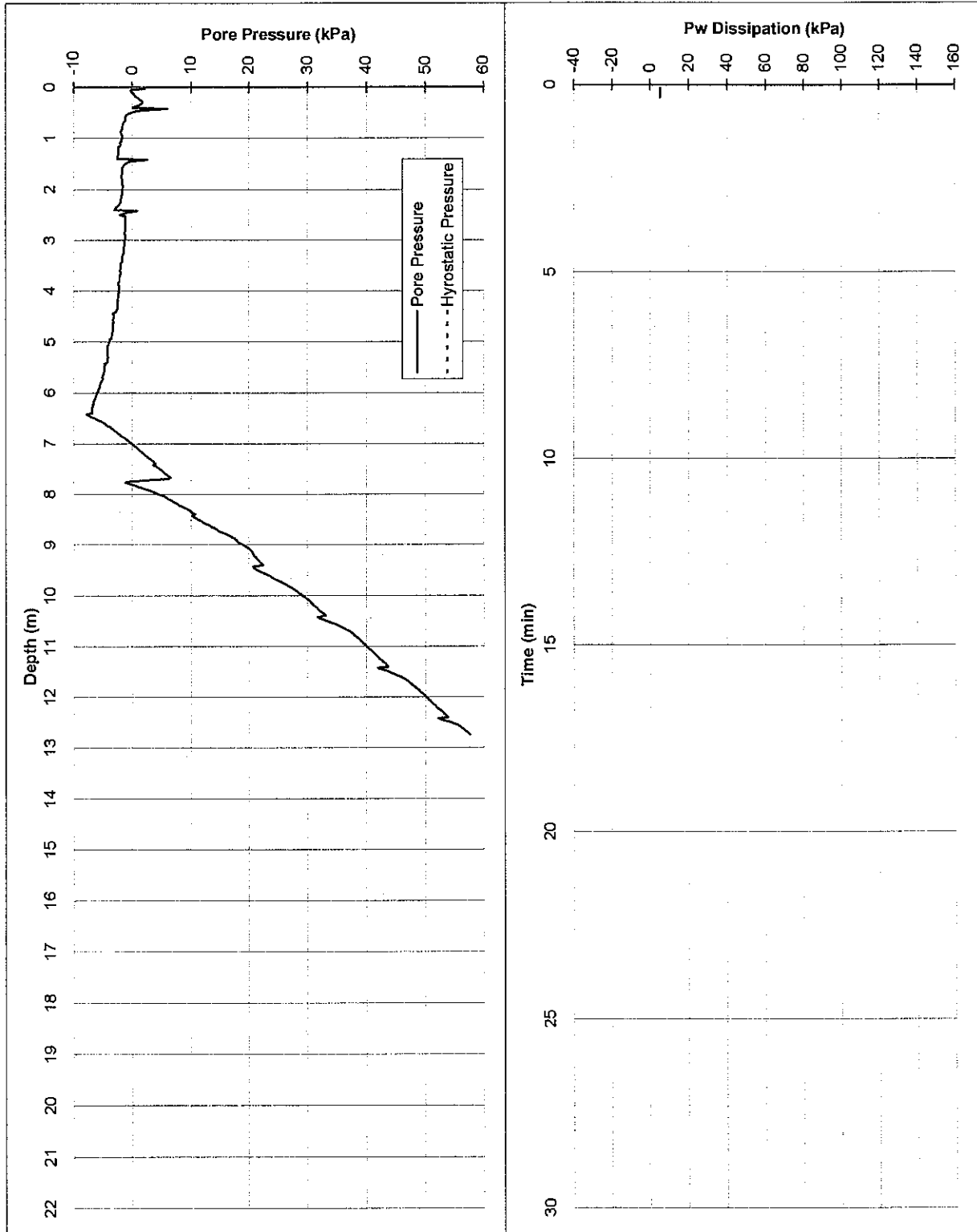
Project: Fiona Stanley Hospital

Probe No.: CPT 43 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

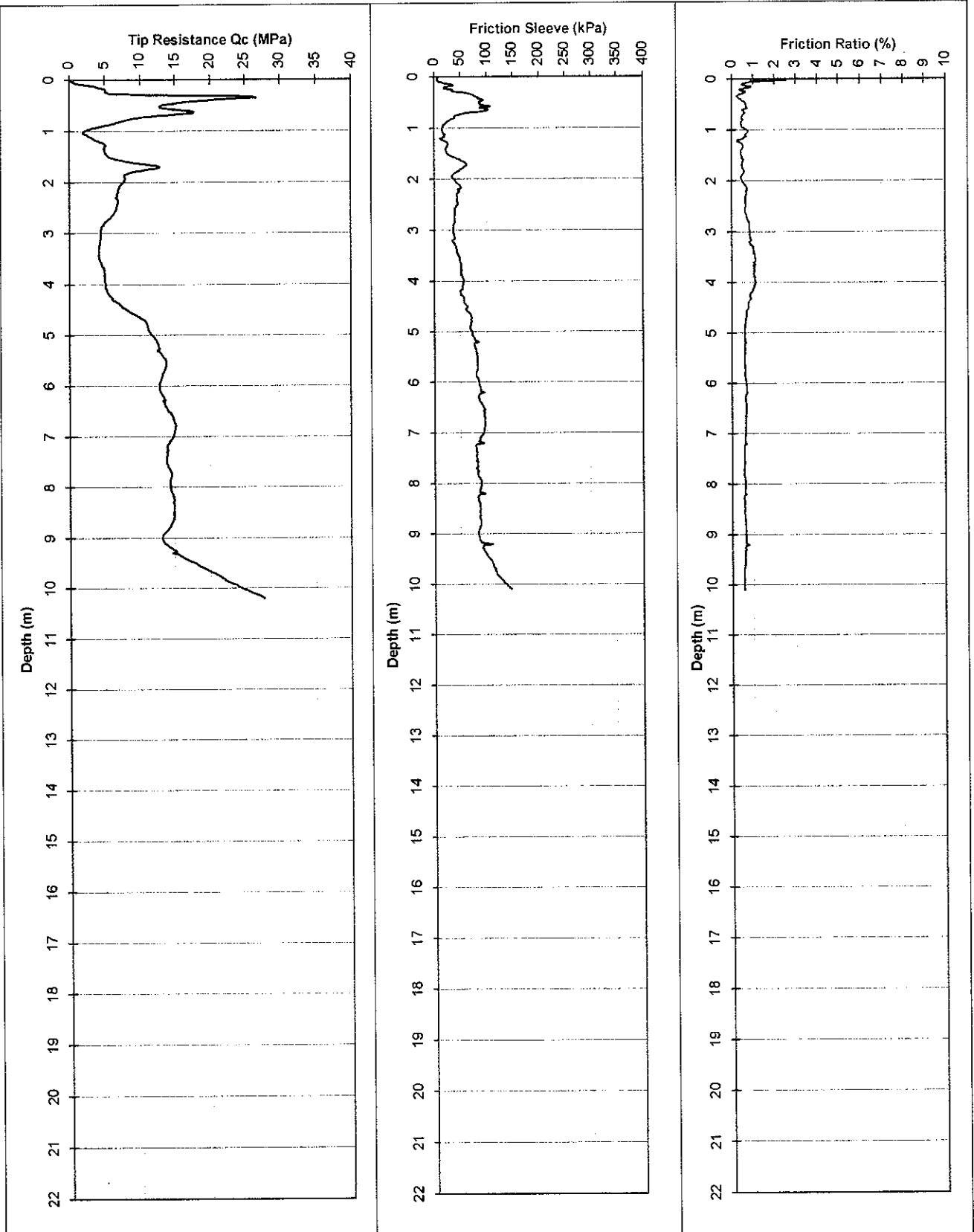
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 44 U

Job Number: 61/19514/01

Co-ordinates:



Water (m): 3.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999
and IRTP 2001 for friction reducer

ELECTRIC FRICTION-CONE PENETROMETER

Client: Department of Housing & Works

Date: 21/06/07

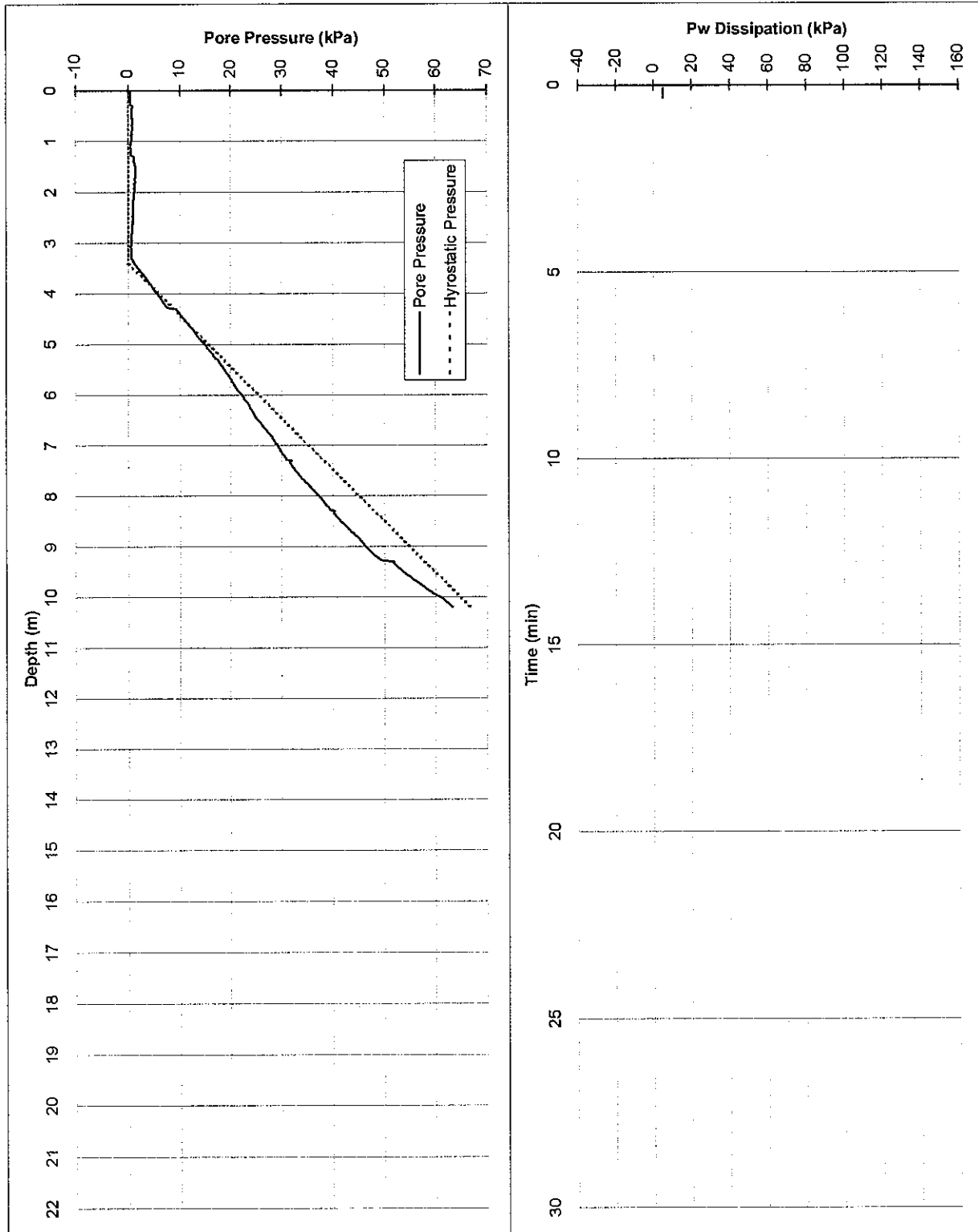
Project: Fiona Stanley Hospital

Probe No.: CPT 44 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



Appendix C

Results of Field Investigation Test Pits

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Excavation No **TP101**

Sheet No. 1 of 1

Project No. **GEOTHERD08304AB**Date excavated **1/5/08**

Date completed

Logged by : **CT**

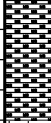
Checked by :

Position : E: 391170.1779, N: 6451573.212 (50 MGA94) Surface Elevation : 23.565m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information							material substance							
method	VE penetration	FH	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
↑ BH ↓			N			-23.5	0.0			TOPSOIL, fine to medium, grey; minor roots (grass) and organics	D	MD	100 200 300 400	
						-23.0	0.5			SAND, fine to medium grained, sub-rounded, mottled yellow and grey	D	MD		
						-22.5	1.0			SAND, fine to medium grained, sub-rounded, orange; well sorted	M	MD		
				D		-22.0	1.5			EXCAVATION TP101 TERMINATED AT 1.50 m				
						-21.5	2.0							
						-21.0	2.5							
						-20.5	3.0							
						-20.0	3.5							
method N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator support T Timbering						penetration  water  10 Oct., 73 Water Level on Date shown water inflow water outflow		samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test			classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit		consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense	

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP102**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391236.1418, N: 6451575.805 (50 MGA94) Surface Elevation : 21.503m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance										
method	VE	E penetration	F	H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
↑ ↓ BH					N			21.5	0.0			SAND, fine to medium grained, grey; trace organics and fine roots	D	L	100	TOPSOIL
								21.0	0.5			D	MD	200		
								20.5	1.0			M	300			
								20.0	1.5				400			
								19.5	2.0			EXCAVATION TP102 TERMINATED AT 2.20 m				
								19.0	2.5							
								18.5	3.0							
								18.0	3.5							
method		penetration			samples & field tests			classification symbols & soil description			consistency / relative density					
N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator					U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test			Based on Unified Classification System			VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard					
support T Timbering		water 10 Oct., 73 Water Level on Date shown water inflow water outflow						moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit			VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense					

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP103**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 390893.1551, N: 6451225.787 (50 MGA94) Surface Elevation : 31.627m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance							
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
VE	E	F	H			0.0			SAND, fine to medium grained, grey; fine roots, organics	D	MD	100	TOPSOIL
BH		N				0.5			SAND, fine to medium grained, sub-rounded, yellow mottled grey; moderately sorted	D	MD	200	
						1.0						300	
						1.5			becoming orange, moist	M	D	400	
						2.0							
						2.5			EXCAVATION TP103 TERMINATED AT 2.50 m				
						2.9							
						3.0							
						3.5							
						3.8							
						4.0							
						4.2							
						4.4							
						4.6							
						4.8							
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						37.0							
						37.2							
						37.4							
						37.6							
						37.8							
						38.0							
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						38.4							
						38.6							
						38.8							
						39.0							
						39.2							

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:53

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP104**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391223.7775, N: 6451462.708 (50 MGA94) Surface Elevation : 20.628m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance							
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
VE						0.0			TOPSOIL, fine to medium, grey; trace organics	D	MD	100	
E						0.5			SAND, fine to medium grained, sub-rounded, grey	D	D	200	
F						1.0			SAND, fine to medium grained, sub-rounded, orange / brown; iron stained, some weakly cemented patches	D	D	300	
H						1.5				M	D	400	
N						2.0							
						2.5							
						3.0							
						3.5							
						3.6			EXCAVATION TP104 TERMINATED AT 3.60 m				
						3.7							
						3.8							
						3.9							
						4.0							
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						4.2							
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						18.6							

method N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator	penetration 10 Oct., 73 Water Level on Date shown water inflow water outflow	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP105**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391110.6994, N: 6451380.261 (50 MGA94) Surface Elevation : 28.182m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information							material substance												
method	VE	E	penetration	F	H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations		
↑ BH ↓	—	—	—	—	—	—	—		0.0	0.0			SAND, fine to medium grained, grey; minor organics, some roots	D	MD	100	TOPSOIL		
	—	—	—	—	—	—	—		28.0	0.5			0.5	SAND, fine to medium grained, sub-rounded, yellow mottled grey; occasional large roots (5cm diameter)	D	MD		200	
	—	—	—	—	—	—	—		27.5	1.0			1.0	becoming orange				300	
	—	—	—	—	—	—	—		27.0	1.5			1.5					400	
	—	—	—	—	—	—	—		26.5	2.0			2.0						
	—	—	—	—	—	—	—		26.0	2.5			2.5						
	—	—	—	—	—	—	—		25.5	3.0			3.0						
	—	—	—	—	—	—	—		25.0	3.5			3.5						
	—	—	—	—	—	—	—		24.5										
	—	—	—	—	—	—	—		—	2.5			2.5			EXCAVATION TP105 TERMINATED AT 2.50 m			
									25.5										
									3.0										
									25.0										
									3.5										
									24.5										
method		penetration				samples & field tests				classification symbols & soil description				consistency / relative density					
N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator						U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test				Based on Unified Classification System				VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard					
support T Timbering		water  10 Oct., 73 Water Level on Date shown water inflow water outflow								moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit				VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense					

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP106**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391231.0379, N: 6451366.841 (50 MGA94) Surface Elevation : 24.995m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance										
method	VE	E	F	H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
↑	BH	↓			N			24.995	0.0			SAND, fine to medium grained, sub-rounded, grey; fine roots, minor organics	D	MD	100	TOPSOIL
								24.5	0.5			SAND, fine to medium grained, sub-rounded, mottled grey and yellow; moderately well sorted	D	L	200	
								24.0	1.0			SAND, fine to medium grained, sub-rounded, orange; moderately well sorted	D	MD	300	
								23.5	1.5					400		
								23.0	2.0							
								22.5	2.5							
								22.0	3.0			becoming fine				
								21.5	3.5			EXCAVATION TP106 TERMINATED AT 3.00 m Collapse				

method		penetration		samples & field tests		classification symbols & soil description		consistency / relative density	
N	Natural Exposure			U50	- Undisturbed Sample 50mm diameter	Based on Unified Classification System	moisture	VS	- Very Soft
X	Existing Excavation			U63	- Undisturbed Sample 63mm diameter			S	- Soft
BH	Backhoe Bucket			D	- Disturbed Sample			F	- Firm
B	Bulldozer Blade			B	- Bulk Disturbed Sample			St	- Stiff
R	Ripper			MC	- Moisture Content			VSt	- Very Stiff
E	Excavator			HP	- Hand Penetrometer (UCS kPa)			H	- Hard
				VS	- Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)			VL	- Very Loose
				PBT	- Plate Bearing Test			L	- Loose
								MD	- Medium Dense
								D	- Dense
								VD	- Very Dense

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:54

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP107**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391343.4493, N: 6451348.457 (50 MGA94) Surface Elevation : 23.012m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance					
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density
N	VE				23.0	0.0			TOPSOIL , fine to medium, grey; roots up to 3cm diameter, organics	D	MD
BH	U				22.5	0.5			SAND , fine to medium grained, sub-rounded, pale grey	D	MD
B					22.0	1.0					
R					21.5	1.5			becoming yellow		
E					21.0	2.0			EXCAVATION TP107 TERMINATED AT 2.00 m		
					20.5	2.5					
					20.0	3.0					
					19.5	3.5					

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/05/2008 11:54

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP109**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391023.9685, N: 6451260.045 (50 MGA94) Surface Elevation : 26.034m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance					
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density
N	VE				26.0	0.0			SAND, fine to medium grained, grey; roots from scrub, minor organics	D	MD
X	UE				25.5	0.5			SAND, fine to medium grained, sub-rounded, mottled yellow and grey; moderately well sorted	D	MD
BH	UE				25.0	1.0			becoming yellow		
B	UE				24.5	1.5			becoming orange, moist, grainsize increasing gradually downward to medium grained dominant	M	
R	UE				24.0	2.0					
E	UE				23.5	2.5					
					23.0	3.0			EXCAVATION TP109 TERMINATED AT 2.80 m		
					22.5	3.5					

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:54

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Excavation No **TP110**

Sheet No. 1 of 1

Project No. ***GEOTHERD08304AB***Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391189.1582, N: 6451288.12 (50 MGA94) Surface Elevation : 27.291m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information							material substance							
method	VE penetration	F H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
</														

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP111**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

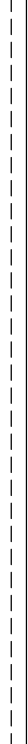
Checked by :

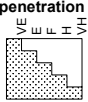
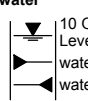
Position : E: 391365.5064, N: 6451251.186 (50 MGA94) Surface Elevation : 28.824m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance										
method	VE	E penetration	F	H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
↑ BH ↓					N			28.824	0.0			SAND, fine to medium grained, grey; fine roots and minor organics	D	MD	100	TOPSOIL
								28.5	0.5			SAND, fine to medium grained, sub-rounded, yellow mottled grey; moderately well sorted	D	MD	200	
								28.0	1.0			SAND, fine to medium grained, sub-rounded, orange / yellow; well sorted	D	MD	300	
								27.5	1.5						400	
								27.0	2.0			becoming fine grained				
								26.5	2.5			EXCAVATION TP111 TERMINATED AT 2.50 m				
								26.0	3.0							
								25.5	3.5							
								25.0								
method		penetration				samples & field tests				classification symbols & soil description			consistency / relative density			
N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator		 water 10 Oct., 73 Water Level on Date shown water inflow water outflow				U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test				Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit			VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense			

method N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator	penetration  water  10 Oct., 73 Water Level on Date shown water inflow water outflow	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP112**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

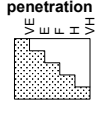
Position : E: 390870.1272, N: 6451168.292 (50 MGA94) Surface Elevation : 27.742m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance					
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density
N	U				0.0				SAND, fine to medium grained, grey; fine roots and organics	D	MD
					27.5						
					0.5				SAND, fine to medium grained, sub-rounded, grey; moderately well sorted		
					27.0				SAND, fine to medium grained, sub-rounded, yellow; well sorted		
					1.0						
					1.5				becoming orange		
					2.0						
					2.5				EXCAVATION TP112 TERMINATED AT 2.30 m		
					2.5						
					25.0						
					3.0						
					24.5						
					3.5						
					24.0						

method	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator	 10 Oct., 73 Water Level on Date shown water inflow water outflow	U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP113**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391043.626, N: 6451150.05 (50 MGA94) Surface Elevation : 22.972m (AHD)
Equipment type : JCB 8tonne backhoe Method : Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance					
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density
N	VE				22.97	0.0			SAND, fine to medium grained, grey; roots and minor organics		
BH	U				22.5	0.5			SAND, fine to medium grained, sub-rounded, grey; moderately well sorted		
					22.0	1.0			becoming white, well sorted		
					21.5	1.5					
					21.0	2.0					
					20.5	2.5			EXCAVATION TP113 TERMINATED AT 2.50 m		
					20.0	3.0					
					19.5	3.5					
					19.0						

method N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator support T Timbering	penetration  water  10 Oct., 73 Water Level on Date shown water inflow water outflow	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP114**

Sheet No. 1 of 1

Project No. **GEOtherD08304AB**

Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391213.7379, N: 6451165.203 (50 MGA94) Surface Elevation : 21.794m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance							
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
VE						0.0			SAND, fine to medium grained, grey; fine roots and organics	D	MD	100	TOPSOIL
E						21.5						200	
F						0.5			SAND, fine to medium grained, sub-rounded, pale grey; moderately well sorted	D	MD	300	
H						21.0						400	
						1.0							
						20.5							
						1.5							
						20.0							
						2.0							
						19.5							
						2.5			EXCAVATION TP114 TERMINATED AT 2.50 m				
						19.0							
						3.0							
						18.5							
						3.5							
						18.0							
												</	

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:55

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP115**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **1/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391375.5112, N: 6451170.354 (50 MGA94) Surface Elevation : 29.853m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance							
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
VE						0.0			SAND, fine to medium grained, grey; minor roots and organics	D	MD	100	TOPSOIL
E						0.5			SAND, fine to medium grained, sub-rounded, mottled grey and yellow; moderately well sorted	D	MD	200	
F						1.0			SAND, fine to medium grained, sub-rounded, yellow; well sorted	D	MD	300	
H						1.5						400	
N						2.0			becoming moist	M			
						2.5							
						3.0							
						3.5			EXCAVATION TP115 TERMINATED AT 3.50 m				
						3.5							
						3.5							
						3.5							
						3.5							
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						3.5							
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COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:55

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP116**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 390954.0475, N: 6451041.296 (50 MGA94) Surface Elevation : 22.76m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance							
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
VE						0.0			SAND, fine to medium grained, grey; organics and fine roots	D	MD	100	TOPSOIL
E						0.5			SAND, fine to medium grained, sub-rounded, yellow mottled grey; moderately well sorted, fine roots	D	MD	200	
F						1.0						300	
H						1.5						400	
N						2.0			becoming orange/yellow				
						2.5							
						3.0			becoming fine grained, pale yellow				
						3.5							
						4.0							
						4.5							
						5.0							
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						6.0							
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						93.0							
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Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Excavation No **TP117**

Sheet No. 1 of 1

Project No. **GEOTHERD08304AB**Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391208.5514, N: 6451064.8 (50 MGA94) Surface Elevation : 22.05m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information							material substance							
method	VE penetration	FH	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH			N			22.0	0.0			SAND, fine to medium grained, grey; roots and organics	D	MD	100	TOPSOIL
						21.5	0.5			SAND, fine to medium grained, grey and yellow	D	D	200	
						21.0	1.0			SAND, fine to medium grained, sub-rounded, dark grey; moderately well sorted, trace organics	D	D	300	
						20.5	1.5			SAND, fine to medium grained, sub-rounded, pale grey / white; well sorted	D	MD	400	
						18.5	3.5			becoming pale brown				
EXCAVATION TP117 TERMINATED AT 4.00 m														
method		penetration		samples & field tests				classification symbols & soil description			consistency / relative density			
N Natural Exposure X Existing Excavation BH Backhoe Bucket B Bulldozer Blade R Ripper E Excavator				U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa) PBT - Plate Bearing Test				Based on Unified Classification System			VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard			
support		water						moisture			VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense			
T Timbering		 10 Oct., 73 Water Level on Date shown water inflow water outflow						D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit						

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP118**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391351.4327, N: 6451047.628 (50 MGA94) Surface Elevation : 26.351m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance					
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description	moisture condition	consistency / relative density
N	VE				26.0	0.0			TOPSOIL, fine to medium, grey; roots and minor organics	D	MD
BH	U				25.0	0.5			SAND, fine to medium grained, sub-rounded, yellow mottled grey; moderately well sorted	D	L
					24.0	1.0			becoming orange/yellow		
					23.5	2.5			EXCAVATION TP118 TERMINATED AT 2.75 m		
					22.5	3.0					
					22.0	3.5					
					21.5						
					21.0						
					20.5						
					20.0						
					19.5						
					19.0						
					18.5						
					18.0						
					17.5						
					17.0						
					16.5						
					16.0						
					15.5						
					15.0						
					14.5						
					14.0						
					13.5						
					13.0						
					12.5						
					12.0						
					11.5						
					11.0						
					10.5						
					10.0						
					9.5						
					9.0						
					8.5						
					8.0						
					7.5						
					7.0						
					6.5						
					6.0						
					5.5						
					5.0						
					4.5						
					4.0						
					3.5						
					3.0						
					2.5						
					2.0						
					1.5						
					1.0						
					0.5						
					0.0						

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Excavation

Excavation No **TP121**

Sheet No. 1 of 1

Project No. ***GEOTHERD08304AB***

Client : **BG & E**

Date excavated **2/5/08**

Principal :

Date completed

Project : ***Fiona Stanley Hospital***

Logged by : **CT**

Location : **Murdoch**

Checked by :

Position : E: 391237.0624, N: 6450920.632 (50 MGA94) Surface Elevation : 29.733m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

[illegible]

Engineering Log - Excavation

Client : **BG & E**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Excavation No **TP122**

Sheet No. 1 of 1

Project No. **GEOHERD08304AB**

Date excavated **2/5/08**

Date completed

Logged by : **CT**

Checked by :

Position : E: 391339.7915, N: 6450923.702 (50 MGA94) Surface Elevation : 29.173m (AHD)

Equipment type : JCB 8tonne backhoe

Method :

Excavation dimensions : 1.00m long 2.50m wide

excavation information						material substance														
method		penetration		support		ground water		samples & field tests		RL (m)	depth (m)	graphic log	classification symbol	material description		moisture condition	consistency / relative density	hand penetrometer	structure and additional observations	
VE	E	F	H											SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components			100 200 300 400			
↑		↓		↓																
BH																				

COFFEY_02.GLB Log EXCAVATION GH08304AB-EXCAVATION.GPJ DWG96148.GDW 12/06/2008 11:56

method

N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper
E Excavator

support

T Timbering

penetration



water

10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remoulded (uncorrected kPa)
PBT - Plate Bearing Test

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Appendix D

Rising Head permeability Testing

CLIENT: BG&E
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch
SUBJECT: Rising Head Permeability Testing
JOB NO: GEOTHERD08304AB



Borehole Number BH101

The method of calculation is outlined in BS5930:1999

Borehole/casing diameter 0.1 m
Elevation at borehole location 0.00 m,RL

$$k = \frac{A}{F(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

where:

k = permeability of the soil
A = cross-sectional area of borehole or casing (m²).
F = intake factor (refer to chart)
H₁ = variable head at time t₁
H₂ = variable head at time t₂

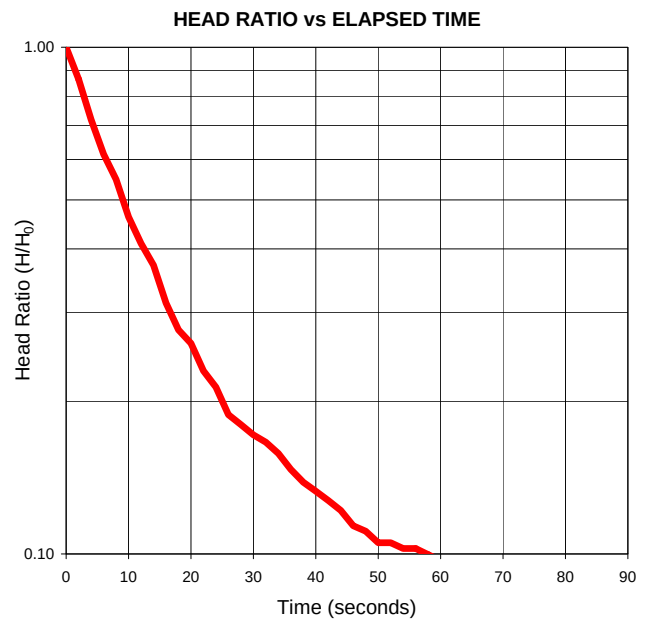
Depth below top of casing/standpipe to:
bottom of borehole 24.5 m
bottom of casing 21.5 m
height of casing above surface 0.8 m
initial ground water level 10.53 m

Intake Factor

Case (b)

No.	Time		Depth (m)	Water Level	Head (m)	H/H ₀	k (m/s) (from H ₀)	k (m/s) (previous)
	(mins)	(secs)						
1	0.0	0	10.89	-10.09	-0.36	1.00		
2	2.0	2	10.84	-10.04	-0.31	0.86	1.24E-04	1.24E-04
3	4.0	4	10.79	-9.99	-0.26	0.72	1.40E-04	1.56E-04
4	6.0	6	10.75	-9.95	-0.22	0.61	1.38E-04	1.35E-04
5	8.0	8	10.73	-9.93	-0.20	0.55	1.28E-04	9.76E-05
6	10.0	10	10.70	-9.90	-0.17	0.46	1.32E-04	1.45E-04
7	12.0	12	10.68	-9.88	-0.15	0.41	1.27E-04	1.03E-04
8	14.0	14	10.66	-9.86	-0.13	0.37	1.21E-04	8.48E-05
9	16.0	16	10.64	-9.84	-0.11	0.31	1.24E-04	1.45E-04
10	18.0	18	10.63	-9.83	-0.10	0.28	1.22E-04	1.04E-04
11	20.0	20	10.62	-9.82	-0.09	0.26	1.15E-04	5.28E-05
12	22.0	22	10.61	-9.81	-0.08	0.23	1.14E-04	1.06E-04
13	24.0	24	10.61	-9.81	-0.08	0.21	1.10E-04	6.40E-05
14	26.0	26	10.60	-9.80	-0.07	0.19	1.10E-04	1.06E-04
15	28.0	28	10.60	-9.80	-0.07	0.18	1.04E-04	3.85E-05
16	30.0	30	10.59	-9.79	-0.06	0.17	1.00E-04	4.03E-05
17	32.0	32	10.59	-9.79	-0.06	0.17	9.57E-05	2.80E-05
18	34.0	34	10.59	-9.79	-0.06	0.16	9.26E-05	4.38E-05
19	36.0	36	10.58	-9.78	-0.05	0.15	9.09E-05	6.21E-05
20	38.0	38	10.58	-9.78	-0.05	0.14	8.88E-05	4.97E-05
21	40.0	40	10.58	-9.78	-0.05	0.13	8.61E-05	3.48E-05
22	42.0	42	10.58	-9.78	-0.05	0.13	8.37E-05	3.63E-05
23	44.0	44	10.57	-9.77	-0.04	0.12	8.16E-05	3.79E-05
24	46.0	46	10.57	-9.77	-0.04	0.11	8.07E-05	6.02E-05
25	48.0	48	10.57	-9.77	-0.04	0.11	7.82E-05	2.11E-05
26	50.0	50	10.57	-9.77	-0.04	0.11	7.68E-05	4.38E-05
27	52.0	52	10.57	-9.77	-0.04	0.11	7.39E-05	0.00E+00
28	54.0	54	10.57	-9.77	-0.04	0.10	7.20E-05	2.27E-05
29	56.0	56	10.57	-9.77	-0.04	0.10	6.94E-05	0.00E+00
30	58.0	58	10.57	-9.77	-0.04	0.10	6.78E-05	2.34E-05
31	60.0	60	10.57	-9.77	-0.04	0.10	6.64E-05	2.40E-05
32	62.0	62	10.57	-9.77	-0.04	0.10	6.42E-05	0.00E+00
33	64.0	64	10.57	-9.77	-0.04	0.10	6.22E-05	0.00E+00
34	66.0	66	10.56	-9.76	-0.03	0.09	6.18E-05	5.02E-05
35	68.0	68	10.56	-9.76	-0.03	0.09	6.00E-05	0.00E+00
36	70.0	70	10.56	-9.76	-0.03	0.09	5.83E-05	0.00E+00
37	72.0	72	10.56	-9.76	-0.03	0.08	5.98E-05	1.10E-04
38	74.0	74	10.56	-9.76	-0.03	0.08	5.89E-05	2.99E-05
39	76.0	76	10.56	-9.76	-0.03	0.08	5.74E-05	0.00E+00
40	78.0	78	10.55	-9.75	-0.02	0.06	6.22E-05	2.45E-04
41	80.0	80	10.54	-9.74	-0.01	0.02	8.41E-05	9.37E-04
42	82.0	82	10.53	-9.73	0.00	0.00	#DIV/0!	#DIV/0!

Length of open hole (m) 23.70
Length of uncased hole (m) 3.00
Cross-sectional area (m²) 7.85E-03
Groundwater level (m) -9.7
Intake Factor 4.603491



Permeability Calculations

Case	Range	k (m/s)
1	1 - 20	8.9E-05
2	1 - 40	6.2E-05
3	30 - 40	4.6E-05
4	15 - 30	3.4E-05

PERMEABILITY vs ELAPSED TIME

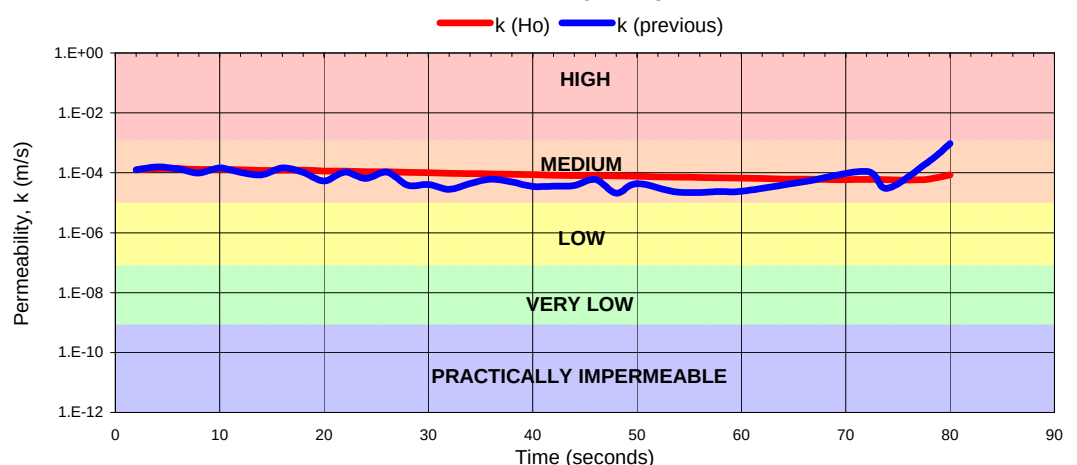


FIGURE 1

CLIENT: BG&E
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch
SUBJECT: Rising Head Permeability Testing
JOB NO: GEOTHERD08304AB



Borehole Number BH102

The method of calculation is outlined in BS5930:1999

Borehole/casing diameter 0.1 m
Elevation at borehole location 0.00 m,RL

$$k = \frac{A}{F(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

where:

k = permeability of the soil
A = cross-sectional area of borehole or casing (m²).
F = intake factor (refer to chart)
H₁ = variable head at time t₁
H₂ = variable head at time t₂

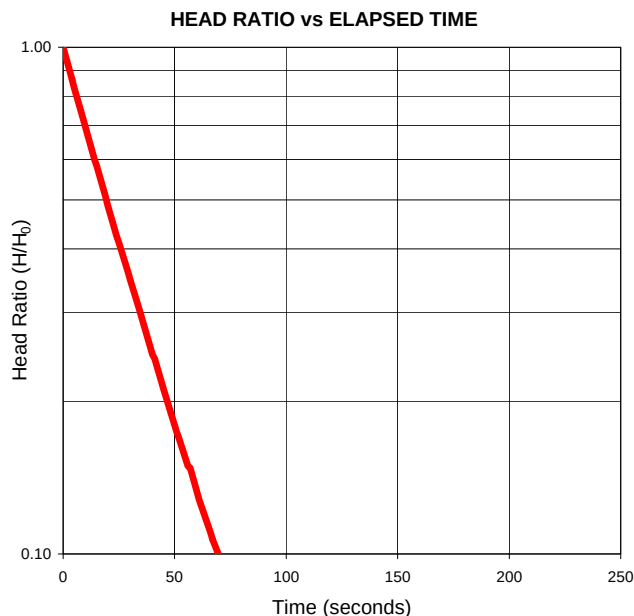
Depth below top of casing/standpipe to:
bottom of borehole 24.5 m
bottom of casing 21.5 m
height of casing above surface 0.8 m
initial ground water level 5.22 m

Intake Factor

Case (b)

No.	Time		Depth (m)	Water Level	Head (m)	H/H ₀	k (m/s) (from H ₀)	k (m/s) (previous)
	(mins)	(secs)						
1	0.0	0	6.07	-5.27	-0.85	1.00		
2	4.0	4	5.96	-5.16	-0.74	0.86	6.24E-05	6.24E-05
3	5.0	5	5.93	-5.13	-0.71	0.83	6.41E-05	7.10E-05
4	8.0	8	5.86	-5.06	-0.64	0.75	6.24E-05	5.94E-05
5	10.0	10	5.81	-5.01	-0.59	0.69	6.24E-05	6.26E-05
6	14.0	14	5.73	-4.93	-0.51	0.60	6.23E-05	6.20E-05
7	15.0	15	5.72	-4.92	-0.50	0.58	6.13E-05	4.74E-05
8	19.0	19	5.65	-4.85	-0.43	0.51	6.08E-05	5.88E-05
9	20.0	20	5.64	-4.84	-0.42	0.49	6.12E-05	6.83E-05
10	24.0	24	5.58	-4.78	-0.36	0.42	6.10E-05	6.05E-05
11	25.0	25	5.57	-4.77	-0.35	0.41	6.05E-05	4.79E-05
12	29.0	29	5.53	-4.73	-0.31	0.36	5.99E-05	5.57E-05
13	30.0	30	5.52	-4.72	-0.30	0.35	5.99E-05	6.20E-05
14	34.0	34	5.48	-4.68	-0.26	0.31	5.96E-05	5.67E-05
15	40.0	40	5.43	-4.63	-0.21	0.25	5.95E-05	5.94E-05
16	41.0	41	5.43	-4.63	-0.21	0.24	5.89E-05	3.27E-05
17	45.0	45	5.40	-4.60	-0.18	0.21	5.89E-05	5.96E-05
18	51.0	51	5.37	-4.57	-0.15	0.17	5.86E-05	5.57E-05
19	52.0	52	5.36	-4.56	-0.14	0.17	5.83E-05	4.67E-05
20	56.0	56	5.35	-4.55	-0.13	0.15	5.80E-05	5.36E-05
21	57.0	57	5.35	-4.55	-0.13	0.15	5.72E-05	1.35E-05
22	61.0	61	5.33	-4.53	-0.11	0.13	5.75E-05	6.18E-05
23	66.0	66	5.31	-4.51	-0.09	0.11	5.70E-05	5.05E-05
24	67.0	67	5.31	-4.51	-0.09	0.11	5.70E-05	5.53E-05
25	71.0	71	5.30	-4.50	-0.08	0.10	5.62E-05	4.44E-05
26	74.0	74	5.29	-4.49	-0.07	0.08	5.70E-05	7.40E-05
27	79.0	79	5.29	-4.49	-0.07	0.08	5.52E-05	2.97E-05
28	82.0	82	5.28	-4.48	-0.06	0.07	5.56E-05	6.38E-05
29	84.0	84	5.28	-4.48	-0.06	0.07	5.49E-05	2.94E-05
30	89.0	89	5.27	-4.47	-0.05	0.06	5.47E-05	5.16E-05
31	92.0	92	5.26	-4.46	-0.04	0.05	5.58E-05	8.77E-05
32	95.0	95	5.26	-4.46	-0.04	0.05	5.45E-05	1.37E-05
33	102.0	102	5.25	-4.45	-0.03	0.04	5.44E-05	5.29E-05
34	105.0	105	5.25	-4.45	-0.03	0.03	5.49E-05	7.35E-05
35	109.0	109	5.25	-4.45	-0.03	0.03	5.46E-05	4.66E-05
36	112.0	112	5.24	-4.44	-0.02	0.03	5.44E-05	4.55E-05
37	119.0	119	5.24	-4.44	-0.02	0.02	5.31E-05	3.25E-05
38	122.0	122	5.24	-4.44	-0.02	0.02	5.32E-05	5.69E-05
39	124.0	124	5.24	-4.44	-0.02	0.02	5.56E-05	2.02E-04
40	125.0	125	5.23	-4.43	-0.01	0.02	5.61E-05	1.18E-04
41	127.0	127	5.23	-4.43	-0.01	0.02	5.57E-05	3.10E-05
42	129.0	129	5.23	-4.43	-0.01	0.02	5.53E-05	3.22E-05
43	132.0	132	5.23	-4.43	-0.01	0.02	5.42E-05	4.39E-06
44	134.0	134	5.23	-4.43	-0.01	0.01	5.38E-05	2.69E-05
45	135.0	135	5.23	-4.43	-0.01	0.01	5.39E-05	6.96E-05
46	137.0	137	5.23	-4.43	-0.01	0.01	5.42E-05	7.42E-05
47	140.0	140	5.23	-4.43	-0.01	0.01	5.42E-05	5.42E-05
48	144.0	144	5.23	-4.43	-0.01	0.01	5.53E-05	9.52E-05
49	150.0	150	5.23	-4.43	-0.01	0.01	5.46E-05	3.80E-05
50	154.0	154	5.23	-4.43	-0.01	0.01	5.32E-05	0.00E+00
51	157.0	157	5.23	-4.43	-0.01	0.01	5.22E-05	0.00E+00
52	164.0	164	5.23	-4.43	0.00	0.01	5.35E-05	8.20E-05
53	167.0	167	5.22	-4.42	0.00	0.01	5.36E-05	5.99E-05
54	175.0	175	5.22	-4.42	0.00	0.00	5.23E-05	2.51E-05
55	179.0	179	5.22	-4.42	0.00	0.00	5.38E-05	1.23E-04
56	185.0	185	5.22	-4.42	0.00	0.00	5.58E-05	1.15E-04
57	188.0	188	5.22	-4.42	0.00	0.00	6.12E-05	3.94E-04
58	192.0	192	5.22	-4.42	0.00	0.00	6.61E-05	2.96E-04

Length of open hole (m) 23.70
Length of uncased hole (m) 3.00
Cross-sectional area (m²) 7.85E-03
Groundwater level (m) -4.4
Intake Factor 4.603491



Permeability Calculations

Case	Range	k (m/s)
1	1 - 58	6.6E-05
2	1 - 29	5.5E-05
3	30 - 58	7.6E-05
4	15 - 43	5.2E-05

PERMEABILITY vs ELAPSED TIME

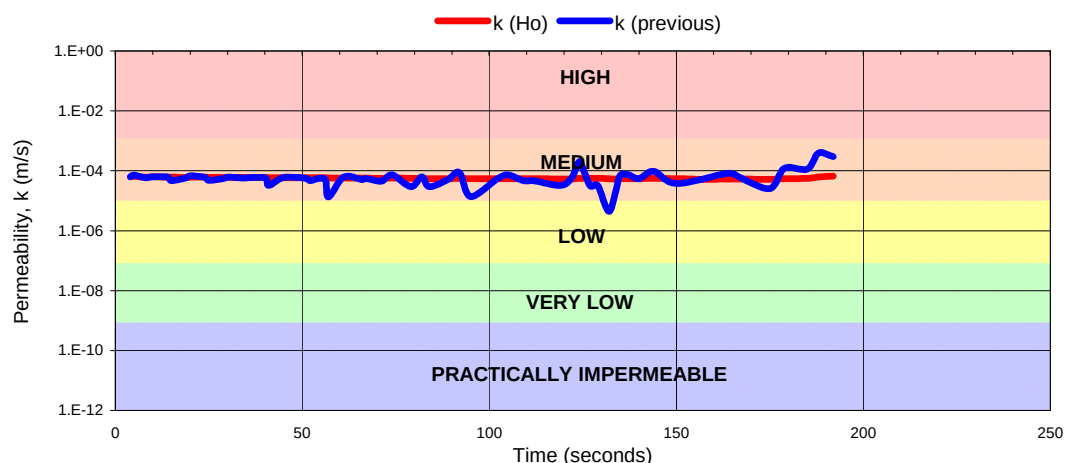


FIGURE 1

CLIENT: BG&E
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch
SUBJECT: Rising Head Permeability Testing
JOB NO: GEOTHERD08304AB



Borehole Number BH103

The method of calculation is outlined in BS5930:1999

Borehole/casing diameter 0.1 m
 Elevation at borehole location 0.00 m,RL

$$k = \frac{A}{F(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

where:

k = permeability of the soil
 A = cross-sectional area of borehole or casing (m²).
 F = intake factor (refer to chart)
 H₁ = variable head at time t₁
 H₂ = variable head at time t₂

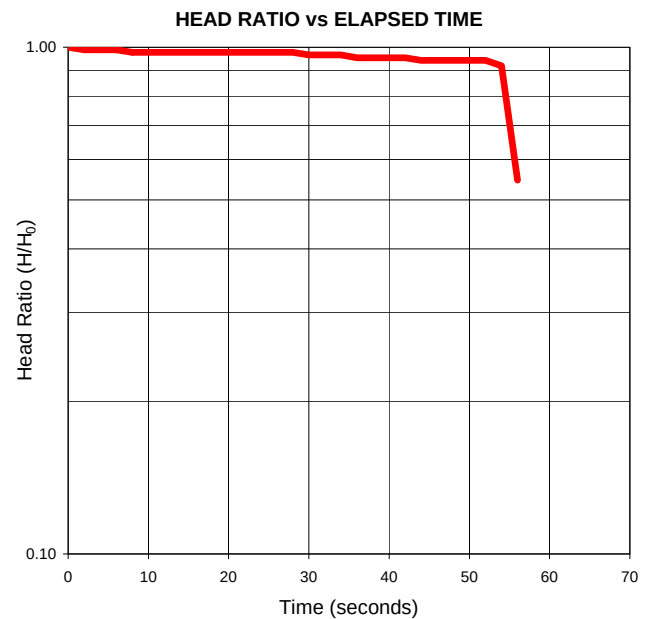
Depth below top of casing/standpipe to:
 bottom of borehole 24.5 m
 bottom of casing 21.5 m
 height of casing above surface 0.8 m
 initial ground water level 14.78 m

Intake Factor

Case (b)

No.	Time		Depth (m)	Water Level	Head (m)	H/H ₀	k (m/s) (from H ₀)	k (m/s) (previous)
	(mins)	(secs)						
1	0.0	0	14.87	-14.07	-0.09	1.00		
2	2.0	2	14.87	-14.07	-0.09	0.99	9.98E-06	9.98E-06
3	4.0	4	14.87	-14.07	-0.09	0.99	4.99E-06	0.00E+00
4	6.0	6	14.87	-14.07	-0.09	0.99	3.33E-06	0.00E+00
5	8.0	8	14.86	-14.06	-0.08	0.98	5.02E-06	1.01E-05
6	10.0	10	14.86	-14.06	-0.08	0.98	4.01E-06	0.00E+00
7	12.0	12	14.86	-14.06	-0.08	0.98	3.35E-06	0.00E+00
8	14.0	14	14.86	-14.06	-0.08	0.98	2.87E-06	0.00E+00
9	16.0	16	14.86	-14.06	-0.08	0.98	2.51E-06	0.00E+00
10	18.0	18	14.86	-14.06	-0.08	0.98	2.23E-06	0.00E+00
11	20.0	20	14.86	-14.06	-0.08	0.98	2.01E-06	0.00E+00
12	22.0	22	14.86	-14.06	-0.08	0.98	1.82E-06	0.00E+00
13	24.0	24	14.86	-14.06	-0.08	0.98	1.67E-06	0.00E+00
14	26.0	26	14.86	-14.06	-0.08	0.98	1.54E-06	0.00E+00
15	28.0	28	14.86	-14.06	-0.08	0.98	1.43E-06	0.00E+00
16	30.0	30	14.86	-14.06	-0.08	0.97	2.02E-06	1.02E-05
17	32.0	32	14.86	-14.06	-0.08	0.97	1.89E-06	0.00E+00
18	34.0	34	14.86	-14.06	-0.08	0.97	1.78E-06	0.00E+00
19	36.0	36	14.86	-14.06	-0.08	0.95	2.26E-06	1.03E-05
20	38.0	38	14.86	-14.06	-0.08	0.95	2.14E-06	0.00E+00
21	40.0	40	14.86	-14.06	-0.08	0.95	2.03E-06	0.00E+00
22	42.0	42	14.86	-14.06	-0.08	0.95	1.93E-06	0.00E+00
23	44.0	44	14.86	-14.06	-0.08	0.94	2.32E-06	1.05E-05
24	46.0	46	14.86	-14.06	-0.08	0.94	2.22E-06	0.00E+00
25	48.0	48	14.86	-14.06	-0.08	0.94	2.13E-06	0.00E+00
26	50.0	50	14.86	-14.06	-0.08	0.94	2.04E-06	0.00E+00
27	52.0	52	14.86	-14.06	-0.08	0.94	1.97E-06	0.00E+00
28	54.0	54	14.86	-14.06	-0.08	0.92	2.68E-06	2.13E-05
29	56.0	56	14.83	-14.03	-0.05	0.55	1.84E-05	4.43E-04
30	58.0	58	14.78	-13.98	0.00	0.00	#DIV/0!	#DIV/0!

Length of open hole (m) 23.70
 Length of uncased hole (m) 3.00
 Cross-sectional area (m²) 7.85E-03
 Groundwater level (m) -14.0
 Intake Factor 4.603491



Permeability Calculations

Case	Range	k (m/s)
1	1 - 20	2.1E-06
2	1 - 25	2.1E-06
3	15 - 25	3.1E-06
4	20 - 28	4.0E-06

PERMEABILITY vs ELAPSED TIME

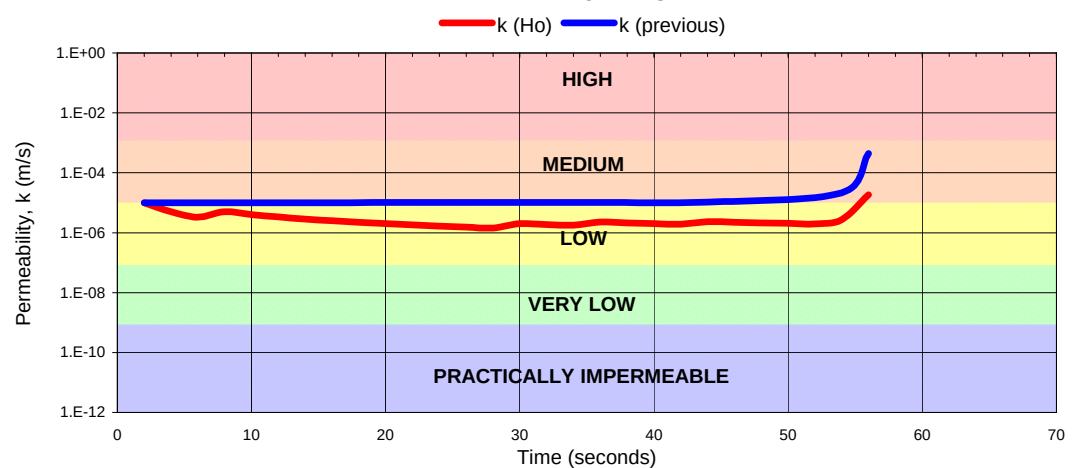


FIGURE 1

CLIENT: BG&E
PROJECT: Fiona Stanley Hospital
LOCATION: Murdoch
SUBJECT: Rising Head Permeability Testing
JOB NO: GEOTHERD08304AB



Borehole Number BH104

The method of calculation is outlined in BS5930:1999

Borehole/casing diameter 0.1 m
Elevation at borehole location 0.00 m,RL

$$k = \frac{A}{F(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

where:

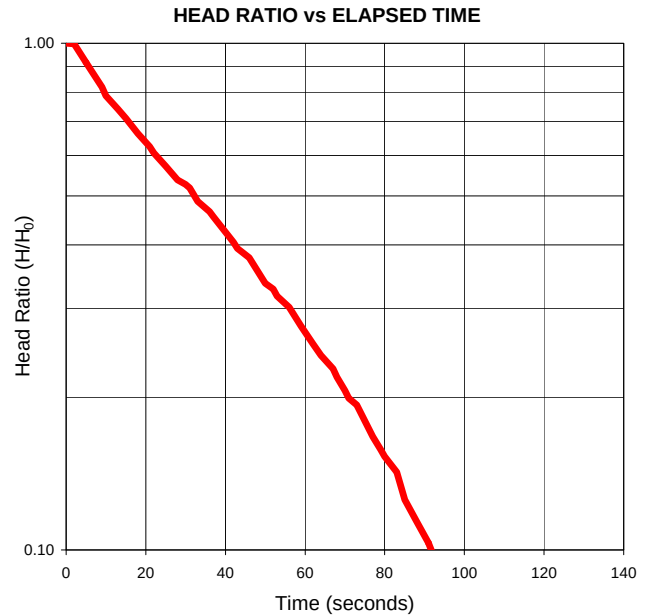
k = permeability of the soil
A = cross-sectional area of borehole or casing (m²).
F = intake factor (refer to chart)
H₁ = variable head at time t₁
H₂ = variable head at time t₂

Depth below top of casing/standpipe to:
bottom of borehole 24.5 m
bottom of casing 21.5 m
height of casing above surface 0.8 m
initial ground water level 6.03 m

Intake Factor Case (b)

No.	Time		Depth (m)	Water Level	Head (m)	H/H ₀	k (m/s) (from H ₀)	k (m/s) (previous)
	(mins)	(secs)						
1	0.0	0	6.87	-6.07	-0.84	1.00		
2	2.0	2	6.87	-6.07	-0.84	1.00	2.03E-06	2.03E-06
3	5.0	5	6.80	-6.00	-0.77	0.92	3.00E-05	4.87E-05
4	9.0	9	6.72	-5.92	-0.69	0.82	3.77E-05	4.73E-05
5	10.0	10	6.69	-5.89	-0.66	0.79	4.07E-05	6.80E-05
6	13.0	13	6.66	-5.86	-0.63	0.74	3.93E-05	3.44E-05
7	15.0	15	6.63	-5.83	-0.60	0.71	3.89E-05	3.62E-05
8	18.0	18	6.59	-5.79	-0.56	0.66	3.89E-05	3.93E-05
9	21.0	21	6.56	-5.76	-0.53	0.63	3.82E-05	3.35E-05
10	22.0	22	6.54	-5.74	-0.51	0.61	3.87E-05	4.93E-05
11	25.0	25	6.51	-5.71	-0.48	0.57	3.81E-05	3.43E-05
12	28.0	28	6.48	-5.68	-0.45	0.54	3.78E-05	3.53E-05
13	30.0	30	6.47	-5.67	-0.44	0.53	3.65E-05	1.71E-05
14	31.0	31	6.47	-5.67	-0.44	0.52	3.62E-05	2.71E-05
15	33.0	33	6.44	-5.64	-0.41	0.49	3.71E-05	5.23E-05
16	36.0	36	6.42	-5.62	-0.39	0.47	3.63E-05	2.69E-05
17	37.0	37	6.41	-5.61	-0.38	0.45	3.64E-05	3.96E-05
18	42.0	42	6.37	-5.57	-0.34	0.40	3.68E-05	3.96E-05
19	43.0	43	6.36	-5.56	-0.33	0.39	3.70E-05	4.56E-05
20	46.0	46	6.35	-5.55	-0.32	0.38	3.62E-05	2.45E-05
21	50.0	50	6.31	-5.51	-0.28	0.34	3.72E-05	4.97E-05
22	52.0	52	6.31	-5.51	-0.28	0.33	3.66E-05	2.14E-05
23	53.0	53	6.30	-5.50	-0.27	0.32	3.70E-05	5.66E-05
24	56.0	56	6.28	-5.48	-0.25	0.30	3.65E-05	2.84E-05
25	59.0	59	6.26	-5.46	-0.23	0.28	3.72E-05	4.91E-05
26	62.0	62	6.25	-5.45	-0.22	0.26	3.76E-05	4.57E-05
27	64.0	64	6.23	-5.43	-0.20	0.24	3.78E-05	4.48E-05
28	67.0	67	6.22	-5.42	-0.19	0.23	3.77E-05	3.45E-05
29	68.0	68	6.22	-5.42	-0.19	0.22	3.81E-05	6.34E-05
30	70.0	70	6.20	-5.40	-0.17	0.21	3.85E-05	5.23E-05
31	71.0	71	6.20	-5.40	-0.17	0.20	3.88E-05	5.99E-05
32	73.0	73	6.19	-5.39	-0.16	0.19	3.84E-05	2.58E-05
33	77.0	77	6.17	-5.37	-0.14	0.17	3.96E-05	6.18E-05
34	79.0	79	6.16	-5.36	-0.13	0.16	3.99E-05	4.98E-05
35	80.0	80	6.16	-5.36	-0.13	0.15	4.00E-05	5.21E-05
36	83.0	83	6.15	-5.35	-0.12	0.14	4.01E-05	4.11E-05
37	85.0	85	6.14	-5.34	-0.11	0.13	4.16E-05	1.06E-04
38	88.0	88	6.13	-5.33	-0.10	0.11	4.21E-05	5.64E-05
39	91.0	91	6.12	-5.32	-0.09	0.10	4.26E-05	5.60E-05
40	92.0	92	6.11	-5.31	-0.08	0.10	4.30E-05	8.03E-05
41	93.0	93	6.11	-5.31	-0.08	0.09	4.37E-05	1.06E-04
42	97.0	97	6.10	-5.30	-0.07	0.08	4.48E-05	7.13E-05
43	98.0	98	6.09	-5.29	-0.06	0.08	4.49E-05	5.25E-05
44	99.0	99	6.09	-5.29	-0.06	0.07	4.55E-05	1.10E-04
45	100.0	100	6.08	-5.28	-0.05	0.06	4.72E-05	2.12E-04
46	105.0	105	6.07	-5.27	-0.04	0.05	4.99E-05	1.05E-04
47	106.0	106	6.07	-5.27	-0.04	0.04	5.03E-05	8.98E-05
48	107.0	107	6.06	-5.26	-0.03	0.04	5.17E-05	1.95E-04
49	108.0	108	6.06	-5.26	-0.03	0.03	5.32E-05	2.20E-04
50	112.0	112	6.05	-5.25	-0.02	0.02	5.70E-05	1.58E-04
51	113.0	113	6.05	-5.25	-0.01	0.02	6.08E-05	4.91E-04
52	115.0	115	6.04	-5.24	-0.01	0.02	6.19E-05	1.22E-04
53	118.0	118	6.04	-5.24	0.00	0.01	7.41E-05	5.43E-04
54	122.0	122	6.02	-5.22	0.01	-0.01	#NUM!	#NUM!

Length of open hole (m) 23.70
Length of uncased hole (m) 3.00
Cross-sectional area (m²) 7.85E-03
Groundwater level (m) -5.2
Intake Factor 4.603491



Permeability Calculations

Case	Range	k (m/s)
1	1 - 53	7.4E-05
2	1 - 30	3.8E-05
3	30 - 53	1.3E-04
4	15 - 45	5.2E-05

PERMEABILITY vs ELAPSED TIME

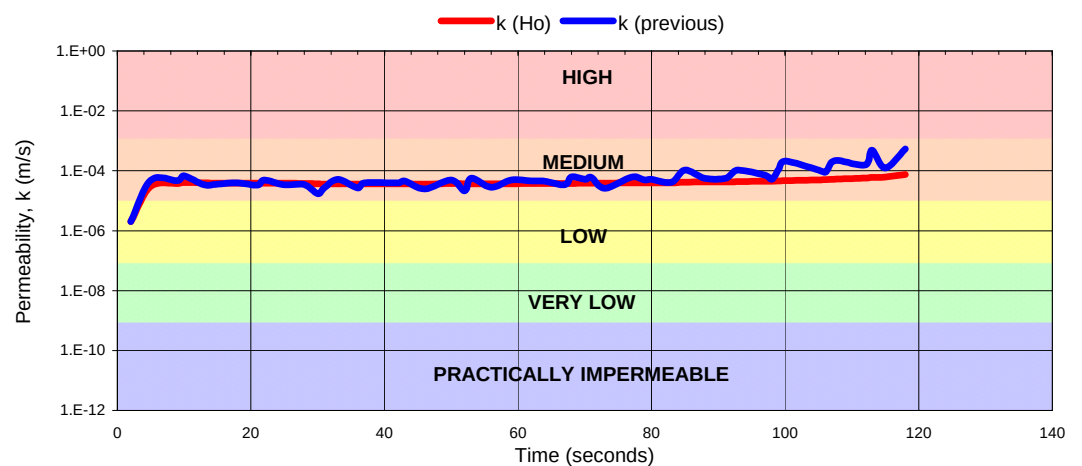


FIGURE 1

Appendix E

Seismic profiling

TABLE E1: RESULTS, LINE 1

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.2	350	150	0.39	112.4	40.5
2.2 – 3.7	380	180	0.36	158.1	58.3
3.7 – 7	1700	245	--	--	--
7 – 11.4	1700	300	--	--	--
11.4 - 16	1700	310	--	--	--
16 – 21.3	1700	314	--	--	--

TABLE E2: RESULTS, LINE 2

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.15	450	170	0.42	147.4	52.0
2.15 – 3.8	500	185	0.42	175.0	61.6
3.8 – 6.6	1600	230	--	--	--
6.6 – 10.8	1600	280	--	--	--
10.8 – 15.9	1600	290	--	--	--
15.9 – 20.4	1600	310	--	--	--

TABLE E3: RESULTS, LINE 3

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 1.7	350	157	0.37	121.9	44.4
1.7 – 3.4	400	170	0.39	144.6	52.0

3.4 – 6.9	450	238	0.31	266.3	102.0
6.9 – 9.2	1700	290	--	--	--
9.2 – 11.1	1700	275	--	--	--
11.1 – 15.9	1700	302	--	--	--
15.9 – 20.4	1700	313	--	--	--

TABLE E4: RESULTS, LINE 4

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2	350	142	0.40	101.7	36.3
2 – 4	400	189	0.36	174.4	64.3
4 – 6.8	450	292	0.14	348.8	153.5
6.8 – 9.3	1700	305	--	--	--
9.3 – 10.8	1700	232	--	--	--
10.8 – 15.4	1700	283	--	--	--
15.4 – 20	1700	311	--	--	--

TABLE E5: RESULTS, LINE 5

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2	350	149	0.39	111.0	40.0
2 – 3.9	400	190	0.35	176.0	65.0
3.9 – 6.9	450	278	0.2	331.5	139.1
6.9 – 9	1600	285	--	--	--
9 – 114	1600	300	--	--	--

11.4 – 15.4	1600	289	--	--	--
15.4 – 20	1600	302	--	--	--

TABLE E6: RESULTS, LINE 6

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.4	350	134	0.41	91.4	32.3
2.4 – 4.8	400	246	0.20	260.5	108.9
4.8 – 7.2	450	262	0.24	307.3	123.6
7.2 – 9	1700	289	--	--	--
9- 11.4	1700	289	--	--	--
11.4 – 15.9	1700	326	--	--	--
15.9 – 19.3	1700	303	--	--	--
19.3 – 24	1700	351	--	--	--

TABLE E7: RESULTS, LINE 7

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.4	350	163	0.36	130.2	47.8
2.4 – 5.5	400	245	0.20	259.3	108.0
5.5 – 7.8	450	266	0.23	313.7	127.4
7.8 – 9.3	1700	276	--	--	--
9.3 – 12.4	1700	280	--	--	--
12.4 – 16.3	1700	333	--	--	--
16.3 – 20.1	1700	307	--	--	--

TABLE E8: RESULTS, LINE 8

Depth	P-Wave	S-Wave	Poisson's	Dynamic	Dynamic
-------	--------	--------	-----------	---------	---------

Interval (m)	Velocity (m/s)	Velocity (m/s)	Ratio	Young's Modulus E (MPa)	Shear Modulus G (MPa)
0 – 2.1	350	103	0.45	55.5	19.1
2.1 – 5	450	276	0.20	328.7	137.1
5 – 7.6	1700	286	--	--	--
7.6 – 11.7	1700	305	--	--	--
11.7 – 15.3	1700	314	--	--	--
15.3 – 21.1	1700	321	--	--	--
21.1 – 25.5	1700	323	--	--	--

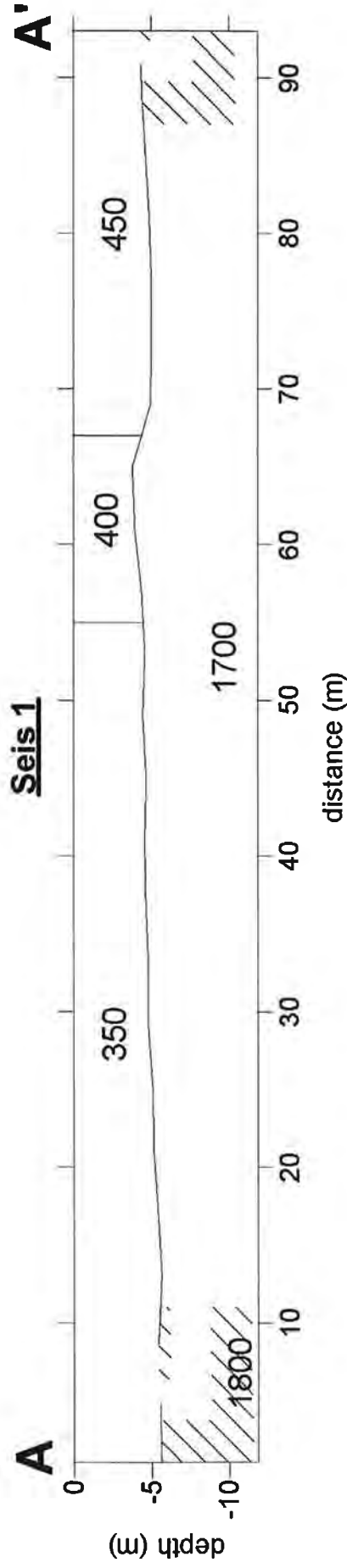
TABLE E9: RESULTS, LINE 9

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.1	350	130	0.42	86.4	30.4
2.1 – 4.9	450	265	0.23	312.1	126.4
4.9 – 7.6	450	275	0.20	327.2	136.1
7.6 – 11.4	2200	288	--	--	--
11.4 - 16	2200	295	--	--	--
16 – 21.3	2200	347	--	--	--
21.3 – 25.5	2200	402	--	--	--

TABLE E10: RESULTS, LINE 10

Depth Interval (m)	P-Wave Velocity (m/s)	S-Wave Velocity (m/s)	Poisson's Ratio	Dynamic Young's Modulus E (MPa)	Dynamic Shear Modulus G (MPa)
0 – 2.1	350	134	0.41	91.4	32.3
2.1 – 4.2	420	258	0.20	286.8	119.8
4.2 – 6.1	450	263	0.24	308.9	124.5

6.1 – 8.7	1700	316	--	--	--
8.7 – 11.1	1700	320	--	--	--
11.1 – 16.9	1700	272	--	--	--
16.9 – 20.7	1700	277	--	--	--
20.7– 24.1	1700	282	--	--	--
24.1– 27.1	1700	301	--	--	--



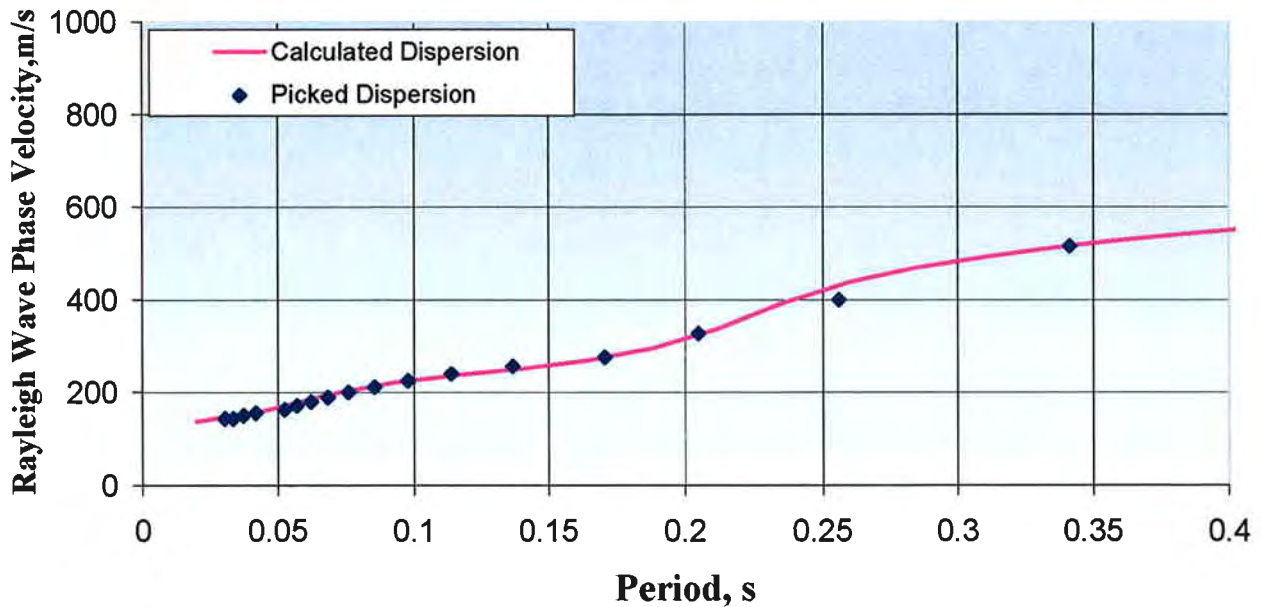
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approved		project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH
date	5/06/08	title:	SECTION SEIS 1
scale		project no:	GEOHERD00023AA
original size	A3	fig no:	FIGURE B-1A
		rev:	

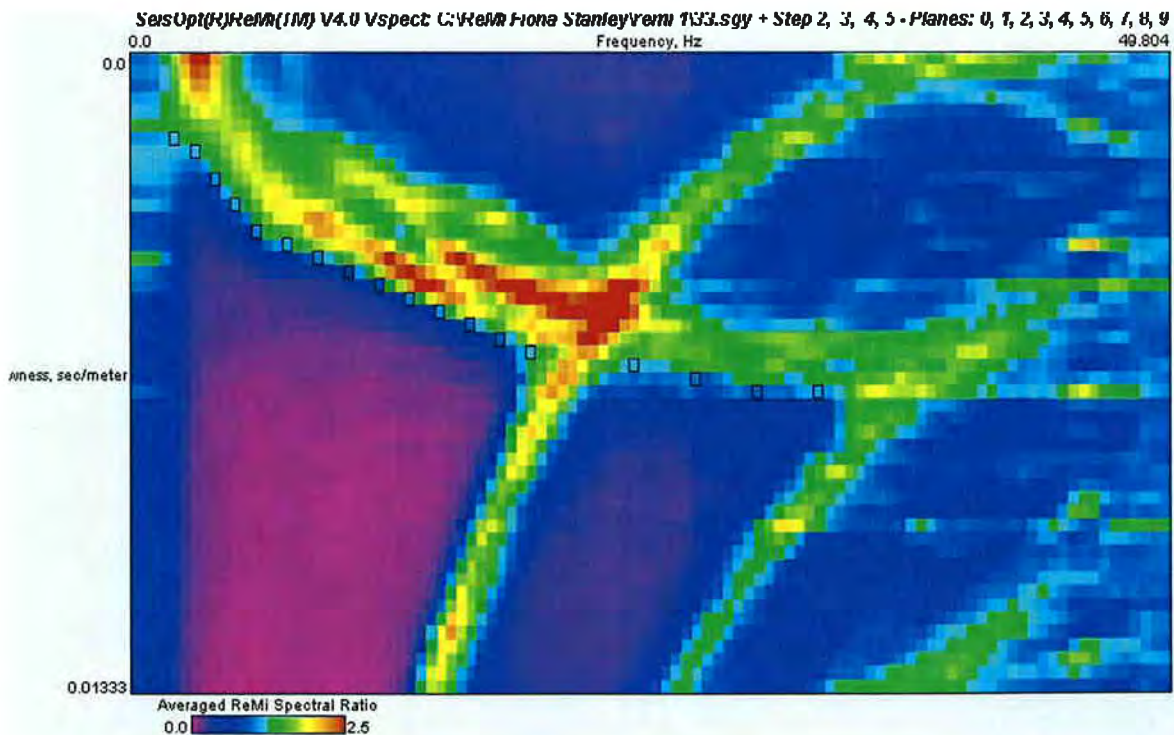
coffey
geotechnics
SPECIALISTS MANAGING
THE EARTH

ReMi 1

Dispersion Curve Showing Picks and Fit



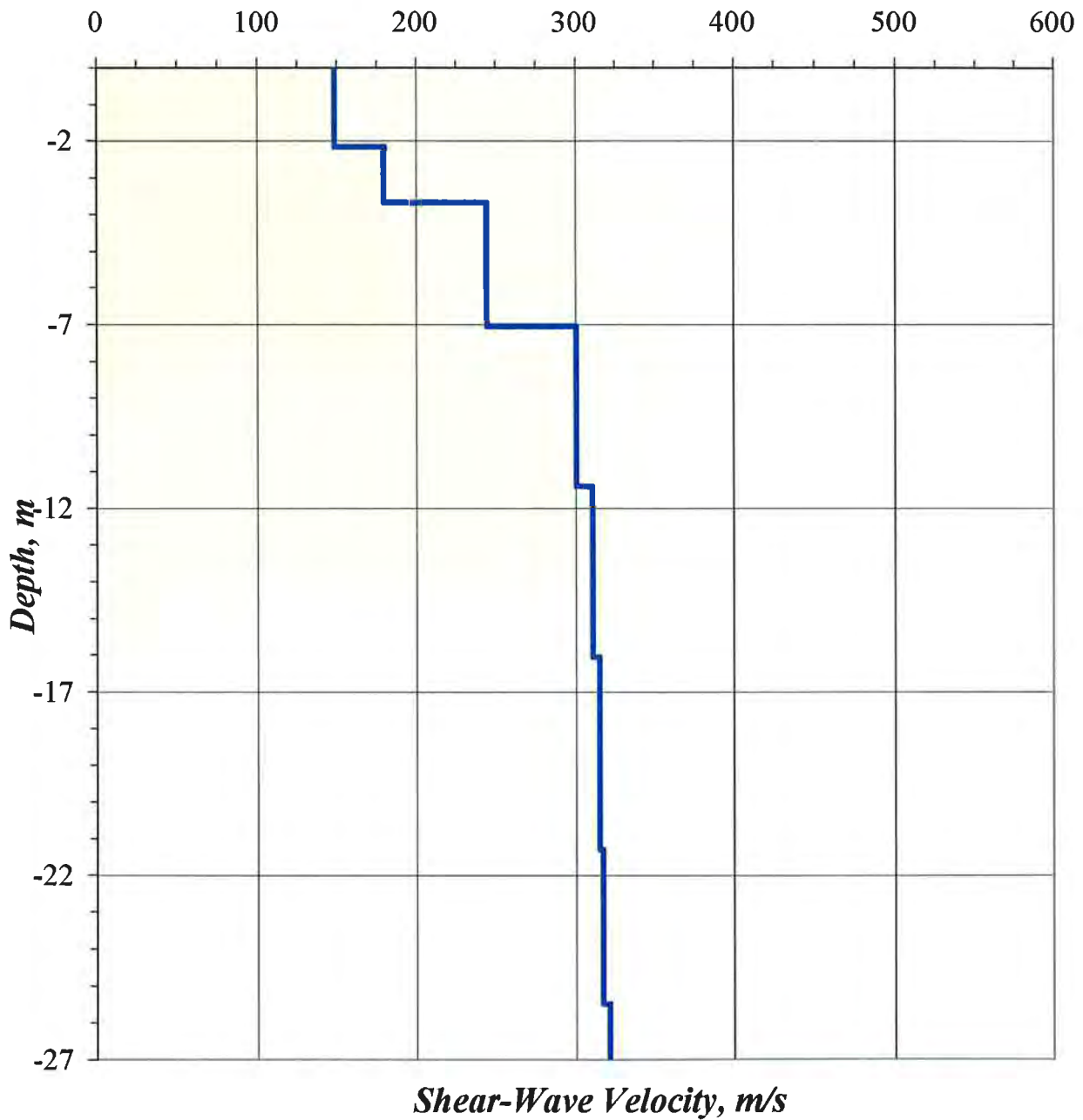
p-f Image with Dispersion Modeling Picks



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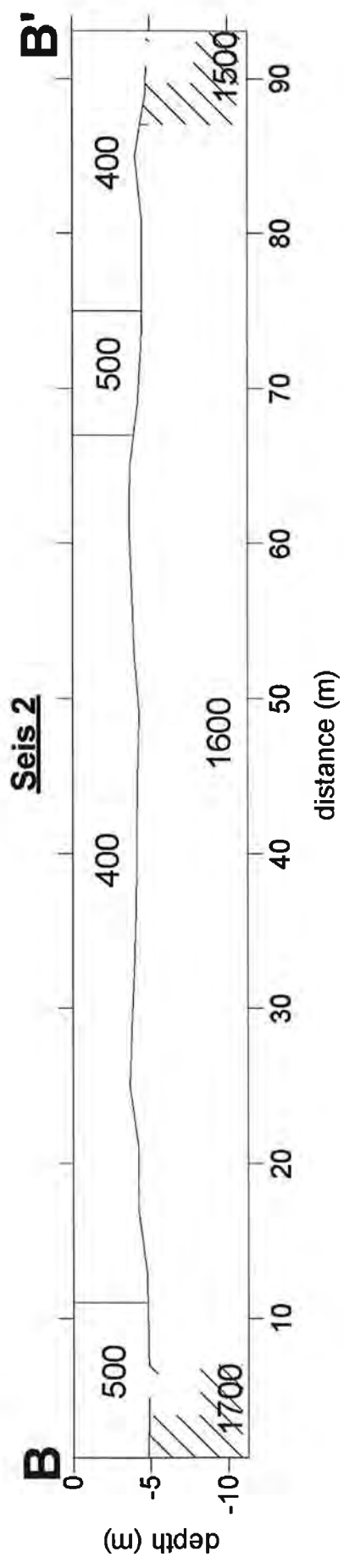
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 1 DISPERSION CURVE		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-1B
original size	A3				rev:	

ReMi 1
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



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drawn	DAC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD		
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 1 MODEL		
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original size	A3				rev:	



P-wave Velocity (m/sec)

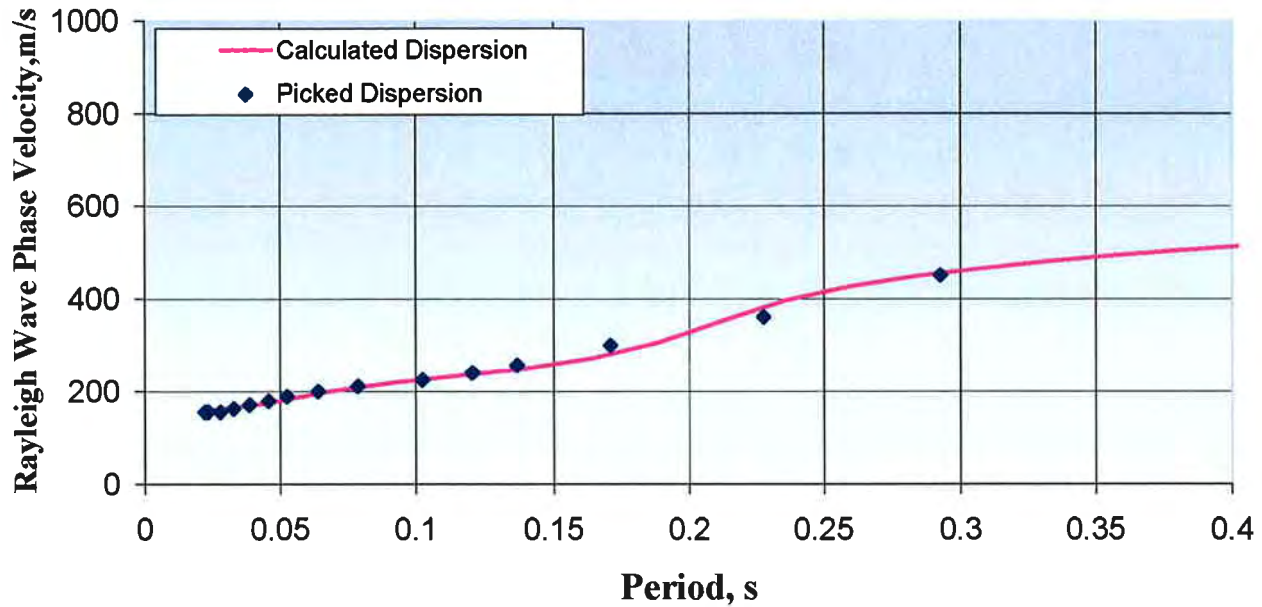
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approved		project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH
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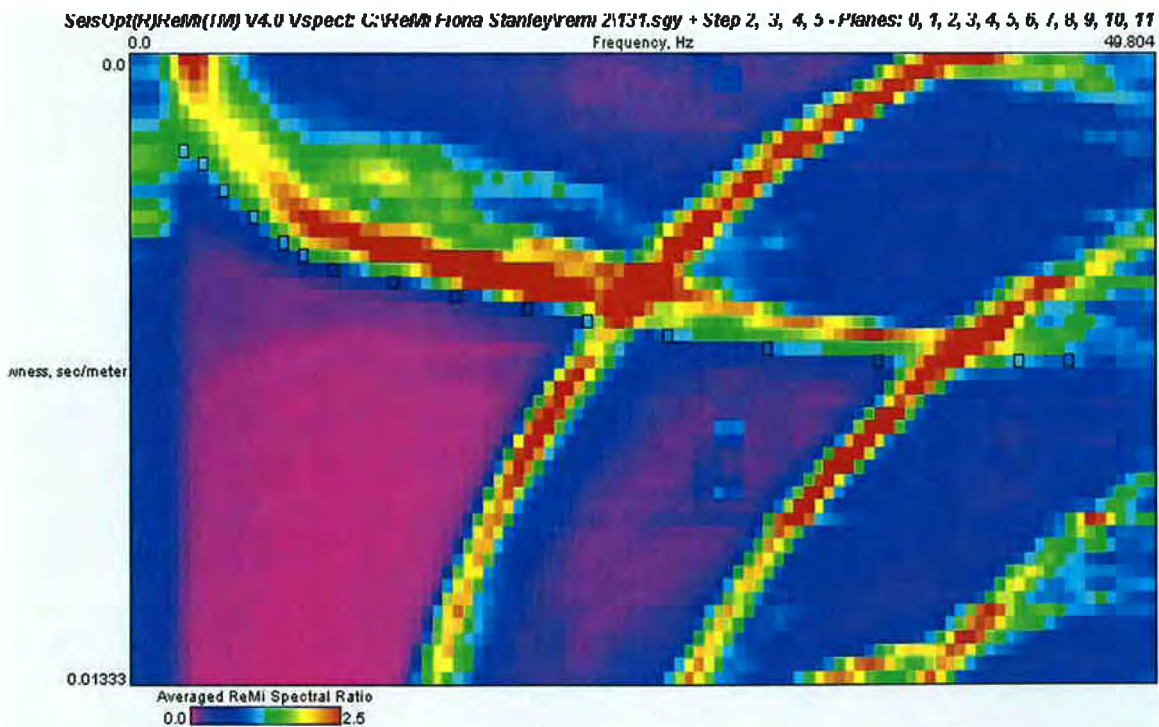


ReMi 2

Dispersion Curve Showing Picks and Fit



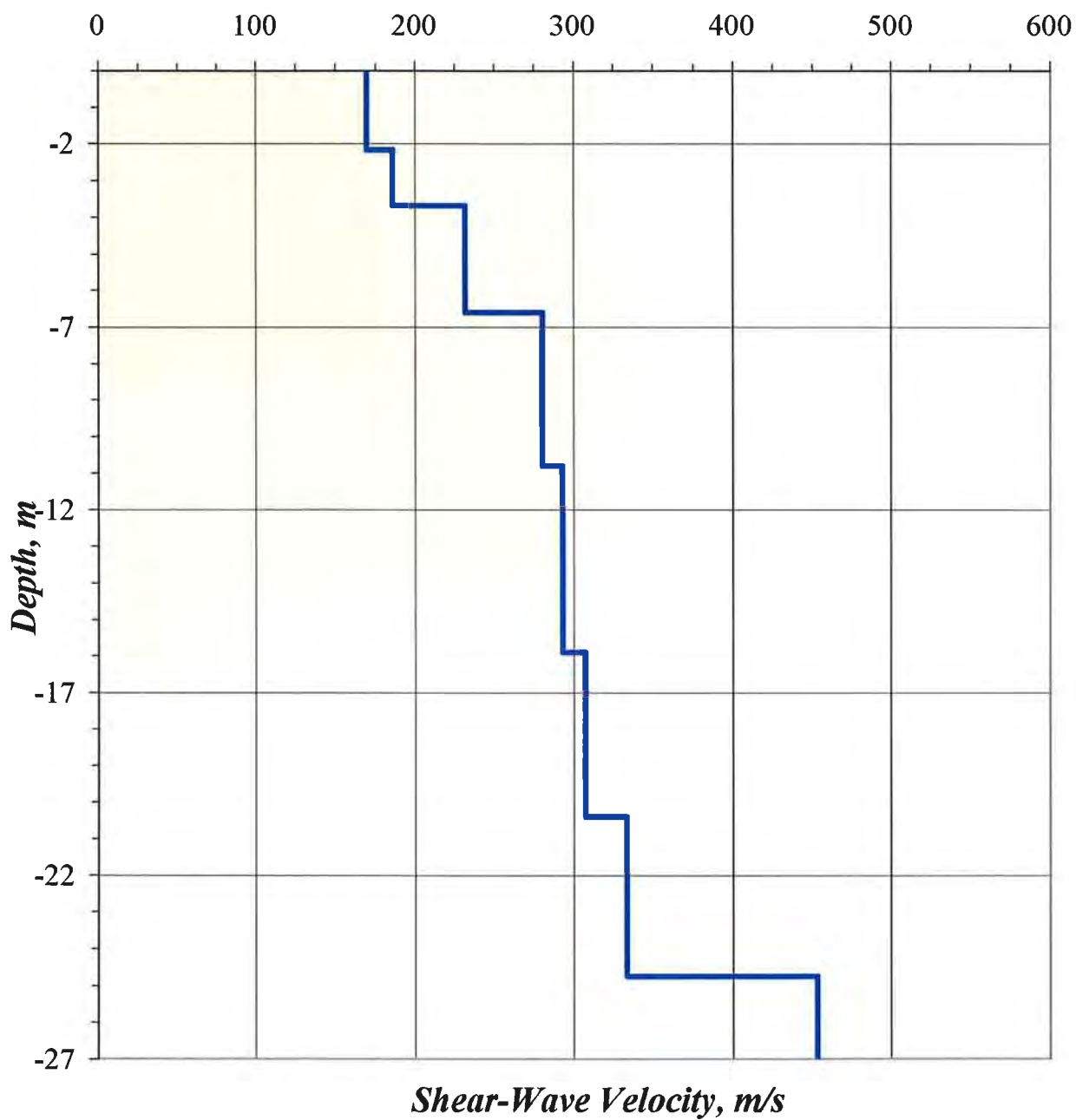
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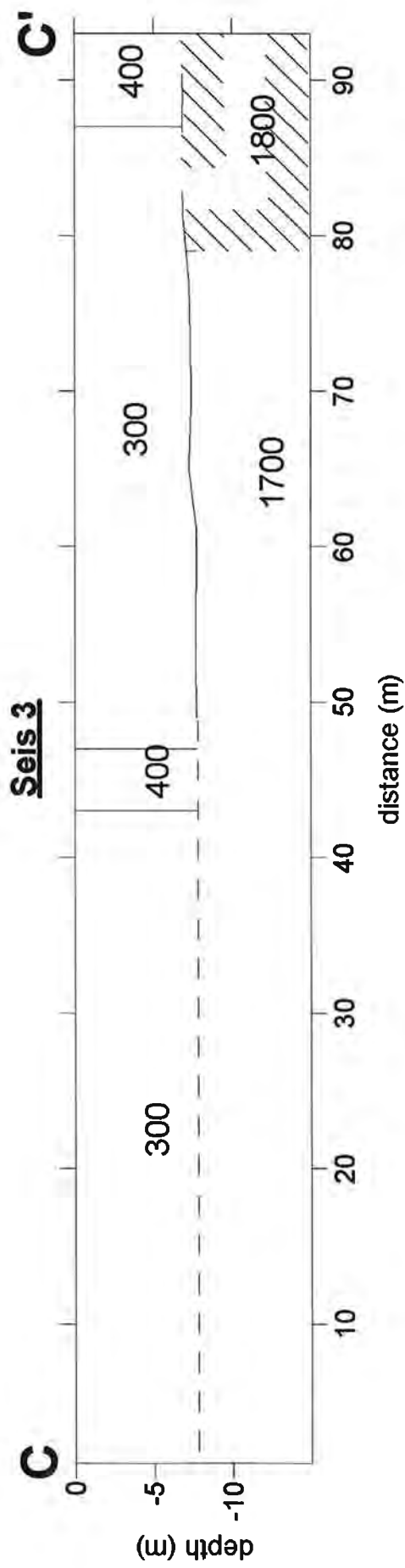
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original size	A3				rev:	

ReMi 2
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



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drawn	DAC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD		
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 2 MODEL		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-2C
original size	A3		rev:			



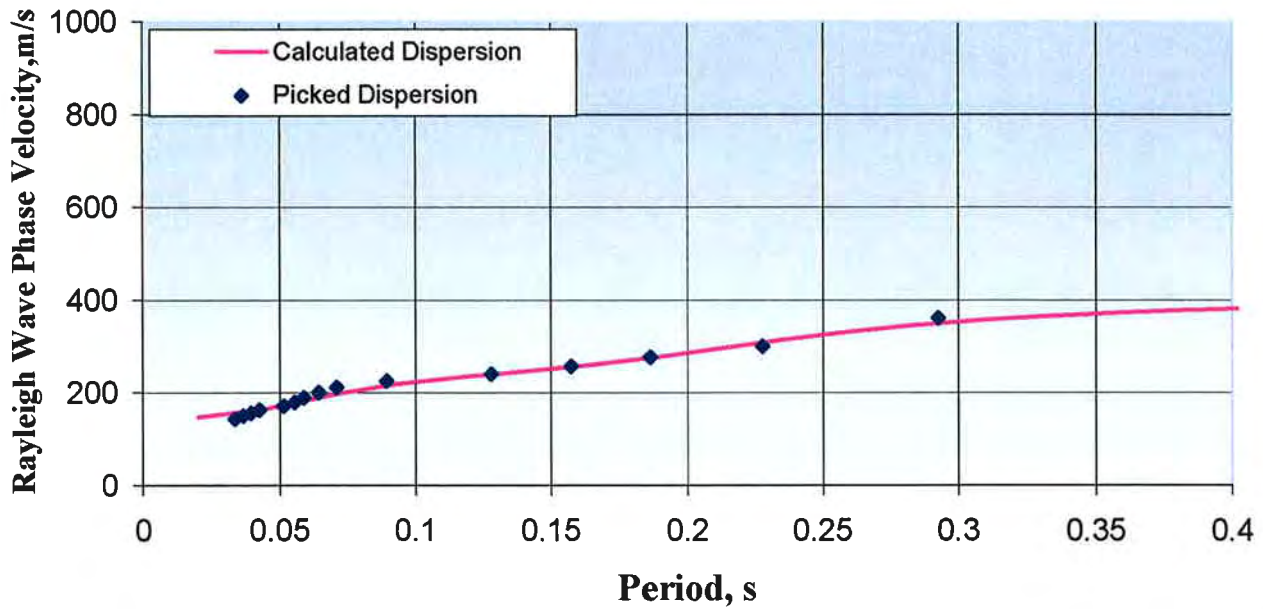
P-wave Velocity (m/sec)

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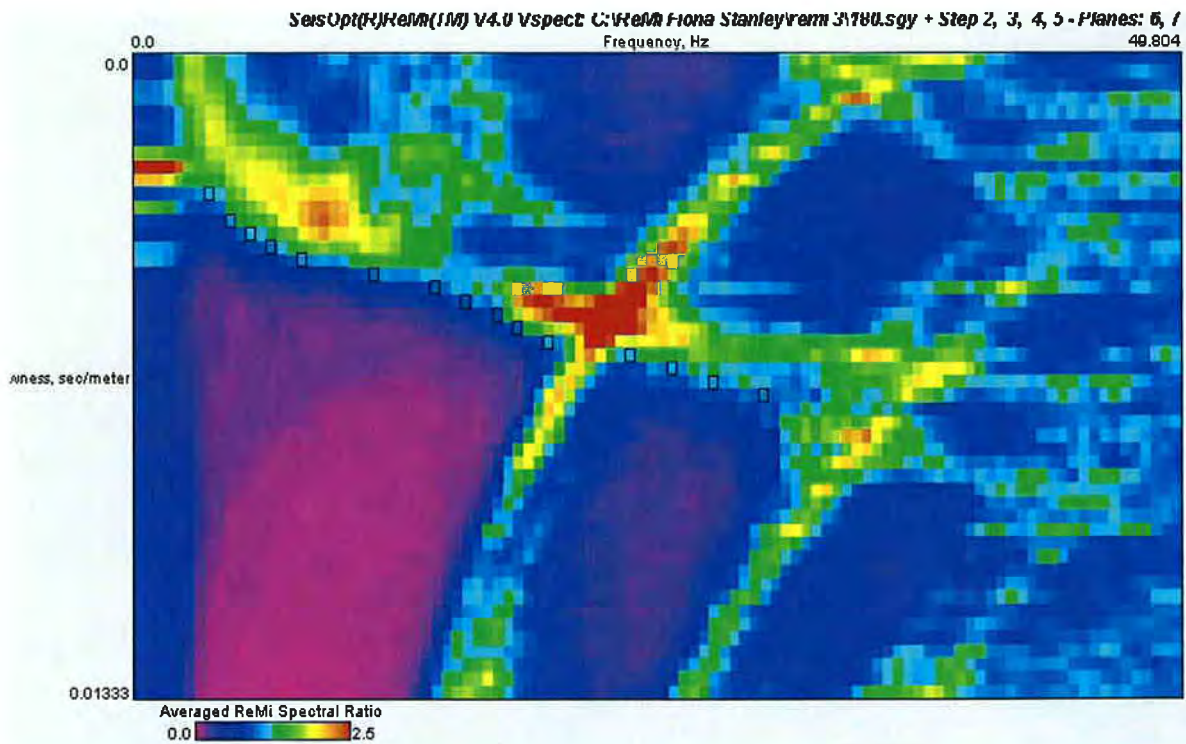
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH
date	5/06/08		title:	SECTION SEIS 3
scale			project no:	GEOPHERD00023AA
original size	A3		fig no:	FIGURE B-3A
			rev:	

ReMi 3

Dispersion Curve Showing Picks and Fit



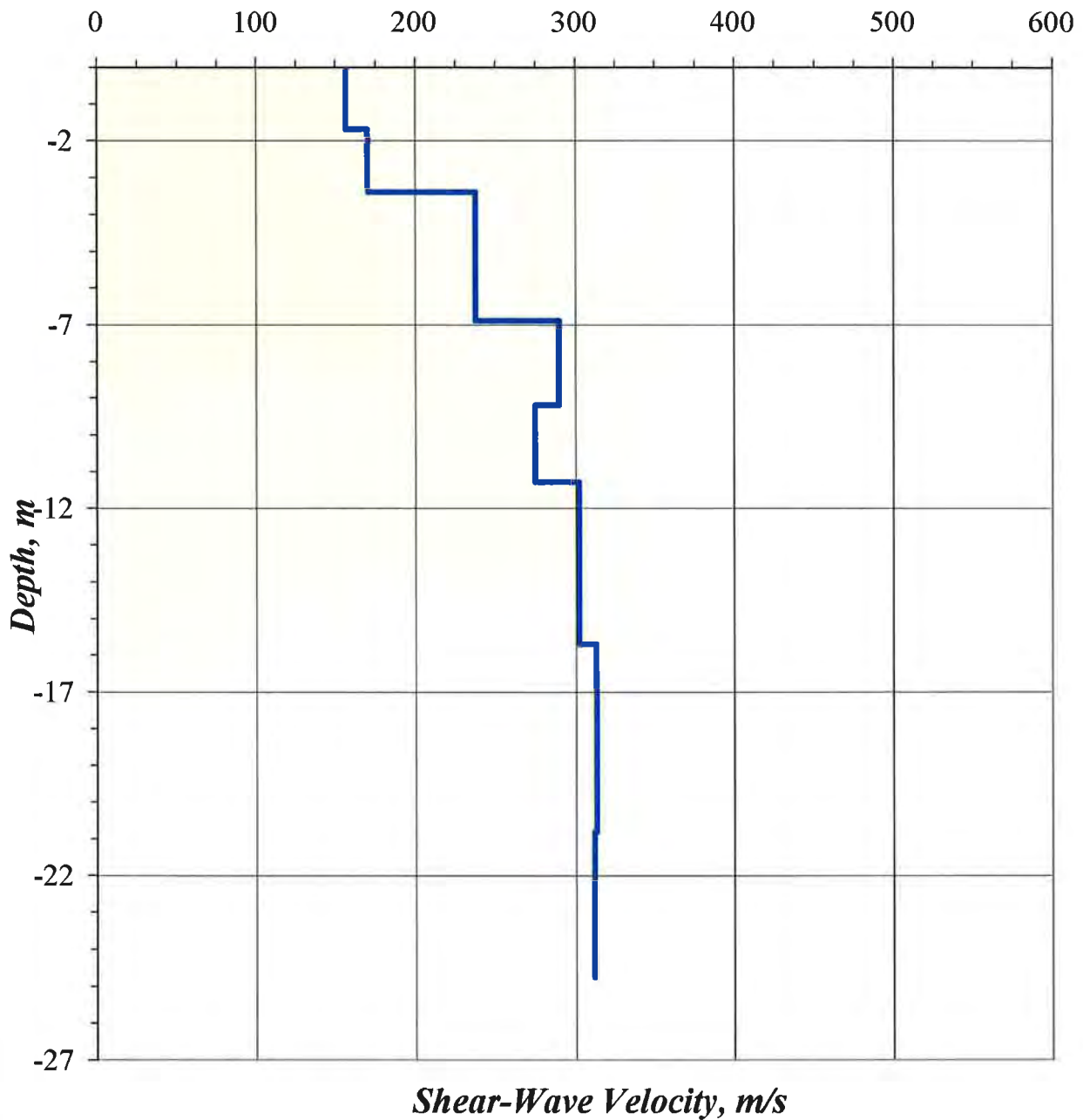
p-f Image with Dispersion Modeling Picks



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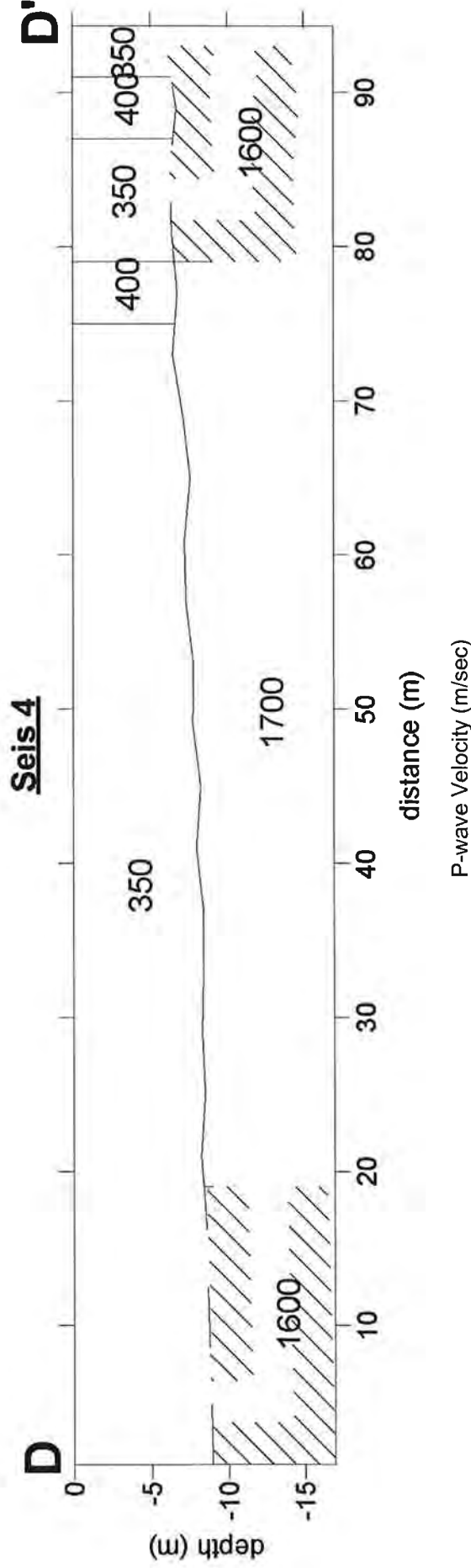
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date	5/06/08		title:	REMI 3 DISPERSION CURVE		
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original size	A3				rev:	

ReMi 3
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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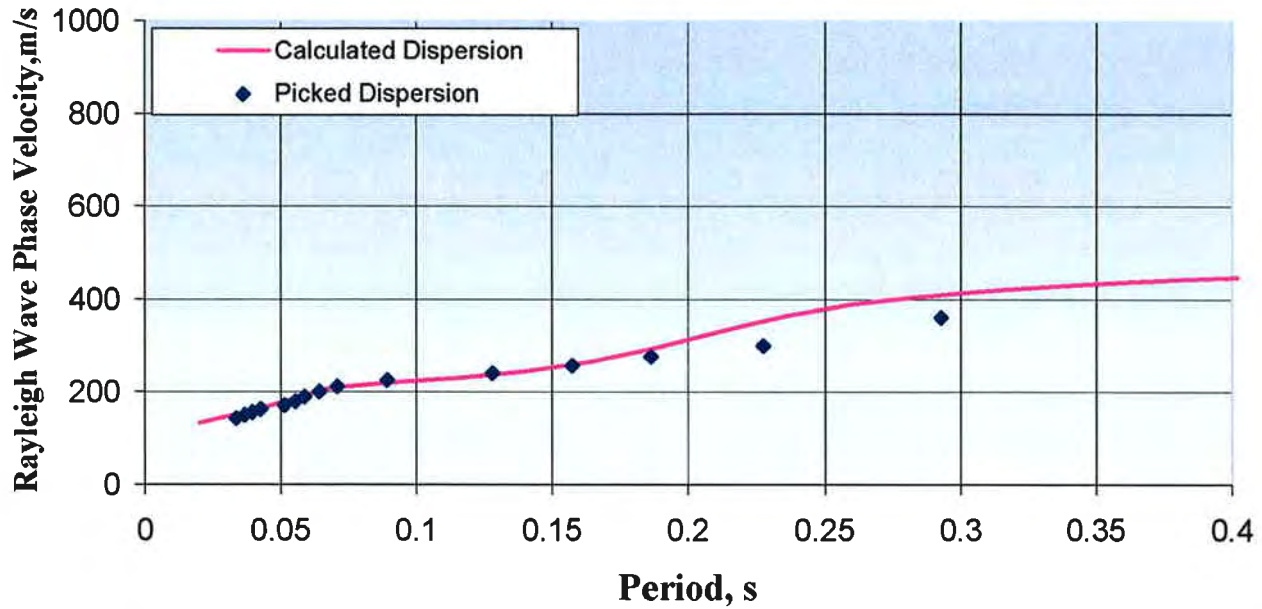


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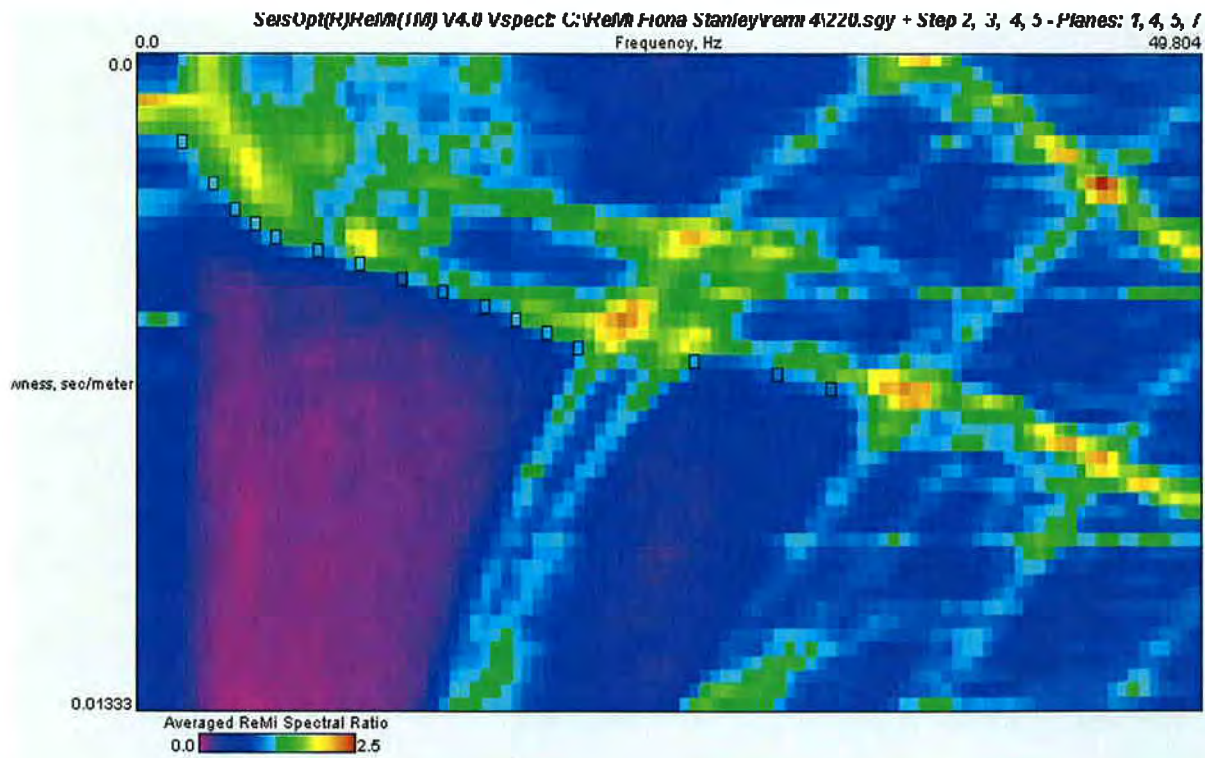
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original size	A3	fig no:	FIGURE B-4A
		rev:	

ReMi 4

Dispersion Curve Showing Picks and Fit



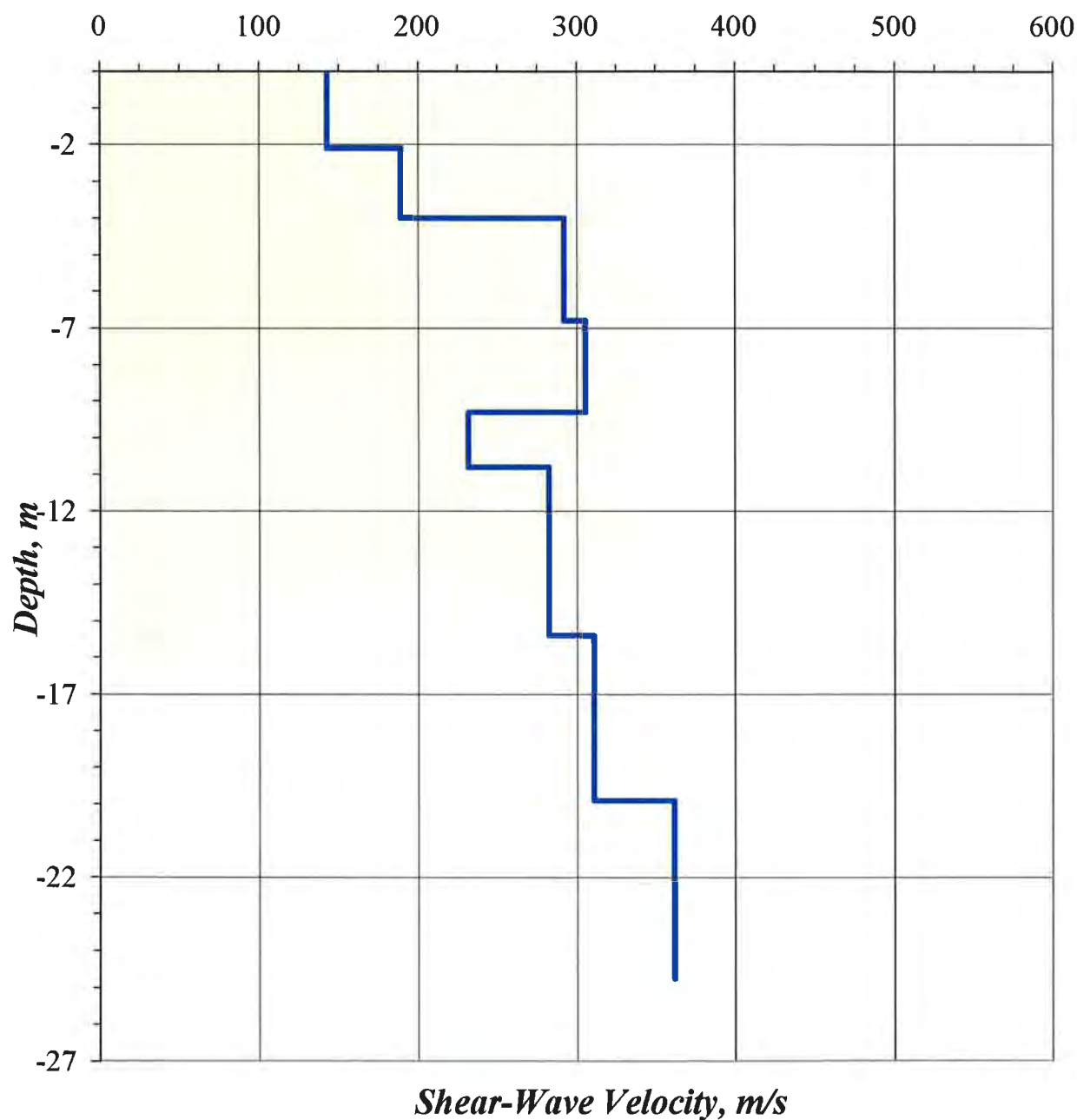
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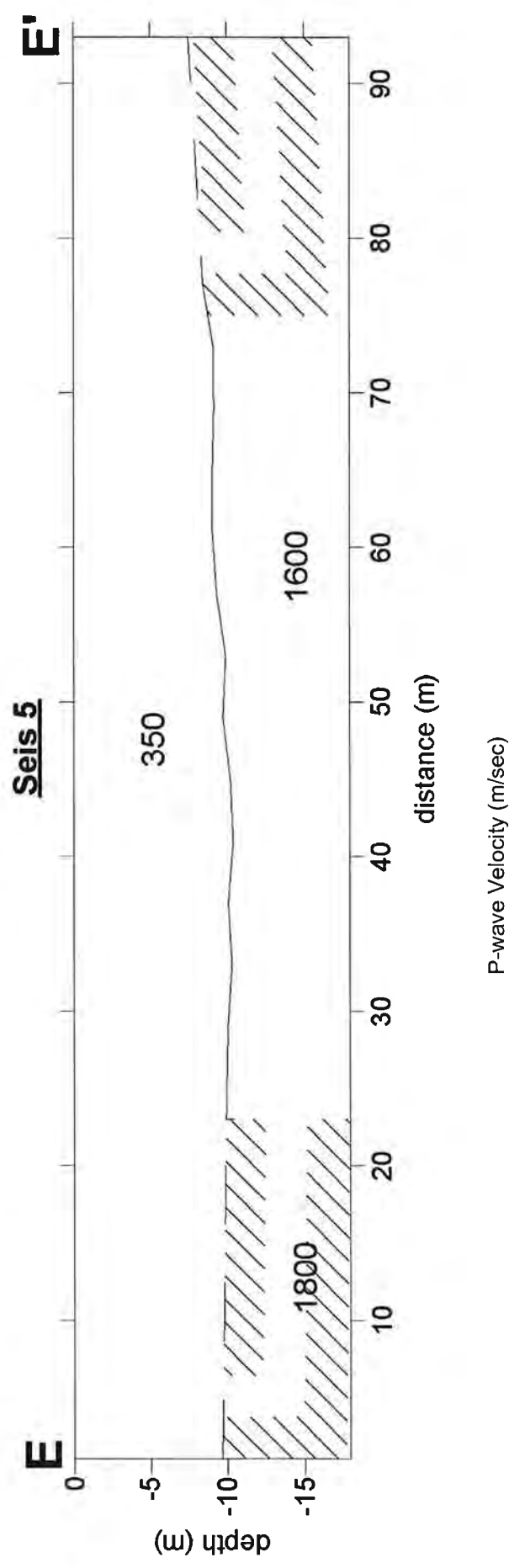
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 4 DISPERSION CURVE		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-4B
original size	A3				rev:	

ReMi 4
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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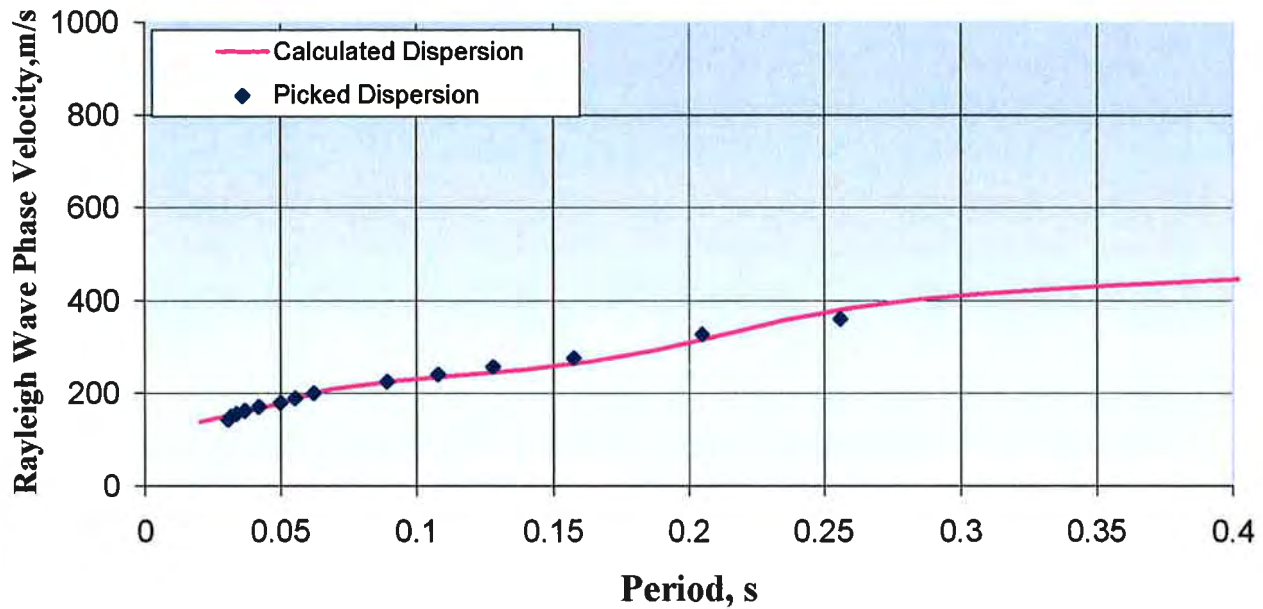


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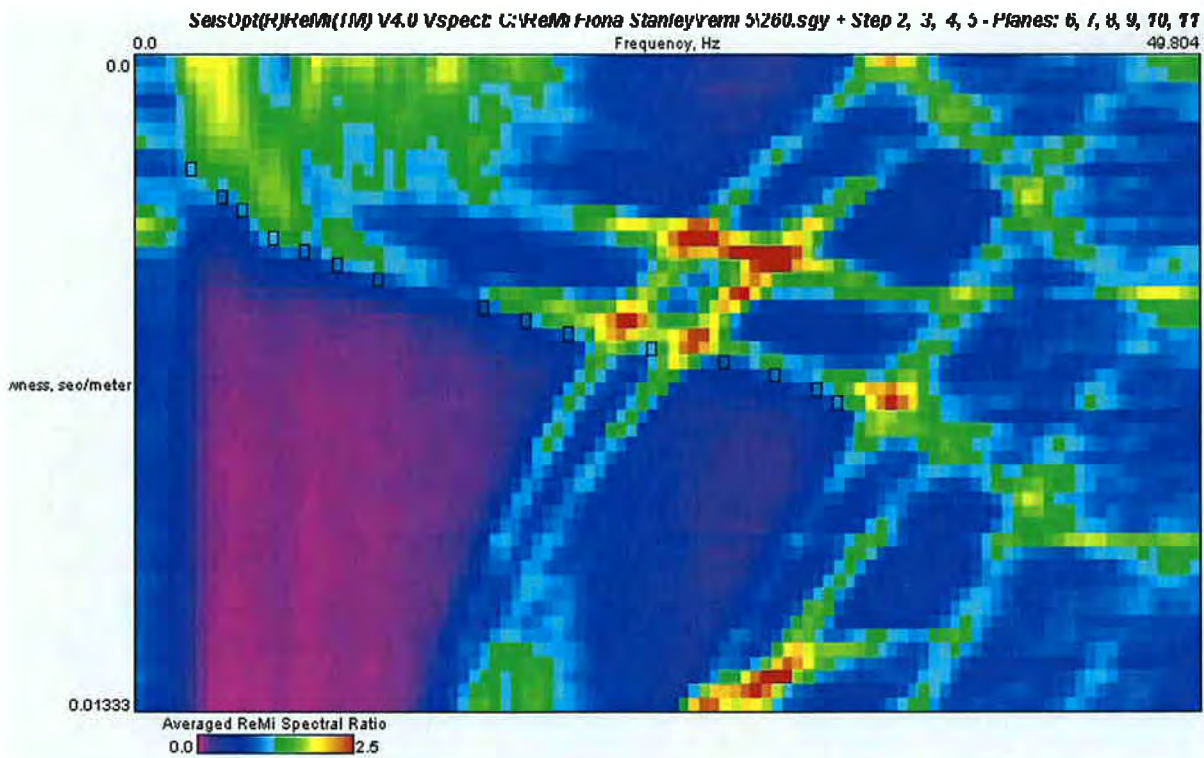
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ReMi 5

Dispersion Curve Showing Picks and Fit



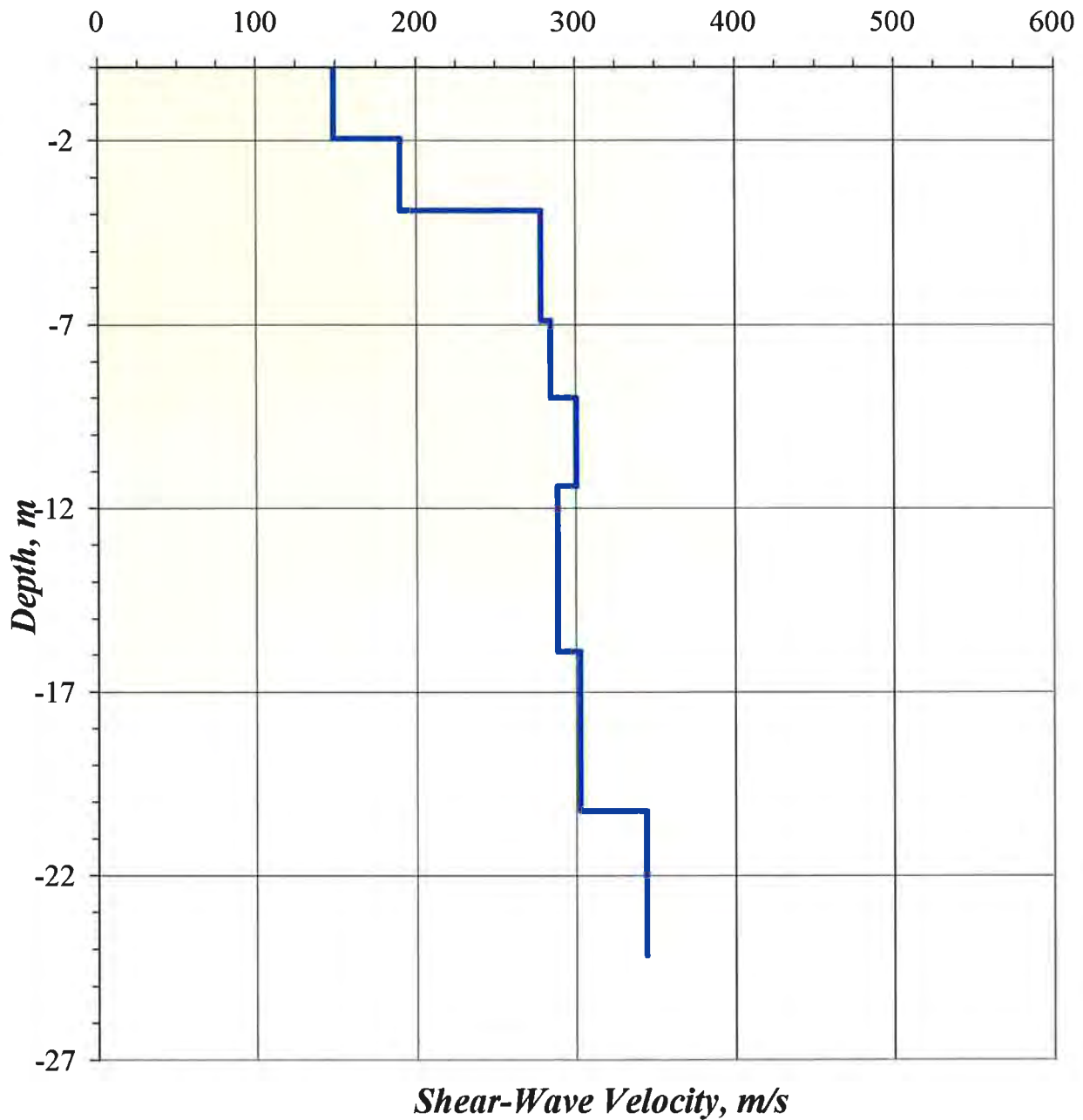
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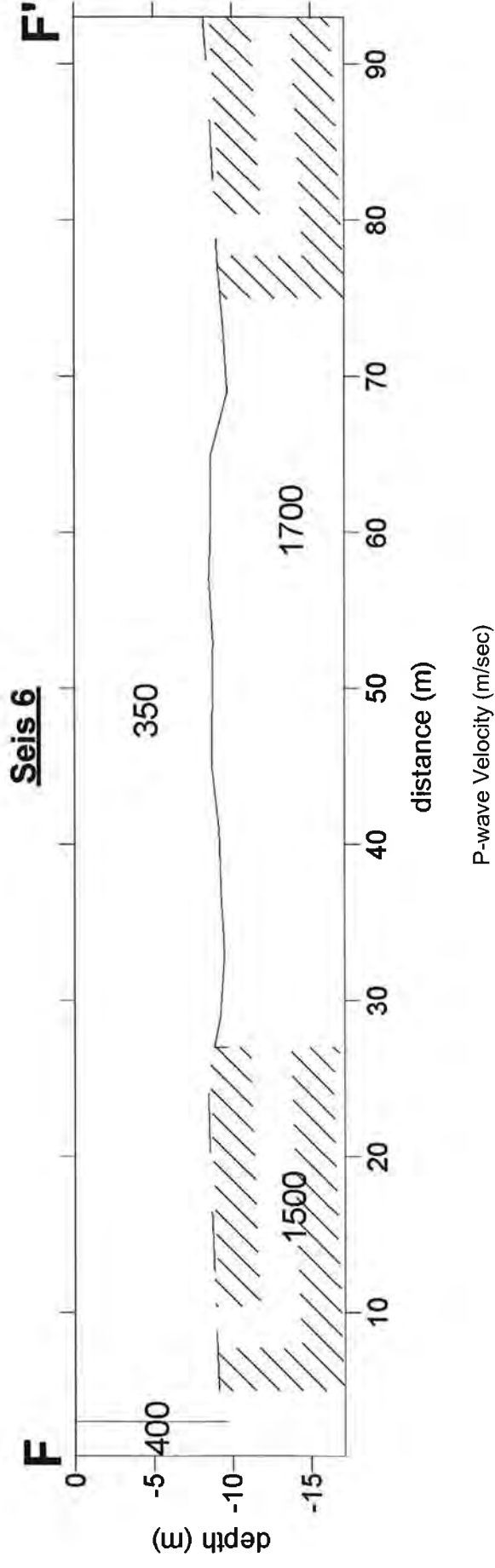
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 5 DISPERSION CURVE		
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original size	A3		rev:			

ReMi 5
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 5 MODEL		
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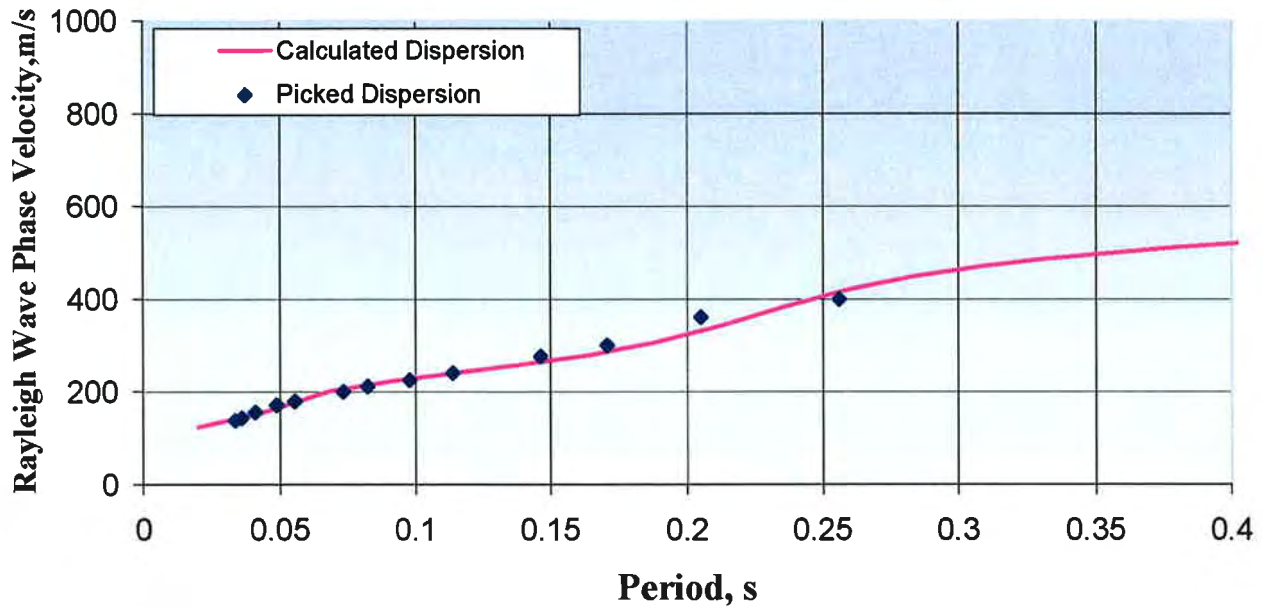


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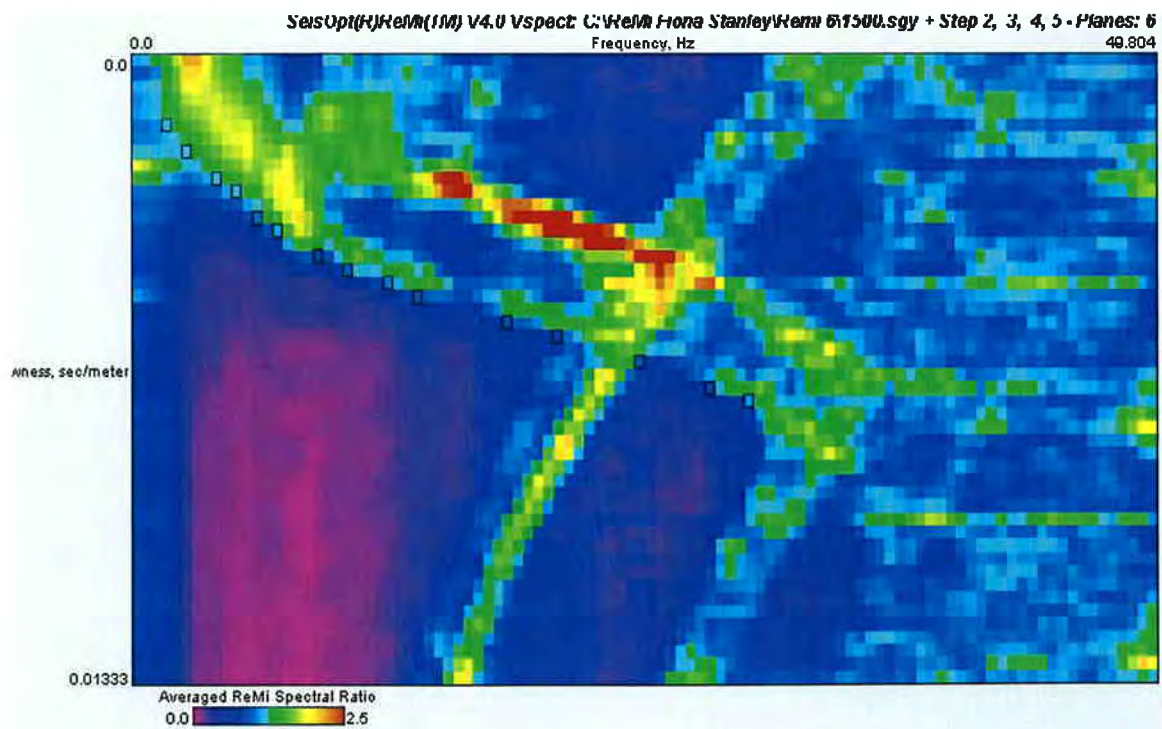
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date	5/06/08		title:	SECTION SEIS 6
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			rev:	

ReMi 6

Dispersion Curve Showing Picks and Fit



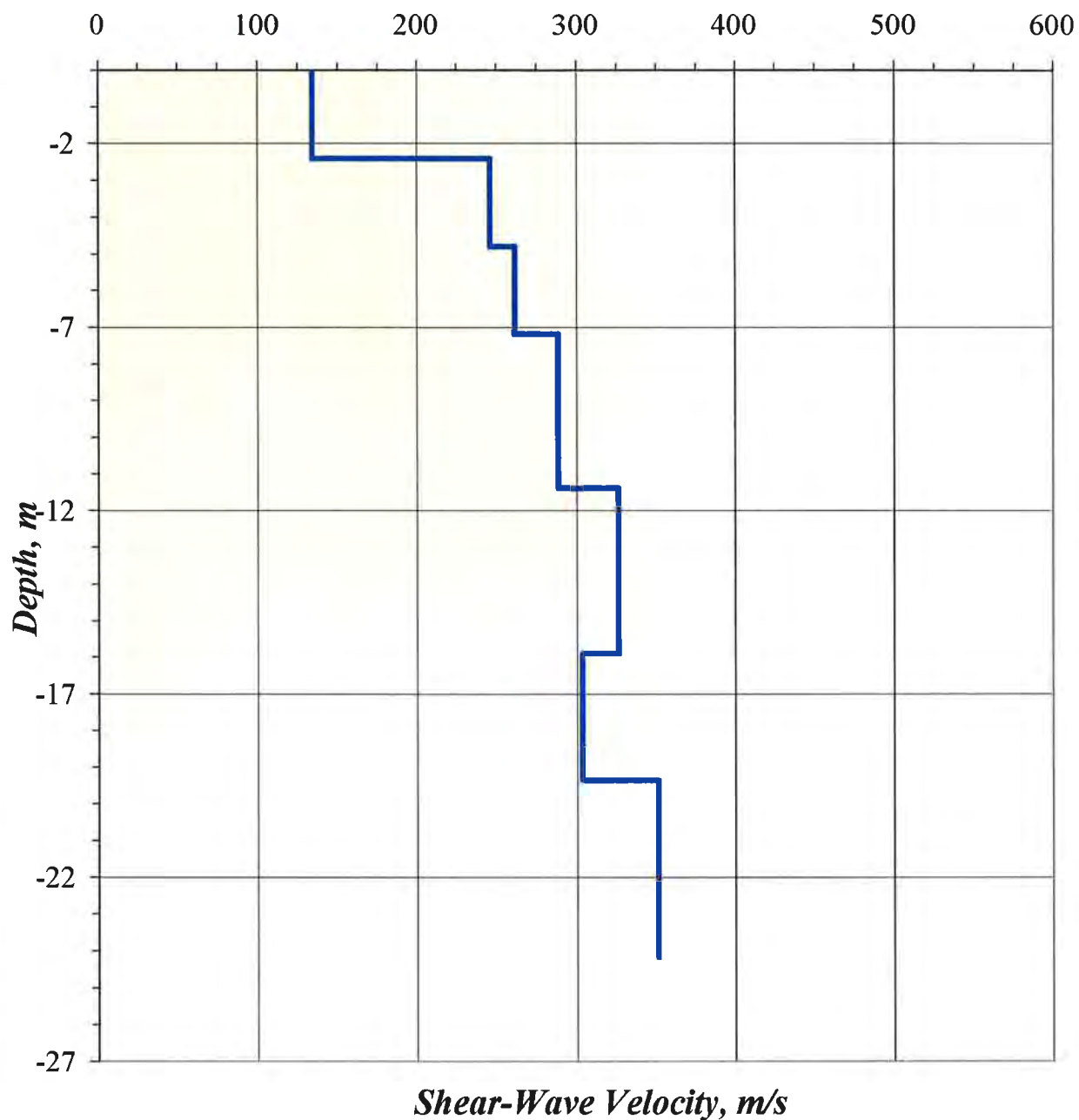
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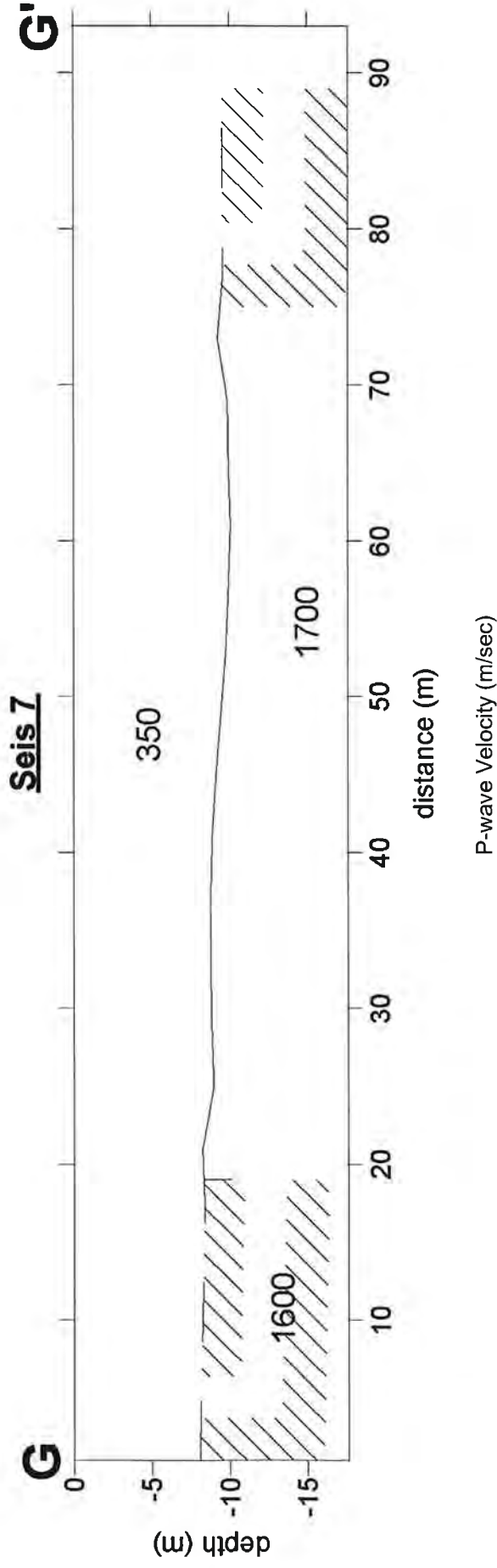
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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original size	A3				rev:	

ReMi 6
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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original size	A3				rev:	



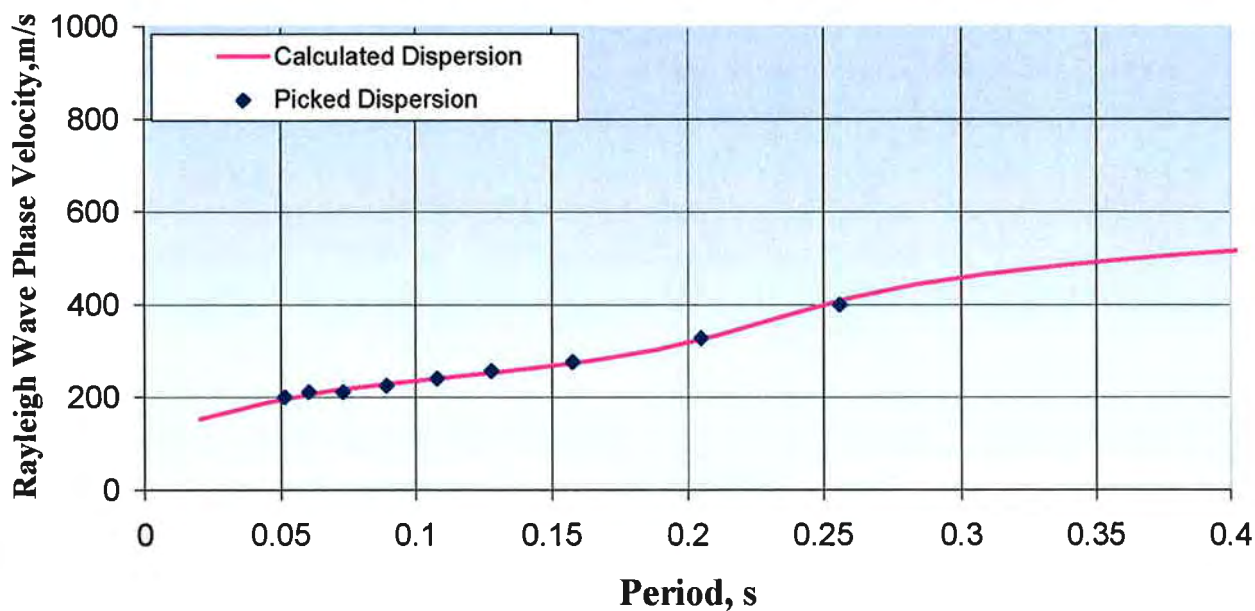
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approved		project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH
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		rev:	

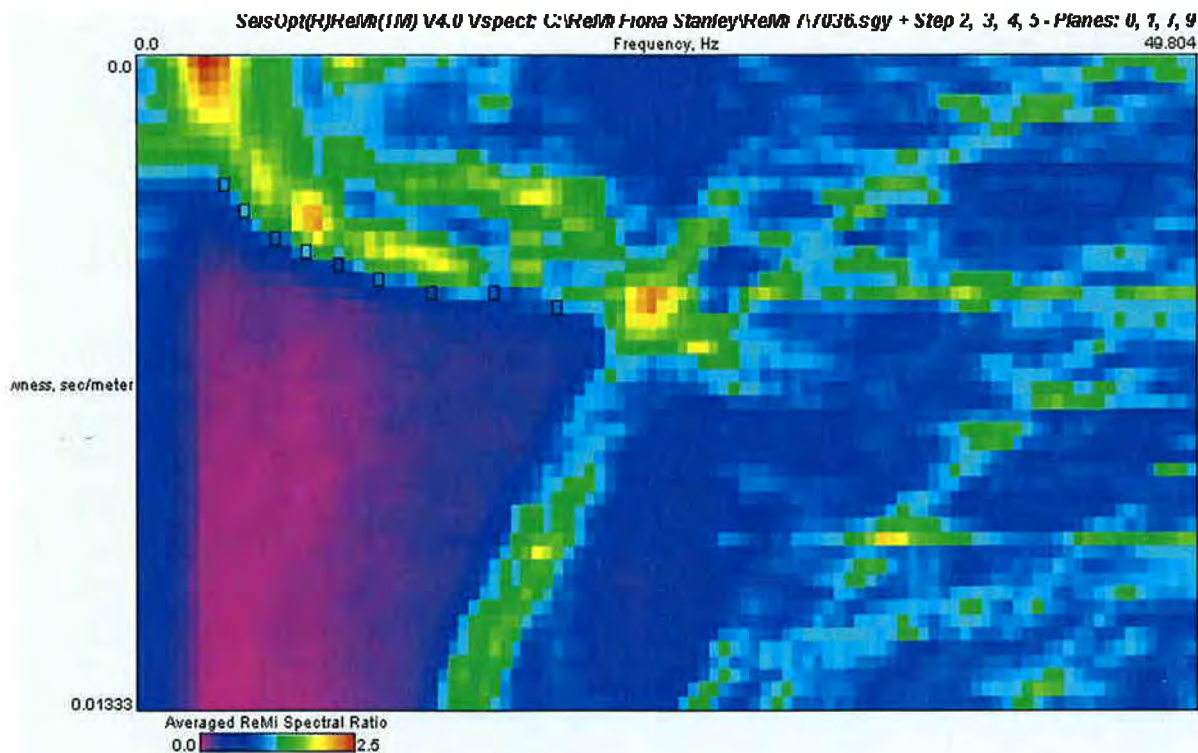
coffey
geotechnics
SPECIALISTS MANAGING
THE EARTH

ReMi 7

Dispersion Curve Showing Picks and Fit



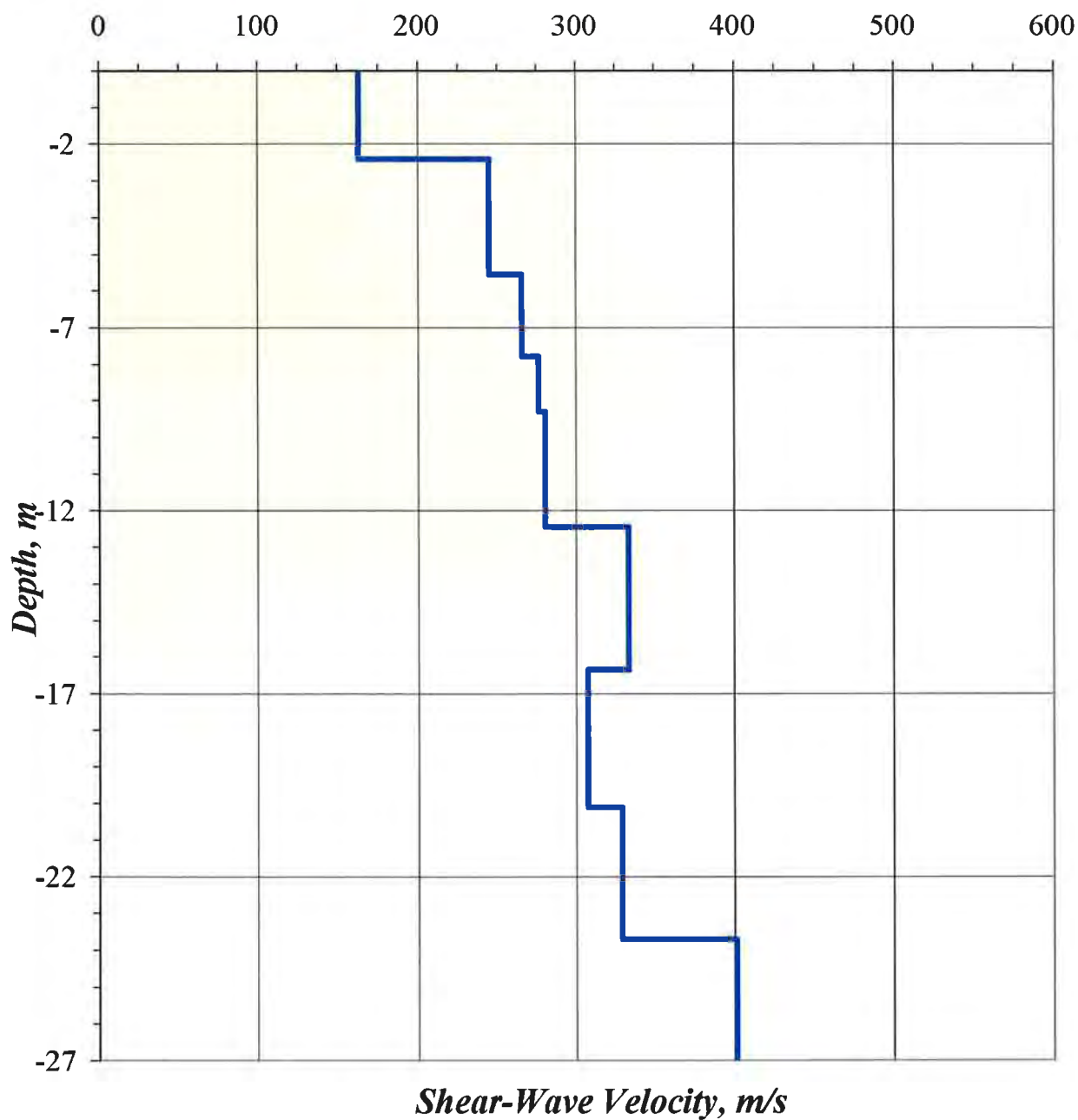
p-f Image with Dispersion Modeling Picks



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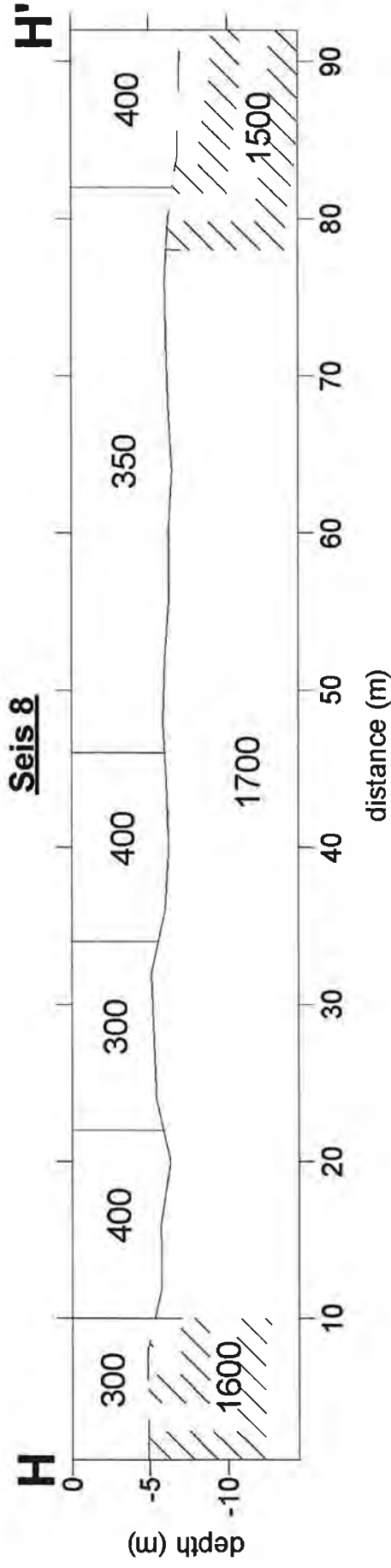
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scale			project no:	GEOHERD00023AA	fig no:	FIGURE B-7B
original size	A3				rev:	

ReMi 7
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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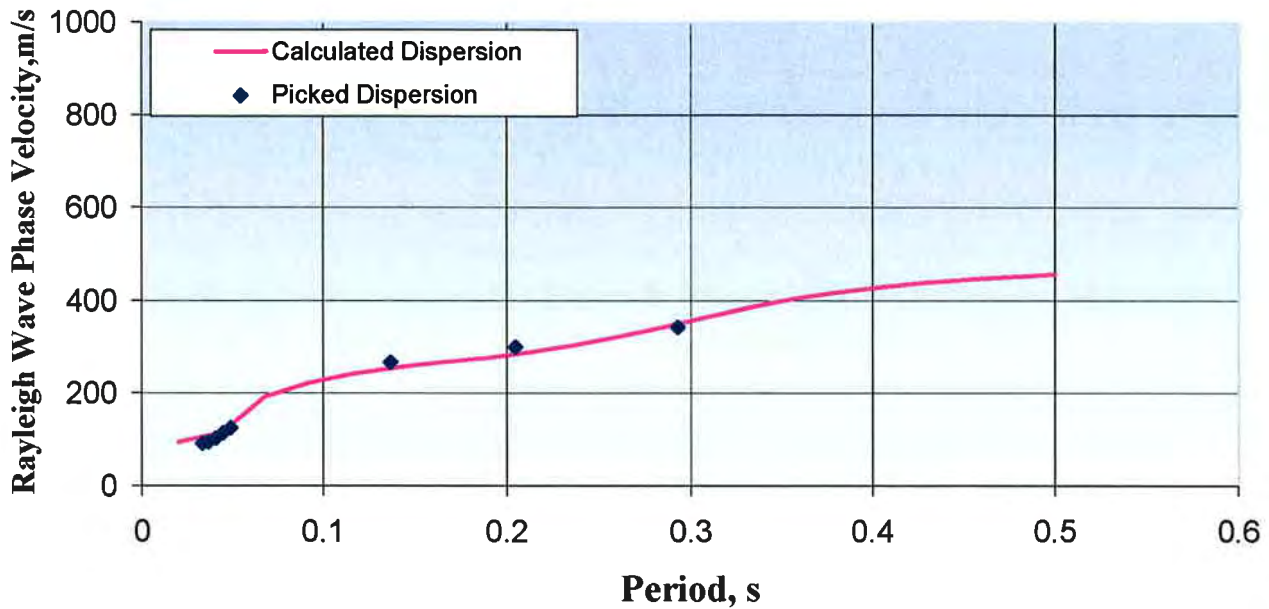


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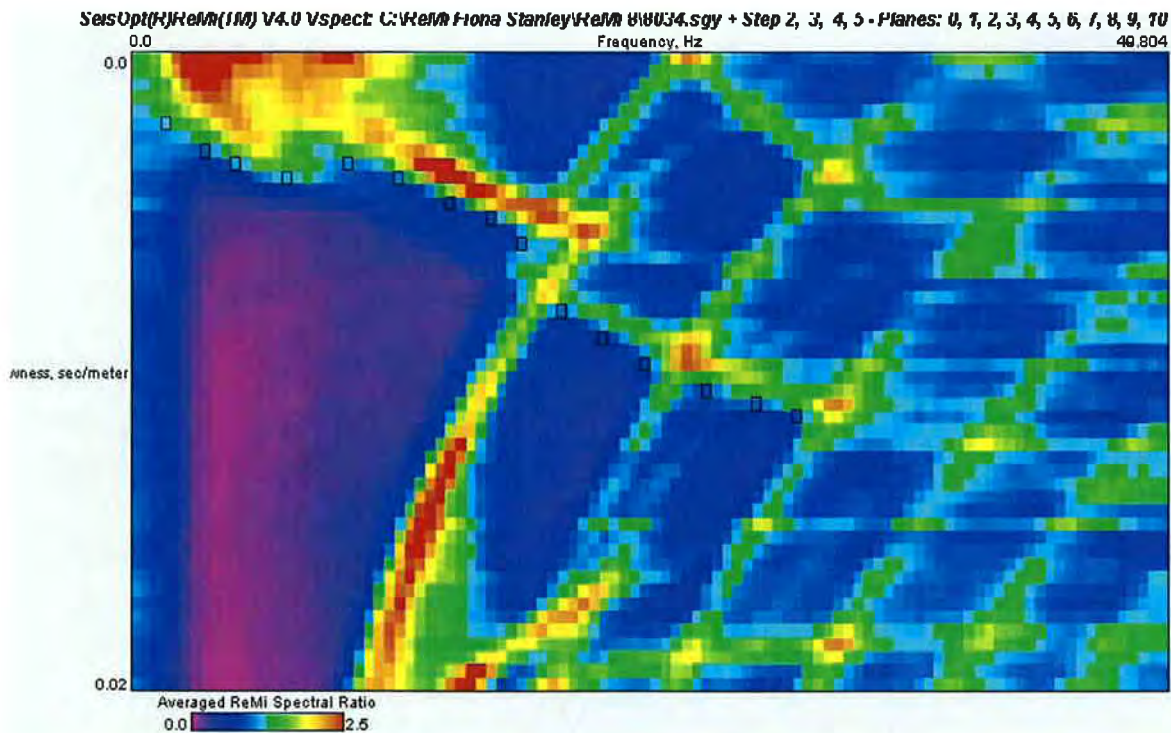
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scale		project no:	GEOPHERD00023AA
original size	A3	fig no:	FIGURE B-8A
		rev:	

ReMi 8

Dispersion Curve Showing Picks and Fit



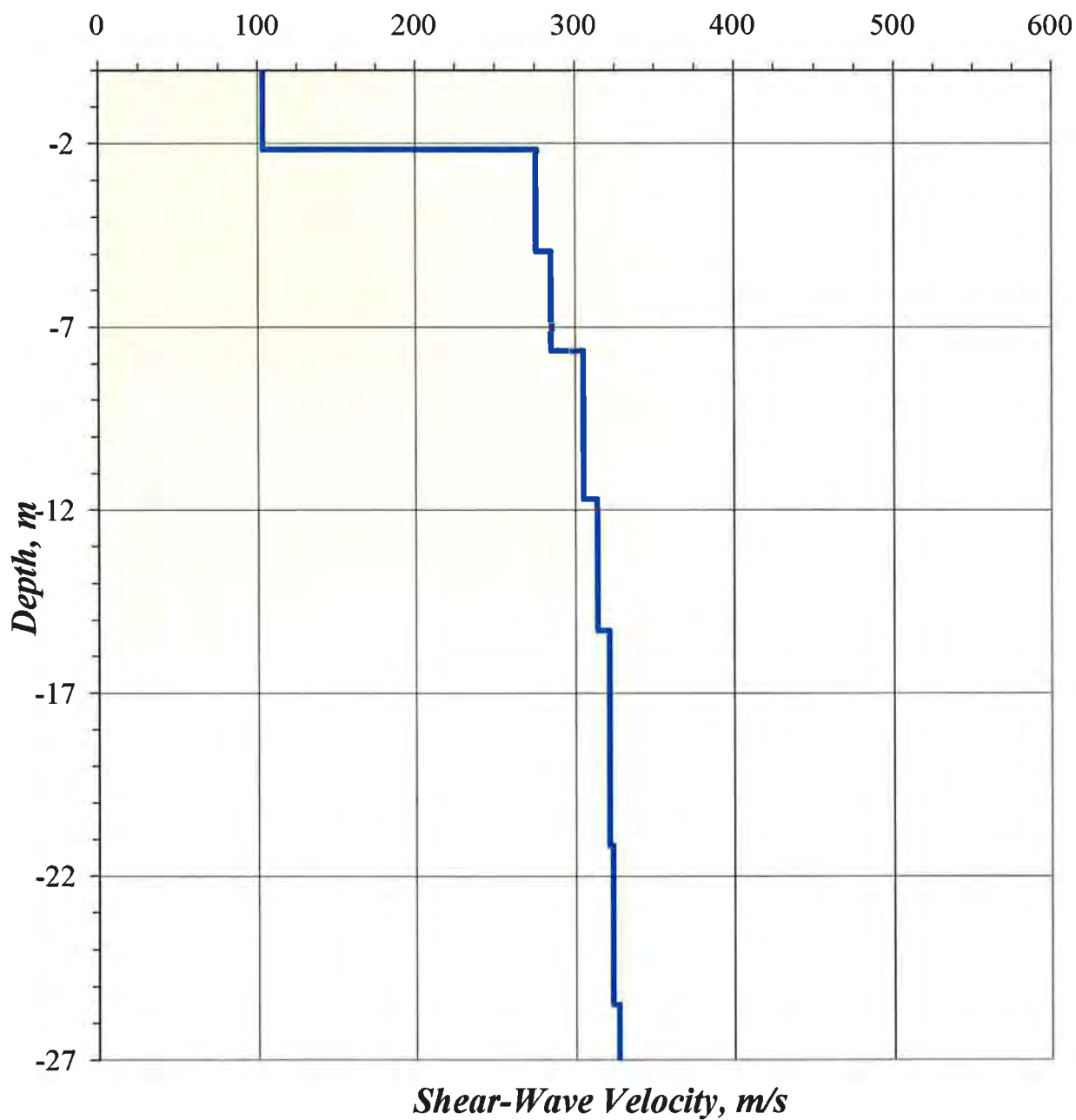
p-f Image with Dispersion Modeling Picks



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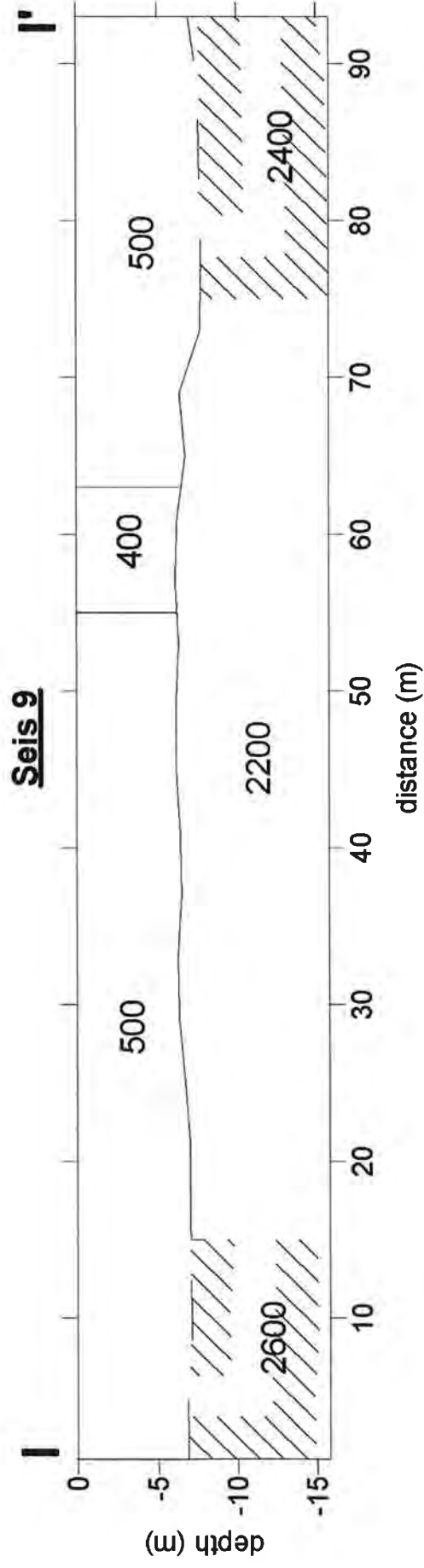
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date	5/06/08		title:	REMI 8 DISPERSION CURVE		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-8B
original size	A3				rev:	

ReMi 8
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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drawn	DAC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD		
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
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scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-8C
original size	A3				rev:	



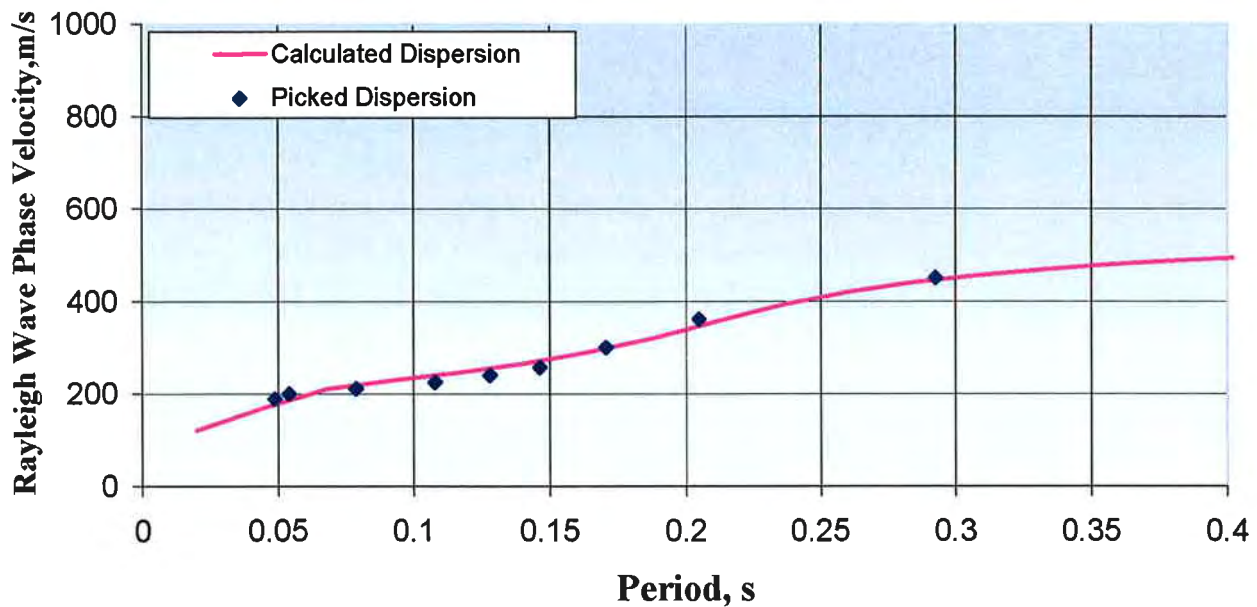
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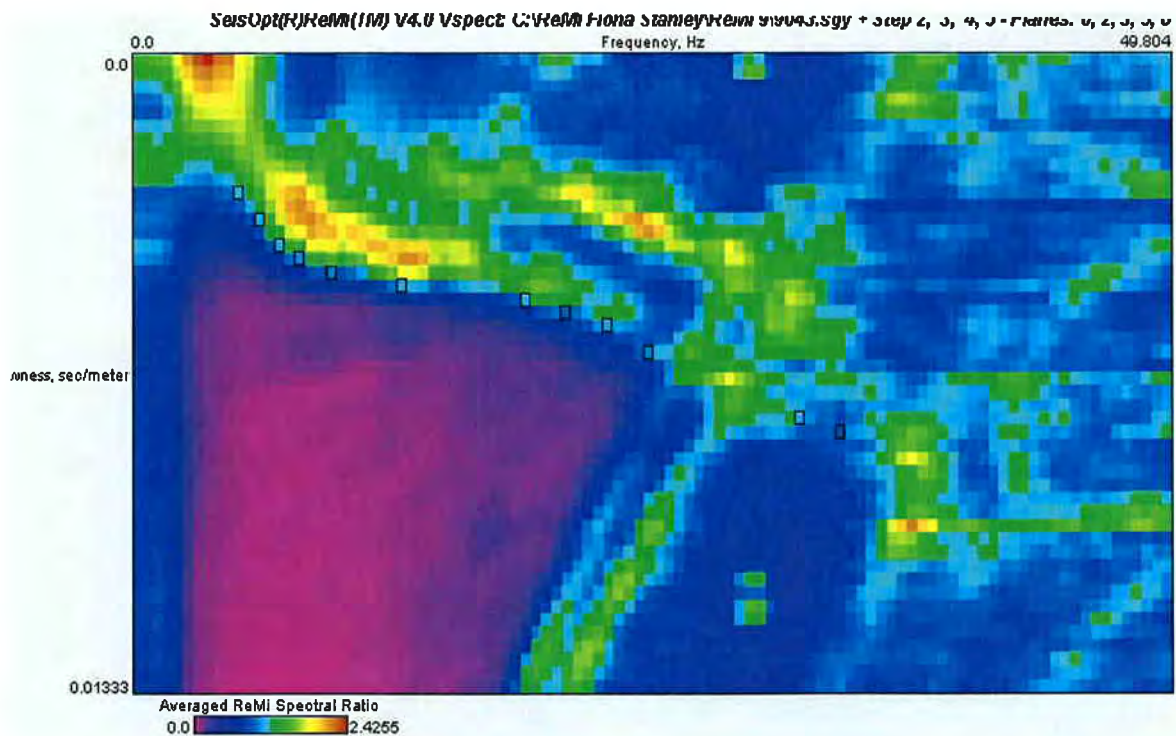
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approved		project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH
date	5/06/08	title:	SECTION SEIS 9
scale		project no:	GEOPHERD00023AA
original size	A3	fig no:	FIGURE B-9A
		rev:	

ReMi 9

Dispersion Curve Showing Picks and Fit



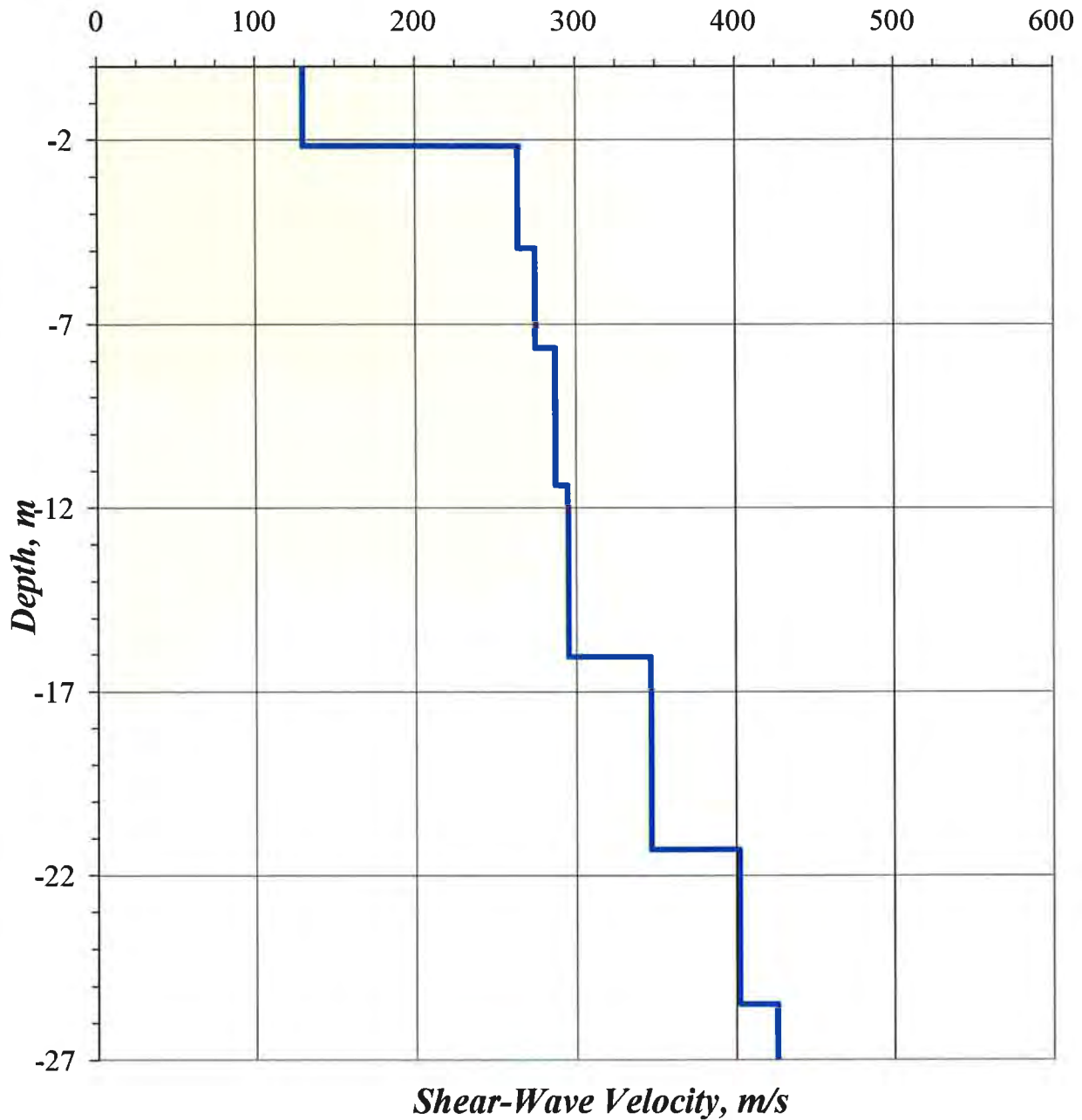
p-f Image with Dispersion Modeling Picks



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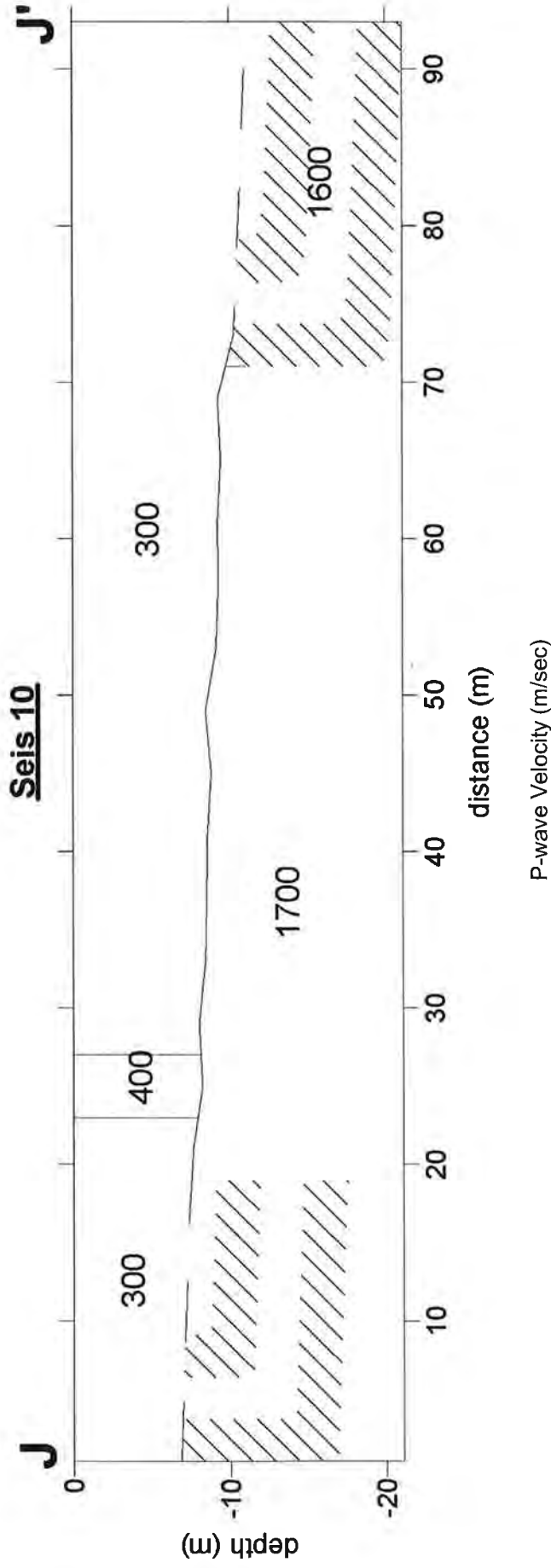
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scale			project no:	GEOHERD00023AA	fig no:	FIGURE B-9B
original size	A3				rev:	

ReMi 9
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



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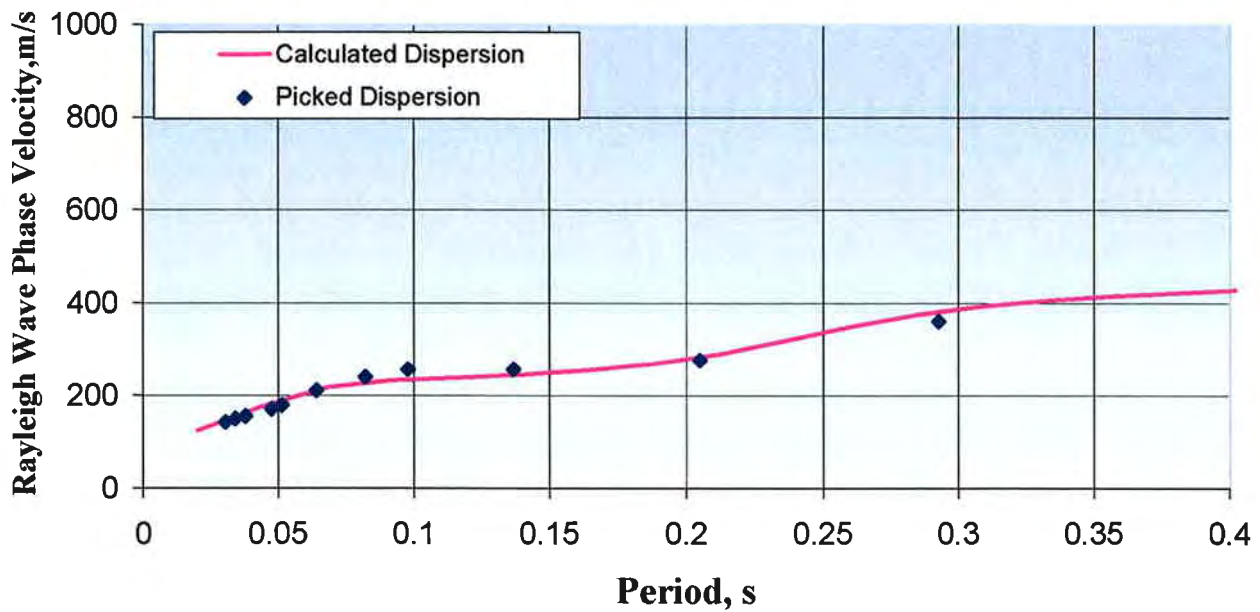


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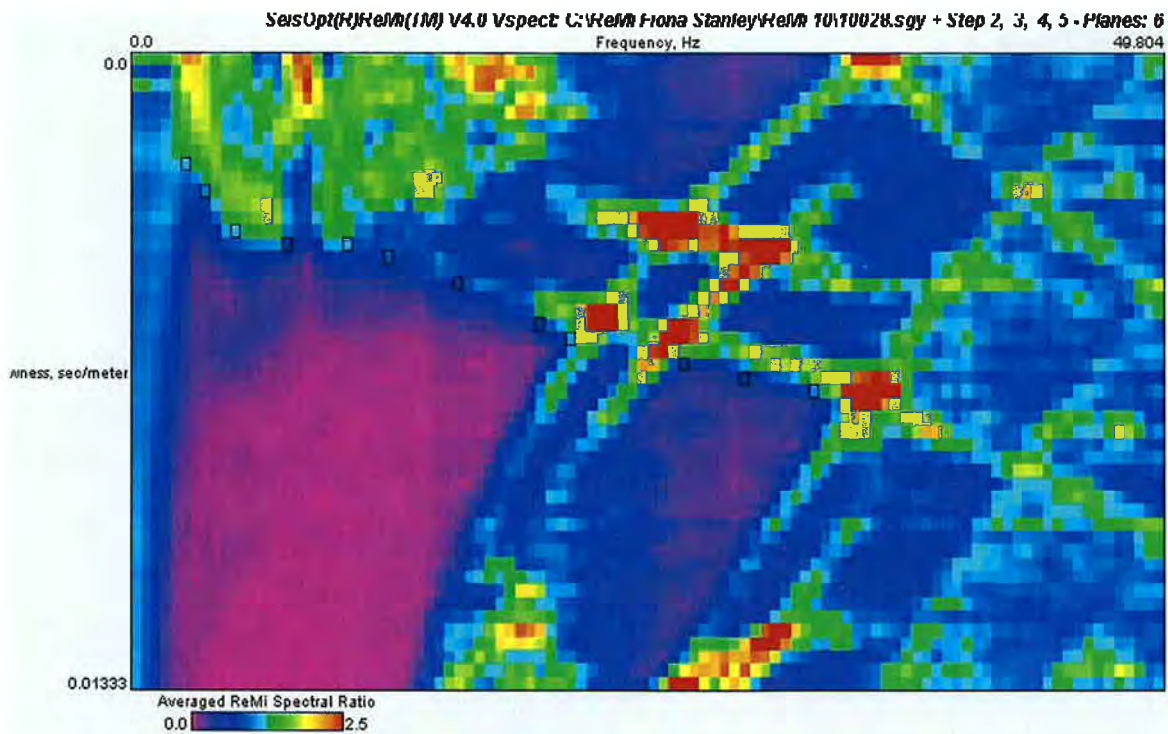
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original size	A3	fig no:	FIGURE B-10A
		rev:	

ReMi 10

Dispersion Curve Showing Picks and Fit



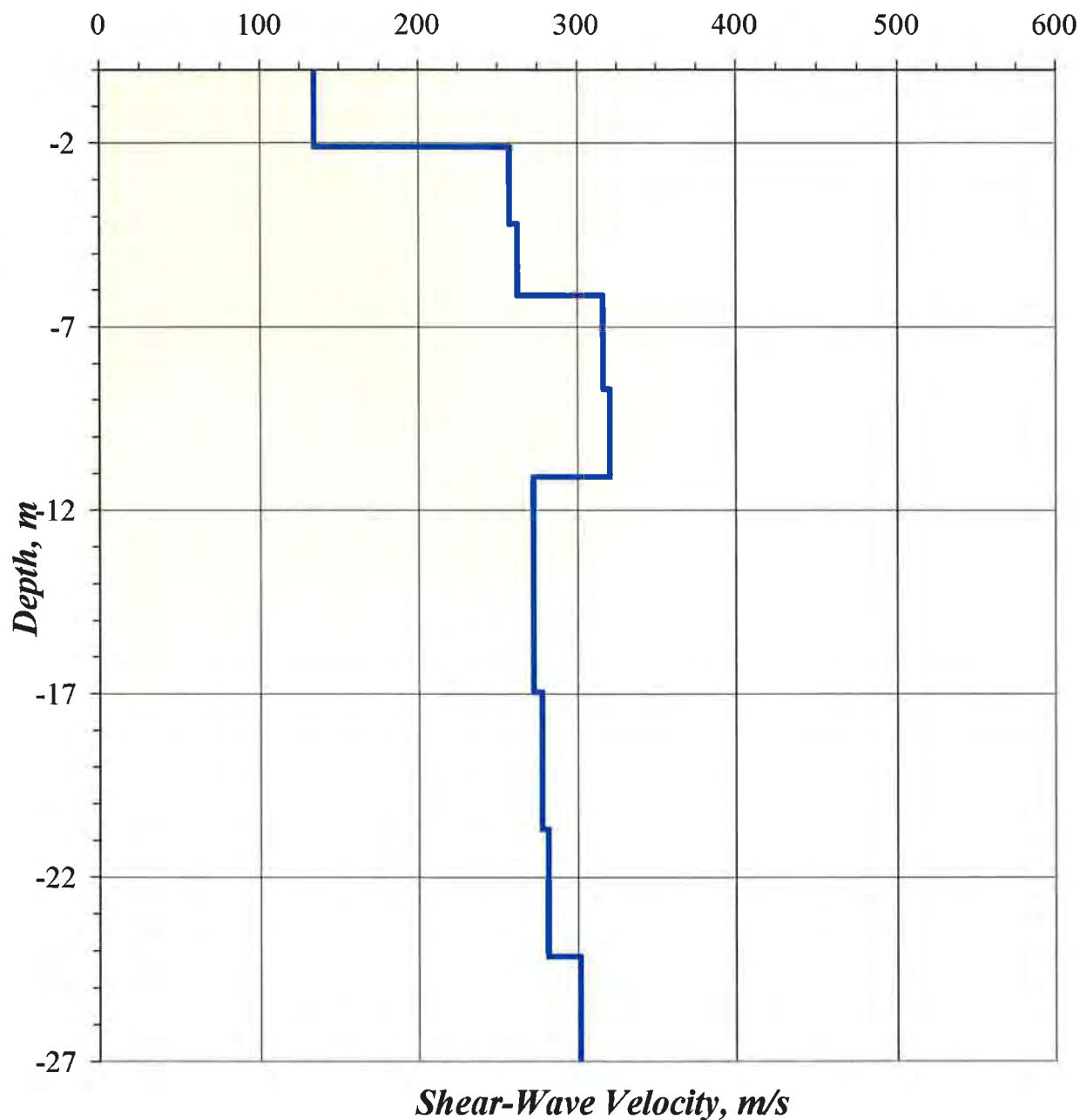
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drawn	DAC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD		
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 10 DISPERSION CURVE		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-10B
original size	A3				rev:	

ReMi 10
Shear-Wave Velocity Profile from SeisOpt ReMi Software Analysis



REF:
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drawn	DAC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD		
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
date	5/06/08		title:	REMI 10 MODEL		
scale			project no:	GEOPHERD00023AA	fig no:	FIGURE B-10C
original size	A3				rev:	

Appendix F

Laboratory Test Data

FIONA STANLEY HOSPITAL – GEOTECHNICAL LABORATORY TEST RESULTS

Sample	Depth (m)	Fines %	MDD (t/m³)	OMC (%)	CBR %
TP112	2.0 – 2.3	1			
TP109	2.5 – 2.8	2			
TP101	1.2 – 1.5	4			
TP104	3.3 – 3.6	2	1.74	14.5	11
TP117	3.7 – 4.0	5	1.77	12.0	17
TP122	2.9 – 3.0	2			
TP116	3.8 – 4.0	4			
TP114	2.3 – 2.5	1			
TP113	2.3 – 2.5	2			
TP115	2.3 – 2.6	2			

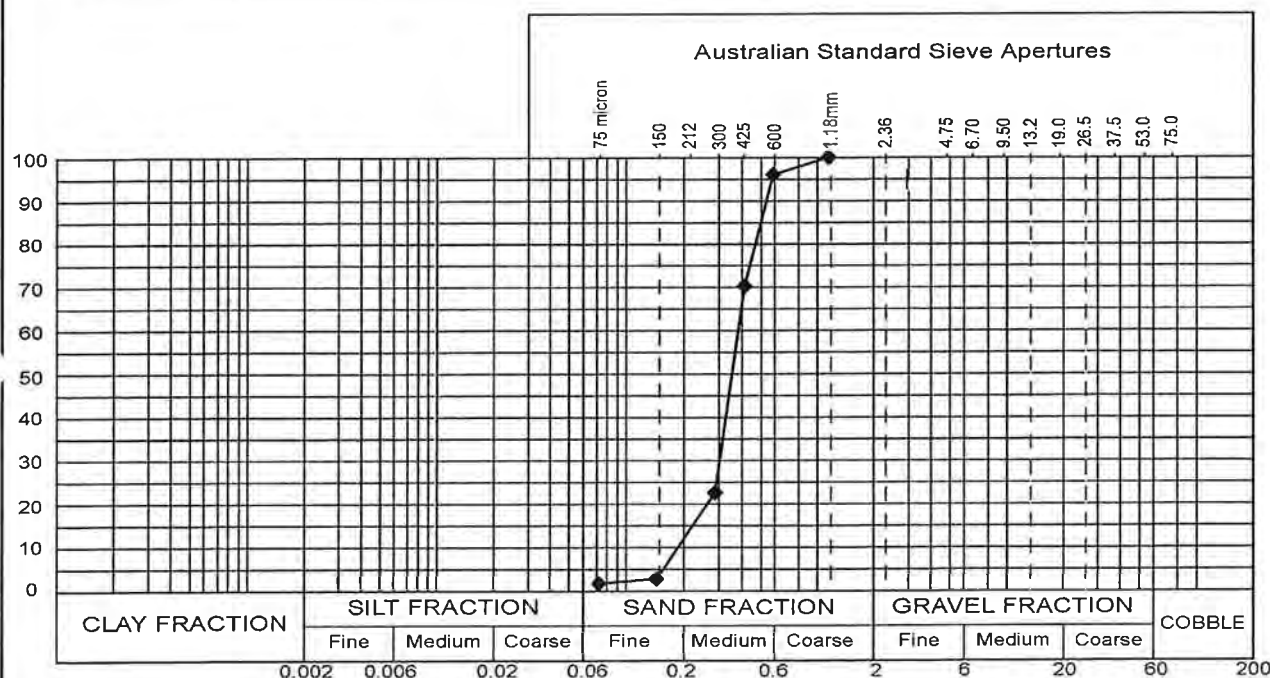
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05035
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP112 @ 2.0-2.3m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	96				
37.5 mm		425 micron	70				
19.0 mm		300 micron	22				
9.50 mm		150 micron	2				
4.75 mm		75 micron	1				
2.36mm							

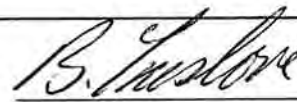


Remarks: Sampling Method/s - Submitted by client



This document is issued in accordance with NATA's Accreditation Requirements. Accredited for compliance with ISO/IEC 17025

Approved Signatory:



B Truslove

Date: 22/05/2008

NATA Acc. Laboratory No 431

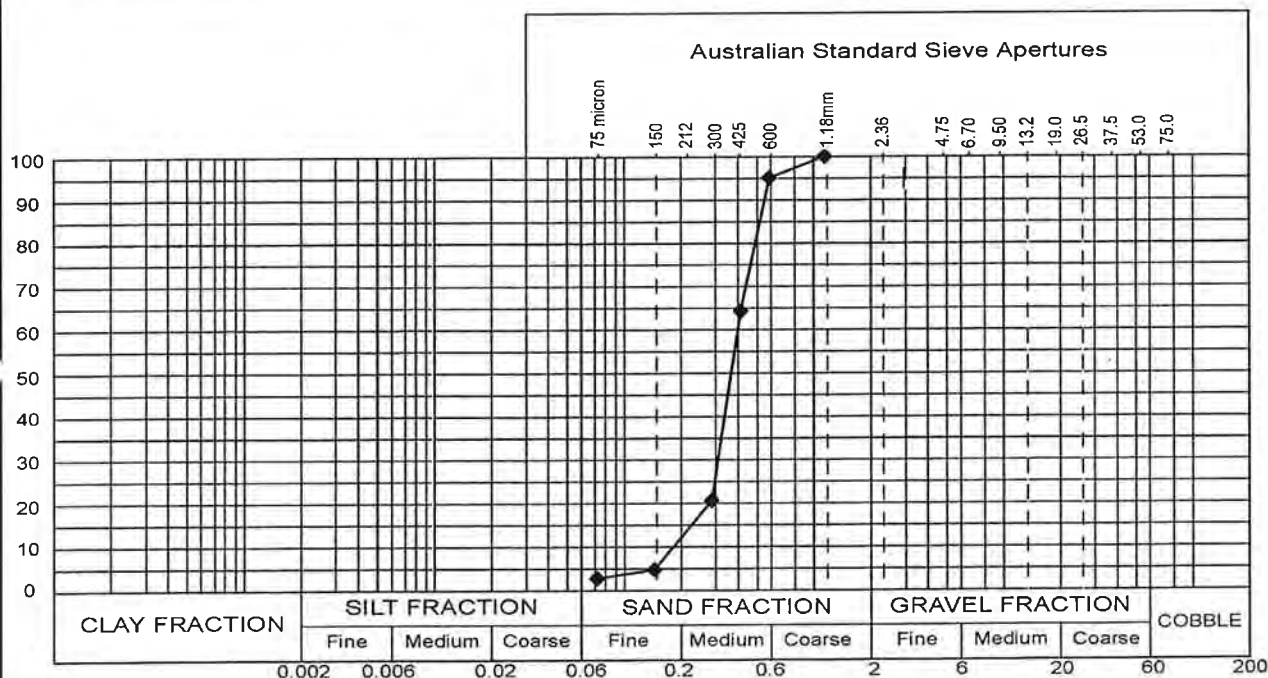
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05036
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP109 @2.5-2.8m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	95				
37.5 mm		425 micron	64				
19.0 mm		300 micron	20				
9.50 mm		150 micron	4				
4.75 mm		75 micron	2				
2.36mm							



Remarks: Sampling Method/s - Submitted by client



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Approved Signatory:

B Truslove
B Truslove

Date: 22/05/2008
NATA Acc. Laboratory No 431

TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch
Sample ID: TP101 @ 1.2-1.5m

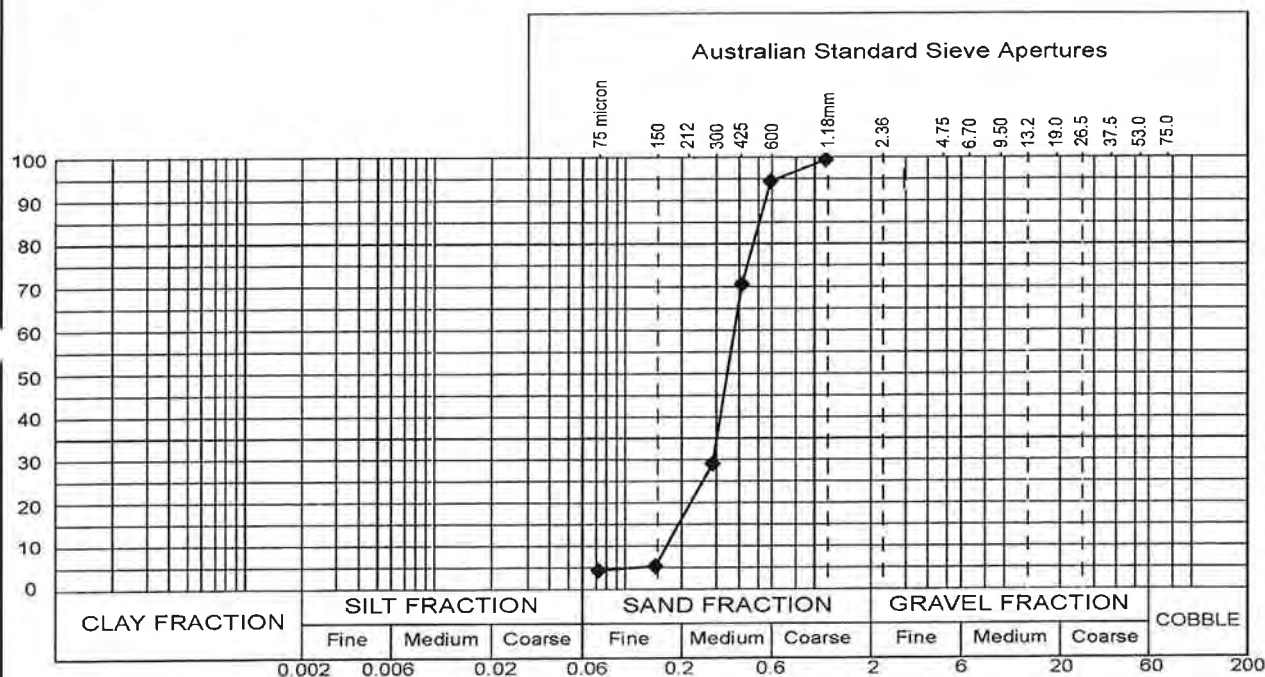
Report No.: HERD08S-05037

Job No.: LABTHERD00503AA

Date Tested: 12/05/2008

Particle Size Distribution & Atterberg Limits of a Soil

Particle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Moisture Content (AS1289 2.1.1)	
150.0mm		1.18 mm	100	Liquid Limit (%)	Not Obtainable- Slips in cup
75.0mm		600 micron	95	Plastic Limit (%)	Non Plastic
37.5 mm		425 micron	71	Plasticity Index (%)	Non Plastic
19.0 mm		300 micron	29	Linear Shrinkage (%)	0.0 *
9.50 mm		150 micron	5	Nature Of Shrinkage	Flat
4.75 mm		75 micron	4	Sample History	Air Dried
2.36mm				Preparation Method	Dry Sieved
				Moisture Content (%)	4.3

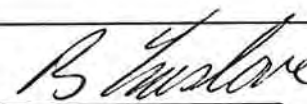


Remarks: Sampling Method/s - Submitted by client
*Non standard linear shrinkage 25 +/- 3 blows not obtainable



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Date: 22/05/2008
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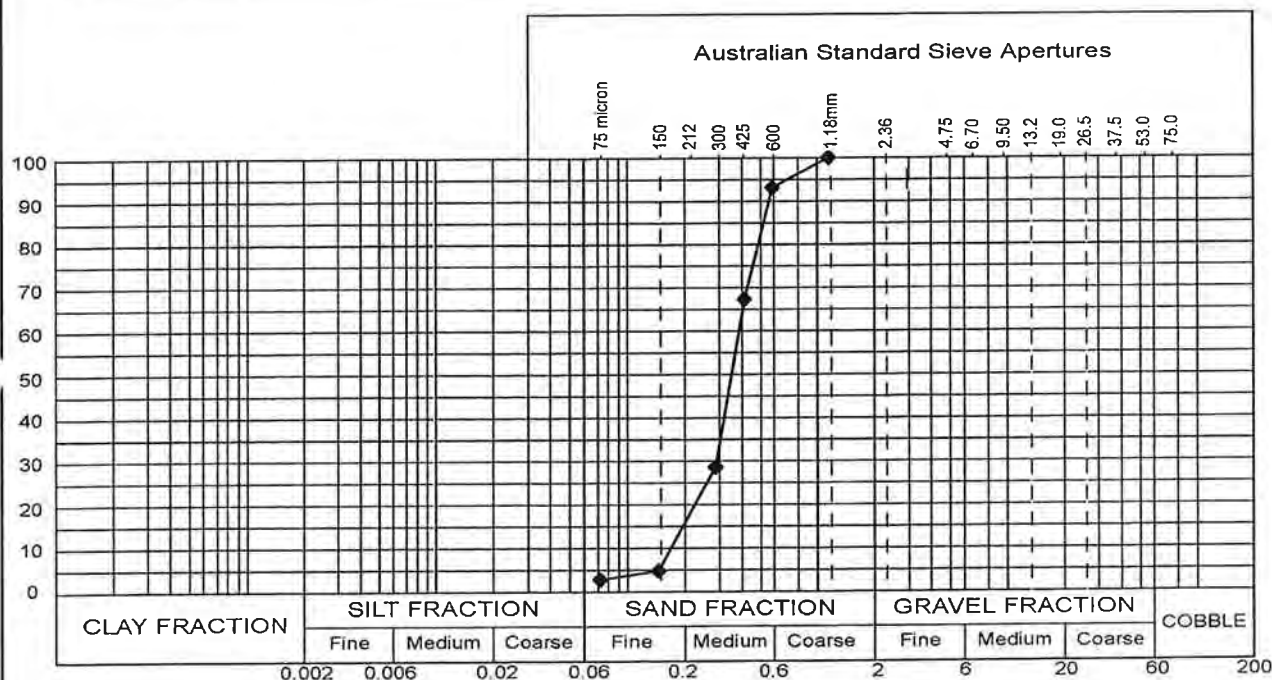
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05038
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP104 @ 3.3-3.6m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	93				
37.5 mm		425 micron	67				
19.0 mm		300 micron	28				
9.50 mm		150 micron	4				
4.75 mm		75 micron	2				
2.36mm							



Remarks: Sampling Method/s - Submitted by client



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Date: 22/05/2008

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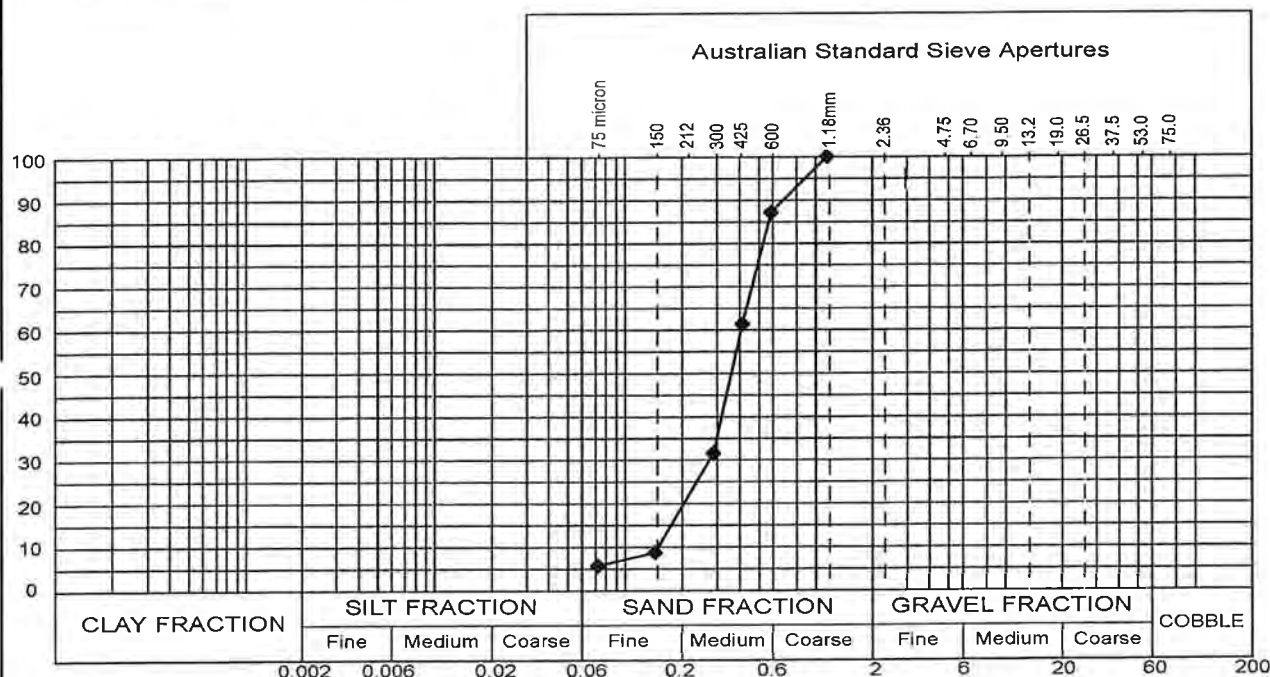
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05039
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP117 @ 3.7-4.0m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	87				
37.5 mm		425 micron	61				
19.0 mm		300 micron	31				
9.50 mm		150 micron	8				
4.75 mm		75 micron	5				
2.36mm							



Remarks: Sampling Method/s - Submitted by client



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Date: 22/05/2008

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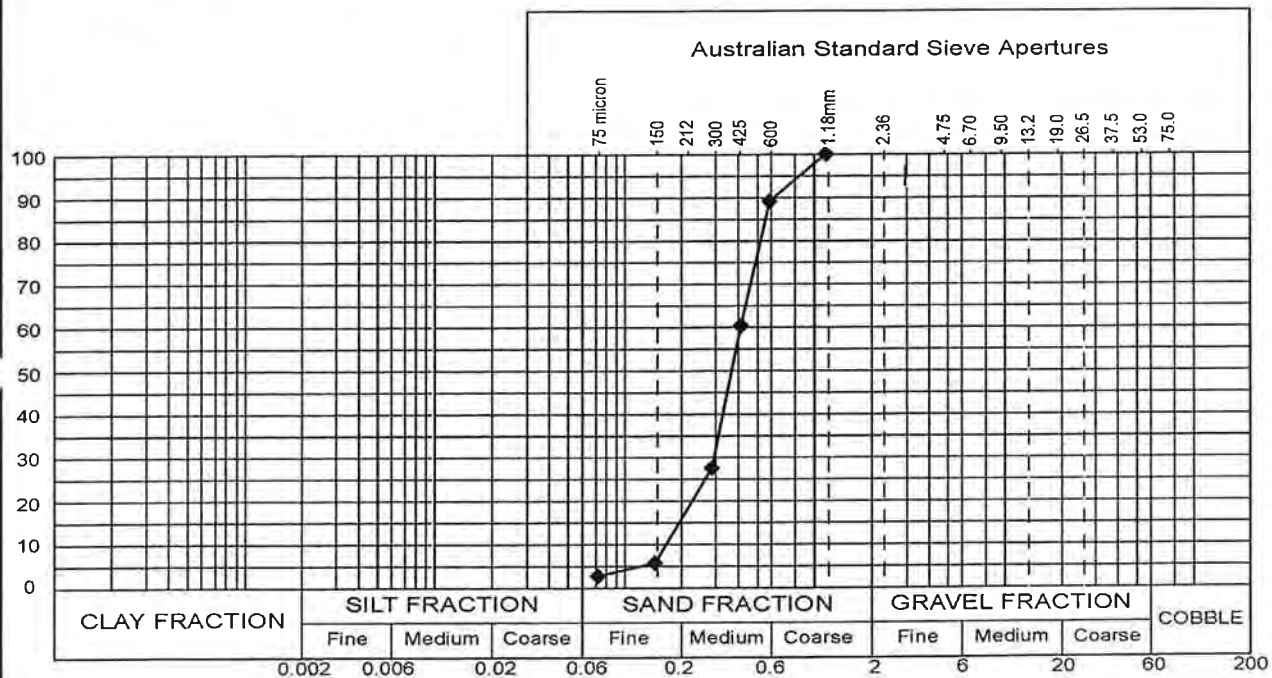
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05040
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP122 @ 2.8-3.0m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	89				
37.5 mm		425 micron	60				
19.0 mm		300 micron	27				
9.50 mm		150 micron	5				
4.75 mm		75 micron	2				
2.36mm							



Remarks: Sampling Method/s - Submitted by client



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Approved Signatory:



B Truslove

Date: 22/05/2008

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TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch
Sample ID: TP116 @ 3.8-4.0m

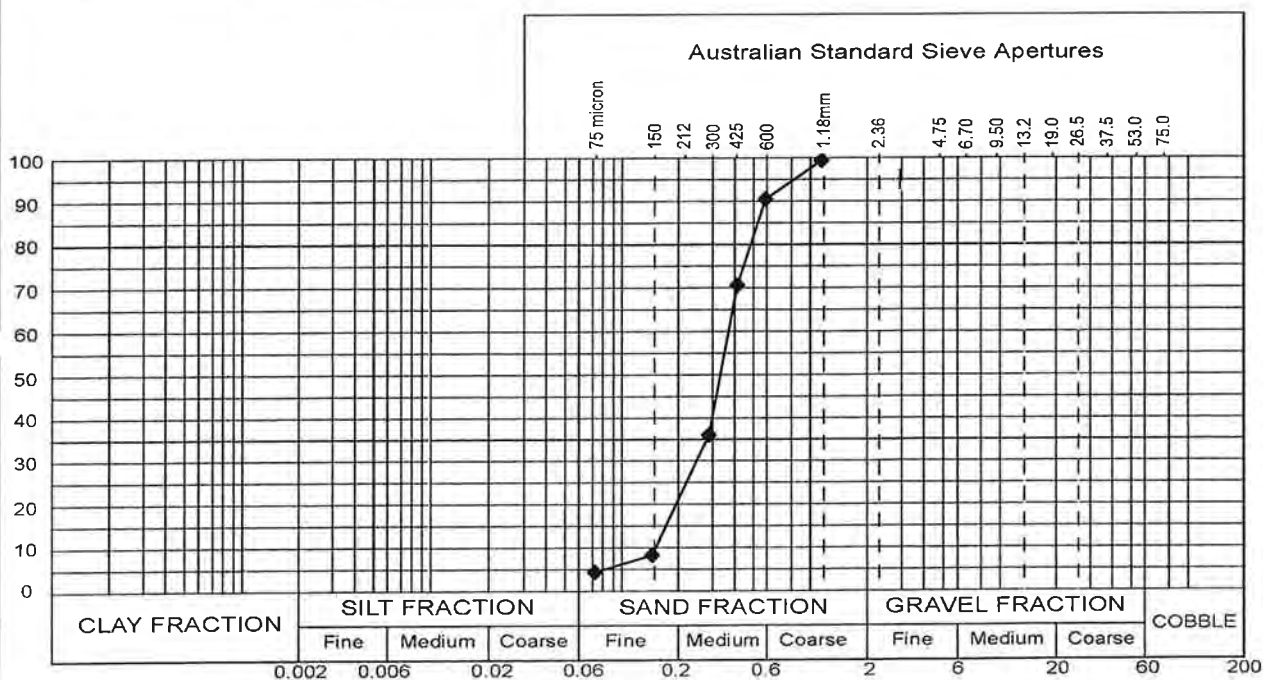
Report No.: HERD08S-05041

Job No.: LABTHERD00503AA

Date Tested: 12/05/2008

Particle Size Distribution & Atterberg Limits of a Soil

Particle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Moisture Content (AS1289 2.1.1)	
150.0mm		1.18 mm	100	Liquid Limit (%)	Not Obtainable- Slips in cup
75.0mm		600 micron	91	Plastic Limit (%)	Non Plastic
37.5 mm		425 micron	71	Plasticity Index (%)	Non Plastic
19.0 mm		300 micron	36	Linear Shrinkage (%)	0.0 *
9.50 mm		150 micron	8	Nature Of Shrinkage	Flat
4.75 mm		75 micron	4	Sample History	Air Dried
2.36mm				Preparation Method	Dry Sieved
				Moisture Content (%)	10.2

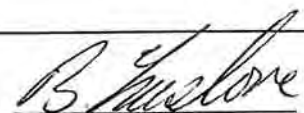


Remarks: Sampling Method/s - Submitted by client
*Non standard linear shrinkage 25 +/- 3 blows not obtainable



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Date: 22/05/2008

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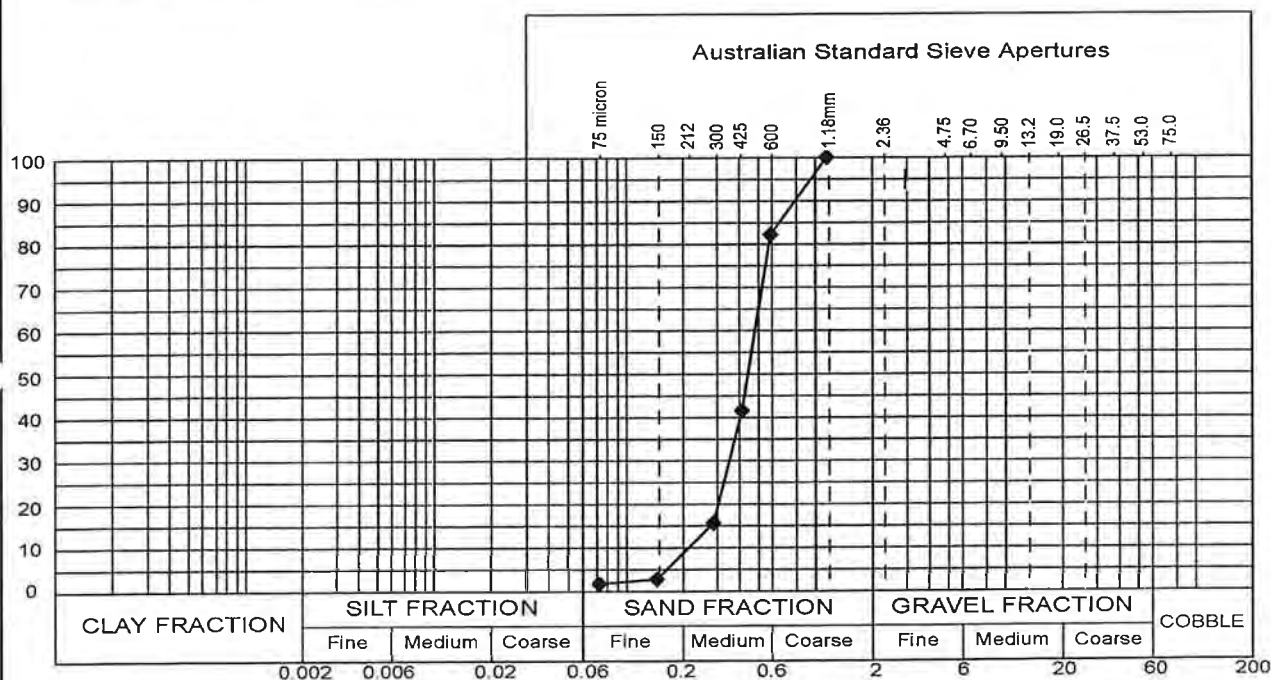
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05042
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP114 @ 2.3-2.5m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	82				
37.5 mm		425 micron	41				
19.0 mm		300 micron	15				
9.50 mm		150 micron	2				
4.75 mm		75 micron	1				
2.36mm							

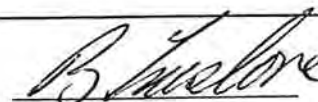


Remarks: Sampling Method/s - Submitted by client



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Approved Signatory:


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Date: 22/05/2008
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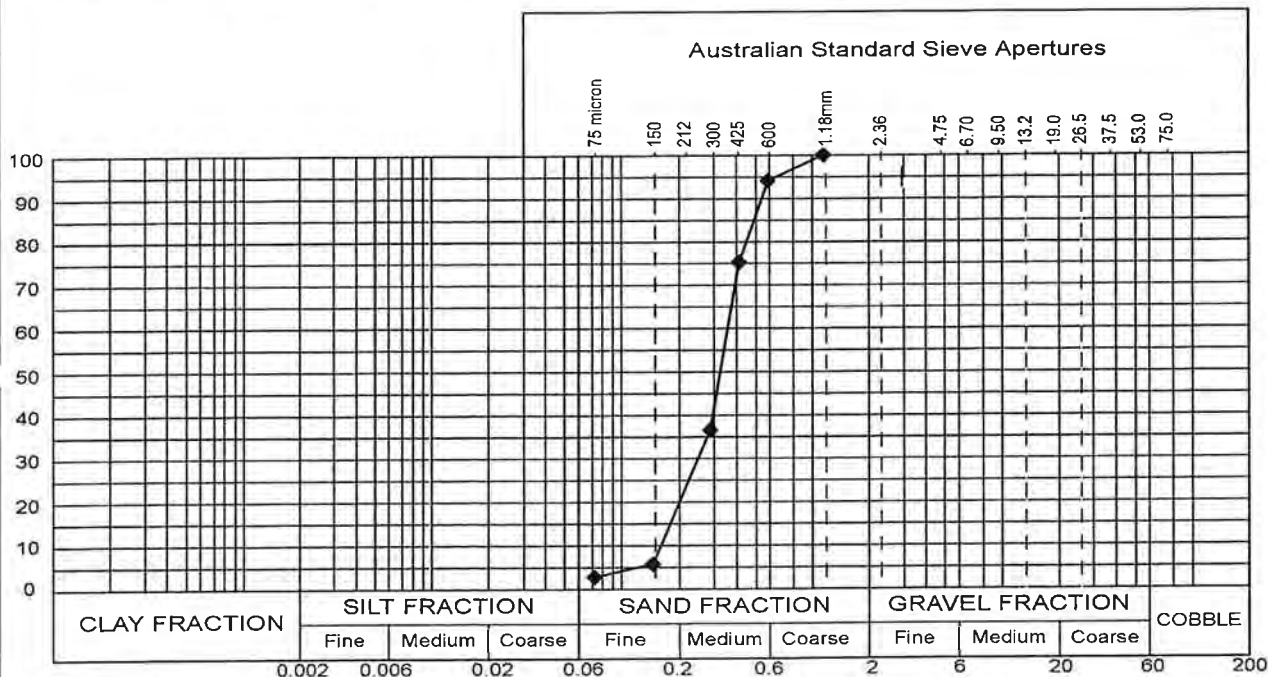
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05043
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: TP113 @ 2.3-2.5m **Date Tested:** 12/05/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	94				
37.5 mm		425 micron	75				
19.0 mm		300 micron	36				
9.50 mm		150 micron	5				
4.75 mm		75 micron	2				
2.36mm							

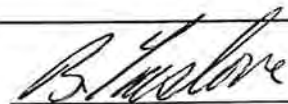


Remarks: Sampling Method/s - Submitted by client



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Approved Signatory:



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Date: 22/05/2008

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TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch
Sample ID: TP115 @ 2.3-2.6m

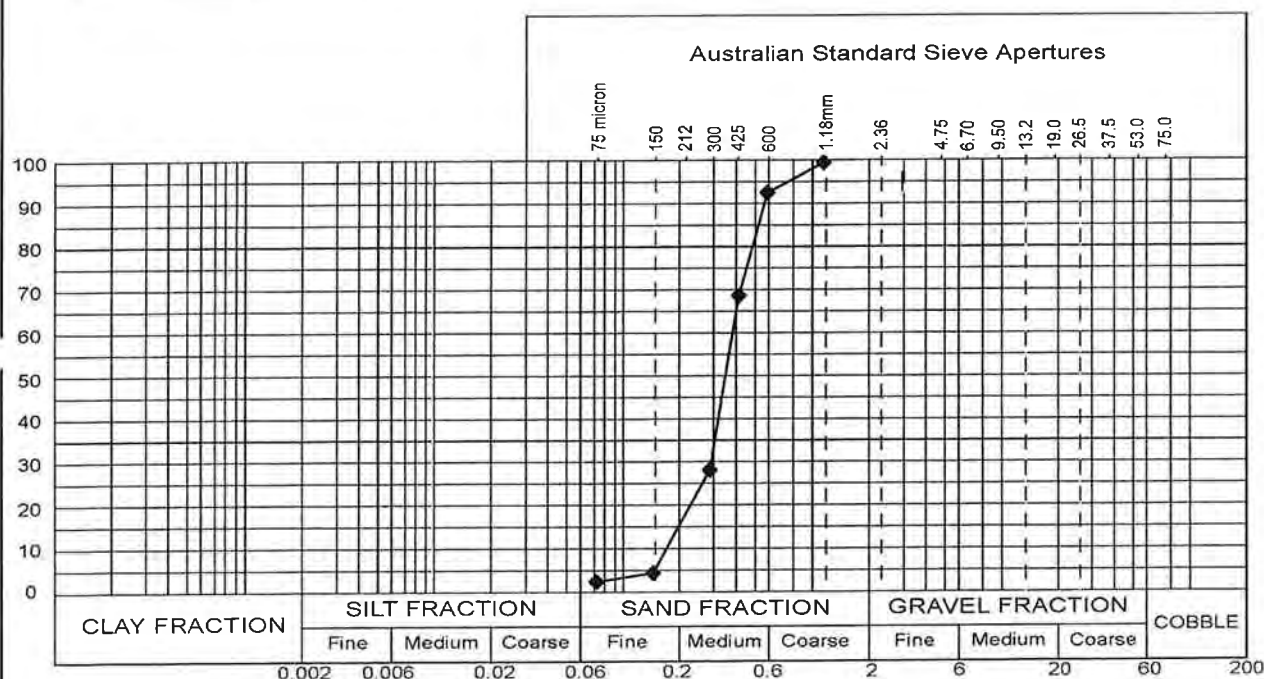
Report No.: HERD08S-05044

Job No.: LABTHERD00503AA

Date Tested: 12/05/2008

Particle Size Distribution & Atterberg Limits of a Soil

Particle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Moisture Content (AS1289 2.1.1)	
150.0mm		1.18 mm	100	Liquid Limit (%)	Not Obtainable- Slips in cup
75.0mm		600 micron	93	Plastic Limit (%)	Non Plastic
37.5 mm		425 micron	69	Plasticity Index (%)	Non Plastic
19.0 mm		300 micron	28	Linear Shrinkage (%)	0.0*
9.50 mm		150 micron	4	Nature Of Shrinkage	Flat
4.75 mm		75 micron	2	Sample History	Air Dried
2.36mm				Preparation Method	Dry Sieved
				Moisture Content (%)	1.8



Remarks: Sampling Method/s - Submitted by client
Non standard linear shrinkage 25 +/- 3 blows not obtainable



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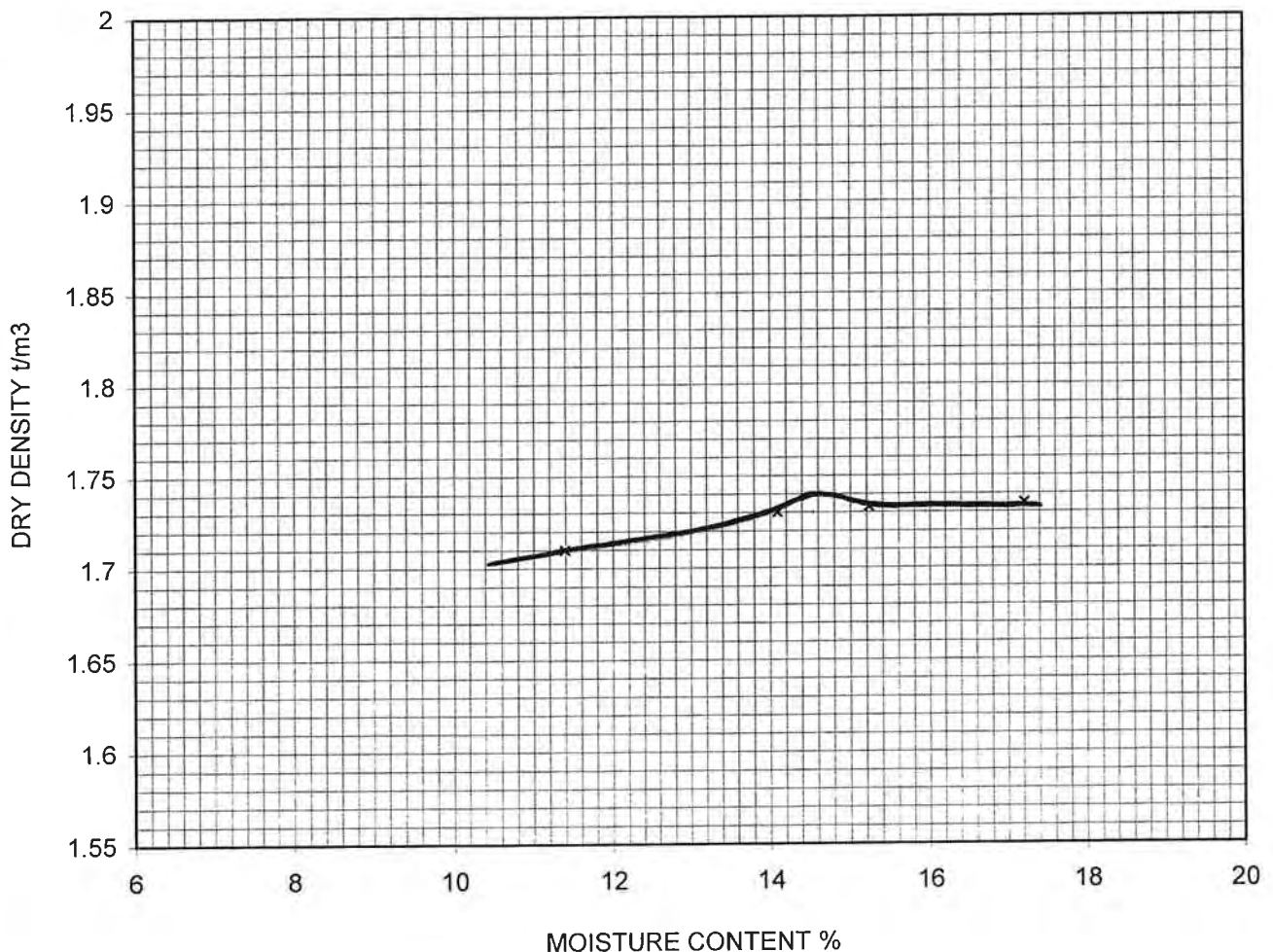
Approved Signatory:


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Date: 22/05/2008
NATA Acc. Laboratory No 431

moisture/density relationship - graph E		job no : LABTHERD00503AA
		report no : HERD08S-05038
client : Coffey Geotechnics - GEOTHERD08304AB	date : 12/05/2008	
principal : BG&E	laboratory Herdsman	
project : Fiona Stanley Hospital	tested by : RB	
location : Murdoch	checked by BT	
test procedure(s) : AS1289.5.2.1	maximum dry density :	1.74 t/m ³
soil particle density : - t/m ³	optimum moisture content :	14.5 %
sample identification : TP104 @ 3.3-3.6m	% retained 19mm sieve:	0 %

ZERO AIR VOIDS FOR SOIL PARTICLE DENSITY SHOWN

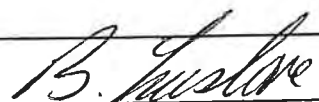


material classification :

Remarks: Sampling Method/s - Submitted by client

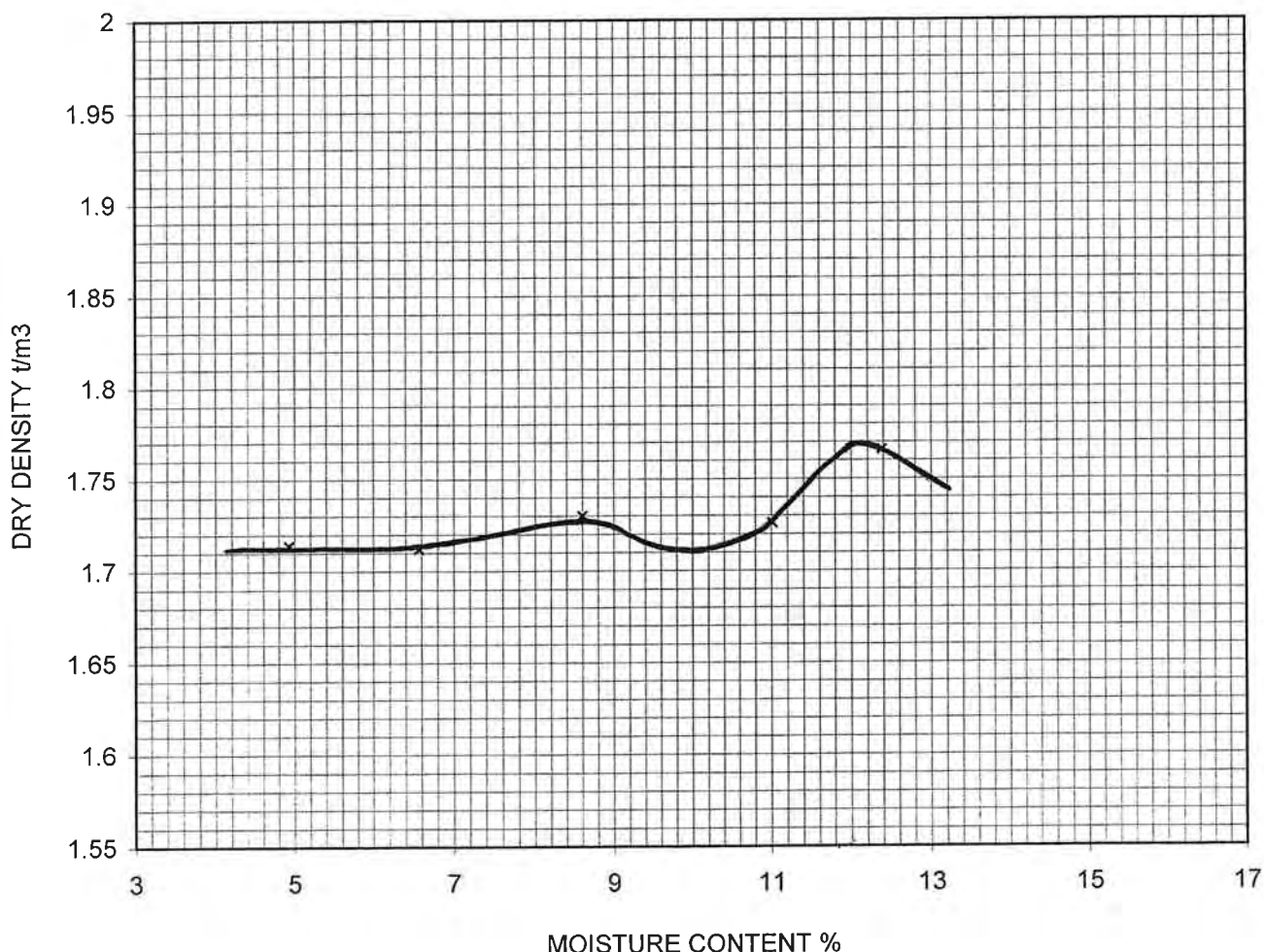


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Approved Signatory: (B Truslove)
NATA Accredited Laboratory No. 431
Date: 22/05/2008

moisture/density relationship - graph E		job no : LABTHERD00503AA
		report no : HERD08S-05039
client : Coffey Geotechnics - GEOTHERD08304AB	date : 12/05/2008	
principal : BG&E	laboratory Herdsman	
project : Fiona Stanley Hospital	tested by : RB	
location : Murdoch	checked by BT	
test procedure(s) : AS1289.5.2.1	maximum dry density : 1.77	t/m ³
soil particle density : - t/m ³	optimum moisture content : 12.0	%
sample identification : TP117 @ 3.7-4.0m	% retained 19mm sieve: 0	%

ZERO AIR VOIDS FOR SOIL PARTICLE DENSITY SHOWN

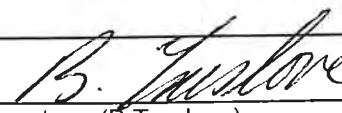


material classification :

Remarks: Sampling Method/s - Submitted by client



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Date: 22/05/2008

TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch

Report No.: HERD08S-05038
Job No.: LABTHERD00503AA
Date Tested: 13/05/2008

California Bearing Ratio of Remoulded Specimens AS1289.6.1.1

SAMPLE IDENTIFICATION			SOAKED	UNSOAKED
SAMPLE NUMBER			TP104	
DEPTH		mm	3.3-3.6m	
MATERIAL DESCRIPTION			-	
COMPACTION PROPERTIES				
MAXIMUM DRY DENSITY		t/m ³	1.74	
OPTIMUM MOISTURE		%	14.5	
TEST CONDITIONS OF SPECIMEN				
DENSITY RATIO REQUIRED		%	95.0	
MOISTURE RATIO REQUIRED		%	95.0	
PERIOD OF SOAKING		days	4	
SURCHARGING OF SPECIMEN		kg	4.5	
COMPACTIVE EFFORT (Modified)		Blows per layer	-	
NUMBER OF LAYERS			5	
MATERIAL RETAINED ON 19mm SIEVE		%	0	
TEST RESULTS				
DRY DENSITY AT COMPACTION		t/m ³	1.72	
DRY DENSITY AFTER SOAKING		t/m ³	1.72	
DRY DENSITY RATIO AT COMPACTION		%	99	
DRY DENSITY RATIO AFTER SOAKING		%	99	
MOISTURE CONTENT AT COMPACTION		%	11.1	
TOP 30MM OF SPECIMEN AFTER PENETRATION		%	14.4	
ENTIRE DEPTH OF SPECIMEN AFTER PENETRATION		%	16.1	
MOISTURE RATIO AT COMPACTION		%	77	
MOISTURE RATIO OF TOP 30MM AFTER PENETRATION		%	99	
MOISTURE RATIO OF ENTIRE DEPTH AFTER PENETRATION		%	111	
SWELL OF SPECIMEN DURING SOAKING		%	0	
CALIFORNIA BEARING RATIO		%	11	
PENETRATION		mm	2.5	

Remarks: Sampling Method/s - Submitted by client
Any material retained on the 19.0mm sieve was excluded from the test sample.



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Approved Signatory:



B Truslove

Date: 22/05/2008

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TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch

Report No.: HERD08S-05039
Job No.: LABTHERD00503AA
Date Tested: 13/05/2008

California Bearing Ratio of Remoulded Specimens AS1289.6.1.1

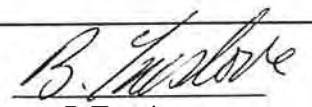
SAMPLE IDENTIFICATION			SOAKED	UNSOAKED
SAMPLE NUMBER			TP117	
DEPTH		mm	3.7-4.0m	
MATERIAL DESCRIPTION			-	
COMPACTION PROPERTIES				
MAXIMUM DRY DENSITY		t/m ³	1.77	
OPTIMUM MOISTURE		%	12.0	
TEST CONDITIONS OF SPECIMEN				
DENSITY RATIO REQUIRED		%	95.0	
MOISTURE RATIO REQUIRED		%	95.0	
PERIOD OF SOAKING		days	4	
SURCHARGING OF SPECIMEN		kg	4.5	
COMPACTIVE EFFORT (Modified)		Blows per layer	-	
NUMBER OF LAYERS			5	
MATERIAL RETAINED ON 19mm SIEVE		%	0	
TEST RESULTS				
DRY DENSITY AT COMPACTION		t/m ³	1.68	
DRY DENSITY AFTER SOAKING		t/m ³	1.68	
DRY DENSITY RATIO AT COMPACTION		%	95	
DRY DENSITY RATIO AFTER SOAKING		%	95	
MOISTURE CONTENT AT COMPACTION		%	12.2	
TOP 30MM OF SPECIMEN AFTER PENETRATION		%	14.4	
ENTIRE DEPTH OF SPECIMEN AFTER PENETRATION		%	15.9	
MOISTURE RATIO AT COMPACTION		%	102	
MOISTURE RATIO OF TOP 30MM AFTER PENETRATION		%	120	
MOISTURE RATIO OF ENTIRE DEPTH AFTER PENETRATION		%	133	
SWELL OF SPECIMEN DURING SOAKING		%	-0.5	
CALIFORNIA BEARING RATIO		%	17	
PENETRATION		mm	2.5	

Remarks: Sampling Method/s - Submitted by client
Any material retained on the 19.0mm sieve was excluded from the test sample.



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Date: 22/05/2008

NATA Acc. Laboratory No 431

FIONA STANLEY HOSPITAL - GROUNDWATER ANALYSES

Test No.	COFFEY					GHD			
	BH101	BH102	BH103	BH104	BH104	BH1	BH2	BH3	NRMH
				Deep	Shallow	2007	2007	2007	2004***
pH	6.6	6.65	6.7	6.35	6.85	6.67	5.06	6.63	6.5 -
Electrical	1500	1800	1100	3200	950	1040	1520	431	-
TDS (mg/L)	970	1200	680	2400	610	640	1760	248	500
CO ₃ ²⁻ (mg/L)	<1	<1	<1	<1	<1	<1	<1	<1	-
HCO ₃ ⁻ (mg/L)	160	190	130	200	130	121	<1	80	-
OH ⁻ (mg/L)	<1	<1	<1	<1	<1	-	-	-	-
Cl ⁻ (mg/L)	280	360	190	700	160	-	-	49.3	250
SO ₄ ²⁻ (mg/L)	92	100	69	58	68	267	334	<1	-
NO ₃ ⁻ (mg/L)	1.2	<0.1	0.2	1.5	0.4	0.2	0.089	0.4	-
Na ⁺ (mg/L)	330	420	240	660	210	67	142	35	-
K ⁺ (mg/L)	3.8	3.3	2.2	2.4	2.1	7	18	3	-
Ca ²⁺ (mg/L)	16	21	9.7	14	12	118	82	38	-
Mg ²⁺ (mg/L)	10	13	4.7	6.6	5.3	21	32	9	-
Hardness (mg/L)	82	100	44	63	52	-	-	-	200
Al Total (mg/L)	2.4	8.5	7.5	3.7	3.3	-	-	-	0.2*
B Total (mg/L)	0.53	0.41	0.46	0.41	0.42	-	-	<0.05	0.3
Ba Total (mg/L)	0.036	0.69	0.051	0.079	0.008	-	-	-	0.7
Be Total (mg/L)	0.0013	0.0055	0.001	0.0006	0.0006	-	-	-	-
Cd Total (mg/L)	<0.001	0.002	<0.001	0.002	<0.001	0.009	-	0.0006	0.002
Co Total (mg/L)	<0.005	0.021	<0.005	0.009	<0.005	-	-	-	-
Cr Total (mg/L)	<0.026	0.069	0.019	0.094	0.018	0.58	-	-	0.1
Cu Total (mg/L)	0.068	0.13	0.25	0.15	0.051	0.05	-	-	2
Fe Total (mg/L)	2.5	7.6	7.5	1.8	1.8	-	-	<0.05	-
Mn Total (mg/L)	0.33	0.9	0.54	0.1	0.28	-	-	-	0.5
Mo Total (mg/L)	0.006	0.011	0.012	<0.005	<0.005	-	-	-	0.05
Ni Total (mg/L)	0.013	0.036	0.01	0.017	0.015	0.08	-	-	0.02
Si Total (mg/L)	15	18	13	601	12	-	-	-	-
Sr Total (mg/L)	0.15	0.2	0.11	0.09	0.11	-	-	-	-
Ti Total (mg/L)	0.04	0.12	0.15	0.06	0.11	-	-	-	-
V Total (mg/L)	0.042	0.12	0.025	0.063	0.018	-	-	-	-
Zn Total (mg/L)	0.11	0.096	0.027	0.21	0.019	0.1	-	0.056	3
As Total (mg/L)	0.004	0.035	0.02	0.004	0.011	0.05	-	-	0.007
Pb Total (mg/L)	0.038	0.016	0.002	0.016	0.001	0.28	-	-	0.01
Se Total (mg/L)	0.003	0.005	<0.001	0.003	0.001	-	-	-	0.01
Hg Total (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	0.001

*** - Drinking Water

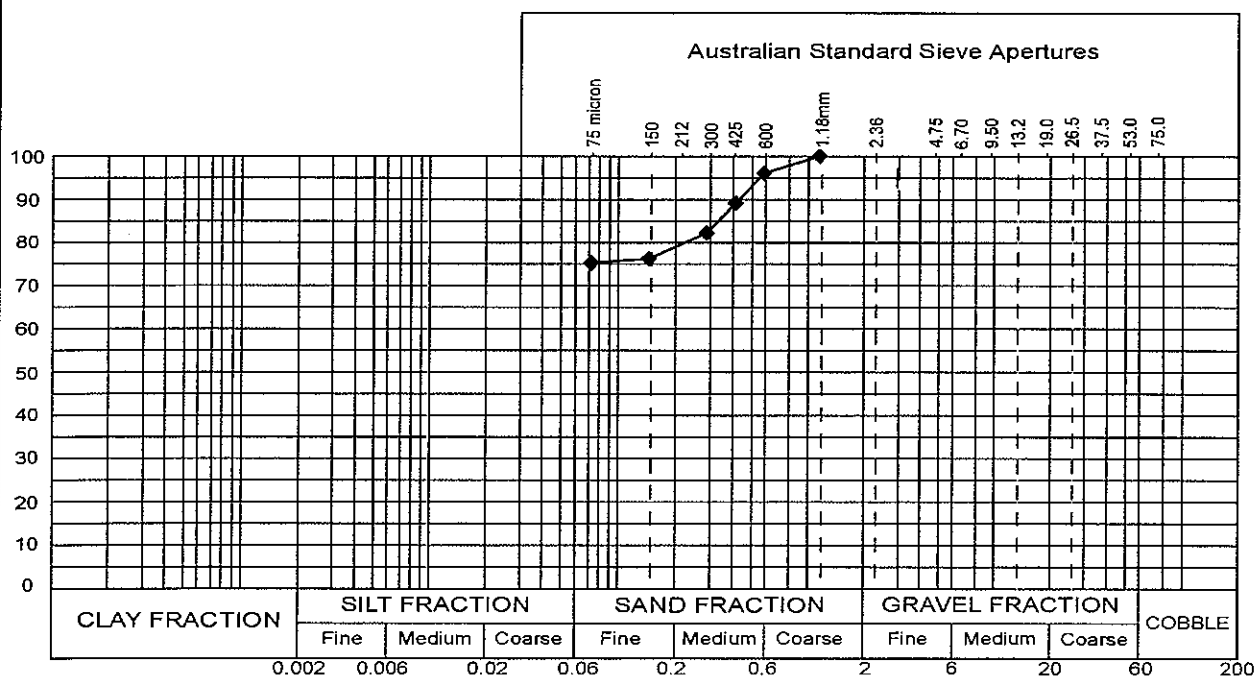
TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB **Report No.:** HERD08S-05938
Principal: BG&E
Project: Fiona Stanley Hospital **Job No.:** LABTHERD00503AA
Location: Murdoch
Sample ID: BH104 @ 8.2m **Date Tested:** 12/06/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm	100				
75.0mm		600 micron	96				
37.5 mm		425 micron	89				
19.0 mm		300 micron	82				
9.50 mm		150 micron	76				
4.75 mm		75 micron	75				
2.36mm							

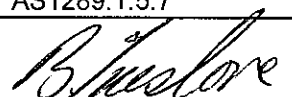


Remarks: Sampling Method/s - Submitted by client
Sample mass does not conform to minimum mass required as per AS1289.1.5.7



This document is issued in
accordance with NATA's
Accreditation Requirements.
Accredited for compliance with
ISO/IEC 17025

Approved Signatory:


B Truslove

Date: 17/06/2008

NATA Acc. Laboratory No 431

TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB

Report No.: HERD08S-05939

Principal: BG&E

Project: Fiona Stanley Hospital

Job No.: LABTHERD00503AA

Location: Murdoch

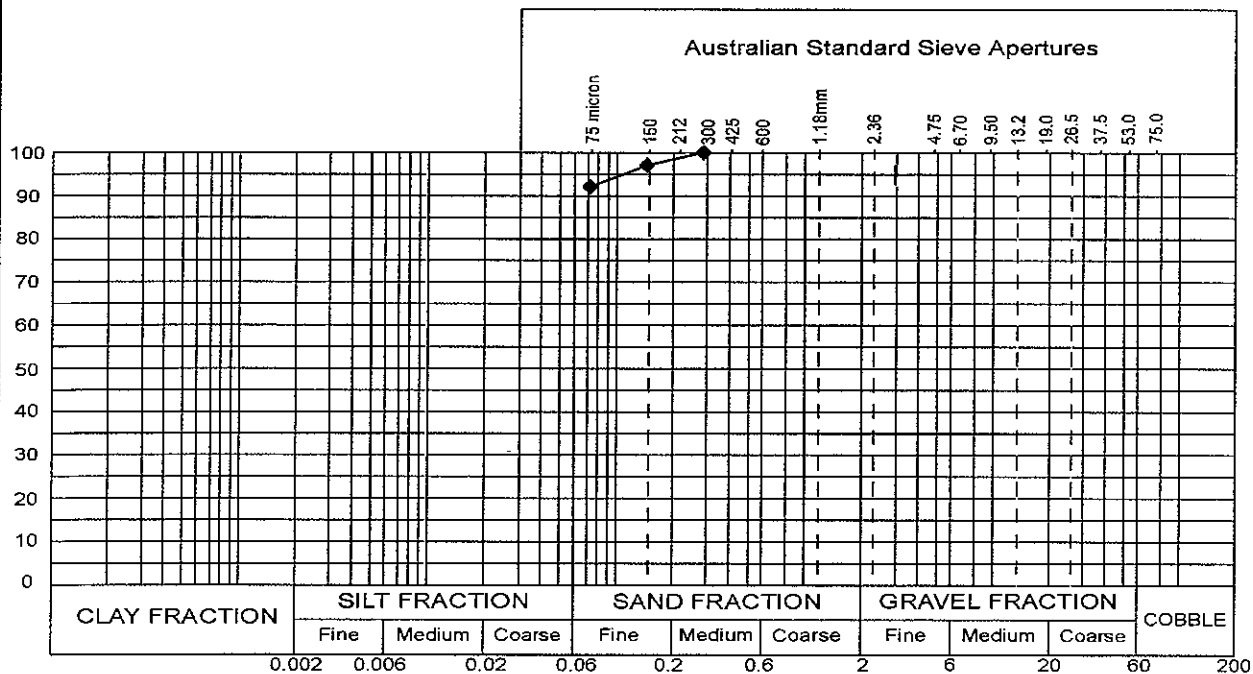
Sample ID: BH104 @ 9.0-9.1m

Date Tested: 12/06/2008

Particle Size Distribution of a Soil

Standard Method of Analysis by Sieving: AS 1289.3.6.1

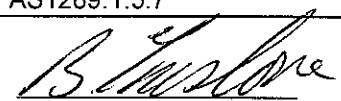
Sieving				Sieving			
Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing	Sieve Size	% Passing
150.0mm		1.18 mm					
75.0mm		600 micron					
37.5 mm		425 micron					
19.0 mm		300 micron	100				
9.50 mm		150 micron	97				
4.75 mm		75 micron	92				
2.36mm							


Remarks: Sampling Method/s - Submitted by client

Sample mass does not conform to minimum mass required as per AS1289.1.5.7



This document is issued in accordance with NATA's Accreditation Requirements. Accredited for compliance with ISO/IEC 17025

Approved Signatory:


B Truslove

Date: 17/06/2008

NATA Acc. Laboratory No 431

TEST CERTIFICATE

Client: Coffey Geotechnics - GEOTHERD08304AB
Principal: BG&E
Project: Fiona Stanley Hospital
Location: Murdoch

Report No.: HERD08S-05940
Job No.: LABTHERD00503AA
Date Tested: 12/06/2008

Atterberg Limits & Linear Shrinkage AS 1289.3.1.2, 3.2.1, 3.3.1, 3.4.1

Laboratory Number	HERD08S 05940
Sample Identification	BH104 @9.15-9.25m
Liquid Limit (%)	Not Obtainable - Slips in Cup
Plastic Limit (%)	Non Plastic
Plasticity Index (%)	Non Plastic
Linear Shrinkage (%)	1.0*
Sample History	Air Dried
Preparation Method	Dry Sieved
Nature Of Shrinkage	Flat

Remarks: Sampling Method/s - Submitted by client
* Non Standard Linear Shrinkage 25+/- 3 Blows not obtainable



This document is issued in
accordance with NATA's
Accreditation
Requirements. Accredited
for compliance with
ISO/IEC 17025

Approved Signatory:

B Truslove

Date: 17/06/2008
NATA Acc. Laboratory No 431

Analytical Report

Extended Water Analysis

Job No : 083174

Client: Coffey Geotechnics

Address: PO Box 1530

OSBORNE PARK

WA 6916

AUSTRALIA

Approved Checker
Luke Rutland

Approved Signatory
Andrew Eitchells

Contact:

Cassie Turvey

E-mail: Cassie.Turvey@coffey.com.au

Fax: 08 9347 0099

Client Reference: GEOTHERD08304AB

Date Sampled: 15/05/2008

Date Received: 19/05/2008

Date Reported: 3/06/2008

Sampled By: Client

Location: Murdoch

Test Method:

Water samples submitted by clients are analysed on an as received basis. Metals analysis on acidified samples as received. Analysis performed in accordance with MPL Laboratories WILAB 5, 6, 8 and 17.



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Date Printed 5/06/2008

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Analytical Report

Job No : 083174

Lab Id External Idents

Units	EC	pH	TDS	CO3	HCO3	OH	Cl	SO4	NO3	Na
LQL	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	1	0.05	1	1	1	1	1	1	0.1	1
	+	+	+	+	+	+			+	
083174-001	1500	6.60	970	<1	160	<1	280	92	1.2	330
083174-002	1800	6.65	1200	<1	190	<1	360	100	<0.1	420
083174-003	1100	6.70	680	<1	130	<1	190	69	0.2	240
083174-004	3200	6.35	2400	<1	200	<1	700	58	1.5	660
083174-005	950	6.85	610	<1	130	<1	160	68	0.4	210
083174-001-DUP	1500	6.60	970	<1	160	<1	280	93	1.2	330

+ Indicates sample received outside holding time recommended by AS/NZ 5667.1.1998

Analytical Report

Job No : 083174

Lab Id External Idents

Units
LQL

083174-001	BH101	K	Ca	Mg	Hard	Al	B	Ba	Be	Cd	Co
083174-002	BH102	3.3	21	13	100	8.5	0.41	0.069	0.0055	0.002	0.021
083174-003	BH103	2.2	9.7	4.7	44	7.5	0.46	0.051	0.0010	<0.001	<0.005
083174-004	BH104 Deep	2.4	14	6.6	63	3.7	0.41	0.079	0.0006	0.002	0.009
083174-005	BH104 Shallow	2.1	12	5.3	52	3.3	0.42	0.008	0.0006	<0.001	<0.005
083174-001-DUP	BH101	3.7	16	9.9	81	2.4	0.52	0.036	0.0013	<0.001	<0.005

Analytical Report

Job No : 083174

Lab Id External Idents

Units
LQL

	Cr	Cu	Fe	Mn	Mo	Ni	Si	Sr	Ti	V
	mg/L 0.001	mg/L 0.005	mg/L 0.01	mg/L 0.001	mg/L 0.005	mg/L 0.005	mg/L 0.1	mg/L 0.01	mg/L 0.01	mg/L 0.002
083174-001	0.026	0.068	2.5	0.33	0.006	0.013	15	0.15	0.04	0.042
083174-002	0.069	0.13	7.6	0.90	0.011	0.036	18	0.20	0.12	0.12
083174-003	0.019	0.25	7.5	0.54	0.012	0.010	13	0.11	0.15	0.025
083174-004	0.094	0.15	1.8	0.10	<0.005	0.017	6.1	0.09	0.06	0.063
083174-005	0.018	0.051	1.8	0.28	<0.005	0.015	12	0.11	0.11	0.018
083174-001-DUP	0.026	0.066	2.5	0.33	0.008	0.014	14	0.15	0.04	0.042

Analytical Report

Job No : 083174

Lab Id	External Idents	Zn mg/L 0.005	As mg/L 0.001	Pb mg/L 0.001	Se mg/L 0.001	Hg mg/L 0.0001 #
083174-001	BH101	0.11	0.004	0.038	0.003	<0.001
083174-002	BH102	0.096	0.035	0.016	0.005	<0.001
083174-003	BH103	0.027	0.020	0.002	<0.001	<0.001
083174-004	BH104 Deep	0.21	0.004	0.016	0.003	0.0002
083174-005	BH104 Shallow	0.019	0.011	0.001	0.001	<0.001
083174-001-DUP	BH101	0.11	0.004	0.037	<0.001	<0.001

indicates sample received was not compliant with preservation procedures recommended by AS/NZ 5667.1:1998

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST



CLIENTS | PEOPLE | PERFORMANCE

GHD House
239 Adelaide Terrace
Perth WA 6004

PO Box Y3106
Perth WA 6832

Telephone 08 6222 8222
Facsimile 08 6222 8555

Page 1 of 1

5801

Project: **Fiona Stanley Hospital**

Client: **DEPT Housing**

Laboratory Quote No. **61/19514/01**

Job Manager (Invoice) **Turnaround Time**

Email Address (Results)

Laboratory: **ALS Environmental**

Address: **10 Hood Way, Malaga 6090**

Laboratory Contact: **6090**

Please Note:
Please sign white copy or receipt and release of samples. Samples are delivered to Laboratory Address. On receipt of samples laboratory, contact should sign white copy and fax to GHD contact above address. On completion of analyses please return white copy with results. Yellow copy is retained by laboratory. Pin copy is retained by sampler.

GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix				Container		Total Volume (ml)	Analyses										Remarks
				S-Soil/S-Sludge/W-Water/A-Air	Type	B-Bottle/J-Jar/V-Vial/Bag	G-Glass/P-Plastic	Preservative	Unpreserved/HQ/H-Soil/HNO ₃ /Other		EA005	EA015	EA071	EA081	EA085	EA087	EA091	EA095	EA097	EA099	
BH1 1/3	①	13/09/07	16:00	W	P-B	UN				1000											Contact Bradley
BH1 2/3	②	"	"	"	"	"				"											Emergency
BH1 3/3	③	"	"	"	"	"				"											
BH1 1/6-7/6	4-89	"	"	"	P-B	UN				100?											62228586
BH1 1/6-3/6	10-12	"	"	"	P-B	Pres				250											

Environmental Division
Perth

Work Order

EP0704187



Sampled by: Greg Bogha	Date/Time: 13/09	Date/Time: 14/9 08:00
Received by: Alison Jennings	Date/Time: 14/09	Date/Time: 14/9 08:40
Received by Lab: ALS (Kristina)	Date/Time: 14/09	Courier/Transport Company:
Sample Conditions:	Remarks:	

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST



CLIENTS | PEOPLE | PERFORMANCE

GHD House
239 Adelaide Terrace
Perth WA 6004

PO Box Y3106
Perth WA 6832

Telephone 08 6222 8222
Facsimile 08 6222 8555

Page 1 of 1

5802

Project Flora Stanley Hospital		Laboratory: ALS Environmental		Please Note: Please sign white copy on receipt and release of samples. Samples are delivered to Laboratory Address. On receipt of samples laboratory contact should sign white copy and fax to GHD contact at above address. On completion of analyses please return white copy with results. Yellow copy is retained by laboratory. Pink copy is retained by sampler.																			
Client DHWC		Job No. 61/19514/01												Address: 10 Hod Way, Malaga									
Laboratory Quote No.		Turnaround Time												Laboratory Contact:									
Job Manager (Invoice)	Laboratory Sample ID		Date	Time	Sample Matrix	Type	Preservative	No	Total Volume (mL)	Analyses													
Randy Kraus	BH2	1/2	14/9/07	11:00	S-Soil/SI-Sludge/W-Water/A-Air	B-Bottle/J-Jar/V-Vial/Bag	G-Glass/P-Plastic		1000	GD 093 LHM	EA 005 PH	CK 071 RP	GA 015 105	GD 041 3.0K (100)	CK 058 103	EP 005 70L	GD 045 U	GD 038 A.4.4.4	GA 010 Land	GD 037P Aik	GA 065 100L	GA 025 55	GL 061 TKM
"	"	2/2	"	"				"															
BH2	1/2		"	"				250															
"	2/2		"	"				"															
BH2	1/4		"	"				100															
	2/4		"	"				"															
	3/4		"	"				"															
	5/4		"	"				"															

Environmental Division
Perth
Work Order
EP0704191



Telephone : + 61-8-9209 7655

Sampled by: Craig Both	Date/Time 14/9/07 11:00	Relinquished by: Craig Both	Date/Time 14/09/07 11:30
Received by: Alison Jennings	Date/Time 14/9/07 11:30	Relinquished by: Alison Jennings	Date/Time 14/09/07 12:45
Received by Lab: Kristina (ALS)	Date/Time 14/9/07 15:56	Courier/Transport Company:	
Sample Conditions:	Remarks:		



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EP0704225	Page	: 1 of 8
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 611951401	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: FIONA STANLEY HOSPITAL	Date Samples Received	: 18-SEP-2007
C-O-C number	: 5851	Issue Date	: 26-SEP-2007
Sampler	: GREG BOTHA	No. of samples received	: 1
Order number	: ---	No. of samples analysed	: 1
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers



Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: x = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation		Analysis	
		Date extracted	Due for extraction	Date analysed	Due for analysis
EA005P: pH by PC Titrator					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	18-SEP-2007	15-SEP-2007
					x
EA010P: Conductivity by PC Titrator					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	18-SEP-2007	13-OCT-2007
					✓
EA015: Total Dissolved Solids					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	20-SEP-2007	22-SEP-2007
					✓
EA025: Suspended Solids					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	19-SEP-2007	22-SEP-2007
					✓
ED037P: Alkalinity by PC Titrator					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	18-SEP-2007	29-SEP-2007
					✓
ED038A: Acidity					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	19-SEP-2007	29-SEP-2007
					✓
ED041: Sulphate (Turbidimetric) as SO4 2-					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	19-SEP-2007	13-OCT-2007
					✓
ED045G: Chloride Discrete analyser					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	19-SEP-2007	13-OCT-2007
					✓
ED093F: Dissolved Major Cations					
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	18-SEP-2007	13-OCT-2007
					✓
EG005T: Total Metals by ICP-AES					
Clear Plastic Bottle - Unfiltered; Lab-acidified BH3 1/1	15-SEP-2007	23-SEP-2007	13-MAR-2008	23-SEP-2007	13-MAR-2008
					✓
EG020F: Dissolved Metals by ICP-MS					
Clear Plastic Bottle - Filtered; Lab-acidified BH3 1/1	15-SEP-2007	---	---	24-SEP-2007	13-MAR-2008
					✓



Matrix: WATER									
Method		Sample Date	Extraction / Preparation		Analysis				
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK057G: Nitrite as N by Discrete Analyser									
Clear Plastic Bottle - Natural	BH3 1/1	15-SEP-2007	----	----	----	18-SEP-2007	17-SEP-2007	x	
EK059G: NOX as N by Discrete Analyser									
Clear Plastic Bottle - Natural	BH3 1/1	15-SEP-2007	----	----	----	18-SEP-2007	17-SEP-2007	x	
EK061: Total Kjeldahl Nitrogen (TKN)									
Clear Plastic Bottle - Sulphuric Acid	BH3 1/1	15-SEP-2007	20-SEP-2007	13-OCT-2007	✓	20-SEP-2007	13-OCT-2007	✓	
EK071G: Reactive Phosphorous as P by discrete analyser									
Clear Plastic Bottle - Natural	BH3 1/1	15-SEP-2007	----	----	----	18-SEP-2007	17-SEP-2007	x	



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: x = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification	
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Acidity as Calcium Carbonate	ED038	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	1	8	12.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	11	18.2	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Filtered	ED093F	1	9	11.1	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	6	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	15	13.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	25.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulphate (Turbidimetric) as SO4 2-	ED041	1	1	100.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids	EA025	2	19	10.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids	EA015	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Recoverable Metals by ICP-AES	EG005T	1	8	12.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Acidity as Calcium Carbonate	ED038	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	1	8	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	11	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Filtered	ED093F	1	9	11.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	6	16.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	6	16.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	15	13.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	25.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulphate (Turbidimetric) as SO4 2-	ED041	1	1	100.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids	EA025	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids	EA015	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	8.3	10.0	✗	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Recoverable Metals by ICP-AES	EG005T	1	8	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	11	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Matrix: **WATER**

Evaluation: * = Quality Control frequency not within specification , ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Method	Count		Rate (%)			Evaluation	Quality Control Specification
Analytical Methods			QC	Regular	Actual	Expected			
Method Blanks (MB) - Continued									
Major Cations - Filtered		ED093F	1	9	11.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser		EK059G	1	6	16.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite as N by Discrete Analyser		EK057G	1	6	16.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser		EK071G	1	4	25.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Sulphate (Turbidimetric) as SO4 2-		ED041	1	1	100.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Suspended Solids		EA025	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Dissolved Solids		EA015	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Kjeldahl Nitrogen as N By Discrete Analyser		EK061G	1	12	8.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Recoverable Metals by ICP-AES		EG005T	1	8	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Matrix Spikes (MS)									
Chloride by Discrete Analyser		ED045G	1	11	9.1	5.0	✓	ALS QCS3 requirement	
Dissolved Metals by ICP-MS - Suite A		EG020A-F	1	20	5.0	5.0	✓	ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser		EK059G	1	6	16.7	5.0	✓	ALS QCS3 requirement	
Nitrite as N by Discrete Analyser		EK057G	1	6	16.7	5.0	✓	ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser		EK071G	1	4	25.0	5.0	✓	ALS QCS3 requirement	
Total Kjeldahl Nitrogen as N By Discrete Analyser		EK061G	1	12	8.3	5.0	✓	ALS QCS3 requirement	
Total Recoverable Metals by ICP-AES		EG005T	1	8	12.5	5.0	✓	ALS QCS3 requirement	



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	APHA 21st ed., 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Conductivity by PC Titrator	EA010-P	WATER	APHA 21st ed., 2510 This procedure determines conductivity by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Dissolved Solids	EA015	WATER	APHA 21st ed., 2540C A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+5C. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Suspended Solids	EA025	WATER	APHA 21st ed., 2540D A gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by both manual measurement and automated measurement (e.g. PC Titrator) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Acidity as Calcium Carbonate	ED038	WATER	APHA 21st ed., 2310 B Acidity is determined by titration with a standardised alkali to an end-point pH of 8.3. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Sulphate (Turbidimetric) as SO4 2-	ED041	WATER	APHA 21st ed., 4500-SO4 Sulfate ions are precipitated in an acetic acid medium with barium chloride to form barium sulphate crystals. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2017-1-L april 2003
Major Cations - Filtered	ED093F	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Recoverable Metals by ICP-AES	EG005T	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 Samples are digested by USEPA 3005 prior to analysis. The ICPAES technique ionises the sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020: The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500 NO3- B. SEAL Method 2-018-1-L February 2003. Nitrite is determined by direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



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 Work Order : EP0704225
 Client : GHD SERVICES PTY LTD
 Project : 611951401

Analytical Methods	Method	Matrix	Method Descriptions
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500 NO ₃ -F. SEAL Method 2-018-1-L February 2003. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by SEAL. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500 NO ₃ -F. SEAL Method 2-018-1-L February 2003. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Cadmium Reduction and direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	APHA 21st ed., 4500-Norg-D25mL water samples are digested using a traditional Kjeldahl digestion followed by determination by Seal by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	APHA 21st ed., 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 21st ed., 4500 Norg - D; APHA 21st ed., 4500 P - H. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QW/EN/38 (in the absence of specific USEPA limits) "Anonymous" Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. This report displays QC Outliers (breaches) only

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **WATER**

Method	Container / Client Sample ID(s)	Extraction / Preparation		Analysis			
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
BH3 1/1					18-SEP-2007	15-SEP-2007	3
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
BH3 1/1					18-SEP-2007	17-SEP-2007	1
EK059G: NOX as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
BH3 1/1					18-SEP-2007	17-SEP-2007	1
EK071G: Reactive Phosphorous as P by discrete analyser							
Clear Plastic Bottle - Natural							
BH3 1/1					18-SEP-2007	17-SEP-2007	1

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification	
	QC	Regular	Actual	Expected		
Laboratory Control Samples (LCS)						
Total Kjeldahl Nitrogen as N By Discrete Analyser	1	12	8.3	10.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	



CERTIFICATE OF ANALYSIS

Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth	Page	: 1 of 5
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp	Work Order	: EP0704187
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090		
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com		
Telephone	: 9429 6666	Telephone	: +61-8-9209 7655		
Facsimile	: 9429 6555	Facsimile	: +61-8-9209 7600		
Project	: 61 19514 01	Quote number	: EN-005-07	Date received	: 14 Sep 2007
Order number	: - Not provided -			Date issued	: 24 Sep 2007
C-O-C number	: 5801			No. of samples	: 3
Site	: Fiona Stanley Hospital				: 3

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ISO/IEC 17025.



WORLD RECOGNISED
ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics - NATA 825 (15847 - Perth)
Celine Conceicao	Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics - NATA 825 (15847 - Perth)



Page Number : 2 of 5
Client : GHD SERVICES PTY LTD
Work Order : EP0704187

Comments

This report for the ALSE reference EP0704187 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Analytical Results for Samples Submitted
- Surrogate Recovery Data

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insufficient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QW/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order EP0704187

TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper. Samples were filtered for ED041: Sulphate (Turbidimetric) as SO₄, due to large amounts of sediment present.



ALS Environmental

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 Client : GHD SERVICES PTY LTD
 Work Order : EP0704187

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID :		
				Sample Matrix Type / Description	Sample Date / Time	Laboratory Sample ID
EA005P: pH by PC Titrator				BH1 1/3 WATER 13 Sep 2007 16:00	BH1 2/3 WATER 13 Sep 2007 16:00	BH1 3/3 WATER 13 Sep 2007 16:00
pH Value		0.01	pH Unit	6.67	6.81	6.97
EA010P: Conductivity by PC Titrator						
Electrical Conductivity @ 25°C		1	µS/cm	1040	1120	1170
EA015: Total Dissolved Solids						
Total Dissolved Solids @ 180°C	GIS-210-010	1	mg/L	640	1070	1130
EA025: Suspended Solids						
Suspended Solids (SS)		1	mg/L	5500	14500	31700
ED037P: Alkalinity by PC Titrator						
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	121	159	244
Total Alkalinity as CaCO ₃		1	mg/L	121	159	244
ED038A: Acidity						
Acidity as CaCO ₃		1	mg/L	112	145	201
ED040F: Dissolved Major Anions						
Sulphate as SO ₄ 2-	14808-79-8	1	mg/L	267	275	259
Sulphur as S	63705-05-5	1	mg/L	89	92	86
ED041: Sulphate (Turbidimetric) as SO₄ 2-						
Sulphate as SO ₄ - Turbidimetric		1	mg/L	220	220	218
ED045G: Chloride Discrete analyser						
Chloride	16887-00-6	1.0	mg/L	105	105	92.7
ED093F: Dissolved Major Cations						
Calcium	7440-70-2	1	mg/L	118	140	162
Magnesium	7439-95-4	1	mg/L	21	21	21
Sodium	7440-23-5	1	mg/L	67	63	58
Potassium	7440-09-7	1	mg/L	7	7	8
EG005T: Total Metals by ICP-AES						
Arsenic	7440-38-2	0.01	mg/L	0.05	0.06	0.06
Cadmium	7440-43-9	0.005	mg/L	0.009	0.011	0.010
Chromium	7440-47-3	0.01	mg/L	0.58	0.61	0.62
Copper	7440-50-8	0.01	mg/L	0.05	0.05	0.05
Lead	7439-92-1	0.01	mg/L	0.28	0.30	0.29
Nickel	7440-02-0	0.01	mg/L	0.08	0.09	0.09
Zinc	7440-66-6	0.01	mg/L	0.10	0.10	0.09
EG020F: Dissolved Metals by ICP-MS						
Arsenic	7440-38-2	0.001	mg/L	0.003	0.003	0.004



ALS Environmental

Page Number : 4 of 5
 Client : GHD SERVICES PTY LTD
 Work Order : EP0704187

Analytical Results

Analytical Results				
Sample Matrix Type / Description : Sample Date / Time :		Client Sample ID :		
Laboratory Sample ID :		BH1 1/3 WATER 13 Sep 2007 16:00 EP0704187-001	BH1 2/3 WATER 13 Sep 2007 16:00 EP0704187-002	BH1 3/3 WATER 13 Sep 2007 16:00 EP0704187-003
Analyte	CAS number	LOR	Units	
EG020F: Dissolved Metals by ICP-MS				
Cadmium	7440-43-9	0.0001 mg/L	<0.0001	<0.0001
Chromium	7440-47-3	0.001 mg/L	<0.001	<0.001
Copper	7440-50-8	0.001 mg/L	0.001	<0.001
Lead	7439-92-1	0.001 mg/L	<0.001	<0.001
Nickel	7440-02-0	0.001 mg/L	0.002	0.001
Zinc	7440-66-6	0.005 mg/L	0.012	<0.005
EG035F: Dissolved Mercury by FIMS				
Mercury	7439-97-6	0.0001 mg/L	<0.0001	<0.0001
EG035T: Total Mercury by FIMS				
Mercury	7439-97-6	0.0001 mg/L	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser				
Nitrite as N		0.010 mg/L	0.028	0.079
EK058G: Nitrate as N by Discrete Analyser				
Nitrate as N	14797-55-8	0.010 mg/L	0.198	1.15
EK059G: NOX as N by Discrete Analyser				
Nitrite + Nitrate as N		0.010 mg/L	0.226	1.23
EK071G: Reactive Phosphorous as P by discrete analyser				
Reactive Phosphorus as P		0.010 mg/L	<0.010	<0.010
EN055: Ionic Balance				
Total Anions		0.01 meq/L	10.9	12.9
Total Cations		0.01 meq/L	10.7	12.5
Ionic Balance		0.01 %	1.03	1.29

Page Number : 5 of 5
Client : GHD SERVICES PTY LTD
Work Order : EP0704187



ALS Environmental

Surrogate Control Limits

- No surrogates present on this report.



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EP0704187	Page	: 1 of 8
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 61 19514 01	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Fiona Stanley Hospital	Date Samples Received	: 14-SEP-2007
C-O-C number	: 5801	Issue Date	: 24-SEP-2007
Sampler	: GB	No. of samples received	: 3
Order number	: ---	No. of samples analysed	: 3
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



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ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics
Celine Conceicao	Spectroscopist	Inorganics
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics

Environmental Division Perth

Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090

Tel. +61-8-9209 7655 Fax +61-8-9209 7600 www.alsglobal.com

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Page : 2 of 8
Work Order : EP0704187
Client : GHD SERVICES PTY LTD
Project : 61 19514 01

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference

Key :

Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting. Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%

Sub-Matrix: WATER		Laboratory Duplicate (DUP) Report							
Laboratory sample ID	Client sample ID	Method/Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 493561)									
EP0704175-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.20	7.16	0.6	0% - 20%
EP0704175-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	8.06	8.07	0.1	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 493560)									
EP0704175-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1190	1180	1.4	0% - 20%
EP0704175-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1570	1580	0.6	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 495378)									
EP0704182-001	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1260	1270	1.3	0% - 20%
EP0704182-010	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	2	3	40.0	No Limit
EA025: Suspended Solids (QC Lot: 493469)									
EP0704175-001	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	17	18	5.7	0% - 50%
EP0704182-004	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	22	26	16.7	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 493559)									
EP0704175-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	----
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	----
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	93	100	7.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	93	100	7.0	0% - 20%
EP0704175-004	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	----
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	----
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	330	325	1.6	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	330	325	1.6	0% - 20%
ED038A: Acidity (QC Lot: 494130)									
EP0704182-001	Anonymous	ED038: Acidity as CaCO3	----	1	mg/L	10	10	0.0	0% - 50%
EP0704182-010	Anonymous	ED038: Acidity as CaCO3	----	1	mg/L	6	7	0.0	No Limit
ED040F: Dissolved Major Anions (QC Lot: 493417)									
EP0704182-001	Anonymous	ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	165	166	0.0	0% - 20%
		ED040F: Sulphur as S	63705-05-5	1	mg/L	55	55	0.0	0% - 20%
EP0704187-001	BH1 1/3	ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	267	263	1.8	0% - 20%
		ED040F: Sulphur as S	63705-05-5	1	mg/L	89	88	1.8	0% - 20%
ED041: Sulphate (Turbidimetric) as SO4 2- (QC Lot: 498078)									
EP0704187-001	BH1 1/3	ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	220	226	2.6	0% - 20%
ED045G: Chloride Discrete analyser (QC Lot: 493599)									
EP0704182-001	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	418	407	2.6	0% - 20%
EP0704182-011	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	117	124	5.6	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 493418)									
EP0704187-001	BH1 1/3	ED093F: Calcium	7440-70-2	1	mg/L	118	122	2.9	0% - 20%



Sub-Matrix: WATER			Laboratory Duplicate (DUP) Report							
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)	
ED093F: Dissolved Major Cations (QC Lot: 493418) - continued										
EP0704187-001	BH1 1/3	ED093F: Magnesium	7439-95-4	1	mg/L	21	21	0.0	0% - 20%	
		ED093F: Sodium	7440-23-5	1	mg/L	67	69	1.8	0% - 20%	
		ED093F: Potassium	7440-09-7	1	mg/L	7	7	0.0	No Limit	
EG005T: Total Metals by ICP-AES (QC Lot: 496002)										
EP0704170-001	Anonymous	EG005T: Arsenic	7440-38-2	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	0.0	----	
		EG005T: Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Copper	7440-50-8	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Lead	7439-92-1	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Nickel	7440-02-0	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	0.0	----	
EP0704208-003		Anonymous	EG005T: Arsenic	7440-38-2	0.01	mg/L	<0.01	<0.01	0.0	----
			EG005T: Cadmium	7440-43-9	0.005	mg/L	<0.005	<0.005	0.0	----
			EG005T: Chromium	7440-47-3	0.01	mg/L	<0.01	<0.01	0.0	----
	EG005T: Copper		7440-50-8	0.01	mg/L	<0.01	<0.01	0.0	----	
	EG005T: Lead		7439-92-1	0.01	mg/L	<0.01	<0.01	0.0	----	
	EG005T: Nickel		7440-02-0	0.01	mg/L	<0.01	<0.01	0.0	----	
		EG005T: Zinc	7440-66-6	0.01	mg/L	<0.01	<0.01	0.0	----	
EG020F: Dissolved Metals by ICP-MS (QC Lot: 496874)										
EP0704182-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.0	No Limit	
		EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	0.0	----	
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	----	
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.008	0.001	152	No Limit	
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	----	
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.014	0.013	0.0	0% - 50%	
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.624	0.613	1.7	0% - 20%	
EP0704182-011		Anonymous	EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	0.0	----
			EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	----
			EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.0	No Limit
	EG020A-F: Copper		7440-50-8	0.001	mg/L	0.001	0.001	0.0	No Limit	
	EG020A-F: Lead		7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	----	
	EG020A-F: Nickel		7440-02-0	0.001	mg/L	0.024	0.024	0.0	0% - 20%	
	EG020A-F: Zinc		7440-66-6	0.005	mg/L	2.55	2.56	0.2	0% - 20%	
EG035F: Dissolved Mercury by FIMS (QC Lot: 498041)										
EP0704169-004	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	----	
ES0712839-002		EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	----	
EG035T: Total Mercury by FIMS (QC Lot: 493391)										
EP0704179-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	----	
EP0704187-001	BH1 1/3	EK057G: Nitrite as N by Discrete Analyser (QC Lot: 493798)	---	0.010	mg/L	0.028	0.015	60.5	No Limit	



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method/Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 493798) - continued									
EP0704210-002	Anonymous	EK057G: Nitrite as N	---	0.010	mg/L	0.052	0.061	15.9	No Limit
EK059G: NOX as N by Discrete Analyser (QC Lot: 493800)									
EP0704187-001	BH1 1/3	EK059G: Nitrite + Nitrate as N	---	0.010	mg/L	0.226	0.211	6.9	0% - 20%
EP0704210-002	Anonymous	EK059G: Nitrite + Nitrate as N	---	0.010	mg/L	0.099	0.101	2.0	0% - 50%
EK071G: Reactive Phosphorous as P by discrete analyser (QC Lot: 493657)									
EP0704185-001	Anonymous	EK071G: Reactive Phosphorus as P	---	0.010	mg/L	<0.010	<0.010	0.0	----
EP0704189-002	Anonymous	EK071G: Reactive Phosphorus as P	---	0.010	mg/L	<0.010	<0.010	0.0	----



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS

Sub-Matrix: WATER

Sub-Matrix: WATER		Method Blank (MB) Report				Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	Low	High
EA005P: pH by PC Titrator (QCLot: 493561)									
EA005-P: pH Value	----	0.01	pH Unit	----	7.00 pH Unit	101		70	130
EA010P: Conductivity by PC Titrator (QCLot: 493560)									
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	3640 µS/cm	100		93.2	107
EA015: Total Dissolved Solids (QCLot: 495378)									
EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	<1	2000 mg/L	98.7		70	130
EA025: Suspended Solids (QCLot: 493469)									
EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	97.8		70	130
ED037P: Alkalinity by PC Titrator (QCLot: 493559)									
ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	102		84.4	114
ED038A: Acidity (QCLot: 494130)									
ED038: Acidity as CaCO3	----	1	mg/L	----	100 mg/L	94.1		70	130
ED040F: Dissolved Major Anions (QCLot: 493417)									
ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	<1	50 mg/L	98.7		70	130
ED040F: Sulphur as S	63705-05-5	1	mg/L	<1	----	----		----	----
ED041: Sulphate (Turbidimetric) as SO4 2- (QCLot: 498078)									
ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	<1	10 mg/L	99.2		74.2	124
ED045G: Chloride Discrete analyser (QCLot: 493599)									
ED045G: Chloride	16887-00-6	1.0	mg/L	<1.0	250 mg/L	96.0		79.6	120
ED093F: Dissolved Major Cations (QCLot: 493418)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.6		70	130
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.0		70	130
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	99.2		70	130
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	99.8		70	130
EG005T: Total Metals by ICP-AES (QCLot: 496002)									
EG005T: Arsenic	7440-38-2	0.01	mg/L	<0.01	1.67 mg/L	109		89.5	115
EG005T: Cadmium	7440-43-9	0.005	mg/L	<0.005	1.67 mg/L	107		92.7	113
EG005T: Chromium	7440-47-3	0.01	mg/L	<0.01	1.67 mg/L	100		88.8	113
EG005T: Copper	7440-50-8	0.01	mg/L	<0.01	1.67 mg/L	108		88.4	114
EG005T: Lead	7439-92-1	0.01	mg/L	<0.01	1.67 mg/L	114		88.4	118
EG005T: Nickel	7440-02-0	0.01	mg/L	<0.01	1.67 mg/L	113		91	117
EG005T: Zinc	7440-66-6	0.01	mg/L	<0.01	1.67 mg/L	118		84.6	123
EG020F: Dissolved Metals by ICP-MS (QCLot: 495874)									



Sub-Matrix: WATER		Method Blank (MB) Report				Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 495874) - continued									
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	102		70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	93.2		70	130
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	98.8		70	130
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	96.0		70	130
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	95.8		70	130
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	96.7		70	130
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	98.9		70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 498041)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	89.5		80.5	117
EG035T: Total Mercury by FIMS (QCLot: 493391)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	99.5		85.7	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 493798)									
EK057G: Nitrite as N	---	0.010	mg/L	<0.010	0.96 mg/L	95.5		67.1	132
EK059G: NOX as N by Discrete Analyser (QCLot: 493800)									
EK059G: Nitrite + Nitrate as N	---	0.010	mg/L	<0.010	0.96 mg/L	101		76.4	126
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 493657)									
EK071G: Reactive Phosphorous as P	---	0.010	mg/L	<0.010	0.5 mg/L	104		84.5	130



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Matrix Spike (MS) Report		
					Spike Recovery (%)	Recovery Limits (%)	
					MS	Low	High
ED045G: Chloride Discrete analyser (QCLot: 493599)							
EP0704182-002	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	89.4	70	130
EG005T: Total Metals by ICP-AES (QCLot: 496002)							
EP0704187-001	BH1 1/3	EG005T: Arsenic	7440-38-2	1.67 mg/L	106	70	130
		EG005T: Cadmium	7440-43-9	1.67 mg/L	104	70	130
		EG005T: Chromium	7440-47-3	1.67 mg/L	99.1	70	130
		EG005T: Copper	7440-50-8	1.67 mg/L	110	70	130
		EG005T: Lead	7439-92-1	1.67 mg/L	109	70	130
		EG005T: Nickel	7440-02-0	1.67 mg/L	111	70	130
		EG005T: Zinc	7440-66-6	1.67 mg/L	114	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 495874)							
EP0704182-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	93.8	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	89.9	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	95.6	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	85.8	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	86.3	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	89.5	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	77.8	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 498041)							
EP0704189-004	Anonymous	EG035F: Mercury	7439-97-6	0.0100 mg/L	95.2	70	130
EG035T: Total Mercury by FIMS (QCLot: 493391)							
EP0704179-002	Anonymous	EG035T: Mercury	7439-97-6	0.0100 mg/L	86.5	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 493798)							
EP0704187-002	BH1 2/3	EK057G: Nitrite as N	---	0.6 mg/L	103	70	130
EK059G: NOX as N by Discrete Analyser (QCLot: 493800)							
EP0704187-002	BH1 2/3	EK059G: Nitrite + Nitrate as N	---	0.6 mg/L	89.7	70	130
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 493657)							
EP0704185-002	Anonymous	EK071G: Reactive Phosphorus as P	---	0.5 mg/L	98.2	70	130



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EP0704187	Page	: 1 of 8
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: aljennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 61 19514 01	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Fiona Stanley Hospital	Date Samples Received	: 14-SEP-2007
C-O-C number	: 5801	Issue Date	: 24-SEP-2007
Sampler	: GB	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Environmental Division Perth

Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax +61-8-9209 7600 www.alsglobal.com

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers

Matrix: WATER

Evaluation: x = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis	
Container / Client	Sample ID(s)		Date extracted	Due for extraction	Date analysed	Due for analysis
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	---	17-SEP-2007	13-SEP-2007
EA010P: Conductivity by PC Titrator						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	---	17-SEP-2007	11-OCT-2007
EA015: Total Dissolved Solids						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	----	19-SEP-2007	20-SEP-2007
EA025: Suspended Solids						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	----	17-SEP-2007	20-SEP-2007
ED037P: Alkalinity by PC Titrator						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	---	17-SEP-2007	27-SEP-2007
ED038A: Acidity						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	----	18-SEP-2007	27-SEP-2007
ED040F: Dissolved Major Anions						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	---	17-SEP-2007	11-OCT-2007
ED041: Sulphate (Turbidimetric) as SO4 2-						
Clear Plastic Bottle - Natural	BH1 2/3, BH1 3/3	13-SEP-2007	---	----	24-SEP-2007	11-OCT-2007



Matrix: WATER									
Method	Sample Date	Extraction / Preparation		Analysis		Evaluation	Due for analysis	Evaluation	Due for analysis
Container / Client Sample ID(s)	Date extracted	Due for extraction	Date analysed	Due for analysis					
ED045G: Chloride Discrete analyser									
Clear Plastic Bottle - Natural BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	17-SEP-2007	11-OCT-2007	✓		
ED093F: Dissolved Major Cations									
Clear Plastic Bottle - Natural BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	17-SEP-2007	11-OCT-2007	✓		
EG005T: Total Metals by ICP-AES									
Clear Plastic Bottle - Unfiltered; Lab-acidified BH1 1/3, BH1 3/3	13-SEP-2007	20-SEP-2007	11-MAR-2008	✓	20-SEP-2007	11-MAR-2008	✓		
EG020F: Dissolved Metals by ICP-MS									
Clear Plastic Bottle - Filtered; Lab-acidified BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	20-SEP-2007	11-MAR-2008	✓		
EG035F: Dissolved Mercury by FIMS									
Clear Plastic Bottle - Filtered; Lab-acidified BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	24-SEP-2007	11-OCT-2007	✓		
EG035T: Total Mercury by FIMS									
Clear Plastic Bottle - Unfiltered; Lab-acidified BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	17-SEP-2007	11-OCT-2007	✓		
EK057G: Nitrite as N by Discrete Analyser									
Clear Plastic Bottle - Natural BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	14-SEP-2007	15-SEP-2007	✓		
EK059G: NOX as N by Discrete Analyser									
Clear Plastic Bottle - Natural BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	14-SEP-2007	15-SEP-2007	✓		
EK071G: Reactive Phosphorous as P by discrete analyser									
Clear Plastic Bottle - Natural BH1 1/3, BH1 3/3	13-SEP-2007	---	---	---	14-SEP-2007	15-SEP-2007	✓		



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification	
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Acidity as Calcium Carbonate	ED038	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	2	19	10.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	17	11.8	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Anions - Filtered	ED040F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Filtered	ED093F	1	4	25.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids	EA025	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids	EA015	2	16	12.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	1	5	20.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Recoverable Metals by ICP-AES	EG005T	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Acidity as Calcium Carbonate	ED038	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Alkalinity by PC Titrator	ED037-P	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	17	5.9	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Anions - Filtered	ED040F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Cations - Filtered	ED093F	1	4	25.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspended Solids	EA025	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids	EA015	1	16	6.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Recoverable Metals by ICP-AES	EG005T	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Matrix: WATER

Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification	
Analytical Methods		QC	Regular	Actual	Expected	Evaluation	
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Conductivity by PC Titrator	EA010-P	1	17	5.9	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Anions - Filtered	ED040F	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Cations - Filtered	ED093F	1	4	25.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	7.1	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite as N by Discrete Analyser	EK057G	1	14	7.1	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	14	7.1	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Suspended Solids	EA025	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Dissolved Solids	EA015	1	16	6.3	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Mercury by FIMS	EG035T	1	5	20.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Recoverable Metals by ICP-AES	EG005T	1	20	5.0	5.0	✓ NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓ ALS QCS3 requirement	
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓ ALS QCS3 requirement	
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓ ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	7.1	5.0	✓ ALS QCS3 requirement	
Nitrite as N by Discrete Analyser	EK057G	1	14	7.1	5.0	✓ ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	14	7.1	5.0	✓ ALS QCS3 requirement	
Total Mercury by FIMS	EG035T	1	5	20.0	5.0	✓ ALS QCS3 requirement	
Total Recoverable Metals by ICP-AES	EG005T	1	20	5.0	5.0	✓ ALS QCS3 requirement	



Page : 6 of 8
 Work Order : EP0704187
 Client : GHD SERVICES PTY LTD
 Project : 61 19514 01

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	APHA 21st ed., 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Conductivity by PC Titrator	EA010-P	WATER	APHA 21st ed., 2510 This procedure determines conductivity by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Dissolved Solids	EA015	WATER	APHA 21st ed., 2540C A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+5C. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Suspended Solids	EA025	WATER	APHA 21st ed., 2540D A gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Colour (True)	EA041	WATER	APHA 21st ed., 2120 B. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by both manual measurement and automated measurement (e.g. PC Titrator) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Acidity as Calcium Carbonate	ED038	WATER	APHA 21st ed., 2310 B Acidity is determined by titration with a standardised alkali to an end-point pH of 8.3. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Major Anions - Filtered	ED040F	WATER	APHA 21st ed., 3120 Sulphur and/or Silicon content is determined by ICP/AES and reported as Sulphate and/or Silica after conversion by gravimetric factor.
Sulphate (Turbidimetric) as SO4 2-	ED041	WATER	APHA 21st ed., 4500-SO4 Sulfate ions are precipitated in an acetic acid medium with barium chloride to form barium sulphate crystals. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride in the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Filtered	ED093F	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICP/AES technique ionises filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Recoverable Metals by ICP-AES	EG005T	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 Samples are digested by USEPA 3005 prior to analysis. The ICP/AES technique ionises the sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICP/MS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.



Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Mercury by FIMS	EG035T	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500 NO ₃ -B. SEAL Method 2-018-1-L February 2003. Nitrite is determined by direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500 NO ₃ -F. SEAL Method 2-018-1-L February 2003. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by SEAL. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500 NO ₃ -F. SEAL Method 2-018-1-L February 2003. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Cadmium Reduction and direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	APHA 21st ed., 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Ionic Balance	EN055 - DA	WATER	APHA 21st Ed. 1030F. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QW/EN38 (in the absence of specific USEPA limits). "Anonymous" Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed

Matrix: WATER

Method	Extraction / Preparation		Analysis	
	Date extracted	Due for extraction	Date analysed	Days overdue
Container / Client Sample ID(s)				
EA005P: pH by PC Titrator				
Clear Plastic Bottle - Natural				
BH1 1/3,			17-SEP-2007	4
BH1 3/3			13-SEP-2007	

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples

- No Quality Control data available for this section.



CERTIFICATE OF ANALYSIS

Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth	Page	: 1 of 4
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp	Work Order	: EP0704191
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090		
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com		
Telephone	: 9429 6666	Telephone	: +61-8-9209 7655		
Facsimile	: 9429 6555	Facsimile	: +61-8-9209 7600		
Project	: 61 19514 01	Quote number	: EN-005-07	Date received	: 14 Sep 2007
Order number	: - Not provided -			Date issued	: 24 Sep 2007
C-O-C number	: 5802			No. of samples	: 2
Site	: Fiona Stanley Hospital			Analysed	: 2

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This document is issued in
accordance with NATA's
accreditation requirements.

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WORLD RECOGNISED
ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics - NATA 825 (15847 - Perth)
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics - NATA 825 (15847 - Perth)

Page Number : 2 of 4
Client : GHD SERVICES PTY LTD
Work Order : EP0704191

Comments

This report for the ALSE reference EP0704191 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insufficient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting, * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **EP0704191**

Samples were filtered for ED041: Sulphate (Turbidimetric) as SO₄, due to large amounts of sediment present.

TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.



ALS Environmental

Page Number : 3 of 4
Client : GHD SERVICES PTY LTD
Work Order : EP0704191

Analytical Results

Analyte		CAS number	LOR	Units	Client Sample ID :		Sample Matrix Type / Description :		Sample Date / Time :		Laboratory Sample ID :	
EA005P: pH by PC Titrator					BH2 1/2		WATER		14 Sep 2007		EP0704191-001	
pH Value			0.01	pH Unit	BH2 2/2		WATER		14 Sep 2007		EP0704191-002	
EA010P: Conductivity by PC Titrator												
Electrical Conductivity @ 25°C			1	µS/cm								
EA015: Total Dissolved Solids												
Total Dissolved Solids @180°C		GIS-210-010	1	mg/L								
EA025: Suspended Solids												
Suspended Solids (SS)			1	mg/L								
ED037P: Alkalinity by PC Titrator												
Hydroxide Alkalinity as CaCO ₃		DMO-210-001	1	mg/L								
Carbonate Alkalinity as CaCO ₃		3812-32-6	1	mg/L								
Bicarbonate Alkalinity as CaCO ₃		71-52-3	1	mg/L								
Total Alkalinity as CaCO ₃			1	mg/L								
ED040F: Dissolved Major Anions												
Sulphate as SO ₄ 2-		14808-79-8	1	mg/L								
Sulphur as S		63705-05-5	1	mg/L								
ED041: Sulphate (Turbidimetric) as SO ₄ 2-												
Sulphate as SO ₄ - Turbidimetric			1	mg/L								
ED045G: Chloride Discrete analyser												
Chloride		16887-00-6	1.0	mg/L								
ED093F: Dissolved Major Cations												
Calcium		7440-70-2	1	mg/L								
Magnesium		7439-95-4	1	mg/L								
Sodium		7440-23-5	1	mg/L								
Potassium		7440-09-7	1	mg/L								
EK057G: Nitrite as N by Discrete Analyser												
Nitrite as N			0.010	mg/L								
EK058G: Nitrate as N by Discrete Analyser												
Nitrate as N		14797-55-8	0.010	mg/L								
EK059G: NOX as N by Discrete Analyser												
Nitrite + Nitrate as N			0.010	mg/L								
EK071G: Reactive Phosphorous as P by discrete analyser												
Reactive Phosphorous as P			0.010	mg/L								
EN055: Ionic Balance												
Total Anions			0.01	meq/L								
Total Cations			0.01	meq/L								
Ionic Balance			0.01	%								



Surrogate Control Limits

- No surrogates present on this report.



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EP0704191	Page	: 1 of 6
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 61 19514 01	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Fiona Stanley Hospital	Date Samples Received	: 14-SEP-2007
C-O-C number	: 5802	Issue Date	: 24-SEP-2007
Sampler	: Greg Both	No. of samples received	: 2
Order number	: ----	No. of samples analysed	: 2
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



WORLD RECOGNISED
ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics

Environmental Division Perth

Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090

Tel. +61-8-9209 7655 Fax +61-8-9209 7600 www.alsglobal.com

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Page 2 of 6
Work Order EP0704191
Client GHD SERVICES PTY LTD
Project 61 19514 01

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :

Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: WATER

Sub-Matrix: WATER											
Laboratory sample ID	Client sample ID	Method/Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Laboratory Duplicate (DUP) Report		
EA005P: pH by PC Titrator (QC Lot: 493561)											
EP0704175-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.20	7.16	0.6	0% - 20%		
EP0704175-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	8.06	8.07	0.1	0% - 20%		
EA010P: Conductivity by PC Titrator (QC Lot: 493560)											
EP0704175-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1190	1180	1.4	0% - 20%		
EP0704175-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1570	1580	0.6	0% - 20%		
EA015: Total Dissolved Solids (QC Lot: 495378)											
EP0704182-001	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1260	1270	1.3	0% - 20%		
EP0704182-010	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	2	3	40.0	No Limit		
EA025: Suspended Solids (QC Lot: 493470)											
EP0704191-001	BH2 1/2	EA025: Suspended Solids (SS)	----	1	mg/L	36700	39200	6.6	0% - 20%		
ED037P: Alkalinity by PC Titrator (QC Lot: 493559)											
EP0704175-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	----		
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	----		
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	93	100	7.0	0% - 20%		
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	93	100	7.0	0% - 20%		
EP0704175-004	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	----		
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	----		
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	330	325	1.6	0% - 20%		
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	330	325	1.6	0% - 20%		
ED040F: Dissolved Major Anions (QC Lot: 493836)											
EP0704191-001	BH2 1/2	ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	493	497	0.9	0% - 20%		
		ED040F: Sulphur as S	63705-05-5	1	mg/L	164	166	0.9	0% - 20%		
EP0704208-003	Anonymous	ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	16	16	0.0	0% - 50%		
		ED040F: Sulphur as S	63705-05-5	1	mg/L	5	5	0.0	No Limit		
ED041: Sulphate (Turbidimetric) as SO4 2- (QC Lot: 498078)											
EP0704187-001	Anonymous	ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	220	226	2.6	0% - 20%		
ED045G: Chloride Discrete analyser (QC Lot: 493599)											
EP0704182-001	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	418	407	2.6	0% - 20%		
EP0704182-011	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	117	124	5.6	0% - 20%		
ED093F: Dissolved Major Cations (QC Lot: 493837)											
EP0704191-001	BH2 1/2	ED093F: Calcium	7440-70-2	1	mg/L	82	83	1.3	0% - 20%		
		ED093F: Magnesium	7439-95-4	1	mg/L	32	32	0.0	0% - 20%		
		ED093F: Sodium	7440-23-5	1	mg/L	142	137	3.6	0% - 20%		
		ED093F: Potassium	7440-09-7	1	mg/L	18	18	0.0	0% - 50%		
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 493798)											



Sub-Matrix: WATER			Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 493798) - continued									
EP0704187-001	Anonymous	EK057G: Nitrite as N	----	0.010	mg/L	0.028	0.015	60.5	No Limit
EP0704210-002	Anonymous	EK057G: Nitrite as N	----	0.010	mg/L	0.052	0.061	15.9	No Limit
EK059G: NOX as N by Discrete Analyser (QC Lot: 493800)									
EP0704187-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.010	mg/L	0.226	0.211	6.9	0% - 20%
EP0704210-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.010	mg/L	0.099	0.101	2.0	0% - 50%
EK071G: Reactive Phosphorous as P by discrete analyser (QC Lot: 493655)									
EP0704191-001	BH2 1/2	EK071G: Reactive Phosphorus as P	----	0.010	mg/L	<0.010	<0.010	0.0	-----



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Sub-Matrix: WATER	Method/Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report				
			LOR	Unit	Result	Spike Concentration	Spike Recovery (%)			
							LCS	Low	High	
EA005P: pH by PC Titrator (QCLot: 493561)										
	EA005-P: pH Value	----	0.01	pH Unit	----	7.00 pH Unit	101	70	130	
EA010P: Conductivity by PC Titrator (QCLot: 493560)										
	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	3640 µS/cm	100	93.2	107	
EA015: Total Dissolved Solids (QCLot: 495378)										
	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	<1	2000 mg/L	98.7	70	130	
EA025: Suspended Solids (QCLot: 493470)										
	EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	97.8	70	130	
ED037P: Alkalinity by PC Titrator (QCLot: 493559)										
	ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	102	84.4	114	
ED040F: Dissolved Major Anions (QCLot: 493836)										
	ED040F: Sulphate as SO4 2-	14808-79-8	1	mg/L	<1	50 mg/L	95.5	70	130	
	ED040F: Sulphur as S	63705-05-5	1	mg/L	<1	----	----	----	----	
ED041: Sulphate (Turbidimetric) as SO4 2- (QCLot: 498078)										
	ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	<1	10 mg/L	99.2	74.2	124	
ED045G: Chloride Discrete analyser (QCLot: 493599)										
	ED045G: Chloride	16887-00-6	1.0	mg/L	<1.0	250 mg/L	96.0	79.6	120	
ED093F: Dissolved Major Cations (QCLot: 493837)										
	ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	98.1	70	130	
	ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	94.3	70	130	
	ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	101	70	130	
	ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	102	70	130	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 493798)										
	EK057G: Nitrite as N	----	0.010	mg/L	<0.010	0.96 mg/L	95.5	67.1	132	
EK059G: NOX as N by Discrete Analyser (QCLot: 493800)										
	EK059G: Nitrite + Nitrate as N	----	0.010	mg/L	<0.010	0.96 mg/L	101	76.4	126	
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 493655)										
	EK071G: Reactive Phosphorus as P	----	0.010	mg/L	<0.010	0.5 mg/L	94.4	84.5	130	



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs) | Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Matrix Spike (MS) Report		
					Spike Recovery (%)	Recovery Limits (%)	
					MS	Low	High
ED045G: Chloride Discrete analyser (QCLot: 493599)							
EP0704182-002	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	89.4	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 493798)							
EP0704187-002	Anonymous	EK057G: Nitrite as N	---	0.6 mg/L	103	70	130
EK059G: NOX as N by Discrete Analyser (QCLot: 493800)							
EP0704187-002	Anonymous	EK059G: Nitrite + Nitrate as N	---	0.6 mg/L	89.7	70	130
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 493655)							
EP0704191-002	BH2 2/2	EK071G: Reactive Phosphorus as P	---	0.5 mg/L	103	70	130



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EP0704191	Page	: 1 of 8
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 61 19514 01	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Fiona Stanley Hospital	Date Samples Received	: 14-SEP-2007
C-O-C number	: 5802	Issue Date	: 24-SEP-2007
Sampler	: Greg Both	No. of samples received	: 2
Order number	: ---	No. of samples analysed	: 2
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Environmental Division Perth

Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090

Tel. +61-8-9209 7655 Fax +61-8-9209 7600 www.alsglobal.com

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Matrix: WATER

Evaluation: x = Holding time breach ; ✓ = Within holding time.

Method	Container / Client Sample ID(s)	Sample Date	Extraction / Preparation		Analysis	
			Date extracted	Due for extraction	Date analysed	Due for analysis
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	14-SEP-2007
						x
EA010P: Conductivity by PC Titrator						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	12-OCT-2007
						✓
EA015: Total Dissolved Solids						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	19-SEP-2007	21-SEP-2007
						✓
EA025: Suspended Solids						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	21-SEP-2007
						✓
ED037P: Alkalinity by PC Titrator						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	28-SEP-2007
						✓
ED040F: Dissolved Major Anions						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	12-OCT-2007
						✓
ED041: Sulphate (Turbidimetric) as SO4 2-						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	24-SEP-2007	12-OCT-2007
						✓
ED045G: Chloride Discrete analyser						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	12-OCT-2007
						✓
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	17-SEP-2007	12-OCT-2007
						✓
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	16-SEP-2007	16-SEP-2007
						✓
EK059G: NOX as N by Discrete Analyser						
Clear Plastic Bottle - Natural						
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	16-SEP-2007	16-SEP-2007
						✓



Matrix: WATER						
Method			Extraction / Preparation		Analysis	
			Date extracted	Due for extraction	Evaluation	Date analysed
Container / Client Sample ID (s)						
Evaluation: x = Holding time breach ; ✓ = Within holding time.						
EK071G: Reactive Phosphorous as P by discrete analyser						
Clear Plastic Bottle - Natural						
BH2 1/2.						
BH2 2/2	14-SEP-2007	----	----	----	16-SEP-2007	16-SEP-2007
						✓



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was (where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: x = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification

Quality Control Sample Type		Count			Rate (%)		Quality Control Specification	
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation		
Laboratory Duplicates (DUP)								
Alkalinity by PC Titrator	ED037-P	2	19	10.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Chloride by Discrete Analyser	ED045G	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Conductivity by PC Titrator	EA010-P	2	17	11.8	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Anions - Filtered	ED040F	2	16	12.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Cations - Filtered	ED093F	1	5	20.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite as N by Discrete Analyser	EK057G	2	14	14.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
pH by PC Titrator	EA005-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	50.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Suspended Solids	EA025	1	2	50.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Dissolved Solids	EA015	2	16	12.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Laboratory Control Samples (LCS)								
Alkalinity by PC Titrator	ED037-P	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Conductivity by PC Titrator	EA010-P	1	17	5.9	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Anions - Filtered	ED040F	1	16	6.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Cations - Filtered	ED093F	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite as N by Discrete Analyser	EK057G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
pH by PC Titrator	EA005-P	2	12	16.7	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	50.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Suspended Solids	EA025	1	2	50.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Total Dissolved Solids	EA015	1	16	6.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Method Blanks (MB)								
Chloride by Discrete Analyser	ED045G	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Conductivity by PC Titrator	EA010-P	1	17	5.9	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Anions - Filtered	ED040F	1	16	6.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Major Cations - Filtered	ED093F	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Nitrite as N by Discrete Analyser	EK057G	1	14	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	50.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Sulphate (Turbidimetric) as SO4 2-	ED041	1	5	20.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	
Suspended Solids	EA025	1	2	50.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement	



Matrix: WATER										Evaluation: * = Quality Control frequency not within specification; ✓ = Quality Control frequency within specification									
Quality Control Sample Type		Method	Count			Rate (%)		Quality Control Specification											
Analytical Methods			QC	Regular	Actual	Expected	Evaluation												
Method Blanks (MB) - Continued																			
Total Dissolved Solids			EA015	1	16	6.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement										
Matrix Spikes (MS)																			
Chloride by Discrete Analyser			ED045G	1	20	5.0	5.0	✓	ALS QCS3 requirement										
Nitrite and Nitrate as N (NOx) by Discrete Analyser			EK059G	1	14	7.1	5.0	✓	ALS QCS3 requirement										
Nitrite as N by Discrete Analyser			EK057G	1	14	7.1	5.0	✓	ALS QCS3 requirement										
Reactive Phosphorus as P-By Discrete Analyser			EK071G	1	2	50.0	5.0	✓	ALS QCS3 requirement										



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	APHA 21st ed. 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Conductivity by PC Titrator	EA010-P	WATER	APHA 21st ed., 2510 This procedure determines conductivity by automated ISE. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Total Dissolved Solids	EA015	WATER	APHA 21st ed., 2540C A gravimetric procedure that determines the amount of 'filterable' residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+5C. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Suspended Solids	EA025	WATER	APHA 21st ed., 2540D A gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Colour (True)	EA041	WATER	APHA 21st ed., 2120 B. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Alkalinity by PC Titrator	ED037-P	WATER	APHA 21st ed., 2320 B This procedure determines alkalinity by both manual measurement and automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Major Anions - Filtered	ED040F	WATER	APHA 21st ed., 3120 Sulphur and/or Silicon content is determined by ICP/AES and reported as Sulphate and/or Silica after conversion by gravimetric factor.
Sulphate (Turbidimetric) as SO4 2-	ED041	WATER	APHA 21st ed., 4500-SO4 Sulfate ions are precipitated in an acetic acid medium with barium chloride to form barium sulphate crystals. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Chloride by Discrete Analyser	ED045G	WATER	The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride in the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Filtered	ED093F	WATER	APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite as N by Discrete Analyser	EK057G	WATER	APHA 21st ed., 4500 NO3- B. SEAL Method 2-018-1-L February 2003. Nitrite is determined by direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrate as N by Discrete Analyser	EK058G	WATER	APHA 21st ed., 4500 NO3--F. SEAL Method 2-018-1-L February 2003. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by SEAL. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	APHA 21st ed., 4500 NO3- F. SEAL Method 2-018-1-L February 2003. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



Analytical Methods		Method	Matrix	Method Descriptions
Reactive Phosphorus as P-By Discrete Analyser		EK071G	WATER	APHA 21st ed., 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by SEAL. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
	Ionic Balance	EN055 - DA	WATER	APHA 21st Ed. 1030F. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QM/EN/38 (in the absence of specific USEPA limits). "Anonymous" Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: WATER

Method	Container / Client Sample ID(s)	Extraction / Preparation		Analysis	
		Date extracted	Due for extraction	Date analysed	Due for analysis
EA005P: pH by PC Titrator					
Clear Plastic Bottle - Natural					
BH2 1/2	BH2 2/2	---	---	17-SEP-2007	14-SEP-2007
					3

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control data available for this section.



CERTIFICATE OF ANALYSIS

Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth	Page	: 1 of 5
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp	Work Order	: EP0704225
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090		
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com		
Telephone	: 9429 6666	Telephone	: +61-8-9209 7655		
Facsimile	: 9429 6555	Facsimile	: +61-8-9209 7600		
Project	: 611951401	Quote number	: EN-005-07	Date received	: 18 Sep 2007
Order number	: - Not provided -			Date issued	: 26 Sep 2007
C-O-C number	: 5851			No. of samples	: Received 1
Site	: FIONA STANLEY HOSPITAL				: Analysed 1

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This document is issued in
accordance with NATA's
accreditation requirements.

Accredited for compliance with
ISO/IEC 17025.



WORLD RECOGNISED
ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics - NATA 825 (15847 - Perth)
Celine Conceicao	Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)

Page Number : 2 of 5
Client : GHD SERVICES PTY LTD
Work Order : EP0704225

Comments

This report for the ALSE reference EP0704225 supersedes any previous reports with this reference. Results apply to the sample as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Analytical Results for Samples Submitted
- Surrogate Recovery Data

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insufficient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QW/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.



ALS Environmental

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Client : GHD SERVICES PTY LTD
Work Order : EP0704225

Analytical Results

Analyte		CAS number	LOR	Units	Client Sample ID :		Sample Matrix Type / Description :		Sample Date / Time :		Laboratory Sample ID :	
EA005P: pH by PC Titrator					BH3 1/1		WATER		15 Sep 2007		EP0704225-001	
pH Value			0.01	pH Unit								
EA010P: Conductivity by PC Titrator												
Electrical Conductivity @ 25°C			1	µS/cm								
EA015: Total Dissolved Solids												
Total Dissolved Solids @180°C		GIS-210-010	1	mg/L								
EA025: Suspended Solids												
Suspended Solids (SS)			1	mg/L								
ED037P: Alkalinity by PC Titrator												
Hydroxide Alkalinity as CaCO ₃		DMO-210-001	1	mg/L								
Carbonate Alkalinity as CaCO ₃		3812-32-6	1	mg/L								
Bicarbonate Alkalinity as CaCO ₃		71-52-3	1	mg/L								
Total Alkalinity as CaCO ₃			1	mg/L								
ED038A: Acidity												
Acidity as CaCO ₃			1	mg/L								
ED041: Sulphate (Turbidimetric) as SO ₄ 2-												
Sulphate as SO ₄ - Turbidimetric			1	mg/L								
ED045G: Chloride Discrete analyser												
Chloride		16887-00-6	1.0	mg/L								
ED093F: Dissolved Major Cations												
Calcium		7440-70-2	1	mg/L								
Magnesium		7439-95-4	1	mg/L								
Sodium		7440-23-5	1	mg/L								
Potassium		7440-09-7	1	mg/L								
EG005T: Total Metals by ICP-AES												
Iron		7439-89-6	0.05	mg/L								
EG020F: Dissolved Metals by ICP-MS												
Cadmium		7440-43-9	0.0001	mg/L								
Copper		7440-50-8	0.001	mg/L								
Zinc		7440-66-6	0.005	mg/L								
Boron		7440-42-8	0.05	mg/L								
Iron		7439-89-6	0.05	mg/L								
EK057G: Nitrite as N by Discrete Analyser												
Nitrite as N			0.010	mg/L								
EK058G: Nitrate as N by Discrete Analyser												
Nitrate as N		14797-55-8	0.010	mg/L								



ALS Environmental

Analytical Results

Analytical Results					Client Sample ID :		Sample Matrix Type / Description :		Sample Date / Time :		Laboratory Sample ID :	
					BH3 1/1		WATER		15 Sep 2007		EP0704225-001	
							</					

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Client : GHD SERVICES PTY LTD
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ALS Environmental

Surrogate Control Limits

- No surrogates present on this report.



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EP0704225	Page	: 1 of 7
Client	: GHD SERVICES PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS ALISON JENNINGS	Contact	: Michael Sharp
Address	: GHD HOUSE PO BOX Y3106 PERTH WA AUSTRALIA 6832	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: ajennings@ghd.com.au	E-mail	: Michael.Sharp@alsenviro.com
Telephone	: +61 08 9429 6666	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9429 6555	Facsimile	: +61-8-9209 7600
Project	: 611951401	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: FIONA STANLEY HOSPITAL	Date Samples Received	: 18-SEP-2007
C-O-C number	: 5851	Issue Date	: 26-SEP-2007
Sampler	: GREG BOTHA	No. of samples received	: 1
Order number	: ----	No. of samples analysed	: 1
Quote number	: EN-005-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



WORLD RECOGNISED
ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements

Accredited for compliance with ISO/IEC 17025

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics
Celine Conceicao	Spectroscopist	Inorganics

Environmental Division Perth
Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax +61-8-9209 7600 www.alsglobal.com

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Page : 2 of 7
Work Order : EP0704225
Client : GHD SERVICES PTY LTD
Project : 611951401



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC



Page : 3 of 7
Work Order : EP0704225
Client : GHD SERVICES PTY LTD
Project : 611951401

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: WATER									
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005P: pH by PC Titrator (QC Lot: 494790)									
EP0704213-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.39	6.40	0.2	0% - 20%
EP0704227-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	5.97	5.93	0.7	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 494791)									
EP0704227-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	598	590	1.3	0% - 20%
EP0704227-007	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	708	702	0.8	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 496188)									
EP0704209-001	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	502	494	1.6	0% - 20%
EP0704240-006	Anonymous	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	342	344	0.6	0% - 20%
EA025: Suspended Solids (QC Lot: 495527)									
EP0704222-001	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	26	28	7.4	0% - 20%
EP0704257-003	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	32	32	0.0	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 494789)									
EP0704213-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	----
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	----
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	45	46	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	45	46	0.0	0% - 20%
ED038A: Acidity (QC Lot: 495649)									
EP0704225-001	BH3 1/1	ED038: Acidity as CaCO3	----	1	mg/L	39	37	5.0	0% - 20%
EP0704256-003	Anonymous	ED038: Acidity as CaCO3	----	1	mg/L	97	94	3.0	0% - 20%
ED041: Sulphate (Turbidimetric) as SO4 2- (QC Lot: 495526)									
EP0704225-001	BH3 1/1	ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	<1	<1	0.0	----
ED045G: Chloride Discrete analyser (QC Lot: 495109)									
EP0704212-020	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	82300	83300	1.2	0% - 20%
EP0704227-004	Anonymous	ED045G: Chloride	16887-00-6	1.0	mg/L	162	160	1.0	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 494722)									
EP0704219-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	4	4	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	----
		ED093F: Sodium	7440-23-5	1	mg/L	12	12	0.0	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	----
EG005T: Total Metals by ICP-AES (QC Lot: 497925)									
EP0704225-001	BH3 1/1	EG005T: Iron	7439-89-6	0.05	mg/L	32.6	32.3	0.8	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 498004)									
EP0704225-001	BH3 1/1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0006	0.0008	22.2	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.004	0.003	0.0	No Limit



Sub-Matrix: WATER									
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 498004) - continued									
EP0704225-001	BH3 1/1	EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.056	0.054	3.5	0% - 50%
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.0	----
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	----
ES0713106-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	0.0	----
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.008	0.007	0.0	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.11	0.11	0.0	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	----		
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 494751)									
EP0704219-001	Anonymous	EK057G: Nitrite as N	----	0.010	mg/L	<0.010	<0.010	0.0	----
EK059G: NOX as N by Discrete Analyser (QC Lot: 494750)									
EP0704219-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.010	mg/L	0.056	0.049	13.3	No Limit
EK061: Total Kjeldahl Nitrogen (TKN) (QC Lot: 494732)									
EP0704208-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.8	0.6	18.1	No Limit
EP0704227-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	4.6	4.8	3.2	0% - 20%
EK071G: Reactive Phosphorous as P by discrete analyser (QC Lot: 494749)									
EP0704222-001	Anonymous	EK071G: Reactive Phosphorus as P	----	0.010	mg/L	0.022	0.024	8.7	No Limit



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Work Order : EP0704225
Client : GHD SERVICES PTY LTD
Project : 611951401

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: WATER

Sub-Matrix: WATER	Method/Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
			LOR	Unit	Result	Spike Concentration	Spike Recovery (%)		
							LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 494790)									
	EA005-P: pH Value	----	0.01	pH Unit	----	7.00 pH Unit	99.5	70	130
EA010P: Conductivity by PC Titrator (QCLot: 494791)									
	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	3600 µS/cm	100	93.2	107
EA015: Total Dissolved Solids (QCLot: 496188)									
	EA015: Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	<1	2000 mg/L	96.7	70	130
EA025: Suspended Solids (QCLot: 495527)									
	EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	102	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 494789)									
	ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	----	200 mg/L	99.1	84.4	114
ED038A: Acidity (QCLot: 495649)									
	ED038: Acidity as CaCO3	----	1	mg/L	----	100 mg/L	94.0	70	130
ED041: Sulphate (Turbidimetric) as SO4 2- (QCLot: 495526)									
	ED041: Sulphate as SO4 - Turbidimetric	----	1	mg/L	<1	10 mg/L	114	74.2	124
ED045G: Chloride Discrete analyser (QCLot: 495109)									
	ED045G: Chloride	16887-00-6	1.0	mg/L	<1.0	250 mg/L	105	79.6	120
ED093F: Dissolved Major Cations (QCLot: 494722)									
	ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	109	70	130
	ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	103	70	130
	ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	107	70	130
	ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	111	70	130
EG005T: Total Metals by ICP-AES (QCLot: 497925)									
	EG005T: Iron	7439-89-6	0.05	mg/L	<0.05	1.00 mg/L	113	82.9	119
EG020F: Dissolved Metals by ICP-MS (QCLot: 498004)									
	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	93.6	70	130
	EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	91.1	70	130
	EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	94.2	70	130
	EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	97.6	70	130
	EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	96.4	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 494751)									
	EK057G: Nitrite as N	----	0.010	mg/L	<0.010	0.96 mg/L	90.8	67.1	132
EK059G: NOx as N by Discrete Analyser (QCLot: 494750)									
	EK059G: Nitrite + Nitrate as N	----	0.010	mg/L	<0.010	0.96 mg/L	96.4	76.4	126



Sub-Matrix: WATER		Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
EK061: Total Kjeldahl Nitrogen (TKN) (QCLot: 494732)								
EK061G: Total Kjeldahl Nitrogen as N	-----	0.1	mg/L	<0.1	10 mg/L	82.9	70	130
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 494749)								
EK071G: Reactive Phosphorus as P	-----	0.010	mg/L	<0.010	0.5 mg/L	95.0	84.5	130



Matrix Spike (MS) Report

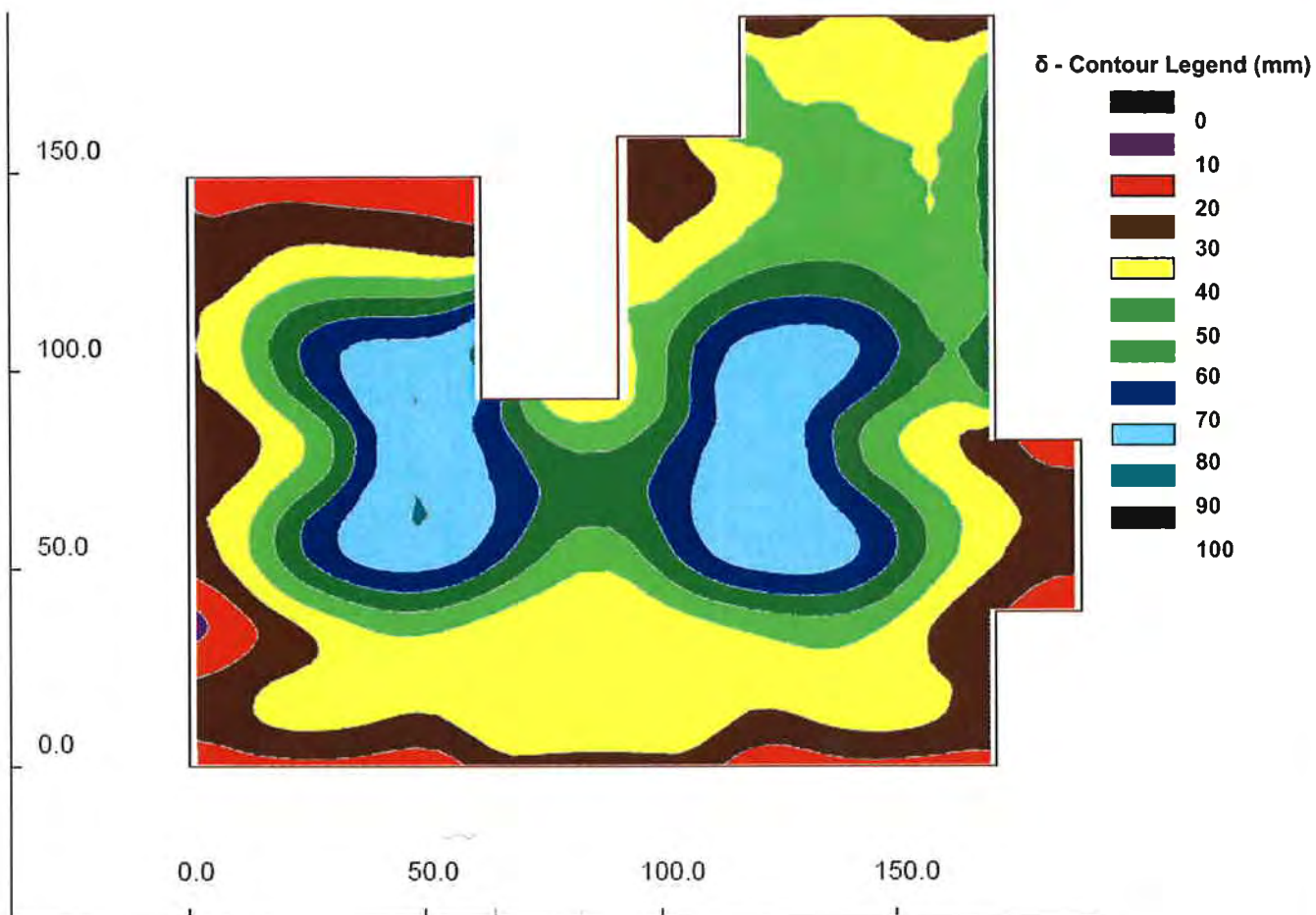
The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs) Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: WATER

Sub-Matrix: WATER				Matrix Spike (MS) Report			
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)
					MS	Low	
ED045G: Chloride Discrete analyser (QCLot: 495109)							
EP0704219-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	122	70	130
EG005T: Total Metals by ICP-AES (QCLot: 497925)							
EP0704253-001	Anonymous	EG005T: Iron	7439-89-6	1.00 mg/L	118	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 498004)							
EP0704225-001	BH3 1/1	EG020A-F: Cadmium	7440-43-9	0.05 mg/L	95.8	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	92.5	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	98.3	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 494751)							
EP0704219-002	Anonymous	EK057G: Nitrite as N	----	0.6 mg/L	74.2	70	130
EK059G: NOX as N by Discrete Analyser (QCLot: 494750)							
EP0704219-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.6 mg/L	96.7	70	130
EK061: Total Kjeldahl Nitrogen (TKN) (QCLot: 494732)							
EP0704208-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	77.3	70	130
EK071G: Reactive Phosphorous as P by discrete analyser (QCLot: 494749)							
EP0704225-001	BH3 1/1	EK071G: Reactive Phosphorus as P	----	0.5 mg/L	92.0	70	130

Appendix G

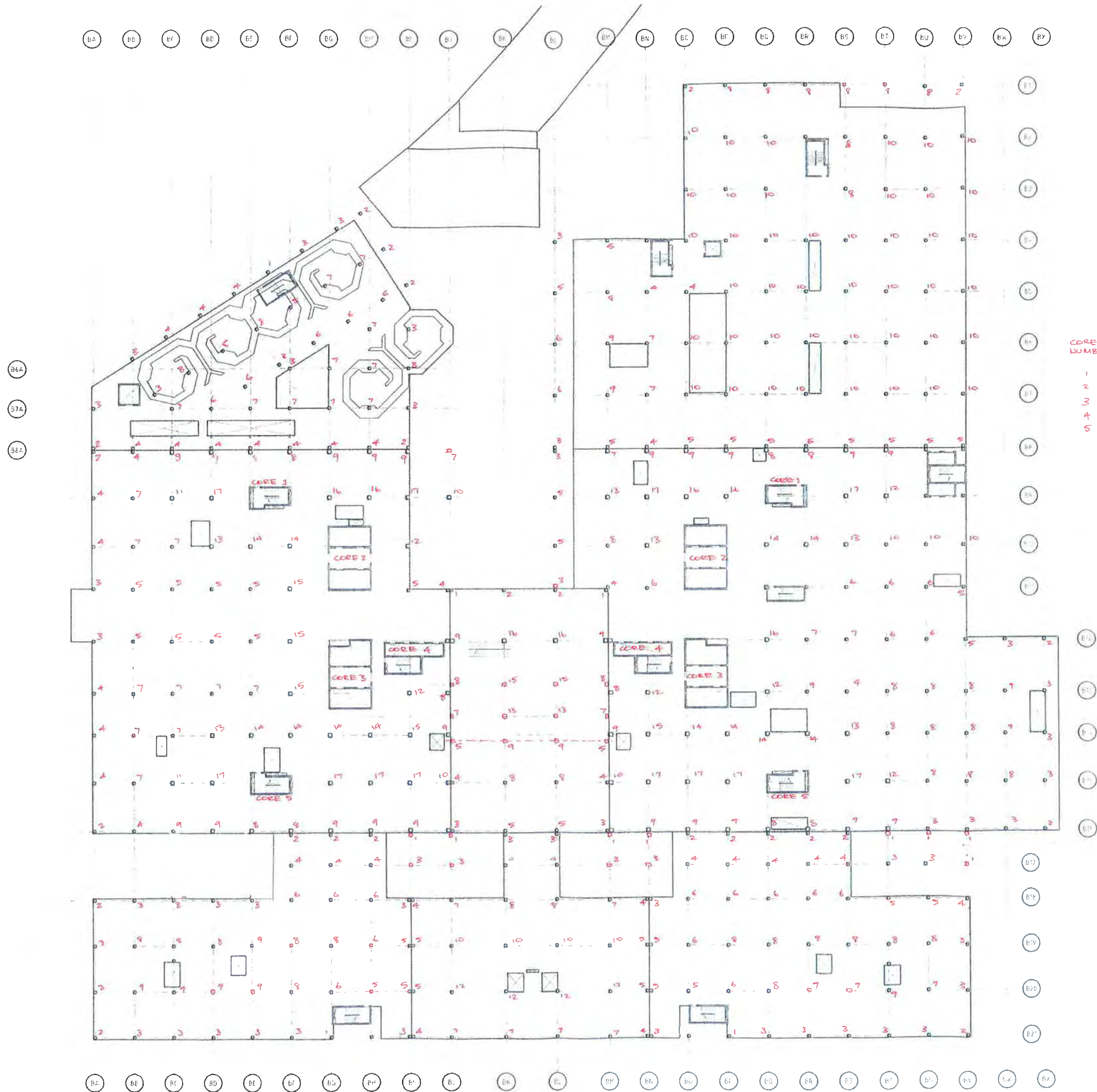
Results of Finite Element Analysis of Rafts (FEAR)



δ = Estimated initial settlement of pad footings

Note: Initial settlement only, does not include creep settlement

drawn	PCW	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E	
approved			project:	Fiona Stanley Hospital	
date	27-Jun-08		title:	Initial Settlements for Footings - (Client Supplied Column Loading)	
scale	As Shown		project no:	GEOTHERD08304AB	figure no: FIGURE G-1
original size	A4				



Column number	Unfactored Loads (kN) Dead	Unfactored Loads (kN) Live	Factored Loads (kN) Ultimate
1	1001	152	1429
2	1243	295	1934
3	1718	544	2876
4	2272	556	3575
5	2650	734	4280
6	2825	1145	5106
7	3771	975	5988
8	4113	1249	6810
9	4781	1517	8012
10	4983	1967	8930
11	5824	1767	9639
12	6537	2068	10947
13	7051	2454	12142
14	7121	2882	12866
15	8152	3130	14477
16	9438	2891	15669
17	9847	3807	17527

CORE NUMBER	UNFACTORED LOADS (kN) DEAD	UNFACTORED LOADS (kN) LIVE	FACTORED LOADS (kN)
1	25000	8900	43250
2	39500	12300	65850
3	40500	12500	67350
4	22000	6000	35400
5	25500	9000	44100

COLUMN LOADS:
LOWER GROUND LEVEL
23/06/08

Appendix H

Acid Sulphate Soils

Summary of Soil Analytical Results
Fiona Stanley Hospital

Sample ID		Field Test Results				Acidity - Lab Analysis										
Sample Location ID	Sample Depth (mBGL)	pH _f	pH _{ox}	pH	Reaction Rate	pH _{KCl}	pH _{ox}	s-TAA	s-TPA	s-TSA	S _{PO3}	S _{CR}	S _{NAS}	ANC _E	Net Acidity (excluding ANC)	Net Acidity Equation
		0.01	0.01	0.01	-	0.1	0.1	0.02	0.02	0.02	0.02	0.02	0.02	%CaCO ₃	% S	-
		<4	<3	3	NV	<4	<3	0.03	NV	NV	0.03	0.03	0.03	NV	0.03	-
TP101	0.25	7	5.3	1.7	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP101	0.5	6.8	5.5	1.3	Slight											
TP101	0.75	6.7	5.5	1.2	Slight											
TP101	1	6.5	5.5	1.0	Slight	6.5	5.5	<0.02	<2	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	S _{CR}
TP101	1.25	6.5	5.5	1.0	Slight											
TP101	1.5	6.5	5.5	1.0	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP102	0.25	5.9	5.2	0.7	Slight	5.7	3.1	<0.02	64	0.1	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP102	0.5	5.5	5.4	0.1	Slight											
TP102	0.75	5.1	5.6	-0.5	Slight											
TP102	1	5.4	5.4	0.0	Slight											
TP102	2	5.3	5.5	-0.2	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP103	0.25	5.8	5.5	0.3	Slight											
TP103	0.5	5.7	5.5	0.2	Slight											
TP103	0.75	6	5.5	0.5	Slight	5.9	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP103	1	5.8	5.4	0.4	Slight											
TP103	1.25	5.8	5.4	0.4	Slight											
TP103	1.5	5.5	5.4	0.1	Slight											
TP103	1.75	5.8	5.5	0.3	Slight											
TP103	2	5.9	5.4	0.5	Slight											
TP103	2.25	5.7	5.4	0.3	Slight											
TP103	2.5	5.8	5.4	0.4	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP104	0.25	5.7	5.5	0.2	Slight											
TP104	0.5	6	5.5	0.5	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP104	0.75	5.8	5.5	0.3	Slight											
TP104	1	5.2	5.3	-0.1	Slight											
TP104	1.25	5.4	5.2	0.2	Slight											
TP104	1.5	5.1	5.1	0.0	Slight											
TP104	1.75	5	5.3	-0.3	Slight											
TP104	2	5.3	5.1	0.2	Slight											
TP104	2.25	4.7	5.4	-0.7	Slight											
TP104	2.5	4.8	5.2	-0.4	Slight	5.5	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP104	2.75	4.6	5.5	-0.9	Slight											
TP104	3	4.7	5.3	-0.6	Slight											
TP104	3.25	5.5	5.4	0.1	Slight											
TP104	3.5	4.8	4.2	0.6	Slight	6	3.8	<0.02	12	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP105	0.25	5.4	5.3	0.1	Slight											
TP105	0.5	5.8	5.4	0.4	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP105	0.75	6	5.5	0.5	Slight											
TP105	1	6	5.6	0.4	Slight											
TP105	1.25	5.8	5.6	0.2	Slight											
TP105	1.5	5.7	5.5	0.2	Slight											
TP105	1.75	5.9	5.6	0.3	Slight											
TP105	2	5.7	5.4	0.3	Slight											
TP105	2.25	5.9	5.4	0.5	Slight											
TP105	2.5	7.1	5.3	1.8	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP106	0.25	6.9	4.8	2.1	Slight	5.8	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP106	0.5	6.8	5.2	1.6	Slight											
TP106	0.75	6.7	5.4	1.3	Slight											
TP106	1	7.3	5.5	1.8	Slight	6.2	4.4	<0.02	<2	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP106	1.25	7.1	5.3	1.8	Slight											
TP106	1.5	7	5.5	1.5	Slight											
TP106	1.75	6.7	5.5	1.2	Slight											
TP106	2	6.6	5.5	1.1	Slight											
TP106	2.25	6.6	5.4	1.2	Slight											
TP106	2.5	6.1	5.5	0.6	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP106	2.75	6.1	5.6	0.5	Slight											
TP106	3	6.1	5.4	0.7	Slight											
TP107	0.25	6.7	4.9	1.8	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP107	0.5	6.5	5.4	1.1	Slight											
TP107	0.75	6.2	5.5	0.7	Slight											
TP107	1	7.2	5.3	1.9	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP107	1.25	7	5.4	1.6	Slight											
TP107	1.5	7.2	5.3	1.9	Slight	6	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP107	1.75	7.3	5.4	1.9	Slight											
TP107	2	7.2	5.3	1.9	Slight											
TP109	0.25	7	5.1	1.9	Slight											
TP109	0.5	7.4	5.1	2.3	Slight	6.4	4.1	<0.02	3	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP109	0.75	7.1	5.4	1.7	Slight											
TP109	1	7.2	5.5	1.7	Slight											
TP109	1.25	7.2	5.5	1.7	Slight											
TP109	1.5	7.3	5.5	1.8	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP109	1.75	7.2	5.5	1.7	Slight											
TP109	2	7.3	5.5	1.8	Slight											
TP109	2.25	7.1	5.4	1.7	Slight											
TP109	2.5	7.3	5.6	1.7	Slight											

Summary of Soil Analytical Results
Fiona Stanley Hospital

Sample ID		Field Test Results				Acidity - Lab Analysis										
Sample Location ID	Sample Depth (mBGL)	pH _f	pH _{ox}	pH	Reaction Rate	pH _{KCl}	pH _{ox}	s-TAA	s-TPA	s-TSA	S _{PO3}	S _{CR}	S _{NAS}	ANC _E	Net Acidity (excluding ANC)	Net Acidity Equation
		0.01	0.01	0.01	-	-	-	-	-	-	% S	-	-	%CaCO ₃	% S	-
		<4	<3	3	NV	<4	<3	0.02	0.02	0.02	0.02	0.02	0.02	NV	0.02	-
TP110	1	7.4	5.5	1.9	Slight											
TP110	1.25	7.8	5.4	2.4	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP110	1.5	7.6	5.4	2.2	Slight											
TP110	1.75	7.4	5.4	2.0	Slight											
TP110	2	7.3	5.5	1.8	Slight											
TP110	2.25	7.3	5.5	1.8	Slight											
TP110	2.5	7.6	5.4	2.2	Slight											
TP110	2.75	7.5	5.3	2.2	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP111	0.25	7.3	5	2.3	Slight											
TP111	0.5	5.9	5.5	0.4	Slight											
TP111	0.75	6	5.5	0.5	Slight	6	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP111	1	6	5.5	0.5	Slight											
TP111	1.25	5.9	5.5	0.4	Slight											
TP111	1.5	6.2	5.5	0.7	Slight											
TP111	1.75	5.9	5.5	0.4	Slight											
TP111	2	5.6	5.4	0.2	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP111	2.25	5.8	5.5	0.3	Slight											
TP111	2.5	5.9	5.5	0.4	Slight											
TP112	0.5	5.8	5.5	0.3	Slight											
TP112	0.75	6.1	5.6	0.5	Slight											
TP112	1	6.2	5.5	0.7	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP112	1.25	6.1	5.5	0.6	Slight											
TP112	2	6.1	5.6	0.5	Slight											
TP112	2.25	6	5.5	0.5	Slight	6.1	4.9	<0.02	<2	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP112	2.3	6	5.5	0.5	Slight											
TP113	0.25	7	5.7	1.3	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP113	0.5	6.6	5.2	1.4	Slight											
TP113	0.75	6.5	5.2	1.3	Slight											
TP113	1	6.7	5.3	1.4	Slight											
TP113	1.25	6.4	5.2	1.2	Slight											
TP113	1.5	5.8	5.2	0.6	Slight											
TP113	1.75	6	5.2	0.8	Slight											
TP113	2	5.9	5.4	0.5	Slight											
TP113	2.25	6.1	5.3	0.8	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP113	2.5	6	5.3	0.7	Slight											
TP114	0.25	6	4.3	1.7	Slight	5.4	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP114	0.5	5.6	4.9	0.7	Slight											
TP114	0.75	5.8	5.1	0.7	Slight											
TP114	1	5.6	5.1	0.5	Slight											
TP114	1.25	5.5	5.2	0.3	Slight											
TP114	1.5	5.4	5.2	0.2	Slight											
TP114	1.75	5.4	5.4	0.0	Slight											
TP114	2	5.7	5.4	0.3	Slight											
TP114	2.25	5.7	5.2	0.5	Slight	6.2	4.3	<0.02	<2	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP114	2.5	5.2	5.2	0.0	Slight											
TP115	0.25	6.1	5.5	0.6	Slight											
TP115	0.5	6.2	5.5	0.7	Slight	6	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP115	0.75	5.9	5.5	0.4	Slight											
TP115	1	5.8	5.8	0.0	Slight											
TP115	1.25	5.9	5.6	0.3	Slight											
TP115	1.5	5.9	5.6	0.3	Slight											
TP115	1.75	6	5.5	0.5	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP115	2	6.1	5.5	0.6	Slight											
TP115	2.25	6	5.5	0.5	Slight											
TP115	2.5	6	5.5	0.5	Slight											
TP115	2.75	6	5.5	0.5	Slight											
TP115	3	6	5.4	0.6	Slight											
TP115	3.25	6	5.5	0.5	Slight											
TP115	3.5	6.1	5.5	0.6	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP116	0.25	6.1	5.4	0.7	Slight											
TP116	0.5	6.2	5.3	0.9	Slight	6.1	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP116	0.75	6.1	5.4	0.7	Slight											
TP116	1	6.3	5.4	0.9	Slight											
TP116	1.25	6.4	5.4	1.0	Slight											
TP116	1.5	6.4	5.4	1.0	Slight											
TP116	1.75	6.4	5.4	1.0	Slight											
TP116	2	6.5	5.4	1.1	Slight											
TP116	2.25	6.4	5.4	1.0	Slight											
TP116	2.5	6.4	5.4	1.0	Slight	6.2	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}
TP116	2.75	6.3	5.4	0.9	Slight											
TP116	3	6.5	5.4	1.1	Slight											
TP116	3.25	6.4	5.4	1.0	Slight											
TP116	3.5	6.2	5.4	0.8	Slight											
TP116	3.75	6.4	5.4	1.0	Slight											

Summary of Soil Analytical Results
Fiona Stanley Hospital

Sample ID		Field Test Results				Acidity - Lab Analysis											
Sample Location ID	Sample Depth (mBGL)	pH _f	pH _{ox}	pH	Reaction Rate	pH _{Ca}	pH _{ox}	s-TAA	s-TPA	s-TSA	S _{Pos}	S _{CR}	S _{NAS}	ANC _E	Net Acidity (excluding ANC)	Net Acidity Equation	
											% S			%CaCO ₃	% S		
		0.01	0.01	0.01	-	0.1	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	-
		<4	<3	3	NV	<4	<3	0.03	NV	NV	0.03	0.03	0.03	NV	0.03	-	
TP116	4	6.4	5.4	1.0	Slight	6.2	5.2	<0.02	<2	<0.02	<0.02	<0.02	<0.02	---	<0.02	TAA+S _{CR}	
TP117	0.25	6.8	5.1	1.7	Moderate	7.4	---	<0.02	---	---	---	<0.02	<0.02	0.56	<0.02	S _{CR}	
TP117	0.5	8.3	5.6	2.7	Slight												
TP117	0.75	9	5.8	3.2	Slight	9.5	---	<0.02	---	---	---	<0.02	<0.02	2.54	<0.02	S _{CR}	
TP117	1	8.6	5.8	2.8	Slight												
TP117	1.25	8.1	5.7	2.4	Slight												
TP117	1.5	7.8	5.6	2.2	Slight												
TP117	1.75	7.6	5.6	2.0	Slight												
TP117	2	7.8	5.6	2.2	Slight												
TP117	2.25	7.7	5.6	2.1	Slight												
TP117	2.5	7.6	5.6	2.0	Slight												
TP117	2.75	7.4	5.5	1.9	Slight												
TP117	3	7.5	5.6	1.9	Slight												
TP117	3.25	7.9	5.9	2.0	Slight												
TP117	3.5	7.9	5.7	2.2	Slight												
TP117	3.75	7.6	5.6	2.0	Slight	7.2	5.6	<0.02	<2	<0.02	0.02	<0.02	<0.02	0.18	<0.02	S _{CR}	
TP117	4	7.4	5.6	1.8	Slight												
TP118	0.25	6.4	5.3	1.1	Slight												
TP118	0.5	6.3	5.4	0.9	Slight												
TP118	0.75	6.5	5.4	1.1	Slight												
TP118	1	6.4	5.4	1.0	Slight	6.7	---	<0.02	---	---	---	<0.02	<0.02	0.56	<0.02	S _{CR}	
TP118	1.25	6.3	5.4	0.9	Slight												
TP118	1.5	6.3	5.3	1.0	Slight												
TP118	1.75	6.5	5.4	1.1	Slight												
TP118	2	6.4	5.3	1.1	Slight	7.1	6	<0.02	<2	<0.02	<0.02	<0.02	<0.02	0.36	<0.02	S _{CR}	
TP118	2.25	6.4	5.4	1.0	Slight												
TP118	2.5	6.4	5.4	1.0	Slight	6.6	---	<0.02	---	---	---	<0.02	<0.02	0.56	<0.02	S _{CR}	
TP118	2.75	6.2	5.4	0.8	Slight												
TP121	0.25	5.8	4.5	1.3	Slight												
TP121	0.5	6.1	4.8	1.3	Slight	9.4	---	<0.02	---	---	---	<0.02	<0.02	0.68	<0.02	S _{CR}	
TP121	0.75	6.2	5.1	1.1	Slight												
TP121	1	6.1	5.3	0.8	Slight												
TP121	1.25	6.2	5.3	0.9	Slight												
TP121	1.5	6.1	5.2	0.9	Slight	9.3	7.4	<0.02	<2	<0.02	<0.02	<0.02	<0.02	1.04	<0.02	S _{CR}	
TP121	1.75	6.2	5.3	0.9	Slight												
TP121	2	6.1	5.3	0.8	Slight												
TP121	2.25	5.9	5.3	0.6	Slight												
TP121	2.5	5.9	5.3	0.6	Slight												
TP121	2.75	6	5.3	0.7	Slight	6.4	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}	
TP122	0.25	5.9	5.3	0.6	Slight												
TP122	0.5	6	5.3	0.7	Slight	9.5	---	<0.02	---	---	---	<0.02	<0.02	1.9	<0.02	S _{CR}	
TP122	0.75	5.9	5.3	0.6	Slight												
TP122	1	5.9	5.2	0.7	Slight												
TP122	1.25	6	5.3	0.7	Slight												
TP122	1.5	6	5.2	0.8	Slight	6.3	---	<0.02	---	---	---	<0.02	<0.02	---	<0.02	TAA+S _{CR}	
TP122	1.75	6.9	5.5	1.4	Slight												
TP122	2	7	5.3	1.7	Slight	6.8	---	<0.02	---	---	---	<0.02	<0.02	0.42	<0.02	S _{CR}	
TP122	2.25	6.8	5.3	1.5	Slight												
TP122	2.5	6.8	5.3	1.5	Slight												
TP122	2.75	6.4	5.3	1.1	Slight												
TP122	3	6.2	5.3	0.9	Slight												

Summary of Soil Analytical Results
Fiona Stanley Hospital

Sample ID		Field Test Results				Acidity - Lab Analysis											
Sample Location ID	Sample Depth (mBGL)	pH _f	pH _{ox}	ΔpH	Reaction Rate	pH _{Ca}	pH _{ox}	s-TAA	s-TPA	s-TSA	S _{POS}	S _{CR}	S _{NAS}	ANC _E	Net Acidity (excluding ANC)	Net Acidity Equation	
		0.01	0.01	0.01	-	0.1	0.1	0.02	0.02	0.02	% S	0.02	0.02	0.02	%CaCO ₃	% S	-
		<4	<3	3	NV	<4	<3	0.03	NV	NV	0.03	0.03	0.03	NV	0.03	-	
BH101	1.0-1.1	8.4	6.5	1.9	Slight												
BH101	1.35-1.45	8.6	5.8	2.8	Slight	8.5	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH101	2.0-2.1	8.8	6	2.8	Slight												
BH101	2.35-2.45	8.6	6.1	2.5	Slight	7.9	6.9	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	S _{CR}	
BH101	3.0-3.1	8.6	6.1	2.5	Slight												
BH101	3.35-3.45	8.6	5.9	2.7	Slight												
BH101	4.0-4.1	8.7	6.2	2.5	Slight	8.9	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH101	4.35-4.45	8.6	6.3	2.3	Slight												
BH101	5.0-5.1	8.6	6.3	2.3	Slight												
BH101	5.35-5.45	8.7	6.3	2.4	Slight												
BH101	6.0-6.1	8.8	6	2.8	Slight	7.1	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH101	6.35-6.45	8.6	6	2.6	Slight	6.6	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH101	7.0-7.1	8.6	6	2.6	Slight												
BH101	7.35-7.45	8.1	6	2.1	Slight	6.5	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH101	8.0-8.1	8.4	6.2	2.2	Slight												
BH101	8.35-8.45	8.1	5.9	2.2	Slight	6.5	6.4	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	S _{CR}	
BH101	9.0-9.1	7.9	5.8	2.1	Slight												
BH101	9.35-9.45	7.9	5.2	2.7	Slight	6.3	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH101	10.5-10.6	8.1	5.4	2.7	Slight	7.2	6.8	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	S _{CR}	
BH101	10.85-10.95	7.2	5.3	1.9	Slight												
BH101	12.0-12.1	7.8	5.4	2.4	Slight												
BH101	12.35-12.45	7.6	3.6	4.0	Slight	6.2	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH101	13.5-13.6	8.2	4.2	4.0	Slight												
BH101	13.85-13.95	8.1	4.5	3.6	Slight												
BH101	15.35-15.45	7.3	5.4	1.9	Slight												
BH101	15-15.1	7	5.8	1.2	Slight												
BH101	16.5-16.6	7.6	5.3	2.3	Slight												
BH101	16.85-16.95	8.1	4.6	3.5	Slight												
BH101	18.35-18.45	7.4	4.4	3.0	Slight												
BH101	18-18.1	8	5.7	2.3	Slight												
BH101	19.5-19.6	7.9	5.8	2.1	Slight												
BH101	19.7-19.75	8.1	5.3	2.8	Slight												
BH101	21.2-21.3	7.9	3.6	4.3	Slight												
BH101	21-21.1	8.2	4.7	3.5	Slight												
BH101	22.5-22.6	8	5.2	2.8	Slight												
BH101	22.7-22.8	8	1.9	6.1	Slight												
BH101	24.1-24.17	8.2	3.2	5.0	Slight												
BH101	24-24.1	8.4	2.2	6.2	Slight												
BH102	1.5-1.6	6.9	5	1.9	Slight	6.7	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH102	3.0-3.1	7.2	5.5	1.7	Slight												
BH102	3.35-3.45	7.2	4.8	2.4	Slight	5.6	5	0.02	<0.02	<0.02	<0.02	0.02	---	0.18	0.03	TAA+S _{CR}	
BH102	4.5-4.6	7	4.3	2.7	Slight												
BH102	4.85-4.95	6.6	3	3.6	Slight	5.7	---	0.02	---	---	---	0.02	---	0.18	0.04	TAA+S _{CR}	
BH102	6.0-6.1	7.3	4.3	3.0	Slight												
BH102	6.35-6.45	7	4.4	2.6	Slight	6.3	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH102	7.5-7.6	7.4	5.7	1.7	Slight												
BH102	7.85-7.95	7.7	5.4	2.3	Slight	6.2	6.3	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH102	9.0-9.1	7.6	5.6	2.0	Slight												
BH102	9.35-9.45	8.3	5.4	2.9	Slight	6.2	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH102	10.5-10.6	8.2	5.5	2.7	Slight												
BH102	10.85-10.95	8.1	5.4	2.7	Slight	6.3	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH102	12.0-12.1	8.1	5.2	2.9	Slight												
BH102	12.35-12.45	7.8	5	2.8	Slight												
BH102	13.5-13.6	7	4.2	2.8	Slight												
BH102	13.85-13.95	6.8	4.1	2.7	Slight												
BH102	15.0-15.1	6.8	4.7	2.1	Slight												
BH102	15.32-15.42	6.4	4.1	2.3	Slight												
BH102	16.5-16.6	6.7	3.1	3.6	Extreme												
BH102	16.75-16.85	6.6	2.4	4.2	Extreme												
BH102	18.1-18.2	8.1	4.8	3.3	Slight												
BH102	18-18.1	7.9	4	3.9	Slight												
BH102	19.5-19.65	8.2	4.4	3.8	Slight												
BH102	21-21.2	8.2	1.8	6.4	Slight												
BH102	22.5-22.7	8.2	2.3	5.9	Extreme												
BH102	24-24.27	8.1	1.9	6.2	Moderate												
BH103	1.0-1.1	6.9	5	1.9	Slight												
BH103	1.35-1.45	6.6	4.4	2.2	Slight	5.9	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH103	2.0-2.1	6.8	4.8	2.0	Slight												
BH103	2.35-2.45	6.9	5.1	1.8	Slight												
BH103	3.0-3.1	7	4.8	2.2	Slight	6.2	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH103	3.35-3.45	7	5.1	1.9	Slight												
BH103	4.0-4.1	7.1	5.1	2.0	Slight												
BH103	4.35-4.45	6.8	4.7	2.1	Slight	6.4	6.2	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH103	5.0-5.1	7	5	2.0	Slight												
BH103	5.35-5.45	7	5	2.0	Slight												

Summary of Soil Analytical Results
Fiona Stanley Hospital

Sample ID		Field Test Results				Acidity - Lab Analysis											
Sample Location ID	Sample Depth (mBGL)	pH _f	pH _{ox}	ΔpH	Reaction Rate	pH _{KCl}	pH _{ox}	s-TAA	s-TPA	s-TSA	S _{PO3}	S _{CR}	S _{NAS}	ANC _E	Net Acidity (excluding ANC)	Net Acidity Equation	
		-	-	-	-	-	-	% S						%CaCO ₃	% S	-	
		0.01	0.01	0.01	-	0.1	0.1	0.02	0.02	0.02	0.02	0.02	0.02		0.02	-	
		<4	<3	3	NV	<4	<3	0.03	NV	NV	0.03	0.03	0.03	NV	0.03	-	
BH103	7.35-7.45	7.3	5.1	2.2	Slight												
BH103	8.0-8.1	7.5	5.2	2.3	Slight												
BH103	8.35-8.45	7.5	5.2	2.3	Slight												
BH103	9.0-9.1	7.7	5.4	2.3	Slight	6.9	6.6	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	S _{CR}	
BH103	9.35-9.45	7.6	5.3	2.3	Slight												
BH103	10.5-10.6	8.1	5.3	2.8	Slight												
BH103	10.85-10.95	7.6	5.3	2.3	Moderate	6.2	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH103	12.0-12.1	7.8	5.4	2.4	Slight												
BH103	12.2-12.37	8	5.7	2.3	Moderate	6.2	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH103	13.5-13.75	8.1	5.2	2.9	Slight												
BH103	15.0-15.1	7.8	4.9	2.9	Slight												
BH103	15.35-15.45	7	3.1	3.9	Slight												
BH103	16.5-16.6	7.6	5.2	2.4	Slight												
BH103	16.7-16.9	7.8	5.1	2.7	Slight												
BH103	18.0-18.3	8.2	5.3	2.9	Slight												
BH103	19.5-19.8	8.2	5.2	3.0	Slight												
BH103	21.0-21.2	8.2	5.6	2.6	Slight												
BH103	22.5-22.69	8.3	5.1	3.2	Slight												
BH103	24.0-24.2	8.2	5.1	3.1	Slight												
BH104	1.5-1.6	7.3	5.4	1.9	Slight	6.6	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH104	1.9-2.0	7.5	5.6	1.9	Slight												
BH104	3.0-3.1	8	5.6	2.4	Slight												
BH104	3.35-3.45	8.2	5.3	2.9	Slight	6.2	6.1	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH104	4.5-4.6	8	5.6	2.4	Slight												
BH104	4.85-4.95	7.5	5.2	2.3	Slight												
BH104	6.0-6.1	8	5.7	2.3	Slight												
BH104	6.35-6.45	8.4	5.4	3.0	Slight												
BH104	7.5-7.6	8.6	5.9	2.7	Slight	7	6.7	<0.02	<0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	S _{CR}	
BH104	8.20	7.6	5	2.6	Slight												
BH104	9.0-9.1	7.9	8.6	-0.7	Extreme	5.5	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH104	9.15-9.25	7.4	2.2	5.2	Slight	6	4.8	<0.02	0.02	<0.02	<0.02	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH104	10.5-10.6	6.9	2.2	4.7	Slight	6.6	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH104	10.85-10.95	6.8	3.5	3.3	Slight												
BH104	12.0-12.1	7	3.8	3.2	Slight	5.8	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	S _{CR}	
BH104	12.35-12.45	6.8	4.2	2.6	Slight												
BH104	13.5-13.6	7.8	5.5	2.3	Slight												
BH104	13.75-13.85	7.9	4.7	3.2	Slight												
BH104	15.0-15.1	8.4	2.7	5.7	Slight	6.1	---	<0.02	---	---	---	<0.02	---	0.18	<0.02	TAA+S _{CR}	
BH104	15.15-15.27	7.3	3.7	3.6	Slight												
BH104	16.5-16.6	7.3	4.7	2.6	Slight												
BH104	16.65-16.78	7.5	4.4	3.1	Slight												
BH104	18.0-18.1	7.8	2	5.8	Extreme												
BH104	18.1-18.25	7.5	2	5.5	Extreme												
BH104	19.5-19.6	7.9	3	4.9	Slight												
BH104	19.6-19.72	8.4	5.4	3.0	Slight												
BH104	21.0-21.1	8.3	1.9	6.4	Extreme												
BH104	21.1-21.7	8.3	1.7	6.6	Extreme												
BH104	22.5-22.6	8.4	1.7	6.7	Extreme												
BH104	22.6-22.67	8.4	1.7	6.7	Extreme												



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EP0802883	Page	: 1 of 8
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802488 2568 2613 2570 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----	Date Samples Received	: 23-MAY-2008
C-O-C number	: ----	Issue Date	: 03-JUN-2008
Sampler	: ----	No. of samples received	: 32
Order number	: ----	No. of samples analysed	: 32
Quote number	: ----		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

Environmental Division Perth
Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax. +61-8-9209 7600 www.alsglobal.com

A Campbell Brothers Limited Company



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
RPD = Relative Percentage Difference
= Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA029-A: pH Measurements (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: pH KCl (23A)	----	0.1	pH Unit	7.9	7.8	0.0	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	6.9	6.7	2.1	0% - 20%
EA029-B: Acidity Trail (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.0	No Limit
EA029-C: Sulfur Trail (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-D: Calcium Values (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.05	0.04	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	0.05	0.05	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-E: Magnesium Values (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-F: Excess Acid Neutralising Capacity (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	0.12	0.12	0.0	No Limit
		EA029: sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	0.04	0.04	0.0	No Limit
		EA029: acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	24	25	0.0	No Limit
EA029-H: Acid Base Accounting (QC Lot: 667642)									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit

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 Work Order : EP0802883
 Client : COFFEY GEOTECHNICS
 Project : Ex EP0802488 2568 2613 2570 GH08304AB



Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA029-H: Acid Base Accounting (QC Lot: 667642) - continued									
EP0802883-002	BH101 2.35 ¿ 2.45	EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-A: Actual Acidity (QC Lot: 667641)									
EP0802883-001	BH101 1.35 ¿ 1.45	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	8.5	8.5	0.0	0% - 20%
EP0802883-011	BH102 1.5 ¿ 1.6	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.7	6.8	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 667643)									
EP0802883-021	BH103 6.35 ¿ 6.45	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.2	6.1	0.0	0% - 20%
EP0802883-031	BH104 12.0 ¿ 12.1	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.8	5.9	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 667641)									
EP0802883-001	BH101 1.35 ¿ 1.45	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802883-011	BH102 1.5 ¿ 1.6	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 667643)									
EP0802883-021	BH103 6.35 ¿ 6.45	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802883-031	BH104 12.0 ¿ 12.1	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 667641)									
EP0802883-001	BH101 1.35 ¿ 1.45	EA033: Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.18	0.18	0.0	0% - 50%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.06	0.06	0.0	No Limit
		EA033: acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	35	35	0.0	No Limit
EP0802883-011	BH102 1.5 ¿ 1.6	EA033: Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.06	0.06	0.0	No Limit
		EA033: sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.02	0.02	0.0	No Limit
		EA033: acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	12	12	0.0	No Limit
EA033-E: Acid Base Accounting (QC Lot: 667641)									
EP0802883-001	BH101 1.35 ¿ 1.45	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit

Page : 5 of 8
 Work Order : EP0802883
 Client : COFFEY GEOTECHNICS
 Project : Ex EP0802488 2568 2613 2570 GH08304AB



Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-E: Acid Base Accounting (QC Lot: 667641) - continued									
EP0802883-001	BH101 1.35 ζ 1.45	EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802883-011	BH102 1.5 ζ 1.6	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-E: Acid Base Accounting (QC Lot: 667643)									
EP0802883-021	BH103 6.35 ζ 6.45	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802883-031	BH104 12.0 ζ 12.1	EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
EA033-E: Acid Base Accounting (QC Lot: 667643)									
EP0802883-021	BH103 6.35 ζ 6.45	EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
EP0802883-031	BH104 12.0 ζ 12.1	EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%)	
							Low	High
EA029-B: Acidity Trail (QCLot: 667642)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 667642)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values (QCLot: 667642)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values (QCLot: 667642)								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 667641)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 667643)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 667641)								
EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 667643)								
EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----



Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result			Low	High
EA033-C: Acid Neutralising Capacity (QCLot: 667641)								
EA033: Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	<0.01	----	----	----	----
EA033: acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 667643)								
EA033: Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	<0.01	----	----	----	----
EA033: acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 667641)								
EA033: ANC Fineness Factor	----	0.5		<0.5	----	----	----	----
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 667643)								
EA033: ANC Fineness Factor	----	0.5		<0.5	----	----	----	----
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries . Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EP0802883	Page	: 1 of 15
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802488 2568 2613 2570 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 23-MAY-2008
C-O-C number	: ----	Issue Date	: 03-JUN-2008
Sampler	: ----	No. of samples received	: 32
Site	: ----	No. of samples analysed	: 32
Quote number	: ----		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in
accordance with NATA
accreditation requirements.

Accredited for compliance with
ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

Environmental Division Perth
Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax. +61-8-9209 7600 www.alsglobal.com

A Campbell Brothers Limited Company

Page : 2 of 15
Work Order : EP0802883
Client : COFFEY GEOTECHNICS
Project : Ex EP0802488 2568 2613 2570 GH08304AB



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH101 1.35 □ 1.45	BH101 2.35 □ 2.45	BH101 4.0 □ 4.1	BH101 6.0 □ 6.1 6	BH101 6.35 □ 6.45
				06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0802883-001	EP0802883-002	EP0802883-003	EP0802883-004	EP0802883-005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	7.9	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	6.9	----	----	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	----	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	0.05	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	0.05	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	0.12	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	24	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	0.04	----	----	----
EA029-H: Acid Base Accounting								



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				BH101 1.35 □ 1.45	BH101 2.35 □ 2.45	BH101 4.0 □ 4.1	BH101 6.0 □ 6.1 6	BH101 6.35 □ 6.45
				06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-001	EP0802883-002	EP0802883-003	EP0802883-004	EP0802883-005
EA029-H: Acid Base Accounting - Continued								
ANC Fineness Factor	----	0.5	-	----	1.5	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	8.5	7.9	8.9	7.1	6.6
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.18	0.18	0.24	0.18	0.18
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	35	35	47	36	36
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.06	0.06	0.08	0.06	0.06
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH101 7.35 □ 7.45	BH101 8.35 □ 8.45	BH101 9.35 □ 9.45	BH101 10.5 □ 10.6	BH101 12.35 □ 12.45
				06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
				EP0802883-006	EP0802883-007	EP0802883-008	EP0802883-009	EP0802883-010
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.5	----	7.2	----
pH OX (23B)	----	0.1	pH Unit	----	6.4	----	6.8	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	<2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	2	----	<2	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	2	----	<2	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	0.02	----	0.03	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	<0.02	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	0.12	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	24	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	0.04	----
EA029-H: Acid Base Accounting								



Analytical Results

Sub-Matrix: SOIL

Client sample ID

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				BH101 7.35 □ 7.45	BH101 8.35 □ 8.45	BH101 9.35 □ 9.45	BH101 10.5 □ 10.6	BH101 12.35 □ 12.45
				06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00	06-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-006	EP0802883-007	EP0802883-008	EP0802883-009	EP0802883-010
EA029-H: Acid Base Accounting - Continued								
ANC Fineness Factor	----	0.5	-	----	1.5	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.5	6.5	6.3	7.2	6.2
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.18	----	----	0.18	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	36	----	----	36	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.06	----	----	0.06	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH102 1.5 □ 1.6	BH102 3.34 □ 3.45	BH102 4.85 □ 4.95	BH102 6.35 □ 6.45	BH102 7.85 □ 7.95
				09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00
				EP0802883-011	EP0802883-012	EP0802883-013	EP0802883-014	EP0802883-015
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.6	----	----	6.2
pH OX (23B)	----	0.1	pH Unit	----	5.0	----	----	6.3
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	<2
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	5	----	----	2
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	4	----	----	2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	----	<0.02
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	----	<0.02
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	----	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	----	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	----	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	----	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	----	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	----	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	<0.02	----	----	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	----	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	----	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	----	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	----	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	----	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	----	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	----	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	----	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	1.5	----	----	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10



Analytical Results

Sub-Matrix: SOIL

Client sample ID

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				BH102 1.5 □ 1.6	BH102 3.34 □ 3.45	BH102 4.85 □ 4.95	BH102 6.35 □ 6.45	BH102 7.85 □ 7.95
				09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00	09-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-011	EP0802883-012	EP0802883-013	EP0802883-014	EP0802883-015
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	<1
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.7	5.6	5.7	6.3	6.2
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	8	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	0.02	0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	16	14	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.06	----	----	----	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	12	----	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.02	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	0.03	0.04	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	17	22	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	1	2	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	0.03	0.04	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	17	22	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	1	2	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Sub-Matrix: SOIL				Client sample ID		BH102		BH102		BH103		BH103		BH103	
						9.35 □ 9.45		10.85 □ 10.9		1.35 □ 1.45		3.0 □ 3.1		4.35 □ 4.45	
				Client sampling date / time		09-MAY-2008 15:00		09-MAY-2008 15:00		13-MAY-2008 15:00		13-MAY-2008 15:00		13-MAY-2008 15:00	
Compound	CAS Number	LOR	Unit	EP0802883-016		EP0802883-017		EP0802883-018		EP0802883-019		EP0802883-020			
EA029-A: pH Measurements															
pH KCl (23A)	----	0.1	pH Unit	----		----		----		----		6.4			
pH OX (23B)	----	0.1	pH Unit	----		----		----		----		6.2			
EA029-B: Acidity Trail															
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----		----		----		----		<2			
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----		----		----		----		4			
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----		----		----		----		4			
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----		----		----		----		<0.02			
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----		----		----		----		<0.02			
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----		----		----		----		<0.02			
EA029-C: Sulfur Trail															
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----		----		----		----		<0.02			
Peroxide Sulfur (23De)	----	0.02	% S	----		----		----		----		<0.02			
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----		----		----		----		<0.02			
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----		----		----		----		<10			
EA029-D: Calcium Values															
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----		----		----		----		<0.02			
Peroxide Calcium (23Wh)	----	0.02	% Ca	----		----		----		----		<0.02			
Acid Reacted Calcium (23X)	----	0.02	% Ca	----		----		----		----		<0.02			
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----		----		----		----		<10			
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----		----		----		----		<0.02			
EA029-E: Magnesium Values															
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----		----		----		----		<0.02			
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----		----		----		----		<0.02			
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----		----		----		----		<0.02			
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----		----		----		----		<10			
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----		----		----		----		<0.02			
EA029-H: Acid Base Accounting															
ANC Fineness Factor	----	0.5	-	----		----		----		----		1.5			
Net Acidity (sulfur units)	----	0.02	% S	----		----		----		----		<0.02			
Net Acidity (acidity units)	----	10	mole H+ / t	----		----		----		----		<10			
Liming Rate	----	1	kg CaCO3/t	----		----		----		----		<1			
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----		----		----		----		<0.02			
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----		----		----		----		<10			



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH102 9.35 □ 9.45	BH102 10.85 □ 10.9	BH103 1.35 □ 1.45	BH103 3.0 □ 3.1	BH103 4.35 □ 4.45
				09-MAY-2008 15:00	09-MAY-2008 15:00	13-MAY-2008 15:00	13-MAY-2008 15:00	13-MAY-2008 15:00
				EP0802883-016	EP0802883-017	EP0802883-018	EP0802883-019	EP0802883-020
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	<1
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	6.3	5.9	6.2	6.4
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH103 6.35 □ 6.45	BH103 9.0 □ 9.1	BH103 10.85 □ 10.9	BH103 12.2 □ 12.37	BH104 1.5 □ 1.6
				13-MAY-2008 15:00	13-MAY-2008 15:00	13-MAY-2008 15:00	13-MAY-2008 15:00	08-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-021	EP0802883-022	EP0802883-023	EP0802883-024	EP0802883-025
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.9	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	6.6	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	0.02	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	0.10	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	20	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	0.03	----	----	----
EA029-H: Acid Base Accounting								



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				BH103 6.35 □ 6.45 13-MAY-2008 15:00	BH103 9.0 □ 9.1 13-MAY-2008 15:00	BH103 10.85 □ 10.9 13-MAY-2008 15:00	BH103 12.2 □ 12.37 13-MAY-2008 15:00	BH104 1.5 □ 1.6 08-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-021	EP0802883-022	EP0802883-023	EP0802883-024	EP0802883-025
EA029-H: Acid Base Accounting - Continued								
ANC Fineness Factor	----	0.5	-	----	1.5	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	6.9	6.2	6.2	6.6
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	0.18	----	----	<0.01
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	36	----	----	<10
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	0.06	----	----	<0.01
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	BH104 3.35 □ 3.45	BH104 7.5 -7.6	BH104 9.0 □ 9.1	BH104 9.15 □ 9.25	BH104 10.5 □ 10.6
				08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00
				EP0802883-026	EP0802883-027	EP0802883-028	EP0802883-029	EP0802883-030
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.2	7.0	----	6.0	----
pH OX (23B)	----	0.1	pH Unit	6.1	6.7	----	4.8	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	----	<2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	----	13	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	----	12	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	----	0.02	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	----	0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	----	12	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	0.02	----	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	0.02	----	<0.02	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	----	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	----	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	----	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	----	<0.02	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	0.11	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	22	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	0.04	----	----	----
EA029-H: Acid Base Accounting								



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				BH104 3.35 □ 3.45	BH104 7.5 -7.6	BH104 9.0 □ 9.1	BH104 9.15 □ 9.25	BH104 10.5 □ 10.6
				08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00	08-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802883-026	EP0802883-027	EP0802883-028	EP0802883-029	EP0802883-030
EA029-H: Acid Base Accounting - Continued								
ANC Fineness Factor	----	0.5	-	1.5	1.5	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	----	0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	----	13	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	----	0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	----	13	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	7.0	5.5	6.0	6.6
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	0.24	----	----	0.12
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	48	----	----	24
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	0.08	----	----	0.04
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: **SOIL**

Client sample ID

Client sampling date / time

Sub-Matrix: SOIL				Client sample ID	BH104 12.0 □ 12.1	BH104 15.0 □ 15.1	----	----	----
				Client sampling date / time	08-MAY-2008 15:00	08-MAY-2008 15:00	----	----	----
Compound	CAS Number	LOR	Unit	EP0802883-031	EP0802883-032	----	----	----	
EA033-A: Actual Acidity									
pH KCl (23A)	----	0.1	pH Unit	5.8	6.1	----	----	----	
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	2	<2	----	----	----	
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	----	----	----	
EA033-B: Potential Acidity									
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	----	----	----	
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	----	----	----	
EA033-E: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-	1.5	1.5	----	----	----	
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	----	----	----	
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	----	----	----	
Liming Rate	----	1	kg CaCO3/t	<1	<1	----	----	----	
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	----	----	----	
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	----	----	----	
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	----	----	----	



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EP0802721	Page	: 1 of 11
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802413 2441 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----	Date Samples Received	: 16-MAY-2008
C-O-C number	: ----	Issue Date	: 27-MAY-2008
Sampler	: ----		
Order number	: ----		
Quote number	: ----	No. of samples received	: 49
		No. of samples analysed	: 49

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers



Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✓	22-MAY-2008	19-AUG-2008	✓
EA029-B: Acidity Trail								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✓	22-MAY-2008	19-AUG-2008	✓
EA029-C: Sulfur Trail								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✓	22-MAY-2008	19-AUG-2008	✓
EA029-D: Calcium Values								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✓	22-MAY-2008	19-AUG-2008	✓



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA029-E: Magnesium Values								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔
EA029-F: Excess Acid Neutralising Capacity								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔
EA029-G: Retained Acidity								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔
EA029-H: Acid Base Accounting								
80* dried soil TP101 - 1, TP104 - 3.5, TP109 - 0.5, TP114 - 2.25, TP121 - 1.5, TP117 - 3.75	TP102 - 0.25, TP106 - 1, TP112 - 2.25, TP116 - 4, TP118 - 2,	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔



Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity								
80* dried soil		01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔
TP101 - 0.25,	TP101 - 1,							
TP101 - 1.5,	TP102 - 0.25,							
TP102 - 2,	TP103 - 0.75,							
TP103 - 2.5,	TP104 - 0.5,							
TP104 - 2.5,	TP104 - 3.5,							
TP105 - 0.5,	TP105 - 2.5,							
TP106 - 0.25,	TP106 - 1,							
TP106 - 2.5,	TP107 - 0.25,							
TP107 - 1,	TP107 - 1.75,							
TP109 - 0.5,	TP109 - 1.5,							
TP110 - 0.25,	TP110 - 1.25,							
TP110 - 2.75,	TP111 - 0.75,							
TP111 - 2,	TP112 - 1,							
TP112 - 2.25,	TP113 - 0.25,							
TP113 - 2.25,	TP114 - 0.25,							
TP114 - 2.25,	TP115 - 0.5,							
TP115 - 1.75,	TP115 - 3.5,							
TP116 - 0.5,	TP116 - 2.5,							
TP116 - 4,	TP121 - 0.5,							
TP121 - 1.5,	TP121 - 2.75,							
TP122 - 0.5,	TP122 - 1.5,							
TP122 - 2,	TP118 - 1,							
TP118 - 2,	TP118 - 2.5,							
TP117 - 0.25,	TP117 - 0.75,							
TP117 - 3.75								



Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA033-B: Potential Acidity								
80* dried soil	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔	
TP101 - 0.25,								TP101 - 1,
TP101 - 1.5,								TP102 - 0.25,
TP102 - 2,								TP103 - 0.75,
TP103 - 2.5,								TP104 - 0.5,
TP104 - 2.5,								TP104 - 3.5,
TP105 - 0.5,								TP105 - 2.5,
TP106 - 0.25,								TP106 - 1,
TP106 - 2.5,								TP107 - 0.25,
TP107 - 1,								TP107 - 1.75,
TP109 - 0.5,								TP109 - 1.5,
TP110 - 0.25,								TP110 - 1.25,
TP110 - 2.75,								TP111 - 0.75,
TP111 - 2,								TP112 - 1,
TP112 - 2.25,								TP113 - 0.25,
TP113 - 2.25,								TP114 - 0.25,
TP114 - 2.25,								TP115 - 0.5,
TP115 - 1.75,								TP115 - 3.5,
TP116 - 0.5,								TP116 - 2.5,
TP116 - 4,								TP121 - 0.5,
TP121 - 1.5,								TP121 - 2.75,
TP122 - 0.5,								TP122 - 1.5,
TP122 - 2,								TP118 - 1,
TP118 - 2,								TP118 - 2.5,
TP117 - 0.25,								TP117 - 0.75,
TP117 - 3.75								

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 Client : COFFEY GEOTECHNICS
 Project : Ex EP0802413 2441 GH08304AB



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA033-C: Acid Neutralising Capacity								
80* dried soil	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔	
TP101 - 0.25,								TP101 - 1,
TP101 - 1.5,								TP102 - 0.25,
TP102 - 2,								TP103 - 0.75,
TP103 - 2.5,								TP104 - 0.5,
TP104 - 2.5,								TP104 - 3.5,
TP105 - 0.5,								TP105 - 2.5,
TP106 - 0.25,								TP106 - 1,
TP106 - 2.5,								TP107 - 0.25,
TP107 - 1,								TP107 - 1.75,
TP109 - 0.5,								TP109 - 1.5,
TP110 - 0.25,								TP110 - 1.25,
TP110 - 2.75,								TP111 - 0.75,
TP111 - 2,								TP112 - 1,
TP112 - 2.25,								TP113 - 0.25,
TP113 - 2.25,								TP114 - 0.25,
TP114 - 2.25,								TP115 - 0.5,
TP115 - 1.75,								TP115 - 3.5,
TP116 - 0.5,								TP116 - 2.5,
TP116 - 4,								TP121 - 0.5,
TP121 - 1.5,								TP121 - 2.75,
TP122 - 0.5,								TP122 - 1.5,
TP122 - 2,								TP118 - 1,
TP118 - 2,								TP118 - 2.5,
TP117 - 0.25,								TP117 - 0.75,
TP117 - 3.75								

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 Work Order : EP0802721
 Client : COFFEY GEOTECHNICS
 Project : Ex EP0802413 2441 GH08304AB



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-D: Retained Acidity								
80* dried soil		01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔
TP101 - 0.25,	TP101 - 1,							
TP101 - 1.5,	TP102 - 0.25,							
TP102 - 2,	TP103 - 0.75,							
TP103 - 2.5,	TP104 - 0.5,							
TP104 - 2.5,	TP104 - 3.5,							
TP105 - 0.5,	TP105 - 2.5,							
TP106 - 0.25,	TP106 - 1,							
TP106 - 2.5,	TP107 - 0.25,							
TP107 - 1,	TP107 - 1.75,							
TP109 - 0.5,	TP109 - 1.5,							
TP110 - 0.25,	TP110 - 1.25,							
TP110 - 2.75,	TP111 - 0.75,							
TP111 - 2,	TP112 - 1,							
TP112 - 2.25,	TP113 - 0.25,							
TP113 - 2.25,	TP114 - 0.25,							
TP114 - 2.25,	TP115 - 0.5,							
TP115 - 1.75,	TP115 - 3.5,							
TP116 - 0.5,	TP116 - 2.5,							
TP116 - 4,	TP121 - 0.5,							
TP121 - 1.5,	TP121 - 2.75,							
TP122 - 0.5,	TP122 - 1.5,							
TP122 - 2,	TP118 - 1,							
TP118 - 2,	TP118 - 2.5,							
TP117 - 0.25,	TP117 - 0.75,							
TP117 - 3.75								



Matrix: SOIL Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA033-E: Acid Base Accounting								
80* dried soil	01-MAY-2008	21-MAY-2008	01-MAY-2009	✔	22-MAY-2008	19-AUG-2008	✔	
TP101 - 0.25,								TP101 - 1,
TP101 - 1.5,								TP102 - 0.25,
TP102 - 2,								TP103 - 0.75,
TP103 - 2.5,								TP104 - 0.5,
TP104 - 2.5,								TP104 - 3.5,
TP105 - 0.5,								TP105 - 2.5,
TP106 - 0.25,								TP106 - 1,
TP106 - 2.5,								TP107 - 0.25,
TP107 - 1,								TP107 - 1.75,
TP109 - 0.5,								TP109 - 1.5,
TP110 - 0.25,								TP110 - 1.25,
TP110 - 2.75,								TP111 - 0.75,
TP111 - 2,								TP112 - 1,
TP112 - 2.25,								TP113 - 0.25,
TP113 - 2.25,								TP114 - 0.25,
TP114 - 2.25,								TP115 - 0.5,
TP115 - 1.75,								TP115 - 3.5,
TP116 - 0.5,								TP116 - 2.5,
TP116 - 4,								TP121 - 0.5,
TP121 - 1.5,								TP121 - 2.75,
TP122 - 0.5,								TP122 - 1.5,
TP122 - 2,								TP118 - 1,
TP118 - 2,								TP118 - 2.5,
TP117 - 0.25,								TP117 - 0.75,
TP117 - 3.75								



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	5	49	10.2	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	11	18.2	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	3	49	6.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	11	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EP0802721	Page	: 1 of 9
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802413 2441 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----	Date Samples Received	: 16-MAY-2008
C-O-C number	: ----	Issue Date	: 27-MAY-2008
Sampler	: ----	No. of samples received	: 49
Order number	: ----	No. of samples analysed	: 49
Quote number	: ----		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



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This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

Environmental Division Perth
Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax. +61-8-9209 7600 www.alsglobal.com

A Campbell Brothers Limited Company



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = Chemistry Abstract Services number
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA029-A: pH Measurements (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: pH KCl (23A)	----	0.1	pH Unit	6.5	6.6	0.0	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	5.5	5.5	0.0	0% - 20%
EP0802721-049	TP117 3.75	EA029: pH KCl (23A)	----	0.1	pH Unit	7.2	7.1	1.7	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	5.6	5.6	0.0	0% - 20%
EA029-B: Acidity Trail (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.0	No Limit
EP0802721-049	TP117 3.75	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.0	No Limit
EA029-C: Sulfur Trail (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-049	TP117 3.75	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	0.02	0.02	0.0	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	0.02	0.02	0.0	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	14	14	0.0	No Limit
EA029-D: Calcium Values (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-049	TP117 3.75	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	0.05	0.05	0.0	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	0.04	0.04	0.0	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	0.03	0.03	0.0	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	19	20	0.0	No Limit
EA029-E: Magnesium Values (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit

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 Client : COFFEY GEOTECHNICS
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Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA029-E: Magnesium Values (QC Lot: 662560) - continued									
EP0802721-002	TP101 1	EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-049	TP117 3.75	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	<0.02	0.0	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA029-H: Acid Base Accounting (QC Lot: 662560)									
EP0802721-002	TP101 1	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-049	TP117 3.75	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.02	0.02	0.0	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	1	1	0.0	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	14	14	0.0	No Limit
EA033-A: Actual Acidity (QC Lot: 662559)									
EP0802721-001	TP101 0.25	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.3	6.1	3.1	0% - 20%
EP0802721-011	TP105 0.5	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.1	6.1	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 662561)									
EP0802721-021	TP110 0.25	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.9	5.9	0.0	0% - 20%
EP0802721-031	TP114 2.25	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.2	6.2	0.0	0% - 20%
EA033-A: Actual Acidity (QC Lot: 662562)									
EP0802721-041	TP122 0.5	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.5	9.5	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 662559)									

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 Client : COFFEY GEOTECHNICS
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Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-B: Potential Acidity (QC Lot: 662559) - continued									
EP0802721-001	TP101 0.25	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-011	TP105 0.5	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 662561)									
EP0802721-021	TP110 0.25	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-031	TP114 2.25	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 662562)									
EP0802721-041	TP122 0.5	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 662562)									
EP0802721-041	TP122 0.5	EA033: Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	1.90	1.94	2.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.61	0.62	2.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	379	387	2.0	0% - 20%
EA033-E: Acid Base Accounting (QC Lot: 662559)									
EP0802721-001	TP101 0.25	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-011	TP105 0.5	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-E: Acid Base Accounting (QC Lot: 662561)									
EP0802721-021	TP110 0.25	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit

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 Work Order : EP0802721
 Client : COFFEY GEOTECHNICS
 Project : Ex EP0802413 2441 GH08304AB



Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA033-E: Acid Base Accounting (QC Lot: 662561) - continued									
EP0802721-021	TP110 0.25	EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802721-031	TP114 2.25	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-E: Acid Base Accounting (QC Lot: 662562)									
EP0802721-041	TP122 0.5	EA033: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.0	No Limit
		EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: Liming Rate	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	0.0	No Limit
		EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%)	
							Low	High
EA029-B: Acidity Trail (QCLot: 662560)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 662560)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.02	----	----	----	----
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values (QCLot: 662560)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values (QCLot: 662560)								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 662559)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 662561)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 662562)								
EA033: pH KCl (23A)	----	0.1	pH Unit	<0.1	----	----	----	----
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 662559)								
EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	----	----



Sub-Matrix: **SOIL**

Method: Compound				Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low High	
CAS Number LOR Unit				Result				
EA033-B: Potential Acidity (QCLot: 662559) - continued								
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 662561)								
EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 662562)								
EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 662559)								
EA033: ANC Fineness Factor	----	0.5		<0.5	----	----	----	----
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 662561)								
EA033: ANC Fineness Factor	----	0.5		<0.5	----	----	----	----
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EA033-E: Acid Base Accounting (QCLot: 662562)								
EA033: ANC Fineness Factor	----	0.5		<0.5	----	----	----	----
EA033: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA033: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA033: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----



Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries . Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EP0802721	Page	: 1 of 21
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802413 2441 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 16-MAY-2008
C-O-C number	: ----	Issue Date	: 27-MAY-2008
Sampler	: ----	No. of samples received	: 49
Site	: ----	No. of samples analysed	: 49
Quote number	: ----		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in
accordance with NATA
accreditation requirements.

Accredited for compliance with
ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

Environmental Division Perth
Part of the **ALS Laboratory Group**

10 Hod Way Malaga WA Australia 6090
Tel. +61-8-9209 7655 Fax. +61-8-9209 7600 www.alsglobal.com

A Campbell Brothers Limited Company



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO₃) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m³ in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m³'.**
- **Retained Acidity not required because pH KCl greater than or equal to 4.5**



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP101 0.25	TP101 1	TP101 1.5	TP102 0.25	TP102 2
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-001	EP0802721-002	EP0802721-003	EP0802721-004	EP0802721-005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.5	----	5.7	----
pH OX (23B)	----	0.1	pH Unit	----	5.5	----	3.1	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	64	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	61	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	0.10	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	0.10	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	0.03	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	0.02	----	0.03	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	1.5	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP101 0.25	TP101 1	TP101 1.5	TP102 0.25	TP102 2
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-001	EP0802721-002	EP0802721-003	EP0802721-004	EP0802721-005
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.3	6.5	6.3	5.7	6.2
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	<0.01	----	----	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	<0.01	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP103 0.75	TP103 2.5	TP104 0.5	TP104 2.5	TP104 3.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-006	EP0802721-007	EP0802721-008	EP0802721-009	EP0802721-010
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	6.0
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	3.8
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	<2
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	12
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	10
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	----	<0.02
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	----	----	----	<0.02
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	----	----	----	----	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	----	----	----	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	----	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	----	----	----	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	----	----	----	<0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	----	----	----	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	----	----	----	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	----	----	----	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	----	----	----	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	----	----	----	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	----	----	----	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	----	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	<10



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP103 0.75	TP103 2.5	TP104 0.5	TP104 2.5	TP104 3.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-006	EP0802721-007	EP0802721-008	EP0802721-009	EP0802721-010
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	----	----	----	----	<1
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	5.9	6.2	6.1	5.5	6.0
Titratable Actual Acidity (23F)	----	2	mole H ⁺ / t	<2	<2	<2	8	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	11	<10
Liming Rate	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	11	<10
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP105 0.5	TP105 2.5	TP106 0.25	TP106 1	TP106 2.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-011	EP0802721-012	EP0802721-013	EP0802721-014	EP0802721-015
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	6.2	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	4.4	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	<2	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	<2	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	----	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	----	----	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	----	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	----	----	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	----	----	<0.02	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	----	----	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	----	----	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	----	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	----	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	----	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	----	----	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	<10	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP105 0.5	TP105 2.5	TP106 0.25	TP106 1	TP106 2.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-011	EP0802721-012	EP0802721-013	EP0802721-014	EP0802721-015
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	----	----	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.1	6.2	5.8	6.2	6.3
Titratable Actual Acidity (23F)	----	2	mole H ⁺ / t	<2	<2	4	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP107 0.25	TP107 1	TP107 1.75	TP109 0.5	TP109 1.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-016	EP0802721-017	EP0802721-018	EP0802721-019	EP0802721-020
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	6.4	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	4.1	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	3	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	3	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	----	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	----	----	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	----	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	----	----	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	----	----	<0.02	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	----	----	<0.02	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	----	----	<0.02	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	----	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	----	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	----	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	----	----	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	<10	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP107 0.25	TP107 1	TP107 1.75	TP109 0.5	TP109 1.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-016	EP0802721-017	EP0802721-018	EP0802721-019	EP0802721-020
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	----	----	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	6.3	6.0	6.4	6.2
Titratable Actual Acidity (23F)	----	2	mole H ⁺ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H ⁺ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO ₃ /t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP110 0.25	TP110 1.25	TP110 2.75	TP111 0.75	TP111 2
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-021	EP0802721-022	EP0802721-023	EP0802721-024	EP0802721-025
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	5.9	6.1	6.2	6.0	6.2
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP112 1	TP112 2.25	TP113 0.25	TP113 2.25	TP114 0.25
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-026	EP0802721-027	EP0802721-028	EP0802721-029	EP0802721-030
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.1	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	4.9	----	----	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	----	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	----	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	<0.02	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	1.5	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP112 1	TP112 2.25	TP113 0.25	TP113 2.25	TP114 0.25
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-026	EP0802721-027	EP0802721-028	EP0802721-029	EP0802721-030
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.1	6.1	6.2	6.3	5.4
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	6
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP114 2.25	TP115 0.5	TP115 1.75	TP115 3.5	TP116 0.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-031	EP0802721-032	EP0802721-033	EP0802721-034	EP0802721-035
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.2	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	4.3	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
Peroxide Sulfur (23De)	----	0.02	% S	<0.02	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.02	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.02	----	----	----	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.02	----	----	----	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.02	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.02	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.02	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.02	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.02	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.02	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	----	----	----	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP114 2.25	TP115 0.5	TP115 1.75	TP115 3.5	TP116 0.5
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-031	EP0802721-032	EP0802721-033	EP0802721-034	EP0802721-035
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	----	----	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	6.0	6.2	6.1	6.1
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP116 2.5	TP116 4	TP121 0.5	TP121 1.5	TP121 2.75
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-036	EP0802721-037	EP0802721-038	EP0802721-039	EP0802721-040
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.2	----	9.3	----
pH OX (23B)	----	0.1	pH Unit	----	5.2	----	7.4	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	<2	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	<0.02	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	<0.02	----	<0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	<0.02	----	<0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	<10	----	<10	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	<0.02	----	0.15	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	<0.02	----	0.28	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	<0.02	----	0.13	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	<10	----	66	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	<0.02	----	0.11	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	<0.02	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	<10	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	<0.02	----	<0.02	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	0.86	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	173	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	0.28	----
EA029-H: Acid Base Accounting								



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP116 2.5	TP116 4	TP121 0.5	TP121 1.5	TP121 2.75
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-036	EP0802721-037	EP0802721-038	EP0802721-039	EP0802721-040
EA029-H: Acid Base Accounting - Continued								
ANC Fineness Factor	----	0.5	-	----	1.5	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	<1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.2	6.2	9.4	9.3	6.4
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	----	0.68	1.04	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	----	135	207	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	----	0.22	0.33	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	TP122 0.5	TP122 1.5	TP122 2	TP118 1	TP118 2
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
				EP0802721-041	EP0802721-042	EP0802721-043	EP0802721-044	EP0802721-045
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	7.1
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	6.0
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	<2
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	<2
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	<2
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	----	<0.02
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	----	----	----	<0.02
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	----	----	----	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	----	<0.02
Peroxide Sulfur (23De)	----	0.02	% S	----	----	----	----	<0.02
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	----	----	----	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	----	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	----	----	----	<0.02
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	----	----	----	0.02
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	----	----	----	<0.02
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	----	----	----	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	----	----	----	<0.02
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	----	----	----	<0.02
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	----	----	----	<0.02
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	----	<10
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	----	----	----	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	----	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	<10



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP122 0.5	TP122 1.5	TP122 2	TP118 1	TP118 2
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00
Compound	CAS Number	LOR	Unit	EP0802721-041	EP0802721-042	EP0802721-043	EP0802721-044	EP0802721-045
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	<1
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.5	6.3	6.8	6.7	7.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	1.90	----	0.42	0.56	0.36
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	379	----	85	111	73
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.61	----	0.14	0.18	0.12
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP118 2.5	TP117 0.25	TP117 0.75	TP117 3.75	----
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	----
Compound	CAS Number	LOR	Unit	EP0802721-046	EP0802721-047	EP0802721-048	EP0802721-049	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	7.2	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	5.6	----
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	----
Titrateable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	<2	----
Titrateable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	<2	----
sulfidic - Titrateable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	----	----	----	<0.02	----
sulfidic - Titrateable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	----	----	----	<0.02	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	----	----	<0.02	----
Peroxide Sulfur (23De)	----	0.02	% S	----	----	----	0.02	----
Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	----	----	----	0.02	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	----	----	----	14	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.02	% Ca	----	----	----	<0.02	----
Peroxide Calcium (23Wh)	----	0.02	% Ca	----	----	----	0.05	----
Acid Reacted Calcium (23X)	----	0.02	% Ca	----	----	----	0.04	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	----	----	----	19	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	----	----	----	0.03	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	----	----	----	<0.02	----
Peroxide Magnesium (23Tm)	----	0.02	% Mg	----	----	----	<0.02	----
Acid Reacted Magnesium (23U)	----	0.02	% Mg	----	----	----	<0.02	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	----	----	----	<0.02	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	14	----



Analytical Results

Sub-Matrix: SOIL

Client sample ID

Client sampling date / time

				TP118 2.5	TP117 0.25	TP117 0.75	TP117 3.75	----
				01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	----
Compound	CAS Number	LOR	Unit	EP0802721-046	EP0802721-047	EP0802721-048	EP0802721-049	----
EA029-H: Acid Base Accounting - Continued								
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	1	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.6	7.4	9.5	7.2	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	0.56	0.56	2.54	0.18	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	112	111	508	37	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	0.18	0.18	0.82	0.06	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	----



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EP0802883	Page	: 1 of 9
Client	: COFFEY GEOTECHNICS	Laboratory	: Environmental Division Perth
Contact	: MS CASSANDRA TURVEY	Contact	: Michael Sharp
Address	: PO BOX 1810 WEST PERTH WA, AUSTRALIA 6872	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: cassandra_turvey@coffey.com	E-mail	: michael.sharp@alsenviro.com
Telephone	: +61 08 9347 0321	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: Ex EP0802488 2568 2613 2570 GH08304AB	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----	Date Samples Received	: 23-MAY-2008
C-O-C number	: ----	Issue Date	: 03-JUN-2008
Sampler	: ----	No. of samples received	: 32
Order number	: ----	No. of samples analysed	: 32
Quote number	: ----		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers



Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA029-A: pH Measurements								
80* dried soil BH101 - 2.35 & 2.45, BH101 - 10.5 & 10.6	BH101 - 8.35 & 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 3.35 & 3.45, BH104 - 9.15 & 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 3.34 & 3.45,	BH102 - 7.85 & 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 4.35 & 4.45,	BH103 - 9.0 & 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
EA029-B: Acidity Trail								
80* dried soil BH101 - 2.35 & 2.45, BH101 - 10.5 & 10.6	BH101 - 8.35 & 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 3.35 & 3.45, BH104 - 9.15 & 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 3.34 & 3.45,	BH102 - 7.85 & 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 4.35 & 4.45,	BH103 - 9.0 & 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
EA029-C: Sulfur Trail								
80* dried soil BH101 - 2.35 & 2.45, BH101 - 10.5 & 10.6	BH101 - 8.35 & 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 3.35 & 3.45, BH104 - 9.15 & 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 3.34 & 3.45,	BH102 - 7.85 & 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 4.35 & 4.45,	BH103 - 9.0 & 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓



Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-D: Calcium Values								
80* dried soil BH101 - 2.35 ĳ 2.45, BH101 - 10.5 ĳ 10.6	BH101 - 8.35 ĳ 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH104 - 3.35 ĳ 3.45, BH104 - 9.15 ĳ 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH102 - 3.34 ĳ 3.45,	BH102 - 7.85 ĳ 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH103 - 4.35 ĳ 4.45,	BH103 - 9.0 ĳ 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
EA029-E: Magnesium Values								
80* dried soil BH101 - 2.35 ĳ 2.45, BH101 - 10.5 ĳ 10.6	BH101 - 8.35 ĳ 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH104 - 3.35 ĳ 3.45, BH104 - 9.15 ĳ 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH102 - 3.34 ĳ 3.45,	BH102 - 7.85 ĳ 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH103 - 4.35 ĳ 4.45,	BH103 - 9.0 ĳ 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
EA029-F: Excess Acid Neutralising Capacity								
80* dried soil BH101 - 2.35 ĳ 2.45, BH101 - 10.5 ĳ 10.6	BH101 - 8.35 ĳ 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH104 - 3.35 ĳ 3.45, BH104 - 9.15 ĳ 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH102 - 3.34 ĳ 3.45,	BH102 - 7.85 ĳ 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH103 - 4.35 ĳ 4.45,	BH103 - 9.0 ĳ 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
EA029-G: Retained Acidity								
80* dried soil BH101 - 2.35 ĳ 2.45, BH101 - 10.5 ĳ 10.6	BH101 - 8.35 ĳ 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH104 - 3.35 ĳ 3.45, BH104 - 9.15 ĳ 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH102 - 3.34 ĳ 3.45,	BH102 - 7.85 ĳ 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔
80* dried soil BH103 - 4.35 ĳ 4.45,	BH103 - 9.0 ĳ 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✔	03-JUN-2008	25-AUG-2008	✔



Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA029-H: Acid Base Accounting								
80* dried soil BH101 - 2.35 ĳ 2.45, BH101 - 10.5 ĳ 10.6	BH101 - 8.35 ĳ 8.45,	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 3.35 ĳ 3.45, BH104 - 9.15 ĳ 9.25	BH104 - 7.5 -7.6,	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 3.34 ĳ 3.45,	BH102 - 7.85 ĳ 7.95	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 4.35 ĳ 4.45,	BH103 - 9.0 ĳ 9.1	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
EA033-A: Actual Acidity								
80* dried soil BH101 - 1.35 ĳ 1.45, BH101 - 4.0 ĳ 4.1, BH101 - 6.35 ĳ 6.45, BH101 - 8.35 ĳ 8.45, BH101 - 10.5 ĳ 10.6,	BH101 - 2.35 ĳ 2.45, BH101 - 6.0 ĳ 6.1 6, BH101 - 7.35 ĳ 7.45, BH101 - 9.35 ĳ 9.45, BH101 - 12.35 ĳ 12.45	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ĳ 1.6, BH104 - 7.5 -7.6, BH104 - 9.15 ĳ 9.25, BH104 - 12.0 ĳ 12.1,	BH104 - 3.35 ĳ 3.45, BH104 - 9.0 ĳ 9.1, BH104 - 10.5 ĳ 10.6, BH104 - 15.0 ĳ 15.1	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 1.5 ĳ 1.6, BH102 - 4.85 ĳ 4.95, BH102 - 7.85 ĳ 7.95, BH102 - 10.85 ĳ 10.9	BH102 - 3.34 ĳ 3.45, BH102 - 6.35 ĳ 6.45, BH102 - 9.35 ĳ 9.45,	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ĳ 1.45, BH103 - 4.35 ĳ 4.45, BH103 - 9.0 ĳ 9.1, BH103 - 12.2 ĳ 12.37	BH103 - 3.0 ĳ 3.1, BH103 - 6.35 ĳ 6.45, BH103 - 10.85 ĳ 10.9,	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓



Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity								
80* dried soil BH101 - 1.35 ≤ 1.45, BH101 - 4.0 ≤ 4.1, BH101 - 6.35 ≤ 6.45, BH101 - 8.35 ≤ 8.45, BH101 - 10.5 ≤ 10.6,	BH101 - 2.35 ≤ 2.45, BH101 - 6.0 ≤ 6.1 6, BH101 - 7.35 ≤ 7.45, BH101 - 9.35 ≤ 9.45, BH101 - 12.35 ≤ 12.45	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ≤ 1.6, BH104 - 7.5 -7.6, BH104 - 9.15 ≤ 9.25, BH104 - 12.0 ≤ 12.1,	BH104 - 3.35 ≤ 3.45, BH104 - 9.0 ≤ 9.1, BH104 - 10.5 ≤ 10.6, BH104 - 15.0 ≤ 15.1	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 1.5 ≤ 1.6, BH102 - 4.85 ≤ 4.95, BH102 - 7.85 ≤ 7.95, BH102 - 10.85 ≤ 10.9	BH102 - 3.34 ≤ 3.45, BH102 - 6.35 ≤ 6.45, BH102 - 9.35 ≤ 9.45,	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ≤ 1.45, BH103 - 4.35 ≤ 4.45, BH103 - 9.0 ≤ 9.1, BH103 - 12.2 ≤ 12.37	BH103 - 3.0 ≤ 3.1, BH103 - 6.35 ≤ 6.45, BH103 - 10.85 ≤ 10.9,	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
EA033-C: Acid Neutralising Capacity								
80* dried soil BH101 - 1.35 ≤ 1.45, BH101 - 4.0 ≤ 4.1, BH101 - 6.35 ≤ 6.45, BH101 - 8.35 ≤ 8.45, BH101 - 10.5 ≤ 10.6,	BH101 - 2.35 ≤ 2.45, BH101 - 6.0 ≤ 6.1 6, BH101 - 7.35 ≤ 7.45, BH101 - 9.35 ≤ 9.45, BH101 - 12.35 ≤ 12.45	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ≤ 1.6, BH104 - 7.5 -7.6, BH104 - 9.15 ≤ 9.25, BH104 - 12.0 ≤ 12.1,	BH104 - 3.35 ≤ 3.45, BH104 - 9.0 ≤ 9.1, BH104 - 10.5 ≤ 10.6, BH104 - 15.0 ≤ 15.1	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 1.5 ≤ 1.6, BH102 - 4.85 ≤ 4.95, BH102 - 7.85 ≤ 7.95, BH102 - 10.85 ≤ 10.9	BH102 - 3.34 ≤ 3.45, BH102 - 6.35 ≤ 6.45, BH102 - 9.35 ≤ 9.45,	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ≤ 1.45, BH103 - 4.35 ≤ 4.45, BH103 - 9.0 ≤ 9.1, BH103 - 12.2 ≤ 12.37	BH103 - 3.0 ≤ 3.1, BH103 - 6.35 ≤ 6.45, BH103 - 10.85 ≤ 10.9,	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓



Matrix: **SOIL**

Evaluation: **x** = Holding time breach ; **✓** = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-D: Retained Acidity								
80* dried soil BH101 - 1.35 ≤ 1.45, BH101 - 4.0 ≤ 4.1, BH101 - 6.35 ≤ 6.45, BH101 - 8.35 ≤ 8.45, BH101 - 10.5 ≤ 10.6,	BH101 - 2.35 ≤ 2.45, BH101 - 6.0 ≤ 6.1 6, BH101 - 7.35 ≤ 7.45, BH101 - 9.35 ≤ 9.45, BH101 - 12.35 ≤ 12.45	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ≤ 1.6, BH104 - 7.5 -7.6, BH104 - 9.15 ≤ 9.25, BH104 - 12.0 ≤ 12.1,	BH104 - 3.35 ≤ 3.45, BH104 - 9.0 ≤ 9.1, BH104 - 10.5 ≤ 10.6, BH104 - 15.0 ≤ 15.1	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 1.5 ≤ 1.6, BH102 - 4.85 ≤ 4.95, BH102 - 7.85 ≤ 7.95, BH102 - 10.85 ≤ 10.9	BH102 - 3.34 ≤ 3.45, BH102 - 6.35 ≤ 6.45, BH102 - 9.35 ≤ 9.45,	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ≤ 1.45, BH103 - 4.35 ≤ 4.45, BH103 - 9.0 ≤ 9.1, BH103 - 12.2 ≤ 12.37	BH103 - 3.0 ≤ 3.1, BH103 - 6.35 ≤ 6.45, BH103 - 10.85 ≤ 10.9,	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
EA033-E: Acid Base Accounting								
80* dried soil BH101 - 1.35 ≤ 1.45, BH101 - 4.0 ≤ 4.1, BH101 - 6.35 ≤ 6.45, BH101 - 8.35 ≤ 8.45, BH101 - 10.5 ≤ 10.6,	BH101 - 2.35 ≤ 2.45, BH101 - 6.0 ≤ 6.1 6, BH101 - 7.35 ≤ 7.45, BH101 - 9.35 ≤ 9.45, BH101 - 12.35 ≤ 12.45	06-MAY-2008	27-MAY-2008	06-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ≤ 1.6, BH104 - 7.5 -7.6, BH104 - 9.15 ≤ 9.25, BH104 - 12.0 ≤ 12.1,	BH104 - 3.35 ≤ 3.45, BH104 - 9.0 ≤ 9.1, BH104 - 10.5 ≤ 10.6, BH104 - 15.0 ≤ 15.1	08-MAY-2008	27-MAY-2008	08-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH102 - 1.5 ≤ 1.6, BH102 - 4.85 ≤ 4.95, BH102 - 7.85 ≤ 7.95, BH102 - 10.85 ≤ 10.9	BH102 - 3.34 ≤ 3.45, BH102 - 6.35 ≤ 6.45, BH102 - 9.35 ≤ 9.45,	09-MAY-2008	27-MAY-2008	09-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ≤ 1.45, BH103 - 4.35 ≤ 4.45, BH103 - 9.0 ≤ 9.1, BH103 - 12.2 ≤ 12.37	BH103 - 3.0 ≤ 3.1, BH103 - 6.35 ≤ 6.45, BH103 - 10.85 ≤ 10.9,	13-MAY-2008	27-MAY-2008	13-MAY-2009	✓	03-JUN-2008	25-AUG-2008	✓



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	4	32	12.5	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	10	10.0	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	32	6.3	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	10	10.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



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Murdoch Mixed Use Precinct

Local Water Management Strategy

DRAFT

Prepared for
LandCorp
by Strategen

November 2015

Murdoch Mixed Use Precinct

Local Water Management Strategy

DRAFT

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

November 2015

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Client: LandCorp

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
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Final Draft Report	1	Revised draft for agency review	M Dunlop/ D Newsome	Electronic	12/11/2015
Final Draft Report					
Final Draft Report					

Filename: LAN15273_01 R002 Rev 1 - 12 November 2015

Executive summary

LandCorp proposes to develop a 9.6 hectare (ha) Murdoch Mixed Use Precinct (MUP) (the site) within the larger Murdoch Activity Centre (MAC). This Local Water Management Strategy (LWMS) has been developed to support the Local Structure Plan for the site.

The MUP is proposed to be developed as a high density node for a range of uses, including support for health and education activities, associated convenience retail and business uses, recreational, hospitality, entertainment, lifestyle and living opportunities (i.e. residential). The Northern Conservation Area [NCA] has been identified and set aside within the Precinct as a commitment of the adjacent Fiona Stanley Hospital Project.

The development will maintain the pre-development surface water flows off the site in events up to and including the 100-year ARI event by ensuring stormwater is infiltrated on site. Because of the small size and high density nature of the site, stormwater will predominantly be infiltrated through a series of infiltration tanks located in the central public open space. This complements and integrates with the design of the Fiona Stanley Hospital stormwater system.

To ensure water quality is maintained, stormwater will be treated through a series of gross pollutant traps prior to infiltration. Because the catchment will be predominantly paved or roofed, nutrient concentrations in runoff are likely to be low but concentrations of particulates and hydrocarbons may be elevated.

Due to the high density nature of the area with multi-storey buildings, there will be little private garden area for irrigation. Water use outside a house within residential lots (ex-house) will therefore be low and it is anticipated that water use will be below 65 kL/person/year.

The development is considered to meet and exceed the design criteria for the site as implemented through the principles and objectives for water management for the site and summarised in Table ES 1.

Table ES 1: Design elements and requirements for best management practices and critical control points

Category	Principles	Objectives	Development design elements and requirements
Water conservation and efficiency	Consider all potential water sources in water supply planning. Integrate water and land use planning. Sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	If possible, achieve a domestic water consumption target of 100 kL/person/year. Minimise the use of potable water where drinking water quality is not essential, particularly for outside uses.	Domestic water use anticipated to be less than 65 kL/person/year because of limited gardens and thus low ex-house water use. Public open space will be of a low water use nature — plantings will be predominantly native and approximately 30% of the landscaping will be hard surfaces, consistent with the highly urban nature of the site.
Water quantity management	Retain natural drainage systems and protect ecosystem health. Protect development from flooding and water-logging. Implement economically viable stormwater systems. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	Post-development annual stormwater discharge volume and peak flow be maintained relative to pre-development conditions. For the critical one year Average Return Interval (ARI) event, the post-development stormwater discharge volume and peak flow rates shall be maintained. Manage the catchment stormwater runoff for up to the 100-year ARI event in the development area to pre-development peak flows.	As occurs in the existing system, no stormwater will be discharged off the site in events up to and including the 100-year ARI event.
Water quality management	Maintain or improve groundwater and surface water quality. Where waterways/open drains intersect the water table, minimise the discharge of pollutants to groundwater. Where development is associated with an ecosystem dependent upon a particular hydrologic regime, minimise discharge or pollutants to shallow groundwater and receiving waterways and maintain water quality in the specified environment.	Maintain surface water and groundwater quality. Ensure all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007).	Stormwater infiltrated on site is not anticipated to have a high nutrient load due to minimal fertiliser use resulting from the limited surface area of gardens and use of natives with low fertiliser demands. All runoff will be treated prior to infiltration.
Disease vector and nuisance insect management	To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a period not exceeding 96 hours. Permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the DoW and Department of Health (DoH).	No new permanent water bodies are proposed for the development. New tanks will be designed to allow detained fully immobile stormwater to be infiltrated within 96 hours of the completion of all events up to and including the 100-year ARI, 72 hour event. New infiltration tanks will be provided with mosquito proof vents to prevent mosquitoes entering the tank. No permanent water bodies are proposed on the site.

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- Appendix 4 Groundwater monitoring results
- Appendix 5 Groundwater Level calculations
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1. Introduction

1.1 Background

The Murdoch Mixed Use Precinct (MUP) Project site (the site) is located approximately 12 km south of the Perth Central Business District (CBD) in the City of Melville (CoM) (Figure 1). The 9.6 ha site is located adjacent to Fiona Stanley Hospital (FSH) within the larger Murdoch Activity Centre (MAC) area. The site is planned for a mixture of uses including residential, offices, retail, commercial, civic uses and entertainment facilities (Figure 2).

The MAC is identified in the Western Australian Government's Directions 2031 strategic planning document for Perth and Peel as one of five Specialised Activity Centres (DoP & WAPC 2010). These centres are intended to be employment/community areas, leveraging off the existing institutions to create vibrant hubs which diversify Perth's employment opportunities (DoP & WAPC 2010).

This report has been prepared to support the local structure planning (LSP) process for submission to CoM and the Western Australian Planning Commission (WAPC). This report provides a summary of the existing environment and an assessment of environmental opportunities and constraints associated with the development of the Site.

A copy of the LWMS checklist is provided in Appendix 1.

1.2 Total water cycle management

This LWMS identifies and describes a range of design elements and management measures being considered for the proposed development. The principal objective of this LWMS is to achieve better urban water management outcomes by specifying development that manages the total water cycle in a sustainable manner. This includes consideration of:

- water conservation and water use efficiency
- management of water quantity in terms of groundwater levels and surface water flows
- management of groundwater and surface water quality
- disease vector and nuisance insect management.

This LWMS has been prepared in accordance with *Better Urban Water Management* guidelines (WAPC 2008) on advice from DoW. The document is consistent with regional and district scale urban water management planning, including the *State Water Plan* (DPC 2007), as well as *State Planning Policy 2.9 Water Resources* (WAPC 2006). The document aims to meet the principles and objectives of stormwater management in Western Australia, as detailed in the *Stormwater Management Manual for Western Australia* (DoW 2004 – 2007).

This LWMS will provide a basis for the future Urban Water Management Plan (UWMP) to achieve better urban water management outcomes.

1.3 Previous studies

Information from a number of studies has been incorporated into this LWMS. Table 1 provides a list of study reports associated with the Site.

Table 1: Previous studies

Report	Author	Date of completion
Fiona Stanley Hospital: Geotechnical Report	Coffey Geotechnics	2008
Numerical Hydrogeological Model for Fiona Stanley Hospital	Coffey Geotechnics	2009
Murdoch Mixed Use Precinct Environmental Report	Strategen	2012

There is no approved DWMS for the MUP precinct or the FSH project.

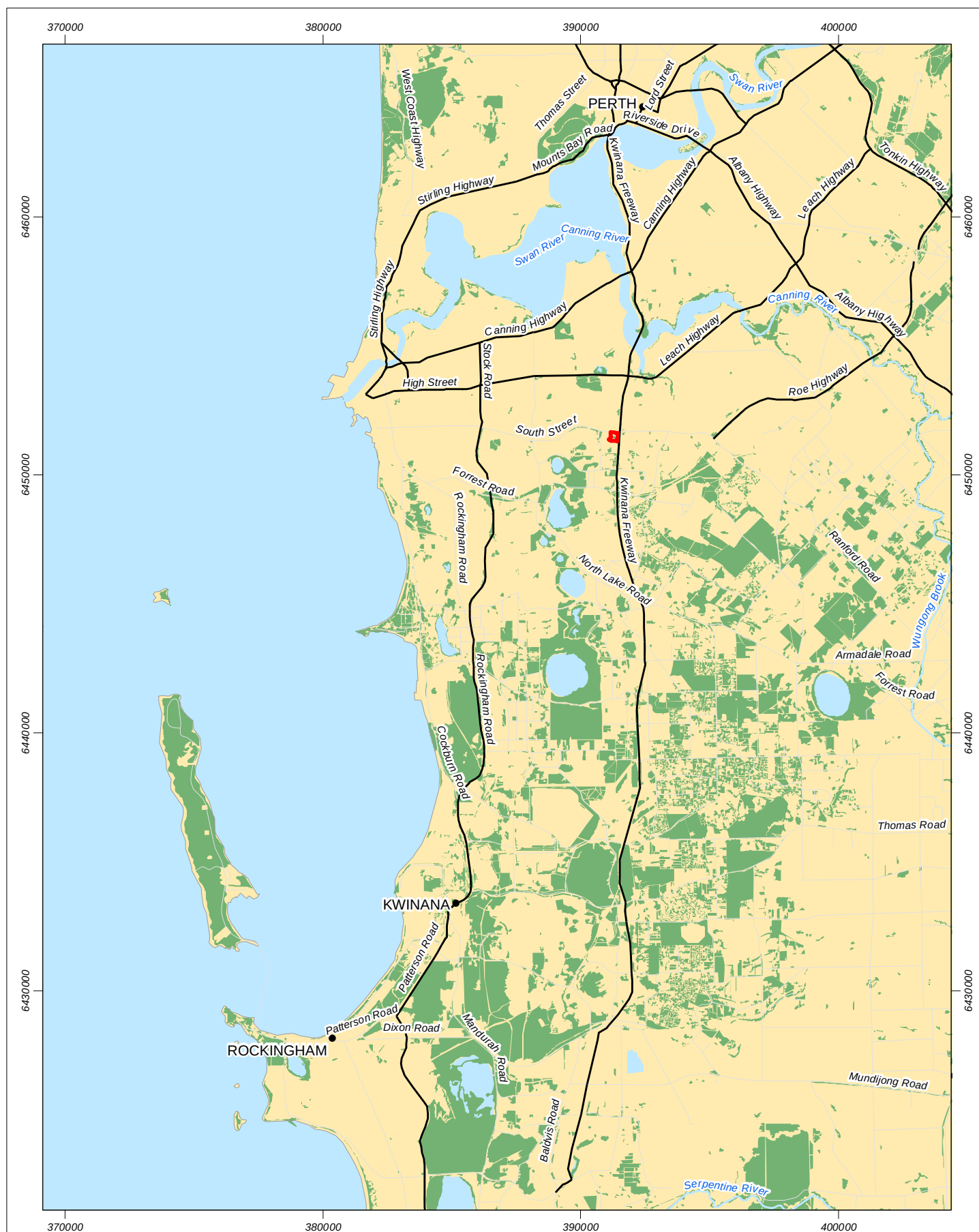
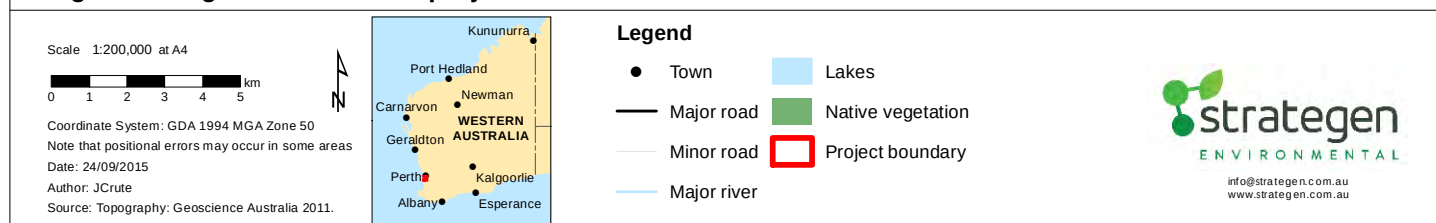


Figure 1: Regional location of project site



2. Proposed development

2.1 Structure plan, zoning and land use

The site is currently separated into two halves, which will be developed as two separate stages (Figure 2). A thin vegetated road verge lines the western side of the off-ramp, which also acts as a drainage basin, and further west consists of cleared land under development and the Conservation Area. The eastern part of the site comprises a public car park for the South Street Train Station.

Land uses surrounding the site are:

- north: South Street and residential development
- east: Kwinana Freeway, Murdoch Train Station and the Mandurah Railway
- south: Fiona Stanley Hospital (FSH)
- west: St John of God Hospital (Figure 2).

The amendment area has been identified by the Western Australian State Government as a strategic priority area for mixed use urban development to support the surrounding area including the FSH, St John of God Hospital, Murdoch University and Challenger TAFE and the local community.

The site is located within the Murdoch Specialised Activity Centre Structure Plan area. Specialised centres are characterised as centres based around major institutions or airports within the centre. It is suggested in the document that these specialised centres should:

- provide adequate locations for business and smaller institutions related to the main institutions
- have places for general commercial and community services to support its employees, students, visitors and residents
- provide places where interaction can occur between users of the centre, so that stronger links can be facilitated across a range of organisations and businesses in the centre (WAPC 2010).

Subsequent to the LSP being approved, the site will be subdivided into a series of large lots for high rise development (Figure 3).

Staging

The MUP development is expected to occur in two stages (Figure 2). Stage 1 will be developed prior to Stage 2, which will involve the resumption of the car park for Murdoch Station. The timing for this stage is unclear because of the need to relocate the car park. Design of both stages is well progressed and this LWMS reflects these outcomes.

The aerial photograph of the site, as shown in Figure 2, shows a network of roads within MUP. Roads and drainage in the Stage 1 area were largely constructed by Department of Health (DoH) as part of the FSH development. LandCorp intends to retain this existing infrastructure. Additional roads and drainage structures will be constructed to connect into this existing infrastructure.

2.2 Previous land use

The site was predominately bushland before being substantially cleared and graded in preparation for the FSH development. A central portion of the site has been retained as a NCA as a condition of the clearing associated with the development of FSH.

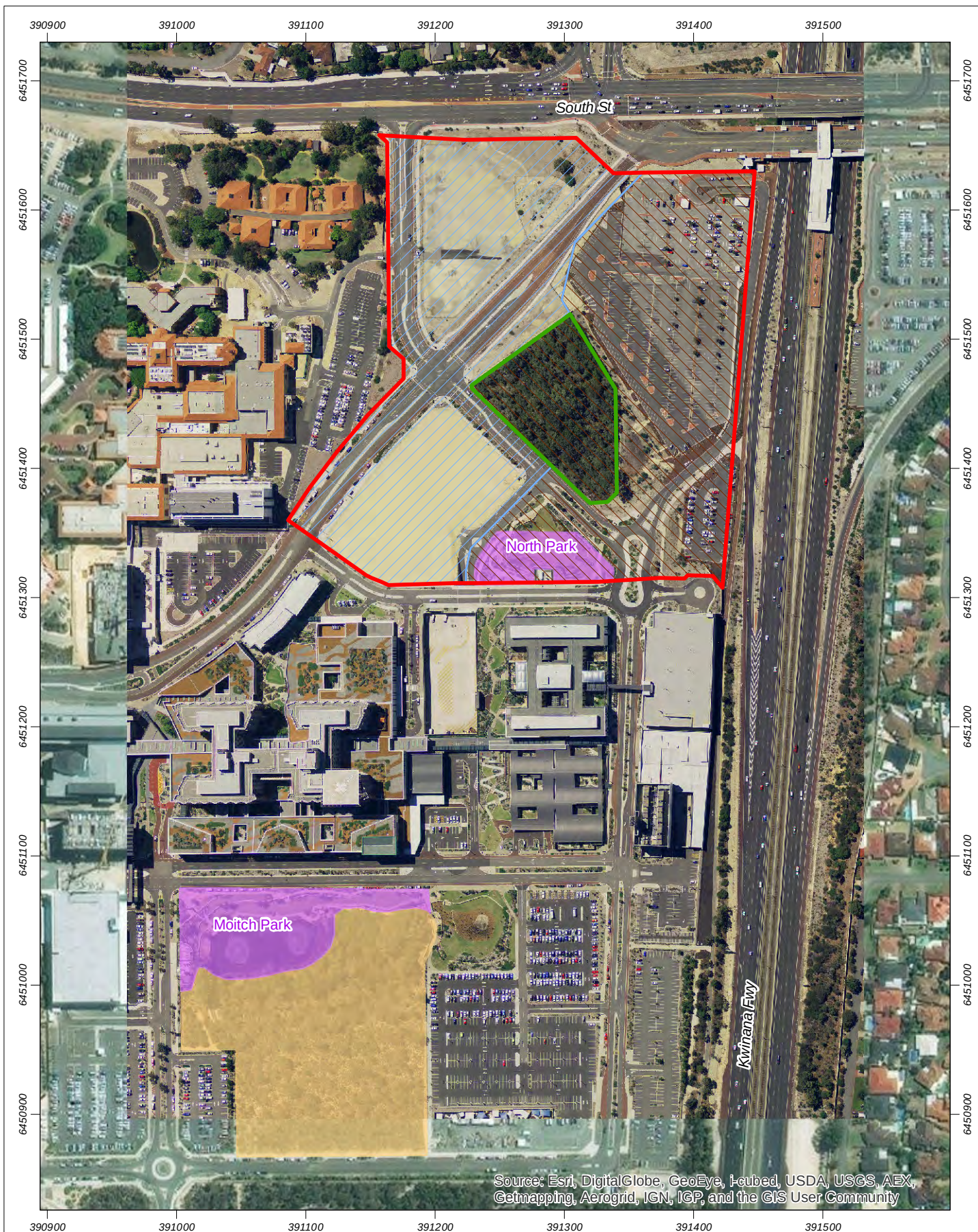


Figure 2: Site context plan

Scale 1:4,000 at A4

0 20 40 60 80 m



Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 24/09/2015

Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Concept plan: Client 2015.

Legend

Project boundary

Northern conservation area

Open space managed by DoH

Southern conservation area

Stage 1

Stage 2

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Source: ARM Architecture

2.3 Landscaping

The landscaping concept plan developed by Emerge Associates can be found in Figure 4. The design emphasis for the central POS is provision of an integrated network of flexible spaces that can have multiple uses and allow different sized activities to occur. These activities range across the age spectrum and the spaces will provide the flexibility for use by people of different abilities and cultures.

The primary objective for the design and construction of the public realm is to provide an appropriate balance between conservation, amenity and public recreation that creates a readily usable, interconnected, aesthetically pleasing and liveable environment to residents and visitors alike.

A total of 0.74 ha of new POS is proposed as part of the development.

2.3.1 Existing open space

The site includes an existing area of open space (North Park) and the Northern Conservation Area (NCA), which are under the management of DoH (Figure 2). NCA DoH has undertaken landscaping of North Park and is responsible for the irrigation of this POS.

Retention and management of the NCA was a condition of the Federal environmental approval for the clearing of land for FSH from the then Department of Environment, Water, Heritage and the Arts (now Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC]) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The clearing was approved subject to a number of conditions, including retention, protection and management of two NCAs (Figure 2). To ensure that this condition is maintained, public access to the NCA is not permitted.

North Park and NCA are proposed to remain under management of DoH in the medium term, with the intention of handover to CoM in future. The proposed development will not result in any changes to North Park. LandCorp does not propose to become involved in management of North Park or the NCA.

2.3.2 Species selection

The DSEWPaC conditions on clearing included requirements for use of native species in landscaping. Stage 1 of the MUP development was cleared as part of the clearing for FSH. As a result, landscaping in Stage 1 is required to consist of 100% native species in POS and streetscapes. In private landscaping, at least 70% of the species used must be native species. There is also a requirement that the majority of species used be suitable for Carnaby's Black-Cockatoo. Native species generally have a low water use and are well adapted to dry summers. While Stage 2 is not required to meet these criteria, it is anticipated that a similar plant palette with a high proportion of native species will be used to ensure a sense of continuity between the landscaping of the two stages.

2.3.3 Irrigation water

The Site lies within the City of Melville groundwater subarea within the Perth groundwater area. A search of the DoW Water Register indicates that groundwater is available for allocation in this area.

The location of the proposed irrigation bore will be confirmed at the UWMP stage.

The total volume of water required for irrigation is estimated at 3500 kL/yr, based on the standard DoW irrigation allowance of 7500 kL/ha/yr. LandCorp has requested a Licence to Take Groundwater from DoW for this amount.

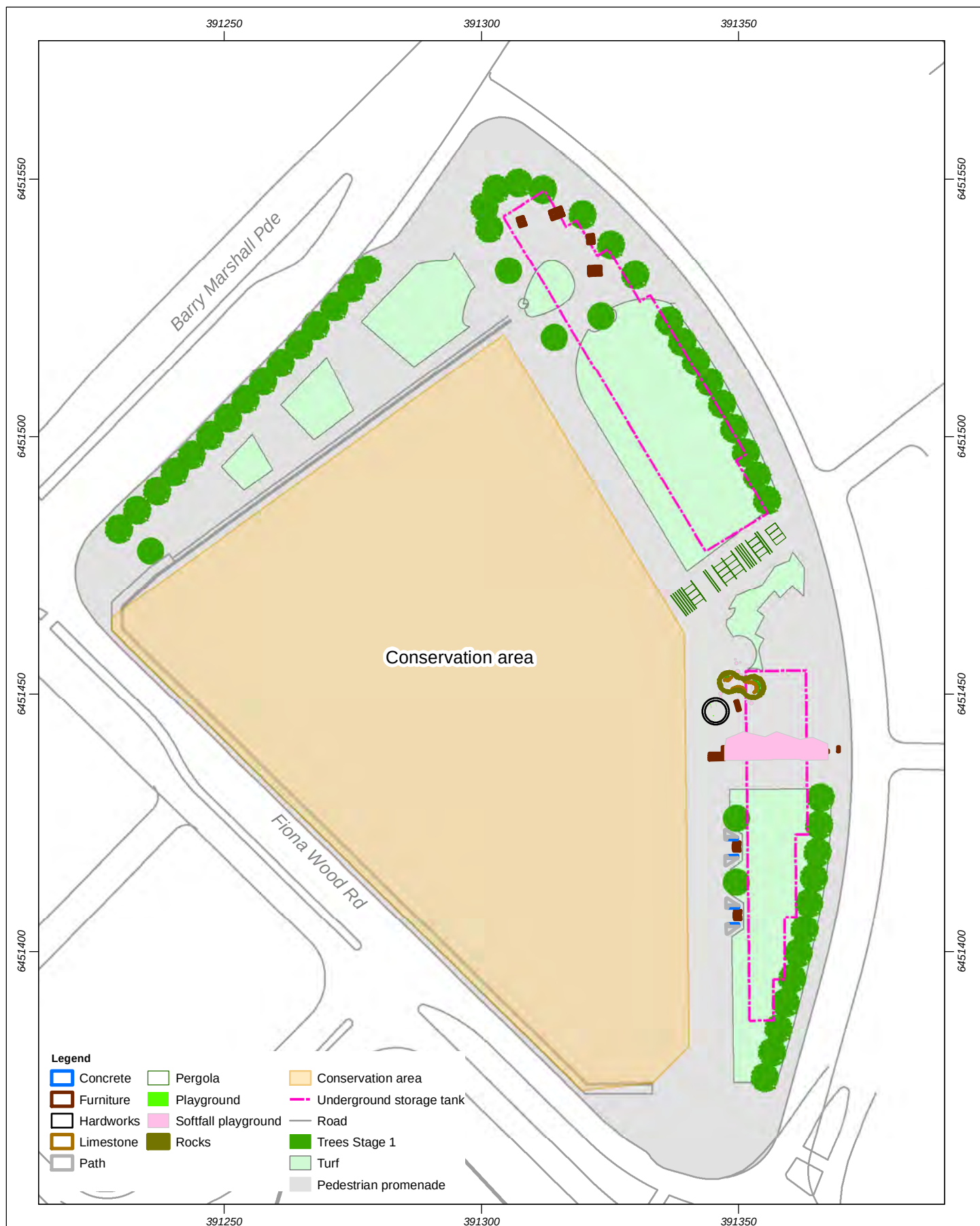
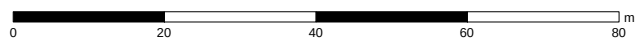


Figure 4: Landscaping plan

Scale 1:1,000 at A4



Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 29/09/2015

Author: DWhite

Source: Aerial image: Landgate, flown March 2015. Concept plan: Client 2015.

Cadastral: SLIP, Landgate 2015.

Path: Q:\CONSUM\2015\LAN\LAN15273\ArcMap_documents\SR002\REV\LAN15273_01_R002_REVA_F004.mxd

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3. Design criteria

3.1 Key principles and objectives

The LWMS uses the following documents to define its principles and objectives:

- Liveable Neighbourhoods (WAPC & DPI 2007)
- Water Resources Statement of Planning Policy 2.9 (WAPC 2004)
- Stormwater Management Manual for WA (DoW 2004 – 2007)
- Decision Process for Stormwater Management in WA (DoE & SRT 2005)
- Better Urban Water Management (WAPC & DPI 2008).

Summaries of principles and objectives applicable to this LWMS based on the above documents and the DWMS are provided in Table 2 and summarised in Sections 3.1.1 to 3.1.3.

Table 2: Summary of LWMS principles and objectives

Category	Principles	Objectives
Water conservation and efficiency	Consider all potential water sources in water supply planning. Integrate water and land use planning. Sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	If possible, achieve a domestic water consumption target of 100 kL/person/year. Minimise the use of potable water where drinking water quality is not essential, particularly for outside uses.
Water quantity management	Retain natural drainage systems and protect ecosystem health. Protect development from flooding and water-logging. Implement economically viable stormwater systems. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	Post-development annual stormwater discharge volume and peak flow be maintained relative to pre-development conditions. For the critical one year Average Return Interval (ARI) event ¹ , the post-development stormwater discharge volume and peak flow rates shall be maintained. Manage the catchment stormwater runoff for up to the 100-year ARI event in the development area to pre-development peak flows.
Water quality management	Maintain or improve groundwater and surface water quality. Where waterways/open drains intersect the water table, minimise the discharge of pollutants to groundwater. Where development is associated with an ecosystem dependent upon a particular hydrologic regime, minimise discharge or pollutants to shallow groundwater and receiving waterways and maintain water quality in the specified environment.	Maintain surface water and groundwater quality. Ensure all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007).
Disease vector and nuisance insect management	To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a period not exceeding 96 hours.	To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a period not exceeding 96 hours. Permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the DoW and Department of Health (DoH).

¹ The largest storm event anticipated to occur once in every 100 years.

3.1.1 Water Resources Statement of Planning Policy 2.9 and Liveable Neighbourhoods

This LWMS has been developed in accordance with regional and local principles and objectives of Integrated Urban Water Management (IUWM).

WAPC (2006) defines IUWM (also known as total water cycle management) as promoting '*management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised*'.

IUWM should also promote water conservation measures, reuse and recycling of water and best practice in stormwater management (WAPC 2006). These objectives are consistent with Liveable Neighbourhoods (WAPC & DPI 2007).

3.1.2 Stormwater Management Manual for WA

The DoW position on Urban Stormwater Management in Western Australia is outlined in Chapter 2: Understanding the Context of the Stormwater Management Manual for Western Australia (DoW 2004-2007), which details the management objectives, principles, and a stormwater delivery approach for WA. Principal objectives for managing urban water in WA are stated as:

- Water Quality: to maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions
- Water Quantity: to maintain the total water cycle balance within development areas relative to the pre-development conditions
- Water Conservation: to maximise the reuse of stormwater
- Ecosystem Health: to retain natural drainage systems and protect ecosystem health
- Economic Viability: to implement stormwater systems that are economically viable in the long term
- Public Health: to minimise the public risk, including risk of injury or loss of life to the community
- Protection of Property: to protect the built environment from flooding and water-logging
- Social Values: to ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater
- Development: to ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles Australia (DoW 2004-2007).

The then Department of Environment (now Department of Environment and Conservation [DEC] and DoW) and Swan River Trust released the *Decision Process for Stormwater Management in WA* in 2005 to provide a decision framework for the planning and design of stormwater management systems and assist in meeting the objectives specified above.

3.1.3 Better Urban Water Management

This LWMS has been developed to be consistent with the framework and process detailed in the guideline document *Better Urban Water Management* (WAPC 2008). The LWMS has been prepared to an appropriate level of detail to support the Local Structure Plan for the development.

4. Pre-development environment

The pre-development environment section briefly outlines the understanding of the existing environment, including existing drainage infrastructure.

4.1 Climate

The Perth area experiences a Mediterranean climate with warm, dry summers and cool, wet winters. The closest Bureau of Meteorology (BoM) monitoring station to the site is situated at the Jandakot Airport (BoM station 9172), which measures temperature and rainfall data (Table 3 and Figure 5). Summer months extend from October to April, with mean maximum daily temperatures reaching just above 30°C. The winter months extend from May to September, with mean minimum temperatures reaching just below 7°C. Rainfall in proximity to the site mainly occurs during winter with a mean monthly rainfall of 178 mm in July and 10 mm in December. The mean annual rainfall for the area is 829 mm.

Table 3: Climate statistics for Jandakot Airport (BoM Station 9172)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max Temp (°C)	31.2	31.5	29.7	25.7	22.1	18.9	17.8	18.4	19.9	22.5	26.2	28.9	24.4
Mean Min Temp (°C)	16.6	17.0	15.4	12.3	9.4	7.4	6.8	6.8	8.1	9.4	12.4	14.5	11.3
Mean Rainfall (mm)	14.6	16.8	15.3	42.8	107.7	162.2	178.3	125.0	84.6	47.0	28.9	9.7	829.1

Source: BoM (2011)

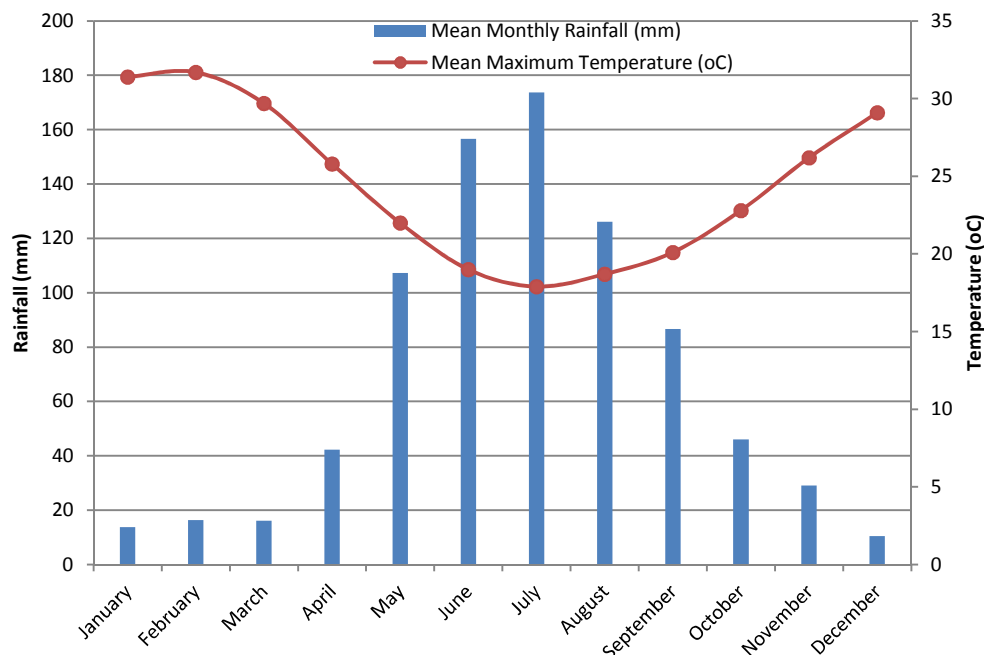


Figure 5: Climate statistics from Jandakot Airport (BoM Station 9172)

Source: BoM (2011)

4.2 Site conditions and topography

The site lies between 20 and 26 mAHD, and generally slopes in a north-easterly direction towards the Kwinana Freeway (DoW 2004) (Figure 6).

The site has been cleared, apart from the vegetated NCA.

4.3 Geology and soils

The superficial formation in the area of the site consists of leached aeolian Bassendean Sands unconformably overlaying the Guildford Formation (Davidson 1995).

Bassendean Sand provides good potential for infiltration, due to its sandy composition (GHD 2007). Low permeability coffee rock was not found on the site (Coffey 2008, Appendix 2).

Preliminary geotechnical surveys indicate that an approximately 2 m thick lens of fine grained silt and clay (the clay layer) is present with a top level of approximately 14 mAHD around the NCA (Coffey 2008) (Figure 7). This formation was not located during the installation of the groundwater bores on the site (Figure 7).

The geology described above is consistent with the observations from the installation of the monitoring bores, which recorded sand throughout the drilled depth at all locations (Appendix 3).

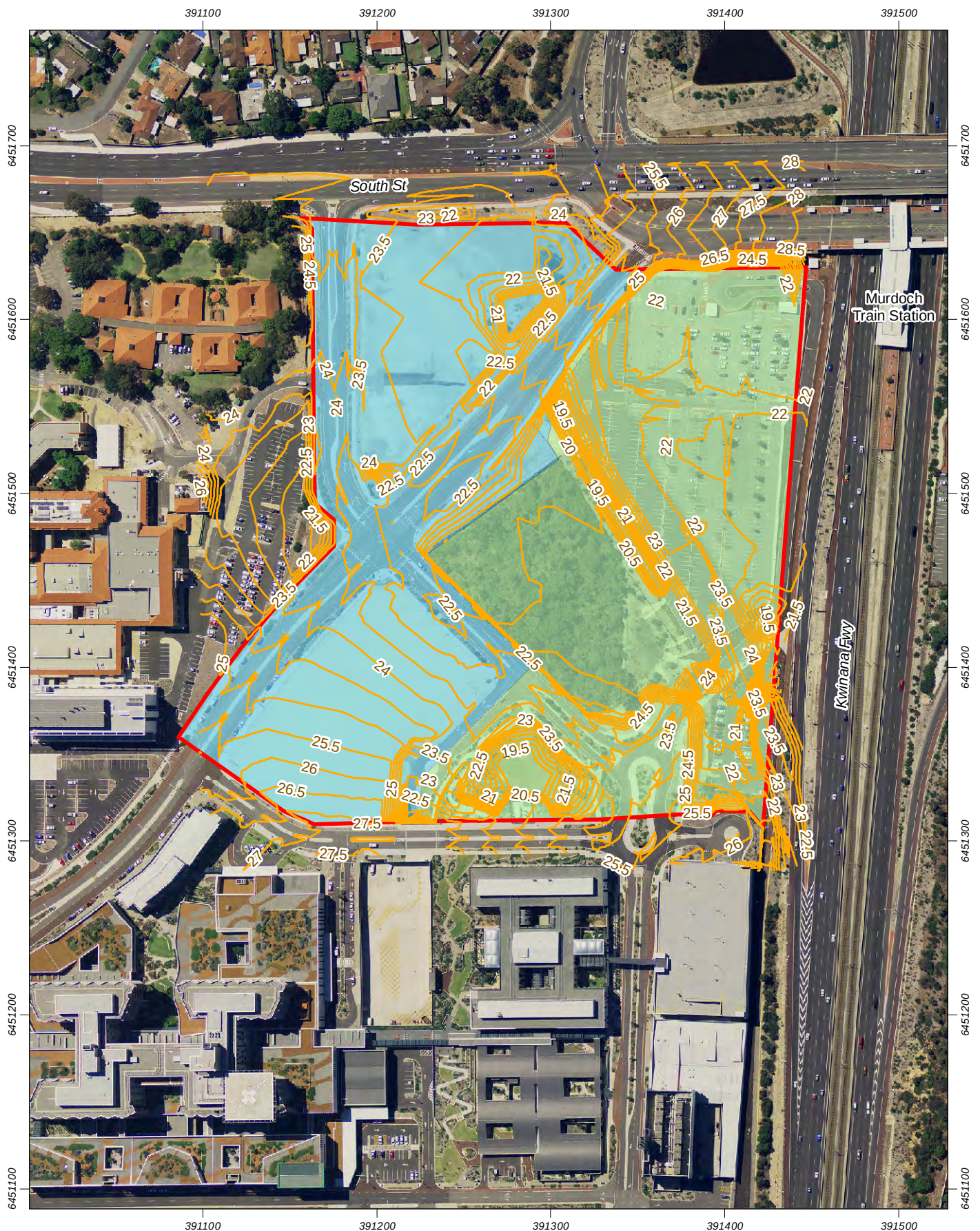


Figure 6: Site condition plan

Scale 1:3,000 at A4

0 20 40 60 80 m

Coordinate System: GDA 1994 MGA Zone 50
 Note that positional errors may occur in some areas
 Date: 24/09/2015
 Author: JCrute
 Source: Aerial image: Landgate, flown March 2015. Concept plan: Client 2015.

Legend

- Surface elevation (mAHD)
- Project boundary
- Stage 1
- Stage 2

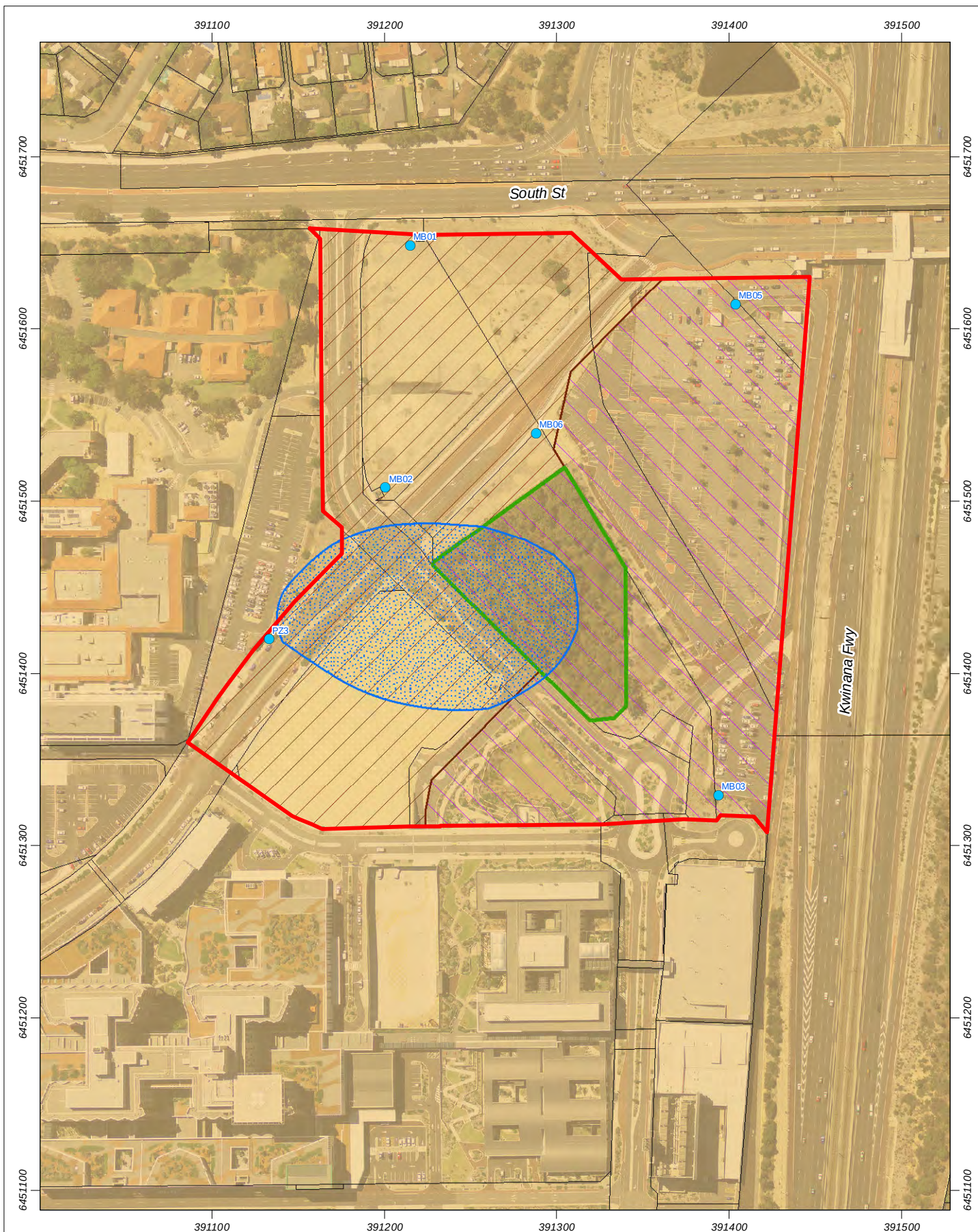
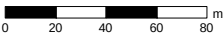


Figure 7: Geotechnical plan

Scale 1:3,000 at A4

 Coordinate System: GDA 1994 MGA Zone 50
 Note that positional errors may occur in some areas
 Date: 24/09/2015
 Author: JCrute
 Source: Aerial image: Landgate, flown March 2015. Concept plan: Client 2015.
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Legend

- | | | |
|--|--|--|
| ● Groundwater bores |  Northern conservation area | ASS risk category |
|  Project boundary |  Stage 1 |  High to moderate risk |
|  Clay soil zone |  Stage 2 |  Moderate to low risk |
| |  Cadastre | |

4.3.1 Acid sulfate soils

There is a 'low to moderate risk' of acid sulfate soils (ASS) occurring at a depth of 3 m from the surface within the site (DEC 2006) (Figure 7). Preliminary testing by Coffey (2008) indicated that such ASS is present at a depth of greater than 3 m at the site. Sampling was also undertaken by Strategen in 2011 to depths of 4 metres below ground level as part of groundwater bore installation process. These tests did not find any additional ASS.

ASS investigations will be required to be undertaken in a manner consistent with DER guidelines where dewatering or major earthworks are proposed. Such investigations are anticipated to be required as a condition of subdivision if dewatering or major earthworks are required. If ASS is encountered, management plans may be required to be developed prior to ground disturbing works. Where excavation is required for construction of on-lot car parks, the need for ASS investigations should also be considered.

4.3.2 Contaminated sites

A search of the DEC Contaminated Sites Database indicates that there are no known contaminated sites located within a 1 km radius of the site.

Based on the current land uses, DER (2014) guidelines do not require a contamination investigation. As such, a Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) are not anticipated to be required for the redevelopment of the car park.

4.4 Groundwater

4.4.1 Regional groundwater

The primary aquifer at the site is associated with the superficial aquifer comprising Quaternary sediments of the Kwinana Group. The Perth Groundwater Atlas indicates peak winter groundwater levels of 19 to 20 mAHD, with groundwater flows in a westerly to north-westerly direction (WRC 1997).

4.4.2 Groundwater monitoring

Pre-development groundwater monitoring commenced in November 2011 and continued until January 2014.

Five superficial monitoring bores (MB01, MB02, MB03, MB05 and MB06) were installed at the site in November 2011. Three of the bores are located in the vicinity of the NCA, being MB02 and MB06 to the north and MB03 to the south (Figure 8). Bore locations were designed to provide groundwater levels representative of the NCA while not impacting on the existing infrastructure and works being undertaken by DoH and Main Roads in the area. Bore logs can be found in Appendix 3.

This included:

- monthly monitoring of water levels in the bores installed, as well as monitoring of a nearby long term DoW monitoring bore and visual observation of the NCA to see if pooling of water is occurring
- quarterly monitoring of water quality including:
 - * field measurements of pH, electrical conductivity (EC)
 - * laboratory analysis of water samples for total nitrogen, total phosphorus, phosphate, nitrate/nitrite, ammonia, Kjeldahl nitrogen
- laboratory analysis for the standard eight heavy metals (As, Cd, Cu, Cr, Pb, Ni, Zn, Hg) on two occasions throughout the 18 month monitoring period, for all bores.

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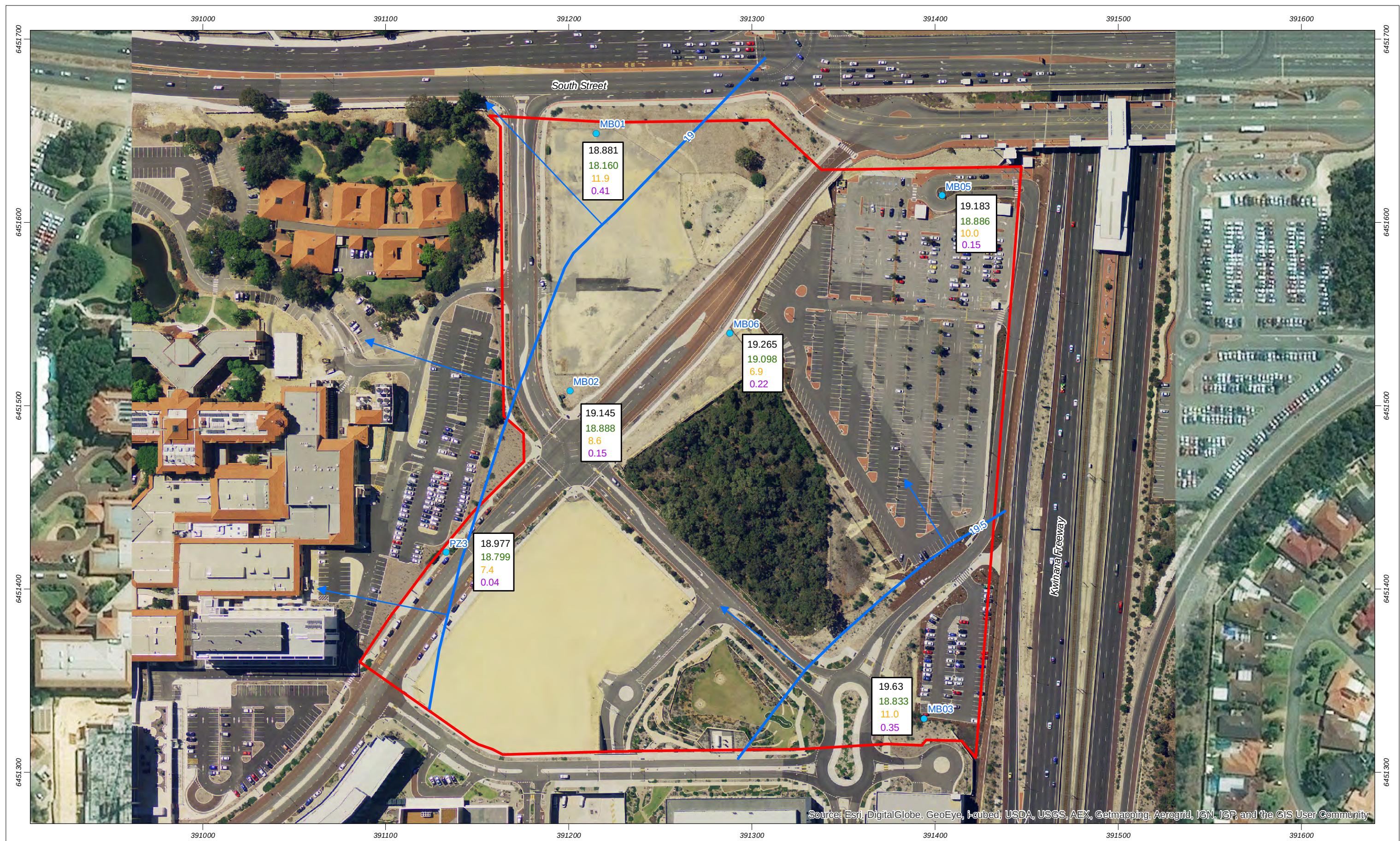


Figure 8: Groundwater plan

Scale 1:1,902 at A3

0 20 40 60 m

Coordinate System: GDA 1994 MGA Zone 50
 Note that positional errors may occur in some areas
 Date: 24/09/2015
 Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Background image: ESRI online, approx. 2014. Concept plan: Client 2015. Topography: Client 2011.
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Legend

- Groundwater bores
- Groundwater flow direction
- AAMGL (mAHD)
- Maximum recorded level (mAHD)
- Median TN (mg/L)
- Median TP (mg/L)
- AAMGL contour (mAHD)
- Project boundary

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Groundwater levels

Groundwater levels peaked in November 2013, with peak levels in bores present onsite at the time ranging between 18.8 and 19.1 mAHD, at least 1 m below ground level at all locations (Figure 9, Appendix 4). Groundwater flows on the site appear to be in a generally westerly to north-westerly direction, consistent with the regional flows (Figure 8).

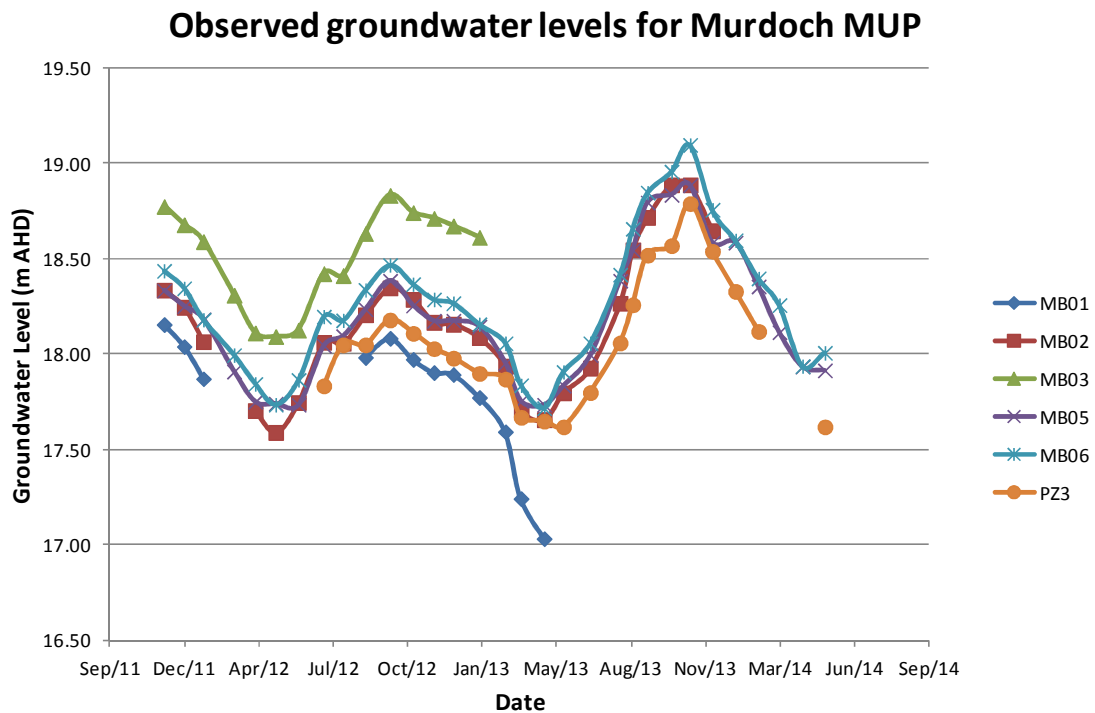


Figure 9: Groundwater level monitoring results

Subsequent to the 2012 peak, construction commenced in the vicinity of MB01 and MB03. This resulted in a high frequency of damage to these bores. After repeated damage and review of suitable sites for relocation, the decision was made not to reinstall these bores.

Long term groundwater levels

Long term groundwater levels were calculated using the long term DoW monitoring bore 4522, monitored since 1975 (Figure 10, Appendix 5). Calculations undertaken based on groundwater data from September 2012, as all bores were monitored during the 2012 peak and water levels in 2012 exceeded those in 2011.

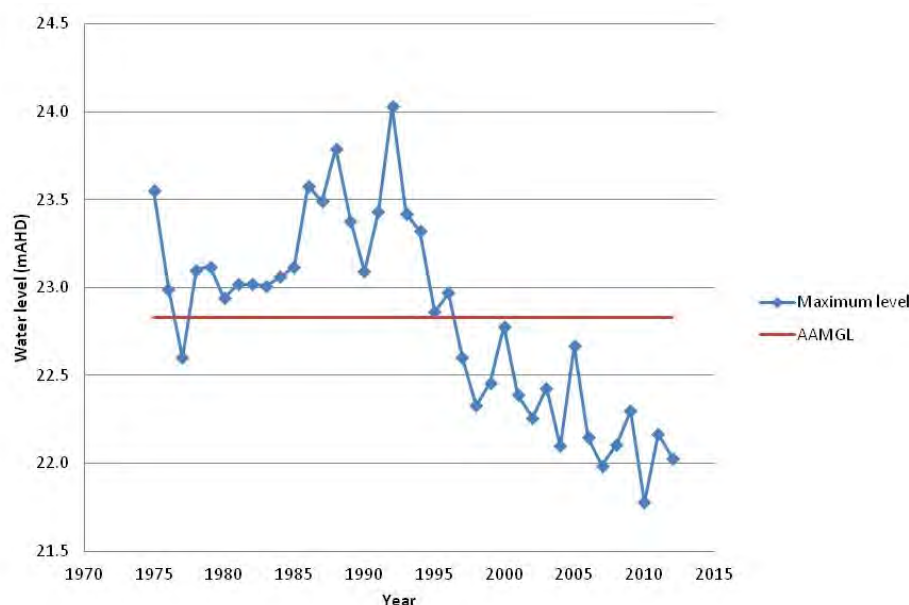


Figure 10: Maximum annual groundwater levels at DoW bore 4522

Bore 4522 is located approximately 2 km south east of the site. The Average Annual Maximum Groundwater Level (AAMGL) at this bore was estimated at 22.872 mAHD based on the long term groundwater record at the bore (Figure 10). Levels above the AAMGL have not been observed at the bore since 1996, most likely due to the drying climate in southwest Australia since 2000 (Figure 10). The Maximum Groundwater Level (MGL) at Bore 4522 was 24.03 mAHD, 1.158 m higher than the AAMGL. Given these trends,

The AAMGL calculated for the site varied from 18.881 mAHD at MB01 to 19.630 mAHD at MB03 (Figure 8, Table 4). The AAMGL was greater than the maximum groundwater levels recorded for all bores during the monitoring period (Table 4).

Table 4: Calculated groundwater levels

Bore	MB01	MB02	MB03	MB05	MB06	PZ3
AAMGL (m AHD)	18.881	19.145	19.630	19.183	19.265	18.977
MGL (mAHD)	20.039	20.303	20.788	20.341	20.423	20.135
Maximum recorded groundwater level (m AHD)	18.160	18.888	18.833	18.886	19.098	18.790

Groundwater quality

Groundwater at MUP was acidic with a median pH of 5.32 and range of 3.34 to 6.30 (Table 5, Appendix 4). This is below the ANZECC and ARM CANZ (2000) trigger value range for slightly disturbed wetlands in south western Australia of pH 6.5 to 8.5. The guidelines note that a pH range of 4.5 to 6.5 is typical in highly coloured wetlands, due to the presence of high concentrations of gilvin, a form of dissolved organic matter (ANZECC and ARM CANZ 2000). Groundwater in the project area has been observed to have the brown colour associated with high gilvin concentrations.

Table 5: Groundwater basic parameters and nutrients concentrations

Parameter	SCWQIP (2009)	Median	Range
pH		5.32	3.34 – 6.30
Electrical conductivity (mS/cm)		0.36	0.11-0.72
Total nitrogen (mg/L)	2 (Short term) 0.5 (Long term)	8.9	1.4 - 26
Total phosphorus (mg/L)	0.2 (Short term) 0.05 (Long term)	0.21	0.03 – 0.79

Electrical conductivity on the site has ranged from 0.11 to 0.72 mS/cm, with a median of 0.36 mS/cm (Table 5), being approximately 65 to 450 mg/L total dissolved solids with a median of 215 mg/L. This range indicates fresh water suitable for irrigation purposes. Levels of nitrogen and phosphorus on the site were slightly elevated, with a median total nitrogen concentration of 8.9 mg/L and a median total phosphorus concentration of 0.21 mg/L (Table 5). Levels of nitrate above Australian Drinking Water Guidelines criteria of 11.3 mg/L total nitrogen were also recorded on at least one occasion at each of MB01, MB02, MB03 and MB05 (Appendix 4). The maximum concentration recorded was 26 mg/L (Appendix 4). The source of this contamination is not known, but it may be due to historical market gardening or unsewered development to the west of the site.

Median metals concentrations in groundwater exceeded the ANZECC and ARMCANZ (2000) trigger values for protection of 95% of species for copper, lead and zinc (Table 6). These elevated values may be due to deposition of particulates from vehicles utilising South Street and the Kwinana Freeway.

Table 6: Groundwater metals concentrations

Parameter	ANZECC & ARMCANZ (2000) Freshwater- 95% trigger value (µg/L)	Median (µg/L)	Range (µg/L)
Arsenic	24	1.25	<1-5
Cadmium	0.2	<0.1	<0.1
Copper	1.4	2.5	<1-14
Chromium	10	7	<1-20
Nickel	11	4	<1-21
Lead	3.4	27	<1-110
Zinc	8	21	6 - 69
Mercury	0.6	<0.1	<0.1

4.5 Surface water and wetlands

In the pre-development situation, no runoff would be expected to occur off site in events up to and including the 100-year ARI event because of the high infiltration rate of the sandy soils, although some ponding may have occurred at low points following extreme rainfall events.

4.5.1 Wetlands

No mapped permanent surface water bodies are present on the site. Quenda Wetland, a Conservation Category Wetland (CCW) (DEC 2010), is located approximately 400 m west of the site (Figure 11). The wetland is defined as a sumpland (DEC 2010), and is seasonally inundated. The wetland is regarded as a significant wetland which has a high level of protection due to its fauna habitat and floristic diversity (GHD 2007).

As part of the groundwater monitoring program, the NCA was monitored for presence of standing water. This was undertaken because some of the vegetation in the NCA displays wetland characteristics, although is not mapped by the DEC as a wetland. The NCA is located at a natural low point and these characteristics are related to a shallow depth to groundwater rather than surface runoff.



Figure 11: Wetlands

Scale 1:8,000 at A4

0 50 100 150 200 m



Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 24/09/2015
Author: JCrute

Source: Aerial image: Landgate, flown March 2015. Background imagery: ESRI online, approx. 2012. Concept plan: Client 2015. Contours: DoW 2001. Wetlands: DPAW 2014.

Legend



Project boundary

Wetland category



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No standing water was observed in the NCA during the monitoring period. This is consistent with groundwater levels recorded on the site that show depth to groundwater greater than 1 m below the surface of the NCA.

4.5.2 Existing drainage infrastructure

The MUP site currently contains road and drainage infrastructure constructed by DoH as part of the development of FSH. This infrastructure has been designed to infiltrate stormwater in events up to the 100-year ARI event without flow off the Site. This includes Barry Marshall Parade, Fiona Wood Road, Yubarl Lane and Bedbrook Row (Figure 12). This infrastructure will be retained as part of the MUP development. A UWMP was not prepared for construction of the FSH drainage infrastructure.

Strategen understands that the existing infrastructure is currently maintained by DoH.

Drainage structures constructed as part of Fiona Stanley Hospital

The drainage structures constructed as part of the FSH development consist of:

- two underground storage tanks under Bedbrook Row (Existing Tanks 2 and 3)
- one infiltration basin in North Park (Existing Basin 4)
- one large underground storage tank to the northeast of NCA (Existing Tank 5)
- allowance for overflow from Existing Tank 5 the NCA in events greater than the 10-year ARI event, when the water level in Existing Tank 5 exceeds 20.80 mAHD (Figure 12).

This infrastructure has been sized to store and infiltrate the 100-year ARI event from the existing infrastructure, with allowance for lot drainage in Catchments A and B. Details of these basins and tanks outlined in Table 7.

Table 7: Existing infrastructure details

Structure	Invert level (mAHD)	100-year ARI top water level (mAHD)	Volume (m ³)	Strategen AAMGL (mAHD)	Depth from invert to AAMGL (m)
Existing Tank 2	20.95	23.95	1700	19.25	1.70
Existing Tank 3	20.95	23.85	2220	19.50	1.45
Existing Basin 4	19.50	21.72	2962	19.40	0.10
Existing Tank 5	19.00	22.00	3708	19.20	-0.20
NCA	20.5 -22.2 (varies)	21.70	5825	19.2 – 19.5 (varies)	Minimum of 1 m

While the invert levels of the structures are above the highest groundwater level recorded on the site by Strategen, the invert level of Existing Tank 5 is approximately 0.2 m below the Strategen AAMGL (Table 7). The design groundwater levels used for FSH were below this AAMGL. This suggests that the bottom of the tank may experience seasonal inundation and low infiltration rates. The 0.1 m separation to the AAMGL at Existing Basin 4 indicates that seasonal inundation and low infiltration rates may also occur at this location (Table 7).

Alteration of existing drainage infrastructure would require the reconstruction of existing roads and potentially the hospital itself. This would be a costly and impractical exercise. New infrastructure constructed within MUP will have elevated bases and designed to reduce inflows into Existing Basin 4 and Existing Tank 5 where feasible. In the case of Existing Tank 5, this is difficult in larger events because this tank provides the overflow outlet into the NCA in this scenario (Figure 12).

Train station carpark

The train station car park located within Stage 2 disposes of drainage by infiltration on site, predominantly through the use of soakwells. This infrastructure will be removed when Stage 2 is developed.

4.6 Flora and Fauna

The only remaining native vegetation on the site is within the NCA (Figure 6).

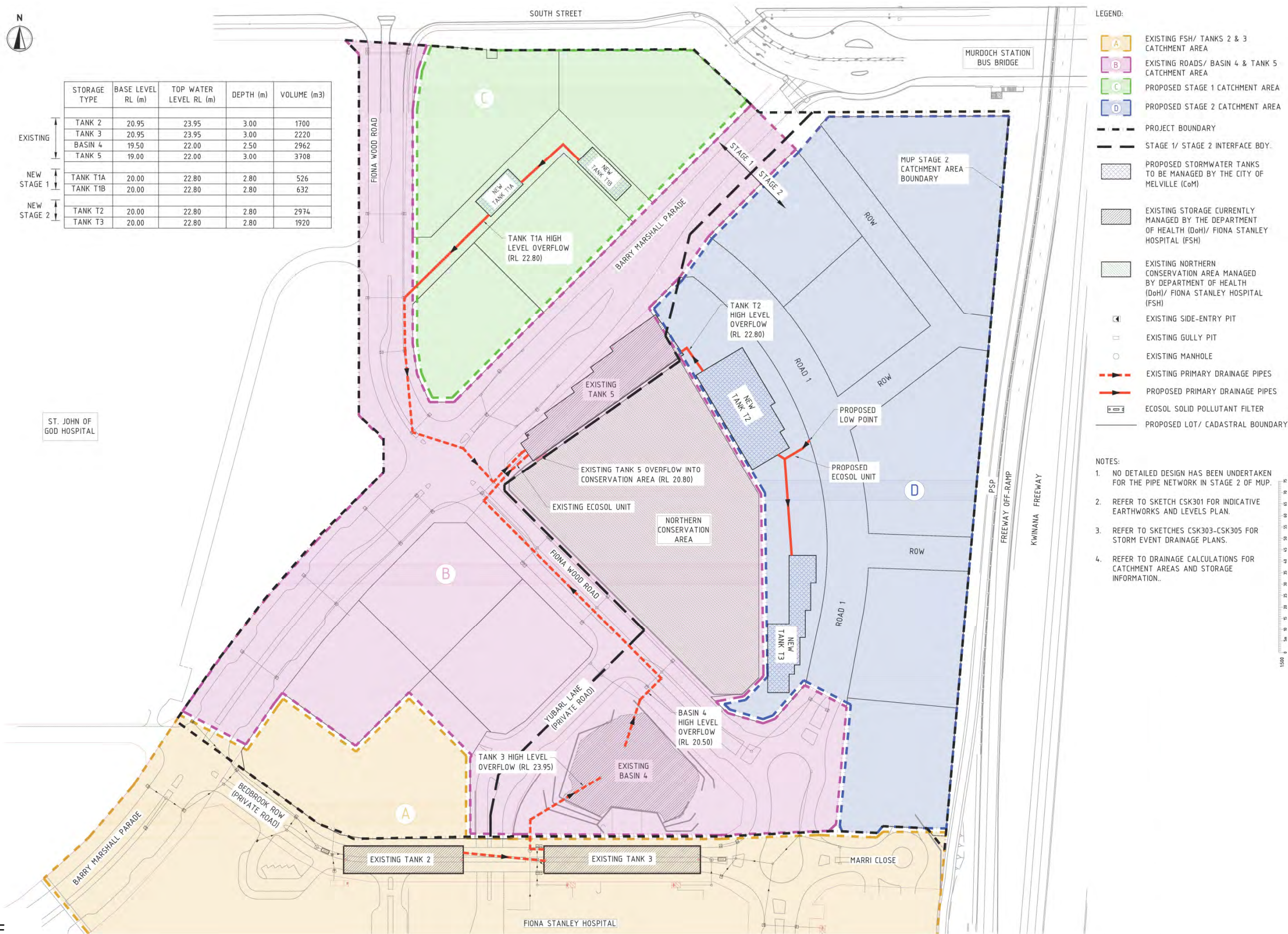
A vegetation and flora assessment of the site was undertaken for Stage 1 as part of the FSH project in 2005, prior to clearing (GHD 2006a).

Since the development of the FSH Project, the only remaining vegetation on Site (apart from a few scattered trees) is contained within the NCA. Vegetation within the NCA is considered to be in Excellent condition (GHD 2006a).

The majority of the NCA is representative of Marri-Banksia-Melaleuca Woodland which was described as a 'small area, recently burnt, comprising an overstorey of *Corymbia calophylla* (Marri) and *Banksia attenuata*, with scattered *B. menziesii* and *Melaleuca preissiana*, over *Xanthorrhoea preissii*, *Hibbertia hypericoides*, *Patersonia*, and various herbs' (GHD 2006a). A small portion of the NCA consists of Jarrah-Banksia Woodland, being *Banksia attenuata*, *B. menziesii* with scattered Jarrah (previously harvested), *Allocasuarina fraseriana*, over *Adenanthos cygnorum*, *Allocasuarina humilis*, *Melaleuca thymoides*, *M. systema*, *Beaufortia elegans*, *Hibbertia hypericoides*. Understorey varied, with mixed undershrubs, sedges and herbs, dominated by *Lepidosperma* species, *Burchardia umbellata*, *Patersonia occidentalis*, *Stirlingia latifolia*, *Briza maxima*, *Ehrharta calycina*, *Gladiolus caryophyllaceus*, *Hardenbergia comptoniana* (GHD 2006a). Subsequent surveys indicate that construction of the FSH project has not affected the composition or condition of the vegetation of the NCA (Strategen 2013).

The NCA is a small fragment of habitat and is not considered large enough to support permanent populations of native mammals. The site is identified as foraging habitat for Carnaby's Black-Cockatoo and may be visited by other bird life (Strategen 2012).

The retention of the NCA and maintenance of the condition of the vegetation is a condition of the EPBC approval of FSH. Strategen understands the NCA is currently managed by Serco as per their contractual arrangements with the Department of Health (DoH) for the operation of the FSH. Public access to the NCA may be permitted with the approval of DoH and the Commonwealth Department of the Environment. The proposed LSP design will not result in public access to the NCA.



- LEGEND:**
- A EXISTING FSH/ TANKS 2 & 3 CATCHMENT AREA
 - B EXISTING ROADS/ BASIN 4 & TANK 5 CATCHMENT AREA
 - C PROPOSED STAGE 1 CATCHMENT AREA
 - D PROPOSED STAGE 2 CATCHMENT AREA
 - PROJECT BOUNDARY
 - STAGE 1/ STAGE 2 INTERFACE BOY.
 - PROPOSED STORMWATER TANKS TO BE MANAGED BY THE CITY OF MELVILLE (CoM)
 - EXISTING STORAGE CURRENTLY MANAGED BY THE DEPARTMENT OF HEALTH (DoH)/ FIONA STANLEY HOSPITAL (FSH)
 - EXISTING NORTHERN CONSERVATION AREA MANAGED BY DEPARTMENT OF HEALTH (DoH)/ FIONA STANLEY HOSPITAL (FSH)
 - EXISTING SIDE-ENTRY PIT
 - EXISTING GULLY PIT
 - EXISTING MANHOLE
 - EXISTING PRIMARY DRAINAGE PIPES
 - PROPOSED PRIMARY DRAINAGE PIPES
 - ECOSOL SOLID POLLUTANT FILTER
 - PROPOSED LOT/ CADASTRAL BOUNDARY

- NOTES:**
- NO DETAILED DESIGN HAS BEEN UNDERTAKEN FOR THE PIPE NETWORK IN STAGE 2 OF MUP.
 - REFER TO SKETCH CSK301 FOR INDICATIVE EARTHWORKS AND LEVELS PLAN.
 - REFER TO SKETCHES CSK303-CSK305 FOR STORM EVENT DRAINAGE PLANS.
 - REFER TO DRAINAGE CALCULATIONS FOR CATCHMENT AREAS AND STORAGE INFORMATION.

Source: BG&E

Murdoch Mixed Use Precinct Local Water Management Strategy
Existing and proposed drainage

Figure
12

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5. Water sustainability initiatives

5.1 Water supply and wastewater management

Potable water supply will be provided from the Water Corporation reticulated water supply scheme. Wastewater services at the site will be provided by Water Corporation through a connection to the broader sewerage system.

The Water Corporation water mains infrastructure within the site will be upgraded to address the additional water requirements for the site (Perkov A [BG&E] 2012, pers. comm. December 14).

The sewer mains for the site have been sized based on the requirements of an intensive business node, along the line of the Perth Central Business District (Petrovich D [BG&E] 2012, pers. comm. December 18).

5.2 Water conservation measures

The development will consist of a mixture of land uses including commercial and residential land uses in strata titled buildings. Water conservation measures will include:

- water efficient fittings and appliances
- residential density
- potentially on-lot water conservation measures.

5.2.1 Water efficient fittings and appliances

Water efficient fittings are mandated through the Western Australian Appendix of the Building Code of Australia (NCC 2012). These include requirements for minimum Water Efficiency Labelling Scheme ratings for showerheads, taps and toilets in new dwellings (NCC 2012).

5.2.2 Residential density

Residential density is anticipated to be a minimum of R60, with densities of R100 likely. All residential and mixed use buildings (i.e. lower floors commercial with residential above) will be strata titled. All garden beds and turf are anticipated to be managed by the strata. Because of the comparatively small size of the lots, areas of garden and turf are anticipated to be smaller than for a conventional lot of 800 m². Because of this, ex-house water use is expected to be well below the Perth average of 65 kL/person/year (Water Corporation, undated publication).

5.2.3 Potential for on-lot water conservation measures

Developments will be required to limit stormwater velocities leaving their sites to 120 l/s/ha (Section 6.1.3). This encourages the installation of stormwater tanks, which may also potentially allow for reuse of rainwater for in-house water use such as toilets and washing machines. Internal use of rainwater requires the installation of a dual piped system and consequently will not be mandated within the development.

The high-density nature of the development means that lots are likely to be strata titled, with numerous owners or tenants per lot. Such developments will be developed and then managed by a strata company. This type of development provides opportunities for on-lot recycling of rainwater and/or wastewater (including greywater) because of the large number of potential users and presence of a strata agency that can manage and maintain such systems at a lot scale.

5.3 Water balance

A lot scale water balance has been undertaken for the Site to assess potable water use. The water balance was undertaken on the basis of the proposed scenario:

- Ten residential buildings with an estimated total of 1200 dwellings (estimated 1800 residents)
- 94 000 m² Gross Lettable Area (GLA) of office space²
- 7750 m² GLA retail space.

Assessment was undertaken on the basis of the Water Corporation spreadsheet water_balance_tool.xls. An allowance of 1.5 persons per dwelling was used based on the assumptions in this spreadsheet.

The results of the modelling are presented in Table 8. The results indicate a total residential water use of 110 950 kL/yr or 61.6 kL/person/year, which is below the domestic water use target of 100 kL/person/year (Table 8). Residential water use represents approximately 57% of the estimated total water use on the site.

Table 8: Water balance

Land use	Potable water consumption (kL/yr)	Potable water consumption per resident (kL/person/yr)	Percentage
Residential	110 950	61.6	57%
Commercial (office and retail)	82 950	46.1	43%
Total	193 900	107.7	

The commercial water use is estimated at 82 950 kL/yr, and represents approximately 43% of the total water use on the site (Table 8).

5.4 Development scale measures

POS design will be based on WaterWise principles, including reducing lawn areas, water efficient irrigation systems, WaterWise plants, irrigation with non-potable water and fertiliser use will be minimised (Section 2.3).

² While other commercial uses are anticipated to occur on the site, offices and retail are considered the most likely of those supported by the water balance tool.

6. Stormwater management strategy

This section addresses the management of stormwater, including detailed drainage design. This summarises the proposed operation of the drainage system. The ultimate drainage system will include both existing drainage infrastructure constructed for FSH and new infrastructure where required.

6.1 1-year Average Return Interval event design

6.1.1 Drainage philosophy

Rainfall in events up to the 1-year ARI event will be treated through use of BMPs that treat water quality, in line with the *Stormwater Management Manual* (DoW 2004-2007). New structural BMPs on the site include:

- gross pollutant and grease and oil traps
- underground infiltration tanks.

The MUP development will be of a high-density nature, with lots anticipated to contain few areas of garden and turf. The POS (outside the NCA) is estimated to be approximately 30% hard surfaces. Road reserves will be predominantly hard surfaces.

The advantage of the high percentage of hardstand is that due to the lower percentage of green areas that may be fertilised, concentrations of nutrients in stormwater are anticipated to be lower than for standard residential developments.

The locations of rain gardens and biofilter structures will be determined at the UWMP stage. Road verges on the site are highly constrained for use of above ground water treatment structures because of the large number of services in the area and the need for parking, pedestrian and cyclist accessibility. This makes it difficult to provide suitable locations for the installation of raingardens and biofilters to remove contaminants from stormwater. Road verges on the site are highly constrained for use of above ground water treatment structures because of the large number of services in the area and the need for parking, pedestrian and cyclist accessibility. If suitable locations are found at the UWMP stage, raingardens or biofilters will be designed based on DoW guidance.

6.1.2 Pollutant and oil traps

Stormwater will be collected through a series of grates and manholes and directed to Ecosol 4000 series gross pollutant traps that are designed to remove gross pollutants, sediments and oil and grease (Figure 13). Overflow from the rain gardens will also enter these areas. The Ecosol 4000 series can collect approximately 98% of gross pollutants and up to 97% of oil and grease (Ecosol 2012).

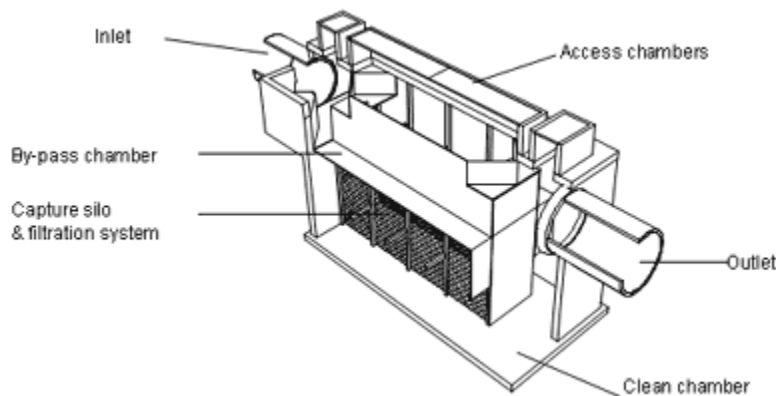


Figure 13: Ecosol 4000 gross pollutant trap

Open bottomed manholes require more maintenance than closed bottomed ones. The advantage of the open bottomed type is that it increases infiltration. The disadvantage is that the not treated via a pollutant trap to remove pollutants prior to infiltration. The type of manhole bottom to be used will be based on the preferences of CoM, discussed with the City prior to the UWMP.

6.1.3 Lot drainage

Because of the high density nature of the development, lots will be predominantly hardstand with underground carparks below. This type of design makes lot infiltration difficult as:

- appropriate setbacks between buildings and infiltration structures generally cannot be obtained
- the base of the car parks may be below groundwater.

Consistent with the design for FSH, lots will be allowed to discharge stormwater to the broader drainage system. The maximum allowable discharge rate will be 120 L/s/ha. Buildings may need to install tanks and flow restriction devices to ensure that this requirement can be met.

Lots will be required to install stormwater treatment systems to remove rubbish, grease and sediments prior to discharge to the broader stormwater system (e.g. Ecosol unit). Design requirements for these structures will be confirmed at the UWMP stage.

6.1.4 Infiltration tanks

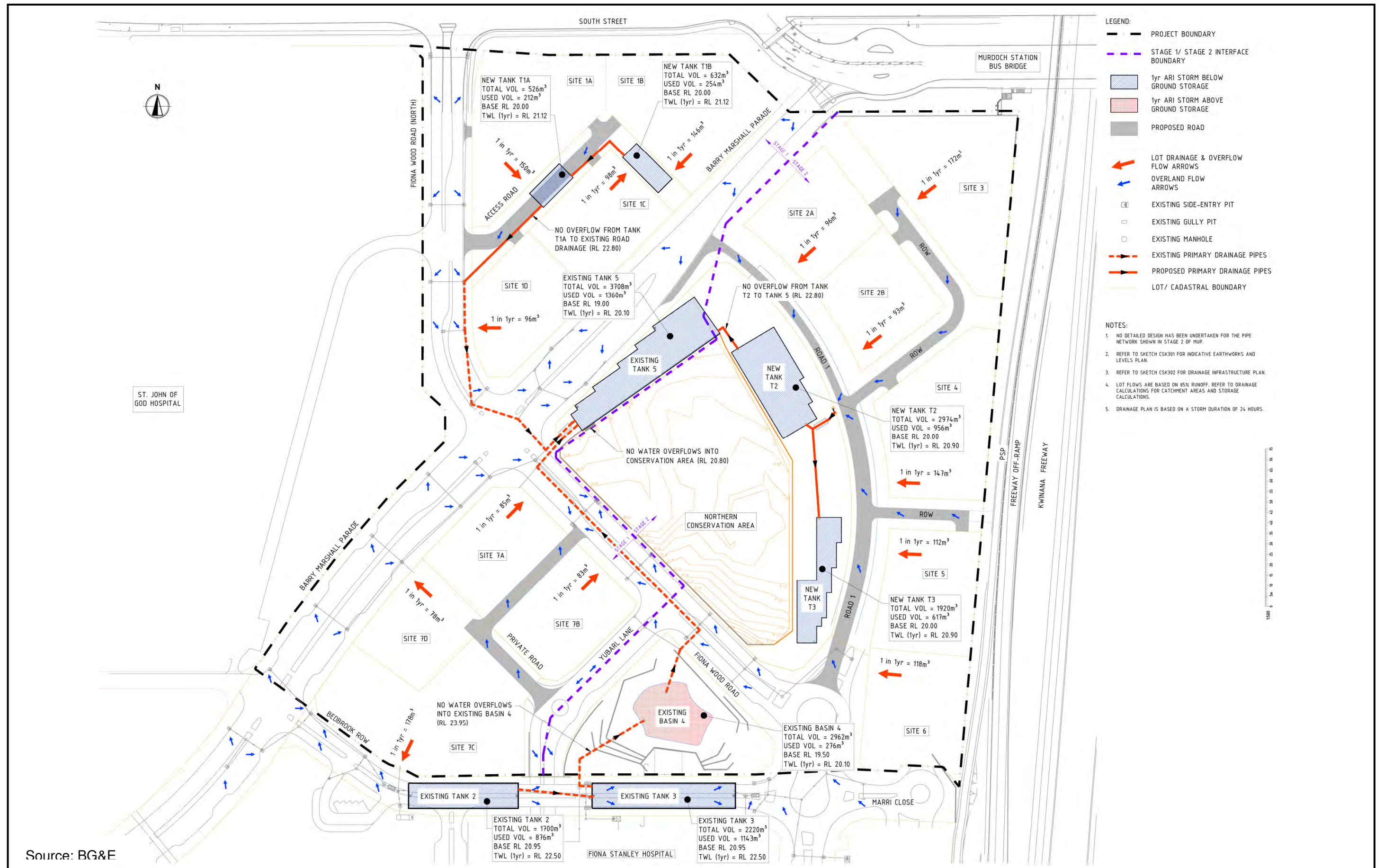
Infiltration tanks have been used at MUP and FSH to minimise the land take required for drainage and maximise the useability of POS in this high density area. New tanks will not be installed under public roads (Figure 14).

Tanks have all been interconnected to maximise the useability of storage and ensure that infiltration occurs over as large an area as possible.

The infiltration tanks will be installed during the earthworks program, with a 200 mm layer of gravel aggregate placed under the base of the tanks to maximise infiltration.

The findings of groundwater monitoring on the site have resulted in a revision of the groundwater levels on the site, with slightly higher groundwater levels being anticipated than those previously estimated for the FSH project. To compensate for this, the base of the new tanks around the NCA will be raised by 300 mm from the previous design to a minimum of 20 mAHd. This will increase the infiltration rate and decrease the potential for the base of the tanks to become waterlogged (Figure 14).

The infiltration tanks will be fully enclosed for public safety reasons. The exceptions to this are the outflow into NCA and the vent required on each tank to prevent pressure build up. Each tank will have two vents located within garden beds or similar low access areas and designed to maintain public safety. To prevent mosquito breeding, the vents of the new tanks will be fitted with mosquito proof mesh.



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6.2 Design detail and modelling

This LWMS proposes the use of underground storage tanks and infiltration basins as well as on lot stormwater management measures to attenuate and infiltrate stormwater flows on the site.

Drainage planning for the site has been undertaken by BG&E. Unless otherwise stated, all information in this section has been provided by BG&E unless otherwise stated. Areas of land uses within the Structure Plan areas were calculated. The stormwater design also takes into account the areas of FSH that contribute to the drainage catchment, as discussed in Section 4.5.2.

Calculations were undertaken using PC Sump to determine the infiltration times. Volumes have been calculated based on Australian Rainfall and Runoff (2014). Stormwater calculations are presented in Appendix 6.

Major event plans are presented as follows:

- 1-year ARI event plan - Figure 14
- 10-year ARI event plan - Figure 15
- 100-year ARI event plan - Figure 16.

Full calculations are presented in Appendix 6.

6.2.1 Modelling assumptions

The following assumptions have been made during drainage modelling:

1. Groundwater table at 19.5 mAHD, being the highest AAMGL contour on the site.
2. Hydraulic conductivity has been estimated at 5 m/day, based on Rising Head permeability test results undertaken as part of the FSH geotechnical investigations (Coffey Geotechnics 2008). Similar hydraulic conductivity values were adopted for the adjacent Kwinana Freeway and South Street Main Roads WA drainage design.
3. Allowance has been made for inflow from the 1-year ARI, 1 hour event from pavement and lot areas only (i.e. POS is assumed not to contribute in these events). Maximum lot discharge rates are limited to 120 L/s/ha.
4. Allowance has been made for runoff from existing stormwater systems that drain into the LSP area, as identified in Section 4.5.2.
5. Consistent with the previous drainage design for FSH, runoff coefficients are:
 - roads: 0.9
 - lots: 0.85
 - FSH loading docks: 1
 - Existing POS: 0.25
 - New POS: 0.5 (due to the anticipated hardstand area).

Impervious areas have been calculated for each catchment based on these runoff coefficients (Table 9).

Table 9: Impervious areas

Catchment	Storages	Existing impervious area (m ²)	New roads (m ²)	New lots (m ²)	New POS (m ²)	Total impervious area (m ²)
Catchment A (Existing)	Existing Tank 2 Existing Tank 3	43 170	0	0	0	43 170
Catchment B (Existing)	Existing Tank 5 Existing Basin 4	31 595	0	1975	0	33 570
Catchment C (New)	Tank T1A Tank T1B	0	1814 (Internal road)	8119	0	9933
Catchment D (New)	Tank T2 Tank T3	0	6514	14 920	2836	24 270

6.2.2 Model outputs and design

Storage volumes and areas of inundation for aboveground structures are presented in Table 10. Existing infrastructure is identified as such. Overflow into the NCA will not occur in events less than the 10-year ARI event, consistent with the FSH drainage design (Table 10). The volume of stormwater entering the NCA in the 100-year ARI event has also been maintained at 5825 m³. This information is also presented pictorially in the event plans (Figure 14 to Figure 16).

Table 10: Storage levels and areas of inundation

Storage	1-year ARI volume (m ³)	1-year ARI above ground inundation area (m ²)	10-year ARI volume (m ³)	10-year ARI above ground inundation area (m ²)	100-year ARI volume (m ³)	100-year ARI above ground inundation area (m ²)
Existing Tank 2	876	0	1552	0	1700	0
Existing Tank 3	1143	0	2026	0	2220	0
Existing Basin 4	276	775	785	1160	2340	1770
Existing Tank 5	1360	0	2101	0	3362	0
NCA (existing overflow)	0	0	0	0	5825	8646
Tank T1A	212	0	374	0	526	0
Tank T1B	254	0	448	0	632	0
Tank T2	726	0	1282	0	2907	0
Tank T3	428	0	755	0	1714	0
Total	5275	775	9323	1160	21 226	10 416

Invert levels for existing and proposed drainage structures are presented in Table 11. The new tanks have a minimum of 0.5 m separation from the base of the tank to the AAMGL, although the majority of tanks have inverts below the MGL (Table 11). The levels of the bases of the tanks have been constrained by:

1. The need to connect to existing drainage infrastructure, particularly Existing Tank 5, which provides the outflow to the NCA in the 100-year ARI event.
2. The requirement to ensure that road and lot levels on the Site match existing surrounding levels, particularly at the connections to Barry Marshall Road and Fiona Wood Road. The site is very small (approximately 330 m by 375 m), which adds to this constraint. The POS in Stage 2 adjacent to the NCA will be built up to match the surrounding levels and allow tanks to be constructed within the NCA.

Table 11: Invert levels and top water levels

Structure	Invert level (mAHD)	MGL (mAHD)	AAMGL (mAHD)	Depth from invert to AAMGL (m)	Emptying time (hours)
Existing Tank 2	20.95	20.4	19.25	1.70	45
Existing Tank 3	20.95	20.65	19.50	1.45	45
Existing Basin 4	19.50	20.55	19.40	0.10	38
Existing Tank 5	19.00	20.35	19.20	-0.20	N/A
NCA	20.5 -22.2 (varies)	20.35 - 20.65	19.2 – 19.5 (varies)	Minimum of 1 m	17
Tank T1A	20.00	20.25	19.1	0.9	40
Tank T1B	20.00	20.35	19.2	0.8	40
Tank T2	20.00	20.45	19.3	0.7	42
Tank T3	20.00	20.65	19.5	0.5	42

Installation of subsoil drainage below the tanks to assist with drainage is not feasible. Any such subsoil drainage would need a free draining outlet, such as a connection into a regional drainage network that is below the desired invert level. No regional drainage network is present in the area. The NCA is not considered an appropriate outlet because:

- increasing the frequency of inundation of the NCA may impact on vegetation health and condition
- the NCA varies in height between 20.5 and 22.2 mAHD, which is above the base of the tanks.

The key concern in terms of water levels is flows into Existing Tank 5. To minimise flows into Existing Tank 5, pipework connecting the new tanks to Existing Tank 5 will be placed as high as possible to ensure that these tanks fill first, before Existing Tank 5.

The proposed design is considered to represent the best potential outcome given the constraints of the existing drainage system, requirements to match lot and road levels and the need to maintain the environmental values of the NCA.

6.2.3 Infiltration and emptying times

The design for the tanks includes a number of factors that maximise infiltration, including:

- the interconnection of all tanks to maximise the use of storage – if one tank is infiltrating more slowly, gravity will cause water to move into the other, more quickly draining tanks
- use of a 200mm thick gravel base to reduce the potential for clogging, and to provide for a even spread of infiltration surface under the tank structure
- installation of the Ecosol units prior to the tanks, to ensure that debris/rubbish is not collected at the base of the tanks and hence reduce infiltration rates.

The estimated hydraulic conductivity of the soils at FSH is estimated at 5 m/day hydraulic conductivity based on Rising Head permeability test results undertaken as part geotechnical investigations (Coffey Geotechnics 2008). With consideration to the shallow water table, BG&E reduced permeability rates by 50% in the PC Sump infiltration modelling to 2.5 m/day. A shallow groundwater table PC Sump model was used to determine infiltration rates.

Emptying times from the cessation of the 100-year ARI, 72-hour event ranged from 17 to 46 hours for all storages except Existing Tank 5, assuming groundwater at 19.5 mAHD (Table 11). The base of Existing Tank 5 is at 19.2 mAHD, which is below the assumed groundwater level at 19.5 mAHD.

6.3 10-year Average Return Interval event design

Stormwater in the 10-year Average Return Interval event is retained and infiltrated in the tanks and basins (Figure 15).

The total volume of stormwater requiring infiltration in the 10-year ARI event is 9323 m³ (Table 10). No flow into the NCA occurs in the 10-year ARI event.

6.4 100-year Average Return Interval event design

Barry Marshall Parade and Fiona Wood Road are critical to the accessibility to Fiona Stanley Hospital, so these have been designed to ensure that no flooding of these roads occurs in the 100 year ARI, 72 hour storm.

There is currently no surface water flow off the site in the 100-year ARI event due to the high permeability of the soils onsite and as a result, surface water infiltrates quickly. Events up to the 100-year ARI event will be retained and infiltrated within the site, consistent with the pre-development conditions.

Under the previous DoH design for FSH and MUP, overflow from Tank 5 would occur in the 10-year ARI event. The increased volume of storage provided for MUP results in a better design, with overflow into the NCA occurring less frequently. The impacts of infrequent inundation (approximately once in 50 years) on the presence of flora species the NCA are considered insignificant. The presence or absence of species within the NCA is likely to depend on more frequent inundation events, such as annual inundation.

The FSH loading dock has a pumped outflow designed to cater for the 100-year ARI event. The outflows from the loading dock have been included in the storage calculations for the Site.

A total of 21 226 m³ of storage is required for MUP in the 100-year ARI event (Figure 16)

6.5 Non-structural controls

Nutrient levels in stormwater infiltrated to groundwater are expected to be low. This is due to the majority of the site being roofed or hardstand, which results in lower concentrations of organic matter and nutrients in the runoff than in runoff from lawns or gardens.

Landscaping on lots will be developed and maintained by the landowner (strata or similar) rather than individual residents. To meet the requirements associated with the EPBC approval of FSH landscaping will be predominantly native species (Section 2.3.2), resulting in less demand for fertilisers.

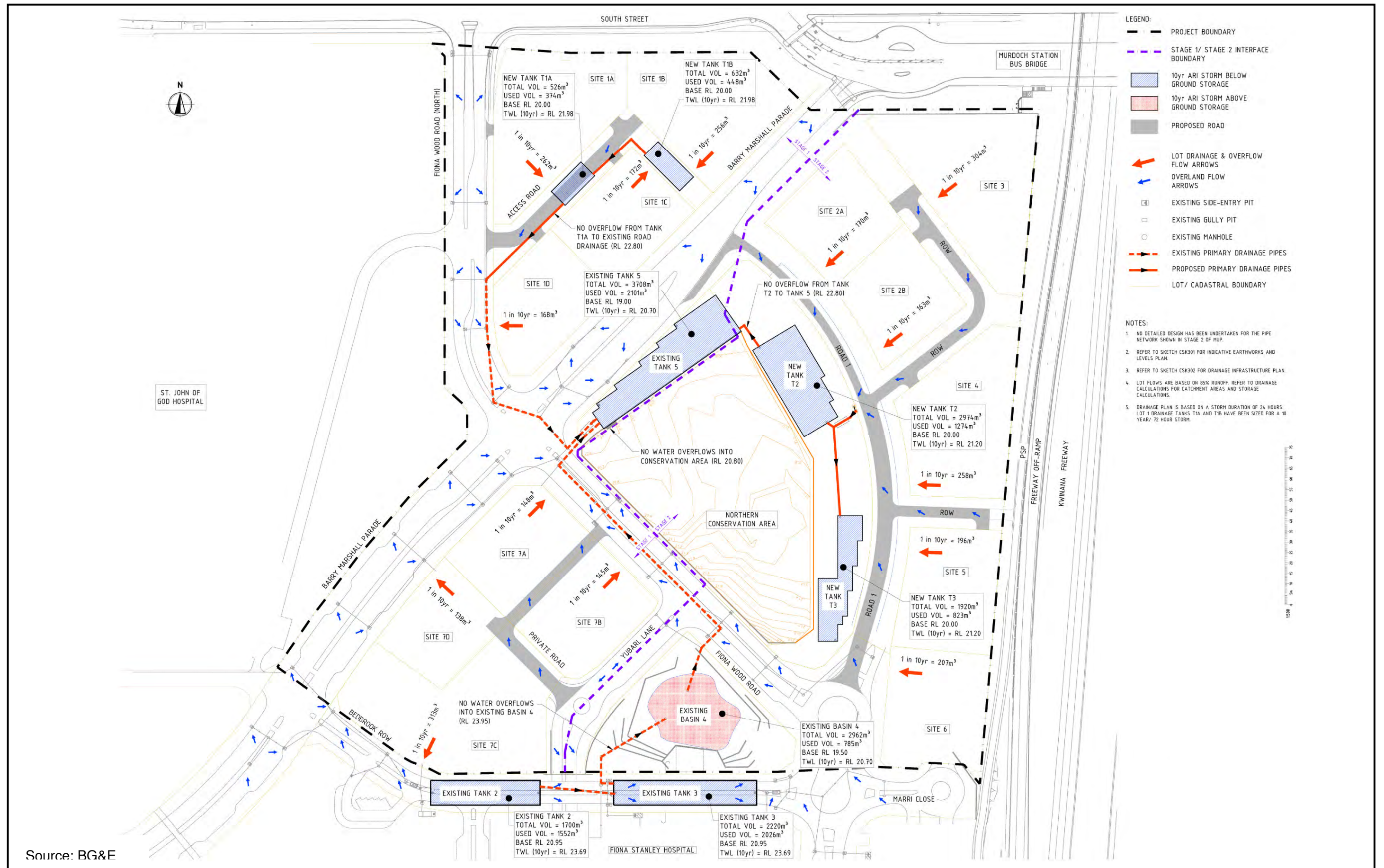
6.6 Disease vector and nuisance insect management

The system is designed to minimise nuisance insect management through infiltration of stormwater within set periods and mosquito proofing.

Stormwater will be infiltrated primarily in the storage tanks. The new tanks have been designed to allow events up to the 100-year ARI, 72 hour event to be infiltrated within the tanks within 96 hours of the end of the event. The new tanks will be designed with mosquito proof mesh inserts on all vents installed to prevent mosquitoes entering the tank.

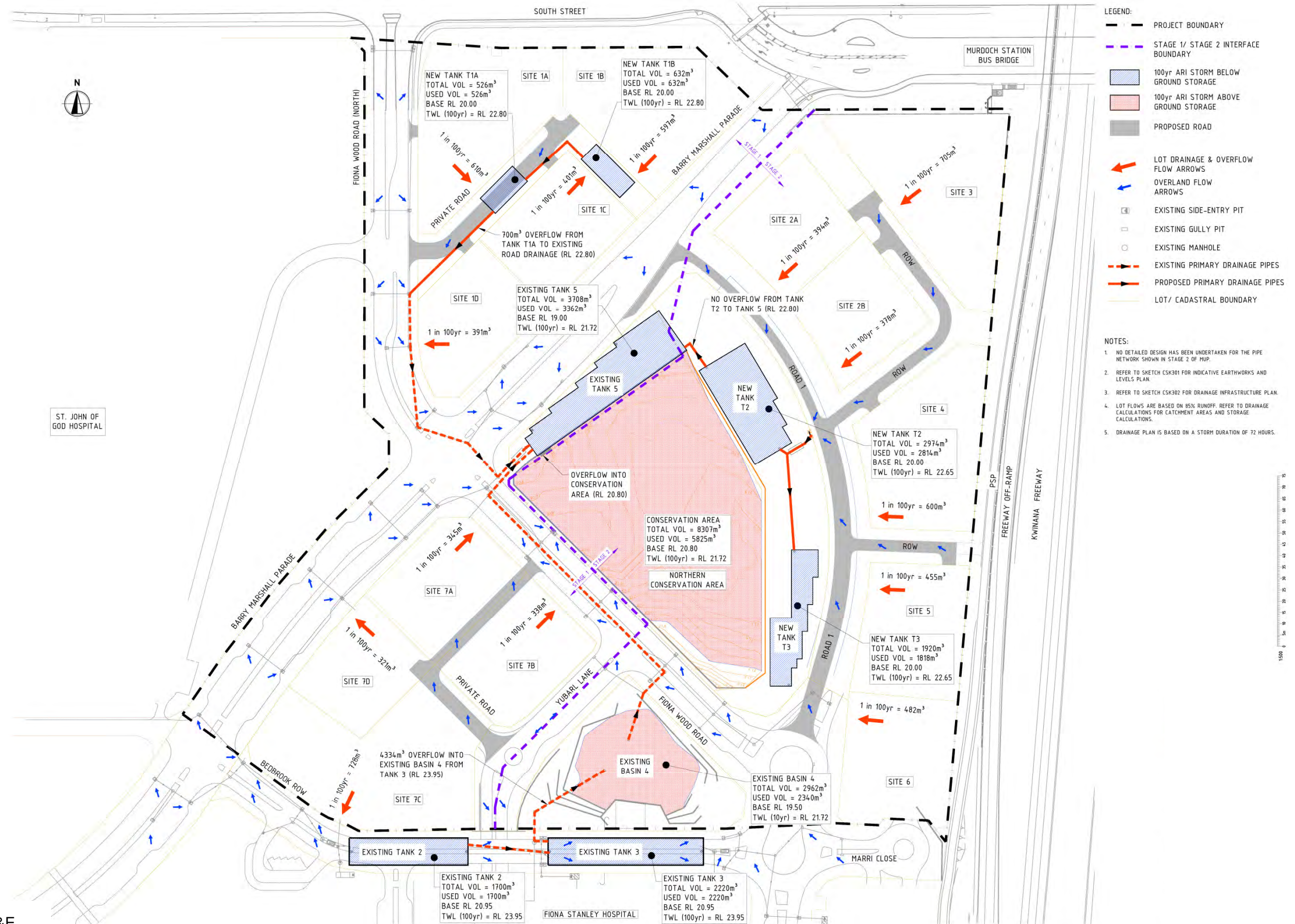
Inundation of the NCA is anticipated to occur for approximately one day following a 100-year ARI, 72 hour event.

No permanent water bodies are proposed for this development.



Murdoch Mixed Use Precinct Local Water Management Strategy
10-year Average Return Interval event plan

Figure
15



Source: BG&E

Murdoch Mixed Use Precinct Local Water Management Strategy
100-year Average Return Interval event plan

Figure
16

7. Groundwater management strategy

Groundwater management on the MUP site encompasses two main factors:

- potential impacts of development on groundwater levels
- selection of finished and basement levels.

No control of groundwater levels is proposed on the site.

7.1 Impacts of development on groundwater levels

Urbanisation can result in rising groundwater levels due to increased recharge rates through concentrated infiltration of runoff from roofs and hardstand and decreased losses through evapotranspiration by vegetation. The extent of rise in groundwater levels will depend on the intensity of the land use and area over which the hydrological regime is changed. Rises in groundwater levels are possible as a result of the FSH and MUP developments because of the extensive new areas of hardstand and use of onsite infiltration to manage stormwater. Abstraction of groundwater for irrigation of POS and landscaping can potentially lower groundwater levels over the drier months.

7.2 Design groundwater levels

From the perspective of lot and road levels, the design groundwater level has taken to be the Maximum Groundwater Level on the site. The MGL varies from 20.039 mAHD at MB01 to 20.79 mAHD at MB03 (Table 4). Road and finished lot levels have been established based on the MGL.

7.3 Road levels

The minimum existing road level of the Site is 22.3 mAHD along Fiona Wood Road to the south of the NCA (Figure 17). The minimum finished level of the new roads is 23.0 mAHD, in the private road near Yubarl Lane. The highest calculated MGL on the site is 20.79 mAHD at MB03 (Table 4). All roads consequently have a minimum separation to MGL of 1.5 m.

7.4 Finished floor and basement levels

Finished floor levels for the site and building floor levels have been developed based on the need to maintain clearance to groundwater and maintain continuity of level between South Street, the site and the FSH project (Figure 17). Finished floor levels for lots vary from 23.0 mAHD to 26.5 mAHD. This provides a minimum separation from the MGL to finished floor levels of 1.5 m, which is considered adequate.

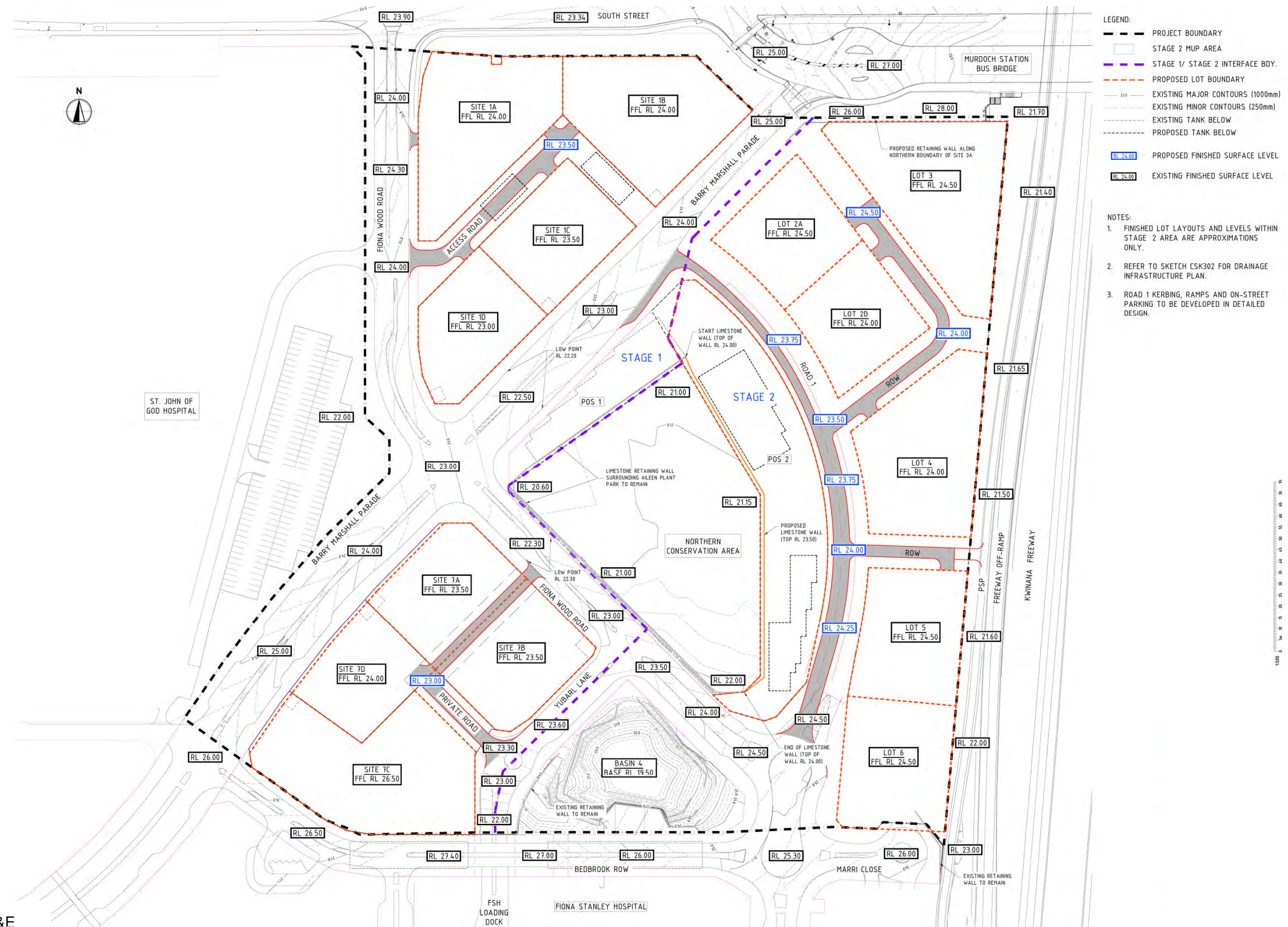
Buildings constructed on the site are expected to have basements for car parking and storage purposes.

If the basements are below the MGL, these will be required to be waterproofed or 'tanked' to prevent water ingress. Tanking of basements is common in high-density areas such as the Perth CBD, where several basement levels may be located below groundwater. To avoid stormwater entering the basements from the street, a speed hump or similar will be required to prevent water ingress without stopping traffic flows.

7.5 Dewatering

Dewatering is not anticipated to be required for installation of sewers within the development. The only services that may require dewatering is the construction of a potable water pipeline along South Street. Dewatering is only anticipated to be required where connection into the existing pipe occurs. Prior to works being undertaken, appropriate ASS testing will be undertaken and an ASSDMP prepared if required.

Should dewatering or disturbance of soil from below the groundwater table be required for construction of basements, developers will be required to undertake ASS investigations. If ASS is present, the developer may be required to prepare an ASS and Dewatering Management Plan (ASSDMP) in order to obtain a licence to take groundwater from the Department of Water.



Source: BG&E

Murdoch Mixed Use Precinct Local Water Management Strategy
Earthworks plan

Figure
17

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8. Subdivision and urban water management plans

The Urban Water Management Plan (UWMP) will be developed in accordance with DoW guidance on *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008).

The UWMP will include:

- detailed landscaping design for the proposed for the POS and details on how this will be managed, including irrigation volumes and methods
- detailed drainage design, including confirmation of pipe sizing and locations, type of manhole, rain garden design and landscaping
- design guidelines and requirements for lot scale drainage systems.

9. Monitoring

9.1 Post-development monitoring

Post development monitoring will occur once 80% of the development is completed. This will not occur until after Stage 2 is completed.

The purpose of this post development monitoring is to assist in identifying any impacts on the site groundwater and surface water as a result of the development. This will involve:

- monthly monitoring of water levels in the bores installed, as well as monitoring of a nearby long term DoW monitoring bore
- visual observation of the NCA and water levels in Existing Tank 5 to assess if pooling of water or overflow is occurring
- quarterly monitoring of water quality in the newly installed bores including:
 - * field measurements of pH, electrical conductivity (EC), total dissolved solids (TDS), redox
 - * laboratory analysis of water samples for total nitrogen, total phosphorus, phosphate, nitrate/nitrite, ammonia, Kjeldahl nitrogen
- laboratory analysis for the standard eight heavy metals (As, Cd, Cu, Cr, Pb, Ni, Zn, Hg) on two occasions throughout the monitoring period, for all bores.

Inspection of tanks will also be undertaken as discussed in Section 10.2. An annual monitoring report will be provided to DoW and CoM.

10. Maintenance and Implementation

10.1 Roles and responsibilities

Developer commitments and the roles of the developer and CoM are presented in Table 12.

The NCA, North Park and the existing underground storage tanks are currently owned and maintained by DoH. These assets will continue to be managed by DoH as per the Memorandum of Understanding between DoH and LandCorp.

No external funding is being sought for this development.

Table 12: Roles and responsibilities

Role	Responsibility	Requirement and Period
Post-development monitoring with annual reporting to DoW and CoM	Proponent	Two years following practical completion of Stage 2.
Preparation of UWMP	Proponent	At subdivision.
Maintenance of new POS and drainage structures	Proponent	Two years following practical completion.
	CoM	After handover from proponent.
Development of lot level design guidelines	Proponent with advice from CoM	Develop design guidelines that ensure that development complies with water sustainability and stormwater management requirements of the LWMS
Enforcement of design guidelines	CoM	Enforce design guidelines developed above through building applications process.
Water efficiency	Proponent	Construction of low water use POS, including low water use landscaping.

The UWMP may be used to revise the design and assumptions of the LWMS if required. This would only occur if the subdivision design changes or additional monitoring indicates that the design requires alteration. In this situation, the UWMP may supersede the LWMS in some respects. This would be discussed with DoW and CoM as part of preparation of the UWMP.

10.2 Maintenance

Tank maintenance will be undertaken on an as-needs requirement. Monitoring of the tanks will be required on an annual basis to check for build up of sediment and debris. The anticipated maintenance of the tanks would typically involve the removal of any sediment and debris that may bypass the upstream gross pollutant tanks using a 'sucker truck'. Removal is anticipated to be required every two to five years.

Tank T5 is proposed to be located in a right of way, which means that traffic management needs to be taken into account during maintenance (Figure 14). BG&E advises that maintenance has already occurred on a similar, larger tank located under the highly trafficked Barry Marshall Parade to the south of the site (Perkov A [BG&E] 2013, pers. comm. 22 January). This maintenance required the closing of one lane of the road for a short period (Perkov A [BG&E] 2013, pers. comm. 22 January). Closure of one lane of a right of way is unlikely to result in significant traffic disruption. Tank access points will be sited to minimise potential traffic management issues.

All stormwater captured from the site passes through installed Ecosol unit designed to remove solid pollutants and oil and grease. These units can store up to 1,137 L of oil and grease and up to 1.03 m³ of solid pollutants. These 'Ecosol' units will require maintenance in the form of removing the captured solid pollutants, oil and grease. The removal of the solid pollutants is carried out separately to the oil and grease removal and therefore separate maintenance periods will need to be developed.

In order to develop the correct maintenance regime for the Ecosol units, quarterly maintenance will be undertaken over the first two years to determine the amount of captured sediment and debris within the units. This maintenance will involve the use of a sucker truck to remove sediment and debris. At the end of this period, an estimate of the rate of build up can be made. This estimate will be used to determine the required frequency of maintenance. The anticipated maintenance of the 'Ecosol' filtration units would typically involve annual removal of sediment prior to the winter rains.

11. Conclusions

LandCorp proposes to develop the 9.6 ha Murdoch Mixed Use Precinct (MUP) (the site) within the larger Murdoch Activity Centre (MAC). This Local Water Management Strategy (LWMS) has been developed to support the Local Structure Plan for the site.

The MUP is proposed to be developed as a high density node for a range of uses, including support for health and education activities, associated convenience retail and business uses, recreational, hospitality, entertainment, lifestyle and living opportunities (i.e. residential). The Northern NCA [NCA] has been identified and set aside within the Precinct as a commitment of the adjacent Fiona Stanley Hospital Project.

The development will maintain the pre-development surface water flows off the site in events up to and including the 100-year ARI event by ensuring stormwater is infiltrated on site. Because of the small size and high density nature of the site, stormwater will predominantly be infiltrated through a series of infiltration tanks located in the central public open space. This complements and integrates with the design of the Fiona Stanley Hospital stormwater system.

To ensure water quality is maintained, stormwater will be treated through a series of gross pollutant traps prior to infiltration. Because the catchment will be predominantly paved or roofed, nutrient concentrations in runoff are likely to be low but concentrations of particulates and hydrocarbons may be elevated. Due to the high density nature of the area with multi-storey buildings, there will be little private garden area for irrigation. Water use outside a house within residential lots (ex-house) will therefore be low and it is anticipated that water use will be below 65 kL/person/year.

The development is considered to meet and exceed the design criteria for the site as implemented through the principles and objectives for water management for the site and summarised in Table 13.

Table 13: Design elements and requirements for best management practices and critical control points

Category	Principles	Objectives	Development design elements and requirements
Water conservation and efficiency	Consider all potential water sources in water supply planning. Integrate water and land use planning. Sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	If possible, achieve a domestic water consumption target of 100 kL/person/year. Minimise the use of potable water where drinking water quality is not essential, particularly for outside uses.	Domestic water use anticipated to be less than 65 kL/person/year because of limited gardens and thus low ex-house water use. Public open space will be of a low water use nature — plantings will be predominantly native and approximately 30% of the landscaping will be hard surfaces, consistent with the highly urban nature of the site.
Water quantity management	Retain natural drainage systems and protect ecosystem health. Protect development from flooding and water-logging. Implement economically viable stormwater systems. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	Post-development annual stormwater discharge volume and peak flow be maintained relative to pre-development conditions. For the critical one year Average Return Interval (ARI) event, the post-development stormwater discharge volume and peak flow rates shall be maintained. Manage the catchment stormwater runoff for up to the 100-year ARI event in the development area to pre-development peak flows.	As occurs in the existing system, no stormwater will be discharged off the site in events up to and including the 100-year ARI event.
Water quality management	Maintain or improve groundwater and surface water quality. Where waterways/open drains intersect the water table, minimise the discharge of pollutants to groundwater. Where development is associated with an ecosystem dependent upon a particular hydrologic regime, minimise discharge or pollutants to shallow groundwater and receiving waterways and maintain water quality in the specified environment.	Maintain surface water and groundwater quality. Ensure all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007).	Stormwater infiltrated on site is not anticipated to have a high nutrient load due to minimal fertiliser use resulting from the limited surface area of gardens and use of natives with low fertiliser demands. All runoff will be treated prior to infiltration.
Disease vector and nuisance insect management	To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a period not exceeding 96 hours. Permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the DoW and Department of Health (DoH).	No new permanent water bodies are proposed for the development. New tanks will be designed to allow detained fully immobile stormwater to be infiltrated within 96 hours of the completion of all events up to and including the 100-year ARI, 72 hour event. New infiltration tanks will be provided with mosquito proof vents to prevent mosquitoes entering the tank. No permanent water bodies are proposed on the site.

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Appendix 1
Local Water Management Strategy
Checklist

Checklist for integrated water cycle management assessment of local structure plan or local planning scheme amendment

1. Tick the status column for items for which information is provided.
2. Enter N/A in the status column if the item is not appropriate and enter the reason in the comments column.
3. Provide brief comments on any relevant issues.
4. Provide a brief description of any proposed best management practices, e.g. multi-use corridors, community based-social marketing, water re-use proposals.

LWMS item	Deliverable	Included?	Location in text
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Design elements and requirements for BMPs and critical control points	✓	Table ES-1, executive summary
Introduction			
Total water cycle management – principles & objectives Planning background Previous studies		✓	Sections 1.2 – 1.3
Proposed development			
Structure plan, zoning and land use. Key landscape features Previous land use	Site context plan Structure plan	✓ ✓	Sections 2.1 -2.2, Figures 2 and 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape Plan	✓	Section 2.3, Figure 4
Design criteria			
Agreed design objectives and source of objective		✓	Section 3
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		✓	Section 4
Site Conditions - existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	✓	Section 4.2, Figure 6
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	✓	Section 4.3, Figure 7
Environmental - areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental Plan plus supporting data where appropriate	✓	Sections 4.3.2, 4.5.1 & 4.6, Figure 11
Surface Water – topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface Water Plan	✓	Section 4.5, Figure 12
Groundwater – topography, pre development groundwater levels and water quality, test bore locations	Groundwater Plan plus details of groundwater monitoring and testing	✓	Section 4.4, Figure 8

LWMS item	Deliverable	Included?	Location in text
Water use sustainability initiatives			
Water efficiency measures – private and public open spaces including method of enforcement		✓	Sections 5.2 – 5.4
Water supply (fit-for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		✓	Section 5.1
Wastewater management		✓	Section 5.1
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event Plan Long section of critical points	✓ ✓	Section 6.4, Figure 16
Manage serviceability - storage and retention required for the critical 10 year ARI storm events Minor roads should be passable in the 10 year ARI event	10 yr event Plan	✓	Section 6.3, Figure 15
Protect ecology – detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1yr event plan Typical cross sections	✓ ✓	Section 6.1, Figure 14
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoils areas/exclusion zones	Groundwater/subsoil Plan	✓	Section 7, Figure 17
Actions to address acid sulfate soils or contamination		✓	Section 4.3.1 and 4.3.2
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design.		✓	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		✓	Section 9
Implementation			
Developer commitments		✓	Section 10
Roles, responsibilities, funding for implementation		✓	Section 10
Review		✓	Section 10

Appendix 2

Geotechnical report

FIONA STANLEY HOSPITAL: GEOTECHNICAL REPORT

**BG & E
Murdoch**

GEOTHERD08304AB-AC (Rev A)
30 June 2008

30 June 2008

BG & E
484 Murray Street
Perth WA 6000

Attention: Donald MacMillan

Dear Sir

RE: Fiona Stanley Hospital: Geotechnical Report

This letter presents our report on a geotechnical investigation carried out at the above site. It revises our earlier draft GEOTHERD08304AB-AC dated 10 June 2007, following receipt of review comments from BG&E.

It should be noted that there are a number of ongoing tasks associated with our original brief. In addition however, we have recommended further studies to be undertaken during design and implementation of this project. Comments on further work are presented in Section 9 of the report.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact Mr Francesco Senatore or the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd



M.O. Hillman

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- 1 Extent of Laboratory Testing
- 2 Groundwater Elevations
- 3 Rising Head permeability Testing
- 4 Geotechnical Model
- 5 General Definition of Site Classes
- 6 Soils Parameters Recommended for Design of Retaining Walls
- 7 Maximum Groundwater Levels (Current Conditions)

Figure

- 1 Site Plan – Coffey Test Sites
- 2 Site Plan – All Test Sites
- 3 Extent of Clay Soils
- 4 Pad Footing Design Chart
- 5 Annual Average Maximum Groundwater Levels (Existing)

Appendices

- A Results of Field Investigation Boreholes (35 pages)
- B Results of Field Investigation Electric Friction Cone Penetrometer (86 pages)
- C Results of Field Investigation Test Pits (20 pages)
- D Rising Head Permeability Testing (4 pages)
- E Seismic profiling (35 pages)
- F Laboratory Test Data (83 pages)
- G Results of Finite Element Analysis of Rafts (FEAR) – (6 pages)
- H Acid Sulphate Soils (78 pages)

1 INTRODUCTION

This report presents the results of geotechnical and geophysical investigations carried out by Coffey Geotechnics Pty Ltd (Coffey) for BG&E on the proposed Fiona Stanley Hospital located at Murdoch.

This work was commissioned by Mr Donald MacMillan of BG&E on 11th April 2008 via a completed "Authorisation to Proceed" form enclosed with the Coffey proposal dated (Ref. GEOTHERD08304AB-P-AA).

This report is prepared and is to be read subject to the terms and conditions contained in our proposal dated 22nd February 2008 (Ref. GEOTHERD08304BA-P-AA). Our advice is based on the information stated and on the assumptions expressed herein. Should that information or the assumptions be incorrect then Coffey Geotechnics Pty Ltd shall accept no liability in respect of the advice whether under law of contract, tort or otherwise.

2 PROPOSED DEVELOPMENT

You have indicated that the development proposed for the site comprises of a new hospital development including a number of multi storey buildings, open areas and car-parking buildings. It is understood that a significant amount of bulk earth works including cuts up to approximately 10m and fill up to approximately 4m will be required.

3 OBJECTIVES

The objectives of the geotechnical investigation were to assess the following:

- A. Review of the following existing geotechnical reports and site investigation work carried out to date for the project:
 - o Report on Preliminary Geotechnical Investigations, prepared by GHD Geotechnics, September 2007, Revision 0.
 - o Preliminary Acid Sulphate Soil Investigation, prepared by GHD Geotechnics, 17 July 2007.
- B. Review of the Site Creation Tender (Bulk Earthworks). Report received during the week commencing 2 June 2008.
- C. Plan and implement as required an additional desk top study to establish geological setting, site history (development and prior land use), including review of existing aerial photographs general site conditions including adjacent structures and potential impacts of planned development.
- D. Plan and implement additional site investigation work as is required for engineering characterisation and items referred to in this scope. Planning is to take account of environmental requirements and specifically land clearing requirements.
- E. Assess soil and groundwater conditions, including likely seasonal variations, across the site including design water-table levels.
- F. Advise on short and long term groundwater control.

- G. Screening for presence of acid sulphate soils and assessment of water quality for construction dewatering.
- H. Review previous studies regarding possible site contamination and undertake additional studies where necessary, to identify possible contaminants, contaminant locations on the site and provide recommendation on additional studies required to determine the extent of such contaminants.
- I. Preparation of Acid Sulphate Soil Management Plan, as required.
- J. Assess ground stability and need for ground improvement or removal of unsuitable materials.
- K. Assess liquefaction potential.
- L. Advise on protection of foundation and service excavations and suitability of materials for structural fill.
- M. Advise on possible fines migration below stormwater compensation tanks and the possible settlement effects on tank structure and adjacent buildings/structures. Provide recommendations to manage effects of potential fines migration.
- N. Provide recommendations on site preparation requirements, including compaction criteria, possible effects on adjacent building / roadways.
- O. Provide recommendations and geotechnical design parameters for earth retaining structures including: bulk density, submerged density, angle of internal friction and coefficients of lateral earth pressure K_0 , K_a , and K_p .
- P. Provide recommendations for excavation and dewatering requirements for input to earthworks specification, including potential for acid sulphate soils.
- Q. Provide recommendations for slope batters.
- R. Provide a qualitative assessment of the potential for on-site disposal of stormwater including transmissive parameters.
- S. Assess the site classification in accordance with AS 2870 "Residential Slabs and Footings".
- T. Assess the appropriate seismic sub soil class in accordance with AS 1170.4 2007.
- U. Provide recommendations on suitable footing systems for the proposed development.
- V. Provide geotechnical design parameters for the recommended footing systems.
- W. Provide estimated total and differential settlements for the suitable footings.
- X. Provide a recommendation for CBR for pavement design.
- Y. Provide geotechnical advice as required during design.
- Z. Provide geotechnical advice as required during construction. Identify extent of involvement and associated costs.

4 INFORMATION SUPPLIED BY OTHERS

You have provided us with the following information:

- Your request for geotechnical consulting services dated 7 February 2008 (ref: P07037 : DM).
- Site Location plan (ref: Figures 1 and 2).
- Site Plans outlining the proposed structures and present surface elevations.
- Draft aerial view Master Plans.
- Architectural Elevations.
- Report on Preliminary Geotechnical Investigations, prepared by GHD Geotechnics, September 2007, Rev 0.
- Preliminary Acid Sulphate Soil Investigation, prepared by GHD Geotechnics, 17 July 2007.
- Construction Environmental Management Plan, prepared by Strategen, November 2007.
- Fiona Stanley Hospital Design Programme (dated 5 February 2008).
- Fiona Stanley Hospital Master Geotech Programme (dated 7 February 2008).
- Preliminary Road Layout Design Contours (ref: 6119514-C101 Rev B.pdf)
- Existing Sewer Pipes line (ref: Exist Sewer.pdf)

5 FIELDWORK

5.1 General

Fieldwork was carried out between 1st May 2008 and 15th May 2008 in the full time presence of personnel from Coffey. Fieldwork was undertaken following consultation with the environmental consultant, Stratogen, and was monitored by personnel representing aboriginal heritage issues. Environmental constraints precluded access to parts of the site, especially in the area of the main hospital.

Investigation locations were measured by GPS. Water level readings were made in the drill holes at times and under conditions stated on the borehole logs. It must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors.

Access at the site was moderate, with investigations being largely limited to existing sand access tracks as approval was not obtained for the clearing of vegetation. Tracks are loose boggy sands suitable for 4WD use only. For drilling access, an 8.5 tonne loader was required to tow the drilling rig and support truck to borehole locations BH103 and BH104.

Weather conditions at the time of fieldwork were mostly fine, with occasional showers.

Approximate investigation locations are shown in Figures 1 and 2.

5.2 Boreholes, Sampling and Testing

The fieldwork included the drilling of 4 boreholes (BH101 to BH104) to depths varying from nominally 24.1m to 25m below existing ground surface using a Jacro 200 Site Investigation Drilling Rig and mud flush techniques.

Sub-soil samples were taken at nominally 1m – 1.5m intervals and included Standard Penetration Tests (SPT's) and thin walled (62 mm diameter) tube samples. The SPT's were carried out on granular materials to estimate the density index at the test depth. The thin walled tube samples were taken in predominantly cohesive materials to provide "undisturbed" samples for laboratory examination and testing. From these samples, further sub samples were taken for acid sulphate soil testing.

Five samples of groundwater were obtained for chemical analyses.

The records of boreholes showing detailed descriptions of the major strata encountered, the depths at which the samples were taken, the depths at which the in situ tests were carried out, and the results of these tests are presented in Appendix A.

Borehole data collected by GHD 2007 is also enclosed in Appendix A for completeness.

5.3 Electric Friction Cone Penetrometer Testing

Electric Friction Cone Penetrometer Test (CPT) probes (CPT101 to CPT105) were carried out at five locations to depths varying from nominally 15m to 20m below the existing ground surface at the approximate locations shown on Figure 1.

Piezocene (CPTu) data collected by GHD 2007 is also enclosed in Appendix B for completeness.

The CPT is described in AS 1289-1999.6.5.1 and the results of these tests in the form of plots of Cone Resistance (q_c) Sleeve Friction (f_s) and Friction Ratio, together with a Technical Note on the application of the CPT to geotechnical investigations, are attached as Appendix B.

5.4 Test Pitting

A total of 19 test pits were excavated by backhoe to depths ranging from 1.5 m to 4m below the existing ground surface at the approximate locations shown on Figure 1.

Disturbed samples were taken from all locations of representative soil types for both environmental and geotechnical laboratory examination and testing.

The records of the test pit logs showing the major strata intersected, the depths at which the samples were taken, insitu tests carried out, and the results of these tests, together with Explanation Sheets defining the terms used, are presented in Appendix C.

5.5 Groundwater Monitoring

The groundwater was monitored by installing 5 piezometers to depths varying from nominally 7m to 25m below ground level using the boreholes described at Section 5.2. Each piezometer comprised 50mm diameter PVC with a 3m interval of slotted screen and fitted with PVC end caps. The slotted sections were gravel/sand packed and sealed with bentonite plugs.

A total of 5 groundwater samples were obtained for chemical analyses.

Rising head tests were carried out in the piezometers. The results of this testing are presented in Section 7.4, and analysis data is provided in Appendix D.

5.6 Seismic Testing

5.6.1 Introduction

The objective of the testing was to obtain laterally distributed information on subsurface geology and to provide in situ dynamic modulus values for the materials at this site to assist foundation design. Seismic testing was carried out along ten (10) lines on 6th and 7th May. Figure 1 shows the location of the seismic test lines plotted on the supplied site plan.

5.6.2 Methodology & Equipment

A combination of seismic testing methods were applied at this site i.e. the Seismic Refraction and Refraction Microtremor (ReMi) methods.

Seismic refraction testing is accepted practice for many problems in geotechnical engineering. This non-destructive test uses a linear array of closely spaced detectors on the earth's surface (from 1m to 10m) to identify first arrival seismic waves travelling through the earth from seismic sources placed at various locations. These data are digitally acquired, computer processed and interpreted to provide the subsurface distribution of seismic P-wave velocities and the locations of significant elastic interfaces.

ReMi testing is a relatively new seismic method for measuring in-situ shear-wave (S-wave) velocities in the subsurface. Testing is performed at the surface using the same conventional seismograph and vertical P-wave geophones used for refraction studies. The seismic source consists of ambient seismic "noise", or microtremors, which are constantly being generated by cultural and natural noise. Conventional seismic equipment is used to record data, and ambient noise is used as a seismic source.

5.6.3 Field Procedures

At this site, ten (10) intersecting seismic refraction lines and ReMi lines (Figure 1) were completed using length from 71m to 94m with geophones at 3m or 4m intervals. The seismic data were acquired using a Geometrics Geode 24-channel digital signal enhancement seismograph with a sample interval of 0.250 ms. The refraction seismic sources were summed hammer impacts on a metal plate placed at various locations in line with the geophone array on each seismic line.

The ReMi data were acquired with a sample interval of 2 milliseconds and record length of 30 sec. Low frequency geophones (4.5 Hz) were used and the seismic sources consists of ambient seismic "noise", or microtremors.

5.6.4 Results & Interpretation

All the acquired seismic data were stored on computer disk for later processing and have been archived in Coffey's database.

In general, data quality was adequate for geophysical analysis and interpretation. The seismic refraction data were interpreted using REFRACT software and the ReMi data analysis was completed using Optim software in accordance with accepted practice. The ReMi data was transformed by frequency-slowness method and surface wave phase velocity picked. Using a numerical Rayleigh wave modelling

procedure and linearised optimisation, layered S- wave velocity models were derived from the observed dispersion curves.

The Seismic results are summarised in Appendix E.

The interpreted refraction sections (Appendix E) show a two-layered subsurface with seismic P-wave velocities in the upper layer typically from 350 to 450 m/s that is typical of essentially dry sandy soils or uncompacted sand fills. The lower layer occurs near RL -4 to -10m and has P-wave velocities from about 1600 to 1700 m/s although beneath Line 9 the P-wave velocity increases to about 2000 m/s suggesting possible induration. This range of P-wave velocities in the lower layer may represent saturated soil materials or materials of increased density extending to the depth of investigation of the refraction testing

The ReMi analysis provided uniformly increasing S-wave velocities to about 27m depth ranging from 150 m/s near the surface to about 300 m/s at depth. These velocities are also consistent with sandy materials increasing in density with depth.

As no abrupt increase in S-wave velocity with depth was observed it is likely that the abrupt increase in P-wave velocity is mainly due to increased saturation.

On each line the averaged P and S – wave velocities obtained have been used to compute indicative dynamic and shear modulus values across the site to assist foundation design. An average density of 1.8 t/m^3 was assumed for the sandy materials that are believed to be present and the standard equations were applied. These modulus values are listed on Tables E1 to E10 in Appendix E.

6 DESCRIPTION OF LABORATORY TESTING

Laboratory testing was carried out in accordance with the general requirements of the latest edition of AS 1289 by the Coffey NATA registered soils laboratory.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in Table 1.

Table 1 – Extent of Laboratory Testing

Type of Test	Number
Particle Size Distribution tests	10
Atterberg Limits, Percent Fines and Moisture Content tests	3
Unsoaked/Soaked CBR tests	2
Extended Water Analysis	5
Acid Sulphate Soil Field Screening	Approximately 400
Quantitative Acid Sulphate Soil Testing (S_{CR} and SPOCAS)	Up to 72

Test results for the above mentioned tests are attached in Appendix F.

7 SITE CONDITIONS

7.1 Surface Conditions

The site occupies an area of 11 ha and is bounded by South Street, Murdoch Drive and The Kwinana Freeway. St John of God Hospital is located to the north of the site. A Police Station and Fire Station are located on the western boundary, fronting Murdoch Drive. The site is situated in undulating topography with gentle slopes.

A sandy ridge crosses the site from north north-west to south-south-east, rising to elevations above 30m AHD. A now dry swamp (drained by the adjacent South Street/Kwinana freeway drainage) with ground level about 20m AHD extends to the north of the sandy ridge. A large low lying depression (elevations less than 21m AHD) extends to the south of the sandy ridge, and will underlie much of the proposed hospital. A pronounced west to east sandy track crosses the site through this depressed area, and marks the southern boundary of currently proposed building development for the hospital. Immediately south of the track is an open man-made water body. A second dunal ridge rising to over 30m AHD is evident south of this water body.

The site is well vegetated with mature native bushland consisting predominantly of Mari, Banksia and Casuarina. Paper bark is present in low lying areas.

Access into some areas of the site was not possible due to dense vegetation, therefore prior to design finalisation and/or commencement of construction further investigation of the vegetated areas will be required to identify appropriate measures for these areas of the site (see Section 9).

7.2 Subsurface Conditions

The 1:50,000 Environmental Geology (Fremantle) indicates that the surface geology is Bassendean Sands.

Based on the results of field testing, the Fiona Stanley Hospital site is within an area of deep sand soils. Topsoils are thin (typically less than 100mm), however thicker organics might be expected in the lower lying areas (swales). TP104 indicated a topsoil as much as 0.4m thick (in the former swamp site to the north of the main development).

Two distinct sand units may be present below the topsoils. The upper unit is dune sand, fine to medium grain size. The upper 4m of the soil profile irrespective of elevation, typically increases from a cone resistance of about 2MPa at ground surface, to in excess of about 10MPa at 4m depth. SPT test results were typically greater than 5 at 1m depth and greater than 12 at 3m depth. Taking into account the low overburden stress at 1m depth, these results suggest a medium dense sand condition in the upper 4m (density index 45% to 60%). Beyond about 4m depth, the soil profile is typically medium dense to dense, becoming very dense with greater depth.

At about +14m AHD in the northern portion of the site, a lense of up to 2m of fine grained typically low plasticity silt and clay (referred to in this report as the "clay" layer) was encountered. The lense appears to mark a disconformity separating the sands above, from deeper soils, also sands but possibly coarser grain size, and typically very dense to cemented.

The clay layer is very stiff. It is judged to comprise diatomaceous earths associated with a former swamp bed, and silts and clays of generally low plasticity. Its approximate extent based on testing undertaken, is illustrated on Figure 3.

The deeper sands may be Gngangara Formation. The seismic profiling work differentiates between an upper layer and deeper indurated sands, however the boundary identified in the seismic profiling appears higher than the unconformity marked by the presence of the clay layer. The seismic profiling identified the presence of the clay layer in Line 4.

The seismic profiling shows similar seismic velocities for all seismic lines in the sands at depth, suggesting uniform consistencies across the site.

Borehole testing has penetrated to an elevation of -7m AHD without intersecting bedrock. Bedrock in this area is likely to be of the order of -20m AHD (i.e. from 40m to 50m below ground surface) and comprise Kardinya Shale Member of the Osborne Formation (refer to Perth Groundwater Atlas 1997 and Davidson 1995).

7.3 Groundwater

7.3.1 Groundwater Levels

Groundwater levels measured during the course of the investigation are presented in Table 2.

Table 2 – Groundwater Elevations

Site No.	Screened Depth (m)	Depth to Groundwater (m) – May 2008	Water Table Level (mAHD) – May 2008
BH101	22 – 25m	9.7	16.9
BH102	22 – 25m	4.4	16.6
BH103	22 – 25m	14.0	17.7
BH104d	22 – 25m	5.2	17.7
BH104s	6 – 9m	5.1	17.8

It should be noted that groundwater levels are subject to variation due to the influence of rainfall and other seasonal affects, and to local drainage and changing land use.

7.3.2 Groundwater Quality

Groundwater quality is generally fresh to brackish. The salinity of BH104 Deep was comparatively high at 3200mg/L TDS. It is noted overlying water in BH104s is fresh. The pH was generally close to neutral for all sites, with BH104 Deep showing the lowest value at 6.35 pH units.

Appendix F presents a summary of analysis results. The water is not suitable for drinking, but would be suitable for earthworks purposes. Salinity in BH104 may be unsuitable for some plants for reticulation. Advice should be sought from the Landscape Architect, if it is intended to draw water from this site for landscaping purposes.

7.3.3 Rising Head Permeability Test Results

The permeability of the sands at the site was calculated as per BS5930:1999. Data was obtained using a Level Troll automatic logging device, which recorded water height above the tip of the instrument at 2 second intervals.

The range in average hydraulic conductivity (k) values obtained from the analysis is presented in the table below. The analysis data is presented in Appendix D.

The results of the analysis show that soil horizontal hydraulic conductivity (k) are consistent with the typical conductivity associated with clean sands, at close to 5m/d. A low permeability measured at BH103 can not be adequately explained by review of the borehole logs. It is lower than would be anticipated for sands with a fines content typically about 3% by weight, or that would be anticipated from region studies of this sand unit. The results for BH103 are more likely to reflect partial blockage of the piezometer slots than aquifer conditions.

Vertical permeability in these sands is expected to be similar to horizontal permeability.

Table 3 – Rising Head Permeability Testing

Test Location	Horizontal Conductivity (k)	
	(m/s)	(m/d)
BH101	$3.4 \times 10^{-5} - 8.9 \times 10^{-5}$	3 to 8
BH102	$5.2 \times 10^{-5} - 7.6 \times 10^{-5}$	4.5 to 6.5
BH103	$2.1 \times 10^{-6} - 4.0 \times 10^{-6}$	0.2 to 0.4**
BH104	$7.4 \times 10^{-5} - 1.3 \times 10^{-4}$	6 to 11

*** - This test result is significantly below expectations for this sand unit, and may reflect a problem with the piezometer, rather than site conditions, based on our review of particle size distributions. This result is ignored in subsequent analysis.*

7.4 Geotechnical Model

The geotechnical model for this site will depend on the final earthworks levels, and thickness and condition of engineered fill (or of cut). For design purposes, and based on CPT and borehole SPT interpretations, a model is proposed as set out in Table 4. A final floor level of about 23m AHD is applicable to most of the hospital. There is however a long tunnel, and an associated deeper basement which will be excavated to a final floor level of 18m AHD. The stiffness of the soil profile (elastic modulus) increases with depth, and the influence of geological surcharge loading (removed to achieve basement elevation) becomes greater. The analysis method used does not accommodate this difference in elevations, and therefore a “typical” elevation for the modelling has been adopted (nominally 20m AHD). The impact would be to overestimate settlements in the area of the deeper basement, and to underestimate settlements in the higher elevation areas.

It should also be noted the clay zone does not encroach to any significant extent into the currently proposed building envelopes, and the model therefore does not allow for its presence.

The bulk density assumed for the sand is 1.8t/m^3 . Effective friction angles of $\Phi' = 32^\circ$ to $\Phi' = 38^\circ$ have been adopted depending on the CPT cone resistance, and assuming earthworks are undertaken in accordance with this report.

Geotechnical design for this project is primarily related to the amount of settlement.

CPT data has been interpreted in terms of elastic modulus “E”. Fahey et al 2003 found that E is related to overburden stress, stress history, and the magnitude of strain generated by the applied load, and can not be interpreted solely from CPT cone resistance q. They proposed a relationship of the form shown in equation (1) .

$$E = C \times (q \times \sigma_v' \times p)^{0.333} \dots\dots\dots(1)$$

Where q_c = CPT cone resistance

σ_v' = effective vertical stress

p_{atm} = atmospheric pressure (100kPa)

C is a factor which is dependent on stress history, and magnitude of strain.

Units must be consistent (for instance all kPa)

Various test methods used to measure soil stiffness can be categorised in terms of the magnitude of strain imposed. The seismic testing is interpreted as a low level strain modulus. The Pressuremeter test unload-reload modulus provides a good estimate of settlements for foundations on the stiff clays and sands of the Perth area (Fahey et al 2003) and reflects an “intermediate strain” modulus. The Marchetti Dilatometer (DMT) testing presents a large strain modulus, oriented in a horizontal direction.

Fahey et al 2003 compared stiffness values from the above three test methods for three rafts in the Perth CBD, and found the stiffness derived from seismic cone testing to be 2 to 3 times higher than that for pressuremeter testing, whilst the stiffness for DMT testing was 2 to 3 times lower. The reason for this difference is the magnitude and direction of strain (elastic modulus is strain dependent), and this highlights the need for caution in the selection of a modulus value appropriate to the magnitude of movement anticipated.

Stress history also has a substantial impact on elastic modulus. Cocks et al 2004 found that the equivalent stiffness of deep Spearwood Sand over Guildford Alluvium at the Mortimer Road bridge crossing of Kwinana Freeway at low stress levels was about 3 times that measured at comparatively high stress levels. This may be attributable to historic preconsolidation levels or aging effects. Fahey et al 2003 showed in the results of Baldi 1979, that for the sands reported by Baldi 1979 at intermediate strain levels, the stiffness of an over consolidated sand was twice that of an aged normally consolidated sand, and 5 times that of a recent normally consolidated sand.

Fahey et al 2003 have proposed a relationship for the factor C for sands in Perth CBD from $C = 70$ for normally consolidated sands under large strain, (a ratio of settlement to footing width greater than 1%) to $C = 200$ for normally consolidated aged sands, and $C = 400$ for over-consolidated sands under intermediate strain (settlement/ footing width of 0.1%).

Cocks et al 2004 present a linear relationship between E and q based on back analysis from settlement monitoring with the ratio of E/q ranging from 12 at comparatively low stress levels (inferred as less than

preconsolidation levels) to 4 for stress levels greater than a threshold value (greater than preconsolidation levels). The threshold value for this bimodal relationship is likely to be dependent on the magnitude of any previous pre-loading or aging effect. For comparatively low loads (less than 150kPa), a value of $E=6 \times q_c$ could be adopted as an approximation of the bimodal relationship, however the multiplier will decrease below about 6 as loads increase. Based on the indicative loads for the major structure at Fiona Stanley, a multiplier of 5 is reasonable.

At Fiona Stanley Hospital, it was found that vertical strain would be greater than 0.5% of footing width without taking account of interference effects between adjoining footings, based on preliminary modelling.

Adoption of $C = 150$ for this level of strain is judged to be adequately conservative based on Figure 24 in Fahey et al 2003, taking into account that the sands can be expected to be aged, cemented and overconsolidated (but not to the extent of the proposed imposed load).

Table 4 presents modulus values for the sands at this site derived from equation 1 with $C = 150$.

The Modulus values derived from $C = 150$ in equation 1 are higher at shallow depths than values derived using Cocks et al 2004, but are comparable overall.

As a further check on elastic modulus, consideration has been given to an interpretation of elastic modulus from Standard Penetrometer Test (SPT) "N". Decourt (1982) proposed $E=3 \times N$ based on extensive investigations using the SPT Test. This value is judged reasonable for intermediate strain levels, but may be high where strains become large. Based on this model, modulus values in the upper 3 or 4 m (where $N < 10$ is recorded at a number of sites) would be underestimated relative to Fahey et al 2003, and modulus values at depth ($N \gg 50$) would be over estimated.

The model developed by Fahey et al 2003 draws heavily on the results of back analysis of settlement data recorded by Fraser 1975. It therefore represents an initial settlement plus some creep that has taken place up to the time of settlement monitoring (which may have been months after most of the load had been applied to the foundations). It does not identify whether further creep may be expected to occur under sustained load during the 100 year structure life. On the other hand the model of Cocks et al 2004 estimates an immediate settlement only, with further allowance being required for creep settlement.

Cocks et al 2004 monitored creep for about 25 days on similar sands, however this monitoring duration was not long enough to establish a model for predicting long term creep. Hillman et al 1999 observed significant creep settlement for large storage tanks under constant load over calcareous soils, and provided a model for assessing long term settlements of the tanks under cyclic loading. It is possible that the low strength of calcareous sand grains (leading to crushing) may make them more susceptible to creep than siliceous sands.

Schmertmann 1970 presents a model for assessment of creep settlement based on a logarithmic time scale, as follows:

$$s_t = s_i \times (1 + 0.2 \times \log(t/0.1)) \quad \dots\dots\dots(7)$$

where s_t = total settlement; s_i = immediate settlement; t = time in years.

The settlement attributable to creep over say a 50 year design life based on this equation is large, and there is little evidence in Perth or elsewhere of problems arising from long term creep settlements of major buildings. The Schmertmann 1970 model is judged to be excessively conservative.

For the Fiona Stanley Hospital it is judged prudent to allow for some creep settlement over and above settlements calculated based on Fahey et al 2003 approach. A further contribution of up to 25% of the settlement calculated using Fahey et al 2003 is proposed for total settlements based on a 50 year structure life.

The geotechnical model for “initial” settlement derived below is applicable to the area of the main structure. Some modification to the model would be required for the area illustrated on Figure 3 as encompassing the “clay” zone intercepted at about 15m AHD – however we understand no buildings are currently planned in that area.

Table 4 – Geotechnical Model

Depth From (m)	Depth To (m)	CPT q_c (MPa)	Friction Angle θ' (degrees)	E(MPa)	Poisson's Ratio
0	2	4	32	35	0.3
2	5	9	34	45	0.3
5	10	15	36	75	0.3
10	20	20	36	100	0.3
20	30	25	36	125	0.3
30	>30	>30	36	150	0.3

Bedrock is anticipated at about -20m AHD (some 40m below ground surface).

8 RECOMMENDATIONS

8.1 General

It should be noted that the ground encountered by the testpits, Electric Friction Cone Penetrometer (CPT's) and seismic testing represent the ground conditions at the location where the tests have been undertaken and as such are an extremely small proportion of the site to be developed. Accordingly, variations to the ground conditions are likely and allowance should be made for variability in the design and construction budgets. If conditions other than those described are encountered, further advice should be sought without delay.

Whilst, to the best of our knowledge, the information contained in this report is accurate at the date of issue, ground conditions including groundwater levels can change in a limited time or due to seasonal fluctuations. For example fill could be added to a site or surface materials removed from a site that will change the thickness of surface materials and depth to the underlying materials. The potential for change in ground conditions should be recognised particularly if this report is used after a protracted delay.

It is also recommended that any plans and/or specifications prepared which relate to the content of this report or amendments to original plans and specifications be reviewed by Coffey to verify that the intent of the recommendations contained in this report are properly reflected in the design.

8.2 Site Classification

Table 5 – General Definition of Site Classes

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay site, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include: Soft soils, such as soft clays or silts or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Australian Standard AS2870-1996 provides a system of site classification for residential slabs and footing design (see Table 5). Whilst this standard is not strictly applicable to commercial scale developments, it does provide guidance on what might be anticipated for lightly loaded structures. A site classification of Class A has been assigned, provided the site is prepared in accordance with the Tender documents for bulk earthworks and Section 8.6. As the proposed structures are generally significantly larger than assumed in AS2870, it is recommended that footings are designed in accordance with the site specific footing recommendations.

8.3 Foundations

8.3.1 General

The investigated ground conditions are suitable to support conventional shallow foundation systems comprising pad and strip footings. Settlement criteria rather than bearing capacity will govern foundation design, and consideration will need to be given to the loads and total and differential settlements before deciding whether to proceed with shallow foundations.

Settlement analysis for shallow foundations has been based on two scenarios:

- Isolated footings of different dimensions (supplied by the client) without interactions;

- Simplified model of interacting footings based on indicative loads (supplied by the client).

Copies of client provided footing layout drawings (Ref: Footing Layout and Sections Reference P07037 Dwg S1 to S10 received June 2008) have been provided together with column loads.

8.3.2 Isolated footing

Allowable bearing pressures and estimated settlements, including allowance for creep (50 years) are shown in Figure 4 (square footings). Allowable bearing pressures are based on the following assumptions:

- Load eccentricity is less than 10% of footing width
- Load inclination (H/V) is less than 10%
- Effective footing embedment exceeds 1.2m.
- The ground surface is horizontal
- There is no interaction between adjacent footings.

This chart should be used for sizing of individual footings within the building complex, and elsewhere across the site where earthworks have been completed, and the “clay zone” is not present.

8.3.3 Interacting Footings with Indicative Column load

If footings are closely spaced then there will be significant interaction between the stressed zones of the individual footings. Consequently, the “pressure bulb” will be greater and the theoretical footing settlements will be higher than those shown on Figure 4.

The client provided footing layout drawings illustrate the close proximity of individual footings to one another. Analysis of the footings with consideration of the interaction effects was undertaken using Finite Element Analysis of Rafts (FEAR). The structure was analysed using the client supplied column loading and the footing layout. The estimated elastic settlement is shown in Appendix G. The maximum elastic settlement of a footing as illustrated in the figure is approximately 80mm. This does not allow for long term creep effects.

Maximum settlement occurs in the “core” of the structure where the load is applied at a basement level some 5m lower than the surrounding structure. The numerical modelling did not take this into account. Based on the geotechnical model at Table 4, footings under load at this lower elevation would be expected to settle measurably less than footings under a similar load at the higher elevation. It is also worthwhile observing that whilst loads in this lower core are significantly higher than loads for the structures at higher elevation, the weight of soil removed to achieve this lower elevation in part offsets the higher structure loads.

The figure at Appendix G should be used to illustrate qualitatively where settlements are large or small across the site, but is judged to be conservative in assessing absolute settlements.

8.3.4 Initial and Total Settlements

The maximum initial settlement of a footing is assessed to be less than 80mm based on the above argument, reducing to nominally 20mm around the margins of the building.

It should be noted that 75% of this initial settlement will take place as the structure is constructed, and will therefore be difficult to accurately monitor. The remainder will occur as the “imposed loadings” are applied.

Section 7.4 discusses the need for an allowance for some on-going creep throughout the structure life. The model proposes an allowance for creep of 25% of initial settlement. This would result in total settlements at the heaviest load concentration areas of less than 100mm, with settlements at the edge of the structure nominally 25mm.

8.3.5 Differential Settlements

The Figure G-1 at Appendix G illustrates differential settlements across the building envelope. As discussed in Section 8.3.3, this settlement distribution is qualitative rather than quantitative. There are factors such as previous stress history, aging effects in the soil, cementation effects, and varying modulus with depth that are extremely difficult (and in most cases impractical) to measure, and therefore further numerical analyses is not proposed to improve these assessments. In addition, geotechnical modelling considers only the soil effects – and not the interaction of the structure that can result in partial transfer of load from areas settling, to areas not settling. This factor is particularly important when considering differential movement brought about by localised geotechnical factors.

The approach adopted to assessing the magnitude of differential settlement is to note the difference in long term settlement between building edge and building “core area” over a distance of in excess of 35m is likely to be less than about 75mm, equating to a differential settlement of the order of 1:500 for this structure.

8.3.6 Ground Improvement

The CPT cone resistance in the upper 2m of a great number of the test sites is comparatively low. Whilst this is in part due to the low overburden over this depth range, consideration has been given as to the extent to which ground improvement might be considered, and to the nature of the ground improvement.

The low cone resistance in the upper 2m is not likely to be an issue where depths of cut in excess of about 1.5m are anticipated. Under these circumstances, the low cone resistance zone is removed, and proof compaction of the cut surface ensures a suitable surface finish.

In areas where depth of cut is less than 1.5m, or where fill is to be placed, two options have been considered:

- The soil profile is excavated to within say 0.5m to 1m of the base of the low cone resistance zone and stockpile, the cut surface is proof compacted, and the stockpiled material then replaced as engineered fill. Under this scenario, the elastic modulus of the unexcavated portion of the low cone resistance zone would have been significantly improved, and the subsequent engineered fill will be comparatively high elastic modulus.
- The surface of the 2m layer is heavily compacted (15 tonne smooth drum vibratory roller or larger) resulting in the likely improvement of the upper 1m, with the remaining 1m barely improved or in its unimproved condition.

It should be noted that sensitivity analyses have been undertaken to assess the likely impact on settlement of the structure, if the elastic modulus for a 1m thick zone was up to half the modulus of the

compacted layer (in the event that localised deepening of the low cone resistance zone occurs). The results of the analyses suggest the likely increase in settlement (initial plus creep) for individual footings proposed for this project based on retention of 1m of unimproved profile is less than 5mm (whether considered in isolation or within a group of closely spaced footings). This is a small figure in the context of an overall settlement of up to 100mm. The main disadvantage therefore of retaining a zone that is lower modulus value, is that because it will not be continuous, it will exaggerate localised differential settlements.

Brief consideration has also been given to the possibility of using stone columns to improve the overall soil stiffness. Column spacing would need to be very close to significantly improve the soil/column overall stiffness, because the existing background stiffness is comparatively high (relative to the stiffness of the stone column). A very substantial amount of limestone would need to be sourced and brought into the site, and issues of noise, vibration, and site water management would be exaggerated. This option is not being pursued.

High Energy Impact Compaction (HEIC) has also been considered, but is unlikely to be suitable without some form of preparatory works such as the placement of a crushed limestone surface because of the sand subgrade, which does not provide a suitable surface on which to rotate the HEIC roller. Vibrations from operation of the HEIC are likely to be significantly greater than normal earthworks plant, and would need to be taken into account if using this compactor. This option is not being pursued.

We understand a decision has been made that the bulk earthworks contract is to be based on excavation of nominally 1m of the low cone resistance zone.

Comments on earthworks requirements are presented in Section 8.6

8.4 Earthquake Classification

The earthquake site sub-soil classification in accordance with Australian Standards (AS 1170.4-2007) is Class C_e – Shallow Soil.

8.5 Retention Systems

Earth retaining structures should be designed in accordance with the requirements of AS 4678-2002. The soil parameters recommended for the design of the retaining walls are presented in Table 6.

Table 6 - Soil Parameters Recommended for Design of Retaining Walls

Soil Type	Depth to Top of Layer (m)	Effective Cohesion (c', kPa)	Friction Angle, (φ' degrees)	Unit Weight (γ kN/m ³)	Active Pressure K _a	At Rest K _o	Passive Pressure K _p
Natural Sand	0 - 2	0	32	18	0.307	0.470	3.255
Natural Sand/ Fill	>2	0	34	18	0.283	0.441	3.537

Key: c' denotes undrained cohesion (kPa).
 Phi' denotes undrained friction angle (degrees)

K_a	fully mobilised coefficient of active earth pressure
K_p	fully mobilised coefficient of passive earth pressure
K_o	at rest earth pressure coefficient

8.6 Earthworks

8.6.1 General

Earthworks requirements for this project are set out in Tender Document “Fiona Stanley Hospital and Health precinct: Stage A Site Clearing and Bulk Earthworks”, which is currently in draft form. Coffey has contributed to the review and improvement of this document. Based on the geotechnical investigations, and the Tender Document as reviewed by Coffey, the following further advice can be given concerning the soils at this site.

8.6.2 Suitability of Cut for Use as Engineering Fill

Unsuitable soils including topsoils, soils with an organic content in excess of 2% by weight, building rubble, timber, mulch, contaminated soils, clay, silt (soils with fines content greater than 5% by weight finer than 0.075mm) and rubbish should be stripped from site. The sands remaining after stripping of unsuitable soils are suitable for use as engineered fill sands within this site.

The landscape architects advice should be sought as to their suitability for landscaping purposes.

8.6.3 Excavatability

Sands encountered at this site become very dense, and probably cemented at depth. Deep ripping may be required at depth to assist in excavation where CPT cone resistance is in excess of 20MPa. We would anticipate ripping to be comparatively easy for a D8 or equivalent dozer with single tyne ripper.

8.6.4 Earthworks Slopes

Excavated slopes will be in sand. It is recommended that temporary excavated slopes be constructed not steeper than 1V:1.8H. In the long term, slopes will require protection from erosion by either reducing slopes and vegetating them (slopes nominally no steeper than 1V:3H) or by stone pitching or other means. Slopes with structures or other surcharge closer to the crest than the height of the slope should be reviewed for stability. Slopes of sumps or immediately adjacent sumps should also be reviewed.

8.6.5 Heavy Proof Compaction in Areas to be Filled

Comparatively dense sands will be exposed in areas where more than say 2m of soil is to be cut. A semi-circular area exists encompassing low lying land north of the main access from Murdoch Road into the site, where filling is likely to take place, and as discussed in Section 8.3, this semi-circular area should be compacted as deeply as practical using a heavy vibratory roller. Guidelines for this work have been developed separately (see Section 8.6.1)

The area requiring heavy compaction for the major structures proposed for this project, is of the order of 100m from the nearest building, and whilst vibration monitoring will be required, the separating distance may be sufficient to maintain vibrations within current background levels for those buildings. Vibration monitoring trials are recommended (see Section 8.12.2).

8.7 Flexible Pavements

8.7.1 Subgrade CBR

A design subgrade 4 day soaked CBR of 10 is recommended based on a consideration of:

- CPT
- Correlations with soil classification tests;
- Regional experience;

The adoption of this design value is contingent upon strict compliance with the site preparation recommendations given in the Tender documents.

8.8 Groundwater

Coffey has previously (2004) examined groundwater elevations in the region immediately encompassing Kwinana Freeway south of South Street intersection. Data used in this assessment spanned the Fiona Stanley hospital site. Data sources that have been drawn on from this previous investigatory work, and from the site specific Fiona Stanley studies include the following:

- Main Roads Bore KW1 located in the south west quadrant of the intersection (and within the boundaries of the Fiona Stanley Hospital site) was monitored monthly from August 1988 to June 1990. Results of that monitoring showed:
 - a normal seasonal cycle of about 1.2m (from minimum to maximum groundwater level);
 - minimum groundwater level was in February 1990 at 18.47m AHD;
 - maximum groundwater level was in August 1988 at 19.54m AHD.
- Department of Environment and Conservation "WIN" database bores 3170 and 3171 located on Murdoch Drive, north of Bramanti Drive (and now abandoned). These bores were monitored from June 1973 to January 1993, and show:
 - a normal seasonal cycle of about 1.2m
 - the highest groundwater level recorded since 1974 was August 1988 – i.e. the time KW1 was being monitored.
- Department of Environment and Conservation "WIN" database bore 4487 located north of Leach Highway records water levels from 1974 to present. This bore also confirms that 1988 was the highest groundwater level recorded since the early 1970's, and that annual maximum levels are generally 0.3m or more below this level.
- Coffey installed a piezometer PZ7 in the west of the Kwinana Freeway at the southern end of the then park-and-bus facility (i.e immediately east of the Fiona Stanley site). Monthly water levels were recorded at that piezometer from June 2004 to November 2004, and showed a minimum groundwater level of 17.64m AHD in June 2004 and a maximum groundwater elevation 18.61m AHD in October 2004. This maximum level was over 0.9m lower than the maximum level recorded in KW81 (in comparatively close proximity) in August 1988.

The above results indicate groundwater levels have typically fallen since the early 1970's and more recently since 1988.

Piezometer levels for the current piezometers installed by Coffey BH101, 102, 103 and 104 (see Table 2) showed a maximum level in April 2008 (i.e. end of summer seasonal minimum) of 17.7mAHD near the boundary of the Fiona Stanley site and the Kwinana Freeway. This level is similar to the end of summer level recorded in PZ7 in June 2004.

In addition to the piezometer records at Table 2, earlier piezocone testing by GHD can be used to provide an approximate interpretation of groundwater elevations across the site at that time (June 2007). Indicative groundwater contours from that data show a predominantly east to west fall of about 1m across the site. A low lying area and associated man made swamp near the southern boundary influenced water contours, with levels not falling across this zone until about its western edge. There is some indication in both the GHD data and the piezometer results that groundwater levels may fall more steeply west of this man made swamp area, towards Murdoch Drive.

Based on the regional data sighted for this project (reinforced by observations elsewhere in urbanised areas of the Perth Coastal plain), groundwater levels have declined in recent decades. The fall is attributable to reduced rainfall, drainage works, and heavy groundwater consumption. There may be other causes. Given the similarity in end of summer water level records for PZ7, and for the bores in Table 2, we have adopted 17.7m AHD as representative of the Annual Average Minimum Groundwater Level, covering the eastern margin (say 100m from the eastern boundary) of the site. Annual Average Maximum Groundwater Level for this area is judged to be 18.9m AHD (allowing for 1.2m of seasonal rise and fall). The groundwater level recorded in KW81 was the highest level recorded since the early 1970's (i.e. a 30 year time frame) at 19.54m AHD. Given the probability that with falling regional groundwater levels, this elevation will not be exceeded, and given the location of this bore, we have adopted 19.6m AHD as a probable maximum groundwater level for this eastern margin.

The fall in groundwater elevations from BH103 and BH104 (eastern margin of the site) to BH101 was 0.8m in April 2008 (end of dry seasonal conditions). BH102 which is located between these sites was lower elevation than BH101, possibly reflecting some influence from the low lying interdunal swale immediately to the south. This observation contrasts with the GHD piezocone data which indicates comparatively high groundwater elevations adjacent the swamp. In order to be conservative in estimating maximum levels the low result from BH102 is ignored.

It is proposed that for design purposes, a fall in groundwater elevations of 0.5 be adopted for the estimates of maximum groundwater elevations, for a line through the eastern road for St John of God Hospital and the western boundary of the man made swamp area, with a further 0.5m fall to Murdoch Road. This distribution is illustrated on Figure 5.

Maximum current groundwater levels for this site are summarised in Table 7. It should be noted that with changing land use there will be some changes in these groundwater levels. For example clearing of trees can be expected to result in increased recharge, however collection of stormwater will direct the recharge into specific areas, rather than distributed across the site. The potential impact of the works on this site will need to be considered as an iterative process as design evolves. It is recommended that for current design purposes, the groundwater elevations presented in Table 6 be adopted.

It should be noted that when designing for water proofing of buried structures, an allowance for capillary rise of 0.6m over and above MPGL will be required.

Table 7 – Maximum Groundwater Levels (Current Conditions)

LOCATION	Annual Average Maximum Groundwater Elevation (AAMGL) - mAHD	Maximum Probable Groundwater Elevation (MPGL) - mAHD
Within 100m of Boundary with Kwinana Freeway	18.9	19.6
Line Coincident with Access Road East of St John of God Hospital	18.4	19.1
Murdoch Drive	17.9	18.6

Groundwater quality is discussed in Section 7.3.2 of this report

8.9 Subsoil Drains & Compensating Basins

Subsoil drainage will be required where the Maximum Probable Groundwater Level rises to within 0.6m of the underside of road base course or to within 0.6m of underside of footings for structures not provided with water proofing of foundations. It is understood that basement of some structures may extend below the water table, in which case the structures must be designed to resist buoyant uplift based on the MPGL plus a suitable Factor of Safety, and to be water proofed allowing for capillary rise.

Compensating or attenuation basins are proposed within this site, the effectiveness of such infrastructure to dispose runoff by infiltration will be limited where the water table is in close proximity to their underside. In addition, consideration will need to be given to the influence of rising groundwater elevations within such storage facilities, on adjoining structures. For design purposes, a permeability of 5m/d (average of the piezometer falling head test results – and a number suitable representative of sands in the region) and a specific yield of 0.20 may be adopted (again, suitably representative of these sands). Detailed design will require a drainage layout plan and design showing the retention/attenuation system details.

8.10 Acid Sulphate Assessment

8.10.1 Soil Sampling Methodology

An *in-situ* ASS soil sampling program was implemented on 1 May 2008 through to 14 May 2008, concurrent with the geotechnical investigations. Soil samples were collected from the 19 test pit locations to a maximum depth of 4m BGL (or pit collapse) and from the 4 borehole locations to 25m BGL. Soil samples were collected at 0.25m intervals from testpits, and 0.5m intervals from boreholes, and stored in ziplock bags with the air excluded and stored on ice. Samples were delivered to the laboratory at the end of each field day.

8.10.2 Sample Analysis

Field tests were conducted on all samples at ALS Laboratory in Malaga, WA. The results of the field tests were used to determine which samples required further laboratory analysis.

Based on the field test results, approximately 25% of the samples were analysed for Chromium Suite (S_{CR}) with approximately 25% of these also being analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS). Laboratory analysis was only carried out on samples which were in the potential zone of disturbance (up to 12m BGL) ALS Laboratory is NATA accredited for the analyses performed.

The S_{CR} and SPOCAS methods provide a standard approach provides measurements of field pH (pH_{KCL}), oxidation pH (pH_{OX} – SPOCAS only), chromium reducible sulphur (S_{CR}) or peroxide oxidisable sulphur (S_{pos}), total actual acidity (TAA), retained acidity (S_{NAS}) and an indication of buffering capacity via calcium, magnesium and sodium analyses before and after oxidation.

The results of the field tests and laboratory analyses are tabulated in Appendix H.

8.10.3 Results

The laboratory screening results for the pH_f and pH_{fox} for test pitting (typically the uppermost 3m) showed only slight reaction, suggesting the presence of acid sulphate soils to be unlikely at shallow depth. This is further confirmed by results from S_{CR} and SPOCAS laboratory testing, with net acidity values below the limit of reporting (i.e. <0.02% Sulphur).

Results from field tests for the boreholes at greater depths (i.e greater than 3m) show a large variability in the degree and severity of reactions, suggesting acid producing sediments may occur at depth, typically below the water table. Laboratory testing identified two samples with a net acidity greater than 0.03% sulphur in BH102. The net acidities did not significantly exceed values, with a net acidity of 0.03%S at 3.35m – 3.45m BGL and a net acidity of 0.04%S at 4.85m-4.95m BGL. These results appear to be associated with an oxidised sand zone around water table level, which is likely to continue throughout the low lying area and man made wetland adjacent to the borehole.

During bulk earthworks, only the upper soil profile will be disturbed in these low lying areas (topsoils, and the next metre). Testing did not encounter acid sulphur conditions in this aerated zone (above normal summer low groundwater elevations). The bulk earthworks therefore do not require an Acid Sulphate Soil Management Plan (ASSMP).

During the subsequent construction phase, the east west “tunnel” will extend below the aerated soil zone, and there is clearly a potential for at least low level acid sulphur conditions to be encountered.

An acid sulphate soil and dewatering management plan will need to be developed for this subsequent phase.

8.11 Dewatering

During bulk earthworks, there is a possibility that localised dewatering may be required, depending on seasonal groundwater conditions, the depth of cutting required in low lying areas, and the size of the earthworks “Lot” being worked at that time. It is unlikely that depths of dewatering required will be less than 1m (and possibly less than 0.5m), and in order to achieve this, the contractor may simply use open drains across the site to assist in lowering water levels to a low “sump” from where the draining water can be pumped into the existing man made wetland south of the main east-west access route. Dewatering rates of less than 5L/s are anticipated assuming the area of earthworks opened at any one time requiring dewatering is less than 4000m².

A licence application for this dewatering should be sought from the Department of Water at the earliest opportunity.

Final floor levels for most of the main structure are at about 23m AHD. This is well above the maximum probable groundwater level for the site. However there is a pronounced east west tunnel, and also an associated basement area – both at final floor level of 18m AHD - which will extend below annual average maximum groundwater levels. In order to construct these lower elevation areas it will be necessary to dewater to as low as 16m AHD (to allow for the foundation thickness plus an allowance to drain the soils on which the footing is cast).

In preliminary planning for the dewatering, it has been necessary to make a number of assumptions:

- Discharge of dewatering water to the low lying area to the north will not be permitted because of risks to the Kwinana Freeway/ South Street pavement and drainage system (there is a risk that significant recharge might overwhelm the drains);
- Discharge is likely to take place into the man made wetland to the south of the main east west access;
- The potential impact on the Police Station or Fire Station arising from elevated groundwater levels down gradient of the recharge area is assumed to be acceptable (but this will need to be confirmed);
- Some bunding around this wetland will be required, allowing it to flood to a level of 21m AHD;
- If the whole of the site is to be dewatered over a 150m length and up to 60m width (the zones encompassing the east and west “core areas” of the main building), with nominally 2.5m drawdown to 16m AHD (based on annual average maximum levels) then a hydraulic gradient between the recharge area and the tunnel of 5m over a distance of about 90m will be created;
- Preliminary analysis indicates dewatering rates of in excess of 2000kL/d must be anticipated based on a permeability of 5m/d. For design purposes (for example to allow for an underestimate of permeability), a discharge area based on 3000kL/d should be sized;
- Preliminary “sump” modelling indicates the wetland to the south of the main east west access, particularly if permitted to fill to a level of 21m AHD, will be able to drain water back into the water table at a sufficiently high rate that this dewatering can continue for a prolonged period.
- It will not be possible to cease dewatering in any one stage until measures have been taken to equalise uplift pressure under the structure that will arise as groundwater levels recover. An alternative approach is to allow the structure to temporarily flood (equalising water pressures), until further load is added;

Consideration may need to be given to dewatering in a series of stages (for example the eastern lobe with Core 1, 2, 3, 4 ; the western lobe with Core 1, 2, 3, 4; and the tunnel in possibly 3 further sections, making 5 sections in all), in order to reduce the dewatering impacts.

Issues associated with dewatering are potentially very significant given the above. A dewatering plan will need to be developed between structural designer, groundwater advisor and environmental consultant, and more detailed numerical analysis undertaken to establish dewatering rates and the adequacy of the recharge area for the duration of these works.

A dewatering approval will be required from the Department of Water prior to any dewatering, and it should be noted that such approval normally takes well over a month to obtain following lodgement of the application.

Dewatering will need to be undertaken in accordance with the Department of Waters guidelines on Dewatering, available through their web page. It is noted that disposal of water by recharge is the preferred approach by the Department. The water quality is judged suitable for disposal as proposed.

8.12 Construction Considerations

8.12.1 General

There are a number of activities that must be undertaken during construction to ensure compliance with design and to ensure the smooth running of the project. The following activities should be carried out during the contract.

8.12.2 Protection of Adjacent Structures

The existing St John of God Hospital in particular, but also the Police Station and the Fire Station need to be protected from vibrations generated at this site. An acceptable level of vibrations has not been investigated for the existing buildings. In laboratories or areas of specialised equipment, even small vibrations may pose a risk firstly to the work to which the equipment is being applied, and secondly to the equipment itself. Prior to commencing works, it is strongly recommended that investigations be undertaken to establish background peak particle velocities at critical locations in adjacent buildings (particularly the hospital), and use these background levels as “not to be exceeded” at the same locations if at all possible, by the construction equipment on the Fiona Stanley Hospital site, operating very much further away.

A specialist vibration consultant should be engaged for that work.

8.12.3 Preparation of Footing Bases in Sands

Foundations for the proposed structures will be founded in areas of cut over natural comparatively dense sands, or in areas of fill, where the subgrade was initially heavily proof compacted, and subsequent filling has been engineered. Nevertheless the site is a large one, and occasional loose sand pockets are possible in both natural and fill environments, or as a result of disturbance during excavation of the footing. It is recommended that the compaction at the base of footings be checked to confirm that it meets the minimum requirements for a Perth Sand Penetrometer of 7 blows over the test interval 150mm to 450mm and 10 blows over the test interval 450mm to 750mm. Further advice should be sought if these criteria are not achieved.

8.13 Construction Monitoring

8.13.1 Settlement Monitoring

The scale of this structure is particularly large, and the settlements assessed in this report are large. Whilst more than 50% of settlements are expected to take place as the structure is built, this still leaves a substantial amount of ongoing settlement as “imposed” loads are applied and as creep settlement takes place. It is strongly recommended a settlement monitoring programme be established on completion of bulk earthworks, and as part of the construction contract.

The settlement monitoring could be undertaken by casting survey “pins” at accessible locations on selected basement columns, and monitoring with survey accurate to nominally 1mm tolerance, x, y and z locations. Monitoring could proceed monthly throughout construction, and 6 monthly through the builders contracted maintenance period. The builder could be given the responsibility for establishing the pins and collecting the data.

8.13.2 Monitoring Water Levels

During the fieldwork stage of this investigation 5 standpipes were put in place to monitor the groundwater table. Where possible, these piezometers should be maintained and monitored monthly throughout the winter months to confirm seasonal conditions. On completion of construction the need for ongoing groundwater monitoring should be reviewed, particularly where the discharge of stormwater may have an adverse impact on the water table.

Depending on the location of stormwater disposal facilities, it may be necessary to establish additional piezometers so that the impact of stormwater disposal can be understood. This work could also be undertaken by the builder, with monitoring conducted monthly during construction, and about April and October of each year during post construction maintenance period.

8.13.3 Earthworks Monitoring

The tender documents set out the requirements for earthworks monitoring for this project. The Superintendent may wish to consider the appointment of a Geotechnical Testing Authority (as defined in AS3798-1996) to provide an independent check on earthworks activities and interpret the contractors quality assurance data on earthworks.

9 FURTHER STUDIES

An additional 3 CPT probes are recommended within the area of the central block of the hospital, where environmental constraints have prevented earlier testing (see Section 7.2). The need for a vibration monitoring study prior to major earthworks has been identified in Section 8.2.2. We have also recommended settlement monitoring, and groundwater level monitoring as outlined in Sections 8.13.1 and 8.13.2, and suggested consideration be given to engaging a Geotechnical Testing Authority during earthworks, in Section 8.13.3.

There are some tasks that formed the “objectives” of this study at Section 3, which have not been completed. These include further advice on Acid Sulphate management during construction of the tunnel (a management plan will be required – see item I in Section 3), and advice on the stormwater compensation system (see item M – at this stage we have not sighted concept drawings). On going advice will also be required under the current brief, for items Y (provide geotechnical advice during design) and Z (provide geotechnical advice during construction).

This report has identified that there may be a significant dewatering requirement for the east west tunnel and associated basement areas for the main building. The main issue is likely to be confirming the approach that is to be taken to dewatering, estimating the quantities and durations of dewatering, and establishing that the water can be disposed of without adverse impact on others/ the environment. Licencing for this dewatering will need to be sought, and adequate time allowed for the statutory processes in view of the likely size of the dewatering operation. The overall dewatering management plan (i.e taking into account disposal and relevant approvals) is beyond the scope of the original brief for this project.

10 IMPORTANT INFORMATION ABOUT YOUR COFFEY REPORT

The reader's attention is drawn to the important information about this report which follows the main text.

11 REFERENCES

The following standards and references were used in the preparation of this report.

AS 1170.4-2007 Structural design actions Part 4: Earthquake Actions in Australia.

AS 1289 Method of Testing Soils For Engineering Purposes.

AS 1726-1993 SAA Geotechnical Site Investigations.

AS 2870-1996 Residential Slabs and Footings.

AS 3798-1996 Guidelines on Earthworks for Commercial and Residential Developments

AS 4678-2002 Earth Retaining Structures

Cocks G.C., Simpson K and Hillman M.O. 2004 "Liquefaction and Settlement Assessment for the Mortimer Road Bridge, Perth", Australian Geomechanics Vol 38 No 4, January 2004

Davidson W.A. 1995 "Hydrogeology and Groundwater Resources of the Perth Region Western Australia", Bulletin 142 Geological Survey of Western Australia

Decourt L 1995 "Prediction of Load- Settlement relationships for Foundations on the Basis of the SPT Test" Ciclo de Conferencias Intern. "Leonardo Zeevaert" UNAM, Mexico 85-104

Fahey M, Lehane B and Stewart D 2003 "Stiffness for Shallow Foundation Design in Perth CBD" Australian Geomechanics Volume 38 No 3, September 2003

GHD Geotechnics 2007 "Fiona Stanley Hospital: Report on Preliminary Geotechnical Investigations" Report prepared for Department of Housing and Works, Revision 0, September 2007

GHD 2008 "Fiona Stanley Hospital – Stage 1 Land Development Technical Specification" document 61/19514/75587 dated May 2008 (in DRAFT form). Document to form part of "Fiona Stanley Hospital and Health Precinct: Stage A Site Clearing and Bulk Earthworks – Tender Document"

Hillman M.O., Cocks G.C., Szymakowski J.B. "Tank Settlements on Calcareous Soils, Kwinana, W.A." In Proceedings 8th Australian New Zealand Conference on Geomechanics: Consolidating Knowledge, Hobart

Water and Rivers Commission 1997 "Perth Groundwater Atlas"

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by

earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

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% 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% 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.

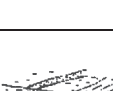
Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

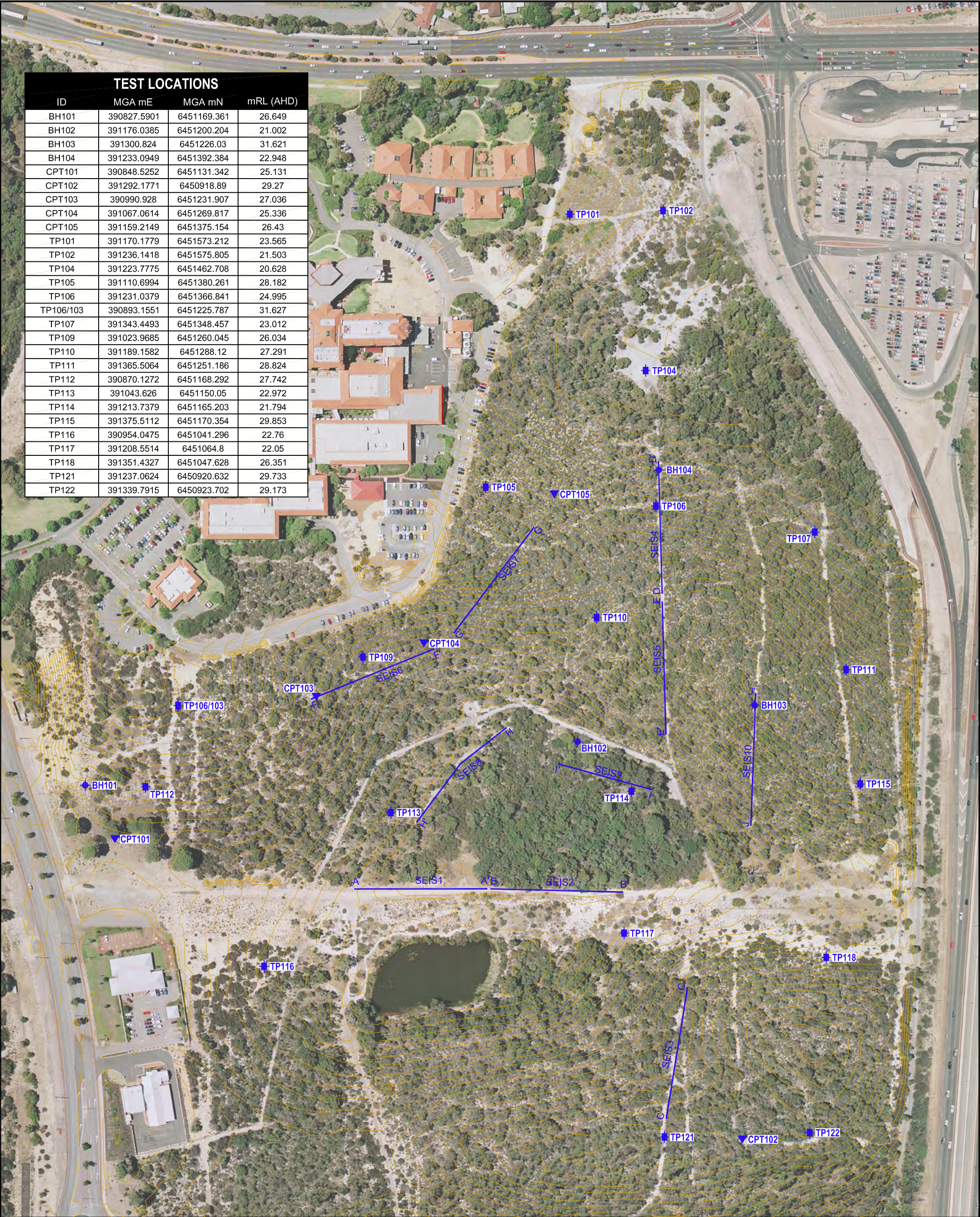
FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)					USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little 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 (A 0.075 mm particle is about the smallest particle visible to the naked eye)	SILTS & CLAYS Liquid limit less than 50	IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.				
		DRY STRENGTH	DILATANCY	TOUGHNESS		
		None to Low	Quick to slow	None	ML	SILT
		Medium to High	None	Medium	CL	CLAY
	SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		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%.						

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

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM	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.		SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
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.		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	
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.		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.	
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.		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.	

Figures



TEST LOCATIONS			
ID	MGA mE	MGA mN	mRL (AHD)
BH101	390827.5901	6451169.361	26.649
BH102	391176.0385	6451200.204	21.002
BH103	391300.824	6451226.03	31.621
BH104	391233.0949	6451392.384	22.948
CPT101	390848.5252	6451131.342	25.131
CPT102	391292.1771	6450918.89	29.27
CPT103	390990.928	6451231.907	27.036
CPT104	391067.0614	6451269.817	25.336
CPT105	391159.2149	6451375.154	26.43
TP101	391170.1779	6451573.212	23.565
TP102	391236.1418	6451575.805	21.503
TP104	391223.7775	6451462.708	20.628
TP105	391110.6994	6451380.261	28.182
TP106	391231.0379	6451366.841	24.995
TP106/103	390893.1551	6451225.787	31.627
TP107	391343.4493	6451348.457	23.012
TP109	391023.9685	6451260.045	26.034
TP110	391189.1582	6451288.12	27.291
TP111	391365.5064	6451251.186	28.824
TP112	390870.1272	6451168.292	27.742
TP113	391043.626	6451150.05	22.972
TP114	391213.7379	6451165.203	21.794
TP115	391375.5112	6451170.354	29.853
TP116	390954.0475	6451041.296	22.76
TP117	391208.5514	6451064.8	22.05
TP118	391351.4327	6451047.628	26.351
TP121	391237.0624	6450920.632	29.733
TP122	391339.7915	6450923.702	29.173

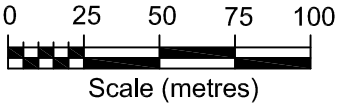
LEGEND

- SEISMIC LINE (COFFEY)
- BH101

BOREHOLE (COFFEY)
- CPT101

CPT (COFFEY)
- TP101

TEST PIT (COFFEY)



drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



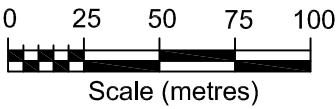
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	TEST LOCATION PLAN - COFFEY		
project no:	GEOTHERD08340AB	fig no:	FIGURE 1
rev:			

DWG: F:\Geotechnical\HERD08000\GEOTHERD08304AB\DWG\REPORT AC\GH8304AB-FIGURE 1-REV8.dwg REF:



LEGEND

- SEISMIC LINE (COFFEY)
- BH101 BOREHOLE (COFFEY)
- CPT101 CPT (COFFEY)
- TP101 TEST PIT (COFFEY)
- CPT02 CPT (OTHERS)
- BH3 BOREHOLE (OTHERS)



drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	TEST LOCATION PLAN - COFFEY & GHD		
project no:	GEOTHERD08340AB	fig no:	FIGURE 2
rev:			

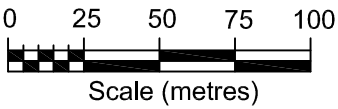
DWG: F:\Geotechnical\HERD08000\GEOTHERD08304AB\DWG\REPORT AC\GH8304AB-FIGURE 1-REV8.dwg

REF:



LEGEND

- SEISMIC LINE (COFFEY)
- BOREHOLE (COFFEY)
- CPT (COFFEY)
- TEST PIT (COFFEY)
- CPT (OTHERS)
- BOREHOLE (OTHERS)



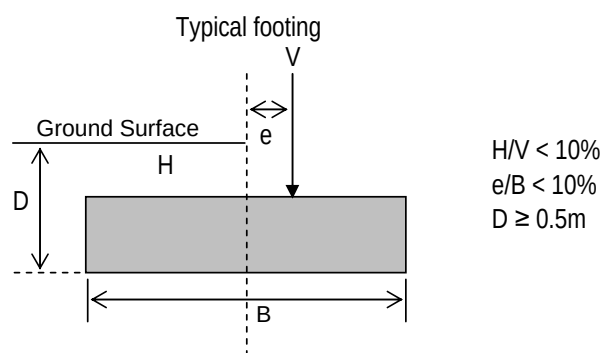
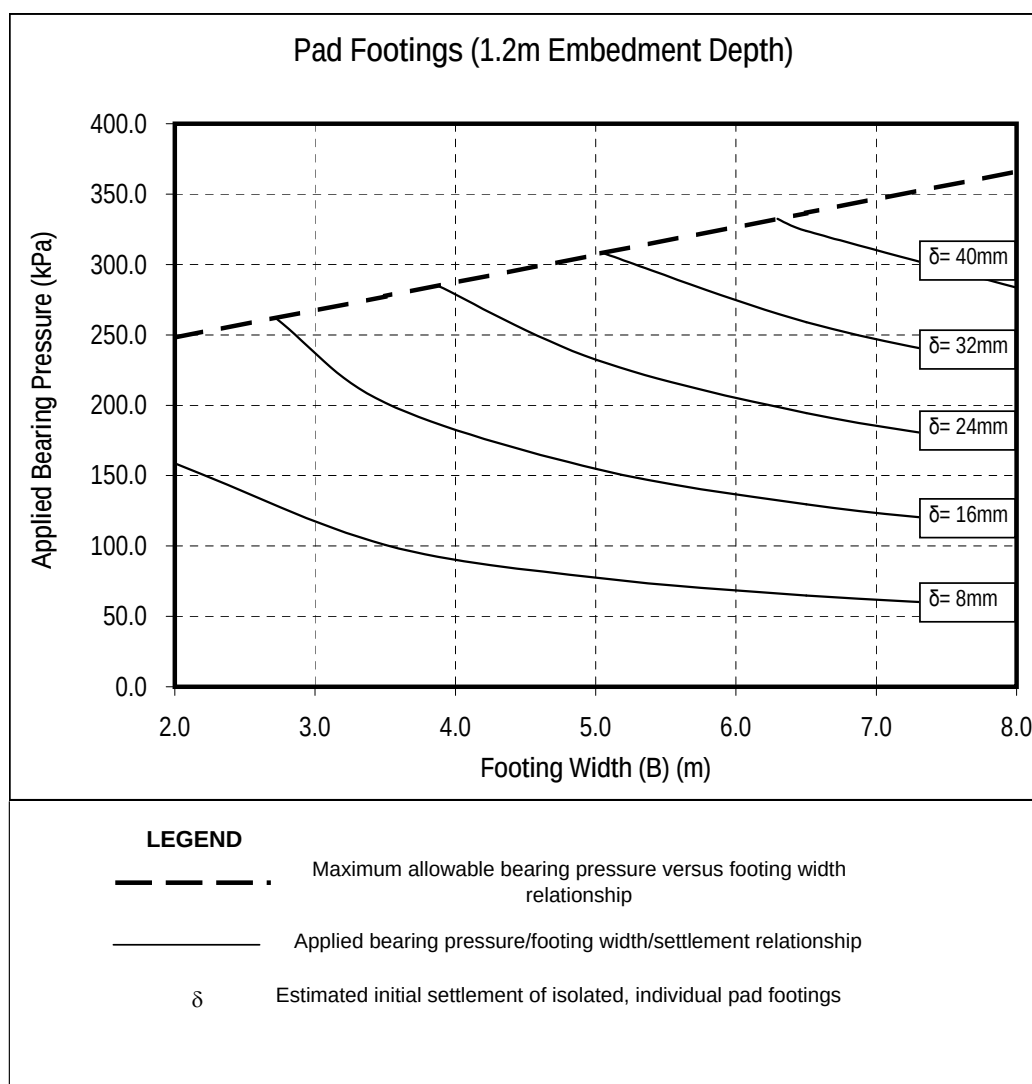
drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	APPROXIMATE EXTENT OF CLAY SOIL ZONE		
project no:	GEOTHERD08340AB	fig no:	FIGURE 3
rev:			

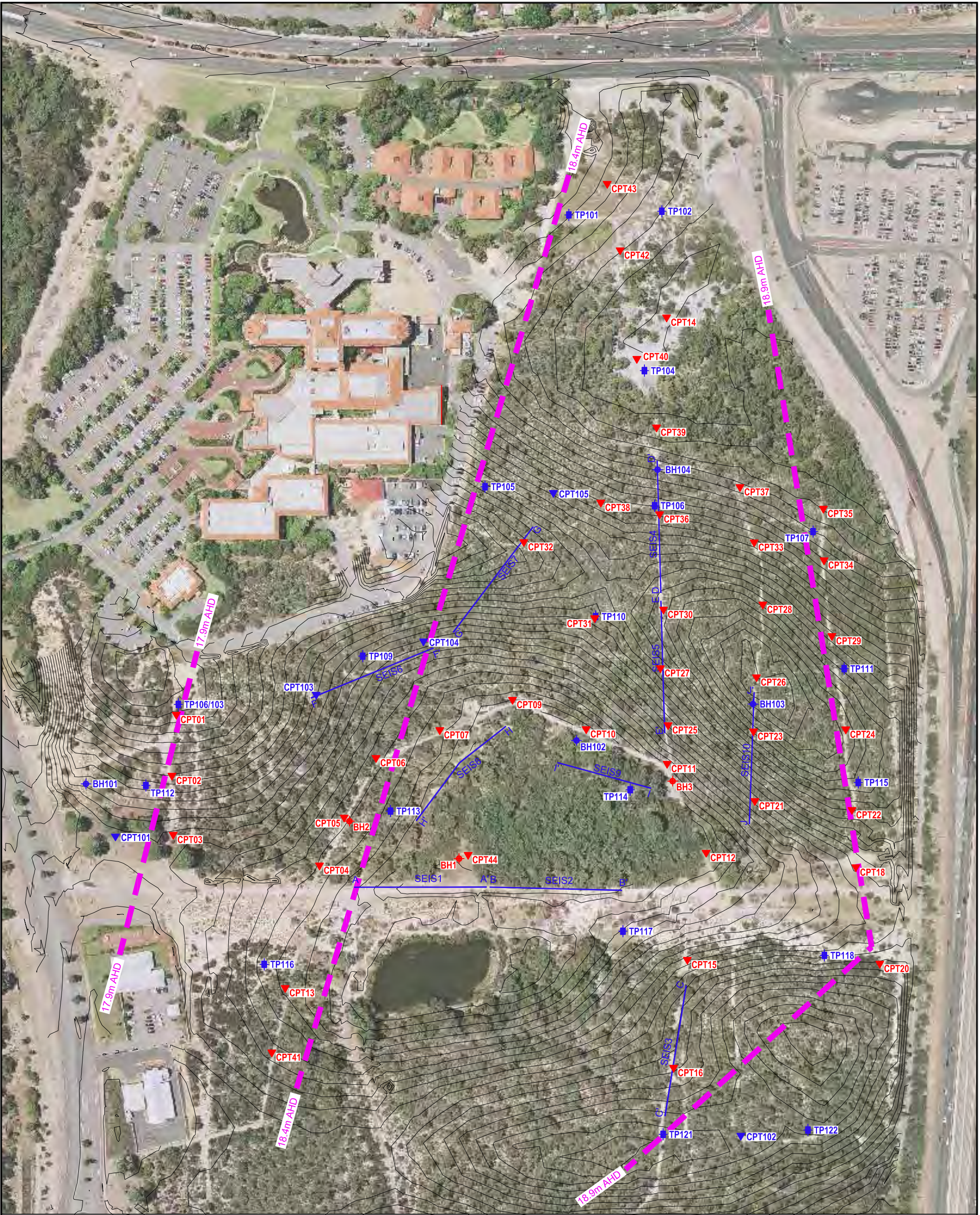
DWG: F:\Geotechnical\HERD08000\GEOTHERD08304AB\DWG\REPORT AC\IGH8304AB-FIGURE 1-REV8.dwg

REF:



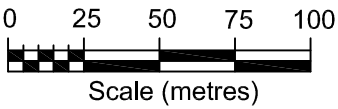
Note: This chart has been constructed assuming there is no interaction between footings.
Initial Settlement only, settlement does not include creep settlement.

drawn	PCW	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E	
approved			project:	Fiona Stanley Hospital	
date	30-May-08		title:	Allowable Bearing Capacities & Settlements for Pad Footings - 1.2m Embedment Depth	
scale	As Shown		project no:	GEOHERD08304AB	figure no: FIGURE 4
original size	A4				



LEGEND

- SEISMIC LINE (COFFEY)
- BH101 BOREHOLE (COFFEY)
- CPT101 CPT (COFFEY)
- TP101 TEST PIT (COFFEY)
- CPT02 CPT (OTHERS)
- BH3 BOREHOLE (OTHERS)



NOTE: AAMGL CAN BE SUSPECTED TO BE EXCEEDED ON AVERAGE EVERY TWO YEARS.

drawn	DAC
approved	
date	5/06/08
scale	1 : 2500
original size	A3



client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	ANNUAL AVERAGE MAXIMUM GROUNDWATER LEVELS (AAMGL)		
project no:	GEOTHERD08340AB	fig no:	FIGURE 5
rev:			

REF:

DWG: F:\Geotechnical\HERD08000\GEOTHERD08304AB\DWG\REPORT AC\IGH8304AB-FIGURE 1-REV8.dwg

Appendix A

Results of Field Investigation Boreholes

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH101**

Sheet No. 1 of 4

Project No. **GH08304AB**

Date started : **6/5/08**

Date completed **7/5/08**

Logged by : **CT**

Checked by :

Position : E: 390827.5901, N: 6451169.361 (50 MGA94) Surface Elevation : 26.649m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Track Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
					0.0			
					26.5			
					26.0			
				SPT 6, 10, 9 N=19	25.5	SAND, fine to medium grained, yellow	W	D
				1.45m				
					25.0			
				SPT 4, 7, 9 N=16	24.5	becoming orange		
				2.45m				
					24.0			
				SPT 4, 7, 9 N=16	23.5			
				3.45m				
					23.0			
				SPT 8, 10, 15 N=25	22.5	becoming pale yellow orange		
				4.45m				
					22.0			
				SPT 8, 13, 18 N=31	21.5			
				5.45m				
					21.0	becomes coarser with depth to fine - coarse grained		
				SPT 8, 11, 13 N=24	20.5			
				6.45m				
					20.0	SAND, sub-rounded, orange	W	D
				SPT 7, 12, 15 N=27	19.5			
				7.45m				
					19.0			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH101**

Sheet No. 2 of 4

Project No. **GH08304AB**

Date started : **6/5/08**

Date completed **7/5/08**

Logged by : **CT**

Checked by :

Position : E: 390827.5901, N: 6451169.361 (50 MGA94) Surface Elevation : 26.649m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Track Casing Diameter : 50 mm

drilling information						material substance							
drilling method & casing	water	VE penetration		samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations		
WB	06/05/08	E	H	SPT 11, 17, 23 N=40 8.45m	18.5			SAND, fine to medium grained, sub-rounded, white pale grey	W	VD			
					18.0								
				SPT 12, 20, 25 N=45 9.45m	17.5								
					17.0								
					16.5								
				SPT 10, 15, 19 N=34 10.95m	16.0								
					15.5								
					15.0								
				SPT 9, 17, 18 N=35 12.45m	14.5							D	
					14.0								
					13.5								
				SPT 11, 19, 26 N=45 13.95m	13.0								
	12.5												
	12.0												
	11.5												
SPT 12, 21, 30 N=51 15.45m	11.0												

Hole No.	BH101
Sheet No.	3 of 4
Project No.	GH08304AB
Date started :	6/5/08
Date completed	7/5/08
Logged by :	CT
Checked by :	

Angle from horizontal : 90°
 Ring Diameter : 50 mm

drilling information						material substance																																					
drilling method & casing	water	penetration VEFH	samples & field tests	RL (m)	depth (m)	graphic log	material description	moisture condition	consistency / relative density	structure and other observations																																	
							SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components																																				
WB			SPT 19, 40, 10 N*=50 16.95m	10.5	16.0		SAND, fine to medium grained, sub-rounded, white pale grey (<i>continued</i>)	W	VD	SPT Recovery: 0.17 m																																	
		SPT 13, 23, 27 N*=50 18.45m	9.5	17.0	SAND, fine to medium grained, sub-rounded, pale grey; well sorted, upper medium to lower coarse grained dominate		SPT Recovery: 0.28 m																																				
		SPT 26, 24, 0 N*=24 19.85m	8.5	18.0	SAND, fine to medium grained, sub-rounded, pale orange grey; well sorted, fine grained dominate						SPT Recovery: 0.24 m																																
		SPT 21, 29 N*=R 21.30m	7.0	19.0	becoming coarser, slight odour (groundwater)							SPT Recovery: 0.27 m																															
		SPT 15, 26, 24 N*=50 22.95m	6.0	20.0									SPT Recovery: 0.15 m																														
			5.5	21.0																																							
			5.0	22.0																																							
			4.5	23.0																																							
			4.0																																								
			3.5																																								
		3.0																																									

METHOD		penetration		samples & field tests		classification symboles & soild description		consistency / relative density	
AS	auger screwing*		No Resistance	U50	- Undisturbed Sample 50mm diameter	Based on Unified Classification System		VS	- Very Soft
AD	auger drilling*			U63	- Undisturbed Sample 63mm diameter			S	- Soft
RR	roller/tricone			D	- Disturbed Sample			F	- Firm
W	washbore			B	- Bulk Disturbed Sample	moisture		St	- Stiff
CT	cable tool			E	- Environmental Sample			D	- Dry
HA	hand auger			MC	- Moisture Content	M	- Moist	H	- Hard
DT	diatube			HP	- Hand Penetrometer (UCS kPa)	W	- Wet	VL	- Very Loose
* bit shown by suffix				N	- Standard Penetration Test (SPT)	Wp	- Plastic Limit	L	- Loose
B	blank bit			N*	- SPT - sample recovered	WL	- Liquid Limit	MD	- Medium Dense
V	V bit			Nc	- SPT with solid cone			D	- Dense
T	TC bit			P	- Pressuremeter			VD	- Very Dense

Hole No.	BH101
Sheet No.	4 of 4
Project No.	GH08304AB
Date started :	6/5/08
Date completed	7/5/08
Logged by :	CT
Checked by :	

Checked by :

Casing Diameter : 50 mm

drilling information						material substance							
drilling method & casing		water	penetration			samples & field tests	RL (m)	depth (m)	graphic log	material description	moisture condition	consistency / relative density	structure and other observations
WB			VE	E	H	SPT 36, 14, 0 N=14 24.45m				SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components			
							24.0						SPT Recovery: 0.17 m
							2.5			BOREHOLE BH101 TERMINATED AT 24.17 m			
							2.0						
							25.0						
							1.5						
							1.0						
							26.0						
							0.5						
							0.0						
							27.0						
							-0.5						
							-1.0						
							28.0						
							-1.5						
							-2.0						
							29.0						
							-2.5						
							-3.0						
							30.0						
							-3.5						
							-4.0						
							31.0						
							-4.5						
							-5.0						

METHOD

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

penetration

No Resistance

water

10 Oct., 73 Water Level on Date shown

water inflow

water outflow

samples & field tests

U50 Undisturbed Sample 50mm diameter
U63 Undisturbed Sample 63mm diameter
D Disturbed Sample
B Bulk Disturbed Sample
E Environmental Sample
MC Moisture Content
HP Hand Penetrometer (UCS kPa)
N Standard Penetration Test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
P Pressuremeter

classification symbols & soil description
Based on Unified Classification System

moisture

D Dry
M Moist
W Wet
W_p Plastic Limit
W_L Liquid Limit

consistency / relative density

VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 1 of 4

Project No. **GH08304AB**

Date started : **8/5/08**

Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94)

Surface Elevation : 21.002m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE penetration	H	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
					RL (m)	SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components		structure and other observations
					0.0	SAND , fine to medium grained, sub-rounded, pale grey; medium grained dominate		MD Note: Paper bark trees nearby
					21.0			
					20.5			
					20.0			
					19.5			
				SPT 2, 4, 5 N=9	1.95m			
					19.0			
					18.5			
					18.0			
				SPT 5, 8, 10 N=16	3.45m	becoming slightly finer		D
					17.5			
					17.0			
					16.5	becoming orangey brown, slight odour		
				SPT 4, 6, 8 N=14	4.95m			
					16.0			
					15.5	becoming pale brownish grey		
					15.0			
				SPT 10, 14, 15 N=29	6.45m			
					14.5			
					14.0			
					13.5			
				SPT 12, 17, 26 N=43	7.95m			

METHOD

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

penetration

No Resistance
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
N - Standard Penetration Test (SPT)
N* - SPT - sample recovered
Nc - SPT with solid cone
P - Pressuremeter

classification symbols & soil description

Based on Unified Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**
Principal :
Project : **Fiona Stanley Hospital**
Location : **Murdoch**

Hole No. **BH102**
Sheet No. 2 of 4
Project No. **GH08304AB**
Date started : **8/5/08**
Date completed **9/5/08**
Logged by : **CT**
Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	graphic log	material description	moisture condition
					RL (m)		SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	consistency / relative density
					8.0		SAND , fine to medium grained, sub-rounded, pale grey; medium grained dominate (<i>continued</i>)	VD
					12.0			
				SPT 10, 16, 17 N=33	9.45m			
					11.0			
				SPT 14, 20, 24 N=44	10.95m			
					10.0			
				SPT 12, 21, 28 N=49	12.45m			
					8.5			
					8.0			
				SPT 18, 24, 26 N=50	13.95m			
					7.0			
					6.5			
				SPT 20, 20, 30 N*=50	15.45m			
					5.5			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	 water	U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 3 of 4

Project No. ***GH08304AB***Date started : **8/5/08**Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD)

Surface Elevation : 21.002m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information							material substance					
drilling method & casing	water	penetration VEFH			samples & field tests	RL (m)	depth (m)	graphic log	SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations
						5.0	16.0		SAND, fine to medium grained, sub-rounded, pale grey; medium grained dominate (<i>continued</i>)		VD	
					SPT 19, 37, 17 N*=54 16.95m	4.5	17.0					SPT Recovery: 0.2 m
					SPT 35, 15 N*=R 18.30m	3.0	18.0					SPT Recovery: 0.2 m
					SPT 50, 0 N*=R 19.80m	1.5	19.0					SPT Recovery: 0.15 m
					SPT 28, 22 N*=R 21.30m	0.0	21.0	trace of silt				SPT Recovery: 0.2 m
					SPT 27, 23 N*=R 22.80m	-1.5	23.0					SPT Recovery: 0.2 m

METHOD

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

penetration

water

- 10 Oct., 73 Water Level on Date shown
- water inflow
- water outflow

samples & field tests

- U50 - Undisturbed Sample 50mm diameter
- U63 - Undisturbed Sample 63mm diameter
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- E - Environmental Sample
- MC - Moisture Content
- HP - Hand Penetrometer (UCS kPa)
- N - Standard Penetration Test (SPT)
- N* - SPT - sample recovered
- Nc - SPT with solid cone
- P - Pressuremeter

classification symbols & soil description
Based on Unified Classification System

moisture

- D - Dry
- M - Moist
- W - Wet
- W_p - Plastic Limit
- W_L - Liquid Limit

consistency / relative density

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

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH102**

Sheet No. 4 of 4

Project No. **GH08304AB**

Date started : **8/5/08**

Date completed **9/5/08**

Logged by : **CT**

Checked by :

Position : E: 391176.0385, N: 6451200.204 (50 MGA94) Surface Elevation : 21.002m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	graphic log	material description	moisture condition
WB				SPT 19, 31 N=R	24.0		SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	consistency / relative density
					24.30m			VD SPT Recovery: 0.27 m
					24.27		BOREHOLE BH102 TERMINATED AT 24.27 m	
					24.5			
					25.0			
					25.5			
					26.0			
					26.5			
					27.0			
					27.5			
					28.0			
					28.5			
					29.0			
					29.5			
					30.0			
					30.5			
					31.0			
					31.5			
					32.0			
					32.5			
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					79.0			
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					80.0			
					80.5			
					81.0			
					81.5			
					82.0			
					82.5			
					83.0			
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					89.0			
					89.5			
					90.0			
					90.5			
					91.0			
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					92.5			
					93.0			
					93.5			
					94.0			
					94.5			
					95.0			
					95.5			
					96.0			
					96.5			
					97.0			
					97.5			
					98.0			
					98.5			
					99.0			
					99.5			
					100.0			

METHOD	penetration	samples & field tests	classification symboles & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH103**

Sheet No. 1 of 4

Project No. ***GH08304AB***

Date started : **12/5/08**

Date completed **12/5/08**

Logged by : **CT**

Checked by :

Position : E: 391300.824, N: 6451226.03 (50 MGA94)

Surface Elevation : 31.621m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance					
drilling method & casing	water	penetration VEFH	samples & field tests	RL (m)	depth (m)	graphic log	material description		moisture condition	consistency / relative density	structure and other observations
							SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components				
WB			SPT 2, 3, 4 N=7	31.5	0.0		SAND, fine to medium grained, sub-rounded, orange yellow			MD	
			1.45m	31.0							
			SPT 5, 7, 19 N=26	30.5	1.0						
			2.45m	30.0							
			SPT 7, 9, 12 N=21	29.5	2.0						
			3.45m	29.0							
			SPT 7, 10, 12 N=22	28.5	3.0						
			4.45m	28.0							
			SPT 8, 14, 16 N=30	27.5	4.0						
			5.45m	27.0							
		SPT 10, 17, 23 N=40	26.5	5.0							
		6.45m	26.0	6.0					VD		
		SPT 11, 16, 24 N=40	25.5	7.0							
		7.45m	25.0								
				24.5							
				24.0							

METHOD

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

penetration

No Resistance

water

10 Oct., 73 Water
Level on Date shown
water inflow
water outflow

samples & field tests

U50 - Undisturbed Sample 50mm diameter
U63 - Undisturbed Sample 63mm diameter
D - Disturbed Sample
B - Bulk Disturbed Sample
E - Environmental Sample
MC - Moisture Content
HP - Hand Penetrometer (UCS kPa)
N - Standard Penetration Test (SPT)
N* - SPT - sample recovered
Nc - SPT with solid cone
P - Pressuremeter

classification symbols &
soil description

Based on Unified
Classification System

moisture

D - Dry
M - Moist
W - Wet
W_p - Plastic Limit
W_L - Liquid Limit

consistency / relative density

VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH103**

Sheet No. 2 of 4

Project No. **GH08304AB**

Date started : **12/5/08**

Date completed **12/5/08**

Logged by : **CT**

Checked by :

Position : E: 391300.824, N: 6451226.03 (50 MGA94)

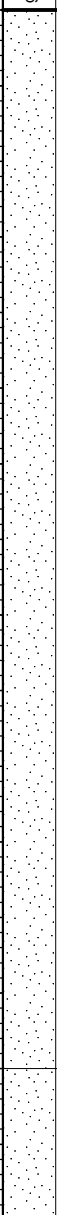
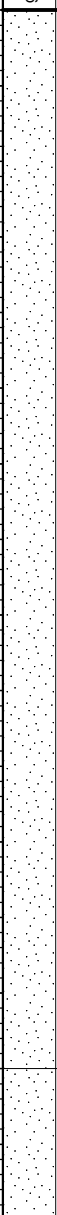
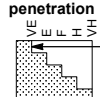
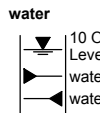
Surface Elevation : 31.621m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

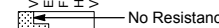
Casing Diameter : 50 mm

drilling information						material substance							
drilling method & casing	water	VE	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations		
WB	12/05/08			SPT 11, 21, 30 N=51	23.5	8.0		SAND, fine to medium grained, sub-rounded, orange yellow (continued)		VD			
				8.45m	23.0								
				SPT 15, 22, 28 N=50	22.5	9.0							
				9.45m	22.0								
				SPT 13, 24, 31 N=55	21.0	10.0							
				10.95m	20.5								
				SPT 19, 30, 20 N=50	19.5	12.0							
				12.45m	19.0								
				SPT 26, 24 N=R 13.80m	18.0	14.0							
				15.45m	17.5								
WB	12/05/08			SPT 8, 13, 14 N=27	16.5	15.0		SAND, fine to medium grained, sub-rounded, grey		MD			
				15.45m	16.0								
METHOD AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit						penetration  water  10 Oct., 73 Water Level on Date shown water inflow water outflow		samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter		classification symbols & soild description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit		consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense	

Hole No.	BH103
Sheet No.	3 of 4
Project No.	GH08304AB
Date started :	12/5/08
Date completed	12/5/08
Logged by :	CT
Checked by :	

Angle from horizontal : 90°
Nozzle Diameter : 50 mm

....becoming slightly coarse (medium grained dominate)

METHOD AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	penetration  water 	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	classification symbols & soil description Based on Unified Classification System	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
			moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH103**

Sheet No. 4 of 4

Project No. **GH08304AB**

Date started : **12/5/08**

Date completed **12/5/08**

Logged by : **CT**

Checked by :

Position : E: 391300.824, N: 6451226.03 (50 MGA94) Surface Elevation : 31.621m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
WB				SPT 30, 20 N*=R 24.30m	7.5	SAND, fine to medium grained, sub-rounded, grey (continued)		SPT Recovery: 0.2 m
					7.0			
					25.0	BOREHOLE BH103 TERMINATED AT 25.00 m		
					6.5			
					6.0			
					26.0			
					5.5			
					5.0			
					27.0			
					4.5			
					4.0			
					28.0			
					3.5			
					3.0			
					29.0			
					2.5			
					2.0			
					30.0			
					1.5			
					1.0			
					31.0			
					0.5			
					0.0			

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 1 of 4

Project No. **GH08304AB**

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD) Angle from horizontal : 90°
Rig type : Jacro Mounting : Truck Casing Diameter : 50 mm

drilling information					material substance			
drilling method & casing	water	VE	penetration	samples & field tests	depth (m)	material description	moisture condition	consistency / relative density
					0.0	SAND , fine to medium grained, sub-rounded, pale yellow mottled orange		D
					22.5			
					22.0			
					21.5			
				SPT 3, 7, 6 N=13	21.0			
				1.95m	20.5			
					20.0	becoming more orange		
				SPT 3, 8, 11 N=19	19.5			
				3.45m	19.0	SAND , fine to medium grained, sub-rounded, pale grey		
					18.5	becoming pale orange/grey		
				SPT 7, 11, 16 N=27	18.0			
				4.95m	17.5			
					17.0	becoming pale grey		
				SPT 13, 17, 23 N=40	16.5			
				6.45m	16.0			
					15.5			
				SPT 10, 11, 5 N=16	15.0			
				7.95m				

METHOD	penetration	samples & field tests	classification symbols & soil description	consistency / relative density
AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit		U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	moisture D - Dry M - Moist W - Wet W _P - Plastic Limit W _L - Liquid Limit	VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense

Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 2 of 4

Project No. ***GH08304AB***

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance						
drilling method & casing	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	structure and other observations		
WB		U63		14.5	8.0		CLAY , low plasticity, grey; (diatomite), sticky when wet, hard brittle when dry, traces of fine sand; no sulfur odour		H	Hard on surface (>600mm), note low SPT sample value 5 for 150mm		
		U63		14.0	9.0						CLAY , low plasticity, dark green; becoming sandy with depth, spongy texture; slight odour	S
				13.5	10.0							
		SPT 15, 22, 28 N=50		12.5	11.0							
		10.95m		12.0	11.5							
		SPT 16, 25, 28 N=53		11.0	12.0							
		12.45m		10.5	13.0							
		SPT 16, 37, 13 N*=50		9.5	14.0							
		13.95m		9.0	15.0							
				8.5							SPT Recovery: 0.2 m	
				8.0	15.0					SPT Recovery: 0.22 m		
		SPT 21, 30 N=R 15.30m		7.5								
				7.0								

METHOD AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	penetration No Resistance water 10 Oct., 73 Water Level on Date shown water inflow water outflow	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : ***Fiona Stanley Hospital***

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 3 of 4

Project No. ***GH08304AB***

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance						
drilling method & casing	water	penetration	samples & field tests	RL (m)	depth (m)	graphic log	material description	moisture condition	consistency / relative density	structure and other observations		
WB		VEFH			16.0		SAND , fine to medium grained, sub-rounded, pale brown grey; sulfurous odour odour(<i>continued</i>)		VD			
					6.5						SPT 28, 22 N*=R 16.80m	SPT Recovery: 0.28 m
					6.0							
					5.5							
					5.0						SPT 26, 24 N*=R 18.30m	SPT Recovery: 0.25 m
					4.5							
					4.0							
					3.5							
					3.0						SPT 30, 20 N*=R 19.80m	SPT Recovery: 0.22 m
					2.5							
				2.0	21.0		SAND , fine to medium grained, sub-rounded, pale brown grey					
				1.5	SPT 37, 13 N*=R 21.30m						SPT Recovery: 0.17 m	
				1.0								
				0.5								
				0.0	23.0							
				-0.5								
				-1.0								

METHOD AS auger screwing* AD auger drilling* RR roller/tricone W washbore CT cable tool HA hand auger DT diatube * bit shown by suffix B blank bit V V bit T TC bit	penetration  No Resistance water 	samples & field tests U50 - Undisturbed Sample 50mm diameter U63 - Undisturbed Sample 63mm diameter D - Disturbed Sample B - Bulk Disturbed Sample E - Environmental Sample MC - Moisture Content HP - Hand Penetrometer (UCS kPa) N - Standard Penetration Test (SPT) N* - SPT - sample recovered Nc - SPT with solid cone P - Pressuremeter	classification symbols & soil description Based on Unified Classification System moisture D - Dry M - Moist W - Wet W _p - Plastic Limit W _L - Liquid Limit	consistency / relative density VS - Very Soft S - Soft F - Firm St - Stiff VSt - Very Stiff H - Hard VL - Very Loose L - Loose MD - Medium Dense D - Dense VD - Very Dense
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Engineering Log - Borehole

Client : **Bruechle Gilchrist & Evans**

Principal :

Project : **Fiona Stanley Hospital**

Location : **Murdoch**

Hole No. **BH104**

Sheet No. 4 of 4

Project No. **GH08304AB**

Date started : **7/5/08**

Date completed **8/5/08**

Logged by : **CT**

Checked by :

Position : E: 391233.0949, N: 6451392.384 (50 MGA94) Surface Elevation : 22.948m (AHD)

Angle from horizontal : 90°

Rig type : Jacro

Mounting : Truck

Casing Diameter : 50 mm

drilling information						material substance			
drilling method & casing	water	VE	E	H	SPT 50, 0 N*=R 24.30m	depth (m)	material description	moisture condition	consistency / relative density
WB						24.0	SAND, fine to medium grained, sub-rounded, pale brown grey (continued)		VD SPT Recovery: 0.15 m
						25.0	BOREHOLE BH104 TERMINATED AT 25.00 m		
						26.0			
						27.0			
						28.0			
						29.0			
						30.0			
						31.0			
						32.0			
						33.0			
						34.0			
						35.0			
						36.0			
						37.0			
						38.0			
						39.0			
						40.0			
						41.0			
						42.0			
						43.0			
						44.0			
						45.0			
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MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 1 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
0	12/09				0.2 [+20.7]		x x	SM	SILTY SAND Light brown, medium to coarse grained, sub-rounded quartz sand, with roots and minor organic material. SAND with SILT Dark grey blotched/mottled brown, medium to coarse grained sand, sub-angular. FILL With medium grained gravel (about 8%), probably imported limestone at 0.5m.	M	L				
1					1.0 [+19.8]			SP	SAND with SILT Light grey, medium grained, sub angular quartz sand. BASSENDEAN SAND With minor dark brown mottling at 1.8m, fine to medium grained. Becoming light brown grey becoming brown at 2.3m.	M	L	1.00 1.45	N	SPT: 3, 4, 5 [N=9]	1
2										D-M	L-MD				2
3										M	L	2.50 2.95	N	SPT: 2, 2, 4 [N=6]	3
4										W	L	4.00 4.45	N	SPT: 2, 3, 6 [N=9]	4
5															5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 2 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117

Ground Surface Elevation: +20.8m

Total Depth: 18.4m

Commenced: 12-Sep-07 **Completed:** 13-Sep-07

Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200

Inclination: Vertical

Logged:

GB

13-Sep-07

Flushing Fluid:

Processed:

WKN

24-Oct-07

Hole Diameter (mm): 150

Checked:

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
6					Hollow Stem Auger	6.0 [+14.8]			SP	SAND with SILT Light grey, medium grained, sub angular quartz sand. BASSENDEAN SAND Becoming predominantly fine grained from about 5.9m.	M	MD			SPT: 8, 11, 15 [N=26]	6
7	12/09 13/09								SP	SAND Light brown, fine to medium grained, sub angular, quartz. BASSENDEAN SAND Light grey brown.					SPT: 6, 9, 13 [N=22]	7
8																
9					Wash Boring					Contains occasional black, coarse grained sand, becoming medium grained. Becoming medium to coarse grained from about 9m.		VD			SPT: 9, 14, 15 [N=29]	8
10						10.0										
													</			

GENERAL LOG 61/19514/01.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH1

Sheet 3 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
						[+10.8]			SP	SAND Light grey brown, medium to coarse grained, occasional black, coarse grained particles. BASSENDEAN SAND	W	D- VD	10.00	N	SPT: 15, 34, * [N>50 (16 blows for 50mm third stage)]	
11										Becoming medium grained.			10.35			
													11.00	N	SPT: 20, 50, * [N>50 (300mm/450mm)]	
													11.30			
12												MD	12.00	N	SPT: 6, 8, 13 [N=21]	
													12.45			
13												VD	13.00	N	SPT: 9, 20, 31 [N=51]	
													13.45			
										With occasional (2% to 5%) fine limestone gravel and black fine (quartz?) gravel. GNANGARA SAND?		D	14.00	N	SPT: 8, 17, 28 [N=45]	
													14.45			
15						15.0										

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH1

Sheet 4 of 4

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 102, N 6451 117
Ground Surface Elevation: +20.8m **Total Depth:** 18.4m
Commenced: 12-Sep-07 **Completed:** 13-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200
Flushing Fluid:
Hole Diameter (mm): 150

Inclination: Vertical

Logged: GB 13-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
					15.6 [+5.6]				CORE LOST 15.0 - 15.m (Possibly blocked SPT)			15.00	N	SPT: 13, 34, * [N>50 (16 blows for 50mm third stage)]	
					15.5 [+5.3]			SP	SAND Light grey brown, fine to medium grained, quartz sand. GNANGARA SAND?	W	VD	15.35			
16									With minor (<5%) quartz gravel, black and clear (white), sub-angular to angular gravel up to 12mm from about 16m.			16.00	N	SPT: 12, 27, * [N>50 (23 blows for 50mm third stage)]	16
				Wash Boring								16.40			
17												17.00	N	SPT: 8, 20, 35 [N=55]	17
												17.45			
18												18.00	N	SPT: 15, 27, * [N>50 (23 blows for 100mm third stage)]	18
												18.40			
1309					18.4 [+2.4]				Termination Depth = 18.4m						
19															19
20															20

GENERAL LOG 61/19514/01.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 1 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
1	14/09					1.5 [+21.7]			SP	SAND with SILT Dark grey, medium grained quartz sand (300/500mm return). TOPSOIL/SUBSOIL Becoming light orange brown. BASSENDEAN SAND Becoming fine to medium grained from about 1m.	M	L				1
2										CORE LOST 1.5 - 2.5m						2
3						2.5 [+20.6]			SP	SAND with SILT Light orange brown, fine to medium grained quartz sand. BASSENDEAN SAND						3
4										Becoming light grey brown.	MD					4
5																5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH2

Sheet 2 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
6				Hollow Stem Auger				SP	SAND with SILT Light orange brown, fine to medium grained quartz sand. BASSENDEAN SAND	M- W	MD	5.00 5.45	N	SPT: 4, 7, 8 [N=15]	6
7										W					7
8												7.50 7.95	N	SPT: 7, 12, 14 [N=26]	8
9					9.0 [+14.1]				CORE LOST 9.0 - 9.5m		D	9.00 9.45	N	SPT: 3, 13, 25 [N=38] Changed to washbore drilling at 9.5m.	9
10				Wash Boring	9.5 [+13.6]			SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND						10

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH2

Sheet 3 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Depth (m)/ [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
				Wash Boring				SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND	W	VD				
11												10.50 10.85	N	SPT: 17, 34, * [N>50 (16 blows for 50mm third stage)]	11
12												12.00 12.28	N	SPT: 25, 50, * [N>50 (50 blows for 150mm second stage)]	12
13												13.50 13.80	N	SPT: 22, 50, * [N>50 (50 blows for 150mm second stage)]	13
14															14
15											D-VD				15

GENERAL LOG 61/1951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 4 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
16					Wash Boring				SP	SAND with SILT Light orange brown, medium grained quartz sand. BASSENDEAN SAND	W	D- VD	15.00	N	SPT: 16, 19, 30 [N=49]	16
													15.45			
													16.50	N	SPT: 13, 23, 24 [N=47]	
17													16.95			17
													18.00	N	SPT: 7, 12, 17 [N=29]	18
													18.45			
													19.50	N	SPT: 11, 24, 29 [N=53]	19
													19.95			
20						20.0										20

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



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BOREHOLE LOG

Borehole
No.:

BH2

Sheet 5 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

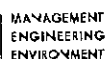
Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
				Wash Boring	23.1			SP	SAND Light orange brown, medium grained, quartz. BASSENDEAN SAND	W	VD				
21									Becoming light grey brown, fine to medium grained from about 21m.			21.00 21.20	N	SPT: 35, *, * [N>50 (15 blows for 50mm second stage)]	21
22									Becoming grey from about 21.5m. GNANGARA SAND?			22.50 22.70	N	SPT: 26, *, * [N>50 (24 blows for 50mm second stage)]	22
23															23
24												24.00 24.40	N	SPT: 16, 25, 25 [N=50]	24
25					25.0										25

GENERAL LOG 61/19514/01 GPJ GHDPER.GDT 24/10/07



Borehole No.: **BH2**

Sheet 6 of 7

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	14-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

[illegible]

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole
No.:

BH2

Sheet 7 of 7

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 000, N 6451 134
Ground Surface Elevation: +23.1m **Total Depth:** 30.2m
Commenced: 14-Sep-07 **Completed:** 14-Sep-07
Contractor: J & S Drilling **Driller:** Evan Dunn

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 14-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
14.09						[6.9] 30.2 [-7.1]			SP	GRAVELLY SAND with CLAY Light grey, medium grained sand, fine to medium grained sub-rounded quartz gravel, GNANGARA SAND? Termination Depth = 30.2m	W	VD	30.00 30.20	N	SPT: 23, *, * [N>50 (27 blows for 50mm second stage)]	
31																31
32																32
33																33
34																34
35																35



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH3

Sheet 1 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
1509								SP	SAND with SILT Dark grey with light grey mottling, medium grained, quartz sand with roots and minor organic material. TOPSOIL / SUBSOIL Light grey brown from 0.4m, poorly graded sand with little or no organics and roots from 0.8m. BASSENDEAN SAND	M-W	L				
1															1
2									With orange mottling from 2.2m to 2.5m.			1.50	N	SPT: 2, 3, 4 [N=7]	2
												1.95			
3									Becoming medium dense with more orange (FeO) stained mottling from 3.0-3.45m.		MD	3.00	N	SPT: 3, 4, 8 [N=12]	3
									With less iron oxide staining from 3.45m.			3.45			
4					3.8 [+18.7]			SP	SAND Light grey with minor orange mottling, medium grained, quartz sand BASSENDEAN SAND	W	L				4
5					5.0										5

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07



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BOREHOLE LOG

Borehole
No.:

BH3

Sheet 2 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
				Hollow Stem Auger	17.5				CORE LOST 5.0 - 6.0m			5.00	N	SPT: 2, 1, 5 [N=6] Water sample taken.	
6					6.0 [+16.5]			SP	SAND Brown, medium grained quartz sand. BASSENDEAN SAND	W	D	5.45			
									Becoming light grey brown, fine to medium grained from about 6.5m.			6.50	N	SPT: 12, 14, 18 [N=32]	
7												6.95			
												8.00	N	SPT: 9, 17, 17 [N=34]	
8				Wash Boring					Becoming light grey in colour from about 8m.			8.45			
												9.50	N	SPT: 12, 21, 17 [N=38]	
9												9.95			
10					10.0										

GENERAL LOG 61/19514/01 GPJ GHDPER GDT 24/10/07



MANAGEMENT
ENGINEERING
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BOREHOLE LOG

Borehole
No.:

BH3

Sheet 3 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200

Inclination: Vertical

Logged: GB 15-Sep-07

Flushing Fluid:

Processed: WKN 24-Oct-07

Hole Diameter (mm): 150

Checked:

Depth Scale (m)	Daily Progress/Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
11					12.5			SP	SAND Light grey, fine to medium grained quartz sand. BASSENDEAN SAND						11
12															12
13									Becoming medium grained sand from about 12.5m.						13
14										VD					14
15					15.0										15

GENERAL LOG 61/19514/01.GPJ GHDFR.GDT 24/10/07

Wash Boring

11.00
11.45

N

SPT: 12, 20, 22 [N=42]

12.50
12.95

N

SPT: 13, 20, 24 [N=44]

14.00
14.40

N

SPT: 13, 27, * [N>50 (23 blows
for 100mm third stage)]



MANAGEMENT
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BOREHOLE LOG

Borehole
No.:

BH3

Sheet 4 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged: GB 15-Sep-07
Processed: WKN 24-Oct-07
Checked:

Depth Scale (m)	Daily Progress/ Observations				Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method											
16				Wash Boring	17.5			SP	SAND Light grey brown, medium grained quartz sand. BASSENDEAN SAND	W	VD				16
									Light grey.			15.50	N	SPT: 12, 26, * [N>50 (24 blows for 100mm third stage)]	
												15.92			
17												17.00	N	SPT: 13, 29, 21 [N=50]	17
												17.40			
18												18.50	N	SPT: 19, 50, * [N>50 (50 blows for 110mm second stage)]	18
												18.75			
19															19
20															20



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole No.: **BH3**

Sheet 5 of 5

Client: Department of Housing and Works
Project: Fiona Stanley Hospital
Preliminary Geotechnical Drilling
Job No.: 61/19514/01

Coordinates: E 391 236, N 6451 169
Ground Surface Elevation: +22.5m **Total Depth:** 20.2m
Commenced: 15-Sep-07 **Completed:** 15-Sep-07
Contractor: J & S Drilling **Driller:** Rory

Rig Type & Mounting: Truck Mounted mounted Jacro 200 **Inclination:** Vertical
Flushing Fluid:
Hole Diameter (mm): 150

Logged:	GB	15-Sep-07
Processed:	WKN	24-Oct-07
Checked:		

Depth Scale (m)	Daily Progress/Observations				Water	Depth (m) [Elev.]	Geological Unit	Graphic Log	Classification	Strata Description (type; colour; fines plasticity or particle characteristics; minor components; structure and/or origin)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments	Depth Scale (m)
	Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method												
15.09						20.2 [+2.4]			SP	Termination Depth = 20.15m	W	VD	20.00 20.15	N	SPT: 50, * * [N>50 (50 blows for 150mm first stage)]	
21																21
22																22
23																23
24																24
25																25

GENERAL LOG 611951401.GPJ GHDPER.GDT 24/10/07

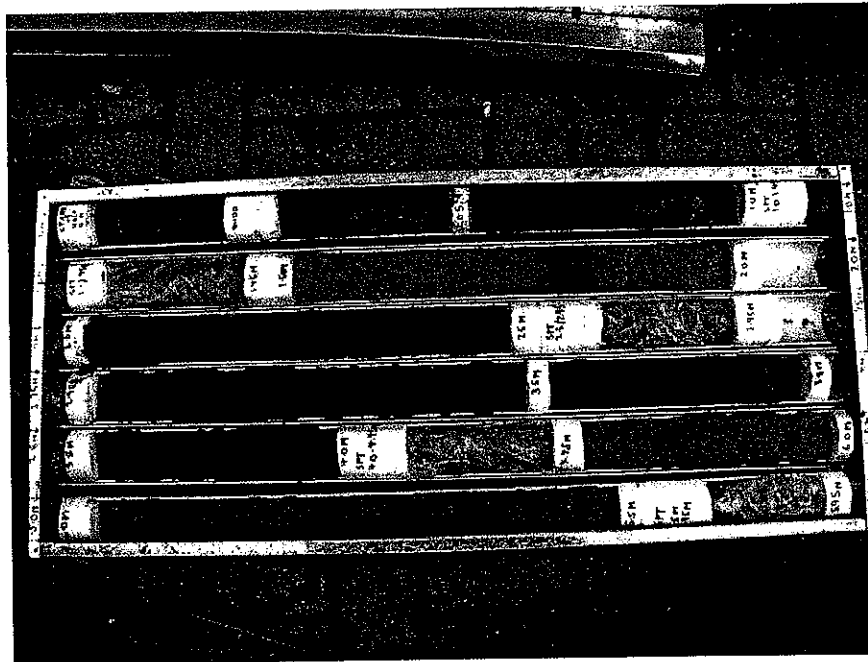


CORE PHOTOGRAPHS

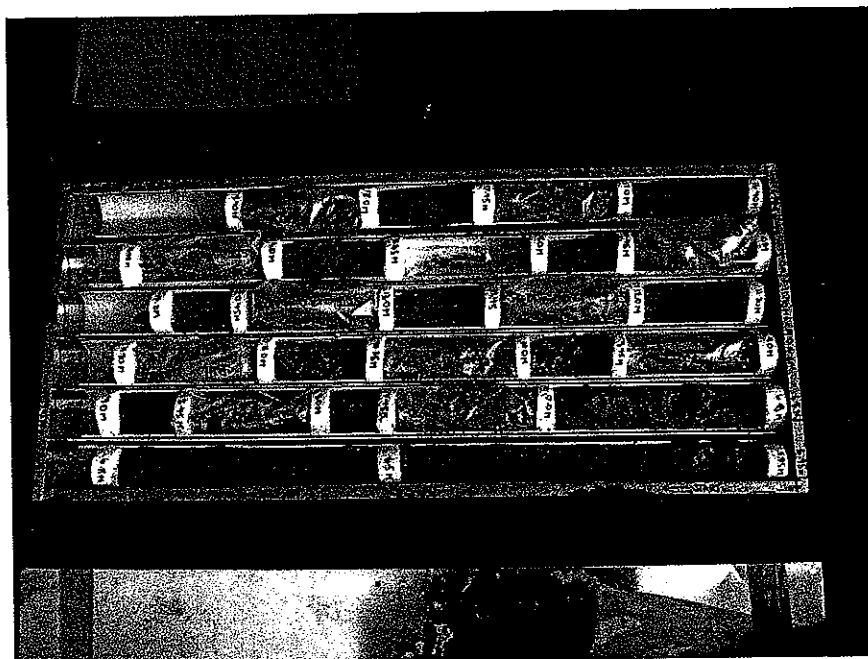
Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH1 – 0.0m to 5.95m



Description: BH1 – 5.95m to 18.4m



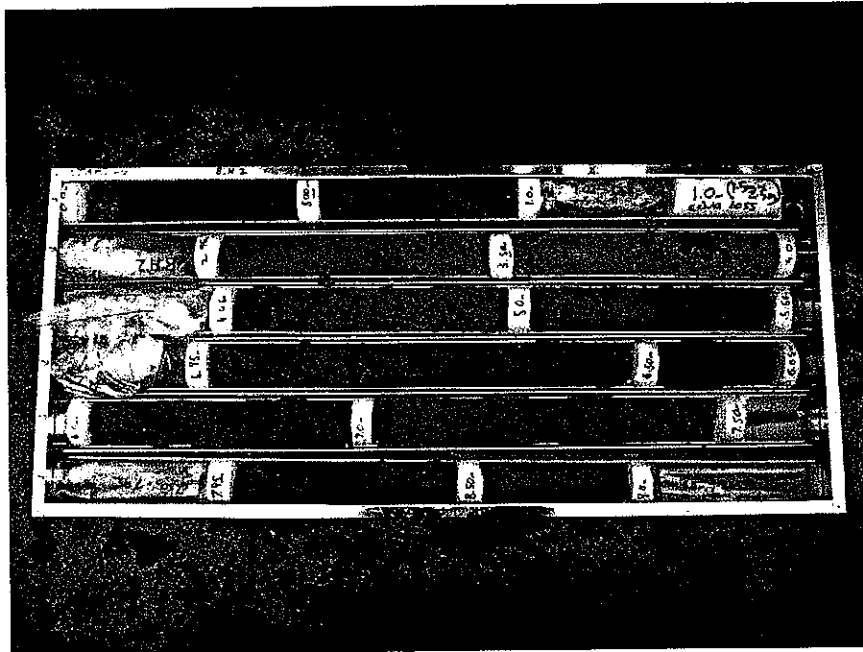


CORE PHOTOGRAPHS

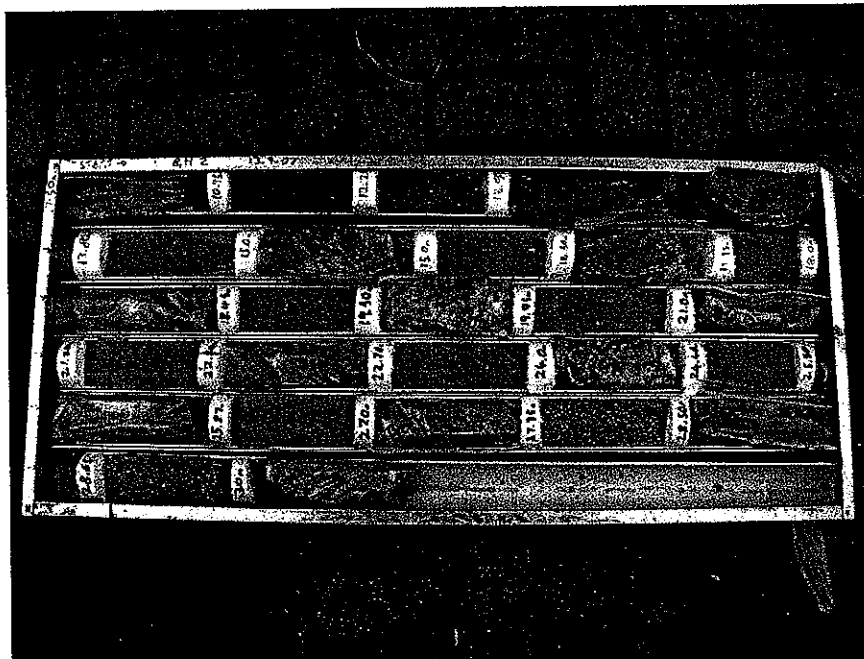
Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH2 – 0.0m to 9.45m



Description: BH2 – 9.45m to 30.45m



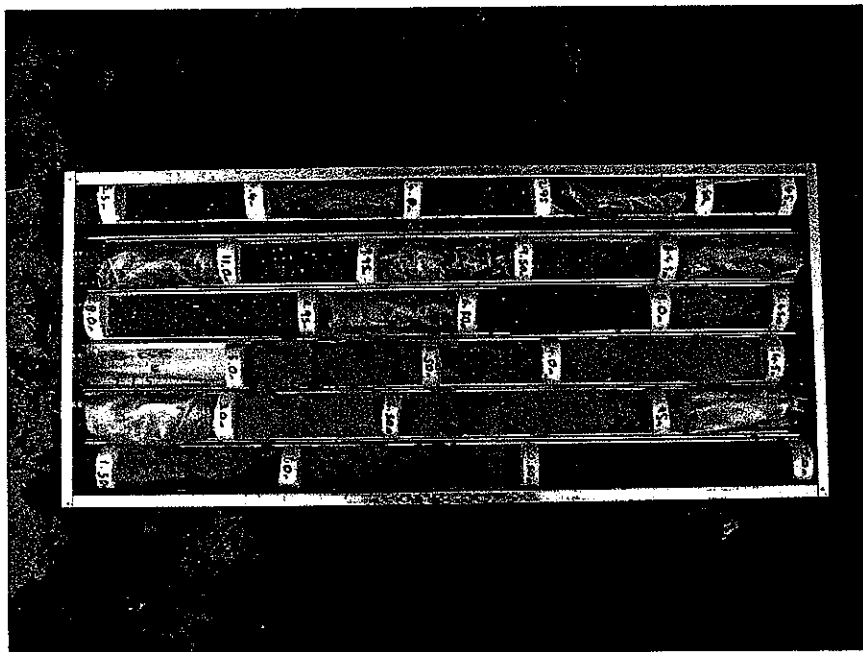


CORE PHOTOGRAPHS

Project: FIONA STANLEY HOSPITAL
PRELIMINARY GEOTECHNICAL INVESTIGATION

Job No.: 61/19514/01
Date: 24/10/2007

Description: BH3 – 0m to 15.5m



Description: BH3 – 15.5m to 20.45m

