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.

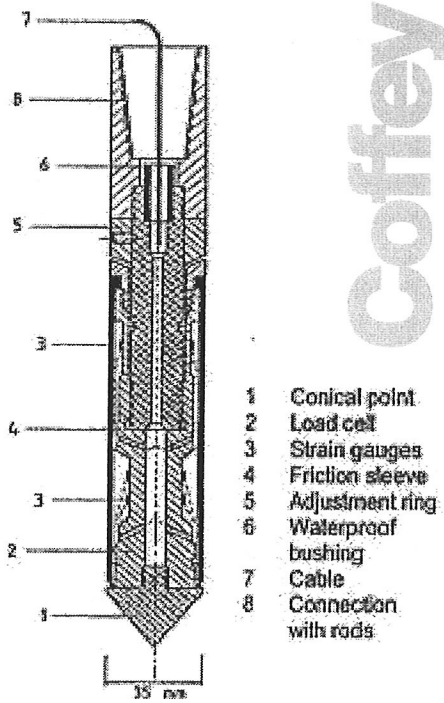
Reaction is provided by a purpose made truck or a conventional drilling rig. It is also possible to operate the penetrometer from a floating barge or a jack-up rig.

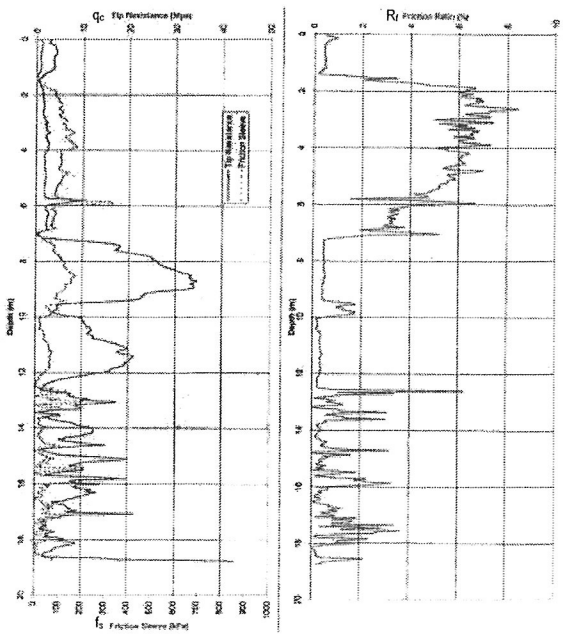
The penetrometer itself consists of a conically shaped tip and a separate cylindrical sleeve fitted immediately behind the tip. The maximum diameter of the tip corresponds to the sleeve diameter, and the cross sectional area is 1,000mm^2. The surface area of the sleeve is 15,000mm^2. Separate force transducers 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

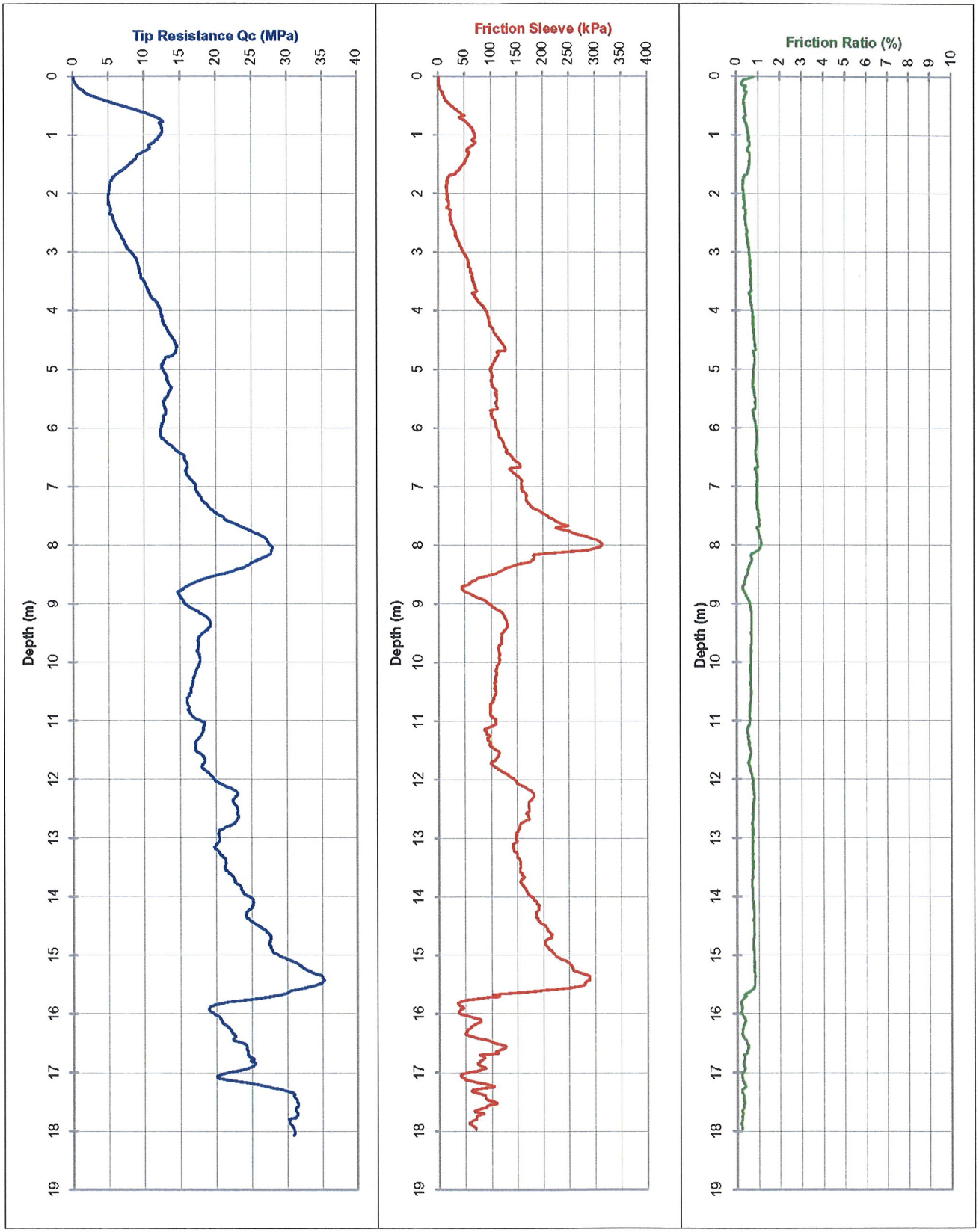
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 101

Job Number: GEOTHERD-08304AB

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 33MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

PROJECT: Fiona Stanley Hospital

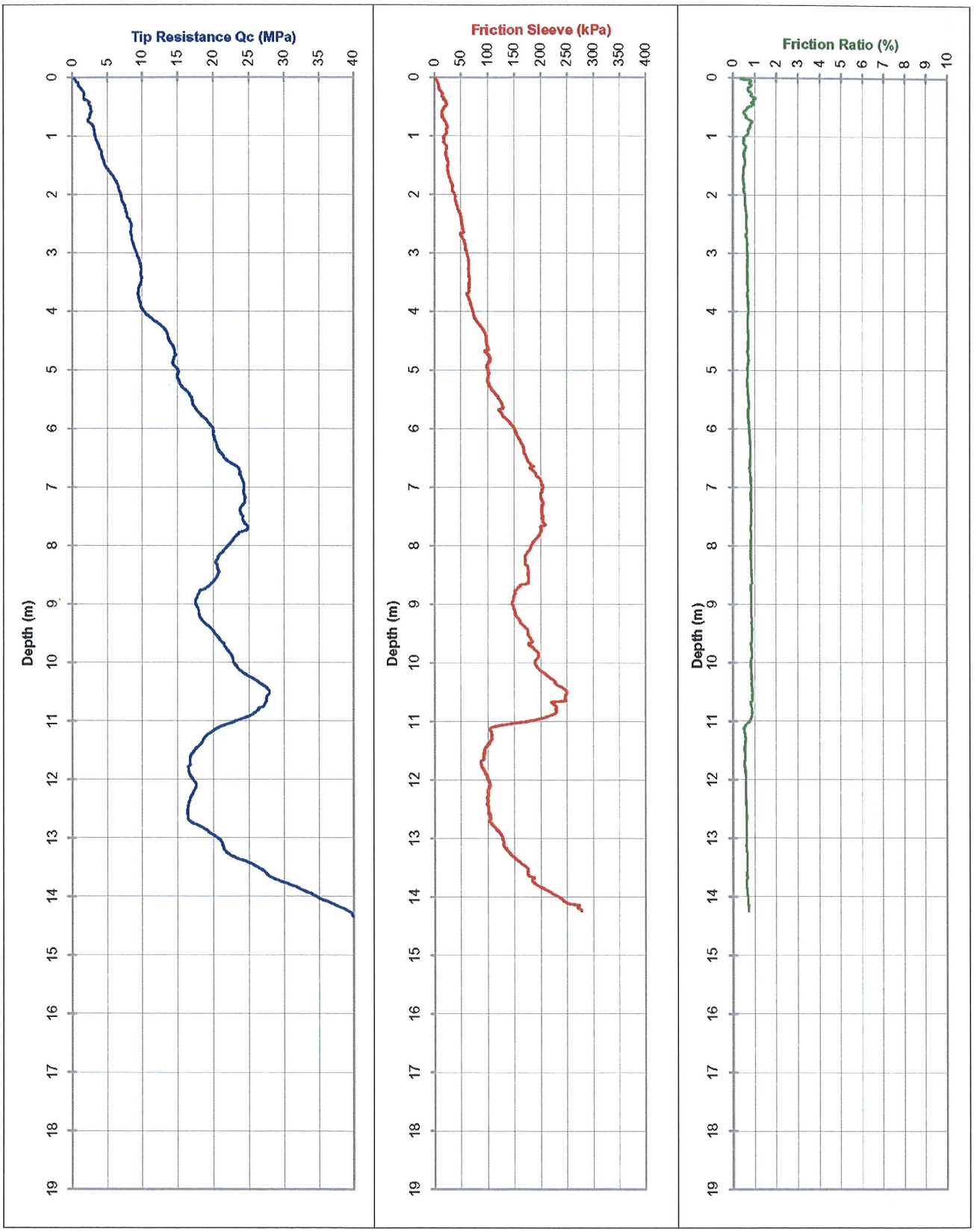
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 102

Job Number: GEOTHERD-08304AB

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 40MPa + R.F.

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

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

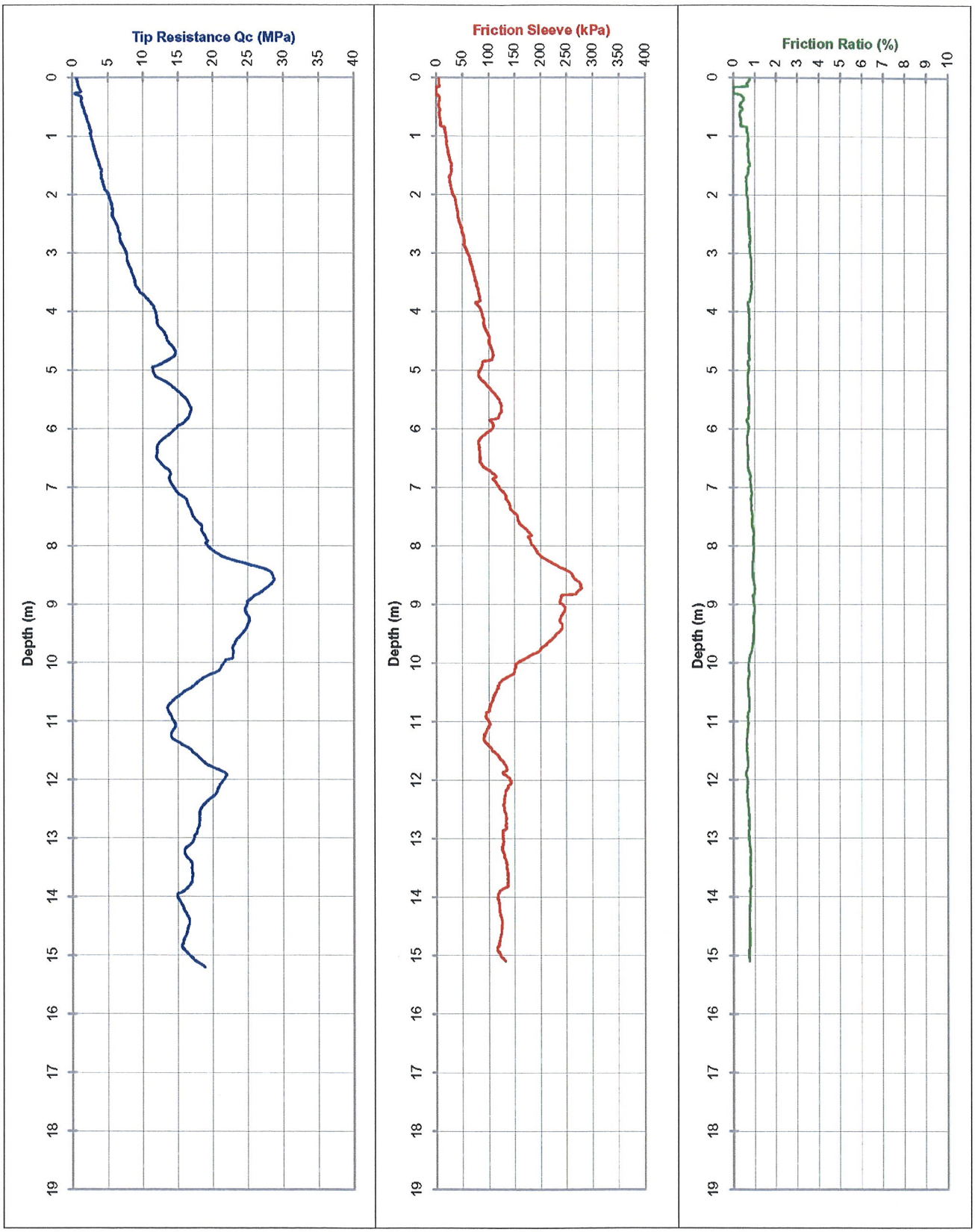
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 103

Job Number: GEOTHERD-08304AB

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 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: CP0845M.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

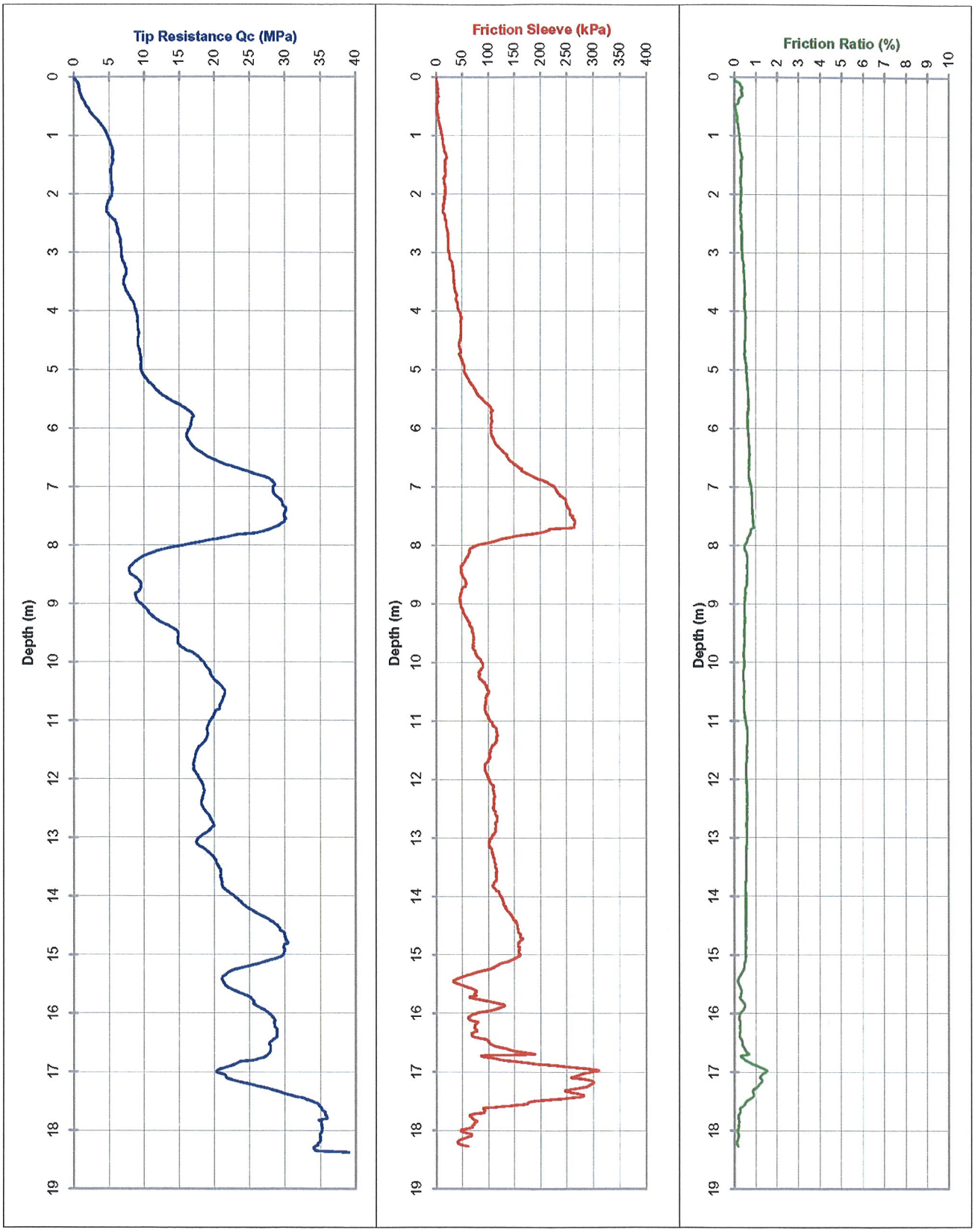
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 104

Job Number: GEOTHERD-08304AB

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax: 9314 6699

Water (m): -

Refusal: 39MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

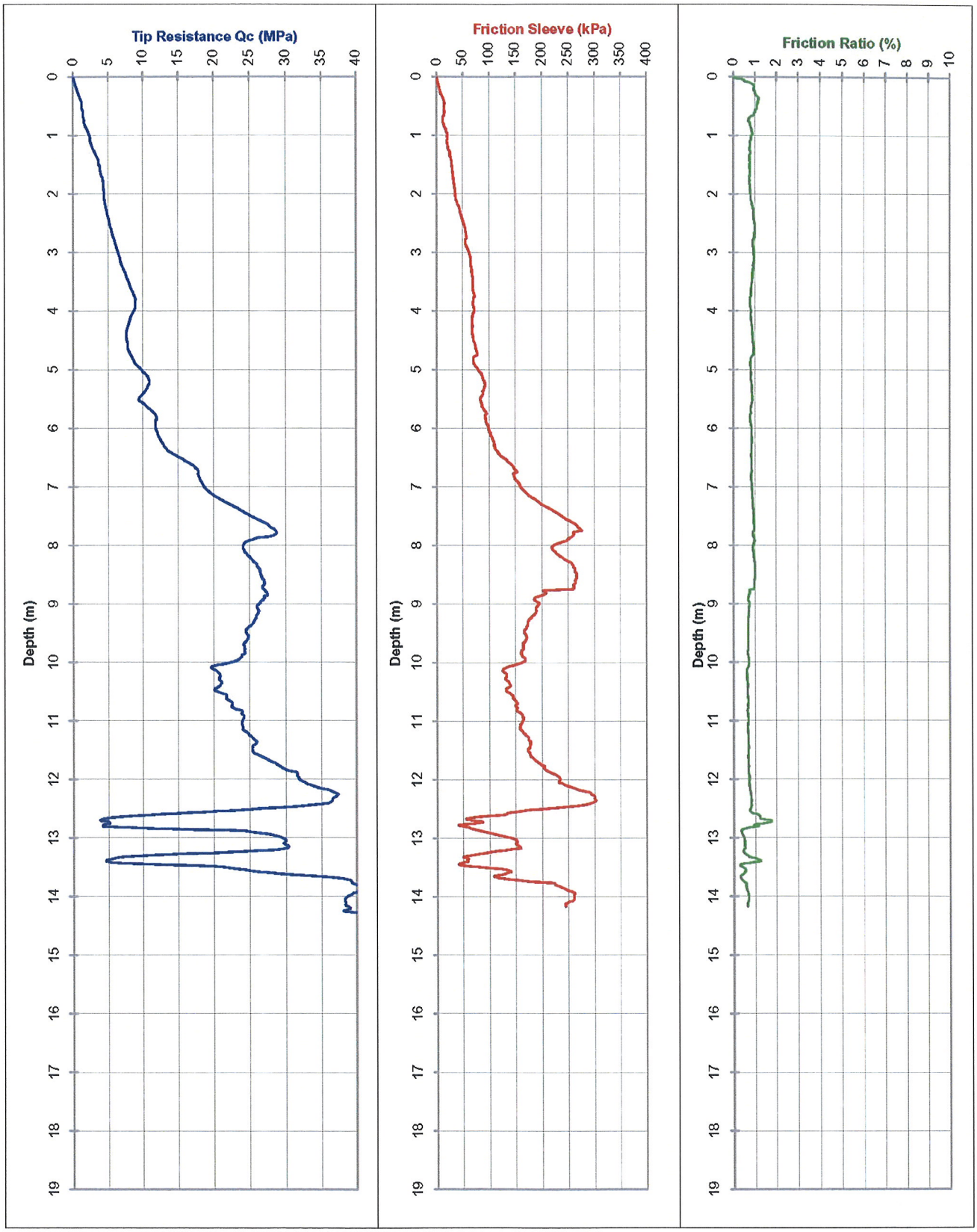
LOCATION: Murdoch

Date: 15/5/08

Probe No.: CPT 105

Job Number: GEOTHERD-08304AB

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax: 9314 6699

Water (m): -

Refusal: 40MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

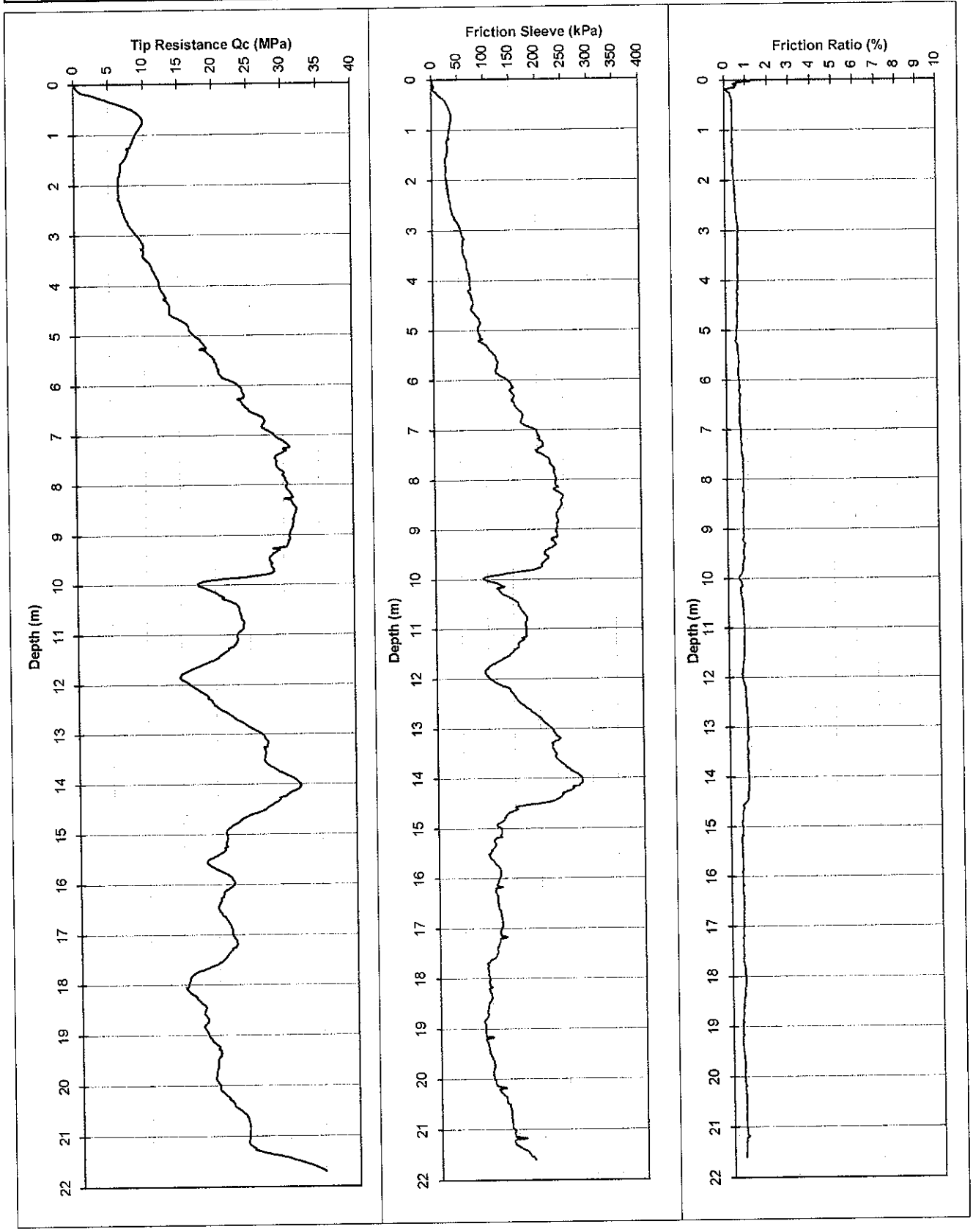
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 01 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph. 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: GH7431TT.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

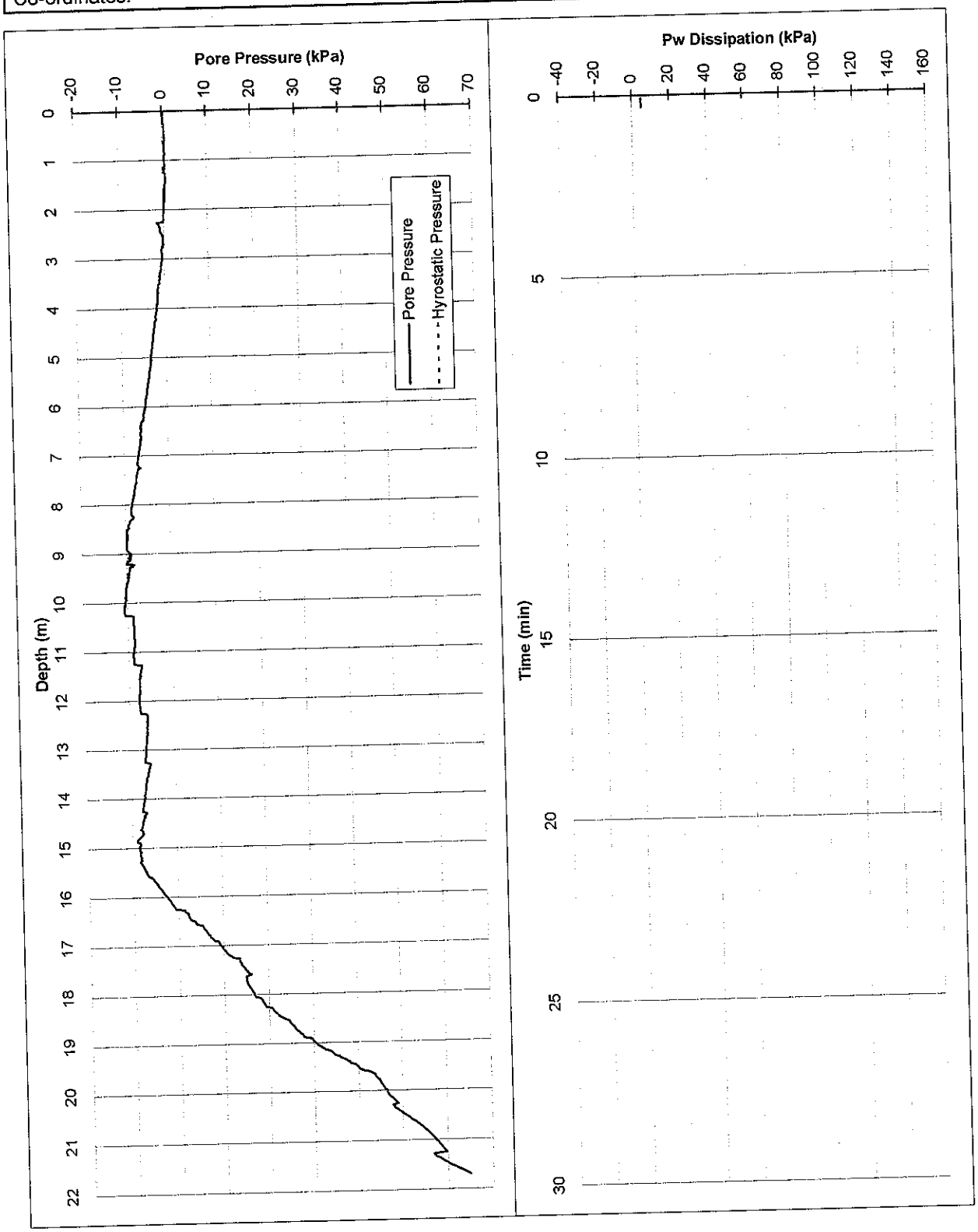
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 01 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7431TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

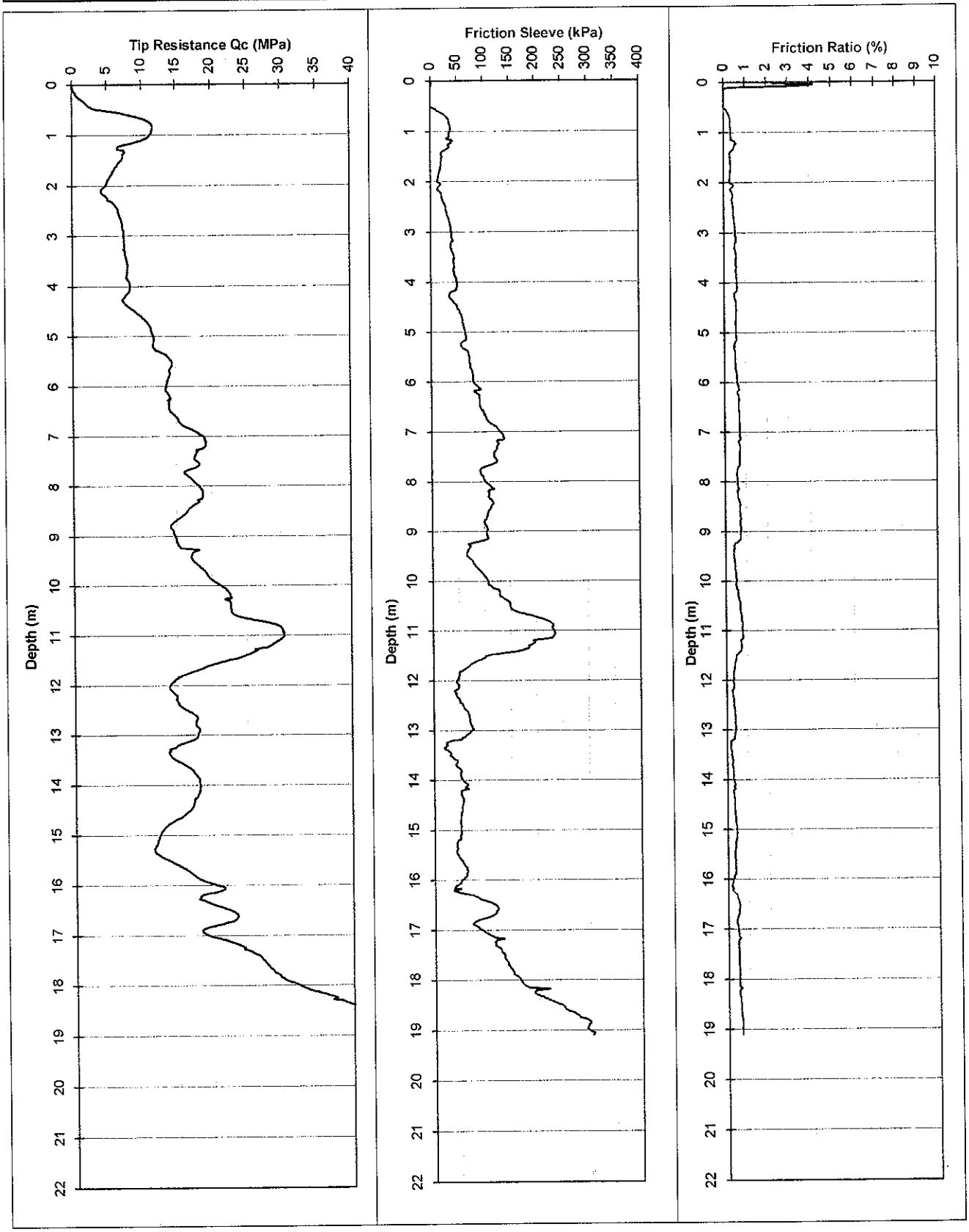
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 02 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Ph: 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: GH7430TT.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

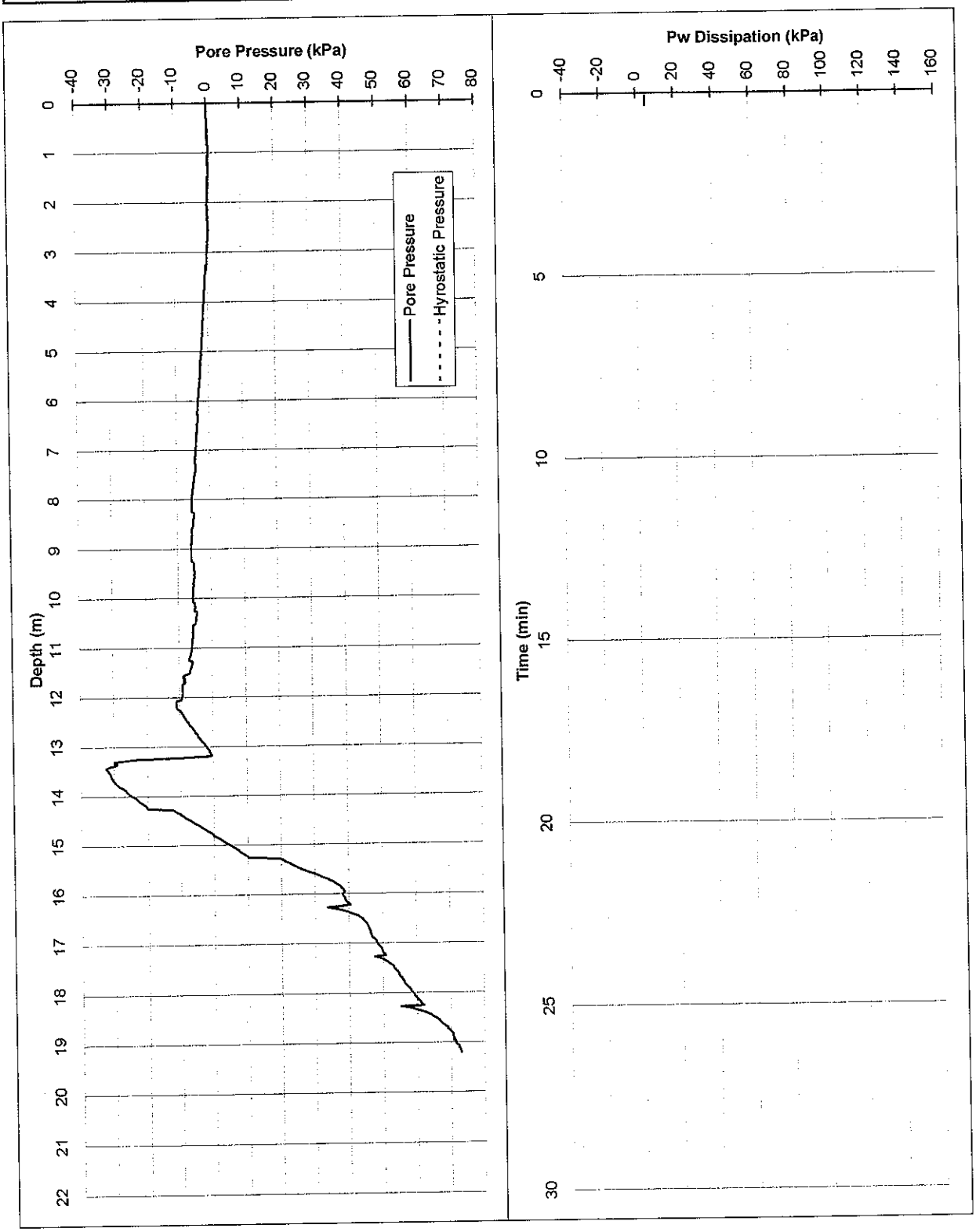
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 02 U

Job Number: 61/19514/01



PROBEDRILL
GEOTECHNICAL SURVEY
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: GH7430TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

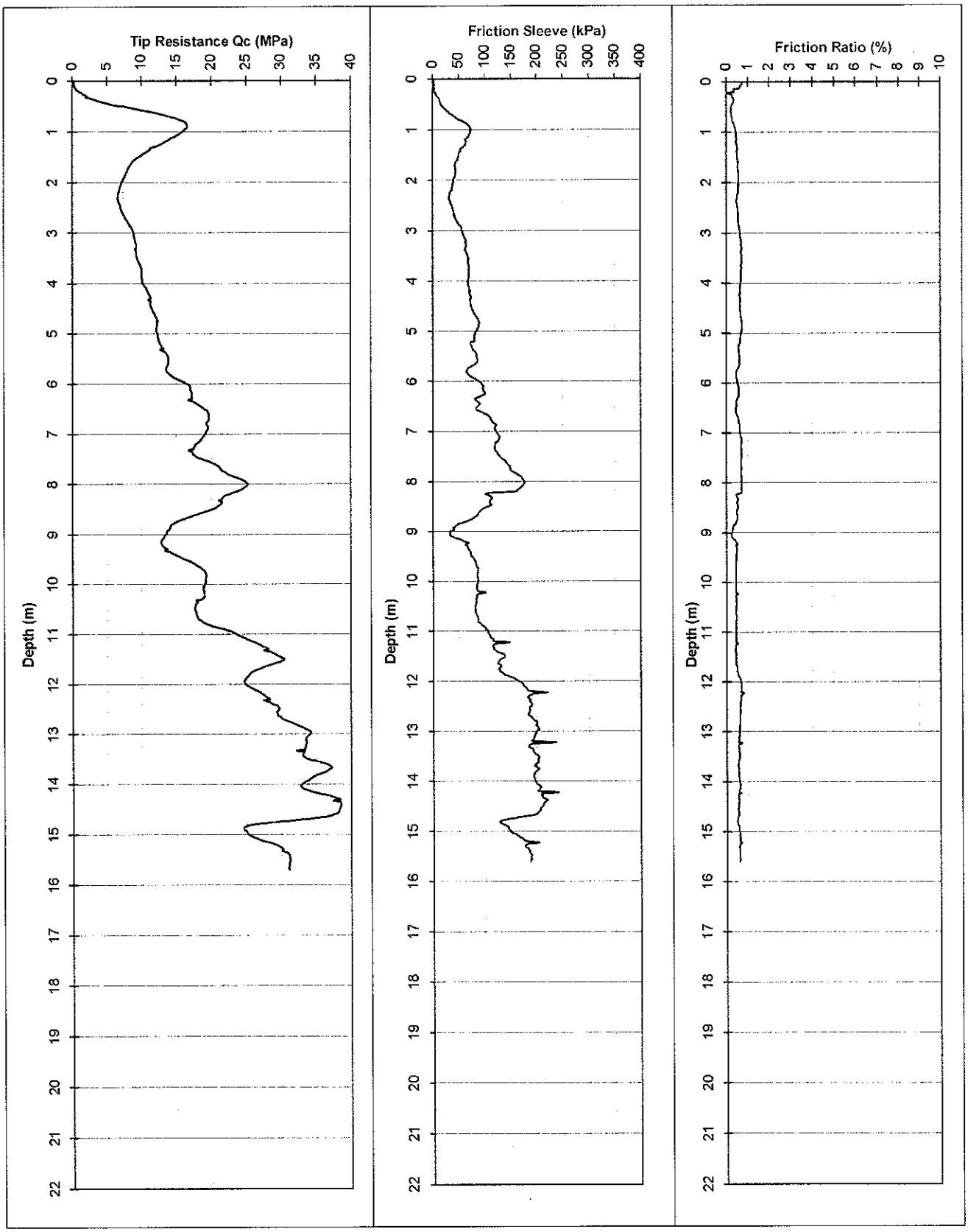
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 03 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): -

Refusal:

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

File: GH7429TT.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

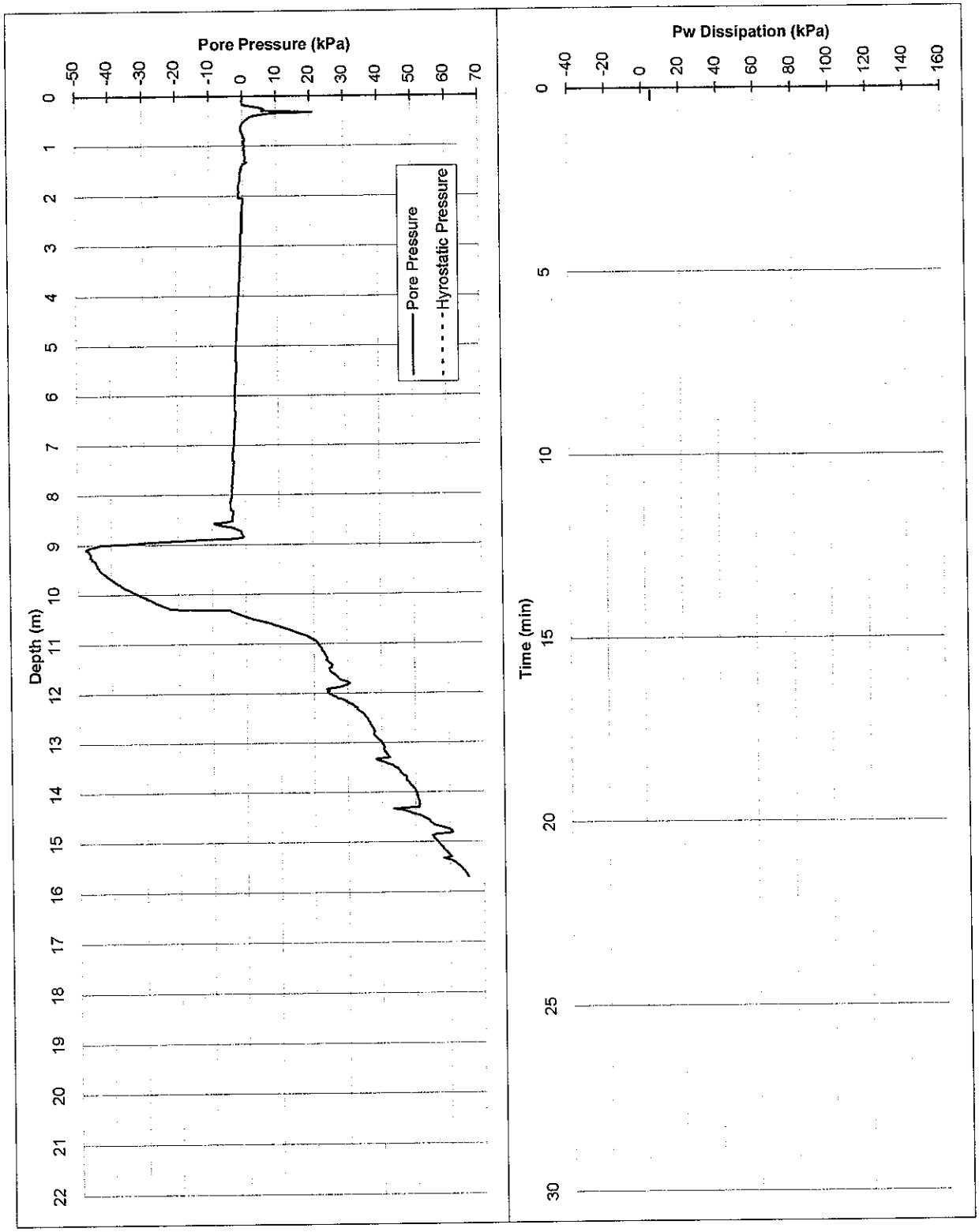
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 03 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7429TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

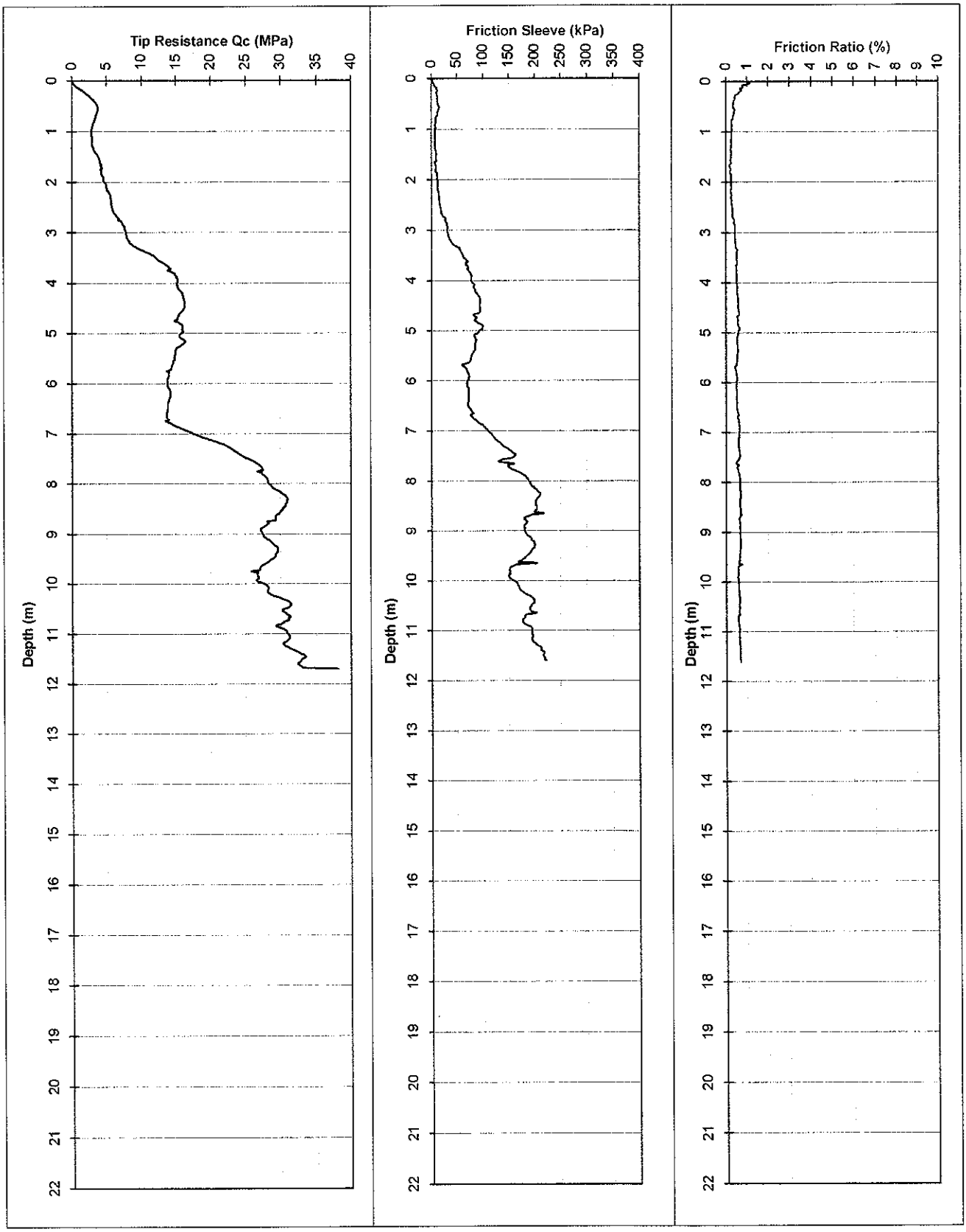
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 04 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 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

File: GH7444TT.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

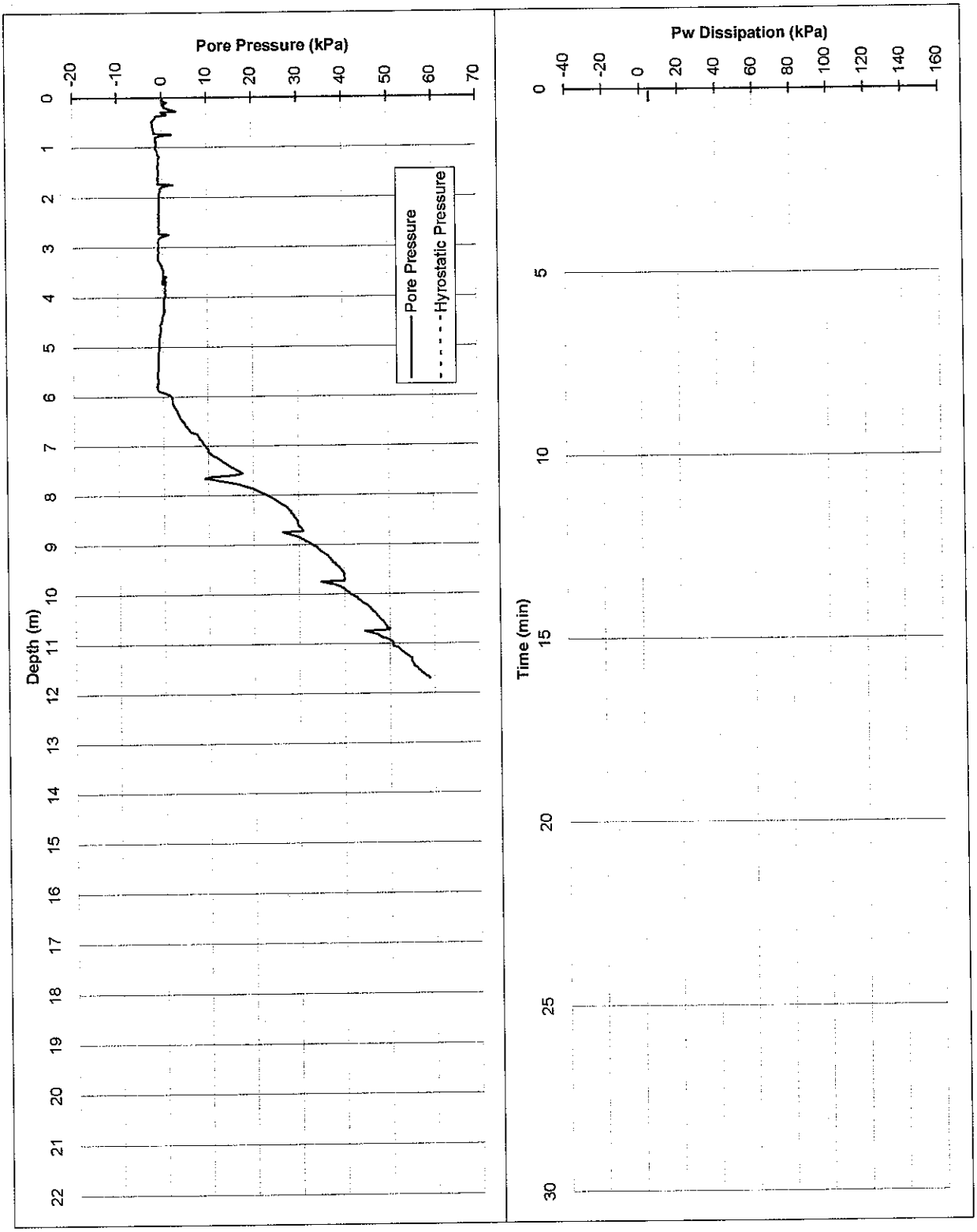
Project: Fiona Stanley Hospital

Probe No.: CPT 04 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7444TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

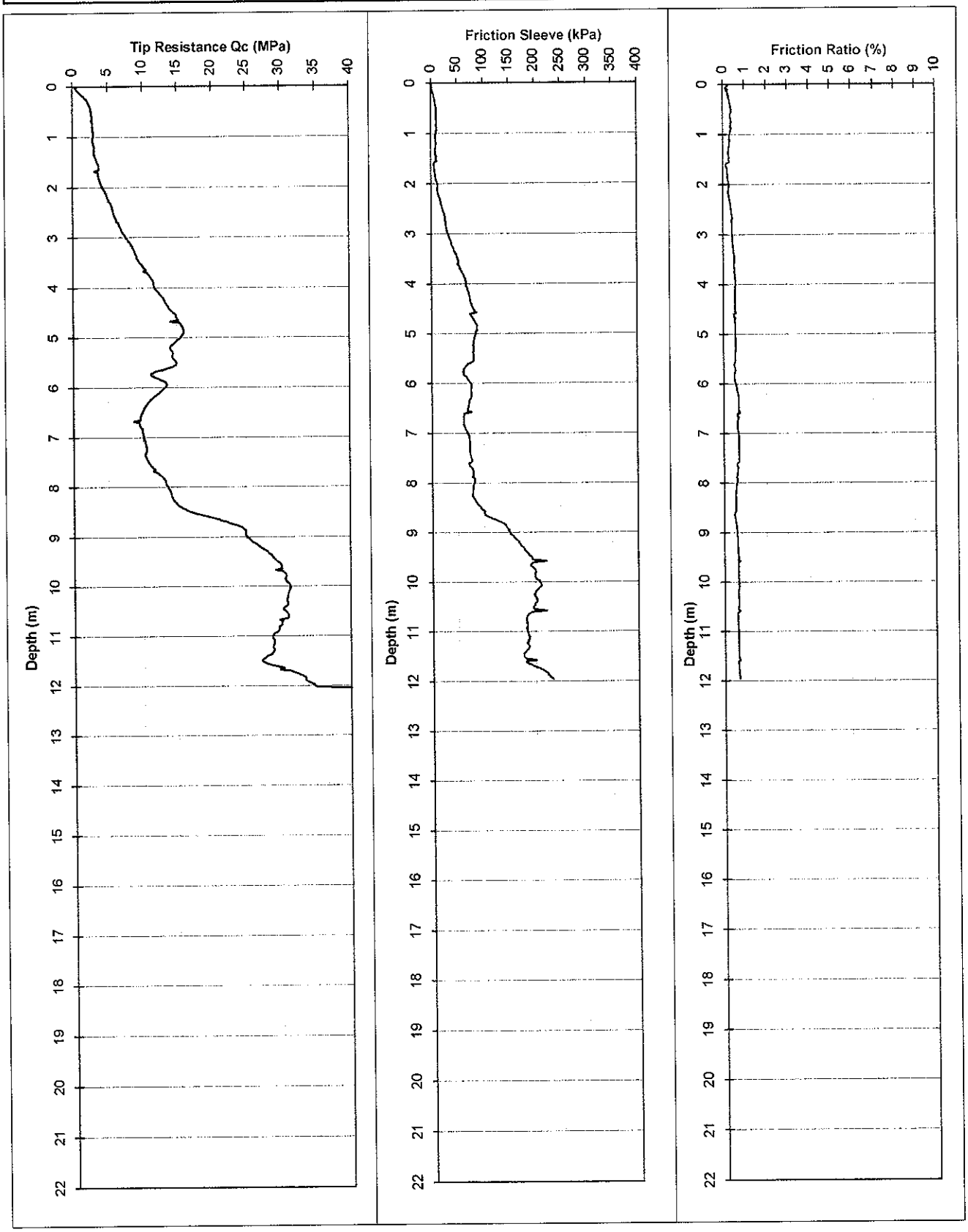
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 05 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 5.0

Refusal: 40MPa

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

File: GH7443TT.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

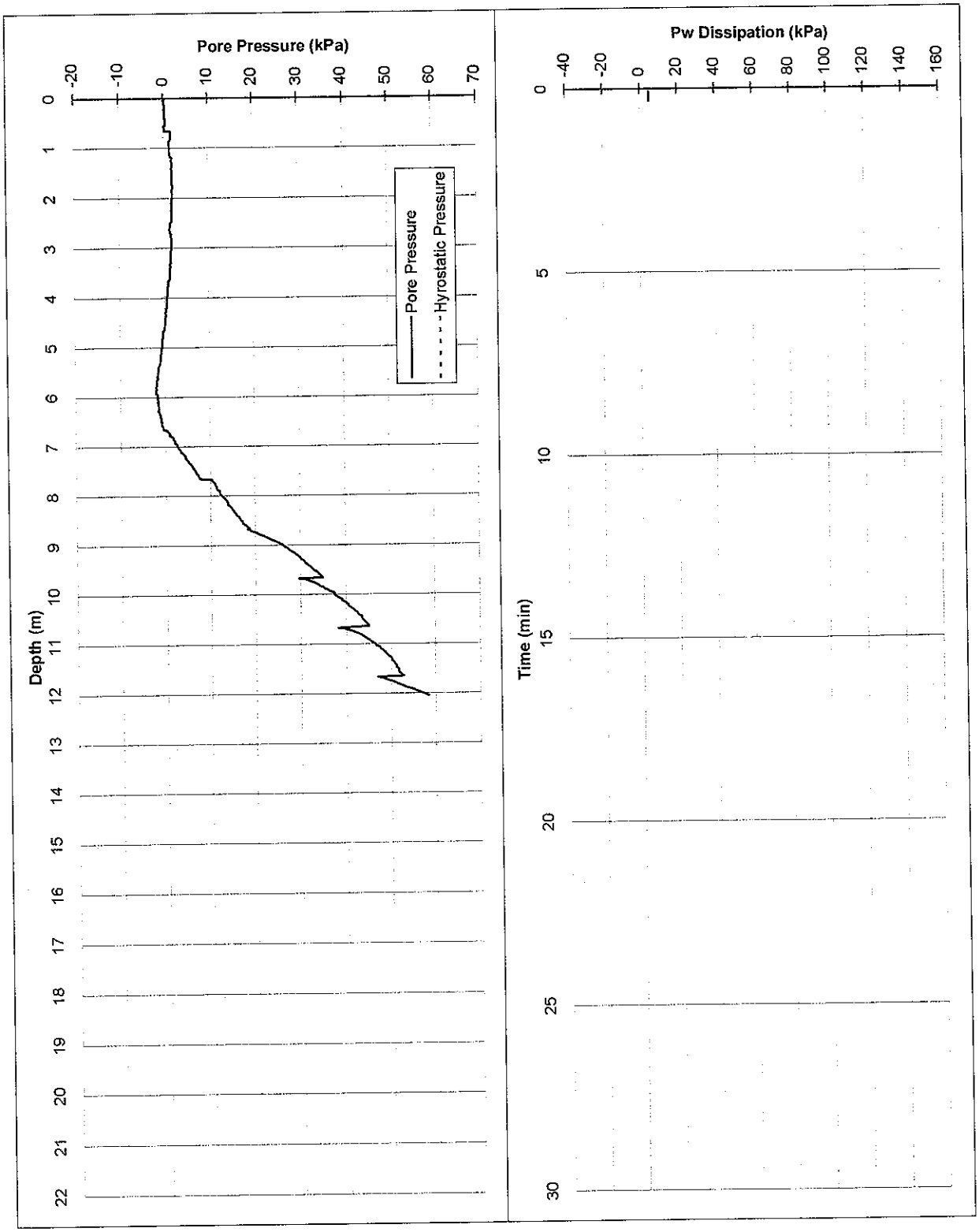
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 05 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7443TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

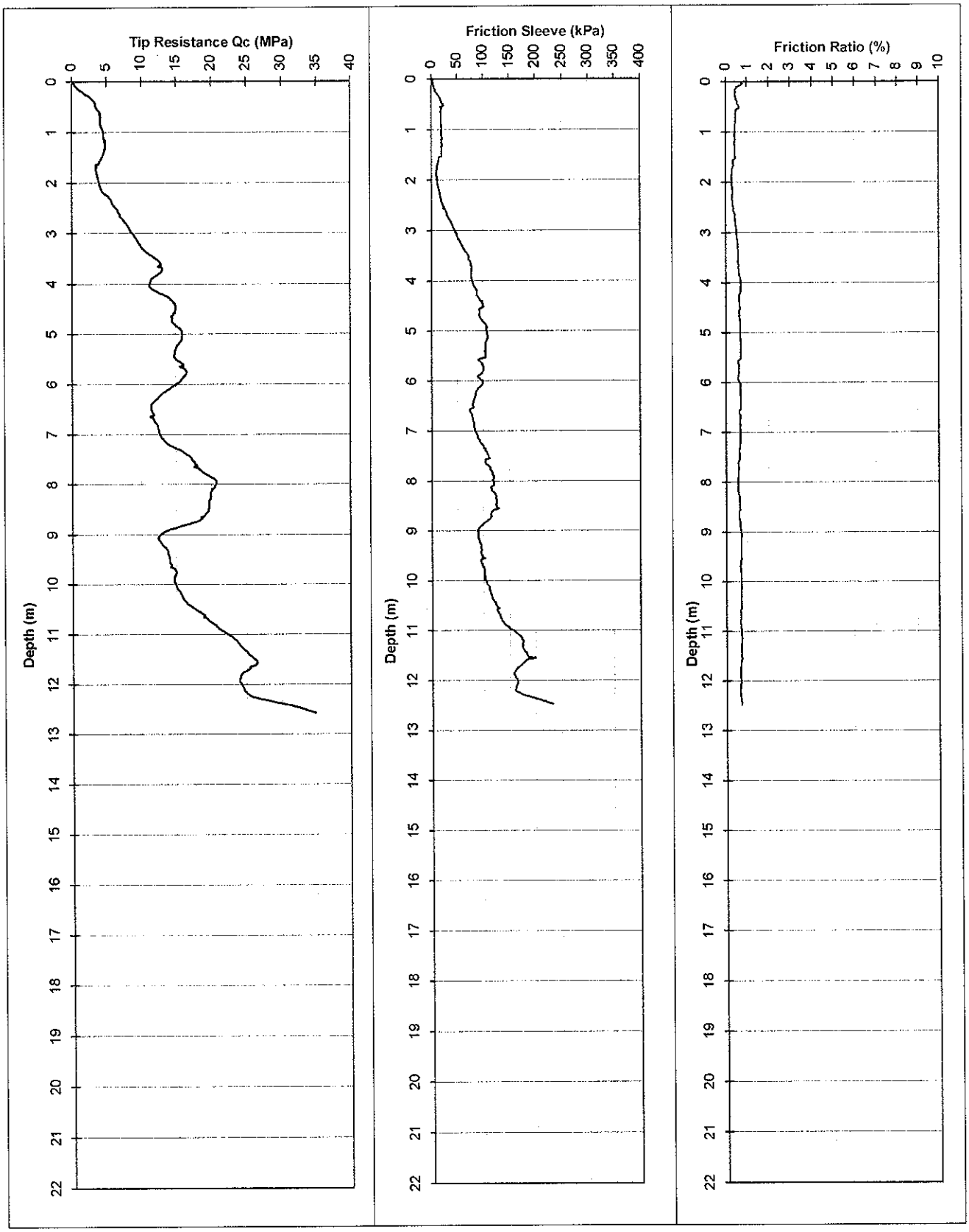
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 06 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph. 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 5.4

Refusal:

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

File: GH7442TT.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

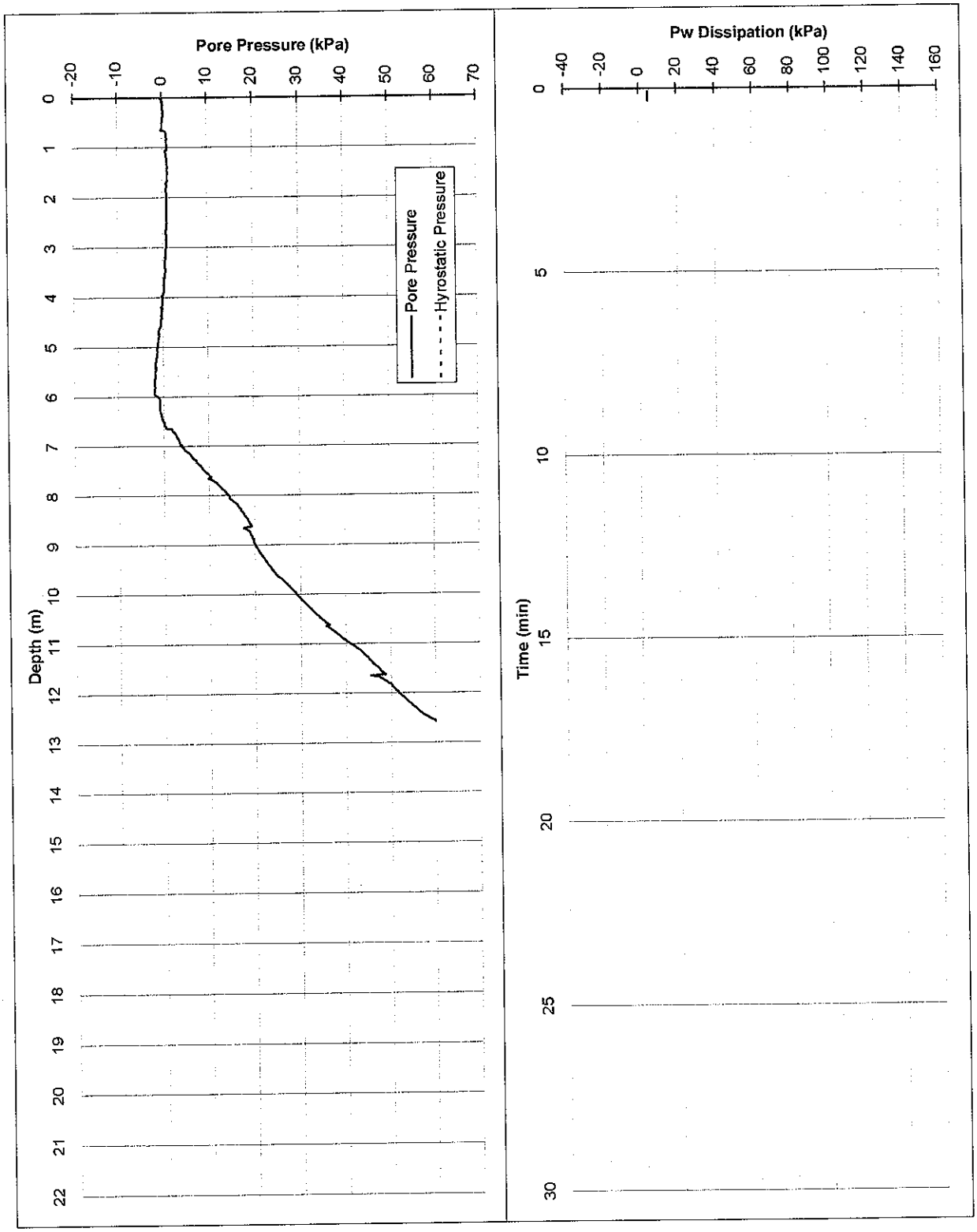
Project: Fiona Stanley Hospital

Probe No.: CPT 06 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Ph: 9314 6611 Fax: 9314 6699

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

File: GH7442TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

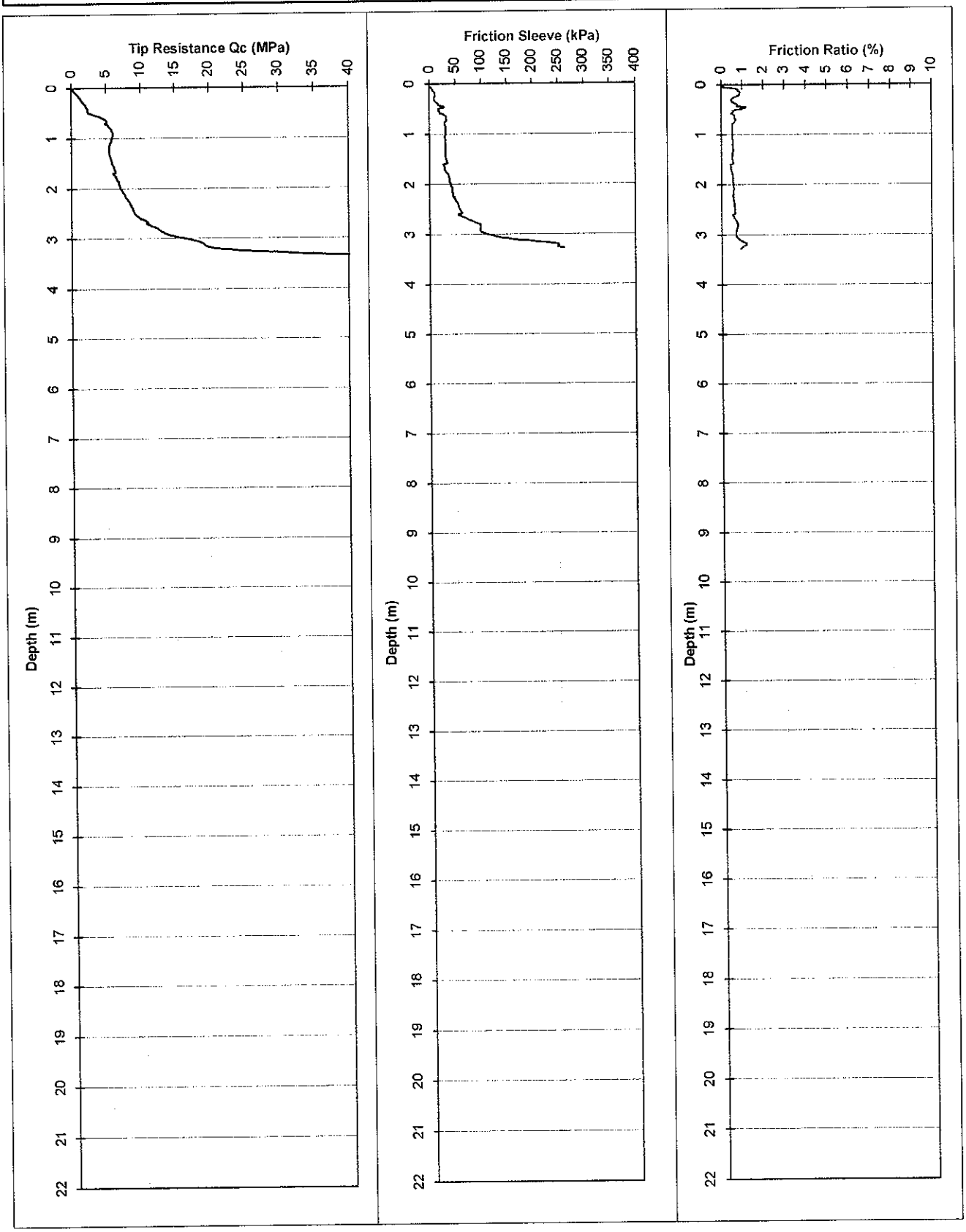
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 07 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 3.0

Refusal: 50MPa

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

File: GH7440TT.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

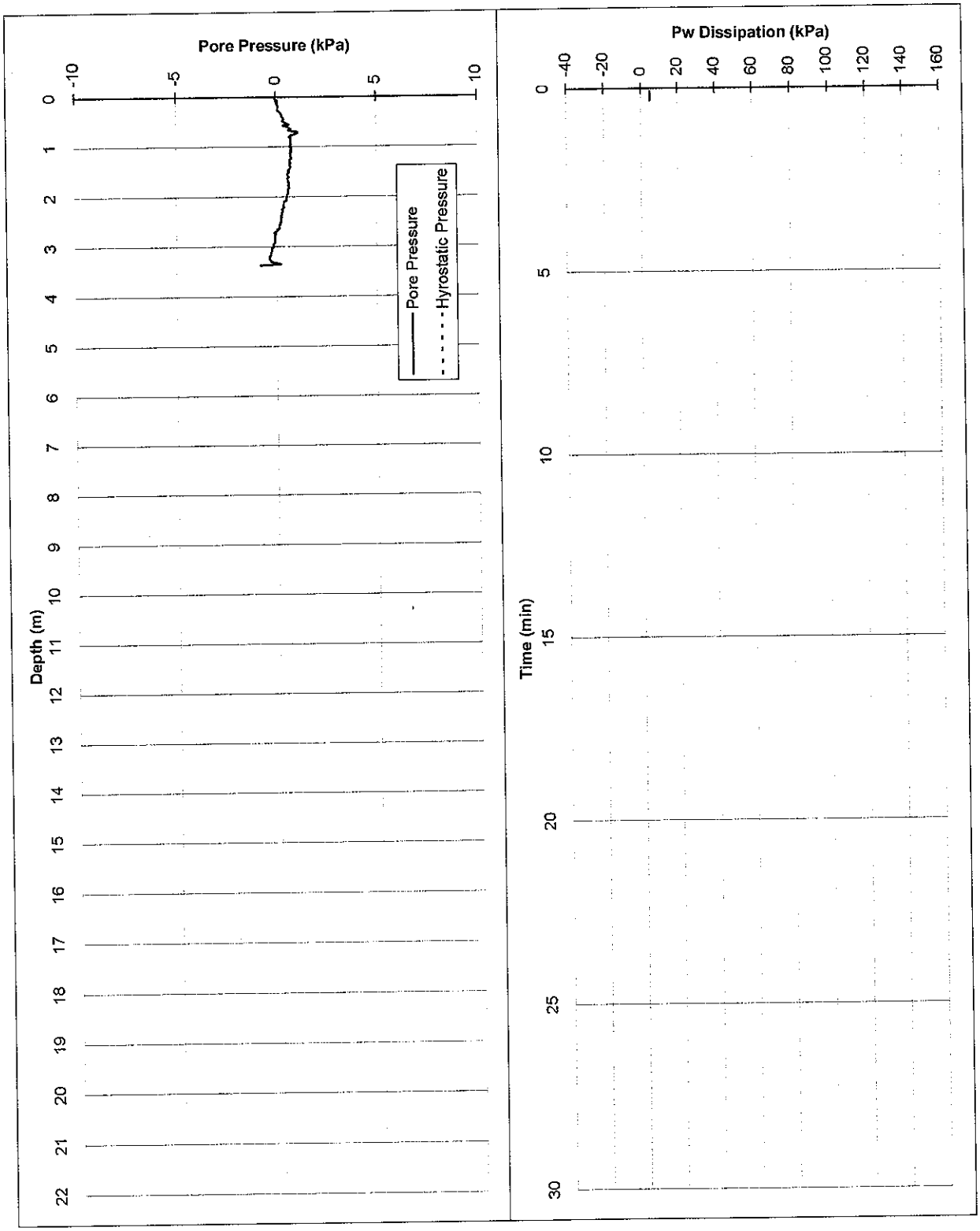
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 07 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7440TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

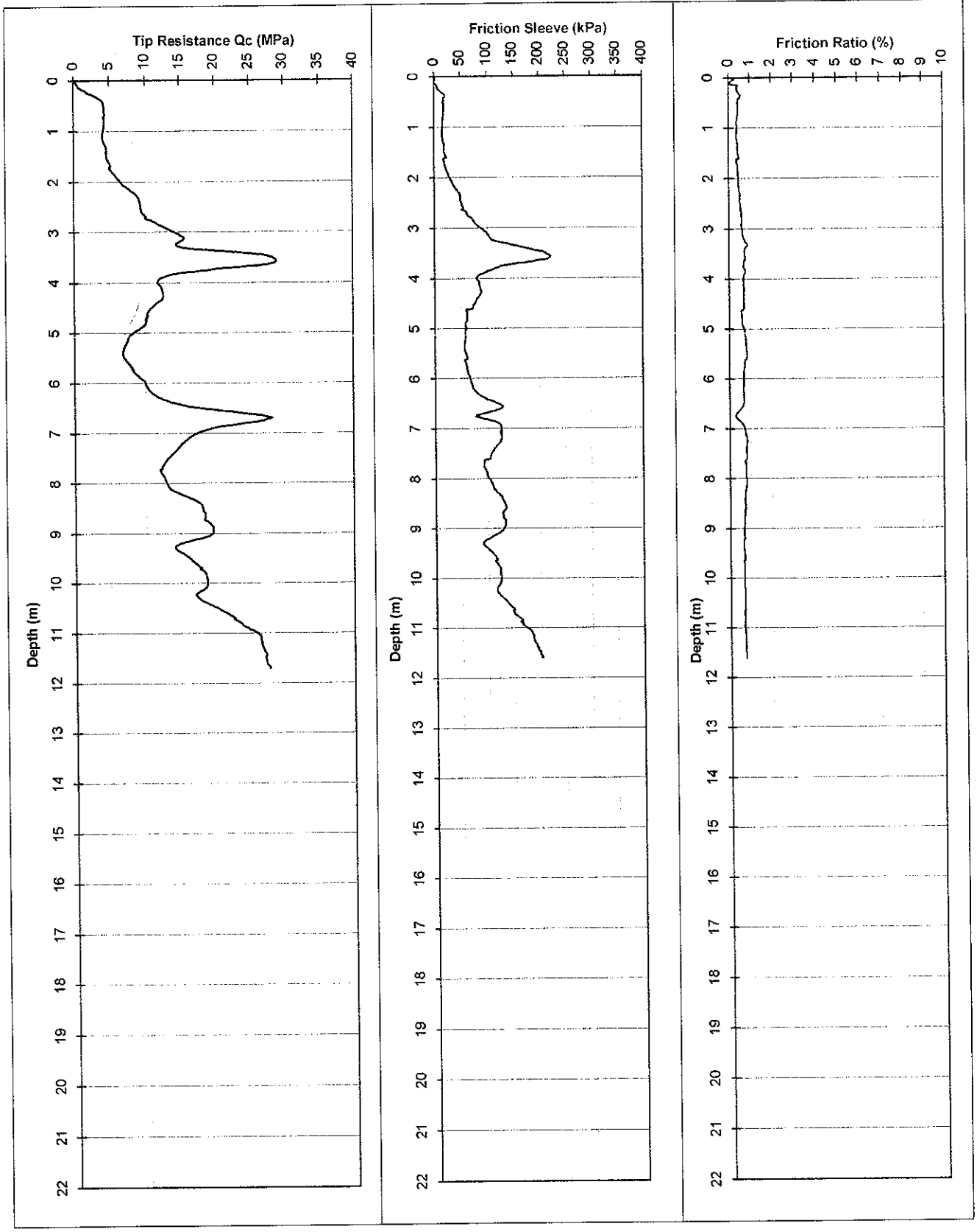
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 07 A U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 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 IRTP 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

Project: Fiona Stanley Hospital

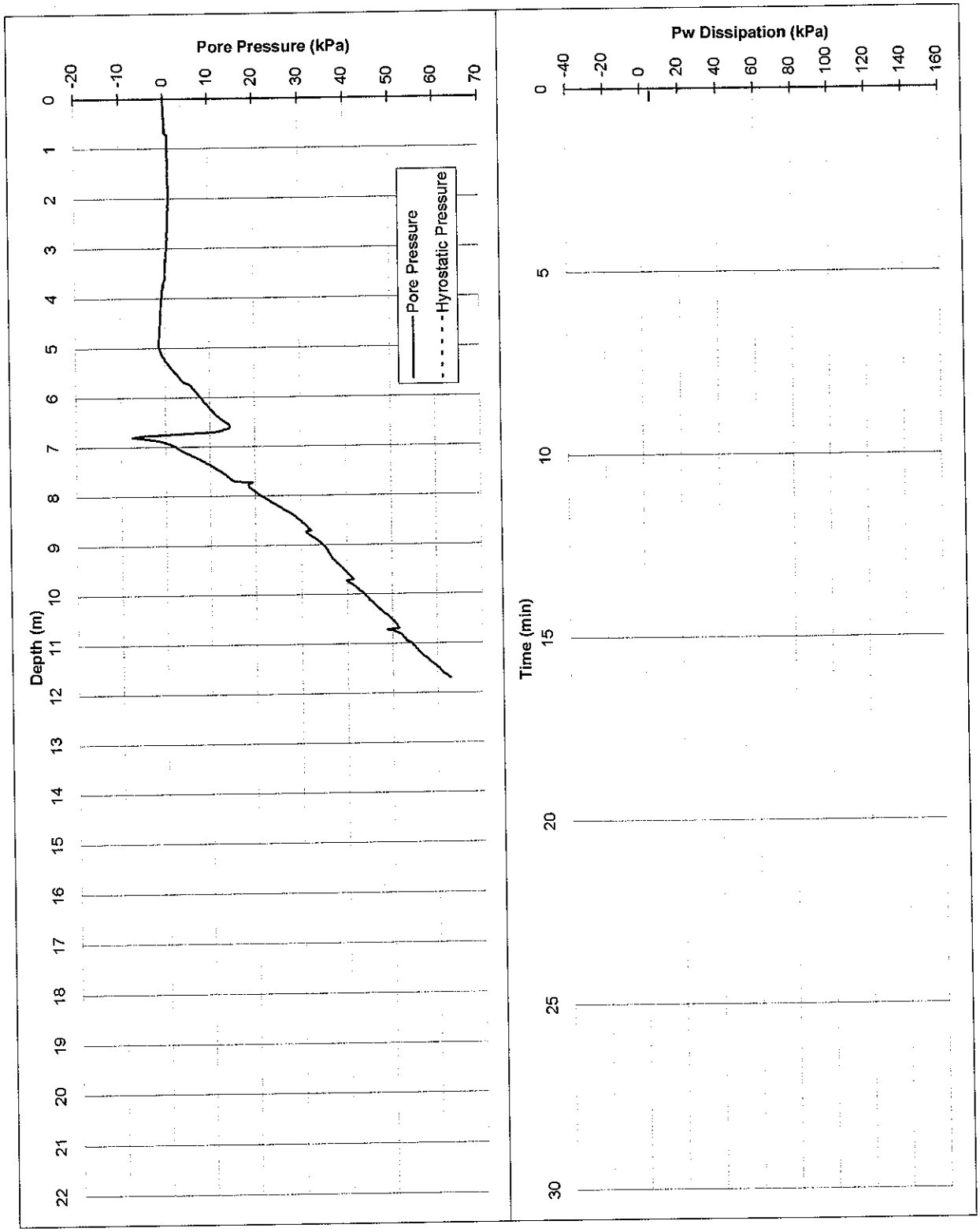
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 07 A U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

7 tonne track mounted CPT Rig.

File: GH7441TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

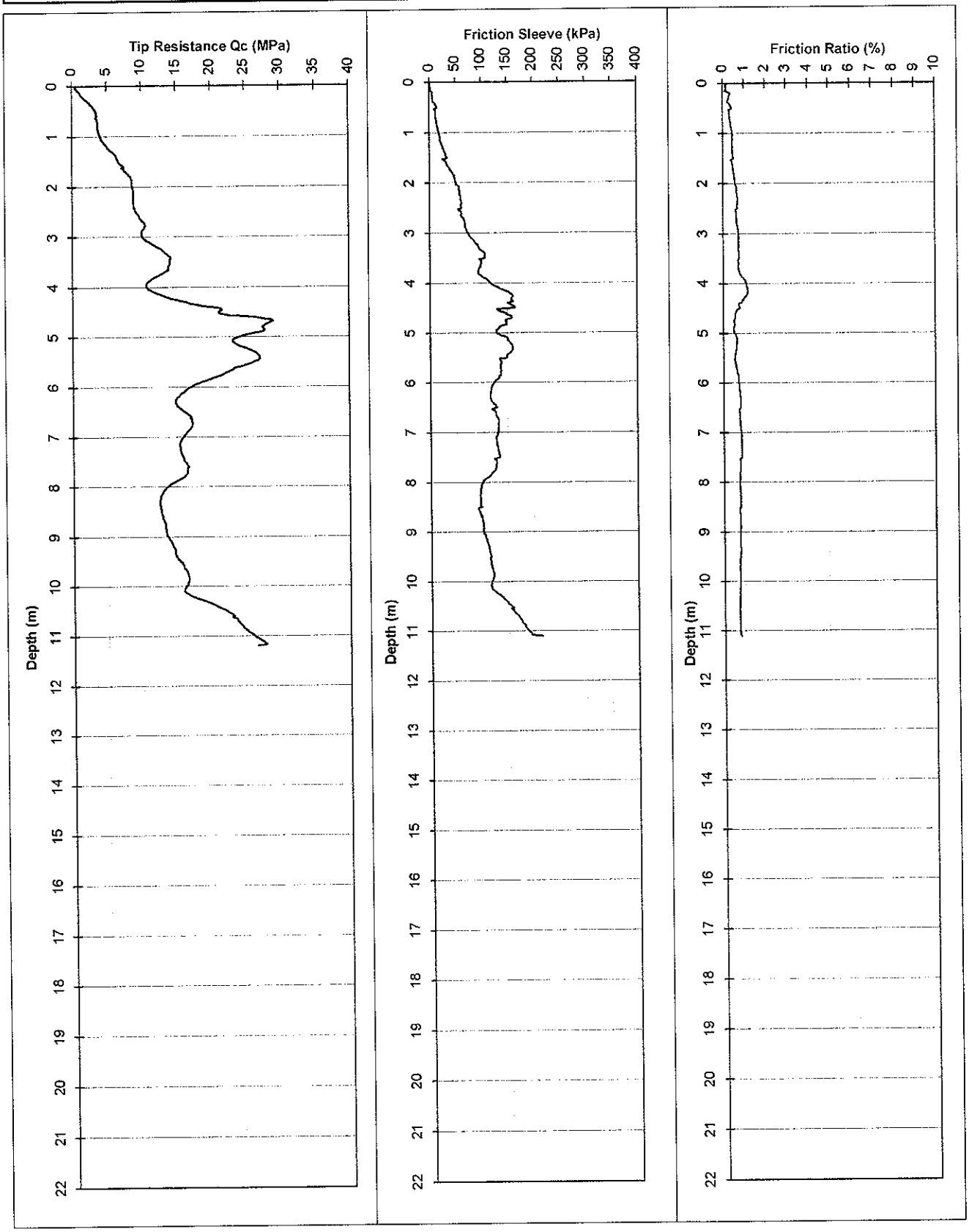
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 09 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 1.0

Refusal:

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

File: GH7439TT.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

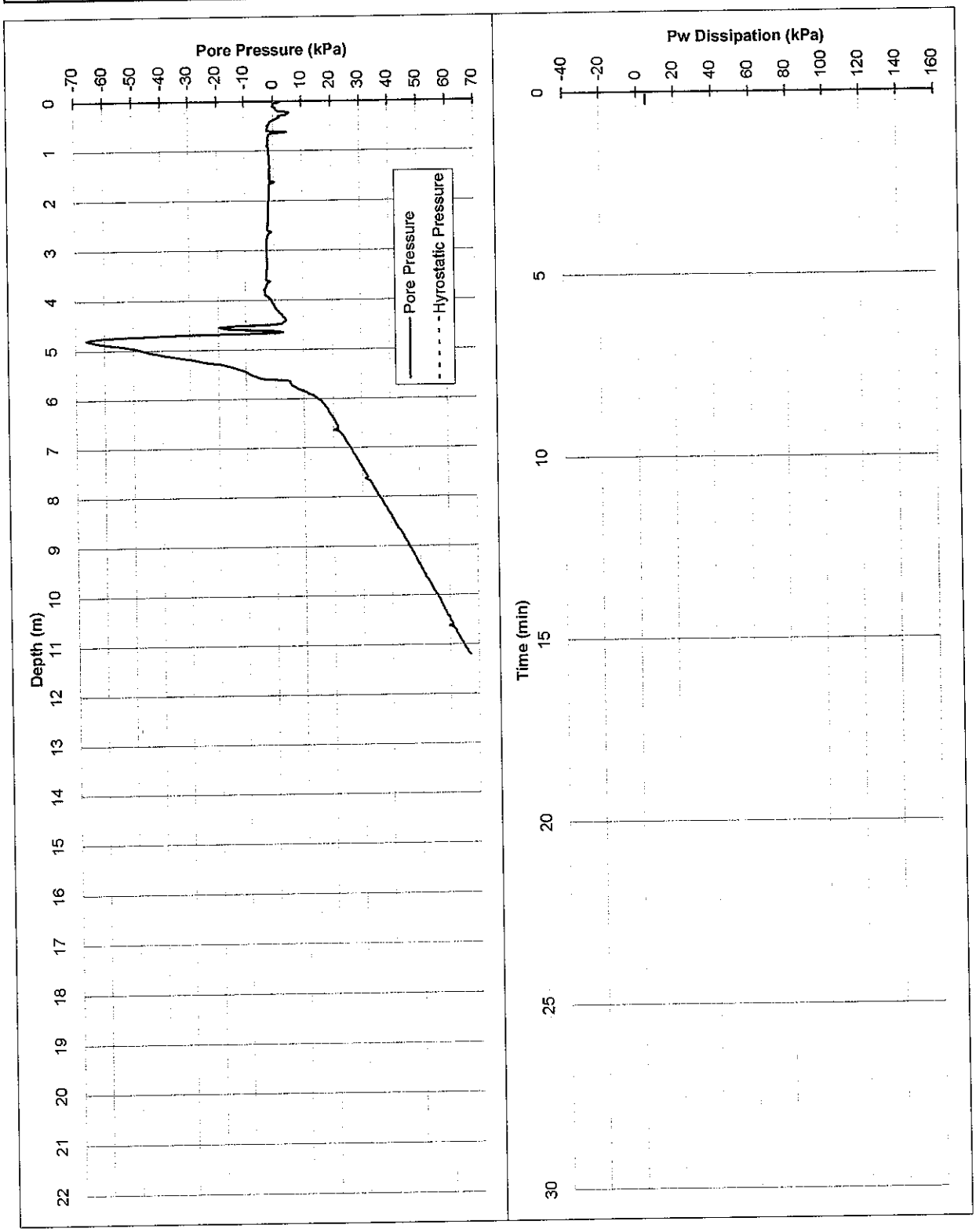
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 09 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

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

7 tonne track mounted CPT Rig.

File: GH7439TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

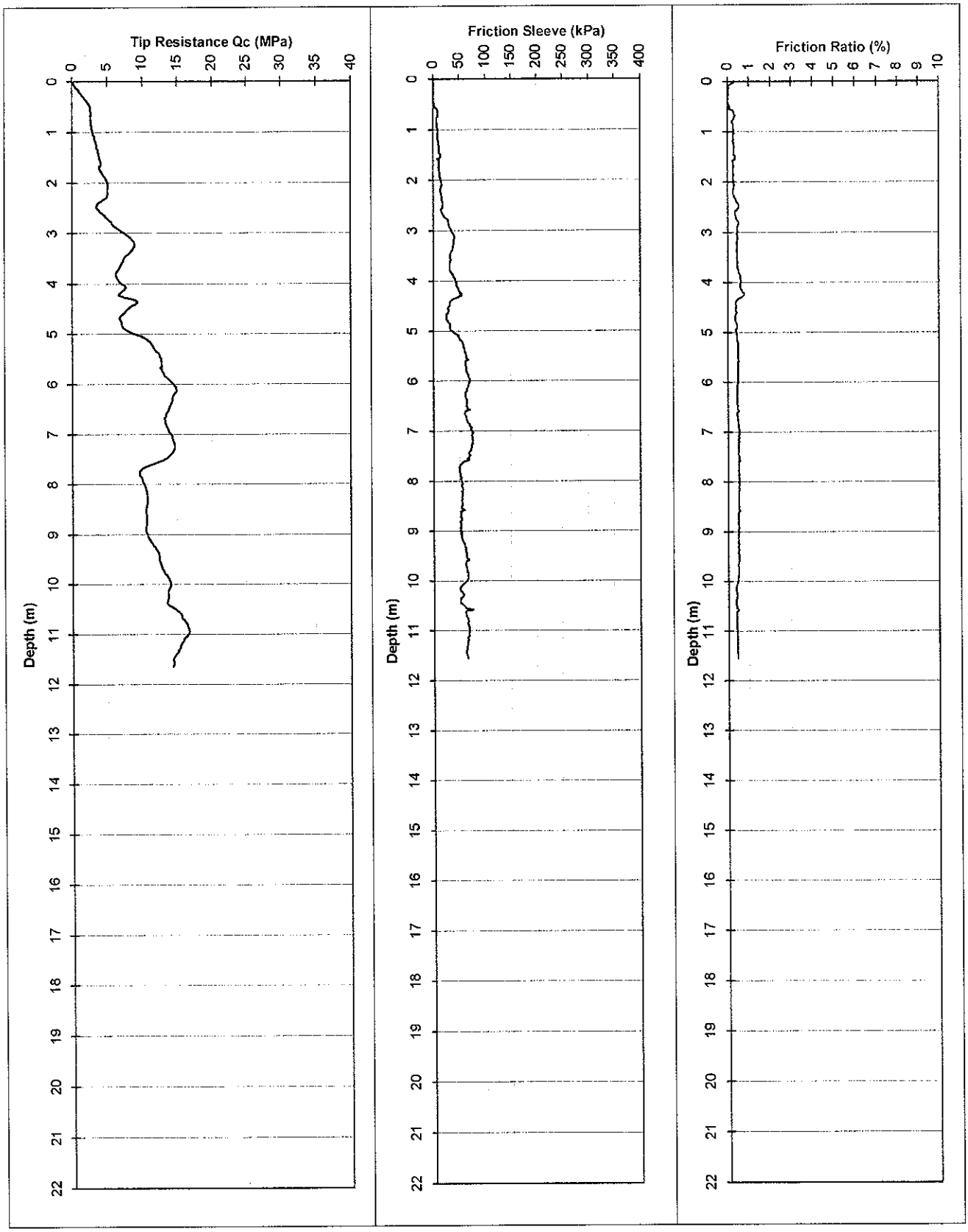
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 10 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph. 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): -

Refusal:

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

File: GH7438TT.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

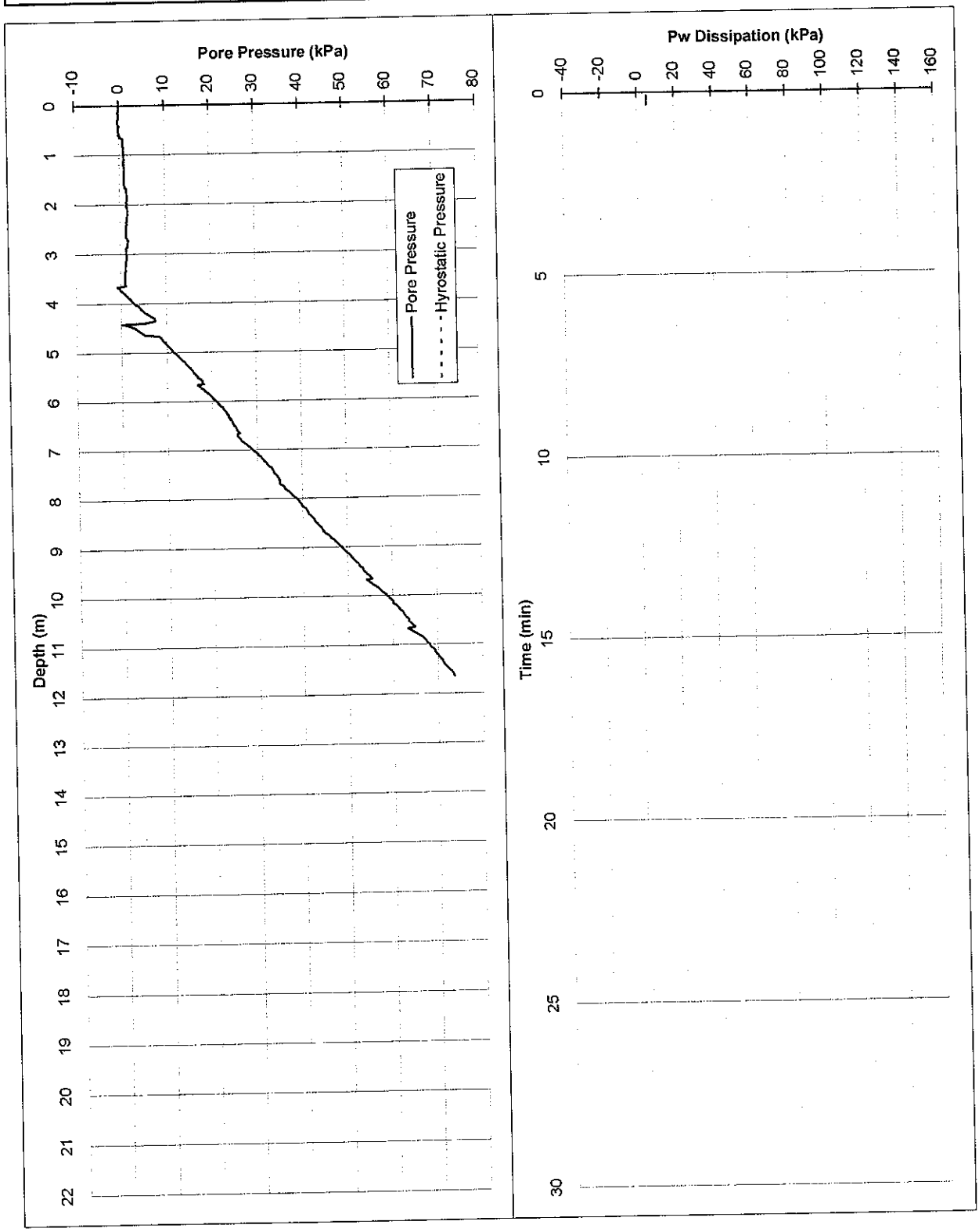
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 10 U

Job Number: 61/19514/01



PROBEDRILL POWER

Ph: 9314 6611 Fax 9314 6699

GEOTECHNICAL SURVEY

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

File: GH7438TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

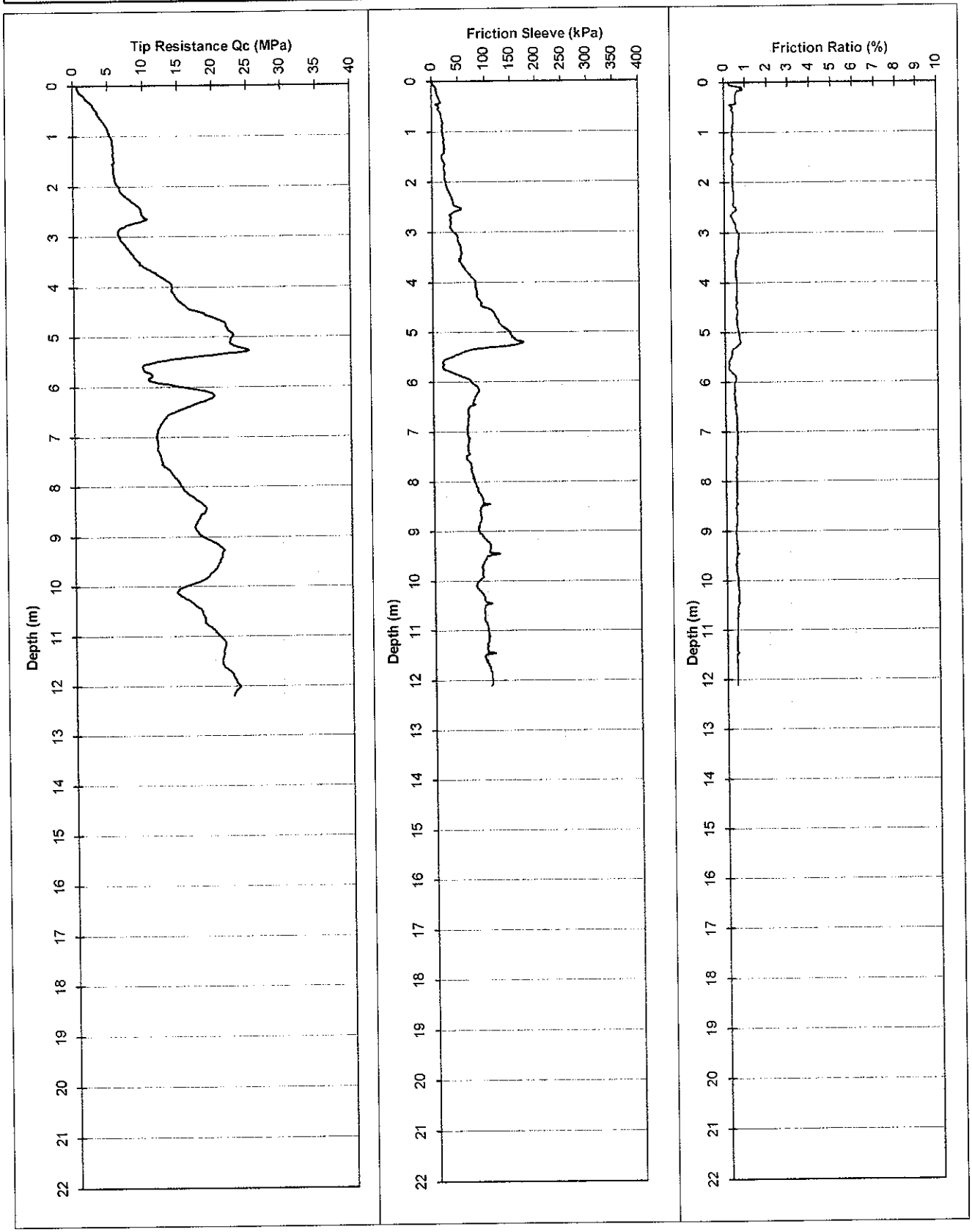
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 11 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 3.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

Date: 21/06/07

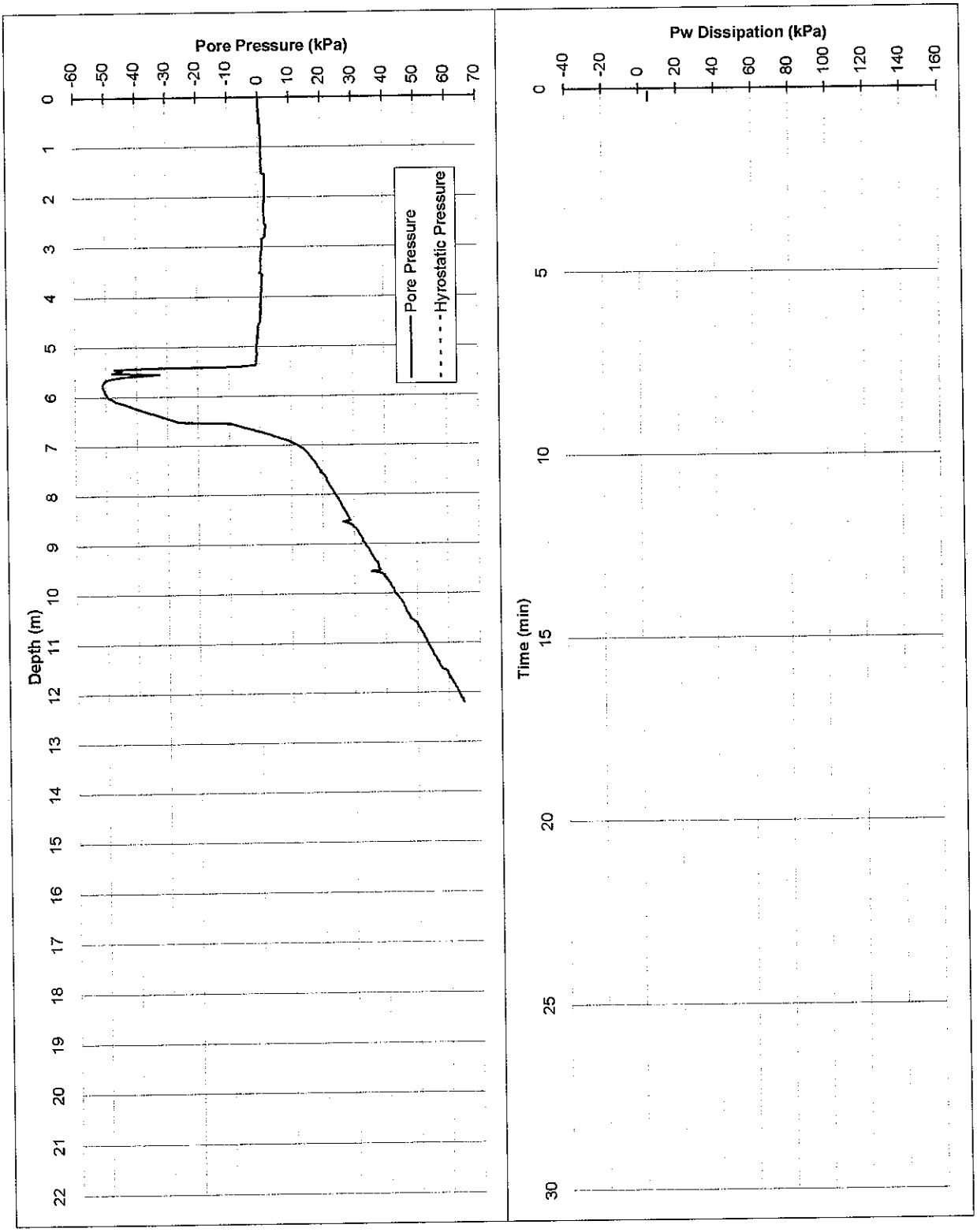
Project: Fiona Stanley Hospital

Probe No.: CPT 11 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7437TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

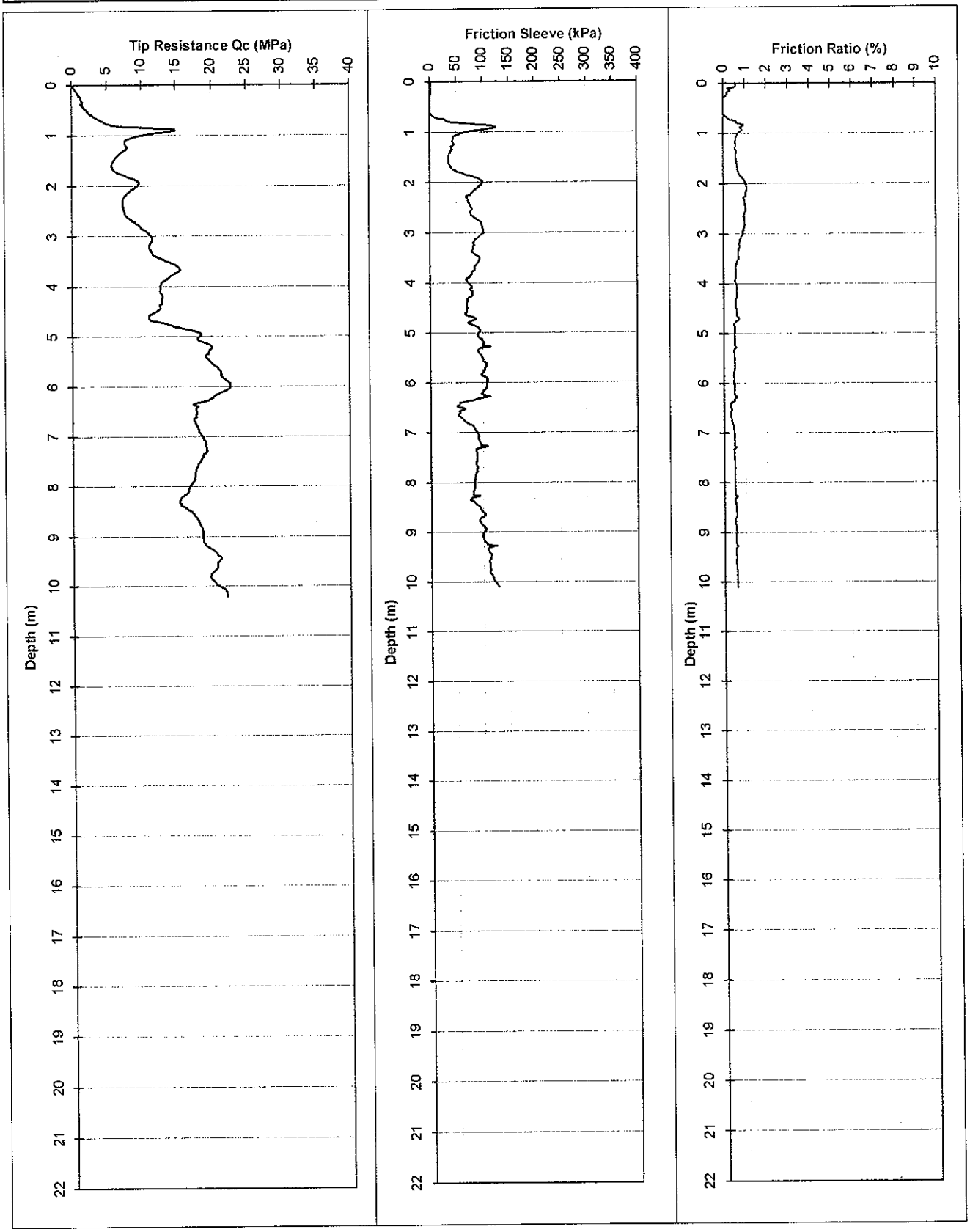
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 14 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): 3.2

Refusal:

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

File: GH7407TT.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

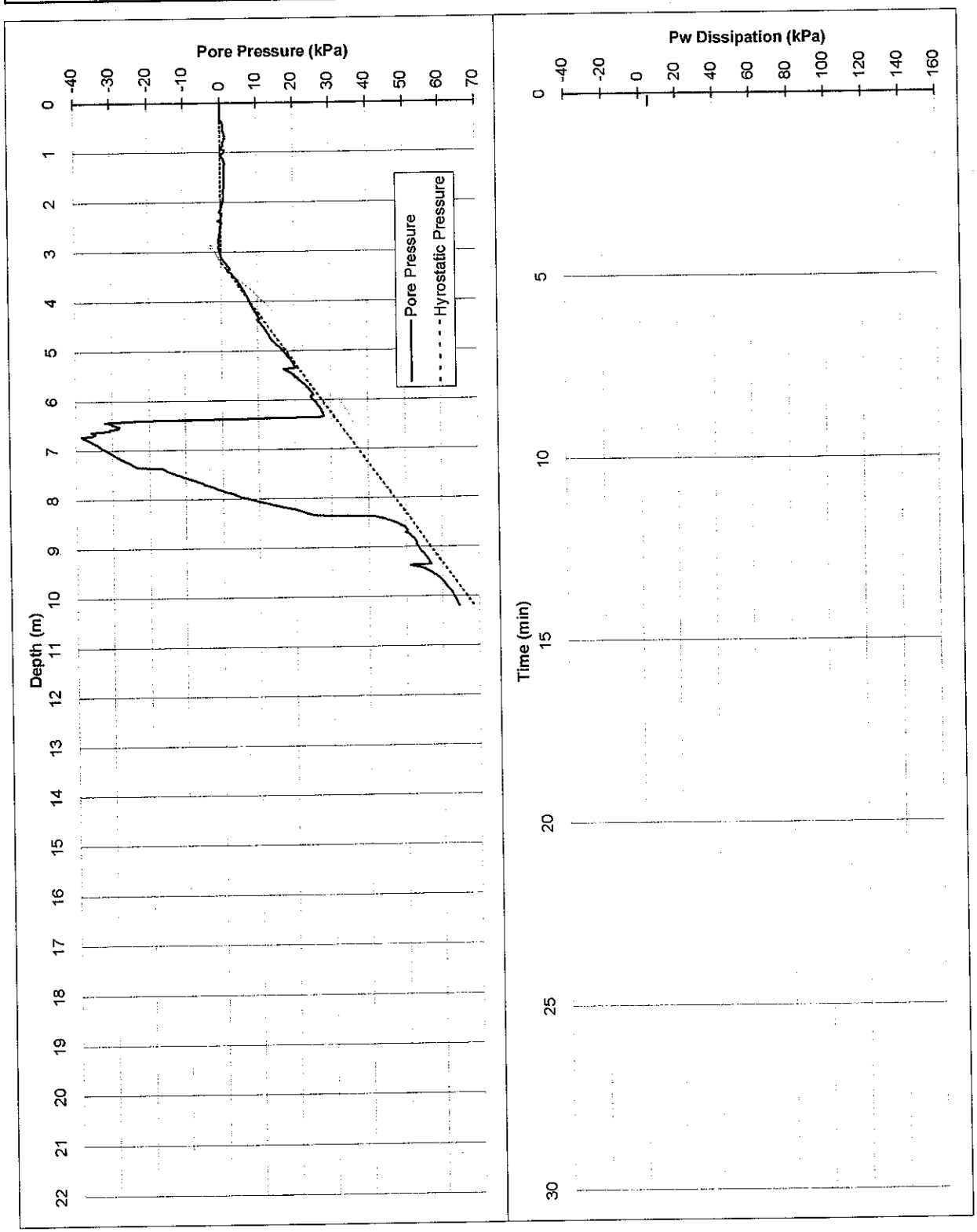
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 14 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7407TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

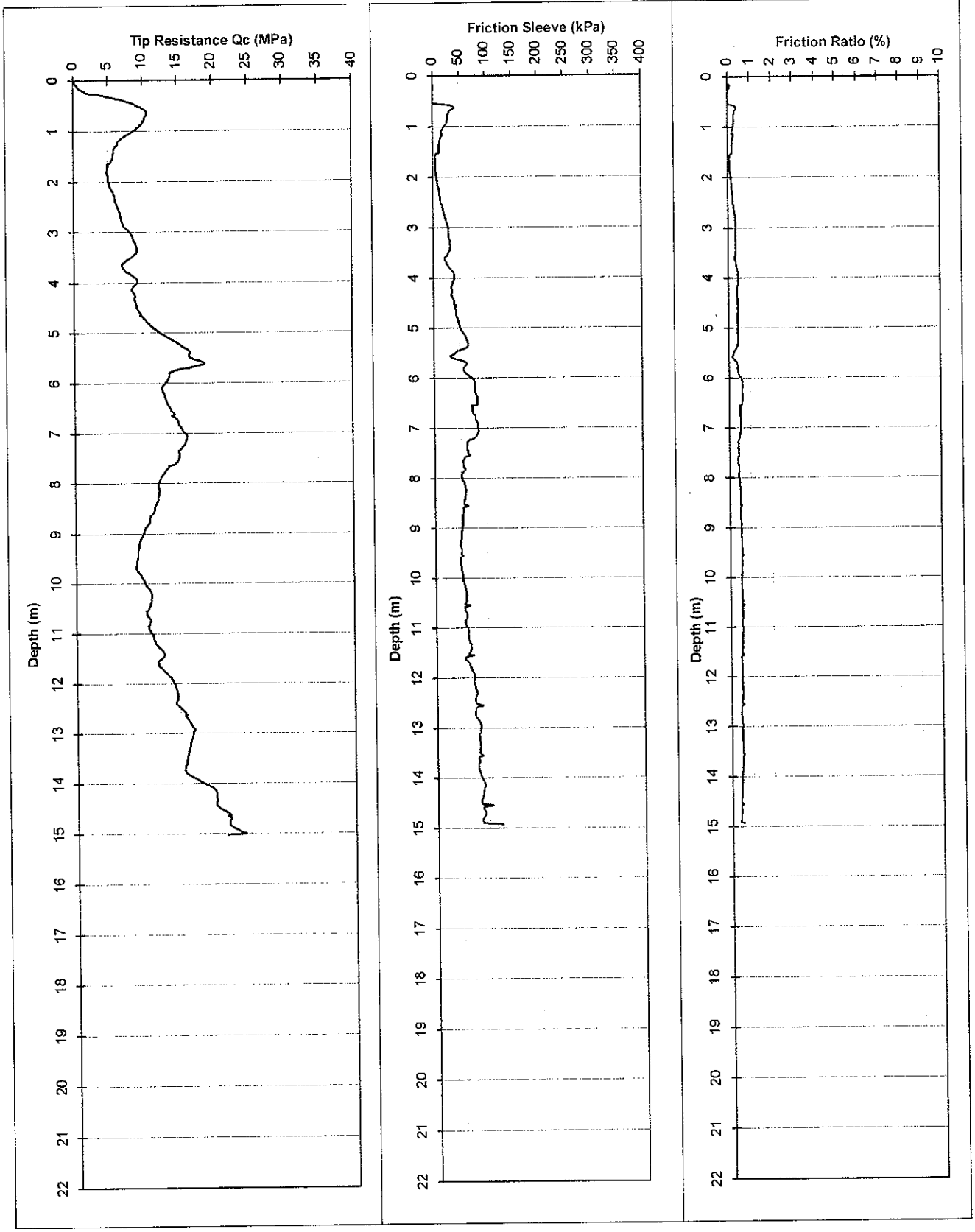
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 15 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph. 9314 6611 Fax 9314 6699

Water (m): Dry to 4.3

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

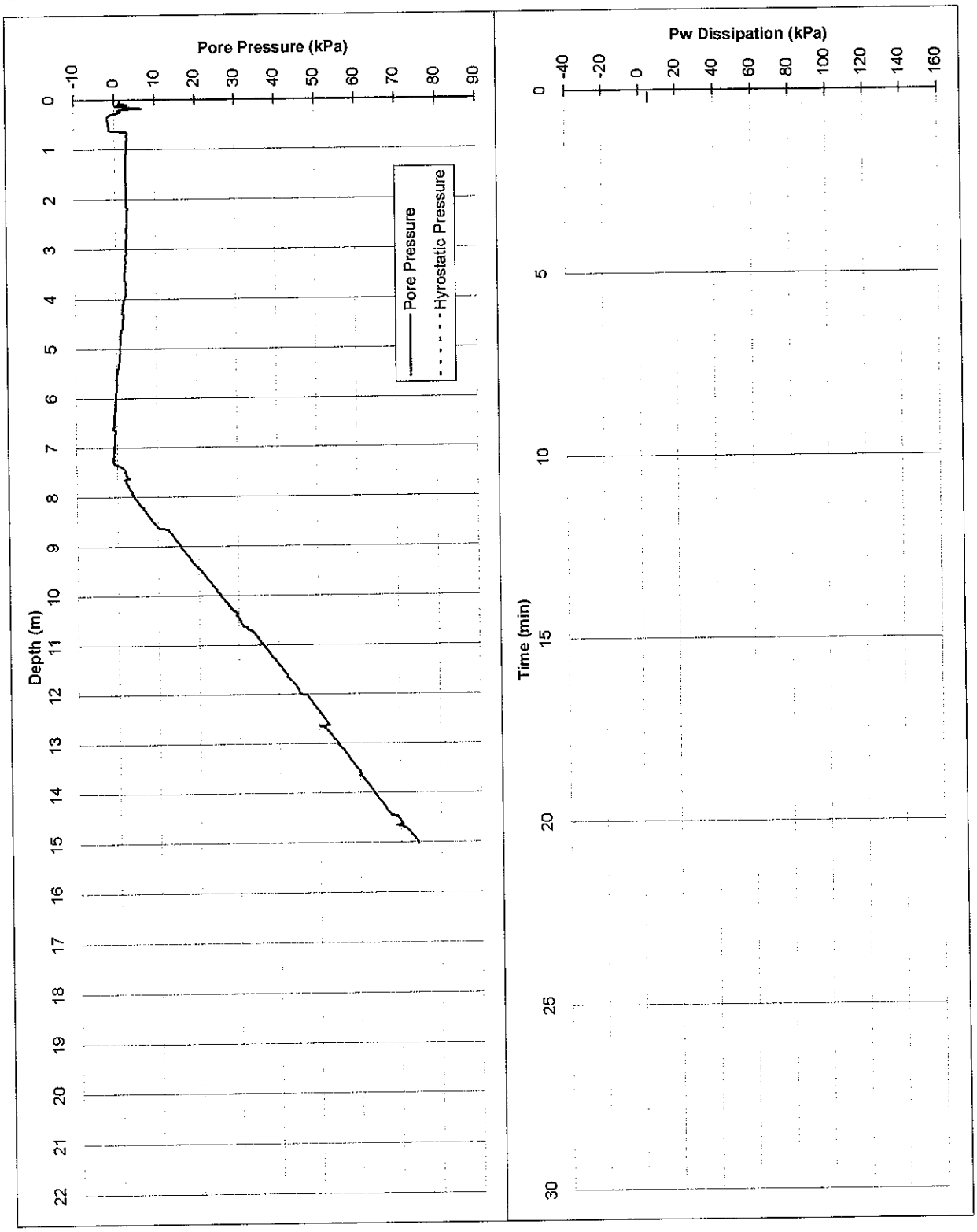
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 15 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

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

7 tonne track mounted CPT Rig.

File: GH7434TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

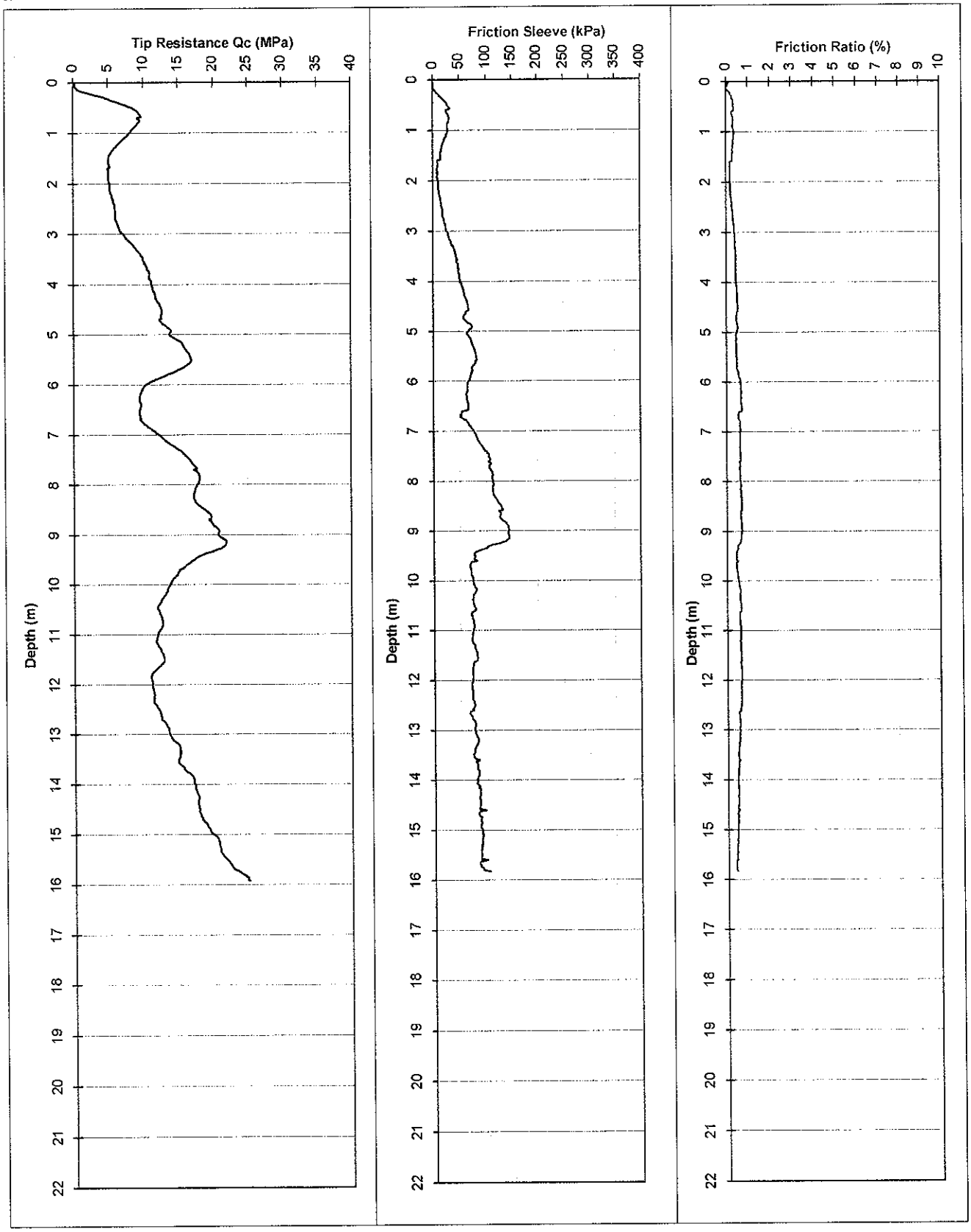
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 16 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL

Ph: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

Water (m): Dry to 9.1

Refusal: 25MPa

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

File: GH7435TT.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

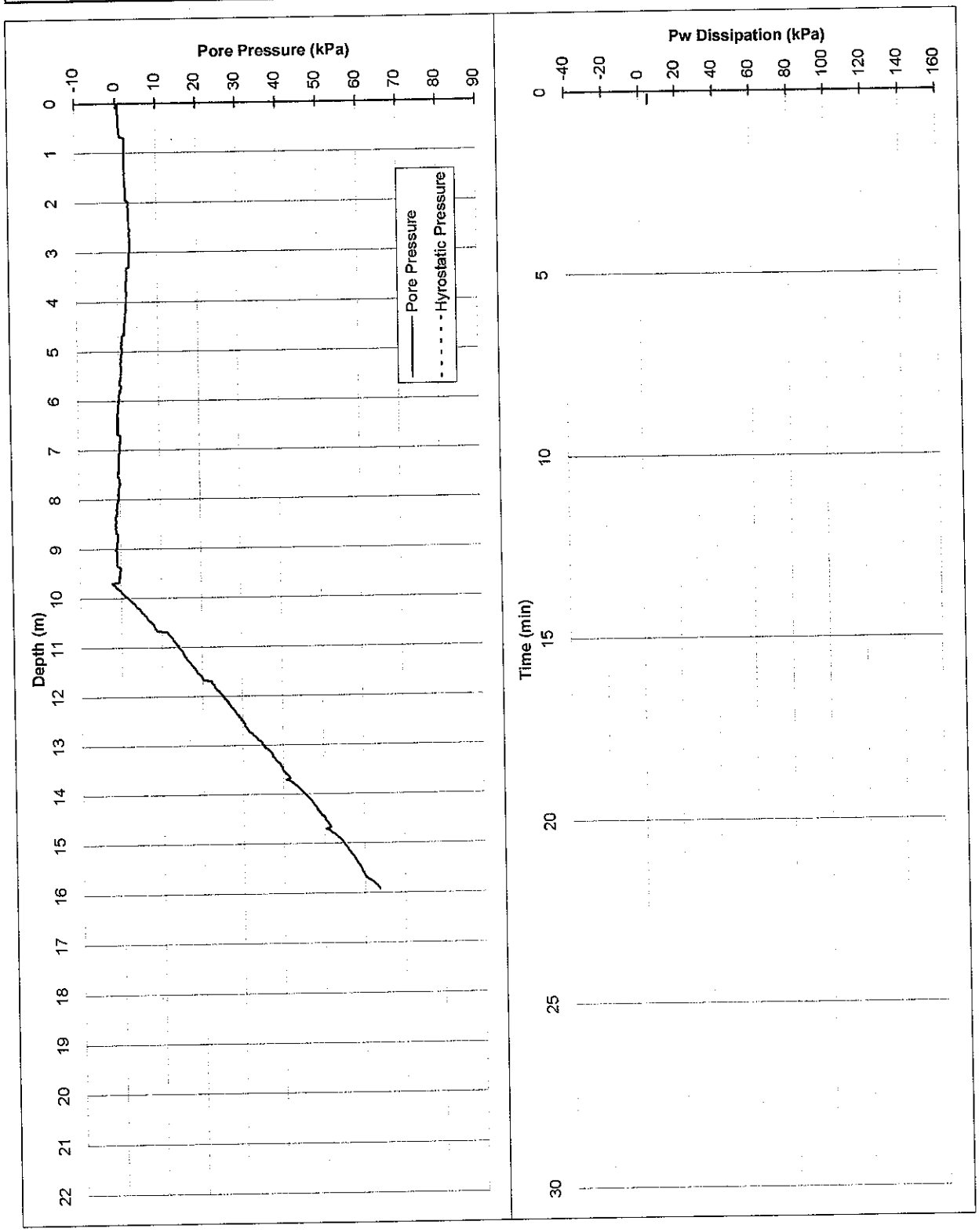
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 16 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

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

7 tonne track mounted CPT Rig.

File: GH7435TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

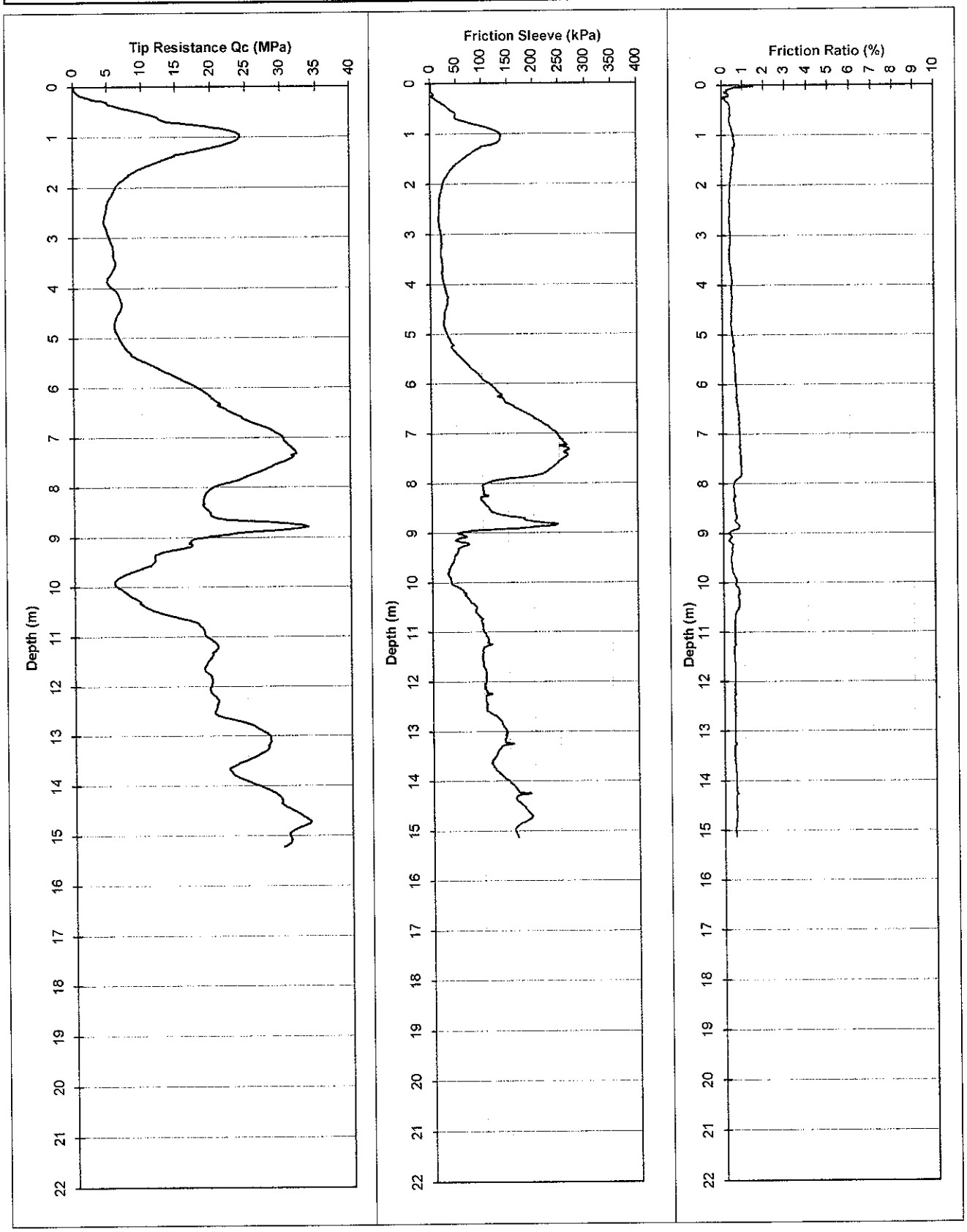
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 19 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 7.0

Refusal:

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

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

Project: Fiona Stanley Hospital

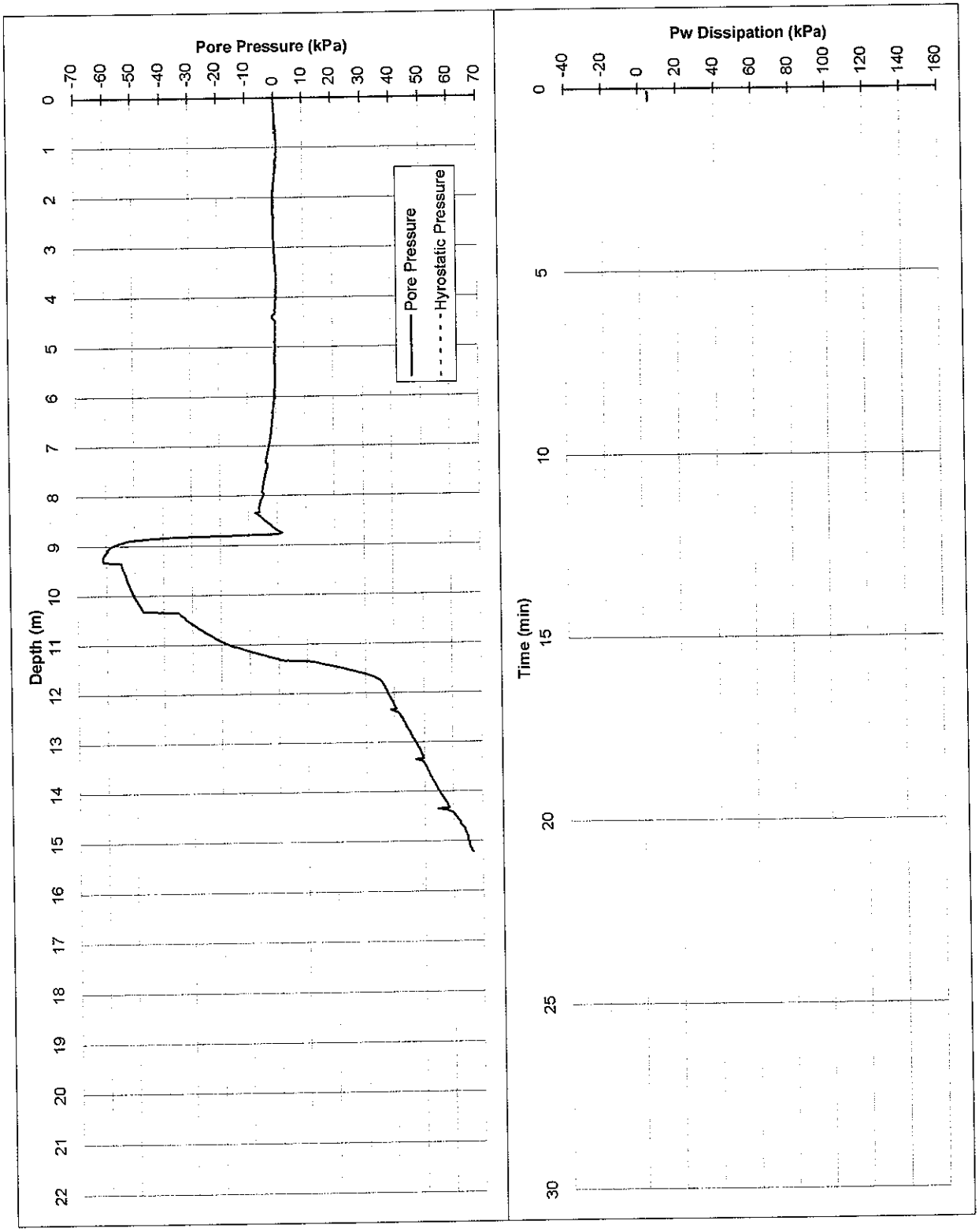
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 19 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7427TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

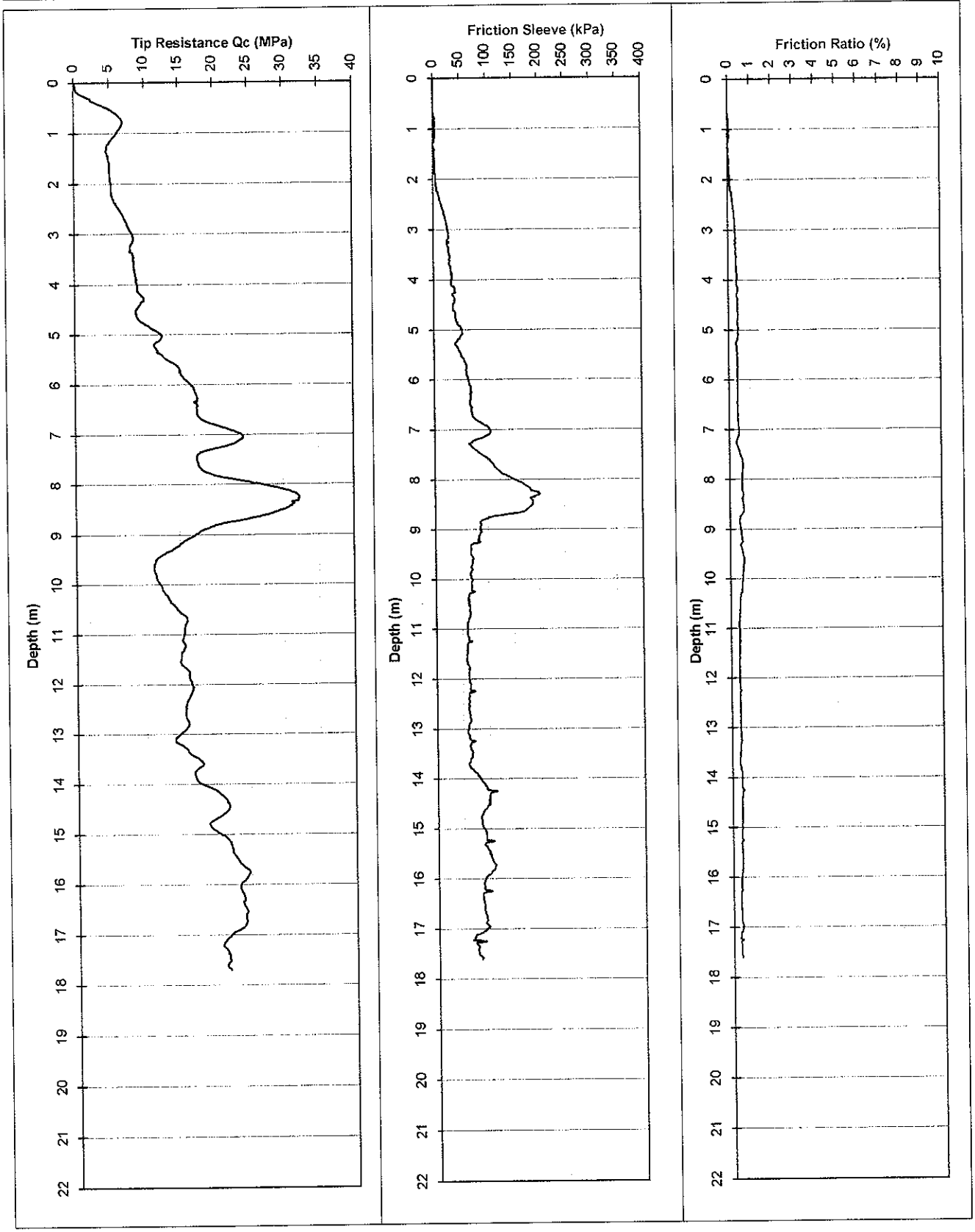
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 20 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PERTH
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): -

Refusal:

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

File: GH7433TT.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

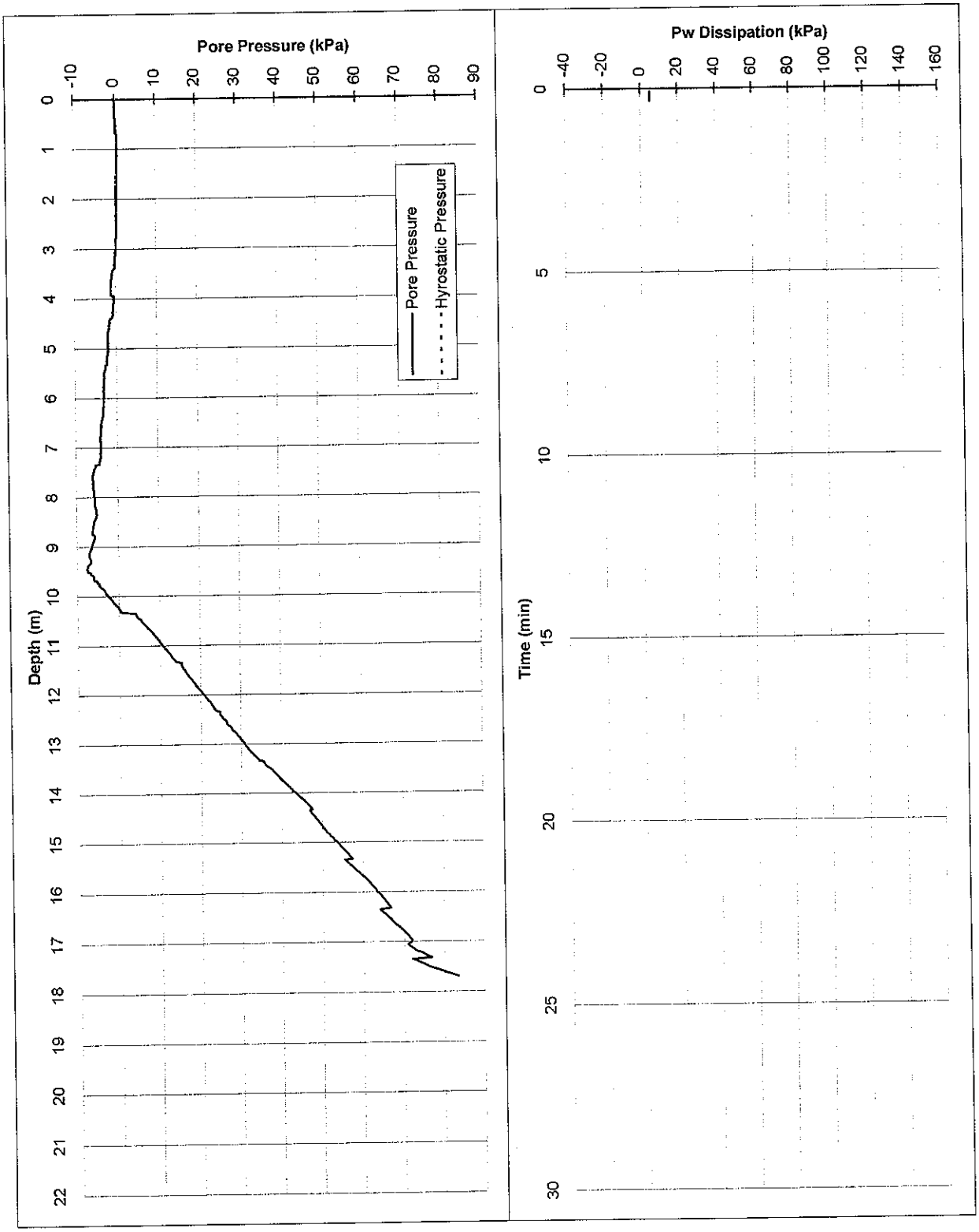
Location: Murdoch

Co-ordinates:

Date: 21/06/07

Probe No.: CPT 20 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7433TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

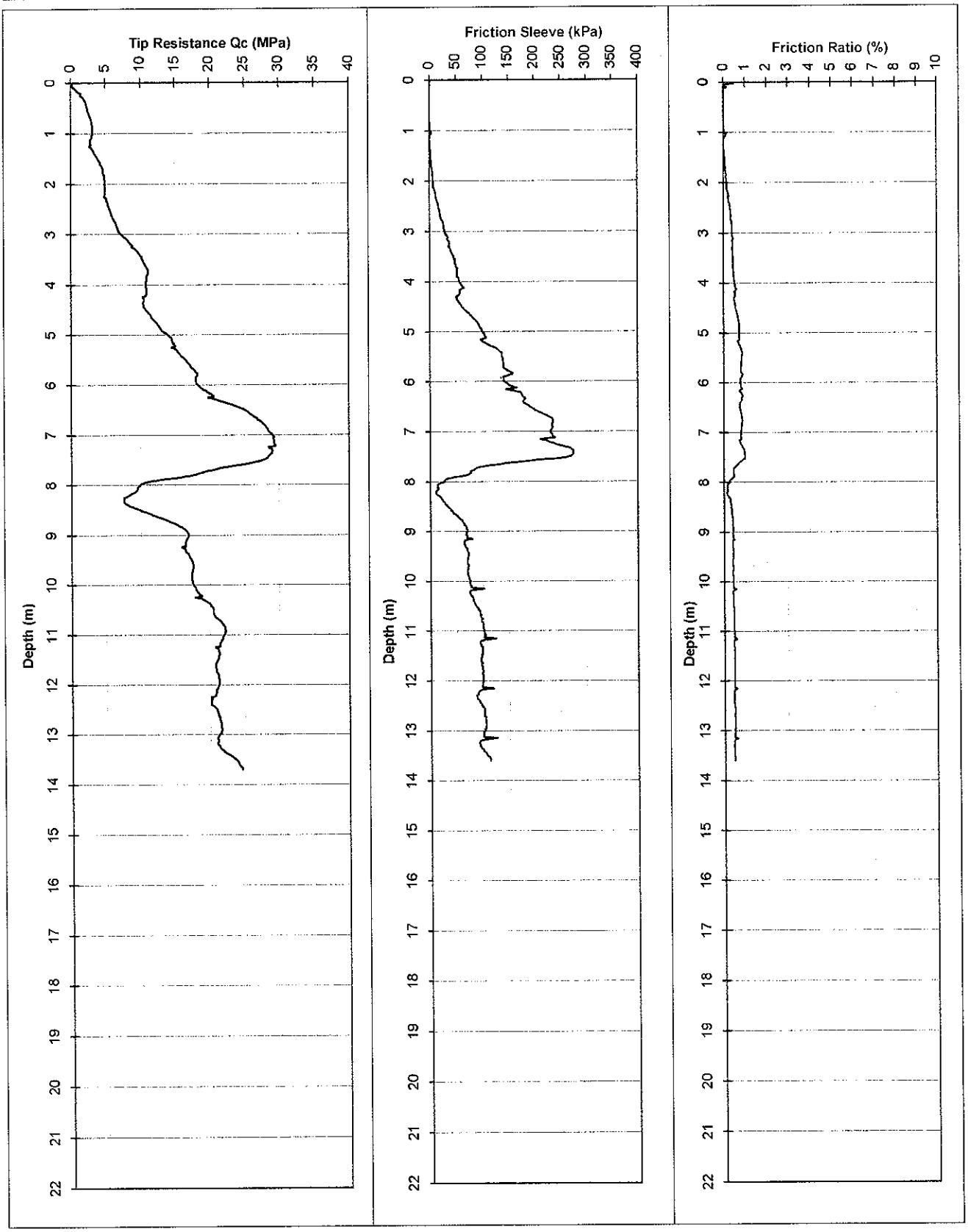
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 21 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): -

Refusal:

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

File: GH7409TT.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

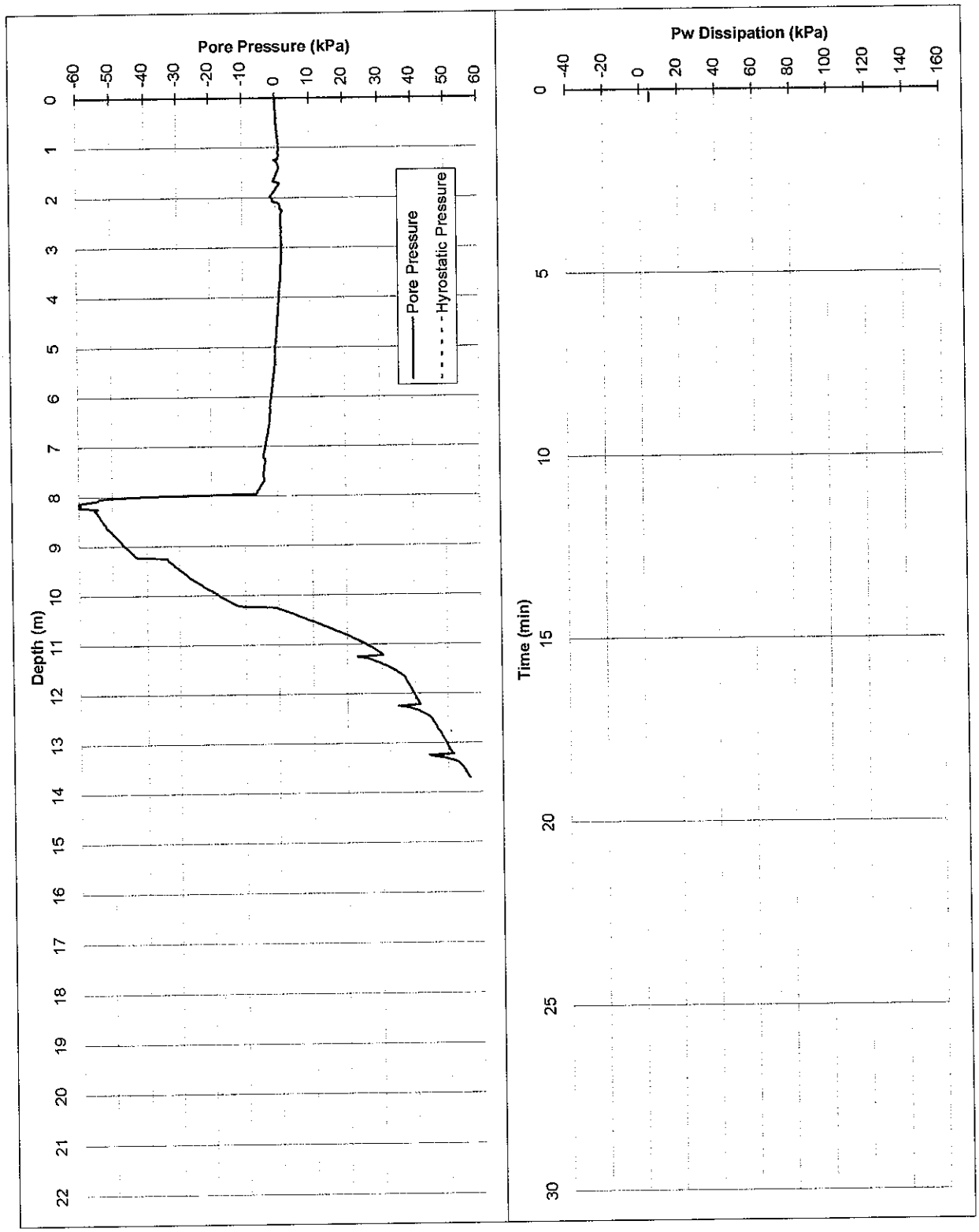
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 21 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD

Ph: 9314 6611 Fax 9314 6699

GEOTECHNICAL SURVEY

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

22 tonne truck mounted CPT Rig.

File: GH7409TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

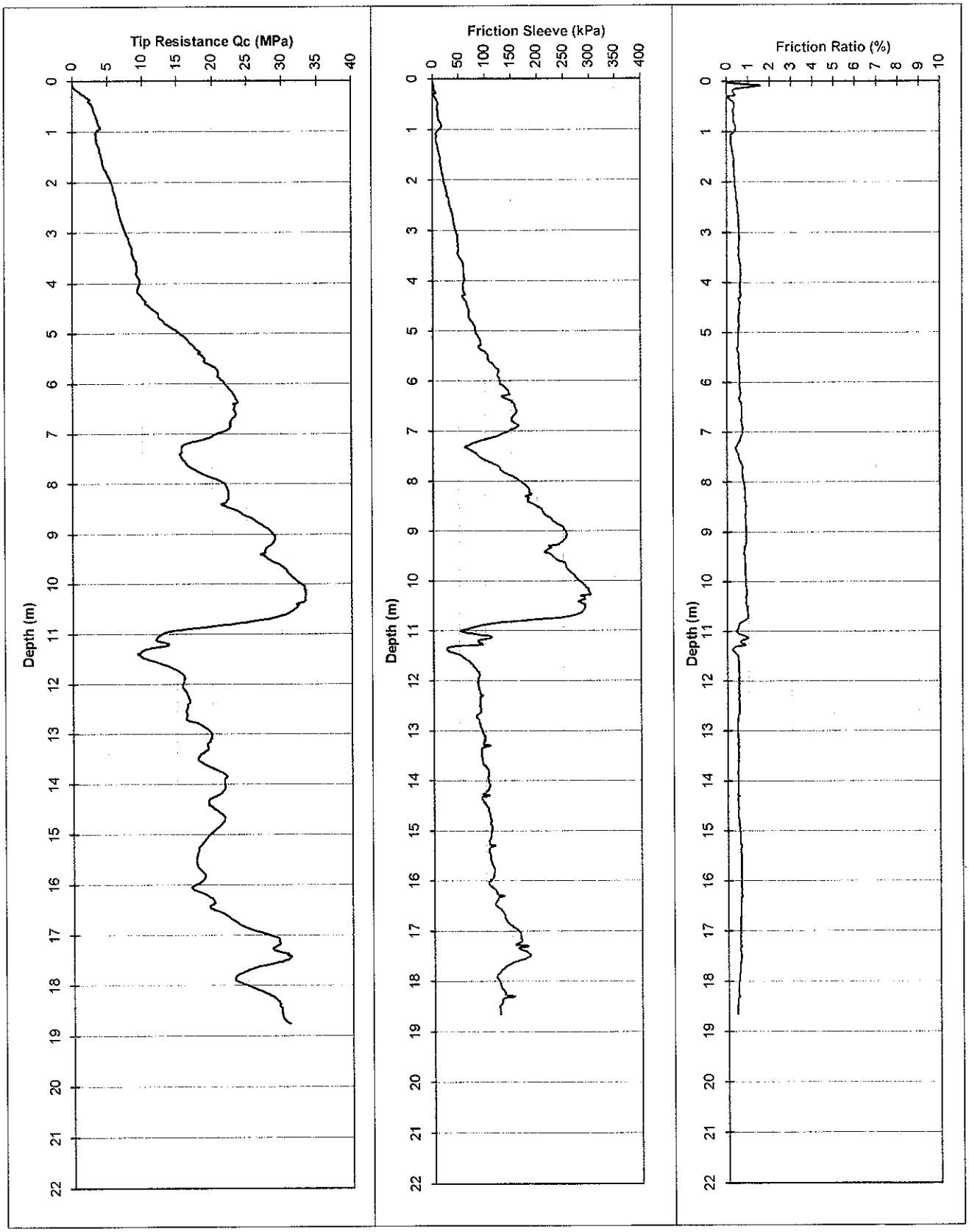
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 22 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 9.2

Refusal:

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

File: GH7426TT.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

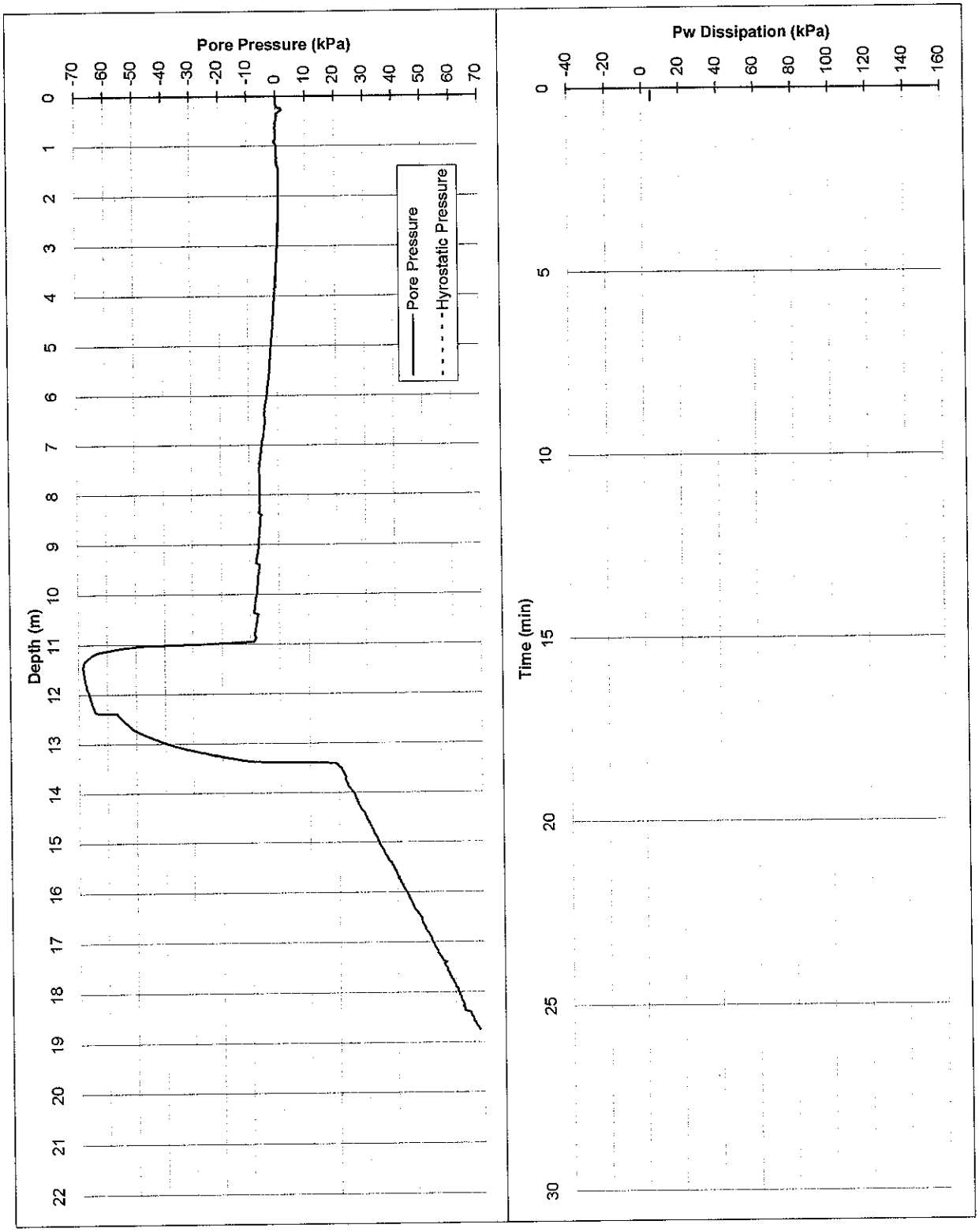
Project: Fiona Stanley Hospital

Probe No.: CPT 22 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
PH: 9314 6811 Fax: 9314 6699

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

File: GH7426TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

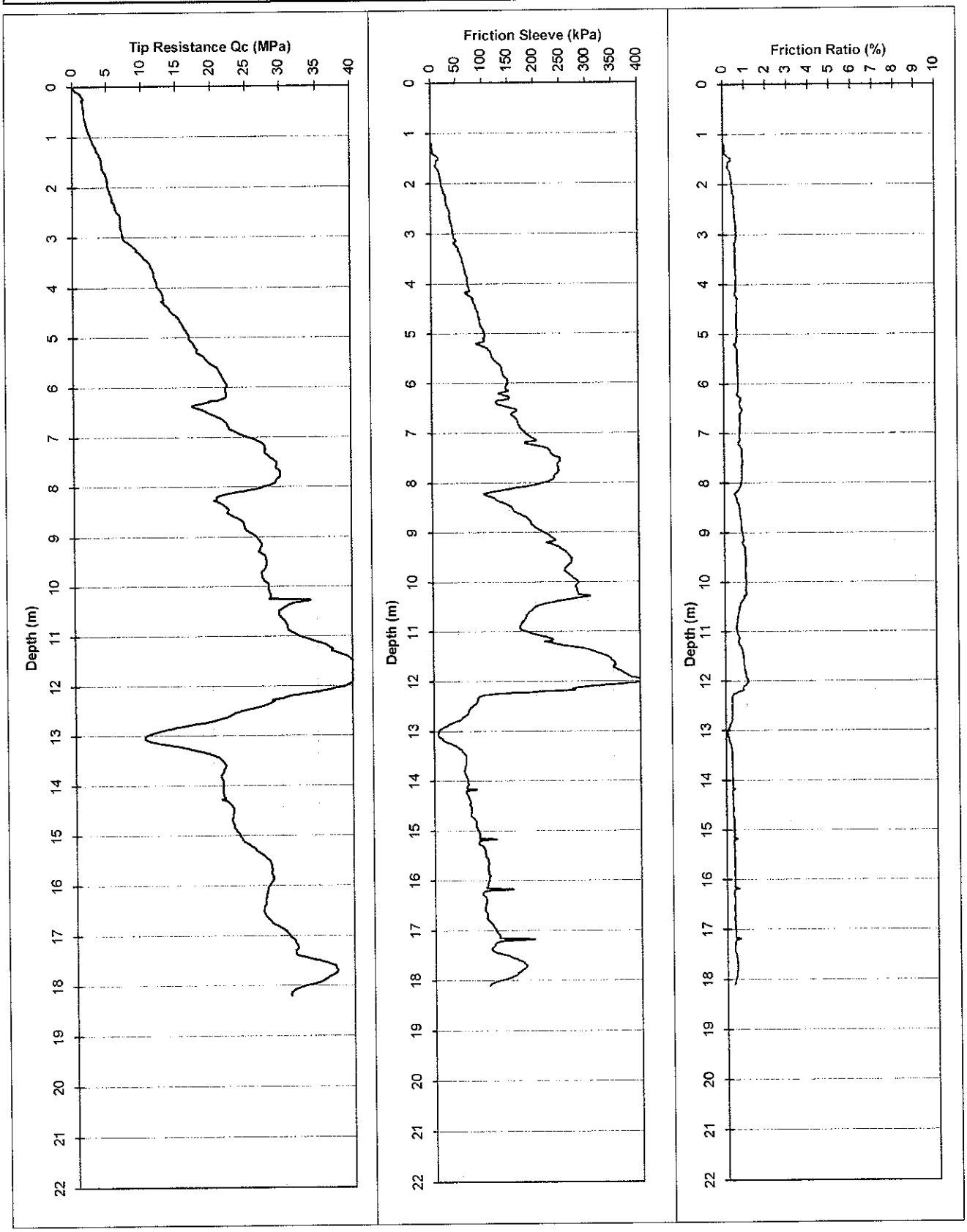
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 23 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph: 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 IRTP 2001 for friction reducer

File: GH7410TT.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

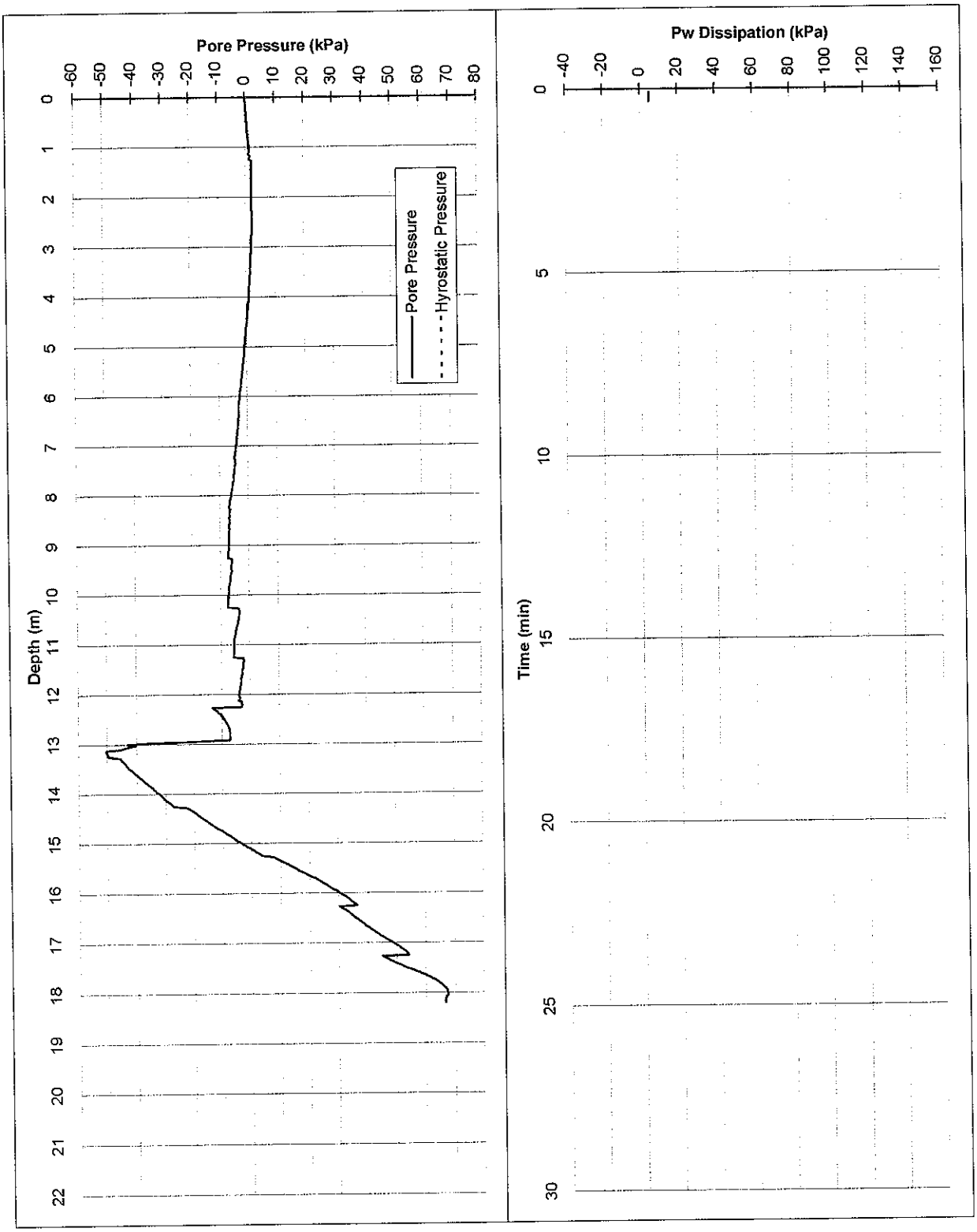
Project: Fiona Stanley Hospital

Probe No.: CPT 23 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

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

File: GH7410TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

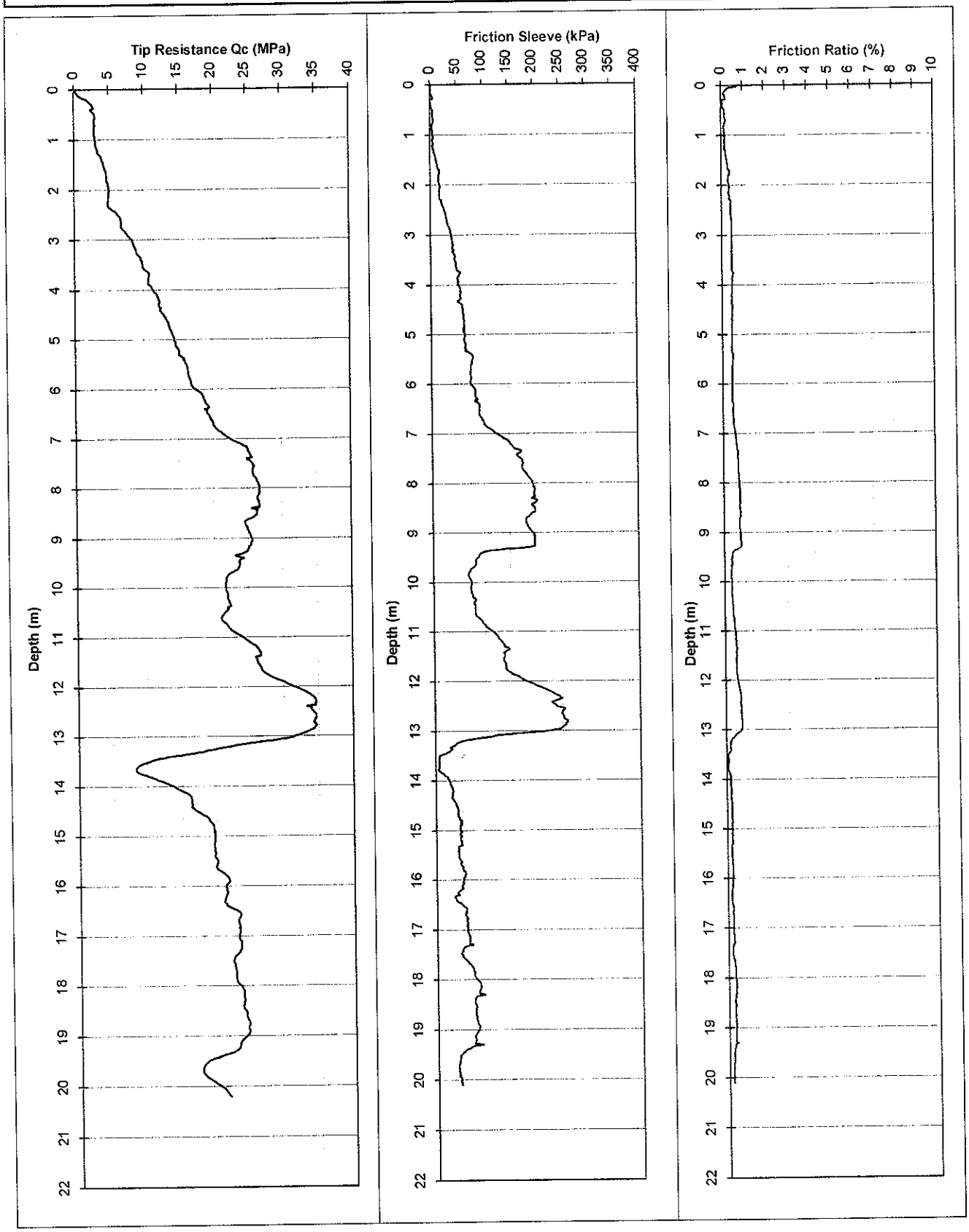
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 24 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
Ph. 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 9.2

Refusal:

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

File: GH7425TT.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

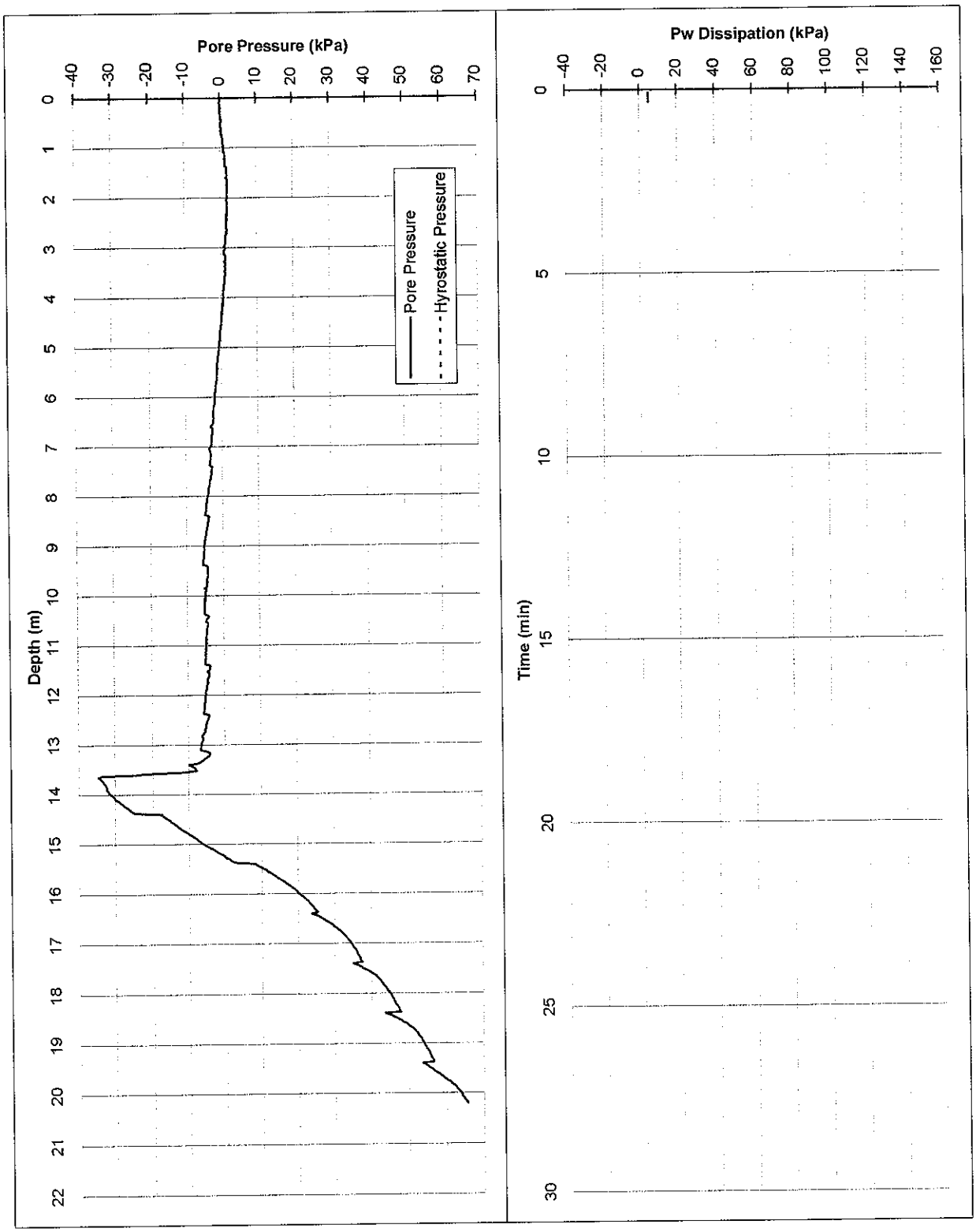
Project: Fiona Stanley Hospital

Probe No.: CPT 24 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

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

File: GH7425TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

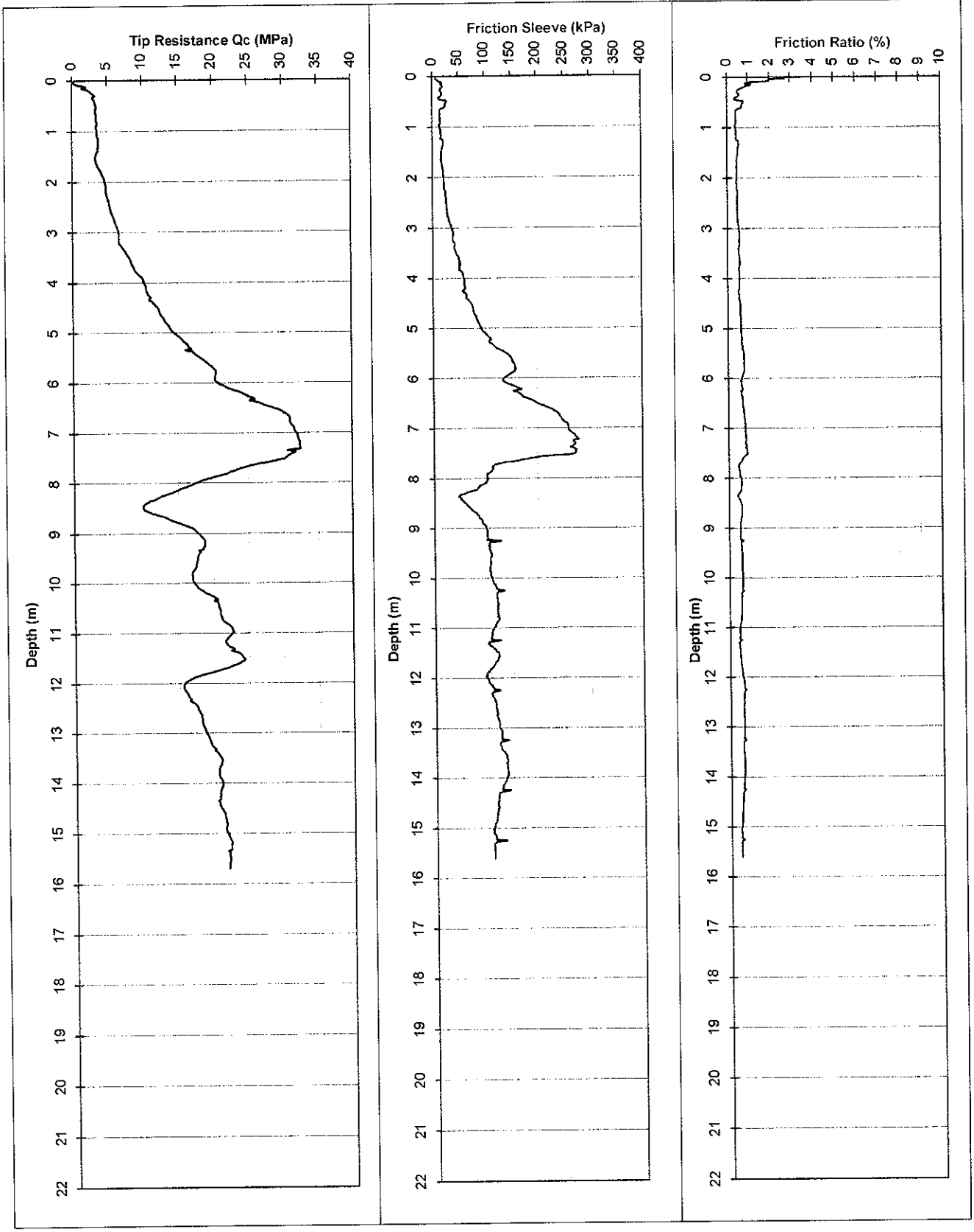
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 25 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 10.1

Refusal:

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

File: GH7420TT.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

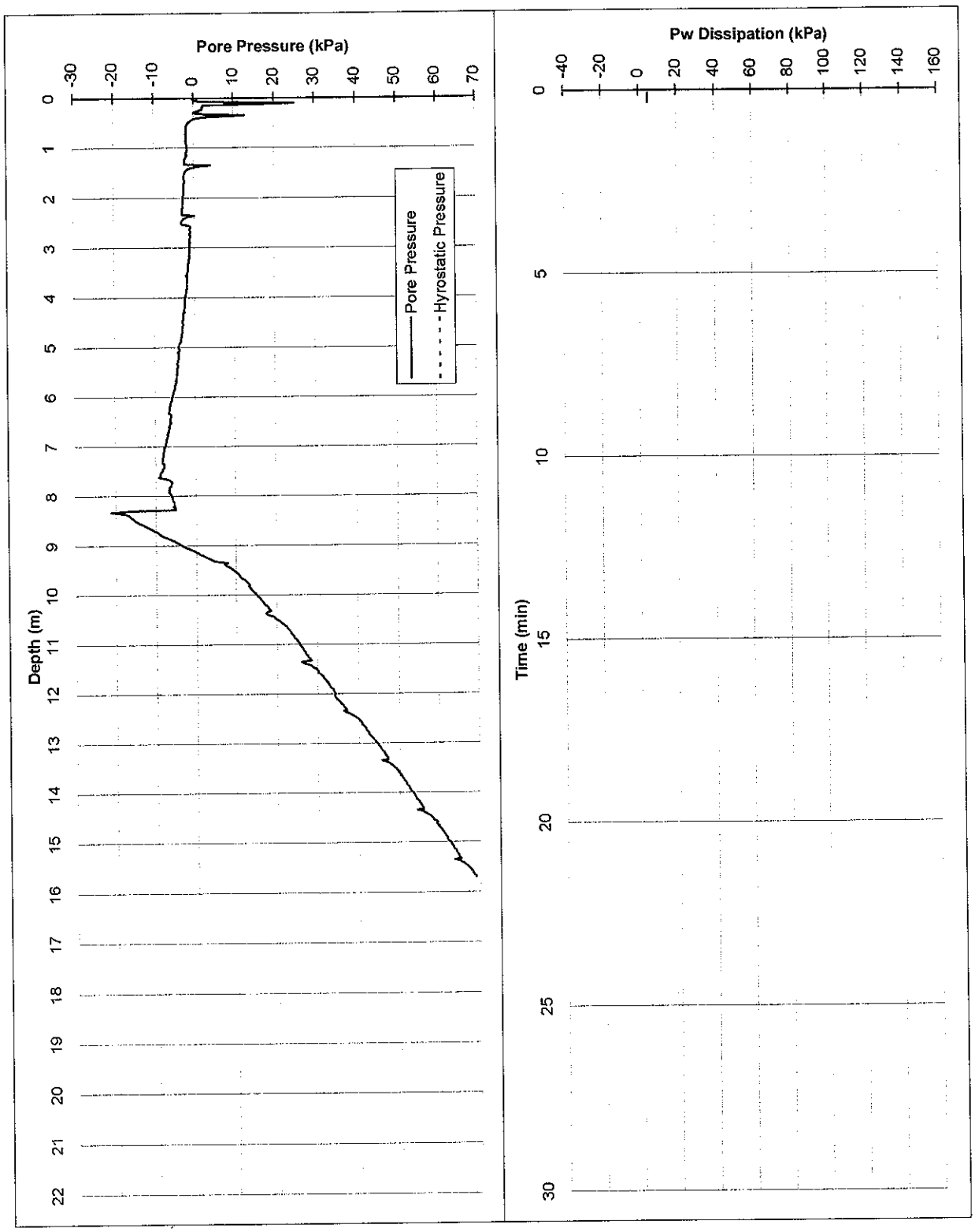
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 25 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD

Ph: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

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

File: GH7420TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

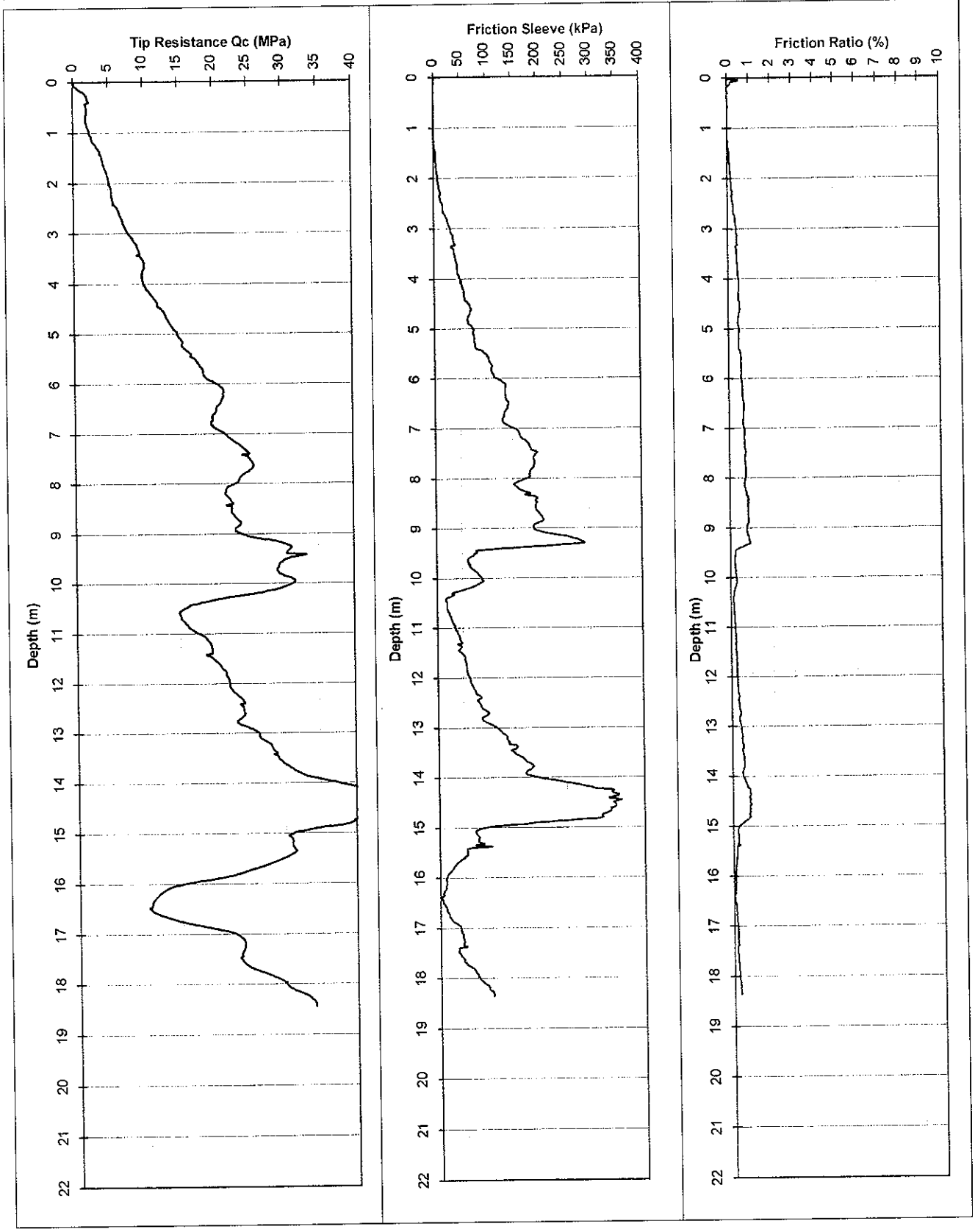
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 26 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax 9314 6699

Water (m): -

Refusal: 40MPa + R.F.

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

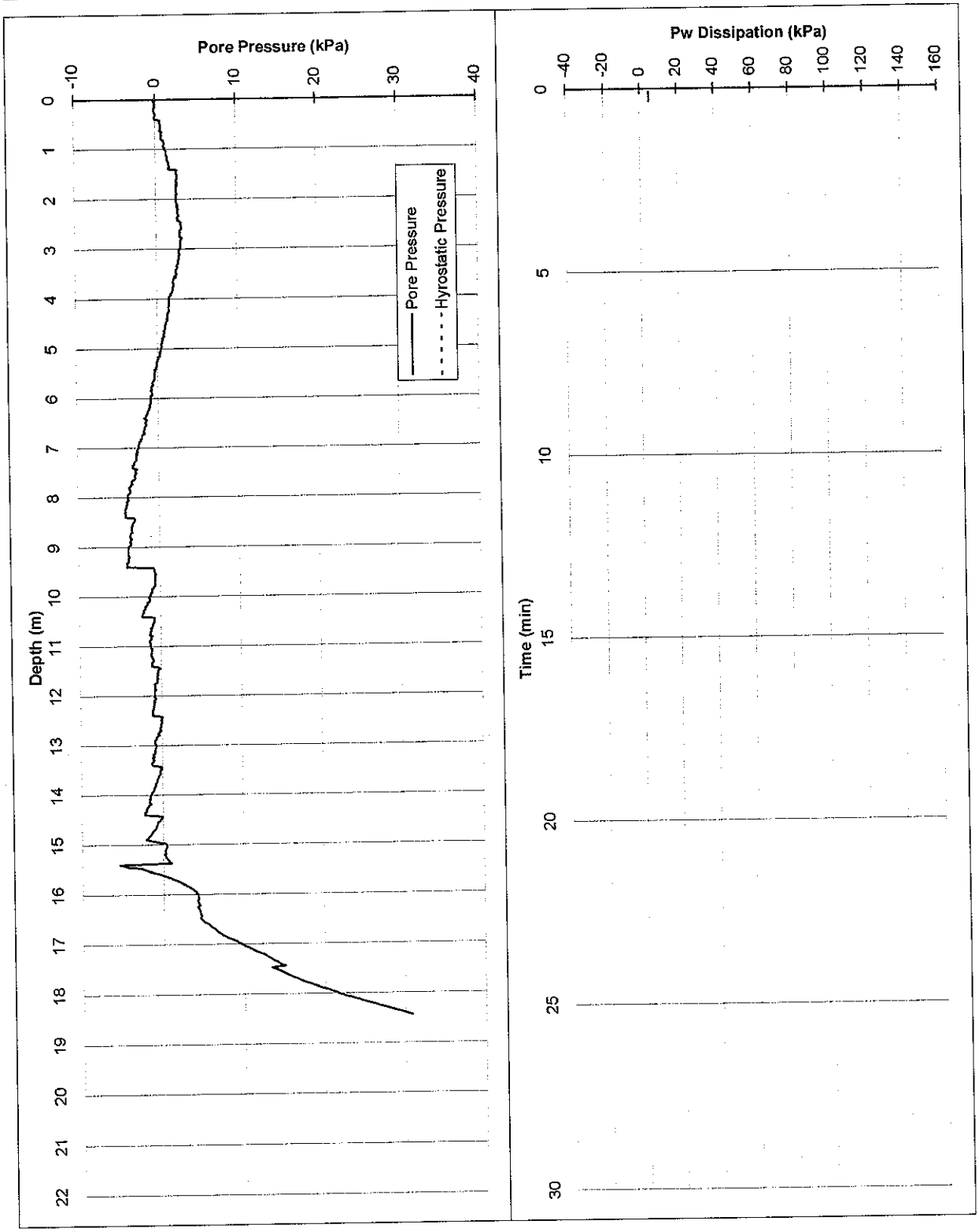
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 26 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD

Ph: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

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

22 tonne truck mounted CPT Rig.

File: GH7411TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

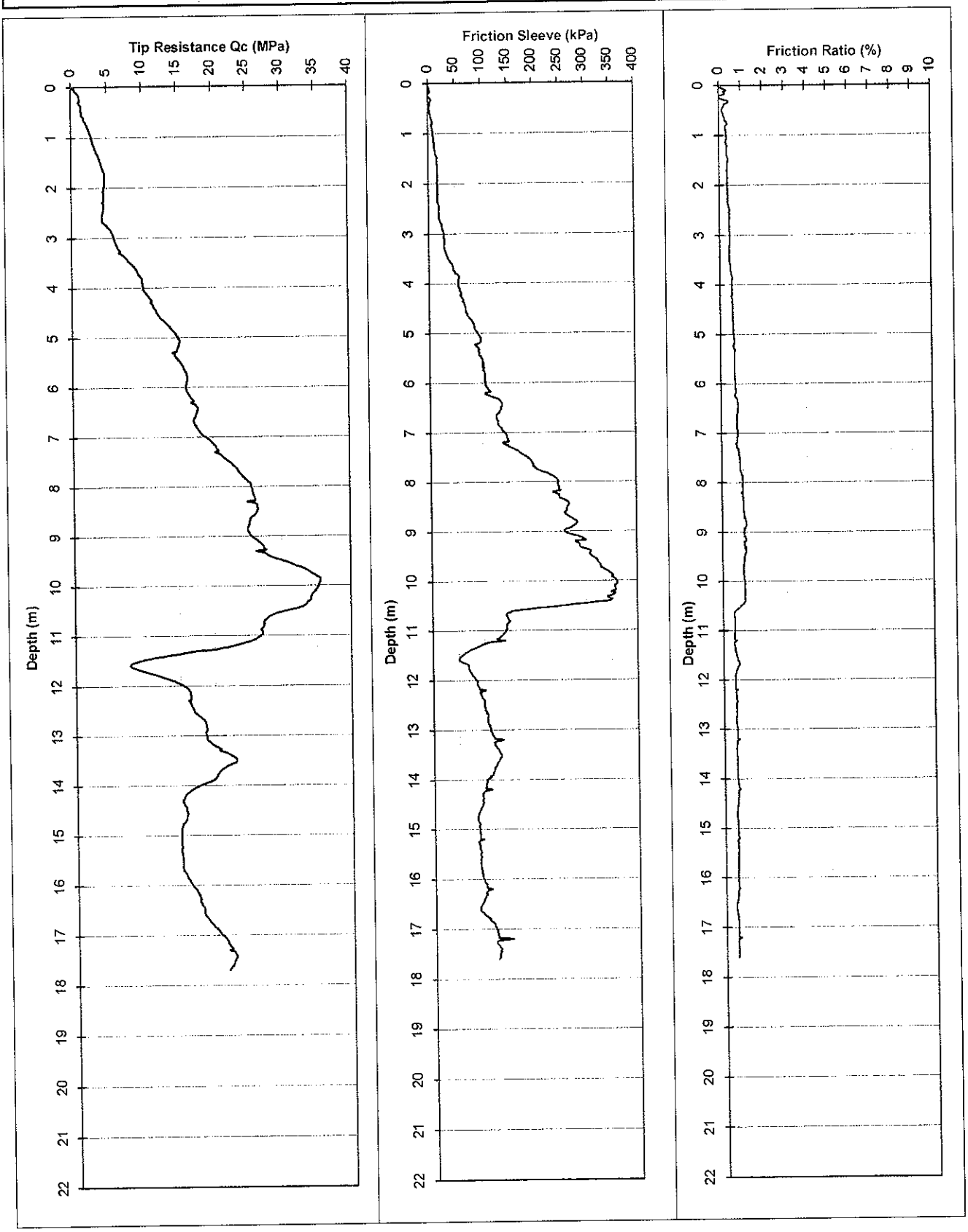
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 27 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY
Ph. 9314 6611 Fax 9314 6699

Water (m): Dry to 10.0

Refusal:

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

File: GH7421TT.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

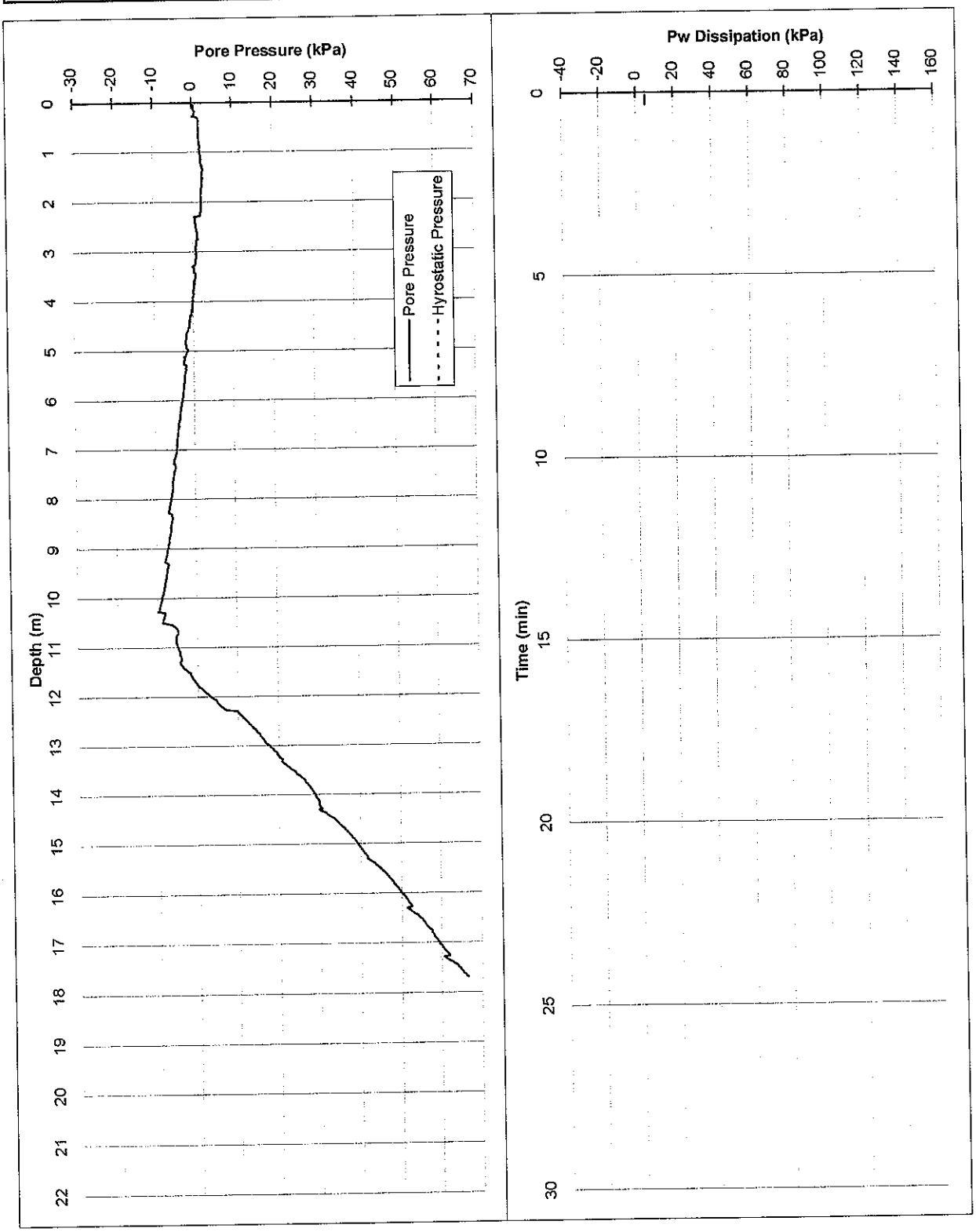
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 27 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7421TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

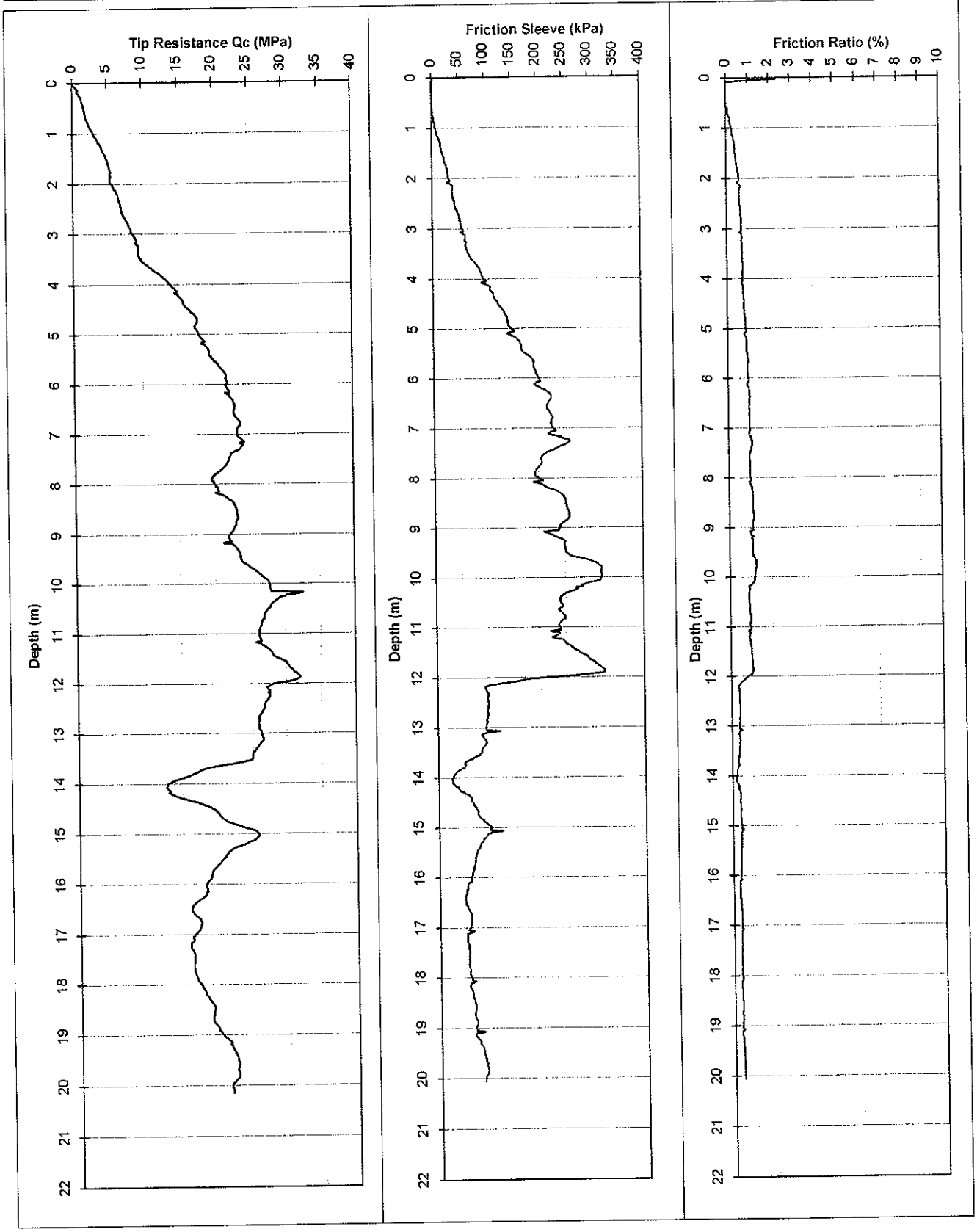
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 28 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax 9314 6699

Water (m): Dry to 10.2

Refusal:

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

File: GH7412TT.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

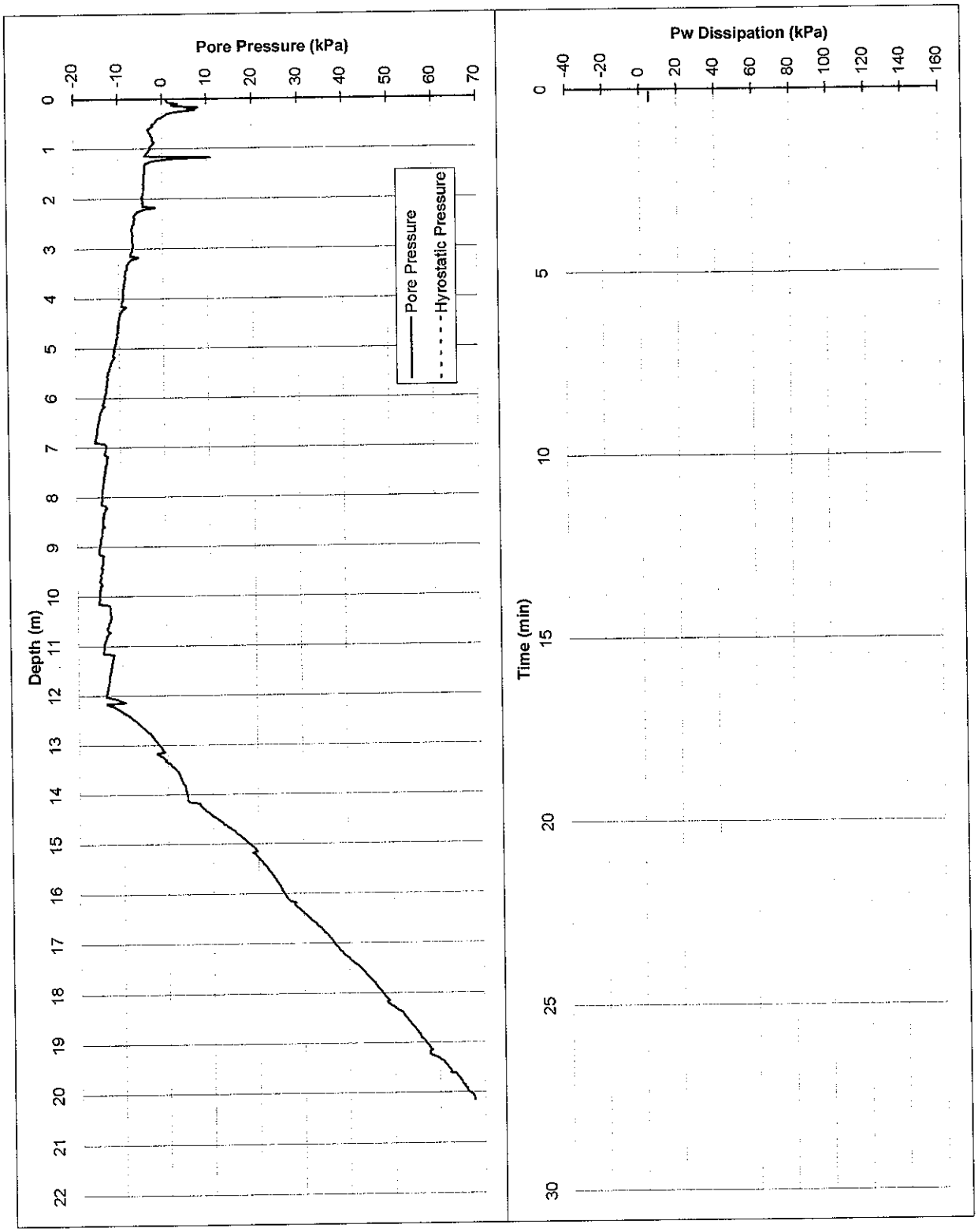
Project: Fiona Stanley Hospital

Probe No.: CPT 28 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7412TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

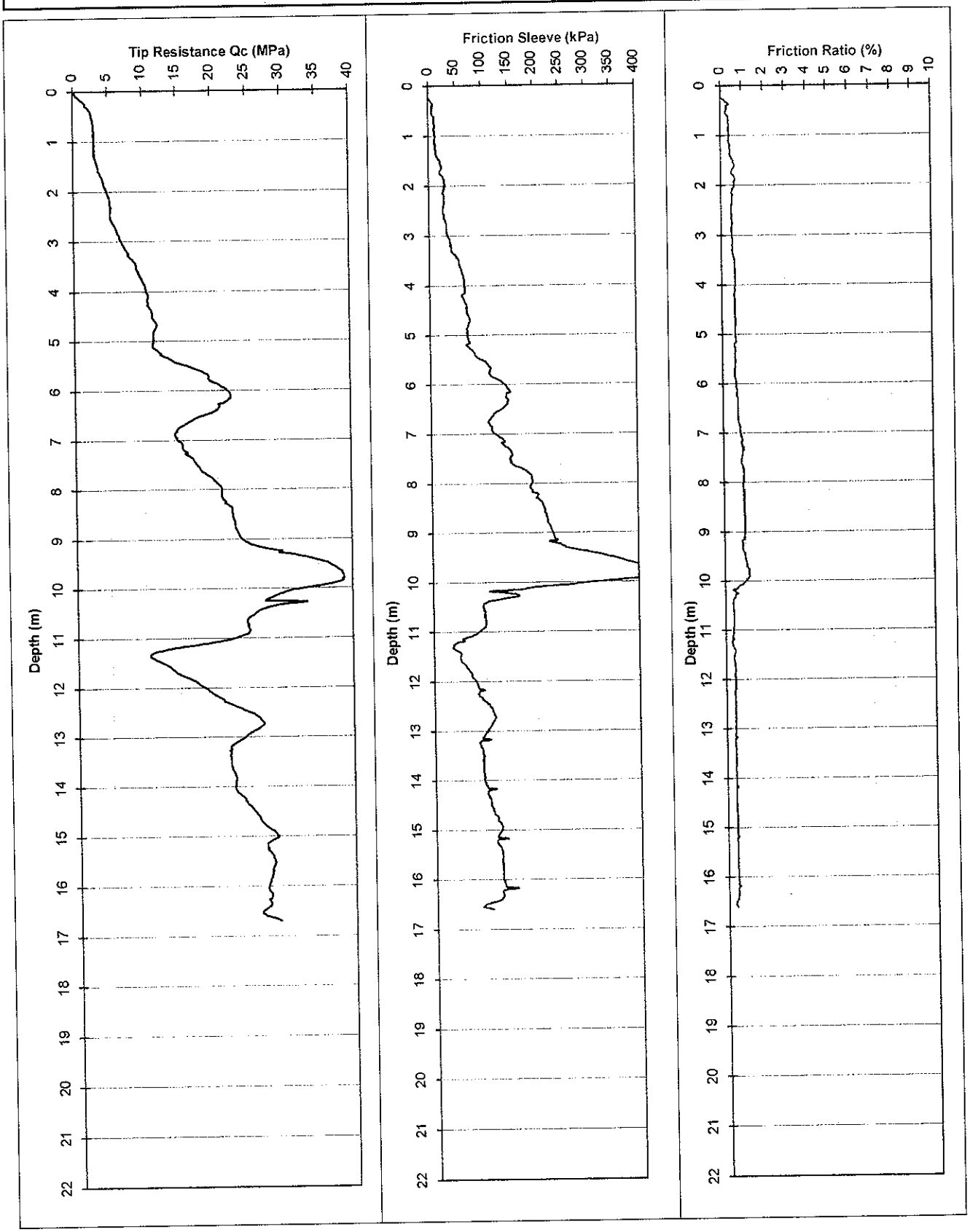
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 29 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

Project: Fiona Stanley Hospital

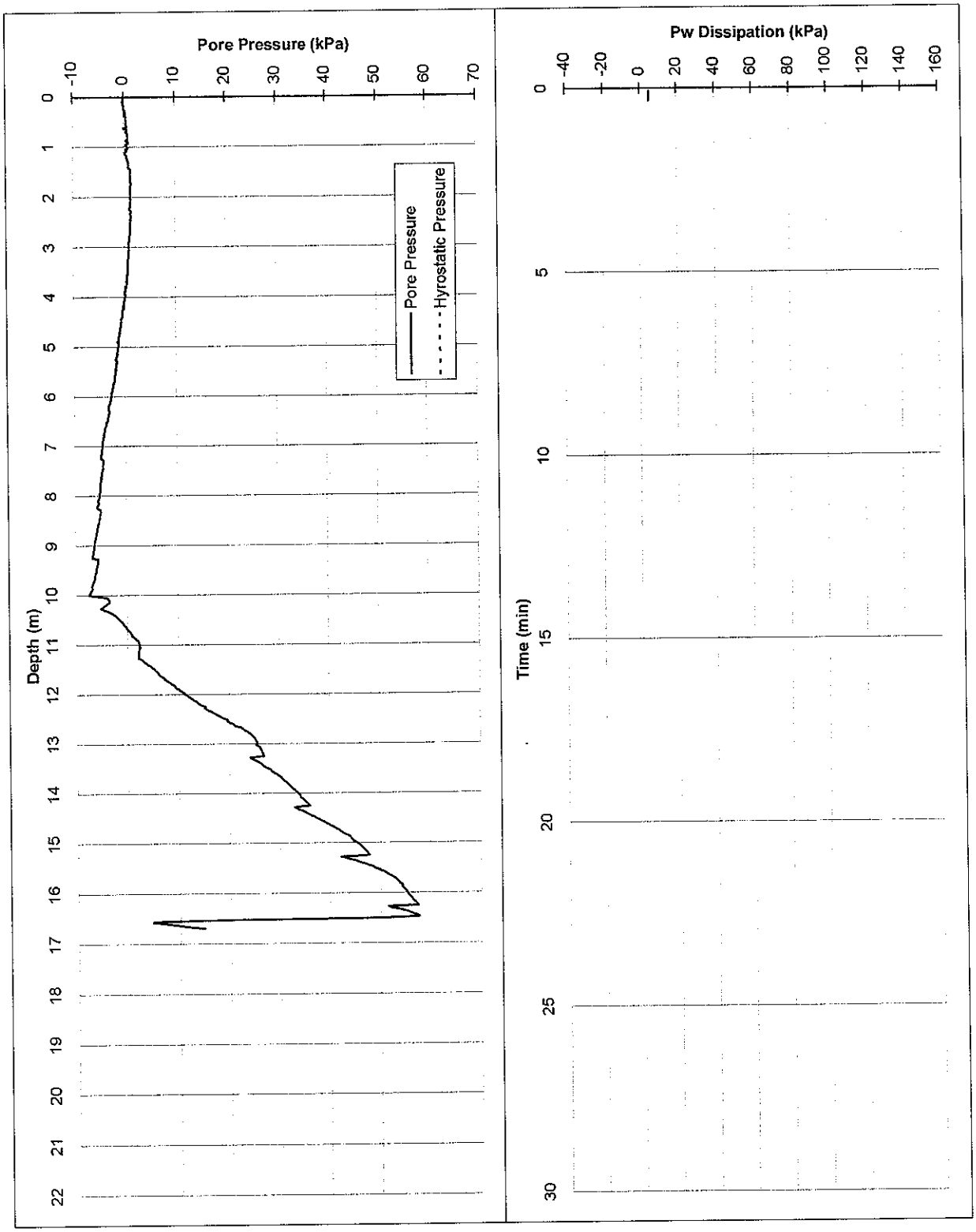
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 29 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD

Ph: 9314 6611 Fax: 9314 6699

GEOTECHNICAL SURVEY

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

File: GH7424TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

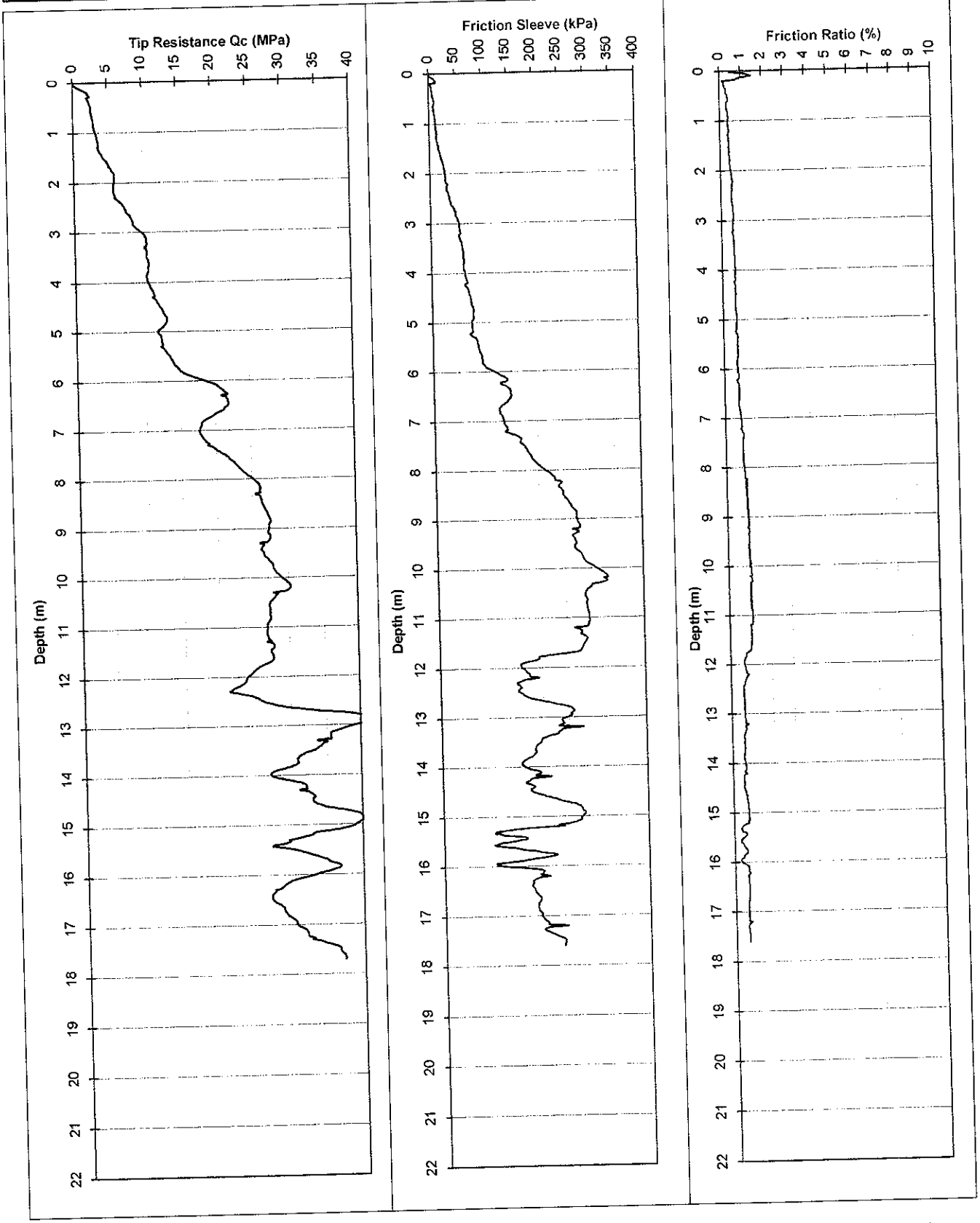
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 30 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 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: GH7422TT.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

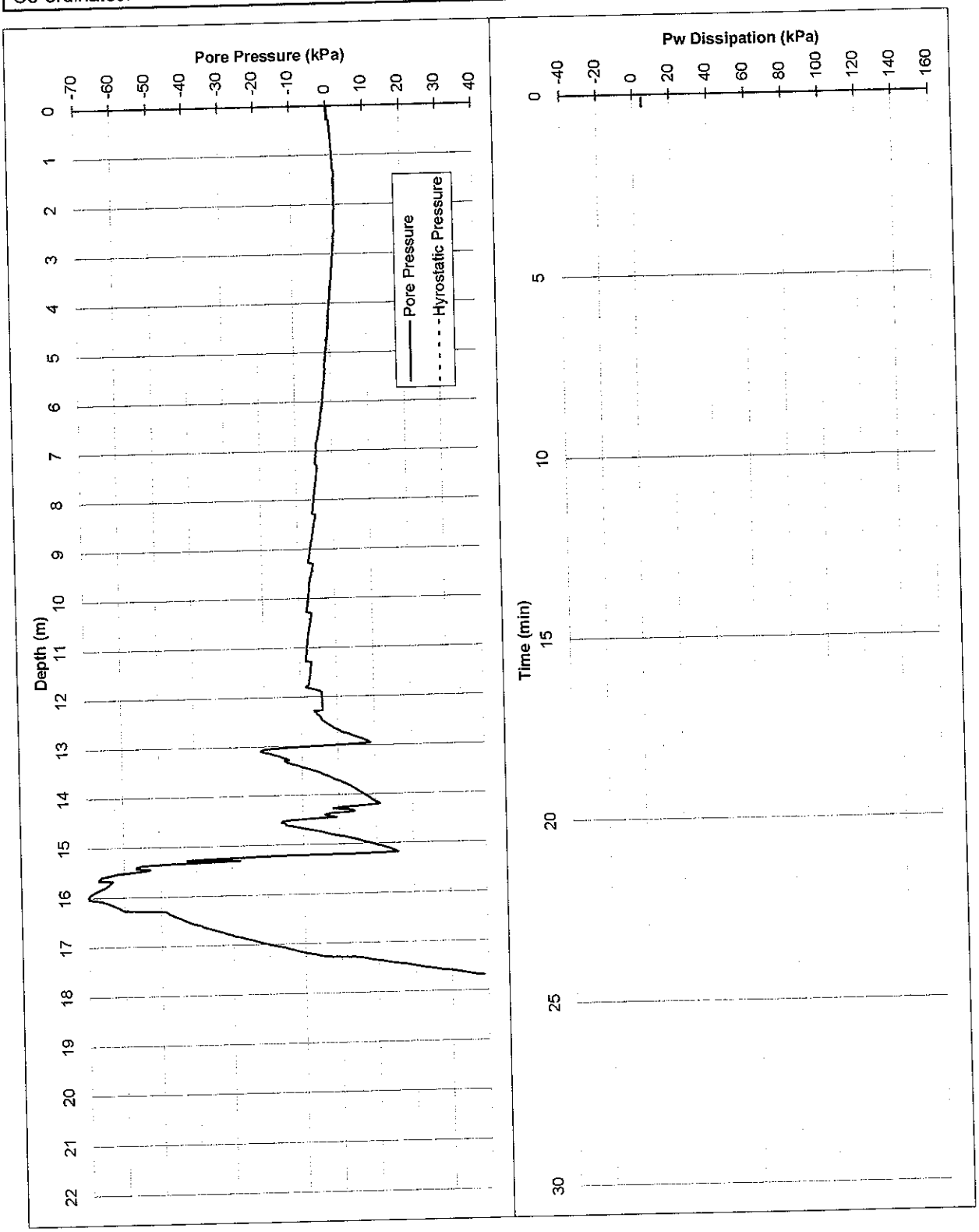
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 30 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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

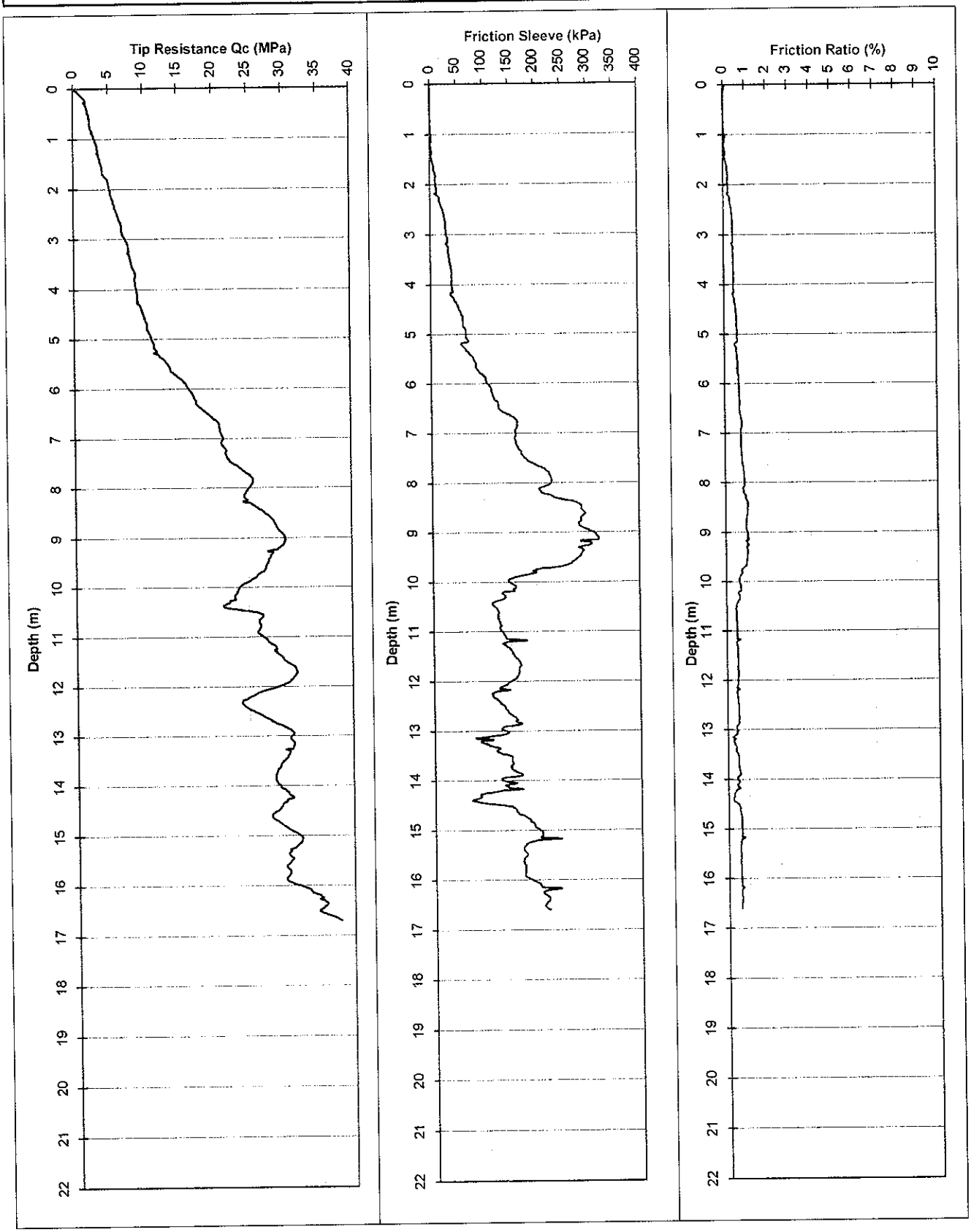
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 31 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PERTH
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 4.6

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

Project: Fiona Stanley Hospital

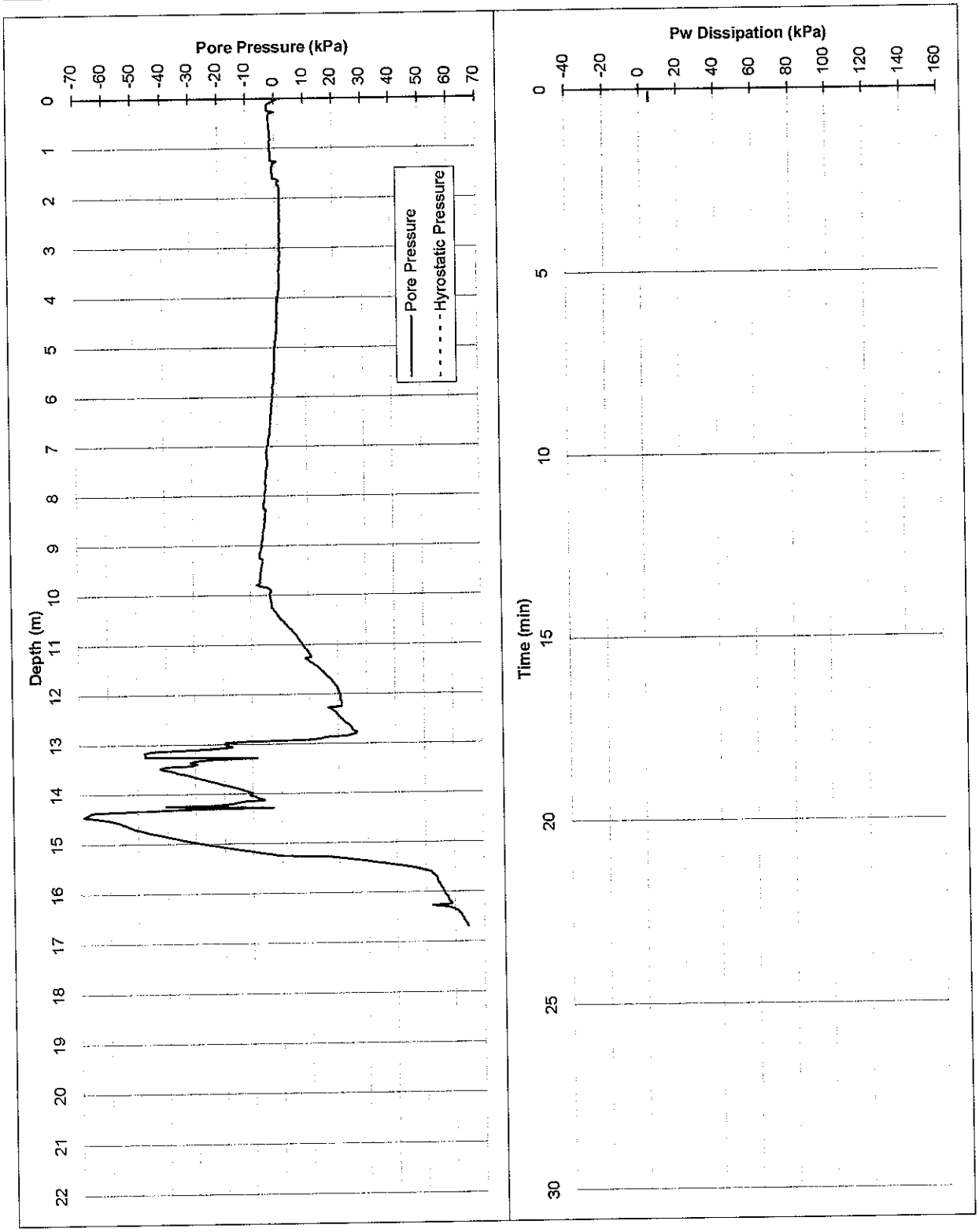
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 31 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY

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: GH7417TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

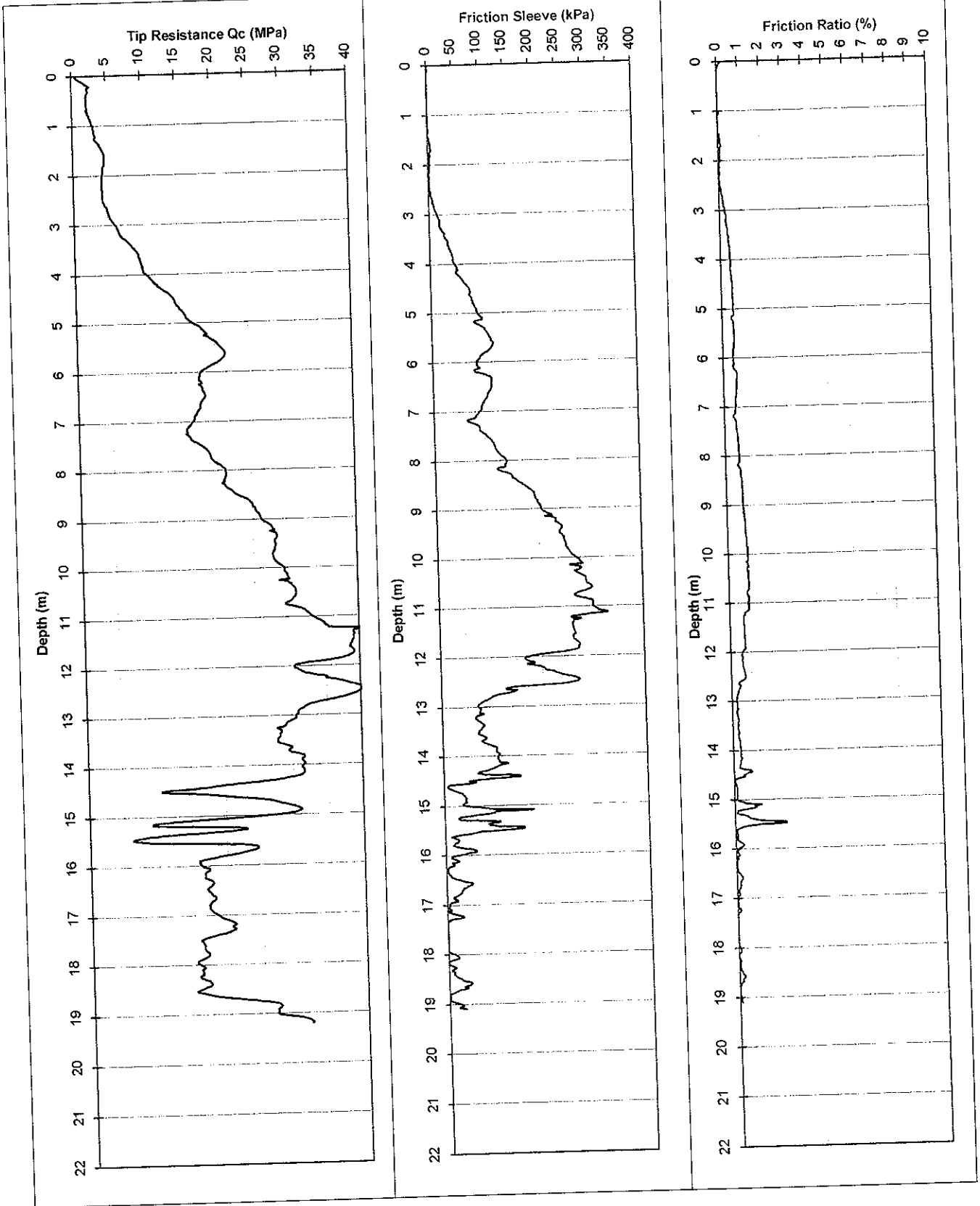
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 32 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 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: GH7419TT.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

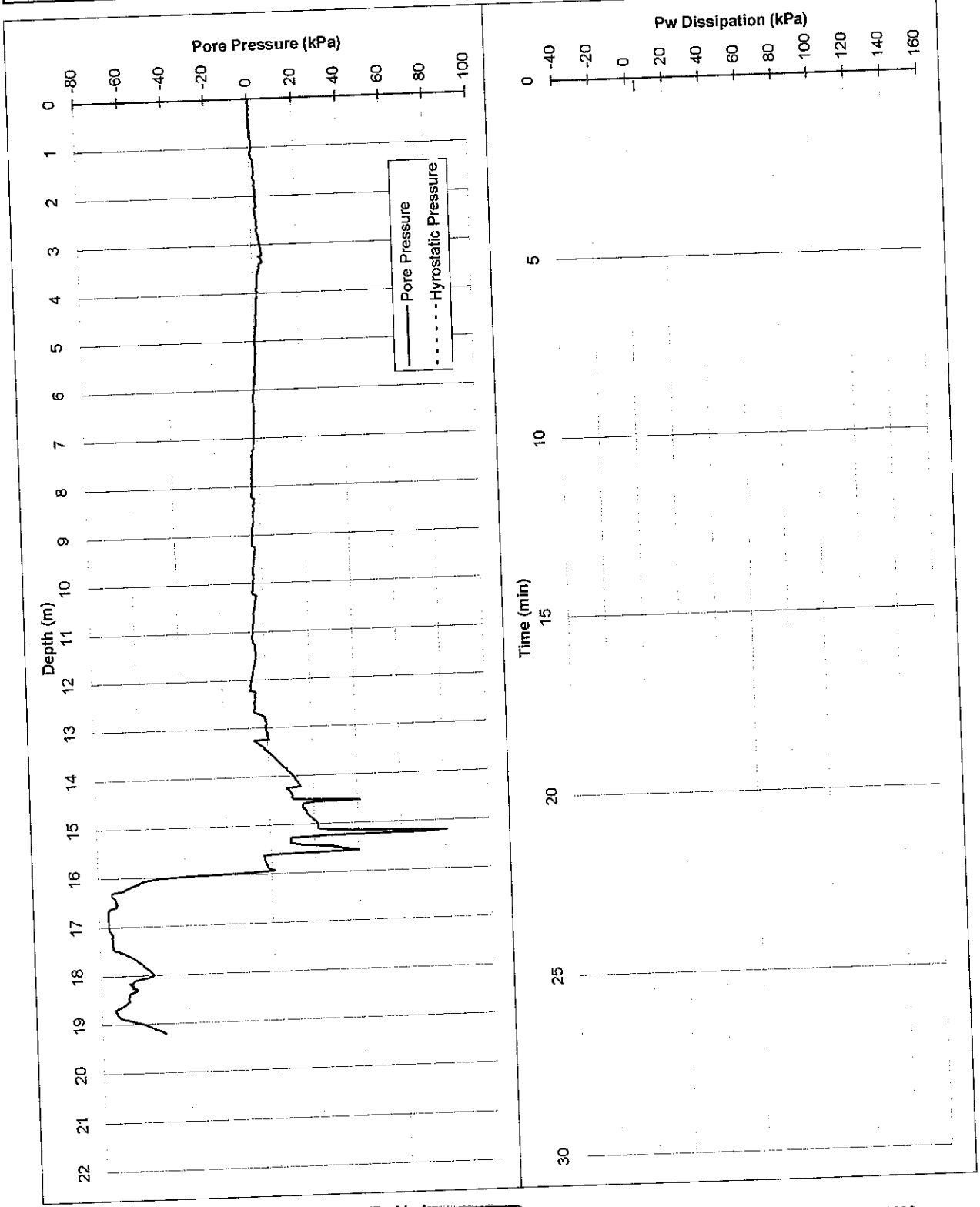
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 32 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7419TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

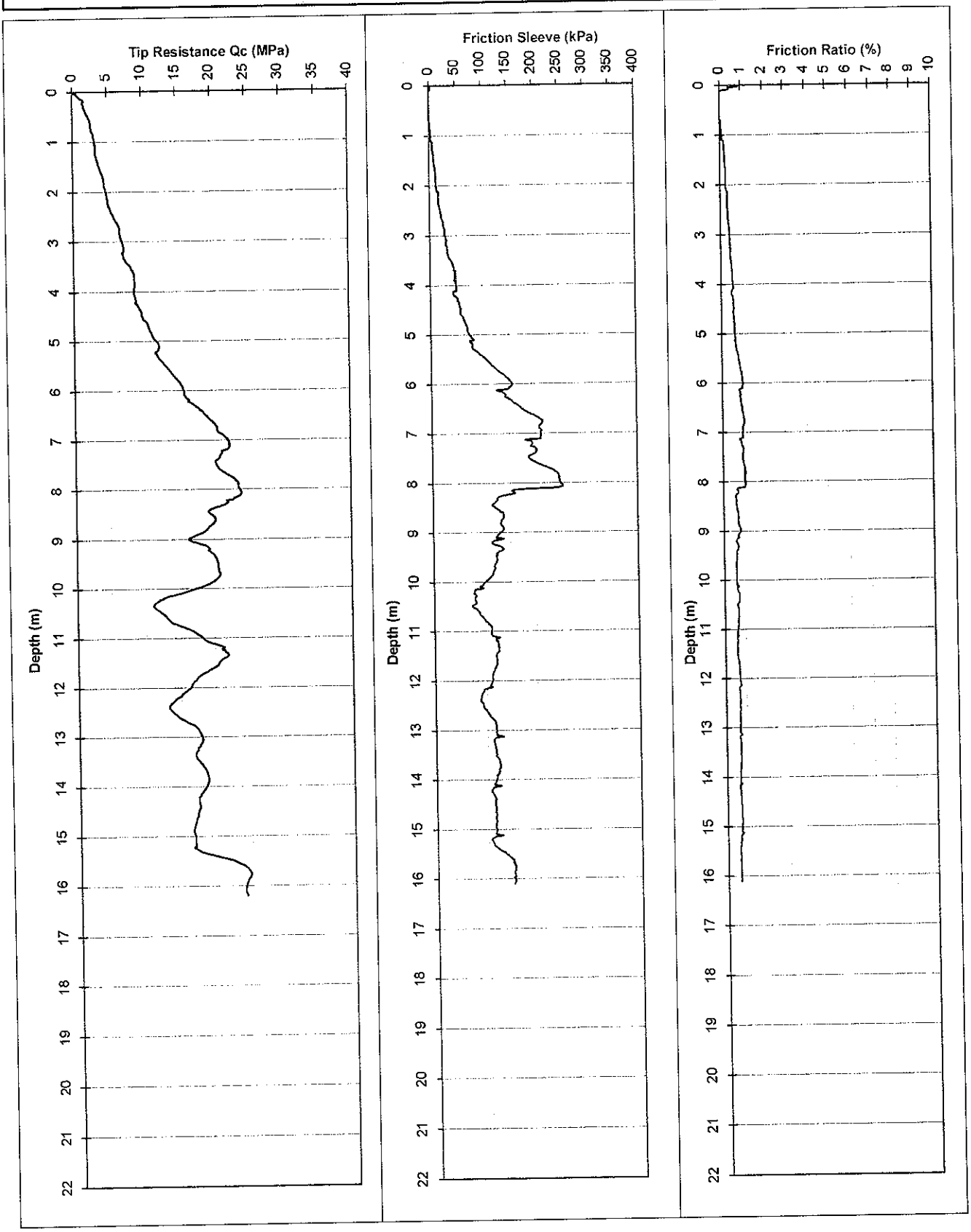
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 33 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 5699

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

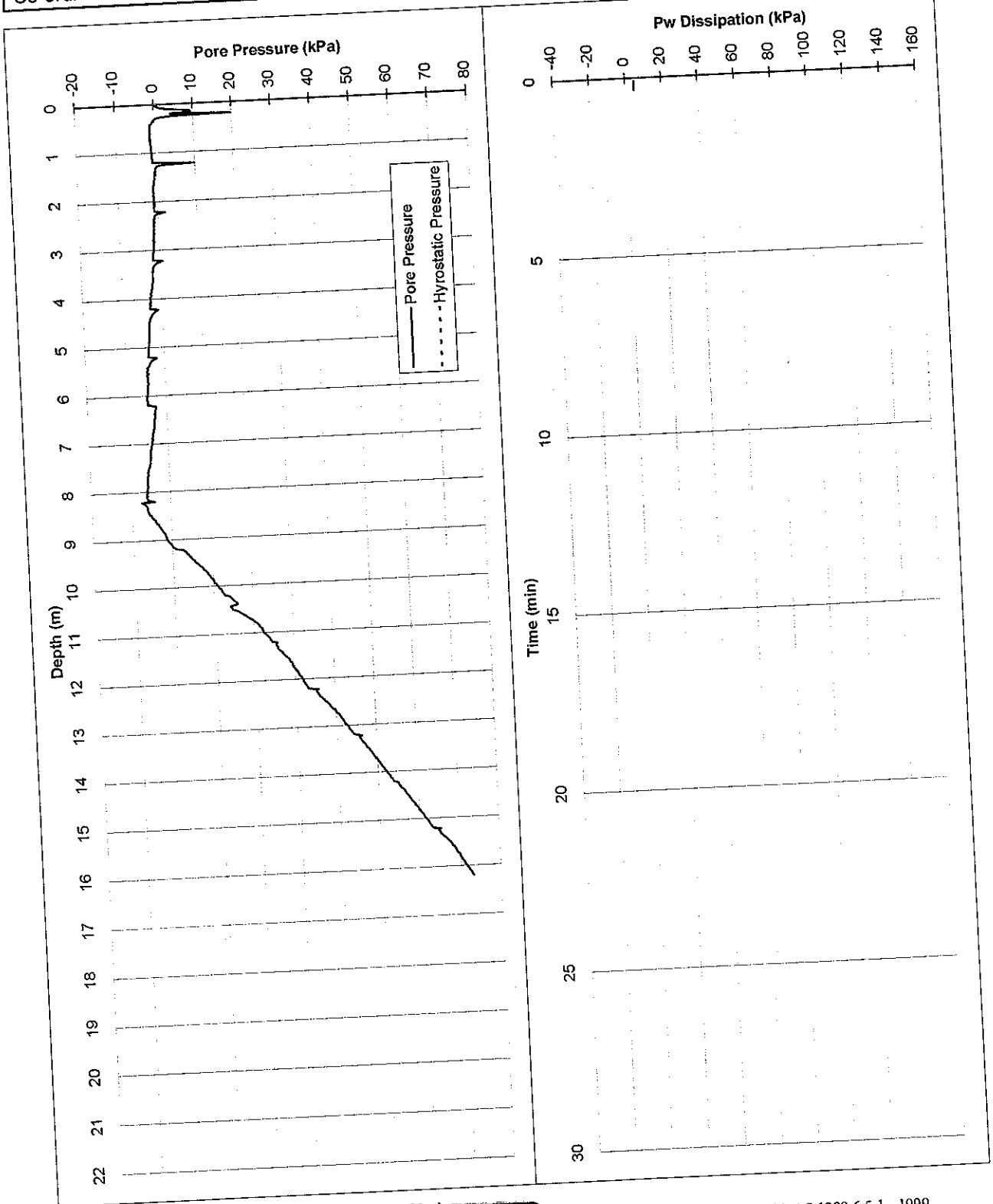
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 33 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7413TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

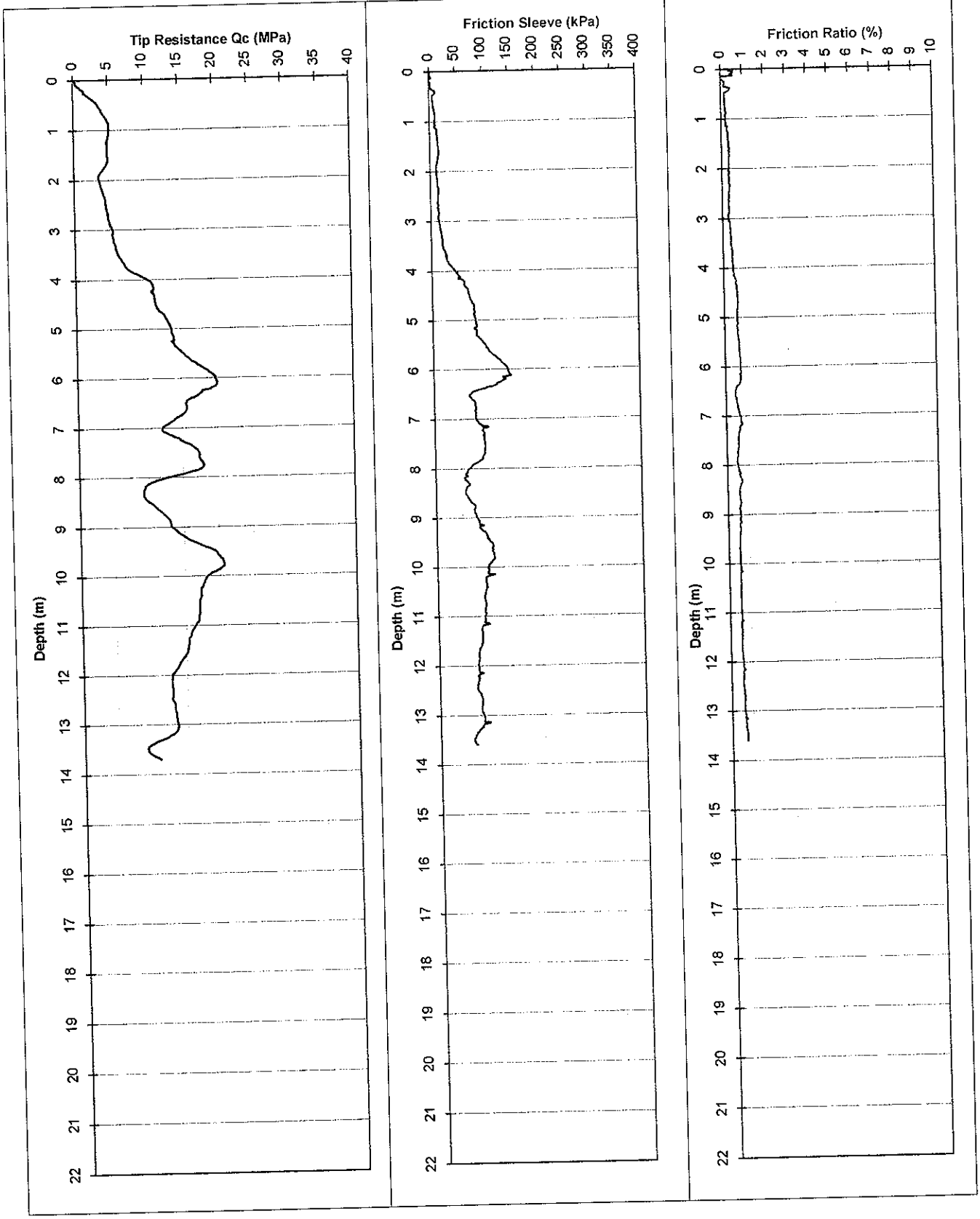
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 34 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
GEOTECHNICAL SURVEY
Ph: 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: GH7423TT.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

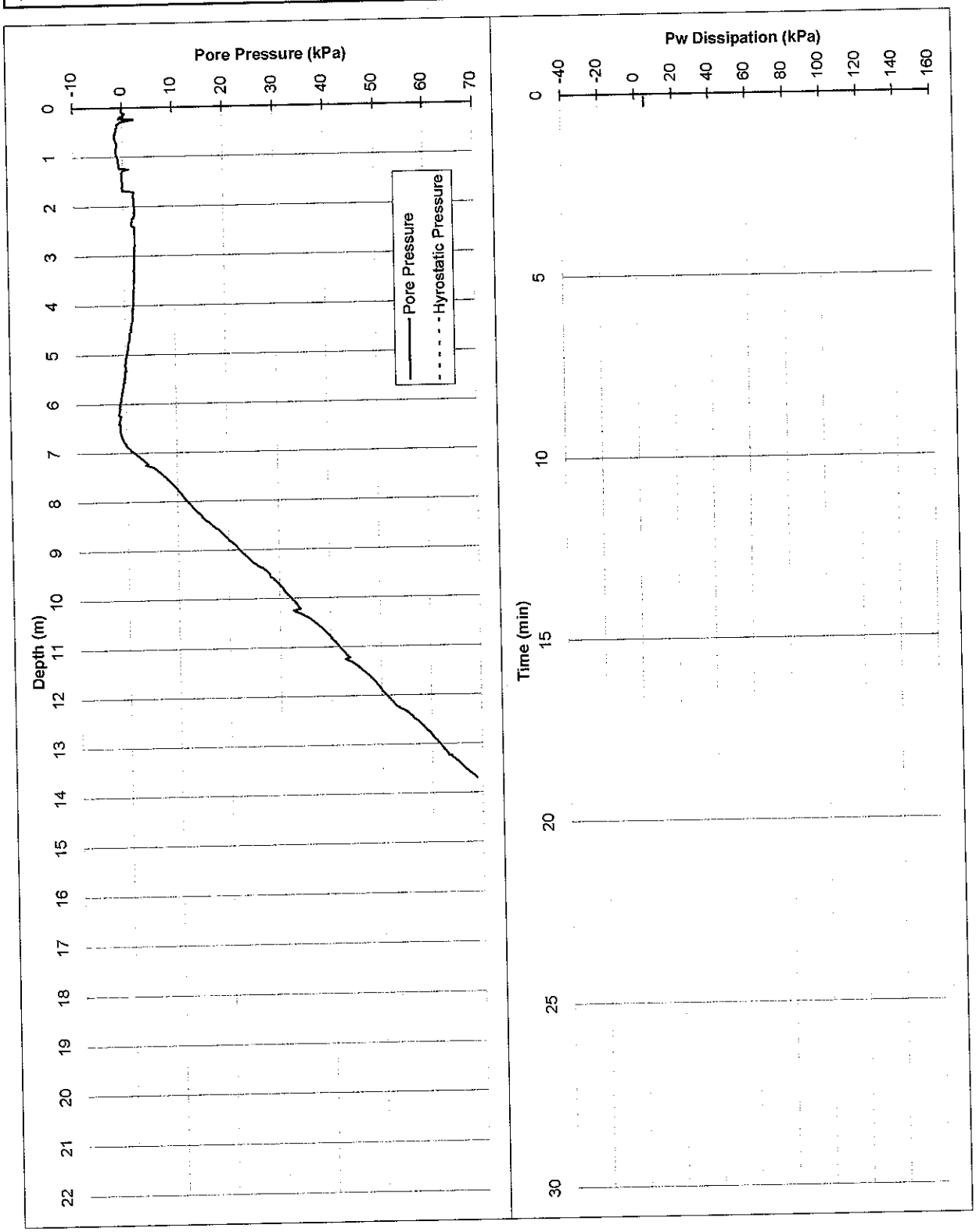
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 34 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7423TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

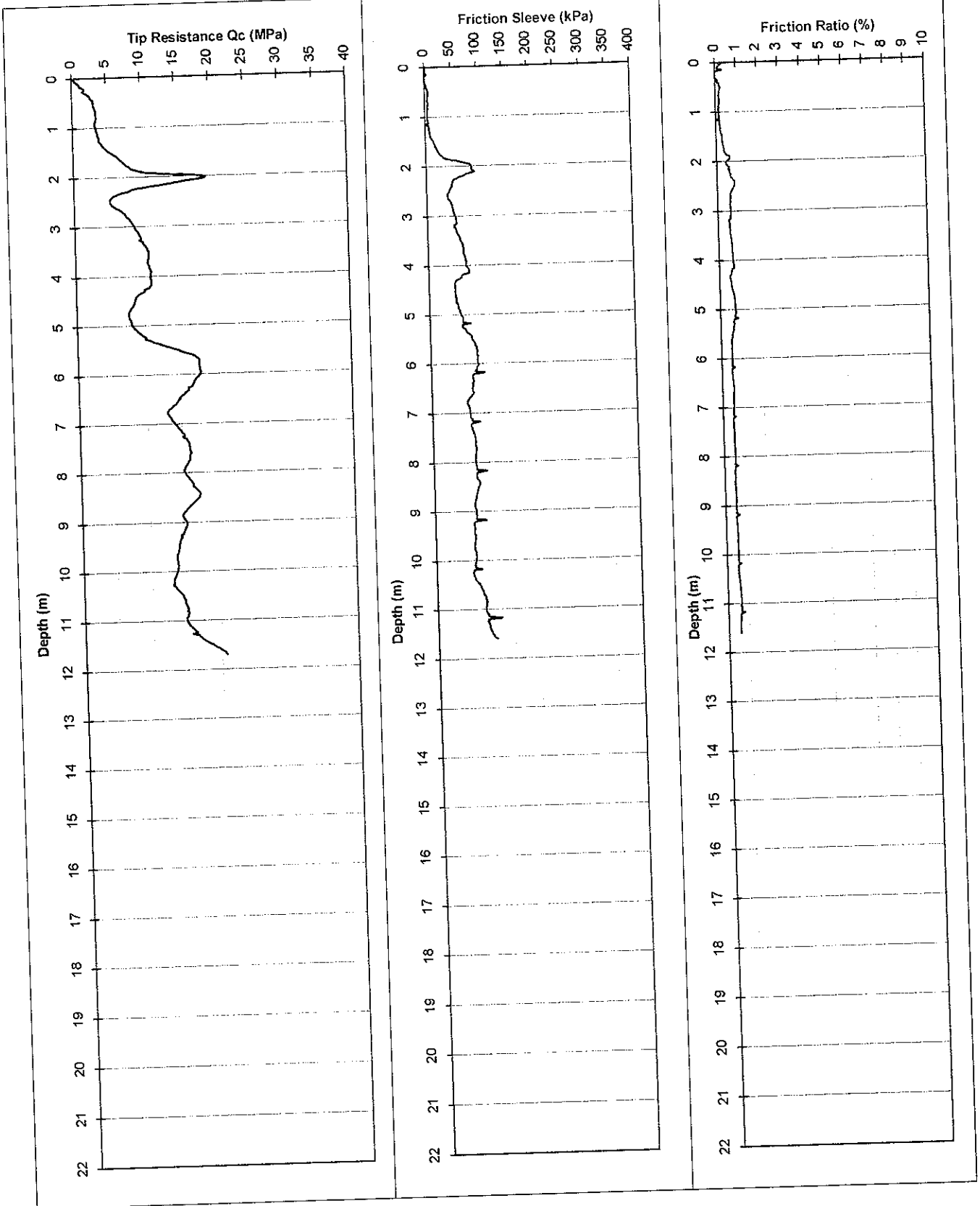
LOCATION: Murdoch

Date: 20/06/07

Probe No.: CPT 35 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY
Ph. 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

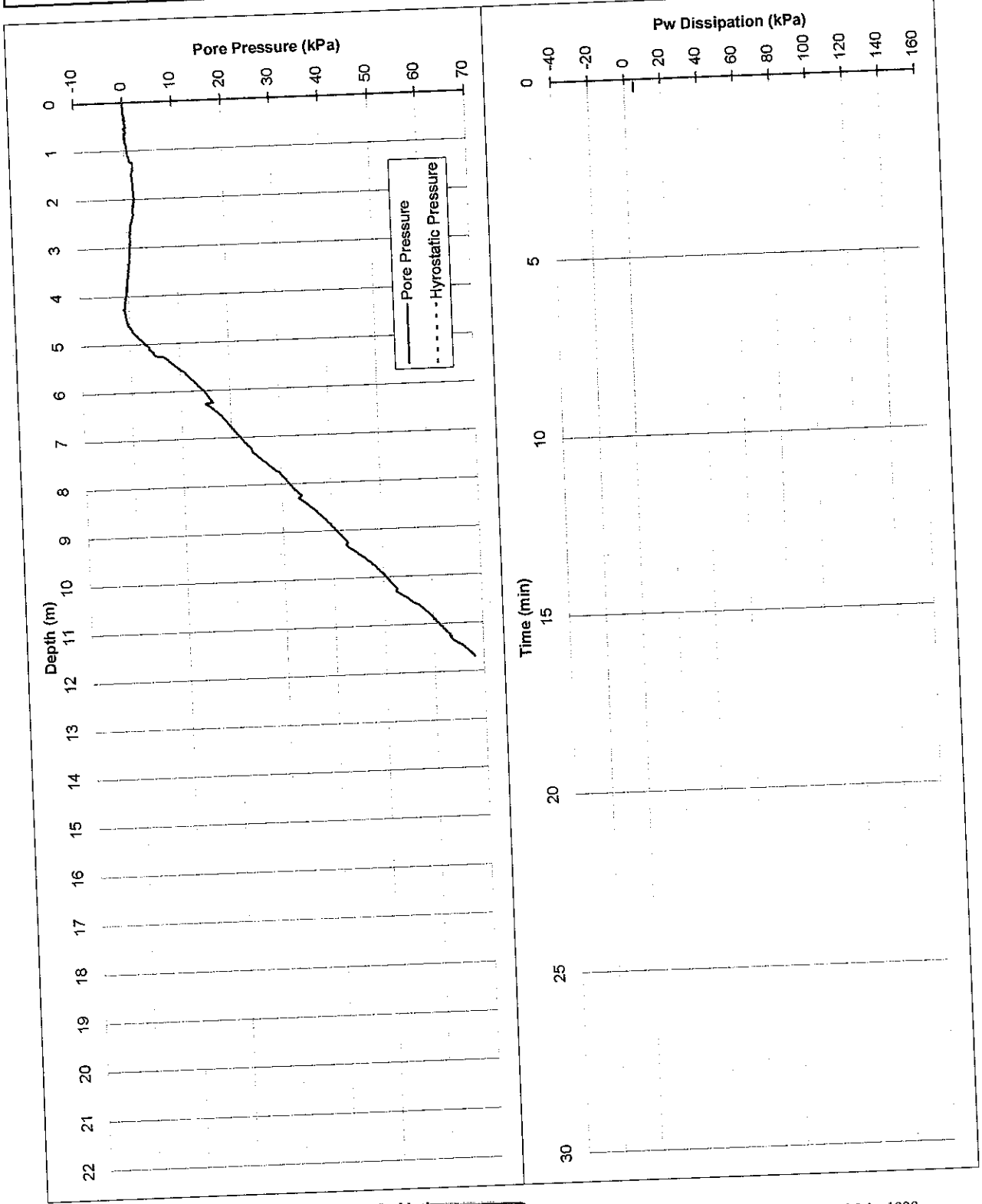
Location: Murdoch

Co-ordinates:

Date: 20/06/07

Probe No.: CPT 35 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7428TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

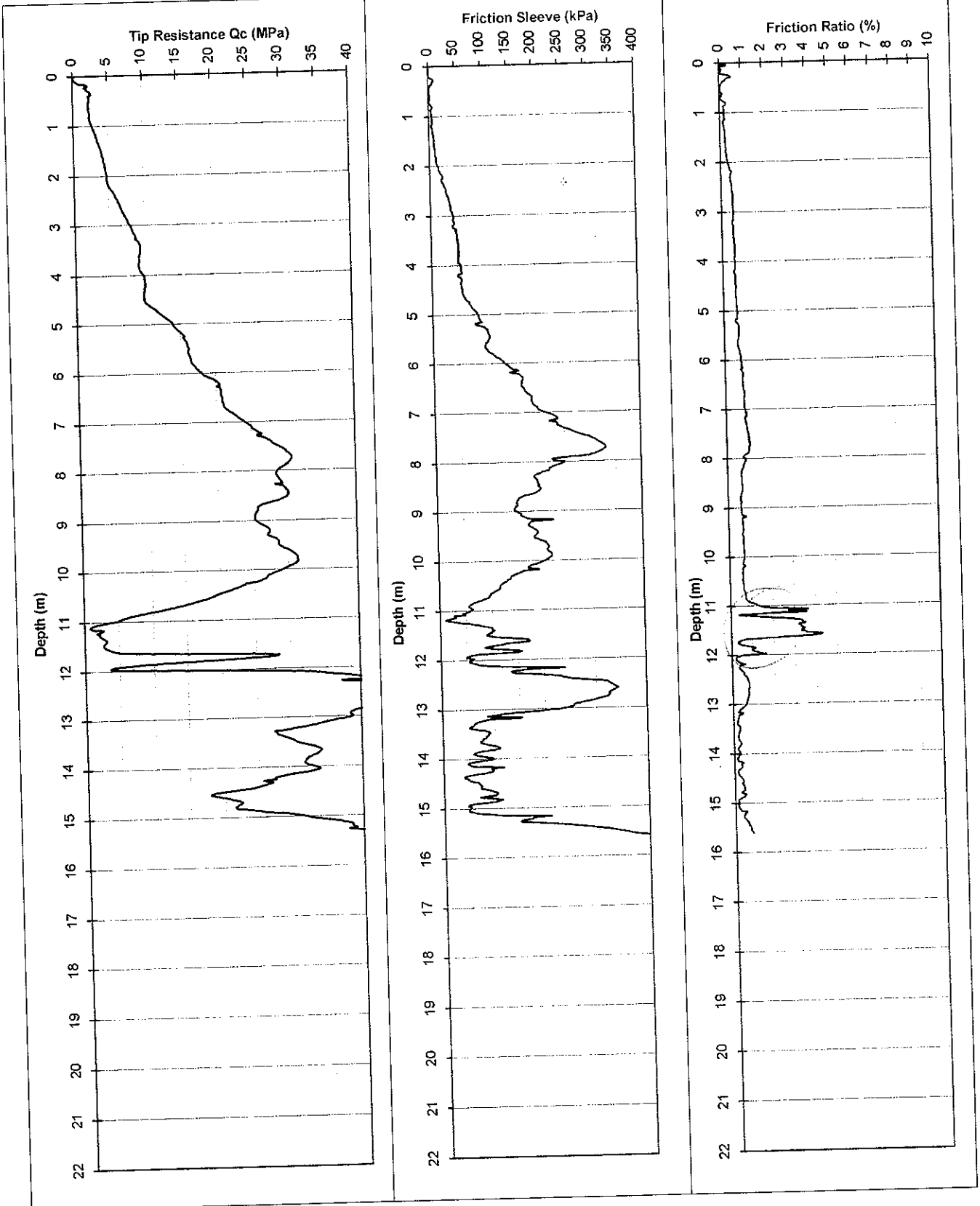
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 36 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY
Ph: 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: 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

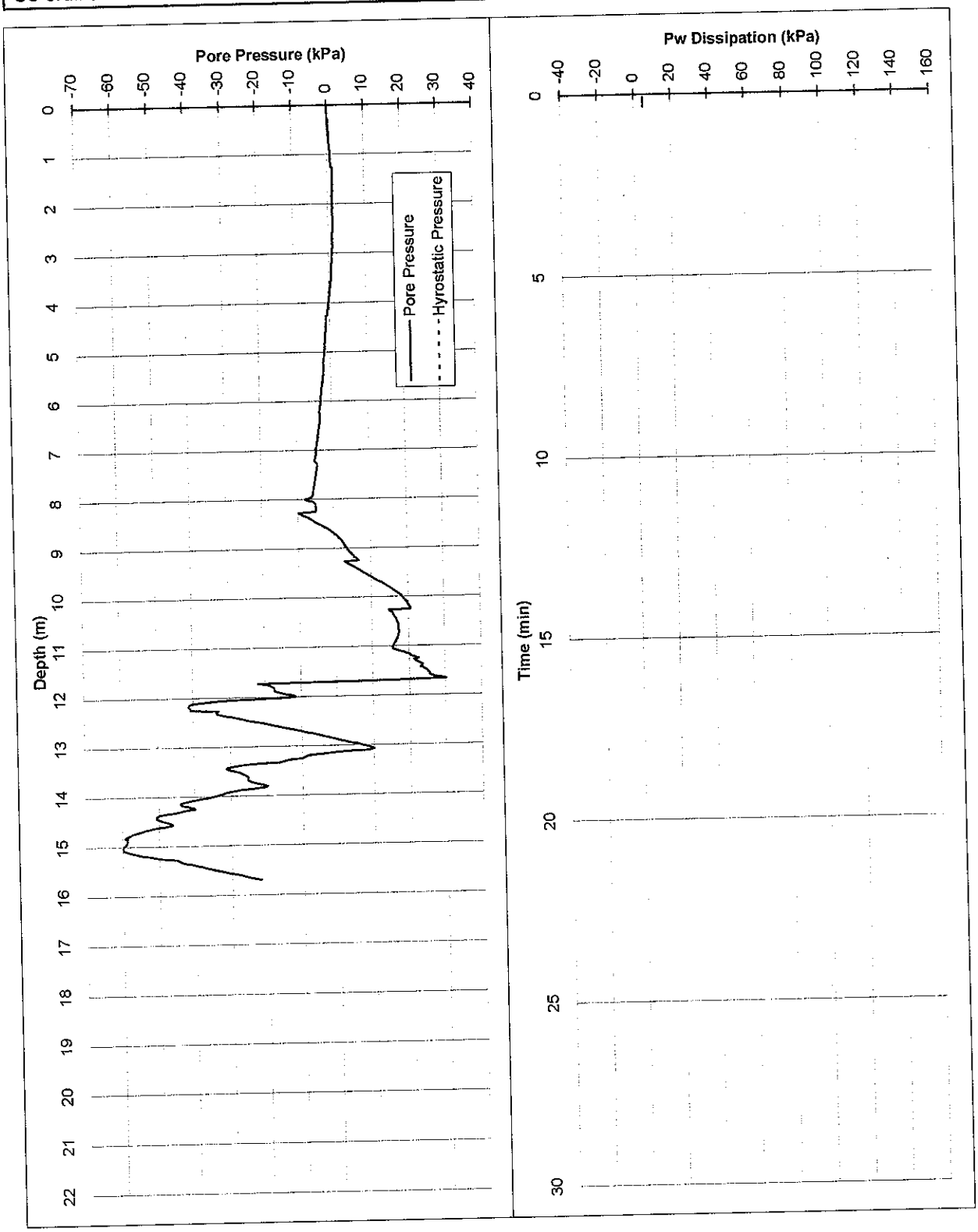
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 36 U

Job Number: 61/19514/01



PROBEDRILL GEOTECHNICAL SURVEY

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: GH7416TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

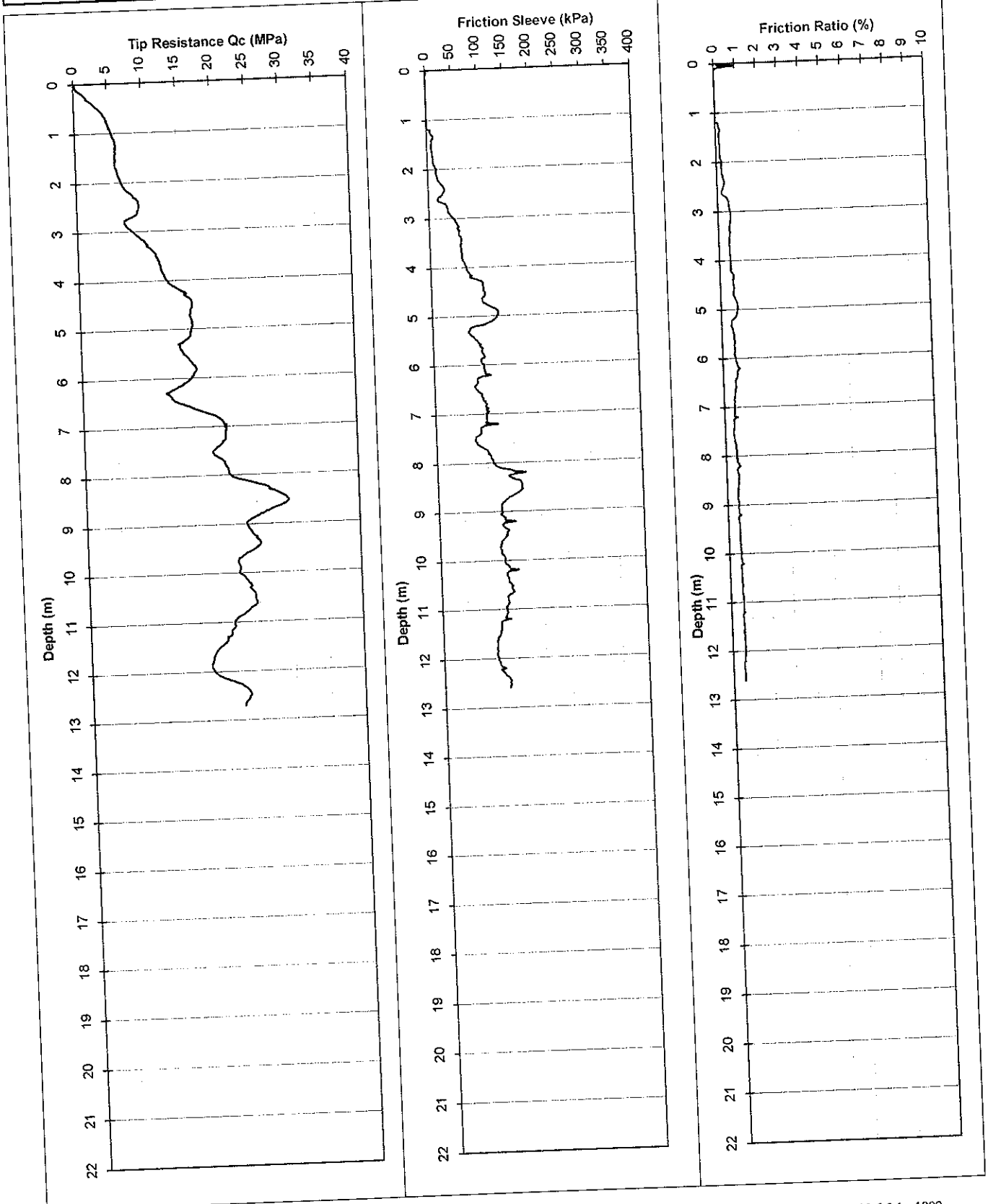
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 37 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 8611 Fax: 9314 5899

Water (m): Dry to 4.1

Refusal:

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

File: GH7414TT.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

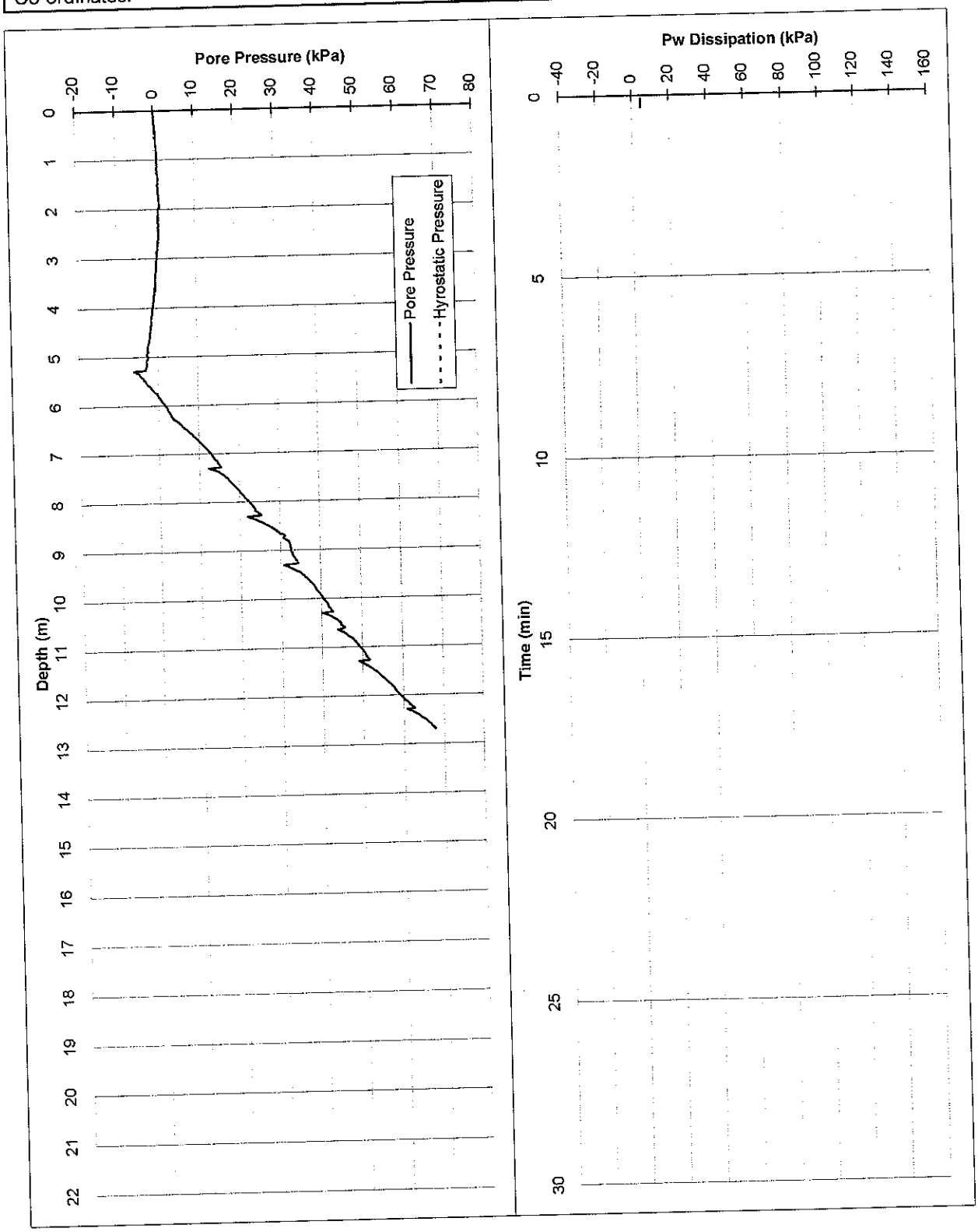
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 37 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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: GH7414TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

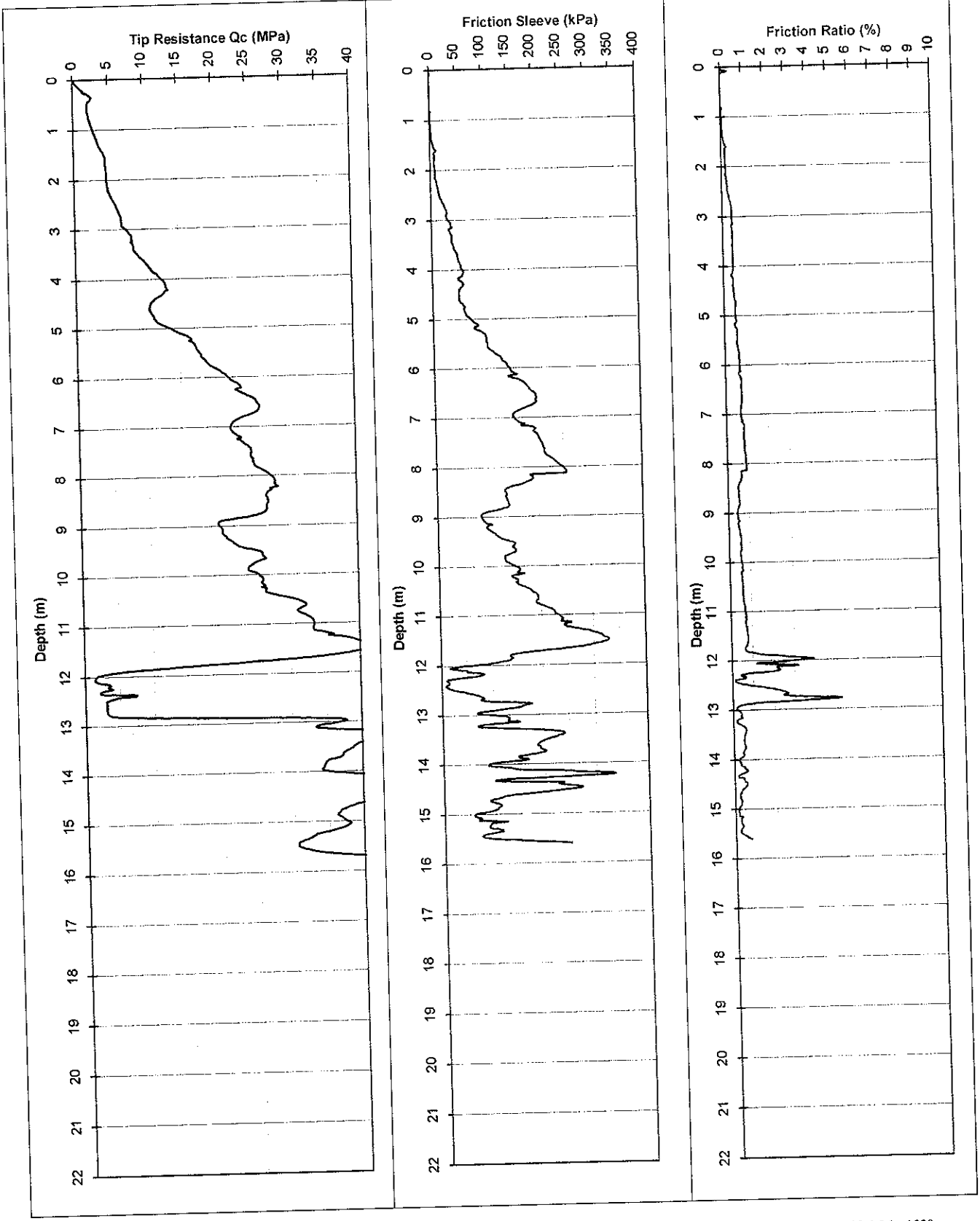
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 38 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph 9314 6611 Fax 9314 6699

Water (m): Dry to 4.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

Project: Fiona Stanley Hospital

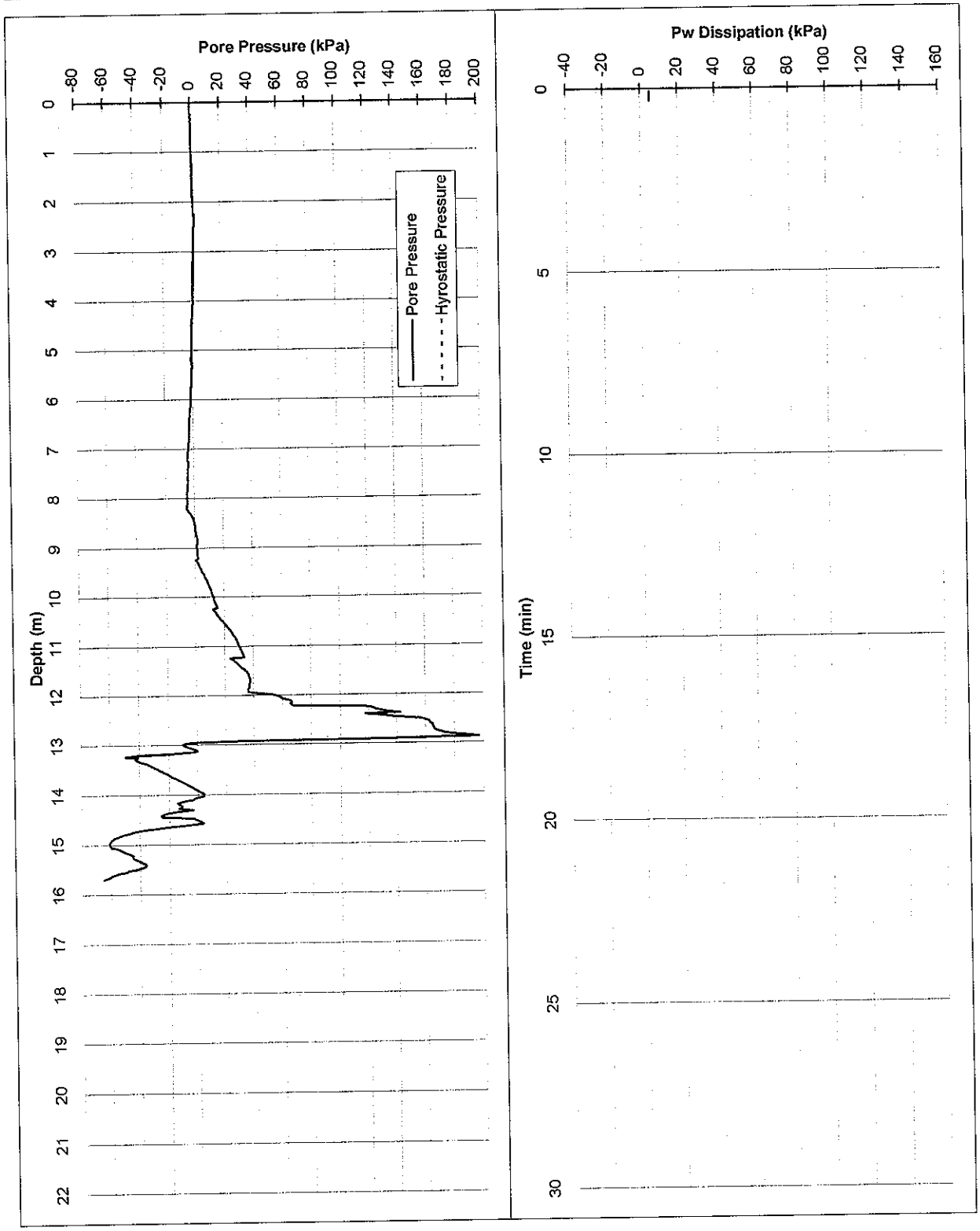
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 38 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

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

22 tonne truck mounted CPT Rig.

File: GH7418TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

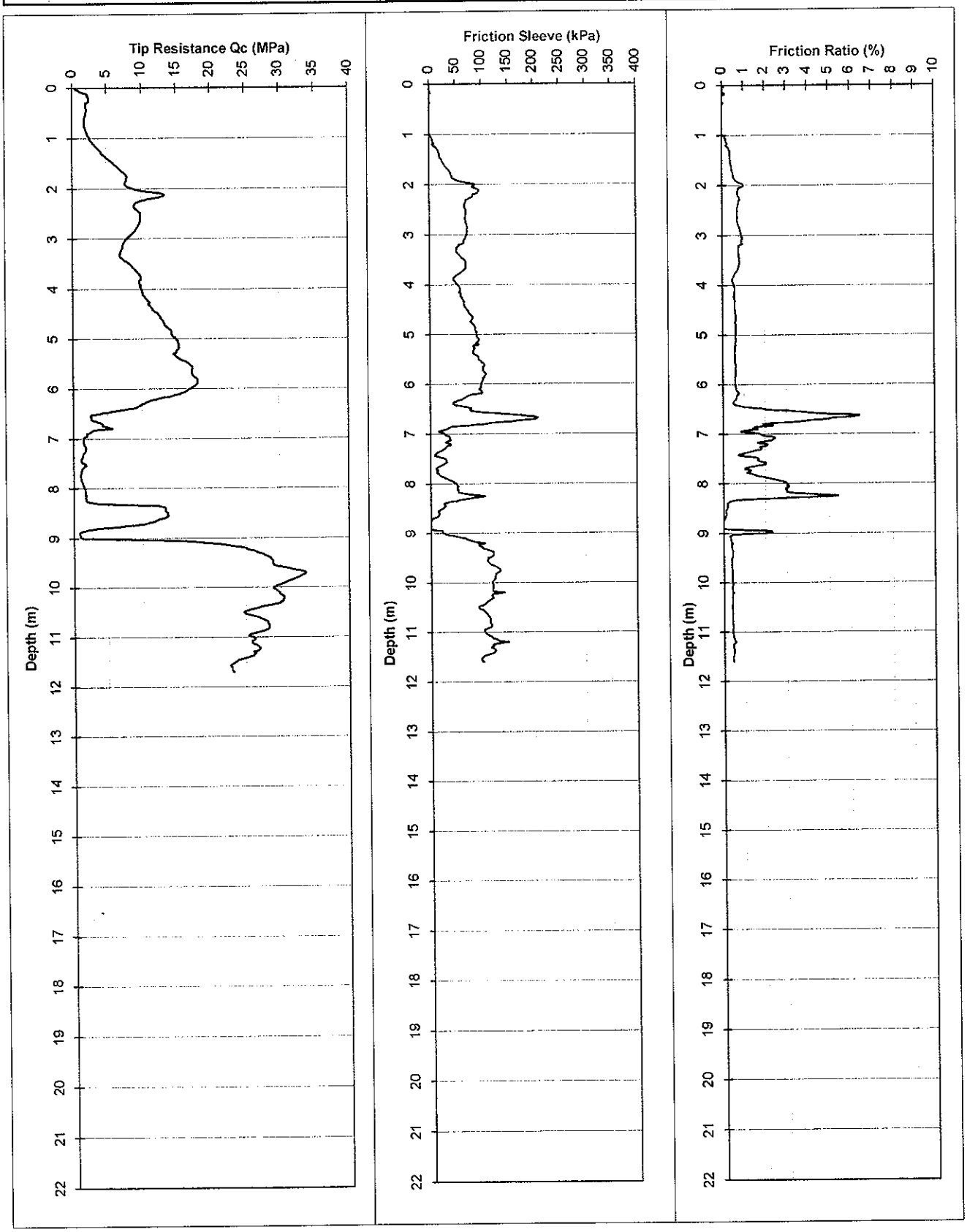
LOCATION: Murdoch

Date: 19/06/07

Probe No.: CPT 39 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax: 9314 5699
GEOTECHNICAL SURVEY

Water (m): Dry to 4.3

Refusal:

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

File: GH7415TT.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

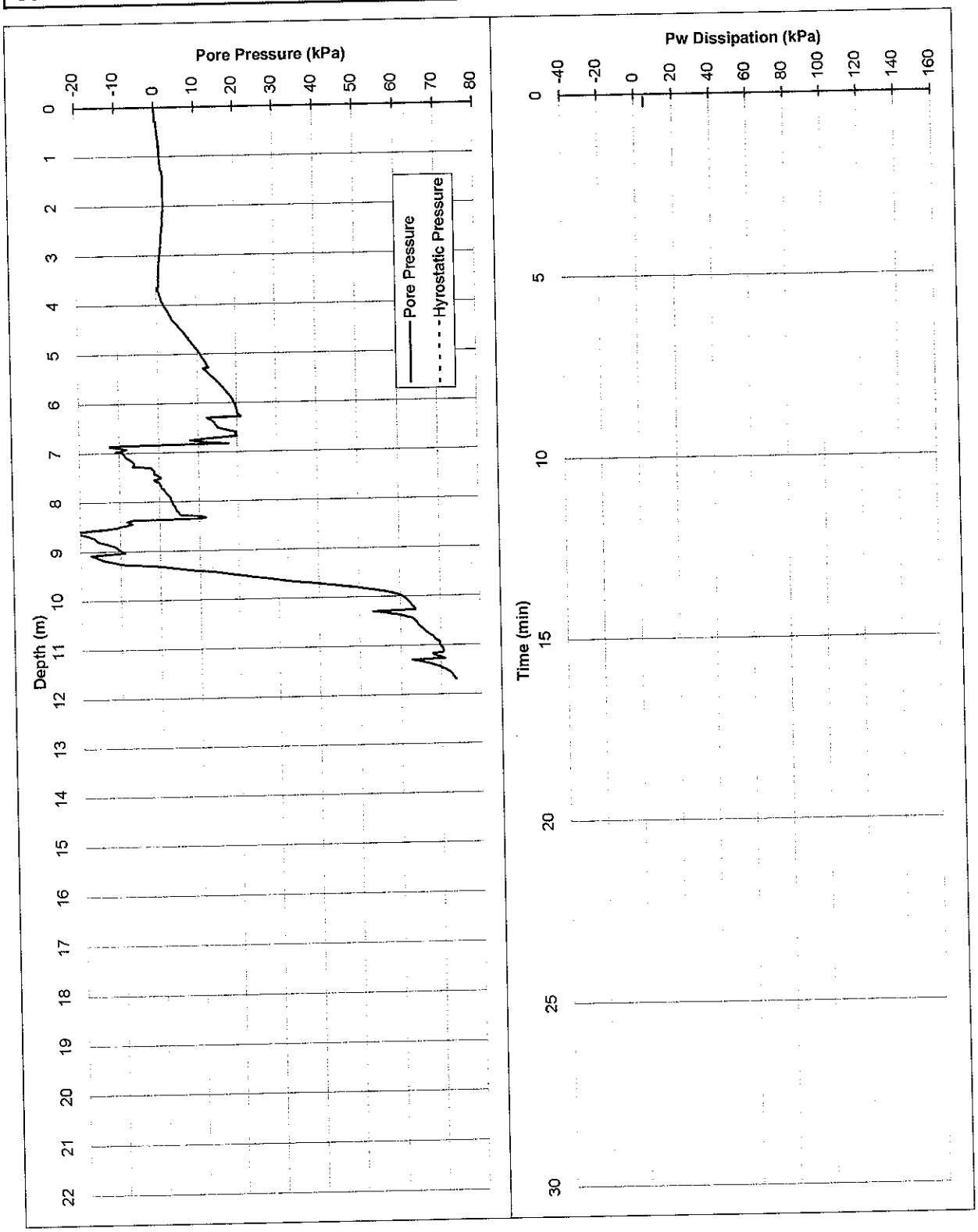
Location: Murdoch

Co-ordinates:

Date: 19/06/07

Probe No.: CPT 39 U

Job Number: 61/19514/01



PROBEDRILL GEOTECHNICAL SURVEY

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: GH7415TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

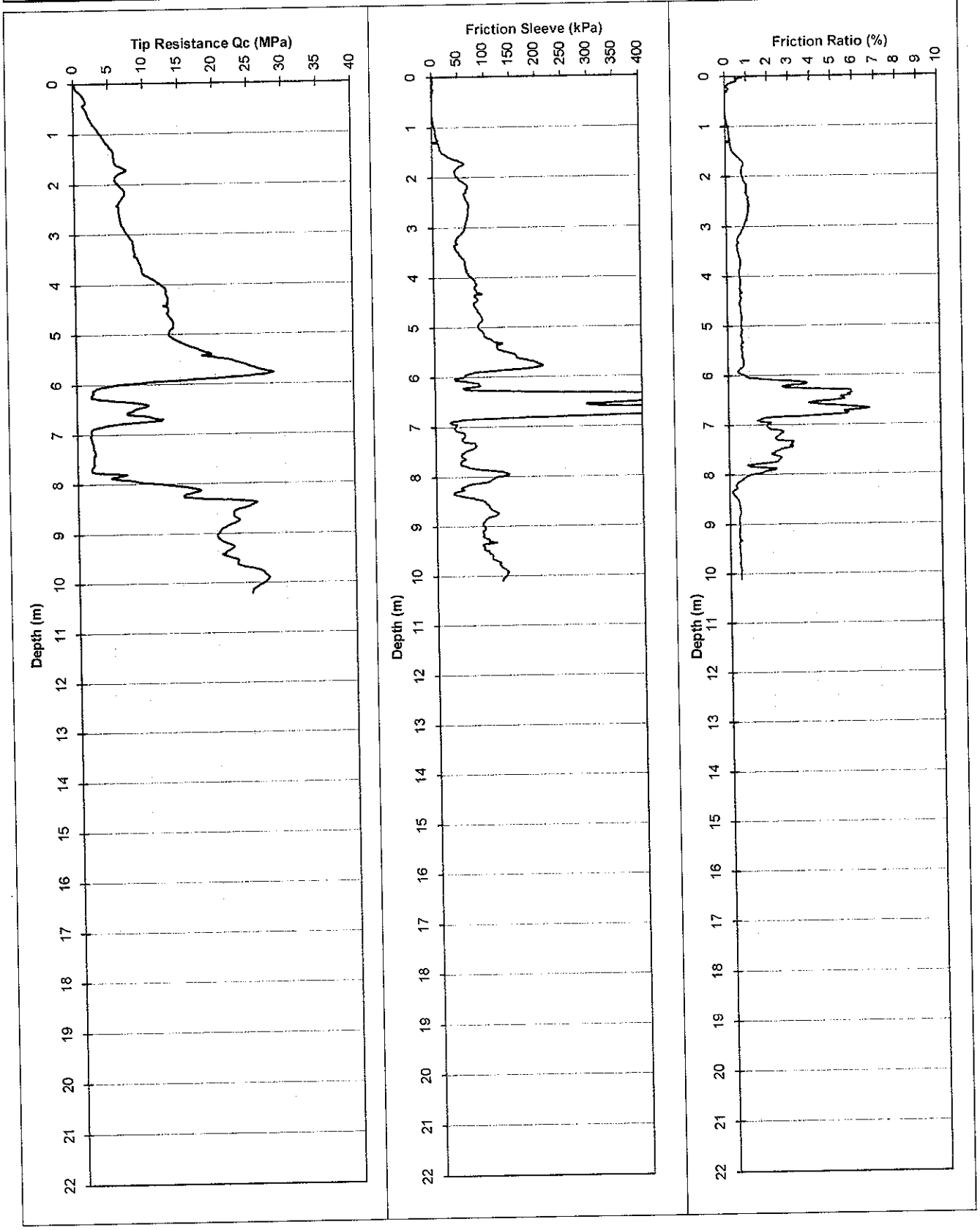
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 40 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
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

File: GH7408TT.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

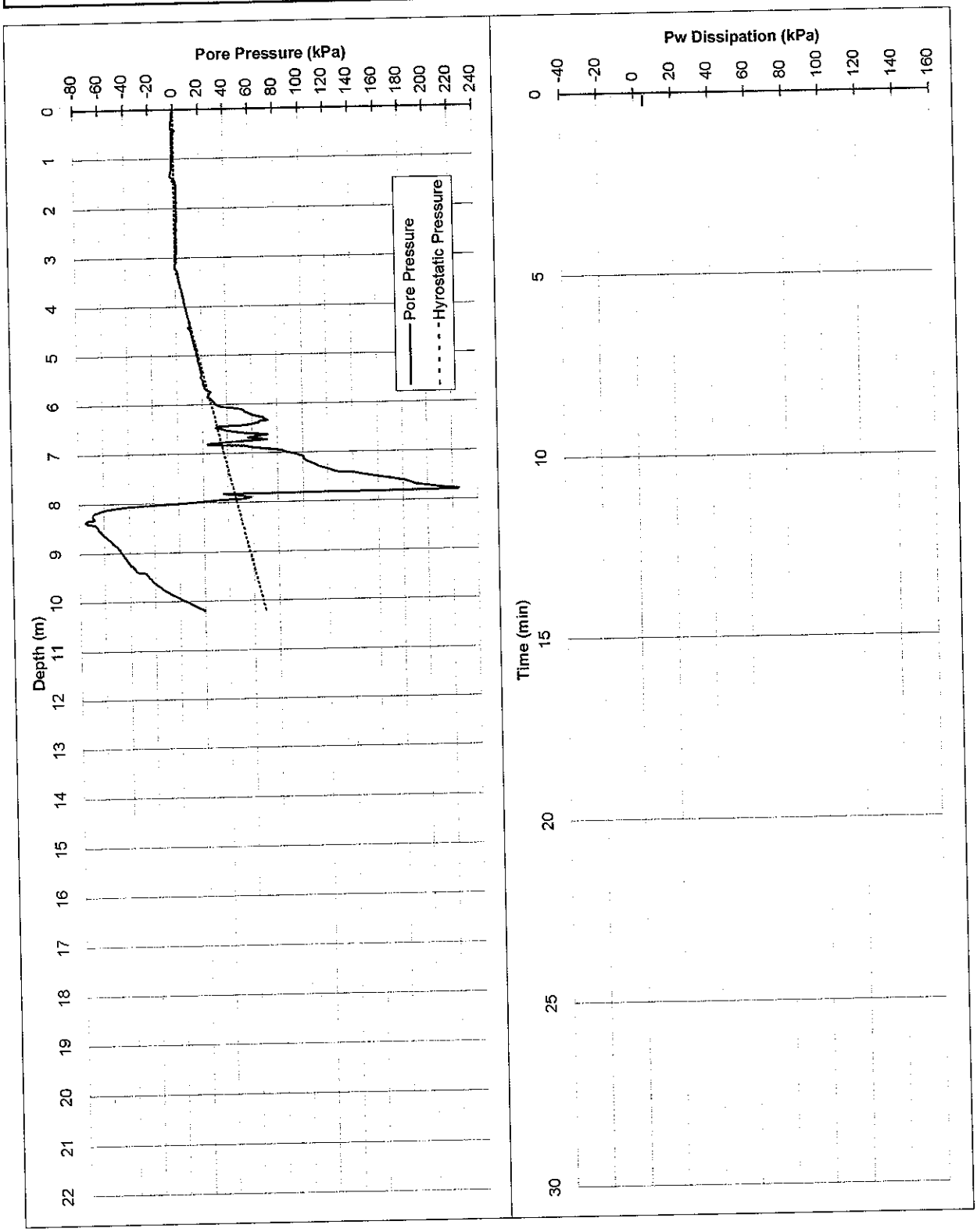
Location: Murdoch

Co-ordinates:

Date: 18/06/07

Probe No.: CPT 40 U

Job Number: 61/19514/01



PROBEDRILL GEOTECHNICAL SURVEY

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: GH7408TT.txt

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

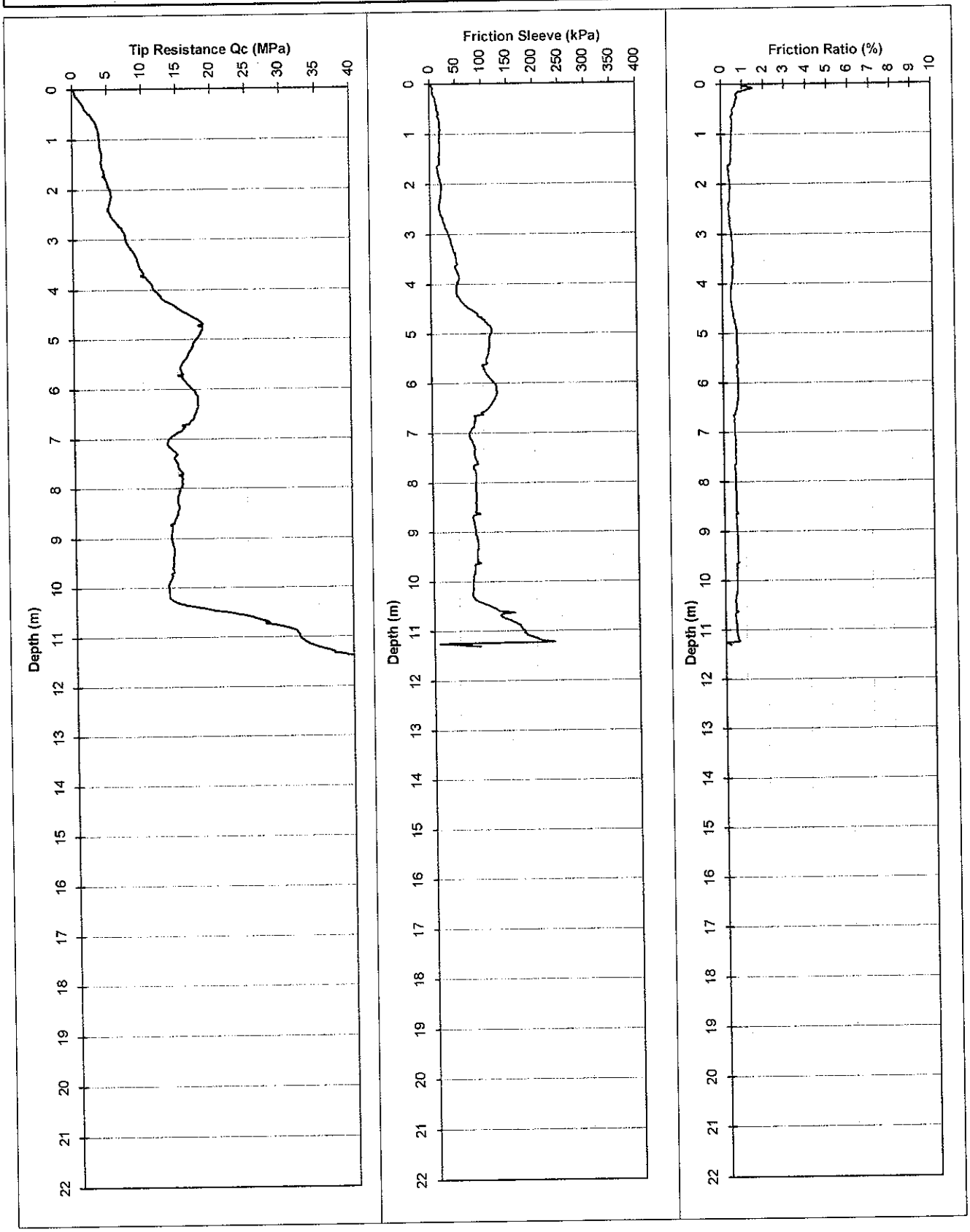
LOCATION: Murdoch

Date: 22/06/07

Probe No.: CPT 41 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL Pty Ltd
Ph: 9314 6611 Fax: 9314 6699
GEOTECHNICAL SURVEY

Water (m): Dry to 4.4

Refusal: 44MPa

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

File: GH7446TT.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

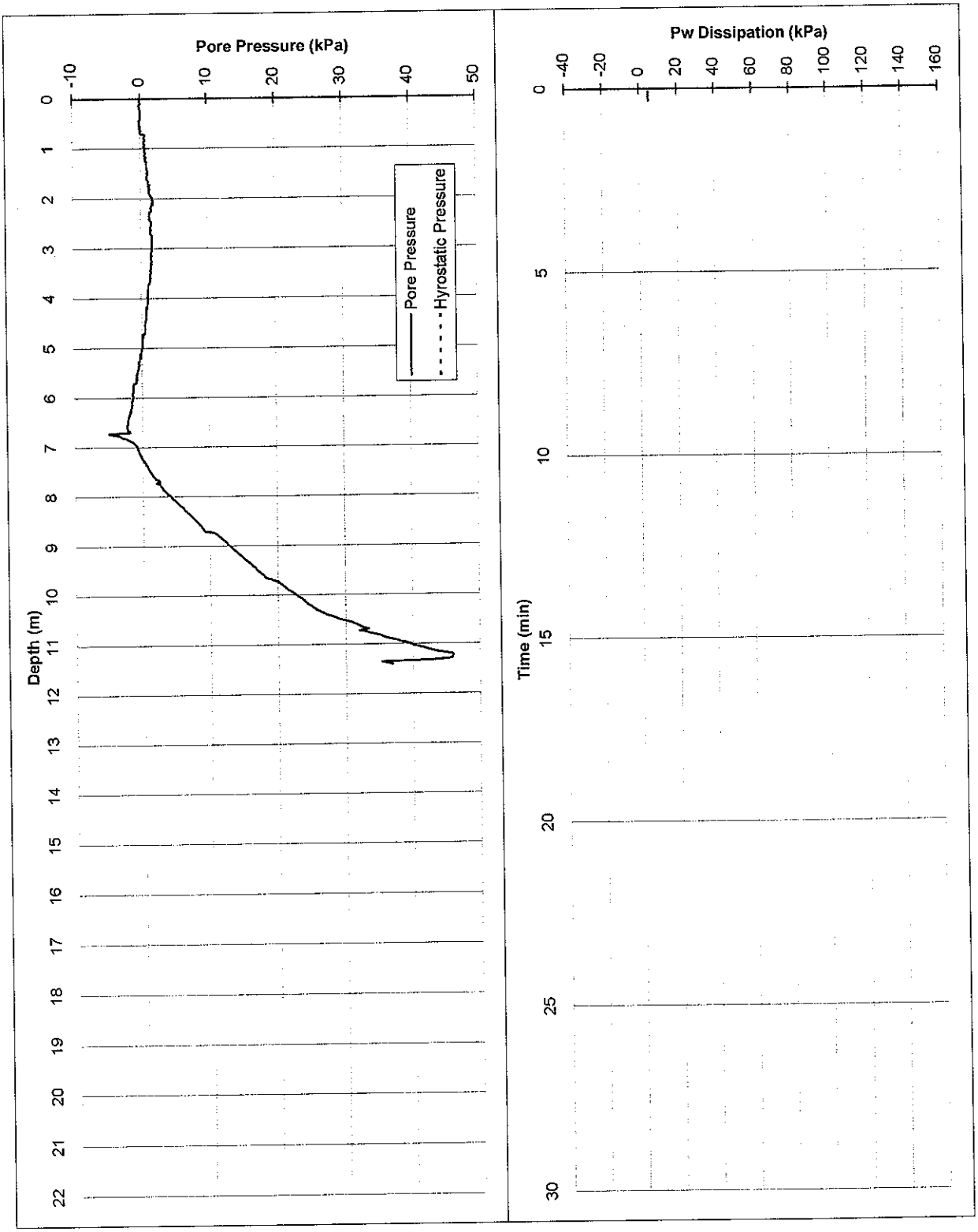
Location: Murdoch

Co-ordinates:

Date: 22/06/07

Probe No.: CPT 41 U

Job Number: 61/19514/01



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

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

File: GH7446TT.txt

7 tonne track mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

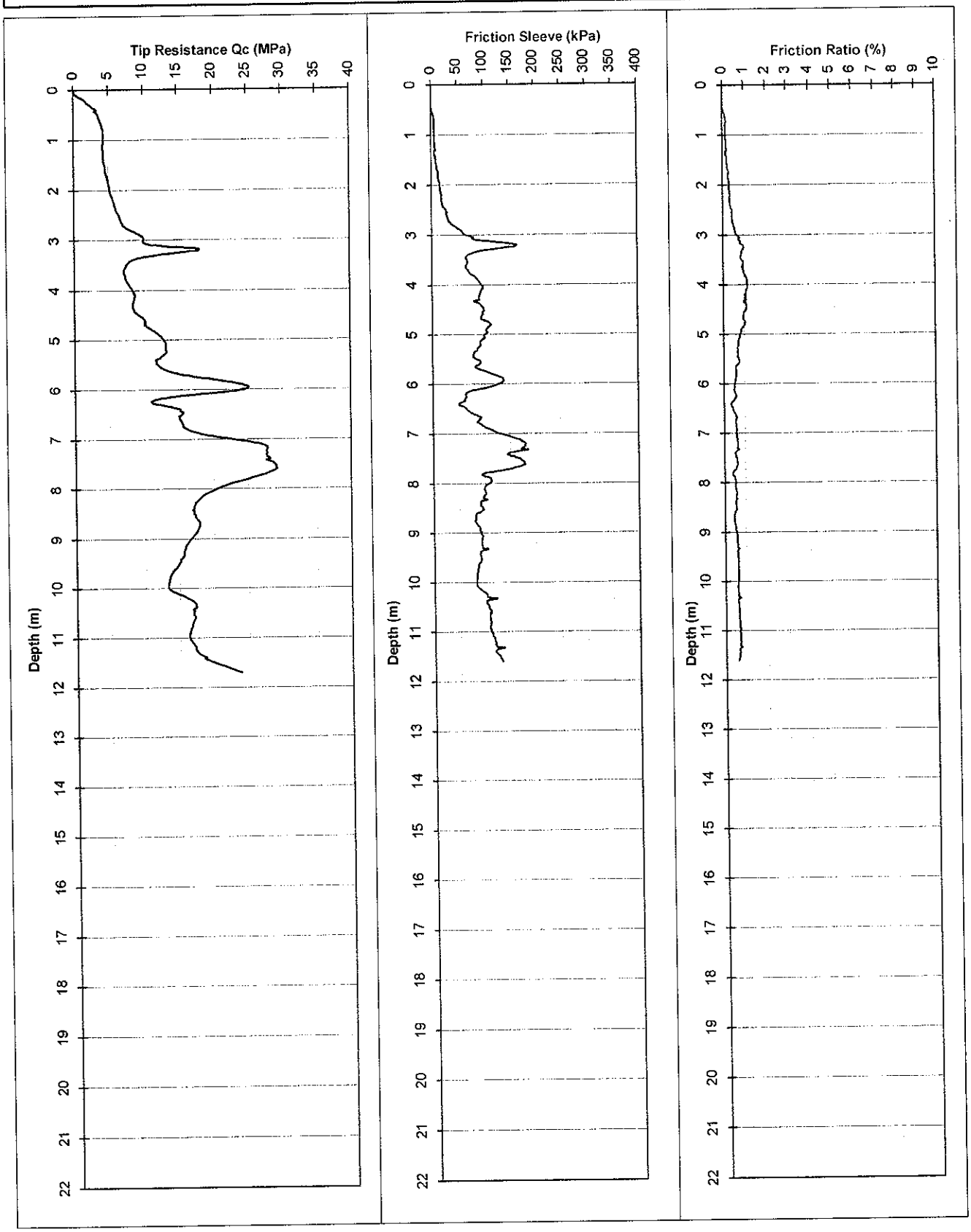
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 42 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Ph: 9314 6611 Fax 9314 6699

Water (m): 4.4

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 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

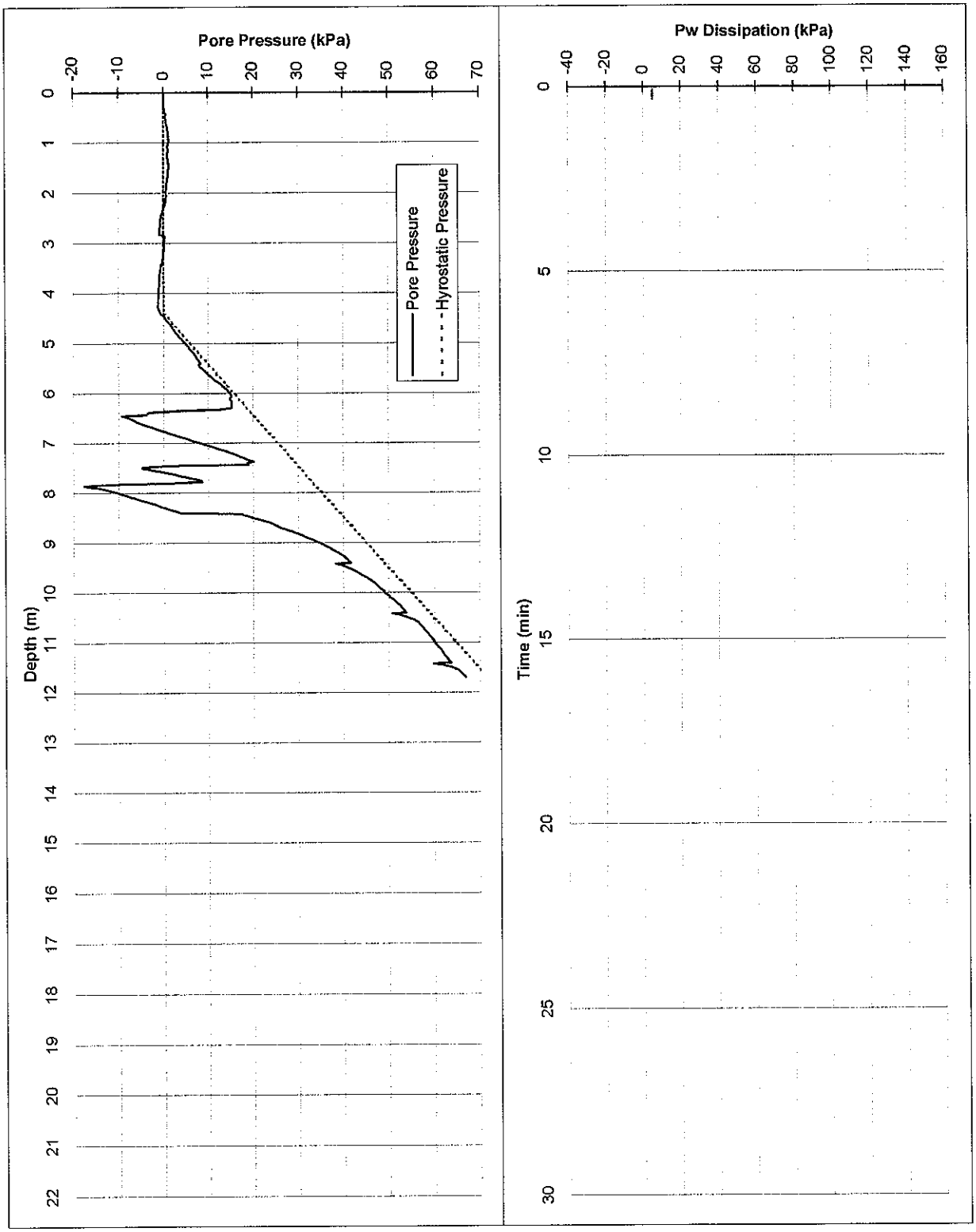
Project: Fiona Stanley Hospital

Probe No.: CPT 42 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

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

File: GH7406TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

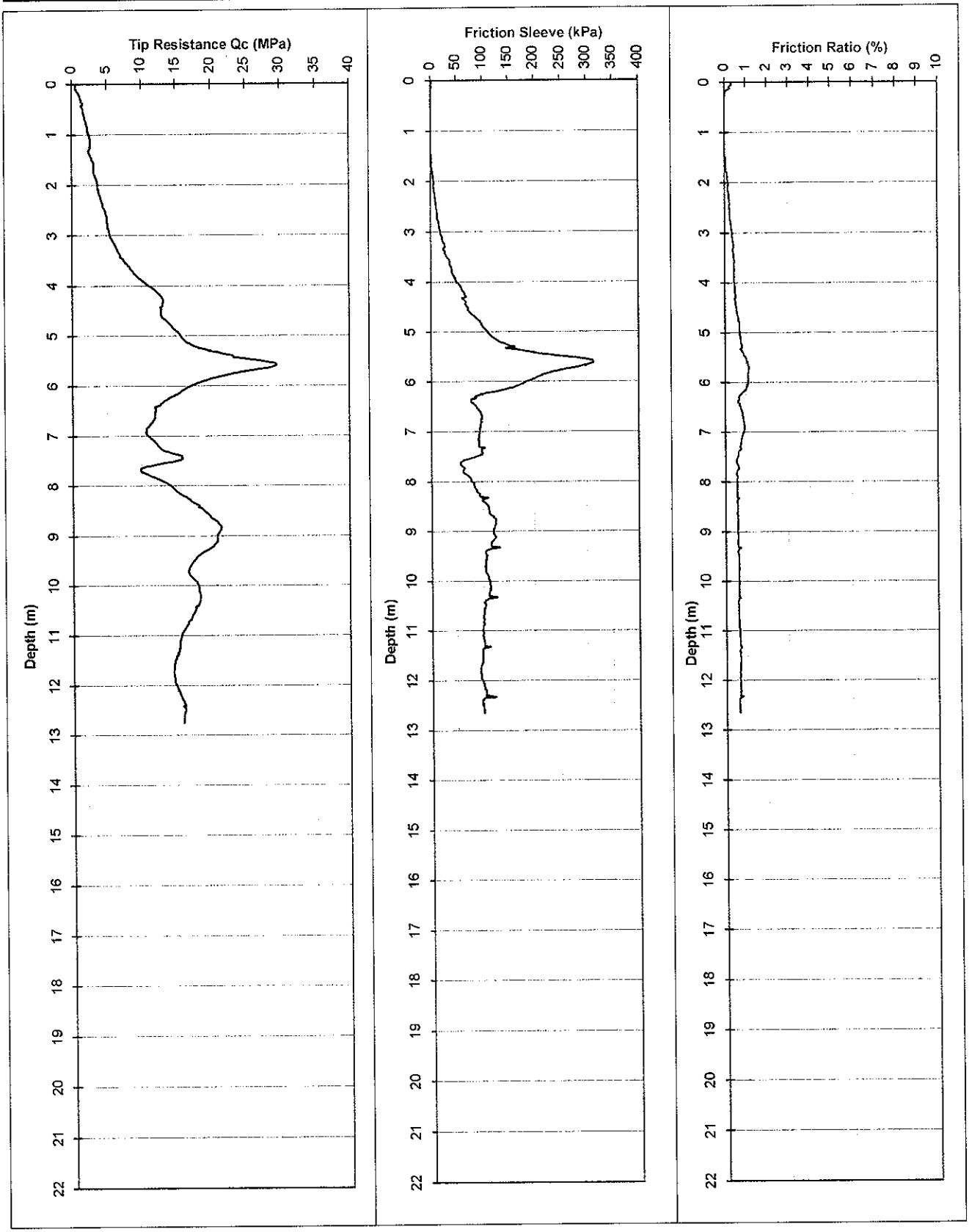
LOCATION: Murdoch

Date: 18/06/07

Probe No.: CPT 43 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL
GEOTECHNICAL SURVEY
Ph: 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

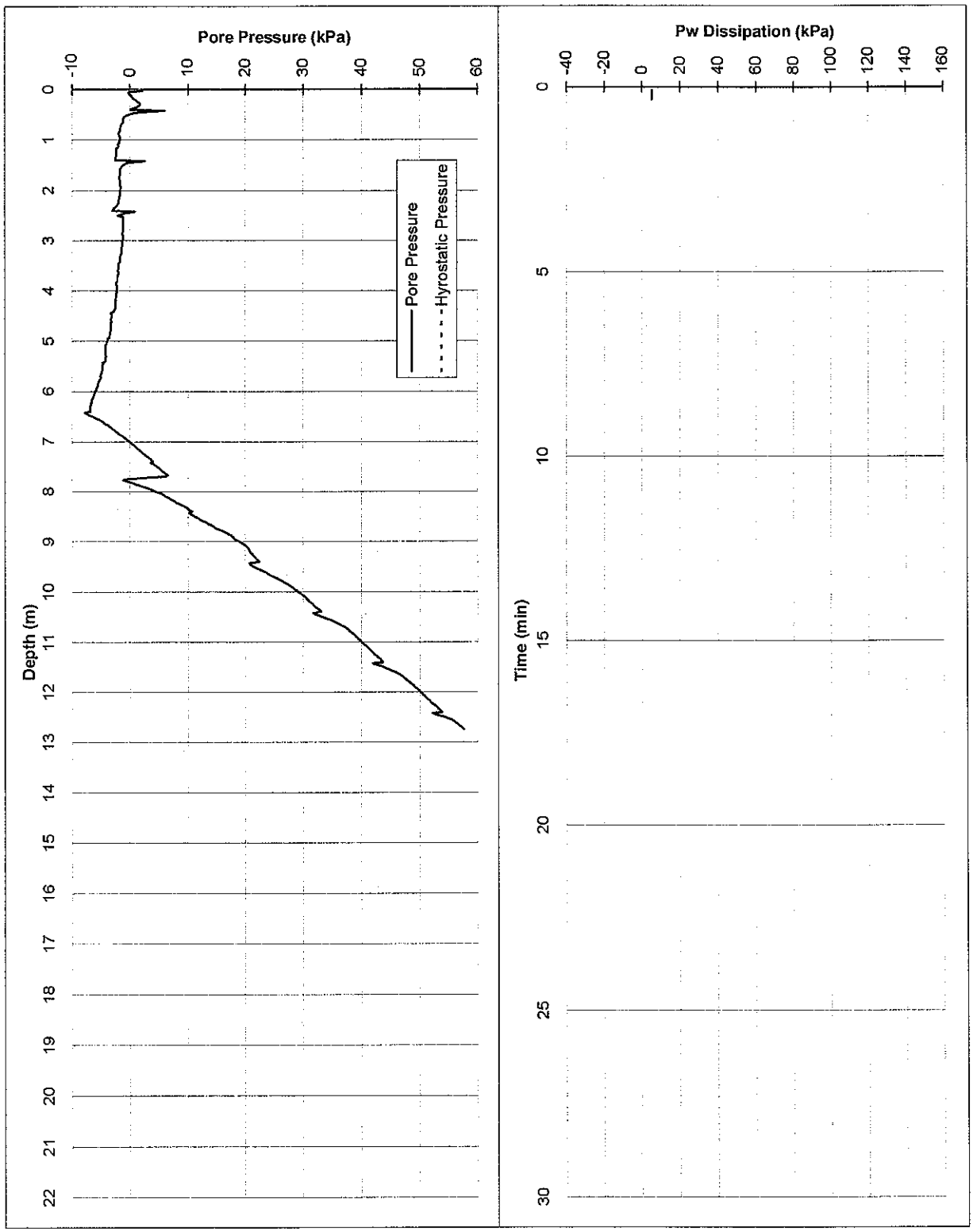
Project: Fiona Stanley Hospital

Probe No.: CPT 43 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL PTY LTD
Ph: 9314 6611 Fax 9314 6699
GEOTECHNICAL SURVEY

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

File: GH7405TT.txt

22 tonne truck mounted CPT Rig.

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Department of Housing & Works

PROJECT: Fiona Stanley Hospital

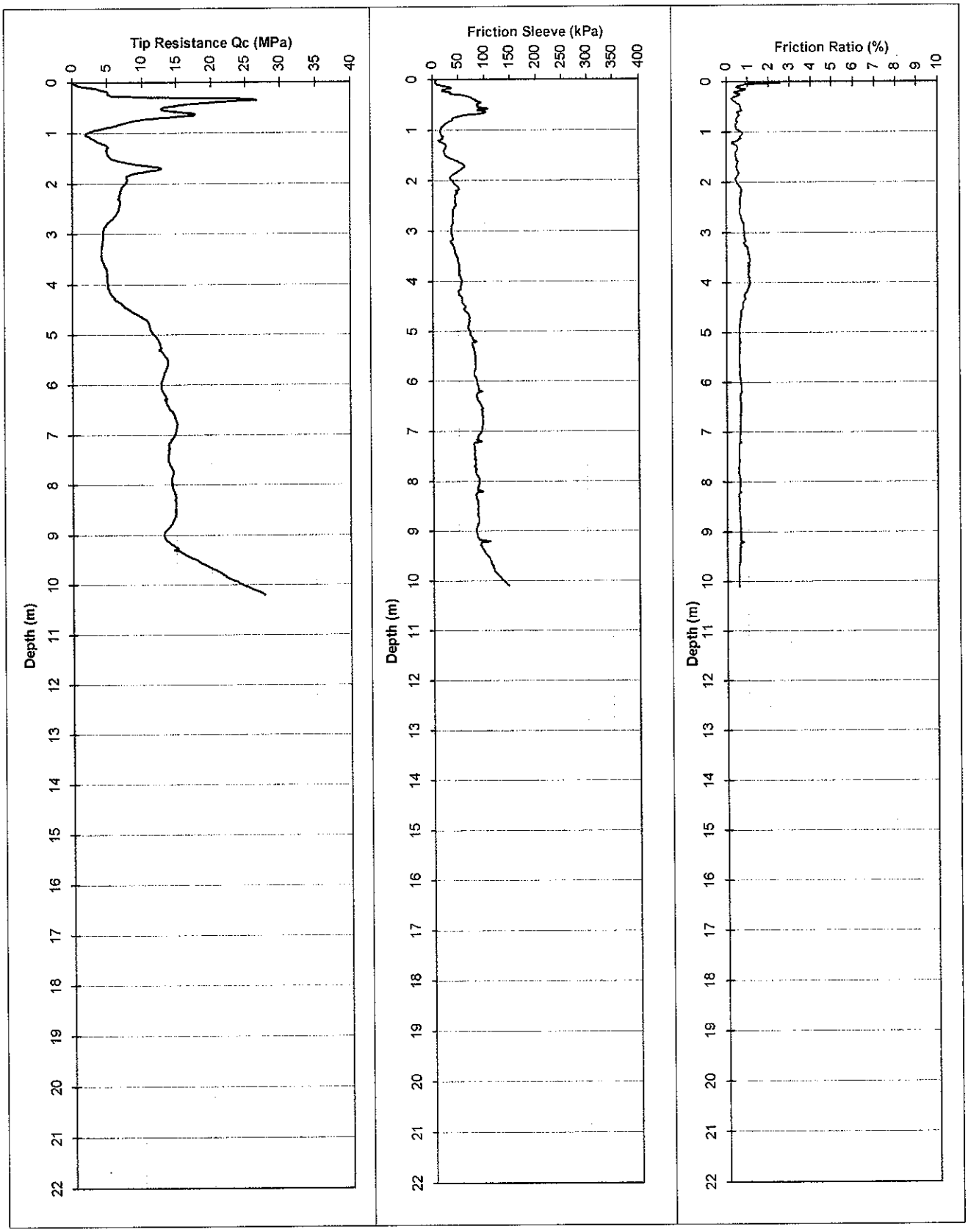
LOCATION: Murdoch

Date: 21/06/07

Probe No.: CPT 44 U

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): 3.4

Refusal:

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

File: GH7432TT.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: 21/06/07

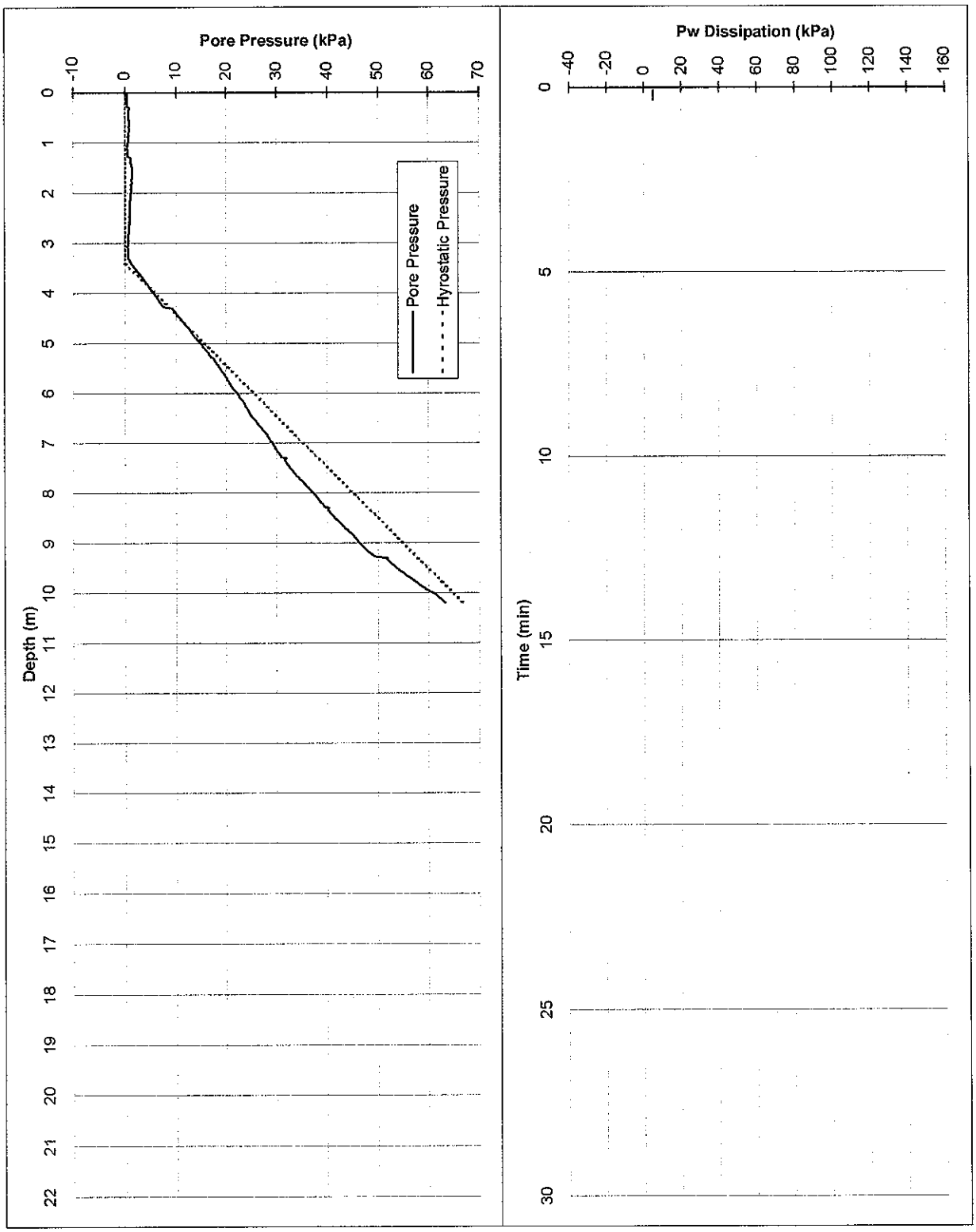
Project: Fiona Stanley Hospital

Probe No.: CPT 44 U

Location: Murdoch

Job Number: 61/19514/01

Co-ordinates:



PROBEDRILL AUSTRALIA

Ph: 9314 6611 Fax: 9314 6699 GEOTECHNICAL SURVEY

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

File: GH7432TT.txt

22 tonne truck mounted CPT Rig.

Appendix C

Results of Field Investigation Test Pits

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP101***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

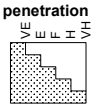
method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components)	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N			23.5	0.0			**TOPSOIL**, fine to medium, grey; minor roots (grass) and organics	D	MD		
					23.0	0.5			**SAND**, fine to medium grained, sub-rounded, mottled yellow and grey	D	MD		
				D	22.5	1.0			**SAND**, fine to medium grained, sub-rounded, orange; well sorted	M	MD		
					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							

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP102***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

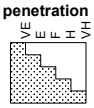
method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components)	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N			21.5	0.0			**SAND**, fine to medium grained, grey; trace organics and fine roots	D	L		TOPSOIL
					21.0	0.5			**SAND**, fine to medium grained, sub-rounded, pale grey; mottles of dark grey	D	MD		
					20.5	1.0			....becoming moist	M			
					20.0	1.5							
					19.5	2.0							
									EXCAVATION TP102 TERMINATED AT 2.20 m				
					19.0	2.5							
					18.5	3.0							
					18.0	3.5							

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



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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP103***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			31.5	0.0			**SAND**, fine to medium grained, grey; fine roots, organics	D	MD		TOPSOIL
					31.0	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly sorted	D	MD		
					30.5	1.0							
					30.0	1.5			....becoming orange, moist	M	D		
					29.5	2.0							
					29.0	2.5			EXCAVATION TP103 TERMINATED AT 2.50 m				
					28.5	3.0							
					28.0	3.5							

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP104***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N	01/05/08	D	20.5	0.0			**TOPSOIL**, fine to medium, grey; trace organics	D	MD		
					20.0	0.5			**SAND**, fine to medium grained, sub-rounded, grey	D	D		
					19.5	1.0							
					19.0	1.5			**SAND**, fine to medium grained, sub-rounded, orange / brown; iron stained, some weakly cemented patches	D	D		
					18.5	2.0				M	D		
					18.0	2.5							
					17.5	3.0							
					17.0	3.5				W			
									EXCAVATION TP104 TERMINATED AT 3.60 m				

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP105***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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	penetration (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			28.0	0.0			**SAND**, fine to medium grained, grey; minor organics, some roots	D	MD		TOPSOIL
					27.5	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; occasional large roots (5cm diameter) ....becoming orange	D	MD		
					27.0	1.0							
					26.5	1.5							
					26.0	2.0							
					25.5	2.5			EXCAVATION TP105 TERMINATED AT 2.50 m				
					25.0	3.0							
					24.5	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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP106***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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	penetration (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			24.5	0.0			**SAND**, fine to medium grained, sub-rounded, grey; fine roots, minor organics	D	MD		TOPSOIL
						0.5			**SAND**, fine to medium grained, sub-rounded, mottled grey and yellow; moderatly well sorted	D	L		
					24.0	1.0			**SAND**, fine to medium grained, sub-rounded, orange; moderatly well sorted	D	MD		
					23.5	1.5							
					23.0	2.0							
					22.5	2.5			....becoming fine				
					22.0	3.0			EXCAVATION TP106 TERMINATED AT 3.00 m Collapse				
					21.5	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
VE E F H VH

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP107***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

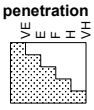
method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N			23.0	0.0			**TOPSOIL**, fine to medium, grey; roots up to 3cm diameter, organics	D	MD		
					22.5	0.5			**SAND**, fine to medium grained, sub-rounded, pale grey	D	MD		
					22.0	1.0							
					21.5	1.5			....becoming yellow				
					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 12/06/2008 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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP109***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

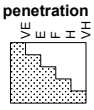
method	penetration (VE E F H)	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N			26.0	0.0			**SAND**, fine to medium grained, grey; roots from scrub, minor organics	D	MD		TOPSOIL
					25.5	0.5			**SAND**, fine to medium grained, sub-rounded, mottled yellow and grey; moderatly well sorted	D	MD		
					25.0	1.0			....becoming yellow				
					24.5	1.5			....becoming orange, moist, grainsize increasing gradually downward to medium grained dominant	M			
				D	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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP110***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

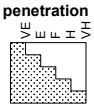
method	penetration VE E F H	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description: SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components	moisture condition	consistency / relative density	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		N			27.0	0.0			**TOPSOIL**, fine to medium, grey; minor roots and organics	D	MD		
						0.5			**SAND**, fine to medium grained, sub-rounded, mottled yellow and grey; moderatly well sorted	D	MD		
					26.5	1.0			**SAND**, fine to medium grained, sub-rounded, orange; moderatly well sorted	D - M	MD		
					26.0	1.5							
					25.5	2.0							
					25.0	2.5							
					24.5	3.0			EXCAVATION TP110 TERMINATED AT 2.75 m				
					24.0	3.5							
					23.5								

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



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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP111***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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	penetration (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			28.5	0.0			**SAND**, fine to medium grained, grey; fine roots and minor organics	D	MD		TOPSOIL
						0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly well sorted	D	MD		
					28.0	1.0			**SAND**, fine to medium grained, sub-rounded, orange / yellow; well sorted	D	MD		
					27.5	1.5							
					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								

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP112***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			27.5	0.0			**SAND**, fine to medium grained, grey; fine roots and organics	D	MD		TOPSOIL
						0.5			**SAND**, fine to medium grained, sub-rounded, grey; moderatly well sorted				
					27.0				**SAND**, fine to medium grained, sub-rounded, yellow; well sorted				
					26.5	1.0							
						1.5			....becoming orange				
				D	26.0	2.0							
					25.5								
									EXCAVATION TP112 TERMINATED AT 2.30 m				
					25.0	2.5							
						3.0							
					24.5								
						3.5							
					24.0								

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP113***
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: 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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			22.5	0.0			**SAND**, fine to medium grained, grey; roots and minor organics				TOPSOIL
						0.5			**SAND**, fine to medium grained, sub-rounded, grey; moderatly 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								

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP114***
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: 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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			21.5	0.0			**SAND**, fine to medium grained, grey; fine roots and organics	D	MD		TOPSOIL
						0.5							
					21.0	1.0			**SAND**, fine to medium grained, sub-rounded, pale grey; moderatly well sorted	D	MD		
					20.5	1.5							
					20.0	2.0							
				D	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
VE E F H VH

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP115***
Sheet No.	1 of 1
Project No.	***GEOTHERD08304AB***
Client : ***BG & E***	Date excavated ***1/5/08***
Principal :	Date completed
Project : ***Fiona Stanley Hospital***	Logged by : ***CT***
Location : ***Murdoch***	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**

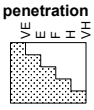
method	penetration	support	ground water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components)	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N			29.5	0.0			**SAND**, fine to medium grained, grey; minor roots and organics	D	MD		TOPSOIL
						0.5			**SAND**, fine to medium grained, sub-rounded, mottled grey and yellow; moderatly well sorted	D	MD		
					29.0				**SAND**, fine to medium grained, sub-rounded, yellow; well sorted	D	MD		
						1.0							
					28.5								
						1.5			....becoming moist	M			
					28.0								
						2.0							
					27.5								
						2.5							
					27.0								
						3.0							
					26.5								
						3.5			EXCAVATION TP115 TERMINATED AT 3.50 m				
					26.0								

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

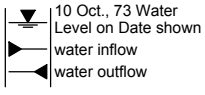
method
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper
- E Excavator

support
- T Timbering

penetration



water



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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP116***
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: 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 (SOIL TYPE, Plasticity or Particle Characteristic, Colour, Secondary and Minor Components)	moisture condition	consistency / relative density	hand penetrometer kPa	structure and additional observations
BH	VE E F H	N		D	22.5	0.0			**SAND**, fine to medium grained, grey; organics and fine roots	D	MD		TOPSOIL
					22.0	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly well sorted, fine roots	D	MD		
					21.5	1.0							
					21.0	1.5			....becoming orange/yellow				
					20.5	2.0							
					20.0	2.5			....becoming fine grained, pale yellow				
					19.5	3.0							
					19.0	3.5							

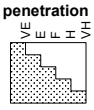
EXCAVATION TP116 TERMINATED AT 4.00 m

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP117***
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: 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	penetration (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			22.0	0.0			**SAND**, fine to medium grained, grey; roots and organics	D	MD		TOPSOIL
					21.5	0.5			**SAND**, fine to medium grained, grey and yellow	D	D		
					21.0	1.0			**SAND**, fine to medium grained, sub-rounded, dark grey; moderatly well sorted, trace organics	D	D		
					20.5	1.5			**SAND**, fine to medium grained, sub-rounded, pale grey / white; well sorted	D	MD		
					20.0	2.0							
					19.5	2.5							
					19.0	3.0			....becoming pale brown				
					18.5	3.5							
				D									

EXCAVATION TP117 TERMINATED AT 4.00 m

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP118***
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: 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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			26.0	0.0			**TOPSOIL**, fine to medium, grey; roots and minor organics	D	MD		
					25.5	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly well sorted	D	L		
					25.0	1.0			....becoming orange/yellow				
					24.5	1.5							
					24.0	2.0							
					23.5	2.5			EXCAVATION TP118 TERMINATED AT 2.75 m				
					23.0	3.0							
					22.5	3.5							

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

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

excavation information | **material substance**

method	penetration (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			29.5	0.0			**SAND**, fine to medium grained, grey; fine roots and minor organics	D	MD		TOPSOIL
					29.0	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly well sorted	D	MD		
					28.5	1.0							
					28.0	1.5			....becoming yellow/orange				
					27.5	2.0			....becoming dense		D		
					27.0	2.5							
					26.5	3.0			EXCAVATION TP121 TERMINATED AT 2.75 m				
					26.0	3.5							

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics

Engineering Log - Excavation

Excavation No	***TP122***
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: 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 (VE E F H)	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 (100 200 300 400)	structure and additional observations
BH		N			29.0	0.0			**SAND**, fine to medium grained, grey; roots, minor organics	D	MD		TOPSOIL
					28.5	0.5			**SAND**, fine to medium grained, sub-rounded, yellow mottled grey; moderatly well sorted	D	MD		
					28.0	1.0							
					27.5	1.5			....becoming yellow/orange		D		
					27.0	2.0							
				D	26.5	2.5			....becoming fine grained, pale yellow		MD		
					26.0	3.0			EXCAVATION TP122 TERMINATED AT 3.00 m				
					25.5	3.5							

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 (VE E F H VH)

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-Remouded (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

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Borehole Number **BH101**

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

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

The method of calculation is outlined in BS5930:1999

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

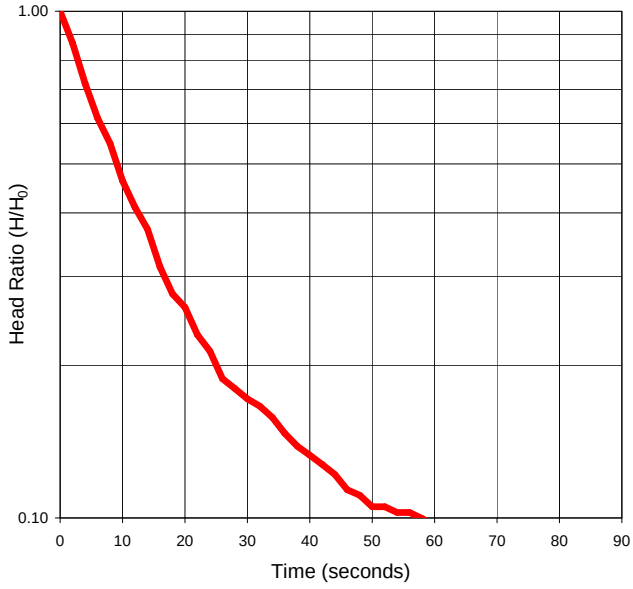
where:
k = permeability of the soil
A = cross-sectional area of borehole or casing (m^2).
F = intake factor (refer to chart)
H_1 = variable head at time t_1
$H_{2=}$- variable head at time t_2

Intake Factor Case (b)

No.	Time (mins)	Time (secs)	Depth (m)	Water Level	Head (m)	H/H_0	k (m/s) (from H_0)	k (m/s) (previous)
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 (m^2)	7.85E-03
Groundwater level (m)	-9.7
Intake Factor	4.603491

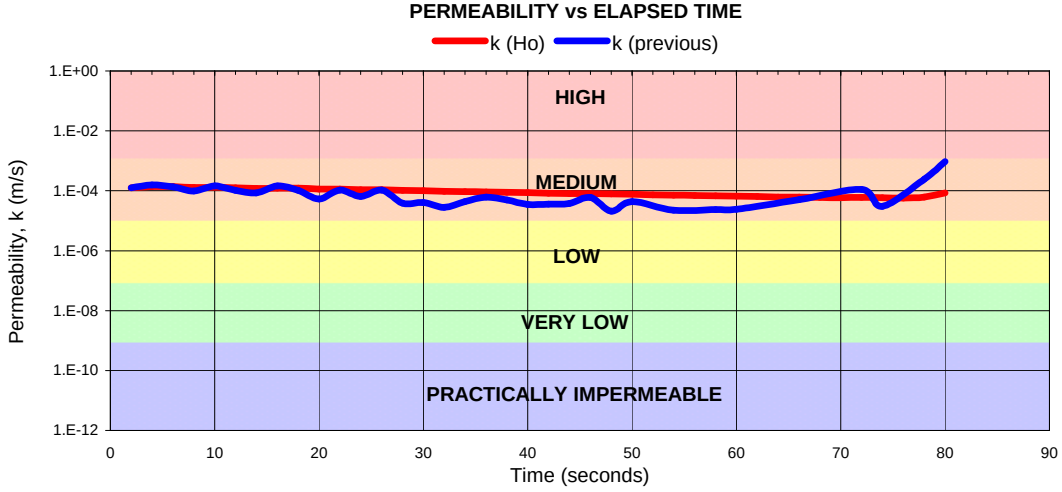
HEAD RATIO vs ELAPSED TIME



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



12/06/2008
Paul Petropulos
F:\Geotechnical\HERD08000\GEOTHERD08304AB\Lab results\groundwater\BH101 rising head (2)

FIGURE 1

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

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

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

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

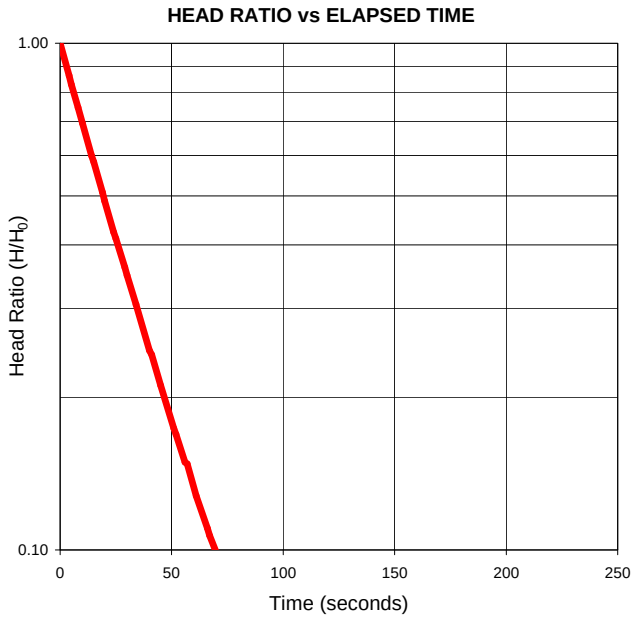
where:
k = permeability of the soil
A = cross-sectional area of borehole or casing (m^2).
F = intake factor (refer to chart)
H_1 = variable head at time t_1
$H_{2=}$- variable head at time t_2

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)

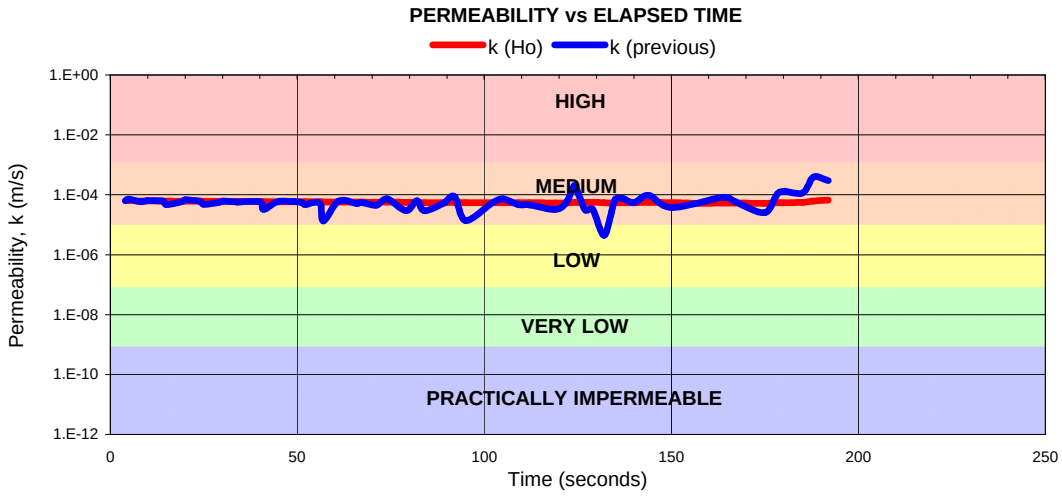
No.	Time (mins)	Time (secs)	Depth (m)	Water Level	Head (m)	H/H_0	k (m/s) (from H_0)	k (m/s) (previous)
1	0.0	0	6.07	-5.27	-0.85	1.00		
2	4.0	4	5.96	-5.16	-0.74	0.86	6.24E-05	6.24E-05
3	5.0	5	5.93	-5.13	-0.71	0.83	6.41E-05	7.10E-05
4	8.0	8	5.86	-5.06	-0.64	0.75	6.24E-05	5.94E-05
5	10.0	10	5.81	-5.01	-0.59	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 (m^2)	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



12/06/2008
Paul Petropulos
F:\Geotechnical\HERD08000\GEOTHERD08304AB\Lab results\groundwater\BH102 rising head (2)

FIGURE 1

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

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Borehole Number **BH103**

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

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

The method of calculation is outlined in BS5930:1999

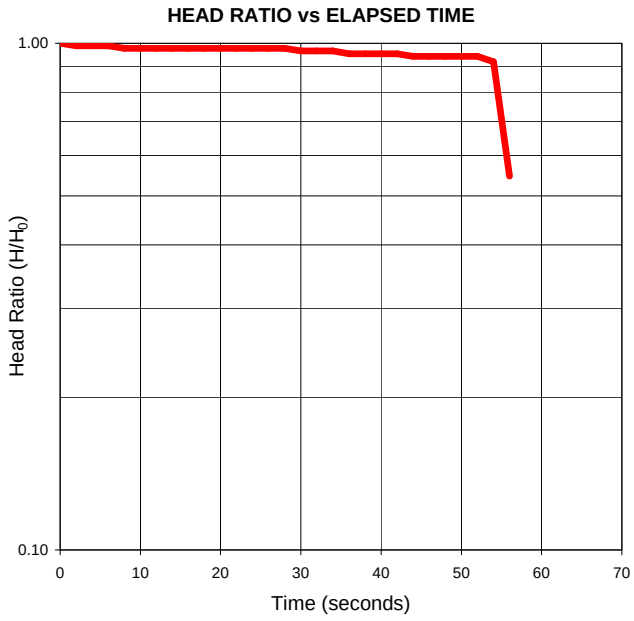
$$k = \frac{A}{F(t_2 - t_1)} \ln\left(\frac{H_1}{H_2}\right)$$

where:
k = permeability of the soil
A = cross-sectional area of borehole or casing (m^2).
F = intake factor (refer to chart)
H_1 = variable head at time t_1
$H_{2=}$- variable head at time t_2

Intake Factor Case (b)

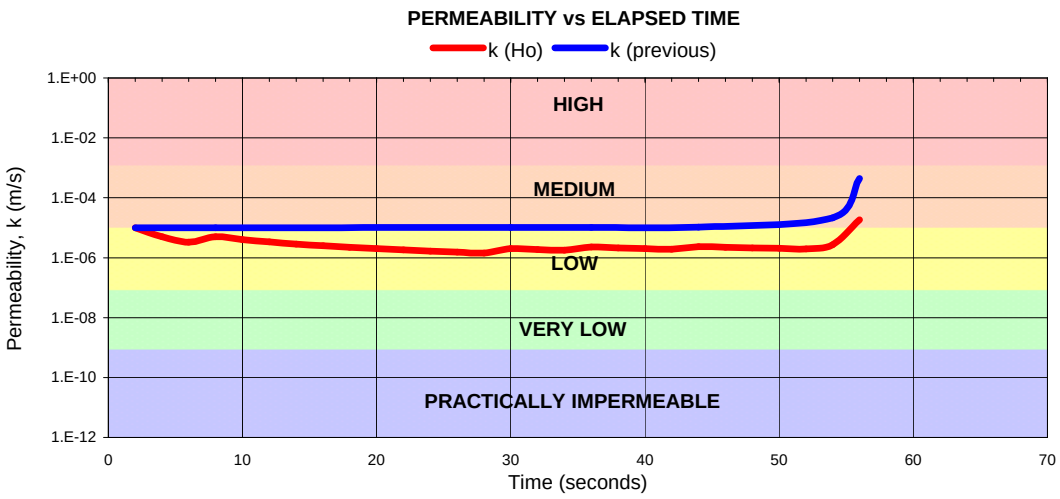
No.	Time (mins)	Time (secs)	Depth (m)	Water Level	Head (m)	H/H_0	k (m/s) (from H_0)	k (m/s) (previous)
1	0.0	0	14.87	-14.07	-0.09	1.00		
2	2.0	2	14.87	-14.07	-0.09	0.99	9.98E-06	9.98E-06
3	4.0	4	14.87	-14.07	-0.09	0.99	4.99E-06	0.00E+00
4	6.0	6	14.87	-14.07	-0.09	0.99	3.33E-06	0.00E+00
5	8.0	8	14.86	-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 (m^2)	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



12/06/2008
Paul Petropulos
F:\Geotechnical\HERD08000\GEOTHERD08304AB\Lab results\groundwater\BH103 rising head (2)

FIGURE 1

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

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Borehole Number **BH104**

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

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

The method of calculation is outlined in BS5930:1999

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

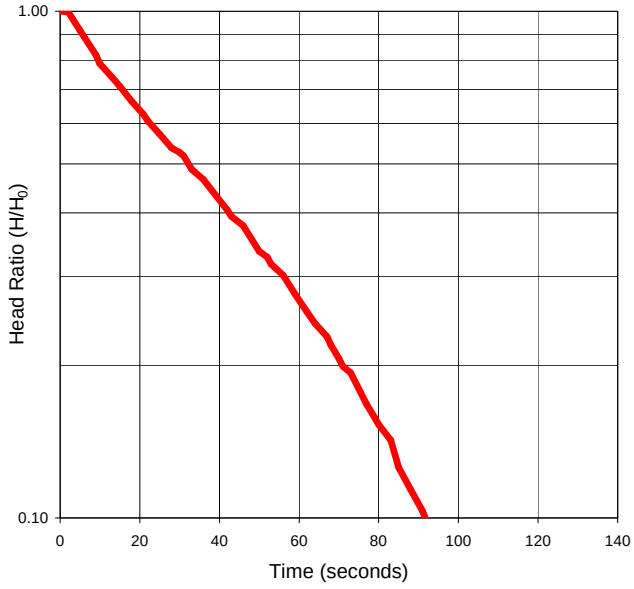
where:
k = permeability of the soil
A = cross-sectional area of borehole or casing (m^2).
F = intake factor (refer to chart)
H_1 = variable head at time t_1
$H_{2=}$- variable head at time t_2

Intake Factor Case (b)

No.	Time (mins)	Time (secs)	Depth (m)	Water Level	Head (m)	H/H_0	k (m/s) (from H_0)	k (m/s) (previous)
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 (m^2)	7.85E-03
Groundwater level (m)	-5.2
Intake Factor	4.603491

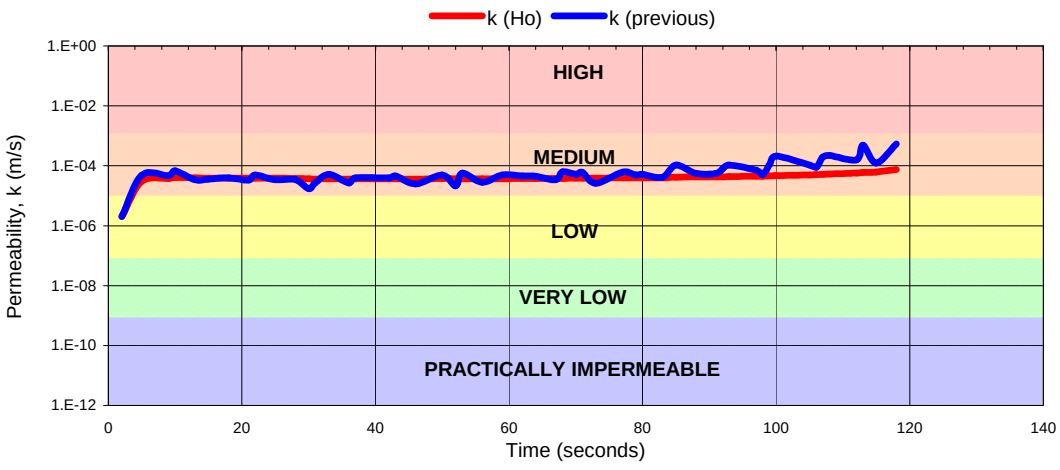
HEAD RATIO vs ELAPSED TIME



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



12/06/2008
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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	--	--	--

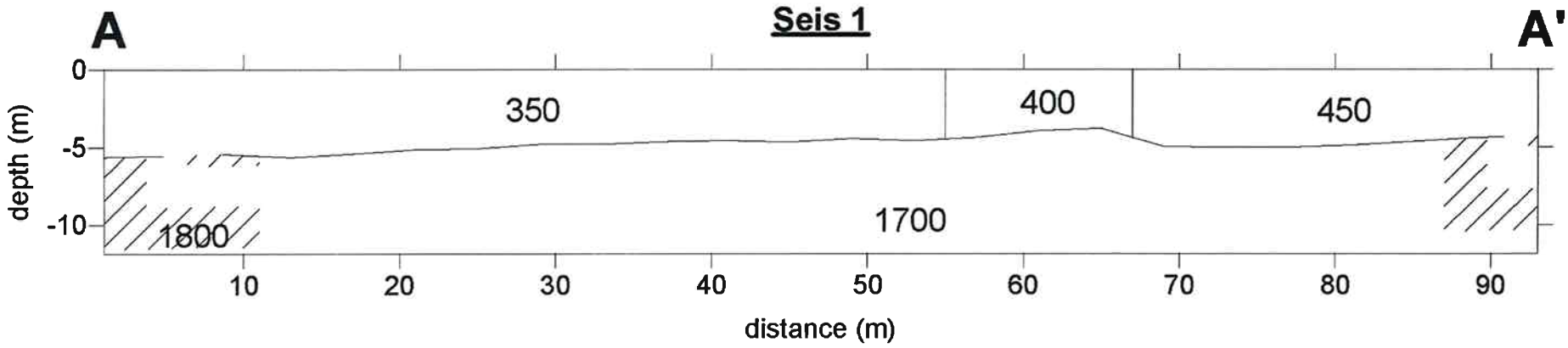
TABLE E9: RESULTS, LINE 9

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	--	--	--



P-wave Velocity (m/sec)

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scale	
original size	A3

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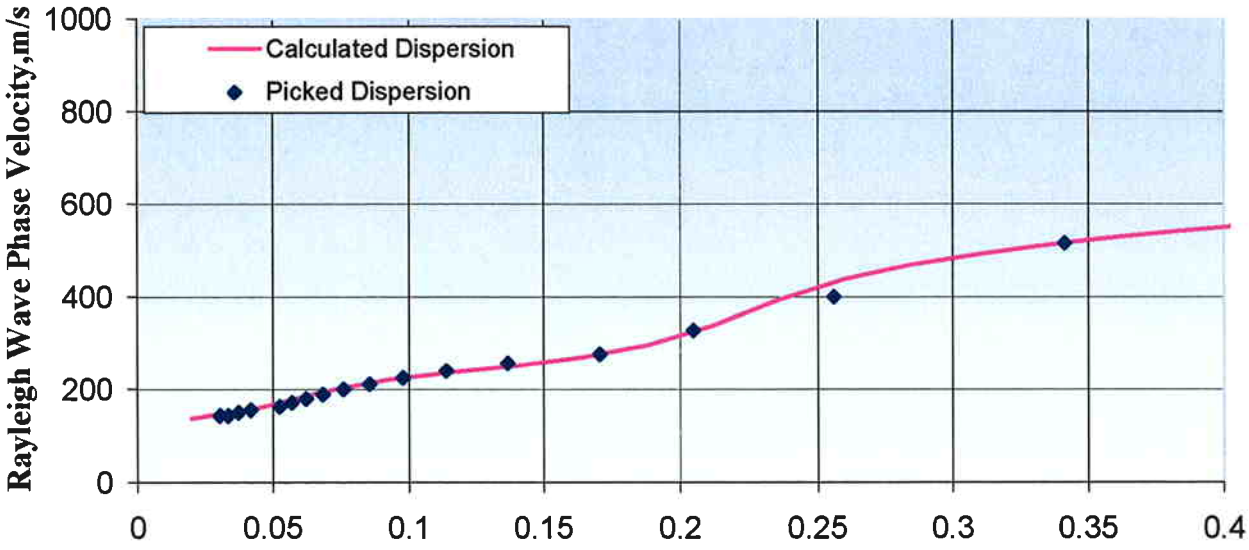
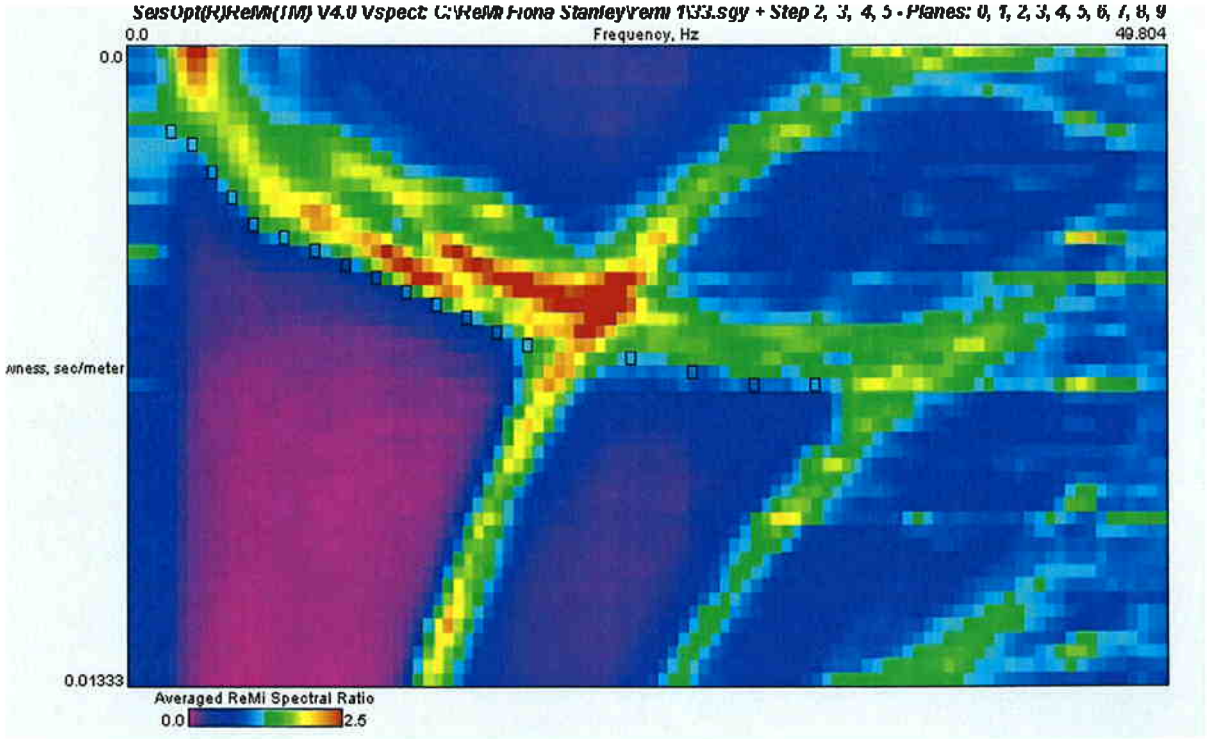
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 1		
project no: GEOPHERD00023AA		fig no: FIGURE B-1A	rev:

ReMi 1

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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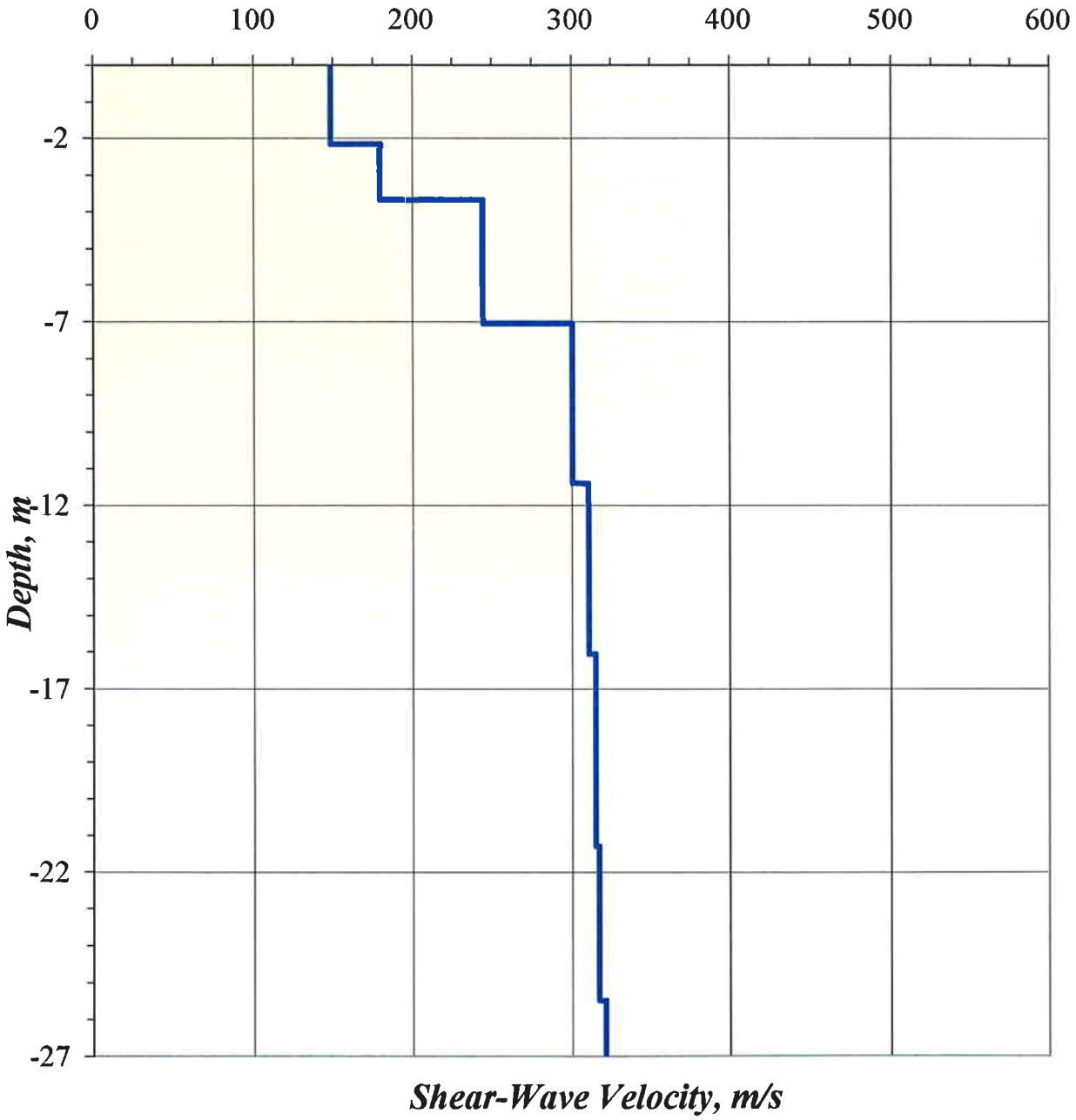
date	5/06/08		title:	REMI 1 DISPERSION CURVE	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-1B	rev:
original size	A3				

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



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approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 1 MODEL	
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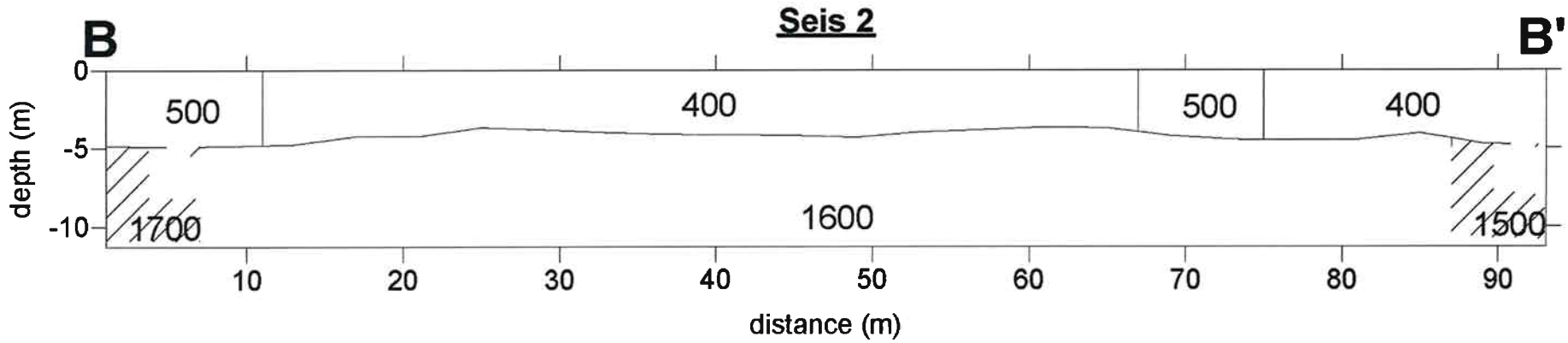

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original size	A3

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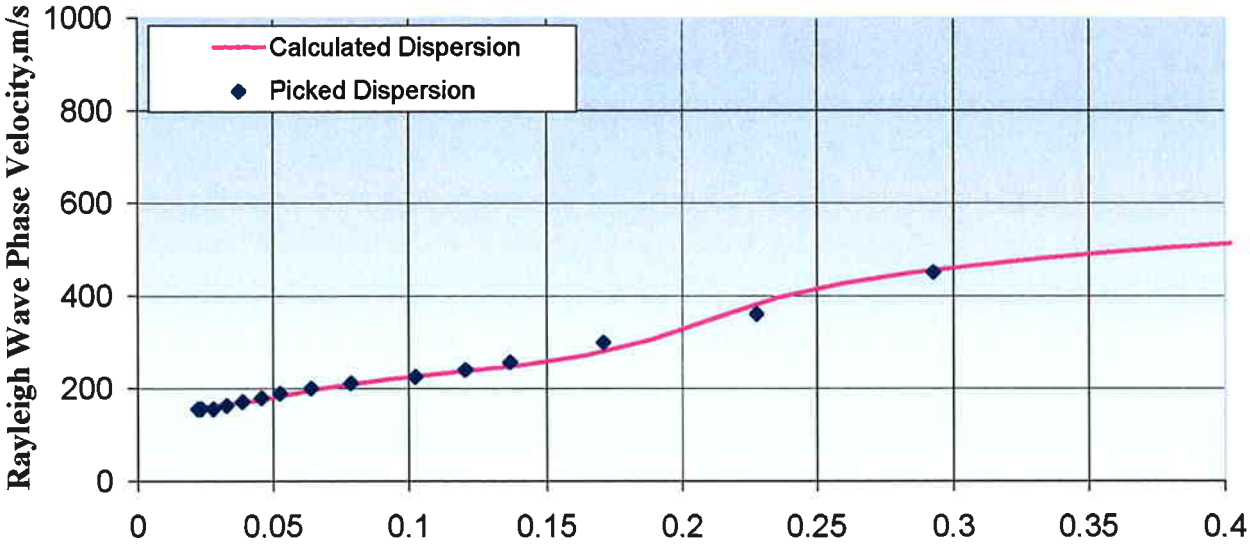
project: FIONA STANLEY HOSPITAL
MURDOCH DRIVE, MURDOCH

title: SECTION SEIS 2

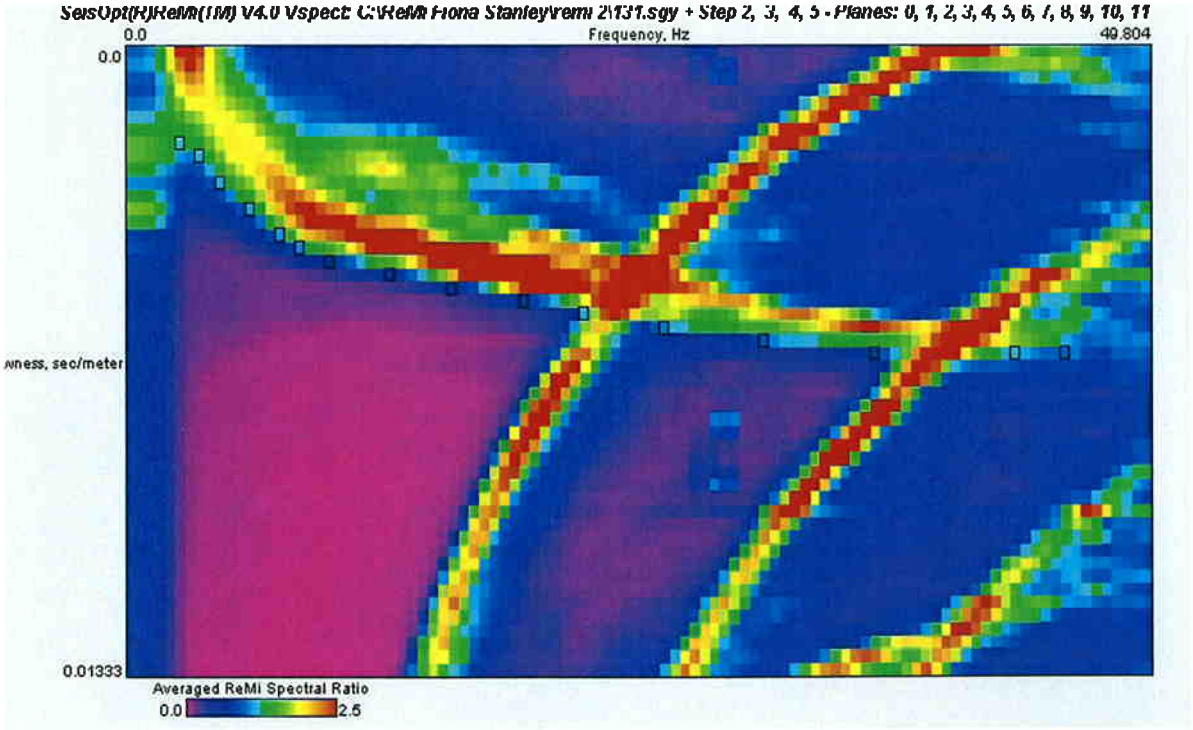
project no: GEOPHERD00023AA | fig no: FIGURE B-2A | rev:

ReMi 2

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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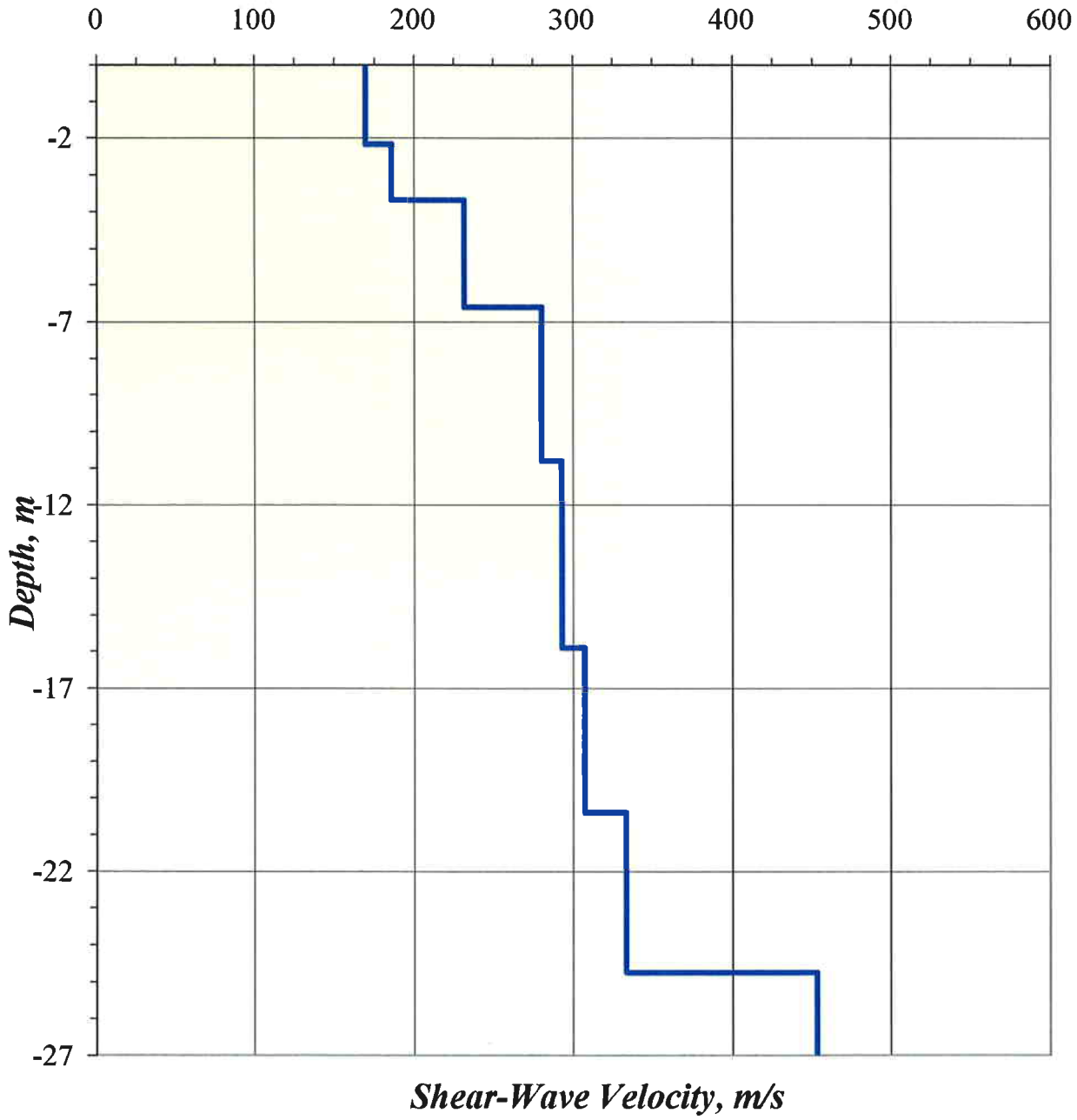
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 2 DISPERSION CURVE		
project no:	GEOPHERD00023AA	fig no: FIGURE B-2B	rev:

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



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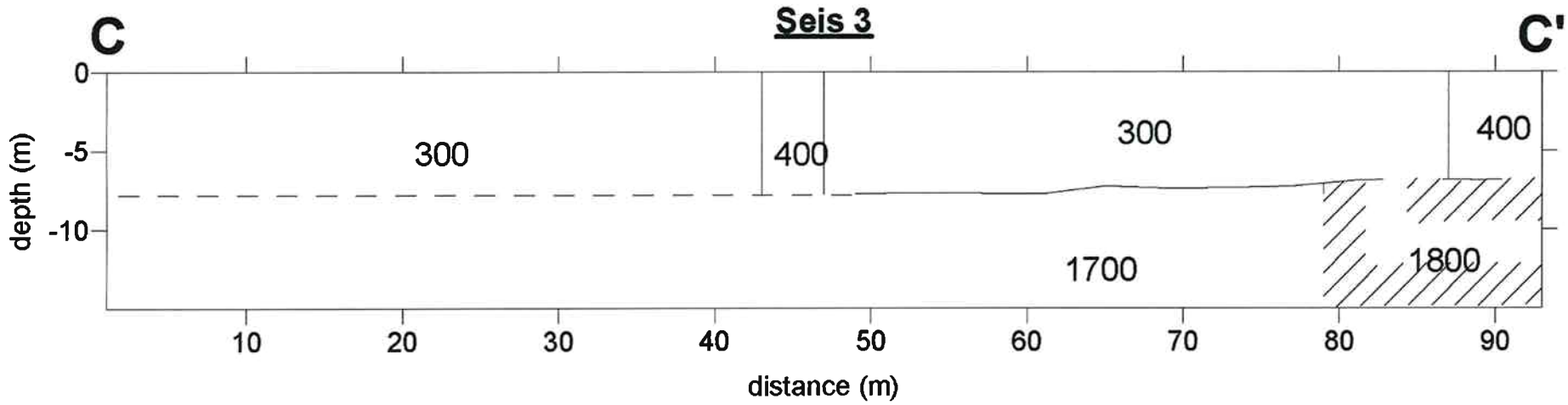

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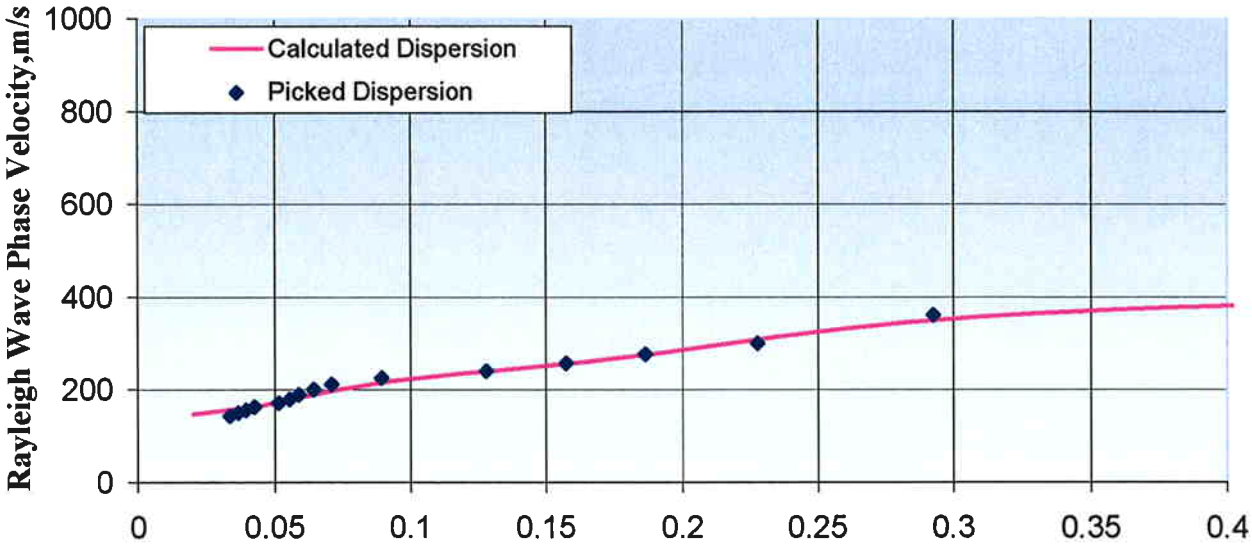
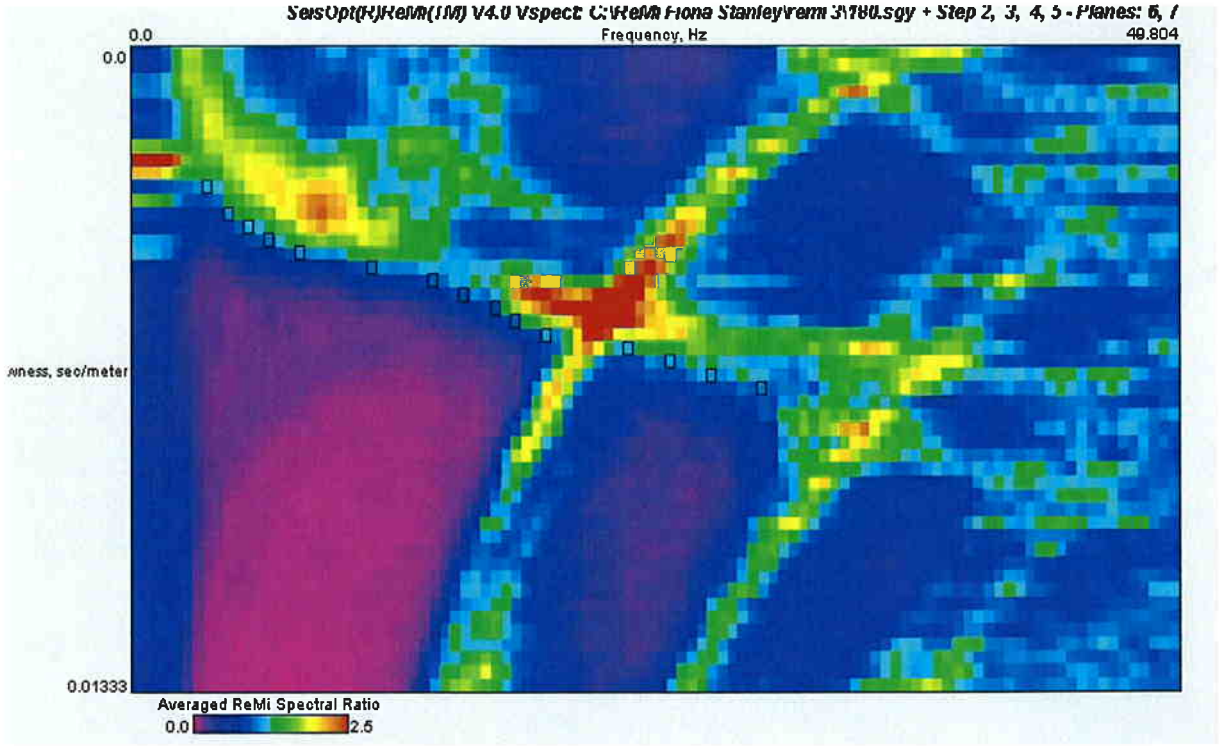
title:	SECTION SEIS 3		
project no: GEOPHERD00023AA		fig no: FIGURE B-3A	rev:

ReMi 3

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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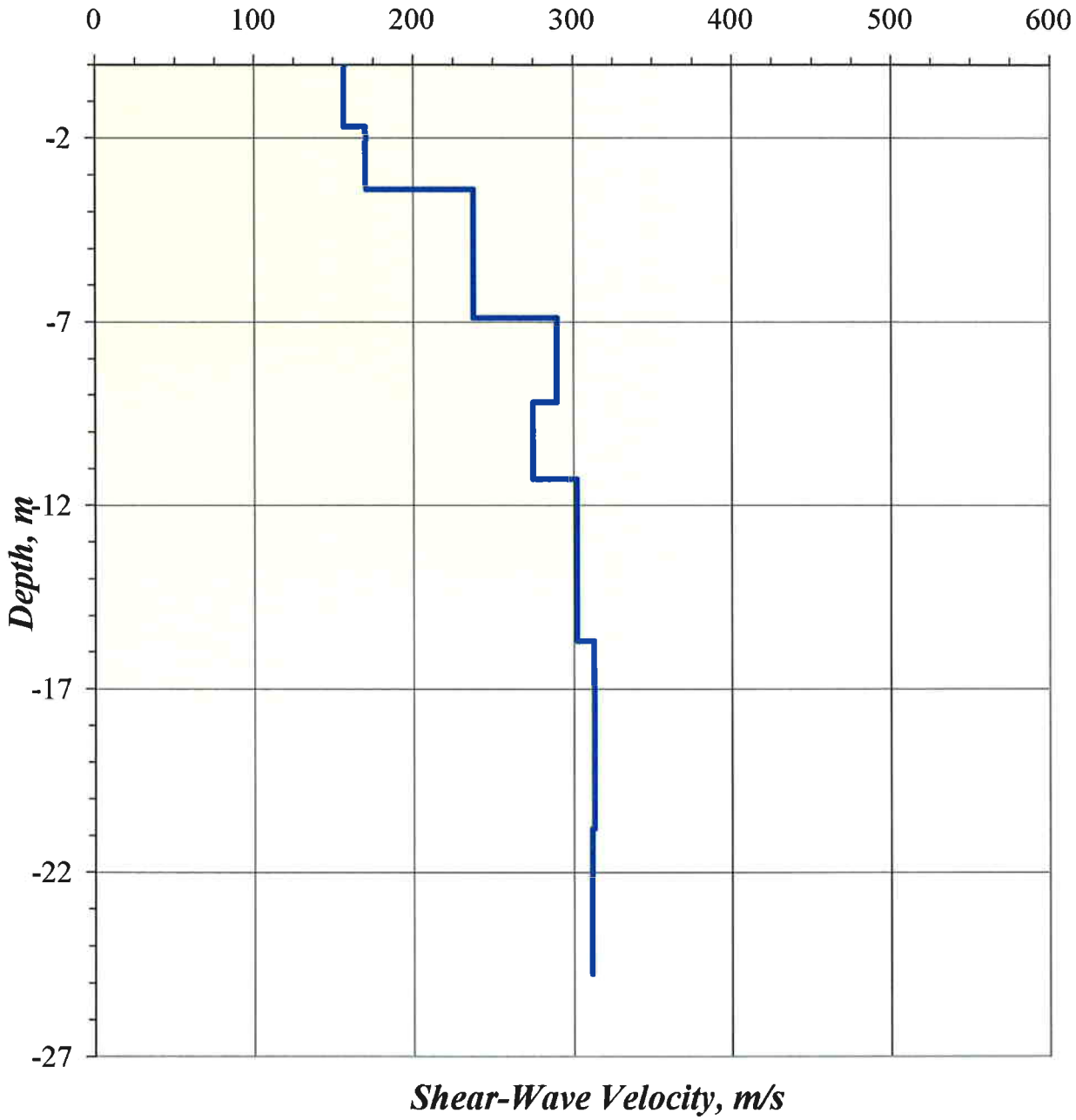
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 3 DISPERSION CURVE		
project no:	GEOPHERD00023AA	fig no: FIGURE B-3B	rev:

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



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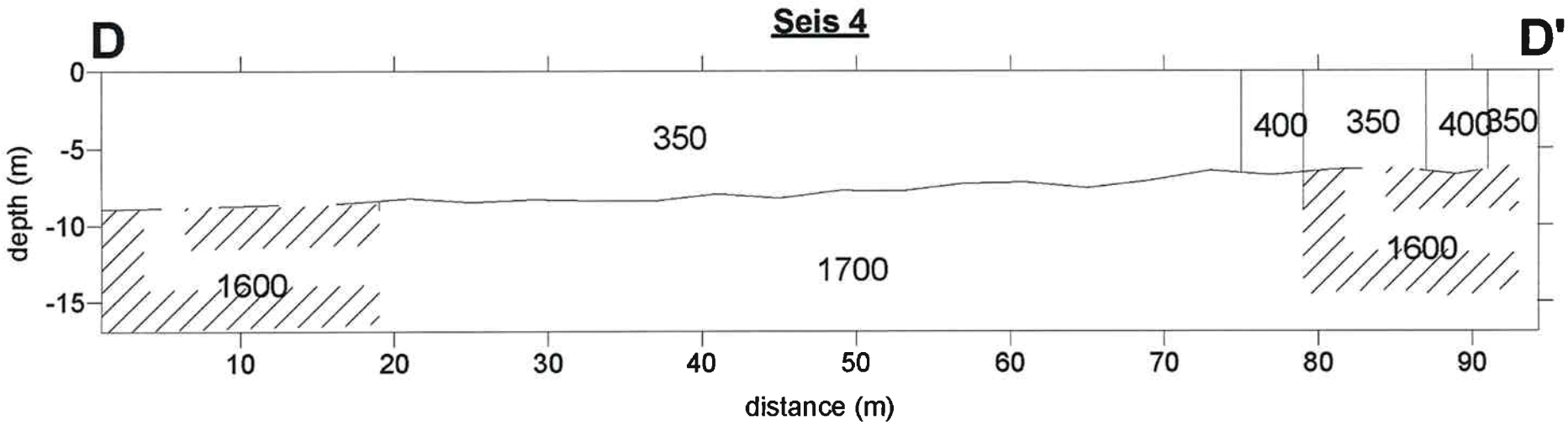
title:	REMI 3 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-3C	rev:



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original size	A3

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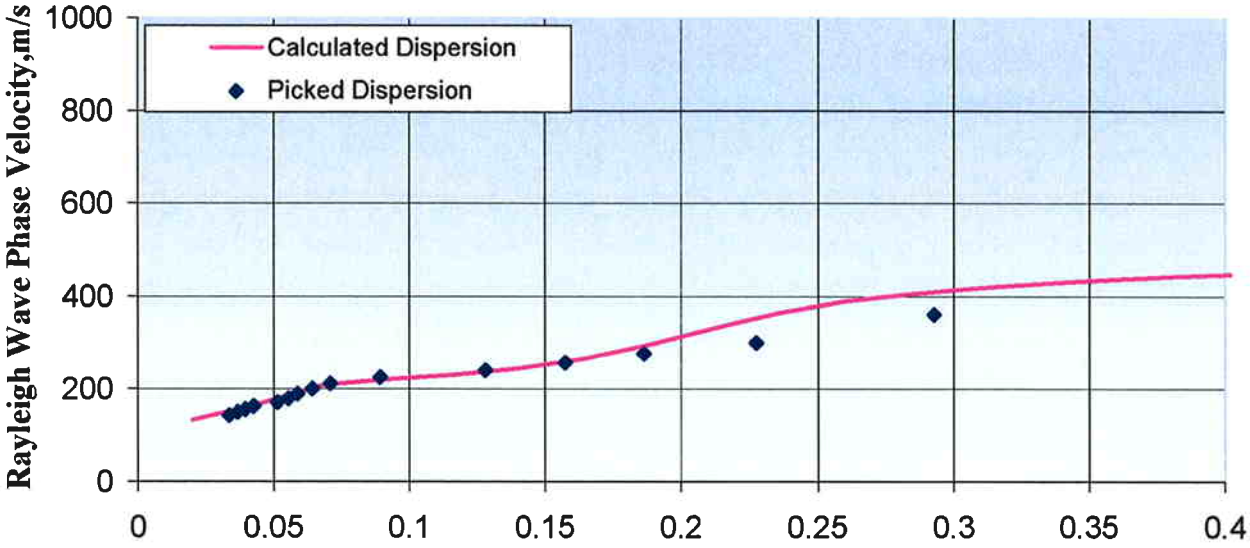
project: FIONA STANLEY HOSPITAL
MURDOCH DRIVE, MURDOCH

title: SECTION SEIS 4

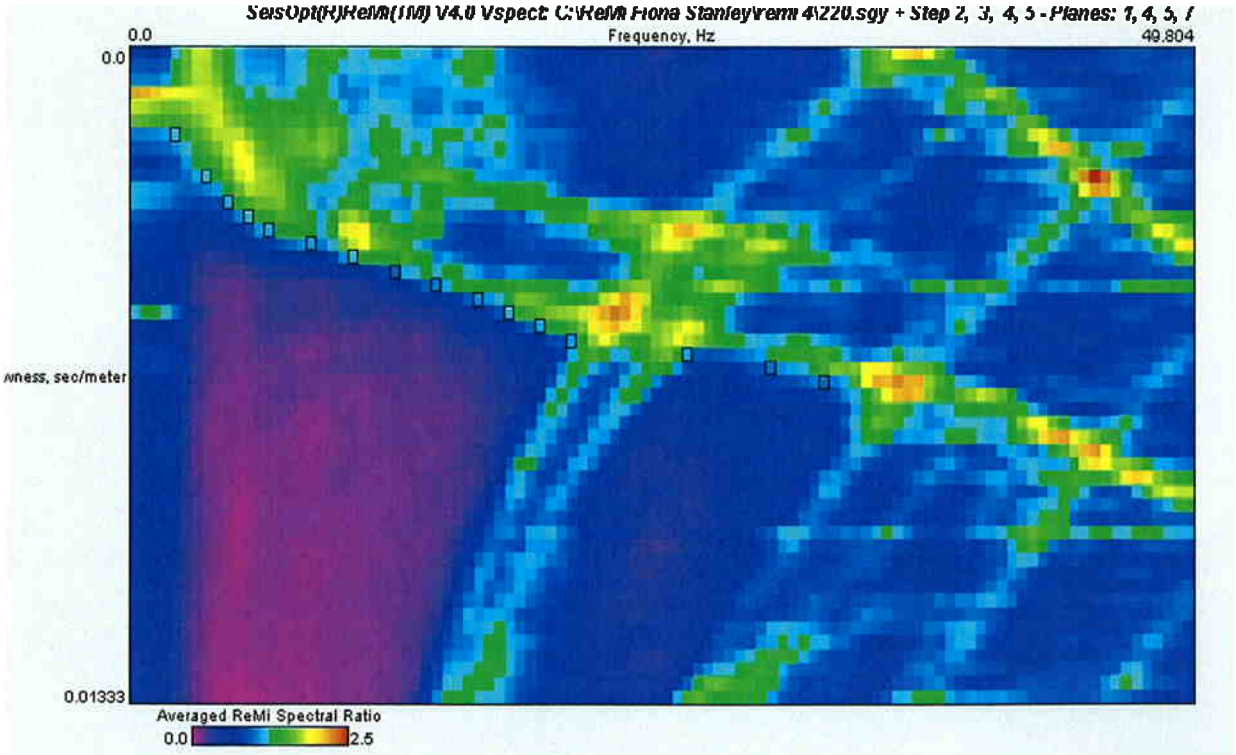
project no: GEOPHERD00023AA | fig no: FIGURE B-4A | rev:

ReMi 4

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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original size	A3

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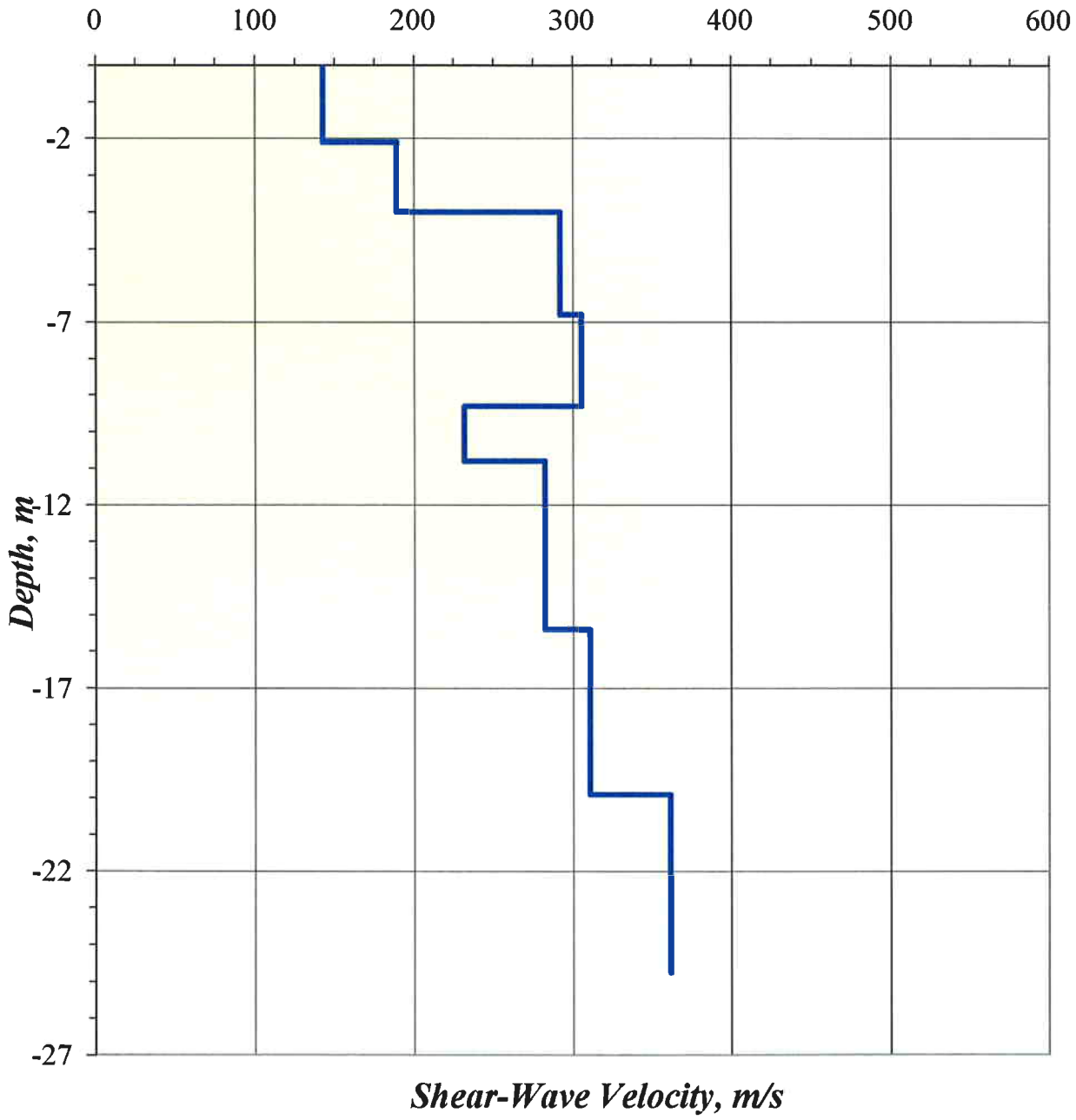
title:	REMI 4 DISPERSION CURVE		
project no:	GEOPHERD00023AA	fig no: FIGURE B-4B	rev:

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



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date	5/06/08
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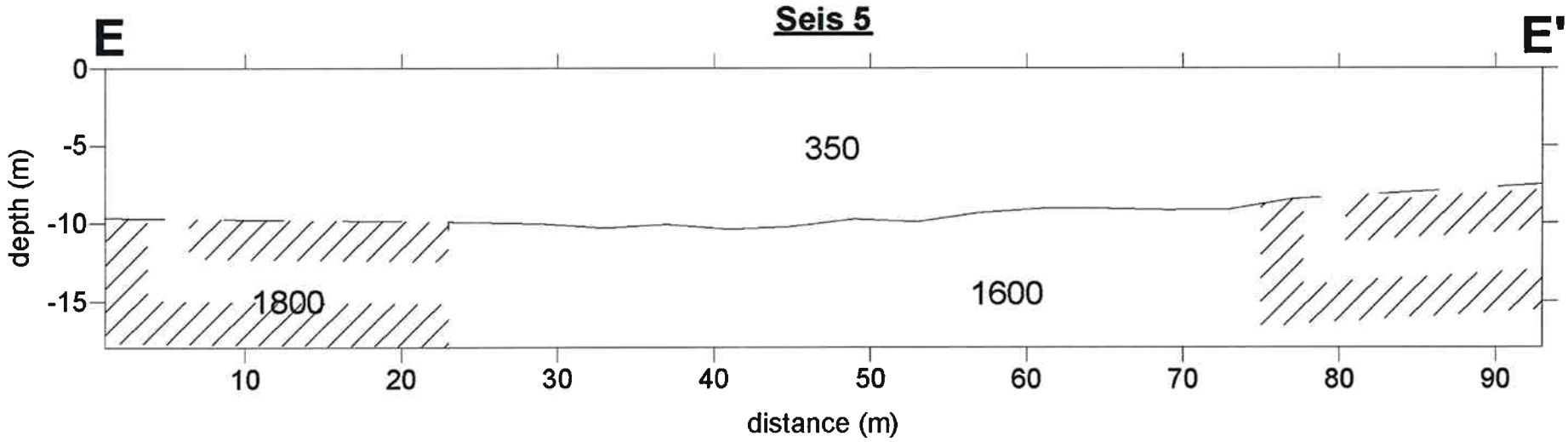
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 4 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-4C	rev:



P-wave Velocity (m/sec)

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date	5/06/08
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original size	A3

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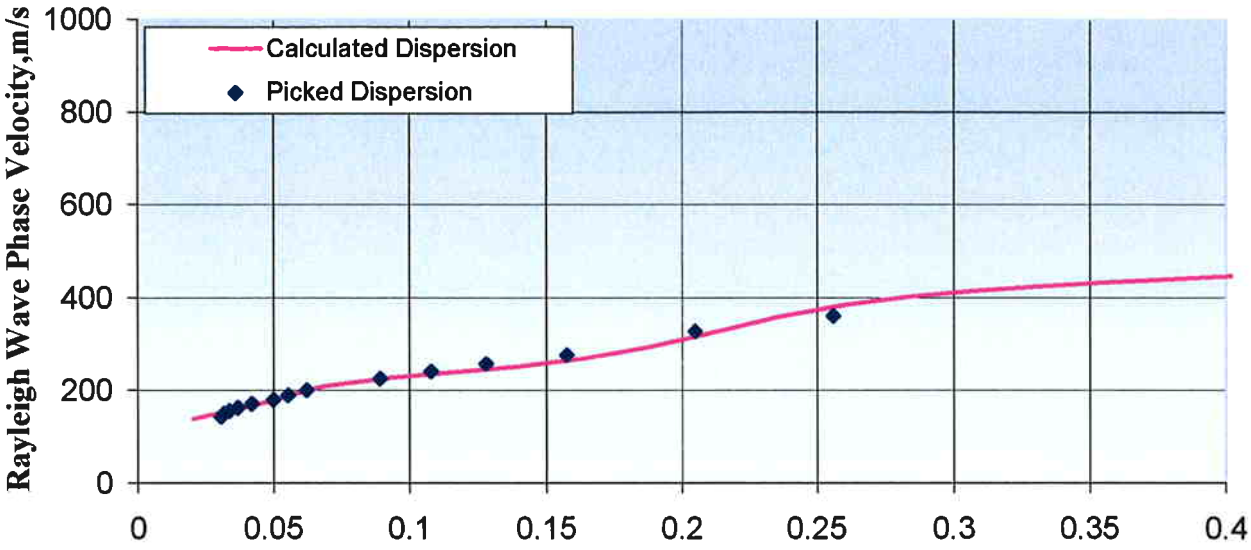
project: FIONA STANLEY HOSPITAL
MURDOCH DRIVE, MURDOCH

title: SECTION SEIS 5

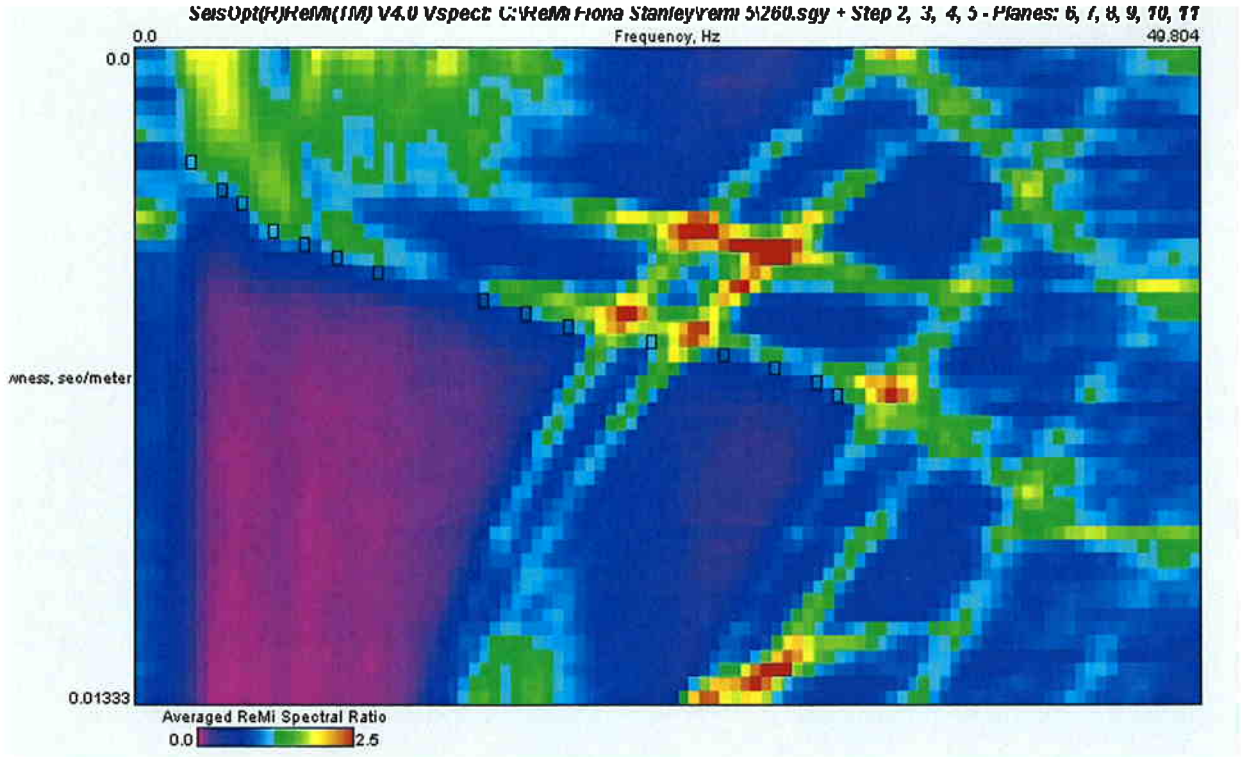
project no: GEOPHERD00023AA | fig no: FIGURE B-5A | rev:

ReMi 5

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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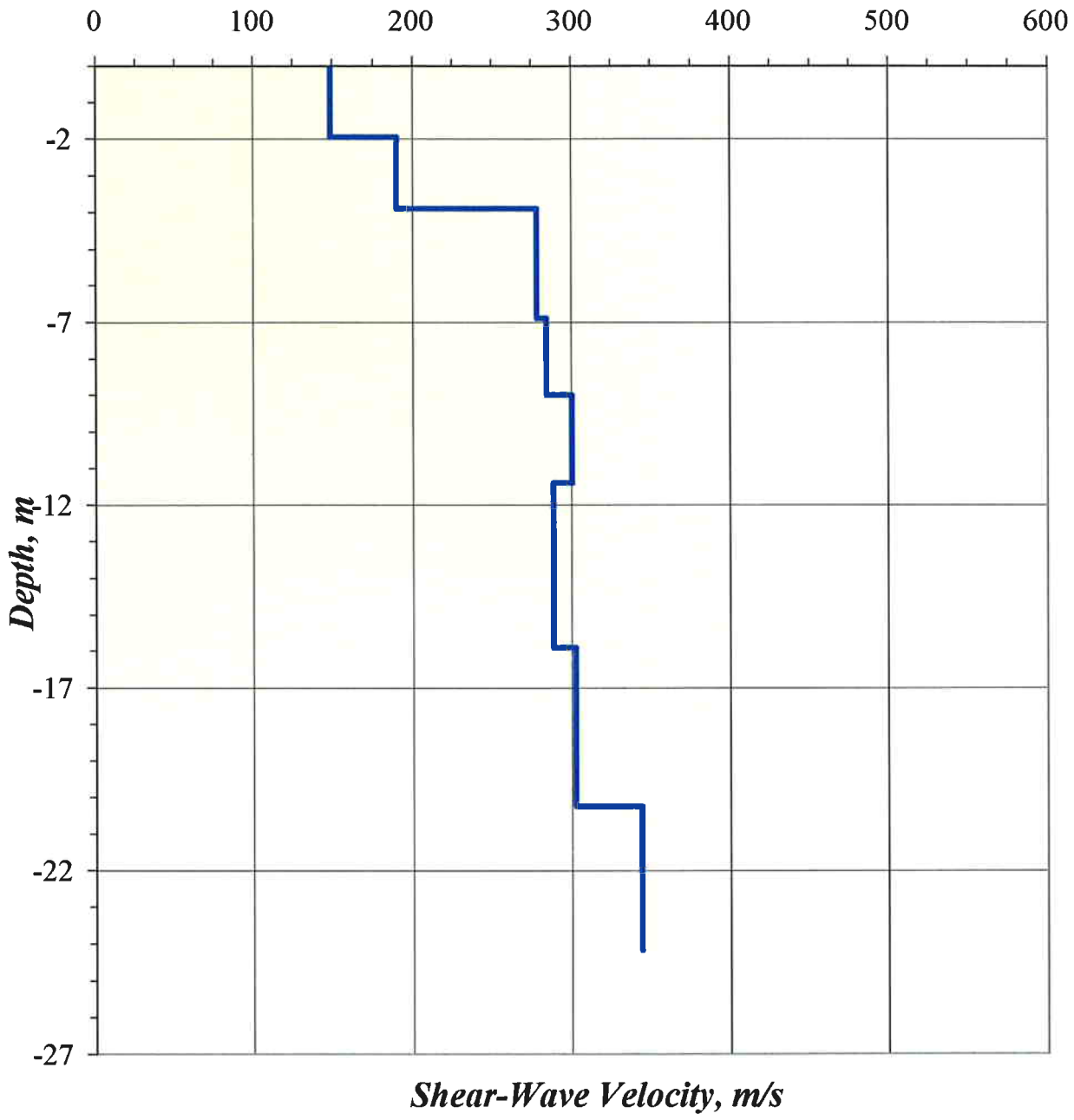
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 5 DISPERSION CURVE		
project no: GEOPHERD00023AA		fig no: FIGURE B-5B	rev:

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



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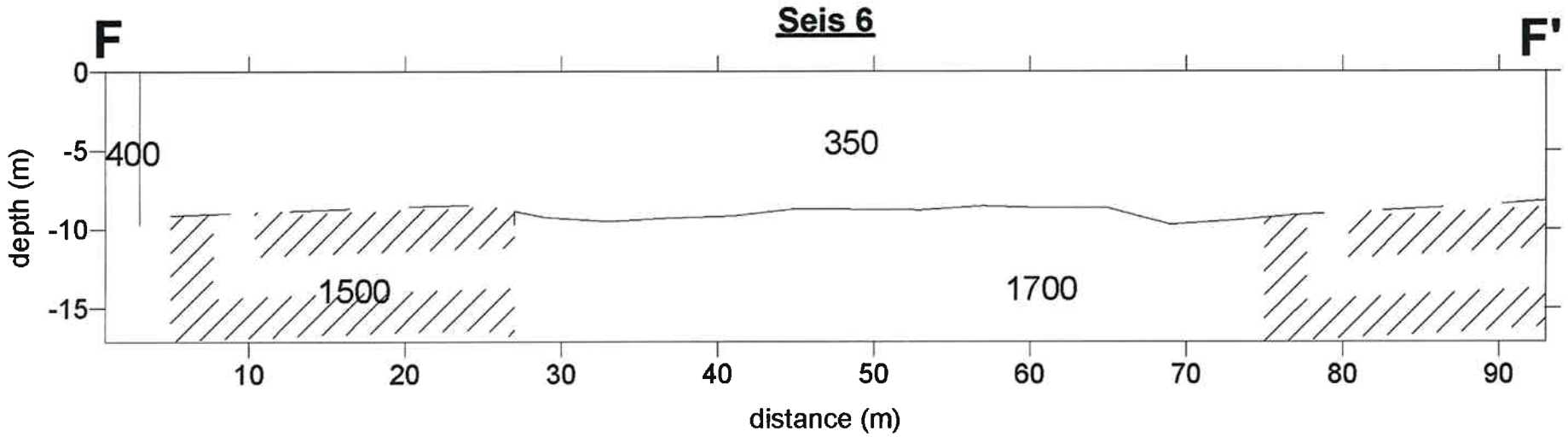
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 5 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-5C	rev:



P-wave Velocity (m/sec)

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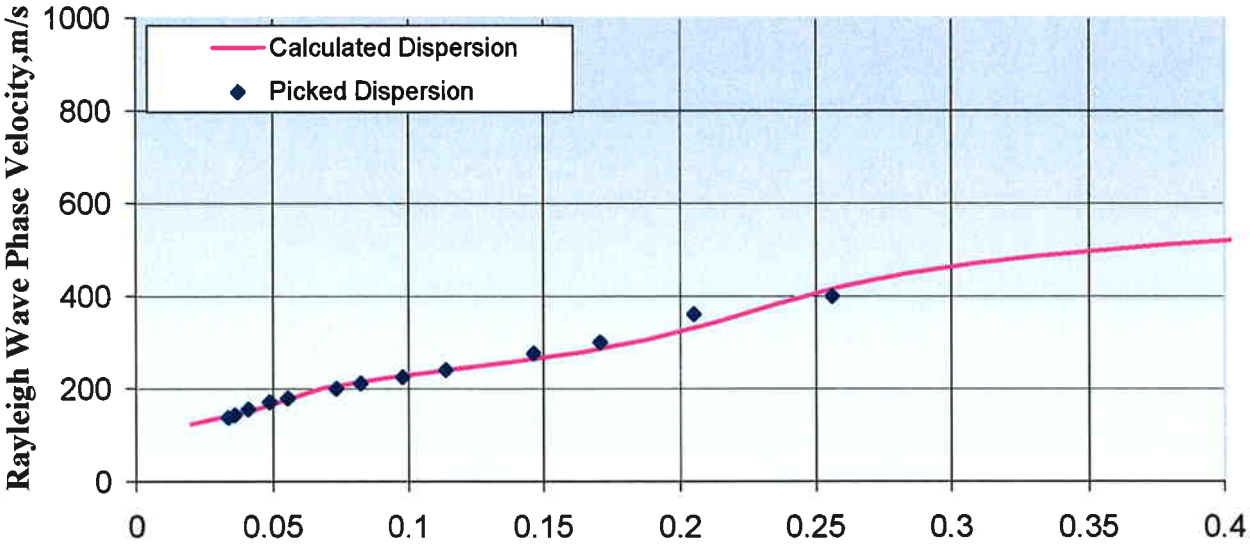
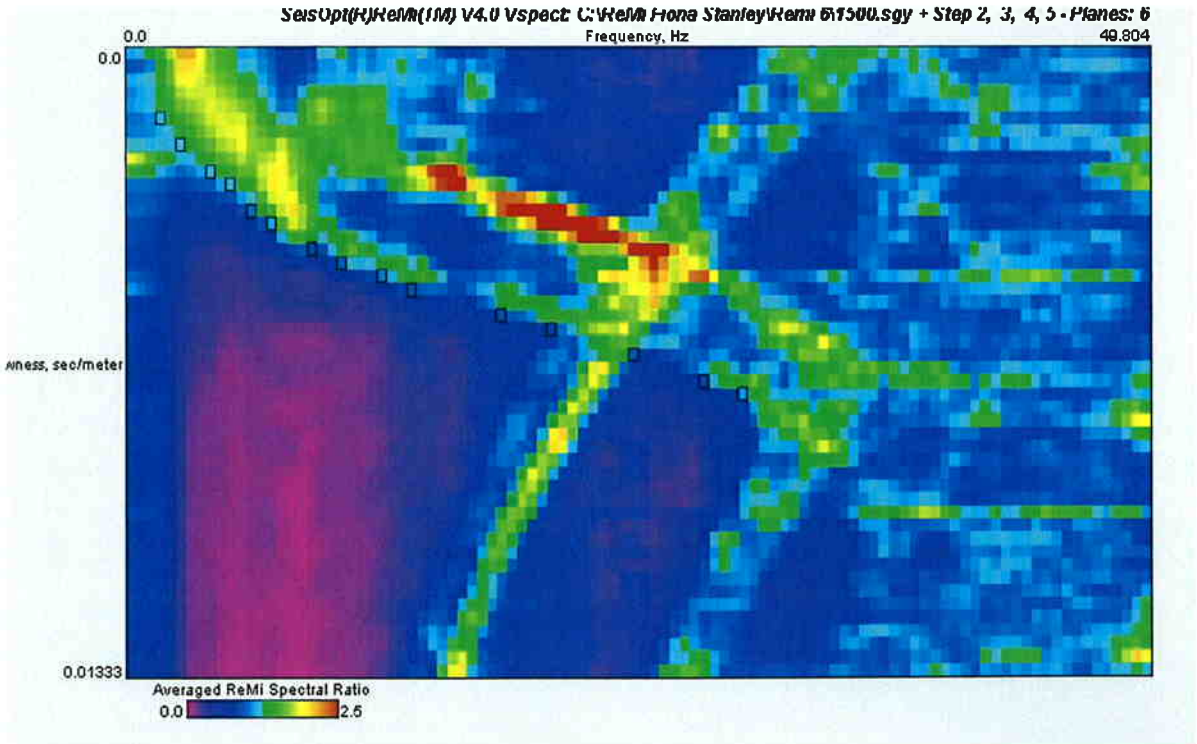
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 6		
project no: GEOPHERD00023AA		fig no: FIGURE B-6A	rev:

ReMi 6

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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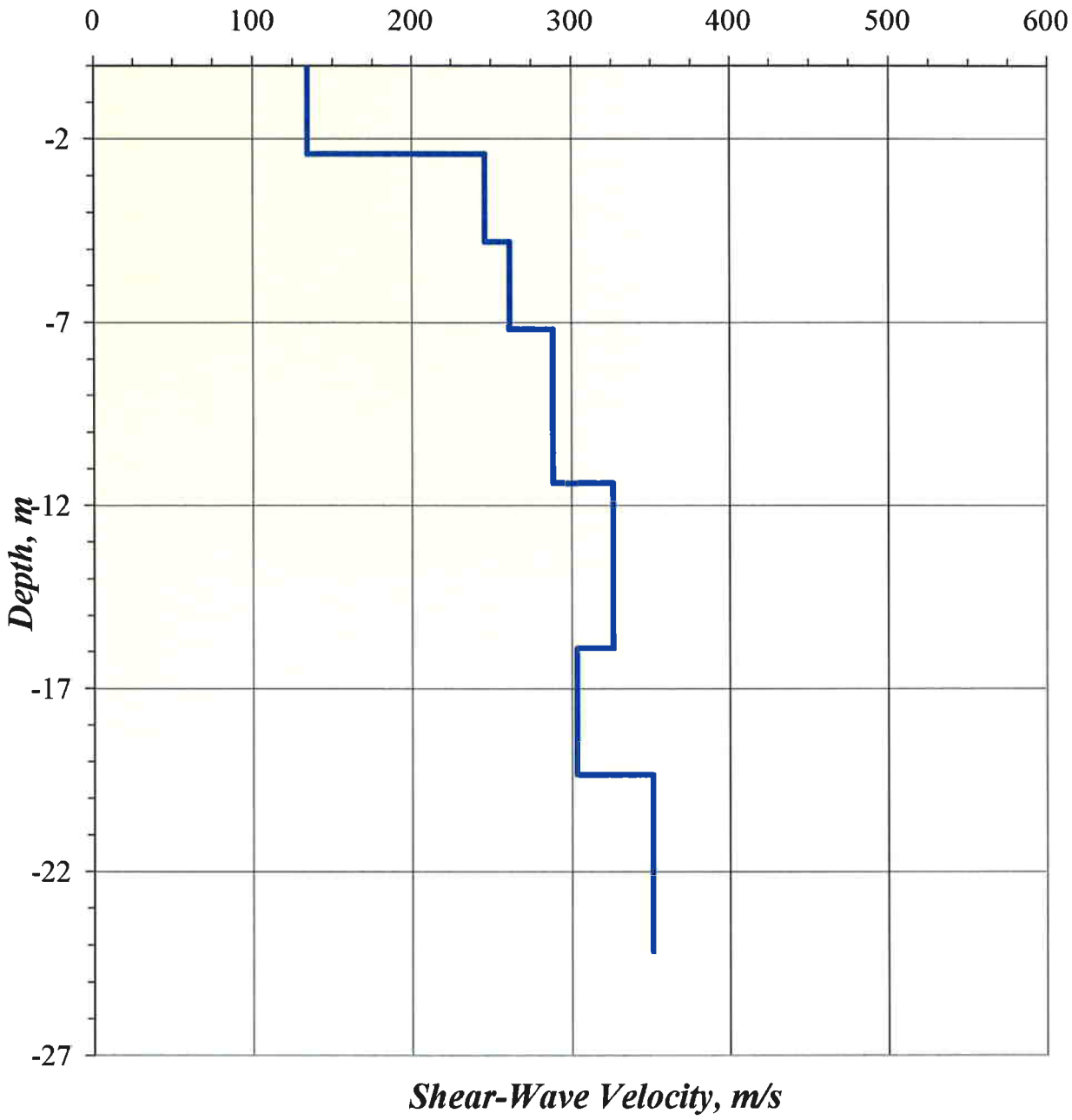
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 6 DISPERSION CURVE		
project no: GEOPHERD00023AA		fig no: FIGURE B-6B	rev:

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



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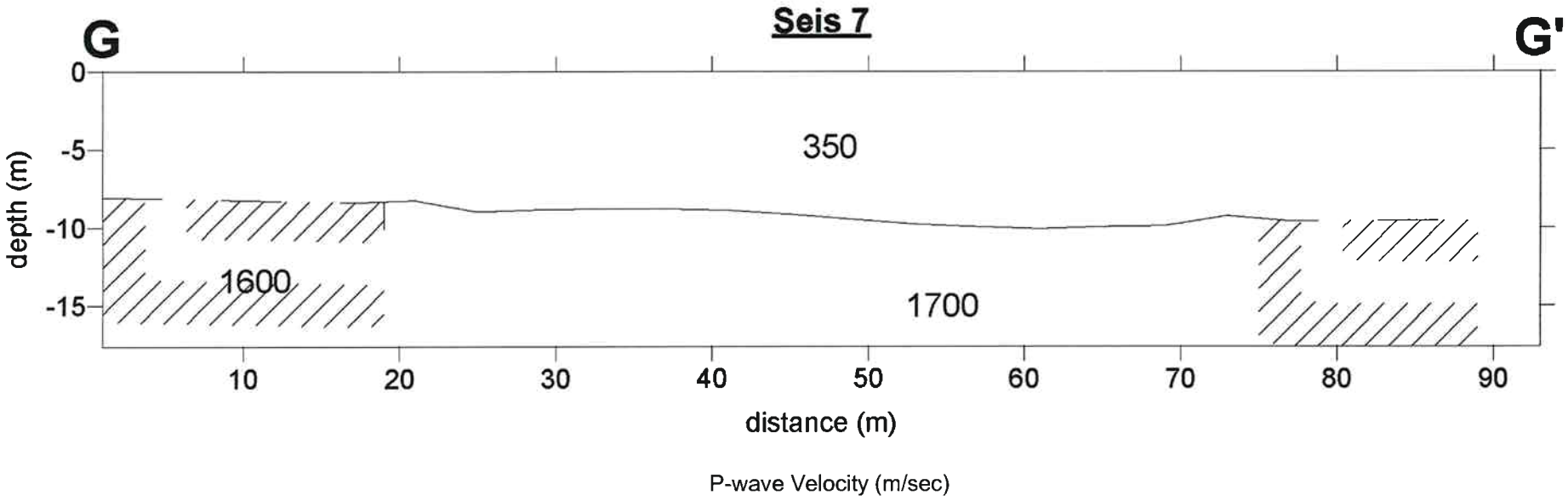
drawn	DAC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD	
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 6 MODEL	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-6C	rev:
original size	A3				



P-wave Velocity (m/sec)

REF:
DWG: F:\Geophysics\PHERD00000\GEOPHERD00023AA - Fiona Stanley Hospital\DWG\GP000023AA-FIGURES-SEIS-revA.dwg

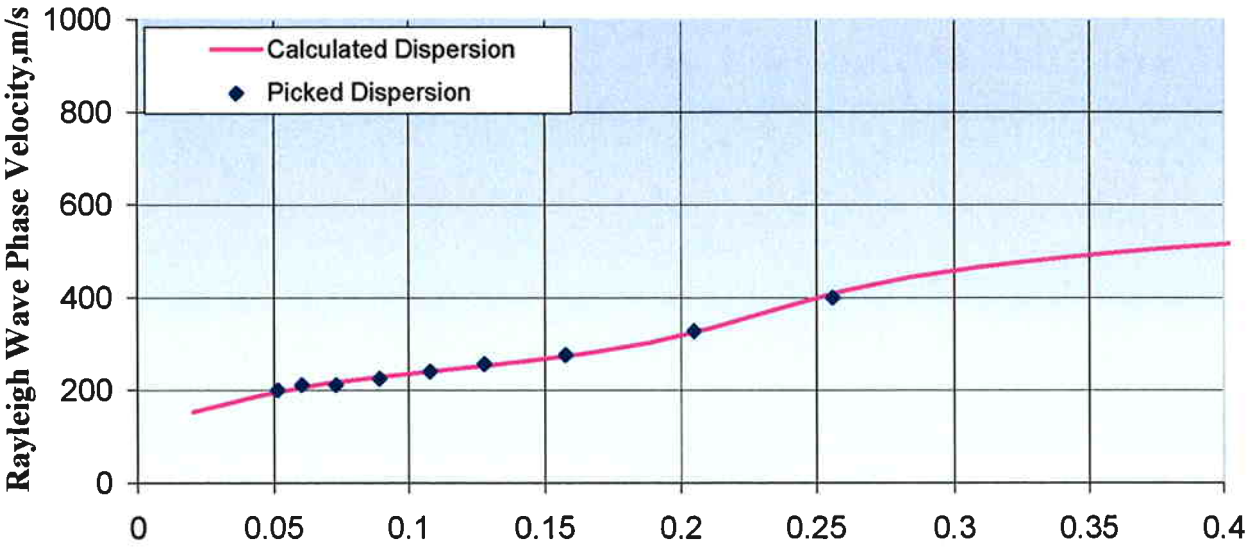
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

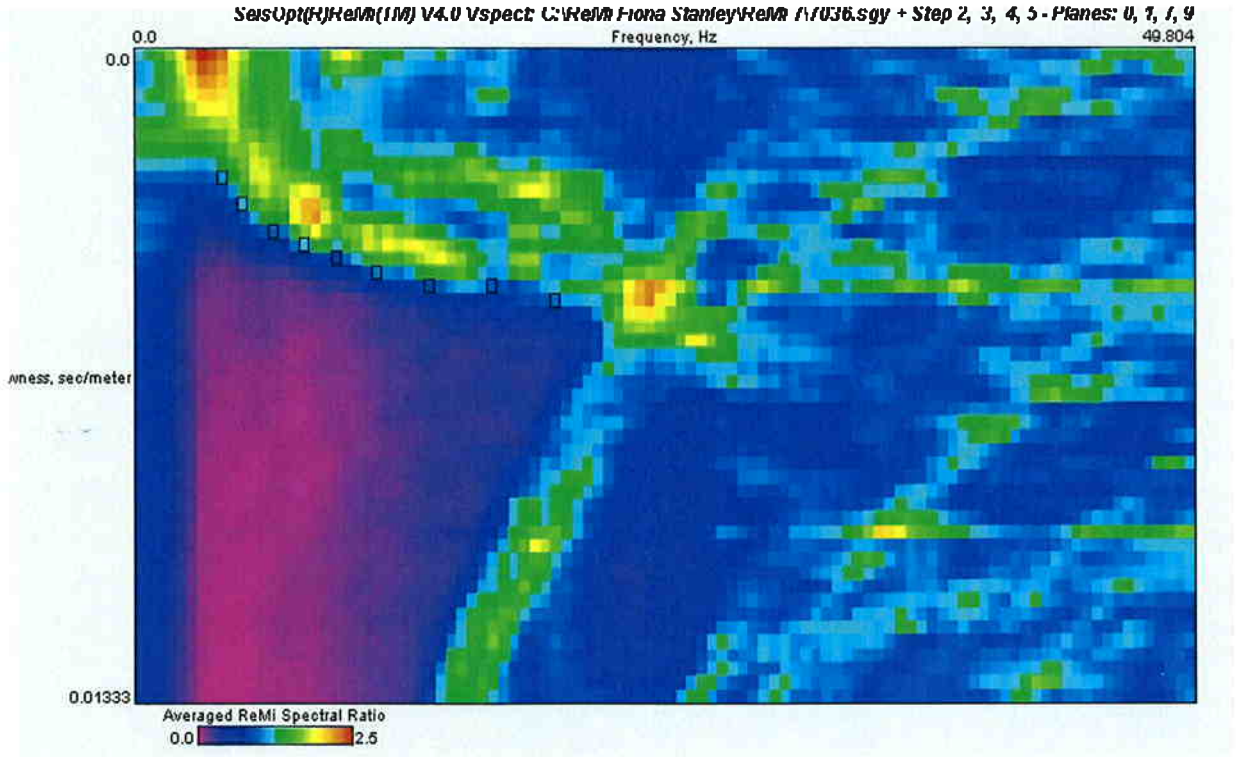
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 7		
project no: GEOPHERD00023AA		fig no: FIGURE B-7A	rev:

ReMi 7

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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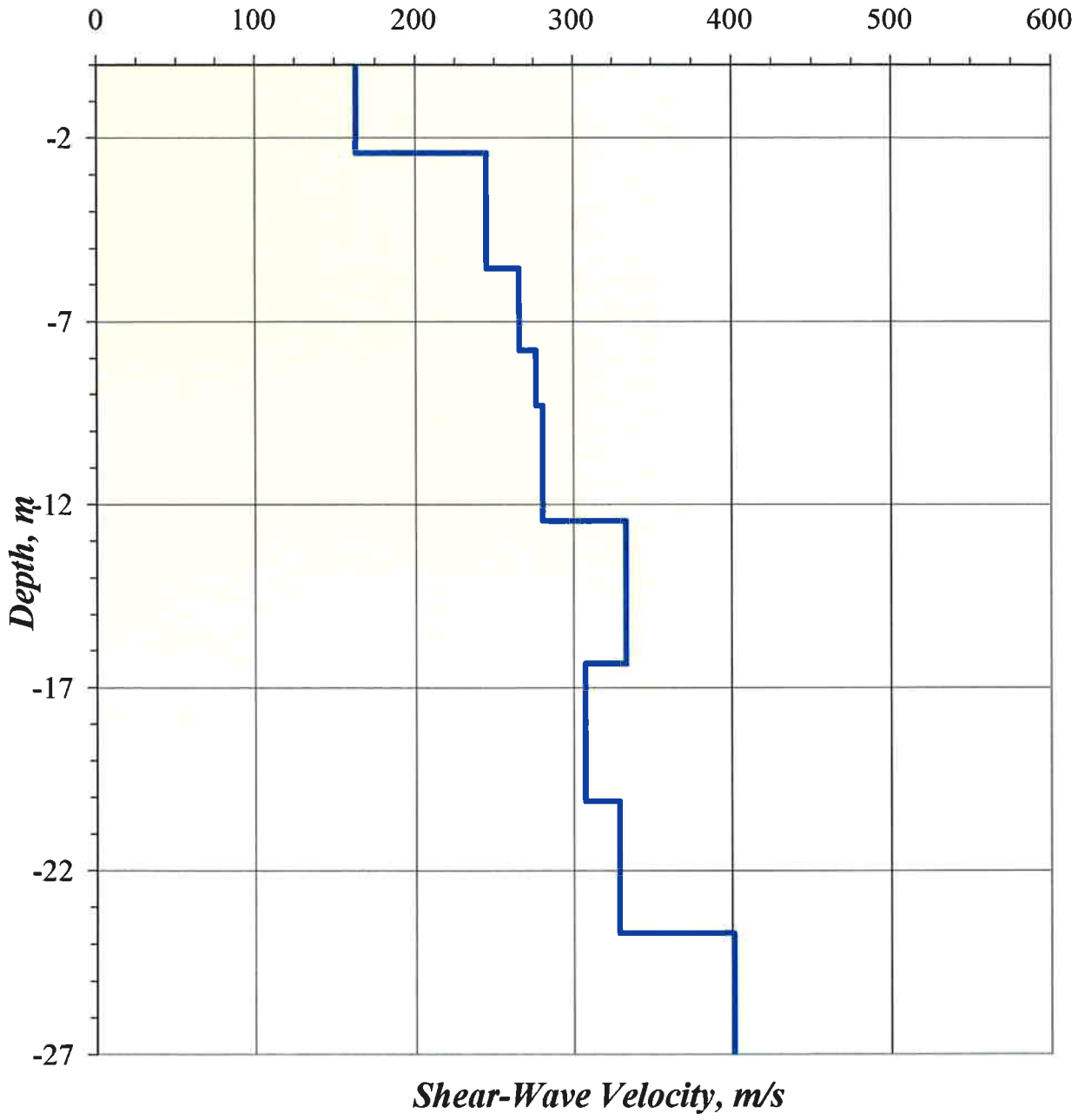
drawn	DAC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD	
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 7 DISPERSION CURVE	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-7B	rev:
original size	A3				

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



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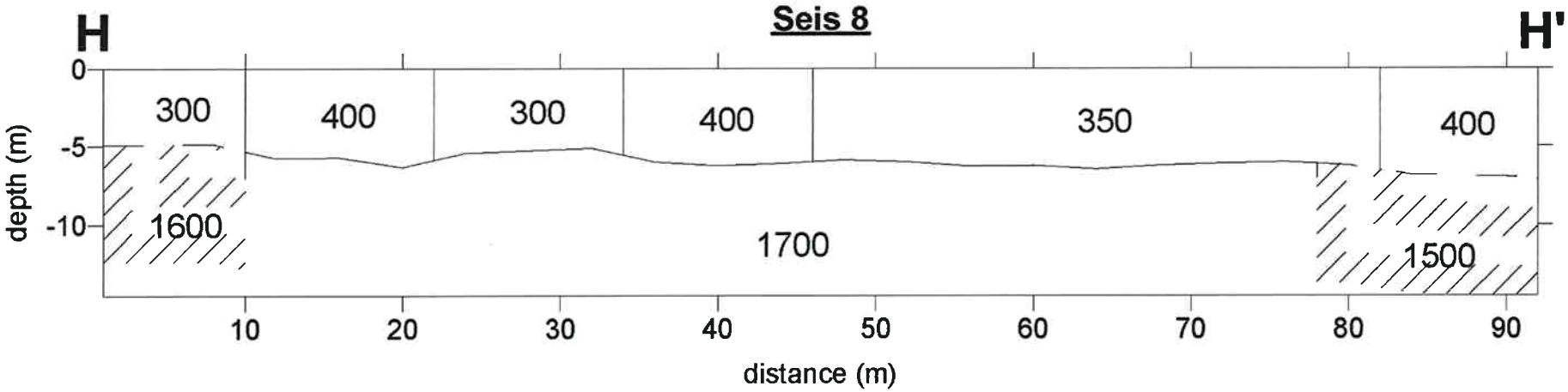
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 7 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-7C	rev:



P-wave Velocity (m/sec)

REF:
DWG: F:\Geophysics\PHERD00000\GEOPHERD00023AA - Fiona Stanley Hospital\DWG\GP000023AA-FIGURES-SEIS-revA.dwg

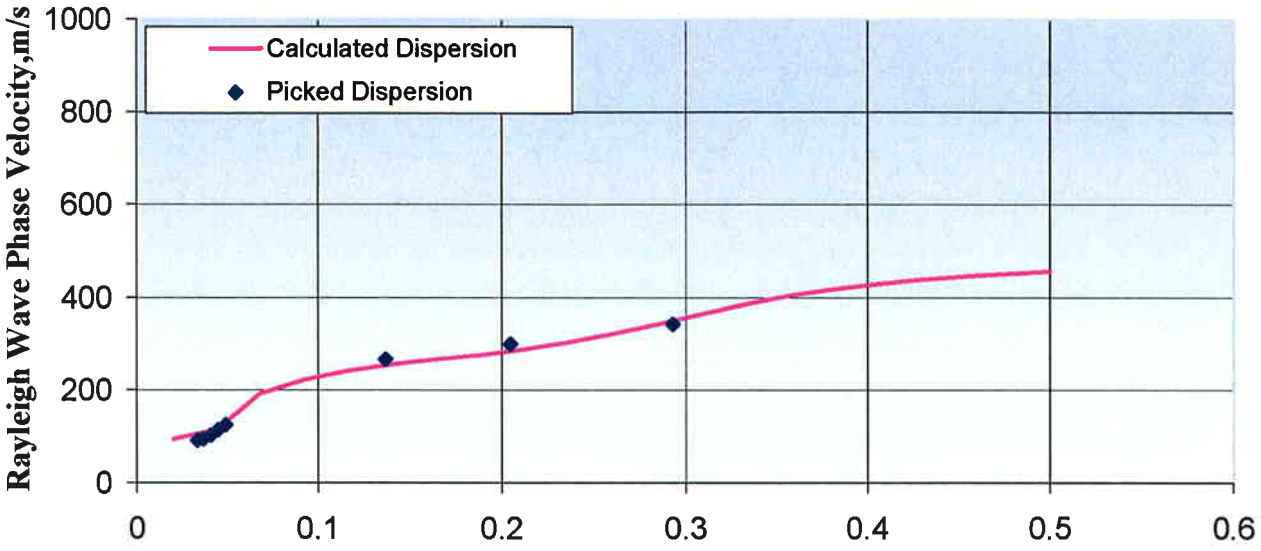
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

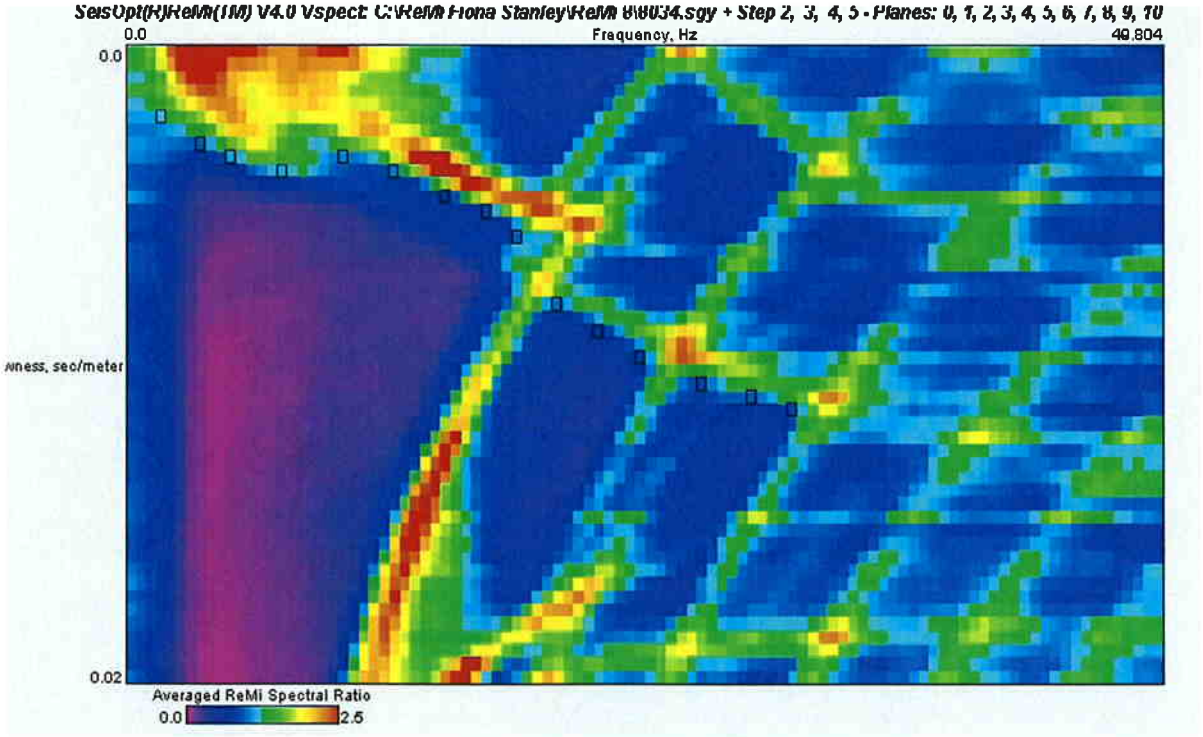
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 8		
project no: GEOPHERD00023AA		fig no: FIGURE B-8A	rev:

ReMi 8

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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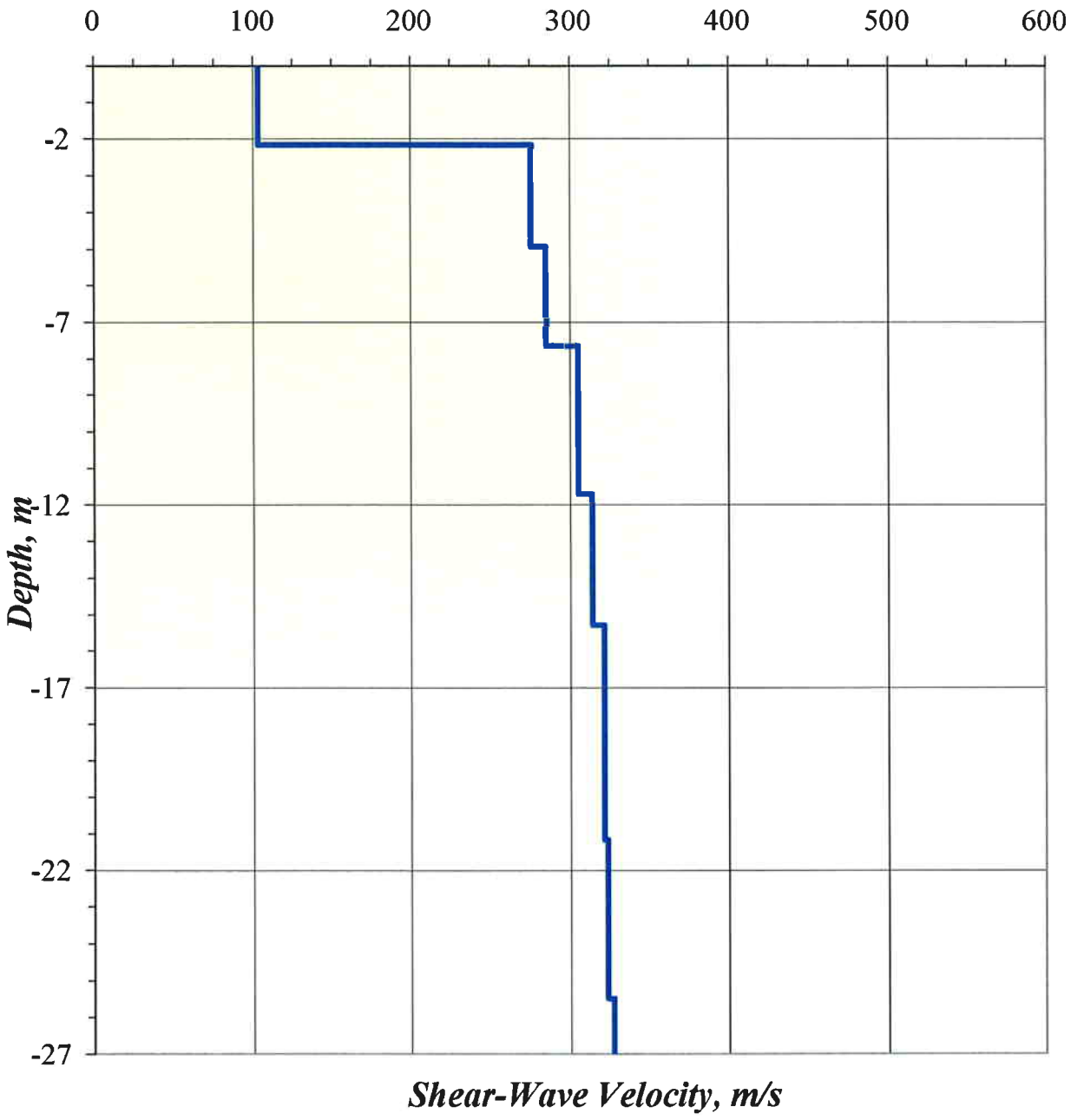
drawn	DAC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD	
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 8 DISPERSION CURVE	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-8B	rev:
original size	A3				

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



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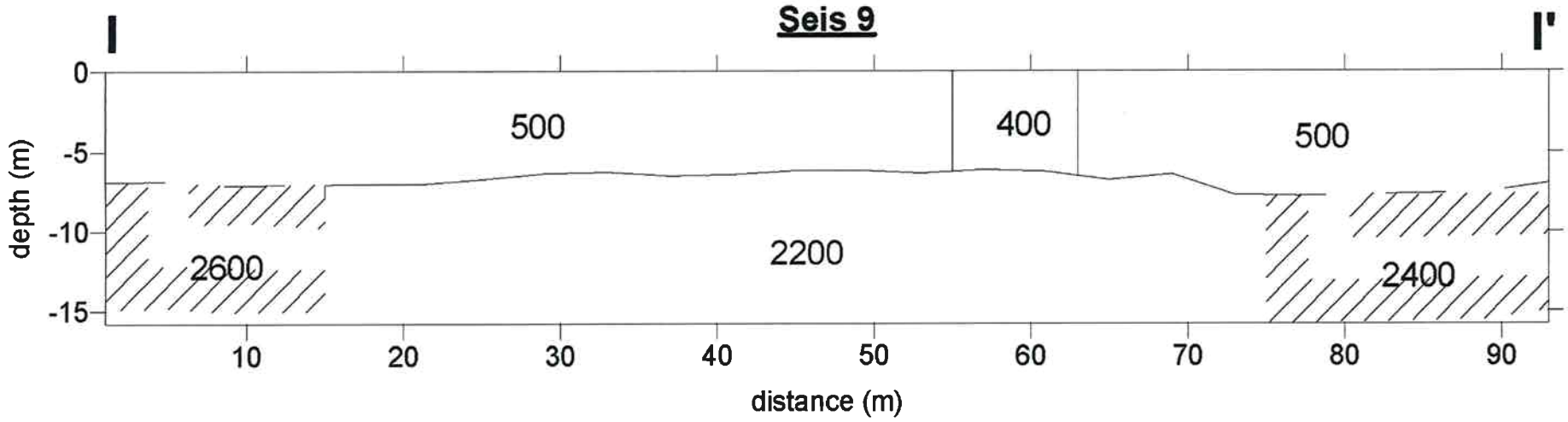
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 8 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-8C	rev:



P-wave Velocity (m/sec)

REF:
DWG: F:\Geophysics\PHERD00000\GEOPHERD00023AA - Fiona Stanley Hospital\DWG\GP000023AA-FIGURES-SEIS-revA.dwg

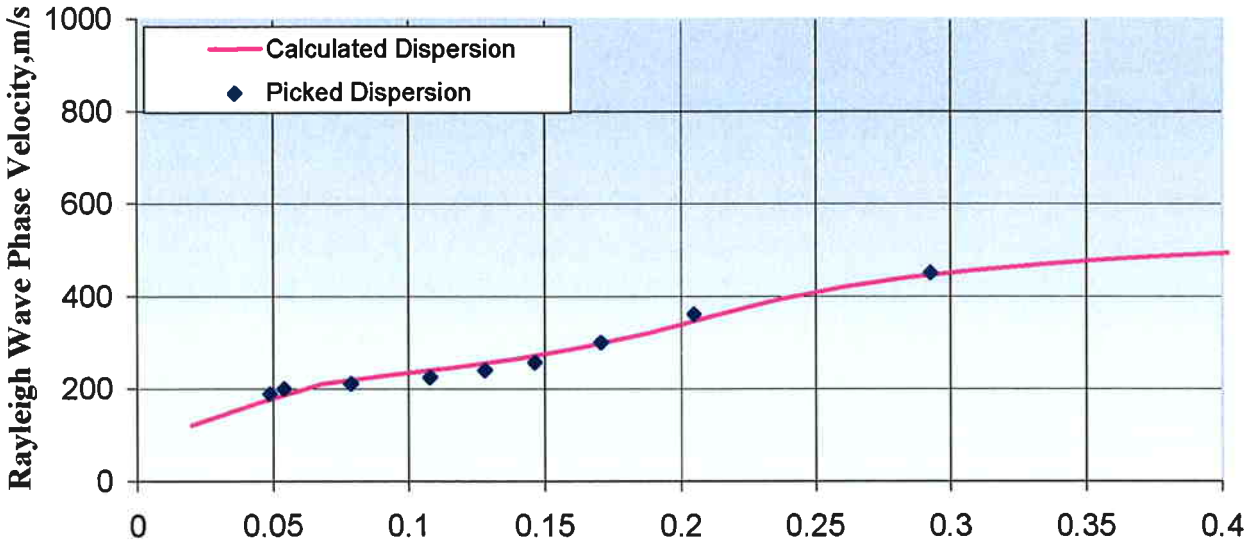
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

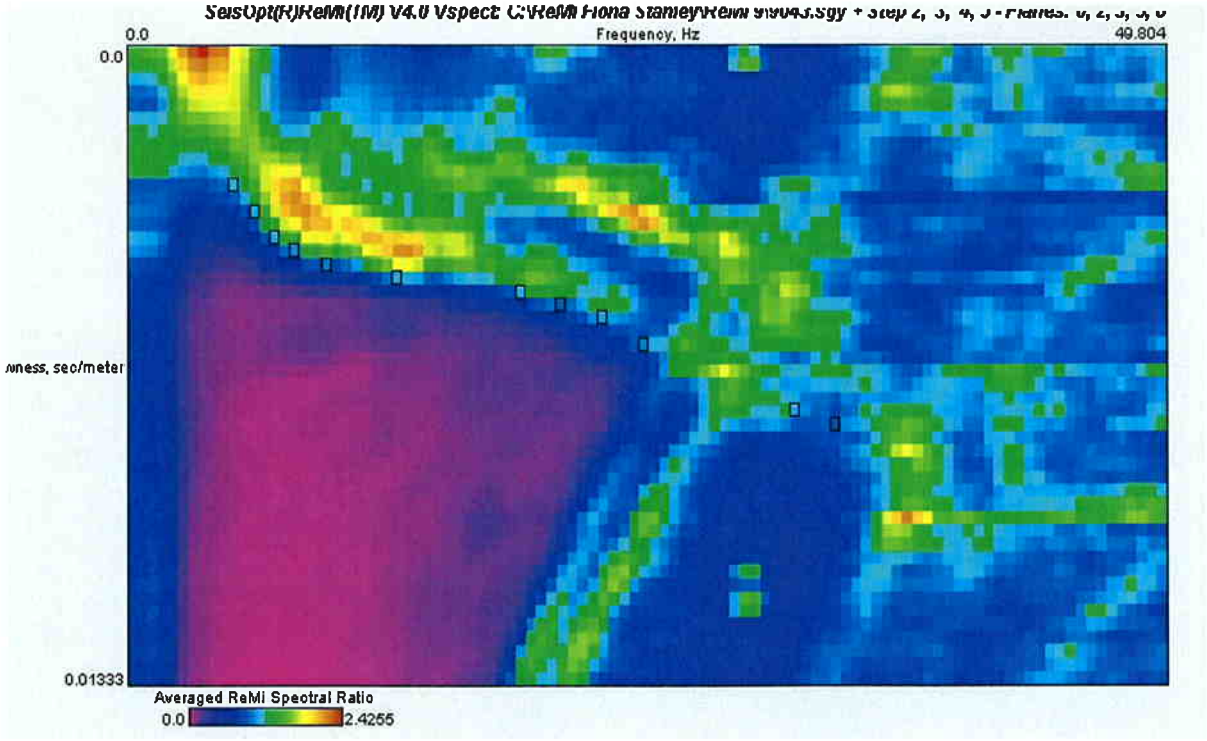
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 9		
project no: GEOPHERD00023AA		fig no: FIGURE B-9A	rev:

ReMi 9

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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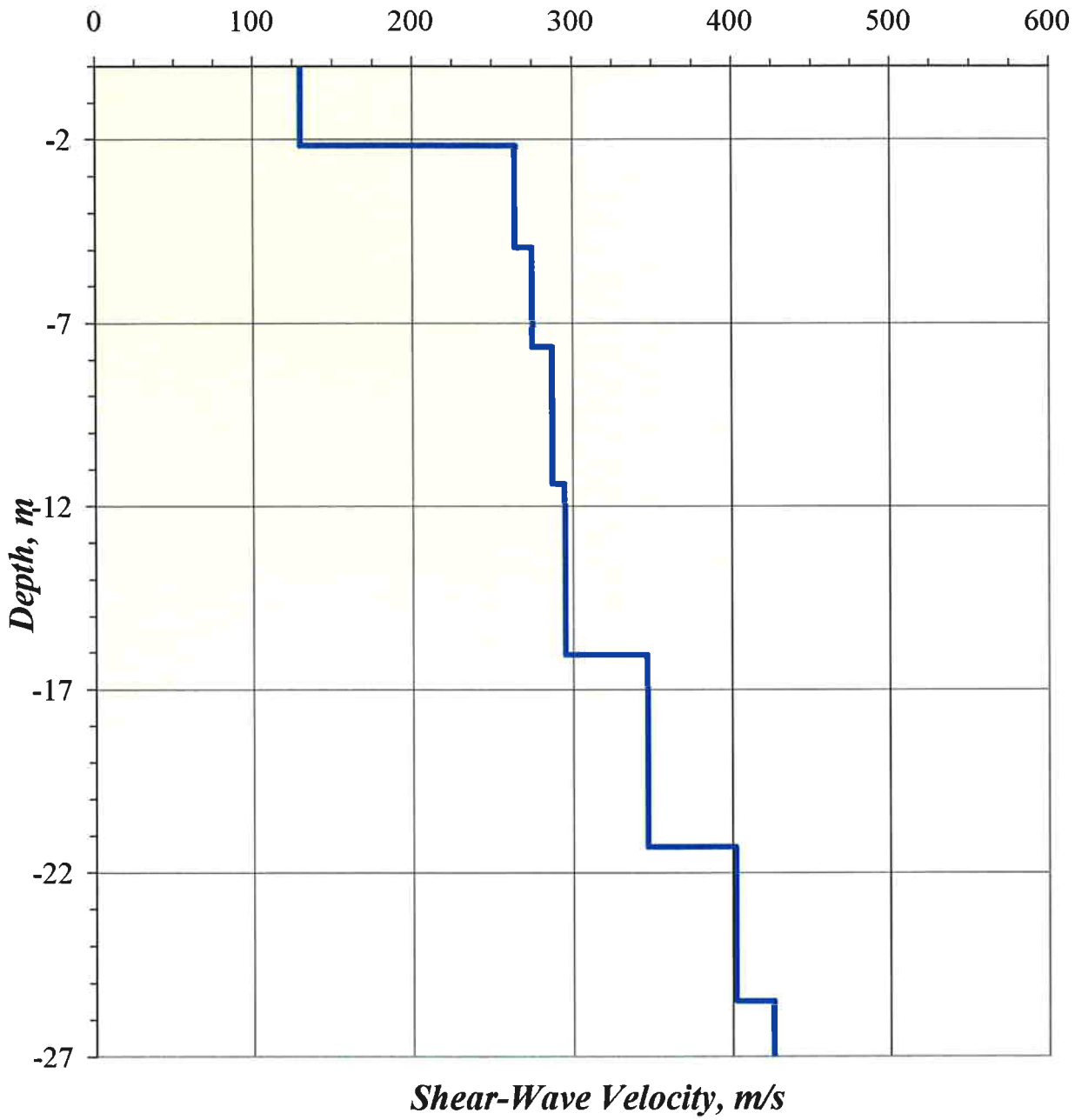
drawn	DAC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD	
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 9 DISPERSION CURVE	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-9B	rev:
original size	A3				

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



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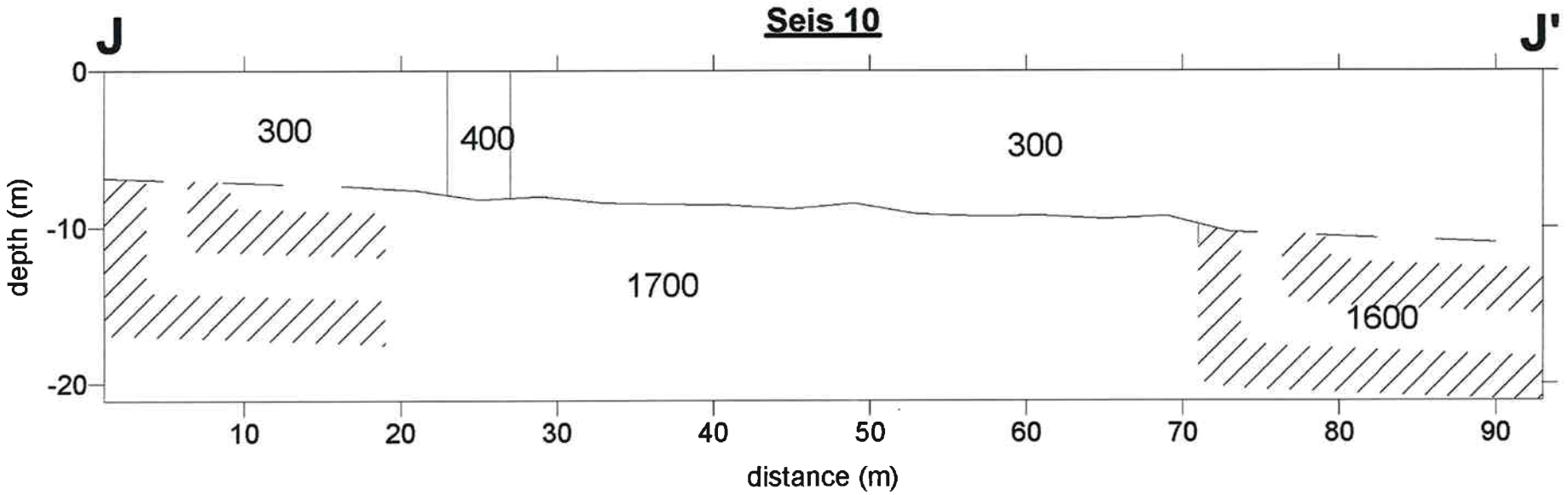
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	REMI 9 MODEL		
project no:	GEOPHERD00023AA	fig no: FIGURE B-9C	rev:



P-wave Velocity (m/sec)

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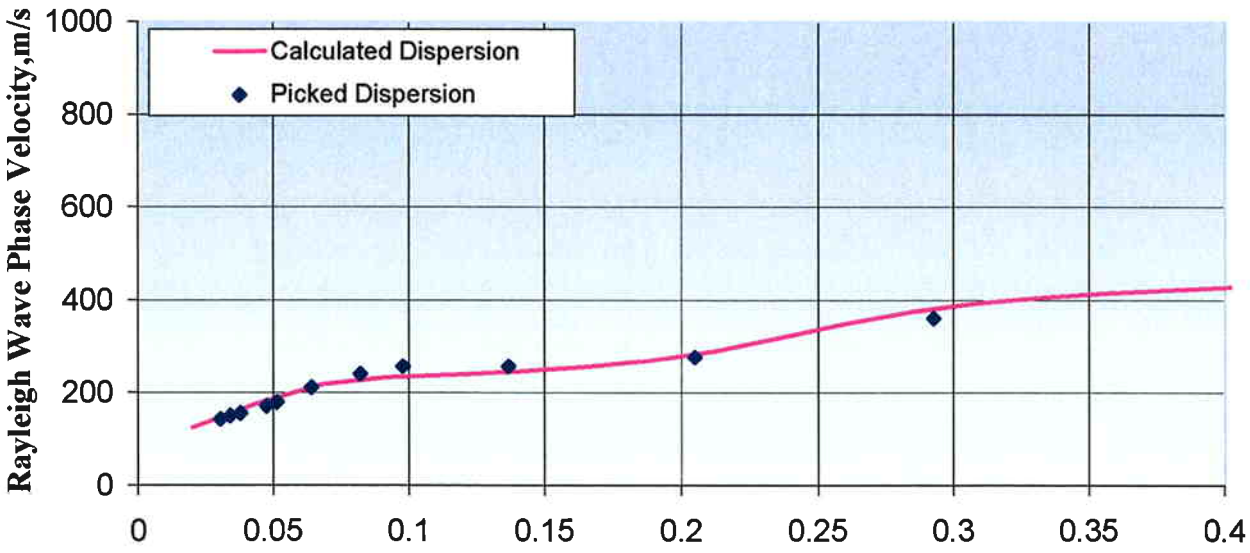
drawn	DAC
approved	
date	5/06/08
scale	
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

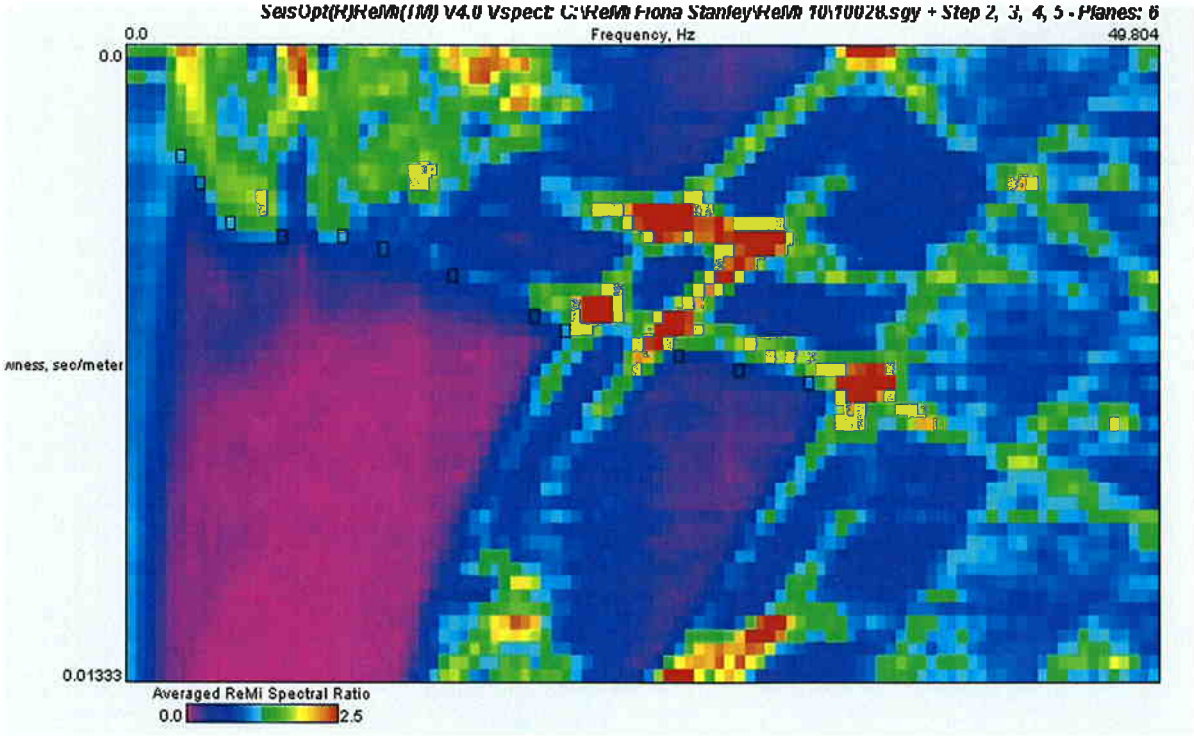
client:	BG & E PTY LTD		
project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH		
title:	SECTION SEIS 10		
project no: GEOPHERD00023AA		fig no: FIGURE B-10A	rev:

ReMi 10

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



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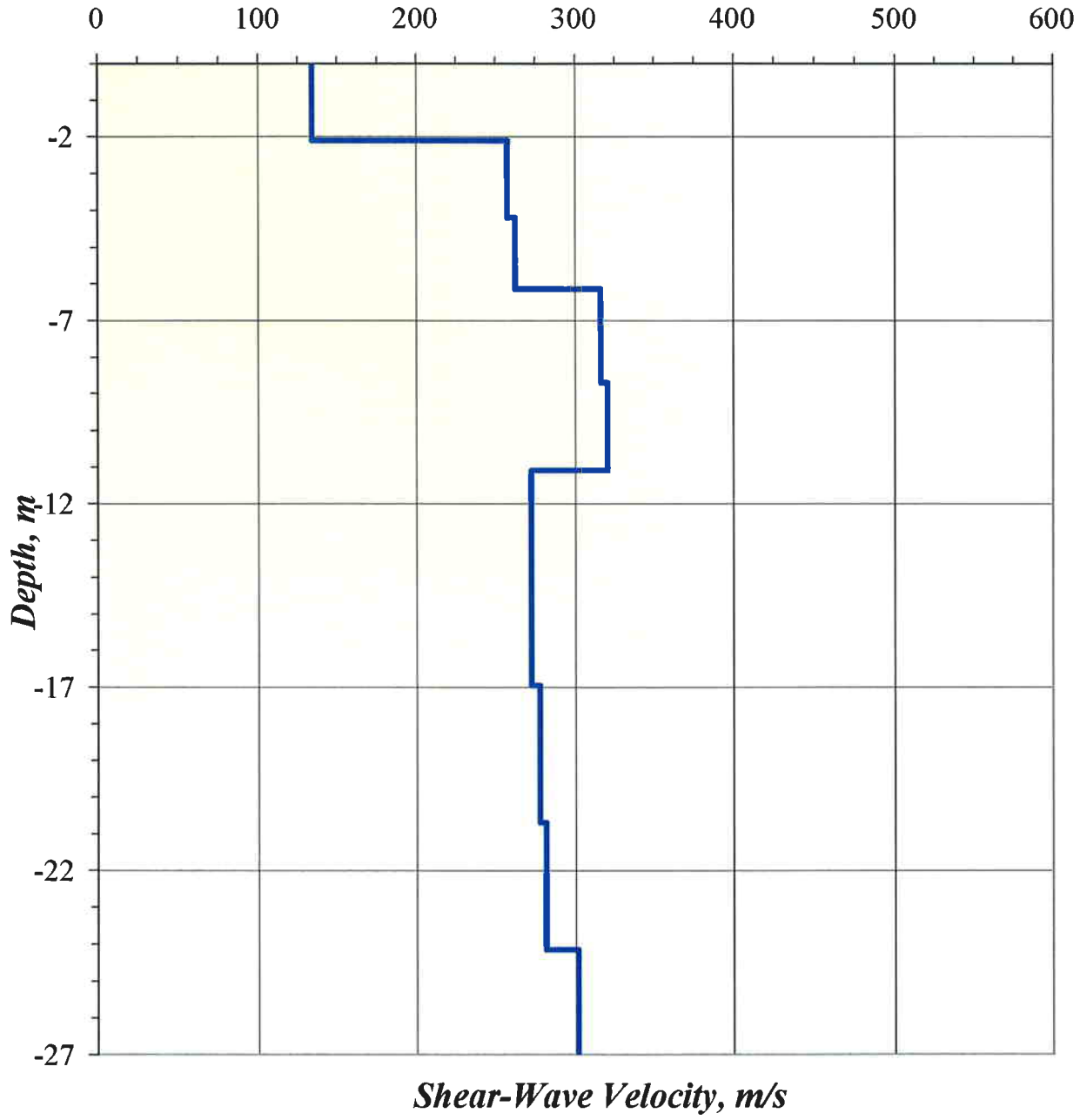
drawn	DAC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	BG & E PTY LTD	
approved			project:	FIONA STANLEY HOSPITAL MURDOCH DRIVE, MURDOCH	
date	5/06/08		title:	REMI 10 DISPERSION CURVE	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-10B	rev:
original size	A3				

ReMi 10
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 10 MODEL	
scale			project no: GEOPHERD00023AA	fig no: FIGURE B-10C	rev:
original size	A3				

Appendix F

Laboratory Test Data

FIONA STANLEY HOSPITAL – GEOTECHNICAL LABORATORY TEST RESULTS

Sample	Depth (m)	Fines %	MDD (t/m^3)	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			

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24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

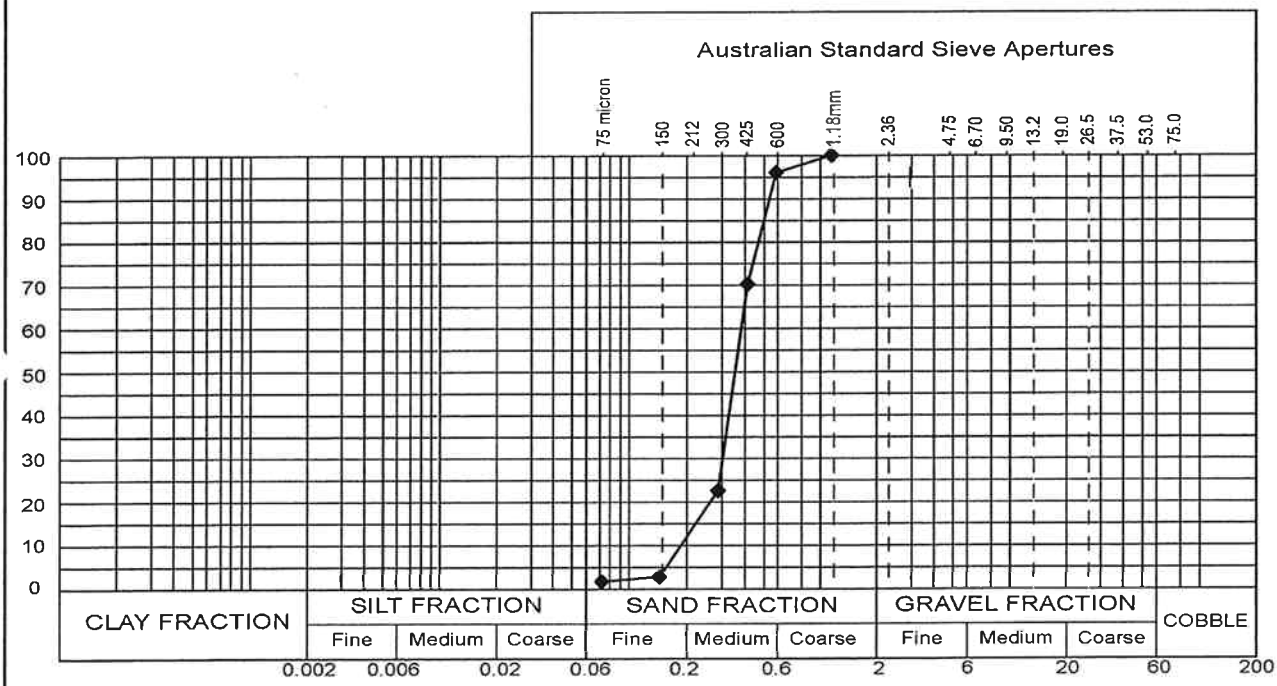
TEST CERTIFICATE

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

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Approved Signatory: B. Truslove
B Truslove
Date: 22/05/2008
NATA Acc. Laboratory No 431

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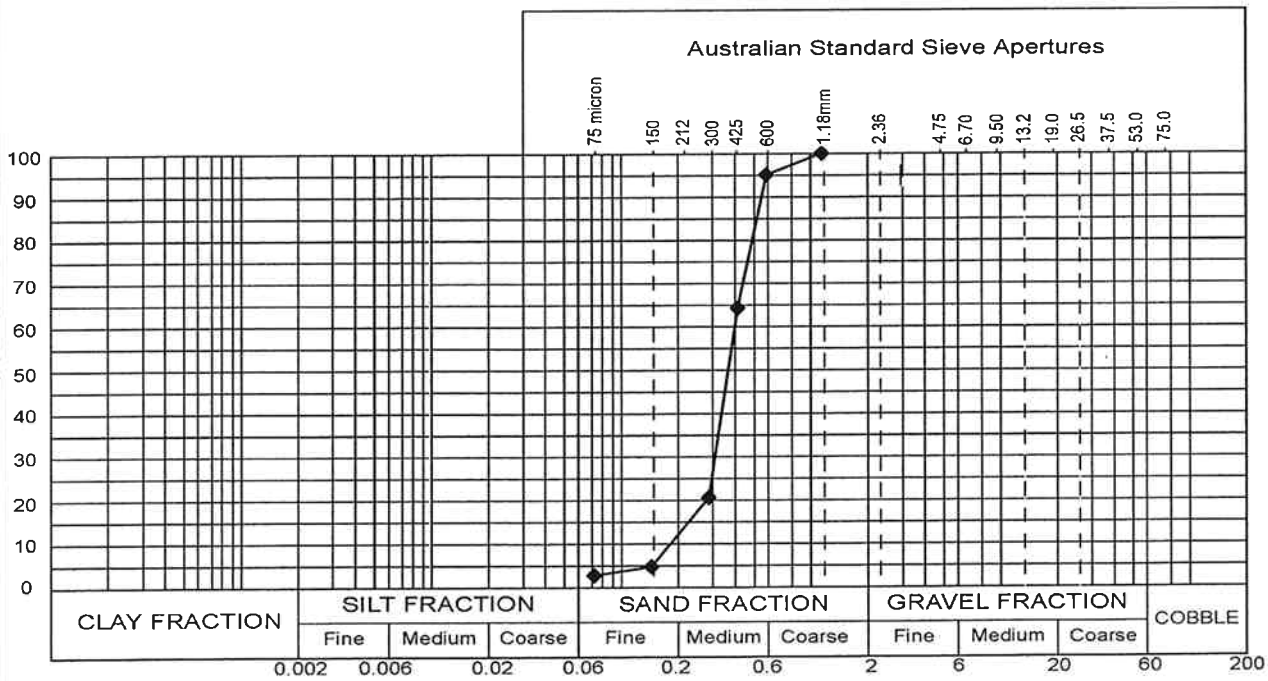
TEST CERTIFICATE

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

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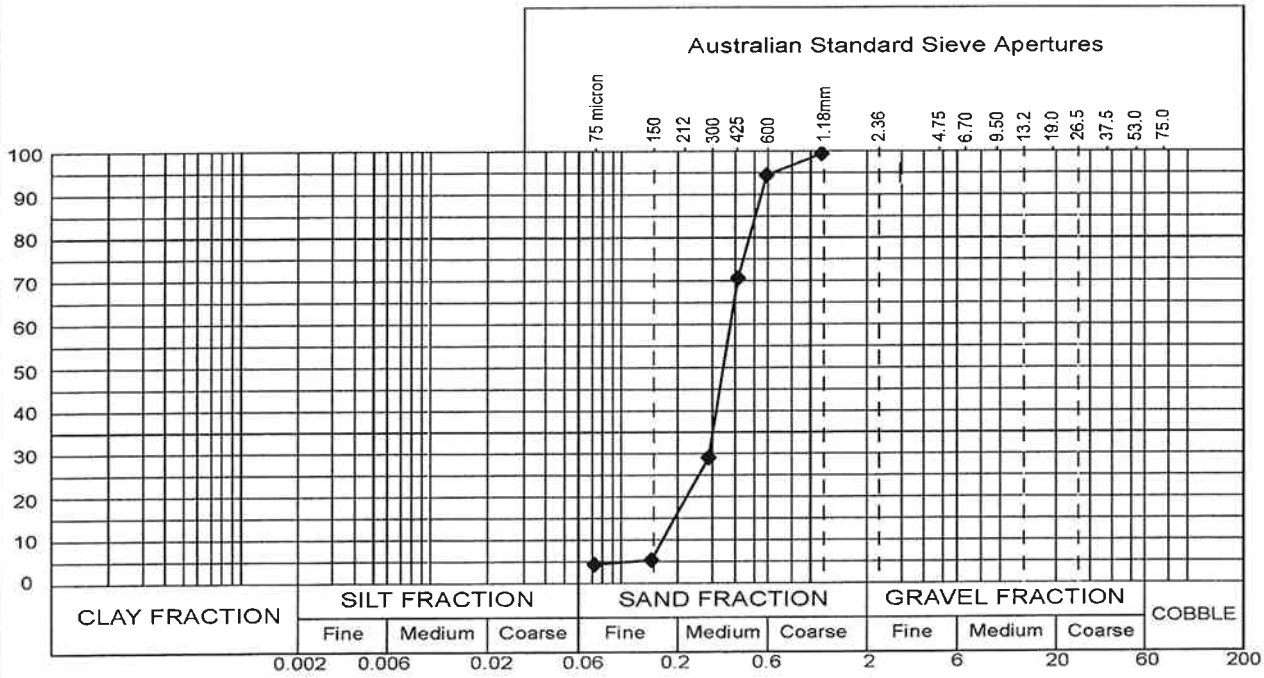
TEST CERTIFICATE

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

Partcle 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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Approved Signatory: B Truslove

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

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www.coffey.com.au

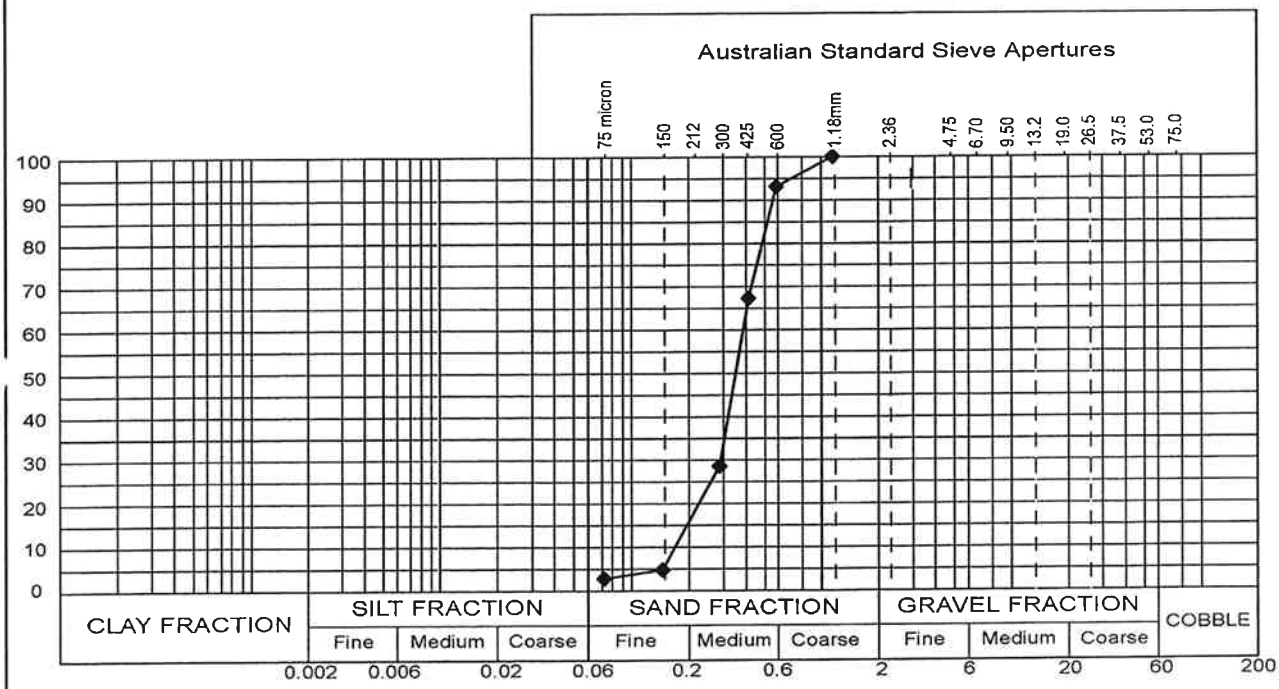
TEST CERTIFICATE

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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Approved Signatory: B Truslove

B Truslove

Date: 22/05/2008

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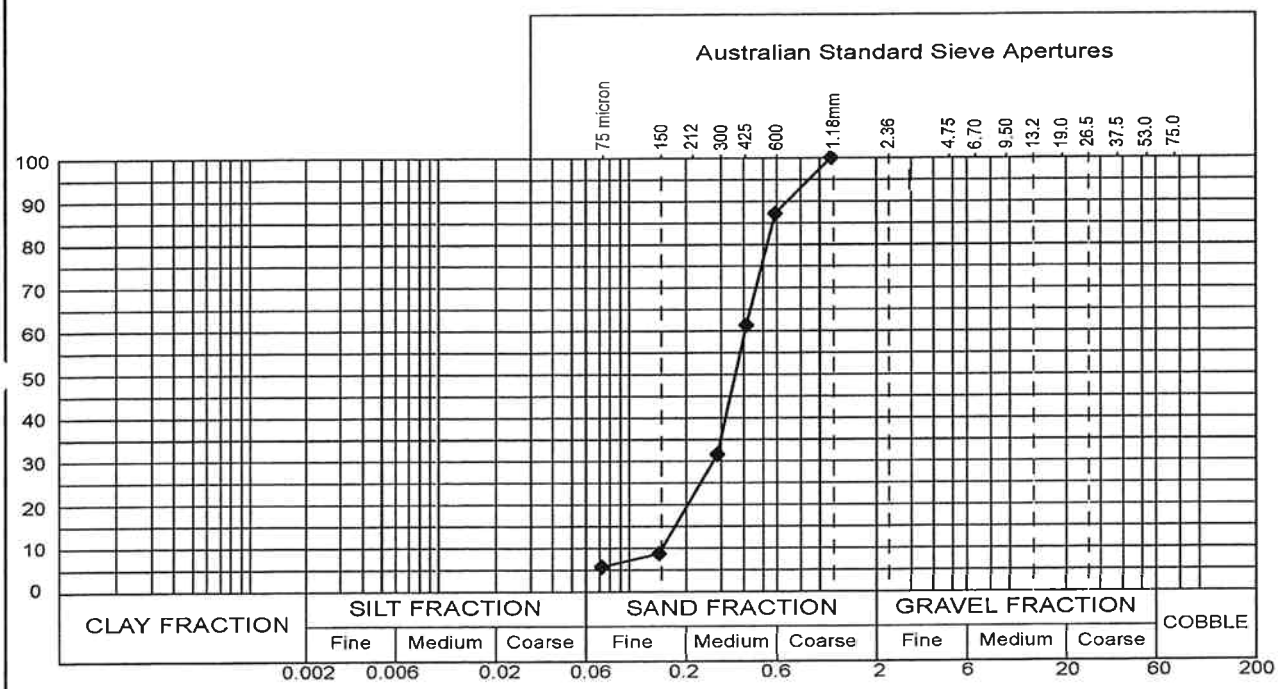
TEST CERTIFICATE

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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Approved Signatory: B Truslove

B Truslove

Date: 22/05/2008

NATA Acc. Laboratory No 431

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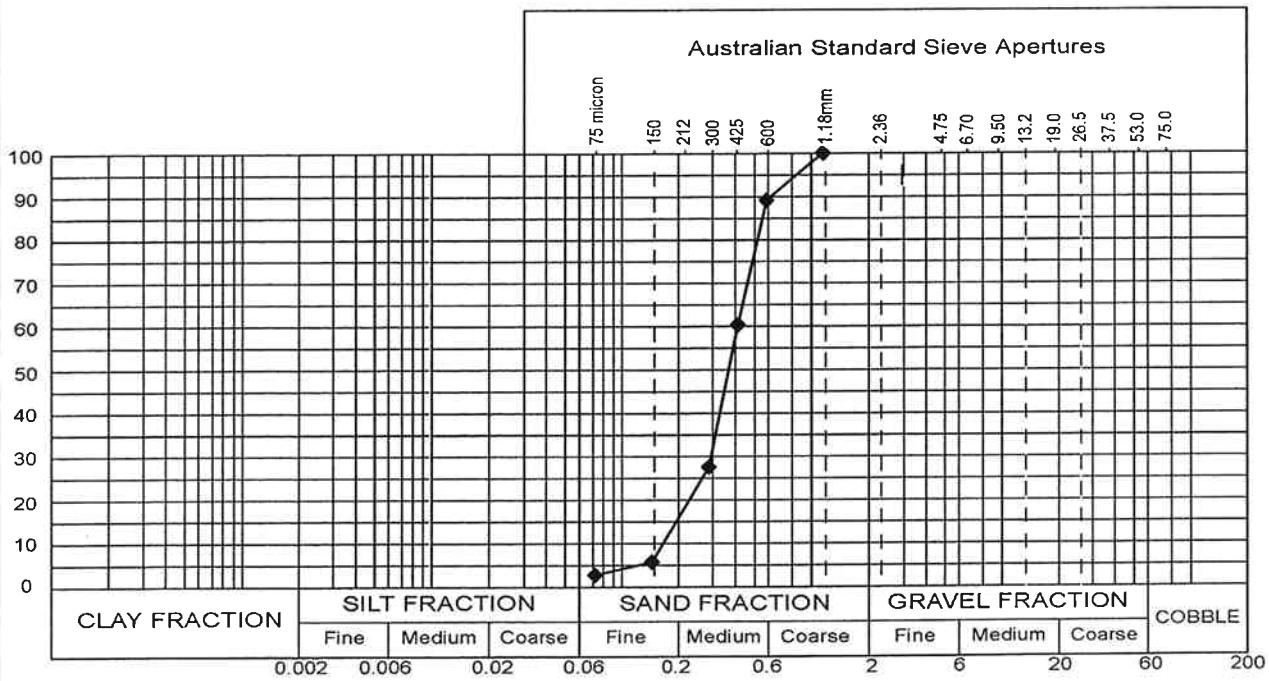
TEST CERTIFICATE

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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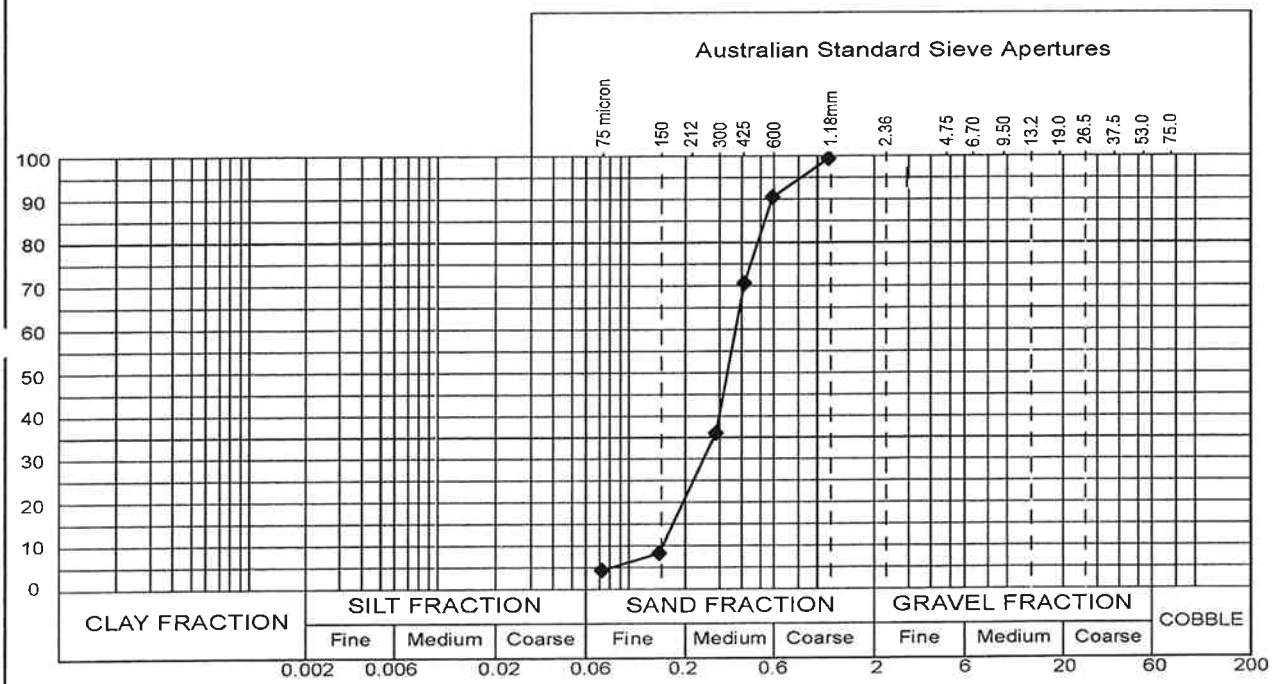
TEST CERTIFICATE

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

Partcle 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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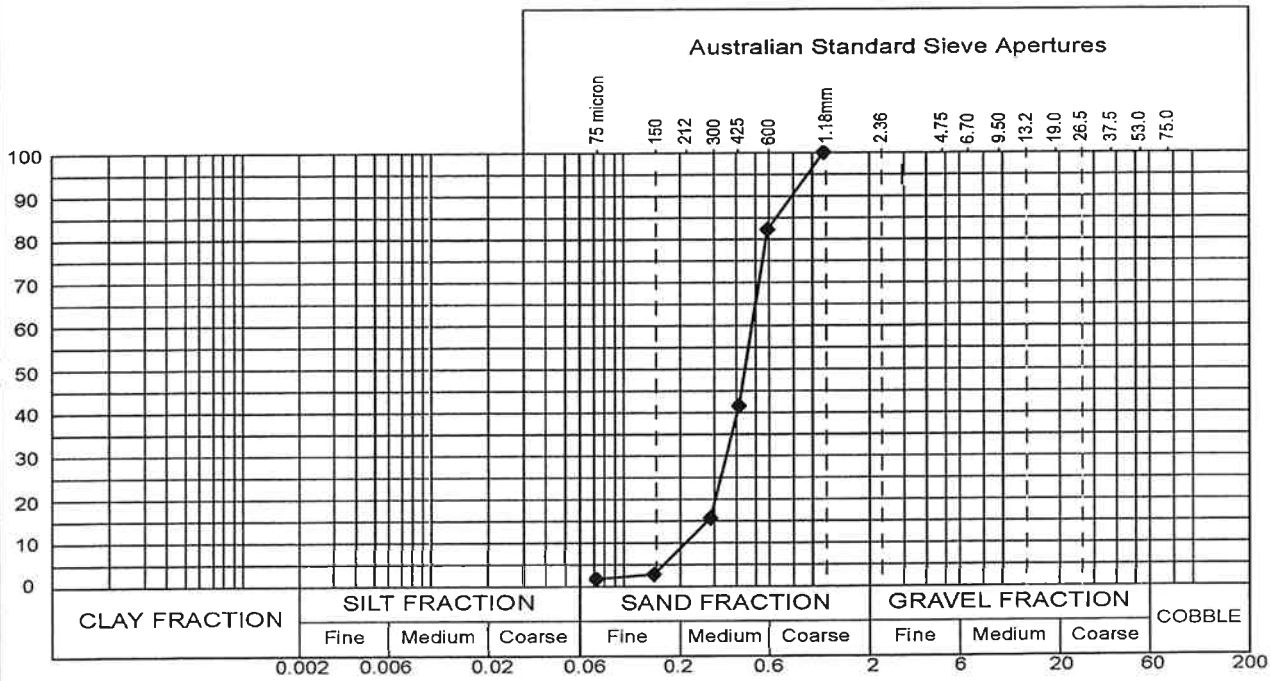
TEST CERTIFICATE

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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Date: 22/05/2008

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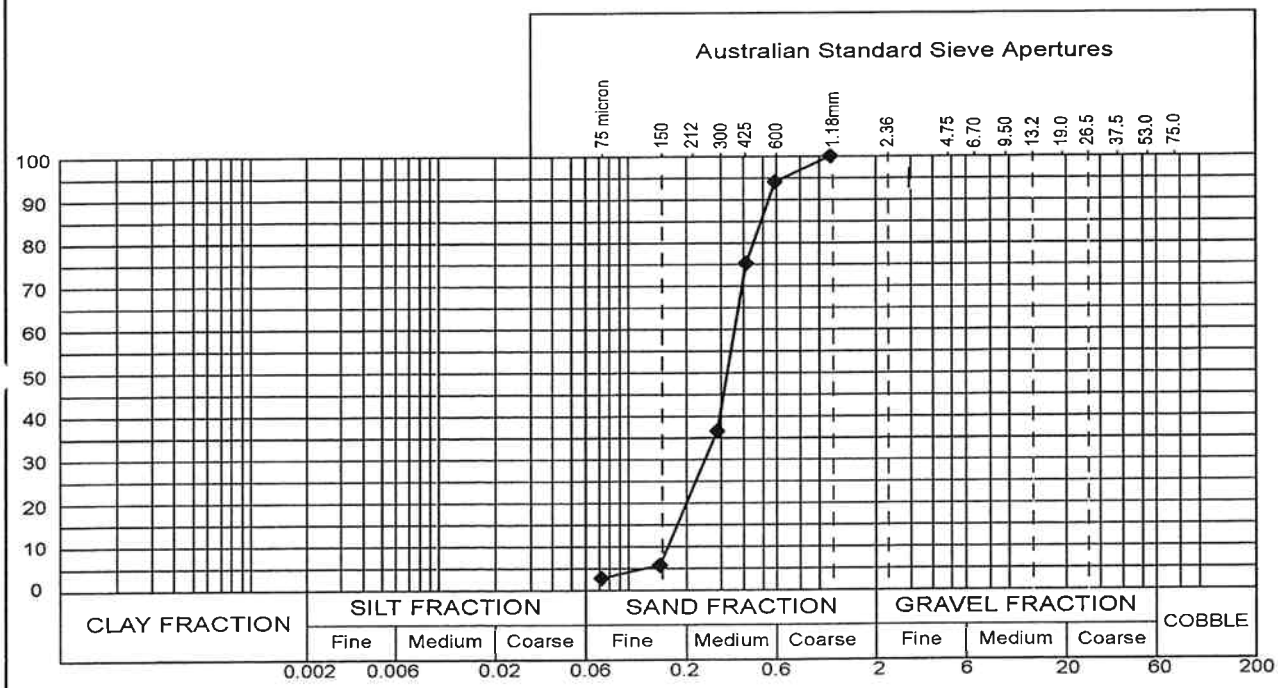
TEST CERTIFICATE

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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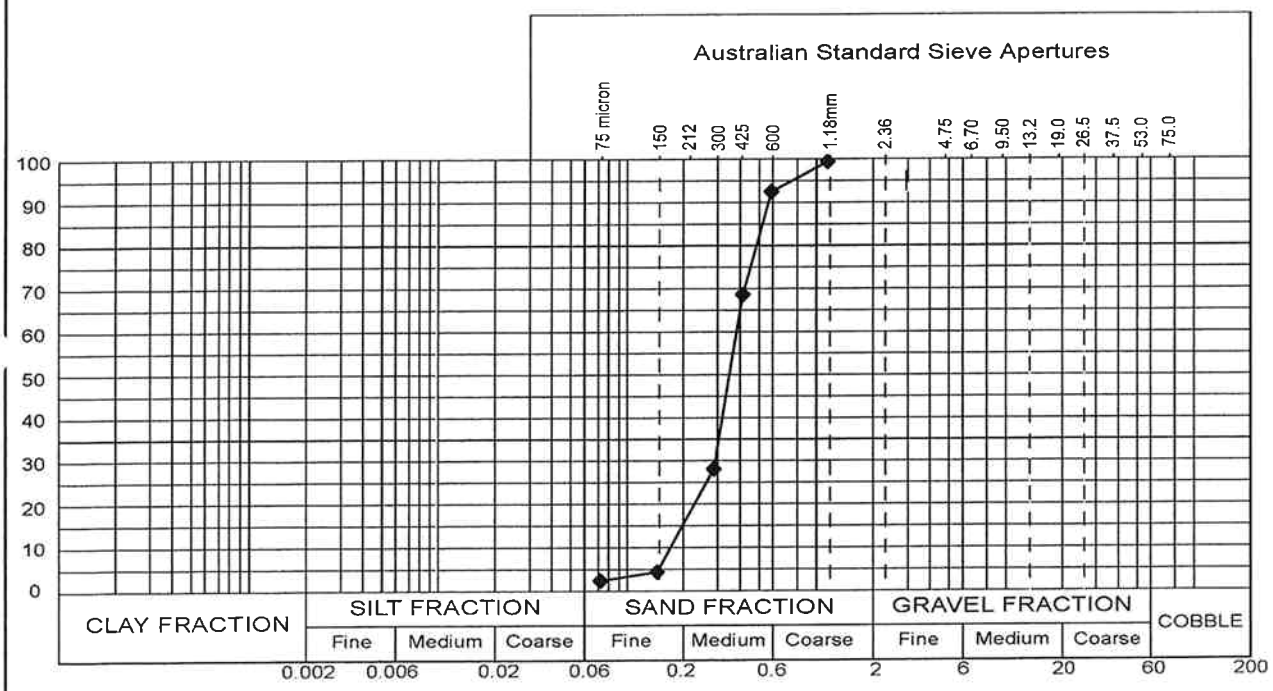
TEST CERTIFICATE

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

Partcle 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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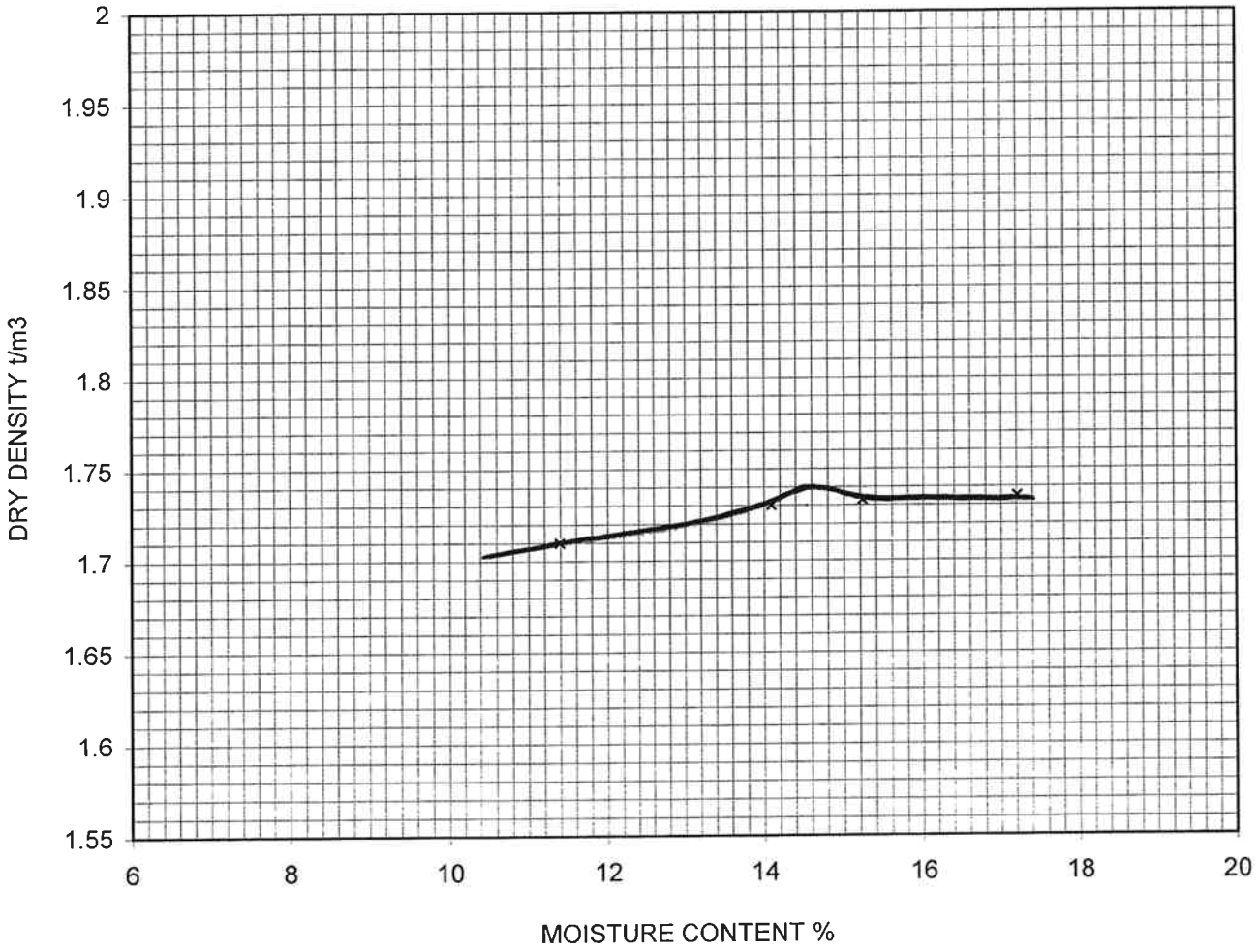
moisture/density relationship - graph E

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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moisture/density relationship - graph E

job no : LABTHERD00503AA
report no : HERD08S-05039

client : Coffey Geotechnics - GEOTHERD08304AB
principal : BG&E
project : Fiona Stanley Hospital
location : Murdoch

date : 12/05/2008
laboratory Herdsman
tested by : RB
checked by BT

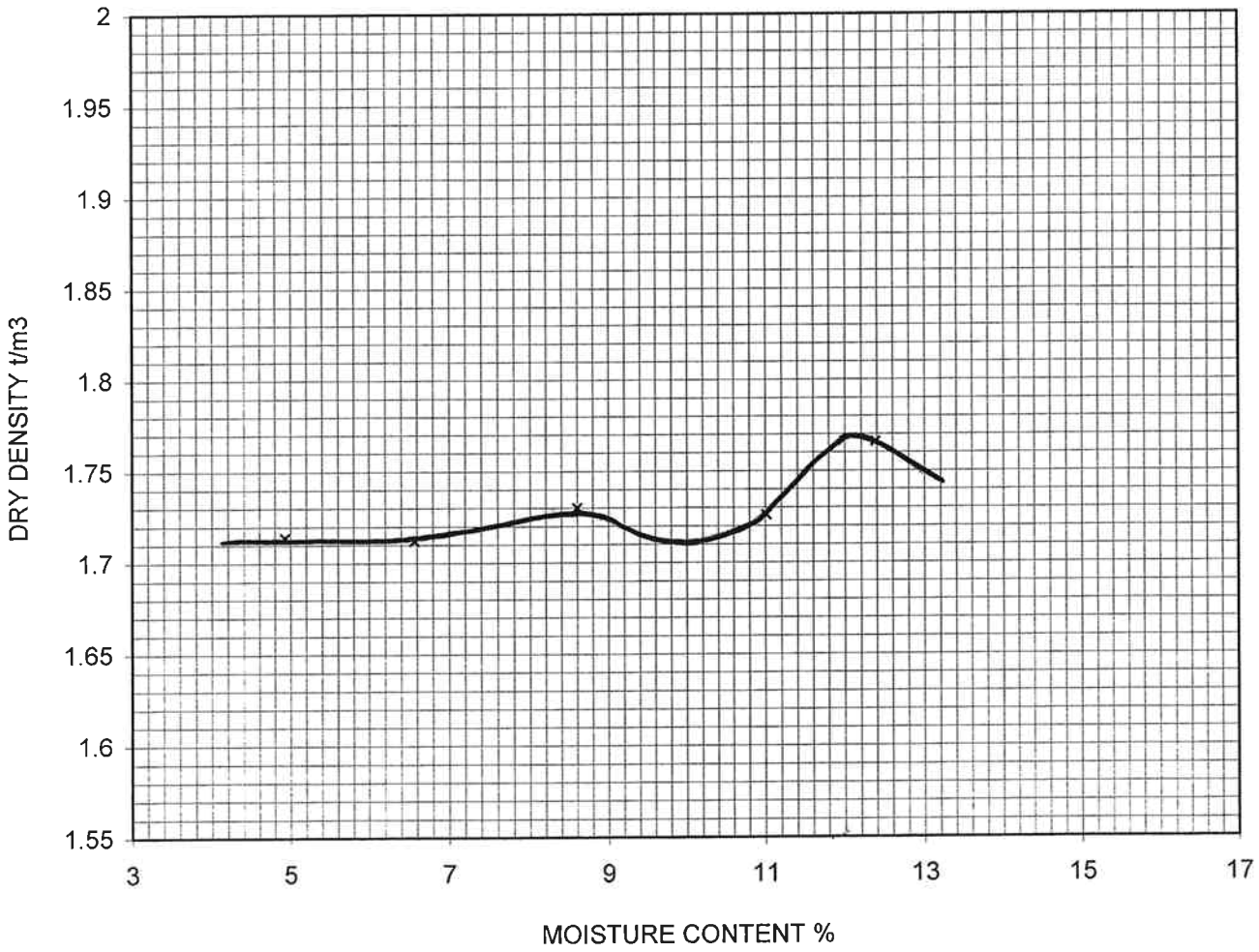
test procedure(s) : AS1289.5.2.1
soil particle density : - t/m^3

maximum dry density : 1.77 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

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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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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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FIONA STANLEY HOSPITAL - GROUNDWATER ANALYSES

			COFFEY			GHD			
Test No.	**BH101**	**BH102**	**BH103**	**BH104 Deep**	**BH104 Shallow**	**BH1 2007**	**BH2 2007**	**BH3 2007**	**NRMH 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**

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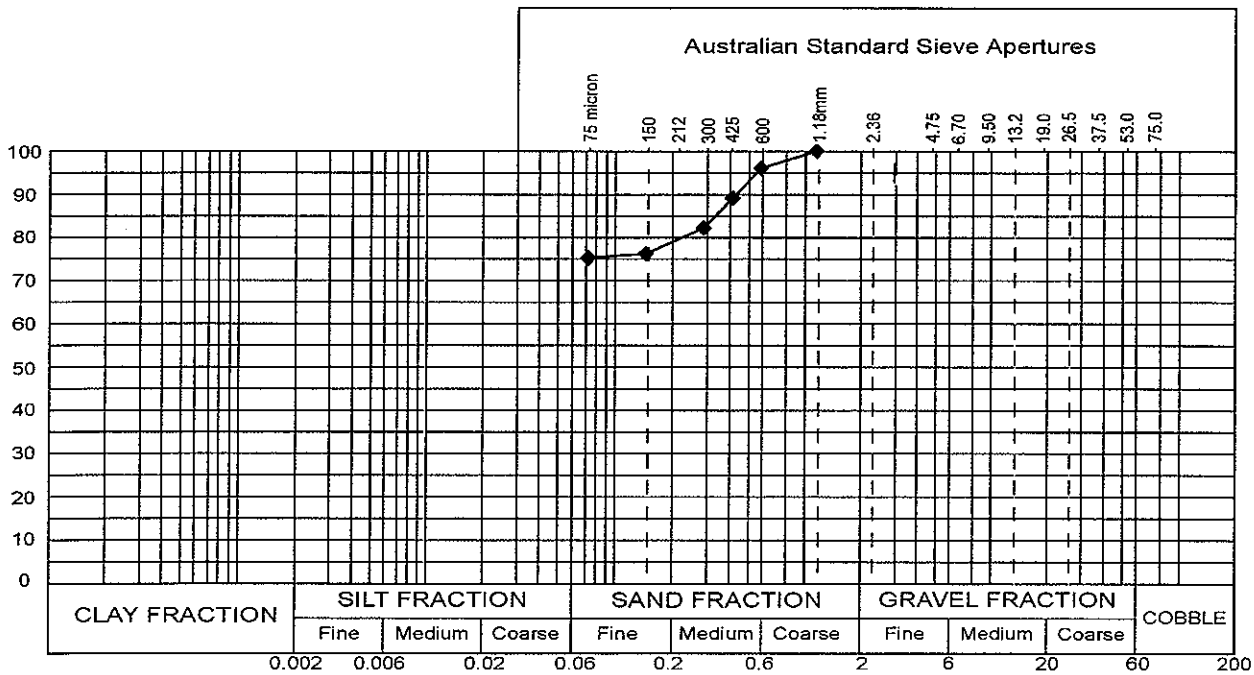
TEST CERTIFICATE

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

NATA
WORLD RECOGNISED ACCREDITATION

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

Approved Signatory: B Truslove
B Truslove
Date: 17/06/2008
NATA Acc. Laboratory No 431

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

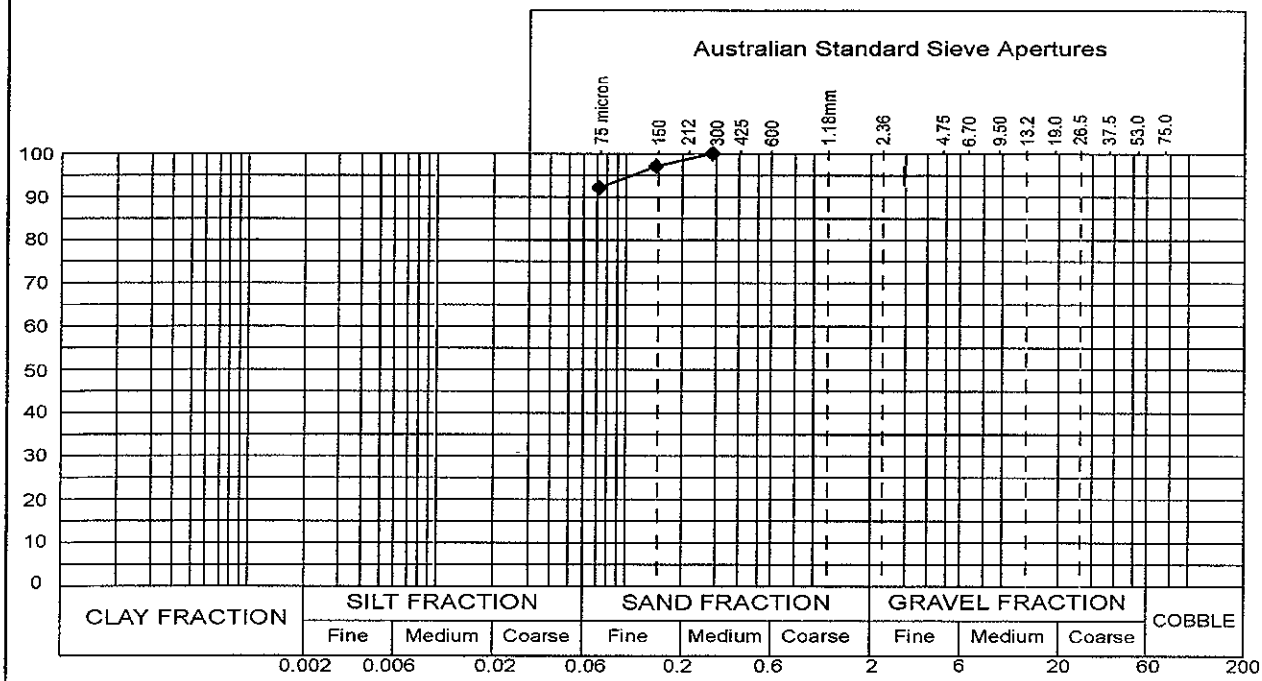
TEST CERTIFICATE

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

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www.coffey.com.au

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

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Approved Signatory: B Truslove

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 Etchells

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.

NATA

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Analytical Report

Job No : **083174**

Lab Id	External Idents	EC	pH	TDS	CO3	HCO3	OH	Cl	SO4	NO3	Na
Units		uS/cm	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LQL		1	0.05	1	1	1	1	1	1	0.1	1
		+	+	+	+	+	+			+	
083174-001	BH101	1500	6.60	970	<1	160	<1	280	92	1.2	330
083174-002	BH102	1800	6.65	1200	<1	190	<1	360	100	<0.1	420
083174-003	BH103	1100	6.70	680	<1	130	<1	190	69	0.2	240
083174-004	BH104 Deep	3200	6.35	2400	<1	200	<1	700	58	1.5	660
083174-005	BH104 Shallow	950	6.85	610	<1	130	<1	160	68	0.4	210
083174-001-DUP	BH101	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

Date Printed **5/06/2008**

Analytical Report

Job No : **083174**

Lab Id	External Idents	K	Ca	Mg	Hard	Al	B	Ba	Be	Cd	Co
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
LQL		**0.1**	**0.1**	**0.1**	**1**	**0.005**	**0.05**	**0.001**	**0.0005**	**0.001**	**0.005**
083174-001	BH101	3.8	16	10	82	2.4	0.53	0.036	0.0013	<0.001	<0.005
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

Date Printed **5/06/2008**

Analytical Report

Job No : **083174**

Lab Id	External Idents	Cr	Cu	Fe	Mn	Mo	Ni	Si	Sr	Ti	V
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
LQL		**0.001**	**0.005**	**0.01**	**0.001**	**0.005**	**0.005**	**0.1**	**0.01**	**0.01**	**0.002**
083174-001	BH101	0.026	0.068	2.5	0.33	0.006	0.013	15	0.15	0.04	0.042
083174-002	BH102	0.069	0.13	7.6	0.90	0.011	0.036	18	0.20	0.12	0.12
083174-003	BH103	0.019	0.25	7.5	0.54	0.012	0.010	13	0.11	0.15	0.025
083174-004	BH104 Deep	0.094	0.15	1.8	0.10	<0.005	0.017	6.1	0.09	0.06	0.063
083174-005	BH104 Shallow	0.018	0.051	1.8	0.28	<0.005	0.015	12	0.11	0.11	0.018
083174-001-DUP	BH101	0.026	0.066	2.5	0.33	0.008	0.014	14	0.15	0.04	0.042

Date Printed **5/06/2008**

Analytical Report

Job No : **083174**

Lab Id Units LQL	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

Date Printed **5/06/2008**

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

GHD 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

5801

Project: FIONA STANLEY HOSPITAL

Client: DEPT HOUSING

Job No.: 61/19514/01

Laboratory Quote No.:

Turnaround Time:

Job Manager (Invoice):

Email Address (Results):

Laboratory: ALS Environmental

Address: 10 Hod Way, Malaga 6090

Laboratory Contact:

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 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.

GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix S-Soil/SL-Sludge/W-Water/A-Air	Container Type B-Bottle/J-Jar/V-Vial/Bag G-Glass/P-Plastic	Container Preservative Unpreserved/HCl/H_2SO_4/HNO_3/Other	Container No	Container Total Volume (mL)	Analyses: EG0051/EG020F metals cations	EA005 ph	EK071 RP	EA015 TDS	EP041 Sulphate (TURB)	EK061 TKN	EK058 NO^3	EP005 TOC	~~EK071~~ EP005 chloride	~~EK067~~ EP038A Acidity	EA010 Conduct	EP037P Alk	EN055 Ionic	EA025 SS	EK055 Ammonia	Remarks
BH1 1/3	1	13/09/07	16:00	W	P-B	UN	1	1000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Contact Bradley
BH1 2/3	2	"	"	"	"	"	1	"	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	if any question
BH1 3/3	3	"	"	"	"	"	1	"	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
																								62228586.
BH1 1/6 → 6/6	4 - 9	"	"	"	P-B	UN	6	100?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
BH1 1/6 - 3/6	10 - 12	"	"	"	P-B	Pres	3	250	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
																								Only analyse w
																								we can on each b
																								as per Bradley.
																							(1-3)	NO TKN, TOC, Amo
																							(4-9)	8 metals by AES
																							(10-12)	NO Sulphide 14

Environmental Division
Perth
Work Order
EP0704187

Telephone : +61-8-9209 7655

Sampled by: Greg Botha	Date/Time 13/09	Greg Botha	Date/Time 14/9 08:0
Received by: Alison Jennings	Date/Time 14/09 08:00	Relinquished by: Alison Jennings	Date/Time 14/9 08:4
Received by Lab: ALS (Kristina)	Date/Time 14/9 14-26	Courier/Transport Company:	
Sample Conditions:	Remarks:		

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

GHD | 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

5802

Project: Fiona Stanley Hospital

Client: DHW

Job No.: 61/19514/01

Laboratory Quote No.:

Turnaround Time:

Job Manager (Invoice): Randy Kraus

Email Address (Results): alison.jennings@ghd.com.au

Laboratory: ALS Environmental

Address: 10 Hod Way, Malaga

Laboratory Contact:

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.

GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix (S-Soil/SL-Sludge/W-Water/A-Air)	Container Type (B-Bottle/J-Jar/V-Vial/Bag G-Glass/P-Plastic)	Container Preservative (Unpreserved/HCl/H_2SO_4/ HNO_3/Other)	Container No	Container Total Volume (mL)	Analyses	Remarks
BH2 1/2	①	14/9/07	11:00					1000	EDO93 Cations; EA005 pH; EK071 RP; EA015 TDS; ED041 Sulfate (Turb); EK058 NO_3; EP005 TOC; ED045 Cl⁻; ED038 Alkalinity; EA010 Cond; ED037 Alk; GN055 Ionic; GA025 SS; EK061 TKN	
" 2/2	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:	Greg Booth	Date/Time	14/9/07 11:00	Relinquished by:	Greg Booth	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		
C-O-C number	: 5851	Date Samples Received	: 18-SEP-2007
Sampler	: GREG BOTHA	Issue Date	: 26-SEP-2007
Order number	: ----		
		No. of samples received	: 1
Quote number	: EN-005-07	No. of samples analysed	: 1

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: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural BH3 1/1	15-SEP-2007	---	---	----	18-SEP-2007	15-SEP-2007	×
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**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		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	×
EK059G: NOX as N by Discrete Analyser							
Clear Plastic Bottle - Natural BH3 1/1	**15-SEP-2007**	----	----	----	**18-SEP-2007**	17-SEP-2007	×
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	×

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: × = 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		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
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 Titrate) 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 librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method2 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)
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)

Analytical Methods	Method	Matrix	Method Descriptions
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 seperately 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)
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 othophosphate 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-QWI/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 / Method	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

ALS Environmental

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*	- *Received* : 3
Site	: Fiona Stanley Hospital				*Analysed* : 3

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

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)

ALS Environmental

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 insuffient 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 **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

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: BH1 1/3 Sample Matrix Type / Description: WATER Sample Date / Time: 13 Sep 2007 16:00 Laboratory Sample ID: EP0704187-001	BH1 2/3 WATER 13 Sep 2007 16:00 EP0704187-002	BH1 3/3 WATER 13 Sep 2007 16:00 EP0704187-003		
EA005P: pH by PC Titrator								
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 CaCO3	DMO-210-001	1	mg/L	<1	<1	<1		
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1		
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	121	159	244		
Total Alkalinity as CaCO3		1	mg/L	121	159	244		
ED038A: Acidity								
Acidity as CaCO3		1	mg/L	112	145	201		
ED040F: Dissolved Major Anions								
Sulphate as SO4 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 SO4 - 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		

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Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: BH1 1/3 Sample Matrix Type / Description: WATER Sample Date / Time: 13 Sep 2007 16:00 Laboratory Sample ID: EP0704187-001	Client Sample ID: BH1 2/3 Sample Matrix Type / Description: WATER Sample Date / Time: 13 Sep 2007 16:00 Laboratory Sample ID: EP0704187-002	Client Sample ID: BH1 3/3 Sample Matrix Type / Description: WATER Sample Date / Time: 13 Sep 2007 16:00 Laboratory Sample ID: EP0704187-003		
EG020F: Dissolved Metals by ICP-MS								
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001		
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001		
Copper	7440-50-8	0.001	mg/L	0.001	<0.001	<0.001		
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001		
Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.001		
Zinc	7440-66-6	0.005	mg/L	0.012	0.010	<0.005		
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001		
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001		
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.028	0.037	0.079		
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.198	0.307	1.15		
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.226	0.344	1.23		
EK071G: Reactive Phosphorous as P by discrete analyser								
Reactive Phosphorus as P		0.010	mg/L	<0.010	<0.010	<0.010		
EN055: Ionic Balance								
Total Anions		0.01	meq/L	10.9	11.9	12.9		
Total Cations		0.01	meq/L	10.7	11.6	12.5		
Ionic Balance		0.01	%	1.03	1.01	1.29		

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Surrogate Control Limits

- **No surrogates present on this report.**

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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		
C-O-C number	: 5801	Date Samples Received	: 14-SEP-2007
Sampler	: GB	Issue Date	: 24-SEP-2007
Order number	: ----		
		No. of samples received	: 3
Quote number	: EN-005-07	No. of samples analysed	: 3

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
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
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics

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 insuffient 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: 495874)									
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	Anonymous	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	----
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 493798)									
EP0704187-001	BH1 1/3	EK057G: Nitrite as N	----	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**

		Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	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: 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: Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
		LOR	Unit	Result	Concentration	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 Phosphorus 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**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	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)							
EP0704169-004	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

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

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	: 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		
C-O-C number	: 5801	Date Samples Received	: 14-SEP-2007
Sampler	: GB	Issue Date	: 24-SEP-2007
Order number	: ----		
		No. of samples received	: 3
Quote number	: EN-005-07	No. of samples analysed	: 3

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: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
BH1 1/3, 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 1/3, BH1 2/3, BH1 3/3	**13-SEP-2007**	---	---	----	**17-SEP-2007**	11-OCT-2007	✓
EA015: Total Dissolved Solids							
Clear Plastic Bottle - Natural							
BH1 1/3, BH1 2/3, BH1 3/3	**13-SEP-2007**	----	----	----	**19-SEP-2007**	20-SEP-2007	✓
EA025: Suspended Solids							
Clear Plastic Bottle - Natural							
BH1 1/3, 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 1/3, BH1 2/3, BH1 3/3	**13-SEP-2007**	---	---	----	**17-SEP-2007**	27-SEP-2007	✓
ED038A: Acidity							
Clear Plastic Bottle - Natural							
BH1 1/3, BH1 2/3, BH1 3/3	**13-SEP-2007**	----	----	----	**18-SEP-2007**	27-SEP-2007	✓
ED040F: Dissolved Major Anions							
Clear Plastic Bottle - Natural							
BH1 1/3, 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 1/3, BH1 2/3, BH1 3/3	**13-SEP-2007**	----	----	----	**24-SEP-2007**	11-OCT-2007	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride Discrete analyser							
Clear Plastic Bottle - Natural							
BH1 1/3, BH1 2/3, BH1 3/3	13-SEP-2007	----	----	----	17-SEP-2007	11-OCT-2007	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural							
BH1 1/3, BH1 2/3, 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 2/3, 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 2/3, 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 2/3, 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 2/3, 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 2/3, 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 2/3, 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 2/3, 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(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: × = 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	*Method*	*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

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)
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 Silcon 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 librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method2 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)
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.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl2)(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 SnCl2 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 (SnCl2)(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 SnCl2 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 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 seperately 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)
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 othophosphate 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)

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). "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						
BH1 1/3, BH1 2/3, BH1 3/3	----	----	----	17-SEP-2007	13-SEP-2007	4

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.**

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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* - *Received*	: 2
Site	: Fiona Stanley Hospital			*Analysed*	: 2

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

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)

ALS Environmental

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 insuffient 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.

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Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: BH2 1/2 Sample Matrix Type / Description: WATER Sample Date / Time: 14 Sep 2007 11:00 Laboratory Sample ID: EP0704191-001	Client Sample ID: BH2 2/2 Sample Matrix Type / Description: WATER Sample Date / Time: 14 Sep 2007 11:00 Laboratory Sample ID: EP0704191-002			
EA005P: pH by PC Titrator								
pH Value		0.01	pH Unit	5.06	5.16			
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C		1	µS/cm	1520	1500			
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	1760	1640			
EA025: Suspended Solids								
Suspended Solids (SS)		1	mg/L	36700	43200			
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1			
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1			
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	2			
Total Alkalinity as CaCO3		1	mg/L	<1	2			
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	493	484			
Sulphur as S	63705-05-5	1	mg/L	164	162			
ED041: Sulphate (Turbidimetric) as SO4 2-								
Sulphate as SO4 - Turbidimetric		1	mg/L	334	319			
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	183	189			
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	82	82			
Magnesium	7439-95-4	1	mg/L	32	32			
Sodium	7440-23-5	1	mg/L	142	140			
Potassium	7440-09-7	1	mg/L	18	19			
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.024	0.022			
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.089	0.063			
EK059G: NOX as N by Discrete Analyser								
Nitrite + Nitrate as N		0.010	mg/L	0.113	0.085			
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	14.8	14.7			
Total Cations		0.01	meq/L	13.5	13.3			
Ionic Balance		0.01	%	4.56	4.92			

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Surrogate Control Limits

- **No surrogates present on this report.**

A Campbell Brothers Limited Company

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		
C-O-C number	: 5802	Date Samples Received	: 14-SEP-2007
Sampler	: Greg Both	Issue Date	: 24-SEP-2007
Order number	: ----		
		No. of samples received	: 2
Quote number	: EN-005-07	No. of samples analysed	: 2

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.

Signatories	*Position*	*Accreditation Category*
Alan Foley	Senior Chemist - Inorganics	Perth Inorganics
Kurt Blackman	Non-Metals Team Leader	Perth Inorganics

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 insuffient 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: 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 sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				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**

		Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	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**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	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		
C-O-C number	: 5802	Date Samples Received	: 14-SEP-2007
Sampler	: Greg Both	Issue Date	: 24-SEP-2007
Order number	: ----		
		No. of samples received	: 2
Quote number	: EN-005-07	No. of samples analysed	: 2

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: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural								
BH2 1/2,	BH2 2/2	14-SEP-2007	---	---	----	17-SEP-2007	14-SEP-2007	×
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**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
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: × = 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		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*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 Silcon 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 librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method2 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 seperately 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 othophosphate 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-QWI/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	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
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.**

ALS Environmental

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

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

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)

ALS Environmental

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 insuffient 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.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: BH3 1/1 Sample Matrix Type / Description: WATER Sample Date / Time: 15 Sep 2007 15:00 Laboratory Sample ID: EP0704225-001				
EA005P: pH by PC Titrator								
pH Value		0.01	pH Unit	6.63				
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C		1	µS/cm	431				
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	GIS-210-010	1	mg/L	248				
EA025: Suspended Solids								
Suspended Solids (SS)		1	mg/L	19500				
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1				
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1				
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	80				
Total Alkalinity as CaCO3		1	mg/L	80				
ED038A: Acidity								
Acidity as CaCO3		1	mg/L	39				
ED041: Sulphate (Turbidimetric) as SO4 2-								
Sulphate as SO4 - Turbidimetric		1	mg/L	<1				
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1.0	mg/L	49.3				
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	38				
Magnesium	7439-95-4	1	mg/L	9				
Sodium	7440-23-5	1	mg/L	35				
Potassium	7440-09-7	1	mg/L	3				
EG005T: Total Metals by ICP-AES								
Iron	7439-89-6	0.05	mg/L	32.6				
EG020F: Dissolved Metals by ICP-MS								
Cadmium	7440-43-9	0.0001	mg/L	0.0006				
Copper	7440-50-8	0.001	mg/L	0.004				
Zinc	7440-66-6	0.005	mg/L	0.056				
Boron	7440-42-8	0.05	mg/L	<0.05				
Iron	7439-89-6	0.05	mg/L	<0.05				
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N		0.010	mg/L	0.018				
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.010	mg/L	0.400				

ALS Environmental

Analytical Results

	Client Sample ID :	BH3 1/1				
	Sample Matrix Type / Description :	WATER				
	Sample Date / Time :	15 Sep 2007 15:00				
	Laboratory Sample ID :	EP0704225-001				
Analyte / CAS number / LOR / Units						
EK059G: NOX as N by Discrete Analyser						
Nitrite + Nitrate as N	0.010 mg/L	0.418				
EK061: Total Kjeldahl Nitrogen (TKN)						
Total Kjeldahl Nitrogen as N	0.1 mg/L	8.7				
EK071G: Reactive Phosphorous as P by discrete analyser						
Reactive Phosphorus as P	0.010 mg/L	<0.010				

ALS Environmental

Surrogate Control Limits

- **No surrogates present on this report.**

A Campbell Brothers Limited Company

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		
C-O-C number	: 5851	Date Samples Received	: 18-SEP-2007
Sampler	: GREG BOTHA	Issue Date	: 26-SEP-2007
Order number	: ----		
		No. of samples received	: 1
Quote number	: EN-005-07	No. of samples analysed	: 1

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
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

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 insuffient 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: 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 Duplicate (DUP) Report					
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

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**

		Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	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: Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
		LOR	Unit	Result	Concentration	LCS	Low	High
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

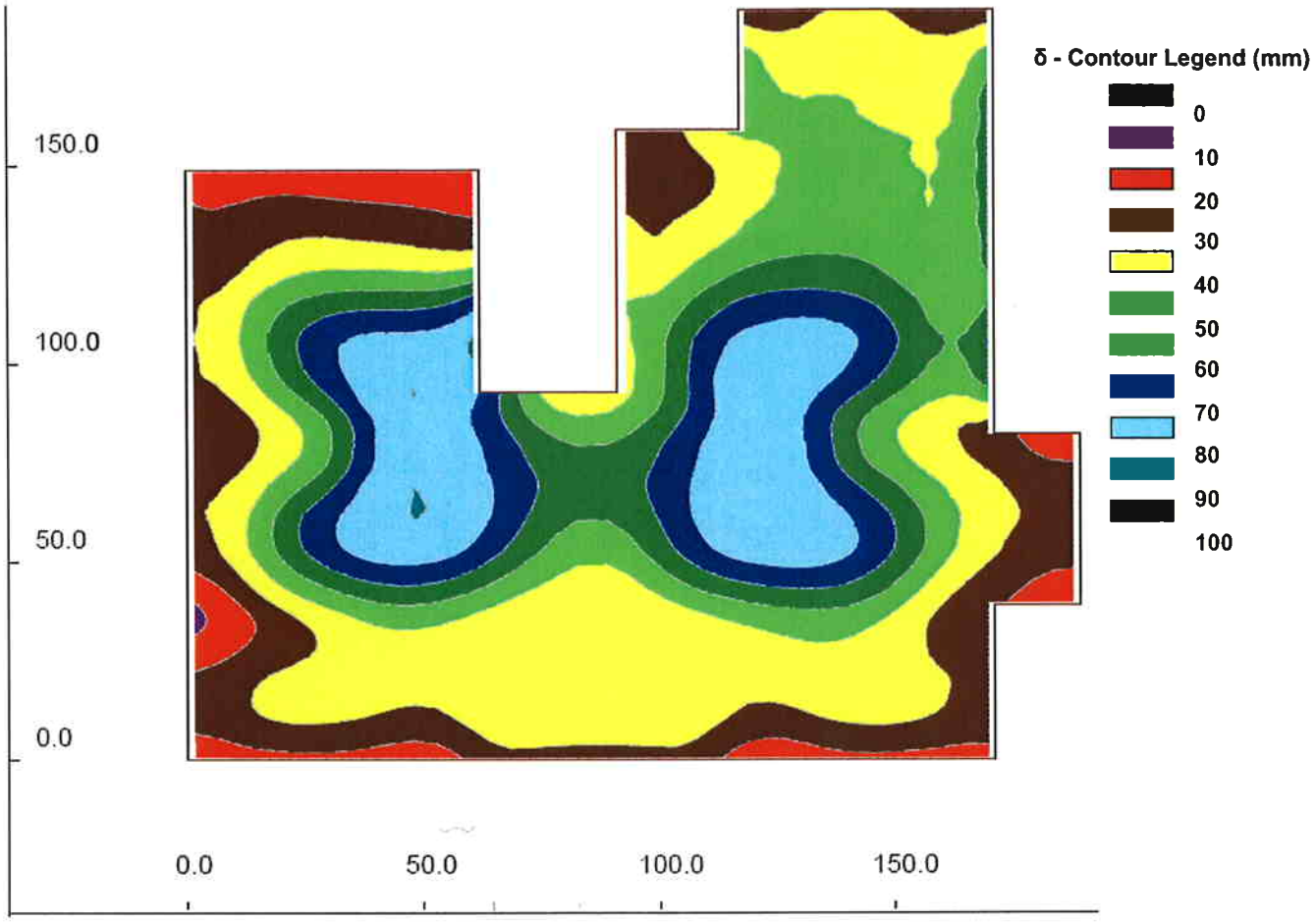
The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
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

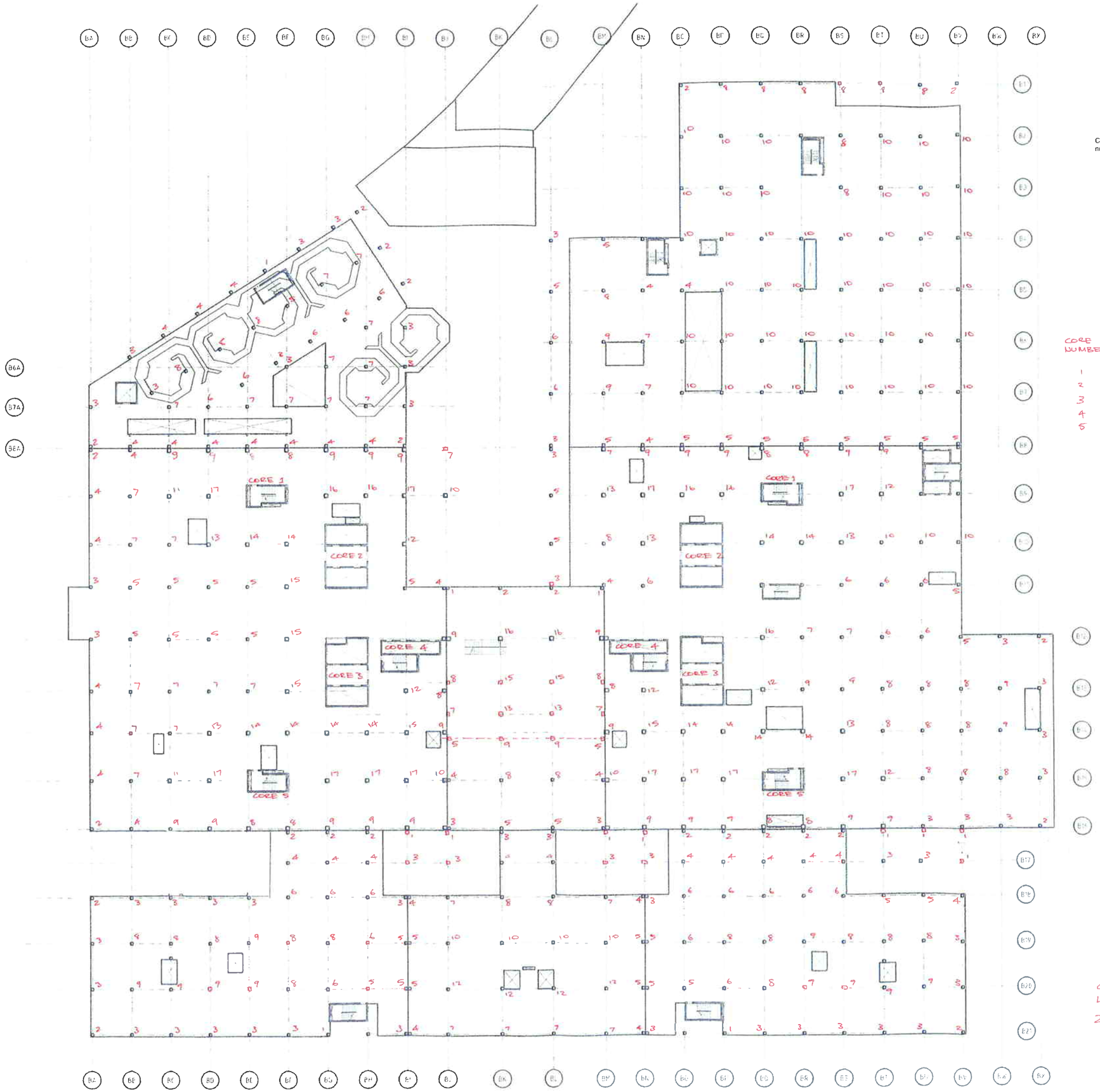
Results of Finite Element Analysis of Rafts (FEAR)



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	Live	Factored Loads (kN) Ulimate
1	1001	152	1429
2	1243	295	1934
3	1718	544	2878
4	2272	566	3575
5	2650	734	4280
6	2825	1145	5108
7	3771	975	5988
8	4113	1249	6810
9	4781	1517	8012
10	4963	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	15663
17	9847	3807	17527

CORE NUMBER	UNFACTORED LOADS (kN) DEAD	LIVE	FACTORED LOADS (kN)
1	25000	8900	43250
2	39500	12300	65850
3	40500	12500	67350
4	22000	6600	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										
SampleLocation ID	Sample Depth (mBGL)	pH_F	pH_{FOX}	ΔpH	Reaction Rate	pH_{KCl}	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*	-
		<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										
SampleLocation ID	Sample Depth (mBGL)	pH_F	pH_{FOX}	ΔpH	Reaction Rate	pH_{KCl}	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	-
		<4	<3	3	NV	<4	<3	0.03	NV	NV	0.03	0.03	0.03	NV	0.03	-
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										
SampleLocation ID	Sample Depth (mBGL)	pH_F	pH_{FOX}	ΔpH	Reaction Rate	pH_{KCl}	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*	-
		<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										
SampleLocation ID	Sample Depth (mBGL)	pH_F	pH_{FOX}	ΔpH	Reaction Rate	pH_{KCl}	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*	-
		<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										
SampleLocation ID	Sample Depth (mBGL)	pH_F	pH_{FOX}	ΔpH	Reaction Rate	pH_{KCl}	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*	-
		<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	: ----		
C-O-C number	: ----	Date Samples Received	: 23-MAY-2008
Sampler	: ----	Issue Date	: 03-JUN-2008
Order number	: ----		
		No. of samples received	: 32
Quote number	: ----	No. of samples analysed	: 32

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
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*
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

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 insuffient 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

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

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 ¿ 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 ¿ 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: Net Acidity excluding ANC (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 ¿ 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
		EA033: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EP0802883-031	BH104 12.0 ¿ 12.1	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			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	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: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	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	: ----		
C-O-C number	: ----	Date Samples Received	: 23-MAY-2008
Sampler	: ----	Issue Date	: 03-JUN-2008
Site	: ----		
		No. of samples received	: 32
Quote number	: ----	No. of samples analysed	: 32

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

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 insuffient 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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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								
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	----	**0.05**	----	----	----
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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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-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
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	0.18	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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
Client sampling date / time				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								
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	----	<0.02	----
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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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-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**
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	**0.18**	----	----	**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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	**5**	----	----	**2**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	**4**	----	----	**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	----	----	<0.02
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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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-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**

Compound	CAS Number	LOR	Unit	Client sample ID	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
				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
					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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			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
				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**

Compound	CAS Number	LOR	Unit	Client sample ID	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
				Client sampling date / time	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
					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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
Client sampling date / time				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
				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**
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	----	**0.18**	----	----	<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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	----	**13**	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	----	**12**	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	----	<0.02	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.02	<0.02	----	**0.02**	----
sulfidic - Titratable 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**

Compound	CAS Number	LOR	Unit	Client sample ID: 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
			Client sampling date / time:	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-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**
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	----	**0.24**	----	----	**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	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**	----	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**2**	<2	----	----	----
sulfidic - Titratable 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	: ----		
C-O-C number	: ----	Date Samples Received	: 16-MAY-2008
Sampler	: ----	Issue Date	: 27-MAY-2008
Order number	: ----		
		No. of samples received	: 49
Quote number	: ----	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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements							
80* dried soil							
TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**01-MAY-2008**	**21-MAY-2008**	01-MAY-2009	✓	**22-MAY-2008**	19-AUG-2008	✓
EA029-B: Acidity Trail							
80* dried soil							
TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**01-MAY-2008**	**21-MAY-2008**	01-MAY-2009	✓	**22-MAY-2008**	19-AUG-2008	✓
EA029-C: Sulfur Trail							
80* dried soil							
TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**01-MAY-2008**	**21-MAY-2008**	01-MAY-2009	✓	**22-MAY-2008**	19-AUG-2008	✓
EA029-D: Calcium Values							
80* dried soil							
TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-E: Magnesium Values							
80* dried soil TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**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, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**01-MAY-2008**	**21-MAY-2008**	01-MAY-2009	✓	**22-MAY-2008**	19-AUG-2008	✓
EA029-G: Retained Acidity							
80* dried soil TP101 - 1, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**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, TP102 - 0.25, TP104 - 3.5, TP106 - 1, TP109 - 0.5, TP112 - 2.25, TP114 - 2.25, TP116 - 4, TP121 - 1.5, TP118 - 2, TP117 - 3.75	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity							
80* dried soil							
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	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity							
80* dried soil							
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	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-C: Acid Neutralising Capacity							
80* dried soil							
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	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-D: Retained Acidity							
80* dried soil							
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	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-E: Acid Base Accounting							
80* dried soil							
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	**01-MAY-2008**	**21-MAY-2008**	01-MAY-2009	✓	**22-MAY-2008**	19-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	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 SW 846 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	: ----		
C-O-C number	: ----	Date Samples Received	: 16-MAY-2008
Sampler	: ----	Issue Date	: 27-MAY-2008
Order number	: ----		
		No. of samples received	: 49
Quote number	: ----	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 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.

Signatories	*Position*	*Accreditation Category*
Stacey Hawkins	Senior Chemist - Acid Sulphate Soils	Perth Inorganics

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 insuffient 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

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				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)									

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

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			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	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	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
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	: ----		
C-O-C number	: ----	Date Samples Received	: 16-MAY-2008
Sampler	: ----	Issue Date	: 27-MAY-2008
Site	: ----		
		No. of samples received	: 49
Quote number	: ----	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 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

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 insuffient 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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP101 0.25	TP101 1	TP101 1.5	TP102 0.25	TP102 2
				Client sampling date / time	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									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		----	<2	----	**2**	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		----	<2	----	**64**	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		----	<2	----	**61**	----
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	----	**0.10**	----
sulfidic - Titratable 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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP101 0.25	TP101 1	TP101 1.5	TP102 0.25	TP102 2
			Client sampling date / time	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-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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP103 0.75	TP103 2.5	TP104 0.5	TP104 2.5	TP104 3.5
				Client sampling date / time	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									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		----	----	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		----	----	----	----	**12**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		----	----	----	----	**10**
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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP103 0.75	TP103 2.5	TP104 0.5	TP104 2.5	TP104 3.5
				Client sampling date / time	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-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		**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 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	**11**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID	TP105 0.5	TP105 2.5	TP106 0.25	TP106 1	TP106 2.5
				Client sampling date / time	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									
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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP105 0.5	TP105 2.5	TP106 0.25	TP106 1	TP106 2.5
				Client sampling date / time	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-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**	**6.2**	**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 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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP107 0.25	TP107 1	TP107 1.75	TP109 0.5	TP109 1.5
				Client sampling date / time	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									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		----	----	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		----	----	----	**3**	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		----	----	----	**3**	----
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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP107 0.25	TP107 1	TP107 1.75	TP109 0.5	TP109 1.5
				Client sampling date / time	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-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**	**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 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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP110 0.25	TP110 1.25	TP110 2.75	TP111 0.75	TP111 2
			Client sampling date / time	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
				EP0802721-021	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**
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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP112 1	TP112 2.25	TP113 0.25	TP113 2.25	TP114 0.25
				Client sampling date / time	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									
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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP112 1	TP112 2.25	TP113 0.25	TP113 2.25	TP114 0.25
			Client sampling date / time	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-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**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	**6**
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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP114 2.25	TP115 0.5	TP115 1.75	TP115 3.5	TP116 0.5
			Client sampling date / time	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
				EP0802721-031	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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP114 2.25	TP115 0.5	TP115 1.75	TP115 3.5	TP116 0.5
			Client sampling date / time	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
				EP0802721-031	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**
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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP116 2.5	TP116 4	TP121 0.5	TP121 1.5	TP121 2.75
			Client sampling date / time	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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP116 2.5	TP116 4	TP121 0.5	TP121 1.5	TP121 2.75
			Client sampling date / time	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-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**
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	----	----	**0.68**	**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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP122 0.5	TP122 1.5	TP122 2	TP118 1	TP118 2
				Client sampling date / time: 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								
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**

Compound	CAS Number	LOR	Unit	Client sample ID: TP122 0.5	TP122 1.5	TP122 2	TP118 1	TP118 2
			Client sampling date / time	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-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	TP118 2.5	TP117 0.25	TP117 0.75	TP117 3.75	----
			Client sampling date / time	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								
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	----	----	----	**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**

Compound	CAS Number	LOR	Unit	Client sample ID	TP118 2.5	TP117 0.25	TP117 0.75	TP117 3.75	----
				Client sampling date / time	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	01-MAY-2008 15:00	----
					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	: ----		
C-O-C number	: ----	Date Samples Received	: 23-MAY-2008
Sampler	: ----	Issue Date	: 03-JUN-2008
Order number	: ----		
		No. of samples received	: 32
Quote number	: ----	No. of samples analysed	: 32

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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		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 - 8.35 ¿ 8.45, BH101 - 10.5 ¿ 10.6	**06-MAY-2008**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 3.35 ¿ 3.45, BH104 - 7.5 -7.6, BH104 - 9.15 ¿ 9.25	**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 - 8.35 ¿ 8.45, BH101 - 10.5 ¿ 10.6	**06-MAY-2008**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 3.35 ¿ 3.45, BH104 - 7.5 -7.6, BH104 - 9.15 ¿ 9.25	**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 - 8.35 ¿ 8.45, BH101 - 10.5 ¿ 10.6	**06-MAY-2008**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 3.35 ¿ 3.45, BH104 - 7.5 -7.6, BH104 - 9.15 ¿ 9.25	**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 / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-D: Calcium Values								
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-E: Magnesium Values								
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-F: Excess Acid Neutralising Capacity								
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-G: Retained Acidity								
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 / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-H: Acid Base Accounting								
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	✓
EA033-A: Actual 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	✓

Matrix: **SOIL**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		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 - 2.35 ¿ 2.45, BH101 - 4.0 ¿ 4.1, BH101 - 6.0 ¿ 6.1 6, BH101 - 6.35 ¿ 6.45, 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**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ¿ 1.6, 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, BH104 - 12.0 ¿ 12.1, 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 - 3.34 ¿ 3.45, BH102 - 4.85 ¿ 4.95, BH102 - 6.35 ¿ 6.45, BH102 - 7.85 ¿ 7.95, BH102 - 9.35 ¿ 9.45, BH102 - 10.85 ¿ 10.9	**09-MAY-2008**	**27-MAY-2008**	09-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ¿ 1.45, BH103 - 3.0 ¿ 3.1, BH103 - 4.35 ¿ 4.45, BH103 - 6.35 ¿ 6.45, BH103 - 9.0 ¿ 9.1, BH103 - 10.85 ¿ 10.9, BH103 - 12.2 ¿ 12.37	**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 - 2.35 ¿ 2.45, BH101 - 4.0 ¿ 4.1, BH101 - 6.0 ¿ 6.1 6, BH101 - 6.35 ¿ 6.45, 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**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ¿ 1.6, 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, BH104 - 12.0 ¿ 12.1, 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 - 3.34 ¿ 3.45, BH102 - 4.85 ¿ 4.95, BH102 - 6.35 ¿ 6.45, BH102 - 7.85 ¿ 7.95, BH102 - 9.35 ¿ 9.45, BH102 - 10.85 ¿ 10.9	**09-MAY-2008**	**27-MAY-2008**	09-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ¿ 1.45, BH103 - 3.0 ¿ 3.1, BH103 - 4.35 ¿ 4.45, BH103 - 6.35 ¿ 6.45, BH103 - 9.0 ¿ 9.1, BH103 - 10.85 ¿ 10.9, BH103 - 12.2 ¿ 12.37	**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 / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		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 - 2.35 ¿ 2.45, BH101 - 4.0 ¿ 4.1, BH101 - 6.0 ¿ 6.1 6, BH101 - 6.35 ¿ 6.45, 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**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ¿ 1.6, 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, BH104 - 12.0 ¿ 12.1, 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 - 3.34 ¿ 3.45, BH102 - 4.85 ¿ 4.95, BH102 - 6.35 ¿ 6.45, BH102 - 7.85 ¿ 7.95, BH102 - 9.35 ¿ 9.45, BH102 - 10.85 ¿ 10.9	**09-MAY-2008**	**27-MAY-2008**	09-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ¿ 1.45, BH103 - 3.0 ¿ 3.1, BH103 - 4.35 ¿ 4.45, BH103 - 6.35 ¿ 6.45, BH103 - 9.0 ¿ 9.1, BH103 - 10.85 ¿ 10.9, BH103 - 12.2 ¿ 12.37	**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 - 2.35 ¿ 2.45, BH101 - 4.0 ¿ 4.1, BH101 - 6.0 ¿ 6.1 6, BH101 - 6.35 ¿ 6.45, 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**	**27-MAY-2008**	06-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH104 - 1.5 ¿ 1.6, 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, BH104 - 12.0 ¿ 12.1, 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 - 3.34 ¿ 3.45, BH102 - 4.85 ¿ 4.95, BH102 - 6.35 ¿ 6.45, BH102 - 7.85 ¿ 7.95, BH102 - 9.35 ¿ 9.45, BH102 - 10.85 ¿ 10.9	**09-MAY-2008**	**27-MAY-2008**	09-MAY-2009	✓	**03-JUN-2008**	25-AUG-2008	✓
80* dried soil BH103 - 1.35 ¿ 1.45, BH103 - 3.0 ¿ 3.1, BH103 - 4.35 ¿ 4.45, BH103 - 6.35 ¿ 6.45, BH103 - 9.0 ¿ 9.1, BH103 - 10.85 ¿ 10.9, BH103 - 12.2 ¿ 12.37	**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 SW 846 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.**

Appendix 3
Geological logs

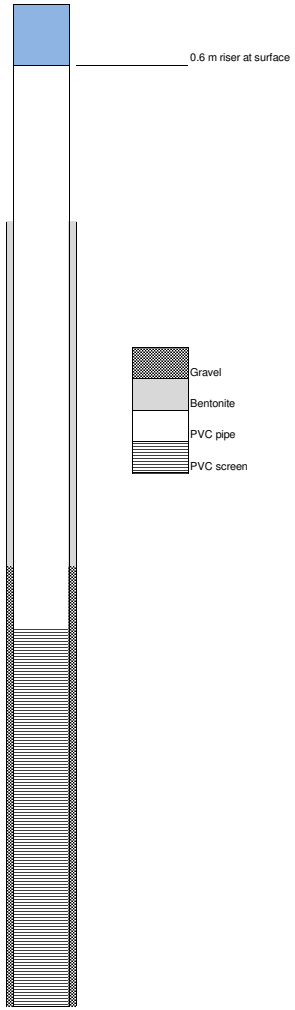
location of bore is 2.5 m south of surveyed point

photos 6316 to 6319 show location next to south st

Soil Log

Page No:		**Drill method:**	**Auger / drill Strataprobe**	
Job Number:	**APG1118.02**	**Hole diameter:**	**50 mm**	
Project:	**Murdoch MUP**	**Groundwater at:**	**5.5 m**	
Date of works:	**12/11/2011**	**End of hole:**	**7.5 m**	
Borehoe ID:	**MB01**	**GPS:**	**391229**	**mE**
Logged by:	**LW**		**6451678**	**mN**

Depth (m)	Graphic log	Description of soil type	Additional observations
0		SAND, sandy, non plascitic, medium subrounded grain, yellow/black, well sorted/poorly graded, moist	no smell
0.25			
0.5			
0.75		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist	no smell
1			
1.25			
1.5			
1.75		SAND, sandy, non plascitic, medium subrounded grain, yellow, well sorted/poorly graded, moist	no smell
2			
2.25			
2.5			
2.75			
3		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist	no smell
3.25			
3.5		SAND, sandy, non plascitic, medium subrounded grain, white, well sorted/poorly graded, moist	no smell
3.75			
4		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist	no smell
4.25			
4.5		SAND, sandy, non plascitic, medium subrounded grain, white, well sorted/poorly graded, wet	no smell
4.75			
5			
5.25			▽ water table
5.5			
5.75			
6		SAND, sandy, non plascitic, medium subrounded grain, grey yellow, well sorted/poorly graded, wet	no smell
6.25			
6.5			
6.75			
7			
7.25			

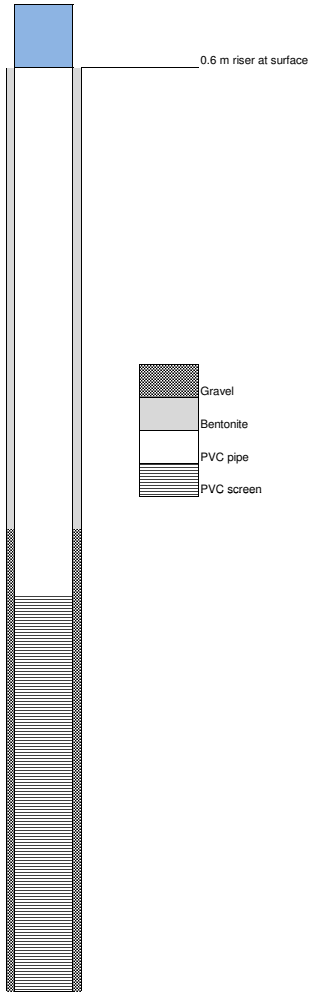


location of bore is 2 m east of surveyed point
photos 6324 to 6326 show location next to south st

Soil Log

Page No:		**Drill method:**	**Auger / drill Strataprobe**
Job Number:	**APG1118.02**	**Hole diameter:**	**50 mm**
Project:	**Murdoch MUP**	**Groundwater at:**	**4.7 m**
Date of works:	**12/11/2011**	**End of hole:**	**7.0 m**
Borehoe ID:	**MB02**	**GPS:**	
Logged by:	**LW**		

Depth (m)	Graphic log	Description of soil type	Additional observations
0		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist	no smell
0.25			
0.5		SAND, sandy, non plascitic, medium subrounded grain, yellow/brown, well sorted/poorly graded, moist	no smell
0.75			
1			
1.25			
1.5			
1.75			
2		SAND, sandy, non plascitic, medium subrounded grain, yellow, well sorted/poorly graded, moist	no smell
2.25			
2.5			
2.75			
3		SAND, sandy, non plascitic, medium subrounded grain, black, well sorted/poorly graded, moist	no smell
3.25		SAND, sandy, non plascitic, medium subrounded grain, yellow, well sorted/poorly graded, moist	no smell
3.5			
3.75			
4		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist/wet	no smell
4.25			
4.5			▽ water table
4.75			
5		SAND, sandy, non plascitic, medium subrounded grain, strong brown, well sorted/poorly graded, wet	no smell
5.25			
5.5			
5.75			
6			
6.25			
6.5			
6.75			



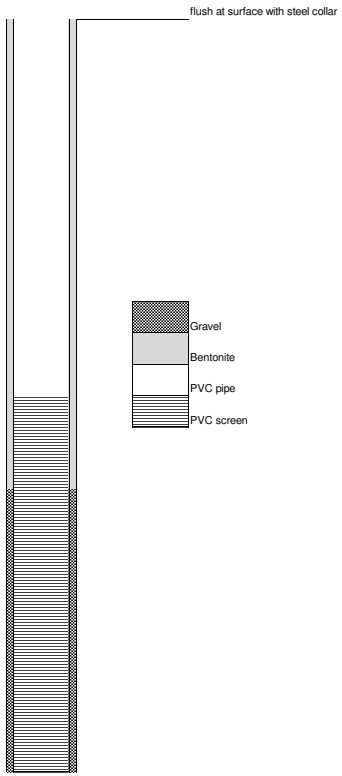
location of bore is 3 m north of original survey point

along bike path, access via underpass from carpark, photos 6313 to 6315

Soil Log

Page No:		**Drill method:**	**Auger / drill Strataprobe**	
Job Number:	**APG1118.02**	**Hole diameter:**	**50 mm**	
Project:	**Murdoch MUP**	**Groundwater at:**	**4 m**	
Date of works:	**12/11/2011**	**End of hole:**	**6 m**	
Borehoe ID:	**MB03**	**GPS:**	**3204 144**	**dS**
Logged by:	**LW**		**115 d 50.961**	**E**

Depth (m)	Graphic log	Description of soil type	Additional observations
0		SAND, sandy, non plascitic, medium subrounded grain, orange, well sorted/poorly graded, moist	no smell
0.25		SAND, sandy, non plascitic, medium subrounded grain, black/grey, well sorted/poorly graded, moist	no smell
0.5			
0.75		SAND, sandy, non plascitic, medium subrounded grain, grey, well sorted/poorly graded, moist	no smell
1			
1.25			
1.5			
1.75		SAND, sandy, non plascitic, medium subrounded grain, white, well sorted/poorly graded, moist	no smell
2			
2.25			
2.5			
2.75			
3			
3.25			
3.5			
3.75		SAND, sandy, non plascitic, medium subrounded grain, brown/red, well sorted/poorly graded, moist	no smell, ▽ water table
4		SAND, sandy, non plascitic, medium subrounded grain, grey/white, well sorted/poorly graded, wet	no smell
4.25			
4.5			
4.75			
5			
5.25			
5.5			
5.75			



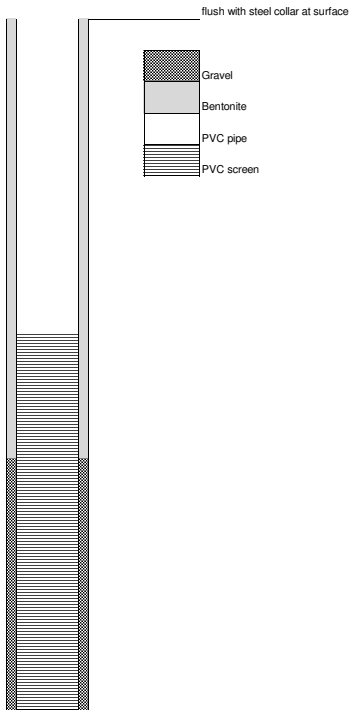
location of bore is approximately 1.5 m south west of surveyed point

photos 6310 to 6312

Soil Log

Page No:		**Drill method:**	**Auger / drill Strataprobe**	
Job Number:	**APG1118.02**	**Hole diameter:**	**50 mm**	
Project:	**Murdoch MUP**	**Groundwater at:**	**3.0 m**	
Date of works:	**12/11/2011**	**End of hole:**	**5.5 m**	
Borehoe ID:	**MB05**	**GPS:**	**391398**	**mE**
Logged by:	**LW**		**6451614**	**mN**

Depth (m)	Graphic log	Description of soil type	Additional observations
0		SAND, sandy, non plastic, medium subrounded grain, yellow/black, well sorted/poorly graded, moist	no smell
0.25			
0.5		SAND, sandy, non plastic, medium subrounded grain, yellow, well sorted/poorly graded, moist	no smell
0.75			
1			
1.25			
1.5			
1.75		SAND, sandy, non plastic, medium subrounded grain, yellow, well sorted/poorly graded, moist	no smell
2			
2.25			
2.5		SAND, sandy, non plastic, medium subrounded grain, dark brown, well sorted/poorly graded, moist	no smell
2.75		SAND, sandy, non plastic, medium subrounded grain, yellow, well sorted/poorly graded, wet	no smell , ▽ water table
3			
3.25			
3.5			
3.75			
4			
4.25			
4.5			
4.75			
5			
5.25			

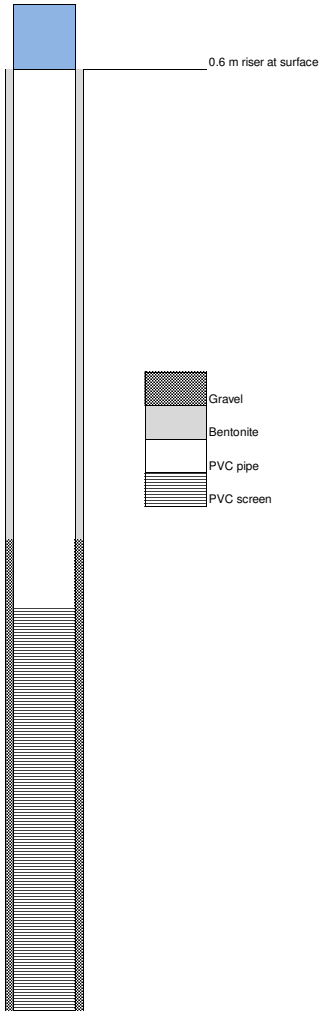


location of bore is approximately 3 m south of surveyed point
photos 6320 to 6323 show location next to south st

Soil Log

Page No:		**Drill method:**	**Auger / drill Strataprobe**	
Job Number:	**APG1118.02**	**Hole diameter:**	**50 mm**	
Project:	**Murdoch MUP**	**Groundwater at:**	**5.0 m**	
Date of works:	**12/11/2011**	**End of hole:**	**7.0 m**	
Borehoe ID:	**MB06**	**GPS:**	**324.027**	**dS**
Logged by:	**LW**		**115 d 50.897**	**E**

Depth (m)	Graphic log	Description of soil type	Additional observations
0		SAND, sandy, non plascitic, medium subangular grain, yellow brown, well sorted/poorly graded, moist	no smell
0.25			
0.5			
0.75			
1			
1.25			
1.5			
1.75			
2			
2.25			
2.5			
2.75			
3			
3.25			
3.5			
3.75			
4			
4.25			
4.5			
4.75			
5		SAND, sandy , non plastic, coarse subrounded grains, strong brown, wel sorted/poorly graded, moist	no smell, ▽ water table
5.25			
5.5		SAND, sandy , non plastic, medium subrounded grains, grey, wel sorted/poorly graded, moist	no smell
5.75			
6			
6.25			
6.5			
6.75			



Appendix 4
Groundwater monitoring results

Sample Identification Number	Sample Date	Depth to groundwater (mbtoc)	Groundwater level (m AHD)	Comments
MB01	Top of casing =	24.034 23.384		15/10/2011 - 17/1/12 22/07/2012 - Present
November	25/11/2011	5.878	18.156	Located near ashplant, and sands that main roads continuely water, water is light brown in colour
December	22/12/2011	5.993	18.041	
January	17/01/2012	6.162	17.872	Bore casing had been knocked over, TOC level no longer accurate
February	-	-	-	Bore is not accessible & damaged
March	-	-	-	Bore is not accessible & damaged
April	-	-	-	Bore is not accessible & damaged
May	24/05/2012	6.474	-	Bore re-established, change TOC level
June	27/06/2012	6.250	-	
July	23/07/2012	-	-	Bore has been paved over, now a car park
August	22/08/2012	5.400	17.984	Bore has been re-installed
September	24/09/2012	5.300	18.084	
October	25/10/2012	5.410	17.974	
November	22/11/2012	5.480	17.904	
December	18/12/2012	5.490	17.894	
January	22/01/2013	5.610	17.774	
February	26/02/2013	5.790	17.594	
March	19/03/2013	6.140	17.244	
April	19/04/2013	6.350	17.034	
May	15/05/2013	-	-	Bore is not accessible & damaged
As discussed discontinued monitoring MB01 due to inaccessability and damage of the bore				
MB02	Top of casing =	23.898		
November	25/11/2011	5.561	18.337	Located near traffic lights and main roads area, water is medium brown in colour
December	22/12/2011	5.651	18.247	
January	17/01/2012	5.832	18.066	
February	27/02/2012	4.270	19.628	Water is medium brown in colour
March	27/03/2012	6.192	17.706	
April	23/04/2012	6.307	17.591	
May	24/05/2012	6.150	17.748	Water is opaque
June	27/06/2012	5.835	18.063	
July	23/07/2012	5.840	18.058	
August	22/08/2012	5.690	18.208	Located near traffic lights and main roads area, water is medium brown in colour
September	24/09/2012	5.550	18.348	
October	25/10/2012	5.610	18.288	
November	22/11/2012	5.730	18.168	Water is medium brown in colour
December	18/12/2012	5.740	18.158	
January	22/01/2013	5.810	18.088	
February	26/02/2013	5.960	17.938	
March	19/03/2013	6.190	17.708	
April	19/04/2013	6.240	17.658	
May	15/05/2013	6.100	17.798	
June	20/06/2013	5.970	17.928	
July	30/07/2013	5.630	18.268	
August	16/08/2013	5.350	18.548	
September	5/09/2013	5.180	18.718	
October	7/10/2013	5.010	18.888	
November	1/11/2013	5.010	18.888	
December	2/12/2013	5.250	18.648	
January	6/01/2014	-	-	Bore has been destroyed, was not replaced as agreed.
As discussed discontinued monitoring MB02 due to damage of the bore				
MB03	Top of casing =	22.703		
November	25/11/2011	3.928	18.775	Water is light brown in colour
December	22/12/2011	4.024	18.679	
January	17/01/2012	4.112	18.591	
February	27/02/2012	4.393	18.310	Water is light brown in colour
March	27/03/2012	4.591	18.112	
April	23/04/2012	4.610	18.093	
May	24/05/2012	4.576	18.127	
June	27/06/2012	4.280	18.423	
July	23/07/2012	4.290	18.413	
August	22/08/2012	4.070	18.633	
September	24/09/2012	3.870	18.833	
October	25/10/2012	3.960	18.743	
November	22/11/2012	3.990	18.713	
December	18/12/2012	4.030	18.673	
January	22/01/2013	4.090	18.613	
February	26/02/2013	-	-	Bore destroyed
As discussed discontinued monitoring MB03 due to damage of the bore				
MB05	Top of casing =	21.896		
November	25/11/2011	3.561	18.335	Water is light brown in colour
December	22/12/2011	3.644	18.252	
January	17/01/2012	3.712	18.184	
February	27/02/2012	3.986	17.910	Water is light brown in colour
March	27/03/2012	4.144	17.752	
April	23/04/2012	4.154	17.742	
May	24/05/2012	4.160	17.736	
June	27/06/2012	3.850	18.046	
July	23/07/2012	3.800	18.096	
August	22/08/2012	3.660	18.236	
September	24/09/2012	3.510	18.386	
October	25/10/2012	3.640	18.256	
November	22/11/2012	3.720	18.176	
December	18/12/2012	3.720	18.176	
January	22/01/2013	3.750	18.146	
February	26/02/2013	3.940	17.956	
March	19/03/2013	4.140	17.756	
April	19/04/2013	4.160	17.736	
May	15/05/2013	4.060	17.836	
June	20/06/2013	3.900	17.996	
July	30/07/2013	3.510	18.386	
August	16/08/2013	3.350	18.546	
September	5/09/2013	3.100	18.796	
October	7/10/2013	3.060	18.836	
November	1/11/2013	3.010	18.886	
December	2/12/2013	3.310	18.586	
January	6/01/2014	3.310	18.586	
February	10/02/2014	3.540	18.356	
March	10/03/2014	3.780	18.116	
April	10/04/2014	3.960	17.936	
May	9/05/2014	3.980	17.916	
End of sampling period				
MB06	Top of casing =	24.108		
November	25/11/2011	5.670	18.438	Water is light brown in colour, lab duplicate MB08
December	22/12/2011	5.762	18.346	
January	17/01/2012	5.927	18.181	
February	27/02/2012	6.112	17.996	Water is dark brown in colour, bore is located near conservation area. Heavy machinery identified in bore location area
March	27/03/2012	6.263	17.845	
April	23/04/2012	6.372	17.736	
May	24/05/2012	6.242	17.866	
June	27/06/2012	5.910	18.198	
July	23/07/2012	5.930	18.178	
August	22/08/2012	5.770	18.338	
September	24/09/2012	5.640	18.468	
October	25/10/2012	5.740	18.368	
November	22/11/2012	5.820	18.288	
December	18/12/2012	5.840	18.268	
January	22/01/2013	5.950	18.158	
February	26/02/2013	6.050	18.058	

March	19/03/2013	6.270	17.838	
April	19/04/2013	6.390	17.718	
May	15/05/2013	6.200	17.908	Bore damaged
June	20/06/2013	6.050	18.058	
July	30/07/2013	5.690	18.418	
August	16/08/2013	5.450	18.658	
September	5/09/2013	5.260	18.848	
October	7/10/2013	5.150	18.958	
November	1/11/2013	5.010	19.098	
December	2/12/2013	5.350	18.758	
January	6/01/2014	5.510	18.598	
February	10/02/2014	5.710	18.398	
March	10/03/2014	5.850	18.258	
April	10/04/2014	6.170	17.938	
May	9/05/2014	6.100	18.008	
				End of sampling period
Conservation Area	TOStake = xx m, GL = xx m			
November	25/11/2011	-	-	No water
December	22/12/2011	-	-	No water
January	17/01/2012	-	-	No water - area quite dry
February	27/02/2012	-	-	No water
March	27/03/2012	-	-	Dry
April	23/04/2012	-	-	Dry
May	24/05/2012	-	-	Dry
June	27/06/2012	-	-	Dry
July	24/09/2012	-	-	Dry
August	22/08/2012	-	-	Dry
September	24/09/2012	-	-	Dry
October	25/10/2012	-	-	Dry
November	22/11/2012	-	-	Dry
December	18/12/2012	-	-	Dry
January	22/01/2013	-	-	Dry
February	26/02/2013	-	-	Dry
March	19/03/2013	-	-	Dry
April	19/04/2013	-	-	Dry
May	15/05/2013	-	-	Dry
June	30/06/2013	-	-	Dry
Concrete Tank	TD = xx m, TOC = xx m, GL = xx m			
February		-	-	No water visible
March	27/03/2012	-	-	No water visible
April	23/04/2012	-	-	No water visible
May	24/05/2012	-	-	No water visible
June	27/06/2012	-	-	No water visible
July	24/09/2012	-	-	No water visible
August	22/08/2012	-	-	No water visible
September	27/03/2012	-	-	No water visible
October	23/04/2012	-	-	No water visible
November	24/05/2012	-	-	No water visible
December	27/06/2012	-	-	No water visible
January	24/09/2012	-	-	No water visible
February	26/02/2013	-	-	No water visible
March	27/03/2012	-	-	No water visible
April	23/04/2012	-	-	No water visible
DoW 4522	Top of casing =	27.62		
May	24/05/2012	6.105	21.515	Depth to ground 17.0m
June	27/06/2012	5.995	21.625	
July	23/07/2012	5.900	21.720	
August	22/08/2012	5.670	21.950	
September	24/09/2012	5.590	22.030	
October	25/10/2012	5.740	21.880	
November	22/11/2012	5.810	21.810	
December	18/12/2012	5.960	21.660	
January	22/01/2013	6.030	21.590	
February	26/02/2013	6.090	21.530	
March	19/03/2013	6.390	21.230	
April	19/04/2013	6.400	21.220	
May	15/05/2013	6.270	21.350	
June	20/06/2013	6.030	21.590	
July	30/07/2013	5.810	21.810	
August	16/08/2013	5.760	21.860	
September	5/09/2013	5.510	22.110	
October	7/10/2013	5.400	22.220	
November	1/11/2013	5.310	22.310	
December	2/12/2013	5.490	22.130	
January	6/01/2014	5.350	22.270	
February	10/02/2014	5.600	22.020	
March	10/03/2014	5.760	21.860	
April	10/04/2014	5.840	21.780	
May	9/04/2014	5.850	21.770	
				End of sampling period
PZ3	Top of casing =	25.020		
May				
June	27/06/2012	7.185	17.835	
July	23/07/2012	6.970	18.050	
August	22/08/2012	6.970	18.050	
September	24/09/2012	6.840	18.180	
October	25/10/2012	6.910	18.110	
November	22/11/2012	6.990	18.030	
December	18/12/2012	7.040	17.980	
January	22/01/2013	7.120	17.900	
February	26/02/2013	7.150	17.870	
March	19/03/2013	7.350	17.670	
April	19/04/2013	7.370	17.650	
May	15/05/2013	7.400	17.620	
June	20/06/2013	7.220	17.800	
July	30/07/2013	6.960	18.060	
August	16/08/2013	6.760	18.260	
September	5/09/2013	6.500	18.520	
October	7/10/2013	6.450	18.570	
November	1/11/2013	6.230	18.790	
December	2/12/2013	6.480	18.540	
January	6/01/2014	6.690	18.330	
February	10/02/2014	6.900	18.120	
March	10/03/2014	DRY	-	
April	10/04/2014	DRY	-	
May	9/04/2014	7.400	17.620	Damp
				End of sampling period
MB07	Top of casing =	unknown, never surveyed		
June	20/06/2013	4.820		MB07 replaced MB03 but was never surveyed
July	30/07/2013	4.510		
August	16/08/2013	4.420		
September	5/09/2013	4.350		
October	7/10/2013	4.210		
November	1/11/2013	4.150		
December	2/12/2013	4.290		
January	6/01/2014	4.280		
Febuary	10/02/2014	4.490		
March	10/03/2014	3.780		
April	10/04/2014	4.950		
May	9/04/2014	4.940		
				End of sampling period

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Groundwater Laboratory Analytical Results

APG - MUP groundwater quality		Metals and Metalloids								Nutrients							Physio - Chem					
		Arsenic	Cadmium	Copper	Chromium	Nickel	Lead	Zinc	Mercury	Ammonia as N	Nitrite as N	Nitrate as N	Total Kjeldahl Nitrogen as N	Total N	Total P	Reactive Phosphorus as P	pH	Electrical Conductivity	Temp	Dissolved Oxygen	Dissolved Oxygen	Redox
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH Unit	ms/cm	oC	mg/L	%	mV
The Swan Canning Water Quality Improvement Plan (short term limits)														2	0.2							
The Swan Canning Water Quality Improvement Plan (Long term limits)														0.5	0.05							
ANZECC & ARMCANZ (2000) guidelines for fresh and marine water quality - 95% trigger value (Freshwater)		24	0.2	1.4	10	11	3.4	8	0.6													
ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in South West Australia																	6.5 - 8.5					
Australian Drinking Water Guideline (2000)												11.3										
Sample ID	**Sample Date**																					
MB01	25/11/2011	3	<0.1	6	7	5	43	41	<0.1	0.03	<0.005	3.50	3.40	6.80	0.38	<0.002	3.34	0.54	20.5	2.950	33.30	317.8
	27/02/2012	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is	is
	24/05/2012	4	<0.1	1	<1	2	10	24	<0.1	1.10	<0.05	0.23	1.20	1.40	0.17	0.01	4.50	0.30	19.4	2.380	24.70	251.0
	22/08/2012	-	-	-	-	-	-	-	-	0.26	<0.005	22.84	2.5	17	0.10	<0.002	5.99	0.63	18.8	3.800	41.20	178.3
	22/11/2012	-	-	-	-	-	-	-	-	0.05	<0.005	24.29	4.50	19.00	0.41	<0.002	4.11	0.36	21.1	3.330	37.80	137.6
	26/02/2013	-	-	-	-	-	-	-	-	0.13	<0.005	3.6	2.1	5.7	0.17	<0.005	4.30	0.27	19.1	2.980	31.50	163.2
	Average	3.5	0.1	3.5	4	4	27	32.5	<0.1	0.31	<0.005	10.89	2.74	9.98	0.25	<0.002	4.49	0.43	19.78	3.09	33.70	209.58
MB02	25/11/2011	5	<0.1	14	20	21	86	69	<0.1	0.06	0.02	13.00	8.60	22.00	0.72	<0.002	4.5	0.57	21.3	2.420	28.50	236.4
	27/02/2012									0.03	<0.05	13.77	5.00	19.00	0.34	<0.002	4.3	0.34	22.8	2.160	24.50	269.6
	24/05/2012	4	<0.1	1	<1	4	11	30	<0.1	0.12	<0.05	0.77	0.95	1.70	0.09	<0.002	4.5	0.21	19.6	1.940	21.10	229.0
	22/08/2012	-	-	-	-	-	-	-	-	0.16	<0.005	2.57	0.99	2.6	0.09	<0.002	4.4	0.20	18.8	6.940	74.50	319.7
	22/11/2012	-	-	-	-	-	-	-	-	0.12	<0.005	10.67	2.10	8.60	0.15	<0.002	4.3	0.27	19.5	3.120	34.20	168.7
	26/02/2013	-	-	-	-	-	-	-	-	0.14	<0.005	4.10	1.70	5.70	0.08	<0.005	4.4	0.58	19.1	3.210	35.60	141.1
	16/05/2013	-	-	-	-	-	-	-	-	0.14	<0.005	7.90	2.20	10.00	0.18	<0.02	4.31	0.31	23.6	1.690	17.90	218.0
	Average	4.5	0.1	7.5	10.1	12.5	48.5	49.5	<0.1	0.11	<0.005	7.48	3.22	9.93	0.25	<0.002	4.41	0.25	20.2	3.3	36.4	227.4
MB03	25/11/2011	<1	<0.1	4	12	2	15	11	<0.1	<0.005	<0.05	24.00	2.50	26.00	0.24	<0.002	5.9	0.48	22.9	5.670	64.20	161.6
	27/02/2012	-	-	-	-	-	-	-	-	<0.005	<0.05	10.16	3.20	14.00	0.46	<0.002	5.7	0.75	23.5	3.240	37.60	137.5
	24/05/2012	<1	<0.1	<1	1	1	<1	7	<0.1	0.018	<0.05	8.40	1.30	9.70	0.25	<0.002	6.3	0.54	23.0	2.860	32.40	180.0
	22/08/2012	-	-	-	-	-	-	-	-	0.060	<0.005	14.00	2.7	11	0.35	<0.002	6.1	0.32	20.4	3.920	43.90	312.3
	22/11/2012	-	-	-	-	-	-	-	-	0.060	<0.005	8.46	3.00	8.10	0.47	<0.002	6.1	0.36	21.7	4.280	48.60	165.4
	26/02/2013	-	-	-	-	-	-	-	-	is	is	is	is	is	is	is	is	is	is	is	is	is
	Average	0.5	0.1	2.3	6.5	1.3	7.8	9.0	<0.1	0.05	0.03	13.00	2.54	13.76	0.35	0.001	6.0	0.54	22.3	4.0	45.3	191.4
MB05	25/11/2011	2	<0.1	5	9	4	91	18	<0.1	0.08	0.02	6.40	4.00	10.00	0.28	<0.002	6.1	0.61	21.5	3.390	39.30	159.2
	27/02/2012	-	-	-	-	-	-	-	-	0.10	<0.05	3.61	2.90	6.50	0.09	<0.002	4.5	0.51	24.9	1.920	23.10	222.8
	24/05/2012	2	<0.1	<1	2	8	26	14	<0.1	0.15	<0.05	7.90	1.30	9.20	0.06	<0.002	4.3	0.66	22.6	2.110	21.70	224.0
	22/08/2012	-	-	-	-	-	-	-	-	0.061	<0.005	21.36	6.3	19	0.19	<0.002	5.8	0.51	21.3	3.090	38.80	144.5
	22/11/2012	-	-	-	-	-	-	-	-	0.11	<0.005	22.45	6.20	20.00	0.15	<0.002	5.2	0.69	22.7	3.350	39.00	183.9
	26/02/2013	-	-	-	-	-	-	-	-	0.20	<0.005	3.5	2.20	5.70	<0.01	<0.005	4.6	0.75	19.8	2.200	28.20	123.5
	16/05/2013	-	-	-	-	-	-	-	-	0.15	<0.005	17	4.00	21.00	0.10	<0.02	3.9	0.53	25.0	1.640	19.50	330.0
	Average	2.0	0.1	2.8	5.5	6.0	58.5	16.0	<0.1	0.12	<0.005	10.87	3.82	11.73	0.15	<0.002	5.18	0.59	22.13	2.68	31.68	176.32
MB06	25/11/2011	2	<0.1	6	11	5	110	36	<0.1	0.58	0.02	1.00	8.50	9.50	0.77	<0.002	6.1	0.37	23.8	3.910	46.50	167.0
	27/02/2012	-	-	-	-	-	-	-	-	0.83	<0.05	0.17	6.80	6.90	0.79	<0.002	5.4	0.11	23.2	2.580	29.10	174.8
	24/05/2012	<1	<0.1	<1	1	1	28	6	<0.1	0.03	<0.05	0.73	1.40	2.10	0.15	<0.002	5.6	0.12	20.8	1.890	20.00	208.0
	22/08/2012	-	-	-	-	-	-	-	-	0.026	<0.005	9.57	2.6	8.4	0.11	<0.002	5.9	0.28	17.6	7.050	74.10	224.2
	22/11/2012	-	-	-	-	-	-	-	-	0.08	<0.005	0.85	3.40	3.90	0.22	<0.002	5.6	0.21	18.9	2.950	32.50	239.7
	26/02/2013	-	-	-	-	-	-	-	-	0.07	<0.005	0.02	1.70	1.70	0.06	<0.005	5.5	0.31	19.5	1.900	22.50	187.5
	Average	1.3	0.1	3.3	6.0	3.0	69.0	21.0	<0.1	0.27	0.02	2.06	4.07	5.42	0.35	<0.002	5.72	0.18	20.63	3.38	37.45	200.19
PZ3	22/08/2012	-	-	-	-	-	-	-	-	0.029	<0.05	10.64	1.0	7.5	0.03	<0.002	4.9	0.45	21.1	2.740	30.90	280.2
	22/11/2012	-	-	-	-	-	-	-	-	0.01	<0.005	10.34	0.79	7.2	0.05	<0.002	4.5	0.51	21.7	3.350	39.00	200.5
	26/02/2013	-	-	-	-	-	-	-	-	<0.005	<0.005	2.5	0.93	3.5	0.07	<0.005	4.4	0.64	20.0	2.560	28.70	198.5
	16/05/2013	-	-	-	-	-	-	-	-	0.014	<0.005	1.4	1.2	2.8	0.1	<0.005	5.1	0.31	23.0	1.700	19.60	244.0
	Average									0.0195	0.025	7.83	0.91	6.07	0.05	0.001	4.7	0.4785	20.93	2.88	32.87	226.4

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LANDCORP - MIXED USE PRECINCT
Monitoring Bores
Whelans Job #14882
Date of survey: 1/12/2011

Bore	Easting (PCG94)	Northing (PCG94)	Easting (MGAz50)	Northing (MGAz50)	RL Top Pipe (Spirit Level)	RL Top Case (Spirit Level)	RL Natural Surface
MB01	52911.20	250812.84	391215.00	6451648.69	23.94	24.03	23.39
MB02	52895.29	250672.46	391200.64	6451508.18	23.80	23.90	23.16
MB03	53086.77	250491.69	391393.96	6451329.56	22.63	22.70	22.70
MB05	53099.59	250776.79	391403.73	6451614.72	21.82	21.90	21.90
MB06	52982.96	250703.04	391287.94	6451539.71	24.00	24.11	23.43
PZ3						25.02	

* from DoH Records

	Easting (PCG94)	Northing (PCG94)	Easting (MGAz50)	Northing (MGAz50)		RL Top Stake (Spirit Level)	RL Natural Surface
Cons. Area	52981.31	250658.99	391286.78	6451495.66		21.54	20.74

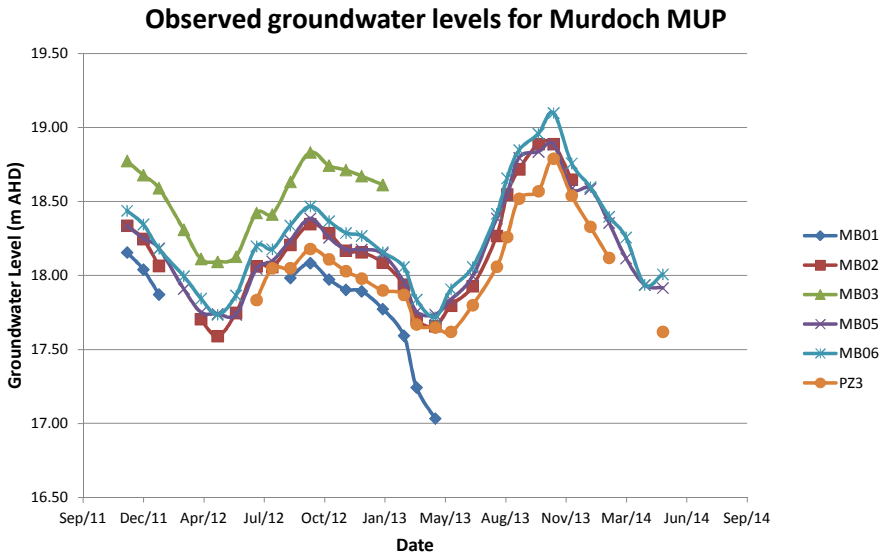
Bore	Max recorded depth
MB01	17.872
MB02	17.591
MB03	18.093
MB05	17.736
MB06	17.736
PZ3	17.835
Cons. Area	-
WC Leeming	27.62

* have data but not in m AHD

strategen ENVIRONMENTAL

Groundwater level results 2011-2014

Survey date	Monitoring Bore							
	MB01	MB02	MB03	MB05	MB06	MB07	PZ3	DoW
Nov-11	18.16	18.34	18.78	18.34	18.44			
Dec-11	18.04	18.25	18.68	18.25	18.35			
Jan-12	17.87	18.07	18.59	18.18	18.18			
Feb-12			18.31	17.91	18.00			
Mar-12		17.71	18.11	17.75	17.85			
Apr-12		17.59	18.09	17.74	17.74			
May-12		17.75	18.13	17.74	17.87			21.52
Jun-12		18.06	18.42	18.05	18.20		17.84	21.63
Jul-12		18.06	18.41	18.10	18.18		18.05	21.72
Aug-12	17.98	18.21	18.63	18.24	18.34		18.05	21.95
Sep-12	18.08	18.35	18.83	18.39	18.47		18.18	22.03
Oct-12	17.97	18.29	18.74	18.26	18.37		18.11	21.88
Nov-12	17.90	18.17	18.71	18.18	18.29		18.03	21.81
Dec-12	17.89	18.16	18.67	18.18	18.27		17.98	21.66
Jan-13	17.77	18.09	18.61	18.15	18.16		17.90	21.59
Feb-13	17.59	17.94		17.96	18.06		17.87	21.53
Mar-13	17.24	17.71		17.76	17.84		17.67	21.23
Apr-13	17.03	17.66		17.74	17.72		17.65	21.22
May-13		17.80		17.84	17.91		17.62	21.35
Jun-13		17.93		18.00	18.06		17.80	21.59
Jul-13		18.27		18.39	18.42		18.06	21.81
Aug-13		18.55		18.55	18.66		18.26	21.86
Sep-13		18.72		18.80	18.85		18.52	22.11
Oct-13		18.89		18.84	18.96		18.57	22.22
Nov-13		18.89		18.89	19.10		18.79	22.31
Dec-13		18.65		18.59	18.76		18.54	22.13
Jan-14				18.59	18.60		18.33	22.27
Feb-14				18.356	18.398		18.120	22.02
Mar-14				18.116	18.258			21.86
Apr-14				17.936	17.938			21.78
May-14				17.916	18.008		17.620	21.77



Appendix 5
Groundwater Level calculations

WIN SITE	AWRC RE	REFEREN	CONTEXT	NAME	ZONE	EASTING	NORTHING	SECURITY L	COLLECTED DATE	READING RELIABILITY	CONVERTED LEVEL (mAHD)	UNIT	USED OUT	Yearly Max
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 15/08/1975	=	23.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 18/09/1975	=	23.550	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 21/10/1975	=	23.440	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 18/11/1975	=	23.330	m	AHD	23.550
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 19/03/1976	=	22.700	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 27/04/1976	=	22.590	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 17/05/1976	=	22.530	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 16/06/1976	=	22.500	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 14/07/1976	=	22.520	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 24/09/1976	=	22.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 22/10/1976	=	22.990	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 17/11/1976	=	22.910	m	AHD	22.990
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 15/04/1977	=	22.310	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 12/05/1977	=	22.230	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 27/06/1977	=	22.170	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/07/1977	=	22.170	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 12/09/1977	=	22.520	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/10/1977	=	22.530	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 16/11/1977	=	22.600	m	AHD	22.600
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/03/1978	=	22.090	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/04/1978	=	22.030	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/05/1978	=	21.950	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/06/1978	=	21.920	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/07/1978	=	22.190	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/08/1978	=	22.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/09/1978	=	22.970	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/10/1978	=	23.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/11/1978	=	23.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/12/1978	=	22.910	m	AHD	23.100
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/01/1979	=	22.750	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/02/1979	=	23.120	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/03/1979	=	22.480	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/04/1979	=	22.330	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/05/1979	=	22.270	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/06/1979	=	22.230	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/07/1979	=	22.330	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/08/1979	=	22.540	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/09/1979	=	22.720	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/10/1979	=	22.730	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/11/1979	=	22.610	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/12/1979	=	22.520	m	AHD	23.120
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/01/1980	=	22.340	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/02/1980	=	22.200	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/03/1980	=	22.060	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/04/1980	=	21.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/05/1980	=	21.940	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/06/1980	=	21.930	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/07/1980	=	22.160	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/08/1980	=	22.360	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/09/1980	=	22.830	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/10/1980	=	22.940	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/11/1980	=	22.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/12/1980	=	22.790	m	AHD	22.940
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/01/1981	=	22.600	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/02/1981	=	22.420	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/03/1981	=	22.290	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/04/1981	=	22.200	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/05/1981	=	22.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/06/1981	=	22.040	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/07/1981	=	22.250	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/08/1981	=	22.490	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/09/1981	=	22.960	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/10/1981	=	23.020	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/11/1981	=	22.920	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/12/1981	=	22.820	m	AHD	23.020
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/01/1982	=	22.640	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 09/02/1982	=	22.650	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/03/1982	=	22.450	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/04/1982	=	22.340	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/05/1982	=	22.290	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 11/06/1982	=	22.220	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/07/1982	=	22.410	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/08/1982	=	22.780	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/09/1982	=	22.950	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/10/1982	=	23.020	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/11/1982	=	22.970	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/12/1982	=	22.820	m	AHD	23.020
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/01/1983	=	22.630	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/02/1983	=	22.460	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 11/04/1983	=	22.260	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/05/1983	=	22.120	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 09/06/1983	=	21.990	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/07/1983	=	22.260	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/08/1983	=	22.540	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/09/1983	=	22.820	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/10/1983	=	23.010	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/11/1983	=	22.900	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/12/1983	=	22.770	m	AHD	23.010
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 10/01/1984	=	22.720	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/02/1984	=	22.420	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/03/1984	=	22.300	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/04/1984	=	22.170	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/05/1984	=	22.080	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/06/1984	=	22.190	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/07/1984	=	22.520	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/08/1984	=	22.680	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 05/09/1984	=	22.810	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/10/1984	=	22.860	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/11/1984	=	22.800	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/12/1984	=	23.060	m	AHD	23.060
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/03/1985	=	22.510	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/04/1985	=	22.380	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/05/1985	=	22.310	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 06/06/1985	=	22.250	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/07/1985	=	22.370	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/08/1985	=	22.790	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 04/09/1985	=	23.070	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/10/1985	=	23.120	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 01/11/1985	=	23.040	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 02/12/1985	=	22.940	m	AHD	23.120
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:40:00 13/01/1986	=	22.690	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:42:00 11/02/1986	=	22.510	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:02:00 04/03/1986	=	22.480	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:50:00 30/04/1986	=	22.290	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:04:00 03/07/1986	=	22.590	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:11:00 05/08/1986	=	23.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:09:00 05/09/1986	=	23.500	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:02:00 30/09/1986	=	23.580	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:25:00 20/11/1986	=	23.460	m	AHD	23.580
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:46:00 05/01/1987	=	23.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 29/01/1987	=	22.950	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:27:00 23/02/1987	=	22.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:14:00 11/03/1987	=	22.660	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:35:00 06/04/1987	=	22.570	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:50:00 18/05/1987	=	22.680	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:51:00 18/06/1987	=	22.610	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:43:00 20/07/1987	=	22.950	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:13:00 20/08/1987	=	23.460	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:37:00 14/09/1987	=	23.490	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:06:00 16/10/1987	=	23.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:36:00 16/11/1987	=	23.300	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 16/12/1987	=	23.180	m	AHD	23.490
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:20:00 12/01/1988	=	23.040	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:17:00 01/03/1988	=	22.675	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:10:00 21/04/1988	=	22.440	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:31:00 16/05/1988	=	22.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:10:00 24/06/1988	=	22.890	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:18:00 27/07/1988	=	23.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:49:00 19/08/1988	=	23.665	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:21:00 19/09/1988	=	23.720	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:08:00 28/10/1988	=	23.790	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:11:00 22/11/1988	=	23.700	m	AHD	23.790
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:32:00 17/01/1989	=	23.330	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:20:00 23/03/1989	=	22.900	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:26:00 19/04/1989	=	22.770	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:16:00 24/07/1989	=	23.010	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:32:00 06/09/1989	=	23.240	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:09:00 22/09/1989	=	23.290	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:45:00 19/10/1989	=	23.380	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:35:00 27/11/1989	=	23.220	m	AHD	23.380
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:14:00 04/01/1990	=	23.090	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:29:00 23/01/1990	=	23.000	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 15/02/1990	=	22.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:40:00 12/03/1990	=	22.740	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:55:00 09/04/1990	=	22.640	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:43:00 10/05/1990	=	22.570	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:12:00 09/06/1990	=	22.510	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:14:00 09/07/1990	=	22.540	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:38:00 14/08/1990	=	22.840	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:05:00 07/09/1990	=	22.910	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 09/10/1990	=	22.910	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:26:00 12/11/1990	=	22.820	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:59:00 03/12/1990	=	22.760	m	AHD	23.090
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:42:00 04/01/1991	=	22.620	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:28:00 14/02/1991	=	22.420	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:08:00 11/03/1991	=	22.290	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:24:00 03/04/1991	=	22.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:23:00 21/05/1991	=	22.110	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:20:00 12/06/1991	=	22.250	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:28:00 11/07/1991	=	22.870	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:06:00 05/08/1991	=	23.160	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:54:00 16/09/1991	=	23.360	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:29:00 07/10/1991	=	23.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:04:00 12/11/1991	=	23.330	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:11:00 09/12/1991	=	23.250	m	AHD	23.430
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 07/01/1992	=	23.130	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:15:00 06/02/1992	=	22.930	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:31:00 09/03/1992	=	23.130	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:44:00 01/04/1992	=	23.140	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:30:00 19/05/1992	=	23.010	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:40:00 11/06/1992	=	23.010	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:48:00 13/07/1992	=	23.435	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:48:00 12/08/1992	=	23.720	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 03/09/1992	=	23.940	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:38:00 07/10/1992	=	24.030	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:06:00 06/11/1992	=	23.790	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:06:00 09/11/1992	=	23.740	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:27:00 07/12/1992	=	23.630	m	AHD	24.030
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:12:00 07/01/1993	=	23.420	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:41:00 03/02/1993	=	23.230	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:29:00 02/03/1993	=	23.050	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:36:00 02/04/1993	=	22.940	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:07:00 04/05/1993	=	22.810	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:42:00 03/06/1993	=	22.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:09:00 08/07/1993	=	22.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:32:00 10/08/1993	=	23.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:52:00 06/09/1993	=	23.320	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:42:00 18/10/1993	=	23.350	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:24:00 04/11/1993	=	23.300	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:16:00 06/12/1993	=	23.090	m	AHD	23.420
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:33:00 07/01/1994	=	22.860	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:16:00 04/02/1994	=	22.640	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:47:00 04/03/1994	=	22.450	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:34:00 07/04/1994	=	22.230	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:39:00 04/05/1994	=	22.130	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:02:00 07/06/1994	=	22.340	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:52:00 05/07/1994	=	22.690	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:20:00 09/08/1994	=	23.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:10:00 08/09/1994	=	23.320	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:25:00 07/10/1994	=	23.320	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:05:00 07/11/1994	=	23.170	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:30:00 05/12/1994	=	22.910	m	AHD	23.320
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:40:00 06/01/1995	=	22.620	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:50:00 06/02/1995	=	22.360	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:45:00 28/02/1995	=	22.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:25:00 03/04/1995	=	22.040	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:20:00 05/05/1995	=	21.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:25:00 13/06/1995	=	22.140	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:50:00 06/07/1995	=	22.200	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:25:00 08/08/1995	=	22.650	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:00:00 08/09/1995	=	22.750	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:30:00 05/10/1995	=	22.860	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:40:00 13/11/1995	=	22.810	m	AHD	22.860
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:50:00 09/01/1996	=	22.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:40:00 13/02/1996	=	22.150	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:55:00 07/03/1996	=	22.000	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:50:00 04/04/1996	=	21.900	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:30:00 13/05/1996	=	21.850	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:05:00 11/06/1996	=	21.820	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:20:00 02/07/1996	=	22.030	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:50:00 09/08/1996	=	22.550	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:16:00 12/09/1996	=	22.830	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:20:00 03/10/1996	=	22.970	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:35:00 14/11/1996	=	22.900	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:35:00 05/12/1996	=	22.830	m	AHD	22.970
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:05:00 08/01/1997	=	22.540	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:24:00 11/02/1997	=	22.260	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:45:00 07/03/1997	=	22.130	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:30:00 04/04/1997	=	22.050	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:10:00 08/05/1997	=	21.990	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:30:00 30/05/1997	=	21.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 02/07/1997	=	22.150	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:25:00 06/08/1997	=	22.220	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:35:00 05/09/1997	=	22.520	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:34:00 02/10/1997	=	22.600	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:25:00 06/11/1997	=	22.350	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:35:00 02/12/1997	=	22.230	m	AHD	22.600
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:45:00 07/01/1998	=	22.030	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:55:00 03/02/1998	=	21.850	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:55:00 05/03/1998	=	21.700	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:25:00 02/04/1998	=	21.650	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:35:00 06/05/1998	=	21.570	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:32:00 04/06/1998	=	21.640	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:12:00 03/07/1998	=	21.810	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:15:00 06/08/1998	=	21.910	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:55:00 03/09/1998	=	22.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:15:00 02/10/1998	=	22.330	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:58:00 30/10/1998	=	22.250	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:37:00 27/11/1998	=	22.100	m	AHD	22.330
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:25:00 07/01/1999	=	21.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:05:00 04/02/1999	=	21.740	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:58:00 05/03/1999	=	21.580	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:45:00 09/04/1999	=	21.500	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:15:00 07/05/1999	=	21.480	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:05:00 10/06/1999	=	21.530	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:46:00 06/07/1999	=	21.690	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:31:00 29/07/1999	=	21.840	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:18:00 08/09/1999	=	22.180	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:12:00 07/10/1999	=	22.390	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:19:00 01/11/1999	=	22.460	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:58:00 07/12/1999	=	22.220	m	AHD	22.460
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:19:00 07/01/2000	=	21.990	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:38:00 02/02/2000	=	22.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:53:00 02/03/2000	=	21.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:50:00 31/03/2000	=	21.870	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:04:00 02/05/2000	=	21.860	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:28:00 02/06/2000	=	21.850	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:51:00 05/07/2000	=	22.030	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:34:00 02/08/2000	=	22.530	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:01:00 04/09/2000	=	22.740	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:21:00 03/10/2000	=	22.780	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:23:00 03/11/2000	=	22.650	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:00:00 07/12/2000	=	22.410	m	AHD	22.780
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:57:00 04/01/2001	=	22.240	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:19:00 01/02/2001	=	21.990	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:02:00 08/03/2001	=	21.780	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:26:00 02/04/2001	=	21.660	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:33:00 27/04/2001	=	21.570	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:02:00 06/06/2001	=	21.690	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:09:00 28/06/2001	=	21.710	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:24:00 31/07/2001	=	21.890	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:46:00 31/08/2001	=	22.280	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:25:00 02/10/2001	=	22.390	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:02:00 29/10/2001	=	22.390	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:21:00 06/12/2001	=	22.180	m	AHD	22.390
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:34:00 07/01/2002	=	21.950	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:18:00 01/02/2002	=	21.820	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:59:00 28/02/2002	=	21.650	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:07:00 04/04/2002	=	21.460	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	15:10:00 23/04/2002	=	21.550	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:46:00 30/05/2002	=	21.580	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	00:00:00 28/06/2002	=	21.740	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:54:00 26/07/2002	=	22.020	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:47:00 23/08/2002	=	22.200	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:11:00 01/10/2002	=	22.260	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:05:00 30/10/2002	=	22.240	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:18:00 05/12/2002	=	22.020	m	AHD	22.260
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:32:00 07/01/2003	=	21.810	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:45:00 31/01/2003	=	21.650	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:15:00 28/02/2003	=	21.500	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:40:00 28/03/2003	=	21.370	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:13:00 02/05/2003	=	21.400	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:39:00 29/05/2003	=	21.460	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:59:00 04/07/2003	=	21.660	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:32:00 31/07/2003	=	22.000	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:29:00 29/08/2003	=	22.240	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:54:00 07/10/2003	=	22.430	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:35:00 11/11/2003	=	22.250	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:57:00 08/12/2003	=	22.080	m	AHD	22.430
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:33:00 14/01/2004	=	21.830	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:34:00 04/02/2004	=	21.690	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:47:00 05/03/2004	=	21.590	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:58:00 02/04/2004	=	21.410	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:30:00 30/04/2004	=	21.340	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:27:00 24/05/2004	=	21.410	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:46:00 01/07/2004	=	21.590	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:09:00 27/07/2004	=	21.760	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:24:00 20/08/2004	=	21.880	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:22:00 01/10/2004	=	22.100	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:21:00 29/10/2004	=	21.980	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:25:00 25/11/2004	=	21.878	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	08:32:00 23/12/2004	=	21.808	m	AHD	22.100
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:46:00 28/01/2005	=	21.488	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:25:00 24/02/2005	=	21.368	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:15:00 24/03/2005	=	21.228	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:35:00 21/04/2005	=	21.228	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:54:00 19/05/2005	=	21.348	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:14:00 16/06/2005	=	21.828	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:07:00 28/07/2005	=	22.378	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:56:00 26/08/2005	=	22.548	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:39:00 23/09/2005	=	22.668	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:22:00 28/10/2005	=	22.668	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:08:00 01/12/2005	=	22.478	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:18:00 22/12/2005	=	22.408	m	AHD	22.668
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:30:00 01/02/2006	=	22.148	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:17:00 01/03/2006	=	22.028	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:32:00 31/03/2006	=	21.838	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:21:00 02/05/2006	=	21.818	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:08:00 31/05/2006	=	21.768	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:07:00 30/06/2006	=	21.728	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:57:00 28/07/2006	=	21.738	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:53:00 31/08/2006	=	21.988	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:45:00 25/09/2006	=	21.998	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:43:00 01/11/2006	=	21.738	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:34:00 01/12/2006	=	21.658	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:19:00 20/12/2006	=	21.528	m	AHD	22.148
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:34:00 17/01/2007	=	21.348	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	08:40:00 16/02/2007	=	21.238	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:57:00 19/03/2007	=	21.118	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:23:00 18/04/2007	=	21.128	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:40:00 16/05/2007	=	21.138	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:16:00 14/06/2007	=	21.148	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:28:00 13/07/2007	=	21.298	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:37:00 10/08/2007	=	21.588	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:35:00 17/09/2007	=	21.868	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:03:00 11/10/2007	=	21.988	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:45:00 09/11/2007	=	21.928	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:14:00 10/12/2007	=	21.748	m	AHD	21.988
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:39:00 11/01/2008	=	21.558	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:29:00 12/02/2008	=	21.418	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:14:00 12/03/2008	=	21.288	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:41:00 03/04/2008	=	21.278	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:28:00 02/05/2008	=	21.388	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:20:00 03/06/2008	=	21.428	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:12:00 30/06/2008	=	21.628	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:48:00 30/07/2008	=	21.888	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:52:00 16/09/2008	=	22.108	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:43:00 22/10/2008	=	22.018	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:51:00 14/11/2008	=	21.998	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:03:00 11/12/2008	=	21.948	m	AHD	22.108
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:09:00 12/01/2009	=	21.688	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:03:00 16/02/2009	=	21.508	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:48:00 06/03/2009	=	21.428	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:54:00 14/04/2009	=	21.308	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:24:00 12/05/2009	=	21.228	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:31:00 05/06/2009	=	21.338	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:23:00 14/07/2009	=	21.508	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:09:00 06/08/2009	=	21.828	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:34:00 03/09/2009	=	22.138	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:39:00 16/10/2009	=	22.298	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:37:00 06/11/2009	=	22.228	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:53:00 09/12/2009	=	22.028	m	AHD	22.298
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:23:00 13/01/2010	=	21.778	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:08:00 08/02/2010	=	21.548	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:19:00 12/03/2010	=	21.368	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:21:00 01/04/2010	=	21.368	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:09:00 07/05/2010	=	21.358	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:37:00 04/06/2010	=	21.438	m	AHD	

4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:10:00 09/07/2010	=	21.538	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:50:00 13/08/2010	=	21.728	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	14:34:00 30/08/2010		21.728	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:10:00 06/10/2010		21.198	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:50:00 05/11/2010		21.478	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:03:00 14/12/2010		21.278	m	AHD	21.778
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:32:00 07/01/2011		21.228	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:40:00 17/02/2011		21.008	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:05:00 15/03/2011		20.878	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	13:01:00 19/04/2011		20.828	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:15:00 19/05/2011		20.898	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	12:19:00 13/06/2011		21.038	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:00:00 13/07/2011		21.328	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	11:02:00 12/08/2011		21.658	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:10:00 19/09/2011		22.028	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	08:45:00 10/10/2011		22.138	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	09:40:00 10/11/2011		22.168	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:06:00 12/12/2011		21.938	m	AHD	22.168
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	08:45:00 12/01/2012		21.738	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	08:16:00 09/02/2012		21.628	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:00:00 12/03/2012		21.498	m	AHD	
4522	61610181	61610181	JANDAKOT	JM2	50	393255	6449867	Unrestricted	10:30:00 10/04/2012		21.438	m	AHD	

AAMGL	22.849
Min	21.778
Max	24.030

Year	Month	Max Reading (AHD)	
1975	September	23.550	12:00:00 18/09/1975
1976	October	22.990	12:00:00 22/10/1976
1977	November	22.600	12:00:00 16/11/1977
1978	November	23.100	12:00:00 06/11/1978
1979	February	23.120	12:00:00 01/02/1979
1980	October	22.940	12:00:00 06/10/1980
1981	October	23.020	12:00:00 02/10/1981
1982	October	23.020	12:00:00 05/10/1982
1983	October	23.010	12:00:00 07/10/1983
1984	december	23.060	12:00:00 04/12/1984
1985	October	23.120	12:00:00 03/10/1985
1986	September	23.580	14:02:00 30/09/1986
1987	September	23.490	12:37:00 14/09/1987
1988	October	23.790	11:08:00 28/10/1988
1989	October	23.380	11:45:00 19/10/1989
1990	January	23.090	12:14:00 04/01/1990
1991	October	23.430	11:29:00 07/10/1991
1992	October	24.030	14:38:00 07/10/1992
1993	January	23.420	12:12:00 07/01/1993
1994	October	23.320	12:25:00 07/10/1994
1995	October	22.86	12:30:00 05/10/1995
1996	October	22.970	10:20:00 03/10/1996
1997	October	22.600	11:34:00 02/10/1997
1998	October	22.330	11:15:00 02/10/1998
1999	November	22.460	11:19:00 01/11/1999
2000	October	22.780	11:21:00 03/10/2000
2001	October	22.390	12:02:00 29/10/2001
2002	October	22.260	14:11:00 01/10/2002
2003	October	22.430	12:54:00 07/10/2003
2004	October	22.100	11:22:00 01/10/2004
2005	October	22.668	11:22:00 28/10/2005
2006	February	22.148	11:30:00 01/02/2006
2007	October	21.988	14:03:00 11/10/2007
2008	September	22.108	09:52:00 16/09/2008
2009	October	22.298	12:39:00 16/10/2009
2010	January	21.778	11:23:00 13/01/2010
2011	November	22.168	09:40:00 10/11/2011
2012	September	22.030	

AAMGL	22.827
Min	21.778
Max	24.030

AAMGL Calculations

Water level

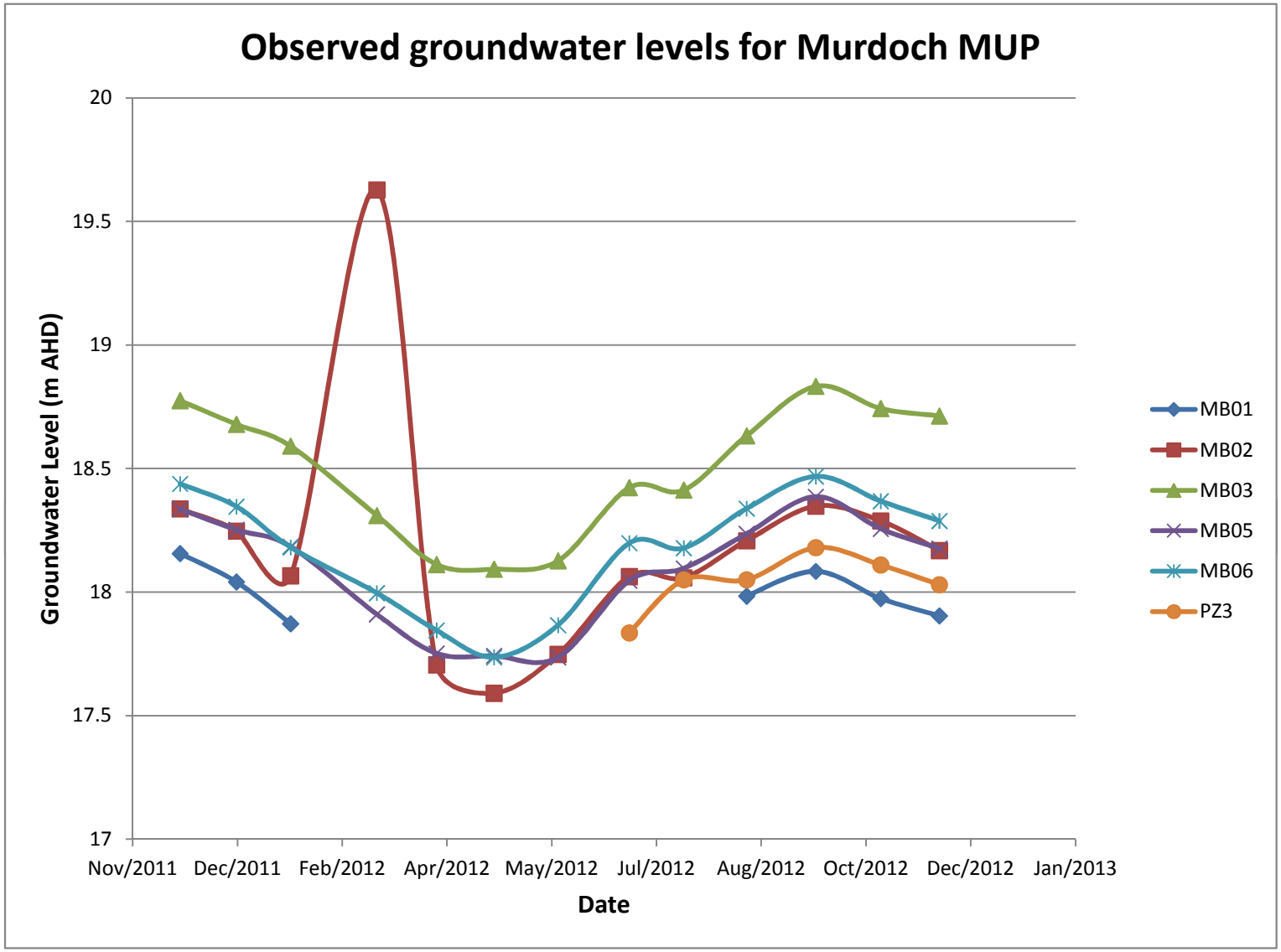
Date	MB01	MB02	MB03	MB05	MB06	PZ3	DoW
25/11/2011 13:50	18.156	18.337	18.775	18.335	18.438		
22/12/2011 11:10	18.041	18.247	18.679	18.252	18.346		
17/01/12	17.872	18.066	18.591	18.184	18.181		
27/02/12		19.628	18.31	17.91	17.996		
27/03/12		17.706	18.112	17.752	17.845		
23/04/12		17.591	18.093	17.742	17.736		
24/05/12		17.748	18.127	17.736	17.866		21.515
27/06/12		18.063	18.423	18.046	18.198	17.835	21.625
23/07/12		18.058	18.413	18.096	18.178	18.05	21.72
22/08/12	17.984	18.208	18.633	18.236	18.338	18.05	21.95
24/09/12	18.084	18.348	18.833	18.386	18.468	18.18	22.03
25/10/12	17.974	18.288	18.743	18.256	18.368	18.11	21.88
22/11/12	17.904	18.168	18.713	18.176	18.288	18.03	21.81

MB02 Data removed, possible outlier

Maximum value for this bore

At 24/9/12		
DoW =	22.03	m AHD
DoW AAMGL =	22.827	m AHD
Difference	0.797	

Date	MB01	MB02	MB03	MB05	MB06	PZ3	DoW
Level at 24/09/2012	18.084	18.348	18.833	18.386	18.468	18.18	22.03
AAMGL (new)	18.881	19.145	19.63	19.183	19.265	18.977	22.827


Observed groundwater levels for Murdoch MUP
Groundwater Level (m AHD)
20
19.5
19
18.5
18
17.5
17
Nov/2011
Dec/2011
Feb/2012
Apr/2012
May/2012
Jul/2012
Aug/2012
Oct/2012
Dec/2012
Jan/2013
Date
MB01
MB02
MB03
MB05
MB06
PZ3

Date	MB01	MB02	MB03	MB05	MB06	PZ3
Level at 24/09/2012	18.084	18.348	18.833	18.386	18.468	18.18
AAMGL (previous)	18.837	19.018	19.456	19.016	19.119	
AAMGL (revised)	18.881	19.145	19.63	19.183	19.265	18.977
	0.044	0.127	0.174	0.167	0.146	

Appendix 6
Stormwater system design calculations

CALCULATION PAGE 1:

1.0 MURDOCH MUP - STORMWATER CATCHMENT AREAS

EXISTING

Existing Tanks 2 & 3 Catchments

Catchment No.	Description	Catchment Area (m^2)	Impervious Factor (%)	Imp. Catchment Area (m^2)
26	Barry Marshall Pde (South)	2,174	90	1,957
25	Bedbrook Row	4,210	90	3,789
28	Fiona Wood Rd Roundabout	5,122	90	4,610
27	Marri Close	1,027	90	924
15B	FSH - Building	19,575	85	16,639
15A	FSH - Loading Dock	4,185	100	4,185
15C	FSH - Loading Dock access	1,224	100	1,224
34	FSH - Building Lot	3,256	85	2,768
31	FSH - Building Lot	3,837	85	3,261
7C	Lot 7C - Building Lot	4,321	85	3,673
				43,029

Existing Basins 4 and Tank 5 Catchments

15D	Loading Dock Access	936	90	842
21	Barry Marshall Pde (North)	3,296	90	2,966
22	Barry Marshall Pde (Central)	5,690	90	5,121
23	Fiona Wood Rd (North)	5,687	90	5,118
24	Fiona Wood Rd (Central)	3,416	90	4,698
7A	Lot 7A - Building Lot	2,048	85	1,741
7B	Lot 7B - Building Lot	2,006	85	1,705
7D	Lot 7C - Building Lot	1,906	85	1,620
7R	Lot 7 - Internal Road	1,376	90	1,238
Basin 4	North Park Basin	4,260	25	1,065
P1	Landscaping Above Tank 5	1,848	50	924
Overflow 6	Aileen Plant Park	9,133	25	2,283
				29,323

NEW STAGE 2

New Lot Catchments

R1	Circle Road	5,356	90	4,820
R2	Road (ROW)	1,150	90	1,035
R3	Road (ROW)	1,492	90	1,343
R4	Road (ROW)	666	90	599
2A	Lot 2A - Building Lot	2,339	85	1,988
2B	Lot 2B - Building Lot	2,247	85	1,910
3	Lot 3 - Building Lot	4,188	85	3,560
4	Lot 4 - Building Lot	3,565	85	3,030
5	Lot 5 - Building Lot	2,703	85	2,298
6	Lot 6 - Building Lot	2,861	85	2,432
P2	Public Open Space	5,670	50	2,835
				25,850

NEW STAGE 1

New Lot 1 Catchments

1A (*)	Lot 1A - Building Lot (*)	3,623	85	3,080
1B (*)	Lot 1B - Building Lot (*)	3,545	85	3,013
1C (*)	Lot 1C - Building Lot (*)	2,383	85	2,026
1D	Lot 1D - Building Lot	2,324	85	1,975
1R (*)	Lot 1 - Internal Road (*	2,016	90	1,814
				11,908

(*) Catchment to be stored in underground tanks for 10yr:72hr storm before overflowing

LEGEND

- NEW LOT CATCHMENT
- NEW ROAD CATCHMENT
- NEW LANDSCAPING CATCHMENT
- NEW LOT 1 CATCHMENT (INTERNAL STORAGE)
- NEW LOT 1 ROAD CATCHMENT (INTERNAL STORAGE)
- EXISTING LOT CATCHMENT
- EXISTING ROAD CATCHMENT
- EXISTING LOADING DOCK CATCHMENT
- EXISTING LANDSCAPING/ BASIN CATCHMENT
- EXISTING CONSERVATION AREA CATCHMENT
- 22 / 5690 m² — EXISTING CATCHMENT NUMBER AND AREA
- 1C / 2383 m² — NEW CATCHMENT NUMBER AND AREA



Calculation Page 2: Catchments & Storage Calculations

Murdoch Mixed Use Precinct

2.1 Existing Drainage Catchment Calculations

Existing Tanks 2 & 3 Catchments

Catchment No.	Comments	Catchment Area (m2)	Impervious Factor (%)	Imp. Catchemnt Area (m2)
26	Barry Marshall Pde (South)	2,174	90	1,957
25	Bedbrook Row	4,210	90	3,789
28	Fiona Wood Rd Roundabout	5,122	90	4,610
27	Marri Close	1,027	90	924
15B	FSH - Building	19,575	85	16,639
15A	FSH - Loading Dock	4,185	100	4,185
15C	FSH - Loading Dock access	1,224	100	1,224
34	FSH - Building Lot	3,256	85	2,768
31	FSH - Building Lot	3,837	85	3,261
7C	Lot 7C - Building Lot	4,321	85	3,673

Total Sub-Area (Ha) = *4.30*

Existing Basins 4 and Tank 5 Catchments

Catchment No.	Comments	Catchment Area (m2)	Impervious Factor (%)	Imp. Catchemnt Area (m2)
15D	Loading Dock Access	936	90	842
21	Barry Marshall Pde (North)	3,296	90	2,966
22	Barry Marshall Pde (Central)	5,690	90	5,121
23	Fiona Wood Rd (North)	5,687	90	5,118
24	Fiona Wood Rd (Central)	3,416	90	4,698
7A	Lot 7A - Building Lot	2,048	85	1,741
7B	Lot 7B - Building Lot	2,006	85	1,705
7D	Lot 7C - Building Lot	1,906	85	1,620
7R	Lot 7 - Internal Road	1,376	90	1,238
Basin 4	North Park Basin	4,260	25	1,065
P1	Landscaping Above Tank 5	1,848	50	924
Overflow 6 (*)	Aileen Plant Park (*)	9,133	25	2,283
1D	Lot 1D - Building Lot	2,324	85	1,975

Total Sub-Area (Ha) = *3.13*

Additional Lot 1 Drainage - Stage 1

Catchment No.	Comments	Catchment Area (m2)	Impervious Factor (%)	Imp. Catchemnt Area (m2)
1A	Lot 1A - Building Lot	3,623	85	3,080
1B	Lot 1B - Building Lot	3,545	85	3,013
1C	Lot 1C - Building Lot	2,383	85	2,026
1R	Lot 1 - Internal Road	2,016	90	1,814

Total Sub-Area (Ha) = *0.99*

Additional MUP Drainage - Stage 2

Catchment No.	Comments	Catchment Area (m2)	Impervious Factor (%)	Imp. Catchemnt Area (m2)
R1	Circle Road	5,356	90	4,820
R2	Road (ROW)	1,150	90	1,035
R3	Road (ROW)	1,492	90	1,343
R4	Road (ROW)	666	90	599
2A	Lot 2A - Building Lot	2,339	85	1,988
2B	Lot 2B - Building Lot	2,247	85	1,910
3	Lot 3 - Building Lot	4,188	85	3,560
4	Lot 4 - Building Lot	3,565	85	3,030
5	Lot 5 - Building Lot	2,703	85	2,298
6	Lot 6 - Building Lot	2,861	85	2,432
P2	Public Open Space	5,670	50	2,835

Total Sub-Area (Ha) = *2.59*

*Refer to Page 1 for Catchment numbers and locations

2.2 Total Storage Volumes Required for Existing Catchments (m^3)

	Storm ARI (years)	Storm Duration (hours)	Rainfall Intensity (mm/h)	Storage Required (m^3)
Minor Storm	1	24	2.02	**2088**
Minor Storm	10	24	3.55	**3669**
Minor Storm	20	24	4.11	**4248**
Major Storm	50	24	4.91	**5075**
Major Storm	100	24	5.57	**5757**
Major Storm	100	72	2.75	**8527**

	Storm ARI (years)	Storm Duration (hours)	Rainfall Intensity (mm/h)	Storage Required (m^3)
Minor Storm	1	24	2.02	**1519**
Minor Storm	10	24	3.55	**2669**
Minor Storm	20	24	4.11	**3090**
Major Storm	50	24	4.91	**3691**
Major Storm	100	24	5.57	**4187**
Major Storm	100	72	2.75	**6202**

	Storm ARI (years)	Storm Duration (hours)	Rainfall Intensity (mm/h)	Storage Required (m^3)	
Minor Storm	1	24	2.02	**482**	
Minor Storm	10	72	1.7	**1217**	Stored in tanks T1A/T1B
Minor Storm	20	24	4.11	**981**	Stored in tanks T1A/T1B
Major Storm	50	24	4.91	**1171**	Stored in tanks T1A/T1B
Major Storm	100	24	5.57	**1329**	Overflow to network
Major Storm	100	72	2.75	**1968**	Overflow to network

	Storm ARI (years)	Storm Duration (hours)	Rainfall Intensity (mm/h)	Storage Required (m^3)
Minor Storm	1	24	2.02	**1254**
Minor Storm	10	24	3.55	**2204**
Minor Storm	20	24	4.11	**2552**
Major Storm	50	24	4.91	**3049**
Major Storm	100	24	5.57	**3458**
Major Storm	100	72	2.75	**5122**

Note: Storage volumes have no allowances for infiltration due to the high water table. Detailed infiltration analysis may reduce these overall storage volumes.

Calculation Page 3: Required Storage

Murdoch Mixed Use Precinct

3.1 Stormwater Catchments:

* Refer to Page 1 for catchment areas
* Refer to Page 2 for catchment area calculations

Existing Tanks 2 & 3 Catchments			
Effective Subcatchment - Tanks 2-3 (ha)			*4.30*
Effective Imp. Catchment Area (ha)			***4.30***

Existing Basins 4 and Tank 5 Catchments			
Effective Subcatchment - Existing Stage 1 (ha)			*3.13*
Effective Imp. Catchment Area (ha)			***3.13***

Additional Lot 1 Drainage - Stage 1			
Effective Subcatchment - Additional Lot 1 (ha)			*0.99*
Effective Imp. Catchment Area (ha)			***0.99***

Additional MUP Drainage - Stage 2		
Effective Subcatchment - MUP Stage 2 (ha)		*2.59*
Effective Imp. Catchment Area (ha)		***2.59***

3.2 Available Storage Structures:

* Refer to Page 4 for storage volumes

FSH & EXISTING

Storage Type	Location	Base Level	Top Water Level (TWL)	Water Depth (m)	Storage (m^3)
Existing Tank No.2	Bedbrook Row	20.95	23.95	3.00	1700
Existing Tank No.3	Bedbrook Row	20.95	23.95	3.00	2220

FSH & EXISTING

Storage Type	Location	Base Level	Top Water Level (TWL)	Water Depth (m)	Storage (m^3)
Existing Basin 4	North Park	19.50	21.70	2.20	2298
Existing Tank 5	POS 2	19.00	22.00	3.00	3708
Overflow 6	Aileen Plant Park	21.00	21.70	0.70	5650

PROPOSED LOT 1 TANKS

Storage Type	Location	Base Level	Top Water Level (TWL)	Water Depth (m)	Storage (m^3)
New Tank T1A	Lot 1 Internal Road	19.50	22.50	3.00	564
New Tank T1B	Lot 1 Internal Road	19.50	22.50	3.00	676

PROPOSED STAGE 2 TANKS

Storage Type	Location	Base Level	Top Water Level (TWL)	Water Depth (m)	Storage (m^3)
New Tank T2	POS 2	19.50	21.70	2.20	1220
New Tank T3	POS 2	19.50	21.70	2.20	1220
New Tank T4	POS 2	19.50	21.70	2.20	1220
New Tank T5	ROW	19.50	21.70	2.20	930
New Tank T6	ROW	19.50	21.70	2.20	790

NOTES:

- Refer to Calculation Page 4 for storage capacities.
- Tank 2 & 3 Overflow level to remainder of storage system = RL 23.95
- Tank 2 & 3 Combined Storage = 3920m^3
- Minimum Road Pavement Level = 22.20 (Barry Marshall Pde)
- Rain garden storage was calculated based on an average single swale. Refer to Calc Page 5.

3.3 Total Required Storage Volumes:

MUP - STAGE 1

	(A) = Calc Page 2.2	**(B)** = Lesser of (A) or 3920	**(C)** = (A) - 3920	**(D)** = Calc Page 2.2	**(E)** = Calc Page 2.2	**(F)** = (C) + (D) + (E)	**(G)** = (F) + (B)	From Calc Page 4	
	FSH Sub-Catchment Volume to Tanks 2/3 (m3)	**Storage within Tanks 2 & 3 (m3)**	**Overflow Vol. From Tanks 2 & 3 to MUP (m3)**	**Storage Req. for Ex Basin 4 and Tank 5 Catchment (m3)**	**Additional Storage Req. Proposed Lot 1**	**MUP Stage 1 Storage Req. after Tanks 2/3**	**Total Stage 1 Storage Req. (m3)**	**Water Level of MUP Storage Network (m)**	**Storage StructuresUtilised (except Rain Gardens)**
Minor Storm: V(req'd) for 1:1yr/24hr ARI storm =	2088	**2088**	**0**	**1519**	**0**	**1519**	**3607**	RL 20.00	Tank 2/ Tank 3/ Basin 4/ Tank 5
Minor Storm: V(req'd) for 1:10yr/24hr ARI storm =	3669	**3669**	**0**	**2669**	**0**	**2669**	**6338**	RL 20.60	Tank 2/ Tank 3/ Basin 4/ Tank 5
Minor Storm: V(req'd) for 1:20yr/24hr ARI storm =	4248	**3920**	**328**	**3090**	**0**	**3418**	**7338**	RL 20.85	Tank 2/ Tank 3/ Basin 4/ Tank 5/ Aileen Plant Park
Major Storm: V(req'd) for 1:50yr/24hr ARI storm =	5075	**3920**	**1155**	**3691**	**0**	**4846**	**8766**	RL 21.10	Tank 2/ Tank 3/ Basin 4/ Tank 5/ Aileen Plant Park
Major Storm: V(req'd) for 1:100yr/24hr ARI storm =	5757	**3920**	**1837**	**4187**	**89**	**6113**	**10033**	RL 21.23	Tank 2/ Tank 3/ Basin 4/ Tank 5/ Aileen Plant Park
Major Storm: V(req'd) for 1:100yr/72hr ARI storm =	8527	**3920**	**4607**	**6202**	**728**	**11537**	**15457**	RL 21.70	Tank 2/ Tank 3/ Basin 4/ Tank 5/ Aileen Plant Park

MUP - ULTIMATE

	(H) = (G)	**(I)** = Calc Page 2.2	**(J)** = (I) + (F)	**(K)** = (H) + (I)	From Calc Page 4	
	Total Stage 1 Storage Req. (m3)	**Storage Req. for MUP Stage 2 Sub-Catchment (m3)**	**MUP Storage Req. after Tanks 2/3 (m3)**	**Total MUP Storage Required (m3)**	**Water Level of MUP Storage Network (m)**	**Storage Structures Utilised (except Rain Gardens)**
Minor Storm: V(req'd) for 1:1yr/24hr ARI storm =	3607	**1254**	**2773**	**4861**		Tank 2/ Tank 3/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5
Minor Storm: V(req'd) for 1:10yr/24hr ARI storm =	6338	**2204**	**4873**	**8542**		Tank 2/ Tank 3/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5
Minor Storm: V(req'd) for 1:20yr/24hr ARI storm =	7338	**2552**	**5969**	**9889**		Tank 2/ Tank 3/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5
Major Storm: V(req'd) for 1:50yr/24hr ARI storm =	8766	**3049**	**7894**	**11814**		Tank 2/ Tank 3/ Basin 4/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5
Major Storm: V(req'd) for 1:100yr/24hr ARI storm =	10033	**3458**	**9571**	**13491**		Tank 2/ Tank 3/ Basin 4/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5/ Aileen Park
Major Storm: V(req'd) for 1:100yr/72hr ARI storm =	15457	**5122**	**16659**	**20579**		Tank 2/ Tank 3/ Basin 4/ Tank T1/ Tank T2/ Tank 5/ Tank T3, T4, T5/ Aileen Park

Calculation Page 4: Available Storage and Water Levels

	STORMWATER STORAGE CAPACITIES (m^3)															
RL	**Tank 2**	**Tank 3**	**Basin 4 (Lot 101)**	**Tank 5**	**Aileen Park Overlfow**	**Total w/out Tanks 2 & 3**	**Stage 1 Total**	**Tank T2**	**Tank T3**	**Tank T4**	**Tank T5**	**Tank T6**	**Stage 2 Total**	**Total w/out Tanks 2 & 3**	**TOTAL STORAGE**	**RL**
BASE	*21.23*	*21.23*	*19.50*	*19.00*	*20.50*			*19.50*	*19.50*	*19.50*	*19.50*	*19.50*				***BASE***
18.70	Utilise Full Tank Capacity prior to sharing of water (overflow @ RL 23.95)	Utilise Full Tank Capacity prior to sharing of water (overflow @ RL 23.95)	0	0	0	0	*3,920*	0	0	0	0	0	*0*	0	**3,920**	**18.70**
18.80			0	0	0	0	*3,920*	0	0	0	0	0	*0*	0	**3,920**	**18.80**
18.90			0	0	0	0	*3,920*	0	0	0	0	0	*0*	0	**3,920**	**18.90**
19.00			0	0	0	0	*3,920*	0	0	0	0	0	*0*	0	**3,920**	**19.00**
19.10			0	124	0	124	*4,044*	0	0	0	0	0	*0*	124	**4,044**	**19.10**
19.20			0	247	0	247	*4,167*	0	0	0	0	0	*0*	247	**4,167**	**19.20**
19.30			0	371	0	371	*4,291*	0	0	0	0	0	*0*	371	**4,291**	**19.30**
19.40			0	494	0	494	*4,414*	0	0	0	0	0	*0*	494	**4,414**	**19.40**
19.50			0	618	0	618	*4,538*	0	0	0	0	0	*0*	618	**4,538**	**19.50**
19.60			41	742	0	782	*4,702*	55	55	55	42	36	*111*	893	**4,813**	**19.60**
19.70			82	865	0	947	*4,867*	111	111	111	85	72	*222*	1,169	**5,089**	**19.70**
19.80			122	989	0	1,111	*5,031*	166	166	166	127	108	*333*	1,444	**5,364**	**19.80**
19.90			163	1,112	0	1,276	*5,196*	222	222	222	169	144	*444*	1,719	**5,639**	**19.90**
20.00			204	1,236	0	1,440	*5,360*	277	277	277	211	180	*555*	1,995	**5,915**	**20.00**
20.10			276	1,360	0	1,635	*5,555*	333	333	333	254	215	*665*	2,301	**6,221**	**20.10**
20.20			348	1,483	0	1,831	*5,751*	388	388	388	296	251	*776*	2,607	**6,527**	**20.20**
20.30			419	1,607	0	2,026	*5,946*	444	444	444	338	287	*887*	2,913	**6,833**	**20.30**
20.40			491	1,730	0	2,222	*6,142*	499	499	499	380	323	*998*	3,220	**7,140**	**20.40**
20.50			563	1,854	0	2,417	*6,337*	555	555	555	423	359	*1,109*	3,526	**7,446**	**20.50**
20.60			674	1,978	0	2,652	*6,572*	610	610	610	465	395	*1,220*	3,872	**7,792**	**20.60**
20.70			785	2,101	0	2,886	*6,806*	665	665	665	507	431	*1,331*	4,217	**8,137**	**20.70**
20.80			896	2,225	112	3,233	*7,153*	721	721	721	550	467	*1,442*	4,674	**8,594**	**20.80**
20.90			1,007	2,348	291	3,647	*7,567*	776	776	776	592	503	*1,553*	5,200	**9,120**	**20.90**
21.00			1,118	2,472	602	4,192	*8,112*	832	832	832	634	539	*1,664*	5,855	**9,775**	**21.00**
21.10			1,277	2,596	1,050	4,923	*8,843*	887	887	887	676	575	*1,775*	6,697	**10,617**	**21.10**
21.20			1,436	2,719	1,656	5,812	*9,732*	943	943	943	719	610	*1,885*	7,697	**11,617**	**21.20**
21.30			1,596	2,843	2,379	6,817	*10,737*	998	998	998	761	646	*1,996*	8,814	**12,734**	**21.30**
21.40			1,755	2,966	3,156	7,877	*11,797*	1,054	1,054	1,054	803	682	*2,107*	9,985	**13,905**	**21.40**
21.50			1,914	3,090	3,963	8,967	*12,887*	1,109	1,109	1,109	845	718	*2,218*	11,185	**15,105**	**21.50**
21.60			2,106	3,214	4,795	10,115	*14,035*	1,165	1,165	1,165	888	754	*2,329*	12,444	**16,364**	**21.60**
21.70	***1,700***	***2,220***	2,298	3,337	5,650	11,285	***15,205***	***1,220***	***1,220***	***1,220***	***930***	***790***	***5,380***	***16,665***	**20,585**	**21.70**
21.80			2,510	3,461	6,524	12,495	*16,415*	0	0	0	0	0	*0*	12,495	**16,415**	**21.80**
21.90			2,731	3,584	7,412	13,727	*17,647*	0	0	0	0	0	*0*	13,727	**17,647**	**21.90**
22.00			2,962	3,708	8,307	14,977	*18,897*	0	0	0	0	0	*0*	14,977	**18,897**	**22.00**
							15,457						**5,122**		**20,579**	

P11268-02 Murdoch MUP Drainage Emptying Times

BG&E 22/09/2015

Guidance on recommended emptying times for such infiltration systems is provided in the Department of Water's Stormwater Management Manual for WA (2004-2007) that cites Engineers Australia (2006) emptying times guidelines, which are based on research carried out by Professor John Argue (2004).

Emptying time is defined as the time taken to completely empty a storage associated with an infiltration system following the cessation of rainfall. This is an important design consideration as the computation procedures previously described assume that the storage is empty prior to the commencement of the design storm event. Continuous simulation modelling for a range of catchments is required to provide reliable emptying time criteria. In the absence of this modelling, Engineers Australia (2006) recommends the interim emptying time criteria outlined in Table 5.
(Stormwater Management Manual for WA: 9 Structural Controls, 2007)

ARI (years)	<=1	2	5	10	20	50	100
Guideline Max Emptying Time (Days)	0.5	1.0	1.5	2.0	2.5	3.0	3.5

Copy of Table 5 from the Stormwater Management Manual for WA (DoW, 2004-2007)

In order to calculate emptying times the following formula (referenced from DoW Stormwater Management Manual) is used:

$$T = -\frac{4.6Lbe_s}{2k_h(L+b)} log_{10}\left[\frac{Lb}{Lb + 2H(L+b)}\right]$$

Where: T = Emptying time (seconds)
L = Retention System Length (metres)
b = Retention System Breadth (metres)
e_s = Void Space Ratio
k_h = Hydraulic conductivity (metres/second)
H = Depth of water in system (metres)

Infiltration Assumptions:

Hydraulic Conductivity (k) = 5 m/day
Reduced Hydr. Cond. (k_h) = 2.5 m/day — Conservatively reduced by 50% due to shallow water table. Note PC_Sump recommendation advised reduction of 20%.
2.89352E-05 m/s

Storage	Length (L)	Breadth (b)	Voids Ratio (e_s)	Hydraulic Conductivity (k_h)	1 Year: 1 Hour Water Depth (PC_SUMP)	Emptying Time	Emptying Time	Emptying Time
	(m)	(m)		(m/s)	(m)	(s)	(hours)	(days)
NEW Tanks T1A/ T1B	9.4	44	1	2.89352E-05	0.38	25027.37433	6.95	**0.29**
NEW Tanks T2/ T3	14.1	120	1	2.89352E-05	0.23	15597.13287	4.33	**0.18**
EXISTING Tanks 2/ 3	11.75	111.15	1	2.89352E-05	0.52	34252.04763	9.51	0.40
EXISTING Basin 4	No overflow to Basin 4 from Tank 5 or Tank 3 - Direct catchment infiltrates in basin							
EXISTING Tank 5	80	16	1	2.89352E-05	0.42	28121.01507	7.81	0.33
EXISTING Aileen Plant Park	No overflow to Aileen Plant Park - Direct catchment infiltrates in park							

Represents over 90% of annual storm events as advised by DoW

Storage	Length (L)	Breadth (b)	Voids Ratio (e_s)	Hydraulic Conductivity (k_h)	1 Year: 24 Hour Water Depth (PC_SUMP)	Emptying Time	Emptying Time	Emptying Time	
	(m)	(m)		(m/s)	(m)	(s)	(hours)	(days)	
NEW Tanks T1A/ T1B	9.4	44	1	2.89352E-05	1.12	67921	18.87	**0.79**	
NEW Tanks T2/ T3	14.1	120	1	2.89352E-05	0.9	58087	16.14	**0.67**	
EXISTING Tanks 2/ 3	11.75	111.15	1	2.89352E-05	1.55	93903	26.08	1.09	
EXISTING Basin 4	21.5	21.5	1	2.89352E-05	0.6	39272	10.91	0.45	Equivalent area (462m^2) for basin between RL 19.50 and RL 20.10
EXISTING Tank 5	80	16	1	2.89352E-05	1.1	70295	19.53	0.81	Equivalent rectangular area (1236m^2) for tank
EXISTING Aileen Plant Park	No overflow to Aileen Plant Park - Direct catchment infiltrates in park								

Storage	Length (L)	Breadth (b)	Voids Ratio (e_s)	Hydraulic Conductivity (k_h)	10 Year: 24 Hour Water Depth (PC_SUMP)	Emptying Time	Emptying Time	Emptying Time	
	(m)	(m)		(m/s)	(m)	(s)	(hours)	(days)	
NEW Tanks T1A/ T1B	9.4	44	1	2.89352E-05	1.98	110415	30.67	**1.28**	
NEW Tanks T2/ T3	14.1	120	1	2.89352E-05	1.2	75847	21.07	**0.88**	
EXISTING Tanks 2/ 3	11.75	111.15	1	2.89352E-05	2.74	152559	42.38	1.77	
EXISTING Basin 4	25.6	25.6	1	2.89352E-05	1.2	75936	21.09	0.88	Equivalent area (654m^2) for basin between RL 19.50 and RL 20.70
EXISTING Tank 5	80	16	1	2.89352E-05	1.7	104547	29.04	1.21	Equivalent rectangular area (1236m^2) for tank
EXISTING Aileen Plant Park	No overflow to Aileen Plant Park - Direct catchment infiltrates								

Storage	Length (L)	Breadth (b)	Voids Ratio (e_s)	Hydraulic Conductivity (k_h)	100 Year: 72 Hour Water Depth (PC_SUMP)	Emptying Time	Emptying Time	Emptying Time	
	(m)	(m)		(m/s)	(m)	(s)	(hours)	(days)	
NEW Tanks T1A/ T1B	9.4	44	1	2.89352E-05	2.8	145474	40.41	**1.68**	
NEW Tanks T2/ T3	14.1	120	1	2.89352E-05	2.65	152752	42.43	**1.77**	
EXISTING Tanks 2/ 3	11.75	111.15	1	2.89352E-05	3	164215	45.62	1.90	
EXISTING Basin 4	32.5	32.5	1	2.89352E-05	2.22	135506	37.64	1.57	Equivalent area (1054m^2) for basin between RL 19.50 and RL 20.70
EXISTING Tank 5	80	16	1	2.89352E-05	2.72	157495	43.75	1.82	Equivalent rectangular area (1236m^2) for tank
EXISTING Aileen Plant Park	50	125	1	2.89352E-05	0.92	61937	17.20	0.72	Equivalent area (6250m^2) between RL 20.80 and RL 21.72

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Project Details	
Project	Murdoch MUP
Job Number	P11268
Task	Existing Basin 4 & Tank 5 - 18/09/2015
Designer	Dusko Petrovich

Catchment Area Details				
Land Form	Area (m2)	Runoff Coeff	Aimp (m2)	Comments
Total Catchment	33600	1	33600	Refer to calculation 2.1
			0	
			0	
TOTAL	33600		33600	

Select Location

Perth

Select design ARI's

☐ Select all ARI's ☐ Clear ARI's

☑ 1 year ARI ☑ 2 year ARI ☑ 5 year ARI ☑ 10 year ARI

☑ 20 year ARI ☑ 50 year ARI ☑ 100 year ARI

Sump Details			
GWL	19.500	m AHD	GWL conservatively assumed as RL 19.50
Depth to GWL from base	0.000	m	
Max Allowable TWL	22.000	m AHD	
Sump Base Level	19.500	m AHD	Basin 4 base RL 19.50, Tank 5 storage only taken into account above RL 19.50
Sump Width at base	20	m	
Sump Length at base	133.4	m	Equivalent base area 2668m^2 for combined Basin 4/ Tank 5 storage (RL 19.5 to RL 22.0)
Side Slope	0.0	1 in --	

Permeability			K based on FSH Geotechnical Report findings Rising Head Permeability Test
Soil Permeability, K	5	m/d	Soil permeability is consistent with values used for FSH and adjacent Freeway works
Permeability Clogged Layer	0.15	m/d	0.15
Thickness of Clogged Layer	200	mm	200
Reduction Factor - Shallow	0.800		0.800
Reduction Factor - Deep	0.333		0.333
Reduction Factor - Clogged	1.000		1.000

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	2250	12.20	37	2213	0.829	20.329	1.671	Shallow water table log model
2	72	1.2	2903	16.11	48	2855	1.070	20.570	1.430	Shallow water table log model
5	72	1.49	3605	20.50	61	3543	1.328	20.828	1.172	Shallow water table log model
10	72	1.7	4113	23.78	71	4041	1.515	21.015	0.985	Shallow water table log model
20	72	1.99	4814	28.48	85	4729	1.773	21.273	0.727	Shallow water table log model
50	72	2.4000001	5806	35.41	106	5700	2.136	21.636	0.364	Shallow water table log model
100	72	2.75	6653	41.60	125	6528	2.447	21.947	0.053	Shallow water table log model

INPUT DATA

Location	Perth	
$A_{impervious}$	3.3600	ha
GWL	19.500	m AHD
Depth to GWL from base	0.000	m
Max Allowable TWL	22.000	m AHD
Sump Base Level	19.500	m AHD
Sump Width at base	20	m
Sump Length at base	133.4	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 1 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	2250	12.20	37	2213	0.829	20.329	1.671	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	410	4.0000	0.154	0.08	50.6	48.83	0.04	2.10	0	409.9
1	1	15.9	534	4.0000	0.200	0.10	51.1	48.83	0.05	2.75	0	534.1
1	2	10.2	685	4.0000	0.257	0.13	51.8	48.83	0.06	3.55	0	685.1
1	3	7.83	789	4.0000	0.296	0.15	52.2	48.83	0.07	4.11	1	788.8
1	4	6.49	872	4.0000	0.327	0.16	52.6	48.83	0.07	4.56	1	871.5
1	5	5.61	942	4.0000	0.353	0.18	52.9	48.83	0.08	4.94	1	941.5
1	6	4.98	1004	4.0000	0.376	0.19	53.1	48.83	0.08	5.27	1	1002.7
1	9	3.82	1155	4.0000	0.432	0.22	53.8	48.83	0.10	6.10	2	1152.9
1	12	3.17	1278	4.0000	0.478	0.24	54.3	48.83	0.11	6.77	3	1274.8
1	18	2.44	1476	4.0000	0.551	0.28	55.1	48.83	0.12	7.87	6	1469.8
1	24	2.02	1629	4.0000	0.607	0.30	55.8	48.83	0.13	8.73	9	1620.2
1	36	1.54	1863	4.0000	0.692	0.35	56.7	48.83	0.15	10.04	15	1847.7
1	48	1.26	2032	4.0000	0.753	0.38	57.4	48.83	0.16	10.99	22	2010.1
1	60	1.07	2157	4.0000	0.797	0.40	57.9	48.83	0.17	11.69	29	2127.9
1	72	0.93	2250	4.0000	0.829	0.41	58.3	48.83	0.18	12.20	37	2213.3
				Maximum	0.829						Maximum	2213.3

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	409.9	1.6650	0.119	0.06	4472.5	93	316.7
1	1	15.9	534.2	1.6650	0.130	0.07	4475.5	186	347.8
1	2	10.2	685.4	1.6650	0.117	0.06	4472.1	373	312.8
1	3	7.83	789.3	1.6650	0.087	0.04	4464.3	558	231.2
1	4	6.49	872.3	1.6650	0.049	0.02	4454.6	742	129.8
1	5	5.61	942.5	1.6650	0.006	0.00	4443.8	926	16.7
1	6	4.98	1004.0	1.6650	0.000	0.00	4442.2	1111	0.0
1	9	3.82	1155.2	1.6650	0.000	0.00	4442.2	1666	0.0
1	12	3.17	1278.1	1.6650	0.000	0.00	4442.2	2221	0.0
1	18	2.44	1475.7	1.6650	0.000	0.00	4442.2	3332	0.0
1	24	2.02	1628.9	1.6650	0.000	0.00	4442.2	4442	0.0
1	36	1.54	1862.8	1.6650	0.000	0.00	4442.2	6663	0.0
1	48	1.26	2032.1	1.6650	0.000	0.00	4442.2	8884	0.0
1	60	1.07	2157.1	1.6650	0.000	0.00	4442.2	11105	0.0
1	72	0.93	2249.9	1.6650	0.000	0.00	4442.2	13327	0.0
				Maximum	0.130			Maximum	347.8

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	410	0.1500	0.149	0.07	554	12	398.4
1	1	15.9	534	0.1500	0.191	0.10	597	25	509.4
1	2	10.2	685	0.1500	0.237	0.12	644	54	631.8
1	3	7.83	789	0.1500	0.264	0.13	673	84	705.2
1	4	6.49	872	0.1500	0.284	0.14	693	115	756.8
1	5	5.61	942	0.1500	0.298	0.15	708	147	795.1
1	6	4.98	1004	0.1500	0.309	0.15	719	180	824.2
1	9	3.82	1155	0.1500	0.329	0.16	740	277	877.7
1	12	3.17	1278	0.1500	0.338	0.17	750	375	903.2
1	18	2.44	1476	0.1500	0.342	0.17	753	565	910.8
1	24	2.02	1629	0.1500	0.332	0.17	743	743	885.8
1	36	1.54	1863	0.1500	0.300	0.15	710	1064	798.5
1	48	1.26	2032	0.1500	0.261	0.13	669	1338	694.5
1	60	1.07	2157	0.1500	0.221	0.11	627	1569	588.5
1	72	0.93	2250	0.1500	0.182	0.09	588	1764	486.2
				Maximum	0.342			Maximum	910.8

INPUT DATA

Location	Perth	
$A_{impervious}$	3.3600	ha
GWL	19.500	m AHD
Depth to GWL from base	0.000	m
Max Allowable TWL	22.000	m AHD
Sump Base Level	19.500	m AHD
Sump Width at base	20	m
Sump Length at base	133.4	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 10 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
10	72	1.7	4113	23.78	71	4041	1.515	21.015	0.985	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	773	4.0000	0.290	0.14	52.1	48.83	0.07	4.02	0	772.7
10	1	28.8	968	4.0000	0.363	0.18	53.0	48.83	0.08	5.08	0	967.5
10	2	18.2	1223	4.0000	0.458	0.23	54.1	48.83	0.10	6.48	1	1222.5
10	3	13.9	1401	4.0000	0.525	0.26	54.8	48.83	0.12	7.48	1	1400.2
10	4	11.4	1532	4.0000	0.574	0.29	55.4	48.83	0.13	8.22	1	1530.8
10	5	9.81	1648	4.0000	0.617	0.31	55.9	48.83	0.13	8.88	2	1646.2
10	6	8.67	1748	4.0000	0.654	0.33	56.3	48.83	0.14	9.45	2	1745.5
10	9	6.6	1996	4.0000	0.746	0.37	57.3	48.83	0.16	10.89	4	1991.8
10	12	5.43	2189	4.0000	0.818	0.41	58.2	48.83	0.17	12.02	6	2183.4
10	18	4.24	2564	4.0000	0.957	0.48	59.7	48.83	0.20	14.26	11	2553.7
10	24	3.55	2863	4.0000	1.067	0.53	61.0	48.83	0.22	16.06	16	2846.7
10	36	2.74	3314	4.0000	1.231	0.62	62.9	48.83	0.25	18.84	28	3286.0
10	48	2.27	3661	4.0000	1.356	0.68	64.3	48.83	0.28	20.99	42	3619.1
10	60	1.94	3911	4.0000	1.445	0.72	65.3	48.83	0.29	22.54	56	3854.7
10	72	1.7	4113	4.0000	1.515	0.76	66.1	48.83	0.30	23.78	71	4041.3
				Maximum	1.515						Maximum	4041.3

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	772.8	1.6650	0.254	0.13	4507.2	94	678.9
10	1	28.8	967.7	1.6650	0.292	0.15	4516.8	188	779.5
10	2	18.2	1223.0	1.6650	0.317	0.16	4523.2	377	846.1
10	3	13.9	1401.1	1.6650	0.313	0.16	4522.2	565	835.8
10	4	11.4	1532.2	1.6650	0.292	0.15	4516.9	753	779.3
10	5	9.81	1648.1	1.6650	0.265	0.13	4510.0	940	708.5
10	6	8.67	1747.9	1.6650	0.233	0.12	4501.8	1125	622.4
10	9	6.6	1995.8	1.6650	0.119	0.06	4472.7	1677	318.6
10	12	5.43	2189.4	1.6650	0.000	0.00	4442.2	2221	0.0
10	18	4.24	2564.4	1.6650	0.000	0.00	4442.2	3332	0.0
10	24	3.55	2862.7	1.6650	0.000	0.00	4442.2	4442	0.0
10	36	2.74	3314.3	1.6650	0.000	0.00	4442.2	6663	0.0
10	48	2.27	3661.1	1.6650	0.000	0.00	4442.2	8884	0.0
10	60	1.94	3911.0	1.6650	0.000	0.00	4442.2	11105	0.0
10	72	1.7	4112.6	1.6650	0.000	0.00	4442.2	13327	0.0
				Maximum	0.317			Maximum	846.1

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	773	0.1500	0.284	0.14	693	14	758.4
10	1	28.8	968	0.1500	0.351	0.18	763	32	935.9
10	2	18.2	1223	0.1500	0.432	0.22	848	71	1152.4
10	3	13.9	1401	0.1500	0.483	0.24	901	113	1288.5
10	4	11.4	1532	0.1500	0.516	0.26	936	156	1376.2
10	5	9.81	1648	0.1500	0.542	0.27	964	201	1447.3
10	6	8.67	1748	0.1500	0.563	0.28	985	246	1501.5
10	9	6.6	1996	0.1500	0.604	0.30	1029	386	1610.2
10	12	5.43	2189	0.1500	0.624	0.31	1050	525	1664.4
10	18	4.24	2564	0.1500	0.656	0.33	1084	813	1751.2
10	24	3.55	2863	0.1500	0.664	0.33	1092	1092	1770.7
10	36	2.74	3314	0.1500	0.641	0.32	1068	1603	1711.6
10	48	2.27	3661	0.1500	0.602	0.30	1027	2054	1607.1
10	60	1.94	3911	0.1500	0.553	0.28	975	2436	1474.6
10	72	1.7	4113	0.1500	0.504	0.25	923	2770	1342.7
				Maximum	0.664			Maximum	1770.7

INPUT DATA

Location	Perth	
$A_{impervious}$	3.3600	ha
GWL	19.500	m AHD
Depth to GWL from base	0.000	m
Max Allowable TWL	22.000	m AHD
Sump Base Level	19.500	m AHD
Sump Width at base	20	m
Sump Length at base	133.4	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 100 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
100	72	2.75	6653	41.60	125	6528	2.447	21.947	0.053	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	1277	4.0000	0.478	0.24	54.3	48.83	0.11	6.78	0	1276.7
100	1	46.2	1552	4.0000	0.582	0.29	55.5	48.83	0.13	8.34	0	1552.0
100	2	28.9	1942	4.0000	0.727	0.36	57.1	48.83	0.16	10.59	1	1941.2
100	3	21.9	2208	4.0000	0.827	0.41	58.3	48.83	0.18	12.16	2	2206.0
100	4	17.9	2406	4.0000	0.901	0.45	59.1	48.83	0.19	13.34	2	2403.5
100	5	15.3	2570	4.0000	0.962	0.48	59.8	48.83	0.20	14.34	3	2567.4
100	6	13.5	2722	4.0000	1.019	0.51	60.5	48.83	0.21	15.26	4	2717.8
100	9	10.2	3084	4.0000	1.153	0.58	62.0	48.83	0.24	17.51	7	3077.9
100	12	8.36	3371	4.0000	1.260	0.63	63.2	48.83	0.26	19.32	10	3361.1
100	18	6.6	3992	4.0000	1.489	0.74	65.8	48.83	0.30	23.34	18	3974.2
100	24	5.57	4492	4.0000	1.673	0.84	67.9	48.83	0.33	26.65	27	4465.0
100	36	4.35	5262	4.0000	1.954	0.98	71.1	48.83	0.38	31.89	48	5213.9
100	48	3.63	5854	4.0000	2.167	1.08	73.6	48.83	0.41	36.01	72	5782.4
100	60	3.13	6310	4.0000	2.329	1.16	75.4	48.83	0.43	39.21	98	6212.1
100	72	2.75	6653	4.0000	2.447	1.22	76.8	48.83	0.45	41.60	125	6528.0
				Maximum	2.447						Maximum	6528.0

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	1276.8	1.6650	0.443	0.22	4555.3	95	1181.9
100	1	46.2	1552.3	1.6650	0.510	0.26	4572.6	191	1361.8
100	2	28.9	1942.1	1.6650	0.584	0.29	4591.5	383	1559.5
100	3	21.9	2207.5	1.6650	0.612	0.31	4598.5	575	1632.7
100	4	17.9	2405.8	1.6650	0.614	0.31	4599.1	767	1639.2
100	5	15.3	2570.4	1.6650	0.604	0.30	4596.6	958	1612.8
100	6	13.5	2721.6	1.6650	0.590	0.29	4592.8	1148	1573.4
100	9	10.2	3084.5	1.6650	0.513	0.26	4573.3	1715	1369.5
100	12	8.36	3370.8	1.6650	0.411	0.21	4547.2	2274	1097.1
100	18	6.6	3991.7	1.6650	0.231	0.12	4501.1	3376	615.8
100	24	5.57	4491.6	1.6650	0.017	0.01	4446.5	4447	45.1
100	36	4.35	5261.8	1.6650	0.000	0.00	4442.2	6663	0.0
100	48	3.63	5854.5	1.6650	0.000	0.00	4442.2	8884	0.0
100	60	3.13	6310.1	1.6650	0.000	0.00	4442.2	11105	0.0
100	72	2.75	6652.8	1.6650	0.000	0.00	4442.2	13327	0.0
				Maximum	0.614			Maximum	1639.2

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	1277	0.1500	0.471	0.24	889	19	1258.3
100	1	46.2	1552	0.1500	0.566	0.28	989	41	1511.1
100	2	28.9	1942	0.1500	0.693	0.35	1123	94	1848.5
100	3	21.9	2208	0.1500	0.771	0.39	1206	151	2056.7
100	4	17.9	2406	0.1500	0.823	0.41	1262	210	2195.4
100	5	15.3	2570	0.1500	0.862	0.43	1303	272	2298.9
100	6	13.5	2722	0.1500	0.895	0.45	1339	335	2386.9
100	9	10.2	3084	0.1500	0.958	0.48	1408	528	2556.7
100	12	8.36	3371	0.1500	0.992	0.50	1444	722	2649.0
100	18	6.6	3992	0.1500	1.067	0.53	1525	1144	2847.7
100	24	5.57	4492	0.1500	1.099	0.55	1560	1560	2932.1
100	36	4.35	5262	0.1500	1.097	0.55	1557	2336	2926.1
100	48	3.63	5854	0.1500	1.058	0.53	1515	3031	2823.6
100	60	3.13	6310	0.1500	1.002	0.50	1455	3636	2673.7
100	72	2.75	6653	0.1500	0.937	0.47	1384	4153	2499.9
				Maximum	1.099			Maximum	2932.1

Project Details	
Project	Murdoch MUP
Job Number	P11268
Task	MUP Lot 1 Drainage - 18/09/2015
Designer	Dusko Petrovich

Catchment Area Details				
Land Form	Area (m2)	Runoff Coeff	Aimp (m2)	Comments
Total Catchment	9940	1	9940	Refer to calculation 2.1
			0	
			0	
TOTAL	9940		9940	

Select Location

Perth

Select design ARI's

☐ Select all ARI's ☐ Clear ARI's

☑ 1 year ARI ☑ 2 year ARI ☑ 5 year ARI ☑ 10 year ARI

☑ 20 year ARI ☑ 50 year ARI ☑ 100 year ARI

Sump Details			
GWL	19.500	m AHD	GWL conservatively assumed as RL 19.50
Depth to GWL from base	0.500	m	
Max Allowable TWL	22.800	m AHD	
Sump Base Level	20.000	m AHD	Base of tank 0.5m above GWL
Sump Width at base	9.4	m	
Sump Length at base	44	m	
Side Slope	0.0	1 in --	

Permeability			K based on FSH Geotechnical Report findings Rising Head Permeability Test
Soil Permeability, K	5	m/d	Soil permeability is consistent with values used for FSH and adjacent Freeway works
Permeability Clogged Layer	0.15	m/d	0.15
Thickness of Clogged Layer	200	mm	200
Reduction Factor - Shallow	0.800		0.800
Reduction Factor - Deep	0.333		0.333
Reduction Factor - Clogged	1.000		1.000

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	666	19.58	59	607	1.467	21.467	1.333	Shallow water table log model
2	72	1.2	859	24.43	73	786	1.899	21.899	0.901	Shallow water table log model
5	72	1.49	1066	30.04	90	976	2.360	22.360	0.440	Shallow water table log model
10	72	1.7	1217	34.35	103	1114	2.691	22.691	0.109	Shallow water table log model
20	72	1.99	1424	40.61	122	1302	3.148	23.148	-0.348	Shallow water table log model
50	72	2.4000001	1718	50.07	150	1567	3.788	23.788	-0.988	Shallow water table log model
100	72	2.75	1968	58.68	176	1792	4.330	24.330	-1.530	Shallow water table log model

INPUT DATA

Location	Perth	
$A_{impervious}$	0.9940	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	9.4	m
Sump Length at base	44	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 1 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	666	19.58	59	607	1.467	21.467	1.333	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	121	4.0000	0.293	0.15	31.7	17.00	0.62	8.40	0	121.1
1	1	15.9	158	4.0000	0.381	0.19	32.8	17.00	0.66	9.13	0	157.7
1	2	10.2	203	4.0000	0.488	0.24	34.0	17.00	0.69	10.04	1	201.9
1	3	7.83	233	4.0000	0.561	0.28	34.8	17.00	0.72	10.68	1	232.2
1	4	6.49	258	4.0000	0.619	0.31	35.5	17.00	0.74	11.20	2	256.2
1	5	5.61	279	4.0000	0.668	0.33	36.0	17.00	0.75	11.64	2	276.4
1	6	4.98	297	4.0000	0.711	0.36	36.5	17.00	0.76	12.02	3	294.0
1	9	3.82	342	4.0000	0.814	0.41	37.7	17.00	0.80	12.98	5	336.9
1	12	3.17	378	4.0000	0.897	0.45	38.6	17.00	0.82	13.77	7	371.2
1	18	2.44	437	4.0000	1.028	0.51	40.1	17.00	0.86	15.04	11	425.3
1	24	2.02	482	4.0000	1.126	0.56	41.3	17.00	0.89	16.01	16	465.9
1	36	1.54	551	4.0000	1.269	0.63	42.9	17.00	0.93	17.47	26	524.9
1	48	1.26	601	4.0000	1.364	0.68	44.0	17.00	0.95	18.47	37	564.2
1	60	1.07	638	4.0000	1.427	0.71	44.7	17.00	0.97	19.15	48	590.3
1	72	0.93	666	4.0000	1.467	0.73	45.2	17.00	0.98	19.58	59	606.8
				Maximum	1.467						Maximum	606.8

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	121.3	1.6650	0.257	0.13	711.5	15	106.4
1	1	15.9	158.0	1.6650	0.310	0.15	716.2	30	128.2
1	2	10.2	202.8	1.6650	0.345	0.17	719.3	60	142.8
1	3	7.83	233.5	1.6650	0.347	0.17	719.5	90	143.6
1	4	6.49	258.0	1.6650	0.334	0.17	718.4	120	138.3
1	5	5.61	278.8	1.6650	0.313	0.16	716.5	149	129.5
1	6	4.98	297.0	1.6650	0.286	0.14	714.1	179	118.5
1	9	3.82	341.7	1.6650	0.187	0.09	705.2	264	77.3
1	12	3.17	378.1	1.6650	0.074	0.04	695.2	348	30.5
1	18	2.44	436.6	1.6650	0.000	0.00	688.6	516	0.0
1	24	2.02	481.9	1.6650	0.000	0.00	688.6	689	0.0
1	36	1.54	551.1	1.6650	0.000	0.00	688.6	1033	0.0
1	48	1.26	601.2	1.6650	0.000	0.00	688.6	1377	0.0
1	60	1.07	638.1	1.6650	0.000	0.00	688.6	1722	0.0
1	72	0.93	665.6	1.6650	0.000	0.00	688.6	2066	0.0
				Maximum	0.347			Maximum	143.6

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	121	0.1500	0.288	0.14	110	2	119.0
1	1	15.9	158	0.1500	0.370	0.18	124	5	152.9
1	2	10.2	203	0.1500	0.462	0.23	140	12	191.1
1	3	7.83	233	0.1500	0.519	0.26	149	19	214.8
1	4	6.49	258	0.1500	0.561	0.28	157	26	231.9
1	5	5.61	279	0.1500	0.593	0.30	162	34	245.0
1	6	4.98	297	0.1500	0.618	0.31	167	42	255.3
1	9	3.82	342	0.1500	0.668	0.33	175	66	275.9
1	12	3.17	378	0.1500	0.696	0.35	180	90	287.9
1	18	2.44	437	0.1500	0.720	0.36	185	139	298.0
1	24	2.02	482	0.1500	0.719	0.36	185	185	297.3
1	36	1.54	551	0.1500	0.685	0.34	179	268	283.3
1	48	1.26	601	0.1500	0.634	0.32	169	339	262.3
1	60	1.07	638	0.1500	0.578	0.29	160	399	239.1
1	72	0.93	666	0.1500	0.522	0.26	150	450	215.9
				Maximum	0.720			Maximum	298.0

INPUT DATA

Location	Perth	
$A_{impervious}$	0.9940	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	9.4	m
Sump Length at base	44	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 10 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
10	72	1.7	1217	34.35	103	1114	2.691	22.691	0.109	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	229	4.0000	0.552	0.28	34.7	17.00	0.71	10.60	0	228.4
10	1	28.8	286	4.0000	0.691	0.35	36.3	17.00	0.76	11.84	0	285.8
10	2	18.2	362	4.0000	0.872	0.44	38.4	17.00	0.81	13.53	1	360.7
10	3	13.9	414	4.0000	0.998	0.50	39.8	17.00	0.85	14.74	2	412.7
10	4	11.4	453	4.0000	1.089	0.54	40.8	17.00	0.88	15.65	3	450.7
10	5	9.81	488	4.0000	1.170	0.59	41.8	17.00	0.90	16.46	3	484.1
10	6	8.67	517	4.0000	1.240	0.62	42.6	17.00	0.92	17.17	4	512.8
10	9	6.6	590	4.0000	1.410	0.71	44.5	17.00	0.96	18.96	7	583.3
10	12	5.43	648	4.0000	1.541	0.77	46.0	17.00	1.00	20.38	10	637.5
10	18	4.24	759	4.0000	1.792	0.90	48.9	17.00	1.06	23.20	17	741.2
10	24	3.55	847	4.0000	1.986	0.99	51.1	17.00	1.10	25.47	25	821.4
10	36	2.74	980	4.0000	2.265	1.13	54.3	17.00	1.16	28.86	43	937.2
10	48	2.27	1083	4.0000	2.466	1.23	56.5	17.00	1.20	31.40	63	1020.3
10	60	1.94	1157	4.0000	2.596	1.30	58.0	17.00	1.23	33.09	83	1074.3
10	72	1.7	1217	4.0000	2.691	1.35	59.1	17.00	1.25	34.35	103	1113.6
				Maximum	2.691						Maximum	1113.6

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	228.6	1.6650	0.516	0.26	734.5	15	213.3
10	1	28.8	286.3	1.6650	0.617	0.31	743.5	31	255.3
10	2	18.2	361.8	1.6650	0.723	0.36	752.9	63	299.1
10	3	13.9	414.5	1.6650	0.773	0.39	757.4	95	319.8
10	4	11.4	453.3	1.6650	0.790	0.39	758.9	126	326.8
10	5	9.81	487.6	1.6650	0.796	0.40	759.4	158	329.3
10	6	8.67	517.1	1.6650	0.791	0.40	759.0	190	327.3
10	9	6.6	590.4	1.6650	0.743	0.37	754.7	283	307.4
10	12	5.43	647.7	1.6650	0.662	0.33	747.5	374	273.9
10	18	4.24	758.6	1.6650	0.504	0.25	733.5	550	208.5
10	24	3.55	846.9	1.6650	0.315	0.16	716.6	717	130.3
10	36	2.74	980.5	1.6650	0.000	0.00	688.6	1033	0.0
10	48	2.27	1083.1	1.6650	0.000	0.00	688.6	1377	0.0
10	60	1.94	1157.0	1.6650	0.000	0.00	688.6	1722	0.0
10	72	1.7	1216.7	1.6650	0.000	0.00	688.6	2066	0.0
				Maximum	0.796			Maximum	329.3

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	229	0.1500	0.545	0.27	154	3	225.4
10	1	28.8	286	0.1500	0.674	0.34	177	7	278.9
10	2	18.2	362	0.1500	0.834	0.42	205	17	344.7
10	3	13.9	414	0.1500	0.935	0.47	223	28	386.6
10	4	11.4	453	0.1500	1.001	0.50	235	39	414.0
10	5	9.81	488	0.1500	1.056	0.53	245	51	436.4
10	6	8.67	517	0.1500	1.097	0.55	253	63	453.8
10	9	6.6	590	0.1500	1.183	0.59	269	101	489.5
10	12	5.43	648	0.1500	1.230	0.61	278	139	508.8
10	18	4.24	759	0.1500	1.305	0.65	292	219	539.7
10	24	3.55	847	0.1500	1.330	0.67	297	297	550.2
10	36	2.74	980	0.1500	1.309	0.65	293	439	541.5
10	48	2.27	1083	0.1500	1.253	0.63	282	564	518.7
10	60	1.94	1157	0.1500	1.177	0.59	268	670	487.2
10	72	1.7	1217	0.1500	1.101	0.55	254	761	455.5
				Maximum	1.330			Maximum	550.2

INPUT DATA

Location	Perth	
$A_{impervious}$	0.9940	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	9.4	m
Sump Length at base	44	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 100 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
100	72	2.75	1968	58.68	176	1792	4.330	24.330	-1.530	Shallow water table log model

Comments: **Error: TWL is greater than the maximum allowable WL**

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	378	4.0000	0.912	0.46	38.8	17.00	0.83	13.91	0	377.4
100	1	46.2	459	4.0000	1.108	0.55	41.1	17.00	0.88	15.84	1	458.6
100	2	28.9	575	4.0000	1.385	0.69	44.2	17.00	0.96	18.69	2	573.0
100	3	21.9	653	4.0000	1.572	0.79	46.4	17.00	1.00	20.72	3	650.5
100	4	17.9	712	4.0000	1.712	0.86	47.9	17.00	1.04	22.28	4	708.0
100	5	15.3	760	4.0000	1.826	0.91	49.3	17.00	1.06	23.59	5	755.5
100	6	13.5	805	4.0000	1.932	0.97	50.5	17.00	1.09	24.82	6	798.9
100	9	10.2	912	4.0000	2.181	1.09	53.3	17.00	1.14	27.82	10	902.1
100	12	8.36	997	4.0000	2.374	1.19	55.5	17.00	1.18	30.22	15	982.1
100	18	6.6	1181	4.0000	2.790	1.39	60.2	17.00	1.27	35.66	27	1154.1
100	24	5.57	1329	4.0000	3.114	1.56	63.9	17.00	1.32	40.14	40	1288.6
100	36	4.35	1557	4.0000	3.591	1.80	69.4	17.00	1.41	47.08	71	1486.0
100	48	3.63	1732	4.0000	3.932	1.97	73.3	17.00	1.46	52.31	105	1627.3
100	60	3.13	1867	4.0000	4.172	2.09	76.0	17.00	1.50	56.11	140	1726.5
100	72	2.75	1968	4.0000	4.330	2.17	77.8	17.00	1.52	58.68	176	1792.1
				Maximum	4.330						Maximum	1792.1

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	377.7	1.6650	0.874	0.44	766.4	16	361.8
100	1	46.2	459.2	1.6650	1.031	0.52	780.4	33	426.7
100	2	28.9	574.5	1.6650	1.228	0.61	797.8	66	508.0
100	3	21.9	653.1	1.6650	1.335	0.67	807.3	101	552.1
100	4	17.9	711.7	1.6650	1.393	0.70	812.5	135	576.3
100	5	15.3	760.4	1.6650	1.427	0.71	815.6	170	590.5
100	6	13.5	805.1	1.6650	1.452	0.73	817.7	204	600.7
100	9	10.2	912.5	1.6650	1.463	0.73	818.8	307	605.5
100	12	8.36	997.2	1.6650	1.425	0.71	815.3	408	589.5
100	18	6.6	1180.9	1.6650	1.383	0.69	811.6	609	572.2
100	24	5.57	1328.8	1.6650	1.274	0.64	801.9	802	526.9
100	36	4.35	1556.6	1.6650	0.957	0.48	773.7	1161	396.0
100	48	3.63	1731.9	1.6650	0.600	0.30	742.0	1484	248.0
100	60	3.13	1866.7	1.6650	0.228	0.11	708.9	1772	94.4
100	72	2.75	1968.1	1.6650	0.000	0.00	688.6	2066	0.0
				Maximum	1.463			Maximum	605.5

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	378	0.1500	0.902	0.45	217	5	373.2
100	1	46.2	459	0.1500	1.085	0.54	251	10	448.8
100	2	28.9	575	0.1500	1.330	0.66	297	25	549.8
100	3	21.9	653	0.1500	1.481	0.74	326	41	612.4
100	4	17.9	712	0.1500	1.581	0.79	345	58	654.2
100	5	15.3	760	0.1500	1.657	0.83	360	75	685.5
100	6	13.5	805	0.1500	1.721	0.86	372	93	712.0
100	9	10.2	912	0.1500	1.846	0.92	397	149	763.6
100	12	8.36	997	0.1500	1.914	0.96	411	205	791.8
100	18	6.6	1181	0.1500	2.057	1.03	440	330	851.0
100	24	5.57	1329	0.1500	2.118	1.06	452	452	876.4
100	36	4.35	1557	0.1500	2.120	1.06	453	679	877.4
100	48	3.63	1732	0.1500	2.058	1.03	440	880	851.8
100	60	3.13	1867	0.1500	1.966	0.98	421	1053	813.3
100	72	2.75	1968	0.1500	1.858	0.93	400	1199	768.9
				Maximum	2.120			Maximum	877.4

Project Details	
Project	Murdoch MUP
Job Number	P11268
Task	MUP Stage 2 Drainage - 18/09/2015
Designer	Dusko Petrovich

Catchment Area Details				
Land Form	Area (m2)	Runoff Coeff	Aimp (m2)	Comments
Total Catchment	24300	1	24300	Refer to calculation 2.1
			0	
			0	
TOTAL	24300		24300	

Select Location

Perth

Select design ARI's

☐ Select all ARI's ☐ Clear ARI's

☑ 1 year ARI ☑ 2 year ARI ☑ 5 year ARI ☑ 10 year ARI

☑ 20 year ARI ☑ 50 year ARI ☑ 100 year ARI

Sump Details			
GWL	19.500	m AHD	GWL conservatively assumed as RL 19.50
Depth to GWL from base	0.500	m	
Max Allowable TWL	22.800	m AHD	
Sump Base Level	20.000	m AHD	Base of tank 0.5m above GWL
Sump Width at base	14.1	m	
Sump Length at base	120	m	
Side Slope	0.0	1 in --	

Permeability			K based on FSH Geotechnical Report findings Rising Head Permeability Test
Soil Permeability, K	5	m/d	Soil permeability is consistent with values used for FSH and adjacent Freeway works
Permeability Clogged Layer	0.15	m/d	0.15
Thickness of Clogged Layer	200	mm	200
Reduction Factor - Shallow	0.800		0.800
Reduction Factor - Deep	0.333		0.333
Reduction Factor - Clogged	1.000		1.000

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	1627	27.82	83	1544	0.912	20.912	1.888	Shallow water table log model
2	72	1.2	2100	32.57	98	2002	1.183	21.183	1.617	Shallow water table log model
5	72	1.49	2607	37.87	114	2493	1.473	21.473	1.327	Shallow water table log model
10	72	1.7	2974	41.84	126	2849	1.684	21.684	1.116	Shallow water table log model
20	72	1.99	3482	47.48	142	3339	1.973	21.973	0.827	Shallow water table log model
50	72	2.4000001	4199	55.80	167	4032	2.382	22.382	0.418	Shallow water table log model
100	72	2.75	4811	63.21	190	4622	2.731	22.731	0.069	Shallow water table log model

INPUT DATA

Location	Perth	
$A_{impervious}$	2.4300	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	14.1	m
Sump Length at base	120	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 1 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	1627	27.82	83	1544	0.912	20.912	1.888	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	296	4.0000	0.175	0.09	56.1	42.69	0.27	15.88	0	296.1
1	1	15.9	386	4.0000	0.228	0.11	56.7	42.69	0.28	16.69	1	385.7
1	2	10.2	496	4.0000	0.292	0.15	57.4	42.69	0.30	17.68	1	494.2
1	3	7.83	571	4.0000	0.336	0.17	57.9	42.69	0.31	18.36	2	568.5
1	4	6.49	631	4.0000	0.371	0.19	58.3	42.69	0.31	18.91	3	627.7
1	5	5.61	682	4.0000	0.400	0.20	58.7	42.69	0.32	19.37	4	677.6
1	6	4.98	726	4.0000	0.426	0.21	59.0	42.69	0.32	19.78	5	721.1
1	9	3.82	835	4.0000	0.489	0.24	59.7	42.69	0.34	20.79	8	827.6
1	12	3.17	924	4.0000	0.540	0.27	60.3	42.69	0.34	21.61	11	913.6
1	18	2.44	1067	4.0000	0.620	0.31	61.2	42.69	0.36	22.92	17	1050.1
1	24	2.02	1178	4.0000	0.682	0.34	61.9	42.69	0.37	23.94	24	1154.1
1	36	1.54	1347	4.0000	0.773	0.39	62.9	42.69	0.39	25.46	38	1309.0
1	48	1.26	1470	4.0000	0.837	0.42	63.6	42.69	0.40	26.54	53	1416.6
1	60	1.07	1560	4.0000	0.882	0.44	64.2	42.69	0.41	27.30	68	1491.8
1	72	0.93	1627	4.0000	0.912	0.46	64.5	42.69	0.41	27.82	83	1543.7
				Maximum	0.912						Maximum	1543.7

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	296.5	1.6650	0.140	0.07	2848.4	59	237.1
1	1	15.9	386.4	1.6650	0.158	0.08	2852.5	119	267.5
1	2	10.2	495.7	1.6650	0.152	0.08	2851.2	238	258.1
1	3	7.83	570.8	1.6650	0.127	0.06	2845.5	356	215.1
1	4	6.49	630.8	1.6650	0.093	0.05	2838.0	473	157.8
1	5	5.61	681.6	1.6650	0.054	0.03	2829.3	589	92.2
1	6	4.98	726.1	1.6650	0.012	0.01	2819.9	705	21.1
1	9	3.82	835.4	1.6650	0.000	0.00	2817.2	1056	0.0
1	12	3.17	924.4	1.6650	0.000	0.00	2817.2	1409	0.0
1	18	2.44	1067.3	1.6650	0.000	0.00	2817.2	2113	0.0
1	24	2.02	1178.1	1.6650	0.000	0.00	2817.2	2817	0.0
1	36	1.54	1347.2	1.6650	0.000	0.00	2817.2	4226	0.0
1	48	1.26	1469.7	1.6650	0.000	0.00	2817.2	5634	0.0
1	60	1.07	1560.1	1.6650	0.000	0.00	2817.2	7043	0.0
1	72	0.93	1627.1	1.6650	0.000	0.00	2817.2	8451	0.0
				Maximum	0.158			Maximum	267.5

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	296	0.1500	0.171	0.09	366	8	288.8
1	1	15.9	386	0.1500	0.218	0.11	398	17	369.8
1	2	10.2	496	0.1500	0.272	0.14	433	36	459.6
1	3	7.83	571	0.1500	0.304	0.15	455	57	513.9
1	4	6.49	631	0.1500	0.326	0.16	470	78	552.5
1	5	5.61	682	0.1500	0.343	0.17	482	100	581.3
1	6	4.98	726	0.1500	0.357	0.18	490	123	603.5
1	9	3.82	835	0.1500	0.381	0.19	507	190	645.2
1	12	3.17	924	0.1500	0.394	0.20	516	258	666.5
1	18	2.44	1067	0.1500	0.400	0.20	520	390	677.4
1	24	2.02	1178	0.1500	0.392	0.20	514	514	663.6
1	36	1.54	1347	0.1500	0.360	0.18	492	739	608.5
1	48	1.26	1470	0.1500	0.319	0.16	465	930	539.6
1	60	1.07	1560	0.1500	0.277	0.14	437	1093	467.4
1	72	0.93	1627	0.1500	0.236	0.12	409	1228	398.7
				Maximum	0.400			Maximum	677.4

INPUT DATA

Location	Perth	
$A_{impervious}$	2.4300	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	14.1	m
Sump Length at base	120	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 10 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
10	72	1.7	2974	41.84	126	2849	1.684	21.684	1.116	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	559	4.0000	0.330	0.16	57.9	42.69	0.30	18.27	0	558.5
10	1	28.8	700	4.0000	0.413	0.21	58.8	42.69	0.32	19.57	1	699.0
10	2	18.2	885	4.0000	0.522	0.26	60.0	42.69	0.34	21.31	2	882.7
10	3	13.9	1013	4.0000	0.597	0.30	60.9	42.69	0.36	22.54	3	1010.5
10	4	11.4	1108	4.0000	0.652	0.33	61.5	42.69	0.37	23.45	4	1104.2
10	5	9.81	1192	4.0000	0.701	0.35	62.1	42.69	0.37	24.26	5	1186.9
10	6	8.67	1264	4.0000	0.743	0.37	62.6	42.69	0.38	24.96	6	1257.8
10	9	6.6	1443	4.0000	0.847	0.42	63.8	42.69	0.40	26.71	10	1433.4
10	12	5.43	1583	4.0000	0.927	0.46	64.7	42.69	0.42	28.08	14	1569.3
10	18	4.24	1855	4.0000	1.082	0.54	66.4	42.69	0.44	30.78	23	1831.5
10	24	3.55	2070	4.0000	1.204	0.60	67.8	42.69	0.46	32.94	33	2037.4
10	36	2.74	2397	4.0000	1.384	0.69	69.9	42.69	0.49	36.22	54	2342.6
10	48	2.27	2648	4.0000	1.519	0.76	71.4	42.69	0.51	38.72	77	2570.3
10	60	1.94	2829	4.0000	1.612	0.81	72.5	42.69	0.53	40.47	101	2727.3
10	72	1.7	2974	4.0000	1.684	0.84	73.3	42.69	0.54	41.84	126	2848.8
				Maximum	1.684						Maximum	2848.8

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	558.9	1.6650	0.295	0.15	2883.0	60	498.8
10	1	28.8	699.8	1.6650	0.342	0.17	2893.6	121	579.3
10	2	18.2	884.5	1.6650	0.380	0.19	2902.0	242	642.7
10	3	13.9	1013.3	1.6650	0.384	0.19	2903.0	363	650.4
10	4	11.4	1108.1	1.6650	0.369	0.18	2899.6	483	624.8
10	5	9.81	1191.9	1.6650	0.348	0.17	2894.9	603	588.8
10	6	8.67	1264.1	1.6650	0.320	0.16	2888.7	722	541.9
10	9	6.6	1443.4	1.6650	0.218	0.11	2865.8	1075	368.7
10	12	5.43	1583.4	1.6650	0.097	0.05	2838.8	1419	164.0
10	18	4.24	1854.6	1.6650	0.000	0.00	2817.2	2113	0.0
10	24	3.55	2070.4	1.6650	0.000	0.00	2817.2	2817	0.0
10	36	2.74	2397.0	1.6650	0.000	0.00	2817.2	4226	0.0
10	48	2.27	2647.7	1.6650	0.000	0.00	2817.2	5634	0.0
10	60	1.94	2828.5	1.6650	0.000	0.00	2817.2	7043	0.0
10	72	1.7	2974.3	1.6650	0.000	0.00	2817.2	8451	0.0
				Maximum	0.384			Maximum	650.4

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	559	0.1500	0.324	0.16	469	10	549.1
10	1	28.8	700	0.1500	0.401	0.20	520	22	678.2
10	2	18.2	885	0.1500	0.494	0.25	583	49	835.9
10	3	13.9	1013	0.1500	0.553	0.28	623	78	935.4
10	4	11.4	1108	0.1500	0.591	0.30	649	108	999.9
10	5	9.81	1192	0.1500	0.622	0.31	671	140	1052.2
10	6	8.67	1264	0.1500	0.646	0.32	687	172	1092.3
10	9	6.6	1443	0.1500	0.694	0.35	720	270	1173.3
10	12	5.43	1583	0.1500	0.719	0.36	737	369	1214.8
10	18	4.24	1855	0.1500	0.757	0.38	764	573	1281.6
10	24	3.55	2070	0.1500	0.768	0.38	772	772	1298.8
10	36	2.74	2397	0.1500	0.747	0.37	757	1135	1262.1
10	48	2.27	2648	0.1500	0.705	0.35	728	1456	1192.1
10	60	1.94	2829	0.1500	0.651	0.33	691	1727	1101.9
10	72	1.7	2974	0.1500	0.598	0.30	654	1962	1011.8
				Maximum	0.768			Maximum	1298.8

INPUT DATA

Location	Perth	
$A_{impervious}$	2.4300	ha
GWL	19.500	m AHD
Depth to GWL from base	0.500	m
Max Allowable TWL	22.800	m AHD
Sump Base Level	20.000	m AHD
Sump Width at base	14.1	m
Sump Length at base	120	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 100 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
100	72	2.75	4811	63.21	190	4622	2.731	22.731	0.069	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	923	4.0000	0.545	0.27	60.3	42.69	0.35	21.70	0	922.9
100	1	46.2	1123	4.0000	0.663	0.33	61.7	42.69	0.37	23.62	1	1121.7
100	2	28.9	1405	4.0000	0.829	0.41	63.6	42.69	0.40	26.40	2	1402.3
100	3	21.9	1597	4.0000	0.941	0.47	64.8	42.69	0.42	28.32	4	1593.0
100	4	17.9	1740	4.0000	1.025	0.51	65.8	42.69	0.43	29.78	5	1734.9
100	5	15.3	1859	4.0000	1.095	0.55	66.6	42.69	0.44	31.00	6	1852.5
100	6	13.5	1968	4.0000	1.158	0.58	67.3	42.69	0.46	32.13	8	1960.3
100	9	10.2	2231	4.0000	1.311	0.66	69.1	42.69	0.48	34.87	13	2217.7
100	12	8.36	2438	4.0000	1.430	0.71	70.4	42.69	0.50	37.06	19	2419.2
100	18	6.6	2887	4.0000	1.687	0.84	73.4	42.69	0.54	41.91	31	2855.4
100	24	5.57	3248	4.0000	1.893	0.95	75.7	42.69	0.57	45.89	46	3202.5
100	36	4.35	3805	4.0000	2.203	1.10	79.2	42.69	0.62	52.10	78	3727.2
100	48	3.63	4234	4.0000	2.435	1.22	81.9	42.69	0.65	56.90	114	4120.2
100	60	3.13	4564	4.0000	2.607	1.30	83.8	42.69	0.68	60.55	151	4412.2
100	72	2.75	4811	4.0000	2.731	1.37	85.3	42.69	0.69	63.21	190	4621.8
				Maximum	2.731						Maximum	4621.8

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	923.4	1.6650	0.510	0.25	2930.9	61	862.3
100	1	46.2	1122.7	1.6650	0.591	0.30	2949.1	123	999.8
100	2	28.9	1404.5	1.6650	0.684	0.34	2969.8	247	1157.1
100	3	21.9	1596.5	1.6650	0.723	0.36	2978.7	372	1224.2
100	4	17.9	1739.9	1.6650	0.735	0.37	2981.2	497	1243.0
100	5	15.3	1859.0	1.6650	0.732	0.37	2980.5	621	1238.0
100	6	13.5	1968.3	1.6650	0.723	0.36	2978.6	745	1223.6
100	9	10.2	2230.7	1.6650	0.661	0.33	2964.8	1112	1118.9
100	12	8.36	2437.8	1.6650	0.570	0.29	2944.6	1472	965.5
100	18	6.6	2886.8	1.6650	0.416	0.21	2910.1	2183	704.3
100	24	5.57	3248.4	1.6650	0.225	0.11	2867.4	2867	381.0
100	36	4.35	3805.4	1.6650	0.000	0.00	2817.2	4226	0.0
100	48	3.63	4234.0	1.6650	0.000	0.00	2817.2	5634	0.0
100	60	3.13	4563.5	1.6650	0.000	0.00	2817.2	7043	0.0
100	72	2.75	4811.4	1.6650	0.000	0.00	2817.2	8451	0.0
				Maximum	0.735			Maximum	1243.0

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	923	0.1500	0.538	0.27	613	13	910.6
100	1	46.2	1123	0.1500	0.647	0.32	688	29	1094.0
100	2	28.9	1405	0.1500	0.791	0.40	788	66	1338.9
100	3	21.9	1597	0.1500	0.881	0.44	850	106	1490.3
100	4	17.9	1740	0.1500	0.941	0.47	892	149	1591.2
100	5	15.3	1859	0.1500	0.985	0.49	923	192	1666.7
100	6	13.5	1968	0.1500	1.023	0.51	950	238	1730.8
100	9	10.2	2231	0.1500	1.097	0.55	1002	376	1854.9
100	12	8.36	2438	0.1500	1.137	0.57	1030	515	1922.6
100	18	6.6	2887	0.1500	1.222	0.61	1091	819	2068.3
100	24	5.57	3248	0.1500	1.259	0.63	1118	1118	2130.6
100	36	4.35	3805	0.1500	1.258	0.63	1117	1676	2129.5
100	48	3.63	4234	0.1500	1.217	0.61	1087	2175	2059.1
100	60	3.13	4564	0.1500	1.155	0.58	1043	2609	1954.9
100	72	2.75	4811	0.1500	1.083	0.54	993	2978	1833.6
				Maximum	1.259			Maximum	2130.6

Project Details	
Project	Murdoch MUP
Job Number	P11268
Task	Existing Tanks 2 & 3 Storage - 18/09/2015
Designer	Dusko Petrovich

Catchment Area Details				
Land Form	Area (m2)	Runoff Coeff	Aimp (m2)	Comments
Total Catchment	43200	1	43200	Refer to calculation 2.1
			0	
			0	
TOTAL	43200		43200	

Select Location

Perth

Select design ARI's

☐ Select all ARI's ☐ Clear ARI's

☑ 1 year ARI ☑ 2 year ARI ☑ 5 year ARI ☑ 10 year ARI

☑ 20 year ARI ☑ 50 year ARI ☑ 100 year ARI

Sump Details			
GWL	19.500	m AHD	GWL conservatively assumed as RL 19.50
Depth to GWL from base	1.460	m	
Max Allowable TWL	23.960	m AHD	
Sump Base Level	20.960	m AHD	
Sump Width at base	11.75	m	Based on equivalent area (1306m2) for V=3920m3 & 3m internal storage for tanks 2 & 3
Sump Length at base	111.15	m	
Side Slope	0.0	1 in --	

Permeability			K based on FSH Geotechnical Report findings Rising Head Permeability Test
Soil Permeability, K	5	m/d	Soil permeability is consistent with values used for FSH and adjacent Freeway works
Permeability Clogged Layer	0.15	m/d	0.15
Thickness of Clogged Layer	200	mm	200
Reduction Factor - Shallow	0.800		0.800
Reduction Factor - Deep	0.333		0.333
Reduction Factor - Clogged	1.000		1.000

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	2893	85.85	258	2635	2.017	22.977	0.983	Shallow water table log model
2	72	1.2	3732	100.43	301	3431	2.626	23.586	0.374	Shallow water table log model
5	72	1.49	4634	116.93	351	4284	3.279	24.239	-0.279	Shallow water table log model
10	72	1.7	5288	129.38	388	4900	3.750	24.710	-0.750	Shallow water table log model
20	72	1.99	6190	147.30	442	5748	4.399	25.359	-1.399	Shallow water table log model
50	72	2.4000001	7465	173.97	522	6943	5.313	26.273	-2.313	Shallow water table log model
100	72	2.75	8554	197.95	594	7960	6.091	27.051	-3.091	Shallow water table log model

INPUT DATA

Location	Perth	
$A_{impervious}$	4.3200	ha
GWL	19.500	m AHD
Depth to GWL from base	1.460	m
Max Allowable TWL	23.960	m AHD
Sump Base Level	20.960	m AHD
Sump Width at base	11.75	m
Sump Length at base	111.15	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 1 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
1	72	0.93	2893	85.85	258	2635	2.017	22.977	0.983	Shallow water table log model

Comments:

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	527	4.0000	0.403	0.20	77.0	39.12	0.68	51.18	1	526.0
1	1	15.9	687	4.0000	0.524	0.26	78.4	39.12	0.70	53.58	2	684.6
1	2	10.2	881	4.0000	0.671	0.34	80.1	39.12	0.72	56.53	5	876.6
1	3	7.83	1015	4.0000	0.771	0.39	81.2	39.12	0.73	58.58	7	1007.4
1	4	6.49	1121	4.0000	0.851	0.43	82.1	39.12	0.74	60.21	10	1111.4
1	5	5.61	1212	4.0000	0.918	0.46	82.9	39.12	0.75	61.60	13	1198.9
1	6	4.98	1291	4.0000	0.976	0.49	83.6	39.12	0.76	62.82	16	1275.1
1	9	3.82	1485	4.0000	1.118	0.56	85.2	39.12	0.78	65.82	25	1460.5
1	12	3.17	1643	4.0000	1.232	0.62	86.5	39.12	0.79	68.25	34	1609.2
1	18	2.44	1897	4.0000	1.411	0.71	88.5	39.12	0.82	72.15	54	1843.2
1	**24**	2.02	**2094**	4.0000	1.546	0.77	90.1	39.12	0.83	75.13	**75**	**2019.2**
1	36	1.54	2395	4.0000	1.743	0.87	92.3	39.12	0.86	79.54	119	2275.7
1	48	1.26	2613	4.0000	1.874	0.94	93.8	39.12	0.87	82.53	165	2447.7
1	60	1.07	2773	4.0000	1.961	0.98	94.8	39.12	0.89	84.55	211	2562.1
1	72	0.93	2893	4.0000	2.017	1.01	95.5	39.12	0.89	85.85	258	2635.1
				Maximum	2.017						Maximum	2635.1

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	527.0	1.6650	0.368	0.18	2249.7	47	480.2
1	1	15.9	686.9	1.6650	0.453	0.23	2267.3	94	592.4
1	2	10.2	881.3	1.6650	0.529	0.26	2282.8	190	691.0
1	3	7.83	1014.8	1.6650	0.558	0.28	2288.7	286	728.7
1	4	6.49	1121.5	1.6650	0.566	0.28	2290.4	382	739.7
1	5	5.61	1211.8	1.6650	0.562	0.28	2289.6	477	734.8
1	6	4.98	1290.8	1.6650	0.550	0.28	2287.1	572	719.0
1	9	3.82	1485.2	1.6650	0.484	0.24	2273.6	853	632.6
1	12	3.17	1643.3	1.6650	0.395	0.20	2255.3	1128	515.7
1	18	2.44	1897.3	1.6650	0.182	0.09	2211.9	1659	238.5
1	24	2.02	2094.3	1.6650	0.000	0.00	2174.5	2174	0.0
1	36	1.54	2395.0	1.6650	0.000	0.00	2174.5	3262	0.0
1	48	1.26	2612.7	1.6650	0.000	0.00	2174.5	4349	0.0
1	60	1.07	2773.4	1.6650	0.000	0.00	2174.5	5436	0.0
1	72	0.93	2892.7	1.6650	0.000	0.00	2174.5	6523	0.0
				Maximum	0.566			Maximum	739.7

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
1	0.5	24.4	527	0.1500	0.397	0.20	401	8	518.7
1	1	15.9	687	0.1500	0.511	0.26	462	19	667.6
1	2	10.2	881	0.1500	0.641	0.32	531	44	837.0
1	3	7.83	1015	0.1500	0.722	0.36	575	72	942.9
1	4	6.49	1121	0.1500	0.781	0.39	607	101	1020.3
1	5	5.61	1212	0.1500	0.828	0.41	632	132	1080.0
1	6	4.98	1291	0.1500	0.864	0.43	652	163	1127.8
1	9	3.82	1485	0.1500	0.938	0.47	693	260	1225.3
1	12	3.17	1643	0.1500	0.983	0.49	718	359	1284.4
1	18	2.44	1897	0.1500	1.027	0.51	742	556	1340.9
1	24	2.02	2094	0.1500	1.033	0.52	745	745	1349.0
1	36	1.54	2395	0.1500	0.999	0.50	727	1090	1305.1
1	48	1.26	2613	0.1500	0.939	0.47	693	1386	1226.2
1	60	1.07	2773	0.1500	0.869	0.43	655	1638	1135.6
1	72	0.93	2893	0.1500	0.799	0.40	616	1849	1043.3
				Maximum	1.033			Maximum	1349.0

INPUT DATA

Location	Perth	
$A_{impervious}$	4.3200	ha
GWL	19.500	m AHD
Depth to GWL from base	1.460	m
Max Allowable TWL	23.960	m AHD
Sump Base Level	20.960	m AHD
Sump Width at base	11.75	m
Sump Length at base	111.15	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 10 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
10	72	1.7	5288	129.38	388	4900	3.750	24.710	-0.750	Shallow water table log model

Comments: **Error: TWL is greater than the maximum allowable WL**

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)	
10	0.5	46	994	4.0000	0.760	0.38	81.1	39.12	0.73	58.34	1	992.4	
10	1	28.8	1244	4.0000	0.950	0.48	83.3	39.12	0.76	62.28	3	1241.6	
10	2	18.2	1572	4.0000	1.199	0.60	86.1	39.12	0.79	67.56	6	1566.9	
10	3	13.9	1801	4.0000	1.372	0.69	88.1	39.12	0.81	71.30	9	1792.5	
10	4	11.4	1970	4.0000	1.499	0.75	89.5	39.12	0.83	74.08	12	1957.6	
10	5	9.81	2119	4.0000	1.610	0.80	90.8	39.12	0.84	76.55	16	2103.0	
10	6	8.67	2247	4.0000	1.705	0.85	91.9	39.12	0.85	78.70	20	2227.6	
10	9	6.6	2566	4.0000	1.940	0.97	94.6	39.12	0.88	84.07	32	2534.6	
10	12	5.43	2815	4.0000	2.121	1.06	96.6	39.12	0.90	88.28	44	2770.8	
10	18	4.24	3297	4.0000	2.469	1.23	100.6	39.12	0.94	96.59	72	3224.6	
10	24	3.55	**3681**	4.0000	2.738	1.37	103.7	39.12	0.97	103.20	**103**	**3577.4**	
10	36	2.74	4261	4.0000	3.132	1.57	108.2	39.12	1.02	113.14	170	4091.5	
10	48	2.27	4707	4.0000	3.418	1.71	111.4	39.12	1.05	120.56	241	4465.9	
10	60	1.94	5028	4.0000	3.609	1.80	113.6	39.12	1.07	125.59	314	4714.5	
10	72	1.7	**5288**	4.0000	3.750	1.88	115.2	39.12	1.08	129.38	388	4899.5	Infiltration used for full tank since overflow is available 300m3/ 72hrs
				Maximum	3.750						Maximum	4899.5	

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	993.6	1.6650	0.723	0.36	2322.4	48	945.2
10	1	28.8	1244.2	1.6650	0.877	0.44	2354.0	98	1146.1
10	2	18.2	1572.5	1.6650	1.051	0.53	2389.6	199	1373.3
10	3	13.9	1801.4	1.6650	1.149	0.57	2409.5	301	1500.2
10	4	11.4	1969.9	1.6650	1.199	0.60	2419.9	403	1566.6
10	5	9.81	2119.0	1.6650	1.235	0.62	2427.2	506	1613.3
10	6	8.67	2247.3	1.6650	1.255	0.63	2431.3	608	1639.4
10	9	6.6	2566.1	1.6650	1.266	0.63	2433.5	913	1653.5
10	12	5.43	2814.9	1.6650	1.227	0.61	2425.5	1213	1602.2
10	18	4.24	3297.0	1.6650	1.141	0.57	2408.1	1806	1491.0
10	24	3.55	3680.6	1.6650	0.997	0.50	2378.5	2378	1302.1
10	36	2.74	4261.2	1.6650	0.620	0.31	2301.3	3452	809.3
10	48	2.27	4707.1	1.6650	0.209	0.10	2217.2	4434	272.7
10	60	1.94	5028.5	1.6650	0.000	0.00	2174.5	5436	0.0
10	72	1.7	5287.7	1.6650	0.000	0.00	2174.5	6523	0.0
				Maximum	1.266			Maximum	1653.5

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
10	0.5	46	994	0.1500	0.751	0.38	591	12	981.3
10	1	28.8	1244	0.1500	0.931	0.47	689	29	1215.5
10	2	18.2	1572	0.1500	1.152	0.58	812	68	1504.8
10	3	13.9	1801	0.1500	1.294	0.65	892	111	1689.9
10	4	11.4	1970	0.1500	1.388	0.69	946	158	1812.3
10	5	9.81	2119	0.1500	1.464	0.73	989	206	1912.8
10	6	8.67	2247	0.1500	1.525	0.76	1024	256	1991.2
10	9	6.6	2566	0.1500	1.649	0.82	1097	411	2154.8
10	12	5.43	2815	0.1500	1.719	0.86	1138	569	2246.0
10	18	4.24	3297	0.1500	1.832	0.92	1204	903	2393.7
10	24	3.55	3681	0.1500	1.876	0.94	1230	1230	2450.4
10	36	2.74	4261	0.1500	1.860	0.93	1221	1831	2430.0
10	48	2.27	4707	0.1500	1.794	0.90	1182	2363	2343.6
10	60	1.94	5028	0.1500	1.697	0.85	1125	2812	2216.9
10	72	1.7	5288	0.1500	1.598	0.80	1067	3200	2088.0
				Maximum	1.876			Maximum	2450.4

INPUT DATA

Location	Perth	
$A_{impervious}$	4.3200	ha
GWL	19.500	m AHD
Depth to GWL from base	1.460	m
Max Allowable TWL	23.960	m AHD
Sump Base Level	20.960	m AHD
Sump Width at base	11.75	m
Sump Length at base	111.15	m
Side Slope	0.0	1 in --
Soil Permeability, K	5	m/d
Permeability Clogged Layer	0.15	m/d
Thickness of Clogged Layer	200	mm
Reduction Factor - Shallow	0.800	
Reduction Factor - Deep	0.333	
Reduction Factor - Clogged	1.000	

SUMP CALCULATIONS FOR 100 year ARI

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage Required (m3)	Water Depth, H (m)	TWL (m AHD)	Freeboard (m)	Critical Model
100	72	2.75	8554	197.95	594	7960	6.091	27.051	-3.091	Shallow water table log model

Comments: **Error: TWL is greater than the maximum allowable WL**

SHALLOW WATER TABLE LOG MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	R (m)	r (m)	ln (R / r)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)	
100	0.5	76	1642	4.0000	1.256	0.63	86.8	39.12	0.80	68.76	1	1640.2	
100	1	46.2	1996	4.0000	1.525	0.76	89.8	39.12	0.83	74.67	3	1992.7	
100	2	28.9	2497	4.0000	1.906	0.95	94.2	39.12	0.88	83.28	7	2490.0	
100	3	21.9	2838	4.0000	2.164	1.08	97.1	39.12	0.91	89.29	11	2827.1	
100	4	17.9	3093	4.0000	2.356	1.18	99.3	39.12	0.93	93.85	16	3077.5	
100	5	15.3	3305	4.0000	2.514	1.26	101.1	39.12	0.95	97.69	20	3284.4	
100	6	13.5	3499	4.0000	2.659	1.33	102.8	39.12	0.97	101.24	25	3473.9	
100	9	10.2	3966	4.0000	3.004	1.50	106.7	39.12	1.00	109.87	41	3924.6	
100	12	8.36	4334	4.0000	3.273	1.64	109.8	39.12	1.03	116.77	58	4275.4	
100	18	6.6	5132	4.0000	3.852	1.93	116.4	39.12	1.09	132.15	99	5033.0	
100	24	5.57	5775	4.0000	4.309	2.15	121.6	39.12	1.13	144.76	145	5630.2	Infiltration used for full tank
100	36	4.35	6765	4.0000	4.989	2.49	129.4	39.12	1.20	164.31	246	6518.7	since overflow is available
100	48	3.63	7527	4.0000	5.487	2.74	135.1	39.12	1.24	179.21	358	7168.8	$110m^3$/ 72hrs
100	60	3.13	8113	4.0000	5.845	2.92	139.1	39.12	1.27	190.22	476	7637.4	
100	72	2.75	8554	4.0000	6.091	3.05	141.9	39.12	1.29	197.95	594	7959.8	Infiltration used for full tank
				Maximum	6.091						Maximum	7959.8	since overflow is available
													$300m^3$/ 72hrs

DEEP WATER TABLE MODEL

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	1641.6	1.6650	1.218	0.61	2423.8	50	1591.1
100	1	46.2	1995.8	1.6650	1.449	0.72	2471.0	103	1892.9
100	2	28.9	2497.0	1.6650	1.750	0.87	2532.6	211	2285.9
100	3	21.9	2838.2	1.6650	1.927	0.96	2568.8	321	2517.1
100	4	17.9	3093.1	1.6650	2.037	1.02	2591.4	432	2661.2
100	5	15.3	3304.8	1.6650	2.114	1.06	2607.1	543	2761.7
100	6	13.5	3499.2	1.6650	2.177	1.09	2620.0	655	2844.2
100	9	10.2	3965.8	1.6650	2.278	1.14	2640.6	990	2975.5
100	12	8.36	4333.8	1.6650	2.305	1.15	2646.1	1323	3010.8
100	18	6.6	5132.2	1.6650	2.398	1.20	2665.3	1999	3133.2
100	24	5.57	5775.0	1.6650	2.383	1.19	2662.1	2662	3112.9
100	36	4.35	6765.1	1.6650	2.172	1.09	2618.9	3928	2836.8
100	48	3.63	7527.2	1.6650	1.853	0.93	2553.6	5107	2420.0
100	60	3.13	8113.0	1.6650	1.472	0.74	2475.8	6190	1923.4
100	72	2.75	8553.6	1.6650	1.057	0.53	2390.9	7173	1381.0
				Maximum	2.398			Maximum	3133.2

CLOGGED BASE MODEL (using wetted area)

ARI (years)	Duration (hours)	Rainfall Intensity (mm/h)	Total Inflow (m3)	Kadjusted (m/day)	Water Depth, H (m)	H' (m)	Infiltration q0 (m3/day)	Total Outflow (m3)	Storage (m3)
100	0.5	76	1642	0.1500	1.243	0.62	863	18	1623.6
100	1	46.2	1996	0.1500	1.496	0.75	1008	42	1953.9
100	2	28.9	2497	0.1500	1.835	0.92	1206	100	2396.5
100	3	21.9	2838	0.1500	2.045	1.02	1332	166	2671.8
100	4	17.9	3093	0.1500	2.187	1.09	1418	236	2856.8
100	5	15.3	3305	0.1500	2.293	1.15	1483	309	2995.9
100	6	13.5	3499	0.1500	2.384	1.19	1538	385	3114.6
100	9	10.2	3966	0.1500	2.562	1.28	1649	618	3347.3
100	12	8.36	4334	0.1500	2.662	1.33	1712	856	3477.8
100	18	6.6	5132	0.1500	2.869	1.43	1844	1383	3749.3
100	24	5.57	5775	0.1500	2.963	1.48	1904	1904	3871.0
100	36	4.35	6765	0.1500	2.980	1.49	1915	2872	3892.9
100	48	3.63	7527	0.1500	2.904	1.45	1866	3733	3794.5
100	60	3.13	8113	0.1500	2.785	1.39	1790	4475	3638.2
100	72	2.75	8554	0.1500	2.643	1.32	1700	5101	3453.1
				Maximum	2.980			Maximum	3892.9

LandCorp

29 October 2012

D R A F T

Murdoch Mixed Use Precinct Residential Development

Road Traffic Noise Assessment



D R A F T

Murdoch Mixed Use Precinct Residential Development

Road Traffic Noise Assessment

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LandCorp

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Executive Summary

This report provides an assessment of road traffic noise impact for the proposed residential development within the Murdoch Mixed Use Precinct (MUP). The assessment has been based on the predicted noise levels at the affected residential buildings, and the associated outdoor living areas against nominated noise criteria.

The future year 2031 has been considered for the assessment of noise impact on the proposed residential development.

The assessment is based on the noise criteria from State Planning Policy (SPP) 5.4 (details refer to Section 2.1). These criteria are applicable for the proposed new MUP residential development affected by adjacent major traffic corridors, i.e. Kwinana Freeway and South Street.

The noise levels based on the $L_{A10,18hr}$ statistical noise descriptor have been predicted using the CoRTN algorithm as implemented by SoundPLAN 6.5 noise modelling software suite. The relevant modelling methodology and modelling parameters are documented in Section 3.0 and 4.0 of the report.

The modelling prediction results have shown that the seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq,\ 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A). The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

The noise levels at the outdoor living area for the proposed MUP residential development, i.e. the Murdoch Circle and the Conservation Zone, are predicted to comply with SPP 5.4 noise criteria.

Preliminary noise mitigation and insulation measure recommendations have been provided considering various predicted facade noise level scenarios, detailed in Section 7.0.

1.0 Introduction

1.1 Background

AECOM has been commissioned by LandCorp to undertake an assessment of road traffic noise impact on the proposed residential development within the Murdoch Mixed Use Precinct (MUP), located approximately 12 km south of the Perth CBD.

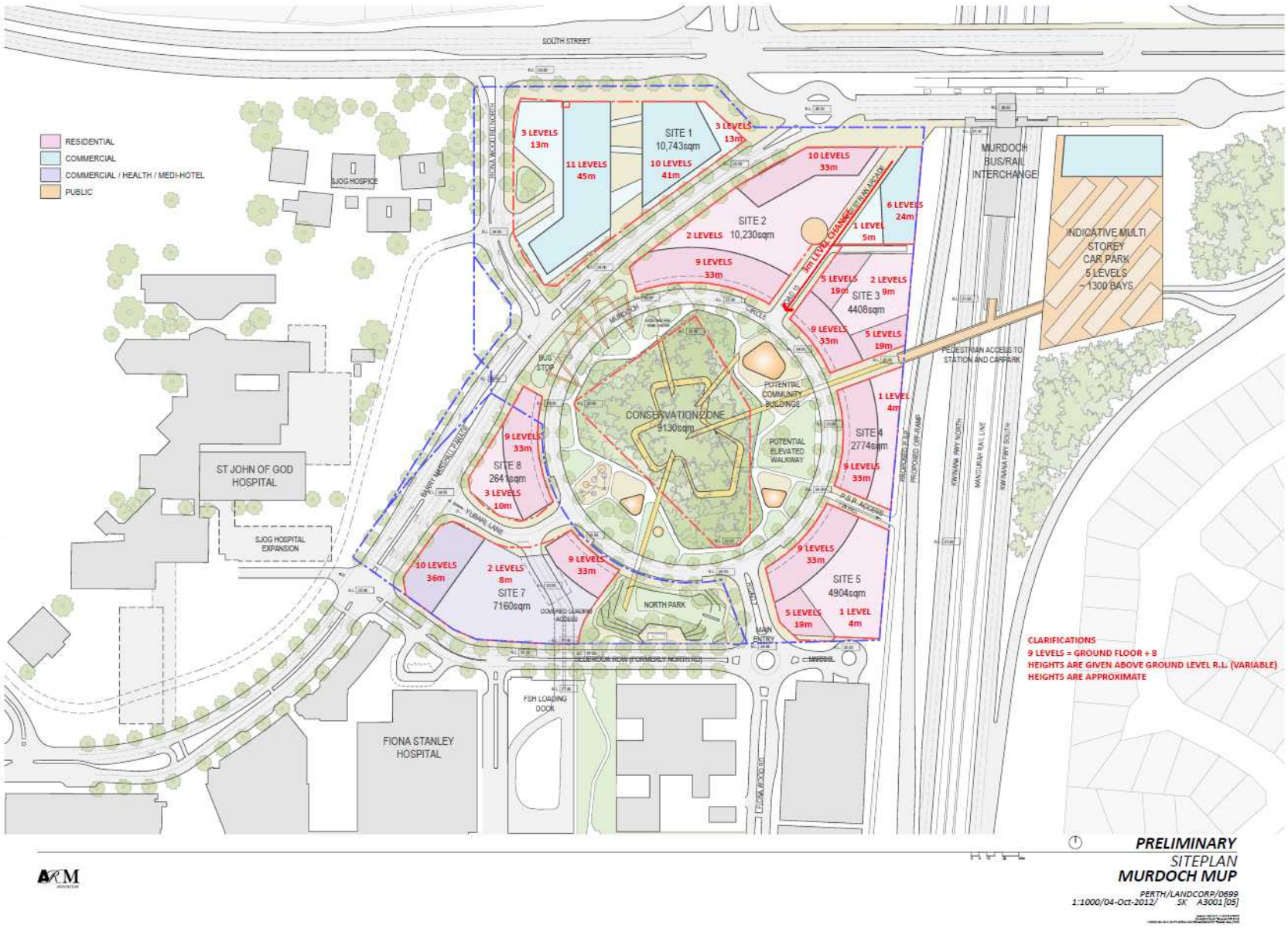
This report details prediction of the traffic noise impact on the proposed residential development and the comparison of predicted noise levels with appropriate assessment criteria, as well as the relevant noise mitigation and insulation measure recommendations.

1.2 Project Description

The Mixed Use Precinct (MUP) site is identified as the heart of the Murdoch Activity Centre (MAC) development, connecting Murdoch Station with the adjacent employment and health nodes and providing an innovative example of a mixed use, transit orientated development.

The proposed site layout design for the MUP has been prepared by LandCorp's architects, ARM, and has progressed through various stages of commentary. shows the proposed MUP site layout, number of storeys, and heights at the building development. It can be seen from the layout that the development mainly consists of a number of residential buildings and the associated podiums around the circular conservation zone, with commercial buildings located along South Street and Kwinana Freeway.

Figure 1 The proposed MUP site layout



Source: ARM on behalf of LandCorp

1.3 Scope of Works

The scope of works for the road traffic noise impact assessment for the MUP residential development is to include:

- Create a noise model to predict the noise levels for a future year traffic scenario (i.e. future year 2031 for the worst case), considering the noise emissions from adjacent major traffic corridors, including Kwinana Freeway and South Street;
- Predict received noise levels from road traffic sources for the proposed MUP residential buildings and associated outdoor living areas;
- Assessment the traffic noise impact on the residential development based on relevant noise criteria, namely SPP 5.4;
- Noise mitigation and insulation measures will be investigated and recommended if required.

2.0 Noise Criteria and the Applications

2.1 Outdoor Noise Criteria

The outdoor noise criteria applicable to the emission of road and rail transport noise, as received at a noise-sensitive land use such as residential dwellings or non-residential noise sensitive receivers such as schools and child care centres, are outlined in the *State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP 5.4).* Table 1 lists the SPP 5.4 outdoor noise target and noise limit for both day time and night time period.

For new noise-sensitive developments, the noise criteria apply to the locations 1m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.

Table 1 SPP 5.4 outdoor noise criteria applicable to noise-sensitive land use

Time of day	Noise Target	Noise Limit
Day (6 am–10 pm) - $L_{Aeq,16hr}$	55 dB(A)	60 dB(A)
Night (10 pm–6 am) – $L_{Aeq,8hr}$	50 dB(A)	55 dB(A)

The 5 dB(A) difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. The policy states that "*In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin*".

2.2 Interpretation and application for new noise-sensitive developments

The SPP 5.4 details the interpretation and application of the noise criteria for new noise-sensitive developments, with supplementary information provided in the Implementation Guidelines for SPP 5.4.

2.2.1 Objectives

The SPP 5.4 specifies the outdoor noise criteria for new noise-sensitive developments, as listed in Table 1, in order to achieve the following objectives:

- acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and
- a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot.

2.2.2 Applications

The SPP 5.4 outlines a number of scenarios regarding the likely outdoor noise levels in a noise-sensitive development area, and the corresponding measured required to be implemented in order to achieve the objectives listed in Section 2.2.1. They are summarised in Table 2.

Table 2 Outdoor noise levels for a new noise-sensitive development and the subsequent measures required

Likely Outdoor Noise Levels	Measures Required
Meet the noise target	No further measures are required
Exceed the noise target, but within the 5 dB margin	- Mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot - Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply noise insulation measures (Package A, referring to Appendix F) detailed in the Implementation Guidelines

Likely Outdoor Noise Levels	Measures Required
Exceed the noise limit, but within 3 dB above the limit	- A detailed noise assessment in accordance with the guidelines should be undertaken by the developer - Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin - Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply noise insulation measures (Package B, referring to Appendix F) detailed in the Implementation Guidelines
Exceed the noise limit, and more than 3 dB above the limit	- A detailed noise assessment in accordance with the guidelines should be undertaken by the developer - Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin - Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, 'Quiet house design' concept (referring to referring Appendix F) is recommended, with the considerations of the interior layout arrangement and higher noise insulation measures. The implementations subject to detailed acoustics review during project design phase.

The SPP 5.4 states that if the policy objectives for noise-sensitive developments are not achievable, best practicable measures as presented in Section 2.3 should be implemented.

2.3 Reasonable and practicable noise mitigation measures

The following paragraphs are reproduced in full from SPP 5.4, and outline reasonable and practicable noise mitigation considerations for new noise-sensitive developments.

'5.8 Reasonable and practicable measures

This policy applies a performance-based approach to the management and mitigation of transport noise. It is recognised that in a number of instances it may not be reasonable and practicable to meet the noise target criteria. Where transport noise is above the target level, measures are expected to be implemented that best balance reasonable and practicable considerations, such as noise benefit, cost, feasibility, community preferences, amenity impacts, safety, security and conflict with other planning and transport policies. In these cases the community should also be consulted to assist in identifying best overall solutions. The guidelines assist in outlining ways in which some reasonable and practicable limitations can be addressed in a manner that also minimises transport noise.

It is further acknowledged that there may also be situations in which the noise limit cannot practicably be achieved, especially in the case of major redevelopment of existing transport infrastructure. Similarly, it may not be practicable to achieve acceptable indoor noise levels if the new development is located very close to the transport corridor. In these situations the primary focus should be on achieving the lowest level of noise, with other reasonable and practicable considerations being secondary to this objective.

In cases where the noise limit or indoor noise criteria cannot practicably be met, longer term strategies for land use planning, transport policy and vehicle emissions should be considered to minimise transport noise impact over time.'

3.0 Noise Modelling Methodology

Modelling prediction of the noise emissions from South Street and Kwinana Freeway was carried out using the UK Department of Transport, “Calculation of Road Traffic Noise” (CoRTN 1998) algorithms as implemented by SoundPLAN 6.5 noise modelling software suite. The modelling software suite allows for traffic volume and mix type of road surface, vehicle speed, road gradient, ground absorption, and shielding from ground topography and intervening structures such as noise barriers and existing dwellings to be taken into account.

Receiver locations, ground topography, future road alignment and other cadastral data (e.g. property boundaries) were derived from proposed site plan, aerial photographs, and electronic information supplied by BG&E Engineering, ARM Architecture and MRWA.

The noise model was developed for the future year 2031, when the traffic volumes, and as such, the noise emissions of these relevant major roads are predicted to be the highest compared with earlier future years.

3.1 Modelling parameters

The CoRTN calculation predicts noise levels based on the $L_{A10,\ 18hr}$ statistical descriptor. In Western Australia, road traffic noise assessments are based on the average energy based noise level criteria $L_{Aeq,16hr}$ for day time and $L_{Aeq,\ 8hr}$ for night time, i.e. the SPP 5.4 noise assessment criteria listed in Section 2.0. We have therefore incorporated the following conversion factors into the model.

3.1.1 L_{A10} to L_{Aeq} conversion factor

Previous noise monitoring results from a relevant project, i.e. Kwinana Freeway - Roe Highway to Leach Highway (Document No. 60100953.BS002.REP) have been used to calculate the average difference of 1.5 dB(A) between the $L_{A10,\ 18hr}$ and $L_{Aeq,\ 16hr}$ noise descriptors. This difference has been applied to the $L_{A10.\ 18hr}$ CORTN output to convert it to the $L_{Aeq,\ 16hr}$ noise descriptor relevant to road traffic noise assessment procedure in Western Australia.

3.1.2 Low volume correction factor

The CoRTN calculation algorithm implements a low volume correction to low traffic flow volumes (i.e. below 200 vehicles/hour) in order to account for the effect that intermittent traffic has on the $L_{A10,\ 18hr}$ statistical descriptor. Traffic volumes in this project have been adjusted to ensure the low volume correction factor is not triggered within the model. CoRTN output is balanced accordingly by applying an additional correction factor to all traffic strings with adjusted traffic volumes. This approach has been successfully used on previous projects and satisfactorily accounts for the L_{Aeq} prediction for both low and high-volume traffic flows.

3.1.3 Modified source height noise modelling

The CoRTN calculation algorithm assumes road traffic noise emission height of 0.5 m above road surface for all vehicle classes. This assumption can overestimate the effect of noise barriers, particularly on heavy vehicle routes, as heavy vehicle noise sources (namely engine and exhaust) have a significantly higher noise emission height. In order to account for the elevated heavy vehicle noise emission height, traffic volumes were split into light and heavy vehicles (Austroads Class 1 and 2, and 3-12 respectively). Light vehicle traffic strings were unmodified, while heavy vehicle traffic was modelled at a height of 1.5 m for heavy vehicle engines and 3.6 m for heavy vehicle exhausts. Corrections were applied to the outputs of the modified heavy vehicle traffic strings (-0.8 dB(A) for engine and -8.0 dB(A) for exhaust) in order to balance the combined output to 0 dB(A) (i.e. no additional gain from having two heavy vehicle noise source strings).These source height implementations are in accordance with the Implementation Guidelines for SPP 5.4.

3.2 Modelling Inputs and Assumptions

3.2.1 Topography

Two data sets were combined into one set of elevation contours used to generate the Digital Ground Model (DGM) used in the *SoundPLAN* model for this noise assessment for the future year 2031. They are the elevation contours provided by MRWA covering the study area and the site elevation information provided by BG&E Engineering for this noise assessment study.

3.2.2 Traffic noise modelling strings

Future road design outlines applicable for the future year 2031 were used to construct ‘traffic strings’ (noise emission lines) for each lane along the modelled roads. On roads where multiple lanes were present, each road lane was modelled separately, with traffic volumes divided equally between the lanes.

3.2.3 Proposed building development

Proposed building outlines, including information of building heights and number of floors for each building, were digitised from the preliminary site plan supplied by ARM Architecture.

3.2.4 Ground absorption

All road surfaces were assumed to be reflective (hard) ground, with absorptive (soft) ground assumed elsewhere in the project area.

3.2.5 Road surface corrections

The road surfaces are a combination of Open Graded Asphalt (OGA) and Dense Graded Asphalt (DGA). All road lanes of Kwinana Freeway have Open Graded Asphalt surface, and South Street and other Freeway onramps and off-ramps have Dense Graded Asphalt surface. A summary of relative noise relationships between different types of assumed road pavement surfaces is presented in Table 3.

Table 3 Noise emissions from different road pavement surfaces relative to Dense Graded Asphalt.

Chip Seal			Asphalt		
14mm	10mm	5mm	Dense Graded	Stone Mastic	Open Graded
+3.5 dB(A)	+2.5 dB(A)	+1.5 dB(A)	0 dB(A)	-1.5 dB(A)	-2.5 dB(A)

4.0 Model Calibration and traffic noise modelling

The computer noise model of the future year 2031 were constructed based on the predicted traffic volumes, posted speed limits, ground topography and the proposed MUP residential development site plan layout.

4.1 Traffic Volume and Speed

The traffic data for the future year of 2031, including travel direction, Annual Average Weekday Traffic (AAWT) and heavy vehicle volumes as percentage of AAWT were derived from MRWA Transport Modelling Section. It is noted that vehicle volumes for the future year 2031 were calibrated based on the differences between the assigned volumes and the count volumes of year 2011 for both light and heavy vehicles. The uncelebrated light vehicle and heavy vehicle traffic volumes for the future year of 2031 were presented in Appendix B. The assigned and count daily traffic volumes of year 2011 for the two vehicle categories were also presented in Appendix C.

The 18 hours traffic volume was assumed to constitute 89% daily traffic volume for Kwinana Freeway and 94% was assumed for the rest of the roads. Designed posted speed limits were used as the speed model input.

Figure 2outlines the relevant parameters for the road sections that have been input for the noise models.

Figure 2 Road traffic data, speed limits and number of lanes for the future year 2031

Road name	2031 AAWT	% HV	Speed (km/h)	Lane Number
South Street Westbound – West of Kwinana Fwy and On/Off Ramps	23957	7	70	3
South Street Eastbound – West of Kwinana Fwy and On/Off Ramps	21235	7	70	3
South Street Westbound – West of Kwinana Fwy and East of On/Off Ramps	24130	7	70	3
South Street Eastbound – West of Kwinana Fwy and East of On/Off Ramps	20980	6	70	3
South Street Westbound – East of Kwinana Fwy	24130	7	70	3
South Street Eastbound – East of Kwinana Fwy	20980	6	70	3
South Street Northbound On Ramp	11688	6	70	1
South Street Northbound Off Ramp	7169	4	70	1
South Street Southbound On Ramp	6687	5	70	1
South Street Southbound Off Ramp	7993	3	70	1
Kwinana Fwy Northbound	66910	11	100	3
Kwinana Fwy Southbound	66171	10	100	3

4.2 Model Calibration

Comprehensive road noise model calibration procedure has been developed and executed in our previous noise model which covers the study area. Details can be referred to previous projects, i.e. Kwinana Freeway – Roe Highway to Leach Highway (Document No. 60100953.BS002.REP). The model calibration procedure was based on noise monitoring at a series of representative locations, and calibration factors were derived for different road types and sections by comparing un-calibrated noise model predictions against measured results.

This study adopts the model calibration results for the existing road strings that have been undertaken in the previous project. For the future year modelling scenario, the calibration factors were assumed unchanged for the road sections relevant to this assessment study.

The previous noise monitoring results also show that the difference between daytime ($L_{Aeq,\ 16hr}$) and night time ($L_{Aeq,\ 8hr}$) noise emissions is 5 dB(A) or more at all noise monitoring locations. Therefore, in line with MRWA guidelines, the night time noise emission targets will be achieved by meeting the daytime noise emission targets.

5.0 Results

Following the modelling methodology presented in the previous sections, received noise levels were predicted for the proposed residential and commercial building facades and outdoor areas. The receivers at the facades locate at the centre of each facade, 1.5 m above each floor and 1 m away from the façade.

5.1 Residential buildings

The seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq, 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A).

The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

5.2 Outdoor living area

The noise levels at the outdoor living area for the proposed MUP residential development, i.e. the Murdoch Circle and the Conservation Zone, are predicted to comply with SPP 5.4 noise criteria. However balconies located on facades with direct line of sight with roads (e.g. facing South Street and Kwinana Freeway) are likely exceed SPP 5.4 noise criteria.

5.3 Commercial buildings

The predicted façade noise levels at proposed three commercial buildings are also shown in Appendix D. The results show that the majority of the building floors of the commercial building facades that directly exposed to South Street or Kwinana Freeway have the received noise levels $L_{Aeq, 16hr}$ above 63 dB(A), with the highest predicted level up to 68 dB(A).

6.0 Noise Mitigation and Insulation Measures

In line with the SPP 5.4 noise criteria applications outlined in Section 2.2.2, for the case of indoor spaces being planned to be facing any outdoor area where the predicted façade noise level exceeding SPP 5.4 noise criteria, the recommended noise mitigation and insulation measures for the proposed residential development are summarised as follows:

- The predicted façade noise level exceeds the SPP 5.4 noise target, but within the 5dB margin. The implementation of the deem-to-comply noise insulation package A is recommended for indoor spaces. The details of the package A measures refer to Table 8 in Appendix F.
- The predicted façade noise level exceeds the SPP 5.4 noise limit, but within 3dB above the limit. The implementation of the deem-to-comply noise insulation package B is recommended for indoor spaces. The details of the package B measures refer to Table 9 in Appendix F.
- The predicted façade noise level exceeds the SPP 5.4 noise limit, and more than 3dB above the limit. In order to achieve acceptable noise levels within the internal noise-sensitive spaces, multiple insulation and mitigation measures might need to be implemented. The possible measures include higher noise insulation measures with upgraded glazing and where necessary, limiting the size of opening to habitable rooms to limit noise intrusion. Another possible and practical measure is the interior layout manipulation by locating the most noise-sensitive spaces away from the source of noise where possible and preferably separated from noise sources by service areas such as bathrooms, laundries and storerooms. The detailed measure implementation subject to detailed acoustics review during project design phase.

7.0 Conclusions

The road traffic noise impact from two major traffic corridors, i.e. South Street and Kwinana Freeway, on the proposed residential development within the Murdoch Mixed Use Precinct (MUP) has been assessed in this study. The assessment was based on the predicted noise levels at the affected residential buildings and the associated outdoor living areas for the future year 2031 scenario.

The assessment is based on the noise criteria from State Planning Policy (SPP) 5.4 (details refer to Section 2.1). These criteria are applicable for the proposed new MUP residential development affected by adjacent major traffic corridors, i.e. South Street and Kwinana Freeway.

The noise levels based on the $L_{A10,18hr}$ statistical noise descriptor have been predicted using the CoRTN algorithm as implemented by SoundPLAN 6.5 noise modelling software suite. The relevant modelling methodology and modelling parameters are documented in Section 3.0 and 4.0 of the report.

The modelling prediction results have shown that the seven proposed residential buildings along South Street and Kwinana Freeway have facades with predicted noise levels exceeding SPP 5.4 noise criteria. The predicted noise levels at the majority of the building floors at these façades exceed noise limit $L_{Aeq, 16hr}$ 60 dB(A), with a number of building floors exceed 63 dB(A). The predicted building façade noise levels with exceedence of SPP 5.4 noise criteria are presented in the table in Appendix D.

The noise levels at the public outdoor living area for the proposed MUP residential are predicted to comply with SPP 5.4 noise criteria.

Preliminary noise mitigation and insulation measure recommendations have been provided considering various predicted facade noise level scenarios, with details refer to Section 7.0.

Appendix A

Acoustic Glossary

D R A F T

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Competent Acoustic Consultant	SPP 5.4 defines a competent acoustic consultant as a member of the AAS or the AAAC. AECOM staff in the Perth acoustics team is all members of the AAS, AECOM is a member company of AAAC.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB Forrest Place at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the “A” filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
L_{Amax}	The maximum sound pressure level measured over a given period.
$L_{Aeq,\ T}$	The logarithmic average sound pressure level over duration period T.
$L_{Aeq.\ 24hr}$	The logarithmic average sound pressure level over 24 hours.
$L_{Aeq,\ 16hr}$	The logarithmic average sound pressure level over 24 hours. In the context of SPP 5.4 this refers to the daytime levels (between 06.00 hours and 22 hours).
$L_{Aeq,\ 8hr}$	The logarithmic average sound pressure level over 8 hours. In the context of SPP 5.4 this refers to the night time levels (between 22.00 hours and 06 hours).
$L_{A10,\ 18hr}$	The A-weighted sound pressure level exceeded for 10% of the measurement period between 6.00am and midnight, as defined in CoRTN modelling algorithm.

Appendix B

Assigned Daily Traffic Volumes for Light and Heavy Vehicles for Future Year 2031

Kwinana Freeway/South St Interchange
Plot of 2031 FMM Truck volumes on V2012 y2031 network (Factor volumes x100)

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
Traffic forecasts should be primarily used for relative comparison, not as absolute values.
Terms & Conditions :
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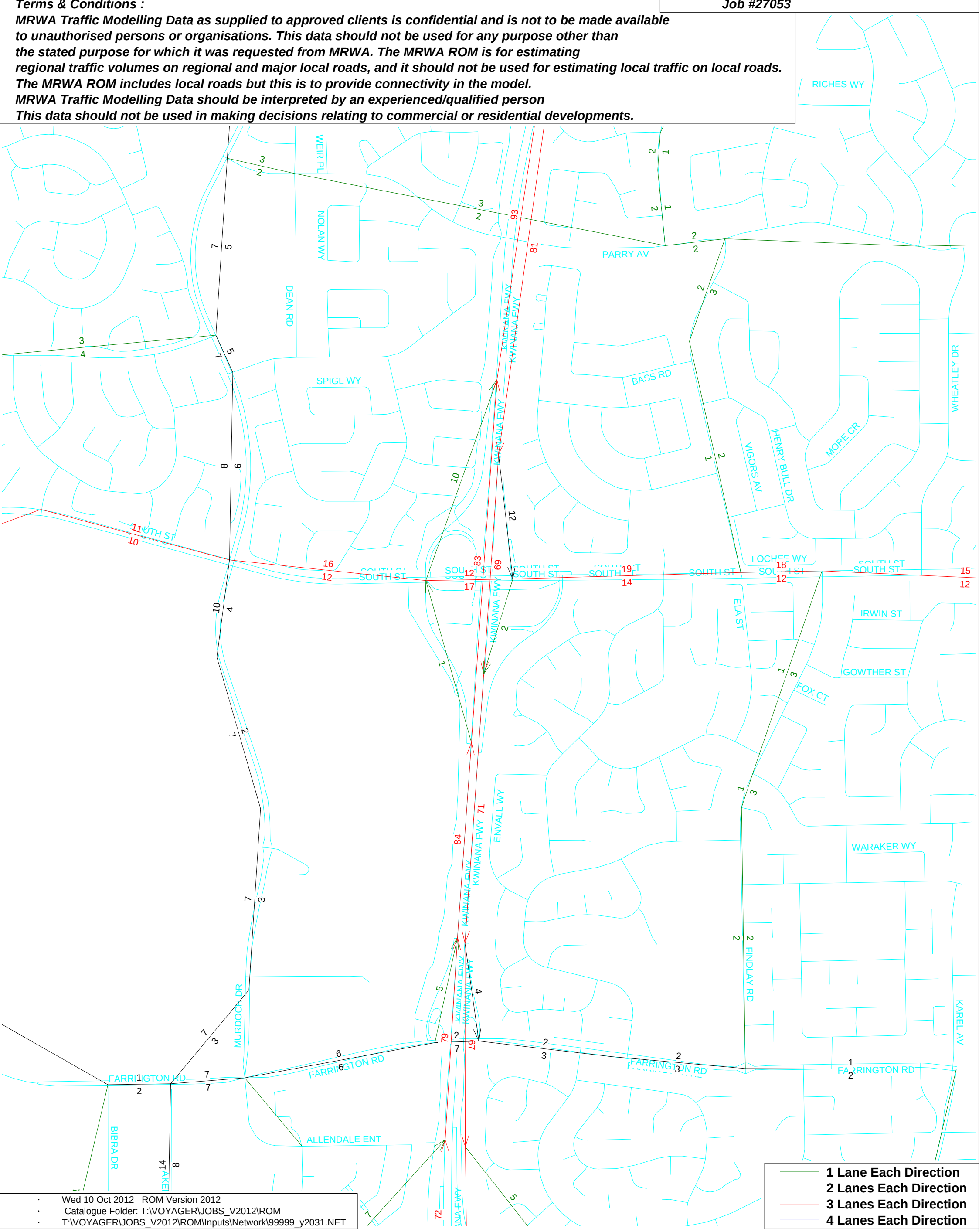
Job #27053



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Kwinana Freeway/South St Interchange - North bound 'off' ramp
Plot of 2031 volumes on V2012 y2031 network (Factor volumes x100)

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
Traffic forecasts should be primarily used for relative comparison, not as absolute values.
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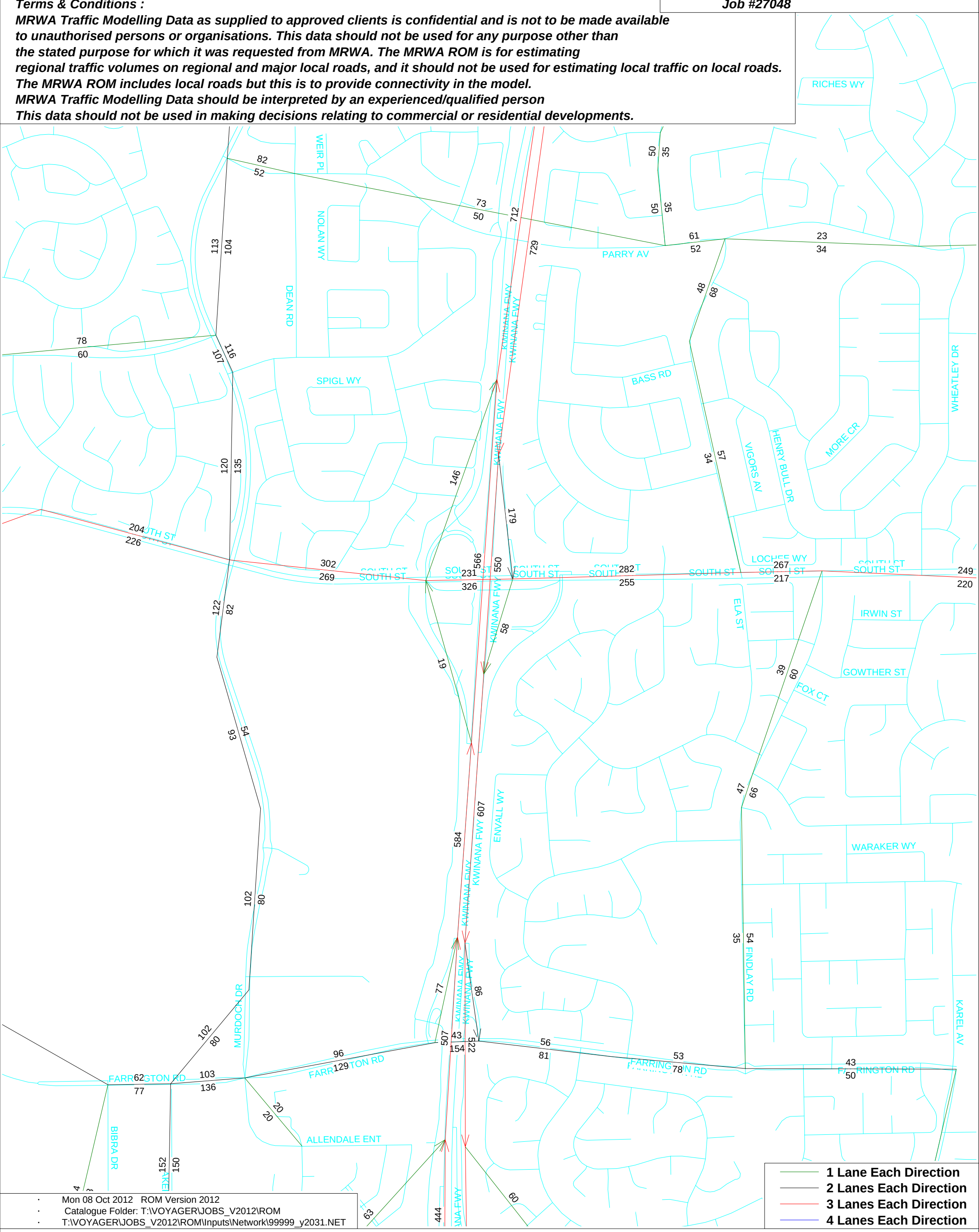

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1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
4 Lanes Each Direction

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Appendix C

Assigned and Count Daily Traffic Volumes of 2011 for Both Light and Heavy Vehicles

Kwinana Freeway/South St Interchange
Plot of 2011 FMM truck volumes & counts on V2012 y2011 network

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
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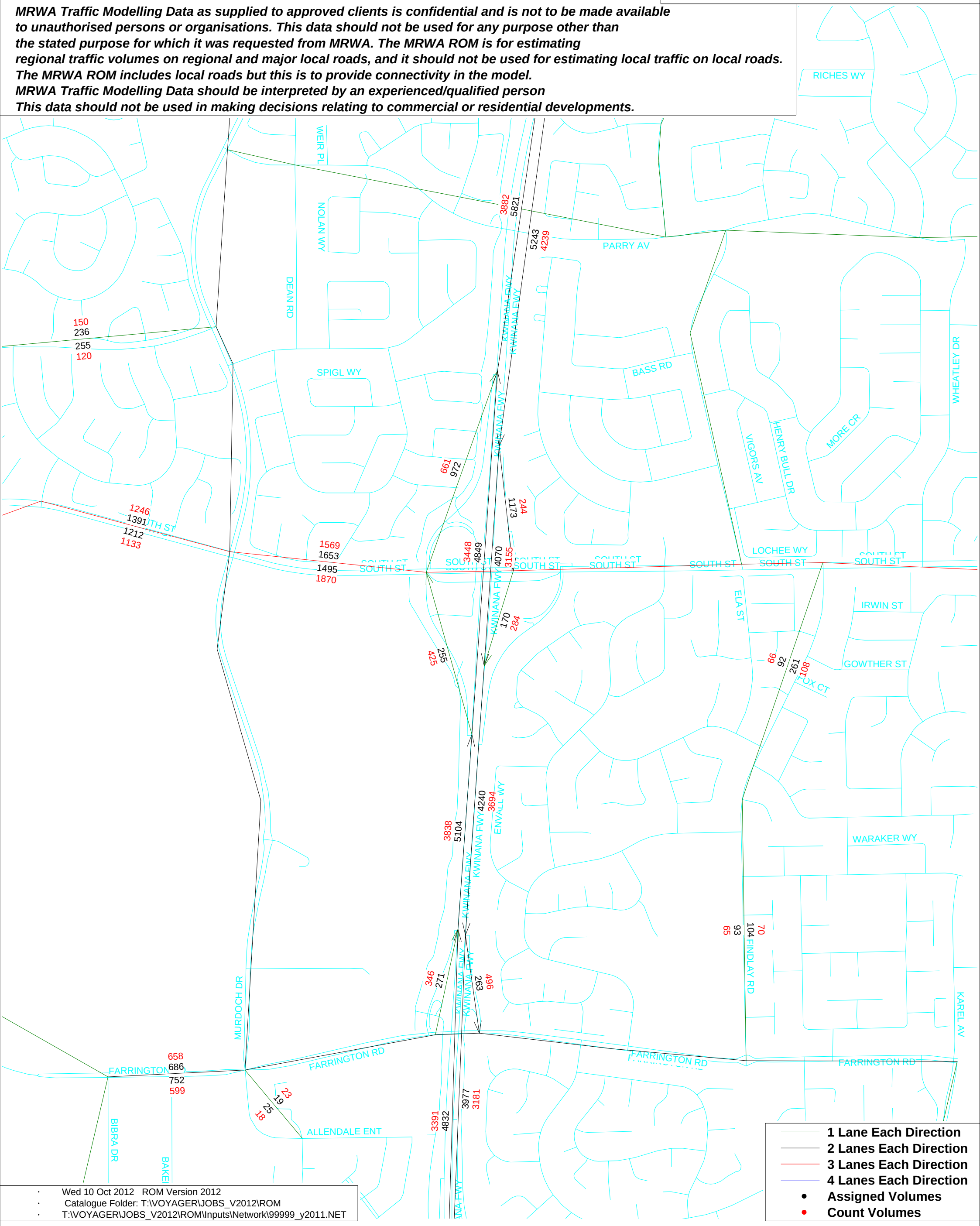

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Kwinana Freeway/South St Interchange - North bound 'off' ramp
Plot of 2011 volumes & counts on V2012 y2011 network

Regional Operations Model (ROM) Network
Unadjusted Average Weekday 24-hour Traffic Volumes
Land Use Data sourced from DOP MLUFS
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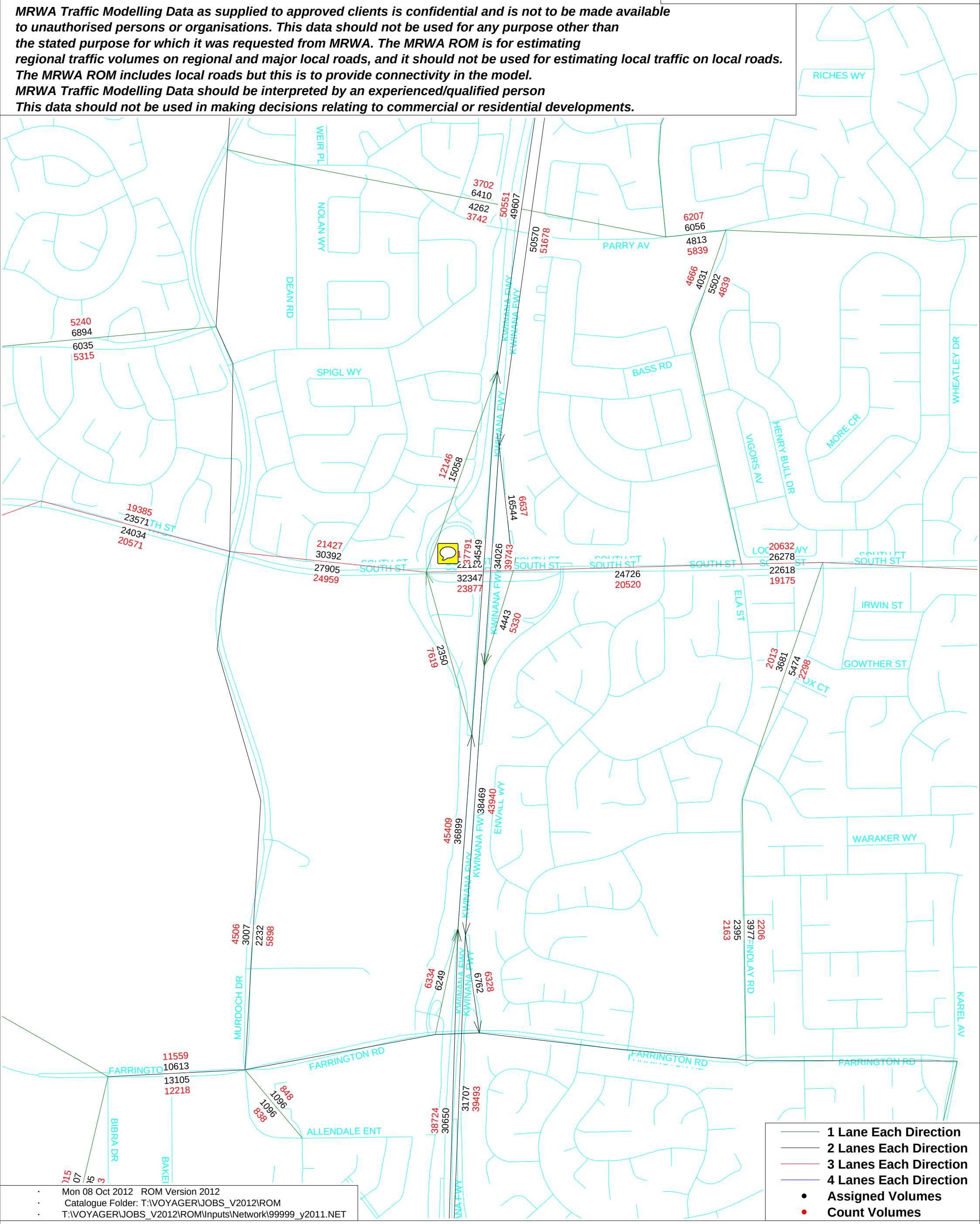

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1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
4 Lanes Each Direction
Assigned Volumes
Count Volumes

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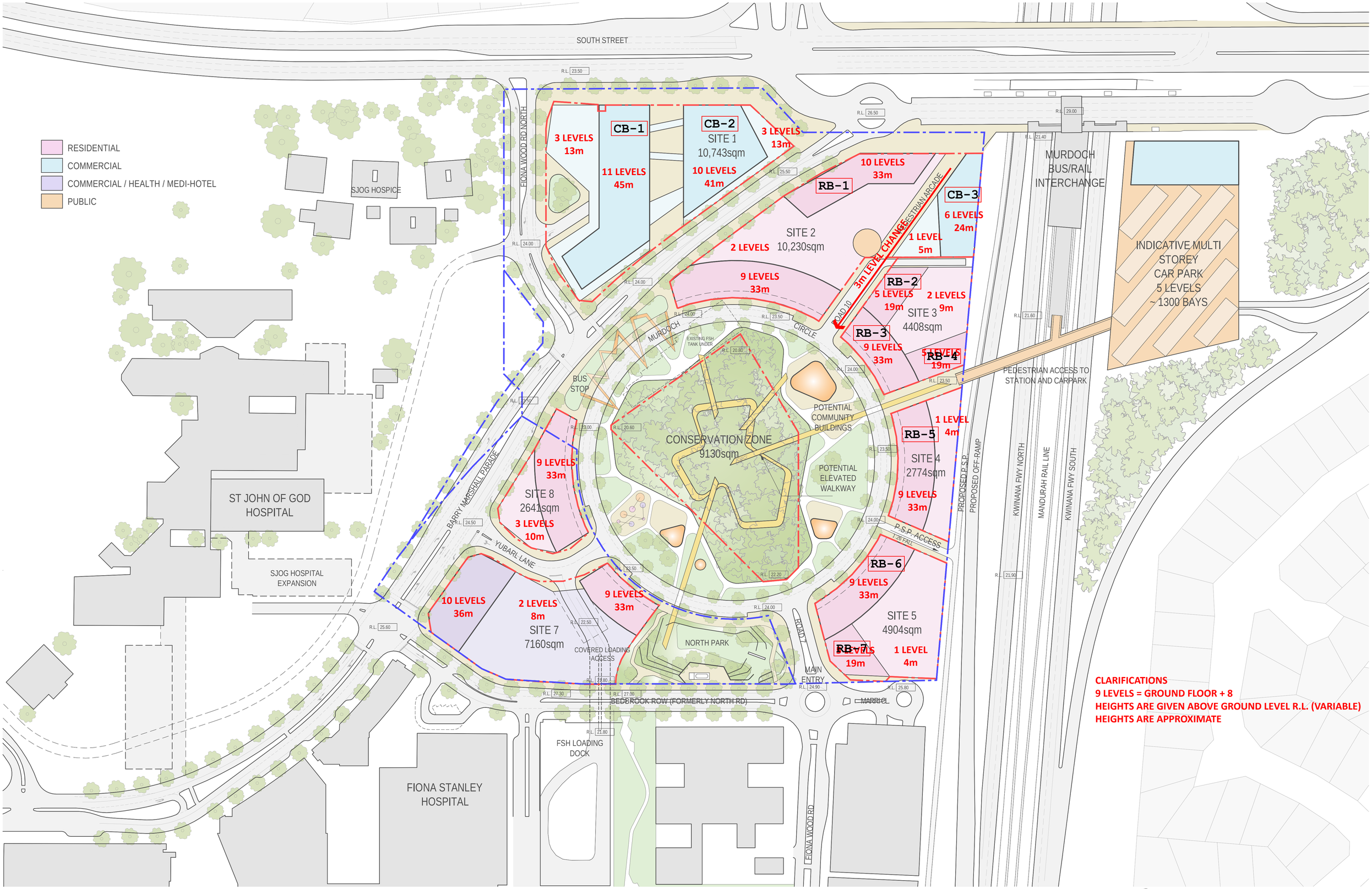
Appendix D

Proposed Residential and Commercial Building Mark-up and Predicted Received Noise Levels at Building Facades



CLARIFICATIONS
9 LEVELS = GROUND FLOOR + 8
HEIGHTS ARE GIVEN ABOVE GROUND LEVEL R.L. (VARIABLE)
HEIGHTS ARE APPROXIMATE

0 5 10 20 30m

ARM ARCHITECTURE

PRELIMINARY

SITEPLAN
MURDOCH MUP

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D R A F T

Table 4 Received Noise Levels at the Facades of the Proposed MUP Residential Buildings (RB) and Commercial Buildings (CB).

Yellow – Levels exceeding 55 dB(A); Brown – Exceeding 60 dB(A); Red – Exceeding 63 dB(A);

Building	Façade Direction	Received Noise Level at Building Levels $L_{Aeq, 16hr}$, dB(A)										
		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	Level 11
RB - 1	North	50.0	62.3	63.5	64.1	64.5	64.7	64.8	64.8	64.8	64.7	
	Northwest	57.7	60.5	61.2	61.5	61.8	61.9	62.0	62.0	62.0	62.0	N/A
	East	N/A		55.8	57.6	58.8	59.5	59.8	60.2	60.7	61.4	
RB - 2	North	51.1	52.4	54.2	55.8	56.7	N/A					
	East	N/A		51.6	55.8	58.6						
RB - 3	East	N/A		49.1	50.4	51.4	56.0	60.7	62.2	62.9	N/A	
	South	54.8	56.7	58.4	59.2	59.5	59.6	59.7	59.7	59.8		
RB - 4	North	N/A		54.2	59.0	61.0	N/A					
	East	68.0	68.2	68.2	68.1	68.0						
	South	61.2	63.3	64.7	64.9	65.0						
RB - 5	North	53.9	54.9	55.7	56.1	56.4	56.8	57.6	58.5	59.3	N/A	
	East	N/A	62.7	65.9	66.4	66.5	66.5	66.5	66.4	66.4		
	South	50.3	56.9	58.9	60.2	60.6	60.7	60.8	60.8	60.8		
RB - 6	North	49.8	57.3	58.9	59.8	60.1	60.2	60.2	60.2	60.2	N/A	
	East	N/A	53.6	61.7	64.0	64.7	64.9	65.0	65.0	64.9		
RB - 7	East	N/A	57.3	61.3	62.8	63.3	N/A					
	South	57.2	60.0	61.1	61.6	61.9						
CB - 1	North	67.3	67.4	67.2	66.9	66.6	66.2	65.9	65.5	65.2	64.9	64.6
	East	53.3	54.0	54.3	54.6	54.7	54.7	54.6	54.6	54.6	55.0	55.1
	West	N/A			47.4	53.3	55.6	56.8	57.6	58.0	58.3	58.4
CB - 1	North	67.6	67.7	67.6	67.3	66.9	66.6	66.2	65.9	65.5	65.2	
	East	N/A			53.1	61.9	63.4	63.6	63.6	63.4	63.3	N/A
	West	54.5	55.2	55.5	55.7	55.6	55.5	55.3	55.1	54.8	54.7	
CB - 1	North	59.2	64.9	66.3	66.5	66.4	66.4					
	East	67.7	67.9	68.0	68.0	67.9	67.8					
	South	59.9	60.6	63.2	63.9	63.9	64.1					

Appendix E

Predicted Outdoor Noise Levels 1.5 m above the Ground in the Study Area

AECOM

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0 15 30 60

metres

Legend

LAeq, 16hr - Free Field (dB)

- < 55
- 55 - 56
- 56 - 57
- 57 - 58
- 58 - 59
- 59 - 60
- 60 - 61
- 61 - 62
- 62 - 63
- 63 - 64
- 64 - 65
- 65 - 66
- 66 - 67
- 67 - 68
- > 68
- Proposed Buildings
- Roads

Murdoch Mixed Use Precinct - Residential Development
Predicted RoadTraffic - LAeq, 16hr
Free Field Noise Levels @ 1.5m AGL

PROJECT ID	60220889
CREATED BY	MMcL
LAST MODIFIED	MMcL 29/10/12

Figure

02

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Appendix F

Practical Noise Mitigation and Insulation Measure Considerations - SPP 5.4 Implementation Guidelines

The Implementation Guidelines for SPP 5.4 present a number of practical noise mitigation and insulation measures applicable to different likely outdoor noise level scenarios as listed in Table 2, in order to achieve the objectives as in Section 2.2.1. They are reproduced as follows for reference.

4.4 "Quiet House" design

Where all practicable steps to avoid or minimise transport noise have been taken but the external noise levels impacting on proposed noise-sensitive developments are predicted to exceed the "target" level criteria, specific noise amelioration measures should be considered in conjunction with the development of new buildings. The purpose of these measures is to:

- provide for at least one protected outdoor area; and
- minimise the extent of noise insulation needed in order to meet the indoor noise level standards.

4.4.1 Design and construction considerations

Measures that should be considered in order to ameliorate the impact of transport noise include:

- *Screen walls:*
  Designing walls to screen part or all of the affected property;

- *Outdoor living areas:*
  Locating outdoor living areas so as to maximise the screening effects of buildings and any barrier walls;

- *Interior layout:*
  Locating the most noise-sensitive activity spaces (bedrooms, living, entertainment, kitchen, dining) so as to minimise the intrusion of noise into such spaces;

- *Openings to habitable rooms:*
  Using upgraded glazing and, where necessary, limiting the size and height of openings to habitable rooms, to limit noise intrusion.

<u>Screen walls</u>

Where development backs onto a major transport corridor and from which access is not permitted, it is normal practice to provide for a continuous wall along the property boundary in conjunction with the original subdivision of the land. The height and construction of such walls as well as their continuity are critical to their effectiveness in reducing noise intrusion. In flat terrain they should normally have a minimum height of around 2.4 metres in order to provide an effective noise screen for immediately adjacent outdoor living areas and adjacent ground floor openings to habitable rooms (see section 4.3).

Where a continuous screen wall is not practicable - for example, where a development faces a major transport corridor - screen walls generally need to have return sections to enclose the area that is intended to be protected.

In general, screen walls will be ineffective at reducing noise levels above ground floor level, and where multi-storey buildings are proposed, appropriate noise reduction measures need to be incorporated in the design and construction of the walls of the building themselves. Such noise reduction measures will also be required for those walls or wall sections for which screening is impractical, which will generally include walls facing transport corridors from which vehicular access is provided.

While screen walls can detract from the visual amenity of the transport corridor and any adjacent access road, this can be minimised by the appropriate design and landscaping. This usually involves some degree of articulation or visual relief, coupled with suitable planting to reduce the adverse visual impact of the walls and minimise their attraction as the object of graffiti. It should be noted, however, that landscape planting alone is relatively ineffective at reducing noise transmission, and it should be seen only as a visual amenity measure.

Outdoor living areas

In many ways, outdoor living areas are the most susceptible to noise from adjacent transport corridors as they are by their nature open and therefore difficult to protect.

Unless such areas can be effectively enclosed by screen walls, they should be located on the opposite side of the building from the transport corridor, i.e. furthest away from the noise source and screened from the noise source by the building itself. This arrangement should generally be sought for residential development that faces a major transport corridor, including property that is separated from the corridor by an access road.

The impact of noise in relation to outdoor living can also be reduced by a choice of housing that places less emphasis on outdoor living areas. This is the case under the medium density codes, and in particular for areas coded R50 and above, where an outdoor living area of only 16 m^2 applies compared with a minimum of 30 m^2 or more under the low density codes.

Interior layout

Noise-sensitive spaces such as bedrooms, dedicated entertainment rooms and living areas should be situated away from the source of noise where possible, and preferably separated from such sources by service areas such as garages, store rooms, bathrooms and laundries. Where these measures are impractical, consideration needs to be given to the design and use of openings, particularly those to habitable rooms.

Openings to habitable rooms

The policy requires that where practicable, buildings should be designed and constructed so as to ensure that indoor noise levels of affected noise-sensitive premises accord with the criteria in the policy.

The most common approaches to acoustic treatment of the building envelope are:

- providing mechanical ventilation or airconditioning so windows can remain closed;
- upgrading glazing thickness;
- improving doors that open from habitable rooms to outdoors; and
- improving roof insulation.

The extent of noise insulation needed at the openings to habitable rooms will depend on how successful the "quiet house" measures have been in reducing outdoor noise levels. Where outdoor noise levels are above the "target" level, by no more than 8dB(A), these guidelines propose two "deemed-to-comply" packages that may be implemented to ensure the indoor noise standards are met

for residential development without requiring detailed specification. At higher noise levels, specialist acoustic advice will be needed.

It should be noted that where noise levels are above the "target", it will not be possible to meet the indoor noise levels standards without windows being closed. This means providing mechanical ventilation or airconditioning.

These issues are discussed in section 4.5 below.

4.4.2 Other design considerations

Care needs to be taken with the integration of the foregoing measures with other design requirements to ensure that safety, functionality and energy efficiency are not compromised in the pursuit of noise reduction. For example, designs with climate requirements may suggest a need for the location of living areas and/or orientation of openings that are not conducive to noise amelioration. In such circumstances, additional measures may be necessary to provide a satisfactory level of noise reduction, or it may be necessary to accept some compromise in relation to either or both of the conflicting design requirements.

In cases in which new living and sleeping areas are to be located in close proximity to a railway or major road, consideration also needs to be given to reducing the maximum passby noise levels, in addition to the "average" L_{Aeq} noise levels, to acceptable levels. This may be done in consultation with the Department of Environment and Conservation.

4.5 Noise insulation – "deemed to comply" packages for residential development

The following "deemed-to-comply" packages outline noise insulation measures designed to ensure that the indoor noise standards in the policy are achieved for residential developments in areas where outdoor noise levels will exceed the "target" noise levels by up to 8dB(A). These packages have been designed for developments adjacent to major roads and passenger railways, where noise levels are likely to be higher during the day than at night. In the case of freight rail, where noise levels are likely to be fairly constant over the 24-hour period, these packages can be adapted. See section 4.8 of the guidelines for guidance on developments adjacent to freight railways.

The deemed-to-comply specifications are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development. However, this should not remove the option to pursue alternative measures or designs. Departures from the deemed-to-comply specifications need to be accompanied by acoustic certification from a competent person, to the effect that the development will achieve the requirements of the policy.

Superior construction standards, such as those specified in the deemed-to-comply packages, are now becoming more prevalent in residential buildings; and they do not significantly increase the cost of building. A similar standard of construction has been recommended by the Western Australian Planning Commission for new housing in areas forecast to be seriously affected by aircraft noise.[4] That recommendation followed a comprehensive assessment of the efficacy and costs of noise attenuation measures, taking into account the recent changes in industry building standards as well as changes to the *Building Code of Australia*.

[4] Statement of Planning Policy No 5.1, *Land Use Planning in the Vicinity of Perth Airport* and the accompanying report on *Aircraft Noise Insulation for Residential Development in the Vicinity of Perth Airport*, February 2004.

Where transport noise levels are more than 8dB above the noise "target", i.e. 3dB above the noise "limit", or where noise-sensitive development other than residential is proposed, a detailed assessment should be prepared by a competent person. The report should specify the level of noise reduction required and the noise insulation measures needed to comply with the policy. The approval may require that the construction drawings be checked for compliance with the detailed assessment, and that follow-up verification be carried out to certify compliance.

4.5.1 Package A: noise levels within the "margin"

The following noise insulation package (Table 8) is designed to meet the indoor noise standards for residential developments in areas adjacent to major roads or passenger railways where noise levels exceed the noise "target" but are within the "limit".

D R A F T

Table 8

Area type	Orientation	Package A measures
Indoors		
Bedrooms	Facing road/rail corridor	• 6 mm laminated glazing • Casement or awning windows • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning (see 4.5.3)
	Side-on to corridor	• 6 mm laminated glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[5]	Facing corridor	• 6 mm laminated glazing • Casement or awning windows • 35 mm (minimum) solid core external doors with acoustic seals[6] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6 mm glazing • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[7]	Facing corridor	• Minimum 2.0 m high solid fence (e.g. Hardifence, pinelap, or Colorbond) • Picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

[5] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Guide of Australia as a "habitable room". The Building Guide of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Guide of Australia describes these utility spaces as "non-habitable rooms".

[6] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[7] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

4.5.2 Package B: noise within 3dB above the "limit"

The following noise insulation package (Table 9) is designed to meet the indoor noise standards for residential developments in areas adjacent to major roads or passenger railways where transport noise levels exceed the noise "limit" but by no more than 3dB (See Table 1 in policy).

Table 9

Area type	Orientation	Package B measures
Indoors		
Bedrooms	Facing road/rail corridor	• 10 mm laminated glazing • Casement or awning windows • No external doors • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning (see 4.5.3)
	Side-on to corridor	• 6 mm laminated glazing • Casement or awning windows • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Living and work areas[6]	Facing corridor	• 10 mm laminated glazing • Casement or awning windows • 40 mm (minimum) solid core external doors with acoustic seals[9] • Sliding doors must be fitted with acoustic seals • Closed eaves • No vents to outside walls/eaves • Mechanical ventilation/airconditioning
	Side-on to corridor	• 6 mm laminated glazing • Casement or awning windows • Closed eaves • Mechanical ventilation/airconditioning
	Away from corridor	No requirements
Other indoor areas	Any	No requirements
Outdoors		
Outdoor living area[10]	Facing corridor	• Minimum 2.4 m solid fence (e.g. brick, limestone or Hardifence) • Colorbond and picket fences are not acceptable
	Side-on to corridor	
	Away from corridor	No requirements

4.5.3 Mechanical ventilation/airconditioning

[8] These deemed-to-comply guidelines adopt the definitions of indoor spaces used in AS 2107-2000. A comparable description for bedrooms, living and work areas is that defined by the Building Guide of Australia as a "habitable room". The Building Guide of Australia may be referenced if greater clarity is needed. A living or work area can be taken to mean any "habitable room" other than a bedroom. Note that there are no noise insulation requirements for utility areas such as bathrooms. The Building Guide of Australia describes these utility spaces as "non-habitable rooms".

[9] Glazing panels are acceptable in external doors facing the transport corridor. However these must meet the minimum glazing requirements.

[10] The Policy requires that at least one outdoor living area be reasonably protected from transport noise. The protected area should meet the minimum space requirements for outdoor living areas, as defined in the Residential Design Codes of Western Australia.

Where outdoor noise levels are above the "target", both packages A and B require mechanical ventilation or airconditioning to ensure that windows can remain closed in order to achieve the indoor noise standards.

In implementing packages A and B, the following need to be observed:

- Evaporative airconditioning systems will meet the requirements for packages A and B provided attenuated air vents are provided in the ceiling space. Without such vents, these systems require windows to remain open.
- Refrigerative airconditioning systems need to be designed to achieve fresh air ventilation requirements.
- Air inlets need to be positioned facing away from the corridor where practicable.
- Ductwork needs to be provided with adequate silencing, particularly in higher noise areas, to prevent noise intrusion.

4.6 Reasonable and practicable considerations

The policy requires consideration and implementation of all "reasonable" and "practicable" noise mitigation measures to achieve the noise target and acceptable indoor noise levels. Where it can be demonstrated that it is neither practicable nor reasonable to reduce noise levels to the noise target, then higher noise levels may be acceptable, but longer term noise management strategies may need to be considered.

"Practicable" considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. These may include:

- limitations of the different mitigation measures to reduce transport noise;
- safety issues (such as impact on crash zones or restrictions on road vision);
- topography and site constraints (such as space limitations);
- drainage requirements;
- access requirements (for driveways, pedestrian access etc);
- maintenance requirements; and
- suitability of the building for acoustic treatments.

For example, if there is insufficient space between a road and a residence then it would not practicable to build an earth bund as a noise mitigation measure, given the technical requirements for the bund to be built at a certain slope.

See also the definition of "practicable" in the *Environmental Protection Act 1986*[11].

"Reasonableness" considerations, for the purposes of the policy, would be based on understanding and balancing a range of factors, and then agreeing on the best overall outcome, taking a triple bottom line approach to the assessment of these factors.

A judgment about whether a noise mitigation measure is reasonable might include a consideration of:

[11] "Practicable" is defined in the *Environmental Protection Act 1986* to mean "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge".

- the noise reduction benefit provided;
- the number of people protected;
- the cost of mitigation;
- existing and future noise levels, including changes in noise levels;
- community views and impacts;
- aesthetic and visual impacts;
- compatibility with other planning policies;
- differences between metropolitan and regional situations; and
- the benefits arising from the proposed development.

The purpose of considering "reasonableness" concerns is to achieve the best balanced outcome with respect to noise abatement. Assessment should involve careful and thorough consideration of a wide range of factors, not just one criterion. The assessment should identify the social, economic and environmental aspects of the benefits, and the disbenefits of implementing the noise mitigation measure. In some cases it may be helpful to quantify performance against each factor, thereby enabling a more objective decision to be made.

An assessment of reasonableness should also clearly demonstrate that efforts have been made to resolve conflicts, without compromising on the need to protect noise amenity. For example, if residents are concerned about the height of a transport noise barrier, have reasonable efforts been made to design, relocate or vegetate the barrier to address these concerns?

It is preferable that reasonableness arguments be presented in triple bottom line terms. For instance, rather than arguing that a transport noise barrier should not be built because residents want their views to be retained, "reasonableness" considerations would cause an investigation into the cost of building a transparent barrier, which would enable residents' views to be retained and their noise amenity to be protected. In another case, the benefits of differing noise mitigation options could be compared by calculating the cost per unit of noise reduction provided by the barrier ($/dB), or the cost per residence ($/residence), or a combination of these ($/dB/residence).

Effective community consultation is critical in noise mitigation planning, and should be considered a vital element in any reasonableness assessment where it is proposed that residual noise impacts will remain even after the application of appropriate noise mitigation measures. This principle applies to developers, who should consult with local government, existing residents and road/rail authorities, and to new transport infrastructure providers, with a responsibility to engage with impacted residents and the local government. Stakeholders should be able to participate in the selection of the most appropriate noise mitigation option in an open, equitable and effective way.

Any case outlining reasonable and practicable considerations must be justifiable and so should be well documented. A submission outlining the reasonable and practicable considerations should help to facilitate a determination on the matter and should assist in communicating that decision to the community in a transparent way.



Murdoch Mixed Use Precinct

Retail Needs Assessment and Employment Generation

October 2015

URBIS STAFF RESPONSIBLE FOR THIS REPORT WERE:

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Executive Summary

In November 2012, Urbis delivered a Retail Needs Assessment and Economic Strategy to support the preparation of an Activity Centre Structure Plan for the Murdoch Mixed Use Precinct (MUP). Since that report was prepared, the West Australian economic and demographic landscape has changed somewhat, with flow on implications for the demand estimation and, ultimately, precinct planning and design.

This report is intended as an update of the analysis conducted in 2012 with the key findings to be summarised in a format suitable for inclusion in the revised Activity Centre Structure Plan prepared by Taylor Burrell Barnett. This report is intended as a stand-alone appendix to the Activity Centre Structure Plan.

The original Retail Needs Assessment and Economic Strategy was written at a time when the WA economy was emerging from a boom period of resources sector activity and private sector investment that drove high levels of employment and population growth, placed upward pressure on residential property prices and rents and stimulated record low CBD office market vacancy rates.

Since that time, the economic environment has cooled significantly. The resources sector has entered the production phase, requiring less skilled labour and private sector capital expenditure than during the construction phase, while interstate and overseas immigration has lessened greatly. Residential property markets have become more affordable for both owners and renters, with higher vacancy rates and downward pressure placed on rents and values.

Demand for office space in Murdoch and within the MUP area will be driven primarily by activities related to the hospitals and, to a lesser extent, by Murdoch University and reflect the importance of the location as a knowledge hub. The previously mooted relocation of aspects of the WA Police to the Murdoch MUP under the State Government's Office Accommodation Master Planning Strategy now seems less likely to occur, due in part to changes in economic and office market conditions over the past three years. In the absence of a significant government anchor tenant, take-up of the commercial office space is expected to be largely determined by market activity and the extent to which there is a requirement for such space from the prospective uses described above.

Development of the commercial space is only likely to proceed given its commercial feasibility and the prevailing market conditions suggests that development of the space is likely to be constrained over the near to medium term, unless there is some other space demand driver to emerge out of the health precinct, such as a shortage of specialised office space / consulting rooms in the hospital complexes as they now stand.

The revised Retail Needs Assessment & Economic Strategy was undertaken by Urbis to assess the demand for retail floorspace generated within the surrounding context (retail trade area). The findings of this analysis are summarised as follows:

- The total trade area turnover by 2030 for the Murdoch MUP is forecasts to reach $45.3 million. $22.4 million (46.8%) will be derived from residents, with the hospital and university staff, patients, visitors and students expected to generate a further $22.9 million.

- The analysis indicates supportable retail floorspace for the MUP of 5,271 m^2 by 2030. The turnover suggests that a supermarket format in the order of 2,500 - 3,000 sq.m could be supported as early as 2021, subject to the quantum of development completed within the Murdoch precinct by this time, with the balance to be comprised of an array of specialty stores.

- By 2030 Grocery / Fresh Food is expected to comprise 73.5% of forecast turnover generated from the Murdoch MUP residents and other user groups. Food and beverage spend (i.e. non grocery), general expenditure and services expenditure account for 13.9%, 10.8%and 5% of turnover respectively.

- A key risk to the potential of a supermarket on the subject site is the road accessible to the site from surrounding areas (i.e. outside the MUP). For residents travelling to the site from the north or east there appears to be no direct (trafficked signal intersection) access to the site. These

potential shoppers would need to travel further west and enter the MUP via the main entry point at Fiona Wood Road and then use the internal roads to access the site. This rather circuitous route for shoppers could be a significant deterrent to the centre's usage.

- In this regard, the potential market shares assessed for the supermarket could be significantly lower than forecast. Furthermore, the accessibility of the site to the wider resident market may prove a barrier to attracting a major chain supermarket, particularly in terms of a store in the 2,500 - 3,000 sq.m range. In this outcome, a smaller supermarket of less than 1,000 sq.m that focusses on serving the MUP, and the occasional shop from the wider resident market may only be realised.

- Planning for the proposed retail centre therefore should allow for a 2,500 - 3,000 sq.m supermarket and a smaller 400-800 sq.m supermarket.

- Ideally, retail floorspace should be concentrated rather than dispersed, and it is suggested the preferred location for the retail space is in an area most easily accessible by the majority of tenants within the MUP and external to the precinct. This would suggest the locations at Lots 1A and 1D, however retail concentrated around Lots 7C and 7D may provide superior accessibility to the users of the health campuses at the same time as retaining a degree of accessibility for internal precinct residents.

- The floorspace yields contained within the Murdoch MUP Activity Centre Structure Plan suggest that by full build out and at full occupancy, the precinct may result in net new employment of approximately 2,430 FTEs. The analysis makes no allowance for the relocation of Police functions to the precinct as had previously been mooted and assumes a conventional take up rate of floorspace over time.

1 Introduction

In November 2012, Urbis delivered a Retail Needs Assessment and Economic Strategy to support the preparation of an Activity Centre Structure Plan for the Murdoch Mixed Use Precinct (MUP). Since that report was prepared, the West Australian economic and demographic landscape has changed somewhat, with flow on implications for the demand estimation and, ultimately, precinct planning and design.

This report is intended as an update of the analysis conducted in 2012 with the key findings to be summarised in a format suitable for inclusion in the revised Activity Centre Structure Plan prepared by Taylor Burrell Barnett. This report is intended as a stand-alone appendix to the Activity Centre Structure Plan.

Much of the original context for the analysis remains as it was in 2012 with this report focussing on:

- Revisiting the economic context and updating the key economic and demographic indicators;
- Reviewing the retail analysis with a view to re-examining the retail catchment, revisiting the population forecasts and employment projections; and
- Understanding the impacts on the demand for floorspace in the Mixed Use Precinct.

1.1 SITE LOCATION AND CONTEXT

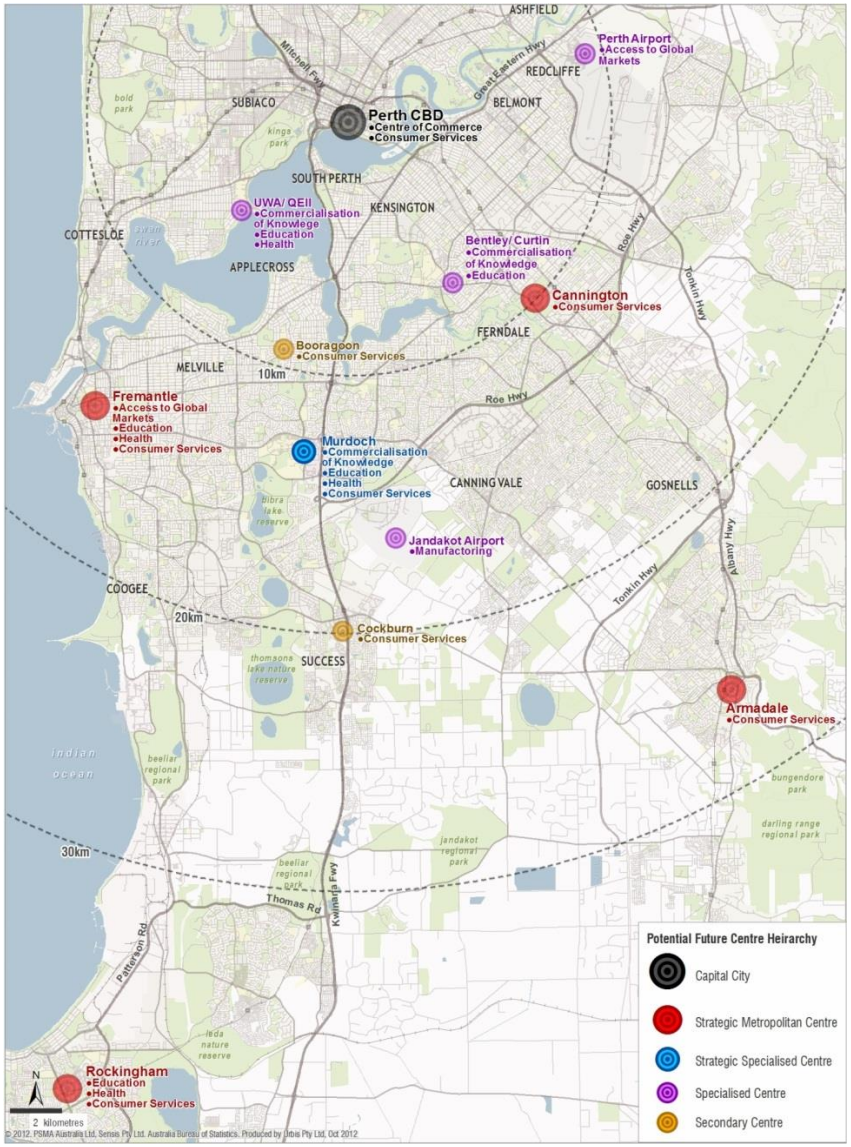
The proposed Murdoch MUP is located approximately 13 kilometres south of Perth CBD, within the Murdoch Activity Centre, in the City of Melville Local Government Area (LGA). Directions 2031 identifies Murdoch as a specialised centre. Specialised centres are places that have strong specialised roles based around major institutions or airports within the centre. These centres are expected to:

- 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; and
- 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.

The Murdoch MUP is located at the juncture of the Kwinana Freeway and South Street, immediately adjacent to the Murdoch train station. It is bordered by South Street to the north, Fiona Stanley Hospital to the south, Kwinana Freeway to the east, and St John of God Hospital to the west. Other surrounding major uses include Murdoch University (800 metres West) and Challenger TAFE (800 metres South).

Activity Centres Hierarchy

AMENDED FROM DIRECTIONS 2031 MAP 1.1



2 Economic Context

The original Retail Needs Assessment and Economic Strategy was written at a time when the WA economy was emerging from a boom period of resources sector activity and private sector investment that drove high levels of employment and population growth, placed upward pressure on residential property prices and rents and stimulated record low CBD office market vacancy rates.

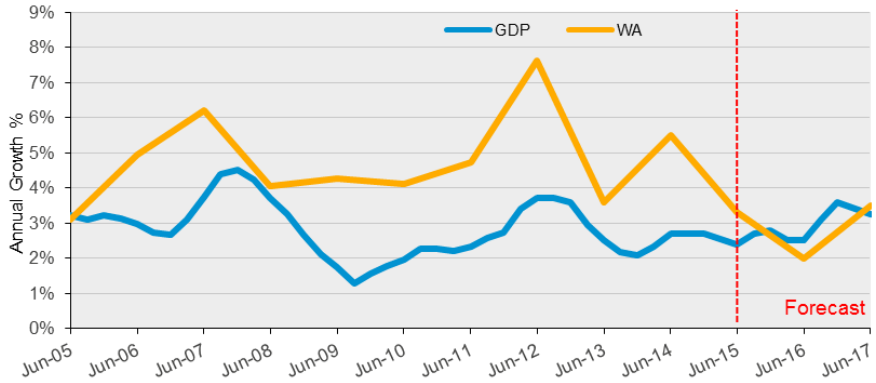
Moreover, by the end of 2012, the cash rate was 3.0%, down from the 4.75% that it had been through most of 2011 and on its way to the now record low of 2.0% (reached in May 2015). High population growth and low interest rates were stimulating high levels of building approvals and dwelling commencements, with favourable first home ownership conditions resulting in a strong domestic construction sector.

Since that time, the economic environment has cooled significantly. The resources sector has entered the production phase, requiring less skilled labour and private sector capital expenditure than during the construction phase, while interstate and overseas immigration has lessened greatly. Residential property markets have become more affordable for both owners and renters, with higher vacancy rates and downward pressure placed on rents and values.

- Non-mining sector investment is taking its time to build and modest consumer demand and residential dwelling investment are currently insufficient to take the economy back to trend growth.
- WA faces a difficult period of adjustment over the year ahead and indeed beyond.
- The OECD is forecasting world economic growth of 3.8% in 2016. India (7.6%) and China (6.7%), two of Australia's largest trading partners, will be key contributors. Solid growth (2.9%) is also anticipated in Australia.
- Final Demand (SFD) in WA slowed by 1.8% in the March quarter (or by 4.9% since March 2014). WA Treasury forecasts Gross State Product growth (SFD plus net exports) of 3.3% in 2014-15 falling to 2% in 2015-16 in response to large falls in mining investment.
- WA's gross state product growth rate has comfortably outstripped national GDP for the past ten years, and is expected to again exceed national performance in the next 2-3 years once the softening effect of the resources sector downturn ameliorates.

Changes in GDP and GSP

WESTERN AUSTRALIA TO JUNE 2015 CHART 2.1

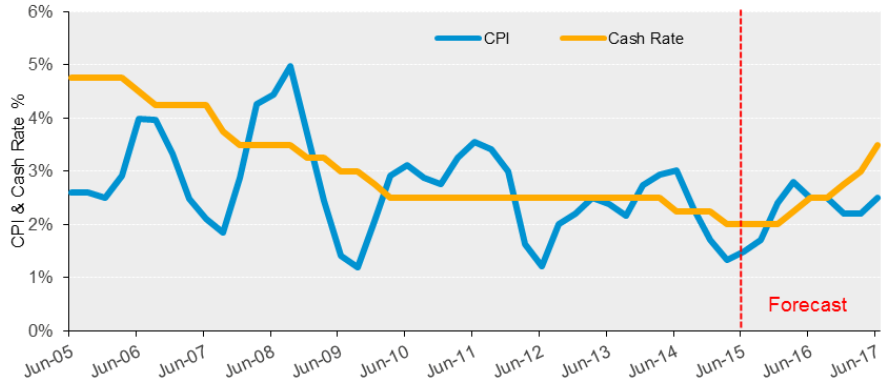


Source: ABS 5206.0; Urbis GDP forecasts; Western Australian State Government
Growth rate in the total real value of goods and services produced in Australia
National GDP reported quarterly and State GSP reported annually

- The decline in resources sector investment has been partially offset by domestic construction and State Government spending on key projects like the Perth Stadium and Forrestfield-Airport Link. In its latest budget, the state government announced a $24.1 billion state-wide infrastructure investment programme over the next four years.
- The Reserve Bank of Australia expects inflation to remain within the target range of 2% to 3% over the next one to two years.
- Urbis economists expect the cash rate to remain on hold at record low levels until 2016. The widely held view by economic commentators is that the cash rate has bottomed out and movements next year will be upward.

National CPI and Cash Rate

HISTORICAL AND FORECAST CHART 2.2

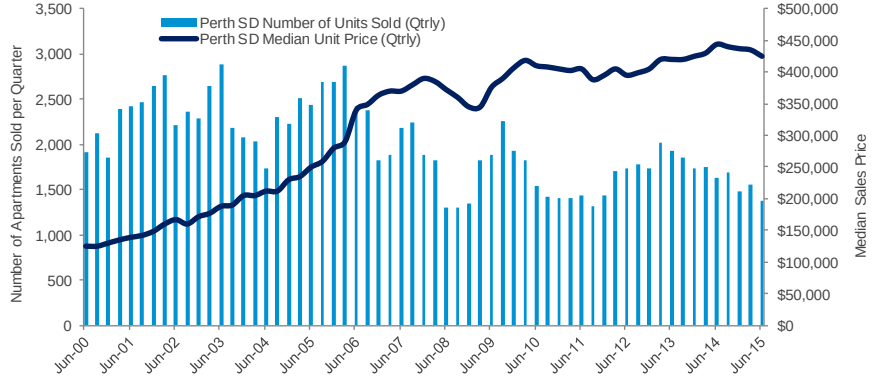


Source: ABS 6401.0; RBA; Urbis forecasts
CPI- percentage change from previous period trimmed mean

- Relatively high household incomes and comparatively low house prices mean that dwelling affordability is greater in Perth than on the east coast. Perth is arguably less exposed to the potential impacts of future interest rate rises.
- The June median Perth house price of $543,333 represented an 8.7% increase over the preceding five years but has contracted 1.2% in the six months to June 2015 from a peak of $550,000. In real terms, the decline in house prices is compounded to some degree by general CPI increases.
- Although median unit prices grew 3.7% over the five years to June 2015, they contracted 4.3% from their June 2014 peak of $444,000.

Change in Unit Sales and Median Price

GREATER PERTH 2000 -2015 CHART 2.3

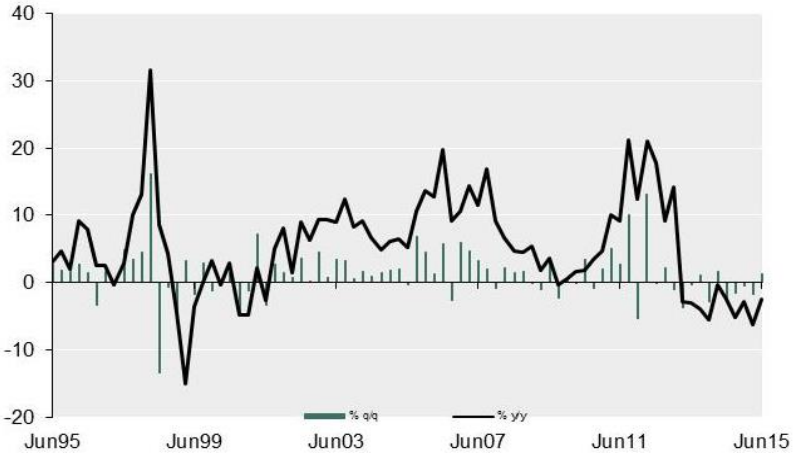


Prepared by Urbis Source: RPData

- Coinciding with the pullback in resources sector private investment since mid-2012, the state's population growth rate has similarly eased, as employment generation moderates.

Changes in Aggregate Private Sector Expenditure

WESTERN AUSTRALIA TO JUNE 2015 CHART 2.4

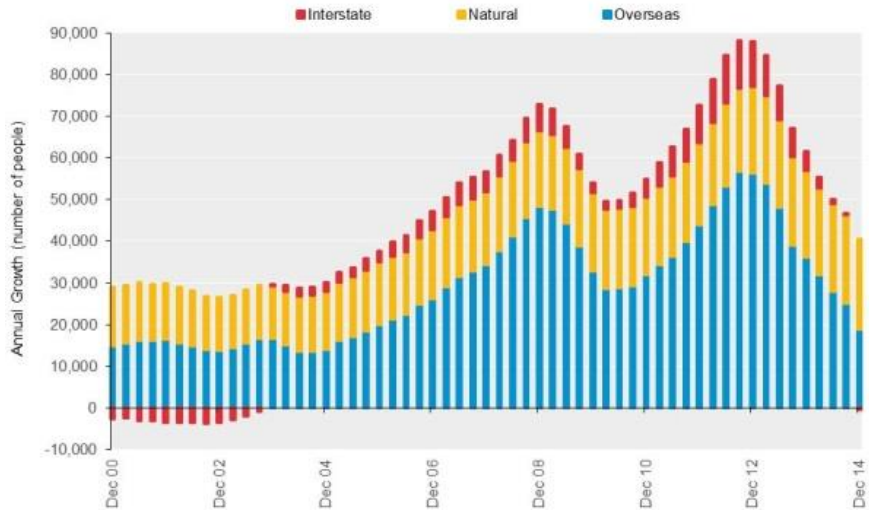


Source: ABS 5206.0, Urbis

- In the year to December 2012, WA added more than 83,000 net new residents with more than 62% derived from overseas migration.
- By December 2014, the rate of growth had effectively halved with overseas migration falling to around 42% of population growth. The previously robust levels of interstate employment related migration effectively disappeared.

Components of Population Change

WESTERN AUSTRALIA TO JUNE 2015 CHART 2.5



Source: ABS 3101.02, Urbis

- WA's retail sector showed slight growth of 0.3% over the March quarter, growing 3.3% over the year to March. Both figures are below the national average of 1.4% and 4.4% respectively.
- Unemployment has increased from 5.1% in May to 5.8% in June. WA is still performing well compared to the 6.0% national average.
- WA's credit rating outlook has been changed from stable to negative. Ratings agencies grow concerned as the budget deficit and debt-to-revenue ratios reach historic lows.
- The lower AUD, easy monetary policy and firming global economic outlook among Australia's major trading partners are together expected to support export sectors in WA. WA's international visitor nights is expected to boost now that the decline in resources sector related travel has reduced the cost of travelling.
- The Federal budget delivers a wide range of spending cuts and revenue raising measures. New expenditure initiatives mean that the Budget remains in deficit over the forward estimates period, albeit marginally, at $2.8 billion or 0.2% of GDP in 2017-18. A new $5 billion 'asset recycling initiative' from 1 July 2014 has been announced which will provide financial incentives for States and Territories to privatise assets and reinvest the proceeds into new infrastructure programs. The budget also included funding for the Perth Freight Link as well as $499 million for road infrastructure to compensate for dwindling GST revenues.

2.1 COMMERCIAL / OFFICE SPACE MARKET

- Today's office leasing markets, both CBD and suburban, have weakened significantly since the mining, oil and gas sectors' passage to production phase, from construction phase, from the second half of 2012.
- Mining, oil and gas companies and their contractors (namely engineering firms) have all downsized their office requirements. This in turn has impacted on other professional services sectors.
- Perth's CBD office vacancy rate increased by 1.8 percentage points, to 16.6%, over the six months to July 2015 (Property Council of Australia). Whilst Perth's CBD rate was the lowest in Australia between January 2012 and January 2014, it is now the highest.

Perth CBD Office Market Performance

CBD MARKET TO JULY 2015 CHART 2.6

	Stock (sq.m.)	Occupied Stock	Total Vacancy (sq.m.)	Sub-lease Vacancy (%)	Direct Vacancy (%)	Vacancy Factor (%)
Perth CBD	1,636,104	1,365,311	270,793	3.5%	13.1%	16.6%

Source: PCA

- Net rents are continuing to decline while incentives (fit-outs and rent free periods) become more generous.
- Over the 12 months to July, there was a 50,500 sqm decline in the total amount of occupied office space in the Perth CBD. This is equivalent to a building the size of Woodside Plaza being vacated due to businesses downsizing or closing.
- A historically high amount of new Perth CBD office supply is scheduled for completion in 2015: 149,600 sqm across eight buildings.
- According to Urbis' estimates, around 44,000 sqm of upcoming supply remains uncommitted and is being actively marketed for lease (as at September 2015).
- While the total stock of office space across the greater Perth metropolitan area is broadly equivalent to that on offer in the CBD, much of the stock is considered to be below A grade standard.
- New supply of metro office stock is very constrained by the subdued market conditions and space availability currently being experienced in the CBD and this is not expected to change significantly in the medium term at least.
- It should also be noted that the Murdoch University Eastern Precinct Draft Master Plan proposal contains allowances for approximately 45,000 sqm of mixed use / retail / office / community uses and up to 265,000 sqm of mixed use / research and development space. Were this to be adopted, and depending on development timelines, it is reasonable to assume that this constitutes to some degree, potentially competing commercial / office supply in the area.

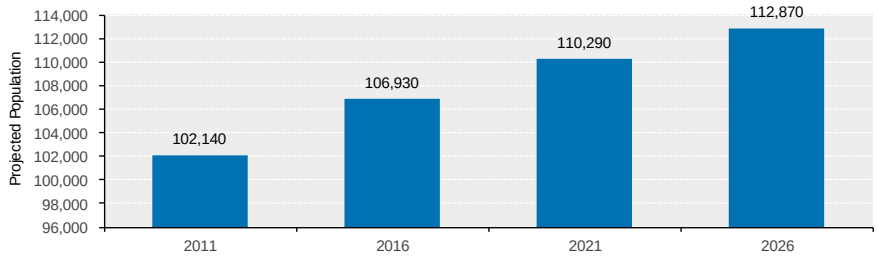
3 Population and Demography

3.1 CURRENT AND PROJECTED POPULATION

- As at June 2011, the estimated resident population of the City of Melville was 102,140 persons and, according to the Department of Planning's WA Tomorrow 2015 modelling, is expected to grow by 10.5% to 112,870 persons in 2026.

Melville LGA – Projected Population

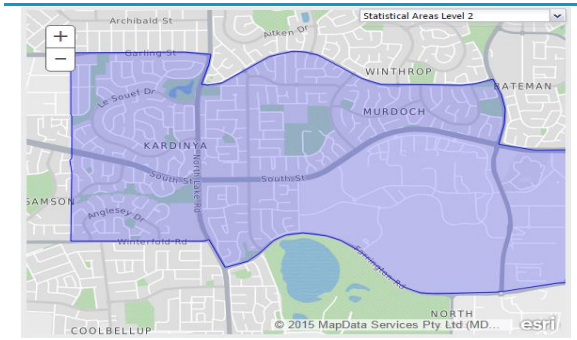
WA TOMORROW 2015 CHART 3.1



Source : DoP WA Tomorrow 2015

Murdoch-Kardinya SA2 Boundary

ABS MAP 3.1

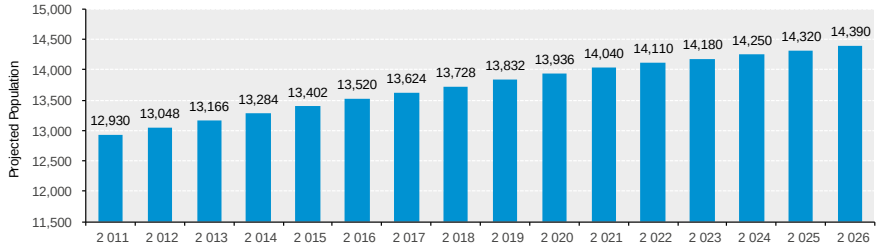


Source: ABS

- The broader Murdoch-Kardinya SA2 is forecast to grow at a slightly higher rate of 11.3% to 14,390 persons over the same period. This slightly higher rate of growth is expected to result from a combination of infill development and anticipated densification of the mixed use eastern precincts.

Murdoch-Kardinya SA2

PROJECTED CATCHMENT POPULATION CHART 3.2



Source: Urbis, WAPC WA Tomorrow (2015) Forecasts

- Current SAFi population forecasts for the study area, (refined since the original analysis), suggest that the study area catchment (as defined in Map 1.1 previously) will grow by approximately 50% between 2014 and 2031.
- The Secondary trade area is effectively mature, with limited scope for growth. The substantial majority of the growth will occur in the Primary trade area. In 2014, the Primary trade area accounted for 15% of the catchment population. By 2031, it is expected to comprise 43% of the catchment population.
- The total trade area population by 2031 is expected to grow to more than 11,500 persons.

Murdoch MUP Population Growth Forecasts

SAFi GROWTH ESTIMATES — TABLE 3.1

	2014	2016	2021	2026	2031
Primary	1,117	1,352	2,963	3,782	4,951
Murdoch	2,607	2,596	2,586	2,578	2,563
Bateman	1,157	1,169	1,200	1,241	1,297
North Lakes	668	663	659	660	649
Bibra Lake	2,131	2,135	2,104	2,109	2,099
Total Primary	1,117	1,352	2,963	3,782	4,951
Total Secondary	6,563	6,563	6,549	6,588	6,609
Main Trade Area	**7,680**	**7,915**	**9,513**	**10,370**	**11,559**

Source: SAFi, Urbis

Murdoch MUP Population Growth Rates

% CHANGE FROM 2014 — TABLE 3.2

	2016	2021	2026	2031
Total Primary	21%	165%	239%	343%
Total Secondary	0%	0%	0%	1%
Main Trade Area	**3%**	**24%**	**35%**	51%

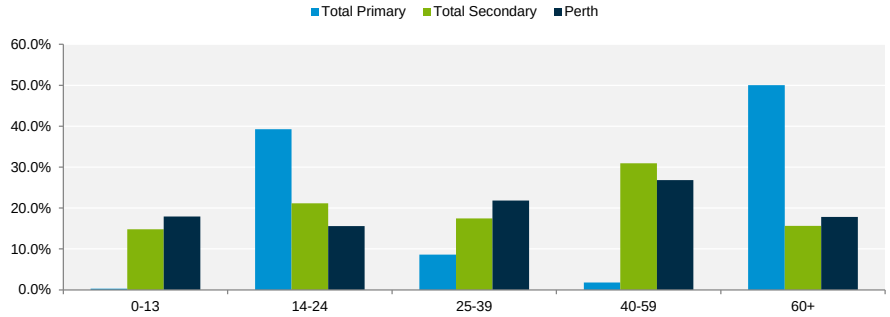
Source: SAFi, Urbis

3.2 DEMOGRAPHY

- It is unclear as to whether the broad demographic profile of the study area catchment as at the 2011 census is representative of the catchment as it now stands, one year out from the 2016 census.
- The demographic profile of the study area may be expected to revert to a mix that more closely reflects the broader Melville LGA over time.
- The demographic mix of the catchment from the 2011 census shows a somewhat distorted mix of age cohorts. The catchment has relatively high levels of 14-24 year olds and persons aged over 60.
- The spread of age cohorts probably reflects the concentration of student and aged persons accommodation in the catchment at that period and it is unreasonable to assume that this demographic mix will continue in subsequent censuses as further development occurs.
- The population mix can be expected to revert to the broader metropolitan mean over time with the disparity in these age cohorts becoming less pronounced.

Murdoch MUP Catchment Population Distribution

2011 CENSUS — CHART 3.3



Source: SAFi and Urbis

- Household densities vary across the study area catchment but the average household size is 2.7 persons, marginally above the Greater Perth average.

Murdoch MUP Catchment Key Characteristics

2011 CENSUS — TABLE 3.3

	Primary 2011	Murdoch 2011	Bateman 2011	North Lakes 2011	Bibra Lake 2011	Total Main 2011	Perth 2011
General							
Estimated Resident Population	1,075	2,468	1,127	574	1,961	7,205	1,832,114
Population 2011 Census	1,009	2,307	1,055	540	1,836	6,747	1,728,694
Population Density (Persons per Sq.km)	294	2,795	1,822	688	1,761	1,012	269
Average Per Capita Income	22,084	36,980	38,440	45,473	40,391	36,885	38,469
Per Capita Income Variation	-43%	-4%	0%	18%	5%	-4%	0%
Average Household Size	2.1	3.1	2.8	2.9	2.7	2.7	2.5
Average Age	51.4	36.6	38.8	34.9	36.5	39.0	36.9
Dependency Ratio1	49%	23%	28%	24%	28%	29%	32%

Source: ABS ; Urbis

- The average age of 39 years is approximately 2 years above the Greater Perth average and is influenced by the skewed characteristics of the Primary catchment which features a higher concentration of aged persons.
- The Murdoch MUP catchment family structures show a tendency towards families with either older children or no children. The future densification of the catchment may be expected to see a continuation of couples without children and single person households.

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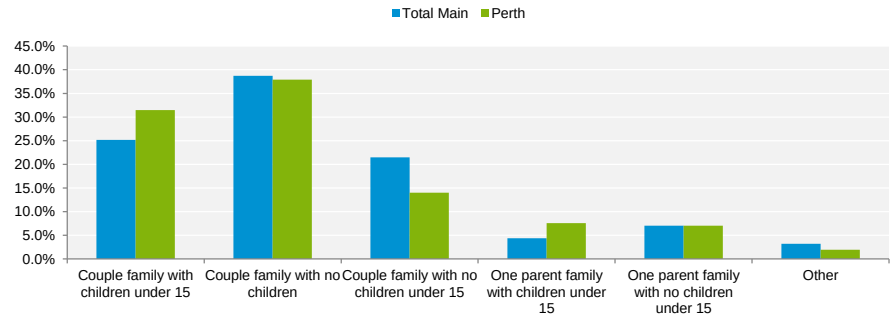
Murdoch MUP Catchment Family Structures

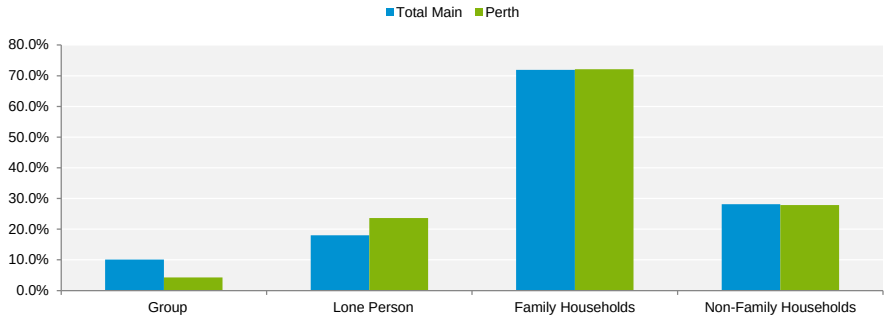
2011 CENSUS — CHART 3.4



Source: ABS, Urbis

Murdoch MUP Catchment Household Types

2011 CENSUS — CHART 3.5

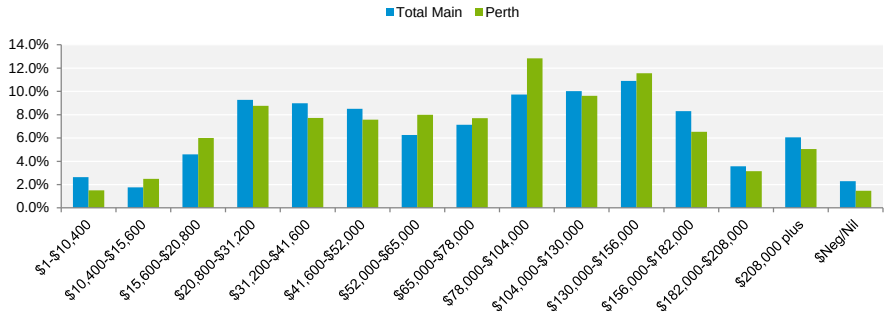


Source: ABS, Urbis

- Household income distribution shows a higher incidence of the $20,000 to $52,000 income bands and over $156,000.

Murdoch MUP Catchment Household Income Profile

2011 CENSUS — CHART 3.6



Source: ABS, Urbis

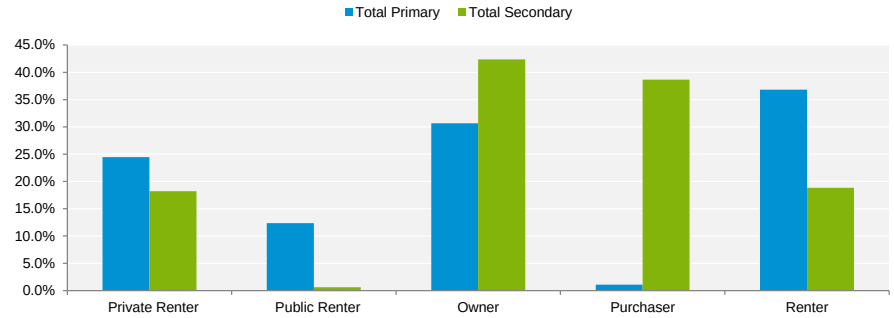
- The study area, particularly in the Secondary Catchment, has a high level of home ownership and, relative to greater Perth, a low incidence of mortgage holders and renters.
- The Primary Catchment, features a relatively high level (28%) of retirement village tenants, that do not self identify as either owners,

purchasers or renters, but are rather classified as ‘Other’ under the ABS nomenclature.

- The Primary Catchment, as at 2011, represents a relatively small percentage of the total trade area catchment. It does however have significant growth potential with the Murdoch MUP likely to increase the precinct population by more than 350% by full build out and occupancy.
- The Primary Catchment also includes a disproportionate ratio of student accommodation, which is primarily rental in nature.

Murdoch MUP Catchment Housing Tenure

2011 CENSUS CHART 3.7



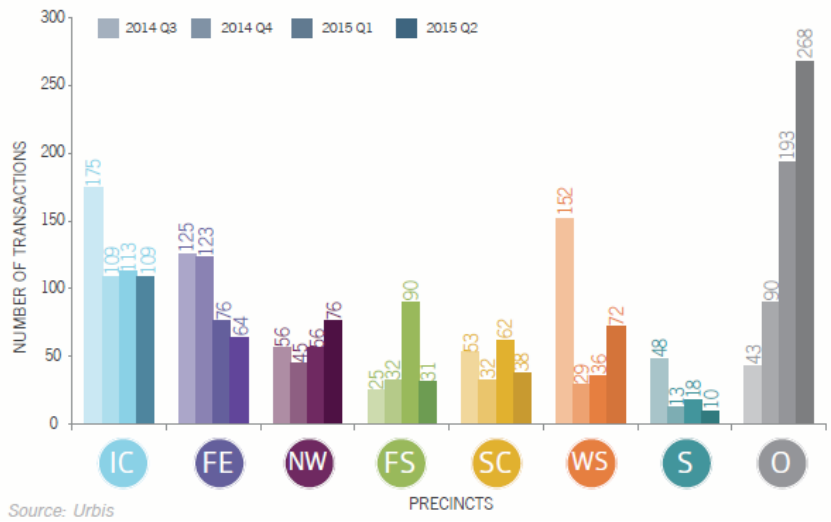
4 Density Development Environment

Urbis tracks all density development projects over 25 units in eight precincts across the metropolitan area. This analysis follows development projects that are currently being marketed and which may be either in development approval or under construction.

- Between Q3 2014 and Q2 2015 there have been 2,462 apartment presales across the metropolitan area.
- The Southern precinct, which is immediately to the south of the Murdoch MUP, accounted for just 4% of all apartment sales, whereas Fringe South, which extends to Brentwood and Booragoon and Southern Coastal (Fremantle to Munster) accounted for a further 7% and 8% of sales respectively.

Sales Trends by Precinct

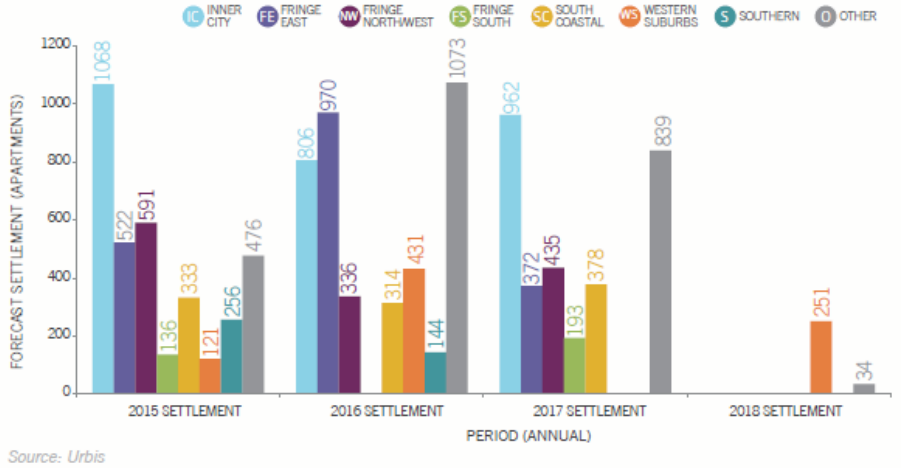
ALL METRO AREA PRECINCTS 2014-2015 CHART 4.1



- There were no apartment sales in the period within close proximity to the Murdoch MUP.
- The majority of project settlements have been, and are expected to continue out to 2017, in the Inner City and Other Precincts. ('Other' areas include general activity across the metropolitan area that does not fall within the seven core precincts)
- There are no strong indications of apartment development within proximity to the Murdoch MUP over the near term.

Project Settlements by Precinct

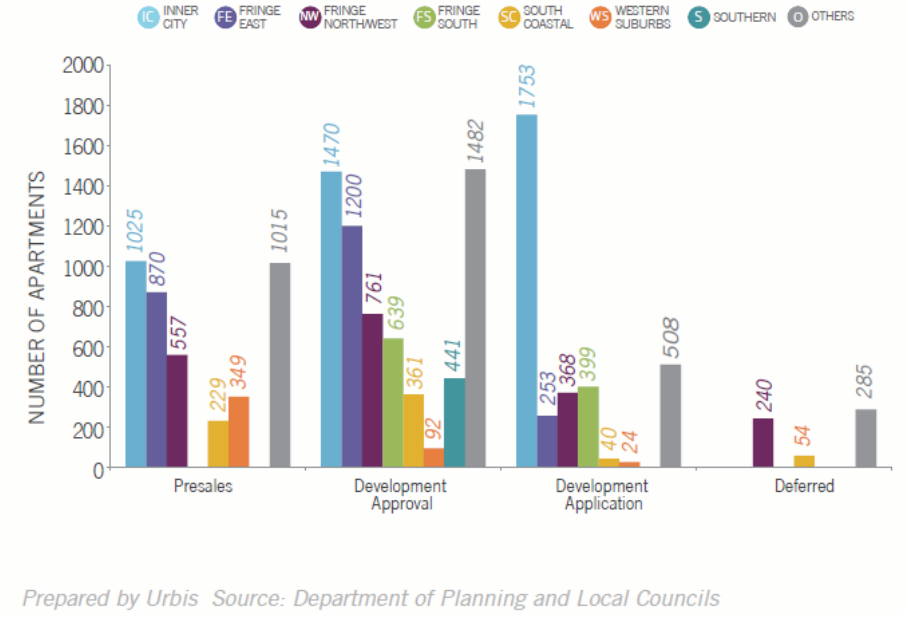
ALL METRO AREA PRECINCTS CHART 4.2



- The Majority of projects with development approval are in the Inner City and Fringe East precincts.
- More than 50% of projects subject to development application are in the Inner City precinct, with negligible activity planned for the area around Murdoch MUP

Future Supply Status by Precinct

ALL METRO AREA PRECINCTS CHART 4.1



Prepared by Urbis Source: Department of Planning and Local Councils

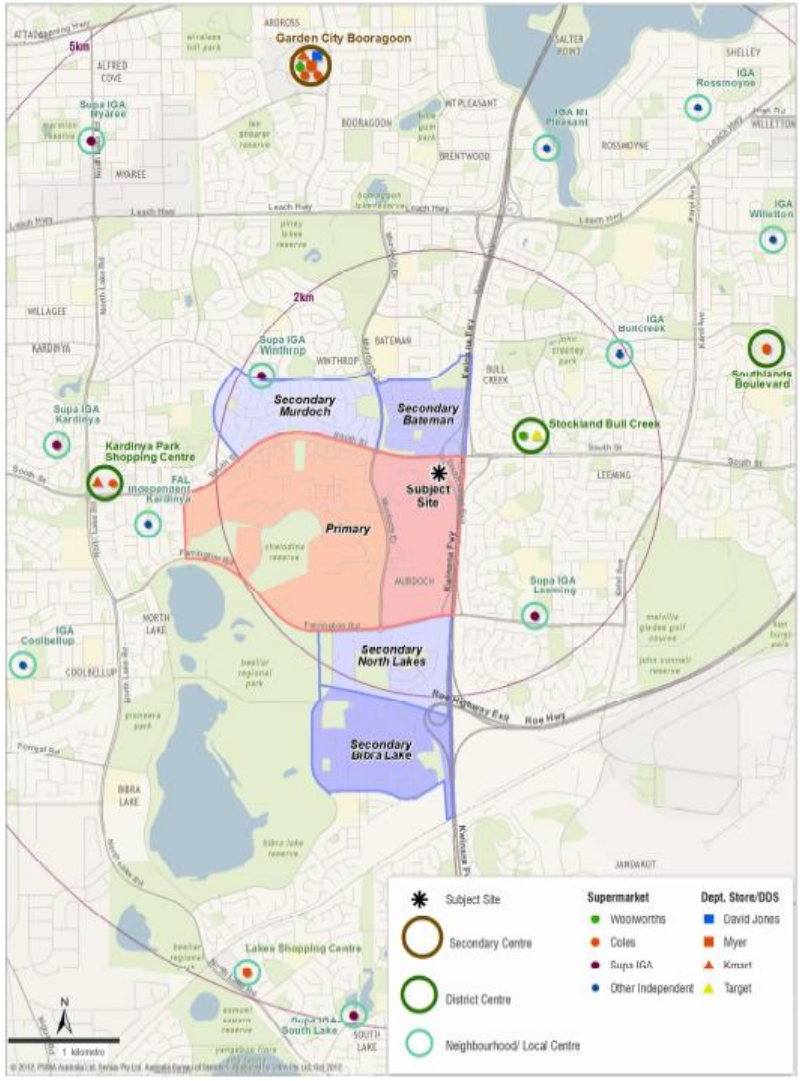
5 Market Segment Analysis

Urbis has determined that, whilst there have been changes in economic conditions and amendments to population growth trajectories, for the state as a whole and for the local government area, the essential trade area as defined in the original study remains the same, namely:

- Primary Trade Area is bounded by South Street to the north, the Kwinana Freeway to the east, Farrington Road to the south and Windelya Road to the west.
- Secondary Murdoch Trade Area includes the residents bounded by Somerville Boulevard to the north, Murdoch Drive to the east, South Street to the south and Prescott Drive to the west.
- Secondary Bateman Trade Area includes the residents bounded by Marsengo Road to the north, the Kwinana Freeway to the east, South Street to the south and Murdoch Drive to the west.
- Secondary North Lake Trade Area includes the residents in the area bounded by Farrington Road in the north, the Kwinana Freeway to the east, Hope Road to the south and Bibra Drive to the west.
- Secondary Bibra Lake Trade Area includes the residents bounded by Hope Road to the north, Bibra Drive in the east, Parkway Road to the south and the Kwinana Freeway to the east.

Murdoch MUP Trade Area

PRIMARY AND SECONDARY CATCHMENTS MAP 4.1



5.1 KEY SEGMENTS

The student, worker, hospital visitor and resident segments are the key markets of relevance to future retail in the Murdoch MUP. These distinct market segments are identified because they are each expected to have different spending behaviour and contributions to the MUP. We have considered the spending capacity of each segment separately.

5.1.1 LOCAL RESIDENTS

A trade area encompassing local residents extends north, south and west of the MUP. This catchment includes surrounding residential areas, as well as students residing on-campus.

5.1.2 HEALTH/TAFE PRECINCT

Bordering the MUP to the south and west, the Health/TAFE Precinct includes the following segments. .

- *TAFE students* – We understand that current TAFE enrolment numbers could potentially increase over the forecast period. This has been accounted for in our analysis.
- *Medical Workers* – The staff at the St John of God Hospital and the Fiona Stanley Hospital will generate some demand for retail in the MUD. However a large portion of hospital worker spend will continue to be contained to facilities within the hospital itself.
- *Other Workers* – Other workers within the precinct include Challenger TAFE as well as future workers within the Murdoch MUP. This reflects a key opportunity for retail in the MUD.
- *Hospital Out-Patients* – Current and future hospital out-patients will generate some spending in the vicinity of the MUP, although most of this spending is likely to be directed to hospital facilities.
- *Hospital Visitors* – As with out-patients, the spending directed to the MUP by hospital visitors is expected to be marginal.

5.1.3 UNIVERSITY PRECINCT

The key market segments within the University Precinct are described below and include the university itself and surrounding and adjoining facilities.

- *Students* – Spending by students who do are not local residents has been assessed separately from those who reside on-campus (the latter is included in the Local Residents market). The analysis incorporates steady growth in student numbers over the forecast period.
- *University staff* – Retail spending generated by university staff is considerably lower than for students.
- *Other Precinct Workers* – Other workers in the vicinity of the university include staff at Wesfarmers, Murdoch College, Winthrop Kennedy Baptist School and the State Animal Resource Centre. These workers are likely to have minimal access to retail currently and should provide good support to retail in the MUP.

5.2 COMPETING SUPPLY

Table 4.1 details the known competing retail supply in proximity to the trade area catchment.

- The trade area supply as profiled below indicates more than 72,700 sqm of competing retail floorspace, of which around 61% is occupied by major retailers like Coles, Woolworths and IGA, with a further 28,200 sqm of floorspace across more than 260 specialty stores.

Murdoch MUP Trade Area

COMPETING RETAIL SUPPLY TABLE 4.1

TYPE	LOCATION	GLAR	KEY TENANTS
Stockland Bull Creek	South St Bull Creek	16,191 sq.m	Target (8,131 sq.m) Woolworths (3,426 sq.m)

			44 Specialties (4,634 sq.m)
Kardinya Park Shopping Centre	North Lake & South Sts, Kardinya	13,709 sq.m	Kmart (7,291 sq.m) Coles (2,411 sq.m) 41 Specialties (4,007 sq.m)
Southlands Boulevarde	Burrendah Blvd, Willetton	14,334 sq.m	Woolworths (4,460 sq.m) Coles (3,710 sq.m) 61 specialties (6,164 sq.m)
Leeming Forum Shopping Centre	Farrington & Findlay Rds Leeming	5,151 sq.m	IGA (1,986 sq.m) 20 Specialities (3,165 sq.m)
South Lake Shopping Centre	Berrigan Dr, South Lake	3,095 sq.m	IGA (1,846 sq.m) 10 Specialties (1,249 sq.m)
Lakes Shopping Centre	North Lake & Omeo Rds, South Lake	8,519 sq.m	Coles (2,500 sq.m) Aldi (1,104 sq.m) 39 Specialities (4,915 sq.m)
Coolbellup Shopping Centre	Coolbellup & Cordelia Aves,	3,622 sq.m	IGA (1,100 sq.m) 32 Specialities (2,522
	Coolbellup		sq.m)
Parry Village	Parry Ave. Bull Creek	2,137 sq.m	IGA (588 sq.m) 15 Specialties (1,549 sq.m)
Winthrop Village	Jackson Ave & Somerville Blvd, Winthrop	4,000 sq.m (est.)	IGA (area not disclosed)
Kardinya IGA	Cnr South St & Gilbertson	2,000 sq.m (est)	IGA (area not disclosed)

6 Murdoch MUP Retail Potential

6.1 MURDOCH MUP RETAIL POTENTIAL

The key outputs from the analysis of available spending and potential capture by segment are shown in Table 5.1.

This includes estimates for the key segments identified, and a small allowance for turnover attracted from ‘beyond’ the local area.

Forecast Turnover and Market Shares, 2030 (Capacity)

MURDOCH MIXED USE PRECINCT (WITH SUPERMARKET 2,500-3,000 SQ.M) TABLE 6.1

	Grocery/Fresh Food					F&B			General			Services			Total Turnover ($M)
	Total Market ($M)	Smkt %	Spend Retained Other %	Spend Retained Other ($M)	Total ($M)	Total Market ($M)	Spend Retained %	Spend Retained ($M)	Total Market ($M)	Spend Retained %	Spend Retained ($M)	Total Market ($M)	Spend Retained %	Spend Retained ($M)	
Health / TAFE Precinct															
Medical workers	2.1	90%	5%	**0.1**	**2.0**	10.5	10%	**1.0**	1.0	40%	**0.4**	1.0	30%	**0.3**	**3.7**
Other workers	2.5	90%	5%	**0.1**	**2.4**	8.0	30%	**2.4**	1.8	40%	**0.7**	0.9	30%	**0.3**	**5.6**
Hospital out-patients	0.1	90%	5%	**0.0**	**0.1**	0.9	4%	**0.0**	0.1	40%	**0.0**	0.1	30%	**0.0**	**0.2**
Hospital visitors	0.5	90%	5%	**0.0**	**0.4**	2.2	4%	**0.1**	0.3	40%	**0.1**	0.1	30%	**0.0**	**0.7**
TAFE students	0.7	90%	5%	**0.0**	**0.7**	3.4	4%	**0.1**	0.2	40%	**0.1**	0.1	30%	**0.0**	**0.9**
Total Precinct	**6.0**	**90%**	**5%**	**0.3**	**5.6**	**25.0**	**15%**	**3.7**	**3.4**	**40%**	**1.4**	**2.2**	**30%**	**0.7**	**11.1**
University Precinct															
Students (non resident)	2.0	90%	5%	**0.1**	**1.9**	9.5	4%	**0.4**	0.6	10%	**0.1**	0.3	10%	**0.0**	**2.3**
University staff	0.5	90%	5%	**0.0**	**0.5**	2.4	4%	**0.1**	0.2	10%	**0.0**	0.2	10%	**0.0**	**0.6**
Precinct workers	8.0	90%	5%	**0.4**	**7.5**	23.9	4%	**1.0**	5.7	10%	**0.6**	2.6	10%	**0.3**	**9.0**
Total Precinct	**10.5**	**90%**	**5%**	**0.5**	**9.9**	**35.8**	**4%**	**1.4**	**6.6**	**10%**	**0.7**	**3.2**	**10%**	**0.3**	**11.8**
Local Residents	61.0	5%	1%	**0.8**	**16.9**	27.4	4%	**1.1**	55.2	5%	**2.8**	6.4	20%	**1.3**	**21.2**
Beyond (@ 5%)					0.9			0.1			0.1			0.1	1.1
Total Residents					**17.8**			**1.2**			**2.9**			**1.3**	**22.4**
Total Segments				**1.5**	**33.3**			**6.3**			**4.9**			**2.3**	**45.3**

Source : Urbis

6.2 SUPERMARKET

The capacity analysis (Table 5.2) outlines the turnover that could be achieved by a supermarket within the MUP over the next 15 years. The turnover potential assumes no new competition, beyond the existing range of supermarkets provided in the area, is developed in this time.

Supermarket turnover will be supported by Food and Grocery (F&G) spending by local residents and the other segments outlined earlier. Allowances are also made for turnover generated by the sale of non-F&G (i.e. general merchandise) and by residents outside the trade area (i.e. turnover from beyond the trade area).

The turnover suggests that a supermarket format in the order of 2,500 - 3,000 sq.m could be supported as early as 2021, subject to the quantum of development completed within the Murdoch precinct by this time.

A key risk to the potential of a supermarket on the subject site is the road accessible to the site from surrounding areas (i.e. outside the MUP). For residents travelling to the site from the north or east there appears to be no direct (trafficked signal intersection) access to the site. These potential shoppers would need to travel further west and enter the MUP via the main entry point at Fiona Wood Road and then use the internal roads to access the site. This rather circuitous route for shoppers could be a significant deterrent to the centre's usage.

In this regard, the potential market shares assessed for the supermarket could be significantly lower than forecast. Furthermore, the accessibility of the site to the wider resident market may prove a barrier to attracting a major chain supermarket, particularly in terms of a store in the 2,500 - 3,000 sq.m range. In this outcome, a smaller supermarket of less than 1,000 sq.m that focusses on serving the MUP, and the occasional shop from the wider resident market may only be realised.

Planning for the proposed retail centre therefore should allow for a 2,500 - 3,000 sq.m supermarket and a smaller 400-800 sq.m supermarket. The implications of a smaller format supermarket on the supportable range of supermarkets are discussed later in this section of the report.

Supermarket Capacity Assessment, 2015-2030

MURDOCH MIXED USE PRECINCT (SUPERMARKET 2,500-3,000 SQ.M)

TABLE 6.2

Factor	Unit	2015	2022	2030
Resident Market				
Total Available F&G Spending	$M	42.9	52.1	61.0
TA Spending Available to Smkts	$M	30.1	36.5	42.7
Spending Captured by Murdoch MUP	$M	8.9	12.7	16.1
Plus Turnover from Beyond TA (@ 5%)	$M	0.5	0.7	0.8
Total Turnover from Residents (F&G)	**$M**	**9.4**	**13.4**	**17.0**
Other Segments				
Total Available F&G Spending	$M	2.4	9.9	16.4
Spending Captured by Murdoch MUP	**$M**	**2.2**	**8.9**	**14.8**
Plus Gen. Merch. Turnover (@ 8%)	$M	0.9	1.7	2.4
Total Turnover	**$M**	**12.4**	**24.0**	**34.1**

Source: Urbis

Based on the spin-off from supermarket shoppers, demand from other segments, and typical retail floorspace trading rates, the potential provision of specialty shop retail floorspace is outlined in Table 4.3. The supportable provision is provided for two scenarios:

- With a supermarket of 2,500-3,000 sq.m.
- With a supermarket of less than 1,000 sq.m.

Given the diverse nature of markets in the local area, an optimal retail mix would likely provide a mix of food and beverage operators (take away/cafes), general retail (e.g. pharmacy, newsagent, etc.) as well as retail services which may include dry cleaning, hairdressing / beauty, optometrist and the like.

Supportable Retail Floorspace, 2030 (Capacity)

MURDOCH MIXED USE PRECINCT TABLE 6.3

Tenant	Supermarket (2,500-3,000 sq.m) No. of Stores	Total (Sq.m)	% of Retail	Supermarket (Less than 1,000 sq.m) No. of Stores	Total (Sq.m)	% of Retail
Majors						
Supermarket	1	3,000	60.3%	1	700	33.5%
Specialty Stores						
• Grocery/Fresh Food	2	206	4.1%	1	100	4.8%
• Food & Beverage	8	779	15.7%	6	550	26.3%
• General	4	667	13.4%	3	500	23.9%
• Services	4	320	6.4%	3	240	11.5%
Total Retail Specialties	**18**	**1,971**	**39.7%**	**13**	**1,390**	**66.5%**
Total Retail Centre	**19**	**4,971**	**100.0%**	**14**	**2,090**	**100.0%**
Non Retail Shops	3	300		2	200	
Total Centre	**22**	**5,271**		**16**	**2,290**	

Source : Urbis

7 Employment Generation

Previous analysis has been predicated on the potential for the WA Police Department to relocate aspects of their operations to the Murdoch Mixed Use Precinct. The prospects of a decentralisation of Police operations now seem unlikely, given the current office market conditions which are not expected to improve significantly in the medium term.

Table 6.1 outlines operational employment for the Murdoch MUP at full build out and assuming 100% take-up of the space. Full build out of commercial space is unlikely to be viable before 2020.

Employment estimates are derived from PLUC estimates of employment densities for Retail and Commercial / Health space and market knowledge of current trends in office employment densities.

Total net new FTE employment for the MUP precinct is estimated at approximately 2,430. This is approximately 15% less than the original Scenario 1 estimates in the original analysis and reflects the reduced demand for commercial / office space in the precinct. The retail employment generation is predicated on Urbis estimates of the maximum supportable retail floorspace for the Murdoch MUP as outlined in Table 5.3.

Murdoch MUP Employment Generation

MURDOCH MUP TABLE 6.1

Space	Ind. GFA (sqm)	Emp. Density	Total Emp.	Distribution % Floorspace	Distribution % Emp.
Retail (Max Supportable NLA)	5,271	3.9 / 100 sqm	206	10%	8%
Commercial / Office	33,120	18 sqm / emp.	1,840	61%	76%
Commercial Health	8,240	3.3 / 100 sqm	272	15%	11%
Short Stay Accommodation	7,530	1.5 / 100 sqm	113	14%	5%
Total Centre	54,161		2,430	100%	100%

Source: Urbis

The take-up of commercial / office space is most likely to be derived from supporting health uses and may include consulting rooms, allied health uses and research foundations not able to be supported by the current provision of space within the hospital complexes. Other uses may include medical technology companies with a need to be co-located adjacent to major health facilities. General suburban commercial / office uses are not favoured.

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Murdoch Mixed Use Precinct
LandCorp
13-Nov-2015

Murdoch Mixed Use Precinct

Transport Assessment



Murdoch Mixed Use Precinct

Transport Assessment

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Appendix A
Traffic Generation Assumptions A

Executive Summary

The Murdoch Mixed Use Precinct (MUP) will provide a transit-orientated hub to support the specialised education and medical activity centre. The MUP site is adjacent to a complex road and rail interchange at Murdoch Station. The adjacent transport corridors constrain the site layout and future traffic generation, but also provide opportunities to achieve a much higher proportion of public transport trips to the site compared to traditional metropolitan developments in Perth. The proposed mix of residential, retail and commercial uses will provide an opportunity to live within walking and cycling distance of major workplaces or tertiary education centres, and to access many daily activities within the site.

The MUP street network and connectivity was developed to meet the following objectives:

- Provide easy and safe access to the bus / rail interchange.
- Provide effective pedestrian linkages through the site.
- Strengthen pedestrian and cycle connectivity to and within the precinct.
- Promote public transport by providing easy, regular and convenient connections.
- Modal split target: 40 per cent Public Transport.
- Low car dependency.
- Transitions from a transit 'Origin' to a 'Destination' over time.

MUP Street Network

Barry Marshall Parade forms the primary road connection between South Street, Murdoch Drive and the MUP site. It is designed to prioritise transit movements over car movements through the use of bus lanes and the transit only link to Murdoch Station. Barry Marshall Parade provides a sightline between the station and the two major hospitals, with active, landscaped streets encouraging pedestrian movements between these key activities.

The internal road network is intended to provide an attractive, pedestrianised centre with a number of walking and cycling connections to Murdoch Station and through to Fiona Stanley Hospital (FSH). It is designed as a slow-speed environment to provide car, walking and cycling access to the MUP and adjacent hospital activities.

Public Transport Connectivity

People living, working or visiting the MUP are all within a 400 metre walk of either the Barry Marshall Parade bus stops or Murdoch Station bus and rail interchange. This is achieved through the provision of several pedestrian and cycling connections between the MUP and Murdoch Station. The MUP development will almost double the number of residents within the Murdoch Station walking catchment (an additional 1,500 residents expected), but will not add a significant demand for peak hour departures compared to the overall boardings for the Mandurah rail line.

The commercial and retail mix proposed within the MUP will generate counter-flow peak trips for the rail network, and attract commuters travelling through Murdoch Station to the two major hospitals and other adjacent Murdoch Activity Centre (MAC) sites. This will assist with the transition of Murdoch Station to a 'destination; rather than 'origin' station as the MUP development is completed over the next ten years. The proposed reduction in standard car parking rates for the MUP, particularly for commercial and retail employees, will support the proposed target of 40 percent of all MUP trips by public transport.

Walking and Cycling Connectivity

The proposed street network and green corridors within the MUP are designed to attract pedestrian trips through the centre and between local activities. The MUP cycling network is designed to link in with the proposed regional cycling routes through the MAC area. The MUP network includes a direct link to the Principal Shared Path along the Freeway corridor, with either a shared or dedicated cycle lanes provided along the connecting MUP streets, and a shared space design for the short, cul-de-sac lot access roads off Fiona Wood Road and Road 1

Traffic Analysis

AECOM was engaged by the Department of Transport to develop a Commuter microsimulation model for the MAC. The 2031 model includes the entire MAC Structure Plan Area and future planned surrounding road upgrades such as the extension of Roe Highway and associated southern connection as well as the southern

extension of Fiona Wood Road to Farrington Road. This model was subsequently refined to undertake the detailed traffic analysis for MUP.

The traffic impact assessment is based upon the full build out and occupancy of MUP Stage 1 only. Stage 2 was not modelled due to the uncertainty surrounding the potential relocation of the Murdoch Station western Park n Ride facility, which sits within the Stage 2 development area. Thus the scenario modelled assumes the Park n Ride facility is retained within the MUP Stage 2 site during Stage 1.

The traffic analysis identified a number of issues with the operation of the external road network, particularly at the South Street / Kwinana Freeway interchange and the Murdoch Drive / Farrington Road / New Southern Connection intersection.

It is noted that the **MUP development is not considered to be the primary cause of the predicted peak period congestion on the external road network**. The MUP parking strategy and objectives to achieve a 40 percent public transport mode share for employees and create a self-sufficient centre all contribute to reducing peak period traffic generated by the MUP development. Vehicle trips generated by the MUP Stage 1 development account for only 10 percent of all vehicle trips into the MAC area.

A significant proportion of the high traffic demands are instead attributed to the wider MAC area. Addressing the predicted traffic demand and corresponding peak period delay at the South Street / Kwinana Freeway interchange should therefore be addressed by the broader MAC transport strategy.

The MUP internal intersections are all predicted to operate satisfactorily.

It is noted that traffic modelling has its limitations. Traffic demands were taken from high level strategic models and as such there is always some level of uncertainty. The results presented in this study should therefore only be viewed as an indication of what may occur in the future.

Transport Network Improvement Opportunities

There are a number of opportunities to improve the MAC transport network, including:

- Roe Highway Extension and new connection to Murdoch Drive (southern connection)
- Southern extension of Fiona Wood Road to Farrington Road.
- Relocation of the western Park n Ride Facility (potentially to a multi-storey carpark on the eastern side of Kwinana Freeway).
- Murdoch Station bus bridge capacity improvement.
- Light Rail Transit link through the MUP to Murdoch Station.
- Free Transit Zone for MAC
- Pedestrian and cycling crossing improvements for South Street and Murdoch Drive.
- Direct pedestrian and cycling connection between catchments on the eastern side of Kwinana Freeway (Leeming and Bull Creek) and the MUP and wider MAC site such as via a pedestrian bridge which also connects to Murdoch Station.
- Bike hire scheme for MAC

These network options are to be further investigated as part of the broader MAC planning process. The MUP site has been developed to enable these opportunities to be realised if these initiatives are progressed in the future.

1.0 Introduction

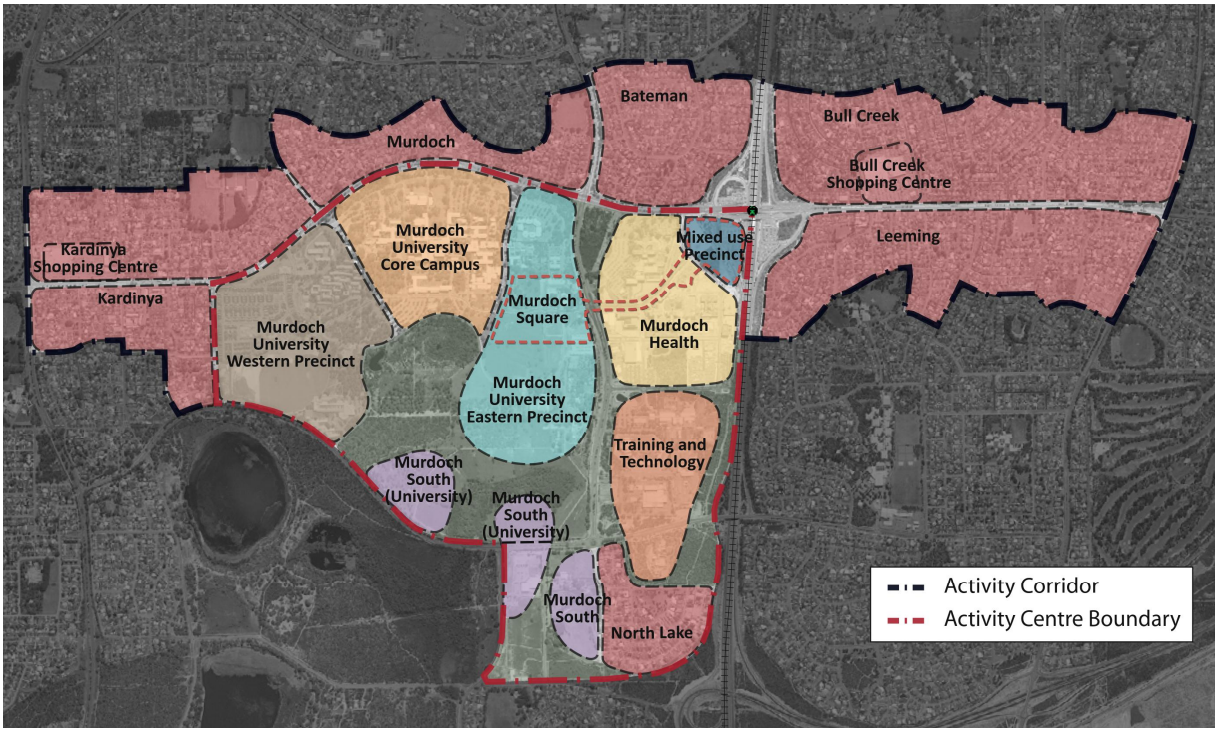
The Murdoch Mixed Use Precinct (MUP) provides an opportunity to develop a transit-orientated hub in a growing strategic activity centre. The MUP will support the specialised Murdoch health and tertiary education centre, providing a range of daily activities, including student and residential dwellings, within walking and cycling distance of other key activities. The MUP site is adjacent to a complex road and rail interchange at Murdoch Station. The adjacent transport corridors constrain the site layout and future traffic generation, but also provide opportunities to achieve a much higher proportion of public transport trips to the site compared to traditional metropolitan developments in Perth.

This report outlines the proposed movement strategy for the MUP, identifying multi-modal access opportunities and the predicted traffic impact of the MUP activities. The information included in this report meets the transport assessment requirements outlined in the *Transport Assessment Guidelines for Developments, Volume 2 – Structure Plans* (Western Australian Planning Commission (WAPC), 2006).

1.1 Integration with the MAC Development

The MUP development is one of a number of growth precincts within Murdoch Activity Centre (MAC), as illustrated in **Figure 1**. On the southern boundary of the MUP is the significant Fiona Stanley Hospital (FSH) development, one of the largest State Government developments in recent times. To the west, the MUP site is bounded by St John of God Hospital (SJOGH) which has recently undergone an expansion adding 174 more beds. These major trip generators will utilise part of the MUP transport network for site access and connectivity to the regional road network and have been a key consideration in the MUP transport network design. In addition, half of the MUP site is currently occupied by Murdoch Station Park n Ride facility. The management and potential relocation of this facility is the responsibility of the Public Transport Authority, and has also been an important consideration of the MUP and broader MAC transport planning process.

Figure 1 MAC Sub-Precincts *(Department of Planning, 2014)*



The MUP development has been progressed through close liaison with MAC stakeholders, particularly the Department of Health and SJOGH management, Department of Planning, Department of Transport, Main Roads Western Australia, Public Transport Authority, City of Melville and Murdoch University. The MUP development has sought guidance on transport strategies from the MAC structure planning process, aligning with the objectives and

recommendations of the *Murdoch Specialised Activity Centre Structure Plan* (WAPC & Department of Planning, January 2014).

As the MAC structure planning process is still underway, there are a number of transport issues which are still to be resolved, such as:

- Potential relocation of Murdoch Station western Park n Ride facility.
- Potential extension of Fiona Wood Road south of MUP and FSH, to relieve traffic congestion on Barry Marshall Parade, Murdoch Drive and South Street.
- Bus capacity at the Murdoch Station bus and rail interchange.
- Long term transit provision through MAC (and MUP).

These issues affect access and connectivity to and through the MUP, but are outside of the scope of the MUP development and are instead to be resolved through the MAC planning process. This transport assessment is based on the current status of committed transport network upgrades, which are outlined in **Section 3.0**. Where network improvement options are still under investigation through the broader MAC process, these initiatives are noted as opportunities in this movement strategy. The MUP site has been developed to enable these opportunities to be realised if these initiatives are progressed in the future.

1.2 MUP Transport and Access Objectives

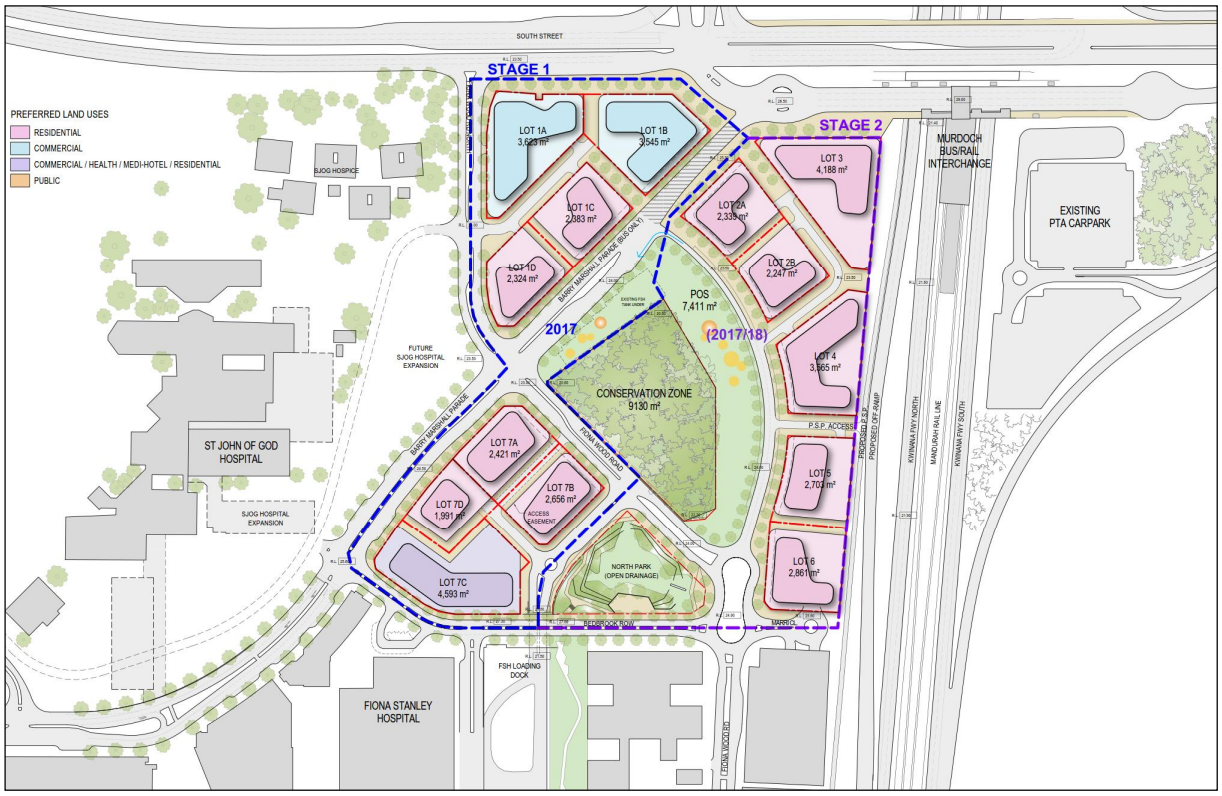
The importance of the movement and access strategy to the success of the development is emphasised by the number of transport objectives included in the MUP vision:

- Provide easy and safe access to the bus / rail interchange.
- Provide effective pedestrian linkages through the site.
- Strengthen pedestrian and cycle connectivity to and within the precinct.
- Promote public transport by providing easy, regular and convenient connections.
- Modal split target: 40 per cent Public Transport.
- Low car dependency.
- Transitions from a transit ‘Origin’ to a ‘Destination’ over time.

1.3 Development Staging

The MUP is proposed to be developed in two stages for commercial reasons and to integrate with other developments affecting the site. The proposed development staging for the MUP is illustrated in **Figure 2.**

Figure 2 Staging Plan (*LandCorp, 2015*)



The timing of the MUP and adjacent developments is summarised below.

- **Stage 1**
    - MUP Stage 1 civil works to be completed by mid-2017.
    - Murdoch Park n Ride facility within the MUP site is retained, with new access via the MUP street network.
- **Stage 2**
    - Although the Murdoch Station western Park n Ride facility lease agreement expires in 2017; commencement of Stage 2 is subject to relocation of the existing Park n Ride which will only occur when there is agreement on a suitable option by all relevant government stakeholders including Main Roads, Department of Transport (DoT) and Public Transport Authority (PTA).

There are also a number of upgrades for the adjacent regional road network to be completed within these timeframes and these are outlined in **Section 3.0**.

2.0 Background

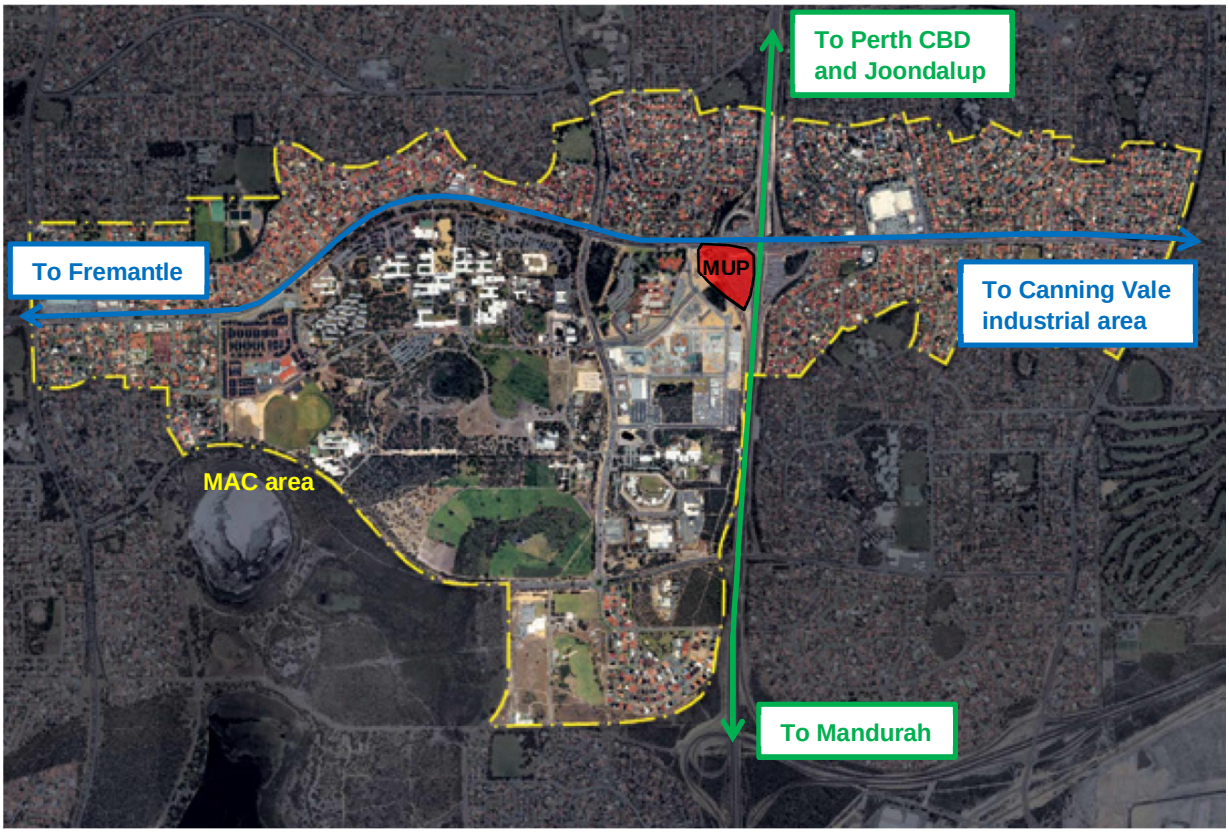
This section outlines the role of the MUP within the strategic MAC development, and transport strategies influencing the MAC regional road and public transport network. A summary is also provided of previous studies investigating constraints and opportunities to improve the long-term capacity of the MAC transport network.

2.1 Regional Context

Under *Directions 2031 and Beyond* (WAPC, 2010), the Murdoch Activity Centre is planned as a specialised activity centre. Specialised activity centres house regionally significant activities, with the health and education functions in Murdoch attracting trips from across the metropolitan area, as well as broader regional and state centres. The MUP is a key development site within the MAC area, supporting the centre to become self-sufficient through new residential, commercial and retail development (thereby encouraging walking and cycling trips for a range of daily activities) and providing an important link to multi-modal regional transport networks.

Figure 3 illustrates the location of MUP within the MAC area and in relation to other strategic centres in Perth.

Figure 3 MUP Location and Regional Context *(Department of Planning, 2014)*



2.2 Role of the MUP in the Regional Transport Network

The location of the MUP immediately adjacent to Murdoch Station and Kwinana Freeway provides a direct rail and regional road link to Perth Central Business District (CBD), as well as the north-south strategic metropolitan centres of Joondalup and Mandurah. The proximity of the MUP to the Mandurah rail line also provides access to the metropolitan wide train services, through the Perth CBD connection to the Fremantle, Armadale and Midland rail lines. South Street on the northern boundary of the site provides a primary east-west road link between the strategic centres of Fremantle, Murdoch and residential and industrial areas in the east. South Street experiences congestion at peak times with heavy demands from traffic accessing the Freeway, as well as regional freight and commuter through-movements. The movement strategy for the MUP recognises the capacity limitations of the regional road network, aiming for a significant increase in the proportion of MAC public transport trips and an increase in local walking and cycling trips between MAC activities.

The *State Planning Policy (SPP) 4.2 – Activity Centres for Perth and Peel (*WAPC, 2010*)* requires access by public transport, walking and cycling to be prioritised over private car access for specialised activities centres. Additional guidance for the MUP development is provided in *Development Control Policy (DCP) 1.6 Planning to Support Transit Use and Transit Orientated Development (*WAPC, 2006*).* The MUP provides for high trip generating commercial and residential development within 800 metres walk of Murdoch Station and high frequency bus or transit routes. Achieving a high proportion of walking, cycling or public transport trips between MUP and other key MAC precincts is an objective of the proposed MUP development, with the attractiveness, ease and convenience of these priority transport modes key design features. The location and supply of parking for MUP and wider MAC activities (including Murdoch Station Park n Ride) will strongly influence travel choices to and within the site.

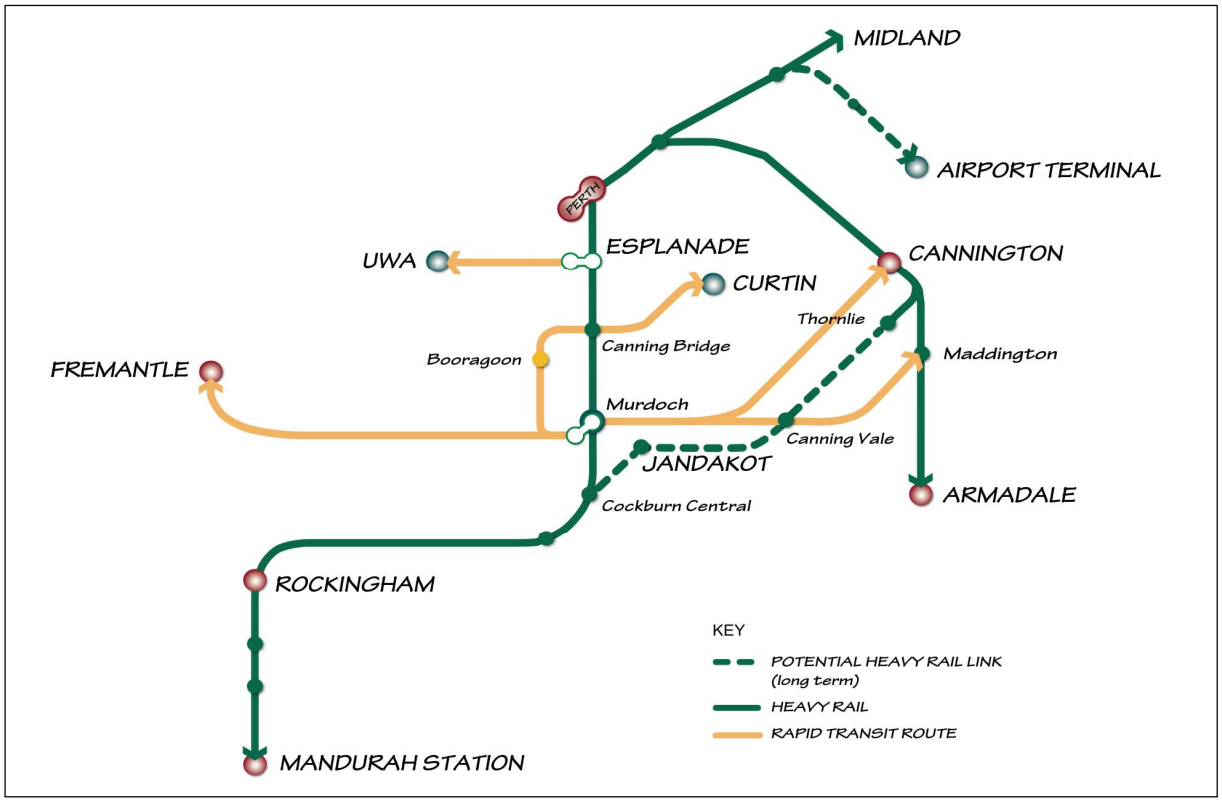
The *Draft Public Transport for Perth in 2031 (*Department of Transport, 2011*)* includes the development of a Bus Rapid Transit link between Fremantle, Murdoch and Cannington to improve east-west connectivity between these strategic centres, as outlined in **Figure 4**.

Figure 4 Public Transport Plan for Perth by 2031 *(Department of Transport, 2011)*



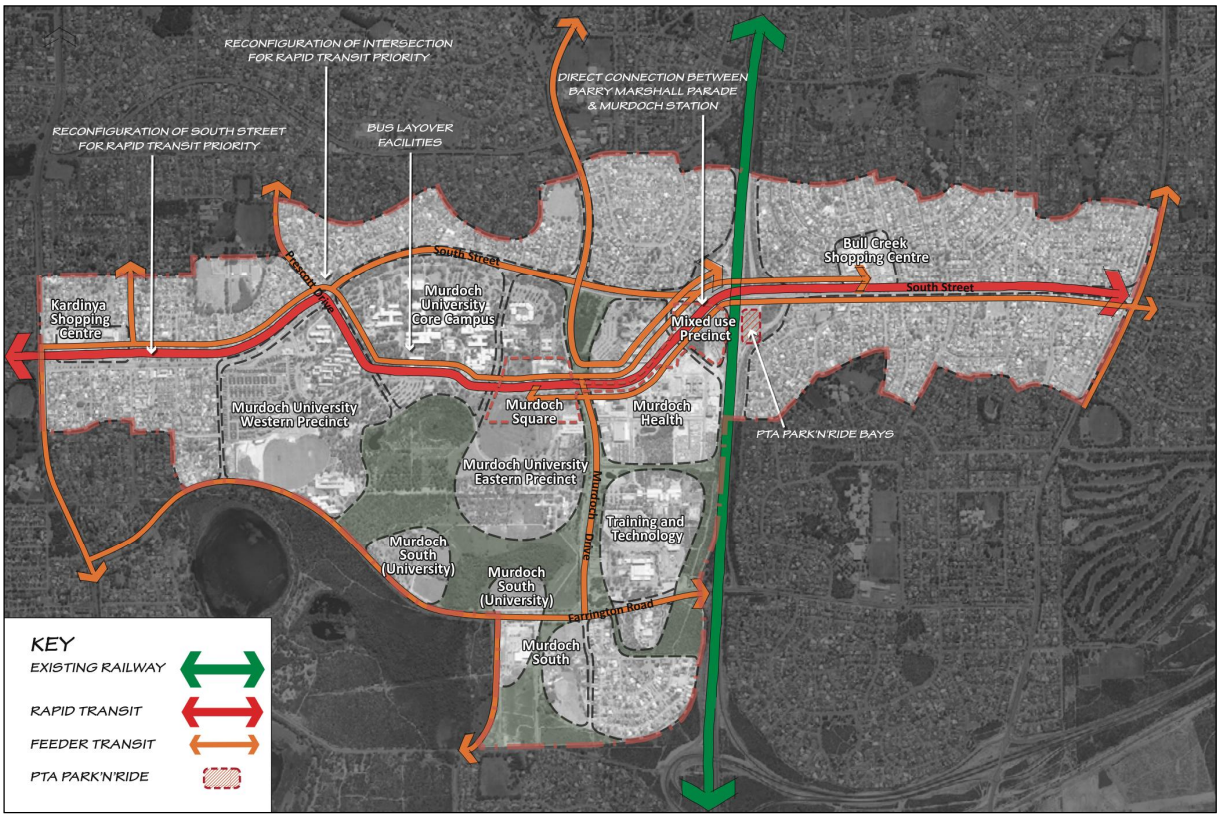
The *draft Murdoch Structure Plan* recommends additional public transport improvements to enable the MUP and broader MAC site to fulfil their growth potential whilst achieving the target modal shift towards at least 40 per cent of trips by public transport. The desired regional public transport connections for MAC are illustrated in **Figure 5**.

Figure 5 MAC Desired Regional Public Transport Connections *(Department of Planning and WAPC, 2014)*



The *draft Murdoch Structure Plan* recommends an extension of the State Government's proposed Light Rail Transit (LRT) system south to Murdoch, connecting to the other strategic health and education centres in the Perth metropolitan area. Extending the LRT along the east-west route between Fremantle and Cannington (or Armadale) is also recommended to greatly improve public transport accessibility to the residential catchments along South Street. The recommended MAC public transport routes are illustrated in **Figure 6**. The internal MUP transport network has been designed to accommodate a future LRT connection, increasing the attractiveness and capacity of public transport access in the longer term.

Figure 6 Recommended Principal Public Transport Routes for Murdoch Activity Centre (*Department of Planning and WAPC, 2014)*



2.3 Previous MAC and MUP Transport Studies

2.3.1 MAC A Structure Plan (2006, 2008)

A Structure Plan was previously prepared for a much smaller MAC A area, which only included the MUP site, FSH, SJOGH, Challenger TAFE and a small eastern portion of Murdoch University (Department of Planning and Department of Health, 2007). As part of the initial planning for FSH, several traffic studies for the area were undertaken, including the *Southern Tertiary Health Precinct Transport Plan Report* (SKM, 2006) and *Southern Tertiary Health Precinct Transport Model Update* (SKM, 2008). These transport studies modelled road network options to improve the long-term peak network capacity, particularly at the South Street and Murdoch Drive intersections within the MAC A site. These studies included a 50 per cent public transport, walking and cycling mode share for major MAC activities. The MAC A road network was based on the recommended network improvements, with a new southern Freeway connection provided between Murdoch Drive and Roe Highway East, and an extension of Fiona Wood Road through to Farrington Road.

2.3.2 MUP Development Plan (2009)

A previous development plan for the MUP was prepared in 2009 (Department of Planning and GHD, 2009). This plan allowed for a significant site development, ultimately up to 17 stories and 320,000 square metres of development floorspace, although the traffic impact of the ultimate development was not assessed in detail. The 2009 MUP plan also included extensive underground parking which is no longer considered commercially viable. To improve access to the MUP site and bypass congested South Street intersections, the 2009 MUP Business Case recommended the construction of a tunnel to provided direct access between the Freeway and the MUP car park facilities. As well as improving the capacity of the road network, the new MUP access option was proposed to increase the attractiveness and development value of the MUP site.

2.3.3 MAC – Assessment of Transport Impacts (2010)

The *Murdoch Activity Centre – Assessment of Transport Impacts (*ARRB, 2010*)* was based on a smaller scale of the 2009 MUP development plan. For the MUP site, the ARRB study included 1,975 jobs and 935 residents by 2021 and ultimately 3,970 jobs and 1,870 residents by 2031 (compared to an ultimate supply of 4,800 jobs and 1,100 dwellings for the current MUP plan). This report included a 60 per cent public transport, walking and cycling

mode share for the MUP site. The assessment tested additional transport network options to improve the long term regional road capacity, including the extension of Roe Highway to form a new southern Freeway connection and the grade separation of Murdoch Drive and South Street intersection. One of the major transport recommendations from this report was to constrain future car parking across the MAC to balance the future traffic demand and the available road network capacity, and to achieve the target public transport mode share. The recommendations on the long term (2031) transport network capacity formed the basis of the proposed maximum parking cap of 17,000 non-residential bays across the MAC area outlined in the *Murdoch Activity Centre Interim Access and Parking Policy* (WAPC, 2011).

2.3.4 MUP Access Study (2011)

In 2011, a more detailed study of the potential benefits for constructing a direct tunnel link between the MUP and Kwinana Freeway was undertaken (*MUP Access Study,* AECOM, 2011). The tunnel options provided direct access to and from the MUP and the northbound Freeway corridor. Other network improvement options considered in this study were southern connections between Murdoch Drive and the Freeway (connection to the Freeway only, as well as options connecting to the Freeway and east to Roe Highway) and a 'right turn' out of the MUP site from Fiona Wood Road onto South Street. The study outcomes recommended the construction of the southern connection to the Freeway and Roe Highway and the 'right turn' from Fiona Wood Road to South Street instead of the MUP tunnel construction, as these options were likely to deliver greater congestion benefits. However the study noted the design feasibility of the 'right turn' from Fiona Wood Road needed to be confirmed through further investigation.

2.3.5 MAC Public Transport Master Plan (2010)

The *Murdoch Activity Centre Public Transport Master Plan* (Worley Parsons, 2010) focused on the future demand for public transport services. The Main Roads Regional Operations Model (ROM) used in the other MAC traffic studies does not explicitly incorporate public transport movements, and an empirical model formula was used to forecast the future public transport demand. The Worley Parsons study was based on the MAC A proposed road network (including the extension of Fiona Wood Road to Farrington Road and a partial southern connection to the Freeway from Murdoch Drive). The study included a 35 per cent mode share for public transport (15 per cent for walking and cycling), and an ultimate of 4,000 jobs and 2,000 dwellings in the MUP site (similar to the ARRB study). The Worley Parsons study assumed the retention of the existing public transport network, allowing for increased services and new bus routes to meet the forecast future MAC demand. The study recommended the construction of a transit link from the MAC to Murdoch Station (via the MUP) as a priority, with public transport priority over general traffic along the transit link. The study also recommended consideration of car parking revenue as a funding source for future public transport initiatives.

2.3.6 MUP Traffic Modelling (2012)

In 2012, a number of recent traffic impact studies were undertaken to test different MUP street network options, FSH and SJOGH parking management and development options, and the Murdoch Station Park n Ride relocation options (Urbsol 2012a, 2012b and 2012c). The studies were based on a detailed Commuter model for the MUP and adjacent hospital precinct, and have been informed by the current MAC structure planning process and recent development plans for the MUP site. The regional road network included in the Commuter modelling incorporates recent network improvements (Kwinana Freeway widening, South Street and Murdoch Drive intersection widening), however did not include network improvement options that were recommended in previous studies but uncommitted at the time, namely the southern connection of Murdoch Drive to Kwinana Freeway and Roe Highway, and the southern extension of Fiona Wood Road to Farrington Road.,

2.3.7 MUP Transport Assessment (2013)

The previous development plan for MUP was prepared in 2013, Traffic analysis undertaken for this Transport Assessment was based on the Commuter modelling undertaken by Urbsol in 2012 to assess the operation of the wider area and external road network, with SIDRA used to assess the individual operation of key intersections within the vicinity of the MUP,

2.3.8 Murdoch Activity Centre Transport Assessment (2015)

AECOM, in collaboration with Flyt, is currently undertaking a transport study for the Department of Transport for the wider MAC study area, including traffic modelling for 2031, and reviews of the Car Parking Policy and Public Transport Master Plan. This study uses a three-tiered approach to modelling for the activity centre, with macroscopic modelling being undertaken using the Department of Transport's strategic model STEM, mesoscopic modelling using SATURN and microscopic modelling using Commuter. The 2031 project road network being

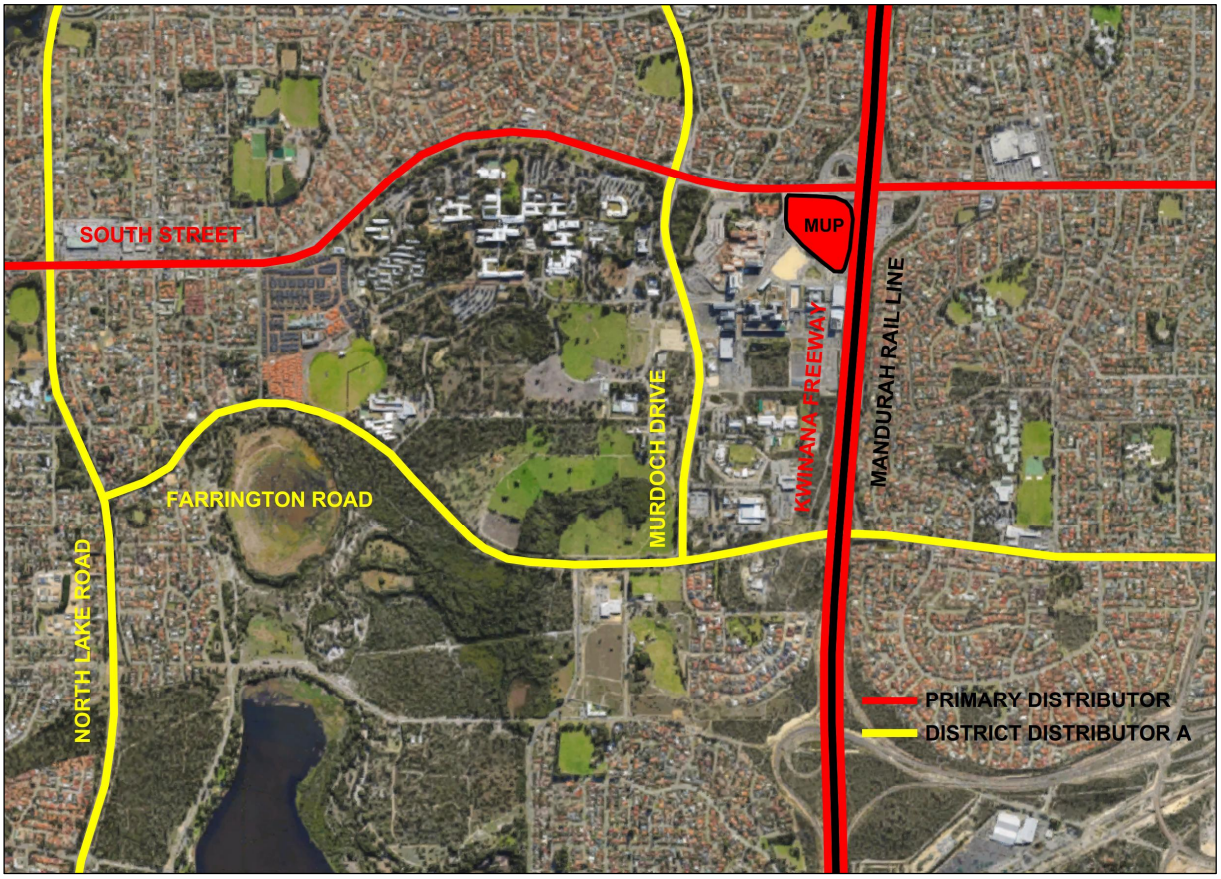
modelled includes the extension of Roe Highway and the associated southern connection to Murdoch Drive, as well as the southern extension of Fiona Wood Road through to Farrington Road,

3.0 Vehicle Movement and Access

The MUP site is located adjacent to the complex Murdoch Station, South Street and Kwinana Freeway interchange as illustrated in **Figure 7**. The MUP site is undeveloped, except for the Murdoch Station Park n Ride facility (to be relocated in Stage 2).

The proposed internal street network for the ultimate MUP development is detailed in this section. The proposed connectivity between the MUP and the regional road network is also outlined in this section, and the MUP integration with adjacent developments and road network improvement projects.

Figure 7 Regional/District Road Network around MUP



3.1 Internal Network

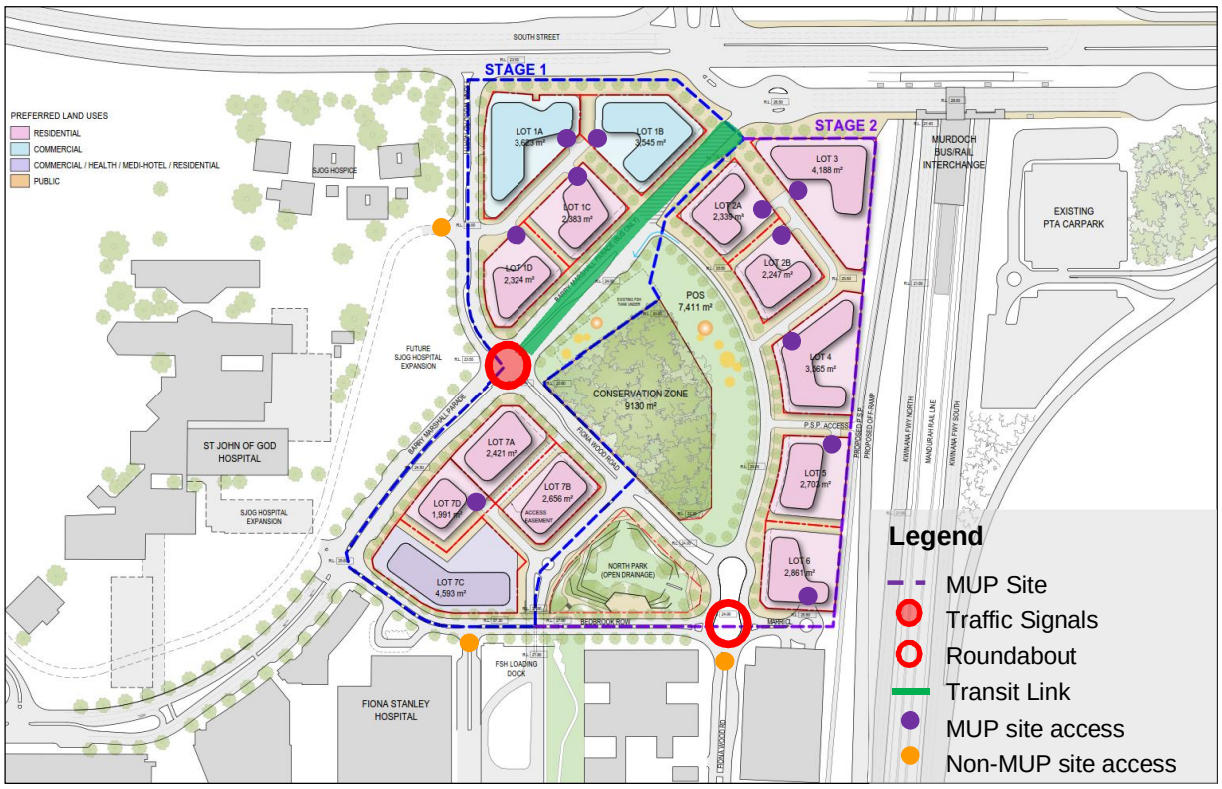
The MUP street network and indicative site access points are illustrated in **Figure 8**. The proposed street network is characterised by the main transit and vehicle through-route along Barry Marshall Parade, with a dispersed, slower street network radiating from the local distributor roads south of Barry Marshall Parade, namely Fiona Wood Road and the arc road east of the conservation zone (referred to as Road 1). The intent of the street network is to provide an efficient transit link through the site linked directly to Murdoch bus and rail interchange, and connecting through to FSH, SJOGH and other key MAC trip generators to the west. Barry Marshall Parade also provides a sightline between the station, FSH and SJOGH with active, landscaped street frontage encouraging pedestrian movements between these key activities.

The MUP internal road network compliments the pedestrianised, people-focused centre of MUP. Road 1 in particular, is unlikely to attract through-traffic, instead trafficked by slower speed vehicles accessing MUP development sites.

It is likely that Bedbrook Row will carry larger volumes of traffic, as it provides access to the FSH staff and visitor car parks. Bedbrook Row includes central islands to assist with traffic flow and pedestrian crossing movements.

The remaining internal MUP roads are characterised as short, low volume streets providing access to specific development sites.

Figure 8 MUP Street Network and Indicative Site Access



Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

3.1.1 MUP Street Network Intersection Control

Barry Marshall Parade provides the primary traffic route to and from the MUP network. The intersection with Fiona Wood Road is signalised, with the signals including pedestrian phases and bus pre-emptive priority phases.

The Barry Marshall Parade / Bedbrook Row intersection is proposed to remain unsignalised. Bedbrook Row provides access to FSH drop-off visitor parking and to the major staff and visitor car parks off Fiona Wood Road South. The intersection of Bedbrook Row and Fiona Wood Road South is proposed to remain controlled as a single-lane roundabout.

The predicted performance of the intersections during peak times are detailed in **Section 6.0**.

3.1.2 Emergency Vehicle Routes

The primary emergency vehicle route to Fiona Stanley Hospital does not intercept the MUP street network as it is via Murdoch Drive and Robin Warren Drive. There is a contingency Hospital emergency access agreed in principle with the Public Transit Authority (PTA) if access along South Street or Murdoch Drive is restricted. This contingency route is through Murdoch Station bus and rail interchange onto Barry Marshall Parade, Bedbrook Road and Fiona Wood Road (south). The proposed Barry Marshall Parade transit link will enable this contingency access route, with emergency vehicles able to use the priority bus lanes (and pre-emptive priority signals).

3.1.3 Service Vehicle Routes

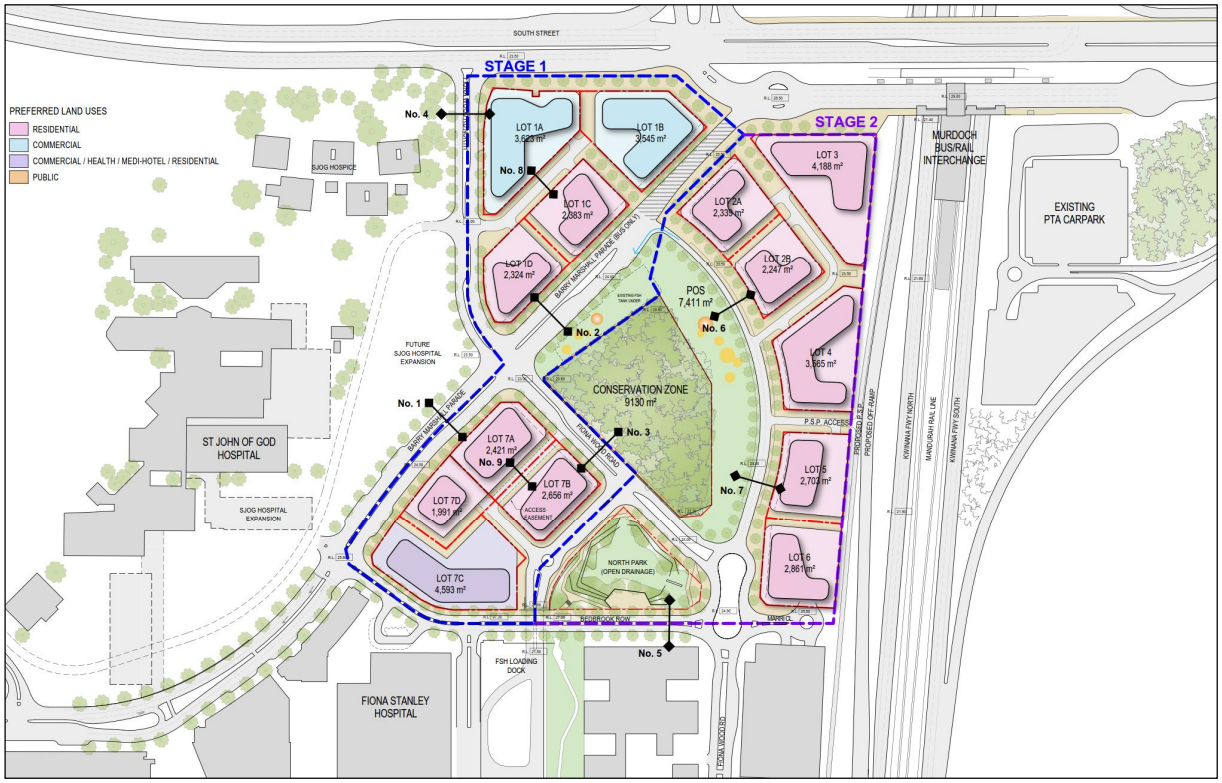
The main service vehicle access for FSH is via a service road off Bedbrook Row located within Site 7, providing access to the FSH underground car park. The FSH car park is designed primarily for 12.5 metre long delivery vehicles, and also caters for less frequent semi-trailer access. This service road is designed for these service vehicles. Other streets within the MUP development allow for larger service vehicles (semi-trailers) access, assuming these will be infrequent movements permissible without being lane correct.

3.2 Road Design

Typical cross-sections for the MUP streets are detailed in this section. These are taken from drawings issued by BG&E (*Drawing CSK400 Revision A*). The cross-section of the major access roads (Fiona Wood Road North, Barry Marshall Parade and Bedbrook Row) are designed to provide adequate intersection capacity to meet the predicted peak hour traffic flows detailed in Section 6. The cross-sections for the smaller access roads are designed to encourage slower speed traffic accessing local on-street or off-street parking facilities. A maximum speed limit of 40 kilometres per hour (km/h) is proposed for all roads within the MUP network to facilitate the safe integration of all road users.

The location of each cross-section is shown in **Figure 9**.

Figure 9 Location of Cross-sections

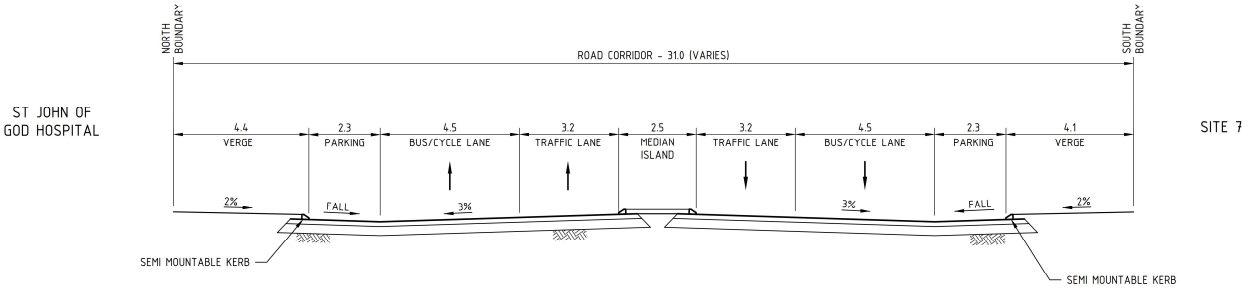


Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

3.2.1 Barry Marshall Parade

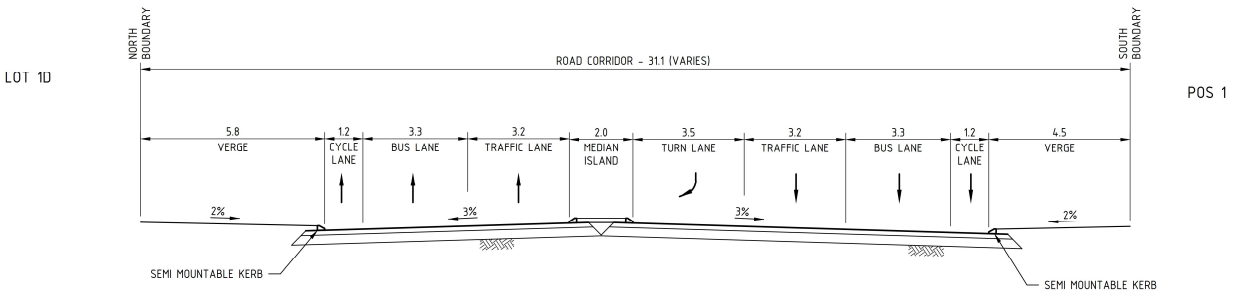
The existing cross-section for Barry Marshall Parade south and north of Fiona Wood Road are shown in **Figure 10** and **Figure 11** respectively. The road includes wide footpaths, dedicated cycle lanes and a median. South of Fiona Wood Road, Barry Marshall Parade has a single traffic lane, a shared bus/cycle lane and on-street parking in both directions. North of Fiona Wood Road, the road is a bus only link, with a dedicated bus lane provided in both directions. Traffic lanes are also provided to allow for future access to the MUP Stage 2 development. The intersection layouts are functional for a local road through a major activity centre, which encourages pedestrian permeability and local access.

Figure 10 Cross-section 1: Barry Marshall Parade – South of Fiona Wood Road



EXISTING - BARRY MARSHALL PARADE
(SOUTH OF FIONA WOOD ROAD)

Figure 11 Cross-section 2: Barry Marshall Parade – North of Fiona Wood Road

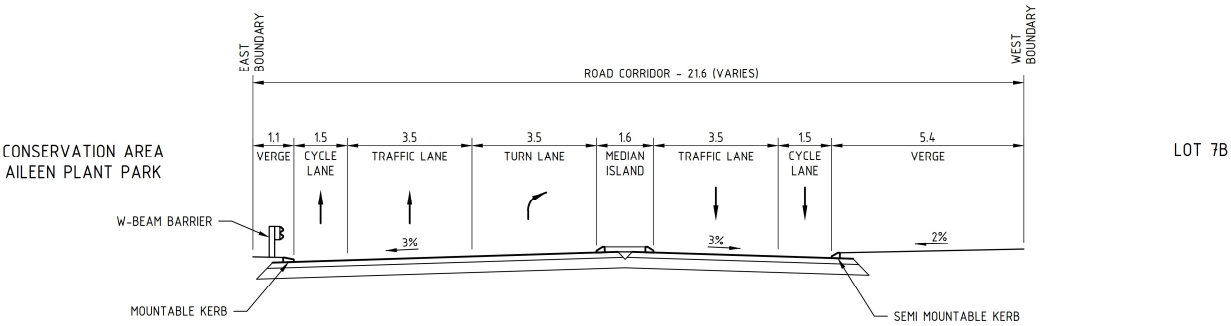


EXISTING - BARRY MARSHALL PARADE
(NORTH OF FIONA WOOD ROAD)

3.2.2 Fiona Wood Road

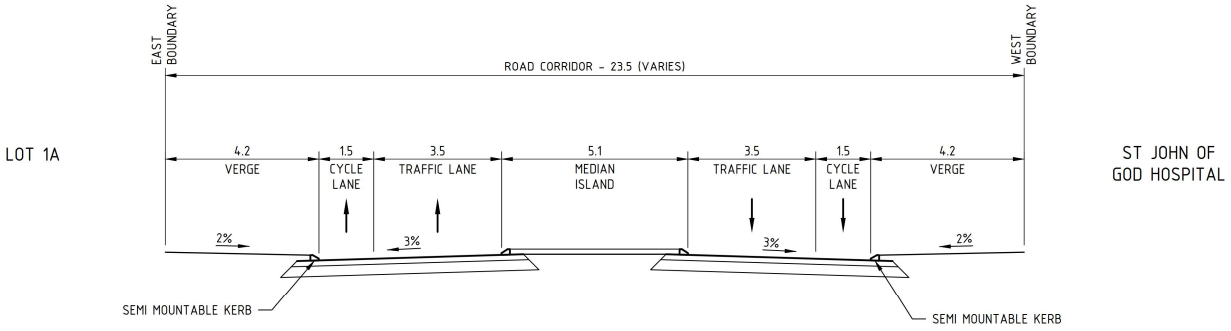
The existing cross-sections for Fiona Wood Road south of Barry Marshall Parade and north of Barry Marshall Parade are illustrated in **Figure 12** and **Figure 13** respectively. These include wide footpaths on the north section and a dedicated cycle lane. Two lanes are provided in the southeast bound direction (travelling towards Bedbrook Row), providing a safe access lane into Site 7.

Figure 12 Cross-section 3: Fiona Wood Road – South of Barry Marshall Parade



EXISTING - FIONA WOOD ROAD
(SOUTH OF BARRY MARSHALL PARADE)

Figure 13 Cross-section 4: Fiona Wood Road– North of Barry Marshall Parade

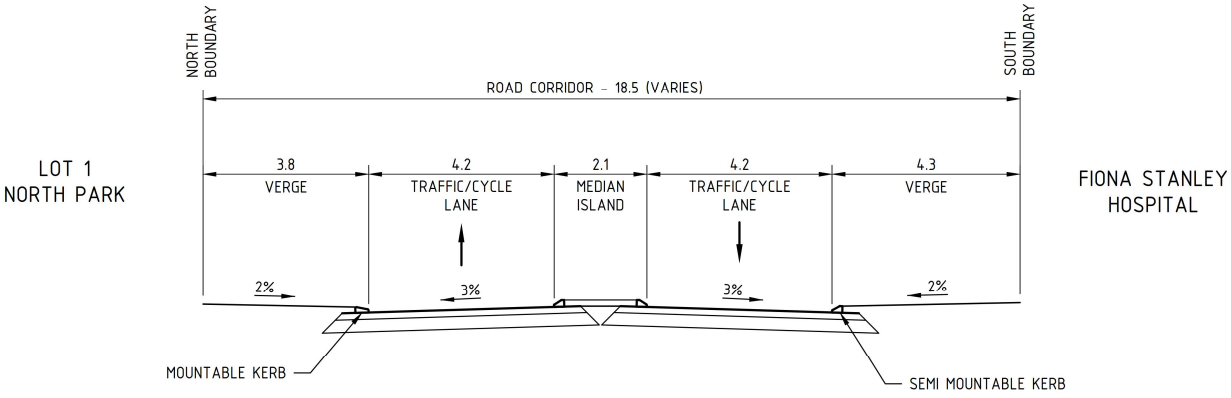


EXISTING - FIONA WOOD ROAD
(NORTH OF BARRY MARSHALL PARADE)

3.2.3 Bedbrook Row

The existing cross-section for Bedbrook Row is illustrated in **Figure 14**. The road has one shared traffic and cycle lane in each direction, with wide verges and a median provided for crossing pedestrians.

Figure 14 Cross-section 5: Bedbrook Row – Approach to Barry Marshall Parade

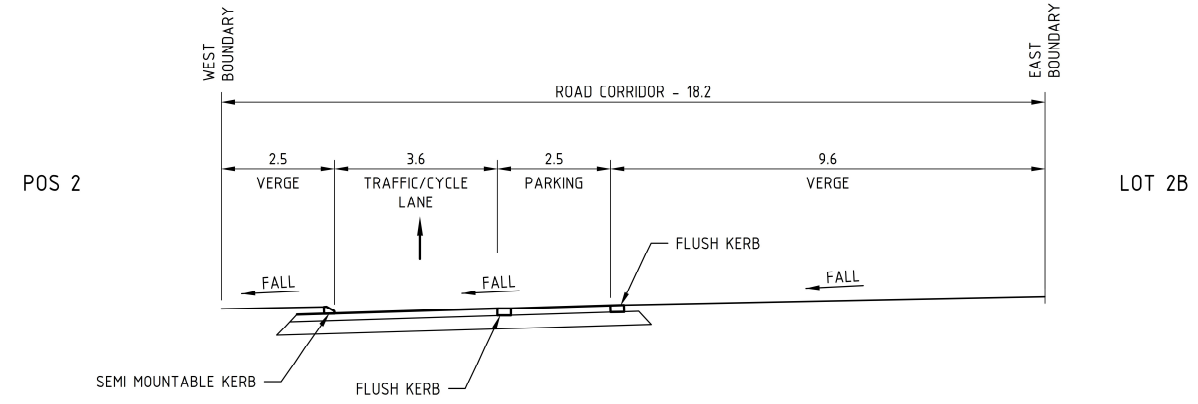


EXISTING - BEDBROOK ROW

3.2.4 Road 1

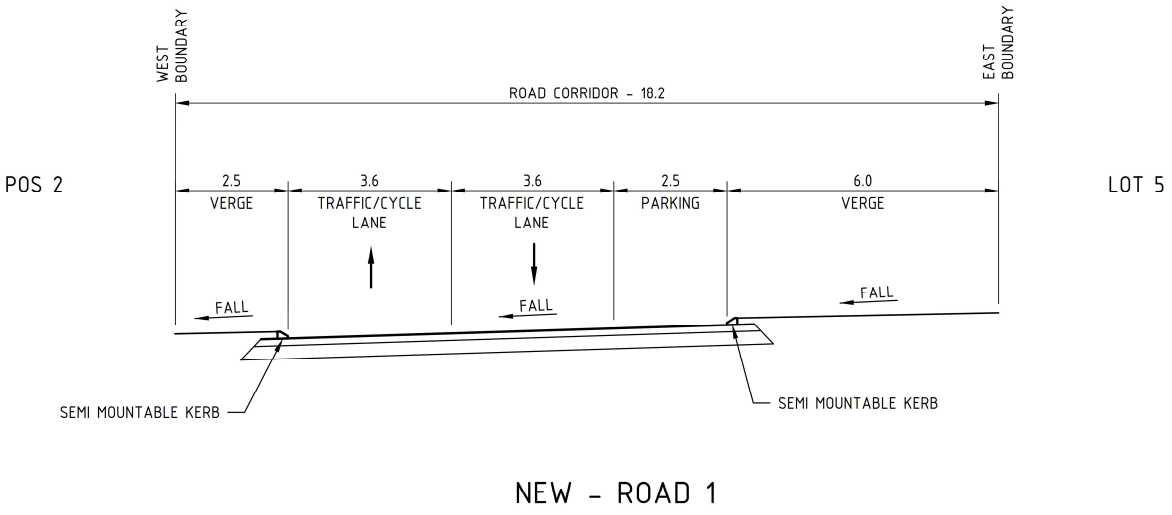
The proposed cross-sections for the north and south sections of Road 1 are illustrated in **Figure 15** and **Figure 16**. The northern section is one way only, consisting of a shared traffic and cycle lane directing traffic northbound onto Barry Marshall Parade. The southern section has one shared traffic and cycle lane in each direction, permitting access onto Fiona Wood Road and Bedbrook Row. The slow-speed road environment will support more confident cyclists sharing the traffic lanes with vehicles. On-street parking is proposed to be provided along Road 1.

Figure 15 Cross-section 6: Road 1 North



NEW - ROAD 1

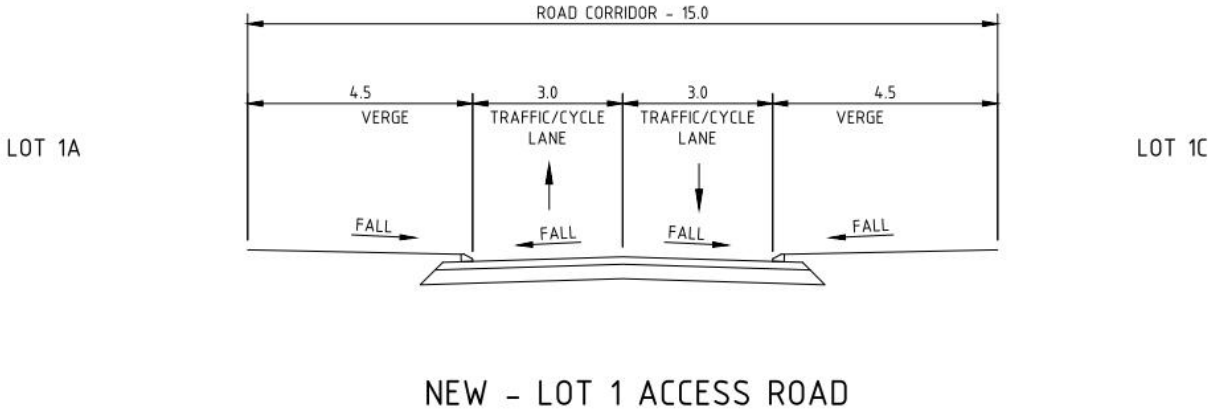
Figure 16 Cross-section 7: Road 1 South



3.2.5 Lot 1 Access Road

The proposed cross-section for the access road to Lot 1 is illustrated in **Figure 17**. The road reserve is 13.0 metres wide with a shared traffic/cycle lane in each direction, given the low volumes and slow-speed environment expected on this access road.

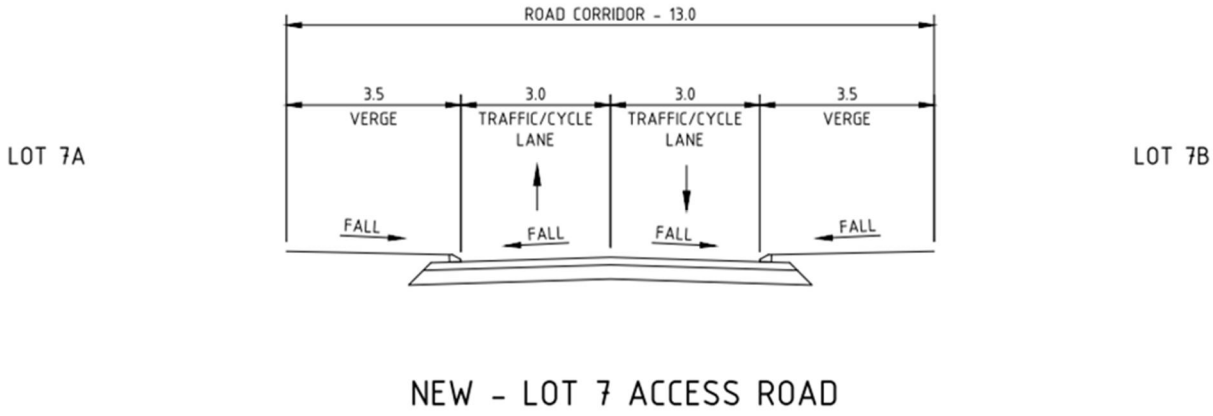
Figure 17 Cross-section 8: Lot 1 Access Road



3.2.6 Lot 7 Access Road

The proposed cross-section for the access road to Lot 7 is illustrated in **Figure 18**. The road reserve is 15.0 metres wide with a shared traffic/cycle lane in each direction, given the low volumes and slow-speed environment expected on this access road.

Figure 18 Cross-section 9: Lot 7 Access Road



3.3 Integration with the External Network

A number of traffic studies have previously been undertaken to assess existing and future capacity constraints on the regional road network surrounding the MUP, as outlined in Section 2.3. These traffic studies considered the impact of more significant traffic generators within MAC (FSH, SJOGH) as well as the MUP development.

There have been a number of upgrades to the road network in the vicinity of MUP in recent years. These include:

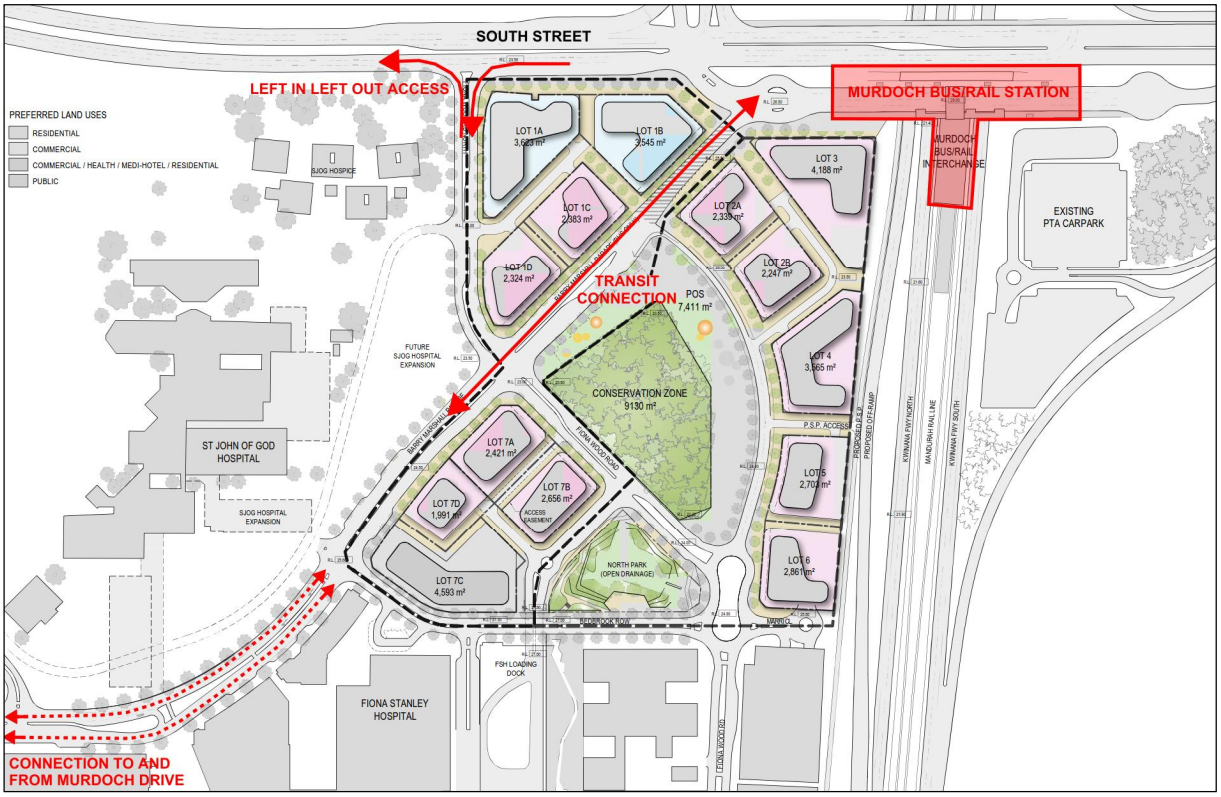
- ***Widening of the Kwinana Freeway (Leach Highway to Roe Highway) – completed in 2013***: The project involved widening Kwinana Freeway to three lanes in each direction between Leach Highway and Roe Highway.
- ***Relocation of the Kwinana Freeway northbound to South Street off-ramp – completed in 2013***: The off-ramp was relocated to access South Street from the north side to allow for construction of the transit connection from Barry Marshall Parade to Murdoch rail / bus interchange. This will also enable future development of Stage 2 of MUP.
- ***Murdoch Drive / South Street intersection upgrade – completed in 2014***: Widening of the whole intersection was undertaken to provide an additional right turning lane from Murdoch Drive northbound onto South Street eastbound (for traffic exiting the MUP / MAC heading towards the Freeway and eastern South Street catchments), and an additional right turning lane from South Street eastbound onto Murdoch Drive northbound.

The upgrade of the Murdoch Drive / South Street intersection in particular has seen a significant reduction in the level of congestion experienced in the peak periods. However, there are still a number of pinch points in the road network, particularly the Kwinana Freeway / South Street interchange and the Murdoch Drive / Farrington Road roundabout.

3.3.1 MUP Access to the External Road Network

The main MUP access points are Fiona Wood Road and Barry Marshall Parade, as illustrated in **Figure 19**.

Figure 19 MUP External Road Access Points



Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

Fiona Wood Road (north) provides a left in, left out access between the MUP and South Street, servicing traffic exiting the freeway, traffic coming from catchments east of Kwinana Freeway and exiting traffic heading west. Fiona Wood Road is a main entrance, with a signalised intersection with Barry Marshall Parade placed to provide adequate queuing space for traffic heading into the MUP and west to FSH.

Barry Marshall Parade links FSH, SJOG and the MUP to Murdoch Drive, a district distributor road. This provides a connection to western catchments via South Street as well as northern and southern catchments within the City of Melville and City of Cockburn. The intersection of Murdoch Drive and South Street, which has recently been upgraded, accommodates all other movements not possible at the Fiona Wood Road north left in, left out access.

The impact of the MUP traffic on the traffic flows along South Street, Murdoch Drive and at the Freeway interchange is discussed in **Section 6.0**.

3.4 Road Network Improvement Opportunities

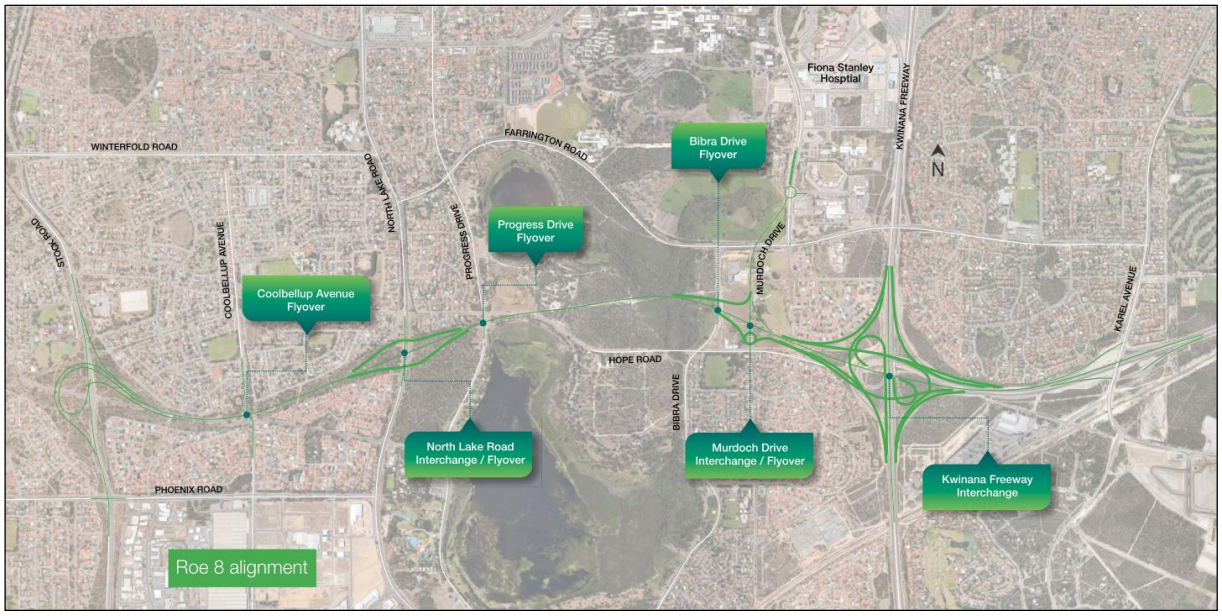
There are several options identified in many of the MAC transport studies which could improve the long-term road network capacity adjacent to the MUP site.

3.4.1 Perth Freight Link (Roe 8 and Southern Connection)

At this stage the State Government has committed to the Perth Freight Link Section 1 road upgrade, which includes the extension of Roe Highway (Roe 8) and a new connection to Murdoch Drive (southern connection), as shown in **Figure 20**.

The extension of Roe Highway would provide regional benefits for freight movements in addition to the connectivity benefits for the Murdoch area. The southern connection will provide an additional Freeway access option for vehicles from the southern catchment, directing traffic away from and easing pressure on the South Street corridor and the congested Freeway interchange.

Figure 20 Perth Freight Link Section 1 (Roe 8)



Source: Main Roads Projects – Roe Highway Extension

3.4.2 Southern Extension of Fiona Wood Road to Farrington Road

Previous studies of the long-term MAC road network have included the extension of Fiona Wood Road south to Farrington Road with the replacement of the existing Kwinana Freeway northbound on-ramp at Farrington Road with a new loop ramp. This link road would provide an additional access route from the MUP and FSH onto the northbound freeway corridor via Farrington Road. This could potentially divert traffic away from Barry Marshall Parade, Murdoch Drive and South Street relieving peak hour congestion and delay, and reducing conflict with the transit and pedestrian priorities of the MUP network.

The construction of this road is identified as a priority for the medium-term (by 2021) in the Murdoch Specialised Activity Centre Structure Plan report.

4.0 Public Transport Movement

The MUP is being developed to capitalise on the ease of access to Murdoch Station, with a target for public transport to be used for a larger proportion of trips (40 per cent) than driving a vehicle (around 35 per cent of trips). The proposed infrastructure connections and initiatives to encourage public transport use for the MUP are outlined in this section.

4.1 MUP objectives and mode share target

The relevant MUP objectives for public transport access are:

- Provide easy and safe access to the bus / rail interchange.
- Promote public transport by providing easy, regular and convenient connections.
- Modal split target: 40 per cent Public Transport.
- Transitions from a transit 'Origin' to a 'Destination' over time.

The target public transport mode share of 40 per cent is considered feasible due to the proximity of MUP to Murdoch Station and the public transport and parking measures outlined in the following sections. This target is consistent with the proposed 40 per cent public transport mode share across the MAC site.

Each site in the MUP is located at a distance of 400 metres or less from Murdoch Station, well within the 800 metre walking catchment, providing an opportunity for the site to be transformed as a Transit Orientated Development (TOD). A general objective of TOD is to increase the residential density within a 10 minute walk (800 metres) of major bus or train stations (*DCP 1.6 Planning to Support Transit Use and Transit Orientated Development,* WAPC, 2006*)*. A particular focus for this TOD is to grow the precinct into a destination (rather than origin) of public transport trips. To achieve this objective a large proportion of the MUP site is to be allocated to commercial activities and supporting retail / hospitality uses (forecast 2,430 jobs). These MUP activities could generate counter flow peak trips on the rail network, assisting to create a more balanced rail demand and achieving broader PTA objectives.

The MUP will provide an additional 910 to 1,230 residential dwellings within the station walking catchment, depending on whether a medium or high yield scenario is developed. This will almost double the current number of residential dwellings within the walkable catchment[1] but will not add a significant demand for peak hour departures compared to the overall boardings for the Mandurah rail line (a total of almost 40,000 boardings per day in 20131). It is assumed the long-term peak period capacity will increase through the purchase of additional railcars as outlined in the *Draft Public Transport for Perth in 2031 (*DoT, 2011*).* In addition, a number of the residential dwellings are targeted at the local student population and local MAC employees, minimising the peak hour demand for residents commuting to other activity centres.

4.2 Existing Network

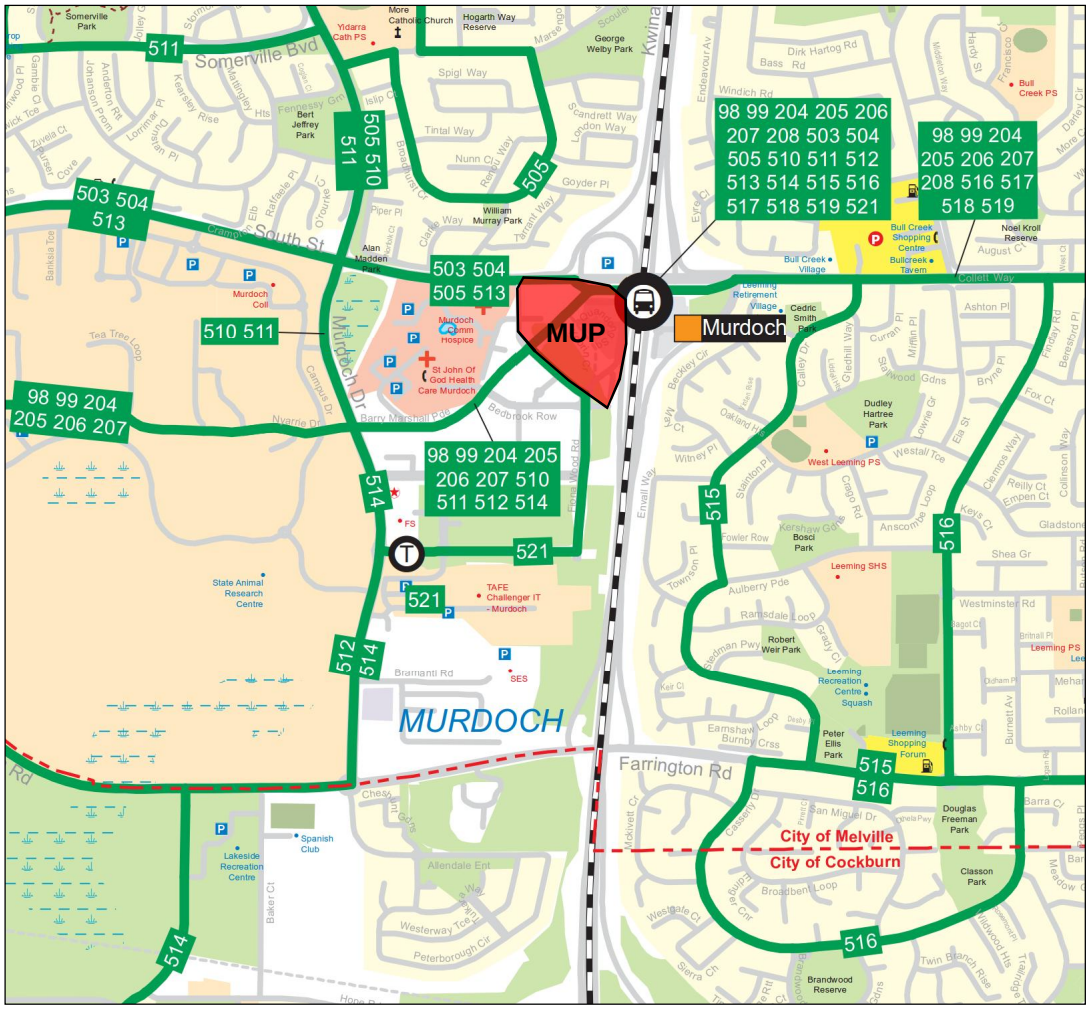
The Murdoch MUP is well serviced by the public transport network, being located adjacent to Murdoch Station, the busiest Transperth interchange outside the Perth CBD. Murdoch Station is serviced by the Mandurah train line, which runs between Perth and Mandurah with an average five minute frequency during peak hours, and every 15 minutes in the afternoons and evenings. The placement of Murdoch station in the centre of a large transport interchange currently reduces the number of people living within the walking or cycling catchment area, with the majority of rail passengers currently arriving by car (30 per cent) or bus (60 per cent) (*Presentation by Peter Martinovich, 2011 SMART Urban Transport Conference*).

Reflecting the important role of bus feeder routes to the Murdoch Station rail patronage, the interchange is well serviced by 21 bus routes, illustrated in **Figure 21**. These buses connect Murdoch to a number of suburbs including Bull Creek and Booragoon to the north, Cannington, Thornlie, Maddington, Willetton, Southern River and North Harrisdale to the east, Jandakot and Cockburn Central to the south and Fremantle to the west. In

[1] Based on a total catchment of 40,000 dwellings for Murdoch Station of which 95% are within the walkable catchment (*Presentation by Peter Martinovich, 2011 SMART Urban Transport Conference*)

addition, the buses include routes 98 and 99 (Circle Route) which travel a ring route through the middle suburbs around the CBD, including centres as far north as Stirling. Overall frequencies in the peak periods average approximately three minutes to the northern and eastern suburbs and two minutes to the southern and western suburbs. However this bus frequency can be misleading as the low density nature of the residential catchment means the majority of people rely on individual bus routes servicing specific suburbs rather than having the option to catch a variety of buses serving the major distributor roads. Traffic delay at peak times reduces the level of service for bus passengers, particularly along South Street on the western approach to the station.

Figure 21 Public Transport Network



Source: Transperth Network Map

A large proportion of rail passengers also currently arrive at the station by car (30 per cent of passengers). There are three existing at-grade Park n Ride facilities surrounding Murdoch Station (providing almost 1,200 bays). For the MUP Stage 2 development to progress, the western car parks (810 bays) must be relocated to another site or below the new MUP development. The relocation is constrained by the feasibility and cost of providing underground car parking at the MUP site, and the impact of Park n Ride movements on the peak traffic flow at the congested South Street and Freeway interchanges.

4.3 Proposed Network

Accentuating the ease and benefits of rail access to the site has been a focus of the MUP design. Providing attractive, efficient bus access for residential catchments to the east and west of the MUP site (not serviced by rail) is also a key consideration, with the proposed bus priority (and potential LRT) link forming the backbone of the MUP street network design.

4.3.1 Transit Link along Barry Marshall Parade

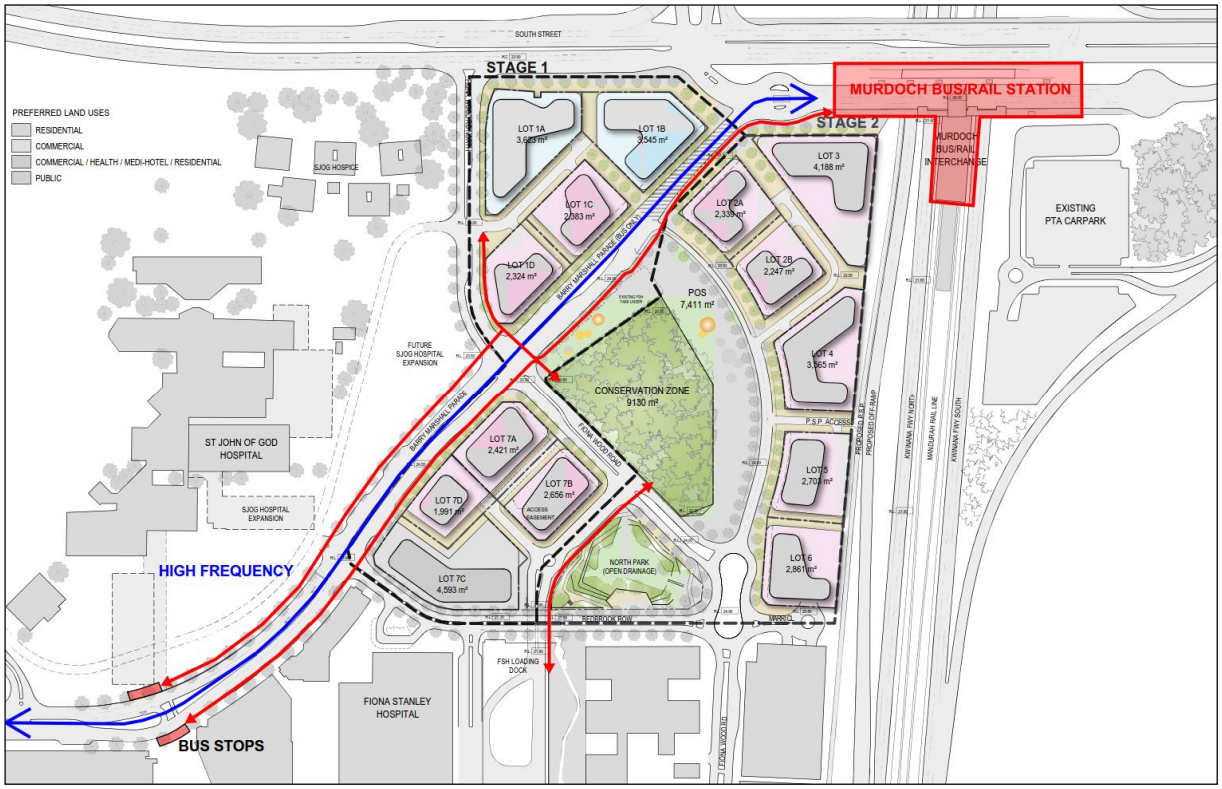
The configuration of Barry Marshall Parade prioritises public transport movements through the MUP site. Bus lanes are provided, with a transit only link through to the interchange at Murdoch Station. Bus priority at the signalised intersections (pre-emptive bus signals) along Barry Marshall Drive has recently been incorporated to further minimise delay for bus passengers. The bus stop locations on Barry Marshall Parade were selected to minimise the distance and major road crossings for the key generators of FSH and SJOGH. People visiting or living in the MUP are within a 400 metre walk of either the Barry Marshall Parade bus stops or Murdoch Station bus interchange.

As shown in **Figure 21**, a large proportion of bus routes accessing Murdoch Station were rerouted through the MUP site, taking advantage of the bus priority measures along Barry Marshall Parade and its direct link to the bus / rail interchange. Through this, it is envisioned that Barry Marshall Parade would form part of the future Rapid Bus Transit network identified in the draft *Public Transport for Perth in 2031* plan and Murdoch Specialised Activity Centre Structure Plan (2014). This transit link provides the potential to significantly improve public transport access to MUP and the broader MAC area from the eastern and western catchment areas (with Main Roads WA strategic ROM model for the precinct assuming over 40 per cent of MUP car trips are generated by eastern and western catchment areas, *AECOM 2011*).

4.3.2 Pedestrian Connections to Bus and Rail Network

Attracting passengers from Murdoch Station to the MUP, and vice versa attracting MUP (and the adjacent FSH and SJOGH) commuters and visitors to travel by rail or bus are objectives embedded in the MUP design process. To achieve this several direct pedestrian links are provided between MUP and Murdoch Station, illustrated in **Figure 22**.

Figure 22 Pedestrian-Public Transport Connections



Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

Barry Marshall Parade provides a direct pedestrian (and bus) link to Murdoch Station. The streetscape is designed to provide a continuous sightline to Murdoch Station along with shaded footpaths activated by retail and hospitality activities.

The proposed PSP Access will provide a direct pedestrian link between the centre of the MUP and the proposed Kwinana Freeway PSP. The access is designed to provide a continuous sightline to the conservation zone, and is likely to encourage commuters using the PSP to visit the MUP

4.4 Public Transport Opportunities

4.4.1 Future Light Rail Transit Link

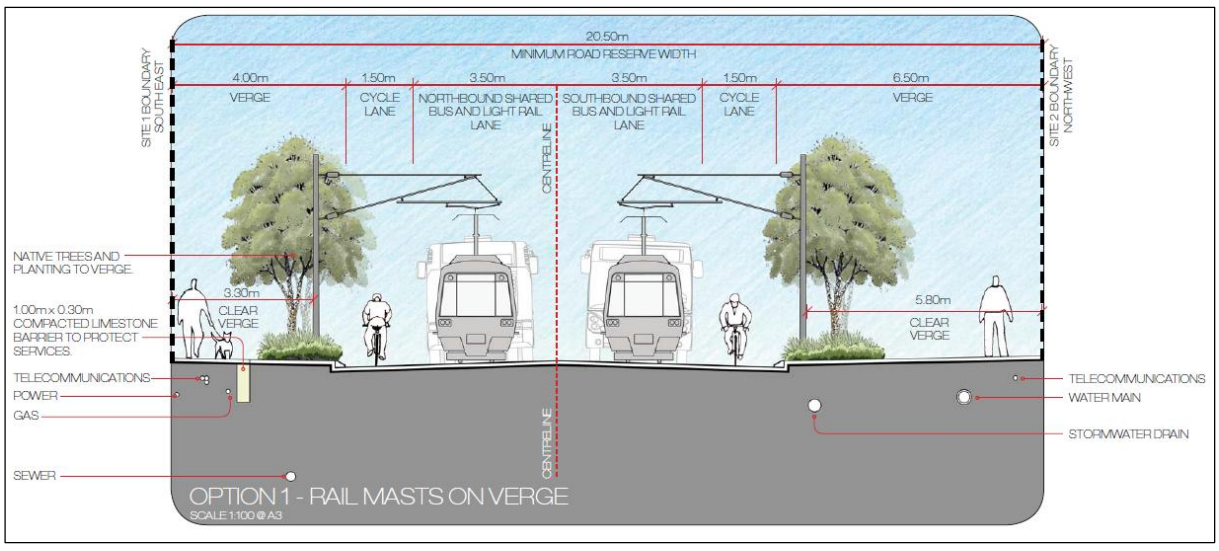
A proposed LRT system through to Murdoch could replace the east-west Rapid Bus Transit route between Fremantle and Cannington via Murdoch Station currently proposed under the *draft Public Transport for Perth in 2031* plan. This would create an attractive, efficient link between Murdoch and other strategic health and tertiary education centres, and greatly improve public transport access to MUP and MAC from eastern and western residential catchments not currently serviced by rail. Such a LRT link would greatly assist with exceeding a 40 per cent mode share for the MAC public transport trips.

Whilst further planning is required to determine the economic feasibility and preferred alignment of a LRT system through the MAC, the transit link along Barry Marshall Parade has been designed to accommodate LRT. The northern section of Barry Marshall Parade (north of Fiona Wood Road) will only provide for transit, cycling and pedestrian movements with a minimum road reservation of 21 metres. This is sufficient to provide LRT, cycle lanes and wide footpaths, as illustrated in **Figure 23**. If required, additional clearance between the cycle and LRT lanes can be provided by reducing the verge width.

Along the remaining section of Barry Marshall Parade which is shared with other traffic, a minimum road reservation of around 31 metres is provided which can accommodate two light rail tracks, power poles, platform stops and footpaths. The bus lanes on Barry Marshall Parade provide some capacity for a future LRT link, although the reduction of traffic lanes is also necessary to provide continuous transit lanes (to be shared between LRT and buses). The design and impact of a light rail stop along Barry Marshall Parade would have further implications for other road and footpath users, but may not be necessary if a major LRT stop is located adjacent to the Murdoch rail / bus interchange.

The provision of a LRT link through Murdoch Station is constrained by load and space limitations on the existing bus bridge. Strengthening and widening the existing bus bridge, building a new bridge or creating an alternative link on South Street are all options which need further investigation by a joint State Government taskforce. This is outside of the MUP site and it is envisaged that State Government will prepare a concept design for the eventual redevelopment of the Murdoch Station area to accommodate this transit route (bus or light rail) and other necessary capacity changes to the station precinct that are required over the next 20 years.

Figure 23 Indicative Light Rail Options for Barry Marshall Parade Transit Link *(Emerge Associates, 2012)*



4.4.2 Free Transit Zone for MAC

Another recommended initiative is the provision of a Free Transit Zone, to encourage public transport use for shorter trips. The MUP is intended to provide many of the daily activities necessary for the broader MAC commuters and residents, making the centre self-sufficient. Whilst MUP residents, commuters and visitors will be able to walk between different activities the provision of the Free Transit Zone would encourage public transport use for people originating from MAC activities further away from the MUP centre (such as Murdoch University). Within the Perth CBD this has been particularly successful at encouraging more public transport use for business and lunchtime trips. This would not rely on the introduction of a special CAT bus service for MAC, but instead could take advantage of existing bus services rerouted along the MUP transit link. This initiative could be investigated as part of the broader MAC structure planning process.

5.0 Pedestrian and Cycling Movement

The vision of the Mixed Use Precinct is to provide a destination precinct that supports, integrates and links with the surrounding health and education uses and injects a range of complimentary business, living and community activities. Through this vision the MUP will support walking and cycling trips for local residents and commuters, as well as visitors to the two adjacent hospitals. The proposed infrastructure and initiatives to encourage people to walk and cycle within and to the MUP are outlined in this section.

5.1 MUP Objectives and Mode Share Targets

The relevant MUP objectives for pedestrian and cycling access are:

- Provide easy and safe access to the bus / rail interchange.
- Provide effective pedestrian linkages through the site.
- Strengthen pedestrian and cycle connectivity to and within the precinct.

The MUP objectives recognise the importance of attractive pedestrian links in achieving the aspirational public transport mode share target. In addition, the objectives highlight the role of the MUP to encourage walking and cycling trips to and from other major MAC activities to access a range of daily activities. The approximate 1,000 residential dwellings will be targeted at MAC employees, students and visitors (up to 82 short-stay rooms), encouraging people to live and work locally to support peak walking and cycling trips. Similar self - sufficient mixed use developments located away from the CBD are relatively untested in Perth, and as such even though there is potential for a significant number of vehicle trips to be avoided, a specific target mode share for walking and cycling has not been specified for the MUP.

5.2 Existing Network

A number of previous studies assessed the existing walking and cycling networks surrounding the MUP and broader MAC site (*Draft Murdoch Activity Centre Structure Plan B Background Report,* Hames Sharley and AECOM 2011*; Murdoch Activity Centre – Assessment of Transport Impacts,* ARRB 2010*; Murdoch Activity Centre Structure Plan A,* DPI 2007). Whilst there are reasonably well connected pedestrian networks within the surrounding suburbs, there are a number of access barriers to the MUP (and wider MAC) site. The road width, volume and speed of traffic along the major road corridors bordering the site (Kwinana Freeway, South Street, Murdoch Drive and potentially the extension of Roe Highway) present safety and perceptual barriers. These roads restrict permeability resulting in longer walking and cycling trips, and the dominance of traffic does little to attract non-vehicular traffic along or across these corridors.

For cycling, a shared path is provided along South Street; although this only continues on the northern side of the road west of Murdoch Drive with no direct access between the MUP site and Murdoch University. Dedicated bicycle lanes are provided along Murdoch Drive between South Street and Farrington Road, connecting to shared paths at both ends.

The residential area of Leeming east of Kwinana Freeway, whilst relatively close by, is disconnected from the MAC by the freeway corridor. There is no convenient walking or cycling access from the residential area to the MAC except via South Street and Farrington Road which are over 1.4 kilometres apart. In addition, this area, as well as the other residential areas north of South Street, are characterised by a cul-de-sac road neighbourhood design that reduces connectivity and increases travel distances to nearby places.

A summary of the existing cycling network surrounding the MUP site is illustrated in **Figure 24**, including the formalised crossings providing access to the MUP.

Figure 24 Existing Cycling Network



Source: Perth Bike Maps, Department of Transport (http://www.transport.wa.gov.au/activetransport/24816.asp)

5.3 Proposed Pedestrian Network

The proposed pedestrian network will provide attractive, easy access between MUP, the adjacent hospital and education activities and Murdoch Station. Focusing on these links will greatly improve pedestrian connectivity between major traffic generators within the MAC and promoting it as a transit oriented development. The proposed MUP improvements will not address the pedestrian access barriers across the major South Street and

Kwinana Freeway road corridors, but the MUP will provide new residences within walking distance of the adjacent MAC activities. Improving access to the existing suburbs is to be addressed through MAC and broader government transport initiatives.

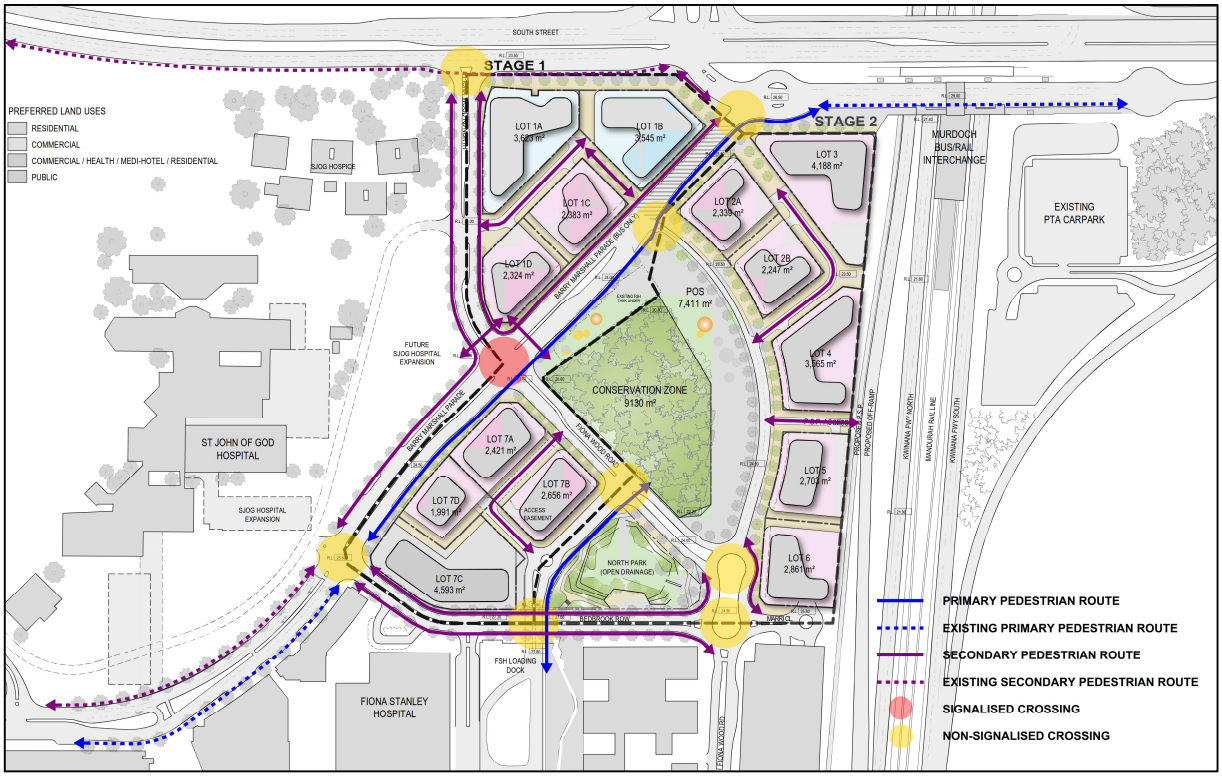
5.3.1 Pedestrian Linkages

Creating a permeable development with attractive, vibrant pedestrian links has been a key focus of the MUP development. The MUP network provides a people-focused centre around the conservation zone, with a number of green and pedestrian-cycling only connections extending from the centre. The central street network is designed to be low speed, low volume with wide footpaths, emphasising the focus on people movement through the heart of the MUP rather than vehicles. A number of pedestrian paths provided around the conservation zone, while providing a recreational purpose, also help to emphasise the pedestrian focus within the MUP. The street network provides a number of route options between Barry Marshall Parade and the MUP and adjacent FSH parking buildings, intended to disperse traffic though the lower speed, people focused areas and provide multiple pedestrian links within MUP.

Figure 25 illustrates the key pedestrian routes within the MUP and the connections to existing infrastructure:

- Pedestrian-focused streetscape along Barry Marshall Parade.
- Pedestrian paths through North Park provide critical, direct links between the MUP and Fiona Stanley Hospital.
- North Park link through to Bedbrook Row/FSH and pedestrian link to Barry Marshall Parade/SJOGH will provide a visual and attractive pedestrian link attracting people to walk between MUP and these major activities.

Figure 25 Pedestrian Linkages



Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

5.3.2 Pedestrian Crossing Opportunities

Within MUP, Barry Marshall Parade is likely to present the most conflict between pedestrian crossing movements and through traffic. To improve crossing opportunities along Barry Marshall Parade it is intended to provide parallel pedestrian crossing phases at the Fiona Wood Road signalised intersection.

With the exception of Fiona Wood Road, the remaining streets within MUP are likely to be characterised by lower volumes of slow moving traffic with a narrow carriageway design. Formal pedestrian crossing facilities are unlikely to be needed along these streets.

5.3.3 Pedestrian Network Opportunities

Creating a self-sufficient centre

A self-sufficient centre is one where residents can live, work and play, being able to access a range of daily activities and needs without travelling outside the centre. The MUP offers an opportunity to achieve this within the broader MAC area. Ensuring that the public realm offers a range of activities will attract users to the MUP from 6am-10pm, every day of the week. Creating after-hours activity will be particularly important, catering for early morning or late evening commuters who need to move through the MUP to access relocated park 'n' ride facilities, attracting hospital shift workers to visit during shift breaks or to commute by non-car modes to and from work, and attracting students who could reside in the MUP or visit to socialise and access Murdoch Station. The safety of walking and cycling routes will be strongly influenced by the provision of passive surveillance, as well as the provision of lighting and continuous networks connecting to the broader MAC area and adjacent activities.

Providing a pedestrian bridge from Murdoch Station Park n Ride to MUP and Leeming / Bull Creek

One identified measure to overcome the connectivity barriers is the provision of a new pedestrian and cycle link between the MUP and the Leeming residential area east of the Freeway (SKM 2007, Department of Planning and GHD 2009), as proposed in previous development plans for MUP. As well as increasing walking opportunities to the MUP, this connection could also increase walking and cycling trips for FSH and SJOGH commuters living in these existing eastern suburbs. The cost of this infrastructure is likely to delay implementation until the MUP site is at a later development stage, and this initiative could be considered as part of the PTA Park n Ride relocation and MAC structure planning process.

Improving pedestrian connections across to northern side of South Street and across Murdoch Drive

South Street, as a high speed and high volume traffic route, presents a significant barrier for pedestrians wishing to cross between the MUP and the residential catchment north of the road. As the MUP is envisaged to be a key destination for residents in Murdoch and the surrounding area, it is essential that sufficient safe and efficient pedestrian connections be established. The MAC strategy indicates that shared paths will be provided across Murdoch Drive connecting Murdoch University to SJOG Hospital and through to the MUP.

5.4 Proposed Cycling Network

The broader MAC strategy proposes that along high volume traffic roads, cycle routes be provided via shared paths separated from the road carriageway. Along transit routes, the road design should ensure the safe integration of the cycle network along the corridor. In other areas, where the focus is on pedestrian and cyclist movement over vehicle movement, on-road cycle lanes are proposed, which will help to lower traffic volumes and speeds, and create a safer environment for non-motorised road users. The proposed cycle facilities within MUP are integrated with existing and proposed cycle routes extending through the MAC and surrounding suburbs.

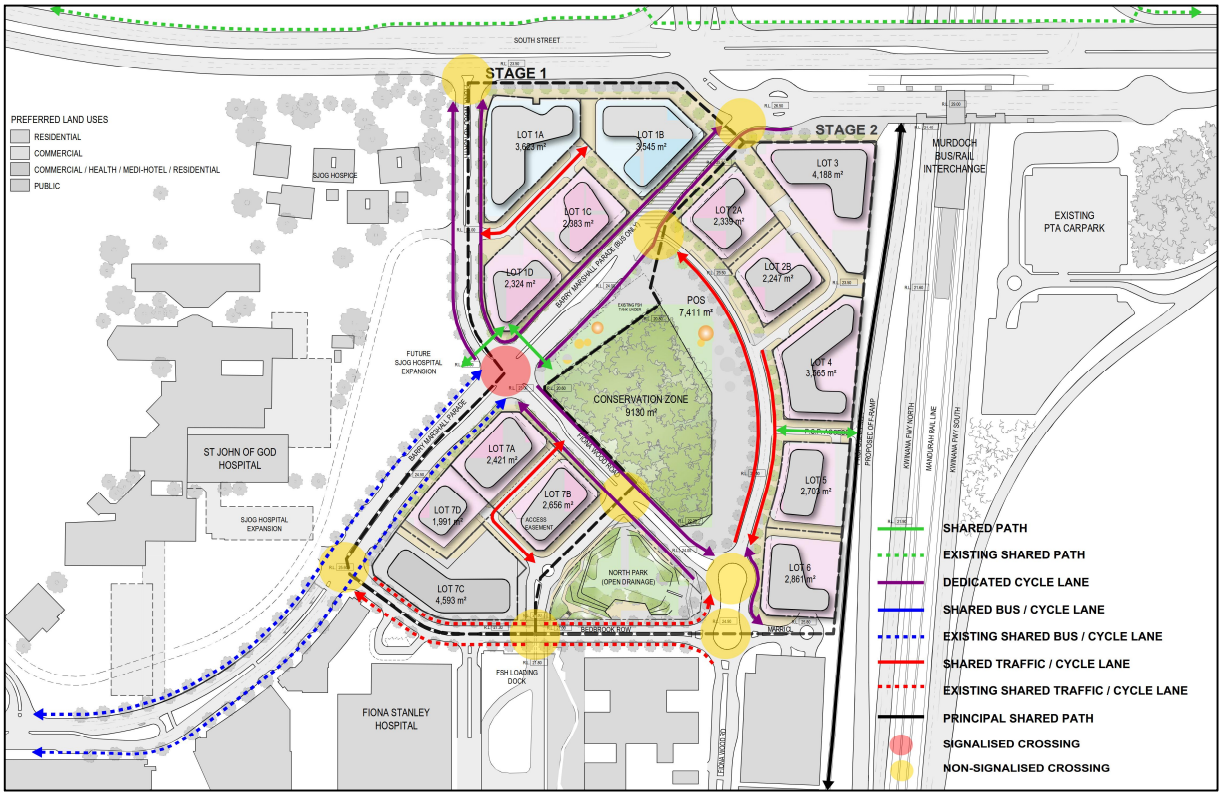
5.4.1 Cycling Linkages

On-road cycles lanes along Barry Marshall Parade and Bedbrook Row and a dedicated cycle only path to the PSP provide direct links to key external routes. Within the centre of the MUP, pedestrian movement becomes the focus, and as such, only informal pedestrian and cycle space is provided along Road 1.

The cycle routes are illustrated in **Figure 26**. This includes:

- Existing dedicated cycle lanes along Fiona Wood Road and on Barry Marshall Parade north of Fiona Wood Road, shared cycle/bus lanes on Barry Marshall Parade south of Fiona Wood Road and on Bedbrook Row– providing a link between the western MAC activities (Murdoch University, FSH) and MUP.
- *PSP connection between Site 4 & 5:* cycle only path providing a direct link into MUP from the north-south regional bike route.

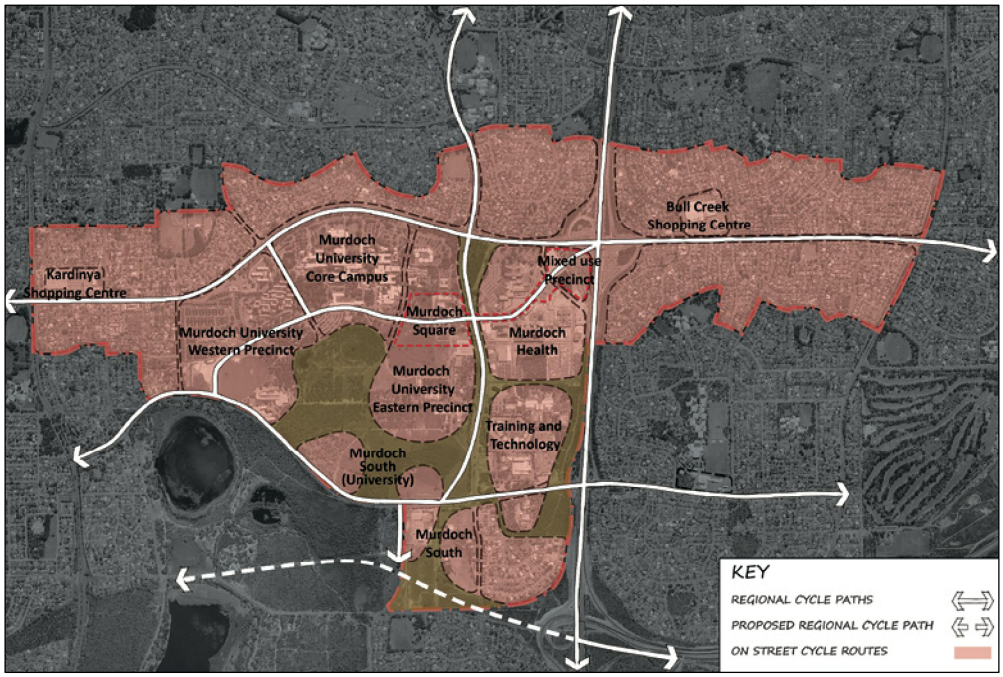
Figure 26 Cycling Linkages



Base plan: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015)

The proposed MUP cycle network connects to the broader MAC cycle network strategy, illustrated in **Figure 27**. The on-road cycle lanes along Barry Marshall Parade link the MUP directly to Murdoch University campus. A cycle path is also proposed to link the MUP to the PSP that runs along Kwinana Freeway.

Figure 27 MAC Bicycle Route Hierarchy *(Department of Planning, 2014)*



5.4.2 Cycle Parking

To further encourage cycling with the MAC area, end of trip facilities including secure, sheltered bike racks and shower facilities are to be provided in all commercial buildings. On-street public bike racks are also to be provided at regular intervals within the MUP. In particular, a bicycle hub is proposed to be located within the transit zone along Barry Marshall Parade. This will include lockable and open bike storage in a shared area adjacent to the on-road cycle paths.

5.4.3 Cycle Network Opportunities

Bike hire scheme linking local activities

The introduction of a bike hire scheme has been considered as part of the MAC structure planning process. This would help to encourage the use of bicycles for local trips such as between the MUP, Murdoch Station, Murdoch University, the hospitals and other activities, and will help to further promote active transport modes and reduce the number of vehicles in the area. Further investigation into implementing such a scheme in order for it to be successful is still required.

6.0 Traffic Assessment

6.1 MAC Traffic Modelling Background

AECOM was engaged by Department of Transport to develop a Commuter microsimulation model for the MAC.

The 2031 model includes the entire MAC Structure Plan Area and future planned surrounding road upgrades such as the extension of Roe Highway and associated southern connection (South Metro Connect design) as well as the southern extension of Fiona Wood Road to Farrington Road. The model extent and road network are shown in **Figure 28**.

This model was subsequently refined to undertake the detailed traffic analysis for MUP.

Figure 28 Commuter Model Network



6.2 Traffic Demands

6.2.1 General Approach for MAC

The 2031 peak period traffic demands (cordon matrices) were obtained from the Department of Transport's STEM Cube model, using the latest MAC modelling scenarios. A base year calibration was undertaken on the critical cordon links and the demands were adjusted accordingly to account for the differences between the modelled and observed counts, assuming these differences would be carried over to the future cases.

For other background traffic generated by the other land uses within MAC, two parking charge sensitivity scenarios were tested in the MAC modelling exercise:

- Scenario 1: No parking charge; and
- Scenario 2: $15/day parking charge

As expected, the traffic demands yielded in Scenario 2 were lower than those yielded in Scenario 1. Thus the overall traffic demands from Scenario 1 were used for this assessment, with the exception of the Murdoch University Eastern Precinct, discussed below.

6.2.2 Murdoch University including Eastern Precinct

The traffic generation for the core Murdoch University was based on the calibration adjusted 2031 STEM model Scenario 1, which has similar magnitude as the observed existing traffic generation. For the Eastern Precinct, the 2031 Scenario 2 forecast was used to provide a more realistic level of traffic generation compared to the proposed parking provision.

6.2.3 Fiona Stanley Hospital and St John of God Hospital

Traffic generation for Fiona Stanley Hospital and St John of God Hospital used in this assessment was taken from previous nano-simulation modelling work undertaken by Urbsol, as this nano model is the most detailed modelling undertaken for this site.

This model was originally developed for Department of Health and has accounted for not only detailed land uses and car park locations, but also detailed operations of both hospitals, such as the shift times for doctors and nurses, and arrival and departure profiles for visitors.

It is noted that the trip generation numbers from Urbsol model used in this study may overestimate some car trips, specifically due to the following points:

- The model does not account for the internalisation of trips within the site – i.e. all generated trips are assumed to originate or terminate from the wider network, which is contrary to the objectives and design of MUP.
- All car trips were assumed to be single occupancy – in reality a number of users may car share which may reduce overall car trip activity.
- For St John of God Hospital, the assumed trip generation includes a 40 percent increase in traffic levels prior to the expansion (based on the proposed 40 percent increase in bed capacity, rather than the smaller increase in car parking spaces).

6.2.4 Murdoch Station Park n Ride

Traffic generation for the Murdoch Station Park n Ride (both eastern and western) was derived from direct observation of existing volumes and movements, as information on how these car parks may change were simply not available.

6.2.5 MUP

The traffic impact assessment is based upon the full build out and occupancy of Stage 1 only. Stage 2 was not modelled due to the uncertainty surrounding the potential relocation of the Murdoch Station western Park n Ride facility, which sits within the Stage 2 development area. Thus the scenario modelled assumes the Park n Ride facility is retained within the MUP Stage 2 site during Stage 1.

Traffic generation assumptions from previous modelling undertaken for MUP by Urbsol have been adopted in this study. However, it is noted that in this study, only vehicle trip components were considered and additional people trips were not modelled.

Traffic generation for stage 1 was split into two zones – Site 1 (comprising lots 1A, 1B 1C and 1D) and Site 7 (comprising lots 7A, 7B and 7C+7D). The proposed land uses are summarised in **Table 1**.

Table 1 Stage 1 Land Use Yields

Site	Retail	Supermarket	Residential	Commercial	Commercial Health	Short-Stay	Parking Bays
	GFA (m^2)	GFA (m^2)	No. of Apartments	GFA (m^2)	GFA (m^2)	No. of Apartments	
Site 1	1,150	-	167	33,120	-	-	720
Site 7	950	2,800	286	-	8,240	82	613

Trip generation for each land use type was determined as follows:

- Retail – based on the maximum number of car parking bays that could be provided as per parking policy and trip movement data at a typical retail / commercial car park.
- Supermarket – based on the gross floor area and rates from the Institute of Transport Engineers (ITE) handbook
- Residential – based on the number of apartment dwellings and vehicle trip generation from residential properties within transit oriented developments (TOD) published by Cervero and Arrington
- Commercial – based on the maximum number of car parking bays that could be provided as per parking policy and assumptions on the occupancy of these during peak periods for employees and visitors
- Commercial Health – same as per commercial
- Short-Stay – based on the number of rooms and rates from the ITE handbook.

The total number of trips assumed to be generated by the MUP Stage 1 development is summarised in **Table 2**.

Table 2 Stage 1 Trip Generation

Peak Period (2 hour)	Inbound Trips	Outbound Trips
Site 1 Total		
AM	474	75
PM	76	519
Site 7 Total		
AM	331	242
PM	500	546

More details on the peak hour traffic generation assumptions are provided **Appendix A**.

It is noted that these assumptions do not account for the 'internalisation' of trips for the MUP site, whereby a number of trips to / from the proposed retail facilities and workplaces will originate from MUP or adjacent sites. This would reduce the number of car and public transport trips generated by the model. The subsequent increase in pedestrian trips would not necessarily affect the MUP signalised intersections, as there are alternative pedestrian routes through the site.

6.2.6 Traffic Generation Summary

A summary of the traffic generation of each MAC precinct is provided in **Table 3**. The data showed that the MUP constitutes approximately 10% of the traffic generated by the MAC area.

Table 3 MAC Traffic Generation Summary

Precinct	AM(7:00-9:00)				PM(16:00-18:00)			
	Outbound	Inbound	Total	Composition	Outbound	Inbound	Total	Composition
Murdoch University	515	2523	3038	22%	1674	819	2492	18%
MU Eastern Precinct	560	3257	3817	28%	3699	1100	4799	34%
Kennedy Baptist College	196	463	659	5%	284	130	414	3%
MUP	323	815	1138	8%	1068	579	1647	12%
SJOG	306	917	1223	9%	862	588	1450	10%
Fiona Stanley Hospital	933	2520	3452	25%	2127	956	3083	22%
Training and Tech Precinct	37	291	328	2%	241	60	300	2%
Total	2869	10787	13656	100%	9955	4230	14185	100%

6.3 Traffic Analysis

6.3.1 Intersection Level of Service

Table 4 summarises the levels of service (LoS) at key intersections in the vicinity of and within the MUP site. Average delay, maximum queues (number of queuing vehicles in all lanes) and LoS are provided.

The results showed significant westbound traffic delay and queueing at South Street / Kwinana Freeway interchange in the AM peak. Since these three intersections are closely spaced, the model results only reflect the delay and queuing on the short links between the intersections. The critical capacity constraint occurs at the northbound interchange, but the queues impact both upstream ramp intersections and beyond towards the east.

Congestion is also expected at the Murdoch Drive / South Street intersection in both peaks. Other intersections in the MUP vicinity are expected to operate satisfactorily.

Table 4 Intersection LoS

Intersection	Approach	AM Peak			PM Peak		
		Ave Delay (s)	Max Queue (veh)	LoS	Ave Delay (s)	Max Queue (veh)	LoS
South Street / Kwinana Fwy Southbound On Ramp	South St EB	28	30	B	31	28	C
	Bus Station EB	94	2	F	94	63	F
	Eastern Car Park NB	81	14	F	69	29	E
	South St WB	370	426	F	31	96	C
	All	230	118	F	34	54	C
South Street / Kwinana Fwy Southbound Off Ramp	South St EB	15	18	B	4	10	A
	South St WB	71	67	F	9	10	A
	Kwinana SB Off-ramp	83	52	F	94	25	F
	All	56	46	D	15	15	B
South Street / Kwinana Fwy Northbound Ramps	South St WB	57	85	E	38	45	C
	Bus Station WB	78	2	F	90	1	F
	South St EB	73	61	F	31	48	C

Intersection	Approach	AM Peak			PM Peak		
		Ave Delay (s)	Max Queue (veh)	LoS	Ave Delay (s)	Max Queue (veh)	LoS
	South St NB Off Ramp	291	96	F	74	19	F
	All	90	61	F	38	28	C
Murdoch Drive / South Street	South St WB	57	76	E	73	88	F
	Murdoch Dr NB	59	46	E	40	68	C
	Murdoch Dr SB	82	43	F	71	30	F
	South St EB	67	42	E	76	52	F
	All	64	52	E	62	60	E
Murdoch Drive / Barry Marshall Pde	Barry Marshall WB	47	18	D	43	38	D
	Murdoch Dr NB	30	27	C	42	35	C
	Murdoch Dr SB	38	44	C	34	24	C
	Discovery EB	50	6	D	50	33	D
	All	38	24	C	42	33	C
Barry Marshall Pde / Fiona Wood Road	Barry Marshall WB	53	3	D	50	5	D
	Fiona Wood NB	59	5	E	58	3	E
	Fiona Wood SB	27	16	B	52	10	D
	Barry Marshall EB	54	11	D	31	19	C
	All	37	9	C	37	9	C

6.3.2 External Road Network

Congestion is generally expected on the road network at the entry points to the MAC area, particularly at the South Street / Kwinana Freeway interchange and at the Murdoch Drive / Farrington Road / New Southern Connection intersection.

Significant westbound congestion is expected to occur at the South Street / Kwinana Freeway interchange with all three intersections experiencing LoS F in the AM peak. Extensive queuing is shown on the westbound approach to the interchange; however it is noted that this is predominantly due to the heavy demand from Kwinana Freeway northern catchment and South Street eastern catchment to access other parts of the MAC development.

The proposed Murdoch Drive / Farrington Road / New Southern Connection intersection connecting MAC to the Roe Highway extension would experience high levels of congestion, especially northbound in the AM peak and southbound in the PM peak, due to large traffic demands generated by MAC. Some of the MAC traffic to Farrington Road west had to be artificially reassigned in the model to South Street and North Lake Road in order to unblock Murdoch Drive.

The Fiona Wood Road entrances, both left in left out intersections, one at the northern end off South Street and the other at the southern end off Farrington Road are shown to operate satisfactorily.

6.3.3 MUP Road Network

The microsimulation modelling has not identified any mid-block capacity issues on the internal road network at Barry Marshall Parade, Fiona Wood Road and Bedbrook Row.

Mid-block capacity analysis has not been considered necessary for the internal MUP street network. The MUP network is generally characterised by short, access streets. The cross-sections for the major access roads (Fiona Wood Road, Barry Marshall Parade and Bedbrook Row) were determined by intersection capacity rather than the mid-block requirements, due to the short length of these street blocks.

All the other MUP streets cater for local access to on-street and off-street parking facilities. The local access streets include a single lane in each direction, and are designed for low traffic and slow speed conditions.

6.3.4 Pedestrian Crossings at Barry Marshall Parade / Fiona Wood Road

The Barry Marshall Parade / Fiona Wood Road intersection is expected to operate at an acceptable LoS of C in the peak periods.

Pedestrian crossings along Barry Marshall Drive were modelled as 12-second fully protected parallel pedestrian crossings (vehicles are not permitted to turn across the pedestrian crossing when the pedestrian signal is green or flashing red).

Given the forecast mode share for the MUP and overall MAC area, there is likely to be a large number of pedestrian movements at the intersection, and as such a fully protected pedestrian crossing was considered preferable. There may be a desire to increase the amount of full protected pedestrian crossing time, should pedestrian volumes warrant it. This would result in reduced green time for vehicle movements. However, there is expected to be sufficient capacity at the intersection to accommodate additional pedestrian crossing time should this be required, without significantly impacting on the LoS for vehicle movements.

6.4 Conclusions

The traffic impact assessment has identified a number of issues with the operation of the external road network, particularly at the South Street / Kwinana Freeway interchange and the Murdoch Drive / Farrington Road / New Southern Connection intersection.

It is noted that the **MUP development is not considered to be the primary cause of the predicted peak period congestion on the external road network**. The MUP parking strategy and objectives to achieve a 40 percent public transport mode share for employees and create a self-sufficient centre all contribute to reducing peak period traffic generated by the MUP development. Vehicle trips generated by the MUP Stage 1 development account for only 10 percent of all vehicle trips into the MAC area.

A significant proportion of the high traffic demands are instead attributed to the wider MAC area. Addressing the predicted traffic demand and corresponding peak period delay at the South Street / Kwinana Freeway interchange should therefore be addressed by the broader MAC transport strategy.

The MUP internal intersections are all predicted to operate satisfactorily.

6.5 Limitations of Modelling

It is noted that traffic modelling has its limitations. Traffic demands were taken from high level strategic models and as such there is always some level of uncertainty. The results presented in this study should therefore only be viewed as an indication of what may occur in the future.

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Appendix A

Traffic Generation Assumptions

Appendix A Traffic Generation Assumptions

1.1 Site 1

Site 1 comprises of 4 lots which have a mix of retail, residential and commercial uses, as summarised in **Table 1**.

Table 1 Site 1 Yield

Lot	Retail	Residential	Commercial		Parking Bays
	GFA (m^2)	No. of Apartments	GFA (m^2)	NLA (m^2)	
1A	0	0	17,150	13,720	270
1B	550	0	15,970	12,776	229
1C	600	82	0	0	111
1D	0	85	0	0	110
Site 1	**1,150**	**167**	**33,120**	**26,496**	**720**

1.1.1 Retail

Site 1 includes a total of 1,150 m^2 of GFA for retail use, for which 23 car parking bays are assumed to be provided (maximum provision as per parking policy).

The Urbsol modelling assumptions for commercial and retail trip generation were based on observed behaviour of car parking facilities that serve mixed commercial / retail purposes such as these. Obtaining information on car park operating dynamics for retail and commercial users was difficult as there are few locations in Perth likely to operate similar to the car parks for the commercial precincts. Data was obtained from a professional car park survey company called Parking Consultants international (PCI) who operate out of Sydney. PCI provided an arrival and departure profile for a typical car park in Chatswood, New South Wales.

While not identical it had a number of features that were likely to be similar to the MUP development:

- Has an 'attached' commercial tower and surrounding commercial offices
- 199 spaces
- Offers early bird, monthly and hourly casual parking
- The survey showed approximately 76% of parkers are monthly, 20% early bird, 4% casual

Figure 1 summarises occupancy through the day for the facility, with further analysis of this data provided in **Table 2**.

Figure 1 Observed Car Park Occupancy

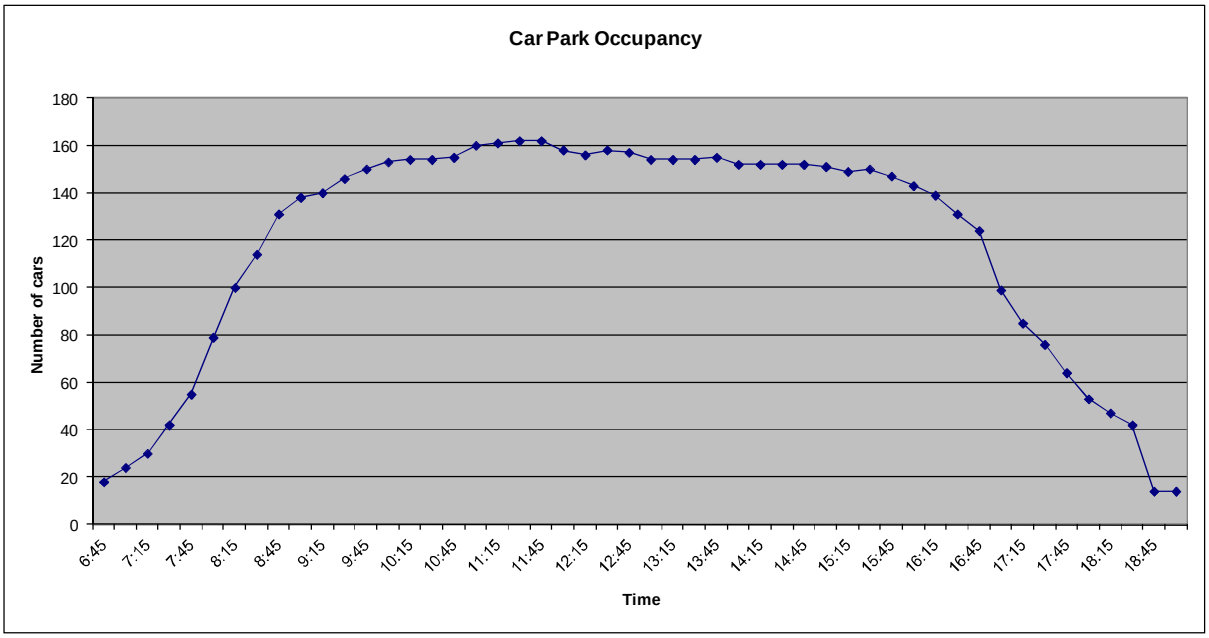


Table 2 Summary of Car Park Data

Time	Inbound			Outbound		
	Bays Occ in period	Tot Bays	Occ Rate	Bays Occ in period	Tot Bays	Occ Rate
06:45 - 07:45	38	199	19.10%	1	199	0.50%
07:45 - 08:45	77	199	38.69%	1	199	0.50%
15:30 - 16:30	5	199	2.51%	24	199	12.06%
16:30 - 17:30	1	199	0.50%	56	199	28.14%

The observed arrival and departure rates of the car park (as a function of the total number of bays) forms the basis for trip generation for large retail land use for the MUP development. The resulting peak period trip assumptions are provided below in **Table 3**.

Table 3 Site 1 – Retail Traffic Generation

Peak Period	Inbound Trips	Outbound Trips
Site 1 Retail – 23 car bays		
AM1	4	0
AM2	9	0
PM1	1	3
PM2	0	6

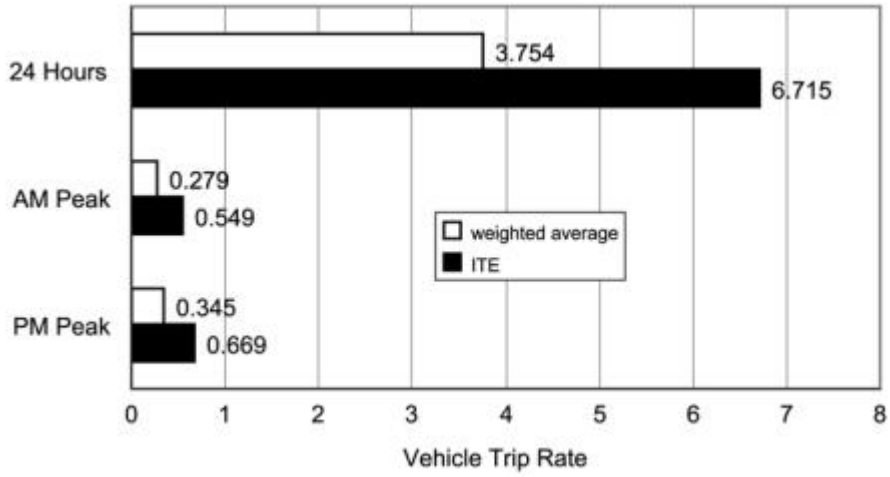
1.1.2 Residential

Site 1 includes a total of 167 residential apartment dwellings.

Urbsol developed traffic generation rates by examining research undertaken in the US relating to Transit Oriented Development. The research by Cervero and Arrington (Cervero and Arrington, 2008) compared the vehicle trip generation from residential properties within TODs and those published by the Institute of Transport Engineers (ITE), shown in **Figure 2**.

- They surveyed 17 housing project sites that ranged in size from 90 unit complexes through to 854 and as such represent a reasonable sample size.
- The average number of parking spaces per project was around 400, yielding an average rate of 1.16 spaces per dwelling unit.
- Six of the surveyed housing projects had ground-floor retail and/or commercial uses; however, all were primarily residential in nature (i.e., over 90% of gross floor area was for residential activities).

Figure 2 Comparison of TOD and ITE Trip Generation Rates (Source Cervero and Arrington 2008)



Given the similarity in bay provision per dwelling to the study, the above rates are adopted for each hour of the model as shown in **Table 4**.

Table 4 Site 1 – Residential Vehicle Trip Generation

Vehicle Trips	Generation Rates (Per Dwelling)	Inbound	Outbound	Generation	Inbound	Outbound
Site 1 Residential – 167 dwellings						
AM Peak Hours	0.279	20%	80%	46	9	37
PM Peak Hours	0.345	65%	35%	57	37	20

1.1.3 Commercial

Site 1 includes a total of 33,120 m^2 of GFA for commercial space, for which 552 car bays (414 employee bays and 138 visitor bays) are assumed to be provided (maximum provision as per parking policy).

For visitor bays, the model assumed 10 percent activity in the AM peak hours (all inbound) and 20 percent activity in the PM peak hour (all outbound).

For staff parking, given the scarcity in provision compared to likely employee levels, it was assumed that all bays are consumed during the model peak periods. The rate of occupation was assumed to follow the parking arrival and departure rates observed from the parking survey illustrated in **Figure 1** and **Table 2** for the retail trip generation assumptions.

All trips in the morning are assumed inbound and all staff trips in the PM peak are assumed outbound.

A summary of the resulting peak period trip assumptions is provided in **Table 5** and **Table 6**.

Table 5 **Site 1 – Commercial Traffic Generation – AM Peak Hours (All Inbound)**

Period	Time	Utilisation	AM1 vs AM2	Employee	Visitor	Total	15 min rates
Site 1 Commercial – 414 employee car bays, 138 visitor car bays							
AM1	06:45 - 07:00	5.22%	33.04%	137	14	145	15.79%
	07:00 - 07:15	5.22%					15.79%
	07:15 - 07:30	10.43%					31.58%
	07:30 - 07:45	12.17%					36.84%
AM2	07:45 - 08:00	20.87%	66.96%	277	14	286	31.17%
	08:00 - 08:15	19.13%					28.57%
	08:15 - 08:30	12.17%					18.18%
	08:30 - 08:45	14.78%					22.08%

Table 6 **Site 1 – Commercial Traffic Generation – PM Peak Hours (All Outbound)**

Period	Time	Utilisation	PM1 vs PM2	Employee	Visitor	Total	15 min rates
Site 1 Commercial – 414 employee car bays, 138 visitor car bays							
PM1	15:30 -15:45	3.75%	30.00%	124	28	141	12.50%
	15:45 - 16:00	8.75%					29.17%
	16:00 - 16:15	5.00%					16.67%
	16:15 - 16:30	12.50%					41.67%
PM2	16:30 -16:45	8.75%	70.00%	290	28	306	12.50%
	16:45 - 17:00	32.50%					46.43%
	17:00 - 17:15	17.50%					25.00%
	17:15 - 17:30	11.25%					16.07%

1.1.4 Total

The total traffic generation for Site 1 is summarised in **Table 7**.

Table 7 **Site 1 – Total Traffic Generation**

Peak Period	Inbound Trips	Outbound Trips
Site 1 Total		
AM1	164	37
AM2	309	37
PM1	38	175
PM2	38	344

1.2 Site 7

Site 7 comprises of 4 lots which have a mix of retail, supermarket, residential, commercial/health and short-stay (hotel) uses, as summarised in **Table 8**.

Table 8 Site 7 Yield

Lot	Retail	Supermarket	Residential	Commercial Health		Short-Stay	Parking Bays
	GFA (m^2)	GFA (m^2)	No. of Apartments	GFA (m^2)	NLA (m^2)	No. of Apartments	
7A	0	0	118	0	0	0	148
7B	0	0	117	0	0	0	142
7C + 7D	950	2,800	51	8,240	6,592	82	323
Site 7	**950**	**2,800**	**286**	**8,240**	**6,592**	**82**	**613**

1.2.1 Retail

Site 7 includes a total of 950 m^2 of GFA for retail use, for which 19 car parking bays are assumed to be provided (maximum provision as per parking policy).

The same traffic generation rates as detailed for retail use in Site 1 are applied, with resulting peak period trip assumptions are provided below in **Table 9**.

Table 9 Site 7 – Retail Traffic Generation

Peak Period	Inbound Trips	Outbound Trips
Site 7 Retail – 19 car bays		
AM1	4	0
AM2	7	0
PM1	0	2
PM2	0	5

1.2.2 Supermarket

Site 7 includes 2,800 m^2 of GFA for a supermarket.

Generation for this component of the site is based on the ITE handbook (Supermarket 850) which produces trip generation assumptions shown in **Table 10**.

Table 10 Site 7 – Supermarket Traffic Generation

Vehicle Trips	ITE Supermarket 850 Generation Rates (per 1000 square feet)	Inbound	Outbound	Generation	Inbound	Outbound
Site 7 Supermarket – 2,800 m^2 = 30, 139 ft^2 GFA						
AM Peak Hours	3.59	61%	39%	108	66	42
PM Peak Hours	10.50	51%	49%	316	161	155

It is also noted that the above trip assumptions are for the AM2 and PM2 peak hours. Trip generation for the AM1 peak hour is assumed to be 85 percent of the AM2 peak hour and trip generation for the PM1 peak hour is assumed to be 98% of the PM2 peak hour.

1.2.3 Residential

Site 7 includes a total of 286 residential apartment dwellings.

The same traffic generation rates as detailed for residential use in Site 1 are applied, with resulting peak period trip assumptions provided below in **Table 11**.

Table 11 Site 7 – Residential Vehicle and Additional Person Trip Generation

Vehicle Trips	Generation Rates (Per Dwelling)	Inbound	Outbound	Generation	Inbound	Outbound
Site 7 Residential – 286 dwellings						
AM Peak Hours	0.279	20%	80%	80	16	64
PM Peak Hours	0.345	65%	35%	99	64	35

1.2.4 Commercial Health

Site 7 includes a total of 8,240 m^2 of GFA for commercial health use, for which 137 car bays (103 employee bays and 34 public / visitor bays) are assumed to be provided (maximum provision as per parking policy)

The same traffic generation rates as detailed for commercial use in Site 1 are applied, with resulting peak period trip assumptions as provided below in **Table 12** and **Table 13**.

Table 12 Site 7 – Commercial Traffic Generation – AM Peak Hours (All Inbound)

Period	Time	Utilisation	AM1 vs AM2	Employee	Visitor	Total	15 min rates
Site 7 Commercial – 103 employee car bays, 34 visitor car bays							
AM1	06:45 - 07:00	5.22%	33.04%	34	3	36	15.79%
	07:00 - 07:15	5.22%					15.79%
	07:15 - 07:30	10.43%					31.58%
	07:30 - 07:45	12.17%					36.84%
AM2	07:45 - 08:00	20.87%	66.96%	69	3	71	31.17%
	08:00 - 08:15	19.13%					28.57%
	08:15 - 08:30	12.17%					18.18%
	08:30 - 08:45	14.78%					22.08%

Table 13 Site 1 – Commercial Traffic Generation – PM Peak Hours (All Outbound)

Period	Time	Utilisation	PM1 vs PM2	Employee	Visitor	Total	15 min rates
Site 7 Commercial – 103 employee car bays, 34 visitor car bays							
PM1	15:30 -15:45	3.75%	30.00%	31	7	36	12.50%
	15:45 - 16:00	8.75%					29.17%
	16:00 - 16:15	5.00%					16.67%
	16:15 - 16:30	12.50%					41.67%
PM2	16:30 -16:45	8.75%	70.00%	72	7	77	12.50%
	16:45 - 17:00	32.50%					46.43%
	17:00 - 17:15	17.50%					25.00%
	17:15 - 17:30	11.25%					16.07%

1.2.5 Short-stay (Hotel)

The hotel will comprise 82 rooms.

The Urbsol model based the hotel trip generation on the ITE handbook (Hotel 310). It was assumed all Hotel trips are vehicle trips. The results are summarised below in **Table 14**.

Table 14 Site 7 Hotel Trip Generation

Vehicle Trips	ITE Hotel 310 Generation Rates (Per Room)	Inbound	Outbound	Generation	Inbound	Outbound
Site 7 Hotel – 82 rooms						
AM Peak Hours	0.56	61%	39%	46	28	18
PM Peak Hours	0.59	53%	47%	49	26	23

1.2.6 Total

The total traffic generation for Site 7 is summarised in **Table 15**.

Table 15 Site 7 – Total Traffic Generation

Peak Period	Inbound Trips	Outbound Trips
Site 7 Total		
AM1	141	118
AM2	190	124
PM1	248	249
PM2	251	297

Murdoch Mixed Use Precinct
LandCorp
13-Nov-2015

Murdoch Mixed Use Precinct

Parking Strategy



Murdoch Mixed Use Precinct

Parking Strategy

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Appendix A
Assessment of opportunities to reduce parking supply rates A

Appendix B
Comparison of Parking Rates B

Executive Summary

The Murdoch Mixed Use Precinct (MUP) provides an opportunity to develop a transit-orientated hub in a significant and rapidly growing activity centre. The MUP will provide a vibrant hub linking Murdoch Bus and Rail Station and Fiona Stanley Hospital and St John of God Hospital. Planning and design of the MUP site is integrated with these developments and the broader Murdoch Activity Centre expansion. This includes consideration of the reserve capacity of the adjacent regional road network (particularly South Street and Kwinana Freeway) and opportunities to reduce traffic generation during peak times.

In recognition of the limited available road capacity at Murdoch, the State Government developed the *Murdoch Activity Centre Access and Parking Policy* (Western Australian Planning Commission (WAPC), 2011). This Parking Policy identifies parking management principles and parking supply limits to support transit orientated development across the Murdoch Activity Centre and minimise traffic congestion during peak periods.

The Murdoch Parking Policy sets a **parking cap of 170 car parks per hectare** for the MUP site. The cap equates to a maximum supply of 1,629 bays (based on a 9.5 hectare MUP site area).This cap is intended to constrain peak period car trips, targeting commercial and long-term visitor parking. The parking cap excludes the Public Transport Authority Park 'n' Ride facility, special purpose parking (such as disabled bays, motorbike parking, and loading zones) and private residential parking.

To achieve this parking cap, opportunities to reduce standard parking supply rates for the proposed MUP land uses were assessed. Reducing the parking supply rate (and subsequent peak period traffic generation) for commercial employees is likely to provide the most benefits for the transport network, with a large number of rail and bus services available at peak commuting times. There is also a significant opportunity to reduce the parking rates for retail employees and visitors as many retail trips are likely to come from adjacent workplaces, residences and hospital visitors (within walking distance), with retail employees also having access to good public transport services. Although the residential parking is not included in the MUP parking cap, benefits were identified from reducing residential parking rates such as assisting in reducing the cost of dwellings and attracting key hospital workers, local students and residents who are interested in sustainable travel options.

The proposed parking rates for the MUP are based on the identified opportunities to reduce the parking supply and extensive research into comparative activity centre developments in Perth and throughout Australia. The proposed **maximum** parking supply rates are outlined in the following table. The parking rates are in accordance with the conditional subdivisional approval based on a previous design (approved 26 April 2013), exceeding the minimum public parking requirements.

Proposed MUP Parking Rates

Land Use	Parking Supply Rate (maximum)
Residential Tenants	- 1 & 2 bedroom dwellings - average of 1.1 parking spaces per dwelling - 3 bedroom dwellings – 2 parking spaces per dwelling
Residential Visitors	- An additional 5% of the residential tenant parking supply
Commercial and Commercial Health	- 1 space per 60 square metres Gross Floor Area (GFA) - A minimum of 25% of the total permitted parking supply to be designated as public parking*****
Hotel Accommodation Employee and Visitor	- 1 space per 3 bedrooms - A minimum 25% of the total permitted parking supply to be designated as public parking*****
Large Retail (>1000 square metres) Employee and Visitor	- 1 space per 35 square metres GFA to be designated as public parking
Small Retail (<1000 square metres) Employee and Visitor	- 1 space per 50 square metres GFA to be designated as public parking

* *Where more than 6 public parking bays are required*

There are limited opportunities to provide on-street public parking within the MUP and the development of a site solely to provide parking is not permitted. Public parking supply rates are therefore incorporated into the total parking supply for the major MUP activities. This will provide the additional benefit of dispersing the public parking

areas throughout the MUP, minimising amenity impacts and distributing the traffic generation across the street network. The public parking must be managed to provide access for visitors to all destinations, but can include time or fee restrictions to prioritise short-term visitor parking over all day commuter parking.

The estimated parking supply for activities included in the MUP parking cap assessment is summarised below.

Estimated Parking Supply for Land Uses included in the Parking Cap

Land Use	Ultimate Floorspace	Maximum Parking Rate	Estimated Total Parking Supply	Minimum Public Parking Supply	Maximum Tenant / Employee Parking Supply
Commercial / Commercial Health	41,360 square metres GFA	- 1 space per 60 square metres GFA - A minimum of 25% of the total parking supply to be designated as public parking**	689 bays	172 public parking bays (minimum)	517 employee parking bays (maximum)
Hotel Short-Term Accommodation	82 bedrooms	- 1 space per 3 bedrooms - A minimum of 25% of the total parking supply to be designated as public parking**	27 bays	7 public parking bays (minimum)	20 employee parking bays (maximum)
Large Retail (Supermarket)	2,800 square metres GFA	- 1 space per 35 square metres GFA - 100% of the total parking supply to be designated as public parking	80 bays	80 public parking bays	-
Small Retail	2,480 square metres GFA	- 1 space per 50 square metres GFA - 100% of the total parking supply to be designated as public parking	50 bays	50 public parking bays	-
On-Street Parking	-	-	41 bays 21 bays (existing) on Barry Marshall Parade and 20 bays (proposed) on Road 1	41 public parking bays	-
Total Estimated Parking Spaces for Parking Cap Assessment			**887 bays**	**Minimum 350 public parking bays (39%)**	**Maximum 537 employee / tenant parking bays**

** *Where more than 6 public parking bays are required*

Approximately 887 commercial, hotel, retail and on-street parking spaces are provided within the MUP development site. This is less than the parking cap of 1,629 bays (170 bays per hectare). This provides flexibility to provide additional spaces without exceeding the parking cap, for example, for specific practitioner demands.

If the demand for commercial, retail or hotel accommodation floorspace is more than the anticipated yields included in the MUP Draft LSP, employee and visitor parking will need to be managed to ensure the total MUP parking cap of 170 bays per hectare is not exceeded. Approval for additional floorspace would require a developer to demonstrate how access can be managed without increasing the total parking supply or how additional parking would not significantly impact peak period traffic congestion.

An estimated 350 public parking spaces (39 per cent) could be dispersed across the MUP development sites and on-street parking spaces. This meets the Murdoch Parking Policy requirement of a minimum of 25 per cent of the parking supply for activities included in the parking cap assessment to be provided as public parking.

Parking for residential tenants and visitors is in addition to the estimated 887 commercial, retail, hotel and on-street parking spaces. Additional parking for people with disabilities and service vehicles is to be provided to meet the Building Code of Australia, Australian Standards and City of Melville specifications. Minimum provision for bicycle parking within each development is also included in this Parking Strategy.

A Development Application must be lodged by the future land owners of individual sites within the MUP, which will include the proposed site parking provision to comply with the maximum parking rates outlined in this Strategy. The Development Application must include a Parking Management Plan outlining the management and enforcement of parking, and a Travel Plan as specified in the Murdoch Parking Policy.

1.0 Introduction

The Murdoch Mixed Use Precinct (MUP) provides an opportunity to develop a transit-orientated hub in a significant and rapidly growing activity centre. The MUP will also support the specialised health and education facilities and provide a range of daily activities, including student and residential dwellings, within walking and cycling distance of key commercial and retail activities.

The site is located alongside the Kwinana Freeway and South Street road interchange and Murdoch Rail and Bus Station. These transport corridors also provide access to other major Murdoch activities, including Fiona Stanley Hospital, St John of God Hospital and Murdoch University. In recognition of the limited available road capacity at Murdoch, the State Government developed the *Murdoch Activity Centre: Access and Parking Policy* (Western Australian Planning Commission (WAPC), 2011). This Policy outlines parking supply limits and management principles to support transit orientated development and reduce peak period traffic generation across the Murdoch Activity Centre.

LandCorp are the State Government agency tasked with developing the Murdoch MUP Structure Plan and providing the supporting infrastructure, Development Guidelines and Parking Strategy to ensure the site's objectives are met. This Parking Strategy identifies feasible parking supply rates which are aligned with the Murdoch Parking Policy objectives, and encourage an increase in public transport, walking and cycling trips for the precinct. The parking rates outlined in this Strategy represent the maximum permissible supply for the major land uses proposed in the MUP Structure Plan.

The Parking Strategy also identifies complimentary parking management measures which can be considered by future land owners and developers of the MUP site. These complementary measures provide opportunities for future developers to support a reduced parking supply on their site, but are not mandatory to meet this Parking Strategy or Murdoch Parking Policy requirements.

1.1 MUP Transport Objectives

The MUP vision includes seven transport objectives to provide an accessible and sustainable centre. The supply and management of parking will influence the travel choices made by the MUP commuters, visitors and residents, and is a key component of achieving an increase in public transport, walking and cycling trips.

The transport objectives for the MUP are:

- Provide easy & safe access to the bus/rail interchange.
- Provide effective pedestrian linkages through the site.
- Strengthen pedestrian and cycle connectivity to and within the precinct.
- Promote public transport by providing easy, regular and convenient connections.
- Modal split target: 40 per cent Public Transport.
- Low car dependency.
- Transitions from a transit 'Origin' to 'Destination' over time.

1.2 Murdoch Activity Centre Access and Parking Policy

The State Government intends to provide detailed guidance for parking management in Specialised Activity Centres in the proposed *State Planning Policy - Metropolitan Centres Parking.* As this is not yet published, the MUP Parking Strategy has been developed to complement the parking supply and management principles in the *Murdoch Activity Centre Access and Parking Policy*.

The Murdoch Parking Policy includes parking supply rates based on the predicted medium and long-term capacity of the surrounding road network. For the MUP, the Murdoch Parking Policy sets **a parking cap of 170 car parks per hectare**. The cap for the MUP site equates to a maximum supply of 1,629 bays (based on a 9.5 hectare site area). This cap is intended to constrain peak period travel, therefore targeting commercial and long-term visitor parking.

The parking cap excludes the following parking facilities present within the MUP site:

- The Public Transport Authority (PTA) Park ‘n’ Ride facility.
- Special purpose parking (such as disabled bays, motorbike parking, and loading zones).
- Private residential parking, including residential visitor parking spaces.

1.3 MUP Subdivision Approval Conditions

Conditional subdivision approval was previously obtained for the MUP site, based on a previous scheme. Although the current proposal has a slightly different layout and design for the site, it is broadly consistent with the previous proposal in terms of land use and yields and thus the previous subdivision conditions are relevant to this proposal. The subdivision approval for the MUP site included conditions for the parking supply and management. These conditions are consistent with the objectives of the *Murdoch Activity Centre Access and Parking Policy* to minimise peak period traffic generation for the MUP site and provide an efficient parking supply. The maximum parking rates in this Parking Strategy meet the subdivision approval conditions.

2.0 MUP Parking Rates

The Murdoch MUP presents a unique opportunity to reduce the parking supply compared to standard commercial, retail or residential developments. This is due to the mixed use nature of the site, and ease of access to local and regional public transport services. The site is being designed to promote self-sufficiency, encouraging short walking trips for a range of daily activities between dwellings, workplaces, supermarkets, cafes and other retail facilities. In addition, the placement of the site immediately adjacent to Murdoch Station, with transit access prioritised along the central road corridor within MUP (Barry Marshall Parade) promotes public transport access for residents, workers, visitors and students to key activities within the Murdoch Activity Centre.

2.1 Opportunities to Minimise Parking

The parking demand from different uses was assessed to identify opportunities and transport network benefits for reducing the parking supply from standard parking rates. The assessment considered the parking demand for the proposed general land uses at MUP; residential, commercial, large and small retail and short-term accommodation (hotel) activities.

The criteria considered in this assessment were as follows:

- Are other travel options available which match typical travel times and needs of the activity?
- Is the activity likely to generate car trips at peak travel times on the MUP and adjacent regional road network?
- Can parking be shared with other users (as public parking) or used by alternative activities at different times (reciprocal use)?

The assessment identified some opportunities to reduce the parking supply for all the activities. In particular reducing the parking rates (and subsequent parking demand) for commercial employees is likely to provide the most benefits for the transport network, with a large number of rail and bus services available at peak commuting times. There is also a significant opportunity to reduce the parking rates for retail employees and visitors as many retail trips are likely to come from adjacent workplaces, residences and hospital visitors, with retail employees also having access to good public transport services. There is some opportunity to reduce the parking rates for residential tenants and visitors, which will assist with reducing the cost of dwellings and attracting key hospital workers, local students and residents who are interesting in sustainable travel options.

More details on the assessment ratings for each land use activity are provided in **Appendix A**.

2.2 Proposed MUP Parking Rates

The maximum proposed MUP parking rates are outlined in **Table 1**. These rates are based on the opportunities to reduce the parking supply identified in the previous section, and extensive research into comparative activity centre developments in Perth and throughout Australia. These maximum rates are considered acceptable to attract the desired commercial investment in the site, whilst still aiming to reduce the proportion of car trips to the centre when compared to traditional Perth metropolitan developments. As such, the rates set a benchmark for TOD developments in Perth. A comparison to the parking rates in comparable centres is provided in **Appendix B**.

Table 1 Proposed MUP Parking Rates

Land Use Activity	Parking Supply Rate (maximum)	Supporting Information
Residential Tenants	1 & 2 bedroom dwellings - average of 1.1 parking spaces per dwelling 3 bedroom dwellings – 2 parking spaces per dwelling	The proposed maximum residential parking rate is less than the standard R-Codes rate, and allows flexibility in supply for individual dwellings within each site. Extensive research in the USA supports a reduced MUP residential parking provision, indicating a 20% reduced parking demand (Parker and Arrington, 2002) and a 44% reduction in vehicle trips (50% at peak times - Cervero and Arrington, 2008) for residents living in a TOD compared to surrounding suburban dwellings. Due to the site location some residents will only require 1 or even 0 spaces (such as student dwellings), which allows other residents to lease / purchase additional spaces as required. This would support resident parking to be unbundled from lease /

Land Use Activity	Parking Supply Rate (maximum)	Supporting Information
		purchase of residential strata lots to allow more efficient use of resident parking.
Residential Visitors	**An additional 5%** of the residential tenant parking supply	The residential visitor supply is for visitors originating from the broader metropolitan area who do not have reasonable access to public transport due to the time of visit or length of their trip. A number of visits will take place after hours when there is less demand for on-street parking and public parking within the MUP, allowing for a reduced visitor parking rate within each individual residential site.
Commercial and Commercial Health Employee	1 space per 60 square metres Gross Floor Area (GFA)	Commuters to MUP commercial activities are a key target for the desired 40 per cent of MUP trips by public transport. To support this target, a considerable reduction in the standard commercial parking supply rate is proposed (Melville City Council – 1 space per 40 square metres). The reduced commercial parking supply (in conjunction with increased public transport use and opportunity for workers to live within MUP) is considered to be feasible for the MUP site. This is supported by USA research which indicates an increase in TOD public transport commuter use by a factor of 5 compared to the surrounding city (Lund, Cervero & Willson, 2004).
Hotel Accommodation Employee	1 space per 3 bedrooms	This maximum rate is less than the standard City of Melville requirements, but more than the standard Road Transport Authority (NSW) rate of 1 per 5 bedrooms which is often used a benchmark in traffic assessments. Due to site location, many interstate and international short-term tenants will not require a car reducing the parking demand. The maximum parking supply will still allow for some visitors to arrive by car, and provide some capacity for employee parking. Parking for restaurants / bars within a hotel should be supplied based on the retail parking rates. Parking for conference facilities would need to be assessed on an individual basis, with the availability of public transport access and general public parking considered rather than an additional supply of parking for the exclusive use of conference attendees.
Commercial, Commercial – Health and Hotel Accommodation Visitor	**A minimum 25%*** of the employee parking supply to be provided as public parking	This parking is provided for visitors to specialised commercial activities who originate from outside the Murdoch Activity Centre. The parking is to be designated as public parking for short-term visitors, with management and enforcement measures to be outlined in the Travel Plans and Parking Management Plans submitted as part of each development application.
Large Retail (>1000 square metres) Employee and Visitor	1 space per 35 square metres GFA, **100% to be provided as public parking**	Large retail includes supermarkets or other larger retail centres. All of this parking is proposed to be supplied as public parking. The proposed rate is a reduction on the standard rate used at other centres in Perth but will still supply adequate parking for the range of MUP visitors who will likely make use of this car park. It is recommended for the parking fee rates to be managed to prioritise the large retail visitors, followed by short-term visitors. All day commuter parking should be discouraged through appropriate fees and / or time limits for a large proportion of the public parking.
Small Retail (<1000 square metres)	1 space per 50 square metres GFA, **100% to be**	This parking rate is similar to the minimum parking rate proposed for other TOD developments. A large proportion of the retail within the MUP development is likely to be categorised as small retail and this is

Land Use Activity	Parking Supply Rate (maximum)	Supporting Information
Employee and Visitor	**provided as public parking**	considered a moderate parking rate to ensure there is some supply of public and retail commuter parking within each development site.

**Only applicable for sites where more than 6 public parking bays would be required*

2.3 Public Parking

Public parking provides an opportunity to minimise the overall supply of visitor parking by providing a shared parking resource. The shared public parking can be used by visitors accessing multiple activities within the MUP site and allowing reciprocal use of parking by activities with different peak visitor times (such as weekday commercial health visitors and weekend / after-hours residential or retail visitors).

There are limited opportunities to provide on-street public parking within the MUP and the development of a site solely to provide parking is not permitted under the Murdoch Parking Policy. Public parking supply rates are therefore incorporated into the total parking supply for the major MUP activities. This will provide the additional benefit of dispersing the public parking areas throughout the MUP, minimising amenity impacts and distributing the traffic generation across the street network.

The proposed parking rates include a minimum 25 per cent of the total parking supply (100 per cent for the retail activities) to be designed and managed as public parking. This excludes residential parking and other activities which are exempt from the Murdoch Parking Policy maximum parking supply cap. Consistent with the MUP conditional subdivision approval, the minimum public parking supply is only applicable if more than six public parking spaces are required for an individual lot based on the maximum permissible employee parking rate (even if less employee parking is elected to be supplied).

The public parking must be available for visitors to all destinations, but can include time or fee restrictions to prioritise short-term visitor parking over all day commuter parking. More information on the management of public parking areas is provided in **Section 5.1.3**.

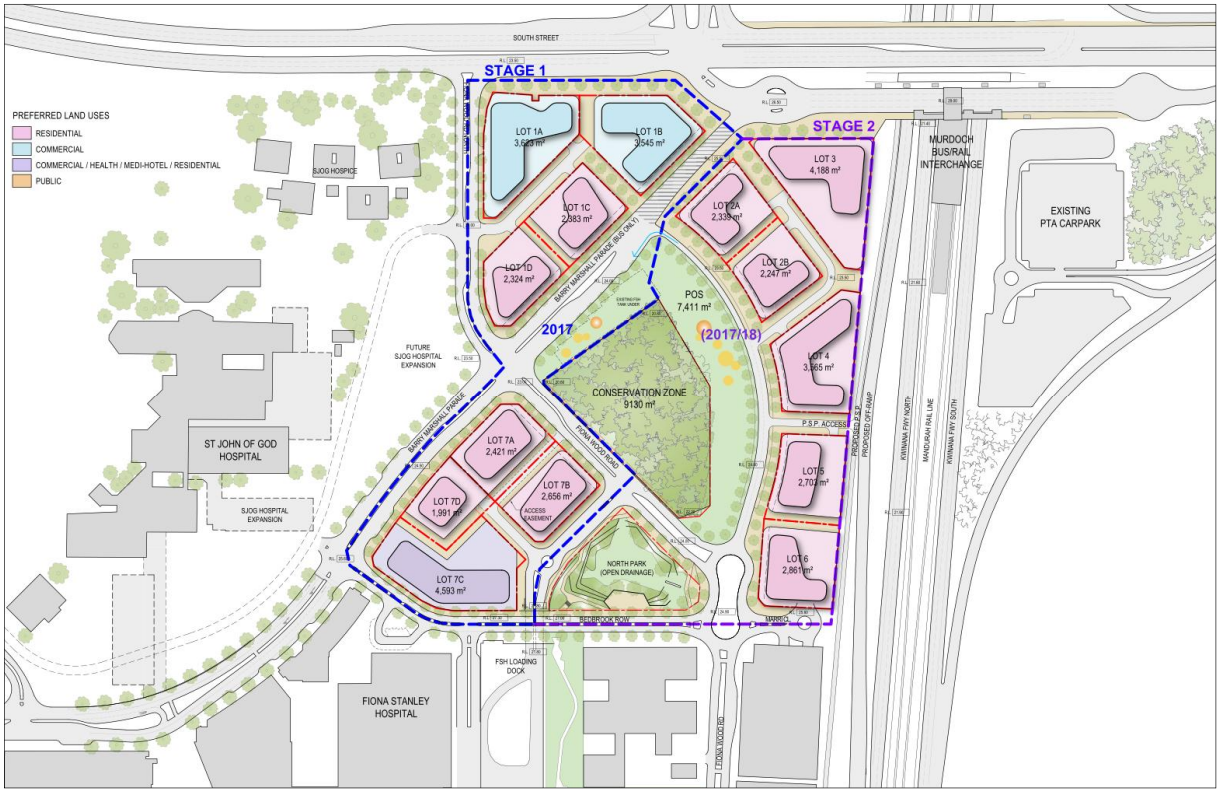
3.0 MUP Development Yields

The proposed site and road layout for the MUP development is illustrated in **Figure 1**. The ultimate scale of development for different land uses is summarised in **Table 2**, with two yield density scenarios developed:

- Scenario 1 – High
- Scenario 2 – Medium

The two scenarios differ only in the number of residential apartments provided.

Figure 1 MUP Development Plan



Source: Murdoch MUP Preliminary Site Plan (ARM Architecture, 10 July 2015

Table 2 Proposed MUP Ultimate Development Yields

Land Use	Ultimate Floorspace / Dwellings	
	Scenario 1 - High	Scenario 2 - Medium
Commercial / Commercial Health	41,360 square metres GFA	
Hotel Short-Term Accommodation	82 bedrooms	
Large Retail (Supermarket)	2,800 square metres GFA	
Small Retail	2,480 square metres GFA	
Residential	1,234 apartment dwellings	913 apartment dwellings

4.0 Parking Supply

4.1 Land Uses included in the Parking Cap

The Murdoch Parking Policy specifies a maximum parking supply of 170 car parks per hectare or 1,629 bays for the MUP development site (the MUP land area is 9.585 hectares). This parking cap only applies to the following proposed land uses for the MUP:

- Commercial and Commercial Health.
- Hotel Short-Term Accommodation.
- Retail.
- On-street public parking.

An estimate of the parking supply for these activities is provided in **Table 3**. The estimated parking supply is based on the ultimate scale of development for MUP and the maximum parking supply rates outlined in **Table 1**.

Table 3 Estimated Parking Supply for Land Uses included in the Parking Cap

Land Use	Ultimate Floorspace	Maximum Parking Rate	Estimated Total Parking Supply	Minimum Public Parking Supply	Maximum Tenant / Employee Parking Supply
Commercial / Commercial Health	41,360square metres GFA	- 1 space per 60 square metres GFA - A minimum of 25% of the total parking supply to be designated as public parking	689 bays	172 public parking bays (minimum)	517 employee parking bays (maximum)
Hotel Short-Term Accommodation	82 bedrooms	- 1 space per 3 bedrooms - A minimum of 25% of the total parking supply to be designated as public parking	27 bays	7 public parking bays (minimum)	20 employee parking bays (maximum)
Large Retail (Supermarket)	2,800 square metres GFA	- 1 space per 35 square metres GFA - 100% of the total parking supply to be designated as public parking	80 bays	80 public parking bays	-
Small Retail	2,480 square metres GFA	- 1 space per 50 square metres GFA - 100% of the total parking supply to be designated as public parking	50 bays	50 public parking bays	-
On-Street Parking	-	-	41 bays 21 bays (existing) on Barry Marshall Parade and 20 bays (proposed) on Road 1	41 public parking bays	
Total Estimated Parking Spaces for Parking Cap Assessment			**887 bays**	**Minimum 350 public parking bays (39%)**	**Maximum 537 employee / tenant parking bays**

As outlined in **Table 3**, based on the forecast ultimate development the estimated parking supply for activities included in the Murdoch Parking Policy is 887 parking bays. This is 742 bays less than the maximum permissible supply of 1,629 bays (maximum 170 bays per hectare for the MUP site). The estimated minimum public parking supply is 39 per cent, which is comparable to the proportion of public parking provided in the Perth CBD. There is thus capacity to provide additional spaces without exceeding the parking cap, for example, this spare capacity could be used to allow commercial health activities to provide additional parking to meet specific practitioner demands. The approval of additional parking would however require an assessment of the impact on the peak period traffic congestion.

The estimated parking supply is based on the forecast ultimate MUP development. Should there be demand for additional commercial, retail or hotel accommodation floorspace in the future, this could be provided if a developer can demonstrate alternative access measures for employees and visitors which do not result in the parking exceeding the maximum parking cap of 1,629 bays for the total MUP site (or for additional parking spaces which don't generate peak period trips).

4.1.1 Employee Parking Rates and Target Mode Share

The MUP target of 40 per cent of trips by public transport is most critical for commuter trips which take place at peak travel periods. The proposed parking supply rates outlined in this strategy aim to reduce traffic generation by commuters, and encourage more public transport trips. To assess the potential contribution of the proposed parking rates to achieving this target, a high level comparison of the estimated supply of commuter parking against the forecast number of commercial and retail employees is provided in **Table 4**. The potential employee numbers included in **Table 4** are based on the forecast MUP employment generation *(* Urbis, 2015).

Table 4 Projected MUP Employees and On-Site Employee Parking

Land Use	Gross Floor Area	Forecast Employee Numbers (Ultimate)	Proposed Parking Supply	% of Employees with access to a Parking Space
Commercial & Commercial Health	41,360 square metres	2,112 employees	689 total bays: 517 employee bays 172 visitor bays	24%
Retail	5,280 square metres	206 employees	130 total bays*: 45 employee bays 85 visitor bays	22%*

*Assumes a maximum of 50% of small retail parking and maximum 25% of large retail parking available for employees, with the remainder used for short-term visitor parking

This comparison allows a potential 'car as driver' mode choice to be calculated, providing for up to 24 per cent of commercial employees and 22 per cent of retail employees to drive to work (in a worst case scenario where everyone within each workplace worked at similar times). In addition to this, a number of employees would arrive as passengers in a car (either dropped off or in a car share arrangement). Allowing for an extra 10 per cent of commuters to arrive as car passengers, a total of 34 per cent of commercial and commercial / health employees and 32 per cent of retail employees could arrive by car. The remaining 66 per cent of commercial and commercial / health employees and 68 per cent of retail employees would arrive by public transport, walking or cycling, exceeding the MUP target of 40 per cent of trips by public transport.

This high level assessment indicates the proposed parking supply rates included in this Strategy will contribute to reducing traffic generation by MUP commuters, supporting the objectives of the MUP development and the Murdoch Parking Policy.

4.2 Land Uses excluded from the Parking Cap

Parking requirements for land uses and activities not included in the MUP parking cap assessment are discussed in this section.

4.2.1 Residential Parking

Residential tenant and visitor parking bays are considered to generate counter-flow peak period trips for the MUP and adjacent regional road network. These parking bays are thus not included in the calculation of the parking cap assessment for the MUP site, as outlined in the Murdoch Parking Policy.

In the high density yield scenario (Scenario 1), an estimated supply of 1,234 apartment dwellings is proposed for the MUP site, which is expected to be supplied as a mix of one, two and three bedroom apartments. In the medium density yield scenario (Scenario 2), an estimated 913 apartment dwellings are proposed. It is noted that the exact ratio of apartment sizes would be determined by the developer.

The estimated total parking supply for the residential dwellings for both scenarios is provided in **Table 5**. The proposed parking rates include specific provision for residential visitors, and in addition residential visitors will be able to use the on-street and proposed off-street public parking bays. There is likely to be low demand from commercial visitors for the public parking bays in the evenings and on weekends, when residential visitor demand is most likely at its highest. This will enable 'reciprocal' use of the public parking bays between these movements.

It is noted that the estimated parking supply in **Table 5** is based on an assumed ratio of 95 percent of dwellings being 1 and 2 bedroom apartments and 5 percent of dwellings being 3 bedroom apartments; however the exact ratio would be determined at a later stage by the developer.

Table 5 Estimated Residential Parking Supply

No. of dwellings		Maximum Parking Rate	Estimated Parking Supply	
Scenario 1 – High	Scenario 2 – Medium		Scenario 1 – High	Scenario 2 – Medium
1,234 dwellings	913 dwellings	**Residential tenants:** 1 & 2 bedroom dwellings – average of 1.1 parking spaces per dwelling 3 bedroom dwellings – 2 parking spaces per dwelling	1,412 parking bays	1,045 parking bays
		Residential visitors: An additional 5% of the residential tenant parking supply	70 parking bays	52 parking bays
Total Estimated Parking Spaces			**1,482 residential bays**	**1,097 residential bays**

4.2.2 Parking for People with Disabilities

This parking is to be provided in accordance with the minimum parking requirements for people with disabilities outlined in the Building Code of Australia and designed to meet Australian Standards dimensions and access specifications. These parking bays are not included in the calculation of the parking cap assessment for the MUP site, as outlined in the Murdoch Parking Policy.

4.2.3 Service Vehicle Parking

Service vehicle parking requirements should be assessed on an individual basis for each development site. As a minimum, in commercial developments over 500 square metres at least one permanently reserved parking bay should be provided for service, delivery and courier vehicles (as specified in the City of Melville Car Parking Policy CP- 079). These parking bays are not included in the calculation of the parking cap assessment for the MUP site, as outlined in the Murdoch Parking Policy.

4.2.4 Bicycle Parking

Providing easily accessible and functional end of trip facilities for cyclists will be important to attract commuter and visitor cycling trips for the MUP. The City of Melville does not specify minimum bicycle parking rates for new developments. The City of Fremantle and City of Vincent include mixed use precincts in their city centres and have parking policies which include minimum bicycle parking details for different land uses. Bicycle parking rates are also included in the Austroads Guide to Traffic Management Part 11: Parking (2008). The recommended minimum bicycle parking rates identified in **Table 6** are based on these parking policies. These minimum parking rates are in addition to bicycle parking provided in the MUP public spaces.

Table 6 Recommended minimum bicycle end of trip facilities for the MUP

Land Use	Minimum supply	Supporting information
Residential	Adequate storage space per dwelling to accommodate a bicycle (as per AS 2890.3 Parking Facilities Part 3: Bicycle parking facilities); and 1 bicycle park per 4 dwellings. Alternatively – a minimum of 1 secure bicycle park per dwelling to be provided	This is more than the minimum bicycle parking rate recommended by City of Vincent and City of Fremantle; but is considered appropriate for the MUP site due to the access to regional bicycle network and the attractiveness of residential options for local students and employees
Residential visitor	1 space per 16 dwellings	To be provided in a publicly accessible area near visitor entrance, either visible from street or clearly signposted
Commercial	1 space per 200 square metres of GFA	It is recommended for shared visitor bicycle parking to be provided in a prominent location outside each development site, or within car park areas clearly signposted from the street
Large Retail (>1000 square metres)	1 space per 300 square metres GFA for employees; and 1 space per 200 square metres GFA for visitors	To be provided in publicly accessible space near main shop entrance, preferably visible from street or clearly signposted
Small Retail (<1000 square metres)	**Café**: 1 space per 25 square metres GFA for employees and 2 spaces for visitor parking **Restaurant:** 1 space per 100 square metres GFA and 2 spaces for visitor parking **Take-away food outlet:** 1 space per 100 square metres GFA for employees and 1 space per 200 square metres GFA **All other small retail:** 1 space per 300 square metres GFA for employees; and 1 space per 200 square metres GFA for visitors	It is recommended for shared visitor bicycle parking to be provided in a prominent location outside each development site, or within car park areas clearly signposted from the street
Hotel Accommodation	1 bicycle park per 40 units	It is also recommended for hotel management to provide several bicycles for free use by hotel visitors to encourage short bicycle trips around the MUP and MAC site.
End of Trip facilities (excludes residential uses)	Developments required to provide 10 or more bicycle parking bays must also provide: - A minimum of one female shower and one male shower, located in separate change rooms. - Additional shower facilities to be provided at a rate of one female shower and one male shower for every additional 10 bicycle parking bays, to a maximum of five female and five male showers per development. - A locker to be provided for every bicycle parking bay provided	

The Green Building Council of Australia include minimum bicycle parking rates in the Green Star assessment. These are based on the number of employees rather than the development floorspace. The Green Star minimum bicycle parking rates can be used instead of the minimum parking rates outlined in **Table 6.**

Table 7 Green Star Minimum Employee Bicycle Parking Rates

Minimum Parking Rate for 1 Point	Minimum Parking Rate for 2 Points
- One secure bike parking space per 20 staff - One shower for every 10 bike parking spaces - Change facilities adjacent to showers - One secure locker per bike space in the change facilities	- One secure bike space per 10 staff - One shower for every 10 bike parking spaces - Change facilities adjacent to showers - One secure locker per bike space in the change facilities

5.0 MUP Parking Management Opportunities

Section 5.1 outlines measures which must be considered by future developers / land owners to ensure parking is managed to reduce peak period traffic generation and is available for the intended user (short-term visitor or weekday commuter). **Section 5.2** provides recommendations for additional measures which may be considered by future site developers / land owners to provide an efficient parking supply, but are not mandatory to meet the Murdoch Parking Policy requirements.

5.1 Mandatory Parking Management Measures

The parking measures outlined in the following section must be considered by future developers to obtain development approval for their site.

5.1.1 Parking Space Ownership

As specified in the Murdoch Parking Policy and MUP conditional subdivision approval, the lot owner is to retain ownership and management of the parking spaces for activities included in the Murdoch Parking Policy parking supply cap. This will ensure parking spaces within each lot are managed efficiently, allowing for reciprocal use where possible and providing a shared, well designed public parking area. It will also ensure the spaces are managed and enforced for their intended use, preventing leasing or licensing of parking spaces for other activities. An exemption to this is the potential placement of public parking on an adjacent or near-by property. This could provide benefits for both visitors and site owners / developers, allowing for more efficient access and layout, wayfinding, enforcement and management of public parking spaces.

5.1.2 Workplace and Residential Travel Plans

Each site user and employer will be required to develop and implement a Travel Plan, as well as a Parking Management Plan. Initiatives to support sustainable transport use and reduce the overall parking demand specific to each activity will be investigated as part of the development process, with a Draft Travel Plan and Parking Management Plan to be submitted with all development applications.

5.1.3 Public Parking

The proposed MUP parking rates include a requirement for commercial, retail and non-permanent accommodation land uses to provide public parking as part of their total parking supply, except where six or less public parking spaces are required. The site owner or developer will be responsible for allocating parking for individual activities within each site. It is recommended for a section of car park on each site to be designed as the public parking area for all the individual site activities. This would enable signage, access and maintenance of the public parking for individual shops or offices to be efficiently managed, and to be easily located by visitors. The area must be available for public access at all times, subject to time or fee restrictions which discourage all day commuter parking.

The public parking is to be managed to discourage additional peak period car trips, with employees of these activities contributing to the largest number of peak trips. Site owners or managers must outline the intended management and enforcement of their public parking supply to ensure these bays are not used as all-day commuter parking. Management can include parking time limits or the charging of fees for longer-stay weekday visitors.

The public parking management and enforcement measures are to be outlined in the site Travel Plan and Parking Management Plan, to be submitted and implemented as part of the development approval process. The Parking Management Plan could include the placement of public parking on a nearby or adjacent site if it is shown to provide user benefits or to overcome site constraints. Consideration of cash-in-lieu for public parking may also be considered by the WAPC.

5.2 Optional Parking Management Measures

The complimentary measures outlined in the following section provide opportunities for future developers to support a reduced parking supply on their site, but are not a development requirement to meet the Murdoch Parking Policy objectives.

5.2.1 Commuter Parking

The management of commuter parking is essential to discourage unnecessary commuter car trips and ensure visitor parking is not occupied for long periods by commuters. As well as minimising the supply of employee parking, management should also consider:

- Appropriate parking fees to reflect the true cost of parking and reduce commuter parking demand with charging on a 'pay as you park' basis rather than monthly or yearly parking fees.
- Reduced parking fees or exclusive parking spaces prioritised for car share (cars arriving with at least two occupants). This would require parking spaces to be monitored (in person or electronically) to restrict these benefits to car drivers arriving with passengers.

It is also recommended for future land owners to investigate opportunities for reciprocal use of parking which could reduce the overall parking supply within their site, saving development costs and increasing design flexibility. After hours use of commercial parking by hospitality, leisure and residential activities within a specific site is one potential opportunity.

5.2.2 Residential Parking

The proposed residential parking rates support the parking to be unbundled from the lease or purchase of dwellings to allow more efficient use of resident parking. Placing a financial value on car parking spaces will encourage prospective residents to only lease or purchase the number of parking spaces they actually require. This arrangement will also attract residents who do not require a car for any of their daily trips, such as those who work or study within the MAC or are able to commute by bus or rail to external workplaces. Purchasing or renting a dwelling without parking will reduce the cost to prospective residents, making the MUP residential apartments more attractive than surrounding traditional dwelling options.

It is also recommended for residential car parks to be designed to enable ultimate flexibility for different vehicle types. For example, designing bays as skinny and deep allows parking for two micro cars or one standard car and a motorbike/scooter. On-wall / pillar bicycle parking can also be provided at the end of each space to enable owners to store bicycles outside their home.

5.2.3 Hotel and Residential Car Share Scheme

To reduce the car parking supply and provide a more attractive facility for prospective residents and hotel customers, it is recommended for developers to coordinate with companies providing short-term car rental or car share schemes as part of a site development. Car share operates in a similar manner as bicycle share schemes, with members paying an annual fee to access shared vehicles located close to their work or homes. This would enable residents who may occasionally need a car for weekend trips or activities which can't be accessed by public transport to join a car share scheme rather than rely on private car ownership.

Residential car share schemes are well established in Sydney, Melbourne and Brisbane, with five different companies providing private car share services in Australia. The car share schemes are often supported by Local Government through the provision of free on-street parking spaces for designated car share vehicles, as occurred in the City of Fremantle when a private car share scheme operated between 2007 and 2010. Proposals for new TOD developments in the eastern states, such as development sites in the Footscray Central Activities District, are including space for car share vehicles (in conjunction with the private car share operators) to support a reduced parking supply for individual tenants.

6.0 MUP Impact on Park ‘n’ Ride Facility

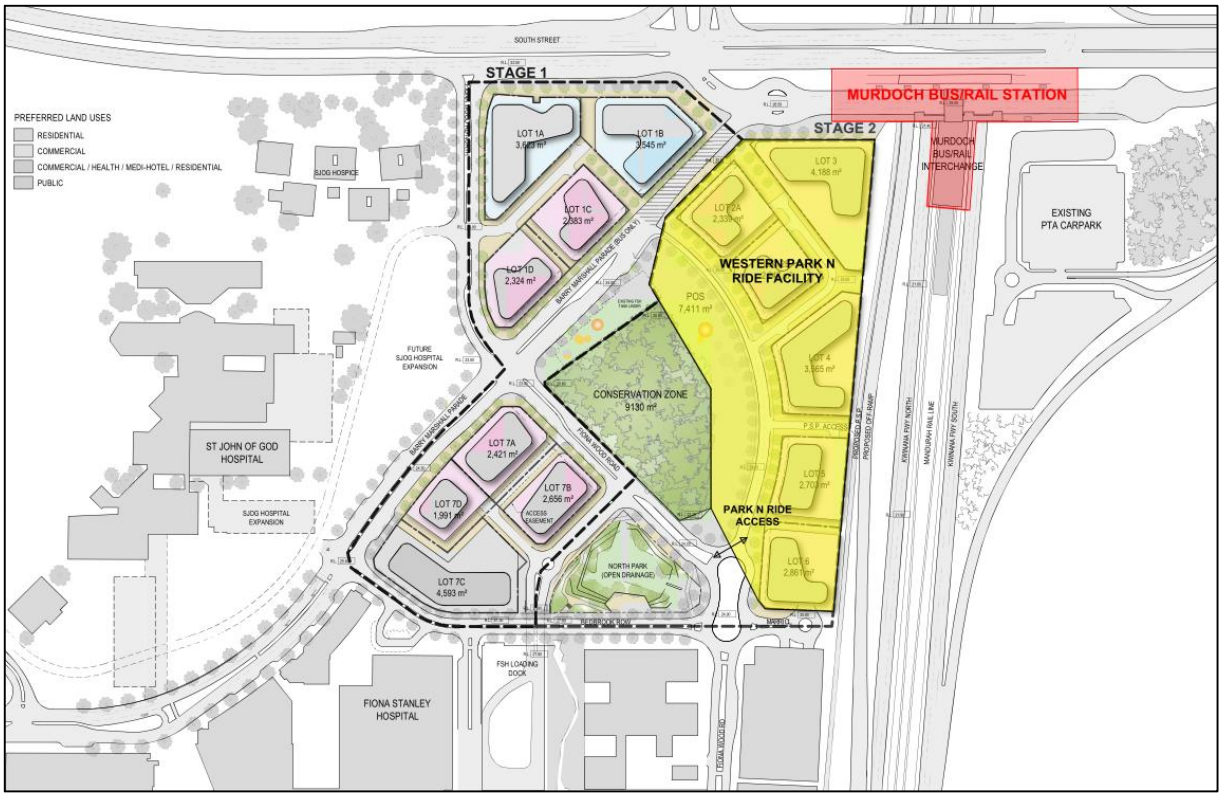
The large western section of the Murdoch Station Park ‘n’ Ride facility is located within the MUP Stage 2 development site. As well as impacting on the MUP development site, the retention of the western Park ‘n’ Ride facility in the current location will impact on peak traffic generation on the MUP and surrounding regional road network. The parking facility peak traffic movements coincide with the morning (6:45-7:45 AM) and afternoon (15:30-16:30 PM) peak movements for the two hospitals adjacent to the MUP site.

For Stage 1 of the MUP development, the western Park ‘n’ Ride facility will be retained within the MUP Stage 2 site. Existing access will be maintained via Fiona Wood Road, as illustrated in **Figure 2**.

It is intended for the western Park ‘n’ Ride facility to be relocated prior to Stage 2 of the MUP development. Several relocation options are under investigation by the PTA and Department of Transport, including the construction of a multi-storey carpark over the existing eastern Park ‘n’ Ride facility. The relocation options would remove all Park ‘n’ Ride vehicle traffic from the MUP network by Stage 2 of the development. The relocation options are subject to further investigations by the PTA and the Department of Transport, followed by consideration by the State Government. Although the Government lease agreement for the western Park ‘n’ Ride site expires in 2017, the relocation will only occur when there is agreement on a suitable option by all relevant government stakeholders.

It is noted that the recently implemented SmartParker system will prevent the use of the PTA car park by MUP commuters and visitors (and the adjacent hospital sites).

Figure 2 MUP Stage 1 Access to the Existing Western Park ‘n’ Ride Facility



7.0 Conclusion

The MUP Parking Strategy identifies opportunities to minimise traffic generation at peak travel times whilst supporting the commercial development of the site. The proposed parking supply rates were developed through research into parking provision at comparable TOD sites, consideration of travel options available for each activity and opportunities to share parking. The parking rates are in accordance with the conditional subdivisional approval based on a previous design (approved 26 April 2013), exceeding the minimum public parking requirements.

The proposed **maximum** parking supply rates are summarised in **Table 8**:

Table 8 Proposed MUP Parking Rates

Land Use	Parking Supply Rate (maximum)
Residential Tenants	- 1 & 2 bedroom dwellings - average of 1.1 parking spaces per dwelling - 3 bedroom dwellings – 2 parking spaces per dwelling
Residential Visitors	- An additional 5% of the residential tenant parking supply
Commercial and Commercial Health	- 1 space per 60 square metres Gross Floor Area (GFA) - A minimum of 25% of the total permitted parking supply to be designated as public parking
Hotel Accommodation Employee and Visitor	- 1 space per 3 bedrooms - A minimum 25% of the total permitted parking supply to be designated as public parking*
Large Retail (>1000 square metres) Employee and Visitor	- 1 space per 35 square metres GFA to be designated as public parking
Small Retail (<1000 square metres) Employee and Visitor	- 1 space per 50 square metres GFA to be designated as public parking

**Where more than 6 public parking bays are required*

The *Murdoch Activity Centre Access and Parking Policy* sets a maximum parking cap of 1,629 bays or 170 bays per hectare for the MUP site, for commercial, retail and all other non-permanent residential activities (excluding special purpose bays). Based on the ultimate scale of development included in the MUP Draft LSP, the proposed parking rates would supply a maximum of 887 parking spaces for the activities included in the parking cap assessment. This is 742 bays less than the maximum permissible commercial and retail parking supply of 1,629 bays. This provides capacity for additional spaces to be provided without exceeding the parking cap, such as for commercial health activities to provide for practitioner demands.

If the demand for commercial, retail or hotel accommodation floorspace is more than the anticipated yields included in the MUP Draft LSP, employee and visitor parking will need to be managed to ensure the total MUP parking cap of 170 bays per hectare is not exceeded. Approval for additional floorspace would require a developer to demonstrate how access can be managed without increasing the total parking supply or how additional parking would not significantly impact peak period traffic congestion.

The estimated total parking supply of 887 parking spaces for activities included in the MUP parking cap assessment incorporates a minimum 350 or 39 per cent public parking spaces (including 41 on-street parking bays). This is similar to the proportion of public parking provided in the Perth CBD and exceeds the minimum 25 per cent public parking required by the MUP conditional subdivisional approval and the *Murdoch Activity Centre Access and Parking Policy.* These parking bays must be available for visitors to all destinations, but can include time or fee restrictions to prioritise short-term visitor parking over all day commuter parking.

The management of parking spaces will be critical to ensure visitor parking is retained for short-term visitors rather than employee parking during peak weekday times. Each landowner must submit a Parking Management Plan and Travel Plan outlining how parking will be managed and enforced as part of the development application approval process, as specified in the Murdoch Parking Policy.

Appendix A

Assessment of opportunities to reduce parking supply rates

Appendix A Assessment of opportunities to reduce parking supply rates

A simple scoring system was used to compare the opportunities and benefits from reducing the parking supply rates for the different MUP uses:

- 1 = Poor opportunities / benefits
- 2 = Fair opportunities / benefits
- 3 = Good opportunities / benefits

The criteria considered in this assessment were:

- Whether other travel options are available which match typical travel times & needs of the activity.
- Whether the activity is likely to generate car trips at peak travel times on the MUP and adjacent regional road network.
- Whether the parking could be shared with other users (as public parking) or used by alternative activities at different times (reciprocal use).

Table 9 Opportunities and benefits for reducing the parking supply rate for different activities

Land Use Activity	Suitability of car-alternative travel options	Impact on peak traffic congestion	Opportunity to share parking with other activities	Opportunity / Benefit for reduced parking (SUM of scores)
Commercial (employee parking)	3 Excellent PT access at peak commuting times, and walk and cycle access for local residents	3 Commuter car trips to commercial activities likely to directly impact peak traffic congestion	2 There is some opportunity for reciprocal use of commercial parking by evening / weekend activities within the same site, depending on security requirements for commercial tenant parking	**8** **Significant opportunity to reduce supply & some opportunity for reciprocal parking use for evening / weekend activities within the same site**
Large Retail	2 Likely to attract many walking trips from local MUP and FSH / SJOGH employees, & commuters from Murdoch Station transferring from rail to bus/car/cycle. Will also attract car trips for larger shops, and from wider residential catchment	2 Unlikely to impact morning peak traffic, but could impact afternoon peak traffic congestion	3 Opportunity to share public parking for range of retail, leisure & entertainment activities	**7** **Large opportunity to provide shared public parking available for range of MUP visitors**
Small Retail	3 Aimed at people already working, living or visiting the MUP or adjacent FSH / SJOGH, therefore minimal	1 Unlikely to generate large number of car trips during morning or afternoon peak traffic congestion (some impact from	3 Opportunity to share public parking for range of retail, leisure & entertainment activities	**7** **Large opportunity to reduce parking supply & provide shared public parking for range of MUP visitors**

Land Use Activity	Suitability of car-alternative travel options	Impact on peak traffic congestion	Opportunity to share parking with other activities	Opportunity / Benefit for reduced parking (SUM of scores)
	demand for visitor parking. Evening retail commuters may require car, but smaller numbers.	employees, but small numbers)		
Short-Term Accommodation Visitors (Hotel)	2 Many international / interstate visitors likely to use taxis for airport travel, with easy PT and walking access within MUP for daily activities – reduces need for individual hire cars. Regional visitors may arrive by car.	2 Visitors commuting to external workplaces will contribute to peak traffic congestion	2 Visitor cars likely to occupy parking for long periods; but demand could be reduced through an onsite car hire scheme	**6** **Some opportunity to reduce parking supply as lower demand from interstate / international visitors**
Short-Term Accommodation Employees (Hotel)	2 Evening hotel employees may require car	2 Daytime hotel employees could contribute to peak traffic congestion	2 Could be provided as public parking for daytime visitors; available exclusively for staff during nights	**6** **Some opportunity to reduce parking supply**
Residential Visitor	2 Many visitors arrive after hours or on the weekend when there are less PT options, and many will come from outside walking & cycling catchments	1 Unlikely to attract many visitors during peak traffic congestion	2 Some opportunity to share visitor parking with other activities (either as shared public parking or reciprocal use of commercial parking in evening / weekend)	**5** **Some opportunity to provide shared public parking for range of MUP visitors**
Residential Tenant	2 PT, walking and cycling available for many weekday activities (work, education trips). Some weekend and after hour activities may require car; opportunity to reduce demand through onsite car hire scheme.	2 Counter-flow peak hour trips for MUP and adjacent MAC road network	1 Resident cars likely to occupy parking bay for long period. Opportunity to unbundle parking from dwelling lease / purchase arrangements to reduce overall parking demand.	**5** **Opportunity to reduce parking for some dwellings**

Appendix B

Comparison of Parking Rates

Appendix B Comparison of Parking Rates

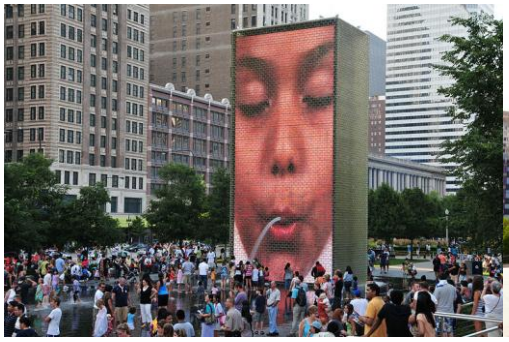
Land Use & Proposed MUP Parking Rate	Comparison Rates					
	City of Melville requirements	North Ryde (Sydney)	Subi Centro	Stirling City Centre (proposed car parking ratios, October 2010)	Cockburn Central	Claremont North East Precinct (proposed ratios, 2012)
Residential 1.2 bays / dwelling +0.06 visitor bays / dwelling Proposed for residential parking to be unbundled from dwelling leases / purchases	R-Codes for multiple dwellings – min of 1 / dwelling, max of 2 per dwelling (includes 10% of bays to be allocated for visitors)	0.6 to 1 bay / one bedroom dwelling 0.9 to 1.2 bay / two bedroom dwelling + 0.2 visitor bays / dwelling	1 bay / dwelling	0 bay / unit min 1 bay / unit max + 0.06 visitor bays, ideally on street	1 bay / 1-2 bedroom dwelling 2 bays / 3 bedroom dwelling + 0.1 visitor bays	1.2 bays / apartment max 2 bays / town house max. Parking to be 'unbundled' from apartments, so that people have a choice whether to buy /rent a bay.
Commercial 1 / 60 square metres *75% tenant, 25% visitor*	1 / 40 square metres NLA	1 bay / 40sq.m. GFA	1 bay / 40 sq.m. min 1 bay / 25 sq.m. max	1 bay / 250 sq.m. min 1 bay / 100 sq.m. max	1 bay / 40 sq.m. GFA	1 bay / 66 square metre *40% tenant, 60% visitor*
Retail Large (>1000sq. m.) – 1 / 35 square metre Small (<1000sq. m.) - 1 / 50 square metre	Shop City Centre – 5.5 bays per 100 sq. m. NLA (1 / 18 sq.m NLA) Small bar / Restaurant / café – 1 / 4 patrons at capacity & 1 / staff member	1 bay / 25sq.m. GFA	Large (>1000sq. m.) 1 bay / 20 sq.m. min 1 bay / 15 sq.m. max Small (<1000sq. m.)– 1 bay / 30 sq.m. min 1 bay / 20 sq.m. max	Large (supermarket) – 1 bay / 50 sq.m. min 1 bay / 25 sq.m. max	1 bay / 25 sq.m. GFA	1 bay / 50 square metre
Hotel (Short Term Accommodation) 1 / 3 bedrooms	1 bay / bedroom & 1 / staff member & 1 per 4 sq. m. of any function area	1 bay / 1.5 rooms				
Notes		The North Ryde /Macquarie Park office market has been a strong		Public car parking encouraged over private parking	Assumes that all parking generated by residential development is contained	The approach has been to maximise the percentage of public

Land Use & Proposed MUP Parking Rate	Comparison Rates					
	City of Melville requirements	North Ryde (Sydney)	Subi Centro	Stirling City Centre (proposed car parking ratios, October 2010)	Cockburn Central	Claremont North East Precinct (proposed ratios, 2012)
		performer. Car parking provision has been widely cited as a key strength.			within the building envelopes and does not extend into any neighbouring at grade parking areas (i.e. under croft parking), while parking for mixed use, office & retail is provided centrally in the street blocks, behind the built form	short term car parking while limiting non-residential private parking.

MURDOCH MIXED USE PRECINCT



PUBLIC ART STRATEGY





"Droplet" Stuart Green, Canberra. "Crown Fountain" Jaume Plensa, Millennium Park, Chicago "Cloud Gate" Anish Kapoor, Millennium Park, Chicago

i. Introduction - Purpose of the Report

Alison Barrett, Art Coordinator, was engaged by LandCorp to prepare a Public Art Strategy for the Murdoch Mixed Use Precinct (MUP). The Public Open Space (POS) will be a focus for retail, commercial, health facilities, community and civic entertainment uses in Murdoch. The public realm will aim to display vibrancy, foster a sense of community and civic pride.

This strategy provides detailed guidelines to the planning, procurement, delivery and management of Public Art in MUP. The strategy will also guide the implementation of Public Art by private developers responsible for the areas surrounding the POS. Within MUP, the funding and delivery of physical infrastructure (roads and footpaths), services (water, power, etc.), community facilities and public open space, together with public art, will be funded by LandCorp.

The purpose of this document is to assist LandCorp in their commitment to deliver land and infrastructure, and to plan communities that are attractive and accessible, while contributing to a distinctive local identity. The project team, development partners, landowners and the City of Melville will use this strategy and guidelines to set a new benchmark for design in Activity Centres, with design responses that will be exemplary, inspirational, innovative and creative.

This strategy provides the foundation for LandCorp's commitment to enhance MUP with public art in the POS. This will be achieved through LandCorp's budget. Contributions from private developers, on a Percent for Art basis, will be used to fund additional public art. This policy applies to all government and private developers of public and privately owned land within MUP. Private developers of these sites have the option of providing cash-in-lieu in place of procuring public art. The cash-in-lieu funds will be held by the City of Melville for the purpose of procuring public art in MUP. A 0.5%/0.5% strategy, whereby developers procure public art and funds are retained by the City of Melville for future public art in the POS should also be considered.

This public art strategy is in two parts:

PART 1 - Public Open Space strategy provides an overview of the public art program and sets out principles and procedures for the procurement, location and management of public art in the Public Open Space.

PART 2 - Public art as part of the built form funded through private developments within MUP. The strategy includes the vision and guidelines for the future development of the area surrounding the POS, procurement process, potential sites and themes for artworks.

ii. Executive Summary

Public art will contribute at all times to the creation of a vibrant contemporary mixed-use precinct. It will celebrate the precinct's unique natural features, rich social history, and its close proximity to institutions that are leaders in healthcare delivery, medical research, and education.

Artwork in the Public Open Space will be primarily landmark pieces, with the opportunity for artwork associated with the built form in the private developments to be more flexible in terms of scale, materials, interactivity and content. The intention of the strategy is not to be prescriptive, but to detail the process and provide opportunities for artists to deliver artwork to the precinct.

Public art at Murdoch Mixed Use Precinct will, at all times, retain a sense of belonging to the public realm, while creating character and identity within the precinct. This identity will be achieved through public and private developer contributions towards public art on a "Percent for Art" basis. In lieu of procuring public art, private developers will provide the equivalent cash, in line with the Percent for Art policy, to the City of Melville for public art in the Murdoch Mixed Use Precinct.

This strategy was written in consideration of the findings, recommendations and guidelines from a number of delivery partners. These guidelines provide the direction of acquisition, location and themes for public art commissioned by LandCorp, private land developers, other government agencies, and arts providers with MUP.

A Public Art Panel, with representation from a variety of interested parties, has been formulated to oversee the commissioning and implementation process. Implementation of this Strategy will be the responsibility of LandCorp and the appointed public art coordinator. Artworks commissioned within public spaces will be owned, and maintained by the City of Melville.



1 & 2. LED lights, Prospect, South Australia

iii. Background – Project History

LandCorp's vision and objectives for MUP is to, *"create a transit based, 'destination' that provides a range of complimentary activities including commercial office, allied health, retail, residential and short-stay accommodation."*

Murdoch Mixed Use Precinct is one of the top four priority Activity Centres under the Directions 2031 framework. Directions 2031 and Beyond: Metropolitan Planning Beyond the Horizon established a vision for the future growth for the Metropolitan Perth and Peel regions.

The 8 ha site located 12km south of Perth CBD, is a catalyst project for the creation of the Murdoch Activity Centre (MAC). The construction target for the first stage of the land delivery is 2016. MAC consists of four major institutional users as key economic drivers: Fiona Stanley Hospital, St John of God, Murdoch University and Challenger Institute of Technology - Murdoch.

MUP is to provide a range of complementary activities, including commercial offices, health, retail, residential, and short-stay accommodation. MUP is located within the Murdoch Activity Centre and connects to the existing transit station and links with Fiona Stanley and St John of God Hospitals, and nearby educational facilities.

Murdoch Mixed Use Precinct is strategically located within MAC to merge with the Murdoch Train Station and is surrounded by institutions that are leaders in healthcare delivery (Fiona Stanley Hospital, St John of God) and medical research (Harry Perkins Institute of Medical Research) and education (Murdoch University and Challenger Institute of Technology). These institutions have been the driving forces in the naming of streets in the precinct: Dr Fiona Wood (Plastic Surgeon), Dr Barry Marshall (Nobel Laureate), Sir George Bedbrook (Orthopaedic surgeon), Dr Aileen Plant Park (Infectious diseases epidemiologist), Dr Robin Warren (Pathologist, Nobel Laureate), and the late Dr Alasdair MacKellar (Pediatrician). The location of MUP facilitates bringing together surrounding transit, health and education precincts, which is a major objective of the Murdoch MUP. MUP also aims to provide 'something for everything', catering for a wide range of audiences and will provide a diverse and flexible mix of programming to activate the public realm.

iv. Role of Public art in Murdoch Mixed Use Precinct

This public art strategy was guided and formed by a working group managed by LandCorp with input from place makers, architects, landscape architects, urban planners, public art consultants and others and together with their respective strategies and guidelines have helped shape these public art guidelines. Place Partners Place Making Strategy set the strategic framework for the precinct. Through consultation with the design team, place drivers for the development were formulated as:

- Youthful - energy, freshness and fun
- Connected - relationships between people and place
- Retreat - another place from less stressful everyday environments

Themes

Public art will enhance the precinct by providing social, economic and environmental benefits, including:

- Physically enhancing public places and realm through points of interest, enjoyment and contributing to 'sense of place' and identity
- Providing meaning, context and interpretations of the precinct by providing links to its history, character and rich culture
- Heritage - acknowledge Aboriginal ownership, connection and history, non-indigenous, place story and aspirations
- Use – anticipated use of the site from culturally diverse demographics
- Ecological – flora and fauna - Conservation Zones' Marri- Banksia - Melaleuca woodland and habitat and food resource for Carnaby's Black Cockatoo
- Reflective and aspirational of todays technology
- Showcase emerging and established artists. Due to the diverse backgrounds, a wide range of cultural perspectives will be evident in the artwork, including indigenous and non-indigenous artists.

These public art guidelines are designed to be intentionally not prescriptive. This will permit artists the flexibility and artistic license to design innovative and creative artworks.

Public Art Locations

Public art is proposed for two principal areas within MUP:

- Public Open Space, and
- Private Developments

Public art is an integral part of Stages 1 and 2 of MUP within the Public Open Space, and as part of the built form in private developments surrounding the POS. Public Art will be linked thematically across the whole precinct, whether in the POS or as part of the private developments. All artworks are to be accessible to residents and visitors to the precinct and bring vibrancy, interest, and a sense of identity to the area.

<u>Public Open Space (POS)</u>
The map below provides an indicative location for public art within the MUP Public Open Space. This location, for Stage 1, was selected in consultation with the Architectural and Landscape teams to enhance the main vehicular and

pedestrian thoroughfare via Barry Marshall Parade. This location, in the open space (West Park) on the corner of Barry Marshall Parade and Fiona Wood Road represents a highly visible location/street intersection. A major landmark artwork located here needs to be engaging, reflective while reinforcing the precinct's sense of place as a centre of innovation, learning and excellence. It needs to provide a direct physical and visual link between the different parks surrounding the POS All artworks are to be developed in accordance with this Public Art Strategy and in accordance with the City of Melville's public art guidelines.

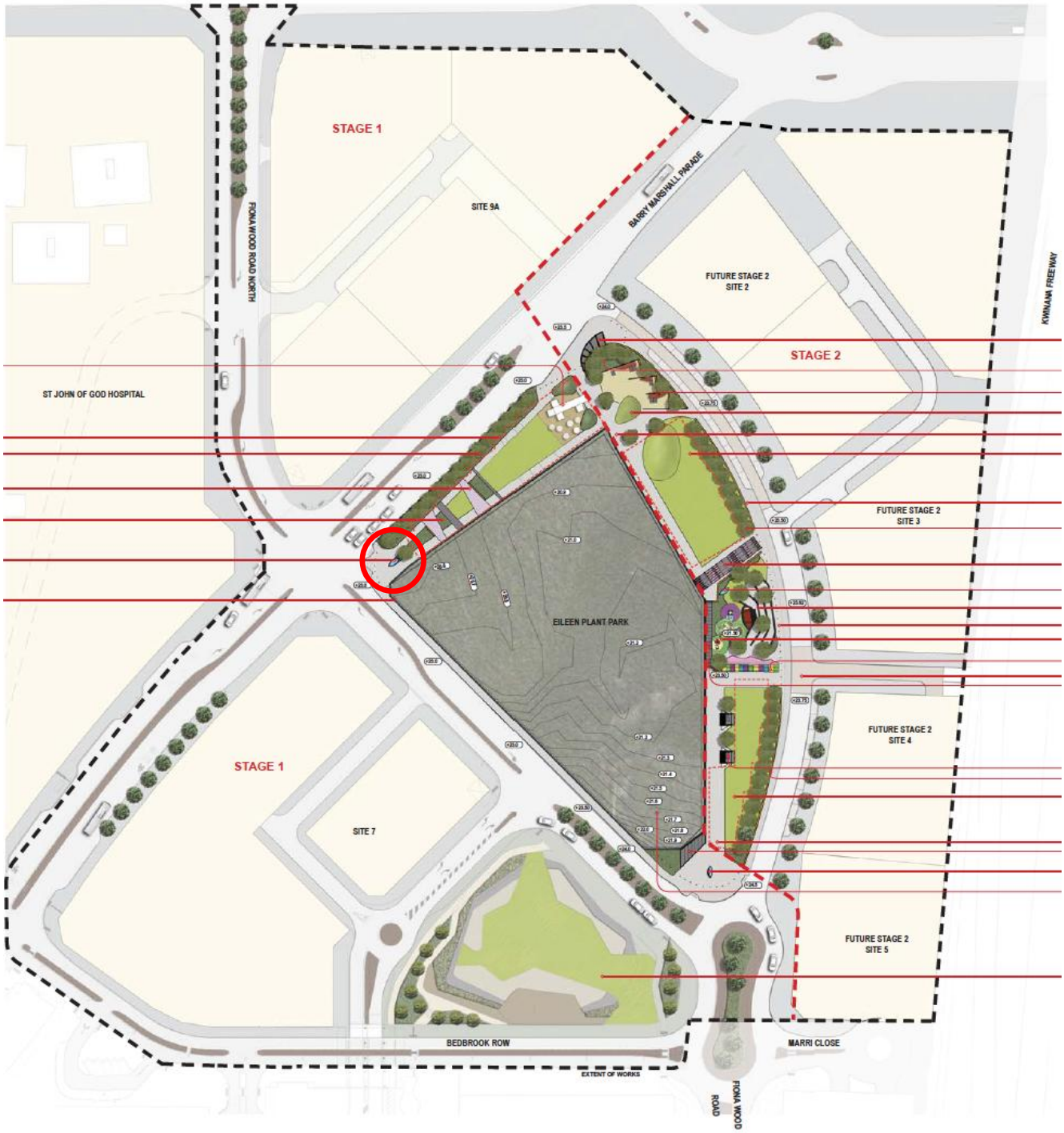


Figure 1. MUP Public Open Space – Stage 1 - indicative location for public art

In addition to the above location, other opportunities were identified for Stage 2. These included the southern and northern ends of the Conservation Zone. These locations were proposed due to their high visibility and because these together with the location at the corner of Barry Marshall Pde and Fiona Wood Rd provide

sight lines around the perimeter of the Conservation Zone. These three locations are at key decision points for vehicular and pedestrian traffic. Each serves as a unique marker and aid in way finding through the precinct. Artwork located at the southern end of the Conservation Zone needs to consider existing artwork in Fiona Stanley's North Park (see appendix 1).

Potential opportunities for artworks were identified by the design team, to be located on the POS and include:

- Large freestanding iconic landmarks
- Works that frame different spaces and provide visual links and viewing corridors through and around the Conservation Zone
- Interactive or kinetic responding to public or environmental interaction. The artwork may be triggered by fluctuations in the external environmental conditions such as movement/speed, wind direction displayed by changes in lighting (LED lights)
- Celebrating creativity and innovation in the use of materials, integrated lighting to enhance the open spaces16/7 appeal. Lighting will contribute to improving the walkability of the area, while combating sections of the site that will be affected by prolonged periods of shade, and
- Engage Indigenous artists or residents of nearby Wandoo Reintegration Facility/Rangeview Remand Centre to design and fabricate artwork, while complying with City of Melville's public art guidelines and LandCorp's commitment to engaging Indigenous artists in public art commissions.

The public art must consider its unique relationship with a diverse and wide-ranging audience, including from young to senior, residents and visitors to the precinct, student, workers, hospital staff, etc. Users of the precinct will come day and night, through different sessions and range of weather. It is, therefore, important that artworks encourage active and passive involvement, through the use of light and new technologies that are durable and easily maintained.



1



2.

1. Willeton Senior High School, Stuart Green, Willeton 2012. 2. Bruce Armstrong, "Bunjil" Melbourne Docklands, 2002.



1



2



3



4



5

1. Marcus Canning/Christian de Vitri “Ascalon”, St Georges Cathedral, Perth 2009 2. Lawrence Argent “ Big Blue Bear” Denver, 2005. 3. Blowhole” - Duncan Stemlet, Melbourne Docklands 2005 .4, “Totem” by Geoffrey Drake Brockman, Perth Arena, Perth 2012 5. Warren Langley, Harris Street, Ultimo

Additional sites have been identified as potential locations for different scaled, artworks that engage and challenge users of the POS in different and meaningful ways in the POS. The procurement of public art in these sites is dependent on additional funding. These sites include:

- South Park - On the pedestrian promenade, adjacent to the roundabout at the southern end of Aileen Plant Park. (conservation zone) A potential disadvantage of this location is its close proximity to Peter Farmer's artwork "*Wardan-Noom*" in Fiona Stanley Hospital's North Park. (see Appendix 1)
- Central Park - Public artwork cascading down a retaining wall or integrated into an arbor – However in light of the other activities in this area, including play equipment/climbing wall, bridge and amphitheatre, this location may already be busy enough to warrant public art.



1



2



3



4



5



6

1. Nice, France 2. Stuart Green 3. Wendy Mills, Queen Street Mall, Brisbane 4. Giant living room - Subi Centro - Peter Dailey 5. "Pieces of Lives" - Hyde Park, Judith Forrest 6. Temporary public art commission, City of Perth

PRIVATE DEVELOPMENTS WITHIN MUP

The aim for all public art at MUP is to create a cohesive public art collection that enhances and animates public places and the public realm, through points of interest to create an exciting and rich urban environment.

The following principles are to be applied to the procurement of public art on private developments within MUP. Artworks must:

- Be visible and accessible from the public realm, frame and contribute to the public amenity of the POS
- Aid in way finding around the precinct
- Be created or designed by professional artists
- Be site specific and to be responsive to the site context
- Be designed, constructed with high quality and contextually appropriate materials
- Be considerate of other public art within proximity of other artwork, and
- Innovatively shape MUP in new and unexpected ways, i.e., innovative lighting and projection.

The location and type of artwork will be unique to each site and will be developed in consultation with the artist, developer and the Art Selection Committee.

The City of Melville requires that all private developments with budgets exceeding $1 million provide public art to the value of 1% of the development cost. This must comply with the Provision of Public Art in Private Developments (Policy No. CP-085), where "*each application for the construction of a multiple dwelling, mixed use or no-residential development will be required to provide public art to the value of 1% of the cost of development*". The proposed public art must be submitted to, and be approved by the City prior to approval of a development application.

The objectives of the Provision of Public Art in Private Developments policy objectives are:

- To contribute to a sense of place through the provision of public art, which provides an interpretation and expression of the local area's natural, physical, cultural and social values
- To enhance public enjoyment and understanding of places through the integration of art into developments
- To add to the appearance, vibrancy, character and amenity of developments and their surrounding environment
- To create local landmarks, and
- To provide increased public exposure to, and understanding of, public art.

The City of Melville requires that all public art within development proposals should satisfy all of the following criteria:

a. Be located where it can be clearly seen from the public realm
b. Be an original artwork
c. Be of high aesthetic quality
d. Be durable, sustainable and easy to maintain
e. Contribute to an attractive and stimulating environment
f. Not detract from the amenity or safety of the surrounding area

g. Where considered appropriate be lit at night by the use of energy efficient lighting but such that there is no adverse amenity impact on the surrounding locality
h. Be responsive to the site context and reflect the local area's natural, physical, cultural or social values history
i. Take into account the existing public art in vicinity so to avoid repetition and to ensure the artwork is unique
j. That the public art be functional where appropriate
k. Be to the value of no less than 1% of the estimated cost of the development, and
l. Be as resistant as possible to vandalism.

If the developer wishes not to procure public art for their development they can provide a cash-in-lieu payment, equivalent to the 1% public art contribution, to the City of Melville. Cash in lieu payment will be received from the developer and be held by the City of Melville Capital Arts Budget. The City will use these funds to procure public art to be located within MUP. These funds could be used to fund public art of varying scale.

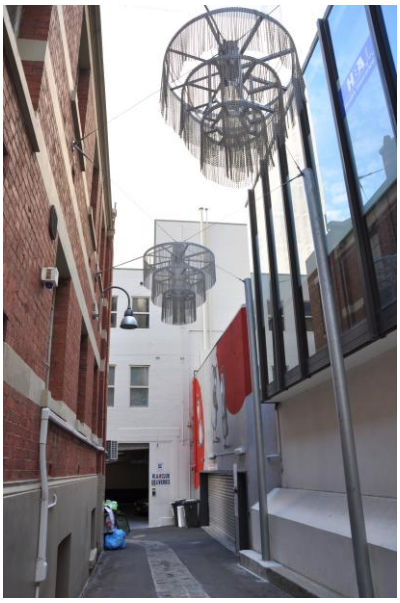
An alternate strategy would involve splitting the 1% public art contribution equally between the private development and the City of Melville. That is:

1. 0.5% is used by the developer to procure public art specifically for the development, and
2. 0.5% is given to the City of Melville. City of Melville funds would accumulate and could subsequently be used to fund public art of varying scale in public open spaces within MUP.

Furthermore, funds accumulated with the City of Melville could be used to support a variety of public art mediums, including temporary and ephemeral art to activate a specific area within MUP. Such funds could also be used to fund the replacement or restoration of existing public art - this also may be appropriate where insufficient funds are available in the project area fund to purchase new works.

Other sources of funding and collaboration for future public art commissions within MUP will be explored and sought on an ongoing basis.





1."The Puddle" , Anna Crane - temporary public art program, Fremantle 2. Lights, City of Perth.

Artist Procurement

When commissioning public art within MUP, LandCorp and the public art selection committee will employ best practice commissioning processes to ensure an equitable and transparent process for the acquisition of quality public art. Evaluation measures will be implemented to ensure that MUP's approach to public art remains innovative and effective.

An experienced Public Art Consultant will be appointed to coordinate and manage the commissioning and management process of every commission. The following steps provide a guide to the process:

1. **Procurement Process** – The type of procurement process is dependent on the size of the budget, time available for each commission and objectives of the project.

a. Generally contracts valued at over $50,000 are required to be advertised through a public tender process. Best practice procurement for projects under $50,000 is to request at least three proposals for consideration. In this process, three artists may be contacted directly for an Expression of Interest (EOI), or LandCorp/City of Melville or the appointed public art consultant may publicly advertise the EOI to gain a wider choice of artists and proposals.
b. A curated process can be applied when a contracted Public Art Consultant selects and invites artists to submit proposals. This may be appropriate where a particular type of artwork is desired and artist/s working in that medium are directly contacted. This process may also be chosen for smaller budget projects to reduce timeframes.
c. Invite an artist/s or team to become part of the design team and design a series of freestanding and integrated works for both the public open space and built form. One artist would be team leader and could allocated different commissions to other members of the team. The selected artist is given the opportunity to select where individual components will go that will have the greatest impact within a particular zone.

2. **Selection Panel** - A Selection Panel will be formed to manage all public art commissions. For the commissioning within the MUP's Public Open Space, an Art Selection Committee has been formed with members form the working group, such as representation from LandCorp (Coordination only), City of Melville, Architect, Landscape Architect and other stakeholders and/or community members depending on the intent, location and budget of the commission. This Committee will consist of:

- LandCorp Development Manager
- Architect - ARM
- Director/Senior Landscape Architect – EMERGE ASSOCIATES
- Strategic Planning, Murdoch University
- Curator/Arts Manager, St John of God Hospital, Murdoch
- Director – Community Development, City of Melville
- Public Art Consultant (non voting)

The consultation panel may change or extra consultation may be required with local community groups, indigenous groups and/or government agencies).

A protocol will need to be established for members of the Selection Panel to ensure potential perceived conflicts of interest are avoided.

Representatives from LandCorp and appointed Art Consultant will attend all public art meetings to provide specialist input and to ensure that public art is integrated with the approved public art guidelines. These representatives will:

- Prepare agendas and document process
- Oversee program planning
- Commissioning of artwork/s
- Oversee fabrication and installation of artwork/s, and
- Advise on any other Public Art matters as required

For public art commissions that form part of the private developers scope of works, the private developers must appoint an independent Art Consultant to mange the project. Private Developers are not to manage the commissioning, procurement or management of public art commissions. From time to time, one or more consultants will be nominated by the Director - Community Development from the City of Melville, may be employed to work on projects on behalf of the City and will report back to Melville.

The City of Melville will formulate a Public Art Advisory Committee with representatives from the City, members from POS Art Selection committee, local residents/MUP residents and managed by an appointed Public Art Coordinator, to oversee all private developments.

Public Art Advisory Committee will:

- Contribute to the development and implementation of the public art strategy and public art projects within the precinct.
- Ensure that the approved process for commissioning artworks is adhered to.
- Ensure that the practice of public art throughout the MUP is consistent with the guidelines in the public art strategy, and
- Will review brief/s and submitted Expressions of Interest (EOI's), participate in artist/s selection processes and design development presentations as required.

Both Art Selection Committees will be engaged for a fixed term and shall be reviewed at various times. The composition of the Art Selection Committee will change over time; it is very important to obtain input from people who reside in the precinct, and who will ultimately have to live with the art. The Committee should change and be responsive to interested parties that are actively living and working in MUP. It is important that as the composition of the committee changes some existing membership is retained to ensure corporate memory of past decisions that may help with future public art decisions/directions.

The City of Melville's Department of Community Development will oversee all public art projects. Their primary role is to administer and oversee each project, to make sure that the Art Coordinator is following due process and that the process is transparent and accountable. The City will contract the management and administration of each public art project to an appointed public art coordinator who will be paid a fee, a percentage of the artwork budget.

3. **Artwork Brief** - an artwork brief will be prepared by an appointed public art consultant in consultation with the City of Melville and the Selection Panel. The brief will provide project background, vision/themes for the artwork, location, budget, timing, and any objectives or constraints with regard to the form/type,

scale, or materials of the artwork. The brief will provide the selection criteria to be used by the Selection Panel to select the short listed artists. It will also provide details of what the artists are to submit with their Expression of Interest - written responses to selection criteria, a short CV, marquette and relevant images of past artworks. The call for EOI's should usually run for between 2 -3 weeks

Alternatively, an artist or a limited number of artists could be engaged/approached directly without going through the tender process. This path may be used when the artwork budget is less than $50,000.

4. **Short Listing** – The Art Committee meets to assess the EOI's to assess each submission against the selection criteria. The Panel discusses each submission and selects the preferred artists or artist teams (normally 3). These artists will be invited to progress to the next stage and submit a Design Concept Proposal.

5. **Design Concept** - Each short listed artist/artist team then prepares a design concept in response to the brief. The submission requirements will usually include concept develop documents, a Marquette or detailed plan showing dimensions, colours and materials, a written design statement and a detailed budget.

Depending on the scale of the project, artists are given 6 to 8 weeks to submit their Design Concept. An artist briefing session is scheduled at the start of the Design Concept process for all shortlisted artists with LandCorp or Developer, Art Coordinator and other design professionals working on the project. Artists will be paid a fee for preparation of the Design Concept.

6. **Final Selection** - The Art Selection Committee meets and each artist or artist team presents their Design Concept Submission to the Panel. Following the presentations, the Panel undertakes a group assessment and selects the preferred proposal.

Once the artwork budget has been approved, artist/s should come on board as quickly as possible to maximize opportunities for involvement decision-making processes that may impact on the artwork. It is essential that artist/s come on board before development applications are lodged to the City of Melville for approval by Council.

7. **Contract** - Once selected, the artist/s are provided with a contract, which sets out terms and obligations, work program and payment schedules.

8. **Government Approvals** – Once the Design Development Report with final detailed design documentation, engineering specifications and certification are received and approved, these are submitted to the City of Melville (COM) for approval to obtain a development approval, or a building license. If development approval is required on COM owned land, COM will prepare and lodge the application. The artist will be responsible for obtaining any building license or other local government approvals, with LandCorp's assistance where required.

9. **Preparation of Artwork** - The artist produces the artwork. LandCorp or developer makes progress payments in response to Tax Invoices submitted by the artists to the Art Consultant for approval. The artist is also required to submit written progress reports (with images where appropriate) when submitting Tax invoices for progress payments. Visits to artist's studios are

arranged by the public Art Consultant to view progress of the artwork.

10. **Installation & Handover** - The artwork is to be finished and delivered to the site by the agreed completion date. LandCorp or the developer arranges with the artist or another contractor for the safe and legal installation of the work and installation of a naming plaque. The artist will then provide a project record and maintenance schedule. Final payment is then made to the artist. An unveiling or media launch of the work may be appropriate.

11. **Maintenance report** - There is the requirement for artists/artist teams to provide a detailed maintenance manual that sets out construction and materials used, expected life span, details of cleaning and fabricator and artist details.

The responsibility of management and maintenance of the public artwork in the POS will be handled by the City of Melville and maintenance of the developments surrounding the POS will be covered by the eventual owner of the development.

12. A plaque or similar identifier is to be installed on, or in close proximity to the public art which details the artist's name, name of the installation and date of the installation.

Prepared by
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APPENDIX 1 - SITES OF EXISTING PUBLIC ART COMMISSIONS LOCATED AROUND MUP

There are several public artworks located around the precinct, commissioned by Main Roads WA (MRWA) and Perth Transit Authority (PTA). The locations, themes and scale of these existing artworks need to be considered when designed new artworks within the precinct.

"*Onward and Upward*" by Mark Datodi
Murdoch Train Station



The stone tiles represent the physical characteristics of the site including topography and the surrounding natural vegetation, in particular the natural limestone that is common to this region of Perth. The stone tiles signify the gridding of the land for urban development with the natural surface texture of the stone referencing the land from an aerial prospective.

"*Black Cockatoo*" by Darren Hutchens (Dazart) with Dan Duggan, Lawry Halden and youth - Perth Transit Authority (PTA) mural programme
Murdoch Train Station



It is a tribute to the black cockatoo and the spider orchid, whose habitat is in the area surrounding Murdoch. The artists saw the wall as a meditation on the importance of public transport in tackling climate and overpopulation issues. As commuters wait at the station, the wall offers them a moment of quiet contemplation amid the rush."

"*Species*" by Rick Vermey - Main Roads WA (MRWA)
Murdoch Drive South Street Intersection upgrade



Two unique graphically pic-perforated corten steel screens, wall mounted, in front of roadside amenity-wall surfaces. Multi-panel screens, backlit illuminated, using programmed colour-changing linear LED down-lighting, to produce a notable change of presence and materiality from day into night.

"*Wardan-Noorn*" by Peter Farmer
North Park, Fiona Stanley Hospital (Between Fiona Wood Road and Bedrook Row)



A design that is traditional in its imagery; it changes from day to night, engages with its landscaped surroundings and readily identifies North Park as a meeting place. This 12 m stainless steel eel swimming through 21 reeds is a traditional design.

(NB. There are 10 artworks located in external and internal locations at the Fiona Stanley Hospital by Anne Neil, Mark Datodi, Stuart Green, Judith Forrest, Tony Jones, Olga Cironis, Jo Darbyshire and Kidogo Art Institute are located with the Fiona Stanley Hospital.)