

GROUNDWATER MONITORING AND MANAGEMENT PLAN, CYGNIA COVE, WATERFORD

Prepared for:

Trustees of the Christian Brothers in Western
Australia Incorporated
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12 January 2010

Trustees of the Christian Brothers in Western
Australia Incorporated
C/- Richard Noble and Company
Level 1
189 Hay Street
SUBIACO WA 6008

Attention: Alex Gregg

Dear Alex

**RE: GROUNDWATER MONITORING AND GROUNDWATER MANAGEMENT PLAN, CYGNIA
COVE, WATERFORD**

The attached Groundwater Monitoring and Groundwater Management Plan for Cygnia Cove, Waterford is intended to satisfy the first component of Proponent Commitment No. 4 for Ministerial Statement 692 (*Prepare Groundwater Management Plan*). This report has been revised to address comments made by the site auditor.

The second component of Proponent Commitment No. 4 involves the development of a Dewatering Program. It is intended that this will be completed at a later date, and will be lodged with the application for a dewatering licence.

If you have any further queries, please contact myself or Paul Zuvela on 9355 7100.

For and on behalf of Coffey Environments Pty Ltd



Pamela Lee
Environmental Scientist

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ABBREVIATIONS

µg/L	micrograms per litre
µm	micrometers
µS/cm	microsiemens per centimetre
ADWG	Australian Drinking Water Guidelines
Al	aluminium
ANZECC	Australian and New Zealand Environment and Conservation Council
ARL	Analytical Reference Laboratory
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	arsenic
AS	Australian Standard
ASS	acid sulphate soil
ASSMP	Acid Sulphate Soil Management Plan
ASSMW	acid sulphate soil monitoring well
ATA	ATA Environmental
ADWG	Australian Drinking Water Guideline
Ba	barium
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
C₁₅₋₂₈	petroleum hydrocarbon chain length
Cd	cadmium
CEMP	Construction Environmental Management Plan
cm	centimetre
COC	Chain of Custody

ABBREVIATIONS

Coffey	Coffey Environments Pty Ltd
COPC	contaminants of potential concern
Cr	chromium
CSM	conceptual site model
Cu	copper
DEC	Department of Environment and Conservation
DO	dissolved oxygen
DoE	Department of Environment
DoH	Department of Health
DQO	data quality objective
DWG	Drinking Water Guidelines
EC	Electrical Conductivity
Eh	Oxidation/reduction (redox)
EIL	Ecological Investigation Level
EPA	Environmental Protection Authority
Fe	iron
FWG	Fresh Water-Rivers guidelines
ha	hectare
Hg	mercury
HMF	Hardness Modification Factor
ID	identification
IL	Investigation Level

ABBREVIATIONS

IP	interface probe
JDA	JDA Consultant Hydrologists
km	kilometre
LOD	Limit of Detection
LOR	Limit of Reporting
LTIWG	Long Term Irrigation Water Guidelines
m	metre
m²	square metre(s)
mAHD	metre(s) Australian Height Datum
mbtoc	metre(s) below top of casing
mE	metres North
mg/kg	milligram(s) per kilogram
mg/L	milligrams per litre
mgCaCO₃/L	milligrams Calcium Carbonate per Litre
MGT	MGT Environmental Consulting
mm	millimetre
mN	metres North
Mn	manganese
mV	millivolts
MW	monitoring well
NA	not applicable
NATA	National Association of Testing Authorities

ABBREVIATIONS

NEPM	National Environment Protection Measure
NH₃-N	Free Ammonia
NHMRC	National Health and Medical Research Council
Ni	nickel
OC	organochlorine
°C	degrees Celsius
OP	organophosphorus
PAH	Polycyclic Aromatic Hydrocarbon
Pb	lead
PCB	Polychlorinated Biphenyl
PER	Public Environmental Review
POS	public open space
PSH	Phase Separated Hydrocarbon
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
RPD	Relative Percent Difference
Se	selenium
SGS	SGS Environmental Services
STIWG	Short Term Irrigation Water Guidelines
SWL	Standing Water Level
TDS	total dissolved solids

ABBREVIATIONS

TKN	Total Kjeldahl Nitrogen
TP	test pit
TPH	Total Petroleum Hydrocarbon
TRH	Total Recoverable Hydrocarbon
TSS	Total Suspended Solids
WRC	Water and Rivers Commission
Zn	zinc

1 INTRODUCTION

1.1 Background and Site Identification

This report presents historical groundwater monitoring data (2003/2006) and a baseline assessment of groundwater quality (2008) prior to remedial works being undertaken at the Cygnia Cove site (formerly known as East Clontarf). The Cygnia Cove site is located south of Manning Road in the suburb of Waterford (Figure 1) and comprises Pt. Lot 83 and Lots 501 and 829 Manning Road, Waterford.

Historical and baseline groundwater monitoring data has been assessed to establish a groundwater monitoring and contingency plan to maintain groundwater quality during remedial works at the site.

The site is located approximately 8km south-east of the Perth central business district, and the area of the site is approximately 20ha. The coordinates of the centre of the site are approximately 395,730mE and 6,457,300mN. Copies of the current Certificates of Title for Lots 501, 83, and 829 Manning Road are presented in Appendix A.

Clontarf Bay on the Canning River forms the southern boundary of the site, and approximately 30% of the site comprises a Resource Enhancement category wetland that trends east-west along the northern central portion of the site. The wetland drains to Clontarf Bay along a narrow drainage line situated near the western edge of the site.

The topography of the site has historically been modified and the original size of the wetland has been reduced. During the 1940s, pine plantations and market gardens were present at the site. Drainage channels were also created and maintained to assist in reducing groundwater levels. It is understood that uncontrolled fill was imported to the site prior to 1968 in order to elevate the area occupied by the Christian Brothers' Clontarf Orphanage playing fields, in the southern portion of the site.

1.2 Previous Investigations

Coffey Environments (then as ATA Environmental, ATA) has previously investigated soil and groundwater contamination at the site, as described in the following reports:

Environmental Assessment, East Clontarf, Manning (ATA, 2001) ATA Environmental Report 2000/179. Prepared for Trustees of the Christian Brothers, January 2001.

Preliminary Assessment, East Clontarf, Manning (ATA, 2002a) ATA Environmental Report 2002/47. Prepared for Trustees of the Christian Brothers, May 2002.

Remediation Report, Asbestos Contamination, Clontarf Aboriginal College, Manning (ATA, 2002b) ATA Environmental Report 2002/122. Prepared for Trustees of the Christian Brothers, September 2002.

Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program (ATA, 2002c) ATA Environmental Report 2002/147. Prepared for Trustees of the Christian Brothers, December 2002.

Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning (ATA, 2003a) ATA Environmental Report 2003/115. Prepared for Trustees of the Christian Brothers, August 2003.

Detailed Soil and Groundwater Investigation, East Clontarf, Waterford (ATA, 2003b) ATA Environmental Report 2002/92. Prepared for Trustees of the Christian Brothers, December 2003.

The site was formally assessed under the *Environmental Protection Act 1986*, and a Public Environmental Review (PER) of the proposed development was prepared and released for public comment in June 2004. Reports associated with the formal assessment process include the following:

Clontarf Residential Subdivision, Waterford, Public Environmental Review Environmental Scoping Document Assessment No. 1467 (ATA, 2003c) ATA Environmental Report 2003/39. Prepared for Trustees of the Christian Brothers, October 2003.

Clontarf Residential Subdivision, Waterford, Public Environmental Review (EPA Assessment No. 1467) (ATA, 2004a) ATA Environmental Report 2003/91, Version 5. Prepared for Trustees of the Christian Brothers, June 2004.

Clontarf Residential Subdivision, Waterford, Responses to Submissions (EPA Assessment No. 1467) (ATA, 2004b) ATA Environmental Report 2004/182. Prepared for Trustees of the Christian Brothers, October 2004.

Clontarf Residential Subdivision, Waterford, Ministerial Statement No. 692, Section 45C Referral (ATA, 2006) ATA Environmental Report 2006/82. Prepared for Trustees of the Christian Brothers, April 2006.

In accordance with Ministerial Statement No. 692, the following management plans have been prepared.

Dust and Asbestos Management Plan (Coffey, 2009) Coffey Environments Report 2006/225, Version 9, prepared for Trustees of the Christian Brothers.

Acid Sulfate Soils Management Plan, Cygnia Cove, Waterford (Coffey Environments, 2010a) Coffey Environments 2006/129, Version 7, prepared for Trustees of the Christian Brothers.

Site Remediation and Validation Management Plan, Cygnia Cove, Waterford (Coffey, 2010b) Coffey Environments Report 2006/130, Version 7, prepared for Trustees of the Christian Brothers.

1.3 Proposed Site Works

It is proposed to develop the site for residential use with public open space (POS), and retain the western portion of the existing wetland (Figure 2). Remedial works will be required prior to development in order to remove geotechnically unsuitable material (uncontrolled fill) which locally exceeds Department of Environment and Conservation (DEC) EIL guidelines for metals, and contains some asbestos sheeting.

1.4 Objective and Scope of Works

As part of Ministerial Statement No. 692, the Trustees for the Christian Brothers have committed to the preparation of a Groundwater Management Plan. More specifically, Proponent Commitment No. 4 states:

“(1) *Prepare a Groundwater Management Plan as a component of the Construction Environmental Management Plan (CEMP) to the satisfaction of the DoE, Swan River Trust and Water Corporation*” which will include:

1. *Determining the nature and extent of groundwater contamination;*

2. *Installation of 2 additional monitoring bores;*
3. *Quarterly sampling of both additional and existing monitoring bores for a 12-month period;*
4. *Groundwater flow characteristics; and*
5. *Groundwater contamination plume management.*

(2) *Develop a Dewatering Program as a component of the CEMP to the satisfaction of the DoE.”*

In order to fulfil the first part of this commitment the following scope of works was undertaken:

- Installation of two additional bores (2006);
- Repair/reinstallation of damaged groundwater monitoring bores; and
- Quarterly sampling for a 12 month period.

In order to satisfy auditors requirements, the following additional works were undertaken:

- Installation of six additional bores (2008);
- Repair/reinstallation of damaged groundwater monitoring bores; and
- Completion of a baseline groundwater monitoring programme.

The work undertaken has culminated in the production of this Groundwater Management Plan.

A Dewatering Management Plan detailing the dewatering program will also be prepared at a later date to ensure that works will be undertaken in a manner that minimises negative impact to the wetland and Canning River environment; thereby fulfilling the second part of Proponent Commitment 4.

2 ENVIRONMENTAL SETTING

2.1 Site Observations

The site is surrounded by the following land uses: the Clontarf Aboriginal College to the west, residential to the north and east, Centennial Park (a former landfill) to the south-east and foreshore reserve and river to the south.

2.2 Topography and Geology

The site slopes down towards the Canning River, with a maximum elevation of approximately 9mAHD near Manning Road, 2-3mAHD through wetland areas, and 1mAHD along the foreshore, and a mound of up to 6m high is present in the south-east corner of the site. The south-eastern boundary of the Cygnia Cove Estate site with the adjacent former landfill site comprises a steep 5m embankment due to the presence of built-up landfill material.

The natural surface geology over the majority of the site (excluding the wetland) is mapped by Jordan (1986) as comprising Unit S₈, Bassendean Sand (of the Superficial Formation). Unit S₈ is described as fine- to medium-grained sub-rounded quartz sand which is very light grey at surface and yellow at depth (Jordan, 1986). The wetland in the north central portion of the site is mapped as comprising Unit S₁₄, Alluvium, which is described as white to pale grey, medium to coarse-grained quartz sand with abundant shell fragments (Jordan, 1986).

Previous investigations at the site have identified deposits of fill in several areas at the site, including several areas to the south of the wetland and two areas on the northern margin of the wetlands, as shown in Figure 2 of the report *Detailed Soil and Groundwater Investigation, East Clontarf, Waterford* (ATA, 2003b). It is estimated that the uncontrolled fill covers approximately 2ha of the site and varies in thickness between 0.1m and 1.5m (ATA, 2003b). Contaminants identified in fill material will result in its removal, as shown on Figure 3.

Natural soils encountered during site investigations included sands consistent with the description of Bassendean Sand by Jordan (1986) over large areas of the site. Extensive areas of peat were also identified (described as sandy to clayey peat) extending beneath the current wetland, along the drainage line near the western margin of the site. Geotechnical investigations at the site were used to infer the extent of peat across the site, as shown in Figure 4 of ATA (2002c). However, instead of peat adjacent to the foreshore, Coffey Environments (formerly ATA) identified clayey and silty soils matching the description of Guildford Formation (Jordan, 1986) at shallow depth beneath the Bassendean Sand unit (ATA, 2002c).

The hydrogeology and surface hydrology of the site has been subject to investigation by JDA Consultant Hydrologists (JDA, 2004). A copy of this investigation is presented as Appendix B in this report.

2.3 Hydrogeology

The following summarises the findings presented in the detailed hydrogeological assessment undertaken by JDA and included as Appendix B.

Superficial Aquifer

The groundwater flow direction in the superficial aquifer in the vicinity of the site is primarily southerly towards the Canning River. As a result groundwater flows enter the site along its northern boundary with Manning Road. There appears to be slight westerly components in the flows due either to the influence of the wetland and its discharge to the Canning River on the western side of the site or a slight topographic influence associated with the closed landfill on the south-eastern boundary of the site (Centenary Park). These influences can be inferred from the groundwater contours presented in Figure 4 and Figure 11.

Groundwater within the Superficial Formation is located between 0.373m and 3.820m AHD, and discharges to the Swan-Canning River system along the southern boundary of the site and also into the wetland along its northern boundary. Groundwater flow is typically in a southerly direction towards the Canning River. Field observations indicate that a water table gradient of approximately 1.5m exists across the wetland within the Superficial Aquifer (JDA, 2004). The depth to the water table is dependent on the surface topography and varies from around 0.5 m on the southern boundary of the site to 6-7m along the northern boundary of the site.

The water table in the wetland and south to the Canning River is effectively controlled by the natural surface, and is in a region of groundwater discharge. There is no evidence that the peat beneath the wetland acts as a groundwater flow barrier (JDA, 2004).

Leederville Aquifer

The Leederville Aquifer underlies the Superficial Formation at a depth of approximately 25m below the ground surface, and is up to 300m thick locally. Within the vicinity of the site, a confining layer exists between the Superficial and Leederville aquifer, and therefore leakage between the two is negligible. The Leederville Aquifer is fresh beneath the site (Davidson, 1995).

2.4 Surface Hydrology

A detailed description of the hydrology of the site is provided in Appendix B. This section briefly summarises the main findings presented in JDA's report titled East Clontarf Hydrological Investigation (2004).

The Cygnia Cove development site contains a large wetland, which is designated as a Resource Enhancement management category feature according to the DEC's *Geomorphic Wetlands Swan Coastal Plain* dataset (<http://apostle.environment.wa.gov.au>; last accessed October 2006). Coffey Environments (formerly ATA) has conducted site specific investigations into the extent and nature of wetlands at the site, which resulted in modified wetland boundaries and classifications that have been accepted by DoE, as shown in Figure 6 of the PER document (ATA, 2004a).

The wetland receives surface water discharges from the surrounding road drainage network and therefore acts, in part, as a compensating basin for these drainage flows. The wetland functions to some extent as a flow-through wetland (JDA, 2004). The wetland has a relatively constant discharge to the Canning River from a drainage line in its south-west corner. Observations on-site over many years and at different seasons confirm that the rate of discharge is reasonably constant and in the range of 10-20 Litres/second.

The volume of discharge from the wetland to the Canning River far exceeds the surface water inputs and as a result it is concluded in the JDA investigation that there is a significant diffuse groundwater

inflow to the wetland from the Superficial Formation along the wetland's northern boundary, and that drainage flow to the Canning River, is from this source rather than aquifer discharge to the drainage channel down-gradient of the wetland (JDA, 2004).

3 CONCEPTUAL SITE MODEL

3.1 Introduction

As per DEC (2006), a Conceptual Site Model (CSM) identifies the nature and extent of contaminated media and describes the pathways by which exposure to the identified contamination at a site may occur. For exposure to occur, a complete pathway must exist between the source of contamination and the receptor (i.e. the person or ecosystem components potentially affected by the contamination). Where an exposure pathway is incomplete, exposure cannot occur, leaving no risk present via that pathway. The potential for components of the CSM to change over time should be considered as part of the overall risk management strategy.

Cygnia Cove, formerly known as the East Clontarf development site, is located south of Manning Road, at the corner of Centenary Avenue, in the suburb of Waterford (Figure 1). The site encompasses an area of approximately 20ha and is bordered to the south by Clontarf Bay on the Canning River, to the west by Clontarf Aboriginal College, to the north-west by Curtin University and both to the north and east by residential housing (Figure 1). Centennial Park (a former landfill site) is east of Centennial Avenue. A Resource Enhancement category wetland trends east-west across the northern central portion of the site and a foreshore reserve forms the southern boundary between the site and Clontarf Bay. The site is currently unused and is intended to undergo remedial works to remove geotechnically unsuitable fill material (uncontrolled fill) prior to redevelopment as a residential subdivision and public open space (POS), as shown in Figure 2.

The following sections review the contaminants of potential concern identified in soil and groundwater on-site, the possible sources, receptors and exposure pathways that may pose a risk to human health or the environment prior to, and during, any remedial works on the site. Sections 3.5 and 3.6 discuss the impacts to human health and the environment, respectively. Section 3.7 discusses the changes to the CSM and the potential risk to human health and the environment following remedial works and redevelopment of the site as a residential subdivision and POS. Two Conceptual Site Models (CSM) are presented in Appendix H for the site under current/remedial conditions (Model A) and as post-remedial final land uses (Model B), respectively.

It is noted that this CSM aims to satisfy Commitment number 6 in Schedule 2 of Ministerial Statement No. 692 requiring the determination of the nature and extent of any soil or groundwater contamination present within the site which may pose a risk to human health or the environment.

3.2 Contaminants of Potential Concern (COPCs)

A number of soil and groundwater investigations at the site identified contaminants in soil and groundwater at concentrations equal to, or in exceedance of, relevant assessment criteria, where available. All soil samples were screened against Ecological Investigation Levels (EILs) presented in *Assessment Levels for Soil, Sediment and Water* (DoE, 2003). COPCs in exceedance of the screening criteria were found across various parts of the site, and included several metals (arsenic, cadmium, chromium, lead, and zinc), pesticides (dieldrin), and chrysotile and/or crocidolite asbestos. These COPCs have been found primarily in upper soil layers and areas of uncontrolled fill. The samples which exceeded the assessment criteria are summarised in Table A.

TABLE A
SOIL SAMPLES EXCEEDING ASSESSMENT CRITERIA

Sample Location	Depth Interval (m)	Soil Type	Contaminant	Concentration (mg/kg)	EIL ¹ (mg/kg)
EC CTP10	0-0.5	Uncontrolled fill	Dieldrin	0.23	0.2
TP 34	0.3	Uncontrolled fill	Asbestos chrysotile	Detected	NA
TP 39	0.5	Sand	Asbestos chrysotile	Detected	NA
TP 46	0.5	Uncontrolled fill	Zinc	610	200
TP 48	0.2	Uncontrolled fill	Lead	460	300
TP 55	0.5	Uncontrolled fill	Arsenic	22	20
TP 56	0.5	Sand	Cadmium	9.4	3
TP 60	0.5	Uncontrolled fill	Zinc	230	200
TP 73	0.5	Uncontrolled fill	Asbestos chrysotile and crocidolite	Detected	NA
			Zinc	380	200
TP 75 (Dup)	1.0	Uncontrolled fill	Dieldrin	0.2	0.2
TP 76	0.2	Uncontrolled fill	Asbestos chrysotile	Detected	NA
TP 90	1.5	Mottled sandy clay	Chromium	50	50
TP 113	0.5	Mottled sandy clay	Chromium	51	50
TP 120	0.5	Uncontrolled fill	Zinc	200	200
TP 121	0.5	Uncontrolled fill	Zinc	620	200
TP 139	1.5	Mottled sandy clay	Chromium	50	50

¹ Ecological Investigation Levels as listed in *Assessment Levels for Soil, Sediment and Water* (DoE, 2003), unless otherwise noted.

Groundwater on-site naturally flows towards the south and slightly south-south-westerly (ATA, 2003b). Surface water from the wetland has a relatively constant discharge to the Canning River from a drainage line in its south-west corner (Coffey Environments, 2010a).

Due to the groundwater flow direction and the proximity to the Canning River, groundwater monitoring results were screened using the Fresh Waters assessment criteria for Aquatic Ecosystems (using Lowland Rivers values where available) specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000). Where no Fresh Waters guidelines existed, monitoring results were screened using Drinking Water Guidelines specified in *Australian Drinking Water Guidelines* (NHMRC and ARMCANZ, 1996). COPCs which exceeded the criteria in groundwater at various locations on the site, in one or more rounds of monitoring between 2001 and 2006, included several metals (aluminium, arsenic, cadmium, chromium, copper, mercury, nickel, zinc), pesticides (DDE, dieldrin), TPH (C₁₅₋₂₈), and various nutrients (total phosphorus, ammonia-N, NO_x-N, and total nitrogen).

3.3 Sources

Based on previous investigations, several potential sources of COPCs in the soil and groundwater have been identified. These sources are summarised in Table B.

TABLE B
CONTAMINANT SOURCES AND AREAS OF POTENTIAL CONCERN

Source	Area of Concern	COPCs and Environmental Media
Off-Site Sources		
Former and current land uses (e.g. residential septic tanks)	Up-gradient (north of the site)	Metals (Al, As, Cr, Cu, Hg, Ni, Zn), TPH, pesticides (DDE), various nutrients (total phosphorus, total nitrogen, NH ₃ -N, NO _x -N) (groundwater)
Surface drainage piped into wetland	Up-gradient (north and south-east of the site)	Various nutrients (total nitrogen, total phosphorus), aluminium, dieldrin (surface water)
Former landfill site	Cross and slightly up-gradient (south-east boundary of the site)	Metals (Cd, Cr, Cu, Ni, Pb, Zn), dieldrin, various nutrients (total nitrogen, total phosphorus, NH ₃ -N, NO _x -N) (groundwater); Metals (Cr) (soil)
On-Site Non-Point Sources		
Components of naturally-occurring Guildford Formation soils	Various	Chromium (soil)
Naturally-occurring acid sulphate soils	Various areas on-site, particularly surrounding wetland	Potential for increased acidity to surrounding soil and groundwater

TABLE B
CONTAMINANT SOURCES AND AREAS OF POTENTIAL CONCERN

Source	Area of Concern	COPCs and Environmental Media
<i>On-Site Point Sources</i>		
Fill material	Historical placement of fill materials across the site	Asbestos, Metals (As, Cd, Cr, Pb, Zn), organochlorine pesticide (dieldrin)
Former Market Garden	Land use as community market garden (north-east corner)	Various nutrients (total nitrogen, total phosphorus, ammonia-N, NO _x -N), pesticide (DDE) and metals (As, Cu, Hg, Ni, Zn) in groundwater; COPCs did not exceed criteria in soil
Proposed temporary abstraction well	North-eastern corner of the site	Metals (Al, As, Cr, Cu, Ni, Zn), various nutrients (total phosphorus, ammonia-N, NO _x -N), pesticide (DDE) in groundwater

3.3.1 Off-Site Sources

Impacted groundwater migrating beneath the site may be a result of the current and former land uses of the surrounding properties. Elevated nutrients and heavy metals in groundwater entering the site across the northern boundary are likely a result of residential septic tanks or other off-site sources. TPH, detected in a single sample along the northern boundary of the site is suspected to originate from an off-site source in the near vicinity of the site (Coffey Environments, 2010a). Surface drainage from external catchments to the north (across Manning Road) and south-east of the site (across Centenary Avenue) discharge into the wetland via drainage pipes, creating another potential off-site source of contaminants. Elevated nutrient levels in groundwater measured along the south-eastern border of the site are likely to be associated with the former municipal landfill site.

3.3.2 On-Site Sources

Areas of concern on-site include various areas of uncontrolled fill, historically brought on-site to even out the surface of the land in certain areas. These regions of uncontrolled fill are a source of asbestos and various metals. Chromium detected at elevated levels in soil at various areas on-site may be attributed to the naturally-occurring Guildford Formation in the area; however, chromium-impacted soil along the south-eastern border of the site is suspected to be a result of the adjacent former landfill. The former market garden area (north-east corner of the site) is a potential source of COPCs due to historical activities related to the community garden, although there is no evidence to support this in the soil sampling results. Finally, acid sulphate soils occur naturally on the site and are a potential source of increased acidity and elevated metals in the soil at various areas on-site, particularly surrounding the wetland area.

3.4 Release Mechanisms

Movement or behaviour of the COPCs within the environment depends on the physio-chemical characteristics of the contaminants and of the media in which the COPCs are present. Physical and chemical characteristics of surrounding media may also contribute to the transport of COPCs on- and off-site. The following potential contaminant transport or release mechanisms were identified:

- vertical migration of COPCs through dissolution in rainwater and infiltration to the subsurface and groundwater;
- lateral migration of COPCs in groundwater along the down-gradient flow path, into the wetland, and the Canning River;
- dispersion of COPCs in groundwater via abstraction from superficial aquifer for use in on-site irrigation and dust suppression;
- volatilisation of COPCs in soil or open water (i.e. wetland); and
- atmospheric transport of dust and asbestos fibres via wind currents.

3.5 Human Health Assessment Under Current and Remedial Site Conditions

3.5.1 Receptors of Concern

Receptors are defined as persons, structures, and utilities, which are, or may be, adversely affected by COPCs. Investigations at the site indicate that previous facilities at the site, including a market garden and sports oval, are no longer in use. The site is currently unused and is considered private property (excluding the foreshore reserve area). An access track is located along the western boundary of the site and the wetland comprises the central part of the site. The site is scheduled to undergo remedial works in order to remove geotechnically unsuitable fill material (uncontrolled fill) and asbestos from across the site. Potential receptors located on the site, near or down-hydraulic gradient from the site, with potential for exposure currently or during remedial works, are as follows:

- On-site recreational visitor (on access track);
- On-site maintenance workers (during remediation and redevelopment);
- On-site construction worker (during redevelopment);
- Off-site recreational visitor (on foreshore);
- Off-site residents/students;
- Off-site recreational swimmer; and
- Off-site recreational angler/fisherman.

3.5.2 Exposure Pathways

An exposure pathway is a means by which an ecosystem, human population or individual (receptor) may be exposed to site-derived contaminants. Exposure pathways are natural and/or man-made and are based on a review of the site geology, hydrogeology, infrastructure and land use. Adverse health effects may be associated with chemical exposure via inhalation, ingestion and/or direct contact.

An exposure pathway consists of the following elements:

- A source and mechanism for release;
- A storage and/or transport medium (e.g. contaminants stored in soil, volatilise and are transported into the atmosphere);
- An exposure point, where the receptor comes in contact with the contamination; and
- An exposure route (e.g. inhalation or dermal absorption).

The physico-chemical characteristics of the COPC and the behaviour of the population of interest will determine the method of exposure and subsequent systemic absorption. An evaluation of the potential exposure pathways previous to, and during, the site remedial works are presented in Tables C and D.

A schematic of the conceptual site model is provided in Appendix H (Model A - Pre-Remediation) presenting a general overview of the reported and observed impacts. Further discussion of on- and off-site impacts are presented in Sections 3.5.3 and 3.5.4.

TABLE C
EXPOSURE PATHWAY EVALUATION - SOIL

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
Fill material	Wind blown dust (asbestos fibres) during remediation works on-site	Outdoor air	<input checked="" type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
				<input checked="" type="checkbox"/> Maintenance worker	✓
			<input type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Construction worker	✓
				<input checked="" type="checkbox"/> Off-site visitor	✓
			<input type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Off-site residents	✓
				<input type="checkbox"/> Off-site swimmer	✗
				<input type="checkbox"/> Off-site angler	✗

TABLE C
EXPOSURE PATHWAY EVALUATION - SOIL

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
	Soil and fill material exposed and transported during remedial works	Direct contact	<input checked="" type="checkbox"/> Inhalation of particulate	<input type="checkbox"/> Recreational visitor	x
				<input checked="" type="checkbox"/> Maintenance worker	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Construction worker	✓
				<input type="checkbox"/> Off-site visitor	x
			<input checked="" type="checkbox"/> Incidental Ingestion	<input type="checkbox"/> Off-site residents	x
				<input type="checkbox"/> Off-site swimmer	x
				<input type="checkbox"/> Off-site angler	x
Guildford Formation soils	Naturally-occurring metals at depth	Direct contact	<input checked="" type="checkbox"/> Inhalation of particulate	<input type="checkbox"/> Recreational visitor	x
				<input checked="" type="checkbox"/> Maintenance worker	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Construction worker	✓
				<input type="checkbox"/> Off-site visitor	x
			<input checked="" type="checkbox"/> Ingestion	<input type="checkbox"/> Off-site residents	x
				<input type="checkbox"/> Off-site swimmer	x
				<input type="checkbox"/> Off-site angler	x

TABLE C
EXPOSURE PATHWAY EVALUATION - SOIL

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
Acid sulphate soils	Disturbance during remedial works	Direct and indirect contact	<input type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input checked="" type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Off-site visitor	✓
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓
Former landfill	Migration (leaching) onto site	Direct contact	<input type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input type="checkbox"/> Ingestion	<input type="checkbox"/> Off-site visitor	✗
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓

¹ Includes both current and potential pathways encountered during remedial works at the site. Refer to Sections 3.4.3 and 3.4.4 for a discussion of the complete and excluded exposure pathways.

TABLE D
EXPOSURE PATHWAY EVALUATION - GROUNDWATER

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
Off-site groundwater and stormwater (entering site across northern site boundary)	Off-site groundwater following natural flow direction towards Canning River; stormwater drainage into wetland	Direct and indirect contact	<input type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input checked="" type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Off-site visitor	✓
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓
Former landfill site	Vertical migration or leaching into groundwater; following natural flow direction towards Canning River	Direct and indirect contact	<input type="checkbox"/> Inhalation	<input type="checkbox"/> Recreational visitor	✗
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input checked="" type="checkbox"/> Ingestion	<input type="checkbox"/> Off-site visitor	✗
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓

TABLE D
EXPOSURE PATHWAY EVALUATION - GROUNDWATER

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
Temporary abstraction well (north-east corner of the site)	Abstracted groundwater used for land and garden irrigation and dust suppression	Direct and indirect contact	<input checked="" type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input type="checkbox"/> Ingestion	<input type="checkbox"/> Off-site visitor	✗
				<input type="checkbox"/> Off-site residents	✗
				<input type="checkbox"/> Off-site swimmer	✗
				<input type="checkbox"/> Off-site angler	✗
Acid sulphate soils	Disturbance during remedial works causing leaching to wetland and Canning River	Direct and indirect contact	<input type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input checked="" type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Off-site visitor	✓
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓

TABLE D
EXPOSURE PATHWAY EVALUATION - GROUNDWATER

Exposure Pathway				Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point	Exposure Route		
Former market garden	Vertical and lateral migration of groundwater from this area	Direct and indirect contact	<input type="checkbox"/> Inhalation	<input checked="" type="checkbox"/> Recreational visitor	✓
			<input checked="" type="checkbox"/> Dermal	<input checked="" type="checkbox"/> Maintenance worker	✓
				<input checked="" type="checkbox"/> Construction worker	✓
			<input checked="" type="checkbox"/> Ingestion	<input checked="" type="checkbox"/> Off-site visitor	✓
				<input type="checkbox"/> Off-site residents	✗
				<input checked="" type="checkbox"/> Off-site swimmer	✓
				<input checked="" type="checkbox"/> Off-site angler	✓

¹ Includes both current and potential pathways encountered during remedial works at the site. Refer to Sections 3.4.3 and 3.4.4 for a discussion of the complete and excluded exposure pathways.

3.5.3 On-Site Impacts

An evaluation of the potential exposure pathways (Tables C and D) suggests complete exposure pathways may presently exist, or be created during proposed remedial works for on-site visitors, remediation and construction workers exposed to soil or groundwater.

Chrysotile and/or crocidolite asbestos in uncontrolled fill at various locations on the site do not pose a health risk when left undisturbed. Asbestos material is not expected to migrate on- or off-site in its current state; however, remedial works at the site, including the proposed removal of the uncontrolled fill, may result in the release of dust and asbestos fibres into the air, which then may be carried by off-site by wind currents. Inhalation of the disturbed dust and asbestos fibres may pose a health risk to on-site maintenance and construction workers and users of the access track on-site, as well as residents and students off-site.

Maintenance workers and construction workers may also be exposed to COPCs via inhalation of particulate, incidental ingestion and dermal contact with both the soil and groundwater (via the latter two exposure routes) on-site, as a result of excavation and removal of the geotechnically unsuitable fill material and surficial soils.

Chromium detected at concentrations equal to or slightly greater than the EIL (50mg/kg) in mottled sandy clay at various locations on the site is considered to be a result of the naturally-occurring concentrations in Guildford Formation soils. As there is no evidence of anthropogenic contamination at the depths where these samples were encountered and no chromium contamination was identified in uncontrolled fill at the site. Given the depth at which the samples were detected (0.5m to 1.5m) and the natural properties of the clays, chromium is not expected to impact human health on-site.

A temporary groundwater abstraction well is scheduled for construction on the north-east corner of the site. Abstracted groundwater is intended for use as irrigation water for the establishment of lawns and gardens of the proposed residential development but is not proposed to act as a long term source of irrigation water. Abstracted groundwater will also be used for dust suppression during redevelopment of the site. Groundwater abstracted from the superficial aquifer will be filtered and treated before use and is not expected to adversely impact human health.

Disturbance of acid sulphate soils on-site have the potential to cause impacts to human health through the release of acidity into the surrounding environment. In order to manage and minimise the generation and release of acidity, an Acid Sulphate Soils Management Plan has been devised and will be followed during all remedial works and development at the site.

3.5.4 Off-Site Impacts

Groundwater and surface water sampled up-hydraulic gradient of the wetland and along the outlet drain to the Canning River showed lower concentrations of aluminium, dieldrin and several nutrients (total nitrogen and total phosphorous) than the water from the outlet drain. This is considered to be a result of elements being absorbed in the sediment and plant matter of the wetland or potentially a result of significant dilution effects within the wetland system.

Bores located slightly down-gradient of the former landfill area had elevated results for nutrients, arsenic and zinc. Due to the topography at the boundary of the former landfill site to the south-east, it is possible that run-off from the former landfill may flow in a north-westerly direction, and possibly introduce some component of north-westerly groundwater flow in this area of the site due to the porous nature of the Bassendean Sand.

Saline ingress is expected to impact the migration and dilution of COPCs in groundwater. Due to the proximity of the superficial groundwater system to the Canning River, it is expected to be in hydraulic conductivity with the tidal fluctuations occurring in the river. Based on the direction of groundwater flow, and as a result of the absorption and dilution effects of the wetland, and the expected dilution of groundwater discharged into the Canning River, COPCs in the groundwater on-site are not expected to adversely impact any off-site receptors.

3.6 Ecological

3.6.1 Receptors of Concern

Ecological receptors are defined as plants, animals, fungi or biota supporting ecological processes associated with a defined area, which are considered to be of significant societal relevance, ecological or economic significance, and are, or may be, adversely affected by COPCs.

Based on investigations at the site, the main habitats are considered to be the wetland, dominated by Bulrush and other sedges and occupying one third of the site, grassland surrounding the wetland and the Canning River including the adjoining foreshore (ATA, 2001).

The kidney-shaped wetland is assigned a management category of Resource Enhancement and is an Estuary-Peripheral wetland. Resource Enhancement wetlands are defined as wetlands that have been partially modified but still support substantial ecological attributes and functions (Hill et al, 1996).

Historically, the wetland was used as a water supply for irrigation and water consumption on-site. More recent investigations at the site indicate the natural wetland environment has been modified over time

and does not provide a diverse natural environment. Currently, the wetland does not provide any recreational function, and no evidence exists suggesting it is used as a site for scientific or educational resource purposes. The wetland does not appear to serve many significant functions other than as part of a drainage system to the Canning River, in which the presence of reeds contributes to maintaining water quality within the wetland and discharge to Canning River (Coffey Environments, 2008a).

There is no open water in the wetland area and the absence of native vegetation around the wetland has enabled weed species to become established. Several native and non-native flora species were identified at the site; however, no Declared Rare or Priority flora species were recorded during flora surveys. The wetland vegetation and its immediate surrounds are of variable condition ranging from Completely Degraded to Very Good. Large areas are mapped as Completely Degraded or Degraded to Good due to the absence of native species and the dominance of introduced species (Coffey Environments, 2008b). No native mammals were observed on-site.

Based on previous environmental surveys and the current conditions of the wetland and Canning River, the following lists potential ecological receptors to consider:

- Frogs (various species);
- Reptiles (snakes, lizards, long-necked tortoises);
- Waterbirds (three species);
- Black Swans;
- Southern Brown Bandicoot; and
- Riparian vegetation.

3.6.2 Exposure Pathways

An exposure pathway is a means by which an ecosystem, human population or individual (receptor) may be exposed to site-derived contaminants. Exposure pathways are natural and/or man-made and are based on a review of the site geology, hydrogeology, infrastructure and land use.

If a source, a transport mechanism (pathway), an exposure point and an exposure route are all present then a complete exposure pathway exists. An evaluation of the potential exposure pathways previous to, and during, the site remedial works are presented in Table E.

TABLE E
ECOLOGICAL EXPOSURE PATHWAY EVALUATION

Exposure Pathway			Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point		
Off-site groundwater and stormwater (entering site across northern and south-eastern site boundary)	Groundwater following natural flow direction towards Canning River; stormwater drainage into wetland	Surface water and sediment in wetland and Canning River	<input checked="" type="checkbox"/> Frogs	✓
			<input checked="" type="checkbox"/> Reptiles	✓
			<input checked="" type="checkbox"/> Waterbirds	✓
			<input checked="" type="checkbox"/> Black Swans	✓
			<input checked="" type="checkbox"/> Southern Bandicoot	✓
			<input checked="" type="checkbox"/> Riparian vegetation	✓
Former landfill site	Vertical migration or leaching into groundwater; following natural flow direction towards Canning River	Surface water in Canning River	<input checked="" type="checkbox"/> Frogs	✓
			<input checked="" type="checkbox"/> Reptiles	✓
			<input checked="" type="checkbox"/> Waterbirds	✓
			<input checked="" type="checkbox"/> Black Swans	✓
			<input checked="" type="checkbox"/> Southern Bandicoot	✓
			<input checked="" type="checkbox"/> Riparian vegetation	✓
Temporary abstraction well (north-east corner of the site)	Abstracted groundwater used for land and garden irrigation and dust suppression	Infiltration to groundwater entering the wetland and the Canning River	<input checked="" type="checkbox"/> Frogs	✓
			<input checked="" type="checkbox"/> Reptiles	✓
			<input checked="" type="checkbox"/> Waterbirds	✓
			<input checked="" type="checkbox"/> Black Swans	✓
			<input checked="" type="checkbox"/> Southern Bandicoot	✓
			<input checked="" type="checkbox"/> Riparian vegetation	✓

TABLE E
ECOLOGICAL EXPOSURE PATHWAY EVALUATION

Exposure Pathway			Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point		
Acid sulphate soils	Disturbance during remedial works causing leaching to wetland and Canning River	Sediment and soils	<input checked="" type="checkbox"/> Frogs	✓
			<input checked="" type="checkbox"/> Reptiles	✓
			<input checked="" type="checkbox"/> Waterbirds	✓
			<input checked="" type="checkbox"/> Black Swans	✓
			<input checked="" type="checkbox"/> Southern Bandicoot	✓
			<input checked="" type="checkbox"/> Riparian vegetation	✓
Former market garden	Vertical and lateral migration of groundwater from this area	Historically impacted soil in region; Surface water in wetland and Canning River	<input checked="" type="checkbox"/> Frogs	✓
			<input checked="" type="checkbox"/> Reptiles	✓
			<input checked="" type="checkbox"/> Waterbirds	✓
			<input checked="" type="checkbox"/> Black Swans	✓
			<input checked="" type="checkbox"/> Southern Bandicoot	✓
			<input checked="" type="checkbox"/> Riparian vegetation	✓
Fill material	Soil and fill material excavation	Surficial soil	<input type="checkbox"/> Frogs	✗
			<input type="checkbox"/> Reptiles	✗
			<input type="checkbox"/> Waterbirds	✗
			<input type="checkbox"/> Black Swans	✗
			<input type="checkbox"/> Southern Bandicoot	✗
			<input type="checkbox"/> Riparian vegetation	✗

TABLE E
ECOLOGICAL EXPOSURE PATHWAY EVALUATION

Exposure Pathway			Receptors	Potential for Complete Pathway ¹
Source	Release Mechanism	Exposure Point		
Guildford Formation soils	Naturally-occurring at depth	Subsurface soil	<input type="checkbox"/> Frogs	x
			<input type="checkbox"/> Reptiles	x
			<input type="checkbox"/> Waterbirds	x
			<input type="checkbox"/> Black Swans	x
			<input type="checkbox"/> Southern Bandicoot	x
			<input type="checkbox"/> Riparian vegetation	x

An evaluation of the potential exposure pathways (Table E) suggests complete pathways may presently exist, or be created during proposed remedial works for ecological receptors.

Groundwater entering the site from the north or south-east may adversely impact ecological receptors reliant on the wetland, the drainage channel or the Canning River as a primary source of food or shelter. The wetland is considered to be a flow through system, with approximately 83% of the total current wetland inflow coming from the superficial aquifer (JDA, 2004). Monitoring of the up-hydraulic gradient groundwater (north of the wetland) and surface water along the drainage channel to the Canning River showed lower concentrations of aluminium, dieldrin and several nutrients (total nitrogen and total phosphorous) in the drainage channel. This is considered to be a result of elements being absorbed in the sediment and plant matter of the wetland or potentially a result of significant dilution effects within the wetland system.

Acid sulphate soils have been identified at various locations nearby the wetland and along the drainage channel. Acidity is primarily associated with the black peaty horizons as well as the grey silty sands. Although vulnerability of the groundwater to acidification is considered to be low, disturbance of these areas has the potential to impact ecological receptors (Coffey Environments, 2008b). In order to manage and minimise the generation and release of acidity, an Acid Sulphate Soils Management Plan has been devised and will be followed during all remedial works and development at the site.

Ecological receptors are not expected to be impacted by COPCs in the soil based on the depth and limited migration of COPCs in the soil. Any concentration of contaminant in groundwater that has the potential to reach the Canning River, is expected to be diluted to the extent that it does not pose a risk to ecological or environmental health of the river.

3.7 Future Land Use

Following remediation, the site is intended for redevelopment as a residential subdivision, Cygnia Cove Estate. Plans for redevelopment include up to 200 residential lots, creation of approximately 8,000m² of

public open space, re-designing the wetland and rehabilitation of the foreshore area. The future land uses at the site will be residential and recreational. The residential lots will be on scheme water and walking paths, including a boardwalk, will be constructed in the wetland area.

As the conditions and land uses at the site change, so do the parameters of the CSM. A review of the potential remaining sources, future receptors and possible exposure pathways is presented in the following sections. Figure B provides a schematic of the CSM under future land uses.

3.7.1 Future Sources and Areas of Concern

Following remediation and redevelopment of the site, previously identified sources and areas of concern may no longer exist. Based on the proposed remediation works and future land uses, an overview of potential sources and areas of concern are presented in Table F.

TABLE F
FUTURE SOURCES AND AREAS OF POTENTIAL CONCERN

Source	Area of Concern	Impacted Media
Off-Site Sources		
Former and current land uses in surrounding area	Up-gradient (across northern border of the site)	Groundwater
Former landfill site	Cross and slightly up-gradient (across north-eastern border of the site)	Groundwater
Surface drainage piped into wetland	Cross and slightly up-gradient (across north-eastern border of the site)	Surface water in wetland, drainage channel, Canning River
On-Site Sources		
Guildford Formation soils	Various areas at depth	Subsurface soil
Temporary abstraction well	North-eastern corner of the site	Groundwater and surficial soil

On-site sources of COPCs will be limited following remediation and redevelopment of the site. Slightly elevated concentrations of chromium detected at depth in Guildford Formation soils are considered to be naturally-occurring and are not expected to pose a risk to human health, due to their inaccessibility. The subsurface soils will be beneath the residential lots, or as part of the open public space, are unlikely to be disturbed by future residents or visitors to the site.

Groundwater entering the site from nearby off-site sources may continue to be slightly impacted by nutrients and heavy metals. Although the groundwater is considered to be consistent with typical urban water quality, mitigation activities and site management plans will be implemented in order to minimise the impact to human health and the environment. The residential development will be on scheme water

and due to the limiting size of the residential lots, creation of gardens and lawns is expected to be minimal. Based on the proposed development, residents are unlikely to access bore water on-site.

As per the *Drainage, Nutrient, Irrigation and Water Quality Management Plan* (Coffey Environments, 2008a), stormwater drainage entering the site will be directed to detention storage areas and then slowly permitted to flow through the wetland, allowing sedges to naturally filter the water entering the wetland, and subsequently, the Canning River. Stormwater entering the site across the south-eastern boundary will be continually monitored to ensure it is not impacting the wetland or the Canning River.

3.7.2 Future Receptors of Concern

As a residential subdivision and public open space, the receptors of concern and the potential exposure pathways on and off-site will be modified. Table G presents the potential human receptors and possible complete exposure pathways. Also listed are the relevant site management plans which, once implemented, will work to mitigate or eliminate the risk of exposure to contaminants for humans and the environment on, or near, the site.

TABLE G
HUMAN EXPOSURE PATHWAY MANAGEMENT AND ASSESSMENT

Exposure Pathway			Complete Pathway ¹	Associated Management Plan(s)
Source	Release Mechanism	Potential Receptors		
Off-site groundwater and stormwater (entering site across northern and south-eastern site boundary)	Off-site groundwater following natural flow direction towards Canning River; stormwater drainage into wetland	<input checked="" type="checkbox"/> Subdivision residents	x	» Wetland Management Plan » Drainage, Nutrient, Irrigation and Water Quality Management Plan » Baseline and Groundwater Monitoring and Management Plan » Site Safety Plan
		<input checked="" type="checkbox"/> Recreational visitor	x	
		<input checked="" type="checkbox"/> Maintenance worker	x	
		<input type="checkbox"/> Off-site visitor	x	
		<input type="checkbox"/> Off-site residents	x	
		<input checked="" type="checkbox"/> Off-site swimmer	x	
		<input checked="" type="checkbox"/> Off-site angler	x	

TABLE G
HUMAN EXPOSURE PATHWAY MANAGEMENT AND ASSESSMENT

Exposure Pathway			Complete Pathway ¹	Associated Management Plan(s)
Source	Release Mechanism	Potential Receptors		
Former landfill site	Vertical migration or leaching into groundwater; following natural flow direction towards Canning River	<input checked="" type="checkbox"/> Subdivision residents	x	» Wetland Management Plan » Drainage, Nutrient, Irrigation and Water Quality Management Plan » Baseline and Groundwater Monitoring and Management Plan » Site Safety Plan
		<input checked="" type="checkbox"/> Recreational visitor	x	
		<input checked="" type="checkbox"/> Maintenance worker	x	
		<input type="checkbox"/> Off-site visitor	x	
		<input type="checkbox"/> Off-site residents	x	
		<input checked="" type="checkbox"/> Off-site swimmer	x	
		<input checked="" type="checkbox"/> Off-site angler	x	
Temporary abstraction well (north-east corner of the site)	Abstracted groundwater used for land and garden irrigation	<input type="checkbox"/> Subdivision residents	x	» Contaminated Sites Reporting Guideline for Chemicals in Groundwater (DOH, 2006) » Site Safety Plan
		<input type="checkbox"/> Recreational visitor	x	
		<input checked="" type="checkbox"/> Maintenance worker	x	
		<input type="checkbox"/> Off-site visitor	x	
		<input type="checkbox"/> Off-site residents	x	
		<input checked="" type="checkbox"/> Off-site swimmer	x	
		<input checked="" type="checkbox"/> Off-site angler	x	

TABLE G
HUMAN EXPOSURE PATHWAY MANAGEMENT AND ASSESSMENT

Exposure Pathway			Complete Pathway ¹	Associated Management Plan(s)
Source	Release Mechanism	Potential Receptors		
Guildford Formation soils	Naturally-occurring metals (chromium) at depth	<input checked="" type="checkbox"/> Subdivision residents	x	Not applicable » Site Safety Plan
		<input type="checkbox"/> Recreational visitor	x	
		<input checked="" type="checkbox"/> Maintenance worker	x	
		<input type="checkbox"/> Off-site visitor	x	
		<input type="checkbox"/> Off-site residents	x	
		<input type="checkbox"/> Off-site swimmer	x	
		<input type="checkbox"/> Off-site angler	x	

¹ Under final site conditions and land uses, following implementation of management plans and mitigating activities.

Ecological receptors on-site will not change instantly with redevelopment of the site; however, it is anticipated that the functioning of the wetland and the quality of the habitat will improve, leading to increased use and inhabitation by ecological receptors.

3.8 Conclusions

As recommended by the DEC (2006), a conceptual site model is a critical component of the assessment of a contaminated site and should be created in order to identify the sources and receptors with the potential to be adversely impacted by exposure to contaminants at a site.

Contaminant sources and complete exposure pathways for humans and the environment have been identified at the site. Mitigation and management of these potential risks are addressed by a suite of management plans related to the remediation, redevelopment and final land use.

It should be noted that this conceptual site model aims to satisfy Commitment Number 6 in Schedule 2 of Ministerial Statement No. 692 requiring a determination of the nature and extent of any soil or groundwater contamination present within the site which may pose a potential risk to human health or the environment.

4 HISTORICAL GROUNDWATER MONITORING

Groundwater on the site has been monitored over a number of years with between five and seven shallow monitoring bores located along the northern, eastern and southern boundaries. The monitoring bore locations were selected to provide information on:

- The groundwater quality entering the site from the north with the local groundwater flow (MW1-MW3).
- The impact of the community market garden to the north (MW3).
- To identify the potential for impacts from the former landfill located adjacent to the south-eastern boundary of the site (MW4).
- The quality of groundwater exiting the site to discharge into the Canning River (MW5-MW7).

No bores screened deeper in the aquifer have been constructed in view of the absence of specific evidence of activities that would contribute to significant levels of contamination or subsurface infrastructure such as tanks or pipe work that may result in the discharge of contaminants deeper in the aquifer. The primary purpose of the monitoring program is to assess the quality of water entering the site on its northern and eastern boundaries and discharging from the southern boundary into the Canning River.

This report also demonstrates compliance with Proponent Commitment No. 4 of Ministerial Statement 692, which indicated that a groundwater monitoring program would be undertaken on a quarterly basis for the period of one year in order to establish a baseline for groundwater quality at the site.

The groundwater monitoring program involved the following:

- Installation of two additional bores; and
- Quarterly sampling for a 12 month period.

4.1 Groundwater Monitoring Bore Network

Groundwater monitoring bores MW1, MW2, MW3, MW4 and MW5, which were originally installed as part of the detailed site investigation (ATA, 2003b), were present on-site upon the commencement of monitoring. The two additional groundwater monitoring bores MW6 and MW7 were installed along the southern margin of the site, close to the Canning River (Figure 3). During the first quarterly sampling event for this program, it was discovered that bores MW1 and MW2 were damaged. Monitoring bore MW1 was damaged beyond repair and was therefore reinstalled, whereas MW2 was repaired by cutting off and replacing the PVC standpipe. These works were undertaken on 15 March 2006. Bore logs for all monitoring wells are presented in Appendix C.

4.1.1 Groundwater Levels

Standing water levels (SWL) recorded for the monitoring period are consistent with values reported by JDA (2004). Groundwater levels were highest in the September 2006 round (consistent with the estimated AAMGL from JDA, 2004), and lowest in the March 2006 round. Groundwater contours from the March 2006 round (Figure 4) indicate that the general direction of groundwater flow is southerly, towards the Canning River. A summary of groundwater levels is presented in Appendix E.

4.2 Groundwater Sampling Methodology

4.2.1 Sampling Procedure

Prior to collecting the groundwater sample, the standing water level (SWL) was measured (from the top of well casing, to the nearest mm) using an electrical depth-to-water indicator.

The monitoring bore was then purged and sampled using a low-flow pump. In order to ensure samples were representative of groundwater within the aquifer, readings of pH, conductivity, and dissolved oxygen were taken and samples were only collected when three successive readings had stabilised to within ± 0.1 , $\pm 3\%$ and $\pm 10\%$ of the previous value, respectively.

Once filled, the sample container was placed in an esky with ice and transported to the laboratory immediately upon completion of the sampling day. The container was packed appropriately to ensure that no damage to the integrity of the container occurred during transport to the laboratory.

Chain of Custody documentation and the analytical certificates for all groundwater analyses are presented in Appendix D.

During the first two sampling rounds (i.e. March and July 2006), both unfiltered and field filtered samples were collected for metals samples. The samples were filtered using a $0.45\mu\text{m}$ filter. Both filtered and unfiltered samples were subject to laboratory analysis in March 2006, however, only unfiltered samples were analysed in July 2006. For the remainder of the monitoring program, only unfiltered samples were collected and subject to analysis, in order to give a worst-case representation of groundwater quality. A discussion of the variance between filtered and unfiltered samples obtained in March 2006 is provided in Table 8 (Appendix F) and discussed in Section 4.3.2.

4.2.2 Field Quality Control

To decrease the chances of cross-contamination, all sampling equipment in contact with groundwater (i.e. low-flow pump, water level meter and water quality meter) was decontaminated prior to and after use. This involved washing with a solution of "PyroNeg" detergent and tap water, followed by a rinse with tap water and then with deionised water. It is noted that the dip metre length was not included in the decontamination procedure and as such there is the potential for a nominal degree of cross contamination to have occurred during historic groundwater gauging events. Measures were taken during the baseline groundwater monitoring in 2008 to address this (see Section 5).

For the low-flow pump, new, unused sampling hose was cut to length and used at each monitoring bore location, and the plastic bladder was replaced thus eliminating the potential for cross-contamination via these routes. Due to the use of these measures, a rinsate blank was not considered necessary. In addition, sample collection personnel wore disposable nitrile gloves that were replaced between each sampling location. The following quality control samples were collected:

- Field Duplicate: collected at a rate of one sample in 20.
- Field Blank each sampling day.
- Trip Blank each sampling day.

The field duplicate samples are used to assess field and analytical precision, and the precision measurement is assessed using the relative percent difference (RPD) between the duplicate sample results.

$$RPD = \frac{X1 - X2}{(X1 + X2)/2} \times 100$$

Generally, it is recommended that the RPD is less than 30-50% (Standards Australia, AS 4482.1-2005).

4.2.3 Analytical Suite

In order to establish the baseline water quality for the site, samples were analysed for an extensive suite of parameters, as follows:

- A suite of metals (Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn);
- Organochlorine (OC) and organophosphorus (OP) pesticides;
- Total Petroleum Hydrocarbons (TPH);
- Benzene, toluene, ethylbenzene, and xylenes (BTEX);
- Polycyclic aromatic hydrocarbons (PAH);
- Inorganic parameters (pH, conductivity, total suspended solids (TSS), acidity, alkalinity, carbonate, hydroxide, chloride, sulphate and hardness); and
- Nutrients (ammonia-N, NO_x-N, total Kjeldahl nitrogen, total nitrogen, and total phosphorus).

The analytical suite was revised during the last round of monitoring (December 2006) to exclude PAH and BTEX, as they had not been detected in any previous monitoring rounds.

4.2.4 Assessment Criteria

The proposed guidelines to be adopted are based on the DEC document titled "Assessment Levels for Soil, Sediment and Water" (DoE, 2003), which have been developed pursuant to the *Contaminated Sites Act 2003*. The DEC assessment levels for water are based on the "Australian Water Quality Guidelines for Fresh and Marine Water Quality" (ANZECC and ARMCANZ, 2000) and the "Australian Drinking Water Guidelines" (NHMRC and ARMCANZ, 1996).

Electrical Conductivity (EC) was measured in the laboratory on three occasions (May 2003, March 2006, and July 2006).

- EC recorded in May 2003 ranged between 410µS/cm (MW2) and 6,600µS/cm (MW6). Corresponding TDS concentrations (calculated from EC measurements multiplied by a factor of 0.65) ranged between 266.5mg/L and 4,290mg/L.
- Electrical Conductivity (EC) recorded in March 2006 (using filtered data) ranged between 480µS/cm (MW1) and 46,000µS/cm (MW6). Corresponding TDS concentrations ranged between 312mg/L and 29,900mg/L.
- Electrical Conductivity (EC) recorded in July 2006 ranged between 430µS/cm (MW1) and 26,000µS/cm (MW6). Corresponding TDS concentrations ranged between 279mg/L and 16,900mg/L.

EC and corresponding TDS concentrations within MW6 (which is located closest to the Canning River foreshore) are significantly greater than monitoring wells located hydraulically up-gradient and is likely to be impacted by saline intrusion. As a conservative approach this data set has been excluded from the

assessment of the highest beneficial use of groundwater. Based on the available data as outlined above, TDS ranges between 731mg/L and 826mg/L. A comparison with the Water and Rivers Commission (WRC, 2004) water quality guidelines indicates the highest potential beneficial use of groundwater beneath the investigation area is suitable for human drinking water purposes (<1,000mg/L).

Based on the site specific variables stated, the adopted DEC guidelines include the following assessment criteria:

- Fresh Waters-Rivers Guidelines

Due to the proximity of the Canning River, the results have been compared to the Fresh Water-Rivers guidelines (FWGs) for Aquatic Ecosystems (utilising Lowland Rivers values where available, from specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000). Where values for more than one type of ecosystem have been provided, the wetland values have been selected. Additional details regarding the assessment of metals using a hardness modification factor is provided in Table 7 (Appendix F) and discussed in Section 4.3.1.

- Australian Drinking Water Guidelines

The proposed development will be serviced by scheme water as such the Drinking Water Guidelines (DWGs) of DoE (2003) and NHMRC and ARMCANZ (1996) are not considered directly applicable but an assessment has been provided for completeness. Furthermore, the presence of former landfill along the northern boundary of the site may prevent the domestic use of groundwater at the site.

Analytical groundwater data has also been compared to the National Health and Medical Research Council Australian Drinking Water Guidelines (ADWG) Health values or Aesthetic values multiplied by a factor of 10 (ADWG x10), as it is proposed to utilise groundwater for non-recreational purposes i.e. reticulation (for the first two years of the development) and dust suppression during earthworks (National Health and Medical Research Council and Natural Resource Management Ministerial Council, 2005).

- Irrigation Guidelines

Abstracted groundwater is proposed to be allowed to infiltrate and/or used for dust suppression. It is therefore proposed to use the short term irrigation water (STIWG) guideline (values specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000). It is considered that the assumptions used to derive the short term trigger values are appropriate for the proposed dewatering project although they are inherently conservative. An assessment against Long Term Irrigation Water Guidelines (LTIWG) has also been undertaken for completeness.

4.3 Historical Groundwater Sampling Results

A summary of the analytical data is presented in Appendix F (Table 1) and a summary of the exceedances recorded when compared to applicable ILs is presented in Appendix F (Tables 2 -7). A brief discussion on general trends is provided below.

- Concentrations of PCBs were less than LOR where analysed and less than applicable ILs where available.

- Laboratory analysis (March 2006) recorded concentrations of DDE (ranging between <0.001ug/L and 0.02ug/L) and dieldrin (less than or equal to the LOR - 0.001ug/L). With the exception of the May 2003, the applicable LORs were appropriate to assess potential exceedances of FWG ILs and ADWG ILs for individual OC/OPs and it is noted that no elevated concentrations of discrete analytes were detected. Subsequent laboratory reports state that no OC/OPs were above applicable LORs. The applicable LOR for dieldrin during the May 2003 monitoring event (<0.1ug/L) has resulted in a number of potential false positives given that it exceeds the FWG (0.002ug/L).
- Laboratory analysis indicates that all discrete PAH analytes were detected at concentrations less than applicable LORs during all monitoring events where analysed. There are currently only ILs established for naphthalene, Benzo(a)pyrene and Total PAH. It is noted that the FWG for naphthalene is 16ug/L and as such concentrations of naphthalene were below adopted ILs. It is noted that the LOR for B(a)P is greater than the ADWG (0.00001mg/L / 0.01ug/L). This is however regarded as a false positive owing to limitations associated with laboratory LORs.

Note: Lower laboratory limits of reporting will be requested to assess the accuracy of the false positives recorded for benzo(a)pyrene as part of the baseline groundwater monitoring programme.

- Concentrations of TPH C₆₋₉, TPH C₁₀₋₁₄, TPH C₂₉₋₃₆ and BTEX compounds were less than LORs where analysed. MW1 recorded one elevated concentration (0.37mg/L) of TPH C₁₅₋₂₈ greater than the LOR on one occasion (September 2006).
- Concentrations of Total PAHs were less than the applicable LOR and/or adopted IL in all seven monitoring wells.
- pH was outside the adopted range (ADWG and FWG) in MW1, MW2, MW3, MW4, MW6 and MW7.
- Elevated EC concentrations were recorded in all seven monitoring wells when compared to FWGs.
- MW4 recorded one elevated TSS concentration in excess of the ADWG on one occasion (March 2006 - unfiltered sample).
- MW5 and MW6 recorded elevated hardness levels (560mgCaCO₃/L and 4,000mgCaCO₃/L respectively) in excess of the ADWG (aesthetic) on one occasion (September 2006).
- All seven monitoring wells recorded exceedances of the LTIWG with respect to chloride. MW6 recorded elevated concentrations of chloride in excess of the ADWG (aesthetic) on three occasions (March, July and September 2006). There are two possible sources of chloride impacting the site. Monitoring wells up-hydraulic gradient (i.e. MW1, MW2 and MW2) along the northern boundary of the site may be affected by septic tank leachate and drainage, as a result of water softening or other similar activities arising from residential properties north of Manning Road. Elevated concentrations of chloride recorded in monitoring wells down-hydraulic gradient i.e. along the foreshore (MW4, MW5 and MW6) are considered to be resultant from the proximity of this well to the Canning River foreshore. Low levels of chloride recorded in MW7 are considered to be as a result of some slight dilution effects from the adjacent surface water course. In essence, elevated concentrations of chloride are considered to be representative of ubiquitous background levels and do not originate from historical site activities.
- MW6 recorded elevated concentrations of sulphate in excess of the ADWG on two occasions (July and September 2006) with concentrations in all other wells significantly less than the adopted IL.

- MW4, MW5 and MW6 recorded elevated concentrations of ammonia - N ($\text{NH}_3\text{-N}$) in excess of ADWG on three occasions (March, July and September 2006). All seven monitoring wells recorded exceedances of the FWG on at least one occasion. It is noted that the LOR ($<0.2\text{mg/L}$) for ammonia-N is greater than the FWG IL, consequently there are potentially a number of false positives and exceedances within MW1, MW2, MW3 and MW7 may potentially be discounted. Concentrations of ammonia-N were generally greater down-hydraulic gradient in wells within closest proximity to the landfill (MW4 and MW5). Concentrations of ammonia may also be accounted for by the use of fertilizers (associated with the historic use of the site and potentially domestic fertilisers sourced from up-hydraulic gradient residential properties) which can yield increasing nutrient contaminants including ammonia.
- Six monitoring wells (MW1-MW6) recorded elevated concentrations of nitrogen in excess of the FWG on at least one occasion. Three MWs (MW1, MW2 and MW5) recorded concentrations of nitrogen in excess of the LTIWG on at least one occasion. One monitoring well (MW5) recorded elevated concentrations of nitrogen in excess of the STIWG on two occasions (July and September 2006). It is noted however, that STIWG are to be developed on a site specific basis and in this instance the lowest i.e. most conservative value has been used (25mg/L).
- All seven monitoring wells recorded elevated concentrations of phosphorous in excess of the FWG and LTIWG on at least one occasion. MW3 recorded one elevated concentration of phosphorous in excess of STIWG in July 2006. Concentrations of phosphorous were in general greater in up-hydraulic gradient wells (notably MW3) and there is an overall trend of decreasing concentrations down-hydraulic gradient. Elevated concentrations of phosphorous may be accounted for by the use of fertilizers in the north of the site associated with the former market gardens.
- No specific criterion is quoted for aluminium at lower pH levels in ANZECC and ARMCANZ (2000) as there is a preference for developing site specific assessment criteria at lower pH levels. It can, however, be inferred that a more conservative value such as the 99% value (0.027mg/L) may be applied. MW1 exceeded the ADWG for aluminium in March 2006. All seven monitoring wells exceeded the FWG ($<0.055\text{mg/L}$), this is however regarded as a potential false positive as the LOR is $<0.1\text{mg/L}$ on a number of monitoring rounds. Higher concentrations were generally recorded in down-hydraulic gradient monitoring wells. However, overall the data shows a decreasing trend in aluminium concentrations throughout the monitoring period.
- MW3 exceeded the FWG for arsenic in July 2006. All other monitoring wells were less than LORs or adopted ILs.
- Concentrations of barium were less than LOR and/or adopted IL in all seven monitoring wells.
- MW1 recorded elevated concentrations of iron in excess of the ADWG (aesthetic). MW1 and MW7 recorded elevated concentrations of iron in excess of LTIWG in March 2006. All other monitoring wells recorded concentrations of iron less than LOR and/or adopted ILs. Elevated concentrations of iron are considered to be representative of ubiquitous background concentrations. Higher concentrations were recorded in down-hydraulic gradient monitoring wells.
- MW1 and MW4 recorded elevated concentrations of manganese in excess of the ADWG (aesthetic) and LTIWG. MW6 recorded elevated concentrations of manganese in excess of the ADWG (health and aesthetic) and also the LTIWG. Given the general widespread trend of elevated concentrations of manganese up and down-hydraulic gradient and also within proximity of the landfill suggests that background concentrations may be elevated within the vicinity of the site, however the highest concentrations are recorded in the down-gradient monitoring wells.

- All seven monitoring wells recorded concentrations of mercury <0.0001mg/L which exceeds the FWG of 0.00006mg/L. This is therefore considered potentially to be a false positive.
- MW6 (filtered sample) recorded an elevated concentration of selenium in excess of the ADWG and FWG in March 2006. All other monitoring wells recorded concentrations of selenium less than LOR and/or adopted ILs.

4.3.1 Metals with Freshwater Hardness Modification Factor

The Fresh Waters-Rivers guidelines for metals have been modified according to groundwater hardness (as mgCaCO₃/L), according to the values given in Table H (from ANZECC and ARMCANZ, 2000).

TABLE H
FRESH WATERS-RIVERS HARDNESS MODIFICATION FACTOR (HMF)

		Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Hardness (mgCaCO ₃ /L)	Bore ID	Modification Factor					
Soft (0-59)	MW1	1	1	1	1	1	1
Moderate (60-119)	MW2, MW3, MW4, MW7	2.7	2.5	2.5	4.0	2.5	2.5
Hard (120-179)	-	4.2	3.7	3.9	7.6	3.9	3.9
Very Hard (180-240)	-	5.7	4.9	5.2	11.8	5.2	5.2
Extreme (>400)	MW5, MW6	10.0	8.4	9.0	26.7	9.0	9.0

Hardness was only measured during the September and December 2006 rounds. These measured values have been used to classify each sample location (as indicated in Table H above), and the resulting modified values have been applied to each location for all rounds.

A screening assessment of metals with hardness modifications applied is provided in Appendix F (Table 7). A brief discussion on general trends is provided below. Data representing filtered or unfiltered samples obtained in March 2006 has been differentiated in the summary below and a discussion of the variance between filtered and unfiltered samples is provided in Section 4.3.2 (data is presented in Table 8 - Appendix F).

Cadmium

One elevated concentration of cadmium was recorded (0.003mg/L) in MW5 on one occasion (May 2003) in excess of the ADWG (0.002mg/L) (but below the ADWG x10).

MW1-MW4 recorded concentrations of cadmium in excess of both the FWG (and the FWG HMF which is unamended) on one occasion (May 2003) owing to the LOR (i.e. <0.002mg/L) (Note: MW6 and MW7 were not installed at the time). Subsequent monitoring recorded concentrations of cadmium less than

the lower LORs applied ($<0.0001\text{mg/L}$ / $<0.0002\text{mg/L}$). As such, exceedances recorded in May 2003 in these wells are considered to be false positives.

MW6 recorded concentrations of cadmium at the FWG (0.0002mg/L) on two occasions (March 2006 (unfiltered sample) and July 2006) and as such are not considered to be significantly elevated.

MW5 was the only well which recorded an elevated concentration of cadmium (0.003mg/L) in May 2003, which exceeded the FWG HMF (0.002mg/L). Subsequent monitoring recorded concentrations of cadmium below LOR and/or ILs.

Concentrations of cadmium within groundwater are not considered to represent a significant risk to fresh water receptors.

Chromium

One marginally elevated concentration of chromium (MW1 0.019mg/L) was recorded in excess of the FWG and FWG HMF (0.01mg/L) in March 2006 (unfiltered sample). Subsequent monitoring recorded concentrations of chromium less than LORs and/or ILs in all monitoring wells. As such, chromium is not considered to represent a significant risk to freshwater receptors.

Copper

MW1-MW5 recorded concentrations of copper in excess of both the FWG (and the FWG HMF which is unamended) on one occasion (May 2003) owing to the LOR (i.e. $<0.01\text{mg/L}$) (Note: MW6 and MW7 were not installed at the time). As such, these exceedances are considered to be false positives.

MW2 and MW4 did not record any elevated concentrations of copper during subsequent monitoring rounds. MW1 recorded one additional marginally elevated concentration of chromium in excess of FWG (and FWG HMF which is unamended) in September 2006 (0.002mg/L). MW3 recorded elevated concentrations of copper during three subsequent monitoring rounds however the results are not considered to be significantly elevated.

Lead

MW1-MW5 recorded elevated concentrations of lead in excess of both the FWG (and the FWG HMF which is unamended) on one occasion (May 2003) owing to the LOR (i.e. $<0.01\text{mg/L}$) (Note: MW6 and MW7 were not installed at the time). As such, these exceedances are considered to be false positives. MW1 recorded one additional marginally elevated concentration of lead (0.004mg/L) (March 2006 (unfiltered sample)). MW6 also recorded a marginally elevated concentration of lead in excess of the FWG at 0.006mg/L ; this is however below the FWG HMF and as such is not considered to represent a significant risk to freshwater receptors.

Nickel

MW3 and MW4 recorded elevated concentrations of nickel in excess of both the FWG and FWG HMF on one occasion (March 2006 using both filtered and unfiltered samples). Subsequent monitoring in these wells recorded concentrations of nickel less than LORs/ILs. MW5 recorded elevated concentrations of nickel in excess of the FWG on one occasion (March 2006 using both filtered and unfiltered samples) however concentrations were below the FWG HMF. MW6 recorded one elevated concentration of nickel in excess of both FWG and FWG HMF in March 2006 using an unfiltered sample. The filtered sample for the same sampling event recorded a concentration of nickel less than the FWG HMF. Subsequent monitoring also recorded concentrations of nickel less than the FWG.

Zinc

MW1, MW3, MW4, MW5 and MW6 recorded concentrations of zinc in excess of both the FWG and FWG HMF on at least one occasion, it is however noted that concentrations generally showed a declining trend over the course of the monitoring events. No exceedances of the FWG HMF were recorded in September 2006.

4.3.2 Variance Between Filtered and Unfiltered Groundwater Samples

An assessment of the variance between filtered and unfiltered groundwater samples is provided in Appendix F (Table 8). Of the thirteen metals analysed for, aluminium, arsenic and iron have been identified as being affected by the filtering process. Analysis of variance between filtered and unfiltered groundwater results in the remaining 10 metals (at a significance level of 95%) indicates that filtering does not have an effect on those particular contaminants. The variance between the unfiltered and filtered samples is not considered to have a significant impact on the overall assessment as each result has been assessed individually against the applicable ILs and not considered as averages over the course of the groundwater monitoring programme. It is noted that future groundwater monitoring undertaken will adopt procedures to filter metals in the field in accordance with industry practice and metal concentrations will be reassessed as part of the baseline monitoring programme.

4.3.3 Quality Control Review

The following quality control procedures were implemented during previous groundwater monitoring events.

Analytical Procedures

The laboratory used, Analytical Reference Laboratory (ARL) WA is NATA accredited for all groundwater analyses undertaken. It is therefore considered that a review of the specific laboratory analytical procedures is not warranted.

Laboratory Limit of Reporting

The laboratory Limit of Detection (LOD) refers to the concentration above which reported results can be expressed with a minimum 99% confidence level. It is acknowledged that there are a number of potential false positives as a result of limitations associated with laboratory Limit of Reporting (LOR) for aluminium, mercury, and NH₃-N (notably the May 2003 monitoring event). All other analytes were at least equal to, if not below, the relevant assessment criterion.

- The LOR for ammonia-N is <0.2mg/L which is greater than the FWG IL 0.15mg/L.
- The LOR for aluminium is <0.1mg/L which is greater than the FWG IL of 0.055mg/L.
- The LOR for cadmium in May 2003 is <0.002mg/L which is greater than the FWG IL of 0.0002mg/L.
- The LOR for copper in May 2003 is <0.01mg/L which is greater than the FWG IL of 0.0014mg/L.
- The LOR for mercury is <0.002mg/L (May 2003) which is equal to the ADWG of 0.002mg/L. The LOR for mercury applied during subsequent monitoring events (<0.0001mg/L) is greater than the FWG of 0.00006mg/L. The LOR for May 2003 data was noted to be equal to the LTIWG and STIWG.
- The LOR for dieldrin in May 2003 was <0.1µg/L which is greater than the FWG of 0.002µg/L.

In the case of mercury, the laboratory has advised that this is the lowest level of detection currently practically obtainable at the time of analysis. For bores MW2, MW3, MW4 and MW7, on the basis of the July 2006 analytical result, it is likely that the concentrations of aluminium in the bores exceeded the FWG during the rounds where the detection limit was greater than the guideline value. For bores MW5 and MW6, the analytical results indicate that the results were likely less than the FWG. Data for all bores indicate that concentrations of $\text{NH}_3\text{-N}$ are likely to have remained above the FWG during the monitoring period.

Accuracy/Bias and Precision Definitions

Accuracy is defined as "exact conformity to truth," or "freedom from error." It is virtually impossible to determine accuracy because the true value being estimated with sampling and analysis methods is rarely known. Bias refers to the systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e. the expected sample measurement is different from the sample's true value). Two bias analytical errors may occur:

- Low Bias Analytical Error - when analytical data indicate that a substance is not present above a specified concentration, when in fact it is.
- High Bias Analytical Error - when analytical data indicate that a substance is present above a specified concentration, when in fact it is not.

Precision is the repeatability of measurements. In order to assess the bias and precision, the following field and laboratory quality control samples were analysed:

- Blanks: to assess bias introduced during sampling and analysis;
- Duplicates: to assess precision;
- Spikes: to assess bias introduced in laboratory.

Blank Samples

Field blanks are used to assess the potential introduction of contaminants from ambient sources (e.g. dust, gaseous and particulate emissions from motors in operation, etc) to the samples during sample collection. The field blank is collected by filling a sampling container with deionised water in the field, simulating the exposure that a sample would have during bottle filling. No samples are collected during this time.

A field blank sample was collected for the each sampling event. The field blank sample was analysed for all analytes of concern. As indicated in Table 9 (Appendix F), minor concentrations of iron and selenium were detected in the field blank samples in March 2006 and July 2006. In the case of iron, as the majority of results were significantly above the DWG, this is not considered to have impacted the results. Furthermore, as the DWG for iron is based on aesthetics and as such is not considered to be significant.

Selenium was detected at concentrations equal to the detection limit in all monitoring rounds. Values at or near to the detection limit have inherent limitations. Concentrations of selenium in the groundwater samples only exceed the guidelines in one monitoring round (March 2006). In this case, the minor amounts detected in the field blank sample are not considered to have a significant impact on the final result.

Trip blanks comprise sample containers filled with laboratory deionised water, which are transported to the site, but are not opened. Trip blanks are then transported with the groundwater samples to assess the amount of contamination introduced during the transport and storage of samples from the time of sampling until the time of analysis. Three trip blank samples were obtained (representing two monitoring events - March 2006 and July 2006) and analysed for BTEX and TPH. All samples recorded concentrations of these analytes below the LOR and as such, samples are not considered to have been impacted by external media during transport.

Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected using identical recovery techniques. Samples are collected simultaneously from the outlet of the low-flow pump. Duplicate samples are treated in an identical manner to other samples during storage, transportation, and analysis. Duplicate samples were collected at a rate of one in 20.

The field duplicate samples are used to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. Generally, it is recommended that the RPD be less than 30-50% (Standards Australia, AS 4482-2005). In this instance, should the RPD not exceed 50%, then the results are considered acceptable. The RPDs for field duplicates are presented in Table 9 (Appendix F).

The following samples recorded an RPD value greater than 50%:

- MW1/MW1 duplicate (March 2006 unfiltered samples) - Chromium - RPD = 62.03%

MW1 recorded a concentration of chromium of 0.019mg/L whilst MW1 duplicate recorded a concentration of 0.01mg/L. The higher concentration recorded in the primary sample (MW1) has been utilised in the assessment when considering the number of exceedances of the FWG. It is noted that MW1 and MW1 duplicate filtered samples for the same monitoring event recorded equal concentrations of chromium.

- MW1/MW1 duplicate (March 2006 unfiltered samples) - Iron - RPD = 116%

MW1 recorded a concentration of iron of 0.34mg/L whilst MW1 duplicate recorded a concentration of 1.4mg/L. As the majority of results were significantly above the DWG, this is not considered to have impacted the overall assessment.

- MW7/MW7 duplicate (September 2006) - Total Acidity - RPD = 78.26%

MW7 recorded a concentration of Total Acidity of 64mgCaCO₃/L whilst MW7 duplicate recorded a concentration of 28mgCaCO₃/L. There is currently no established IL for Total Acidity with respect to general groundwater quality however this parameter has been considered within the Acid Sulphate Soil Management Plan. Total acidity was generally recorded at concentrations higher than the duplicate sample and as such, is not considered to significantly impact the overall assessment.

- MW7/MW7 duplicate (September 2006) - Sulphate - RPD = 61.22%

MW7 recorded a concentration of sulphate of 32mg/L whilst MW7 duplicate recorded a concentration of 17mg/L. Both values are significantly below the ADWG of 250mg/L and as such this is not considered to have impacted the results and overall assessment.

- MW7/MW7 duplicate (September 2006) - NO_x-N - RPD = 66.66%

MW7 recorded a concentration of NO_x-N of <0.01mg/L whilst MW7 duplicate recorded a concentration of 0.02mg/L. Both concentrations are less than adopted ILs and as such this is not considered to have impacted the overall assessment.

- MW7/MW7 duplicate (September 2006) - Total Phosphorous - RPD = 57.14%

MW7 recorded a concentration of total phosphorous of <0.09mg/L whilst MW7 duplicate recorded a concentration of 0.05mg/L. A number of samples recorded concentrations of total phosphorous greater than 0.05mg/L and the higher concentration recorded in the primary sample has been utilised in the assessment as a conservative approach.

- MW7/MW7 duplicate (September 2006) - Iron - RPD = 79.83%

MW7 recorded a concentration of iron of 1.7mg/L whilst MW7 duplicate recorded a concentration of 0.73mg/L. As the majority of results were significantly above the DWG, this is not considered to have impacted the overall assessment.

A review of analytical results with RPD exceedances indicates that results can be attributed to one or more explanations listed below and are not considered to compromise the integrity of the analytical results and overall assessment.

1. Reported concentrations for both the routine (primary) and duplicate sample are above the adopted criteria, or where there are no criteria the reported concentrations indicate the presence of impact. The calculated RPD values are not considered to affect the integrity of the results as both results indicate the presence of impact.
2. Low analyte concentrations have exaggerated the percentage differences with respect to small total concentration differences. The calculated RPD values are not considered to affect the integrity of the results as both results remain well below adopted criteria.
3. The variation in RPDs is attributed to laboratory preparation techniques/instrument error and was confirmed with the laboratory.
4. Sample variation is exaggerated where only one of the sample pair has been detected given the adopted calculation method for RPD (i.e. half the laboratory detection limit concentration for the non-detectable sample).
5. Elevated RPDs are likely to be a result of either the heterogeneous nature of the groundwater or sampling procedures.

It is acknowledged that no triplicate samples were obtained in groundwater monitoring events completed to date. Triplicate samples are typically sent to a second independent NATA accredited laboratory to provide an additional level of quality control over and above that provided by the primary laboratory data (primary and duplicate samples). As indicated above, the majority of duplicate samples fell within the acceptable RPD range. Instances where the RPD exceeded 50% are rationalised in the section above and are not considered to significantly impact the overall assessment of groundwater conditions underlying the site. A QA/QC procedures proposed for future monitoring events are outlined in Section 9.0.

Spike Data

The occurrence of both low and high bias errors can be estimated by reviewing the percent recovery of matrix spikes, which is expected to vary between 70-130% unless otherwise stated. A summary of the reported matrix spike results presented in Table 10 (Appendix F) indicates that the quality of the analytical data is sound.

Documentation

As a part of this Quality Assurance, ATA Environmental has a standard Chain of Custody form. All projects in which sample collection is undertaken must have a completed Chain of Custody prior to submission of the samples to a laboratory. Both the laboratory and ATA Environmental retain a copy of the Chain of Custody once the samples have been submitted. All quality system documentation is retained for a minimum period of five years. Quality system documentation is generally archived rather than being disposed of after the minimum retention period has expired.

Conclusion

The field method validation and laboratory QA/QC measures employed throughout the assessment have enabled the quality of field sample collection and laboratory analysis procedures to be examined. Based on the above, the data is considered of acceptable quality for interpretation and environmental assessment of the site. Details relating to QA/QC procedures proposed for subsequent groundwater monitoring events are outlined in Section 6.

4.4 Assessment of Groundwater Quality Due to Historical Land Uses

Overall the monitoring results are consistent with the relative passive land uses that have historically been present on this site. There is no significant evidence of contamination with petroleum hydrocarbons, solvents, pesticides or other toxic organic compounds other than a single result from bore MW1 in September 2006. The single hydrocarbon result in MW1 (September 2006 (0.37mg/L) has been discounted on the basis of the following arguments:

- The result has not been supported by any visual or olfactory evidence from soil, surface or groundwater results on-site.
- None of the results of analysis from samples from any other groundwater bore has detected any petroleum hydrocarbon compounds.
- There is no identifiable source on-site or in the near vicinity up-gradient of the monitoring well which may have resulted in the contamination.

There is evidence of low level metals contamination from a regional source in urban areas to the north of the Cygnia Cove site. The metals results are consistent with typical urban water quality.

The concentrations of metals detected in all bores exhibit a general decreasing trend throughout the monitoring period. The majority of metal concentrations suggest that contaminant concentrations are no greater in down-gradient bores (MW5, MW6 and MW7) with respect to up-gradient bores (MW1, MW2, MW3, MW4). Contaminants identified in up-gradient bores are considered to potentially be the result of up-gradient land uses off-site.

The results suggest that the presence of the uncontrolled fill on the site does not appear to be impacting adversely on groundwater quality.

A number of the bores have detected levels of nitrogen compounds which primarily appear to be a regional phenomenon. There is limited evidence in the records of bores MW4 and MW5 of possible influence from the former municipal landfill in the south-eastern portion of the site.

Elevated parameters such as $\text{NH}_3\text{-N}$, TKN, chloride, sulphate, conductivity and zinc in are generally considered to be associated with impacts from municipal waste or waste water. The elevated concentrations of these parameters in bores MW4 and MW5 may suggest that the former municipal landfill site that is located immediately to the north and east of these bores may be impacting on groundwater quality in this vicinity.

It is noted that the upward discharge of brackish water from the Leederville aquifer into the superficial aquifer causes elevated salinity concentrations adjacent to the Canning River (Davidson, 1995), which is considered to result in the elevated concentrations of chloride recorded.

It is also noted that within the Perth region, dissolved iron in the groundwater of the superficial aquifer potentially originates from a chemical reaction between acidic groundwater and ilmenite grains (Baxter, 1977), which are contained mainly in the Bassendean Sand Formation which is present on-site.

Although groundwater contours presented in Figure 4 do not suggest a north-westerly flow direction in this area, it is possible that a component of north-westerly flow may be induced in this area due to the topography at the boundary of the former landfill site to the south-east. This may be either due a slight mounding of the watertable underneath the landfill or to surface run-off from the raised landfill (the former is considered more likely than the latter). To date, the location of groundwater bores on-site (which resulted in the groundwater contours shown in Figure 4) do not allow for a detailed assessment of the groundwater flow patterns underneath the former landfill site on the adjacent site; however this is considered the most likely explanation for the elevated parameters; rather than an on-site source. This will be further assessed upon completion of the baseline groundwater monitoring programme.

Based on the bore monitoring undertaken to date there appears to be little evidence that current or historical on-site activities have contributed to significant groundwater contamination. Owing to the transient nature of groundwater, a baseline monitoring programme was completed prior to the commencement of remedial works. The baseline monitoring completed is discussed further in Section 5.0 and 6.0.

4.4.1 Assessment of Impacts on Environmental Receptors

As indicated in Section 3.6, the receptor for groundwater or surface water contamination originating on the Cygnia Cove site is the Canning River. A requirement of the EPA's assessment of the site was to undertake an ecotoxicological assessment of the groundwater discharge under current conditions. This is regarded as a conservative predictor of future of the post-remediation ecotoxicological impact for all parameters other than nutrients as the remediation of the site will remove all identified contaminants at above EIL concentration and remove a significant fraction of the potentially acidic soil that currently exists on the site.

An Ecotox study has been initiated by Dr Jill Woodworth of Geotechnical Services under the direction of Coffey Environments. The initial phase of work consisted of a screening assay using the unicellular algal test *Isochrysis* sp. With water samples from all seven sampling wells (MW1-7) and a sample of River water taken from near the shoreline on the southern boundary of the site. Unicellular algal growth inhibition tests have been shown to be sensitive to organics and metals and are deemed to be a suitable screening test to assess this site. The test protocols were performed in accordance with Geotech Work Instruction WIENV-45 that is based on the method described by Stauber et al (1994).

The results of this screening study indicated that all samples resulted in enhanced algal growth probably due to the presence of nutrients in the samples which enhanced algal growth. As a result of the masking effect of the nutrients it was not possible to draw any conclusions regarding the impact of the low levels of metals that are known to be present in groundwater on the site.

Subsequently samples from five of the seven bores (MW3-MW7) were subject to microtox testing.

In this test, selected species of bioluminescent bacteria were challenged with groundwater samples and the level of bioluminescence used to assess whether any toxic impacts were observed. The tests were completed in accordance with Geotech Work instruction WIENV-30.

Microtox results showed that water samples from sites MW4 and MW5 exhibited toxicity to the bacteria. These two sites are closest to a former landfill site so would be expected to show some toxicity.

However, these two sites are also located furthest from the wetland discharge site and would be unlikely to contribute to direct impacts through the surface water discharge from the site.

Based on this original work, an ecotox monitoring program has been developed and agreed with the EPA. The program consists of detailed testing using five analytical methods following a rain event and ground disturbance with monthly/quarterly screening tests using the Microtox procedure. A copy of the plan and DEC correspondence approving it are provided at Appendix H.

5 BASELINE GROUNDWATER MONITORING

Following discussions with the appointed Auditor it was agreed that a number of additional groundwater monitoring bores located more centrally within the site would be installed to:

1. Assist in monitoring the impacts from the implementation of the Acid Sulfate Soil Management Plan prepared for the site (ATA, 2007b);
 2. Provide additional evidence to show that neither the community market garden previously located in the northern part of the site adjacent to Manning Road nor the uncontrolled fill located to the south of the wetland are contributing to localised contamination of the aquifer that has not been evidenced in bores located on the boundaries of the site; and
- MW1 and MW2 were gauged in September 2008 and noted to be dry as a result of either a fall in groundwater levels or the bores were potentially damaged. Consequently, the bores were redrilled approximately 1m down-hydraulic gradient and have been assigned a prefix of MW1(A) and MW2(A).

The locations of the six additional shallow monitoring bores which were installed in October 2008 are shown on Figure 3. These monitoring bores have been assigned a prefix of 'ASSMW' but numbered sequentially from 8-13 to avoid any possible confusion with the number of the existing seven monitoring bores with the MW prefix.

All 13 wells were gauged and sampled to establish baseline groundwater quality prior to remediation works. The groundwater assessment field activities conducted at the site are summarised in Table I.

TABLE I
GROUNDWATER ASSESSMENT METHODOLOGY

Activity	Details
Date of Field Activity	17 and 22 September 2008 (drilling works). 28-29 October 2008 (baseline groundwater monitoring event).
Well Construction	Monitoring wells installed in September 2008 (MW1(A), MW2(A) and ASSMW8-ASSMW13) targeted the superficial aquifer and were constructed using 50mm diameter class 18 PVC. Slotted sections were extended to accommodate the potential drawdown in groundwater levels during dewatering activities so as to enable groundwater sampling to be undertaken in the future (i.e. post-remediation). Clean gravel pack was backfilled around the screened interval. A bentonite seal (generally 0.5m) was installed above the gravel pack and the remainder of the well was backfilled using soil cuttings. The wells were completed with a cemented steel riser. Well construction details are included in the drilling logs in Appendix I.

TABLE I
GROUNDWATER ASSESSMENT METHODOLOGY

Activity	Details
Well Survey	Wells were surveyed to mAHD by licensed surveyors. Survey results are detailed in Appendix J. Potentiometric groundwater contours for the most recent monitoring event (28-29 October 2008) are provided in Figure 11.
Well Development	The wells were purged until water quality parameters stabilised or groundwater obtained from the well was sediment free.
Well Gauging	Monitoring wells were gauged using an oil/water interface probe (IP) after a minimum seven day settling period from installation date. The IP was decontaminated between each monitoring well. Field well gauging sheets are contained in Appendix K.
Well Purging	Purging of each monitoring well was undertaken until water quality parameters (pH, oxidative/reduction potential, temperature, electrical conductivity) stabilised (i.e. three consecutive measurements $\pm 10\%$) using disposable bailers. Field purging data sheets are contained in Appendix K.
Sampling Method	Groundwater samples were collected using the low-flow sampling techniques.
Decontamination Procedure	The water sampling equipment, IP (including the full length of the IP meter, equalling the length of the bore gauged) and water quality meter were decontaminated with laboratory grade detergent and rinsed with deionised water between wells. Dedicated disposable nitrile gloves were used for each sample. Decontamination records are contained within Appendix L.
Sample Preservation	Samples were placed in laboratory supplied bottles containing appropriate preservatives. Samples were stored on ice ($<4^{\circ}\text{C}$) in an esky while on-site and in transit to the laboratory. Samples collected for metals analysis were filtered in the field.

Groundwater gauging data and water quality measurements collected during field activities are presented in Appendix K. Based on the gauging data collected during field activities, interpreted groundwater contours are detailed in Figure 11. Site specific hydrogeology for the site is summarised in Table J.

TABLE J
SITE SPECIFIC HYDROGEOLOGY

Item	Description
Depth to Groundwater	Standing water levels (SWLs) across the area of investigation ranged between 0.545m below top of casing (mbtoc) (MW6) and 6.562mbtoc (MW2A). Corrected water elevations ranged between 0.373mAHD (MW7) to 3.820mAHD (MW3).
Phase Separated Hydrocarbon (PSH)	PSH was not encountered during the monitoring event.
Gradient and Groundwater Flow Direction	Based on the groundwater contour plan, groundwater flow direction is to the south towards the Canning River.
Groundwater Discharge Location	Groundwater discharges to the Swan-Canning River system along the southern boundary of the site and also into the wetland along its northern boundary.

5.1.1 Field Groundwater Quality Parameters

Groundwater quality parameters measured post-purge during field activities conducted on 28 and 29 October 2008 are presented in Appendix K. Post-purge groundwater quality measurements are assumed to be more representative of fresh water flowing within the aquifer, and are discussed below, where available.

- Dissolved oxygen (DO) measurements ranged between 0.28mg/L (MW4) and 4.65mg/L (ASSMW12), indicating aerobic conditions.
- Oxidation/reduction (redox) potential (Eh) measurements ranged between -125mV (MW5) and 311mV (ASSMW12) indicating oxidising conditions.
- EC measurements ranged between 426 μScm^{-1} (ASSMW13) and 1,710 μScm^{-1} (ASSMW12).
- Field TDS concentrations (calculated from the field EC measurements by a factor of 0.65) ranged between 277mg/L (ASSMW13) and 1,112mg/L (ASSMW12), with an average of 503mg/L.
- pH measurements ranged between 4.64 (ASSMW12) and 6.95 (MW5). The pH range indicates neutral to acidic conditions.
- Temperature measurements ranged between 15.86 $^{\circ}\text{C}$ (ASSMW8) and 20.81 $^{\circ}\text{C}$ (MW3).

6 ASSESSMENT CRITERIA FOR BASELINE GROUNDWATER MONITORING DATA

The guidelines adopted for the Baseline Groundwater Monitoring Assessment are outlined in Section 4.2.4. As indicated in Section 4.3.1, previous groundwater monitoring and assessment undertaken assessed heavy metals using the Fresh Waters-Rivers guidelines hardness modification factor (HMF) (from ANZECC and ARMCANZ, 2000). Hardness was measured during the September and December 2006 rounds. These measured values have been used to classify each sample location (as indicated in Section 4.3.1 - Table H), and the resulting modified values have been applied. Hardness was not assessed in the most recent groundwater monitoring completed. Whilst it is acknowledged that alkalinity and hardness have similar values owing to the fact that carbonates and bicarbonates responsible for total alkalinity are usually in the form of calcium carbonate or magnesium carbonate, it is however noted that total alkalinity is not always representative since the carbonates can be in the form of sodium or potassium carbonate also. Consequently, a conservative approach has been adopted and a hardness modification factor of 1 has been applied to groundwater samples within ASSMW8-ASSMW13. A screening assessment of metals with hardness modifications applied is provided in Appendix M (Table 14).

Groundwater analytical results, including field QC data and comparisons to the adopted ILs are presented in Tables 11 to 18 as outlined in Table K.

TABLE K
TABLE IDENTIFICATION FOR BASELINE GROUNDWATER ANALYTICAL RESULTS (2008)

Tables	Analytes
Table 11	Summary of Baseline Groundwater Analytical Results
Table 12	Summary of Baseline Groundwater Analytical Results in excess of ADWG and ADWG x10
Table 13	Summary of Baseline Groundwater Analytical Results in excess of FWG
Table 14	Summary of Baseline Groundwater Analytical Results in excess of FWG with HMF assessment
Table 15	Summary of Baseline Groundwater Analytical Results in excess of LTIWG
Table 16	Summary of Baseline Groundwater Analytical Results in excess of STIWG

Certified laboratory reports are included in and Chain of Custody (COC) documentation is presented in Appendix N. A summary of the baseline groundwater analytical results is presented in Table L below.

TABLE L
SUMMARY OF BASELINE GROUNDWATER ANALYTICAL RESULTS (2008)

Analytes	Comments
Metals	<p>Copper</p> <p>MW1(A), MW3 and ASSMW9-ASSMW13 recorded concentrations of copper in excess of the FWG with HMF.</p> <p>Iron</p> <p>Elevated concentrations of iron were recorded in excess of the ADWG in MW3, MW7, MW8 and MW10-MW13. Concentrations of iron exceed the ADWG x10 in MW4, MW5, MW6 and MW9. Concentrations of iron exceeded the LTIWG in MW1(A) and MW3-ASSMW13. Concentrations of iron exceed the STIWG in MW4, MW6 and MW9.</p> <p>Manganese</p> <p>Concentrations of manganese were recorded in excess of the ADWG and LTIWG in MW4 and MW6.</p> <p>Mercury</p> <p>All 13 groundwater monitoring bores (including QC samples) recorded elevated concentrations of mercury owing to limitations associated with laboratory LORs. The laboratory has advised that it is not possible to achieve a lower LOR and as such, these exceedances may be considered to be false positives. The laboratory has advised that a lower LOR is not achievable.</p> <p>Selenium</p> <p>One bore (MW6) recorded an elevated concentration of selenium in excess of the FWG.</p> <p>Zinc</p> <p>All 13 groundwater monitoring bores, with the exception of MW5 and MW6, recorded elevated concentrations of zinc in excess of the FWG with HMF.</p>
PAHs	Concentrations were detected less than the LORs and adopted ILs (where available).
Phenolics	Concentrations were detected less than the LORs and adopted ILs (where available).
BTEX	Concentrations were detected less than the LORs.
TRH	Concentrations were detected less than the LORs.
OC/OP	Elevated concentrations of DDT, aldrin, chlordane, chlorpyrifos, diazinon, fenitrothion and methyl parathion were recorded in excess of FWG owing to limitations associated with laboratory LORs. It is noted that no samples exceeded adopted ADWG where available. The laboratory has advised that a lower LOR is not achievable.

TABLE L
SUMMARY OF BASELINE GROUNDWATER ANALYTICAL RESULTS (2008)

Analytes	Comments
Carbamate Pesticides	Concentrations were detected less than the LORs.
Major Anions and Cations	<p>Ammonia</p> <p>Elevated concentrations of ammonia were recorded in excess of the ADWG in MW4, MW5, ASSMW9 and ASSMW13. Concentrations of ammonia exceeded the FWG in QC1, MW4-MW6, ASSMW8 and ASSMW13.</p> <p>Chloride</p> <p>Concentrations of chloride exceeded the ADWG in MW6 and ASSMW12. Concentrations of chloride exceeded the LTIWG in all 13 groundwater monitoring bores (including QC samples).</p> <p>Hydrogen Sulphide</p> <p>All 13 groundwater monitoring bores (including QC samples) recorded elevated concentrations of hydrogen sulphide in excess of the FWG owing to limitations associated with laboratory LOR. The LOR for hydrogen sulphide is 0.05mg/L (i.e. equal to the ADWG but greater than the FWG), and as such may be considered to be false positives.</p> <p>Nitrate</p> <p>Eight groundwater monitoring bores (MW1(A), MW2(A) (including QC1 - duplicate of MW2(A) and QC2 - triplicate of MW2(A)), MW3, ASSMW10, ASSMW11 and ASSMW13) recorded concentrations of nitrate in excess of the FWG.</p> <p>Total Dissolved Solids (TDS)</p> <p>MW4, MW6, ASSMW8 and ASSMW12 recorded elevated concentrations of TDS in excess of the ADWG.</p> <p>Total Nitrogen (N)</p> <p>MW1(A), MW2(A) (including QC1 - duplicate of MW2(A) and QC2 - triplicate of MW2(A)), MW3, MW5 and ASSMW9-ASSMW11 recorded elevated concentrations of total nitrogen in excess of the FWG. MW2(A) (including QC1 - duplicate of MW2(A) and QC2 - triplicate of MW2(A)), MW5 and ASSMW10 recorded elevated concentrations of total nitrogen in excess of the LTIWG.</p> <p>Total Phosphate</p> <p>MW1(A), MW2(A) (including QC1 - duplicate of MW2(A)), MW3, MW5, MW7 and ASSMW10 and ASSMW11 recorded elevated concentrations of total phosphate in excess of the FWG.</p> <p>All 13 groundwater monitoring bores, with the exception of MW4, MW6, ASSMW8, ASSMW9 and ASSME12, recorded concentrations of total phosphate in excess of the LTIWG.</p>

6.1 Baseline Groundwater Monitoring - Field and Laboratory QA/QC Data Assessment

Groundwater samples (including field QC samples) were submitted to MGT Environmental Consulting (MGT) laboratory. Triplicate samples were submitted to SGS Environmental Services (SGS) laboratory. Both MGT and SGS are NATA accredited for the laboratory analysis performed.

6.1.1 Groundwater Quality Control

A total of 13 groundwater samples along with one duplicate/triplicate pair selected from a primary groundwater sample (QC1, QC2 for MW2(A)) were submitted for heavy metals, carbamate pesticides, OC/OP and major anions and cations. Certified laboratory reports and laboratory QA/QC data is included in Appendix N. Assessment of the analytical results for the groundwater sampling is summarised in Table M.

TABLE M
BASELINE GROUNDWATER MONITORING - ANALYTICAL QUALITY CONTROL VALIDATION

Requirement	Yes/No
All soil and groundwater samples were submitted to NATA accredited laboratories.	Yes
All samples were extracted within the required holding time.	Yes
Percentage recovery results were all within the acceptable range for all duplicates.	Yes
Laboratory internal standards, calibration blanks and mid-range calibration verifications were acceptable.	Yes
The RPDs for analytes tested were all within the acceptable RPD range.	No

6.1.2 Assessment of Baseline Groundwater Monitoring RPD's

All duplicates and triplicates were found within the acceptable RPD range (<50%) for groundwater samples with the exception of:

- Ammonia: 116.67% RPD between QC1 (duplicate of MW2(A) and MW2(A)). It is noted that QC2 (duplicate of MW2(A) constituent analyte concentrations were less than applicable LORs.
- Total phosphate: 66.67% RPD between QC2 (triplicate of MW2(A) and MW2(A)). It is noted that QC1 (duplicate of MW2(A) was found within the acceptable RPD range (34.48%).
- Total Kjeldahl Nitrogen (N): 80% RPD between QC2 (triplicate of MW2(A) and MW2(A)). It is noted that QC1 (duplicate of MW2(A) was found within the acceptable RPD range (15.38%).
- Bicarbonate alkalinity: 53.66% RPD between QC2 (triplicate of MW2(A) and MW2(A)). It is noted that QC1 (duplicate of MW2(A) constituent analyte concentrations were less than applicable LORs.

Elevated RPDs could result from a number of factors including the heterogeneous nature of ground conditions, sampling procedures and analytical methods. In addition, variations can be expected to be

higher for organic versus inorganic analyses and for low analytes concentrations, which will exaggerate apparent differences. It should also be noted that for concentrations close to the LOR, acceptance targets for RPDs are difficult to apply as the uncertainty of the concentration can approach, and even equal, the reported concentration (Keith, 1991).

6.2 Blank Quality Control Sample

In addition to the field duplicate/triplicate QC samples, equipment rinsate, field blanks and trip blanks were collected during the sampling program. Equipment rinsate blanks were collected from the final rinse of either the IP or the water quality meter using distilled water in laboratory supplied containers with appropriate preservative. Trip blanks were prepared prior to each field day using distilled water in laboratory supplied containers with appropriate preservative and stored in an esky during fieldwork. Equipment rinsates and trip blanks collected during the current investigation are summarised in Table N.

TABLE N
BASELINE GROUNDWATER MONITORING - EQUIPMENT RINSATE, FIELD BLANKS
AND TRIP BLANKS

Sample ID	Sample Type	Analysis Conducted
QC3	Equipment Rinsate (28 October 2008)	Heavy metals, carbamate pesticides, organochlorine pesticides, organophosphorous pesticides and major anions and cations.
QC4	Field Blank (28 October 2008)	
QC5	Trip Blank (28 October 2008)	
QC6	Equipment Rinsate (29 October 2008)	
QC7	Field Blank (29 October 2008)	
QC8	Trip Blank (29 October 2008)	

Targeted analyte concentrations were less than the laboratory LOR for the equipment rinsate, field blanks and trip blanks analysed.

6.3 QA/QC Summary

The field method validation and laboratory QA/QC measures employed throughout the assessment have enabled the quality of field sample collection and laboratory analysis procedures to be examined. Based on the above, the data is considered of acceptable quality for interpretation and environmental assessment of the site.

6.4 Discussion of Baseline Groundwater Monitoring Analytical Results

Analytical results from the baseline groundwater monitoring have recorded similar trends to those identified in previous groundwater monitoring events. It is noted that contaminants were generally recorded at lower concentrations than previous monitoring events indicating an overall improvement in the general groundwater quality in the past two years.

Concentrations of TPH C₁₅₋₂₈ were recorded in MW1 in September 2006. Subsequent baseline groundwater monitoring of MW1(A) (or any other monitoring bores) did not detect concentrations of any TPH fraction greater than LORs. As such, the elevated concentration recorded in 2006 is considered to be an anomaly. There is no identified soil source and it may be a result of vandalism.

The following exceedances were recorded in the baseline groundwater monitoring event recently completed:

- Concentrations of copper, selenium, zinc, ammonia, hydrogen sulphide, nitrate, total nitrogen and phosphate exceeded the FWG in the baseline groundwater monitoring event.
- Concentrations of iron, manganese, ammonia, chloride and TDS exceeded the ADWG whilst only iron exceeded the ADWG x10 (for non-recreational use).
- Concentrations of iron, manganese, total nitrogen and phosphate exceed the LTIWG whilst no contaminants exceeded the STIWG.

The following comments are made with respect to the exceedances recorded:

- Elevated concentrations of chloride, ammonia, iron, zinc are considered to be representative of ubiquitous background levels and do not originate solely from historical site activities given their presence in up-hydraulic gradient wells.
- Elevated concentrations of nutrients (nitrate and total nitrogen) were recorded in wells principally to the north of the wetland area (MW1(A), MW2(A), MW3, ASSMW10, ASSMW11 and ASSMW13 and the highest concentrations were recorded in MW1(A), MW2(A) and MW3 along the northern boundary of the site suggesting that off-site sources are contributing to the overall nutrient loading of groundwater beneath the site.
- Whilst elevated concentrations of total phosphate were recorded in both up and down-hydraulic gradient wells in excess of the FWG and LTIWG, the higher concentrations were primarily recorded in monitoring bores in the north of the site. Elevated concentrations of phosphorous may be accounted for by the use of fertilizers in the north of the site associated with the former market gardens.
- Concentrations of ammonia recorded in the south-east of the site (MW4 and MW5) are considered to be resulting from the adjacent landfill site and as such is arising from an off-site source. Ammonia appears to be localised along the south-eastern boundary of the site and given the groundwater flow direction (south) it is unlikely to migrate beneath the site beyond MW4 and MW5 (i.e. against the hydraulic gradient). Ammonia has a low volatility (low Henrys Law Constant) and binds to organic material further reducing its mobility. Consequently, low levels of ammonia in groundwater in the south-east of the site is not considered to represent a significant risk.

Based on the bore monitoring undertaken to date there appears to be little evidence that current or historical on-site activities have contributed to significant groundwater contamination.

The ASSMP (Coffey Environments, 2010a) and DAMP (Coffey Environments, 2009) produced for this site have indicated that a bore will be installed in the north-east of the site and will be used for dust suppression measures and landscape irrigation for the first two years of the development to aid vegetation growth. As indicated in Section 4.2.4, ADWG x10 (for non-recreational use) and STIWG are considered to be the most appropriate assessment criteria.

On the basis that only concentrations of iron exceeded the ADWG x10 and no contaminants exceeded the STIWG, the use of groundwater for dust suppression and irrigation is considered appropriate. Management procedures for the use of bore water are outlined in Section 8.0.

7 PROPOSED SURFACE WATER MONITORING

Baseline sampling of surface water quality will be commenced prior to remediation or earthworks starting. Sampling will be conducted in the wetland, the drain (two locations and also in the near shore area of the Canning River to provide an indication of the likelihood of surface water discharged from the site impacting on aquatic biota resident in the near shore area of the canning river adjacent to the site. The surface water program will include indicator parameters for acidification processes including:

- pH
- metals (ASS suite)
- Total Acidity
- Chloride
- Sulphate
- Total Alkalinity

If these indicators suggest that acidification is occurring, then a full ASS sampling regime will be implemented for the surface water sample locations. This sampling will continue though the soil remediation program (Contamination and ASS) as part of the Ecotox investigation described in Appendix H.

8 GROUNDWATER MANAGEMENT AND CONTINGENCY PLAN

8.1 Groundwater Management

The development of the site will involve the removal (down to natural surface) of geotechnically unsuitable material (uncontrolled fill) which locally exceeds EIL guidelines for metals and contains some asbestos sheeting, as well as removal of isolated pockets of contamination as shown in Figure 3. Note that remedial works involve the removal of contaminated and geotechnically unsuitable fill material only, and does not include bulk earthworks or final subdivision works.

Remedial works are not expected to cause a negative impact to groundwater quality; however, ongoing groundwater monitoring will allow an assessment of the groundwater quality post-remedial works.

Investigations undertaken by Coffey Environments (formerly ATA) identified that acid sulphate soils (ASS) are present at the site, triggering the preparation of an Acid Sulphate Soil Management Plan (ASSMP) (Coffey Environments, 2010a). ASS was encountered within the east-west portion of the wetland and extending from the wetland to the foreshore along the western edge of the site, as shown in Figure 3). Acidity is primarily associated with black peaty material as well as grey silty sands (ATA, 2003a). Works with the potential to directly disturb ASS include enhancement of the wetland and non-wetland POS areas, excavation of uncontrolled fill and geotechnically unsuitable material from the remainder of the site, and linear trenching to install buried services. Indirect disturbance, (via dewatering) may be required during both bulk earthworks and subdivision works.

The ASSMP (Coffey Environments, 2010a) provides a strategy for the management of both the excavation and treatment of ASS and dewatering so as to minimise the possibility of adverse impacts from the disturbance of ASS during site works. The *Dewatering Management Plan* (lodged with the Application for the Dewatering Licence) will detail exactly how dewatering works will be undertaken to comply with the ASSMP.

8.1.1 Groundwater Monitoring Frequency

Remedial works are anticipated to take approximately three months. On the basis of the results of the baseline groundwater monitoring, it is proposed to undertake groundwater monitoring during and after ASS disturbance and dewatering at the site, as stipulated in the ASSMP (Coffey Environments, 2010a). The frequency and analytical parameters required for the monitoring will vary based on field measurements of untreated dewatering effluent as specified in Table 5 of the ASSMP (Coffey Environments, 2010a).

Upon completion of remedial works, it is proposed to undertake three-monthly groundwater monitoring for a period of six months (i.e. two rounds) to assess the impact of remedial works on groundwater. At this point, the need for further groundwater monitoring will be evaluated.

8.1.2 Groundwater Contingency Plan

As bulk earthworks and subdivision works will be undertaken in stages (where each stage may take one to two months) there will be a considerable period of groundwater monitoring for ASS parameters, which will allow an assessment of groundwater quality with time. If groundwater monitoring conducted as part of the ASSMP suggests that groundwater quality is being significantly impacted, the following actions will be taken:

1. The site Auditor and the DEC will be notified of the impacts.
2. The extent and frequency of monitoring to be completed under this plan will be reviewed after considering the data generated from ASS monitoring.
3. If necessary additional monitoring or remedial actions will be implemented in consultation with the site Auditor and/or DEC.

Significant change for the purpose of notifying the auditor will be as follows:

- pH reading of <4.5.
- Total Acidity readings in excess of 30mg/L.
- Any other parameter varying in a trend by more than 10% from baseline readings. Note that a single reading in the range 10-20% of baseline will not be regarded as significant until confirmed by a second reading taken within two weeks for the first reading with a result more than 10% above baseline.

To ensure that the Auditor remains informed, copies of all groundwater reporting will be forwarded to the Auditor for information.

8.1.3 Use of Bore Water for Dust Suppression and Irrigation

On the basis that only concentrations of iron exceeded the ADWG x10 and no contaminants exceeded the STIWG, the use of groundwater for dust suppression and short term irrigation (for the establishment of gardens and lawns) is considered appropriate. However, on the basis that some elevated contaminant concentrations were recorded in groundwater the following measures will be put in place to limit any potential negative effects:

1. The upper 10cm of surface soil cover will be dampened down. This is considered sufficient volume to control dust whilst limiting excessive infiltration to the underlying aquifer. Should excessive surface run-off be produced, it will be managed appropriately (i.e. bunding) to ensure no water reaches the wetland or surface waters.
2. The root zone of the proposed landscaping will be assessed and calculations for the volume of water required and the application rate will be completed to limit excessive infiltration to the underlying aquifer.

9 GROUNDWATER ANALYSIS AND SAMPLING METHODOLOGIES

9.1 Data Quality Objectives

The following data quality objectives (DQO) are suggested as being appropriate for any subsequent groundwater monitoring and are consistent with the process set out in AS 4482. The DQO defines how the quality of the data collected through the various phases of the investigation is to be assessed. These criteria are summarised in Table O.

TABLE O
EVALUATION CRITERIA OF THE VARIOUS FACETS OF THE INVESTIGATION

Feature	Evaluation Criteria
Documentation and data completeness	<ul style="list-style-type: none"> • Site conditions properly described. • Sampling locations properly described. • Completion of field records, calibration results, Chain of Custody documentation, laboratory test. certificates from NATA registered laboratories. • Samples collected from all areas of potential environmental concern identified (in consideration of works scope). • Samples are tested for all appropriate COPC.
Data comparability	<ul style="list-style-type: none"> • Use of appropriate techniques for the sampling, storage and transportation of samples. • Use of NATA certified laboratory using NEPM procedures. • Use of NATA certified check laboratory.
Data representativeness	<ul style="list-style-type: none"> • Collection of representative samples from each sampling location. • Collection of representative samples across the site. • Use of the appropriate techniques for the sampling, storage and transportation of samples. • Collection of equipment rinsate, field blanks and trip blanks at a frequency of one per day whilst underrating groundwater sampling.

TABLE O
EVALUATION CRITERIA OF THE VARIOUS FACETS OF THE INVESTIGATION

Feature	Evaluation Criteria
Precision for sampling and analysis	<ul style="list-style-type: none"> • Use of properly trained and qualified personnel. • Use of duplicate and triplicate samples to be collected at a minimum rate of 1 in 20. • RPDs to be less than 50%. • Acceptable recovery of trip spikes. • Acceptable quality of rinsate blanks.
Accuracy for sampling and analysis	<ul style="list-style-type: none"> • Achieve laboratory QC criteria. • Blanks returned with no contamination. • All matrix and surrogates returned acceptable results.

Groundwater sampling methodologies will be completed in accordance with procedures outlined in Section 4.2.1. Field quality control protocol will be completed in accordance with that outlined in Section 4.2.2 and the assessment criteria used will be as per specifications of the ASSMP (Coffey Environments, 2010a).

9.2 Reporting Requirements

9.2.1 Pre- Earthworks Operations

Groundwater monitoring data will be presented to the DEC after the second round of post-remedial groundwater monitoring (i.e. six months after completion of remedial works). Copies of all groundwater reporting will be forwarded to the Auditor for information.

9.2.2 During Earthworks Operations

Monitoring will be conducted during periods when acid sulphate soils are being disturbed due to the more extensive and intrusive nature of these works. As indicated in Section 6.1.2 and also in the ASSMP (Coffey Environments, 2010a), in the event that there is evidence that groundwater quality is being impacted as a result of processes associated with the oxidation of acidic or potentially acidic soils, a review will be undertaken of the need for additional monitoring or management under this groundwater management plan. The outcome of the review and any additional management measures will be discussed and agreed with the Auditor

9.2.3 Post-Remediation and Earthworks

If post-remediation groundwater data indicates significant increases of contaminants in groundwater that are attributable to on-site impacts, and which have the potential to impact on the Canning River environment, then the DEC will be notified so that an appropriate management strategy can be emplaced. It is likely that the management strategy will involve one or more of the following measures:

- Review of current site works to address possible alternative sources of contaminants;
- Increased monitoring frequency to verify the contaminant trends;
- Assessment of possible on-site management strategies (e.g. removal of any residual contamination that may be contributing to groundwater impacts, pump and treat options or installation of permeable reactive barriers). The exact nature of such strategies can only be determined based on and assessment of the nature and extent of the impacts that are detected;
- Sampling and analysis of Canning River water to assess any potential impact; and
- Risk-based assessment of any potential impacts on the river/wetland environment and/or human health.

10 BIBLIOGRAPHY

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Volume 1 The Guidelines (Chapters 1 to 7). National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.

ATA Environmental (ATA) (2001) *Environmental Assessment, East Clontarf, Manning*. ATA Environmental Report 2000/181 Final Report. ATA Environmental Report 2000/179. Prepared for Trustees of the Christian Brothers, January 2001.

ATA (2002a) *Preliminary Assessment, East Clontarf, Manning*. ATA Environmental Report 2002/47. Prepared for Trustees of the Christian Brothers, May 2002.

ATA (2002b) *Remediation Report, Asbestos Contamination, Clontarf Aboriginal College, Manning*. ATA Environmental Report 2002/122. Prepared for Trustees of the Christian Brothers, September 2002.

ATA (2002c) *Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program*. ATA Environmental Report 2002/147. Prepared for Trustees of the Christian Brothers, December 2002.

ATA (2003a) *Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning*. ATA Environmental Report 2002/147. ATA Environmental Report 2003/115. Prepared for Trustees of the Christian Brothers, August 2003.

ATA (2003b) *Detailed Soil and Groundwater Investigation, East Clontarf, Waterford*. ATA Environmental Report 2002/92. Prepared for Trustees of the Christian Brothers, December 2003.

ATA (2003c) *Clontarf Residential Subdivision, Waterford, Public Environmental Review Environmental Scoping Document Assessment No. 1467*. ATA Environmental Report 2003/39. Prepared for Trustees of the Christian Brothers, October 2003.

ATA (2004a) *Clontarf Residential Subdivision, Waterford, Public Environmental Review (EPA Assessment No. 1467)*. ATA Environmental Report 2003/91, Version 5. Prepared for Trustees of the Christian Brothers, June 2004.

ATA (2004b) *Clontarf Residential Subdivision, Waterford, Responses to Submissions (EPA Assessment No. 1467)*. ATA Environmental Report 2004/182. Prepared for Trustees of the Christian Brothers, October 2004.

ATA (2006) *Clontarf Residential Subdivision, Waterford, Ministerial Statement No. 692, Section 45C Referral*. ATA Environmental Report 2006/82. Prepared for Trustees of the Christian Brothers, April 2006.

Baxter (1977) *Heavy Mineral Sand Deposits of Western Australia, Western Geological Survey, Mineral Resources Bulletin 10*.

Coffey Environments (2008a) *Drainage Nutrient, Irrigation and Water Quality Management Plan, Cygnia Cove, Waterford*. Report reference: ENVIPERT00214AA V2 (2007/259).

Coffey Environments (2008b) *Foreshore Management Plan*, Cygnia Cove, Waterford. Report reference: ENVIPERT00213AA V4 (2007/109).

Coffey Environments (2009) *Dust and Asbestos Management Plan*. Coffey Environments Report 2006/225, Version 9. Prepared for Trustees of the Christian Brothers.

Coffey Environments (2010a) *Acid Sulfate Soils Management Plan*, Cygnia Cove, Waterford. Report Reference: 2006/129 (V7), January 2010. Prepared for Trustees of the Christian Brothers.

Coffey Environments (2010b) *Site Remediation and Validation Management Plan*, Cygnia Cove, Waterford. Prepared for Trustees of the Christian Brothers, January 2010.

Davidson (1995) *Hydrogeology and Groundwater Resources of the Perth Region, Western Australia*. Geological Survey of Western Australia, Perth, Bulletin 142.

DEC (2006) Use of Risk Assessment in Contaminated Site Assessment and Management (Contaminated Sites Management Series).

Department of Environment (DoE) (2003) *Assessment Levels for Soil, Sediment and Water (Draft)*. Version 3. Contaminated Sites Management Series, Department of Environment (DoE), Perth.

Department of Health (DoH) (2006): Contaminated Sites Reporting Guideline for Chemicals in Groundwater http://www.public.health.wa.gov.au/2/656/2/contaminated_sites.pm

Hill, AL, Semeniuk, CA, Semeniuk, V, Del Marco, A, (1996) *Wetlands of the Swan Coastal Plain : Wetland Mapping Classification and Evaluation*. Water Authority, Department of Environmental Protection. Perth, Western Australia.

JDA Consultant Hydrologists (JDA) (2004) *East Clontarf Hydrological Investigation*. JDA Consultant Hydrologists, April 2004.

Jordan JE (1986) *Armadale, Part Sheets 2033 I and 2133 IV, Perth Metropolitan Region 1:50,000 Environmental Geology Series*. Geological Survey of Western Australia, Perth.

Keith, LH (1991) *Environmental sampling and analysis*. A practical guide. Lewis Publishers, Chelsea, Michigan.

National Health and Medical Research Council (NHMRC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (1996) *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

National Health and Medical Research Council and Natural Resource Management Ministerial Council (NHMRC and NRMCMC) (2005) - *Guidelines of Managing Risks in Recreational Water*.

Standards Australia (2005) Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1: Non-volatile and semi-volatile compounds. AS 4482.1-2005.

Stauber, JL, Tsai, J, Vaughan, G, Peterson, SM, and Brockbank, CI (1994) Algae as indicators of toxicity of BEKM effluents, 1-82. National Pulp Mills Research Program Technical Report Series 3. Canberra (AU) CSIRO.

Water and Rivers Commission (WRC) (2004) Draft Policy and Principles, Protection of Waters from Pollution in Western Australia. Water and Rivers Commission Water Resource Protection Series.

11 STATEMENT OF LIMITATIONS

(please refer over the page)

Important information about your **Coffey** Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change

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

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

Important information about your **Coffey** Environmental Report

Your report will only give preliminary recommendations

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

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

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

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

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

Responsibility

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

Figures

**Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA**

Appendix A

Certificates of Title

**Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA**

WESTERN



AUSTRALIA

REGISTERED NUMBER	
SOL/DP30878	
DUPPLICATE EUT/DOV	DATE DUPPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
222PAGE
238

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant of freehold) and to the limitations, interests, encumbrances and notifications shown in the second schedule.


 REGISTRAR OF TITLES


LAND DESCRIPTION

LOT 501 ON DEPOSITED PLAN 30878

REGISTERED PROPRIETOR (FIRST SCHEDULE)

TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC OF 51 REDMOND STREET
MANNING

(A1161324) REGISTERED 7 JULY 2002

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS (SECOND SCHEDULE)

1. A204584 EASEMENT TO CITY OF SOUTH PERTH. SEE SKETCH ON DEPOSITED PLAN 30878 REGISTERED 13/1969.
2. C225050 EASEMENT TO METROPOLITAN WATER SUPPLY, SEWERAGE AND DRAINAGE BOARD. SEE SKETCH ON DEPOSITED PLAN 30878 REGISTERED 29/1981.
3. E874839 EASEMENT TO THE WATER AUTHORITY OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 30878 REGISTERED 3/3/1992.
4. H084076 EASEMENT TO WATER CORPORATION. SEE SKETCH ON DEPOSITED PLAN 30878 REGISTERED 19/4/1999.
5. H480522 EASEMENT TO ELECTRICITY CORPORATION. SEE SKETCH ON DEPOSITED PLAN 30878 REGISTERED 22/6/2000.
6. *1080093 MEMORIAL HERITAGE OF WESTERN AUSTRALIA ACT 1990 AS TO PORTION ONLY. LODGED 19/4/2002.

Warning: A current sketch of the sketch of the land should be obtained where it is required to show the position, dimensions or area of the lot is required.
Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or lots.

END OF CERTIFICATE OF TITLE

STATEMENTS

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for a local government, legal, surveying or other professional advice.

SKETCH OF LAND	DP30878
PREVIOUS TITLE	2145-823, 2145-827, 1791-107
PROPERTY STREET ADDRESS	69 WATFORD AV, WATERFORD
LOCAL GOVERNMENT AREA	CITY OF SOUTH PERTH



INTERESTS AND NOTIFICATIONS

SUBJECT	PURPOSE	STATUTORY REFERENCE	FORGON	LAND DIMENSIONS	DEED REF TO	COMMENTS
(D)	EASEMENT		DOC # 1721506-1	LOT 501	QTY OF 5 CUM FORTH	SEE NOTE 7
(E)	EASEMENT		DOC # 1721505-1	LOTS 500 & 501	SEE DOCUMENT	SEE NOTE 7
(D)	EASEMENT		DOC # 1714459-1	LOT 501	SEE DOCUMENT	
(C)	EASEMENT		DOC # 1185076-1	LOT 501	WATER COMP. BATH	
(D)	EASEMENT		DOC # 11781904-1	LOT 500	WATER COMP. WASH	
(D)	EASEMENT		DOC # 1167052-1	LOTS 500 & 501	SEE DOCUMENT	SEE NOTE 7

8. AND POSITION ON THIS PLAN
SEE ORIGINAL DOCUMENT

[illegible]

(1) EASEMENT
ON ACCESSION
NOT TO SCALE



(2) EASEMENT
ON ACCESSION
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(3) EASEMENT
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(4) EASEMENT
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NOT TO SCALE



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CERTIFICATE OF TITLE VOL. FOL.
.. 2048 181

WESTERN



AUSTRALIA

REGISTER NUMBER	
83/P2461	
DUPLICATE EDITION	DATE DUPLICATION ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 2048
FOLIO 181

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

J. Doyle
REGISTRAR OF TITLES



LAND DESCRIPTION:

LOT 83 ON PLAN 2461

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC OF 53 REDMOND STREET,
MANNING

(A F931160) REGISTERED 18 JULY 1995

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE, VOL 2048 FOL 181.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 2048-181.
PREVIOUS TITLE: 1731-311.
PROPERTY STREET ADDRESS: LOT 83 MANNING RD, WATERFORD.
LOCAL GOVERNMENT AREA: CITY OF SOUTH PERTH.

LT. 37

WESTERN



AUSTRALIA

VOL.

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Volume 1731 Folio 311

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1893" AS AMENDED

CT 2048

184



I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

Dated 18th July, 1995

REGISTER OF TITLES



ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Canning Location 1 and being part of Lot 83 on Plan 2461 (Sheet 2), delineated on the map in the Third Schedule hereto.

FIRST SCHEDULE (continued overleaf)

Trustees of the Christian Brothers in Western Australia Inc. of 53 Redmond Street, Manning.

SECOND SCHEDULE (continued overleaf)

2111

THIRD SCHEDULE



PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

is provided - copy for review

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WESTERN



AUSTRALIA

REGISTER NUMBER 829/D88770	
Duplicate Edition N/A	DATE DULPLICATE ISSUED N/A

RECORD OF CERTIFICATE OF TITLE UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
2048FOLIO
180

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

Jan Doyle
REGISTRAR OF TITLES



LAND DESCRIPTION:

LOT 829 ON DIAGRAM 88770

REGISTERED PROPRIETOR: (FIRST SCHEDULE)

TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC OF 53 REDMOND STREET,
MANNING

(T 048292) REGISTERED 6 DECEMBER 1995

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS: (SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	2048-180.
PREVIOUS TITLE:	1731-311.
PROPERTY STREET ADDRESS:	LOT 829 MANNING RD, WATERFORD.
LOCAL GOVERNMENT AREA:	CITY OF SOUTH PERTH.

Superseded - Copy for Streets and Papers only

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LT. 37

Application F931159 WESTERN
Volume 1731 Folio 311



AUSTRALIA

REGISTER BOOK
VOL. FOL.

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1993" AS AMENDED

CT 2048 180

I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

G. Jack
REGISTRAR OF TITLES



Dated 18th July, 1995

ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Canning Location 1 and being Lot 829 on Diagram 88770, delineated on the map in the Third Schedule hereto.

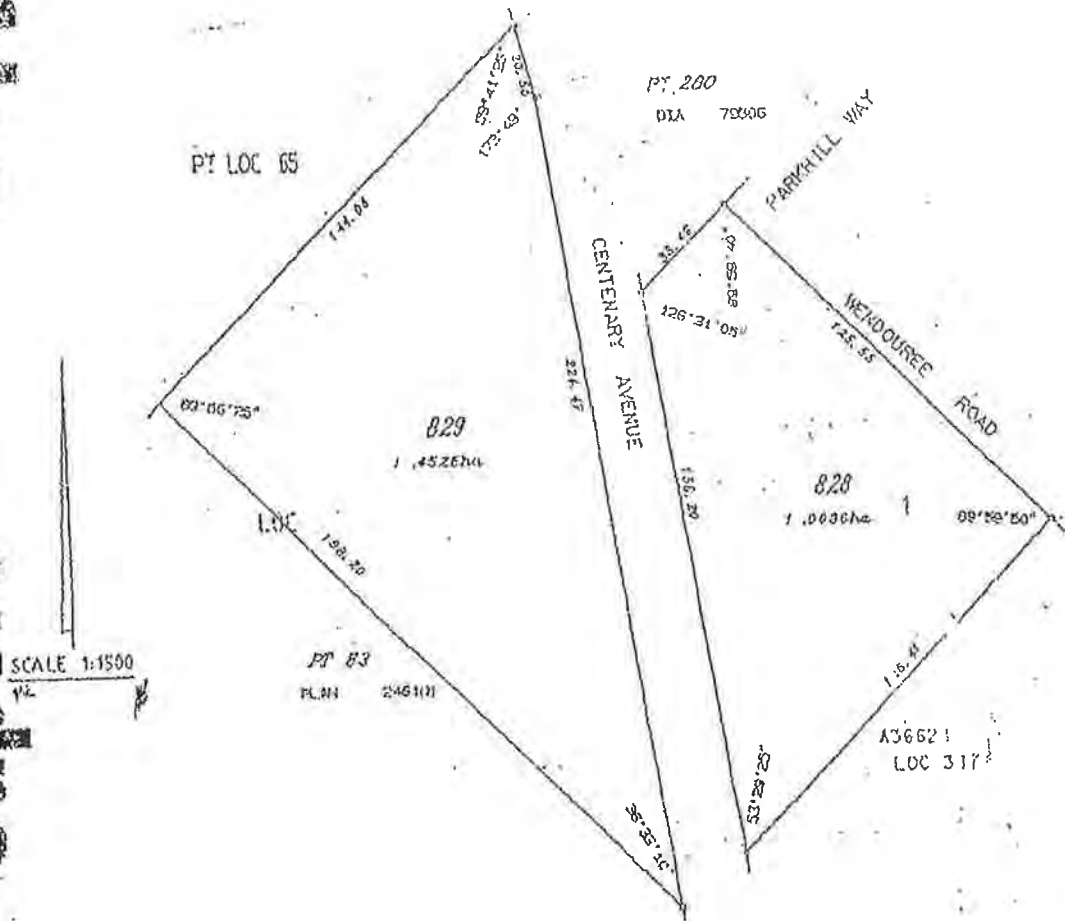
FIRST SCHEDULE (continued overleaf)

~~Trustees of the Christian Brothers in Western Australia Inc. of 53 Heddon Street, North Melbourne~~

SECOND SCHEDULE (continued overleaf)

NIL

THIRD SCHEDULE



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MULTIPLE SCLEROSIS SOCIETY OF WESTERN AUSTRALIA INC.		TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC.	
TRANSFER	AMOUNT	TRANSFER	AMOUNT
Transfer	£531.61	Transfer	£18.7.95
Transfer	£482.92	Transfer	£6.12.95
			£11.21

Transfer	F931161	18.7.95	15.24
Transfer	G48292	6.12.95	11.21

Trustees of The Christian Brothers in Western Australia Inc. of 53 Redmond Street, Manning.

SECOND SCHEDULE (continued)

NOTE: ENTRIES MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS

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CERTIFICATE OF TITLE VOL. 2048 FOL. 180

Appendix B
East Clontarf Hydrological Investigation,
JDA Consultant Hydrologists

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

Richard Noble and Company

East Clontarf Hydrological Investigation

April, 2004

Project Team

Jim Davies
Sasha Martens
Marnie O'Donnell
Scott Wills



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APPENDICES

1. JDA Lithological Logs

1. INTRODUCTION

This hydrological investigation has been prepared by JDA Consultant Hydrologists on behalf of Richard Noble & Company for the East Clontarf Area (Figure 1).

The objective of the investigation is to provide a general understanding of the existing surface water and shallow groundwater interaction, and to provide advice regarding seasonal groundwater variation, flow regime of wetlands, water balance, and stormwater drainage. This report also reviews these findings in the context of implications for proposed land use change within the Study Area.

This report has been prepared following site investigations carried out by JDA on 10 and 13 November 2002, and 20 February and 8 May 2003, and following discussions with Water and Rivers Commission, City of Canning, and City of South Perth.

2. PHYSICAL ENVIRONMENT

2.1 Location & Topography

The Study Area comprises of a total area of approximately 18.5 ha, located adjacent to the Canning River in the City of South Perth, approximately 8km south east from the Perth Central Business District. The Study Area is bounded by Clontarf Aboriginal Education and Training College to the west, Centenary Avenue to the east, Manning Rd to the north and Canning River foreshore reserve to the south (Figure 1).

Topographic contours range from 0 mAHD immediately adjacent to the Canning River, to 9 mAHD near Manning Rd (Figure 2). Much of the Study Area is flat and less than 3 mAHD, rising relatively steeply in the north of the site. The large wetland in the western area is below 2 mAHD. An elevated mound to 6 mAHD exists in the south-east part of the Study Area.

2.2 Rainfall

Long term average annual rainfall is approximately 860 mm (based on Bureau of Meteorology's Perth Regional Station, 1880 to present). Annual rainfalls are shown in Figure 3. The average annual rainfall for Perth has decreased significantly since the mid 1970's. From 1975, the average annual rainfall has been 790 mm, representing an 8% reduction compared to the long term.

2.3 Geomorphology & Surface Geology

Jordan (1986) describes the Study Area as part of a low level river terrace of the Canning River. The surface deposits are holocene alluvial sands overlain by aeolian Bassendean sands. The eastern part is shown as "made ground" associated with an inactive solid waste disposal site.

A geotechnical investigation (Coffey, 2000) presents information on the surface deposits over the Study Area, and interprets the sand as Bassendean sand rather than river terrace. Cross sections extending north south from Manning Road to the Canning River (Figure 2) through the western and eastern wetland areas respectively have been interpreted based on Coffey (2000) as shown in Figures 4 and 5.

Figure 4 shows that adjacent to Manning Road there is a deep sand soil profile, transitional to a thick (3m+) thick peat deposit beneath the western wetland area, which decreases in thickness towards the Canning River. Figure 5 shows a quite different sequence with the community market garden adjacent to Manning Road as shallow uncontrolled fill over sand. Further south there is uncontrolled fill over peat within the eastern wetland area. The cross sections indicate the eastern wetland area to have a higher natural surface than the western wetland area.

2.4 Surface Drainage

Based on 1m DOLA topographic contours, approximately 12.2 ha of the 18.5 ha Study Area is estimated to drain to the wetland (includes the wetland area itself) and 6.3ha is estimated to drain directly to the Canning River (Figure 6).

The Study Area also receives surface drainage from external catchments as shown on Figure 6 :

- ❑ Manning Rd and Conlon St catchment of approximately 6.9 ha which discharges into the north western area of the wetland via piped drainage. The extent of this catchment area is indicative only as it is based on topographic data. Detailed drainage plans for this region are not available from City of South Perth or City of Canning.
- ❑ Centenary Avenue catchment (26.0 ha), which includes urban areas to the east of Centenary Avenue and north of Manning Rd. These areas discharge into the Study Area via a piped drainage under

Centenary Avenue into the eastern region of the wetland. During JDA's field investigations in October 2002 the outlet from the drainage system to the wetland was observed to be submerged.

- Two smaller catchments to the west (1.0 ha) and south east (1.5 ha), which may discharge into the Study Area from impervious areas as diffuse overland flow.

On this basis, the total estimated upstream area draining into the Study Area is 35.4 ha, of which 33.9 ha drains into the wetland and is discharged to the Canning River through a 750 mm dia culvert from the wetland into an overgrown trapezoidal channel (Figure 6).

The total existing catchment area of the wetland is therefore 46.1 ha.

The flow rate discharging from the wetland was visually estimated by JDA during field work on 10 November and 31 December 2002 to be in the order of 20 L/s (1700 m³/d). ATA Environmental estimated a discharge rate from the wetland of 18 L/s (1600 m³/d) on 6 November 2000 (ATA, 2001). Anecdotal evidence provided by a groundskeeper at Clontarf Aboriginal Education and Training College indicates continuous flow throughout the year at a relatively constant rate of approximately 20 L/s (1700 m³/d)

Assuming 35% rainfall runoff from the 46.1 ha catchment and 790 mm/yr rainfall, the estimated annual average surface runoff is approximately 127,000 m³/yr, corresponding to 4 L/s (300 m³/d), which is far less than the observed discharge. It is therefore considered unlikely that surface drainage is sustaining the observed discharge from the wetland to the Canning River.

Figure 6 shows the Study Area is above WRC's 100 year floodway and flood fringe for the Canning River.

2.5 Hydrogeology

2.5.1 Superficial Aquifer

The superficial formations is the name given to the Quaternary deposits on the Swan Coastal Plain. Within the study area these deposits comprise alluvial sands overlain by aeolian sands as described in Section 2.3 above. Peaty sands occur in the vicinity of the wetland.

Groundwater flow systems can be described by flow lines indicating the direction of groundwater flow and contours of water table elevation (or potentiometric contours in confined systems). Flow lines are perpendicular to water table contours.

The groundwater flownet associated with the superficial formation aquifer in the vicinity of the Study Area is shown in Figure 7a. Clontarf is located between the 1 and 10 mAHD water table contours and the curvature of the contours along the Canning and Swan Rivers is indicative of groundwater discharge to those river systems.

The Cloverdale groundwater system extends to the Darling Scarp in the east and to the Swan Canning River System around its boundary. Figure 7a shows the water table rises to a maximum of above 20 m AHD towards the Darling Scarp and falls to 0 m AHD around the river boundary.

The Study Area lies on the northern bank of the Canning River, which forms the southern boundary of flow channel 2 of the Cloverdale area groundwater flownet. Davidson (1995) estimates groundwater throughflow in this flow channel to the Swan Canning River system as 7,000 m³/d. Beneath the 10 mAHD contour, considered more representative of the Clontarf location, Davidson (1995) estimates the groundwater throughflow for flow channel 2 to be approximately 4,000 m³/d. The 10 mAHD water table contour in flow channel 2 is approximately 10 km long, so that the groundwater throughflow corresponds to 400 m³/d/km. The Study Area represents approximately 0.5 km, through which 200 m³/d may be expected as the groundwater throughflow.

Further discussion of the small superficial aquifer throughflow estimate of 200 m³/d in the context of the observed 1700 m³/d discharge from the wetland to the Canning River is contained in Section 5.4.

Groundwater salinity beneath the Study Area is described in Davidson (1995) as fresh (less than 1000 mg/L), but salinity will increase along the Canning River foreshore. Superficial groundwater may have been contaminated by previous land uses (ATA, 2001).

2.5.2 Leederville Aquifer

The Leederville aquifer (artesian) underlies the superficial formation at a depth of approximately 25 m below natural surface and is approximately 300 m thick locally. The groundwater flownet in the Leederville aquifer is shown in Figure 7b.

The Study Area is located within flow channel 6 of the Leederville aquifer. Davidson (1995) estimates the groundwater throughflow beneath the 10 mAHD potentiometric contour in flow channel 6 to be 200 m³/d. The length of the 10 mAHD contour is approximately 20 km. The Study Area represents approximately 0.5 km along this contour, corresponding to 10 m³/d.

Figure 7b also shows the Study Area located within an area of upward head difference from the Leederville aquifer into the superficial aquifer, although the head difference is small (less than 1 m). The Study Area is however located within the boundary of a confining layer of shale between the two aquifers, so that leakage between the aquifers is negligible.

The Leederville aquifer water is fresh beneath the Study Area (Davidson 1995).

Further discussion of the Leederville Aquifer throughflow estimate of 10 m³/d in the context of the observed 1700 m³/d discharge from the wetland to the Canning River is contained in Section 5.4.

2.6 Wetlands

A wetland is located in the central region of the Study Area, extending in an east-west direction across the site (Figure 8). The wetland is densely vegetated with reeds and some open water (Plate A).

As explained by ATA (2001) different definitions of wetlands have been applied resulting in different definition of wetland boundaries. In chronological order the following wetland definitions apply :

- ☐ The wetland was classified as an Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP) wetland. This definition was applied to all wetlands on the Swan Coastal Plain with greater than 1000 m² of open water area in December 1991. We understand that some wetlands were defined by field inspection and some by air photo interpretation. The EPP wetland boundary extends to land as high as 9 mAHD.
- ☐ WRC's Wetland Atlas (Hill et al 1996) maps the wetland and the area between the wetland and the Canning River as peripheral estuary, known as the Clontarf River Flats. This definition is a geomorphic one and describes the land as flat wetland rather than a basin wetland. This mapping extends to 6 mAHD natural surface.
- ☐ Mapping of a basin wetland boundary by ATA Environmental (2001), which roughly coincides with a 2 mAHD natural surface contour in the western wetland area.

Field investigations undertaken by JDA in November 2002, and February and May 2003 confirm the ATA mapping as a more accurate representation of the extent of the wetland boundary within the Study Area. The field investigations undertaken are discussed further in Chapters 4 and 5 of this report.

2.7 Groundwater Abstraction

Advice from Clontarf College indicates there are 2 superficial aquifer bores located west of the Study Area used for irrigation of the College grounds. Abstraction rates from these two bores combined are estimated as 1,200 m³/d maximum.

There is no abstraction from the Study Area wetland for irrigation purposes. A small community market garden along Manning Road was irrigated from mains water supply, but closed earlier this year.

3. LAND USE HISTORY

Historical land use for the Study Area based on air photo interpretation, Clontarf historical documents, and anecdotal information received from Clontarf Brothers O'Doherty and Tuppin, is presented below in the context of changes in water management within the Study Area :

- ☐ **1901–1940.** Establishment of Clontarf orphanage, and associated clearing of wetland vegetation in the western wetland and establishment of vegetable gardens, orchard and grazing using the spring as water supply. Drain dug to reduce water logging of this land, draining to Canning River. This land use would have lowered the wetland water table and reduced water logging, allowing for the garden, and resulted in oxidation of the peat soils in the wetland, with consequent lowering of the natural surface.
- ☐ **1940–1945.** Christian Brothers and orphans evacuated and the buildings occupied by RAAF personnel. Gardens fell into disuse during this period and wetland vegetation re-established.
- ☐ **1946–1986.** Christian Brothers re-occupied the buildings and re-established the gardens, although not to the extent of pre 1940. By 1959 the aerial photographs indicate gardens are no longer used and wetland vegetation re-established. 1968 aerial photography suggests a deepening of the drain to the Canning River to allow part of the wetland to be filled for use as sports oval. This again would have lowered the water table, leading to further oxidation of the peat and further lowering of the natural surface.
- ☐ **1970's.** Installation of the current pipe culvert and access track which has probably obstructed the improved drainage necessary for operation of the garden, thereby raising the water level in and around the wetland.

The Study Area is currently zoned as Urban in the Metropolitan Region Scheme (MRS) and Residential in the City of South Perth Town Planning Scheme. Land adjacent to Canning River is reserved for Parks and Recreation in the MRS (Plate B).

At present, the site consists of a wetland in the central region, a community based market garden along the northern boundary, evidence of landfill between the wetland and Canning River (land previously used as a sports oval, since abandoned), and the channel draining the wetland from its south west corner to the Canning River. Apart from the market garden, which uses mains water supply, the site appears presently unused.

Land to the south east of the site was previously used for refuse disposal purposes, and has since been capped and vegetated with grass (ATA, 2001).

4. WATER TABLE INVESTIGATION

4.1 JDA Monitoring Bores & Staff Gauge

On 8 and 13 November 2002, JDA installed 8 groundwater monitoring bores (labelled EC1 to EC8) by 75 mm hand auger within the Study Area (Figure 9). These bores consisted of 50 mm PVC capped at both ends and slotted for the lower 1 m (Plate C). The bores were broadly located in two north-south transects through the Study Area and wetland. Lithological logs for the bores are shown in Appendix 1. The logs show deep Bassendean sands along the northern boundary of the Study Area, with black sandy silts around the wetland fringes and clays in the low lying areas of the Canning River foreshore. The logs are generally consistent with those of a previous geotechnical investigation (Coffey, 2000).

A staff gauge was installed in the south western corner of the wetland (Plate D), where the wetland flows under a small bridge via a 750 mm dia culvert into an open drain. (Figure 9).

The levels of these bores and staff gauge were surveyed by PGS Hope & Partners to Australian Height Datum (m AHD). Open water levels were also surveyed, including two locations in the open drains (S1 and S2), the wetland just north of the staff gauge, the wetland at Centenary Road drainage culvert and the Canning River foreshore lake in the south east corner of the Study Area (Figure 9).

Table 1 and Figure 10 presents water levels measured on 13 November 2002. The culvert draining the western wetland invert is 0.53 m AHD (upstream) and 0.47m AHD (downstream).

Table 1: Water Level Data

Bore	Natural Surface (m AHD)	Top of Casing (m AHD)	Water Level Recorded 13/11/02 (m BNS) (m AHD)		AAMGL (mAHD)
JDA Monitoring Bores					
EC1	2.43	3.20	1.34	1.09	1.29
EC2	2.03	3.24	1.59	0.44	0.64
EC3	4.82	5.74	2.65	2.17	2.57
EC4	7.59	8.58	4.69	2.90	3.70
EC5	0.58	1.14	0.52	0.06	0.26
EC6	2.10	2.90	0.95	1.15	1.35
EC7	3.92	5.14	1.61	2.31	2.71
EC8	7.97	8.69	4.18	3.79	4.59
JDA Staff Gauge					
G1	0.53	-	-	0.72 *	0.72 *
WRC Monitoring Bore					
G61610356	7.46	7.46	-	5.30	6.10
Open Drains					
S1	-	-	-	0.92 *	0.92 *
S2	-	-	-	0.10	0.10
S3	-	-	-	-0.12	-0.12
Wetland at Centenary Rd Culvert		-	-	2.25	2.25
Canning River Foreshore Lake		-	-	0.14	0.34

m AHD = metres Australian Height Datum

m BNS = metres below Natural Surface

* For the staff gauge and open drain S1 near the wetland outlet, levels recorded on 13 November have been adjusted down by 0.20m as a blockage existed in the culvert at the time of recording water levels. The blockage was subsequently cleared which resulted in a 0.20m reduction in water level at the staff gauge.

4.2 WRC Monitoring Bore

The long term WRC superficial aquifer monitoring bore located nearest to the Study Area is bore G61610356 (Figure 10). The bore is located within residential development approximately 600 m east of the Study Area.

On 13 November 2002 the water level recorded in G61610356 was 5.30 mAHD. This bore has a long term record dating back to 1956 (Figure 10). Since 1989 the frequency of measurements has been reduced to less than 3 per year, rendering the data unreliable for estimation of long term averages. In addition, the water level data shows constant values from 1997 to 1999, indicating spurious data over this period.

On this basis, JDA has estimated the AAMGL for this bore based on the period of record from 1956-1989. The AAMGL is estimated to be 6.10 mAHD, 0.80 m above the level measured by JDA on 13 November 2002.

4.3 Estimation of AAMGL

WRC's Average Annual Maximum Groundwater Level (AAMGL) policy was developed in the early 1990's and requires that the AAMGL be maintained to prevent nutrient rich groundwater draining from the area as surface water, polluting water bodies downstream. Maintenance of AAMGL also prevents the drying out the wetlands, saving groundwater dependent vegetation. The policy allowed a subsoil drainage network, as long as it is laid at or above the AAMGL, with fill imported to give adequate separation between land surface and groundwater.

To calculate the AAMGL for the Study Area an adjustment is made to monitoring bores installed across the Study Area, consistent with the water level measured in the long term WRC monitoring bore. On 13 November 2002 the water level in WRC bore G61610356 was 0.80 m below its 1975 -1989 AAMGL of 6.10 m AHD. However, given the presence of the culvert discharging water from the wetland area to the Canning River and anecdotal evidence of relatively constant interannual and interseasonal discharge from the wetland, there is expected to be a lower variation in water table for the wetland and its surrounding area. On this basis the following adjustments to calculate AAMGL have been applied :

- ☐ no rise to AAMGL for water levels surveyed in the wetland and open drains.
- ☐ 0.20m rise to AAMGL for bores EC1, EC2, EC5, and EC6 located on the southern side of the wetland
- ☐ 0.40m rise for bores EC3 and EC7 located between the wetland northern boundary and Manning Rd
- ☐ 0.80m rise for bores EC4 and EC8 located adjacent to Manning Rd.

The approach described above is consistent with WRC's accepted methods for calculating the AAMGL.

Estimated AAMGL's for JDA monitor bores are shown in Table 1, with a contoured AAMGL map over the Study Area presented in Figure 11. AAMGL contours range from 0.50 mAHD in the southern area adjacent to the Canning River, to 4.5m AHD in the north eastern corner.

Perth Groundwater Atlas (WRC, 1997) mapping for the Study Area is also shown in Figure 11. A maximum groundwater contour of 5 mAHD passes east-west through the northern region of the Study Area, decreasing to 3 mAHD approximately midway between Manning Road and the Canning River. Groundwater flow is typically in a southerly direction towards the Canning River. These atlas contours are estimated maximum groundwater levels based on regional data. The atlas contours do not take into account the local variability expected to occur within the Study Area associated with the wetland. Consequently the contours should not be relied on for land use management purposes (WRC 1997), and are presented here for comparison purposes only. JDA's AAMGL is typically in the order of 1.5m lower than WRC's Groundwater Atlas maximum groundwater contours.

The calculated AAMGL is shown as a depth to groundwater below natural surface in Figure 12. Note that the natural surface contours are 1m interval and based on 2001 land surface conditions, and do not

extend below the 2 mAHD in the wetland presumably due to standing water or obscured natural surface by vegetation.

The water table gradient north of the wetland to Manning Road is similar to that of the region beyond Clontarf. Within the wetland and south of it to the Canning River, the water table gradient shown on Figure 11 is less due to the water being effectively at natural surface and the natural surface itself being of lesser gradient than north of the wetland. In other words, the water table in the wetland and south of the Canning river is effectively controlled by the natural surface and is in a region of groundwater discharge. There is no evidence that the peat beneath the wetland acts as a groundwater flow barrier.

5. WETLAND INVESTIGATION

This Chapter details the results of JDA's wetland investigation including field investigation conducted on 20 February and 8 May 2003 to identify the source of wetland inflow to sustain a relatively constant discharge throughout the year. The behaviour of wetland water levels under existing conditions during flood events is also analysed.

5.1 Canning River Discharge

As previously stated in Section 2.4, the flow rate discharging from the western wetland to the Canning River was estimated by JDA on 10 November 2002 and 31 December 2002 to be approximately 20 L/s, similar to a rate of 18L/s measured on 6 November 2000 (ATA, 2001). Anecdotal evidence provided by a groundskeeper at Clontarf College on 10 November 2002 indicated continuous flow throughout the year over the years at approximately 20 L/s (1,700 m³/d).

During a site visit by JDA on 31 December 2002, Brother Tuppin, a resident at Clontarf since 1935, confirmed that this drain has always flowed at a similar rate. He observed that in his early years at Clontarf the drain flowed at a greater rate than at present. This observation is consistent with rainfall having been generally higher in the mid part of the last century with associated higher groundwater levels, however may also have been due to increased stormwater inflow during this period.

During field investigations by JDA on 8 May 2003, water depth discharging through the 750mm diameter culvert from the wetland was observed to be 0.10m. Using culvert hydraulics modelling software CulvertW, the discharge through the culvert for 0.10 m flow depth is estimated as 17 L/s (1500 m³/d), consistent with field observations and anecdotal evidence.

5.2 Evaluation of Possible Sources of Wetland Inflow

5.2.1 Surface Water Inflow

As previously stated in Section 2.4, assuming 35% rainfall runoff, from the 46.1 ha catchment flowing to the wetland and 790 mm/yr rainfall, the estimated annual average surface runoff is approximately 127,000 m³/yr, corresponding to 300 m³/d, which is far less than the observed discharge. It is therefore considered unlikely that surface drainage is sustaining the observed discharge from the wetland to the Canning River.

5.2.2 WRC Private Bore Database - Spring 20018351

WRC's private bore database identifies a spring occurring within the Study Area (Figure 9). The WRC database annotation of this spring is as follows :

"The stream (spring) 20018351. The spring has been flowing for 70 years and used to be the only water supply. Elevation originally recorded as approx. 10 ft lwf. Supply originally recorded as 8,000 plus gph".

8,000 gallons per hour (gph) corresponds to approximately 900 m³/d or 10 L/s. This is approximately a half of the estimated flow rate by JDA and ATA. WRC were unable to provide any authority for this annotation.

The spring location in WRC's database is given as south of the wetland, and this could not be located by JDA during field investigations. JDA also found no physical, recorded or anecdotal evidence of such a well having been dug, there being little reference to the water supply in the historical documents sourced at Battye Library, City of South Perth Library.

The possibility of whether a hand dug deep well may have been constructed in the early days of the Clontarf orphanage (during the early 20th century) has also been examined. Such a well may have been constructed through the superficial formation and into the Leederville formation aquifer which commences approximately -20 mAHd (25 m below natural surface). Brother Tuppin is of the opinion that there never was a hand dug deep well on any part of the Christian Brother's property at Clontarf.

As calculated in Section 2.5.2, the estimated groundwater throughflow in the Leederville aquifer for the Study Area is only 10 m³/d, and is unlikely to sustain such a high flow even if there were a disused Leederville formation well within wetland.

5.2.3 Water Corporation Mains Leakage

JDA has discussed with Water Corporation whether part of the flow rate may be due to a leaking water main or sewerage pipeline, both of which occur within the Manning Road Reserve, immediately north of Clontarf.

This appears unlikely given that the spring is thought to have flowed for at least 70 years, which pre-dates the laying of these pipelines along Manning Road.

5.2.4 Superficial Aquifer Discharge

It is considered likely that the inflow to the wetland sustaining the 1700 m³/d discharge to the Canning River is discharge from the superficial formation. The water, as measured in the drain is fresh (approximately 200mg/L TDS) consistent with the superficial aquifer water quality.

If the flow is sourced from the superficial formation, its rate suggests that the groundwater throughflow estimates by Davidson (1995) may be underestimated. Combining the estimated wetland discharge rate to the Canning River of 1700 m³/d and estimated bore abstraction rates of 1200 m³/d (Section 2.7) results in a total of 2,900 m³/d, or 75% of the estimated groundwater throughflow in flow channel 2 of the superficial formation (Section 2.5.1).

During recent drilling of an irrigation bore in the superficial formation at Curtin University, highly transmissive sediments were encountered at greater depth than mapped by WRC, which may be indicative of a paleochannel of the Canning River (Phil Wharton, Rockwater Pty Ltd, pers. comm.). The drilling evidence of a highly transmissive zone may be related to East Clontarf and as described, is not documented in the official hydrogeology of the area (Davidson, 1995).

Prior to development of the Multiple Sclerosis Society land immediately east of Centenary Ave, the land had peaty soils and a low lying swamp area. The swamp was identified as an expression of the water table and not a spring. A City of Canning subsoil drain along Centenary Ave intercepts groundwater flow and discharges to a sump in the north east corner of Centenary Park (S. Trinca, City of Canning, pers. comm.). If this is the case, wetland inflow sustaining approximately 1700 m³/d discharge is most likely confined to within the Study Area.

Field investigations undertaken by JDA to better define the location of groundwater discharge to the wetland from the superficial aquifer are discussed in Section 5.4.

5.3 Field Investigation of Wetland Inflow via Transects

To assist in the determination of the location of superficial groundwater discharge into the wetland further field investigations were undertaken by JDA on 20 February and 8 May 2003. The investigation involved limited localised clearing to enable seven 20 m long transects to be established along the northern bank of the wetland. These transects allowed the extent of the seepage face for the wetland to be determined, and better definition of the northern boundary of the wetland and extent of open water otherwise hidden by dense vegetation.

Each transect consisted of a 3m wide cleared path to the edge of the wetland, where a hole was dug into the water table adjacent to the wetland, seepage observed, and the static water level reached in the hole surveyed to Australian Height Datum by PGS Hope & Partners.

The location of each of the transects and survey results are shown in Table 2 and in Figure 13 in relation to JDA AAMGL mapping and ATA wetland extent mapping. Summarising the results of the investigation :

- ❑ The results of the investigation indicate the inflow to the wetland as being from a diffuse seepage face along the northern boundary as previously described in Section 5.3,
- ❑ The extent of the wetland and also support ATA Environmental mapping as a more accurate representation of the extent of the wetland boundary within the Study Area, compared to WRC's Wetland Atlas (Hill et al 1996) and Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP) wetland mapping.
- ❑ The results confirm the presence of a water table gradient across the wetland. At the staff gauge near the wetland outlet, the water level was 0.70 mAHD, increasing to 1.38 mAHD at Transect 1 near the north western wetland boundary. At the eastern boundary of the wetland near Centenary Avenue, the water level was 2.24m AHD, representing a 1.54m gradient through the wetland.
- ❑ Seasonal variations in water table within the wetland and Study Area are small compared to more typical seasonal groundwater variations of 1.0-1.5m on the Swan Coastal Plain. Differences in water levels for JDA monitoring bores compared to 13 November 2002 readings ranged from 0.03m at bore EC1 to 0.30m at EC3. The water level at the JDA staff gauge was constant compared to the adjusted November reading and the water level in the wetland at the Centenary Rd culvert showed almost no change (0.01m difference). These variations are consistent with adjustments applied in JDA AAMGL calculations (Section 4.3, Table 1).

Table 2: Wetland Transect Investigation Data

Location	Water Level 8 May 2003 (m AHD)	Water Level 13 Nov 2002 (m AHD)	Water Level Difference
JDA Wetland Transect			
T1	1.68	-	-
T2	1.39	-	-
T3	1.38	-	-
T4	1.45	-	-
T5	2.07	-	-
T6	1.98	-	-
T7	2.00	-	-
JDA Monitoring Bores			
EC1	1.12	1.09	0.03
EC2	0.57	0.44	0.13
EC3	1.97	2.17	0.30
EC4	Dry	2.90	-
EC5	Destroyed	0.06	-
EC6	1.06	1.15	0.09
EC7	2.09	2.31	0.22
EC8	Dry	3.79	-
Staff Gauge	0.72	0.72	0.00
Wetland at Centenary Rd Culvert	2.24	2.25	0.01

m AHD = metres Australian Height Datum

m BNS = metres below Natural Surface

5.4 Annual Water Balance

As previously calculated in Sections 2.4 and 5.1.1, the estimated average annual surface runoff from external catchments to the wetland is approximately 127,000 m³/yr. Annual average groundwater inflow is estimated as 630,000 m³/yr. On an annual basis therefore the flux of groundwater through the study area exceeds the flux of surface water by a factor of approximately 5.

On this basis groundwater is estimated to contribute approximately 83% of wetland inflow.

5.5 Water Level Variation due to Stormwater Inflow

Based on a simple XP-UDD model, given an approximate wetland size of 3.5 ha and a 750mm diameter outlet pipe, the 10 year average recurrence interval (ARI) flood event is estimated to result in a flood rise of approximately 0.24 m within the wetland with a discharge of 0.19 m³/s for the critical 6 hour duration storm event.

The 100 year ARI event is estimated to result in a flood rise of 0.31 m, and a discharge of 0.32 m³/s for the critical 6 hour duration storm event.

These calculated flood rises are based on an assumed horizontal water surface, while the existing wetland has a water surface gradient of approximately 1.54 m across it from Centenary Avenue to the outlet culvert. The water surface will therefore be inclined from Centenary Avenue down to the culvert outlet during flood events. This is contrast to the horizontal water surface which generally occurs in more open water bodies such as lakes.

These calculated flood levels should be considered indicative only as detailed flood modelling has not been performed as part of this study. More detailed modelling of flood levels is recommended to accurately define wetland flood levels for detailed design.

These results indicate that while groundwater inflow greatly exceeds stormwater inflow on an annual basis, significant variations in water level within the wetland are likely to be as a result of storm events rather than seasonal groundwater variation.

5.6 Summary of Findings

Based on the above analysis it is JDA's opinion that the inflow to the wetland sustaining a relatively constant 1700 m³/d discharge to the Canning River is diffuse discharge from the superficial formation along the northern boundary of the wetland. The high discharge rate suggests that the superficial groundwater throughflow estimates contained in Davidson (1995) may be underestimated.

The present wetland contains some area of open water, and as such functions to some extent as a flow-through wetland (Townley et al 1993). Given the near constant flow rate believed to occur (based on anecdotal evidence and field investigations), there is likely to be only small seasonal variation in both groundwater flow rate and water table elevation and therefore in the extent of inundation or waterlogging.

Given the proximity of the wetland to the Canning River, it is unlikely that the wetland surface water is able to recharge the aquifer on the down gradient (southern) side, but rather it drains as surface water at the Canning River.

As the wetland is underlain by peat, there is the possibility of a perched water table forming, particularly in early winter. However given the very constant groundwater discharge associated with the wetland to the Canning River, this is unlikely to be the case. The wetland is therefore considered to be part of the regional groundwater flow system of the superficial aquifer.

The rate of discharge from the wetland will be effected to some extent by land use and by the excavation or blockage of manmade drains. However, these are considered to have relatively little impact on the rate of flow which has probably been fairly consistent for the last 100 years at least. Interannual variation of water level within the wetland are therefore also considered likely to be minor.

6. IMPLICATIONS OF LAND USE CHANGE

The proposed residential development plan for the Study Area is shown in Figure 14. With respect to drainage, the Clontarf Subdivision Application (DPS, 2002) provides the following strategy based on written advice provided by WRC :

- ❑ No new stormwater drainage from the Study Area is to enter the wetland.
- ❑ The new stormwater should be directed into the river as far as possible from the freshwater outlet of the wetland
- ❑ The new stormwater should be treated before release to the river
- ❑ The existing inflow/outflow from the central wetland should be maintained (maintain existing hydrological balance)
- ❑ The construction of a detention basin adjacent to the foreshore is optional.

Based on the outcomes of analysis detailed in Chapters 2, 4, and 5, Table 3 presents a summary of key issues related to the proposed development plan and drainage strategy for the Study Area in relation to groundwater and surface water management of the wetland.

The results indicate the wetland water balance is not significantly altered from its existing hydrological balance as a result of implementing the proposed development plan, and that changes which occur are considered manageable.

Table 3 : Summary of Land Use Change Implications for Water Management

Issue	Status with Existing Land Use	Implication of Proposed Land Use Change
Groundwater		
Wetland Inflow	<p>Groundwater inflow to the existing wetland is estimated to be approximately 630,000 m³/year, discharging to the wetland along its whole northern boundary at a relatively constant rate of 1700 m³/d (considering vegetation uptake and evaporation as secondary effects).</p> <p>Groundwater is estimated to currently contribute approximately 83% of the total current wetland inflow</p>	<p>The proposed development plan for the Study Area is to fill part of the eastern area of the wetland adjacent to Centenary Avenue. This will reduce the length of the northern boundary of the wetland and hence the length over which groundwater discharges by approximately 20%. This would be expected to reduce groundwater inflow to the wetland by a similar amount.</p> <p>To prevent water table rise beneath the developed area sub soil drains will be required to convey shallow groundwater towards the wetland or possibly the Canning River.</p>
Wetland Level	<p>Wetland levels due to groundwater are estimated to remain relatively constant seasonally and inter-annually.</p> <p>The wetland AAMGL is estimated to grade from 0.7 mAHd at its downstream culvert to 2.25 mAHd at the upstream Centenary Rd culvert.</p>	<p>Wetland levels are expected to remain relatively constant with small seasonal variation.</p> <p>The extent to which the existing dense vegetation is responsible for the existing water table gradient through the wetland is unclear. Removing and rehabilitating the wetland with the inclusion of several open water bodies may require a series of weir structures to be installed if the existing gradient across the wetland is to be maintained.</p>
Wetland Discharge	Groundwater discharge from the wetland to the Canning River occurs at a relatively constant rate of 1700 m ³ /d.	As stated above, installation of subsoil drainage in the filled eastern area of the wetland if drained to the wetland can maintain the existing groundwater flow regime.
Surface Water		
Wetland Inflow	<p>Average surface water inflow to the existing wetland is estimated to be approximately 127,000 m³/year. Inflow rates vary depending on individual storm events.</p> <p>Of the 127,000 m³/year average surface water inflow, approximately 74% is estimated to be from developed catchments external to the Study Area.</p> <p>Surface water is estimated to currently contribute approximately 17% of the total current wetland inflow</p>	<p>WRC have requested all drainage from development within the Study Area is to be diverted away from the wetland. This will reduce the contributing catchment to the wetland from 46.1 ha currently (including the wetland surface area) to 37.9 ha</p> <p>This will result in an average reduction in surface inflow to the wetland of 16,000 m³/year or approximately 9%, which is considered small compared to inter annual variability.</p> <p>This reduction represents only 2% of the total surface water and groundwater inflow.</p>
Wetland Level	<p>The 10 year ARI flood event is estimated to result in a flood rise of approximately 0.24 m within the wetland. The 100 year ARI event is estimated to result in a flood rise of 0.31 m.</p> <p>Levels should be considered indicative only based on preliminary modelling.</p>	<p>Change to the wetland surface area and surface water catchment results in changes to wetland levels during flood events. The 10 year ARI flood event post development is estimated to result in a flood rise of approximately 0.28 m (0.04m increase) within the wetland. The 100 year ARI event is estimated to result in a flood rise of 0.36 m (0.05m increase).</p> <p>Levels should be considered indicative only based on preliminary modelling.</p>
Wetland Discharge	Discharge for the critical 6 hour duration 10 and 100 year ARI events are estimated to be 190 L/s and 320 L/s respectively	<p>Discharge for the critical 6 hour duration 10 and 100 year ARI events are estimated to be increased to 260 L/s and 420 L/s respectively.</p> <p>A smaller outlet pipe than the existing 750mm diameter would be required to reduce discharges to existing levels however this would then result in higher flood levels within the wetland.</p>

7. CONCLUSIONS/RECOMMENDATIONS

This hydrological investigation was undertaken by JDA on behalf of Richard Noble & Company for the East Clontarf Area to provide a general understanding of the hydrology of the site and to review findings in the context of implications for proposed land use change within the Study Area. Study conclusions and recommendations are summarised below :

- ❑ Based on 1m DOLA topographic contours, approximately 12.2 ha of the 18.5 ha Study Area is estimated to drain to the central wetland (includes the 3.5 ha wetland area itself) and 6.3 ha is estimated to drain directly to the Canning River.
- ❑ The Study Area also receives surface drainage from external developed catchments. The total estimated upstream catchment draining into the Study Area is 35.4 ha, of which 33.9 ha drains into the wetland.
- ❑ Field investigations confirm ATA (2001) wetland mapping as a more accurate representation of the extent of the wetland within the Study Area, than previous Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP) wetland mapping and WRC Wetland Atlas mapping (Hill et al 1996).
- ❑ Field analysis indicates the presence of a water table gradient across the wetland. Near the wetland outlet, the water level was 0.70 mAHD in May 2003, increasing to 2.24 mAHD at the eastern boundary near Centenary Avenue. This represents a 1.54m gradient through the wetland.
- ❑ Seasonal variations in water table within the wetland and Study Area are small compared to more typical seasonal groundwater variations of 1.0-1.5m on the Swan Coastal Plain. Given the near constant flow rate believed to occur from the wetland (based on anecdotal evidence and field investigations), there is likely to be only small seasonal and inter annual variation in flow rate to the wetland and wetland water level.
- ❑ The relatively constant 1700 m³/d (20 L/s) discharge from the wetland to the Canning River is considered to be sustained by diffuse inflow from the superficial formation along the northern boundary of the wetland. The high discharge rate suggests that superficial groundwater throughflow estimates contained in Davidson (1995) may be underestimated.
- ❑ The estimated annual average surface runoff from external catchments to the wetland is approximately 127,000 m³/yr. Annual average groundwater inflow is estimated as 630,000 m³/yr, based on 1700 m³/d constant discharge. Groundwater is therefore estimated to contribute approximately 83% of wetland inflow.
- ❑ Based on a preliminary flood modelling, the 10 year ARI flood event is estimated to result in a flood rise of approximately 0.24 m within the wetland with a discharge of 0.19 m³/s to the Canning River for the critical 6 hour duration storm event. The 100 year ARI event is estimated to result in a flood rise of 0.31 m, and a discharge of 0.32 m³/s for the critical 6 hour duration storm event.
- ❑ Calculated flood levels should be considered indicative only as detailed flood modelling has not been performed in this study. More detailed modelling of flood levels is recommended to more accurately define wetland flood levels for detailed design.
- ❑ The results indicate that while groundwater inflow greatly exceeds stormwater inflow on an annual basis, significant variations in water level within the wetland are likely to be as a result of storm events rather than seasonal groundwater variation.
- ❑ Based on the analysis presented in Chapter 6, the wetland water balance will not be significantly altered from its existing hydrological balance as a result of implementing the proposed development plan.

- The steady discharge of groundwater from the superficial formation aquifer to the drain flowing to the Canning River will tend to dilute the affects of any pollution due to previous or existing land uses within or upgradient of the study area. That is, the relatively high surface flow to the river will rapidly dilute any high concentrations of pollutants within the study area.

8. REFERENCES

ATA Environmental (2001) Environmental Assessment East Clontarf, Manning, Report No 2000/1 79, January 2001

Coffey Geosciences Pty Ltd (2000) East Clontarf Manning, Report on Geotechnical Studies, October 2000.

Davidson, W.A. (1995) Hydrogeology and Groundwater Resources for the Perth Region Western Australia, GSWA Bulletin 142.

Development Planning Strategies (2002), Clontarf Subdivision Application, December 2002

Hill, A.L., Semeniuk, C.A., Semeniuk, V. & Del Marco, A. (1996) Wetlands Of The Swan Coastal Plain Volume. 2b, Wetland Mapping, Classification And Evaluation, Wetland Atlas.

Swan River Trust (1999), Swan Canning Cleanup Program Action Plan, An Action Plan to Clean up the Swan Canning Rivers and Estuary, May 1999.

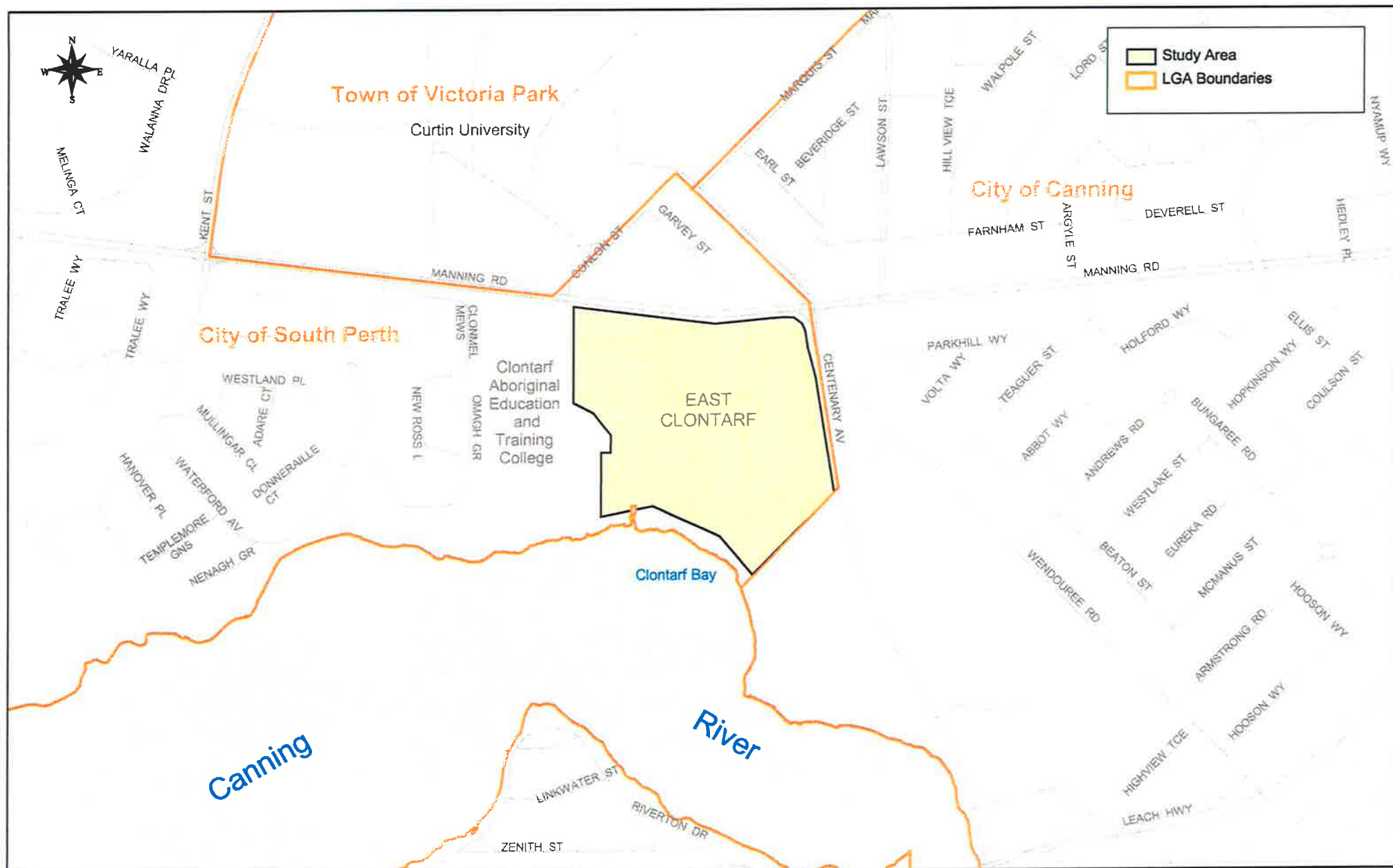
Townley L.R., Turner, J.V., Barr, A.D., Trefry, M.G., Wright, K.D., Gailitis, V., Harris, C. J. & Johnston, C.D. (1993) Wetlands of the Swan Coastal Plain, Interaction Between Lakes, Wetlands and Unconfined Aquifers Vol. 3.

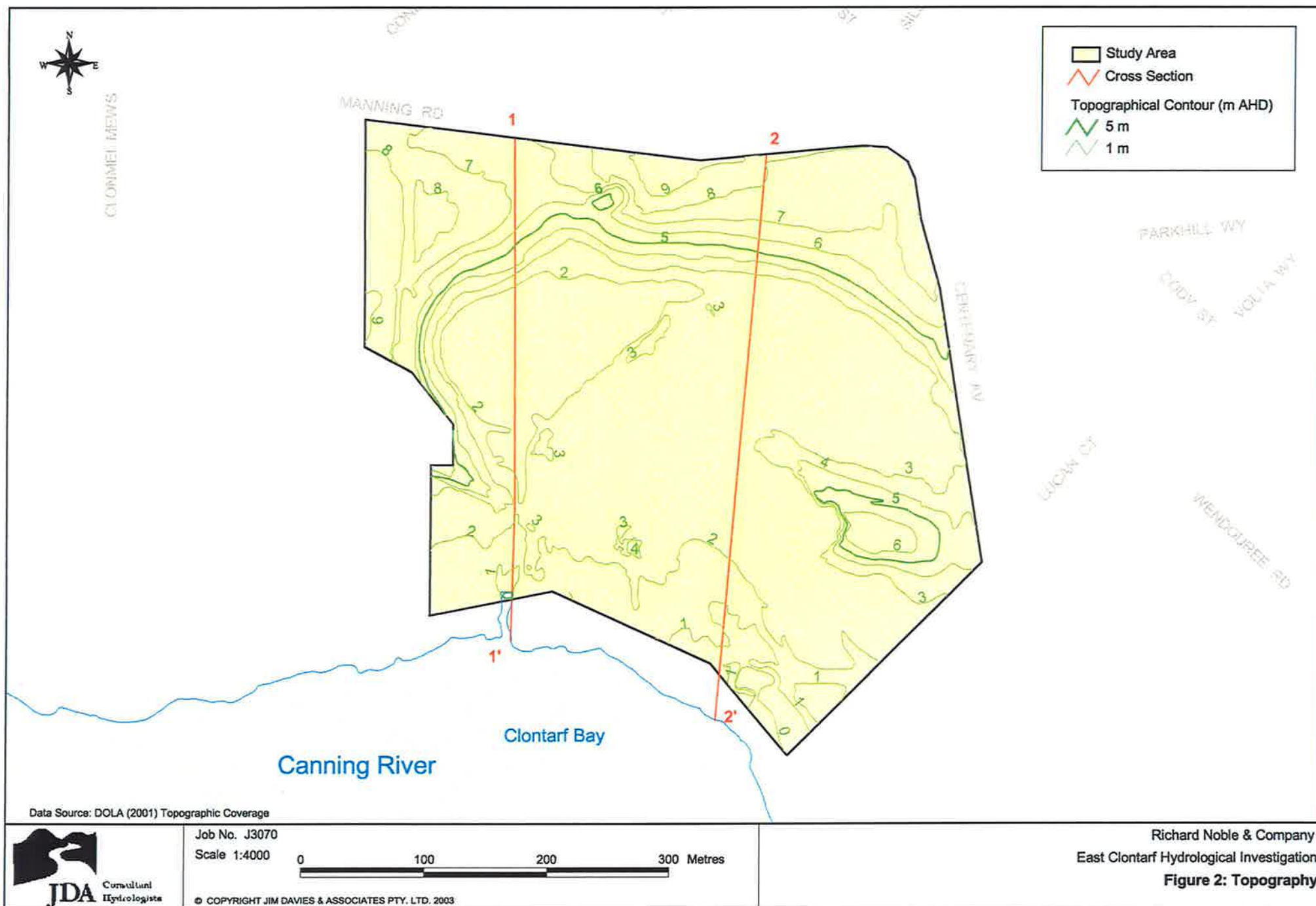
Water & River Commission (1997) Perth Groundwater Atlas.

Water and Rivers Commission (1998) A Manual for Managing Urban Stormwater Quality in Western Australia, August 1998.

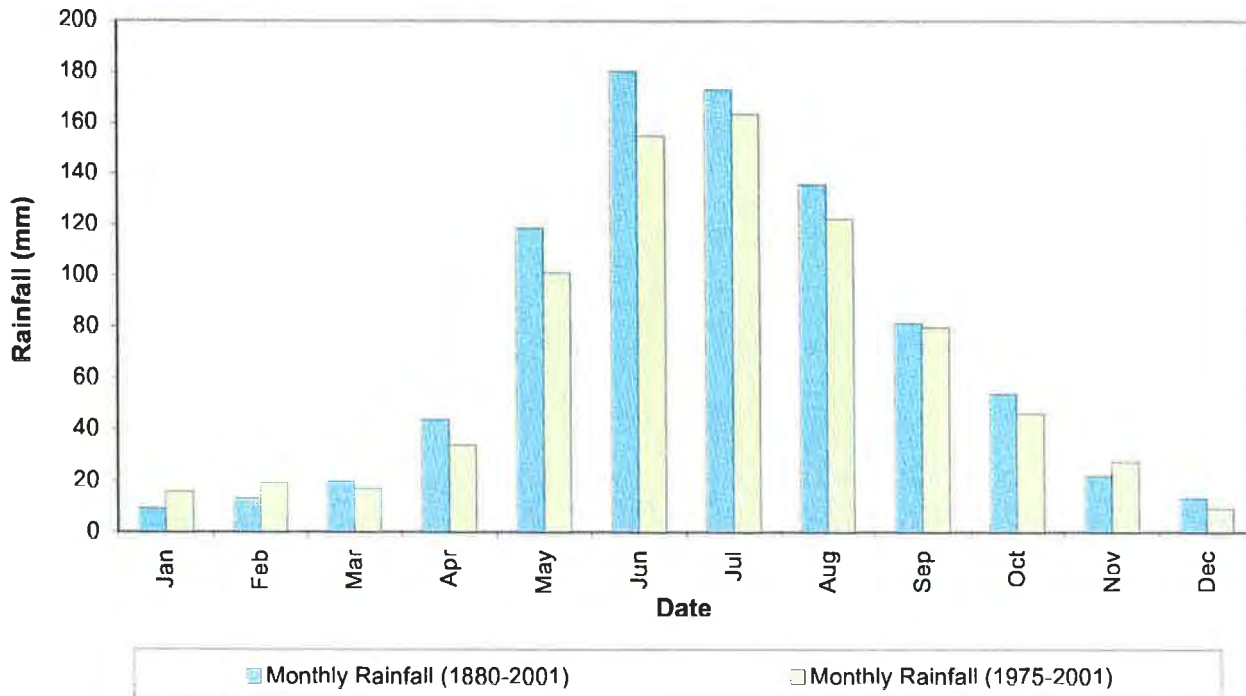
Water and Rivers Commission (2003), Interim Position Statement Urban Stormwater Management in Western Australia Principles and Objectives, February 2003

FIGURES

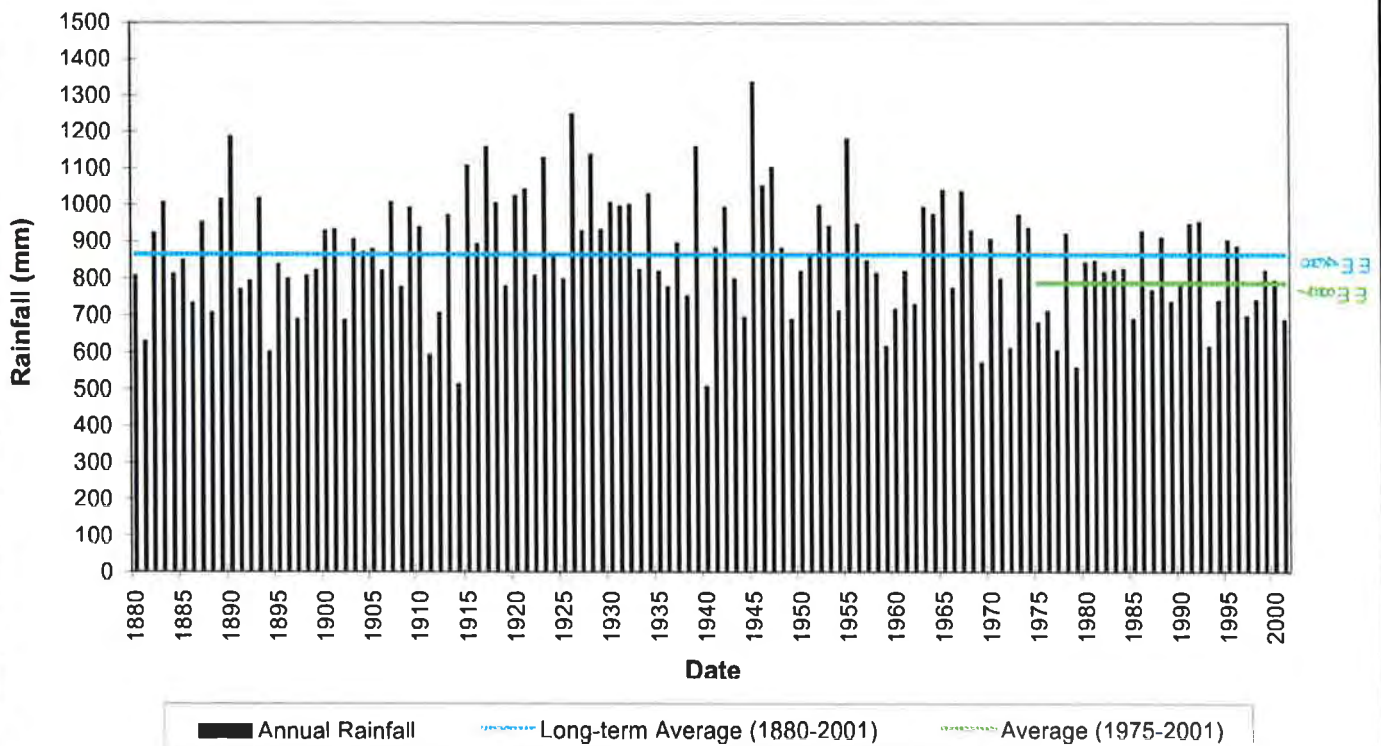




Monthly Rainfall at Perth Regional Station



Annual Rainfall at Perth Regional Station



Data Source : Bureau of Meteorology (2002)

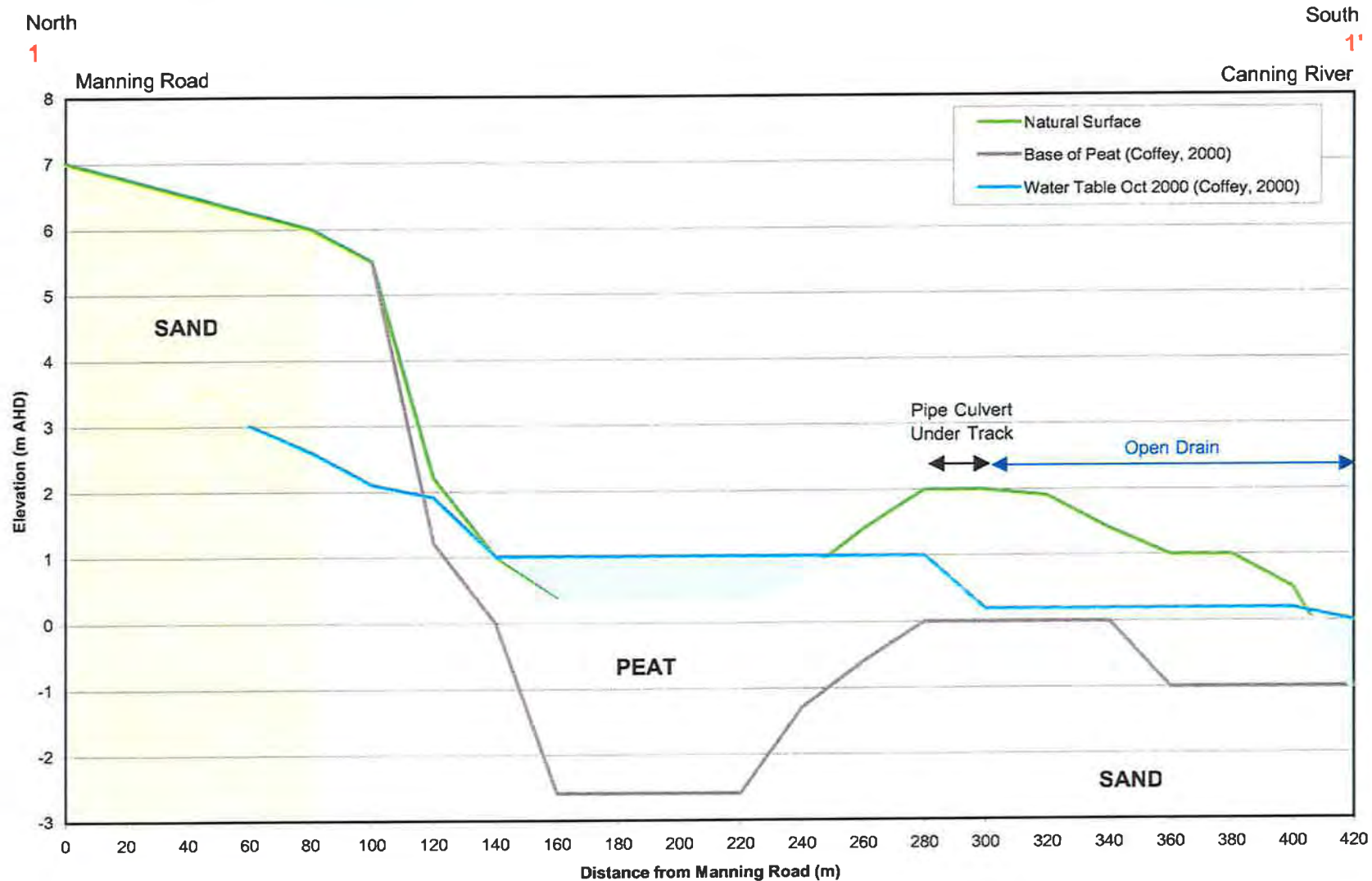
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Figure 3: Annual and Monthly Rainfall



Note:

1. Coffey (2000) assumed natural surface at 2.0 m AHD through wetland
2. These report uses Coffey (2000) peat thickness but wetland at 0.5 m AHD



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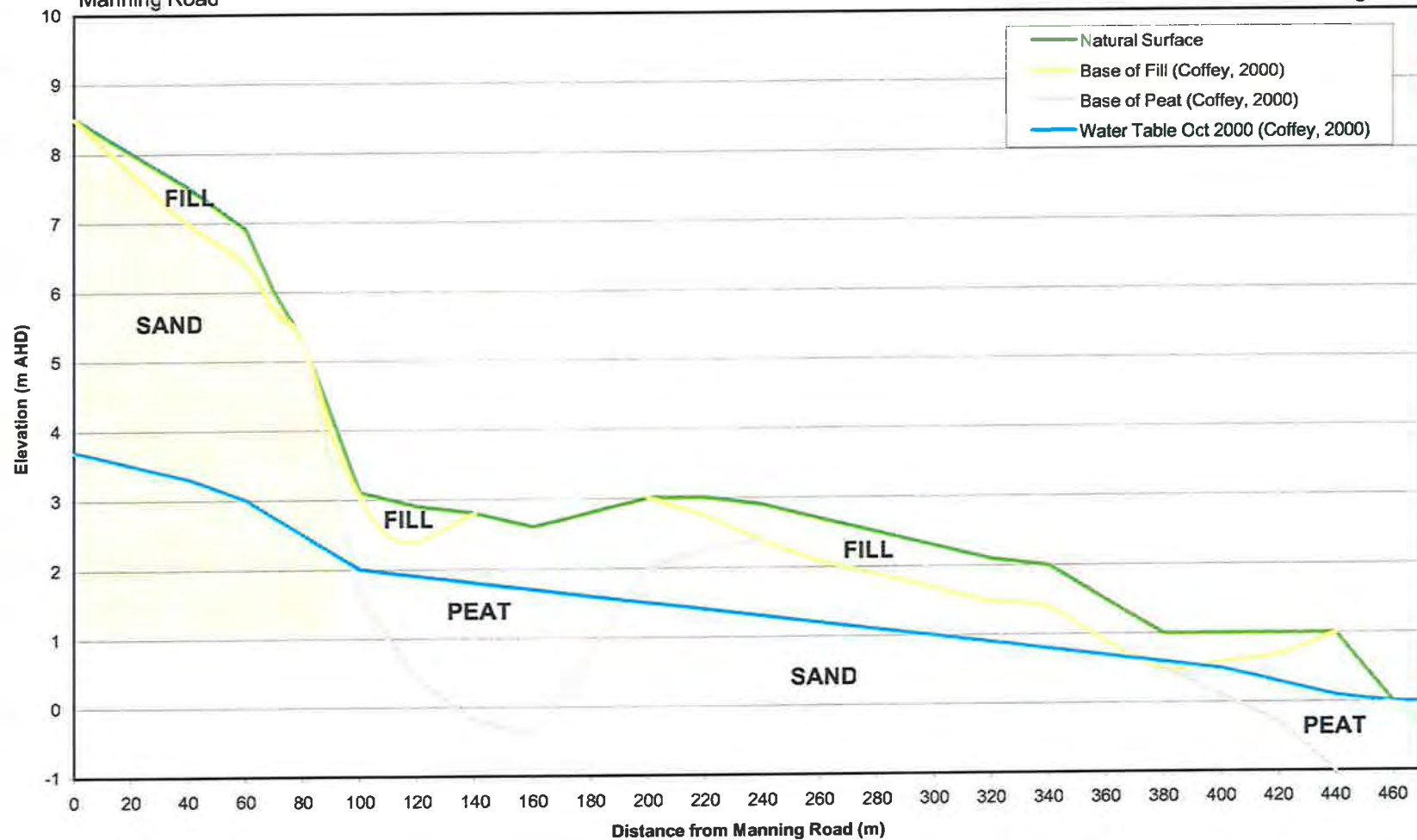
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Figure 4: Cross Section 1 : Western Wetland

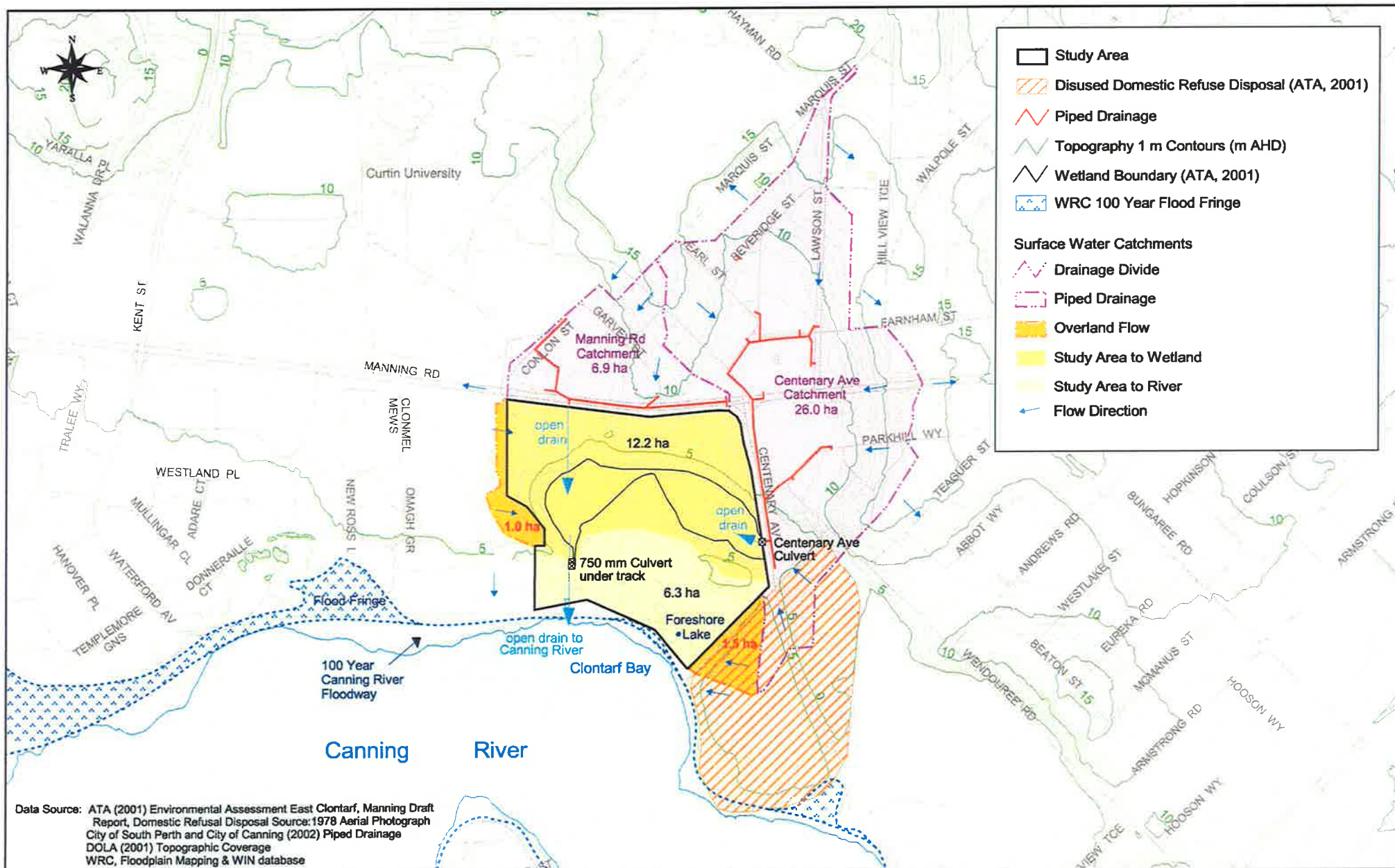
North
2

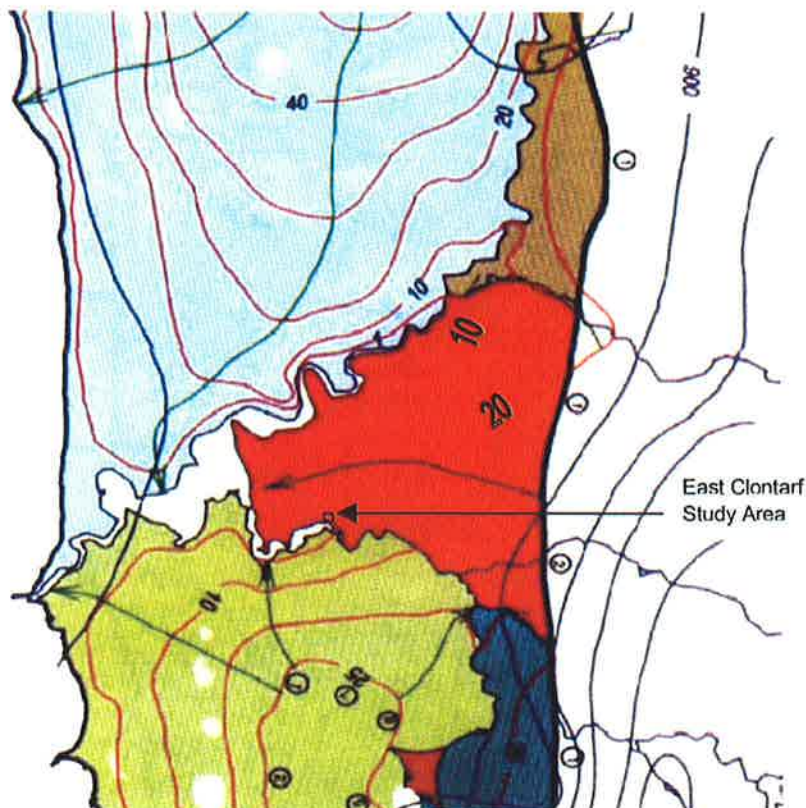
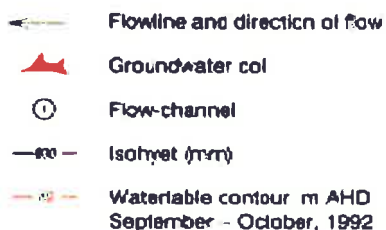
South
2'

Manning Road

Canning River

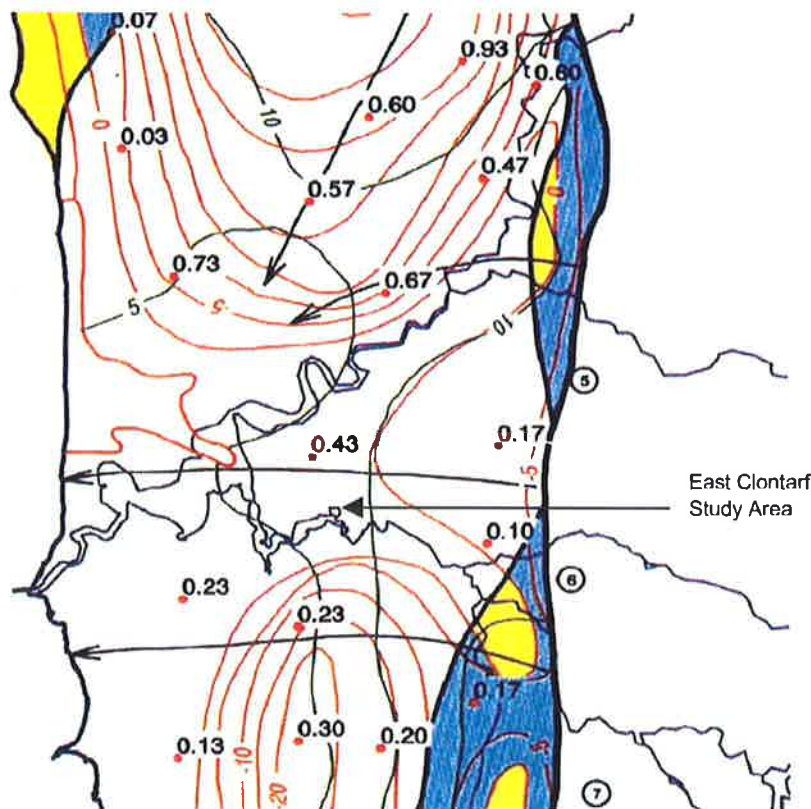
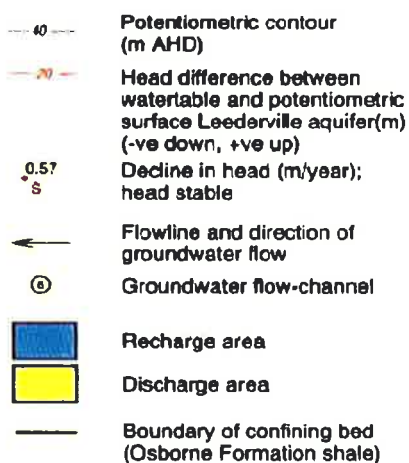






(a) Superficial Aquifer Groundwater Flownet

reproduced from Plate 53



(b) Leederville Aquifer Groundwater Flownet

reproduced from Plate 64

Data Source : Davidson, W.A. (1995) Hydrogeology and Groundwater Resources of the Perth Region Western Australia, Dept. Of Minerals And Energy, Bulletin 142.

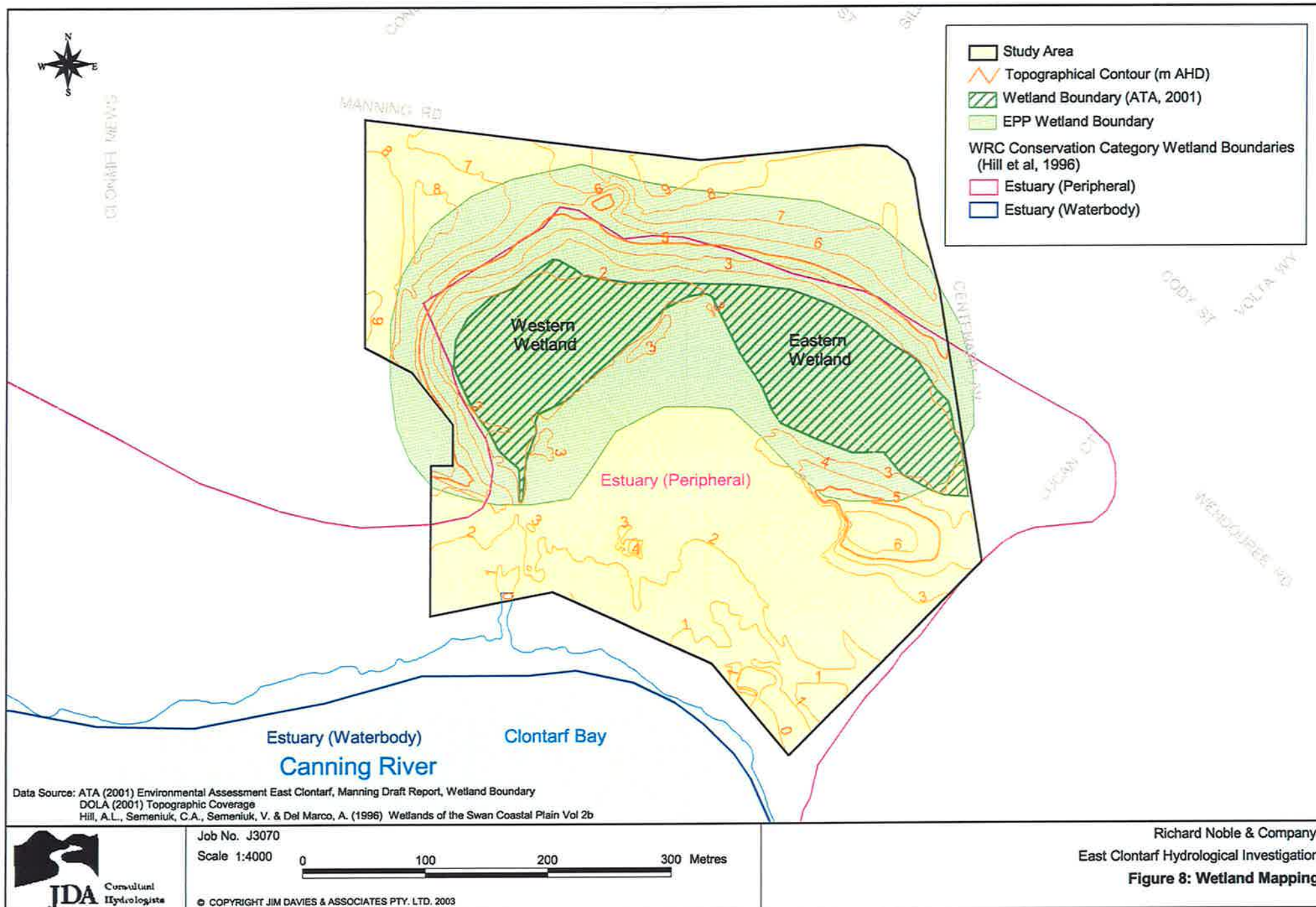
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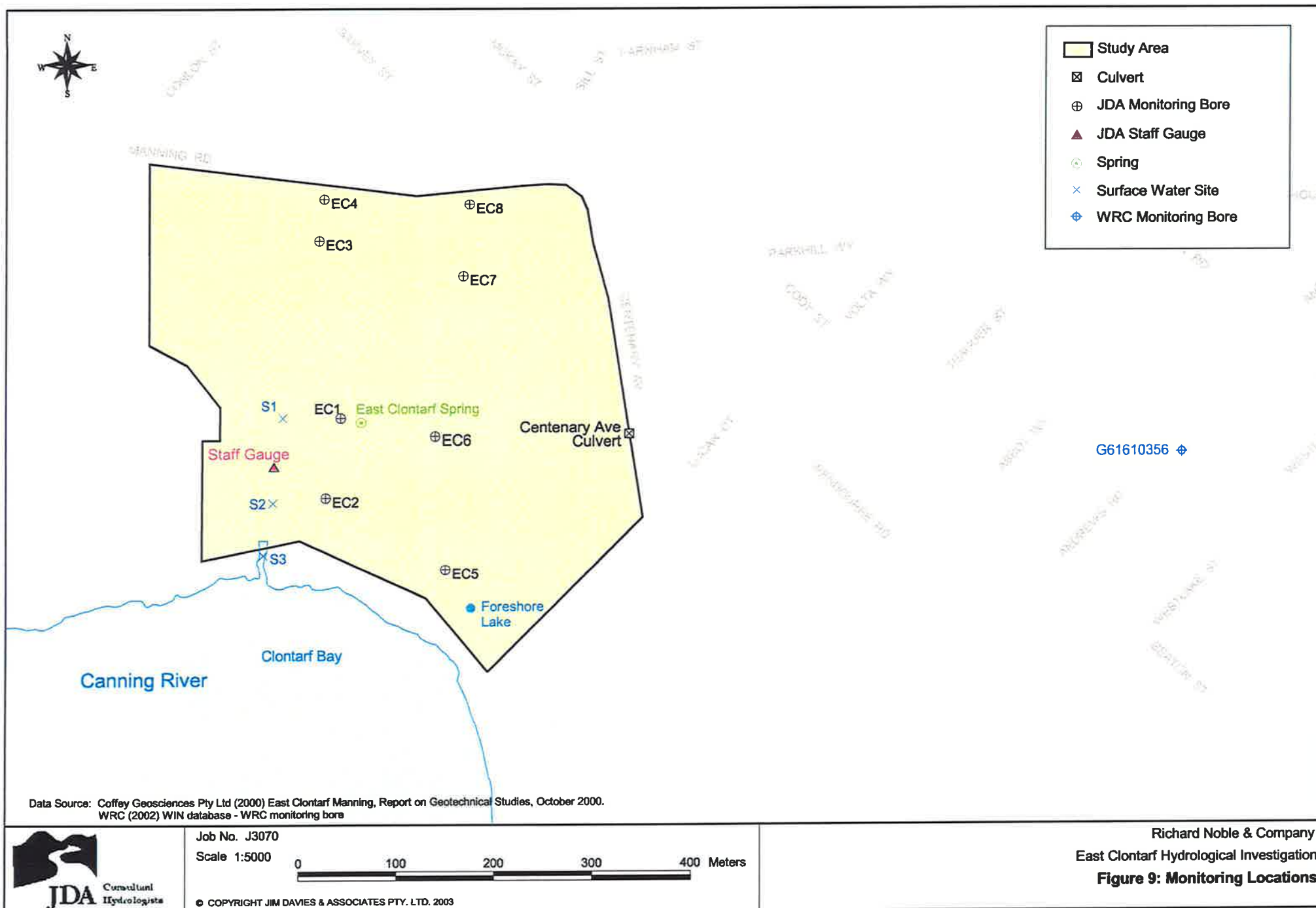


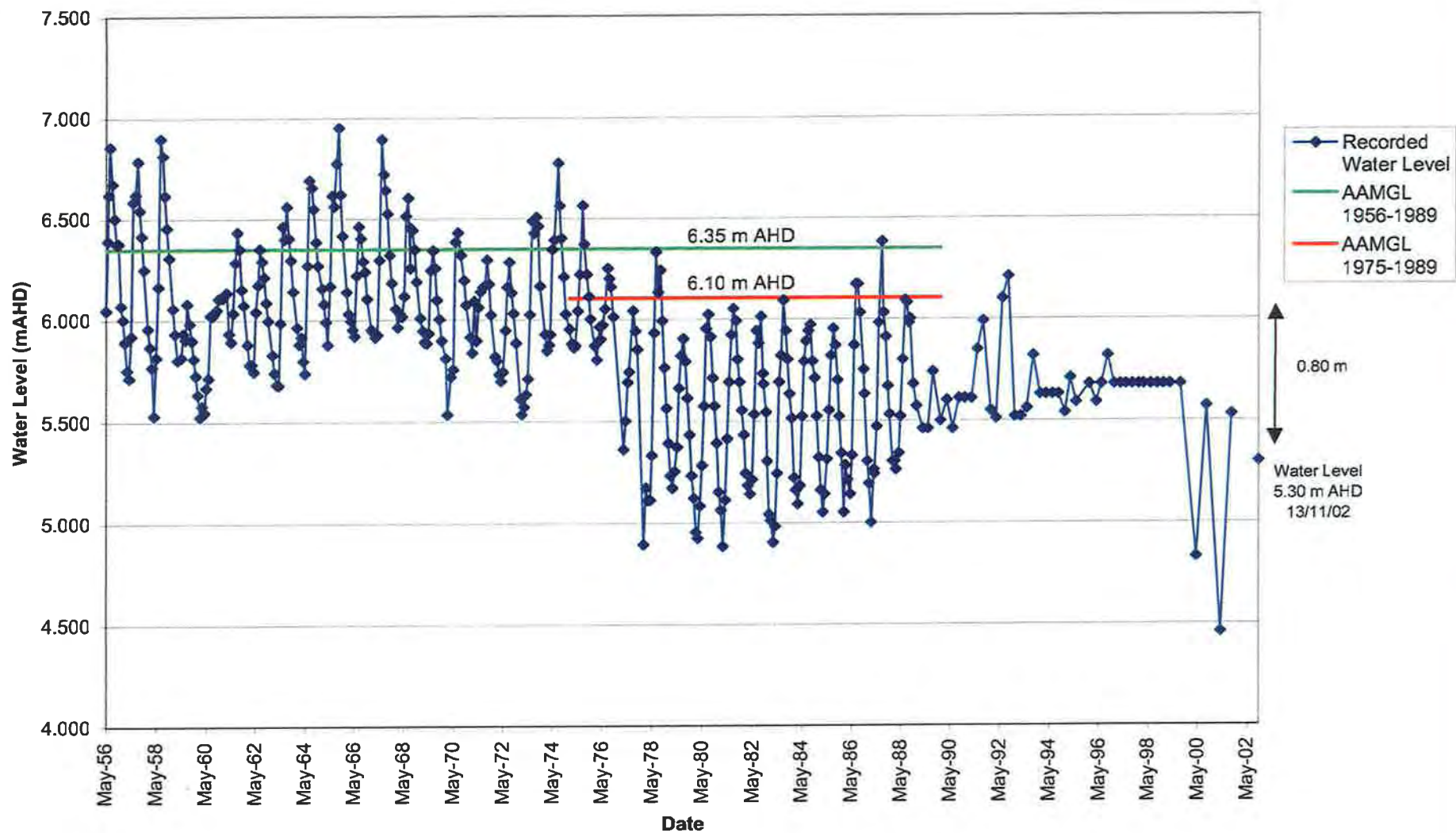
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Figure 7: Groundwater Flownets







Data Source: Water & Rivers Commission



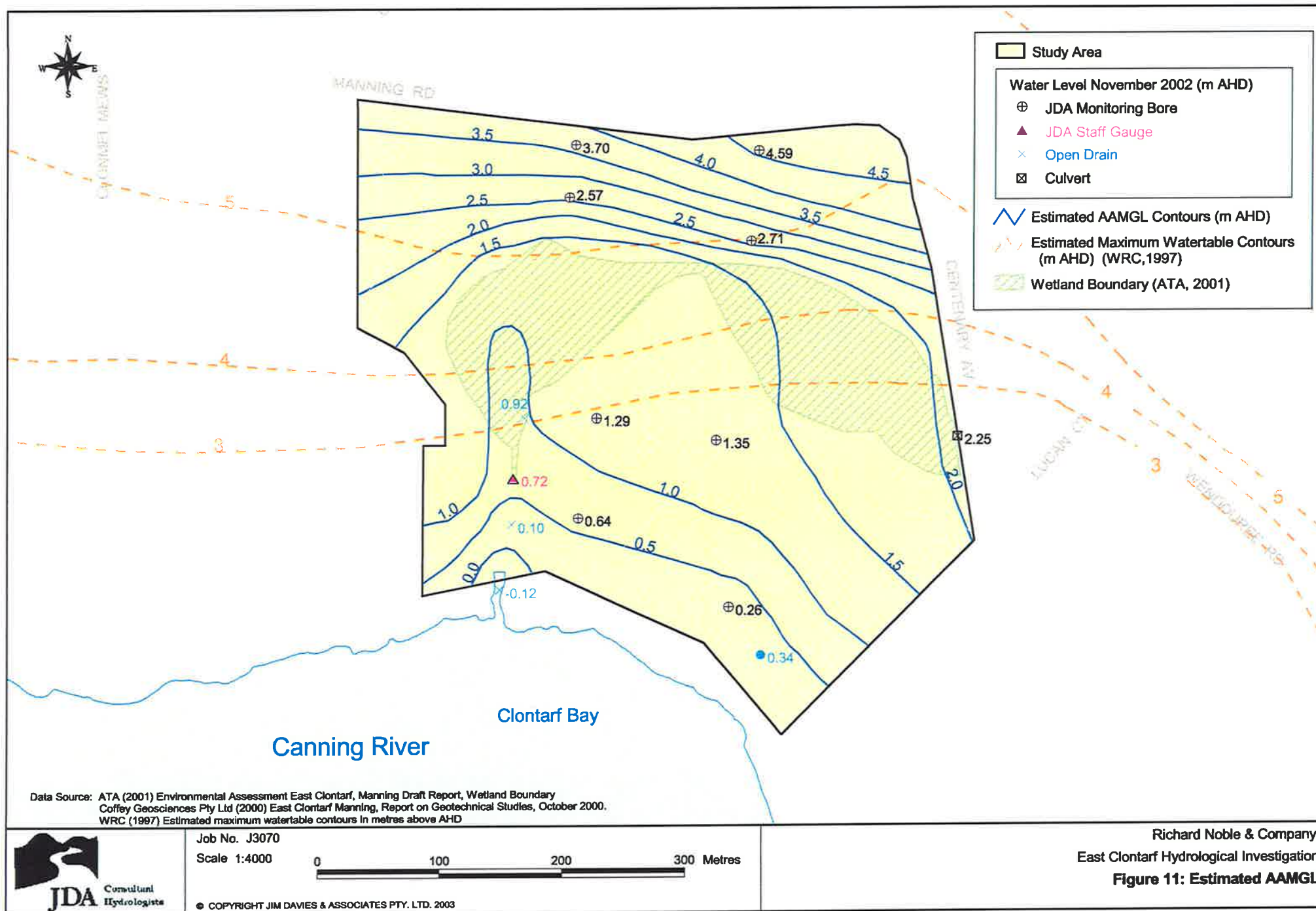
Job No. J3070

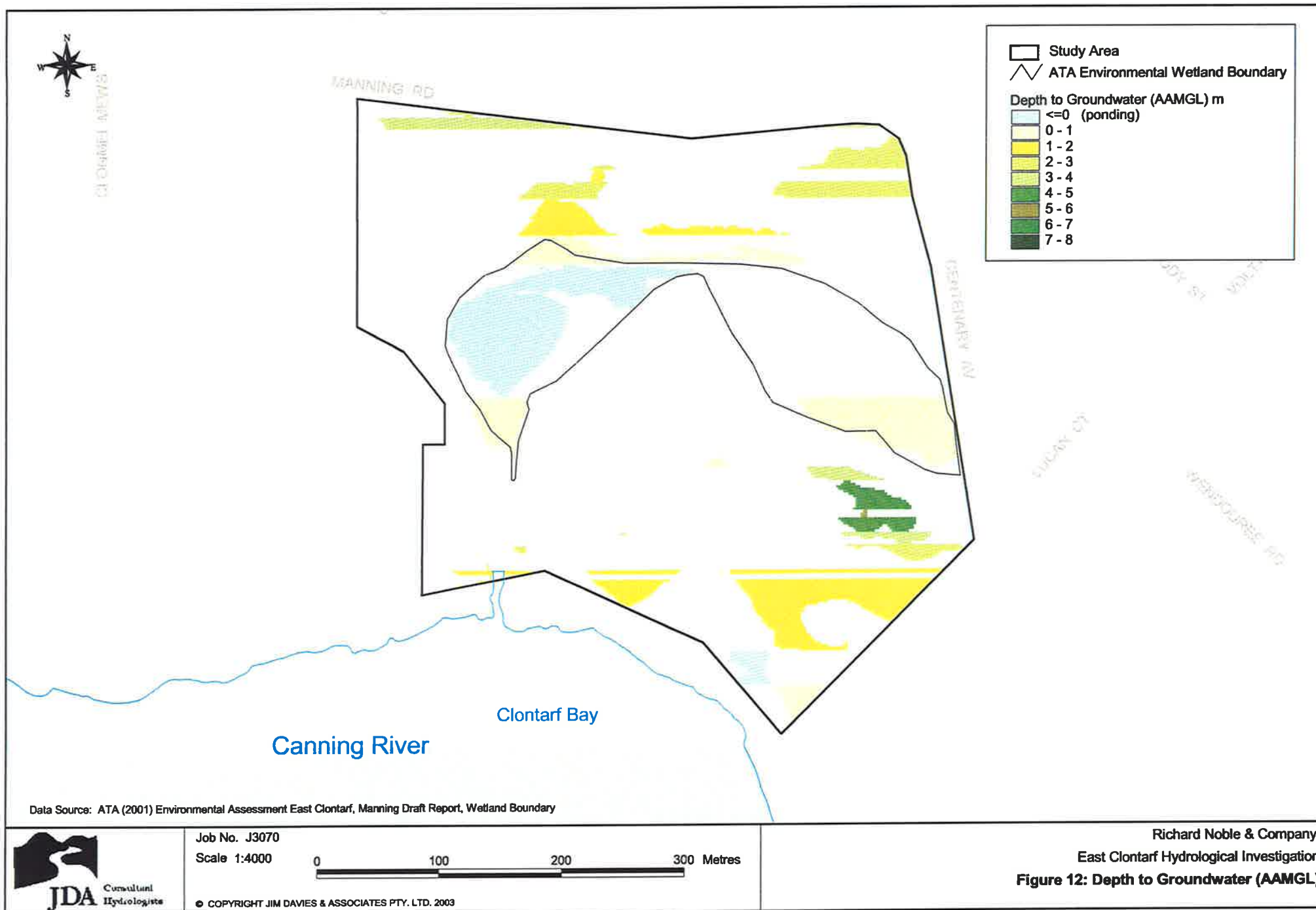
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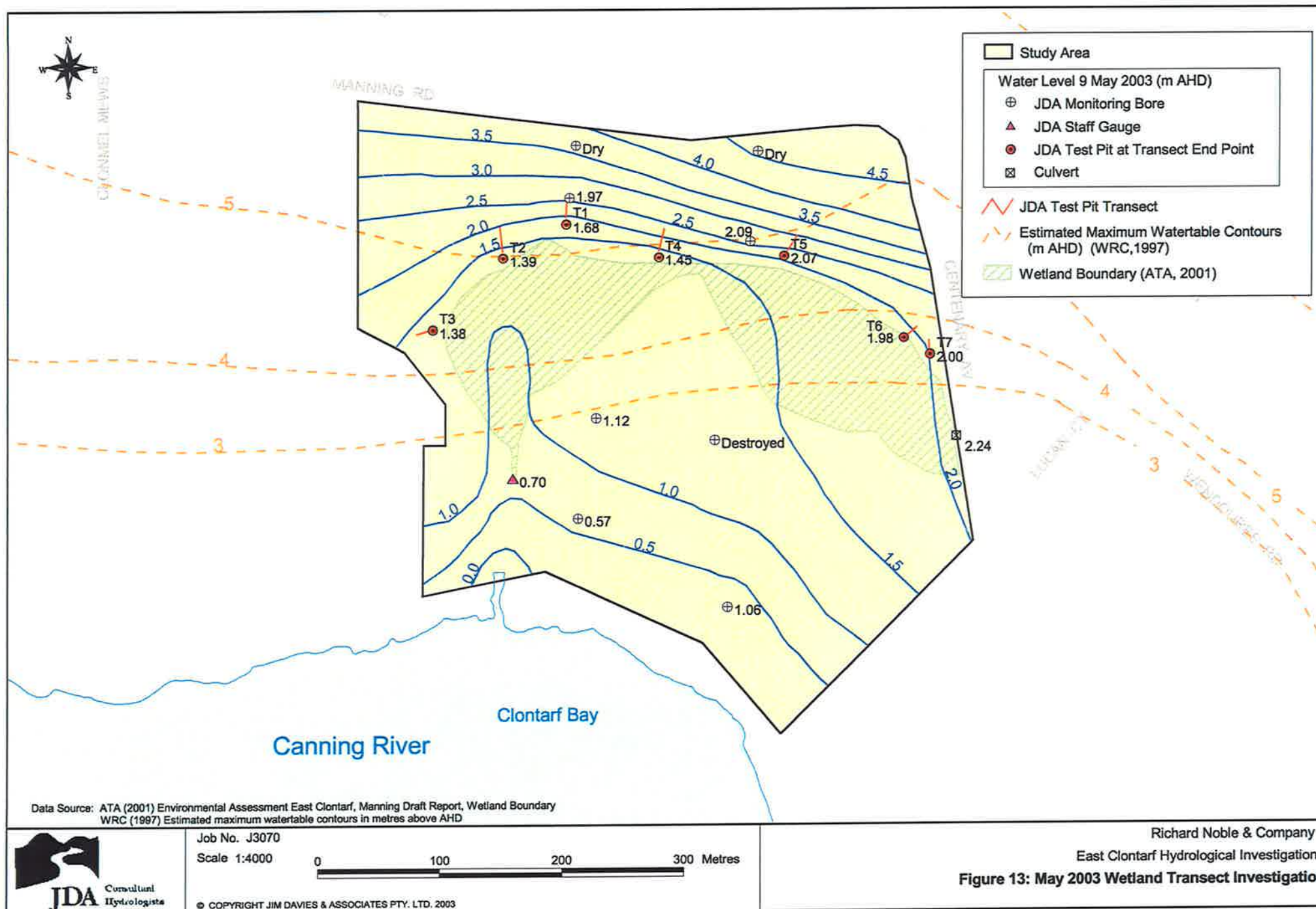
Richard Noble & Company

East Clontarf Hydrological Investigation

Figure 10: WRC Monitoring Bore G61610356 Hydrograph









Source: Extract from Figure 9, Clontarf Subdivision Application,
Development Planning Strategies (2002)

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Job No. J3070
Scale 1 : 3000

Richard Noble & Company
East Clontarf Hydrological Investigation
Figure 14: Proposed Development

PLATES



Plate A : View of wetland to north showing dense reed growth (November 2002)



Plate B : View to west of Study Area from Centenary Park with Clontarf Aboriginal College in distance (November 2002)



Plate C : JDA Bore EC7 located in bracken fern on northern side of wetland.
View to south west across wetland toward Clontarf College (November 2002).



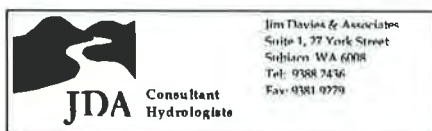
Plate D : Staff gauge installed at south western corner of wetland near wetland outlet in area of relatively open water (November 2002).



Plate E : Wetland Investigation Transect 1 near JDA Bore EC3, view to south (February 2003)



APPENDIX 1

JDA Lithological Logs



LITHOLOGICAL LOG

Client:	Richard Noble & Company	Job No:	J3070
Project:	East Clontarf Hydrological Investigation	Hole commenced:	8/11/02
Bore location:	395761E, 6457276N	Hole completed:	8/11/02
Datum:	MGA94/AHD	Logged by:	SW/ASM
Bore Name:	EC1	Total Depth:	2.00 m
Drill type:	Hand Auger	R.L. TOC:	3.20 mAHD
Hole diameter:	75mm	Natural Surface:	2.43 mAHD

Soil Characteristics				Soil Characteristics										
method	1	2	3	penetration	support	water	Slot / Screen Depth	Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
IIA					PVC (Class 9)			0.5m	Grey	Medium Fine	Sand	Medium	Dry	
								1.0m	Black	Fine	Sandy Silt	High		
								1.5m	Brown	Medium	Sand	Medium	Moist	
								2.0m	Grey/Brown hlemish				Saturated	
								2.5m	End of Hole					

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark: Brown, Red, Orange, Yellow, Grey, Blue

Medium: Brown, Red, Orange, Yellow, Grey, Blue

Light: Brown, Red, Orange, Yellow, Grey, Blue

Tones: solid colour, hlemish or mottle

PARTICLE SIZE: Particles are either FINE, MEDIUM or COARSE

TEXTURE: Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

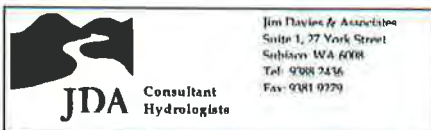
STATIC WATER LEVEL

Date: 13/11/02

WL below TOC 2.11 m

Stickup above NS: 0.77 m

WL 1.34 m below NS



LITHOLOGICAL LOG

Client:	Richard Noble & Company	Job No:	J3070
Project:	East Clontarf Hydrological Investigation	Hole commenced:	8/11/02
Bore location:	395746E, 6457193N	Hole completed:	8/11/02
Datum:	MG94/AHD	Logged by:	SW/ASM
Bore Name:	EC2	Total Depth:	2.00 m
Drill type:	Hand Auger	R.L. TOC:	3.24 mAHD
Hole diameter:	75mm	Natural Surface:	2.03 mAHD

method	1	2	3	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS					COMMENTS
								COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	
IIA				PVC (Class 3)			0.5m	Grey/Brown	Fine	Loamy Sand	Medium	Dry	
							1.0m	Grey	Medium	Sand	Low	Moist	
							1.5m						
							2.0m	Brown				Saturated	End of Hole
							2.5m						
							3.0m						
							3.5m						
							4.0m						
							4.5m						
							5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark : Brown, Red, Orange, Yellow, Grey, Blue

Tones : solid colour, bluish or mottle

Medium : Brown, Red, Orange, Yellow, Grey, Blue

Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clay Loam
 Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
 SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

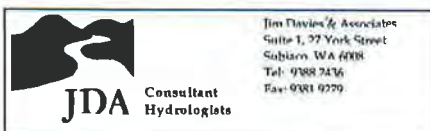
STATIC WATER LEVEL

Date: 13/11/02

WL below TOC 2.80 m


Stickup above NS: 1.21 m

WL 1.59 m below NS



LITHOLOGICAL LOG

Client:	Richard Noble & Company	Job No:	13070
Project:	East Clontarf Hydrological Investigation	Hole commenced:	13/11/02
Bore location:	395738E, 6457458N	Hole completed:	13/11/02
Datum:	MG94/AHD	Logged by:	SW/ASM
Bore Name:	EC3	Total Depth:	3.30 m
Drill type:	Hand Auger	R.L. TOC:	5.74 mAHD
Hole diameter:	75mm	Natural Surface:	4.82 mAHD

Soil Characteristic				SOIL CHARACTERISTICS									
method	1	2	3	support	water	Slot / Screen Depth	Depth (metres)	COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA				PVC (Class 2)		0.5m	Black	Fine	Sandy Silt	High	Dry	<i>End of Hole</i>	
						1.0m	Light Brown						
						1.5m							
						2.0m	Dark Brown	Medium	Sand	Medium	Moist		
						2.5m							
						3.0m							
											Saturated		
						3.5m							
						4.0m							
						4.5m							
						5.0m							

NOTES ON BORELOG

NOTES ON BUREAU



COLOURS: Solid colours are BLACK, WHITE, BEIGE		Tones: solid colour, blemish or mottle
Dark:	Brown, Red, Orange, Yellow, Grey, Blue	
Medium:	Brown, Red, Orange, Yellow, Grey, Blue	
Light:	Brown, Red, Orange, Yellow, Grey, Blue	
PARTICLE SIZE: Particles are either FINE, MEDIUM or COARSE		
TEXTURE: Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clay Loam Clay, Sandy Clay		
ORGANIC CONTENT: VOLUME: High, Medium, Low SIZE: Fine, Medium, Coarse		
MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED		

STATIC WATER LEVEL
Date: 13/11/02
WL below TOC 3.57 m
Stickup above NS: 0.92 m
WL 2.65 m below NS

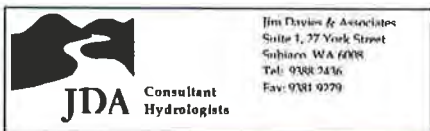


COLOURS: Solid colours are BLACK, WHITE, BEIGE		TONES: solid colour, hlemish or mottle	
Dark :	Brown, Red, Orange, Yellow, Grey, Blue		
Medium :	Brown, Red, Orange, Yellow, Grey, Blue		
Light :	Brown, Red, Orange, Yellow, Grey, Blue		
PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE			
TEXTURE :	Sand, Loamy Sand, Clayey Sand Silt, Loam, Sandy Loam, Clay Loam Clay, Sandy Clay		
ORGANIC CONTENT:	VOLUME:	High, Medium, Low	
	SIZE:	Fine, Medium, Coarse	
MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED			



Hole Diameter:				75mm		Natural Surface:		0.56 mAH				
Method	Penetration			Support	Water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS				
	1	2	3					COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE
HA			PVC (Class 2)			0.5m	Black	Fine	Sandy Silt	High	Moist	
						Brown	Sandy Clay					
						Grey						
						1.0m						
						1.5m	Red		Clay	Low		
						2.0m						
						2.5m						
						3.0m						
3.5m												
4.0m												
4.5m												
5.0m												

WL 0.52 m below NS



LITHOLOGICAL LOG

Client:		Richard Noble & Company				Job No:		J3070				
Project:		East Clontarf Hydrological Investigation				Hole commenced:		8/11/02				
Bore location:		395858E, 6457257N				Hole completed:		8/11/02				
Datum:		MGA94/AHD				Logged by:		SW/ASM				
Bore Name:		EC6				Total Depth:		2.00 m				
Drill type:		Hand Auger				R.L. TOC:		2.90 mAHD				
Hole diameter:		75mm				Natural Surface:		2.10 mAHD				
method	1	2	3	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS				
								COLOUR	PARTICLE SIZE		TEXTURE	ORGANIC CONTENT
HA				PVC (Class 2)	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></di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NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark : Brown, Red, Orange, Yellow, Grey, Blue

Medium : Brown, Red, Orange, Yellow, Grey, Blue

Light : Brown, Red, Orange, Yellow, Grey, Blue

Tones : solid colour, bluish or mottle

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

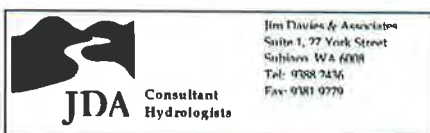
STATIC WATER LEVEL

Date: 13/11/02

WL below TOC 1.75 m

Stickup above NS: 0.80 m

WL 0.95 m below NS



LITHOLOGICAL LOG

Client:	Richard Noble & Company	Job No:	J3070
Project:	East Clontarf Hydrological Investigation	Hole commenced:	8/11/02
Bore location:	395886E, 6457421N	Hole completed:	8/11/02
Datum:	MGA94/AHD	Logged by:	SW/ASM
Bore Name:	EC7	Total Depth:	2.00 m
Drill type:	Hand Auger	R.L. TOC:	5.14 mAHD
Hole diameter:	75mm	Natural Surface:	3.92 mAHD

Note diameter: 75mm				Natural Surface: 3.92 mAH									
method	penetration			support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS					
	1	2	3					COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA	PVC (Class 9)				0.5m	Grey	Medium Fine	Sand	Low	Dry	<i>End of Hole</i>		
					1.0m								
					1.5m	Light Grey	Medium			Moist			
					2.0m	Grey				Saturated			
					2.5m								
					3.0m								
					3.5m								
					4.0m								
					4.5m								
					5.0m								

NOTES ON BORELOG

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 Silt, Loam, Sandy Loam, Clay Loam
 Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
 SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

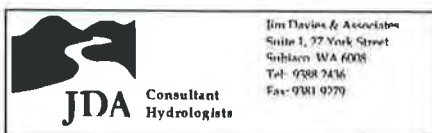
STATIC WATER LEVEL

Date: 13/11/02

WL below TOC 2.83 m

Stickup above NS: 1.22 m

WL 1.61 m below NS



LITHOLOGICAL LOG

Client:	Richard Noble & Company	Job No:	J3070
Project:	East Clontarf Hydrological Investigation	Hole commenced:	8/11/02
Bore location:	395892E, 6457496N	Hole completed:	8/11/02
Datum:	MGA94/AHD	Logged by:	SW/ASM
Bore Name:	EC8	Total Depth:	5.00 m
Drill type:	Hand Auger	R.L. TOC:	8.69 mAHD
Hole diameter:	75mm	Natural Surface:	7.97 mAHD

Hole diameter: 75mm				Natural Surface: 7.97 mARD										
method	penetration			support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS						
	1	2	3					COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS	
IIA				PVC (Class 2)			0.5m	Grey					Dry	
						1.0m								
						1.5m								
						2.0m		Medium	Sand	Low				
						2.5m								
						3.0m								
						3.5m	White						Moist	
						4.0m								
						4.5m								
						5.0m							Saturated	
														End of Hole

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

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Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

Tones : solid colour, blemish or mottle

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 13/11/02

WL below TOC 4.92 m

Stickup above NS: 0.72 m

WL 4.20 m below NS

Appendix C
Groundwater Monitoring Bore Logs
(2003/2006)

**Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA**

Project No: TCB-2006-006-QMON

Bore Hole No: MW-1

coffey environments

Project: Cygnia Cove

Logged By: BC

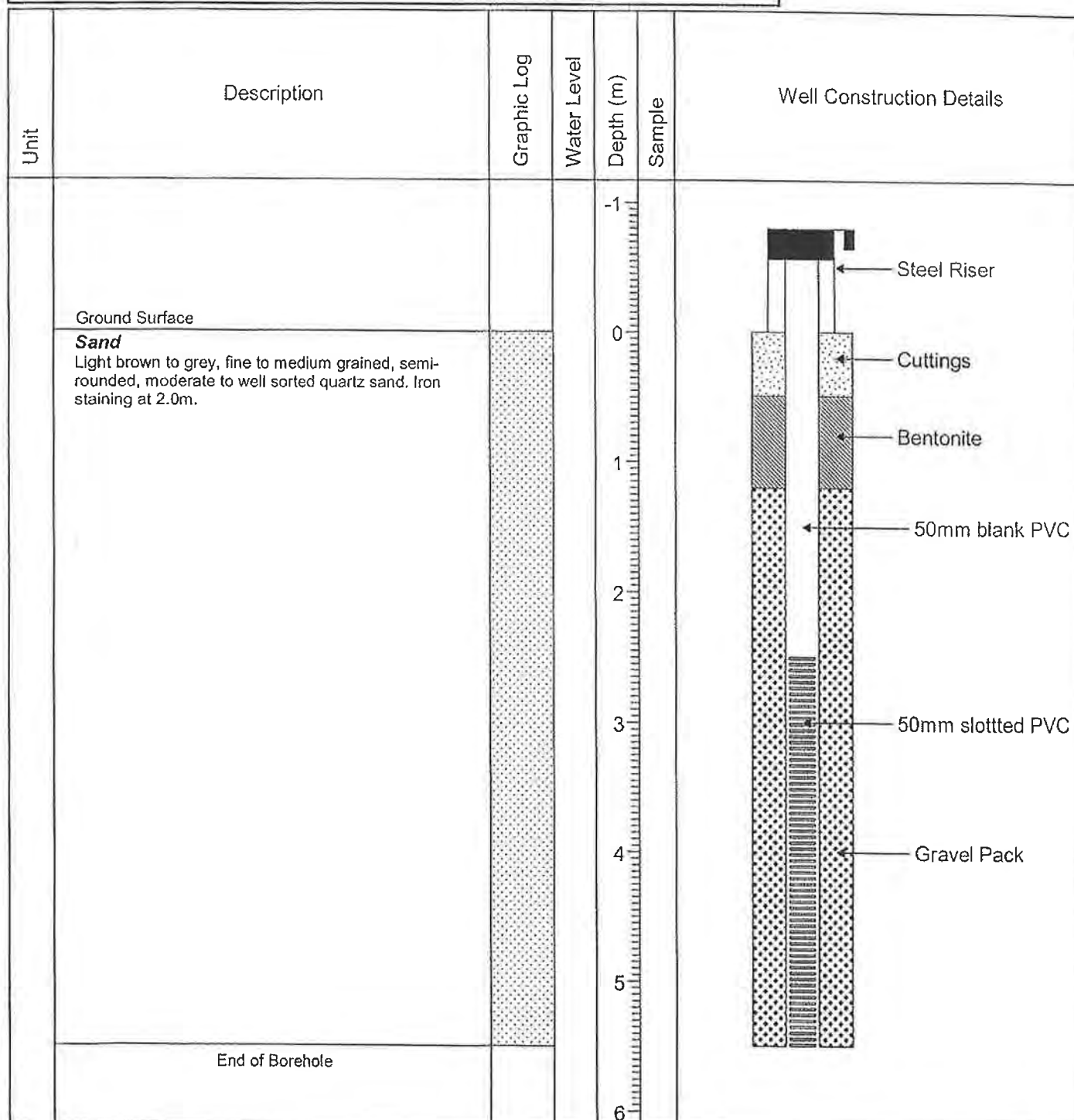
Client: Christian Brothers

Checked By: BC

Site Location: Waterford

Date Logged: 15 March 2006

Dilhorn House
2 Bulwer Street
PERTH WA 6000



Drilled By: Ecoprobe

Northing: 6457509.16

Drill Method: Hollow Stem

Easting: 395672.32

Site Conditions: fine

Elevation: 6.86 (TOC)

Project No: 99161-C

Monitoring Well ID: MW2

Project: DETAILED SITE INVESTIGATION

Logged By: BILL LINES

Client: CHRISTIAN BROTHERS

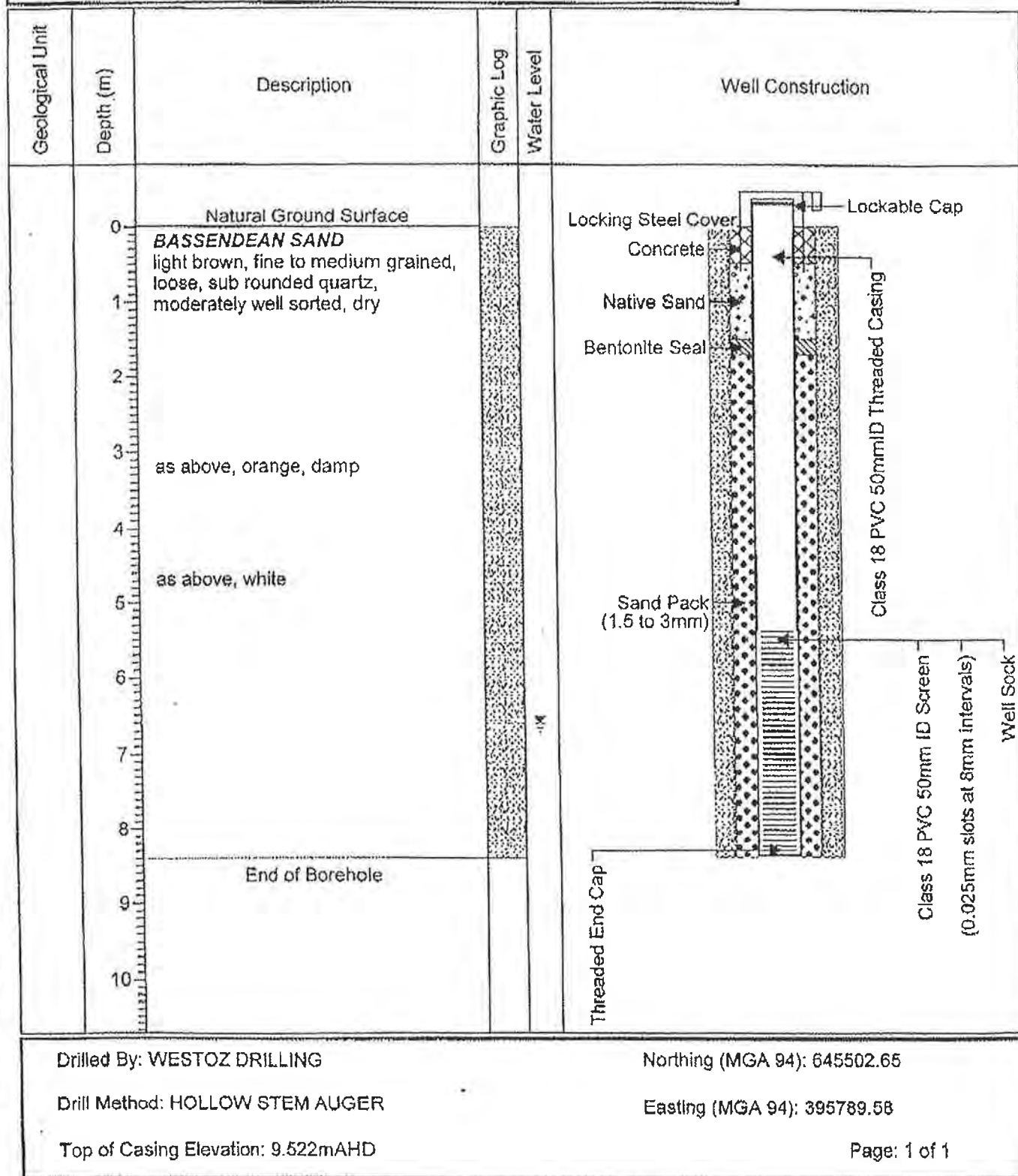
Checked By: MATT JONES

Site Location: EAST CLONTARF WATERFORD

Date Logged: 8 MAY 2003



Naturaliste Business Centre
3/236 Naturaliste Terrace
DUNSBOROUGH WA 6281



Drilled By: WESTOZ DRILLING

Northing (MGA 94): 645502.65

Drill Method: HOLLOW STEM AUGER

Easting (MGA 94): 395789.58

Top of Casing Elevation: 9.522mAHD

Page: 1 of 1

Project No: 99161-C

Monitoring Well ID: MW3

Project: DETAILED SITE INVESTIGATION

Logged By: BILL LINES

Client: CHRISTIAN BROTHERS

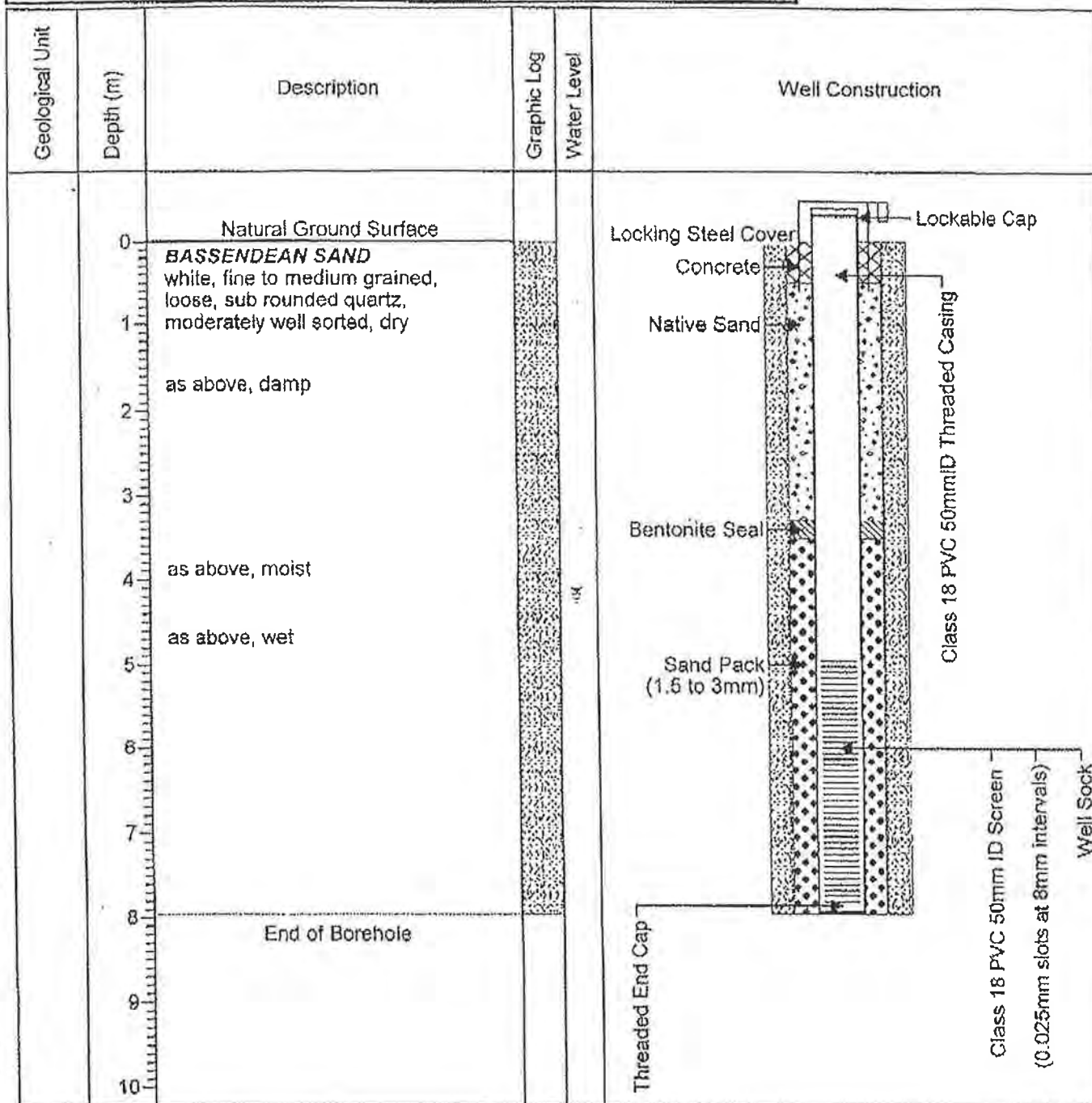
Checked By: MATT JONES

Site Location: EAST CLONTARF WATERFORD

Date Logged: 8 MAY 2003



Naturaliste Business Centre
3/236 Naturaliste Terrace
DUNSBOROUGH WA 6281



Drilled By: WESTOZ DRILLING

Northing (MGA 94): 6457490.13

Drill Method: HOLLOW STEM AUGER

Easting (MGA 94): 395928.97

Top of Casing Elevation: 7.877m AHD

Page: 1 of 1

Project No: 99161-C

Monitoring Well ID: MW4

Project: DETAILED SITE INVESTIGATION

Logged By: BILL LINES

Client: CHRISTIAN BROTHERS

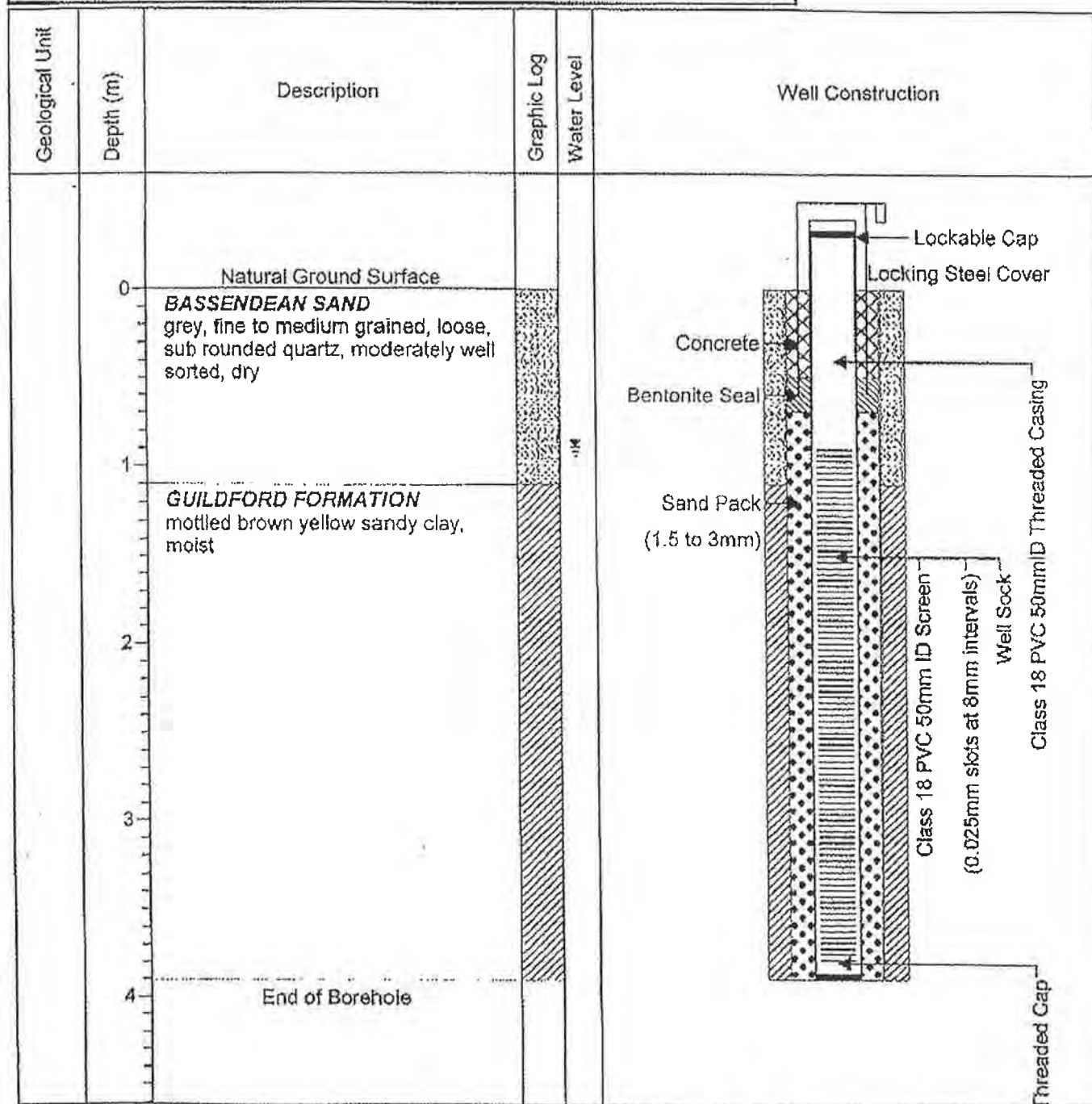
Checked By: MATT JONES

Site Location: EAST CLONTARF WATERFORD

Date Logged: 8 MAY 2003



Naturaliste Business Centre
3/236 Naturaliste Terrace
DUNSBOROUGH WA 6281



Drilled By: WESTOZ DRILLING

Northing (MGA 94): 6457127.47

Drill Method: HOLLOW STEM AUGER

Easting (MGA 94): 396018.42

Top of Casing Elevation: 3.072m AHD

Page: 1 of 1

Project No: 99161-C

Monitoring Well ID: MW5

Project: DETAILED SITE INVESTIGATION

Logged By: BILL LINES

Client: CHRISTIAN BROTHERS

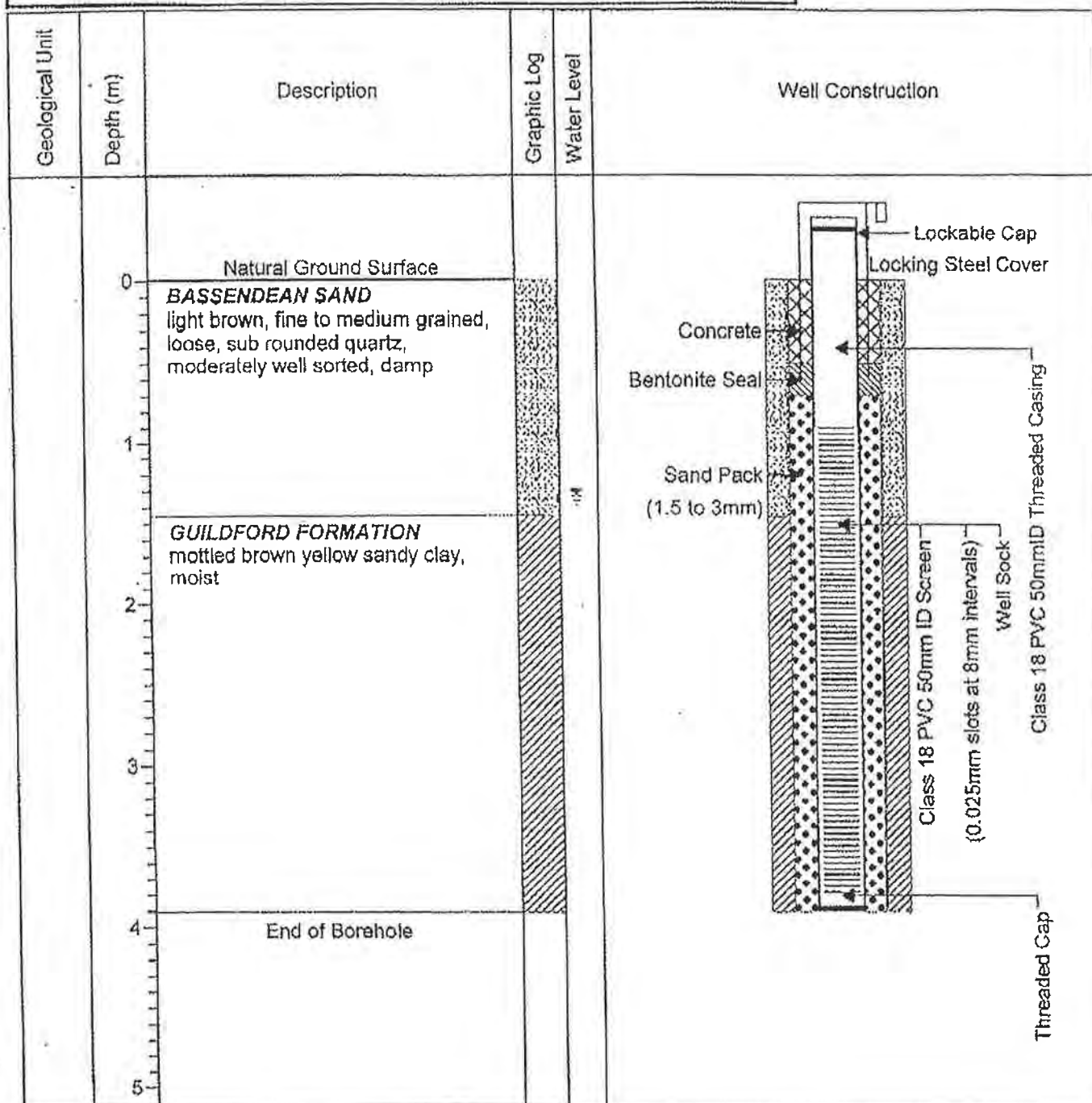
Checked By: MATT JONES

Site Location: EAST CLONTARF WATERFORD

Date Logged: 8 MAY 2003



Naturaliste Business Centre
3/235 Naturaliste Terrace
DUNSBOROUGH WA 6281



Drilled By: WESTOZ DRILLING

Northing (MGA 94): 6457078.81

Drill Method: HOLLOW STEM AUGER

Easting (MGA 94): 395967.14

Top of Casing Elevation: 1.670m AHD

Page: 1 of 1

Project No: TCB-2006-006-QMON

Bore Hole No: MW-6

coffey environments

Project: Cygnia Cove

Logged By: BC

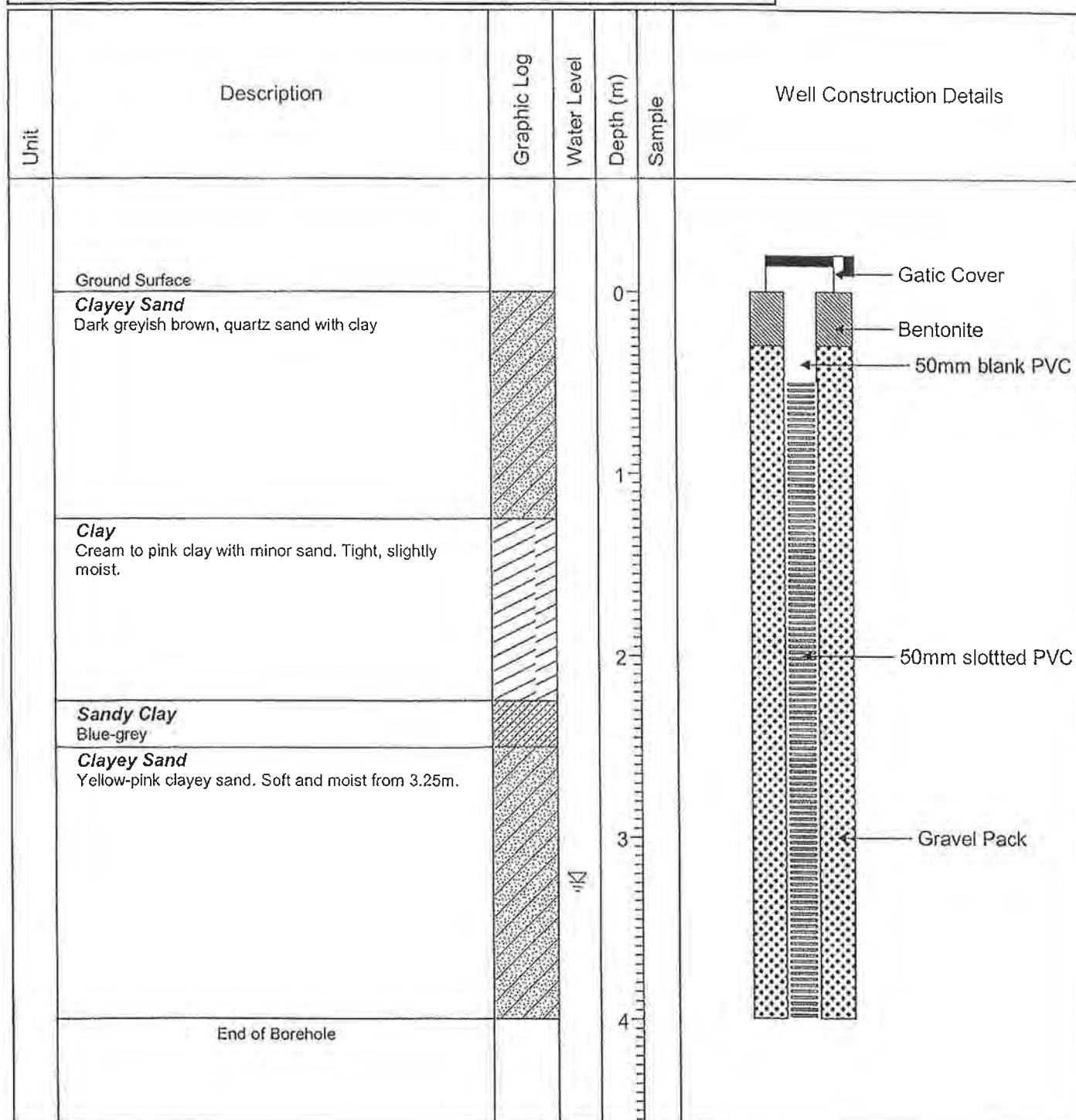
Client: Christian Brothers

Checked By: BC

Site Location: Waterford

Date Logged: 16 February 2006

Dilhorn House
2 Bulwer Street
PERTH WA 6000



Drilled By: Ecoprobe

Northing: 6457096.18

Drill Method: Hollow Stem

Easting: 395856.44

Site Conditions: fine

Elevation: 0.53 (TOC)

Project No: TCB-2006-006-QMON

Bore Hole No: MW-7

coffey environments

Project: Cygnia Cove

Logged By: BC

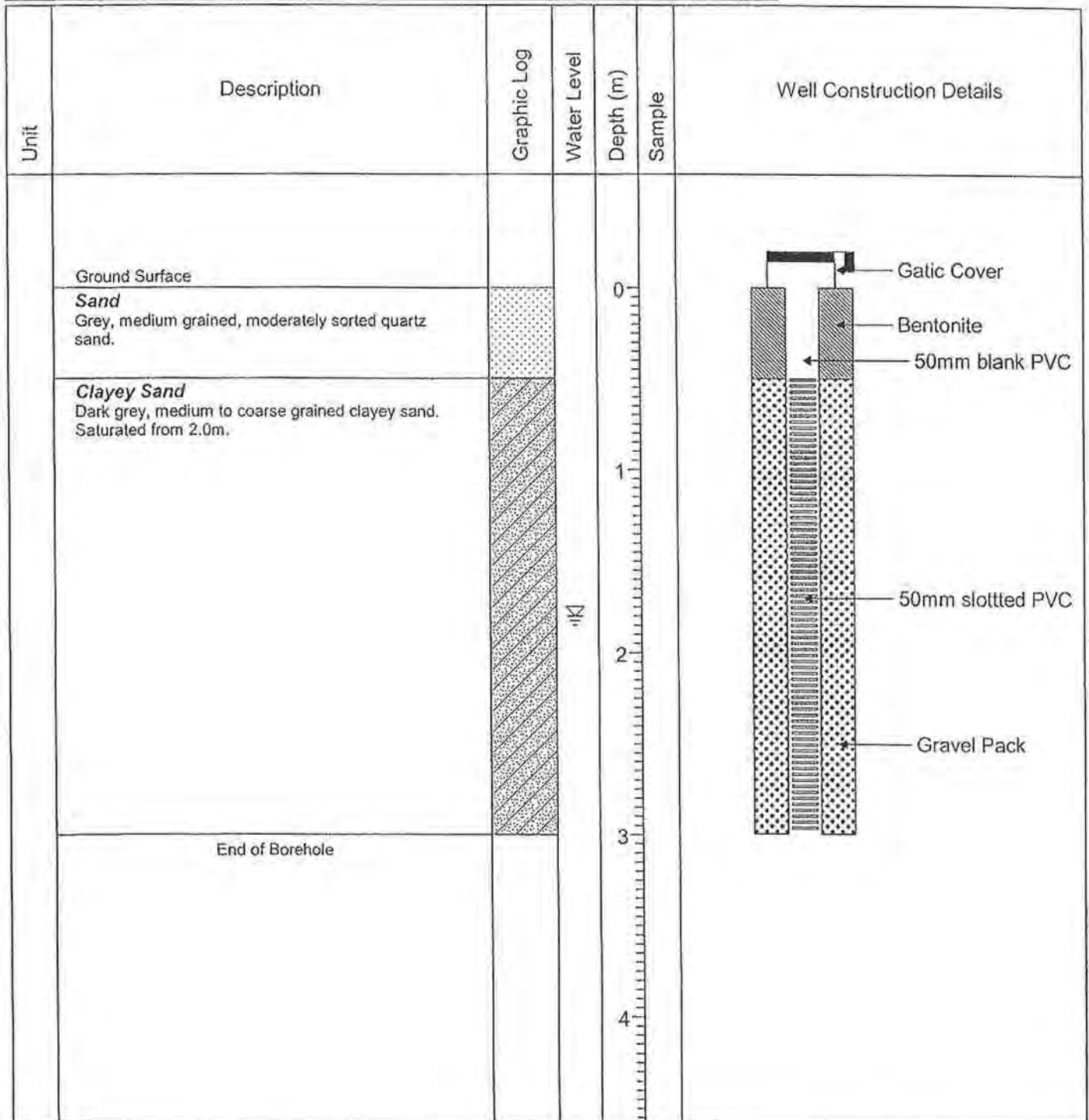
Client: Christian Brothers

Checked By: BC

Site Location: Waterford

Date Logged: 16 February 2006

Dilhorn House
2 Bulwer Street
PERTH WA 6000



Drilled By: Ecoprobe

Northing: 6457148.18

Drill Method: Hollow Stem

Easting: 395660.20

Site Conditions: fine

Elevation: 1.21 (TOC)

Appendix D
Chain of Custody Documentation and
Laboratory Certificates (2003/2006)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

PFD2(V2)



Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

To: Analytical Reference Laboratory (WA) Pty Ltd
Address: 55 Wittenoom Street
EAST PERTH WA 6004
Attention: Kim Rodgers
Telephone: (08) 9221 1415
Facsimile: (08) 9325 2398
Received by: *Greg*
Date received: 16-3-06

Project No.: TCB-2006-006-QMON
Project: East Clontarf
Purchase Order No: 20122
Results required by: 28/03/2006
Delivery Method: hand
Sent By: Jon Ferguson
Date Delivered: 14/03/2006

Sample Type: Soil ☐ Groundwater ☒ Other: _____

PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER,
PURCHASE ORDER NUMBER AND DATE ON ALL CORRESPONDENCE

PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

Sample ID	Date Sampled	Container	Analyses														
			OC/OP	PAH	BTEX	TPH	8 Metals (all low DL except As, Ni) Ba, Se, Fe, Mn, Al (Std)	pH	Conductivity	Ammonia	TSS	Chloride	Sulphate	Total Acidity	Total Alkalinity	Total N, Total P	Carbonate, Bicarbonate
MW3	6121	13-Mar-06	500ml Glass, 1L Glass (x3), 250ml Plastic, 1L Plastic, 40ml Vials (x2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW3 (filtered)	6121F	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW4	6122	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW4 (filtered)	6122F	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW5	6123	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW5 (filtered)	6123F	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ATA-6	6124	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ATA-6 (filtered)	6124F	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ATA-7	6125	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ATA-7 (filtered)	6125F	13-Mar-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: only 1 x 1L glass bottle supplied for sample MW3.



Environmental and Analytical Chemists

LABORATORY REPORT

ARL LAB No: 6121-5

DATE: 06 April 2006

CLIENT: ATA Environmental
"Dilhorn House"
2 Bulwer Street
PERTH WA 6000

ENTERED
10 APR 2006

ATTENTION: Mr J. Ferguson

SAMPLE DESCRIPTION: Five water samples as received for analysis of benzene, toluene, ethyl benzene and xylene (BTEX), organochlorine and organophosphorus pesticides (OC/OP), polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), alkalinity, chloride, conductivity, ammonia-N, total nitrogen, pH, total phosphorus, sulphate, total suspended solids and total acidity. Ten water samples as received for analysis of metals.

DATE RECEIVED: 15 March 2006

PURCHASE ORDER NUMBER: 20122

PROJECT NUMBER: TCB-2006-006-QMON

PROJECT NAME: East Clontarf

METHODS:

Benzene Toluene Ethyl Benzene and Xylene	ARL No 007
Organochlorine and Organophosphorus Pesticides	ARL No 002
Polycyclic Aromatic Hydrocarbons	ARL No 005
Total Petroleum Hydrocarbons	ARL No 009
Alkalinity	ARL No 037
Chloride	ARL No 018
Conductivity	ARL No 019
Metals	ARL No 029
Ammonia-N	ARL No 035
Total Nitrogen	ARL No 034
pH	ARL No 014
Total Phosphorus	ARL No 036
Sulphate	ARL No 028
Total Suspended Solids	ARL No 016

Page 1 of 7

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

RESULTS:

Total Petroleum Hydrocarbons

Lab No	Sample Marks	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
				mg/l	
6121	MW3	<0.02	<0.02	<0.04	<0.04
6122	MW4	<0.02	<0.02	<0.04	<0.04
6123	MW5	<0.02	<0.02	<0.04	<0.04
6124	ATA-6	<0.02	<0.02	<0.04	<0.04
6125	ATA-7	<0.02	<0.02	<0.04	<0.04

BTEX

Lab No	Sample Marks	Benzene	Toluene	Ethyl Benzene	Xylene
				mg/l	
6121	MW3	<0.001	<0.001	<0.001	<0.003
6122	MW4	<0.001	<0.001	<0.001	<0.003
6123	MW5	<0.001	<0.001	<0.001	<0.003
6124	ATA-6	<0.001	<0.001	<0.001	<0.003
6125	ATA-7	<0.001	<0.001	<0.001	<0.003

Organochlorine and Organophosphorus Pesticides

Lab No	Sample Marks	DDE	Dieldrin
			µg/l
6121	MW3	0.020	<0.001
6122	MW4	0.001	0.001
6123	MW5	0.001	<0.001
6124	ATA-6	<0.001	<0.001
6125	ATA-7	<0.001	<0.001

No other common organochlorine and organophosphorus pesticides were detected in the five water samples.

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

Limits of detection:	µg/l
Aldrin	0.001
BHCs	0.001
Chlordane	0.001
Chlorpyrifos	0.005
DDD	0.001
DDT	0.001
Endosulphan I	0.001
Endosulphan II	0.001
Endosulphan Sulphate	0.001
HCB	0.001
Heptachlor	0.001
Heptachlor Epoxide	0.001
Oxychlordane	0.001
Bromophos Ethyl	0.005
Ethion	0.01
Diazinon	0.01
Malathion	0.01
Fenitrothion	0.01
Bifenthrin	0.05
Surrogate Recovery	72%, 107%

Polycyclic Aromatic Hydrocarbons

Lab No	Sample Marks
6121	MW3
6122	MW4
6123	MW5
6124	ATA-6
6125	ATA-7

No polycyclic aromatic hydrocarbons were detected in the five water samples.

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

Limit of Detection:	µg/l
Naphthalene	<0.1
2-Methyl-naphthalene	<0.1
Acenaphthylene	<0.1
Acenaphthene	<0.1
Fluorene	<0.1
Phenanthrene	<0.1
Anthracene	<0.1
Fluoranthene	<0.1
Pyrene	<0.1
Benz(<i>a</i>)anthracene	<0.2
Chrysene	<0.2
Benzo(<i>b</i>)fluoranthene	<0.2
Benzo(<i>k</i>)fluoranthene	<0.2
Benzo(<i>a</i>)pyrene	<0.2
Indeno(1,2,3- <i>c,d</i>)pyrene	<0.2
Dibenz(<i>a,h</i>)anthracene	<0.2
Benzo(<i>ghi</i>)perylene	<0.2
Surrogate Recovery	78%, 69%

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

Lab No	6121	6122	6123
Sample Marks	MW3	MW4	MW5
pH #	7.0	6.0	6.8
Conductivity (mS/cm)	0.48	0.69	1.3
Total Acidity (mgCaCO ₃ /l)	<5	<5	<5
Alkalinity (mgCaCO ₃ /l)	42	630	63
Bicarbonate (mgCaCO ₃ /l)	42	630	63
Carbonate (mgCaCO ₃ /l)	<5	<5	<5
Hydroxide (mgCaCO ₃ /l)	<5	<5	<5
		mg/l	
Chloride	120	220	220
Ammonia-N	<0.2	1.1	19
NOx-N	0.39	0.29	0.10
Total Kjeldahl Nitrogen	0.6	1.9	1.7
Total Nitrogen	1.0	2.2	1.8
Total Phosphorus	0.72	0.23	0.20
Sulphate	39	49	39
Total Suspended Solids	14	980	380
Aluminium	0.7	2.8	2.0
Arsenic	0.003	0.002	0.003
Barium	<0.1	0.3	0.2
Cadmium	<0.0002	<0.0002	<0.0002
Chromium	0.002	0.001	0.001
Copper	0.016	0.001	0.001
Manganese	<0.01	0.58	0.15
Mercury	<0.0001	<0.0001	<0.0001
Nickel	0.06	0.08	0.03
Lead	0.001	<0.001	<0.001
Iron	0.45	22	21
Selenium	0.001	0.003	0.002
Zinc	0.086	0.049	0.006

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

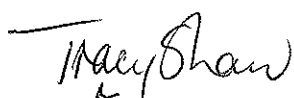
Lab No	6124	6125
Sample Marks	ATA-6	ATA-7
pH #	6.8	7.2
Conductivity (mS/cm)	6.6	1.2
Total Acidity (mgCaCO ₃ /l)	<5	<5
Alkalinity (mgCaCO ₃ /l)	180	170
Bicarbonate (mgCaCO ₃ /l)	180	170
Carbonate (mgCaCO ₃ /l)	<5	<5
Hydroxide (mgCaCO ₃ /l)	<5	<5

	mg/l	
Chloride	320	21
Ammonia-N	0.4	<0.2
NOx-N	0.25	0.01
Total Kjeldahl Nitrogen	0.8	0.3
Total Nitrogen	1.0	0.3
Total Phosphorus	0.17	0.07
Sulphate	170	28
Total Suspended Solids	130	<5

Lab No	6124	6125	6121F
Sample Marks	ATA-6	ATA-7	MW3 (Filtered)
	mg/l		
Aluminium	1.1	<0.1	<0.1
Arsenic	0.004	0.005	0.002
Barium	0.4	<0.1	<0.1
Cadmium	0.0002	<0.0002	<0.0002
Chromium	0.001	<0.001	0.001
Copper	0.003	0.001	0.016
Manganese	1.9	0.09	<0.01
Mercury	<0.0001	<0.0001	<0.0001
Nickel	0.10	0.01	0.04
Lead	<0.001	<0.001	<0.001
Iron	15	0.68	0.08
Selenium	0.008	0.005	0.002
Zinc	0.13	0.010	0.084

Mr J. Ferguson
ATA Environmental
ARL Lab No: 6121-5
06 April 2006

Lab No Sample Marks	6122F MW4 (Filtered)	6123F MW5 (Filtered)	6124F ATA-6 (Filtered)	6125F ATA-7 (Filtered)
	mg/l			
Aluminium	<0.1	<0.1	<0.1	<0.1
Arsenic	0.001	0.001	<0.001	<0.001
Barium	<0.1	<0.1	0.3	<0.1
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002
Chromium	<0.001	0.001	0.001	0.001
Copper	0.001	0.002	0.002	0.001
Manganese	0.44	0.01	1.7	<0.01
Mercury	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	0.05	0.02	0.09	0.01
Lead	<0.001	<0.001	<0.001	<0.001
Iron	<0.01	0.01	<0.01	0.26
Selenium	0.003	0.003	0.02	0.02
Zinc	0.050	0.005	0.14	0.008



Kim Rodgers
Laboratory Manager



LABORATORY REPORT

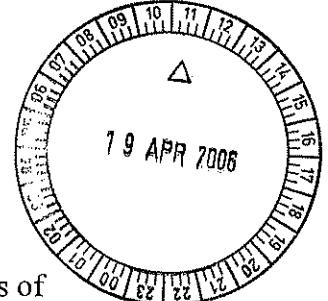
Environmental and Analytical Chemists

ARL LAB No: 7084-89

DATE: 18 April 2006

CLIENT: ATA Environmental
"Dilhorn House"
2 Bulwer Street
PERTH WA 6000

ATTENTION: Andrew Greenfield



SAMPLE DESCRIPTION: Four water samples as received for analysis of benzene, toluene, ethyl benzene and xylene (BTEX), organochlorine and organophosphorus pesticides (OC/OP), polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), chloride, conductivity, ammonia-N, total kjeldahl nitrogen (TKN), total phosphorus, sulphate and total suspended solids. Three water samples as received for analysis of alkalinity, pH and total acidity. Seven water samples as received for analysis of metals.

DATE RECEIVED: 28 March 2006

PURCHASE ORDER NUMBER: 19387

PROJECT NUMBER: TCB-6-6-QMON

PROJECT NAME: East Clontarf

METHODS:

Benzene Toluene Ethyl Benzene and Xylene	ARL No 007
Organochlorine and Organophosphorus Pesticides	ARL No 002
Polycyclic Aromatic Hydrocarbons	ARL No 005
Total Petroleum Hydrocarbons	ARL No 009
Alkalinity	ARL No 037
Chloride	ARL No 018
Conductivity	ARL No 019
Metals	ARL No 029
Ammonia-N	ARL No 035
Total Kjeldahl Nitrogen	ARL No 034
Total Nitrogen	ARL No 034
pH	ARL No 014
Total Phosphorus	ARL No 036
Sulphate	ARL No 028
Total Suspended Solids	ARL No 016

Page 1 of 6

Analytical Reference Laboratory (WA) Pty. Ltd.

55 Wittenoom Street, East Perth, Western Australia 6004 Telephone: 08 9221 1415 Facsimile: 08 9325 2398

ABN: 91 050 159 898 www.arlwa.com.au

Andrew Greenfield
ATA Environmental
ARL Lab No: 7084-89
18 April 2006

RESULTS:

Total Petroleum Hydrocarbons

Lab No	Sample Marks	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
				mg/l	
7084	SW1	<0.02	<0.02	<0.04	<0.04
7086	SW2	<0.02	<0.02	<0.04	<0.04
7088	SW Duplicate	<0.02	<0.02	<0.04	<0.04
7083	Trip Blank	<0.02	<0.02	<0.04	<0.04

BTEX

Lab No	Sample Marks	Benzene	Toluene	Ethyl Benzene	Xylene
				mg/l	
7084	SW1	<0.001	<0.001	<0.001	<0.003
7086	SW2	<0.001	<0.001	<0.001	<0.003
7088	SW Duplicate	<0.001	<0.001	<0.001	<0.003
7083	Trip Blank	<0.001	<0.001	<0.001	<0.003

Surrogate Recovery 112%

Organochlorine and Organophosphorus Pesticides

Lab No	Sample Marks	Dieldrin
		µg/l
7084	SW1	<0.001
7086	SW2	0.001
7088	SW Duplicate	0.001
7082	Field Blank	<0.001
Spike Recovery		97%

No other common organochlorine and organophosphorus pesticides were detected in the four water samples.

Andrew Greenfield
ATA Environmental
ARL Lab No: 7084-89
18 April 2006

Limits of detection:	µg/l	Spike Recovery
Aldrin	0.001	98%
BHCs	0.001	92%
Chlordane	0.001	-
Chlorpyrifos	0.005	-
DDD	0.001	-
DDE	0.001	-
DDT	0.001	-
Endosulphan I	0.001	-
Endosulphan II	0.001	-
Endosulphan Sulphate	0.001	-
HCB	0.001	-
Heptachlor	0.001	110%
Heptachlor Epoxide	0.001	-
Oxychlordane	0.001	-
Bromophos Ethyl	0.005	-
Ethion	0.01	-
Diazinon	0.01	-
Malathion	0.01	-
Fenitrothion	0.01	-
Bifenthrin	0.05	-
Surrogate Recovery	108%, 102%	

Polycyclic Aromatic Hydrocarbons

Lab No	Sample Marks
7084	SW1
7086	SW2
7088	SW Duplicate
7082	Field Blank

No polycyclic aromatic hydrocarbons were detected in the four water samples.

Andrew Greenfield
ATA Environmental
ARL Lab No: 7084-89
18 April 2006

Limit of Detection:	µg/l
Naphthalene	<0.1
2-Methyl-naphthalene	<0.1
Acenaphthylene	<0.1
Acenaphthene	<0.1
Fluorene	<0.1
Phenanthrene	<0.1
Anthracene	<0.1
Fluoranthene	<0.1
Pyrene	<0.1
Benz(<i>a</i>)anthracene	<0.2
Chrysene	<0.2
Benzo(<i>b</i>)fluoranthene	<0.2
Benzo(<i>k</i>)fluoranthene	<0.2
Benzo(<i>a</i>)pyrene	<0.2
Indeno(1,2,3- <i>c,d</i>)pyrene	<0.2
Dibenz(<i>a,h</i>)anthracene	<0.2
Benzo(<i>ghi</i>)perylene	<0.2
Surrogate Recovery	74%, 83%, 120%, 108%

Andrew Greenfield
ATA Environmental
ARL Lab No: 7084-89
18 April 2006

Lab No	7084	7085	7086
Sample Marks	SW1	SW1 (filtered)	SW2
pH #	6.6	*	6.6
Conductivity (mS/cm)	0.52	*	0.94
Total Acidity (mgCaCO ₃ /l)	10	*	19
Alkalinity (mgCaCO ₃ /l)	33	*	35
Bicarbonate (mgCaCO ₃ /l)	33	*	35
Carbonate (mgCaCO ₃ /l)	<5	*	<5
Hydroxide (mgCaCO ₃ /l)	<5	*	<5
		mg/l	
Chloride	120	*	340
Ammonia-N	<0.2	*	<0.2
Total Kjeldahl Nitrogen	0.4	*	0.4
Total Nitrogen	0.48	*	0.50
Total Phosphorus	0.04	*	0.03
Sulphate	45	*	71
Total Suspended Solids	<5	*	<5
Aluminium	<0.1	<0.1	<0.1
Arsenic	<0.001	<0.001	<0.001
Barium	<0.05	<0.05	<0.05
Cadmium	<0.0001	<0.0001	<0.0001
Chromium	<0.001	<0.001	<0.001
Copper	<0.001	0.001	<0.001
Manganese	0.01	<0.01	<0.01
Mercury	<0.0002	<0.0002	<0.0002
Nickel	<0.001	<0.001	<0.001
Lead	<0.001	<0.001	<0.001
Iron	0.07	0.08	0.08
Selenium	0.001	0.001	<0.001
Zinc	0.007	0.016	0.009

Andrew Greenfield
ATA Environmental
ARL Lab No: 7084-89
18 April 2006

Lab No	7087	7088	7089	7082
Sample Marks	SW2	SW	SW Duplicate	Field Blank
	(filtered)	Duplicate	(filtered)	
pH #	*	6.6	*	*
Conductivity (mS/cm)	*	1.0	*	<0.01
Total Acidity (mgCaCO ₃ /l)	*	33	*	*
Alkalinity (mgCaCO ₃ /l)	*	35	*	*
Bicarbonate (mgCaCO ₃ /l)	*	35	*	*
Carbonate (mgCaCO ₃ /l)	*	<5	*	*
Hydroxide (mgCaCO ₃ /l)	*	<5	*	*
		mg/l		
Chloride	*	220	*	<5
Ammonia-N	*	<0.2	*	<0.2
Total Kjeldahl Nitrogen	*	0.4	*	<0.2
Total Nitrogen	*	0.43	*	<0.2
Total Phosphorus	*	0.04	*	<0.01
Sulphate	*	10	*	<3
Total Suspended Solids	*	<5	*	<5
Aluminium	<0.1	<0.1	<0.1	<0.1
Arsenic	0.001	<0.001	<0.001	<0.001
Barium	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	<0.001	<0.001	<0.001	<0.001
Copper	0.001	<0.001	<0.001	<0.001
Manganese	<0.01	<0.01	0.01	<0.01
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	<0.001	<0.001	<0.001	<0.001
Lead	<0.001	<0.001	<0.001	<0.001
Iron	0.07	0.06	0.07	<0.01
Selenium	0.001	0.001	<0.001	<0.001
Zinc	0.014	0.008	0.014	<0.001

*Denotes results not required.





Kim Rodgers
Laboratory Manager



LABORATORY REPORT

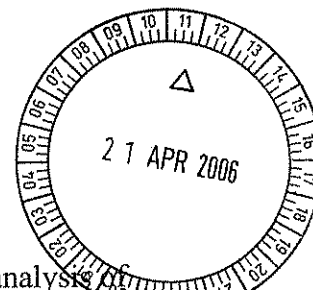
Environmental and Analytical Chemists

ARL LAB No: 7076-83

DATE: 20 April 2006

CLIENT: ATA Environmental
"Dilhorn House"
2 Bulwer Street
PERTH WA 6000

ATTENTION: Andrew Greenfield



SAMPLE DESCRIPTION: Four water samples as received for analysis of benzene, toluene, ethyl benzene and xylene (BTEX), organochlorine and organophosphorus pesticides (OC/OP), polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), chloride, conductivity, ammonia-N, total kjeldahl nitrogen (TKN), total phosphorus, sulphate and total suspended solids. Three water samples as received for analysis of alkalinity, pH and total acidity. Seven water samples as received for analysis of metals.

DATE RECEIVED: 28 March 2006

PURCHASE ORDER NUMBER: 19386

PROJECT NUMBER: TCB-6-6-QMON

PROJECT NAME: East Clontarf

METHODS:

Benzene Toluene Ethyl Benzene and Xylene	ARL No 007
Organochlorine and Organophosphorus Pesticides	ARL No 002
Polycyclic Aromatic Hydrocarbons	ARL No 005
Total Petroleum Hydrocarbons	ARL No 009
Alkalinity	ARL No 037
Chloride	ARL No 018
Conductivity	ARL No 019
Metals	ARL No 029
Ammonia-N	ARL No 035
Total Kjeldahl Nitrogen	ARL No 034
Total Nitrogen	ARL No 034
pH	ARL No 014
Total Phosphorus	ARL No 036
Sulphate	ARL No 028
Total Suspended Solids	ARL No 016

Page 1 of 6

Analytical Reference Laboratory (WA) Pty. Ltd.

55 Wittenoom Street, East Perth, Western Australia 6004 Telephone: 08 9221 1415 Facsimile: 08 9325 2398

ABN: 91 050 159 898 www.arlwa.com.au

Andrew Greenfield
ATA Environmental
ARL Lab No: 7076-83
20 April 2006

RESULTS:

Total Petroleum Hydrocarbons

Lab No	Sample Marks	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
				mg/l	
7076	ATA-MW1	<0.02	<0.02	<0.04	<0.04
7078	ATA-MW2	<0.02	<0.02	<0.04	<0.04
7080	Duplicate	<0.02	<0.02	<0.04	<0.04
7083	Trip Blank	<0.02	<0.02	<0.04	<0.04

BTEX

Lab No	Sample Marks	Benzene	Toluene	Ethyl Benzene	Xylene
				mg/l	
7076	ATA-MW1	<0.001	<0.001	<0.001	<0.003
7078	ATA-MW2	<0.001	<0.001	<0.001	<0.003
7080	Duplicate	<0.001	<0.001	<0.001	<0.003
7083	Trip Blank	<0.001	<0.001	<0.001	<0.003

Surrogate Recovery 110%

Organochlorine and Organophosphorus Pesticides

Lab No	Sample Marks
7076	ATA-MW1
7078	ATA-MW2
7080	Duplicate
7082	Field Blank

No other common organochlorine and organophosphorus pesticides were detected in the four water samples.

Andrew Greenfield
ATA Environmental
ARL Lab No: 7076-83
20 April 2006

Limits of detection:	µg/l
Aldrin	0.001
BHCs	0.001
Chlordane	0.001
Chlorpyrifos	0.005
DDD	0.001
DDE	0.001
DDT	0.001
Dieldrin	0.001
Endosulphan I	0.001
Endosulphan II	0.001
Endosulphan Sulphate	0.001
HCB	0.001
Heptachlor	0.001
Heptachlor Epoxide	0.001
Oxychlordane	0.001
Bromophos Ethyl	0.005
Ethion	0.01
Diazinon	0.01
Malathion	0.01
Fenitrothion	0.01
Bifenthrin	0.05

Polycyclic Aromatic Hydrocarbons

Lab No	Sample Marks
7076	ATA-MW1
7078	ATA-MW2
7080	Duplicate
7082	Field Blank

No polycyclic aromatic hydrocarbons were detected in the four water samples.

Andrew Greenfield
ATA Environmental
ARL Lab No: 7076-83
20 April 2006

Limit of Detection:	µg/l
Naphthalene	<0.1
2-Methyl-naphthalene	<0.1
Acenaphthylene	<0.1
Acenaphthene	<0.1
Fluorene	<0.1
Phenanthrene	<0.1
Anthracene	<0.1
Fluoranthene	<0.1
Pyrene	<0.1
Benz(<i>a</i>)anthracene	<0.2
Chrysene	<0.2
Benzo(<i>b</i>)fluoranthene	<0.2
Benzo(<i>k</i>)fluoranthene	<0.2
Benzo(<i>a</i>)pyrene	<0.2
Indeno(1,2,3- <i>c,d</i>)pyrene	<0.2
Dibenz(<i>a,h</i>)anthracene	<0.2
Benzo(<i>ghi</i>)perylene	<0.2
Surrogate Recovery	74%, 83%, 120%, 108%

Andrew Greenfield
ATA Environmental
ARL Lab No: 7076-83
20 April 2006

Lab No	7076	7077	7078
Sample Marks	ATA-MW1	ATA-MW1 (filtered)	ATA-MW2
pH #	5.7	*	6.2
Conductivity (mS/cm)	0.43	*	0.51
Total Acidity (mgCaCO ₃ /l)	88	*	45
Alkalinity (mgCaCO ₃ /l)	30	*	25
Bicarbonate (mgCaCO ₃ /l)	30	*	25
Carbonate (mgCaCO ₃ /l)	<5	*	<5
Hydroxide (mgCaCO ₃ /l)	<5	*	<5
		mg/l	
Chloride	96	*	85
Ammonia-N	<0.2	*	<0.2
NOx-N	0.35	*	9.0
Total Kjeldahl Nitrogen	1.0	*	0.9
Total Nitrogen	1.0	*	0.9
Total Phosphorus	0.07	*	0.03
Sulphate	57	*	38
Total Suspended Solids	<5	*	<5
Aluminium	0.7	0.4	<0.1
Arsenic	<0.001	0.001	<0.001
Barium	<0.05	<0.05	<0.05
Cadmium	<0.0001	<0.0001	<0.0001
Chromium	0.019	0.001	0.001
Copper	0.001	0.001	0.001
Manganese	0.34	0.33	0.01
Mercury	<0.0001	<0.0001	<0.0001
Nickel	0.010	0.009	0.005
Lead	0.004	<0.001	<0.001
Iron	1.4	0.50	0.02
Selenium	0.001	0.002	0.001
Zinc	0.025	0.016	0.017

Andrew Greenfield
ATA Environmental
ARL Lab No: 7076-83
20 April 2006

Lab No	7079	7080	7081	7082
Sample Marks	ATA-MW2 (filtered)	Duplicate	Duplicate (filtered)	Field Blank
pH #	*	5.7	*	*
Conductivity (mS/cm)	*	0.43	*	<0.01
Total Acidity (mgCaCO ₃ /l)	*	92	*	*
Alkalinity (mgCaCO ₃ /l)	*	25	*	*
Bicarbonate (mgCaCO ₃ /l)	*	25	*	*
Carbonate (mgCaCO ₃ /l)	*	<5	*	*
Hydroxide (mgCaCO ₃ /l)	*	<5	*	*
		mg/l		
Chloride	*	92	*	<5
Ammonia-N	*	<0.2	*	<0.2
NOx-N	*	0.40	*	-
Total Kjeldahl Nitrogen	*	1.1	*	<0.2
Total Nitrogen	*	1.1	*	<0.2
Total Phosphorus	*	0.08	*	<0.01
Sulphate	*	56	*	<3
Total Suspended Solids	*	<5	*	<5
Aluminium	<0.1	0.6	0.4	<0.1
Arsenic	<0.001	0.005	<0.001	<0.001
Barium	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	0.001	0.010	0.001	<0.001
Copper	0.001	0.001	0.001	<0.001
Manganese	<0.01	0.34	0.30	<0.01
Mercury	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	0.005	0.009	0.009	<0.001
Lead	<0.001	0.004	<0.001	<0.001
Iron	0.02	1.4	0.48	0.01
Selenium	0.001	<0.001	0.001	0.001
Zinc	0.018	0.016	0.015	<0.005

*Denotes results not required.


Kim Rodgers
Laboratory Manager

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

Analysis Reference Laboratory (WA) Pty Ltd
11 Willemson Street
EAST PERTH WA 6004
Attention: Kim Rodgers
Telephone: (08) 9221 1415
Facsimile: (08) 9325 2398
Received by: *[Signature]*
Date received: 17/7/06

Project No.: TCB-2006-006-QMON
Project: East Clontarf
Purchase Order No.: 19781
Results required by: 7/08/2006
Delivery Method: hand
Sent By: B Coleman
Date Delivered: 18/03/2006

Sample Type: Soil ☐ Groundwater ☒ Other: _____

PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE ORDER NUMBER AND DATE ON ALL CORRESPONDENCE

PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

Sample ID	Date Sampled	Container	Analyses															
			OC/OP	PAH	BTEX	TPH	8 Metals (all low DI, except As, Ni)	Ba, Se, Fe, Mn, Al (Std)	pH	Conductivity	Ammonia	TSS	Chloride	Sulphate	Total Acidity	Total Alkalinity	Total N, Total P	Carbonate, Bi-carbonate
MW1 filtered	17-Jul-06	500ml Glass, 1L Glass (x3), 250ml Plastic, 1L Plastic, 40ml Vials (x2)																
MW1 unfiltered	17-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW2 filtered	17-Jul-06																	
MW2 unfiltered	17-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW3 filtered	17-Jul-06																	
MW3 unfiltered	17-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FB 17/7	17-Jul-06		✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TB 17/7	17-Jul-06				✓	✓												
MW4 filtered	18-Jul-06																	
MW4 unfiltered	18-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW5 filtered	18-Jul-06																	
MW5 unfiltered	18-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW6 filtered	18-Jul-06																	
MW6 unfiltered	18-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW7 filtered	17-Jul-06																	
MW7 unfiltered	17-Jul-06		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FB 18/7	18-Jul-06		✓	✓														
TB 18/7	18-Jul-06				✓	✓												



Environmental and Analytical Chemists

LABORATORY REPORT

ARL Lab No: 16407-17, 16775

Date: 21 August 2006

CLIENT: ATA Environmental
Dilhorn House
2 Bulwer Street
PERTH WA 6000

ATTENTION: Ms Blaire Coleman

SAMPLE DESCRIPTION: Ten water samples as received for analysis of organochlorine and organophosphorus pesticides (OC/OP), polycyclic aromatic hydrocarbons (PAH), benzene, toluene, ethyl benzene and xylenes (BTEX), total petroleum hydrocarbons (TPH), heavy metals, pH, conductivity, ammonia-N, total nitrogen, total suspended solids, chloride, sulphate, total acidity, total alkalinity and total phosphorus.

DATE RECEIVED: 19 July 2006

LOCATION / JOB NO: TCB-2006-006-QMON East Clontarf

PURCHASE ORDER: 19781

METHOD REFERENCES:

Organochlorine, Organophosphorus Pesticides and Polychlorinated Biphenyls in Water	ARL No. 002
Polycyclic Aromatic Hydrocarbons in Water	ARL No. 005
Benzene, Toluene, Ethyl Benzene and Xylenes in Water	ARL No. 007
Total Petroleum Hydrocarbons in Water	ARL No. 009
pH in Water	ARL No. 014
Total Suspended Solids in Water	ARL No. 016
Chloride	ARL No. 018
Conductivity in Water	ARL No. 019
Total Acidity in Water	ARL No. 021
Sulphate in Water	ARL No. 028
Metals in Water	ARL No. 029, 038, 039, 040, 065, 066
Nitrate	ARL No. 032
Nitrite	ARL No. 033
Total Kjeldahl Nitrogen	ARL No. 034
Ammonia	ARL No. 035
Total Phosphorus	ARL No. 036
Alkalinity	ARL No. 037


Kim Rodgers
Laboratory Manager

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

OC/OP Quality Control Data

	% Recovery
Surrogate Standard -	110%, 100%, 104%, 97%
Dibutylchloroendate / tetrachloro-m-xylene	
Spike Recovery -	
Lindane	107%
Heptachlor	120%
Aldrin	104%
Dieldrin	103%
Endrin	120%
DDT	84%

Total Petroleum Hydrocarbons Quality Control Data

	% Recovery
Spike - Diesel Range Hydrocarbons	120%,103%

BTEX Quality Control Data

	% Recovery
Surrogate Standard -	98%, 91%, 100%, 98%, 97%
a,a,a-Trifluorotoluene	

PAH Quality Control Data

	% Recovery
Surrogate Standard -	70%, 95%, 68%, 86%, 75%, 103%
2-Fluoro-1,1'-Biphenyl / p-Terphenyl-d14	
Spike Recovery -	
Naphthalene	102%
Acenaphthene	101%
Phenanthrene	102%
Pyrene	106%
Chrysene	92%
Benz(a)pyrene	98%

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Metals Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
Aluminium	-	83%
Arsenic	90%	90%
Barium	-	94%
Cadmium	-	91%
Chromium	-	88%
Copper	-	84%
Iron	-	109%
Mercury	112%	105%
Manganese	-	103%
Nickel	-	103%
Lead	-	87%
Selenium	95%	86%
Zinc	-	94%

Nutrients Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
Ammonia	100%	103%
Total Kjeldahl Nitrogen	106%	105%
Total Nitrogen	106%	105%
NOx-N	125%	104%
Total Phosphorus	-	102%

Inorganics Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
pH	-	100%
Conductivity	-	100%
Alkalinity	-	-
Total Acidity	-	108%
Chloride	112%	97%
Sulphate	82%	97%
Total Suspended Solids	-	86%

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Organochlorine and Organophosphorus Pesticides

Date Extracted 31/07/2006
Date Analysed 2/08/2006

ARL Lab No	Method Detection Limit	16407	16408	16409	16410	16412	16413	16414	16415	16416	16775
Sample Marks		MW1 Unfiltered	MW2 Unfiltered	MW3 Unfiltered	FB 17/7	MW4 Unfiltered	MW5 Unfiltered	MW6 Unfiltered	MW7 Unfiltered	FB 18/7	Duplicate Unfiltered
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Aldrin	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
BHCs	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chlordane	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chlorpyrifos	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
DDE	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DDD	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DDT	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dieldrin	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan I	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan II	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan Sulphate	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
HCB	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Heptachlor	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Heptachlor Epoxide	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Oxychlordane	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Bromophos Ethyl	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Diazinon	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Malathion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fenitrothion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Bifenthrin	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Polycyclic Aromatic Hydrocarbons

Date Extracted 27/07/2006
Date Analysed 31/07/2006

ARL Lab No	Method Detection Limit	16407	16408	16409	16410	16412	16413	16414	16415	16416	16775
Sample Marks		MW1 Unfiltered	MW2 Unfiltered	MW3 Unfiltered	FB 17/7	MW4 Unfiltered	MW5 Unfiltered	MW6 Unfiltered	MW7 Unfiltered	FB 18/7	Duplicate Unfiltered
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Naphthalene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methyl-naphthalene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benz(a)anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Total Petroleum Hydrocarbons

Date Extracted 26/07/2006
Date Analysed 31/07/2006

ARL Lab No	Sample Marks	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
		mg/l			
Method Detection Limit		0.02	0.02	0.04	0.04
16407	MW1 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16408	MW2 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16409	MW3 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16411	TB17/7	< 0.02	< 0.02	< 0.04	< 0.04
16412	MW4 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16413	MW5 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16414	MW6 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16415	MW7 Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04
16417	TB 18/7	< 0.02	< 0.02	< 0.04	< 0.04
16775	Duplicate Unfiltered	< 0.02	< 0.02	< 0.04	< 0.04

Att: Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX)

Date Analysed 18/08/2006

ARL Lab No	Sample Marks	Benzene	Toluene	Ethyl Benzene	Xylenes
		mg/l			
Method Detection Limit		0.001	0.001	0.001	0.003
16407	MW1 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16408	MW2 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16409	MW3 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16411	TB17/7	< 0.001	< 0.001	< 0.001	< 0.003
16412	MW4 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16413	MW5 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16414	MW6 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16415	MW7 Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003
16417	TB 18/7	< 0.001	< 0.001	< 0.001	< 0.003
16775	Duplicate Unfiltered	< 0.001	< 0.001	< 0.001	< 0.003

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Nutrients

Date Prepared 19/07/2006
Date Analysed 31/07/2006, 04/08/2006, 08/08/2006

ARL Lab No	Method Detection Limit	16407	16408	16409	16410	16412	16413	16414	16415	16416	16775
Sample Marks		MW1 Unfiltered	MW2 Unfiltered	MW3 Unfiltered	FB 17/7	MW4 Unfiltered	MW5 Unfiltered	MW6 Unfiltered	MW7 Unfiltered	FB 18/7	Duplicate Unfiltered
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ammonia-N	0.2	0.2	0.2	0.4	< 0.2	1.6	34	2.0	< 0.2	< 0.2	< 0.2
Total Kjeldahl Nitrogen	0.2	0.7	1.1	1.0	< 0.2	1.6	34	2.0	0.2	< 0.2	< 0.2
NOx-N	0.01	0.03	2.1	1.1	< 0.01	0.03	0.17	0.03	0.02	< 0.01	0.02
Total Nitrogen	0.2	0.7	1.1	1.0	< 0.2	1.0	32	1.8	0.2	< 0.2	< 0.2
Total Phosphorus	0.01	0.19	0.06	1.5	< 0.01	0.15	0.02	< 0.01	0.06	< 0.01	0.05

Att: Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

Metals

Date Prepared 19/07/2006

Date Analysed 02/08/2006, 09/08/2006, 10/08/2006, 16/08/2006, 17/08/2006

ARL Lab No	Method Detection Limit	16407	16408	16409	16410	16412	16413	16414	16415	16416	16775
Sample Marks		MW1 Unfiltered	MW2 Unfiltered	MW3 Unfiltered	FB 17/7	MW4 Unfiltered	MW5 Unfiltered	MW6 Unfiltered	MW7 Unfiltered	FB 18/7	Duplicate Unfiltered
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Aluminium	0.01	0.73	0.08	0.09	0.01	0.02	0.02	0.01	0.05	< 0.01	0.06
Arsenic	0.001	< 0.001	< 0.001	0.026	< 0.001	0.001	0.003	< 0.001	0.003	< 0.001	0.003
Barium	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	0.2	< 0.1	< 0.1	< 0.1
Cadmium	0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.008	< 0.001	< 0.001	< 0.001
Copper	0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.001	0.007	0.001	< 0.001	< 0.001
Iron	0.01	0.99	< 0.01	0.09	< 0.01	9.5	8.3	9.2	0.88	< 0.01	0.73
Mercury	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Manganese	0.01	0.06	< 0.01	< 0.01	< 0.01	0.34	0.07	8.6	0.02	< 0.01	0.03
Nickel	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01
Lead	0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.01*	0.001	< 0.001	< 0.001
Selenium	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.003	< 0.001	< 0.001	< 0.001
Zinc	0.005	0.027	0.007	0.076	< 0.005	0.028	0.005	0.039	0.089	< 0.005	0.005

*Denotes detection limit raised due to nature of the sample.

Att:Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

ARL Lab No	Date Analysed	Units	Method Detection Limit	16407	16408	16409	16410	16412	16413	16414
Sample Marks				MW1 Unfiltered	MW2 Unfiltered	MW3 Unfiltered	FB 17/7	MW4 Unfiltered	MW5 Unfiltered	MW6 Unfiltered
pH	20/07/2006	#	-	6.0	6.3	6.4	6.4	6.5	7.1	5.9
Conductivity	20/07/2006	mS/cm	0.01	0.48	0.54	0.59	< 0.01	0.84	1.9	46
Alkalinity	20/07/2006	mg CaCO ₃ /l	5	25	20	37	< 5	96	150	43
Bicarbonate	20/07/2006	mg CaCO ₃ /l	5	25	20	37	< 5	96	150	43
Carbonate	20/07/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Hydroxide	20/07/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Total Acidity	20/07/2006	mg CaCO ₃ /l	5	80	31	56	< 5	170	180	160
Chloride	25/07/2006	mg/l	5	110	92	110	< 5	170	170	15000
Sulphate	28/07/2006	mg/l	3	23	27	54	< 3	30	17	430
Total Suspended Solids	20/07/2006	mg/l	5	28	< 5	< 5	< 5	25	34	71

Att: Ms Blaire Coleman
ATA Environmental
ARL Lab No: 16407-17, 16775
21 August 2006

ARL Lab No	Date Analysed	Units	Method	16415	16416	16775
Sample Marks			Detection Limit	MW7 Unfiltered	FB 18/7	Duplicate Unfiltered
pH	20/07/2006	#	-	6.8	6.7	6.6
Conductivity	20/07/2006	mS/cm	0.01	0.61	0.02	0.43
Alkalinity	20/07/2006	mg CaCO ₃ /l	5	58	< 5	60
Bicarbonate	20/07/2006	mg CaCO ₃ /l	5	58	< 5	60
Carbonate	20/07/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5
Hydroxide	20/07/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5
Total Acidity	20/07/2006	mg CaCO ₃ /l	5	35	< 5	28
Chloride	25/07/2006	mg/l	5	89	< 5	92
Sulphate	28/07/2006	mg/l	3	15	< 3	17
Total Suspended Solids	20/07/2006	mg/l	5	< 5	< 5	< 5

ATA
Environmental
environmental scientists

Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

To: Analytical Reference Laboratory (WA) Pty Ltd
Address: 55 Wittenoom Street
EAST PERTH WA 6004
Attention: Kim Rodgers
Telephone: (08) 9221 1415
Facsimile: (08) 9325 2398
Received by: *RH*
Date received: *27/12/06*

Project No.: TCB-2006-006-QMON
Project: East Clontarf
Purchase Order No: 20561
Results required by: 11-Oct-06
Delivery Method: Hand
Sent By: B Coleman
Date Delivered: 25-Sep-06

Sample Type: Soil ☐ Groundwater ☒ Other ☐

PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE ORDER
NUMBER AND DATE ON ALL CORRESPONDENCE

PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

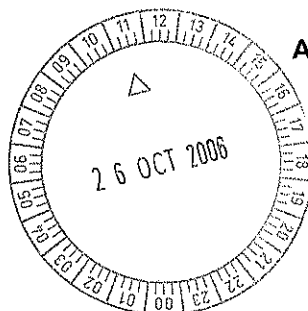
Page 1 of 1



Environmental and Analytical Chemists

LABORATORY REPORT

ARL Lab No: 22609-18
Date: 23 October 2006



CLIENT: A.T.A. Environmental
"Dilhorn House"
2 Bulwer Street
PERTH WA 6000

ATTENTION: Blaire Coleman

SAMPLE DESCRIPTION: Seven water samples as received for analysis of hardness.

DATE NOTIFIED: 13 October 2006

LOCATION / JOB NO: TCB-2006-006-QMON - East Clontarf

PURCHASE ORDER: 19658

METHOD REFERENCES:

Metals in Water

ARL No. 029, 038, 039, 040, 065, 066


Kim Rodgers
Laboratory Manager

Attention: Blaire Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
23 October 2006

Inorganics Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
Hardness	-	99%

Attention: Blaire Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
23 October 2006

ARL Lab No	Date Analysed	Units	Method Detection Limit	22609	22610	22611	22612	22613	22614	22615
Sample Marks				MW1	MW2	MW3	MW4	MW5	MW6	MW7
Hardness	13/10/2006	mg CaCO ₃ /l	5	56	73	78	74	540	4000	68

LABORATORY REPORT



Environmental and Analytical Chemists

ARL Lab No: 22609-18
Date: 07 November 2006

CLIENT: A.T.A. Environmental
"Dilhorn House"
2 Bulwer Street
PERTH WA 6000

ATTENTION: B Coleman

SAMPLE DESCRIPTION: Nine water samples as received for analysis of benzene, toluene, ethyl benzene, xylenes (BTEX), organochlorine and organophosphorus pesticides (OC/OP), polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), alkalinity, chloride, conductivity, metals, ammonia-N, NOx-N, total kjeldahl nitrogen (TKN), total nitrogen, pH, total phosphorus, sulphate, total suspended solids (TSS) and total acidity.

DATE RECEIVED: 27 September 2006

LOCATION / JOB NO: TCB-2006-006-QMON - East Clontarf

PURCHASE ORDER: 20561

METHOD REFERENCES:

Organochlorine, Organophosphorus Pesticides in Water
Polycyclic Aromatic Hydrocarbons in Water
Benzene, Toluene, Ethyl Benzene and Xylenes in Water
Total Petroleum Hydrocarbons in Water
pH in Water
Total Suspended Solids in Water
Chloride
Conductivity in Water
Chemical Oxygen Demand
Total Acidity in Water
Sulphate in Water
Metals in Water
NOx-N
Total Kjeldahl Nitrogen
Ammonia-N
Total Phosphorus
Alkalinity

ARL No. 002
ARL No. 005
ARL No. 007
ARL No. 009
ARL No. 014
ARL No. 016
ARL No. 018
ARL No. 019
ARL No. 020
ARL No. 021
ARL No. 028
ARL No. 029, 038, 039, 040, 065, 066
ARL No. 032
ARL No. 034
ARL No. 035
ARL No. 036
ARL No. 037

Kim Rodgers
Laboratory Manager

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

OC/OP Quality Control Data

	% Recovery
Surrogate Standard -	87%, 89%, 95%, 96%, 104%, 104%
Dibutylchloroendate / tetrachloro-m-xylene	
Spike Recovery -	
Lindane	97%
Heptachlor	98%
Aldrin	97%
Dieldrin	108%
Endrin	106%
DDT	103%

Total Petroleum Hydrocarbons Quality Control Data

	% Recovery
Spike - Diesel Range Hydrocarbons	94%, 107%

BTEX Quality Control Data

	% Recovery
Surrogate Standard -	97%, 96%, 97%, 97%, 98%, 97%, 98%, 97%, 97%
a,a,a-Trifluorotoluene	
Spike Recovery -	
Benzene	96%
Toluene	95%
Ethyl Benzene	108%
Xylenes	94%

PAH Quality Control Data

	% Recovery
Surrogate Standard -	62%, 94%, 107%, 117%
2-Fluoro-1,1'-Biphenyl / p-Terphenyl-d14	

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Metals Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
Aluminium	-	116%
Arsenic	-	93%
Barium	-	111%
Cadmium	110%	93%
Chromium	94%	103%
Copper	95%	116%
Total-Iron	-	117%
Mercury	105%	96%
Manganese	-	-
Nickel	100%	111%
Lead	-	89%
Selenium	100%	96%
Zinc	-	90%

Nutrients Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
Ammonia-N	-	94%
Total Kjeldahl Nitrogen	100%	98%
Total Nitrogen	100%	98%
NOx-N	100%	107%
Total Phosphorus	98%	96%

Inorganics Quality Control Data

	Matrix Spike	Certified Reference Material
	% Recovery	
pH	-	92%
Conductivity	-	92%
Alkalinity	-	103%
Total Acidity	-	-
Chloride	101%	99%
Sulphate	105%	92%
Total Suspended Solids	-	89%

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Organochlorine and Organophosphorus Pesticides

Date Extracted 11/10/2006
Date Analysed 23/10/2006

ARL Lab No	Method Detection Limit	22609	22610	22611	22612	22613	22614	22615	22616	22618
Sample Marks		MW1	MW2	MW3	MW4	MW5	MW6	MW7	Duplicate	Field Blank
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Aldrin	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
BHCs	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chlordane	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chlorpyrifos	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
DDE	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DDD	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DDT	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Dieldrin	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan I	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan II	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Endosulphan Sulphate	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
HCB	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Heptachlor	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Heptachlor Epoxide	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Oxychlordane	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Bromophos Ethyl	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ethion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Diazinon	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Malathion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fenitrothion	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Bifenthrin	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Polycyclic Aromatic Hydrocarbons

Date Extracted 04/10/2006
Date Analysed 06/10/2006

ARL Lab No	Method Detection Limit	22609	22610	22611	22612	22613	22614	22615	22616	22618
Sample Marks		MW1	MW2	MW3	MW4	MW5	MW6	MW7	Duplicate	Field Blank
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Naphthalene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methyl-naphthalene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benz(a)anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Total Petroleum Hydrocarbons

Date Extracted 04/10/2006

Date Analysed 06/10/2006

ARL Lab No	Sample Marks	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
		mg/l			
Method Detection Limit		0.02	0.02	0.04	0.04
22609	MW1	< 0.02	< 0.02	0.37	< 0.04
22610	MW2	< 0.02	< 0.02	< 0.04	< 0.04
22611	MW3	< 0.02	< 0.02	< 0.04	< 0.04
22612	MW4	< 0.02	< 0.02	< 0.04	< 0.04
22613	MW5	< 0.02	< 0.02	< 0.04	< 0.04
22614	MW6	< 0.02	< 0.02	< 0.04	< 0.04
22615	MW7	< 0.02	< 0.02	< 0.04	< 0.04
22616	Duplicate	< 0.02	< 0.02	< 0.04	< 0.04
22617	Trip Blank	< 0.02	< 0.02	< 0.04	< 0.04

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX)

Date Analysed 29/09/2006

ARL Lab No	Sample Marks	Benzene	Toluene	Ethyl Benzene	Xylenes
		mg/l			
Method Detection Limit		0.001	0.001	0.001	0.003
22609	MW1	< 0.001	< 0.001	< 0.001	< 0.003
22610	MW2	< 0.001	< 0.001	< 0.001	< 0.003
22611	MW3	< 0.001	< 0.001	< 0.001	< 0.003
22612	MW4	< 0.001	< 0.001	< 0.001	< 0.003
22613	MW5	< 0.001	< 0.001	< 0.001	< 0.003
22614	MW6	< 0.001	< 0.001	< 0.001	< 0.003
22615	MW7	< 0.001	< 0.001	< 0.001	< 0.003
22616	Duplicate	< 0.001	< 0.001	< 0.001	< 0.003
22617	Trip Blank	< 0.001	< 0.001	< 0.001	< 0.003

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Nutrients

Date Prepared 27/09/2006
Date Analysed 09/10/2006, 18/10/2006, 30/10/2006

ARL Lab No	Method Detection Limit	22609	22610	22611	22612	22613	22614	22615	22616	22618
Sample Marks		MW1	MW2	MW3	MW4	MW5	MW6	MW7	Duplicate	Field Blank
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ammonia-N	0.2	< 0.2	< 0.2	< 0.2	1.0	28	0.8	< 0.2	< 0.2	< 0.2
Total Kjeldahl Nitrogen	0.2	1.7	1.2	0.7	2.2	36	1.1	0.6	0.4	< 0.2
NOx-N	0.01	< 0.01	12	3.6	< 0.01	0.09	0.01	< 0.01	< 0.01	< 0.01
Total Nitrogen	0.2	1.7	13	4.3	2.2	36	1.1	0.6	0.4	< 0.2
Total Phosphorus	0.01	0.14	0.07	0.19	0.05	0.07	0.05	0.09	0.11	< 0.01

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

Metals

Date Prepared
Date Analysed

27/09/2006

03/10/2006, 05/10/2006, 10/10/2006, 23/10/2006, 24/10/2006, 02/11/2006

ARL Lab No	Method Detection Limit	22609	22610	22611	22612	22613	22614	22615	22616	22618
Sample Marks		MW1	MW2	MW3	MW4	MW5	MW6	MW7	Duplicate	Field Blank
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Aluminium	0.1	0.7	0.2	< 0.1	0.2	< 0.1	< 0.1	0.2	0.2	< 0.1
Arsenic	0.001	0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.002	0.002	< 0.001
Barium	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cadmium	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	< 0.0001	< 0.0001
Chromium	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	0.002	0.001	0.001	< 0.001	0.001	0.007	< 0.001	< 0.001	< 0.001
Total-Iron	0.01	1.9	0.03	0.07	9.3	8.9	8.8	1.7	1.7	< 0.01
Mercury	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Manganese	0.01	0.15	< 0.01	< 0.01	0.35	0.17	6.8	0.02	0.02	< 0.01
Nickel	0.001	0.003	0.001	< 0.001	0.004	0.001	0.099	0.001	0.001	< 0.001
Lead	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	< 0.001	< 0.001	< 0.001
Selenium	0.001	0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	0.005	0.006	0.010	< 0.005	0.015	0.005	0.035	0.007	0.007	0.006

Attention: B Coleman
A.T.A. Environmental
ARL Lab No's: 22609-18
07 November 2006

ARL Lab No	Date Analysed	Units	Method Detection Limit	22609	22610	22611	22612	22613
Sample Marks				MW1	MW2	MW3	MW4	MW5
pH	28/09/2006	#	-	6.1	6.2	6.2	5.9	6.8
Conductivity	28/09/2006	mS/cm	0.01	0.43	0.52	0.44	0.70	1.8
Alkalinity	28/09/2006	mg CaCO ₃ /l	5	47	22	37	61	770
Bicarbonate	28/09/2006	mg CaCO ₃ /l	5	47	22	37	61	770
Carbonate	28/09/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5	< 5
Hydroxide	28/09/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5	< 5
Total Acidity	28/09/2006	mg CaCO ₃ /l	5	65	21	40	170	260
Chloride	28/09/2006	mg/l	5	95	94	84	170	170
Sulphate	28/09/2006	mg/l	3	10	34	44	32	< 3
Total Suspended Solids	28/09/2006	mg/l	5	33	< 5	6	64	59

ARL Lab No	Date Analysed	Units	Method Detection Limit	22614	22615	22616	22618
Sample Marks				MW6	MW7	Duplicate	Field Blank
pH	28/09/2006	#	-	5.5	6.3	6.2	5.7
Conductivity	28/09/2006	mS/cm	0.01	26	0.50	0.43	< 0.01
Alkalinity	28/09/2006	mg CaCO ₃ /l	5	31	45	45	< 5
Bicarbonate	28/09/2006	mg CaCO ₃ /l	5	31	45	45	< 5
Carbonate	28/09/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5
Hydroxide	28/09/2006	mg CaCO ₃ /l	5	< 5	< 5	< 5	< 5
Total Acidity	28/09/2006	mg CaCO ₃ /l	5	270	64	65	< 5
Chloride	28/09/2006	mg/l	5	11000	98	99	< 5
Sulphate	28/09/2006	mg/l	3	1300	32	30	< 3
Total Suspended Solids	28/09/2006	mg/l	5	43	7	< 5	< 5

Appendix E
Groundwater Levels and Field Records
(2003/2006)

**Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA**

Project TCB-6-6

Groundwater Sampling Field Work Sheet



TCB-2006-004

Contact: Tony (Ground Manager) - Clontarf Sampled by: JF

Date sampled: 13/3/06

Bore#	Depth (m)	SWL (m)	Column (Depth-SWL)	Factor	Purge Volume (L) (Factor*Column)	Time Collected	pH	EC	Temp	Oxy	Comments
ATA-7	2.865	1.136	1.729	1.789724		10.59	6.77	1028	24.0	0.74	-56
orange						11.01	6.69	1025	23.8	0.62	-60
(murky brown water) ~ slight odour						11.03	6.67	1023	23.7	0.49	-65
- flow rate ~ 0.5 L/min						11.05	6.69	1022	23.6	0.54	-70
ATA-6	3.950	0.495	3.455			12.38	5.65	~3.3	34.3	0.94	51
light						12.40	5.66	~2.8	33.4	1.15	55
murky brown water ~ no odour						12.42	5.70	6.43	32.5	1.25	59
Flow rate ~ 0.1 L/min.						12.44	5.71	6.10	32.2	1.09	59
→ no recharge after 10 mins of bottle filling						12.46	5.71	6.01	31.9	1.12	61
				@ 1.20 pm							
MWS	3.875	1.696				2.08	6.92	1255	26.2	2.24	109
murky black water ~ no odour						2.10	6.92	1088	25.7	2.10	110
Don't forget Duplicate, Rinse Blank and/or Field Blank.						2.12	6.89	1054	25.3	2.05	110
Factor = (bore radius) ² x 22/7 x 1000 x 6 (15x for 75mm bore)						2.14	6.91	1049	25.1	1.99	110
					- Decan. after each sample location						
Flow rate ~ 0.2 L/min											

PTO.

TCB-6-4

TCB-6-6-QMon
13/5/06.

MW4

Total depth (TD) = 3.81m

SWL = 1.145m

Water Column = 2.67

<u>Time.</u>	<u>pH</u>	<u>EC</u>	<u>Temp</u>	<u>Oxy</u>	<u>SAL.</u>
3.40	6.71	1145	26.9	1.51	70
3.42	6.68	1120	26.9	1.34	71
3.44	6.68	1080	26.6	1.26	70
3.46	6.68	1072	26.6	1.19	71

Flow rate \approx 0.1 L/min

MW3

Total depth = 7.878

SWL = 4.372

Water Column = 3.50

<u>Time</u>	<u>pH</u>	<u>EC</u>	<u>Temp</u>	<u>Oxy</u>	<u>SAL</u>
5.58	6.94	980	25.6	1.07	76
6.00	6.98	967	25.6	1.09	79
6.02	6.97	964	25.5	1.14	81
6.04.	6.97	952	25.6	1.11	77

Flow rate \approx 0.1 L/min

No duplicate - glass bottle missing
only filled 1x 1 L glass due to well running dry /
slow recharge.

TCB-6-6-QMOW

13/3/06

CLONTAKF

TD=6

SWL = 4.186

ATTN W1 - cloudy orange-brown +DUP

Time	DO	COND	PH	mV	°C
1028	0.7	410	5.41	138	22.2
1030	0.6	410	5.41	134	22.2
1032	0.5	420	5.42	127	22.2

ATTN W2 - CLEAR

TD=8.5 SWL=6.991

1142	3.0	537	5.91	114	23.3
3 1144	2.2	537	5.92	112	23.1
1146	2.0	537	5.92	104	23.3
1148	1.8	534	6.0	93	22.9
1150	1.8	534	6.0	86	22.8
1152	1.8	532	6.1	85	22.9

SW1 - PIPE DISCHARGE

DO	COND	PH	EL	°C
6.5	486	6.18	110	18.7

~~50395869689~~

50395689

6457213 N

SW2 - ~ 20m from river

50395681E

6457122N

DO	COND	PH	EL	°C
SILT	18,000	6.80	SILT	22.3

Clontarf TCB-2006-006-QMON

Low Flow Groundwater Sampling Field Work Sheet



MW1

Depth: 6m		SWL: 3.913		Tube: 6m -		Date: 26/9/06		
Time	Temp °C	Cond µS/cm	DO mg/L	pH	Salinity PSS	DO % sat	ORP mV	Comments
0913	19.41	479	1.39	5.65	0.3	14.7	115	Purged for 5 minutes while labelling bottles
0915	19.39	479	1.19	5.58	0.3	12.7	92	
0917	19.33	479	1.09	5.73	0.3	11.6	58	
0919	19.27	479	1.05	5.66	0.3	11.6	38	
0922	19.53	480	1.21	5.71	0.3	13.0	-25	Mulpy
0924	19.58	480	1.15	5.66	0.3	12.6	-110	
0926	19.60	479	1.20	5.66	0.3	12.8	-130	Flow ~ 300mL/min
0928	19.59	478	1.17	5.65	0.3	12.5	-132	
0930	19.59	480	1.21	5.66	0.3	13.0	-138	
Sampled by: <i>AK</i>								
Bottle filling order: 3x 1L glass → 1x 500mL glass → 2x 40mL vials → 1x 1L plastic → 1x 500mL plastic → 1x 250mL plastic+acid → put filter on outlet → 1x 250mL plastic+acid								

Clontarf TCB-2006-006-QMON

Low Flow Groundwater Sampling Field Work Sheet



MW2

Depth: 8.3m		SWL: 6.8/0		Tube: 9m		Date: 26/9/2006		
Time	Temp °C	Cond µS/cm	DO mg/L	pH	Salinity PSS	DO % sat	ORP mV	Comments
1005	20.22	581	2.92	5.89	0.4	29.5	96	Rushed for 5 minutes while labelling.
1007	20.23	577	2.67	5.77	0.4	30.4	104	
1009	20.33	573	2.66	5.77	0.4	29.3	112	
1011	20.39	571	2.60	5.77	0.4	28.4	117	CLEAR
1013	20.45	569	2.61	5.76	0.4	28.9	119	
								Flow ~ 250mL/min
Sampled by: AG								
Bottle filling order: 3x 1L glass → 1x 500mL glass → 2x 40mL vials → 1x 1L plastic → 1x 500mL plastic → 1x 250mL plastic+acid → put filter on outlet → 1x 250mL plastic+acid								

Clontarf TCB-2006-006-QMON

Low Flow Groundwater Sampling Field Work Sheet



MW3

Depth:		SWL: 4.200		Tube: 6m		Date: 26/9/2006		
Time	Temp °C	Cond µS/cm	DO mg/L	pH	Salinity PSS	DO % sat	ORP mV	Comments
1047	21.00	504	2.14	5.82	0.3	23.6	128	Purged for 5 minutes while labelling bottles CCGAR
1049	21.21	496	1.85	5.81	0.3	20.3	128	
1051	21.29	494	1.67	5.79	0.3	18.6	129	
1053	20.91	489	1.69	5.80	0.3	18.8	130	
1055	21.30	486	1.67	5.79	0.3	18.6	130	
								Flowrate ~ 300mL/min
Sampled by: AG								
Bottle filling order: 3x 1L glass → 1x 500mL glass → 2x 40mL vials → 1x 1L plastic → 1x 500mL plastic → 1x 250mL plastic+acid → put filter on outlet → 1x 250mL plastic+acid								

Clontarf TCB-2006-006-QMON

Low Flow Groundwater Sampling Field Work Sheet



MW4

Depth:		SWL: 0.902		Tube: 3m		Date: 26/9/2006		
Time	Temp °C	Cond µS/cm	DO mg/L	pH	Salinity PSS	DO % sat	ORP mV	Comments
1140	16.04	824	1.20	6.23	0.5	11.5	-121	Purged for 5 minutes while labelling bottles
1142	16.08	840	0.84	6.08	0.5	8.4	-133	
1144	16.08	851	0.73	6.03	0.5	6.8	-126	
1146	16.12	859	0.61	6.03	0.6	6.1	-114	Light orange @ 1140
1148	16.20	852	0.56	6.01	0.5	4.9	-97	Almost clear @ 1145
1150	16.27	839	0.54	5.98	0.5	5.5	-79	Clear @ 1154
1152	16.35	825	0.55	5.91	0.5	5.7	-56	
1154	16.29	809	0.57	5.82	0.5	5.7	-20	
1156	16.26	805	0.53	5.79	0.5	5.3	-18	
1158	16.28	805	0.52	5.78	0.5	5.3	-16	
								Flow rate ~ 250L/min
Sampled by: AG								
Bottle filling order: 3x 1L glass → 1x 500mL glass → 2x 40mL vials → 1x 1L plastic → 1x 500mL plastic → 1x 250mL plastic+acid → put filter on outlet → 1x 250mL plastic+acid								

Clontarf TCB-2006-006-QMON

Low Flow Groundwater Sampling Field Work Sheet



MW5

Depth:		SWL: 1-239		Tube: 3m		Date: 26/9/2006		
Time	Temp °C	Cond µS/cm	DO mg/L	pH	Salinity PSS	DO % sat	ORP mV	Comments
1256	18.46	2010	3.09	6.76	1.3	29.0	-155	Light brown-orange
1258	18.41	2020	1.88	6.59	1.3	20.0	-153	
1300	18.38	2030	1.47	6.57	1.3	14.2	-150	Almost clear.
1302	18.18	2030	1.00	6.56	1.3	10.1	-150	
1304	18.20	2030	0.90	6.56	1.3	9.7	-149	
1306	18.24	2030	0.90	6.56	1.3	9.6	-148	
								Flowrate ~ 200ml/min
Sampled by: AG								
Bottle filling order: 3x 1L glass → 1x 500mL glass → 2x 40mL vials → 1x 1L plastic → 1x 500mL plastic → 1x 250mL plastic+acid → put filter on outlet → 1x 250mL plastic+acid								

Appendix E - Groundwater Levels (2006)

Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Bore ID	TOC mAHD	Date	SWL mbTOC	SWL mAHD
MW1	6.86	28/03/2006	4.19	2.67
	6.86	17/07/2006	4.14	2.72
	6.86	26/09/2006	3.91	2.95
	6.86	19/12/2006	-	-
	9.55	28/03/2006	6.99	2.56
MW2	9.55	17/07/2006	6.97	2.58
	9.55	26/09/2006	6.81	2.74
	9.55	19/12/2006	Dry	-
	7.91	28/03/2006	4.73	3.18
	7.91	17/07/2006	4.42	3.49
MW3	7.91	26/09/2006	4.20	3.71
	7.91	19/12/2006	4.46	3.45
	3.08	28/03/2006	1.15	1.94
	3.08	17/07/2006	0.95	2.14
	3.08	26/09/2006	0.90	2.18
MW4	3.08	19/12/2006	1.11	1.97
	2.1	28/03/2006	1.70	0.40
	2.1	17/07/2006	1.59	0.51
	2.1	26/09/2006	1.24	0.86
	2.1	19/12/2006	-	-
MW-5	0.990	28/03/2006	0.50	0.49
	0.990	17/07/2006	0.15	0.84
	0.990	26/09/2006	0.42	0.57
	0.990	19/12/2006	0.53	0.46
	1.690	28/03/2006	1.14	0.55
MW6	1.690	17/07/2006	0.95	0.74
	1.690	26/09/2006	0.89	0.80
	1.690	19/12/2006	1.31	0.38
	1.690	28/03/2006	1.14	0.55
	1.690	17/07/2006	0.95	0.74
MW7	1.690	26/09/2006	0.89	0.80
	1.690	19/12/2006	1.31	0.38
	1.690	28/03/2006	1.14	0.55
	1.690	17/07/2006	0.95	0.74
	1.690	26/09/2006	0.89	0.80

Appendix F

Summary of Historical Groundwater Analytical Data (2003/2006)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

APPENDIX F - Table 1
Summary of Historical Groundwater Analytical Results (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)															PCB (µg/L)	OC/OP Pesticides (µg/l)			
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO ₃ -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a
Drinking Water Guidelines (ADWG) ¹		6.5-8.5*	NV	500	NV	NV	NV	NV	200*	250*	250	0.5	221	NV	NV	NV	NV	0.3 ^a	0.2 ^a	NV	NV
Drinking Water Guidelines (ADWG) X 10 ⁻²		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	3	2	NV	NV
Fresh Waters-Rivers Guidelines FWG ³		6.5-8.5	0.12-0.3	NV	NV	NV	NV	NV	NV	NV	NV	0.08	0.15	NV	1.2	0.065	NV	0.002	NV	NV	NV
Long Term Irrigation Water GuideLines (LTIWG) ¹⁴		NV	NV	NV	NV	NV	NV	NV	NV	40	NV	NV	NV	NV	5	0.05	NV	NV	NV	NV	NV
Short Term Irrigation Water Guidelines (STIWG) ¹		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	25-125 ^a	0.8-12 ^a	NV	NV	NV	NV	NV
Sample ID	Date																				
MW1	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	<0.1	<0.1	<2.7	<0.9
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	<0.1	<0.1	<2.7	<0.9
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	<0.1	<0.1	<2.7	<0.9
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	<0.1	<0.1	<2.7	<0.9
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	1.4	-	-	15	0.03	<0.14	<0.1	<0.1	<2.7	<0.9
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095

Notes:
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) guideline
◀ = All constituent analyte concentrations are less than LOR and RPD cannot be calculated
^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX F - Table 1
Summary of Historical Groundwater Analytical Results (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		BTEX (mg/l)				TPH (mg/l)				PAH (µg/L)	Heavy Metals (mg/L)												
		Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₈	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	Polycyclic Aromatic Hydrocarbons ^a	Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Drinking Water Guidelines (ADWG) ¹		0.001	0.8 (0.025*)	0.3 (0.003*)	0.6 (0.02*)	NV	NV	NV	NV	NV	0.2*	0.007	0.7	0.002	0.05	2 (1.0*)	0.3*	0.5 (0.1*)	0.001	0.02	0.01	0.01	3*
Drinking Water Guidelines (ADWG) X 10 ⁻²		NV	NV	NV	NV	NV	NV	NV	NV	NV	2	0.07	7	0.02	0.5	20 (10*)	3	5 (1.0*)	0.01	0.2	0.1	0.1	30
Fresh Waters-Rivers Guidelines FWG ³		0.95	0.003	NV	NV	NV	NV	NV	NV	3.0	0.055	0.013	NV	0.0002	0.01	0.0014	NV	1.9	0.00006	0.011	0.0034	0.005	0.008
Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}		NV	NV	NV	NV	NV	NV	NV	NV	NV	5	0.1	NV	0.01	0.1	0.2	0.2	0.2	0.002	0.2	2	0.02	2
Short Term Irrigation Water Guidelines (STIWG) ¹		NV	NV	NV	NV	NV	NV	NV	NV	NV	20	2	NV	0.05	1	5	10	10	0.002	2	5	0.05	5
Sample ID	Date																						
MW1	May-03	-	-	-	-	-	-	-	-	-	0.96	0.005	-	<0.002	-	<0.01	0.46	-	<0.002	-	<0.01	-	-
MW1	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016
MW1	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027
MW1	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04	<2.5	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001	0.003	0.001	0.001	0.006
MW2	May-03	-	-	-	-	-	-	-	-	-	0.08	0.004	-	<0.002	-	<0.01	0.065	-	<0.002	-	<0.01	-	-
MW2	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018
MW2	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.08	<0.001	<0.1	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010
MW3A	May-03	-	-	-	-	-	-	-	-	-	0.11	0.003	-	<0.002	<0.01	<0.01	0.05	-	<0.002	-	<0.01	-	0.034
MW3	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084
MW3	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	-	-	-	-	-	-	-	-	-	0.003	-	<0.002	<0.01	<0.01	-	0.37	<0.002	<0.01	<0.01	-	0.16
MW4	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050
MW4	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015
MW5	May-03	-	-	-	-	-	<0.03	<0.10	<0.10	<0.8	-	0.011	-	0.003	<0.01	<0.01	-	0.08	<0.002	<0.01	<0.01	-	0.031
MW5	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005
MW5	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	-	-	-	-	-	-	-	-	<2.5	1.1	0.004	0.4	0.0002	0.001	0.003	15	1.9	<0.0001	0.100	<0.001	0.008	0.130
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001	0.090	<0.001	0.020	0.14
MW6	Jul-06	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10	<2.5	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001	0.04	<0.001	0.003	0.039
MW6	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001	0.01	<0.001	0.005	0.010
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	<0.1	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001	0.01	<0.001	0.020	0.008
MW7	Jul-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
MW7	Sep-06	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	0.001	<0.001	<0.001	0.007

Notes:
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
* Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated
^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
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³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
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⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX F - Table 2
Historical Groundwater Analytical Results - Exceedances of ADWG (2003/2006)

Baseline Groundwater Monitoring Management Plan, Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)															PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)			
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO _x -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus		Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈
Drinking Water Guidelines (ADWG) ¹ (Health)		NV	NV	500	NV	NV	NV	NV	NV	250	0.5	221	NV	NV	NV	NV	NV	0.3 ^a	0.2 ^b	NV	NV	0.001	0.8	0.3	0.6	NV	NV	NV	NV
Drinking Water Guidelines (ADWG) ¹ (Aesthetic)		6.5-8.5*	NV	NV	NV	NV	NV	NV	200*	250*	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	0.025*	0.003*	0.02*	NV	NV	NV	NV	
Sample ID	Date																												
MW1	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	-	-	-	15	0.03	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	<0.03	<0.10	<0.10	
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04

Notes:
⊠ Implies that the LOR is greater than the adopetd IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin

* Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

⁴ Australian and New Zealand Guideines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds Drinking Water Guidelines (ADWG)¹ (Health)

Drinking Water Guidelines (ADWG)¹ (Aesthetic)

APPENDIX F - Table 2
Historical Groundwater Analytical Results - Exceedances of ADWG (2003/2006)

Baseline Groundwater Monitoring Management Plan, Cygnia Cove

		PAH (µg/L)	Heavy Metals (mg/L)												
		Polycyclic Aromatic Hydrocarbons ^a	Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Drinking Water Guidelines (ADWG) ¹ (Health)		NV	NV	0.007	0.7	0.002	0.05	2	NV	0.5	0.001	0.02	0.01	0.01	NV
Drinking Water Guidelines (ADWG) ¹ (Aesthetic)		NV	0.2*	NV	NV	NV	NV	1*	0.3*	0.1*	NV	NV	NV	NV	3*
Sample ID	Date														
MW1	May-03	-	0.96	0.005	-	<0.002	-	<0.01	0.46	-	<0.002 ^a	-	<0.01	-	-
MW1	Mar-06	<2.5	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
MW1 (Filtered)		-	0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016
MW1	Jul-06	<2.5	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027
MW1	Sep-06	<2.5	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001	0.003	0.001	0.001	0.006
MW2	May-03	-	0.08	0.004	-	<0.002	-	<0.01	0.065	-	<0.002 ^a	-	<0.01	-	-
MW2	Mar-06	<2.5	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017
MW2 (Filtered)		-	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018
MW2	Jul-06	<2.5	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010
MW3A	May-03	-	0.11	0.003	-	<0.002	<0.01	<0.01	0.05	-	<0.002 ^a	-	<0.01	-	0.034
MW3	Mar-06	<2.5	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086
MW3 (Filtered)		-	<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084
MW3	Jul-06	<2.5	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	-	0.003	-	<0.002	<0.01	<0.01	-	0.37	<0.002 ^a	<0.01	<0.01	-	0.16
MW4	Mar-06	<2.5	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049
MW4 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050
MW4	Jul-06	<2.5	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015
MW5	May-03	<0.8	-	0.011	-	0.003	<0.01	<0.01	-	0.08	<0.002 ^a	<0.01	<0.01	-	0.031
MW5	Mar-06	<2.5	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006
MW5 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005
MW5	Jul-06	<2.5	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<2.5	<0.1	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	<2.5	1.1	0.004	0.4	0.0002	0.001	0.003	15	1.9	<0.0001	0.100	<0.001	0.008	0.130
MW6 (Filtered)		-	<0.1	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001	0.090	<0.001	0.020	0.14
MW6	Jul-06	<2.5	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001	0.04	<0.001	0.003	0.039
MW6	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<2.5	<0.1	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001	0.01	<0.001	0.005	0.010
MW7 (Filtered)		-	<0.1	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001	0.01	<0.001	0.020	0.008
MW7	Jul-06	<2.5	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
MW7	Sep-06	<2.5	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	0.001	<0.001	<0.001	0.007

Notes:

⊠ Implies that the LOR is greater than the adopetd IL

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

[#] Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments

^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:

¹ DoE (2003) and ARMCANZ (1996)

² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

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⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

	Exceeds Drinking Water Guidelines (ADWG) ¹ (Health)
	Drinking Water Guidelines (ADWG) ¹ (Aesthetic)

APPENDIX F - Table 3
Historical Groundwater Analytical Results
Exceedances of Drinking Water Guidleines (ADWG) X 10 (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)														PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO ₃ -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OC ^a	Total OP ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆
Drinking Water Guidelines (ADWG) X 10 ⁻² (Health)		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	3	2	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
Drinking Water Guidelines (ADWG) X 10 ⁻² (Aesthetic)		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
Sample ID	Date																												
MW1	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	1.4	-	-	15	0.03	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	<0.03	<0.10	<0.10
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04

Notes:
■ Implies that the LOR is greater than the adopetd IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this
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« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated
^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
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References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

	Exceeds Drinking Water Guidelines (ADWG) X 10 ² (Health)
	Exceeds Drinking Water Guidelines (ADWG) X 10 ² (Aesthetic)

APPENDIX F - Table 3
Historical Groundwater Analytical Results
Exceedances of Drinking Water Guidleines (ADWG) X 10 (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		PAH (µg/L)	Heavy Metals (mg/L)												
		Polycyclic Aromatic Hydrocarbons ^a	Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Drinking Water Guidleines (ADWG) X 10 ² (Health)		NV	2	0.07	7	0.02	0.5	20	3	5	0.01	0.2	0.1	0.1	30
Drinking Water Guidleines (ADWG) X 10 ² (Aesthetic)		NV	NV	NV	NV	NV	NV	10	30	1	NV	NV	NV	NV	NV
Sample ID	Date														
MW1	May-03	-	0.96	0.005	-	<0.002	-	<0.01	0.46	-	<0.002	-	<0.01	-	-
MW1	Mar-06	<2.5	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
MW1 (Filtered)		-	0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016
MW1	Jul-06	<2.5	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027
MW1	Sep-06	<2.5	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001	0.003	0.001	0.001	0.006
MW2	May-03	-	0.08	0.004	-	<0.002	-	<0.01	0.065	-	<0.002	-	<0.01	-	-
MW2	Mar-06	<2.5	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017
MW2 (Filtered)		-	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018
MW2	Jul-06	<2.5	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010
MW3A	May-03	-	0.11	0.003	-	<0.002	<0.01	<0.01	0.05	-	<0.002	-	<0.01	-	0.034
MW3	Mar-06	<2.5	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086
MW3 (Filtered)		-	<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084
MW3	Jul-06	<2.5	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	-	0.003	-	<0.002	<0.01	<0.01	-	0.37	<0.002	<0.01	<0.01	-	0.16
MW4	Mar-06	<2.5	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049
MW4 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050
MW4	Jul-06	<2.5	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015
MW5	May-03	<0.8	-	0.011	-	0.003	<0.01	<0.01	-	0.08	<0.002	<0.01	<0.01	-	0.031
MW5	Mar-06	<2.5	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006
MW5 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005
MW5	Jul-06	<2.5	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<2.5	<0.1	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	<2.5	1.1	0.004	0.4	0.0002	0.001	0.003	15	1.9	<0.0001	0.100	<0.001	0.008	0.130
MW6 (Filtered)		-	<0.1	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001	0.090	<0.001	0.020	0.14
MW6	Jul-06	<2.5	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001	0.04	<0.001	0.003	0.039
MW6	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<2.5	<0.1	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001	0.01	<0.001	0.005	0.010
MW7 (Filtered)		-	<0.1	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001	0.01	<0.001	0.020	0.008
MW7	Jul-06	<2.5	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
MW7	Sep-06	<2.5	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	0.001	<0.001	<0.001	0.007

Notes:

□ Implies that the LOR is greater than the adopetd IL

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

[#] Requires site specific assessment. Lowest value considered in this

* indicates aesthetic (not health) guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments

^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:

¹ DoE (2003) and ARMCANZ (1996)

² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

⁴ Australian and New Zealand Guidleines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

	Exceeds Drinking Water Guidelines (ADWG) X 10 ² (Health)
	Exceeds Drinking Water Guidelines (ADWG) X 10 ² (Aesthetic)

APPENDIX F - Table 4
Historical Groundwater Analytical Results
Exceedances of Fresh Water Guidelines (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)															PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				PAH (µg/L)
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO ₃ -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	Polycyclic Aromatic Hydrocarbons ^a
Fresh Waters-Rivers Guidelines FWG ³		6.5-8.5	0.12-0.3	NV	NV	NV	NV	NV	NV	NV	0.08	0.15	NV	1.2	0.065	NV	0.002	NV	NV	NV	NV	0.95	0.003	NV	NV	NV	NV	NV	NV	3.0
Sample ID	Date																													
MW1	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	-	<0.1 ^a	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2 ^a	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2 ^a	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04	<2.5
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	-	<0.1 ^a	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2 ^a	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2 ^a	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	-	<0.1 ^a	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2 ^a	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2 ^a	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	-	<0.1 ^a	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	1.4	-	-	15	0.03	<0.14	<0.1 ^a	<0.1	<2.7	<0.9	-	-	-	-	-	<0.03	<0.10	<0.10	<0.8
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-	<2.5
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10	<2.5
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2 ^a	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2 ^a	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2 ^a	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5

Notes:
□ Implies that the LOR is greater than the adopetd IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and
^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^b Conversion factor applied (Nm^g/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidleines for Fresh and Marine Water Quality (2000)
⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds the Fresh Waters-Rivers Guidelines FWG³

APPENDIX F - Table 4
Historical Groundwater Analytical Results
Exceedances of Fresh Water Guidelines (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Heavy Metals (mg/L)												
		Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Fresh Waters-Rivers Guidelines FWG ³		0.055	0.013	NV	0.0002	0.01	0.0014	NV	1.9	0.00006	0.011	0.0034	0.005	0.008
Sample ID	Date													
MW1	May-03	0.96	0.005	-	<0.002▣	-	<0.01	0.46	-	<0.002▣	-	<0.01	-	-
MW1	Mar-06	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001▣	0.01	0.004	0.001	0.025
MW1 (Filtered)		0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001▣	0.009	<0.001	0.002	0.016
MW1	Jul-06	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001▣	<0.01	0.002	<0.001	0.027
MW1	Sep-06	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001▣	0.003	0.001	0.001	0.006
MW2	May-03	0.08	0.004	-	<0.002▣	-	<0.01	0.065	-	<0.002▣	-	<0.01	-	-
MW2	Mar-06	<0.1▣	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001▣	0.005	<0.001	0.001	0.017
MW2 (Filtered)		<0.1▣	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001▣	0.005	<0.001	0.001	0.018
MW2	Jul-06	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001▣	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001▣	0.001	<0.001	0.001	0.010
MW3A	May-03	0.11	0.003	-	<0.002▣	<0.01	<0.01	0.05	-	<0.002▣	-	<0.01	-	0.034
MW3	Mar-06	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001▣	0.060	0.001	0.001	0.086
MW3 (Filtered)		<0.1▣	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001▣	0.040	<0.001	0.002	0.084
MW3	Jul-06	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001▣	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001▣	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	0.003	-	<0.002▣	<0.01	<0.01	-	0.37	<0.002▣	<0.01	<0.01	-	0.16
MW4	Mar-06	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001▣	0.080	<0.001	0.003	0.049
MW4 (Filtered)		<0.1▣	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001▣	0.050	<0.001	0.003	0.050
MW4	Jul-06	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001▣	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001▣	0.004	<0.001	<0.001	0.015
MW5	May-03	-	0.011	-	0.003▣	<0.01	<0.01	-	0.08	<0.002▣	<0.01	<0.01	-	0.031
MW5	Mar-06	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001▣	0.030	<0.001	0.002	0.006
MW5 (Filtered)		<0.1▣	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001▣	0.020	<0.001	0.003	0.005
MW5	Jul-06	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001▣	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<0.1▣	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001▣	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	1.1	0.004	0.4	0.0002	0	0.003	15	1.9	<0.0001▣	0.100	<0.001	0.008	0.130
MW6 (Filtered)		<0.1▣	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001▣	0.090	<0.001	0.020	0.14
MW6	Jul-06	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001▣	0.04	<0.001	0.003	0.039
MW6	Sep-06	<0.1▣	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001▣	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<0.1▣	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001▣	0.01	<0.001	0.005	0.010
MW7 (Filtered)		<0.1▣	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001▣	0.01	<0.001	0.020	0.008
MW7	Jul-06	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001▣	<0.01	0.001	<0.001	0.089
MW7	Sep-06	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001▣	0.001	<0.001	<0.001	0.007

Notes:
▣ Implies that the LOR is greater than the adopetd IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and
^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^b Conversion factor applied (Nm^g/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidleines for Fresh and Marine Water Quality (2000)
⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds the Fresh Waters-Rivers
Guidelines FWG³

APPENDIX F - Table 5
Historical Groundwater Analytical Results
Exceedances of Long Term Irrigation Guidelines (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)															PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO _x -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	
Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}		NV	NV	NV	NV	NV	NV	NV	NV	40	NV	NV	NV	NV	5	0.05	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
Sample ID	Date																													
MWI	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04	
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	1.4	-	-	15	0.03	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	<0.03	<0.10	<0.10	
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10	
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	

Notes:
▣ Implies that the LOR is greater than the adopedt IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin

Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^u Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds Long Term Irrigation Water GuideLines (LTIWG)^{1/4}

APPENDIX F - Table 5
Historical Groundwater Analytical Results
Exceedances of Long Term Irrigation Guidelines (2003/2006)
Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		PAH (µg/L)	Heavy Metals (mg/L)												
		Polycyclic Aromatic Hydrocarbons ^a	Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Long Term Irrigation Water GuideLines (LTIWG) ¹⁴		NV	5	0.1	NV	0.01	0.1	0.2	0.2	0.2	0.002	0.2	2	0.02	2
Sample ID	Date														
MW1	May-03	-	0.96	0.005	-	<0.002	-	<0.01	0.46	-	<0.002	-	<0.01	-	-
MW1	Mar-06	<2.5	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
MW1 (Filtered)		-	0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016
MW1	Jul-06	<2.5	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027
MW1	Sep-06	<2.5	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001	0.003	0.001	0.001	0.006
MW2	May-03	-	0.08	0.004	-	<0.002	-	<0.01	0.065	-	<0.002	-	<0.01	-	-
MW2	Mar-06	<2.5	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017
MW2 (Filtered)		-	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018
MW2	Jul-06	<2.5	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010
MW3A	May-03	-	0.11	0.003	-	<0.002	<0.01	<0.01	0.05	-	<0.002	-	<0.01	-	0.034
MW3	Mar-06	<2.5	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086
MW3 (Filtered)		-	<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084
MW3	Jul-06	<2.5	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	-	0.003	-	<0.002	<0.01	<0.01	-	0.37	<0.002	<0.01	<0.01	-	0.16
MW4	Mar-06	<2.5	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049
MW4 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050
MW4	Jul-06	<2.5	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	<2.5	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015
MW5	May-03	<0.8	-	0.011	-	0.003	<0.01	<0.01	-	0.08	<0.002	<0.01	<0.01	-	0.031
MW5	Mar-06	<2.5	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006
MW5 (Filtered)		-	<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005
MW5	Jul-06	<2.5	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<2.5	<0.1	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	<2.5	1.1	0.004	0.4	0.0002	0.001	0.003	15	1.9	<0.0001	0.100	<0.001	0.008	0.130
MW6 (Filtered)		-	<0.1	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001	0.090	<0.001	0.020	0.14
MW6	Jul-06	<2.5	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001	0.04	<0.001	0.003	0.039
MW6	Sep-06	<2.5	<0.1	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<2.5	<0.1	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001	0.01	<0.001	0.005	0.010
MW7 (Filtered)		-	<0.1	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001	0.01	<0.001	0.020	0.008
MW7	Jul-06	<2.5	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
MW7	Sep-06	<2.5	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	0.001	<0.001	<0.001	0.007

Notes:
□ Implies that the LOR is greater than the adopedt IL
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey Environments
^u Conversion factor applied (Nm^g/L = 14/62xNO₃mg/L⁻¹)

References:
¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁵ USEPA, Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds Long Term Irrigation Water GuideLines (LTIWG)^{1/4}

APPENDIX F - Table 6
Historical Groundwater Analytical Results
Exceedances of Short Term Irrigation Guidelines (2003/2006)

Baseline Groundwater Monitoring Management Plan Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)														PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				PAH (µg/L)	
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO _x -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	Polycyclic Aromatic Hydrocarbons ^a
Short Term Irrigation Water Guidelines (STIWG) ⁴		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	25-125 ^d	0.8-12 ^d	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
Sample ID	Date																													
MW1	May-03	5.9	-	-	-	-	-	-	-	-	-	-	-	-	5.9	0.16	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW1	Jul-06	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW1	Sep-06	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04	<2.5
MW2	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.04	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW2	Mar-06	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9	0.9	0.9	0.03	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW2	Jul-06	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.1	1.1	1.1	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW2	Sep-06	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12	1.2	13	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3A	May-03	6.3	-	-	-	-	-	-	-	-	-	-	-	-	0.69	0.17	-	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW3	Mar-06	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72	-	<0.001	0.02	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW3	Jul-06	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.1	1.0	1.0	1.5	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW3	Sep-06	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.6	0.7	4.3	0.19	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4	May-03	6.2	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.04	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	-	-	-	-
MW4	Mar-06	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23	-	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW4	Jul-06	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW4	Sep-06	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5	May-03	7.0	-	-	-	-	-	-	-	-	-	1.4	-	-	15	0.03	<0.14	<0.1	<0.1	<2.7	<0.9	-	-	-	-	-	<0.03	<0.10	<0.10	<0.8
MW5	Mar-06	6.8	1.3	380	<5	63	<5	<5	-	220	39	19	0.1	1.7	1.8	0.2	-	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW5	Jul-06	7.1	1.9	34	180	150	<5	<5	-	170	17	34	0.17	34	32	0.02	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW5	Sep-06	6.8	1.8	59	260	770	<5	<5	540	170	<3	28	0.09	36	36	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	6.8	6.6	130	<5	180	<5	<5	-	320	170	0.4	0.25	0.8	1.0	0.17	-	-	-	-	-	-	-	-	-	-	-	-	-	<2.5
MW6 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Jul-06	5.9	46	71	160	43	<5	<5	-	15000	430	2.0	0.03	2	1.8	<0.01	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	-	<0.03	<0.10	<0.10	<2.5
MW6	Sep-06	5.5	26	43	270	31	<5	<5	4000	11000	1300	0.8	0.01	1.1	1.1	0.05	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	7.2	1.2	<5	<5	170	<5	<5	-	21	28	<0.2	0.01	0.3	0.3	0.07	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	-	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5

Notes:

- Implies that the LOR is greater than the adopted IL

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

[#] Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey

^b Conversion factor applied ($\text{Nm}\text{g/L} = 14/62 \times \text{NO}_3\text{mg/L}^{-1}$)

References:

¹ DoE (2003) and ARMCANZ (1996)

² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX F - Table 6
Historical Groundwater Analytical Results
Exceedances of Short Term Irrigation Guidelines (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Heavy Metals (mg/L)												
		Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Short Term Irrigation Water Guidelines (STIWG) ⁴		20	2	NV	0.05	1	5	10	10	0.002	2	5	0.05	5
Sample ID	Date													
MW1	May-03	0.96	0.005	-	<0.002	-	<0.01	0.46	-	<0.002	-	<0.01	-	-
MW1	Mar-06	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
MW1 (Filtered)		0.4	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016
MW1	Jul-06	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027
MW1	Sep-06	0.7	0.001	<0.5	0.0001	0.001	0.002	1.9	0.15	<0.0001	0.003	0.001	0.001	0.006
MW2	May-03	0.08	0.004	-	<0.002	-	<0.01	0.065	-	<0.002	-	<0.01	-	-
MW2	Mar-06	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017
MW2 (Filtered)		<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018
MW2	Jul-06	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007
MW2	Sep-06	0.2	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010
MW3A	May-03	0.11	0.003	-	<0.002	<0.01	<0.01	0.05	-	<0.002	-	<0.01	-	0.034
MW3	Mar-06	0.7	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086
MW3 (Filtered)		<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084
MW3	Jul-06	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076
MW3	Sep-06	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
MW4	May-03	-	0.003	-	<0.002	<0.01	<0.01	-	0.37	<0.002	<0.01	<0.01	-	0.16
MW4	Mar-06	2.8	0.002	0.3	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049
MW4 (Filtered)		<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050
MW4	Jul-06	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028
MW4	Sep-06	0.2	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015
MW5	May-03	-	0.011	-	0.003	<0.01	<0.01	-	0.08	<0.002	<0.01	<0.01	-	0.031
MW5	Mar-06	2.0	0.003	0.2	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006
MW5 (Filtered)		<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005
MW5	Jul-06	0.02	0.003	0.2	<0.0002	0.001	0.001	8.3	0.07	<0.0001	<0.01	<0.001	0.002	0.005
MW5	Sep-06	<0.1	0.001	<0.5	0.0001	<0.001	0.001	8.9	0.17	<0.0001	0.001	<0.001	<0.001	0.005
MW6	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-
MW6	Mar-06	1.1	0.004	0.4	0.0002	0.001	0.003	15	1.9	<0.0001	0.100	<0.001	0.008	0.130
MW6 (Filtered)		<0.1	<0.001	0.3	<0.0002	0.001	0.002	<0.01	1.7	<0.0001	0.090	<0.001	0.020	0.14
MW6	Jul-06	0.01	<0.001	0.2	0.0002	0.008	0.007	9.2	8.6	<0.0001	0.04	<0.001	0.003	0.039
MW6	Sep-06	<0.1	<0.001	<0.5	0.0001	0.001	0.007	8.8	6.8	<0.0001	0.09	0.006	<0.001	0.035
MW7	May-03	-	-	-	-	-	-	-	-	-	-	-	-	-
MW7	Mar-06	<0.1	0.005	<0.1	<0.0002	<0.001	0.001	0.68	0.09	<0.0001	0.01	<0.001	0.005	0.010
MW7 (Filtered)		<0.1	<0.001	<0.1	<0.0002	0.001	0.001	0.26	<0.01	<0.0001	0.01	<0.001	0.020	0.008
MW7	Jul-06	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
MW7	Sep-06	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	0.001	<0.001	<0.001	0.007

Notes:

▣ Implies that the LOR is greater than the adopedt IL

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

[#] Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

^a Total OCs / OPs / PAHs are summations undertaken by Coffey

^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:

¹ DoE (2003) and ARMCANZ (1996)

² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

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⁴ Australian and New Zealand Guidleines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Exceeds Short Term Irrigation Water GuideLines (LTIWG)⁴

APPENDIX F - Table 7
Historical Groundwater Analytical Results
Exceedances of Fresh Water Guidelines for Metals with Hardness Modification Factor (2003/2006)

Baseline Groundwater Monitoring and Management Plan
Cygnia Cove

	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF
	Cadmium (mg/L)		Chromium (mg/L)		Copper (mg/L)		Lead (mg/L)		Nickel (mg/L)		Zinc (mg/L)	
MW1	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
May-03	<0.002		-		<0.01		<0.01		-		-	
Mar-06	<0.0001		0.019		0.001		0.004		0.01		0.025	
	<0.0001 (filtered)		0.001 (filtered)		0.001 (filtered)		<0.001 (filtered)		0.009 (filtered)		0.016 (filtered)	
Jul-06	<0.0002		0.001		<0.001		0.002		<0.01		0.027	
Sep-06	0.0001		0.001		0.002		0.001		0.003		0.006	
MW2	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
May-03	<0.002		-		<0.01		<0.01		-		-	
Mar-06	<0.0001		0.001		0.001		<0.001		0.005		0.017	
	<0.0001 (filtered)		0.001 (filtered)		0.001 (filtered)		<0.001 (filtered)		0.005 (filtered)		0.018 (filtered)	
Jul-06	<0.0002		<0.001		<0.001		<0.001		<0.01		0.007	
Sep-06	0.0001		<0.001		0.001		<0.001		0.001		0.01	
MW3	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
May-03	<0.002		<0.01		<0.01		<0.01		-		0.034	
Mar-06	<0.0002		0.002		0.016		0.001		0.06		0.086	
	<0.0002 (filtered)		0.001 (filtered)		0.016 (filtered)		<0.001 (filtered)		0.04 (filtered)		0.084 (filtered)	
Jul-06	<0.0002		<0.001		0.002		<0.001		<0.01		0.076	
Sep-06	0.0001		<0.001		0.001		<0.001		<0.001		<0.005	
MW4	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
May-03	<0.002		<0.01		<0.01		<0.01		<0.01		0.16	
Mar-06	<0.0002		0.001		0.001		<0.001		0.08		0.049	
	<0.0002 (filtered)		<0.001 (filtered)		0.001 (filtered)		<0.001 (filtered)		0.05 (filtered)		0.05 (filtered)	
Jul-06	<0.0002		<0.001		<0.001		<0.001		<0.01		0.028	
Sep-06	0.0001		<0.001		<0.001		<0.001		0.004		0.015	
MW5	0.0002	0.002	0.01	0.084	0.0014	0.0126	0.0034	0.09078	0.011	0.099	0.008	0.072
May-03	0.003		<0.01		<0.01		<0.01		<0.01		0.031	
Mar-06	<0.0002		0.001		0.001		<0.001		0.03		0.006	
	<0.0002 (filtered)		0.001 (filtered)		0.002 (filtered)		<0.001 (filtered)		0.02 (filtered)		0.005 (filtered)	
Jul-06	<0.0002		0.001		0.001		<0.001		<0.01		0.005	
Sep-06	0.0001		<0.001		0.001		<0.001		0.001		0.005	
MW6	0.0002	0.002	0.01	0.084	0.0014	0.0126	0.0034	0.09078	0.011	0.099	0.008	0.072
May-03	-		-		-		-		-		-	
Mar-06	0.0002		0.001		0.003		<0.001		0.1		0.13	
	<0.0002 (filtered)		0.001 (filtered)		0.002 (filtered)		<0.001 (filtered)		0.09 (filtered)		0.14 (filtered)	
Jul-06	0.0002		0.008		0.007		<0.001		0.04		0.039	
Sep-06	0.0001		0.001		0.007		0.006		0.09		0.035	
MW7	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
May-03	-		-		-		-		-		-	
Mar-06	<0.0002		<0.001		0.001		<0.001		0.01		0.01	
	<0.0002 (filtered)		0.001 (filtered)		0.001 (filtered)		<0.001 (filtered)		0.01 (filtered)		0.008 (filtered)	
Jul-06	<0.0002		<0.001		0.001		0.001		<0.01		0.089	
Sep-06	0.0001		<0.001		<0.001		<0.001		0.001		0.007	

FWG = Fresh Water-Rivers guidelines (FWGs) for Aquatic Ecosystems (utilising Lowland Rivers values where available) as specified within Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).

FWGHMF = Fresh Water-Rivers guidelines Hardness Modification Factor for Aquatic Ecosystems (utilising Lowland Rivers values where available) as specified within Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 20

	Cells shaded yellow denotes that the concentration exceeds the FWG
	Cells shaded yellow denotes that the concentration exceeds the FWG with HMF
	Cells shaded orange denotes that the concentration exceeds both the FWG and FWG with HMF

APPENDIX F - Table 8
Historical Groundwater Analytical Results
Variance between Filtered and Unfiltered Groundwater Samples (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

	Aluminium (pH>6.5)		Arsenic		Barium		Cadmium		Chromium		Copper		Iron		Manganese		Mercury		Nickel		Lead		Selenium		Zinc	
	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
	Filt	Unfilt.	Filt	Unfilt.	Filt	Unfilt.	Unfilt.	Filt	Unfilt.	Filt	Unfilt.	Unfilt.	Filt	Unfilt.	Filt	Unfilt.	Unfilt.	Filt	Unfilt.	Filt	Unfilt.	Unfilt.	Filt	Unfilt.	Filt	Unfilt.
MW1	0.4	0.7	0.001	0.001	0.05	0.05	0.0001	0.0001	0.001	0.019	0.001	0.001	0.50	0.37	0.33	0.34	0.0001	0.0001	0.009	0.01	0.001	0.004	0.002	0.001	0.016	0.025
MW2	0.1	0.1	0.001	0.001	0.05	0.05	0.0001	0.0001	0.001	0.001	0.001	0.001	0.02	0.02	0.01	0.01	0.0001	0.0001	0.005	0.005	0.001	0.001	0.001	0.001	0.018	0.017
MW3	0.1	0.7	0.002	0.003	0.1	0.1	0.0002	0.0002	0.001	0.002	0.016	0.016	0.08	0.45	0.01	0.01	0.0001	0.0001	0.040	0.060	0.001	0.001	0.002	0.001	0.084	0.086
MW4	0.1	2.8	0.001	0.002	0.1	0.3	0.0002	0.0002	0.001	0.001	0.001	0.001	0.01	22	0.44	0.58	0.0001	0.0001	0.050	0.080	0.001	0.001	0.003	0.003	0.050	0.049
MW5	0.1	2.0	0.001	0.003	0.1	0.2	0.0002	0.0002	0.001	0.001	0.002	0.001	0.01	21	0.01	0.15	0.0001	0.0001	0.020	0.030	0.001	0.001	0.003	0.002	0.005	0.006
MW6	0.1	1.1	0.001	0.004	0.3	0.4	0.0002	0.0002	0.001	0.001	0.002	0.003	0.01	15	1.7	1.9	0.0001	0.0001	0.090	0.100	0.001	0.001	0.020	0.008	0.14	0.130
MW7	0.1	0.1	0.001	0.005	0.1	0.1	0.0002	0.0002	0.001	0.001	0.001	0.001	0.26	0.68	0.01	0.09	0.0001	0.0001	0.01	0.01	0.001	0.001	0.020	0.005	0.008	0.010
Mean	0.1428571	1.0714286	0.0011429	0.0027143	0.1142857	0.1714286	0.0001714	0.0001714	0.001	0.0037143	0.0034286	0.0034286	0.1271429	8.5028571	0.3585714	0.44	0.0001	0.0001	0.032	0.0421429	0.001	0.0014286	0.0072857	0.003	0.0458571	0.0461429
Variance	0.0128571	1.002381	1.429E-07	2.238E-06	0.0072619	0.0182143	2.381E-09	2.381E-09	0	4.557E-05	3.095E-05	3.129E-05	0.0352571	107.45202	0.3821476	0.4562667	2.143E-40	2.143E-40	0.0009397	0.0014488	0	1.286E-06	7.59E-05	0.000007	0.0025175	0.0021405
Kurtosis	7	-0.0632233	7	-0.9677682	5.4303144	-0.4903499	-0.84	-0.84	#DIV/0!	6.9306611	6.838097	6.5913346	2.2361215	-2.2932885	5.1358478	4.9893164	-3	-3	1.2021536	-1.5269301	#DIV/0!	7	-0.8592819	1.1714286	0.9991274	0.4258851
Skewness	2.6457513	0.936909	2.6457513	0.2559973	2.2103697	0.9283775	-1.2296341	-1.2296341	#DIV/0!	2.6292559	2.6065559	2.5535807	1.6926178	0.531164	2.2173287	2.1861805	-1.2961481	-1.2961481	1.273654	0.5677099	#DIV/0!	2.6457513	1.2029845	1.3606721	1.3286412	1.1944044
t-test p-values	0.034314551		0.009695972		0.26913299		1		0.222810925		1		0.040367074		0.795467168		1		0.520689422		0.355917684		0.194005203		0.97012387	

Notes:

H₀: $\sigma_{\text{filtered}} = \sigma_{\text{unfiltered}}$

H_A: $\sigma_{\text{filtered}} \neq \sigma_{\text{unfiltered}}$

This is the null hypothesis, stating that the two means (fitered and unfiltered) are equal

This is the alternate hypothesis, stating that the two means differ.

It is assumed that each data set is normally distributed.

If the p-value for any given test is greater than 0.05, the two means do not differ at a significance level of 95%, and conclude that filtering does not have an effect for that particular contaminant

If the p-value is less than 0.05, the two means do differ at a significance level of 95%, and conclude that filtering does have an effect for that particular contaminant

APPENDIX F - Table 9
Historical Groundwater Quality Control (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Inorganics & Nutrients (mg/L unless otherwise stated)															PCB (µg/L)	OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				PAH (µg/L)	
		pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness (mgCaCO ₃ /l)	Chloride	Sulphate	Ammonia-N	NO ₃ -N ^b	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus	Polychlorinated Biphenyls	Dieldrin	DDE	Total OCs ^a	Total OPs ^a	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	Polycyclic Aromatic Hydrocarbons ^a	
Drinking Water Guidelines (ADWG) ¹		6.5-8.5*	NV	500	NV	NV	NV	NV	200*	250*	250	0.5	221	NV	NV	NV	NV	0.3 ^a	0.2 ^a	NV	NV	0.001	0.8 (0.025*)	0.3 (0.003*)	0.6 (0.02*)	NV	NV	NV	NV	NV	
Drinking Water Guidelines (ADWG) X 10 ⁻²		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	3	2	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	
Fresh Waters-Rivers Guidelines FWG ³		6.5-8.5	0.12-0.3	NV	NV	NV	NV	NV	NV	NV	NV	0.08	0.15	NV	1.2	0.065	NV	0.002	NV	NV	NV	0.95	0.003	NV	NV	NV	NV	NV	NV	3.0	
Long Term Irrigation Water GuideLines (LTIWG) ^{1d}		NV	NV	NV	NV	NV	NV	NV	NV	40	NV	NV	NV	NV	5	0.05	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	
Short Term Irrigation Water Guidelines (STIWG) ⁴		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	25-125 [#]	0.8-12 [#]	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	
Quality Control																															
Blanks																															
Trip Blank	Mar-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	-	
Trip Blank (17/7/06)	Jul-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	-	
Trip Blank (18/7/06)	Jul-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	-	
Field Blank	Mar-06	-	<0.01	<5	-	-	-	-	-	<5	<3	<0.2	-	<0.2	<0.2	<0.01	ND	<0.001	<0.001	<0.019	<0.095	-	-	-	-	-	-	-	-	ND	
Field Blank (17/7/06)	Jul-06	-	<0.01	<5	-	-	-	-	-	<5	<3	<0.2	-	<0.2	<0.2	<0.01	ND	<0.001	<0.001	<0.019	<0.095	-	-	-	-	-	-	-	-	ND	
Field Blank (18/7/06)	Jul-06	-	<0.01	<5	-	-	-	-	-	<5	<3	<0.2	-	<0.2	<0.2	<0.01	ND	<0.001	<0.001	<0.019	<0.095	-	-	-	-	-	-	-	-	ND	
Field Blank	Sep-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1.7	-	-	<0.019	<0.095	-	-	-	-	-	-	-	-	<1.7	
Duplicates & RPDs																															
MW1	Mar-06	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1	1	0.07	ND	<0.001	<0.001	<0.019	<0.095	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	ND	
Duplicate		5.7	0.43	<5	92	25	<5	<5	-	92	56	<0.2	0.4	1.1	1.1	0.08	ND	<0.001	<0.001	<0.019	<0.095	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	ND	
RPD (%)		«	«	«	4.44%	18.18%	«	«	-	4.25%	1.76%	«	13.00%	9.52%	9.52%	16.00%	N/A	«	«	«	«	«	«	«	«	«	«	«	«	«	N/A
MW1 (Filtered)	Mar-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Duplicate (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
RPD (%)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MW7	Jul-06	6.8	0.61	<5	35	58	<5	<5	-	89	15	<0.2	0.02	0.2	0.2	0.06	ND	<0.001	<0.001	<0.019	<0.095	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	ND	
Duplicate		6.6	0.43	<5	28	60	<5	<5	-	92	17	<0.2	0.02	<0.2	<0.2	0.05	ND	<0.001	<0.001	<0.019	<0.095	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	ND	
RPD (%)		2.98%	34.60%	«	22.22%	3.38%	«	«	-	3.31%	12.50%	«	«	«	«	18.18%	N/A	«	«	«	«	«	«	«	«	«	«	«	«	«	N/A
MW7	Sep-06	6.3	0.50	7	64	45	<5	<5	68	98	32	<0.2	<0.01	0.6	0.6	0.09	<1.7	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<1.7	
Duplicate		6.6	0.43	<5	28	60	<5	<5	-	92	17	<0.2	0.02	<0.2	<0.2	0.05	ND	<0.001	<0.001	<0.019	<0.095	<0.001	<0.002	<0.003	<0.003	<0.02	<0.02	<0.04	<0.04	ND	
RPD (%)		4.65%	15.05%	33.33%	78.26%	28.57%	«	«	N/A	6.31%	61.22%	«	66.66%	«	«	57.14%	«	«	«	«	«	«	«	«	«	«	«	«	«	«	«

Notes:

- = Analysis not completed
- NV = No Value / IL
- NA = Not Applicable
- ^A Value for both dieldrin and aldrin
- [#] Requires site specific assessment. Lowest value considered in this instance.
- * indicates aesthetic (not health) guideline
- « = All constituent analyte concentrations are less than LOR
- ^a Total OCs / OPs / PAHs are summations undertaken by Coffey
- ^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)

References:

¹ DoE (2003) and ARMCANZ (1996)

² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX F - Table 9
Historical Groundwater Quality Control (2003/2006)
Baseline Groundwater Monitoring Management Plan
Cygnia Cove

		Heavy Metals (mg/L)												
		Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc
Drinking Water Guidelines (ADWG) ¹		0.2*	0.007	0.7	0.002	0.05	2 (1.0*)	0.3*	0.5 (0.1*)	0.001	0.02	0.01	0.01	3*
Drinking Water Guidelines (ADWG) X 10 ⁻²		2	0.07	7	0.02	0.5	20 (10*)	3	5 (1.0*)	0.01	0.2	0.1	0.1	30
Fresh Waters-Rivers Guidelines FWG ³		0.055	0.013	NV	0.0002	0.01	0.0014	NV	1.9	0.00006	0.011	0.0034	0.005	0.008
Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}		5	0.1	NV	0.01	0.1	0.2	0.2	0.2	0.002	0.2	2	0.02	2
Short Term Irrigation Water Guidelines (STIWG) ⁴		20	2	NV	0.05	1	5	10	10	0.002	2	5	0.05	5
Quality Control														
Blanks														
Trip Blank	Mar-06	-	-	-	-	-	-	-	-	-	-	-	-	-
Trip Blank (17/7/06)	Jul-06	-	-	-	-	-	-	-	-	-	-	-	-	-
Trip Blank (18/7/06)	Jul-06	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Blank	Mar-06	<0.1	<0.001	<0.05	<0.0001	<0.001	<0.001	0.01	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
Field Blank (17/7/06)	Jul-06	<0.1	<0.001	<0.05	<0.0001	<0.001	<0.001	0.01	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
Field Blank (18/7/06)	Jul-06	<0.1	<0.001	<0.05	<0.0001	<0.001	<0.001	0.01	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005
Field Blank	Sep-06													
Duplicates & RPDs														
MW1	Mar-06	0.7	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.01	0.004	0.001	0.025
Duplicate		0.6	<0.005	<0.05	<0.0001	0.010	0.001	1.4	0.34	<0.0001	0.009	0.004	<0.001	0.016
RPD (%)		15.38%	«	«	«	62.06%	«	116%	«	«	10.52%	«	«	43.90%
MW1 (Filtered)	Mar-06	0.4	0.001	<0.05	<0.0001	0.001	0.001	0.5	0.33	<0.0001	0.009	<0.001	0.002	0.016
Duplicate (Filtered)		0.4	<0.001	<0.05	<0.0001	0.001	0.001	0.48	0.3	<0.0001	0.009	<0.001	0.001	0.015
RPD (%)		«	«	«	«	«	«	«	2%	«	«	«	17%	2%
MW7	Jul-06	0.05	0.003	<0.1	<0.0002	<0.001	0.001	0.88	0.02	<0.0001	<0.01	0.001	<0.001	0.089
Duplicate		0.06	0.003	<0.1	<0.0002	<0.001	<0.001	0.73	0.03	<0.0001	<0.01	<0.001	<0.001	<0.005
RPD (%)		18.18%	«	«	«	«	«	18.63%	40.00%	«	«	«	«	«
MW7	Sep-06	0.2	0.002	<0.5	0.0001	<0.001	<0.001	1.7	0.02	<0.0001	<0.001	<0.001	<0.001	0.007
Duplicate		0.06	0.003	<0.1	<0.0002	<0.001	<0.001	0.73	0.03	<0.0001	<0.01	<0.001	<0.001	0.005
RPD (%)		2.15%	40.00%	«	«	«	«	79.83%	20.00%	«	«	«	«	33.33%

Notes:
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR
^a Total OCs / OPs / PAHs are summations undertaken by Coffey
^b Conversion factor applied (Nmg/L = 14/62xNO₃mg/L⁻¹)
References:

¹ DoE (2003) and ARMCANZ (1996)
² National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
³ Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

⁴ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
⁵ USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX F - Table 10
Historical Laboratory Quality Control (2003/2006)

Baseline Groundwater Monitoring Management Plan
Cygnia Cove

ARL LAB #	Date	Analyte	Data Type	Range
6121-6125	6/04/2006	OCP	Surrogate	72-107%
		PAH	Surrogate	78-69%
16407-16417	21/08/2007	OCP	Spike	84-120%
		TPH	Spike	103-120%
		BTEX	Surrogate	97-100%
		PAH	Spike	92-106%
		Metals	Matrix Spike	90-115%
		Nutrients	Matrix Spike	100-125%
		Inorganic	Matrix Spike	82-112%
22609-22618	7/11/2006	OCP	Spike	97-108%
		TPH	Spike	94-107%
		BTEX		94-108%
		PAH	Surrogate	62-117%
		Metals	Matrix Spike	94-110%
		Nutrients	Matrix Spike	98-100%
		Inorganic	Matrix Spike	101-105%
30775-30781	15/01/2007	OCP	Spike	89-102%
		TPH	Spike	102%
		Metals	Matrix Spike	84-115%
		Nutrients	Matrix Spike	93-110%
		Inorganic	Matrix Spike	90-113%

Appendix G

Ecotoxicological Program

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

From: Juliet.Cole@dec.wa.gov.au
To: bernadette.vdw@hotmail.com; Ilona.Dsouza@dec.wa.gov.au
CC: Ilona.Dsouza@dec.wa.gov.au
Date: Wed, 9 Apr 2008 11:32:47 +0800
Subject: FW: Cygnia Cove Meeting Notes

Bernadette

Thanks for your email, and revised meeting minutes.

With regard to the availability of management plans – I will follow this up with Ilona de Souza.

I also note that the Ecotoxicological Testing Plan was approved by the SMS (James Treloar) on 23/10/2207 – and it appears that this plan has not been made publicly available. However, given you have requested a modification to the plan, the plan will need to be modified to reflect the amendment and then be made publicly available.

On this issue, I have received advice back from Steve Appleyard to indicate that "Provided that testing is carried out in an appropriate manner, the proposed changes are considered acceptable". I will therefore write to you shortly accepting the modified change and a request that you provide an amended copy of the plan reflecting the modification.

Juliet

From: Bernadette Van der Wiele [mailto:bernadette.vdw@hotmail.com]
Sent: Wednesday, 9 April 2008 10:48 AM
To: Cole, Juliet
Cc: Alex Gregg; paul zuvela
Subject: Cygnia Cove Meeting Notes

Hello Juliet
Please find attached revised Meeting Notes incorporating your requested amendments.

With respect to the issue of 'public availability' of the Management Plans, I have reviewed Ministerial Statement 692 and the wording with respect to those Plans required to be made publicly available states:

'The proponent shall make the Wetland Management Plan required by condition 6-2 publicly available.'

Further Plans required to be made publicly available are 7-3 (Drainage, Nutrient, Irrigation & Water Quality Management Plan), 7-6 (Ecotoxicological Testing Plan) and 8-3 (Site (Soil & Groundwater) Contamination Investigation, Remediation & Validation Management Plan.

I have attached the EPA's document 'Procedure for Public Availability' provided to the proponent by the DEC's Audit branch. Can you please let me know whether this document has been superseded and if it has been please provide the latest version?

Kind regards and many thanks for your assistance.

Bernadette Van der Wiele

EndPlan Environmental Planning
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21 January 2008

Department of Environment & Conservation
Environmental Impact Assessment Division
The Atrium
168 St George's Terrace
PERTH WA 6000

Attention: Peter Walkington

Dear Peter,

**RE: EAST CLONTARF RESIDENTIAL DEVELOPMENT, WATERFORD, CITY OF SOUTH PERTH -
ECOTOXICOLOGICAL TESTING PLAN (STATEMENT 692)**

I refer to your letter dated 23 October 2007 approving the proposed ecotoxicological testing plan for the Clontarf Bay site as developed by Geotechnical Services Pty Ltd in May 2007.

On behalf of our client I am seeking a modification to the approved testing plan. The approved testing plan nominated a testing frequency of monthly for the duration of the development. We are requesting that this testing frequency be modified to monthly during the first 12 months of construction and thereafter quarterly with an annual review after the completion of each 12 months of monitoring. It should be noted that the remedial works proposed for the site will be completed within the first 12 month period and therefore the intensive monthly monitoring will be conducted during this period.

If you require further discussion on this request, please feel free to contact the undersigned on (08) 6462 7900 or via Paul_Zuvela@coffey.com.

For and on behalf of Coffey Environments Pty Ltd



PAUL ZUVELA
Manager (Environmental Planning)



DR PAUL VAN DER MOEDEL
Principal

cc.

Mr Alex Gregg, Richard Noble and Company

Proposal for Ecotoxicological Testing of Clontarf Bay Site

Prepared for

ATA Environmental

Report ECX07-0905

16 May 2007

Prepared by

Dr Jill Woodworth

**GEOTECHNICAL
SERVICES PTY LTD**

41-45 Furnace Road, Welshpool, Western Australia 6106
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Locked Bag 27, Cannington, Western Australia 6107
ACN 050 543 194

Email: jill@geotechnical-services.com.



Introduction

This proposal will address and fulfil the Ministerial Conditions for East Clontarf Residential Subdivision No 7 Water Quality

Following is a Scope of Work that will address the requirements of subsections 7-4, 7-5 and 7-6 of the ministerial statement:

“7 Water Quality

- 7-4 Prior to ground-disturbing activity, the proponent shall prepare an Ecotoxological Testing Plan to monitor the benthic habitat at the wetland discharge point into Clontarf Bay to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.
- 7-5 The proponent shall implement the Ecotoxological Testing Plan required by condition 7-4.
- 7-6 The proponent shall make the Ecotoxological Testing Plan required by condition 7-4 publicly available.”

Background

The proposed residential subdivision bound by Manning Road to the north, Centenary Avenue to the east, the Clontarf Aboriginal Education and Training College to the west, and Canning River (Clontarf Bay) to the south has the potential to release contaminants into the Canning River. If the ground is disturbed there is potential to release heavy metals and total petroleum hydrocarbons, thus increasing the contaminant load in the Canning River at the wetland discharge point.

A baseline study to assess the current state of the wetland discharge point has been performed using a unicellular algal growth test (Geotech Report ENV06-193) in August 2006 and a Microtox bacterial growth test (Geotech Report ECX07-2703) in March 2007. These results are shown in Table 1. Results for the microalgal growth inhibition assay showed that growth was enhanced in all concentrations of groundwater where some constituents of the samples were acting as nutrients. Therefore, the nutrients within the samples may be ameliorating or masking the effects of any toxicants present. The Microtox results showed that sites MW4 and MW5 exhibited toxicity to the bacteria. These two sites are closest to a former landfill site so would be expected to show some toxicity. However, these two sites are furthest from the wetland discharge site and would be unlikely to impact on the wetland discharge.

Table 1 Toxicity Test Results

Site	Algal IC50 %	Microtox EC50 %
MW1	>72.4	No Sample
MW2	>72.4	No Sample
MW3	>72.4	>90.9
MW4	>72.4	42.5
MW5	>72.4	34.9
MW6	>72.4	>90.9
MW7	>72.4	>90.9
Canning River Water	>100	>90.9

Proposal for Further Testing

A range of bioassays using different species from several different trophic levels are commonly used to assess environmental samples following the ANZECC (2000) Water Quality Guidelines. Several species are used as the sensitivities of different species varies eg. one species may be very sensitive and another may be very tolerant, as shown in the preliminary tests.

As the salinity of the Canning River varies from 10 ppt (as measured in August 2006) to 41 ppt (as measured in March 2007), the benthic communities at the discharge site would not remain static throughout the year. As the salinity changes, the organisms living in or on the benthos would move to a more suitable site. Therefore, performing tests on Canning River organisms is not feasible due to the changing community structure and salinities. To overcome this problem Geotech proposes to perform a suite of bioassays using freshwater species indigenous to the wetland to characterise the toxicity of the discharge. Geotech also propose to assess the toxicity of the sediment using an indigenous amphipod (*Grandiderellia* sp.).

Proposed Bioassays

Geotech proposes to use Microtox as a screening test and then as a routine monitoring test and a suite of freshwater bioassays listed in Table 2.

Microtox

The basic technology of the Microtox Test System is based upon the use of luminescent bacteria, specifically the strain *Vibrio fischeri* NRRL B-11177, to measure toxicity from environmental samples. When properly grown, luminescent bacteria produce light as a by-product of their cellular respiration. Cell respiration is fundamental to cellular metabolism and all associated life processes. Bacterial bioluminescence is tied directly to cell respiration, and any inhibition of cellular activity (toxicity) results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence. The more toxic the sample, the greater the percent light loss from the test suspension of luminescent bacteria.

Bacterial bioluminescence has proved to be a convenient measure of cellular metabolism and consequently, a reliable sensor for measuring the presence of toxic chemicals in aquatic samples. Strain 11177 was originally chosen for the acute and chronic tests because it displayed a high sensitivity to a broad range of chemicals.

Table 2. Freshwater Bioassays

Test	Species	Duration	End Point
Unicellular Alga	<i>Chlorella sp.</i>	72 hours	Growth
Duckweed	<i>Lemna sp.</i>	7 days	Growth
Daphnia	<i>Ceriodaphnia dubia</i>	7 Days	Reproduction
Copepod	<i>Unidentified</i>	26 days	Reproduction
Larval Fish	Pygmy Perch	7 days	Growth

Unicellular Alga Growth

Algae are primary producers of organic matter upon which animals depend either directly or indirectly through the food chain. As such, test procedures using algae are valuable for determining the primary productivity of a water samples and for testing the toxicity of chemicals present in the water. The chronic toxicity test using marine microalgae are used to measure the effect of test materials on growth over a 72 h period. This test has the added benefit of measuring stimulatory as well as inhibitory effects. Geotech is proposing to use the common microalgal species *Chlorella protothecoides*. In Australia, the tests using *Chlorella protothecoides* have been widely used along side invertebrate toxicity tests.

Copepod Reproduction

The freshwater Copepod (*species unidentified*) is commonly found in freshwater systems around Perth. Copepods are the most common crustacean which live in the plankton and eat unicellular algae. This bioassay exposes more than one life stage to the discharge. This reproduction bioassay using the copepod is similar to the USEPA 7 day *Ceriodaphnia dubia* reproduction tests and the methodology is based on the USEPA Method 1002.0. This test assesses the reproductive ability of a female exposed to the toxicant from the neonate stage.

Daphnia Reproduction

As above similar to the copepod reproduction using the USEPA Method 1002.0 7 day Daphnia reproduction test.

Duckweed Growth Test

Duckweed (*Lemna* sp.) is a common plant in freshwater systems around Perth. Duckweed provides food and shelter for many freshwater organisms and is an important part of the ecosystem. This test uses the ASTM E 1415-91 (Reapproved 2004) methodology and uses growth after 7 days as the end point.

Larval Fish Growth

The test organism, the pygmy perch (*Edelia vittata*) is one of the most common and widespread freshwater fishes endemic to south-western Western Australia. It is found in rivers, streams, lakes and pools and is associated with riparian vegetation. *E. vittata* feeds on daphnia and copepods. The *E. vittata* larvae are obtained from naturally spawning commercial broodstock. Broodstock are fed a varied diet to ensure good quality larvae. The eggs are collected each morning and the quality determined. Only larvae from high quality eggs are used in the bioassays. The newly hatched larvae are grown for 7 days and the growth determined and used to calculate the EC50.

Amphipod Sediment Bioassay

Amphipods (a small “sand flea”-like crustacean) are an important component of the benthic community, providing food for birds, fish and larger invertebrates. Geotech proposes to perform a sediment bioassay using the local amphipod *Grandidierella* sp. with a sample of sediment taken from the site and compared with a control sample. This bioassay measures growth of the amphipod after 14 days exposure to the sediments.

Statistical Calculations

All statistical calculations are performed using the Tidepool Scientific ToxCalc v5. The concentration of discharge affecting 50% and 10% of the population (EC50 or IC50, EC10 or IC10) will be determined by a Probit analysis or the trimmed Spearman-Kärber Method. The concentration causing no observed effect (NOEC) and the lowest concentration causing an effect (LOEC) will be determined using an analysis of variance followed by Dunnett's or a non-parametric test, depending on normality of distribution.

The EC10 values of the freshwater tests will be used to calculate a protection value (99%, 95%, 90% or 80%) as determined by the DEC using the BurrliOZ statistics package as recommended by the ANZECC Water Quality Guidelines (2000).

Monitoring

In order to fulfil the Ministerial statements 7.4 Geotech suggests performing a suite of five bioassays on the species listed above following ground disturbance and a rain event. This will determine if toxicity has changed due to an increase in contaminants leaching from the site to obtain a “worst case scenario”.

A routine monitoring program is then recommended which involves screening of the site on a regular basis using Microtox on a monthly basis during construction and a three monthly basis after completion. If any changes are detected then a full investigation (a full suite of toxicity tests) and management procedures are implemented.

The results from this monitoring can be used to trigger further testing or implementation of management procedures if results are significantly above those obtained from the baseline data assessment. Sediments are long-term integrators of contaminants and need only to be monitored annually.

Statistical Analysis of Microtox Test Data

Microtox					
Start Date:	28/03/2007	Test ID:	ECX07-2703	Sample ID:	MW3
End Date:	28/03/2007	Lab ID:	Freo	Sample Type:	Groundwater
Sample Date:		Protocol:	GEOTECH WIENV30	Test Species:	Vibrio fischeri
Comments:					

Conc-%	1	2	3
Control	1.0000	1.0000	1.0000
3.37	0.7780	0.7230	0.7140
10.1	0.7170	0.7230	0.7210
30.3	0.6520	0.6560	0.6460
90.91	0.5440	0.5150	0.5140

Transform: Arcsin Square Root										1-Tailed Critical	MSD	Number Resp	Total Number
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat					
Control	1.0000	1.0000	1.5208	1.5208		0.000	3					0	300
*3.37	0.7383	0.7383	1.0344	1.0065		3.861	3	30.347	2.470	0.0396		79	300
*10.1	0.7203	0.7203	1.0136	1.0099		0.336	3	31.648	2.470	0.0396		84	300
*30.3	0.6513	0.6513	0.9391	0.9336		0.562	3	36.291	2.470	0.0396		104	300
*90.91	0.5243	0.5243	0.8098	0.7994		2.108	3	44.365	2.470	0.0396		143	300

Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.86454	0.835	1.33721	3.86753	
Equality of variance cannot be confirmed										
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<3.37	3.37			0.00551	0.00552	0.21922	0.00039	9.6E-12	4, 10

Microtox					
Start Date:	28/03/2007	Test ID:	ECX07-2703	Sample ID:	MW4
End Date:	28/03/2007	Lab ID:	Freo	Sample Type:	Groundwater
Sample Date:		Protocol:	GEOTECH WIENV30	Test Species:	Vibrio fischeri
Comments:					

Conc-%	1	2	3
Control	1.0000	1.0000	1.0000
3.37	0.7160	0.6980	0.6960
10.1	0.6630	0.6450	0.6580
30.3	0.5160	0.5160	0.5460
90.91	0.4060	0.4390	0.4170

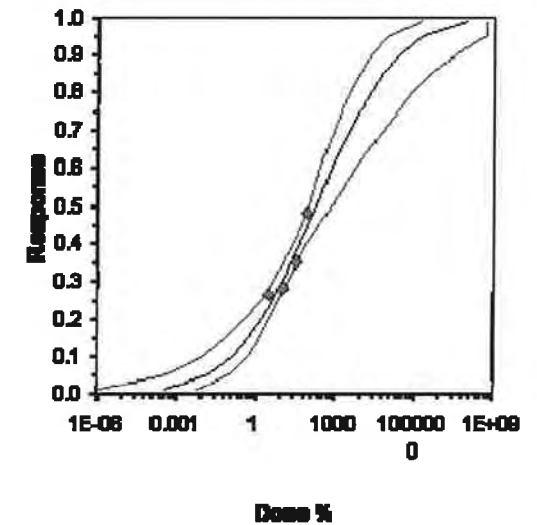
Transform: Arcsin Square Root										1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number	Number
Control	1.0000	1.0000	1.5208	1.5208		1.5208	3	0.000			0	300	
*3.37	0.7033	0.7033	0.9948	0.9868		1.0088	3	49.931	2.470	0.0260	88	300	
*10.1	0.6553	0.6553	0.9434	0.9325		0.9514	3	54.818	2.470	0.0260	104	300	
*30.3	0.5260	0.5260	0.8114	0.8014		0.8315	3	67.344	2.470	0.0260	141	300	
*90.91	0.4207	0.4207	0.7057	0.6908		0.7242	3	77.381	2.470	0.0260	173	300	

Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.92355	0.835	0.65639	-0.5823	
Equality of variance cannot be confirmed										
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<3.37	3.37			0.00327	0.00328	0.29738	0.00017	3.2E-14	4, 10

					Maximum Likelihood- Probit Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Parameter	Value	SE	95% Fiducial Limits								
Slope	0.40697	0.07107	0.26766	0.54627	0	3.58727	5.99148	0.17	2.26823	2.4572	3

Intercept
TSCR

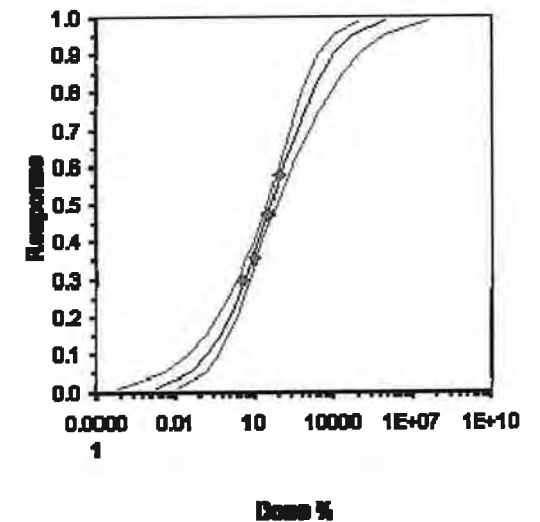
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	0.00036	1.2E-06	0.00585
EC05	3.355	0.01685	0.00042	0.10479
EC10	3.718	0.13158	0.00941	0.49169
EC15	3.964	0.52663	0.07609	1.40779
EC20	4.158	1.58563	0.39521	3.29194
EC25	4.326	4.08203	1.58347	6.99895
EC40	4.747	44.2289	28.4869	85.9688
EC50	5.000	185.451	93.3251	674.956
EC60	5.253	777.596	282.12	5742.86
EC75	5.674	8425.28	1707.99	209614
EC80	5.842	21690	3473.88	877910
EC85	6.036	65305.8	7934.58	4668608
EC90	6.282	261369	22396.7	3.8E+07
EC95	6.645	2041548	104059	4.9E+08
EC99	7.326	9.6E+07	1850052	4.9E+08



					Maximum Likelihood- Probit Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Parameter	Value	SE	95% Fiducial Limits								
Slope	0.53255	0.07005	0.39525	0.66985	0	1.06138	5.99148	0.59	1.62872	1.87776	3

Intercept
TSCR

Point	Probits	%	95% Fiducial Limits	
EC01	2.674	0.00182	7.2E-05	0.01231
EC05	3.355	0.03468	0.0038	0.12934
EC10	3.718	0.16683	0.03128	0.45536
EC15	3.964	0.48144	0.129	1.06932
EC20	4.158	1.11777	0.39562	2.11898
EC25	4.326	2.30242	1.02664	3.84005
EC40	4.747	14.223	10.0172	19.4641
EC50	5.000	42.532	30.3134	67.2261
EC60	5.253	127.187	78.163	272.499
EC75	5.674	785.684	346.455	3040.48
EC80	5.842	1618.38	620.163	7988
EC85	6.036	3757.44	1219.39	24689.7
EC90	6.282	10843.4	2848.28	102368
EC95	6.645	52162.9	9987.59	844929
EC99	7.326	993223	104624	4.4E+07



Microtox					
Start Date:	28/03/2007	Test ID:	ECX07-2703	Sample ID:	MW5
End Date:	28/03/2007	Lab ID:	Freo	Sample Type:	Groundwater
Sample Date:		Protocol:	GEOTECH WIENV30	Test Species:	Vibrio fischeri
Comments:					

Conc-%	1	2	3
Control	1.0000	1.0000	1.0000
3.37	0.7110	0.7560	0.7700
10.1	0.7340	0.7240	0.7200
30.3	0.5800	0.6940	0.6430
90.91	0.2370	0.2930	0.2780

Transform: Arcsin Square Root										1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number	Number
Control	1.0000	1.0000	1.5208	1.5208		0.000	3				0		300
*3.37	0.7457	0.7457	1.0427	1.0032		3.370	3	17.006	2.470	0.0694	76		300
*10.1	0.7260	0.7260	1.0199	1.0132		0.794	3	17.815	2.470	0.0694	83		300
*30.3	0.6390	0.6390	0.9269	0.8657		6.421	3	21.123	2.470	0.0694	109		300
*90.91	0.2693	0.2693	0.5453	0.5085		6.042	3	34.698	2.470	0.0694	219		300

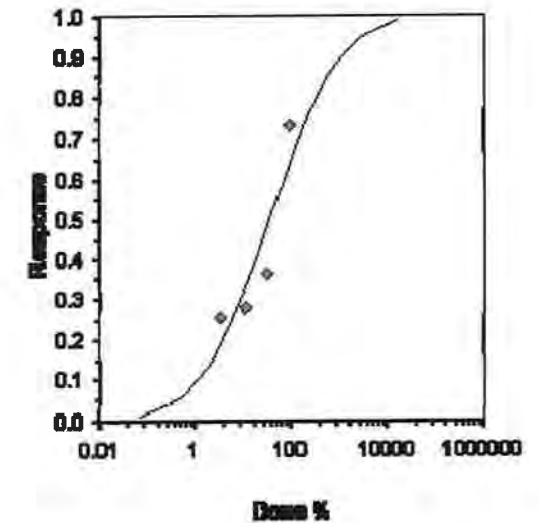
Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.93686	0.835	-0.349	0.90611	
Equality of variance cannot be confirmed										
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<3.37	3.37			0.0117	0.01173	0.3637	0.00119	2.1E-10	4, 10

					Maximum Likelihood-Probit						
Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	0.86081	0.31471	-0.4933	2.21491	0	36.9427	5.99148	9.5E-09	1.54385	1.16169	3

Intercept 3.67103 0.43685 1.79141 5.55066
TSCR

Point	Probits	%	95% Fiducial Limits
EC01	2.674	0.0694	
EC05	3.355	0.42957	
EC10	3.718	1.13522	
EC15	3.964	2.18692	
EC20	4.158	3.6825	
EC25	4.326	5.75835	
EC40	4.747	17.7638	
EC50	5.000	34.9821	
EC60	5.253	68.8902	
EC75	5.674	212.517	
EC80	5.842	332.315	
EC85	6.036	559.578	
EC90	6.282	1077.98	
EC95	6.645	2848.76	
EC99	7.326	17633.6	

Significant heterogeneity detected (p = 9.51E-09)



Microtox					
Start Date:	28/03/2007	Test ID:	ECX07-2703	Sample ID:	MW6
End Date:	28/03/2007	Lab ID:	Freo	Sample Type:	Groundwater
Sample Date:		Protocol:	GEOTECH WIENV30	Test Species:	Vibrio fischeri
Comments:					
Conc-%	1	2	3		
Control	1.0000	1.0000	1.0000		
3.37	0.7780	0.7700	0.7400		
10.1	0.7530	0.7390	0.7520		
30.3	0.7000	0.5200	0.7240		
90.91	0.6560	0.6780	0.6440		

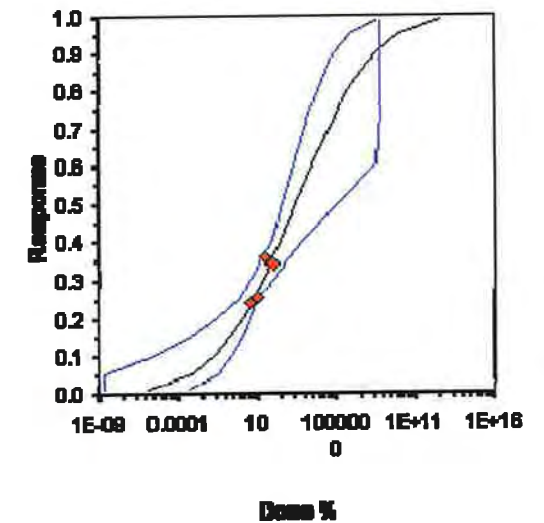
Transform: Arcsin Square												
Conc-%	Mean	N-Mean	Root			CV%	N	t-Stat	1-Tailed Critical	MSD	Number Resp	Total Number
			Mean	Min	Max							
Control	1.0000	1.0000	1.5208	1.5208		0.000	3				0	300
*3.37	0.7627	0.7627	1.0622	1.0357		2.203	3	10.489	2.470	0.1080	71	300
*10.1	0.7480	0.7480	1.0449	1.0346		0.858	3	10.884	2.470	0.1080	76	300
*30.3	0.6480	0.6480	0.9381	0.8054		12.329	3	13.327	2.470	0.1080	106	300
*90.91	0.6593	0.6593	0.9476	0.9315		1.924	3	13.109	2.470	0.1080	102	300

Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)						0.80812	0.835	-1.5035	5.62756	
Equality of variance cannot be confirmed										
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<3.37	3.37			0.02226	0.02232	0.17319	0.00287	5.8E-07	4, 10

Parameter	Value	SE	95% Fiducial Limits	Maximum Likelihood-Probit						
				Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	0.25089	0.072	0.10978 0.39201	0	3.13021	5.99148	0.21	3.40036	3.98573	3

Intercept 4.14687 0.09922 3.9524 4.34133
TSCR

Point	Probits	%	95% Fiducial Limits	
EC01	2.674	1.3E-06	2.1E-09	0.00051
EC05	3.355	0.0007	2.1E-09	0.02857
EC10	3.718	0.01961	2.7E-06	0.24622
EC15	3.964	0.18596	0.00045	1.06982
EC20	4.158	1.11144	0.02557	3.54758
EC25	4.326	5.15262	0.73781	10.9264
EC40	4.747	245.804	83.0302	7900.31
EC50	5.000	2513.99	395.409	1492183
EC60	5.253	25712.1	1799.17	2.9E+08
EC75	5.674	1226586	21783.8	4.9E+08
EC80	5.842	5686425	58408.3	4.9E+08
EC85	6.036	3.4E+07	184173	4.9E+08
EC90	6.282	3.2E+08	780234	4.9E+08
EC95	6.645	9E+09	6619521	4.9E+08
EC99	7.326	4.7E+12	3.6E+08	4.9E+08



Microtox					
Start Date:	28/03/2007	Test ID:	ECX07-2703	Sample ID:	MW7
End Date:	28/03/2007	Lab ID:	Freo	Sample Type:	Groundwater
Sample Date:		Protocol:	GEOTECH WIENV30	Test Species:	Vibrio fischeri
Comments:					
Conc-%	1	2	3		
Control	1.0000	1.0000	1.0000		
3.37	0.7590	0.7800	0.7950		
10.1	0.7400	0.7860	0.7440		
30.3	0.6520	0.7050	0.6530		
90.91	0.5000	0.4940	0.5060		

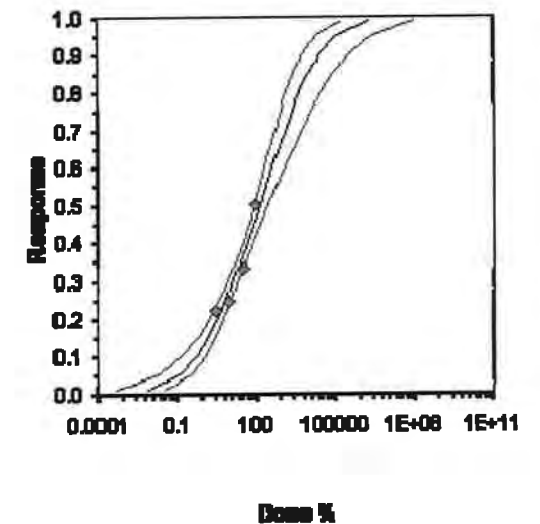
Transform: Arcsin Square Root										1-Tailed		Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number	Number
Control	1.0000	1.0000	1.5208	1.5208			3	0.000			0	300	
*3.37	0.7780	0.7780	1.0804	1.0577			3	24.293	2.470	0.0448	66	300	
*10.1	0.7567	0.7567	1.0553	1.0357			3	25.677	2.470	0.0448	73	300	
*30.3	0.6700	0.6700	0.9591	0.9398			3	30.983	2.470	0.0448	99	300	
*90.91	0.5000	0.5000	0.7854	0.7794			3	40.566	2.470	0.0448	150	300	

Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.89075	0.835		0.83459	0.04301
Equality of variance cannot be confirmed										
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<3.37	3.37			0.00646	0.00648	0.22222	0.00049	3.0E-11	4, 10

					Maximum Likelihood-Probit						
Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	0.55105	0.0727	0.40856	0.69354	0	5.61243	5.99148	0.06	2.10968	1.81472	3

Intercept
TSCR

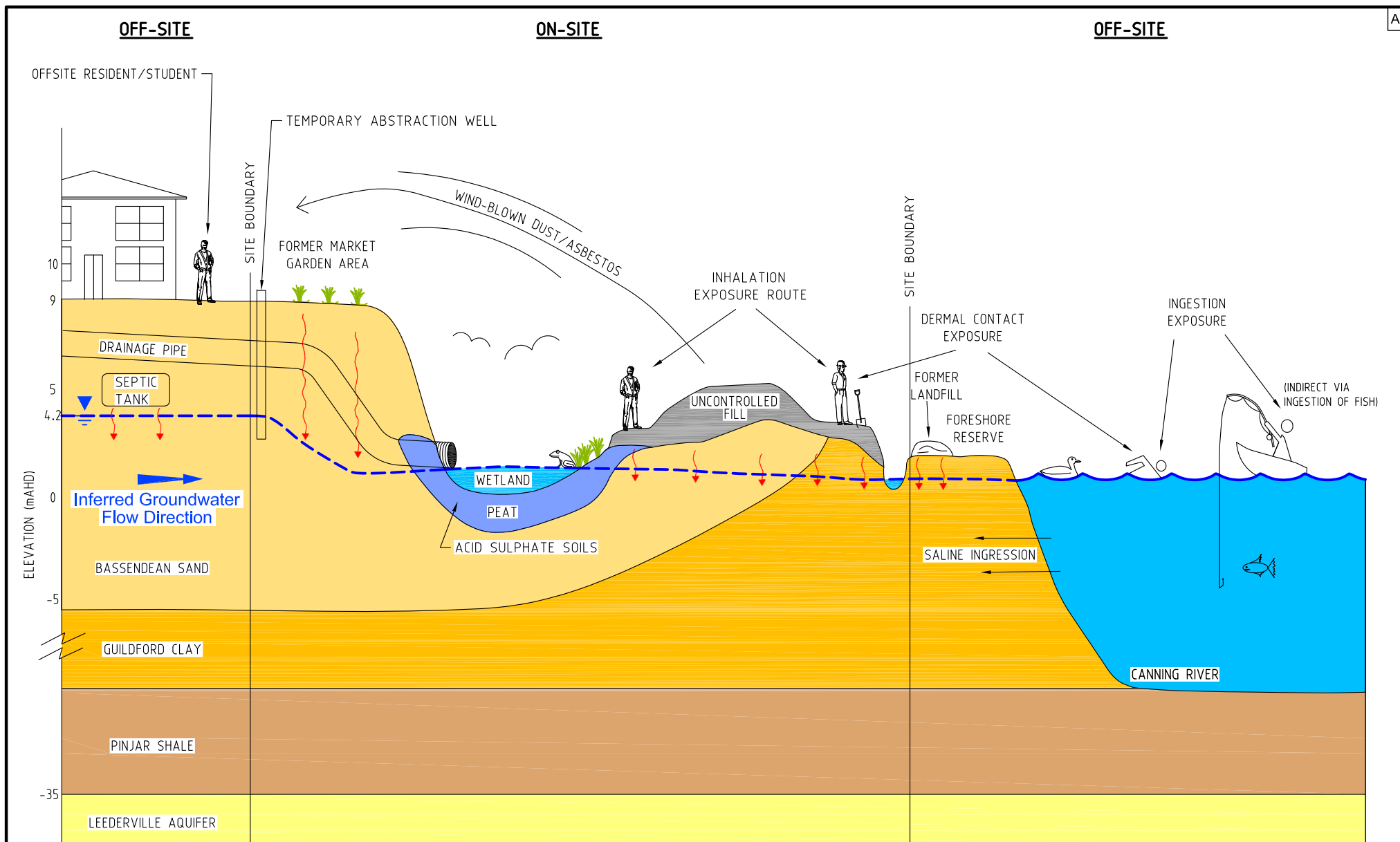
Point	Probits	%	95% Fiducial Limits	
EC01	2.674	0.00773	0.00049	0.03971
EC05	3.355	0.13327	0.02243	0.38664
EC10	3.718	0.60816	0.17111	1.31189
EC15	3.964	1.69371	0.66754	3.02061
EC20	4.158	3.82269	1.94155	5.94501
EC25	4.326	7.6854	4.73175	10.8979
EC40	4.747	44.6605	31.9015	70.2418
EC50	5.000	128.729	79.8638	271.305
EC60	5.253	371.05	190.969	1097.09
EC75	5.674	2156.2	790.625	11515.4
EC80	5.842	4334.97	1384.01	29388.2
EC85	6.036	9784	2654.49	87712.2
EC90	6.282	27248.2	6015.18	347683
EC95	6.645	124345	20185.1	2682093
EC99	7.326	2144634	194962	1.2E+08



Appendix H

Conceptual Site Models

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA



THIS IS ONE INTERPRETATION ONLY
OTHER INTERPRETATIONS ARE POSSIBLE.

NOTE:
DIAGRAMMATIC-NOT TO SCALE

Rev	Date	Revision Details	Drn
A	22.08.08	ISSUE	LZ

coffey
environments
SPECIALISTS IN LIVING
AND WORKING PLACES

Ground Floor
89-91 Burswood Rd
Burswood, WA 6100
Ph: (08) 9355 7100
Fax: (08) 9355 7197

Client:
**TRUSTEES OF THE CHRISTIAN
BROTHERS IN WESTERN
AUSTRALIA INCORPORATED**

Project:
CYGNIA COVE DEVELOPMENT
(FORMERLY EAST CLONTARF)
Location:
LOT 83 AND LOTS 501 & 829 MANNING ROAD
WATERFORD, WESTERN AUSTRALIA

Drawing Title:
**SITE CONCEPTUAL MODEL (A)
CYGNIA COVE, WATERFORD**

Coffey Environments Pty Ltd © DRAFT		
Drawn LZ	Date 22.08.08	
Project - Drawing No. ENVIBURW11899AA-D02	Figure No.	Rev. A

NOTE:
DIAGRAMMATIC-NOT TO SCALE

[illegible]

Appendix I

Groundwater Monitoring Bore Logs (2008)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

Drilling Log

Monitoring Well

ASSMW10

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 7.3 m. Total Hole Depth 8.0 m. North 6457407.53 m East 396027.43 m.
 Top of Casing 7.67 m. Water Level Initial ▽ 4.0 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 5.0 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 3.0 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							
						SW	SAND: Brown, coarse grained, subrounded, well sorted, with a trace of rootlets, dry.
2						SW	SAND: Grey, coarse grained, subrounded, well sorted, moist/wet.
4							... Groundwater strike observed at 4.0m.
6						SW	SAND: White/grey, coarse grained, subrounded, well sorted, moist, wet.
8						SW	SAND: Black/brown/grey, medium grained, subrounded, well sorted, moist, wet/saturated.
							End of hole at 8.0m.
10							

Drilling Log

Monitoring Well

ASSMW11

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 6.1 m. Total Hole Depth 9.5 m. North 6457436.58 m East 395916.41 m.
 Top of Casing 6.60 m. Water Level Initial ▽ 4.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 5.5 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 4.0 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							
2						SW	SAND: White/grey, coarse grained, subrounded, well sorted, dry/wet.
4							... Groundwater strike observed at 4.5m.
6						SW	SAND: Brown, medium/coarse grained, subrounded, well sorted, wet.
8						SW	SAND: White/grey, coarse grained, subrounded, well sorted, wet/saturated.
10							End of hole at 9.0m.

Drilling Log

Monitoring Well

ASSMW12

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 5.7 m. Total Hole Depth 8.0 m. North 6457426.73 m East 395654.12 m.
 Top of Casing 6.34 m. Water Level Initial ▽ 4.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 4.5 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 3.5 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						SP	SAND: Brown/grey, fine/coarse grained, subrounded, poorly sorted, dry.
2						SW	SAND: White/brown, coarse grained, subrounded, well sorted, dry.
						SW	SAND: Orange/yellow, fine/medium grained, subrounded, well sorted, dry/damp.
4						SW	SAND: Black/brown, medium grained, subrounded, well sorted, moist.
						SW	SAND: Orange/yellow, fine/medium grained, subrounded, well sorted, wet.
						SW	... Water inflow observed at 4.5m.
						SW	SAND: White/brown, medium grained, subrounded, well sorted, wet.
6						CL CH	SAND: White/brown/grey, medium to coarse grained, subrounded, well sorted, wet.
						SW	CLAY: Grey, moderate plasticity, soft, (<= wet plastic limit), with some fine grained sand, subangular, damp.
						SW	SAND: White/grey, coarse grained, subrounded, well sorted, wet/saturated.
						SW	SAND: White/brown, coarse grained, subrounded, well sorted, saturated.
8							End of hole at 8.0m.
10							

Drilling Log

Monitoring Well

ASSMW13

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 3.1 m. Total Hole Depth 6.0 m. North 6457313.19 m East 395633.17 m.
 Top of Casing 3.68 m. Water Level Initial ▽ 2.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 4.4 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 1.5 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							
						SW	SAND: Grey, medium/coarse grained, subrounded, well sorted, dry.
2						SW	SAND: Black, non plastic, coarse grained, subrounded, well sorted, moist.
						SW	SAND: Grey, medium grained, subrounded, moderately sorted, with some low to moderate plasticity clay, soft/firm, (<= wet plastic limit), dry. ... Groundwater strike observed at 2.45m.
4						SW	SAND: Grey, coarse grained, subrounded, well sorted, wet/saturated.
6							... Borehole collapsed and backfilled from 5.9-6.0m. End of hole at 6.0m.
8							
10							

Drilling Log

Monitoring Well

ASSMW8

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 2.8 m. Total Hole Depth 5.0 m. North 6457293.54 m East 395733.94 m.
 Top of Casing 3.41 m. Water Level Initial ▽ 2.0 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 4.0 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 1.0 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						SW	SAND: Brown, medium grained, subrounded, moderately sorted, with some rootlets, dry.
						SW	SAND: Brown/grey, coarse grained, subrounded, well sorted, with some rootlets, dry.
2						SW	... Groundwater Strike observed at 2.0m.
						PT	SAND: Grey, coarse grained, subrounded, well sorted, moist.
							PEAT: Dark brown/black, wet.
							SAND: Grey, coarse grained, subrounded, well sorted, wet/saturated.
4						SW	...Saturated at 4.3m.
6							End of hole at 5.0m.
8							
10							

Drilling Log

Monitoring Well

ASSMW9

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. 4.6 m. Total Hole Depth 6.5 m. North 6457230.34 m East 395941.23 m.
 Top of Casing 5.24 m. Water Level Initial ▽ 4.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 3.0 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 3.5 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 17/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						SW	SAND: White/brown, medium/coarse grained, subrounded, well sorted, dry.
						SW	SAND: Orange/yellow, medium/coarse grained, subrounded, well sorted, dry.
2						SW	SAND: Brown, medium/coarse grained, subrounded, well sorted, dry.
						CL CH	CLAY: Red/brown, moderate plasticity, firm, (= wet plastic limit), with some fine/medium grained sand lenses, subrounded, dry. ... Groundwater encountered perched on top of clay horizon at 3.3m.
4						SW	SAND: Grey, coarse grained, subrounded, well sorted, moist/wet. ... groundwater strike observed at 5.24m.
6							End of hole at 6.5m.
8							
10							

Drilling Log

Monitoring Well **MW(1A)**

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. NA Total Hole Depth 10.0 m. North _____ East _____
 Top of Casing NA Water Level Initial ▽ 6.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 4.5 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 5.5 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 22/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0							SAND: Brown, coarse grained, subrounded, well sorted, dry.
2						SW	SAND: Orange, coarse grained, subrounded, well sorted, dry.
4						SP	SAND: Pale orange/yellow, medium/coarse grained, subrounded, moderately sorted, dry.
						SW	SAND: Grey, coarse grained, subrounded, well sorted, dry.
						SW	SAND: Brown/grey, coarse grained, subrounded, well sorted, dry.
6						SW	SAND: Pale grey, coarse grained, subrounded, well sorted, with some low plasticity clay and some silt, damp.
							SAND: White/pale grey, coarse grained, subrounded, well sorted, dry.
							...Groundwater strike at 6.5m.
8						SW	
10							End of hole at 10.0m

Drilling Log

Monitoring Well

MW(2A)

Page: 1 of 1

Project Cygnia Cove (ENVIBURW11899AA) Owner Trustees Of Christian Brothers
 Location Manning Road, Waterford Proj. No. EB11899AA
 Surface Elev. NA Total Hole Depth 10.0 m. North _____ East _____
 Top of Casing NA Water Level Initial ▽ 6.5 m. Static NA Diameter 100 mm.
 Screen: Dia 50 mm. Length 4.5 m. Type/Size Class 18 PVC/0.5 mm.
 Casing: Dia 50 mm. Length 5.5 m. Type Class 18 PVC
 Fill Material Sand, bentonite, cuttings Rig/Core SONIC
 Drill Co. STRATAPROBE Method SONIC
 Driller John McCabe Log By PL Date 22/10/08 Permit # NA
 Checked By PL License No. NA

COMMENTS

Screen length extended to accommodate drawdown effects & enable G.W. monitoring during dewatering works.

Depth (m.)	Well Completion	NA (ppm)	Sample ID % Recovery	Blow Count Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic descriptions are based on ASTM Standard D 2487-93 and the USCS.
0						SW	SAND: Pale brown, medium/coarse grained, subrounded, well sorted, dry.
						SW	SAND: Brown/grey, coarse grained, subrounded, well sorted, dry.
						SW	SAND: Pale orange/yellow, coarse grained, subrounded, well sorted, dry.
2						SW	SAND: Orange, coarse grained, subrounded, well sorted, dry.
						SW	SAND: Pale orange, medium/coarse grained, subrounded, well sorted, dry.
4						SW	SAND: White/grey, medium/coarse grained, subrounded, well sorted, dry.
						SW	SAND: White/pale brown/grey, coarse grained, subrounded, well sorted, damp.
6						SW	SAND: Orange/brown, coarse grained, subrounded, well sorted, damp. ...Damp at 6.0-6.2m. ...Moist at 6.2-6.5m. ..Wet/saturated from 6.5-10.0m, with groundwater strike at 6.5m.
8						SW	
10							End of hole at 10.0m.

Appendix J

Survey Data

**Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA**

CYGNIA COVE ASSMW BOREHOLE LOCATIONS

Description	Easting (MGA)	Northing (MGA)	Top of Casing (AHD)	Ground Level (AHD)
ASS MW8	395733.94	6457293.54	3.41	2.77
ASS MW9	395941.23	6457230.34	5.24	4.61
ASS MW10	396027.43	6457407.53	7.67	7.34
ASS MW11	395916.41	6457436.58	6.60	6.07
ASS MW12	395654.12	6457426.73	6.34	5.72
ASS MW13	395633.17	6457313.19	3.68	3.08

Appendix K
Baseline Groundwater Monitoring
Field Records (2008)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

APPENDIX K
Groundwater Gauging and Field Water Quality Parameters (2008)
Cygnia Cove Baseline Groundwater Monitoring and Management Plan

Well ID	Date	TOC Elevation (mAHD)	Depth to Water (mbtoc)	Total Depth (mbtoc)	PSH Thickness (m)	Corrected Water Elevation (mAHD)	DO (mg/L)	EC * (uS/cm)	Redox Eh (mV)	pH	Temp (0C)	TDS ** (mg/l)	Purge Volume (L)
MW1(A)	28-Oct-08	6.860	3.570	10.395	ND	3.290	0.82	720.00	101.00	5.41	20.09	468	10
MW2(A)	28-Oct-08	9.550	6.562	10.380	ND	2.988	2.05	449.00	191.00	6.08	20.10	292	10
MW3	28-Oct-08	7.910	4.090	7.935	ND	3.820	0.41	525.00	64.00	6.27	20.81	341	10
MW4	29-Oct-08	3.080	0.920	3.880	ND	2.160	0.28	977.00	-96.00	6.62	16.41	635	12
MW5	29-Oct-08	2.100	1.200	3.760	ND	0.900	0.28	840.00	-125.00	6.95	17.95	546	10
MW6	29-Oct-08	0.990	0.545	4.460	ND	0.445	0.50	1057.00	51.00	5.78	18.93	687	12
MW7	29-Oct-08	1.690	1.317	3.470	ND	0.373	0.30	659.00	-60.00	6.52	19.33	428	8
ASSMW8	29-Oct-08	3.410	2.203	5.590	ND	1.207	0.35	909.00	-20.00	6.20	15.86	591	10
ASSMW9	29-Oct-08	5.240	3.160	6.987	ND	2.080	0.56	800.00	-61.00	5.99	19.24	520	8
ASSMW10	28-Oct-08	7.670	3.995	8.300	ND	3.675	2.47	567.00	128.00	5.89	20.36	369	6
ASSMW11	28-Oct-08	6.600	3.118	9.660	ND	3.482	0.71	431.00	18.00	6.29	20.01	280	12
ASSMW12	28-Oct-08	6.340	3.874	8.650	ND	2.466	4.65	1710.00	311.00	4.64	19.02	1112	8
ASSMW13	28-Oct-08	3.680	2.003	6.470	ND	1.677	0.67	426.00	71.00	5.62	20.19	277	8
							Minimum	0.28	426	-125	4.64	15.86	277
							Maximum	4.65	1710	311	6.95	20.81	1112
							Average	1.08	774.62	44.08	6.02	19.10	503.50

Notes:

ID = Identification

EC = Electrical Conductivity (or Specific Conductance)

TDS = Total dissolved solids

** TDS (mg/l) = EC (uS/cm) X 0.65

TOC = Top of casing

mAHD = metres above Australian Height Datum

mbtoc = metres below top of casing

DO = Dissolved oxygen

m = metres

All gauging measurements made pre-purge, all water quality measurements made post-purge.

PSH = Phase separated hydrocarbons

mV = millivolts

uS/cm = microsiemens per centimetre

L = litres

mg/L = milligrams per litre

ND = None Detect

Field Equipment Used:

Herron Interface Probe

Hydrolab HLQ3

Geotech Peristaltic Pump

Project Name: Cygnia Cove		Date: 28 th October 2008
Project Number: ENVIBURW11899AA		Arrival Time: <u>9.00</u>
Field Personnel: Ron Everest & Pamela Lee		Departure Time: <u>17.45</u>
Project Manager: Pamela Lee		
Purpose of Visit (Tick Appropriate Box)		
Drilling <input type="checkbox"/>	GW Sampling <input checked="" type="checkbox"/>	Soil Sampling <input type="checkbox"/>
Gauging <input type="checkbox"/>	Cable locating <input type="checkbox"/>	Other <input type="checkbox"/>
Site inspection <input type="checkbox"/>	Tank removal and validation <input type="checkbox"/>	Specify: _____

Equipment Used (Provide ID Number)

FID: _____	LEL/O2/Toxic Gas Meter: _____
PID: _____	Water Quality Meter: <u>HYDROLAB HLQ3</u>
IP: _____	Other Meter: <u>GEOTECH PERISTALTIC PUMP</u> <u>HEWON WATER LEVEL METER</u>

Equipment calibrated prior to use, and/or equipment calibration records checked: ☒

Other Calibration Performed (if any): _____

Sampling

Sampling Conducted: Y <input checked="" type="checkbox"/> N <input type="checkbox"/>	Matrix: Soil <input type="checkbox"/> Water <input checked="" type="checkbox"/> Other <input type="checkbox"/>
COC Completed and Samples Sent: Y <input checked="" type="checkbox"/> N <input type="checkbox"/>	COC No(s): <u>80285 TO 80288</u>
Primary Lab: <u>MGT</u>	Secondary Lab: <u>SGS</u>

Description of Activities (e.g., What did you do—drilled 3 soil borings (i.e. SB1—SB7)—installed 3 MWs, etc.)

GAUGED PUMPS AND SAMPLED 8 MWs

Attached Forms

Daily Field Summary: Y <input type="checkbox"/> N <input checked="" type="checkbox"/>	Relevant Field Forms (list): _____
Site Map / Sketch: Y <input checked="" type="checkbox"/> N <input type="checkbox"/>	Others (Specify): _____
Field Quality Control Log Y <input checked="" type="checkbox"/> N <input type="checkbox"/>	

FIELD REPORTING COVER SHEET

Project Name: Cygnia Cove

Date: 29th October 2008

Project Number: ENVIBURW11899AA

Arrival Time: 8.30

Field Personnel: Ron Everest

Departure Time: 15.00

Project Manager: Pamela Lee

Purpose of Visit (Tick Appropriate Box)

Drilling	<input type="checkbox"/>	GW Sampling	<input checked="" type="checkbox"/>	Soil Sampling	<input type="checkbox"/>
Gauging	<input type="checkbox"/>	Cable locating	<input type="checkbox"/>	Other	<input type="checkbox"/>
Site inspection	<input type="checkbox"/>	Tank removal and validation	<input type="checkbox"/>	Specify:	

Equipment Used (Provide ID Number)

FID: _____	LEU/O2/Toxic Gas Meter: _____
PID: _____	Water Quality Meter: HYDROLAB HQ93
IP: _____	Other Meter: GROTACH PERISTALTIC PUMP HARDY WATER LEVEL METER

Equipment calibrated prior to use, and/or equipment calibration records checked: ☒

Other Calibration Performed (if any): _____

Sampling

Sampling Conducted: Y ☒ N ☐ Matrix: Soil ☐ Water ☒ Other ☐

COC Completed and Samples Sent: Y ☐ N ☐ COC No(s): 80285 TO 80288

Primary Lab: MGT Secondary Lab: SGS

Description of Activities (e.g. What did you do—drilled 3 soil borings (i.e. SB1—SB7), installed 3 MWs, etc.

GAUGED, PURGED AND SAMPLED 5 MWs

Attached Forms

Daily Field Summary: Y ☐ N ☒

Relevant Field Forms (list): _____

Site Map / Sketch: Y ☒ N ☐

Others (Specify): _____

Field Quality Control Log Y ☒ N ☐

FIELD QUALITY CONTROL LOG

Project No. ENVIBURW11899AA

Date: 28th October 2008

Page 1 of 1

Project Name: Cygnia Cove

What Matrix is Being Sampled?

Field Personnel (Initials):

Project Manager (Initials):

Soil



Groundwater

☒

Other



Surface Water

[illegible]

WELL MONITORING (GAUGING) FORM

Project No: ENVIBURW11899AA

Date: 28/10/08

Page 1 of 1

Project Name: Cygnia Cove

Field Personnel: Ron Everest & Pamela Lee

Project Manager: Pamela Lee

Equipment: HERON WATER LEVEL METER

Time <i>AM</i>	Well ID	Well Diameter (mm)	Depth to PSH (Product) (mBTC) (A)	Depth to Groundwater (mBTC) (B)	Total Well Depth (mBTC)	PSH (Product) Thickness (mm) (B - A)	Height of Well Stickup (mm)	Comments (e.g Odour*, colour, sheen, product (and its colour), remediation system etc...)
9.00	ASSMW10	50	—	3.995	8.3000		0.375	
10.08	ASSMW11	50	—	3.118	9.660		0.500	
10.55	MW2(A)	50	—	6.562	10.380		0.40	
12.37	MW3	50	—	4.080	7.935		0.50	
14.30	MW1(A)	50	—	3.570	10.395		0.42	
15.21	ASSMW12	50	—	3.874	8.650		0.574	
16.28	ASSMW13	50	—	2.003	8.490		0.60	
17.18	MW7	50	—	1.317	3.470		0.48	
18.44	ASSMW9	50	—	3.160	6.987		0.635	
19.42	ASSMW8	50	—	2.203	5.590		0.640	
10.40	MW6	50	—	0.545	4.460		0.460	
12.12	MW5	50	—	1.200	3.760		0.530	
13.30	MW4	50	—	0.920	3.880		0.420	
14.44	MW6	50	—	1.532				

* Do not attempt to sniff the monitoring well to detect any odours, only note any apparent odour when the well cap is opened

Issue Date: 11/07/08

PROJECT NAME: Cygnia Cove				PROJECT NUMBER: ENVIBURW11899AA											
FIELD PERSONNEL: Ron Everest & Pamela Lee				DATE: 28/29 October 2008											
PROJECT MANAGER: Pamela Lee															
WELL ID: MW2 (A)			TOTAL WELL DEPTH: 10.380					SCREEN INTERVAL: 5.5-							
EQUIPMENT ID: HYDROLAB METER ID: HLG3			WELL DIAMETER: 50mm					WELL STICK-UP: 0.40							
PUMP INTAKE DEPTH: 7.0 m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: 6.562 m below TOC											
TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)	
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*		
11:35	NA	8		3.19		0.465		6.22		176		19.96			
		8		3.20		0.445		6.18		180		20.06			
		8		2.42		0.437		6.09		190		20.06			
		P.P.		2.05		0.449		6.08		191		20.10			
STABILISATION CRITERIA (3 Readings within following Ranges)			± 0.05	± 10%		± 10% ✓		± 10% ✓		± 10 mV ✓		± 0.1°C ✓			
DUPLICATE COLLECTED: <input checked="" type="checkbox"/> Y <input type="checkbox"/> N				DUPLICATE ID: QCI				TRIPLICATE COLLECTED: <input checked="" type="checkbox"/> Y <input type="checkbox"/> N				TRIPLICATE ID: QC2			
WERE METALS FIELD FILTERED? <input checked="" type="checkbox"/> Y <input type="checkbox"/> N				(UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))											

PROJECT NAME: Cygnia Cove				PROJECT NUMBER: ENVIBURW11899AA											
FIELD PERSONNEL: Ron Everest & Pamela Lee				DATE: 28-29 October 2008											
PROJECT MANAGER: Pamela Lee															
WELL ID: MW3				TOTAL WELL DEPTH: 7.935				SCREEN INTERVAL:							
EQUIPMENT ID: HYDROL 198				METER ID: HLC 93				WELL DIAMETER: 50				WELL STICK-UP: 0.50			
PUMP INTAKE DEPTH: 7.0 m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: 4.090, 4.093 m below TOC											
TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)	
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*		
pm															
0	NA														
12:47		2	4.090	1.76		0.519		6.65		134		20.75			
12:50		4	4.097	0.85		0.525		6.38		79		20.77			
12:55		6	4.097	0.66		0.521		6.30		60		20.78			
1:00		8	4.090	0.50		0.526		6.28		66		20.79			
1:03		10	4.093	0.41		0.525		6.27		64		20.81			
STABILISATION CRITERIA (3 Readings within following Ranges)				± 0.05 ✓		± 10% ✓		± 10% ✓		± 10 mV ✓		± 0.1°C ✓			
DUPLICATE COLLECTED: <input type="checkbox"/> Y <input checked="" type="checkbox"/> N				DUPLICATE ID: _____				TRIPLICATE COLLECTED: <input type="checkbox"/> Y <input checked="" type="checkbox"/> N				TRIPLICATE ID: _____			
WERE METALS FIELD FILTERED? <input checked="" type="checkbox"/> <input type="checkbox"/>				(UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE, 'METALS' BOTTLE))											

PROJECT NAME: <u>Cygnia Cove</u>				PROJECT NUMBER: <u>ENVIBURW11899AA</u>			
FIELD PERSONNEL: <u>Ron Everest & Pamela Lee</u>				DATE: <u>28/29 October 2008</u>			
PROJECT MANAGER: <u>Pamela Lee</u>							
WELL ID: <u>MW4</u>		TOTAL WELL DEPTH: <u>3.880</u>		SCREEN INTERVAL: _____			
EQUIPMENT ID: <u>HYDROLAB</u> METER ID: <u>4203</u>		WELL DIAMETER: <u>50 mm</u>		WELL STICK-UP: <u>0.42</u>			
PUMP INTAKE DEPTH: <u>3.00</u> m below TOC		DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: <u>0.920</u> / <u>0.925</u> m below TOC					

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	
0	NA													
13.42		2	1.320	0.55		0.990		6.77		-108		16.22		
13.46		4	1.507	0.46		0.983		6.69		-109		16.28		
13.53		6	1.653	0.38		0.997		6.72		-112		16.55		
14.00		8	1.805	0.32		0.997		6.70		-108		16.40		
14.07		10	1.935	0.31		0.989		6.67		-104		16.38		
14.15		12	2.090	0.28		0.977		6.62		-96		16.41		
STABILISATION CRITERIA (3 Readings within following Ranges)			± 0.05	✓ ± 10%		✓ ± 10%		✓ ± 10%		✓ ± 10 mV		✓ ± 0.1°C		

DUPLICATE COLLECTED: <input type="checkbox"/> Y <input checked="" type="checkbox"/> N WERE METALS FIELD FILTERED? <input checked="" type="checkbox"/> <input type="checkbox"/>	DUPLICATE ID: _____ (UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))
TRIPPLICATE COLLECTED: <input type="checkbox"/> Y <input checked="" type="checkbox"/> N TRIPLICATE ID: _____	

PROJECT NAME: <u>Cygnia Cove</u>				PROJECT NUMBER: <u>ENVIBURW11899AA</u>										
FIELD PERSONNEL: <u>Ron Everest & Pamela Lee</u>				DATE: <u>28/29 October 2008</u>										
PROJECT MANAGER: <u>Pamela Lee</u>														
WELL ID: <u>MW 5</u>		TOTAL WELL DEPTH: <u>3.760</u>				SCREEN INTERVAL: _____								
EQUIPMENT ID: <u>HYDROLAB</u>		METER ID: <u>HLQ3</u>		WELL DIAMETER: <u>50 mm</u>				WELL STICK-UP: <u>0.53</u>						
PUMP INTAKE DEPTH: <u>3.00</u> m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: <u>1.200</u> , <u>1.205</u> m below TOC										

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	
0	NA													
12.30		2.00	1.247	1.26		1.042		7.05		-99		18.09		
12.33		4.00	1.247	0.50		0.894		7.04		-110		17.95		
12.37		6.00	1.247	0.34		0.858		7.01		-118		17.95		
12.40		8.00	1.247	0.31		0.845		6.97		-123		17.94		
12.43		10.00	1.247	0.28		0.840		6.95		-125		17.95		
STABILISATION CRITERIA (3 Readings within following Ranges)			± 0.05	± 10%	± 10%	± 10%	± 10%	± 10 mV	± 0.1°C					

DUPLICATE COLLECTED: ☐ Y ☒ N
 DUPLICATE ID: _____

WERE METALS FIELD FILTERED? ☒ ☐ (UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))

TRIPPLICATE COLLECTED: ☐ Y ☒ N
 TRIPPLICATE ID: _____

PROJECT NAME: <u>Cygnia Cove</u>				PROJECT NUMBER: <u>ENVIBURW11899AA</u>			
FIELD PERSONNEL: <u>Ron Everest & Pamela Lee</u>				DATE: <u>28/29 October 2008</u>			
PROJECT MANAGER: <u>Pamela Lee</u>							
WELL ID: <u>MW6</u>		TOTAL WELL DEPTH: <u>4.460</u>		SCREEN INTERVAL: _____			
EQUIPMENT ID: <u>H7D46193</u>		METER ID: <u>H693</u>		WELL DIAMETER: <u>50 mm</u>		WELL STICK-UP: <u>0.46</u>	
PUMP INTAKE DEPTH: <u>3.5</u> m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: <u>0.495</u> / <u>0.506</u> m below TOC			

TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (mS or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	
0	NA													
10.51		2.00	1.065	1.76		10.16		6.12		25		18.54		
10.55		4.00	1.230	0.67		10.48		5.75		44		19.26		
11.03		6.00	1.305	0.58		12.44		5.61		68		19.21		
11.12		8.00	1.355	0.45		11.57		5.69		58		19.28		
11.23		10.00	1.400	0.36		11.88		5.73		53		19.05		
11.31		12.00	1.655	0.50		10.57		5.78		51		18.93		
STABILISATION CRITERIA (3 Readings within following Ranges)			± 0.05	± 10%	± 10%	± 10%	± 10 mV	± 0.1°C						

DUPLICATE COLLECTED: ☐ Y ☒ N
 WERE METALS FIELD FILTERED? ☒ ☐ (UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))

DUPLICATE ID: _____
 TRIPPLICATE COLLECTED: ☐ Y ☒ N
 TRIPPLICATE ID: _____

Issue Date: 11/07/08

[illegible]

PROJECT NAME: Cygnia Cove				PROJECT NUMBER: ENVIBURW11899AA													
FIELD PERSONNEL: Ron Everest & Pamela Lee				DATE: 28 29 October 2008													
PROJECT MANAGER: Pamela Lee																	
WELL ID: ASS MWG				TOTAL WELL DEPTH: 6.987				SCREEN INTERVAL:									
EQUIPMENT ID: H4D20LAB METER ID: HLQ3				WELL DIAMETER: 50 mm				WELL STICK-UP: 0.635									
PUMP INTAKE DEPTH: 5.50 m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: 3.160 , 3.223 m below TOC													
TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (ms or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)			
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*				
0	NA																
9.03		2	3.562	1.01		0.783		6.01		-63		19.21					
9.07		4	3.610	0.59		0.802		5.99		-61		19.18					
9.10		6	3.620	0.48		0.806		5.98		-61		19.25					
9.13		8	3.635	0.56		0.800		5.99		-61		19.24					
STABILISATION CRITERIA (3 Readings within following Ranges)			± 0.05	± 10%	± 10%		± 10%		± 10 mV		± 0.1°C						
DUPLICATE COLLECTED:				<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	DUPLICATE ID:				TRIPLICATE COLLECTED:				<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	TRIPLICATE ID:			
WERE METALS FIELD FILTERED?				<input checked="" type="checkbox"/> <input type="checkbox"/>	(UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))												

Issue Date: 11/07/08

Issue Date: 11/07/08

[illegible]

PROJECT NAME: Cygnia Cove				PROJECT NUMBER: ENVIBURW11899AA											
FIELD PERSONNEL: Ron Everest & Pamela Lee				DATE: 28/29 October 2008											
PROJECT MANAGER: Pamela Lee															
WELL ID: ASS MW 13				TOTAL WELL DEPTH: 6.490				SCREEN INTERVAL:							
EQUIPMENT ID: HYDROLAB METER ID: HCL93				WELL DIAMETER: 50 mm				WELL STICK-UP: 0.60							
PUMP INTAKE DEPTH: 5.0 m below TOC				DEPTH TO WATER BEFORE / AFTER PUMP INSTALLATION: 2.003 , 2.010 m below TOC											
TIME OF DAY	CYCLE/ PUMP RATE (ml/min)	VOLUME (L)	DEPTH TO WATER (m)	DISSOLVED OXYGEN (mg/l)		ELECTRICAL CONDUCTIVITY (ms or µS/cm)		pH (pH units)		REDOX POTENTIAL (mV)		TEMPERATURE (°C)		COMMENTS (ODOUR/ COLOUR/ SEDIMENTS/ PSH COLLECTED?)	
				READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*	READING	CHANGE*		
0	NA														
16.28		2	2.010	1.77		0.427		6.43		41		20.20			
16.33		4	2.028	0.88		0.422		5.75		68		20.21			
16.36		6	2.028	0.69		0.417		5.64		72		20.21			
16.39		8	2.028	0.67		0.426		5.62		71		20.19			
STABILISATION CRITERIA (3 Readings within following Ranges)				± 0.05	± 10%	± 10 %	± 10 %	± 10 mV	± 0.1 °C						
DUPLICATE COLLECTED:				<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	DUPLICATE ID:				TRIPLICATE COLLECTED:				<input type="checkbox"/> Y <input checked="" type="checkbox"/> N	TRIPLICATE ID:	
WERE METALS FIELD FILTERED?				<input checked="" type="checkbox"/> <input type="checkbox"/>	(UNFILTERED SAMPLES MUST NOT BE PUT INTO A PRESERVED CONTAINER (IE. 'METALS' BOTTLE))										

Appendix L

Decontamination Records (2008)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA



Calibration Information

ECO Environmental Pty Ltd
214 Lord Street
Perth WA 6000

P +61 8 9328 2900
F +61 8 9328 2677
W www.ecoenvironmental.com.au
E eco@ecoenvironmental.com.au

ABN: 47 115 383 661

Calibration Information

Instrument: HLQ3
Serial Number: Serial #: QD02729 (Display)
Serial #: QT02734 (Sonde)

Equipment Check	Enclosed	Returned	Comment
Hydrolab Display	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Hydrolab Sonde	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Carry Case	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Sample Cup	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Calibration Cup	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Probe Guard	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Instruction Manual	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Spare Batteries (C x 3)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Calibration Details

Sensor	Calibration undertaken	Accuracy	Pass	Fail
pH	<input checked="" type="checkbox"/> pH 4.00	± 0.2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/> pH 7.00	± 0.2	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Conductivity	<input checked="" type="checkbox"/> 1413uS/cm	$\pm 1\%$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/> 12.88mS/cm	$\pm 1\%$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Salinity	<input checked="" type="checkbox"/> Auto calibrated using above EC value.	$\pm 1\%$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Dissolved Oxygen	<input checked="" type="checkbox"/> Factory zero	$\pm 0.2\text{mg/L} < 20\text{mg/L}$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/> 100% Saturation	$\pm 0.6\text{mg/L} > 20\text{mg/L}$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/> Pressure compensation	761 mmHg	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Redox	<input checked="" type="checkbox"/> 240mV	$\pm 25\text{mV}$	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Temperature	<input checked="" type="checkbox"/> Factory Calibrated	$\pm 0.15^\circ\text{C}$	<input checked="" type="checkbox"/>	<input type="checkbox"/>

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturers calibration procedure as recommended in the instruments service manual. ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards

y/k 22/10/08

Equipment Specialist
ECO Environmental Pty Ltd



Decontamination Information

ECO Environmental Pty Ltd
214 Lord Street
Perth WA 6000

Decontamination Information

Instrument: Geotech Peristaltic Pump 3

P +61 8 9328 2900
F +61 8 9328 2677
W www.ecoenvironmental.com.au
E eco@ecoenvironmental.com.au

ABN: 47 115 383 661

Equipment Check	Enclosed	Returned	Comment
GeoPump Controller	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Geotech 12v Battery & Charger	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Carry Case	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Power Supply Cable	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Cigarette Lighter Adapter	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Inspection Details

	Pass	Fail	Comment
Decon wash of controller & cable	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Decon wash of battery & carry case	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Inspection for faults, corrosion, damage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Unit in good working order, clean and ready for use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

This is to certify that where possible, this instrument has been cleaned in a phosphate free biodegradable detergent accordance with the manufacturers general maintenance procedure as recommended in the instruments service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards

yk 19 / 09 / '08

Equipment Specialist
ECO Environmental Pty Ltd



Decontamination Information

Decontamination Information

Instrument: H1003
Serial Number: SN#14078

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Perth WA 6000

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E eco@ecoenvironmental.com.au

ABN: 47 115 383 661

Equipment Check	Enclosed	Returned	Comment
Heron Water Level Meter	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Heron Carry Bag	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Inspection Details

Sensor	Pass	Fail	Comment
Decon wash of tape (100m)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Decon wash of reel	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Inspection for faults, corrosion, damage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Meter in good working order, clean and ready for use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

This is to certify that where possible, this instrument has been cleaned in accordance with the manufacturers general maintenance procedure as recommended in the instruments service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards

yk 23/10/08

Equipment Specialist
ECO Environmental Pty Ltd

Appendix M

Summary of Baseline Groundwater Analytical Results (2008)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

APPENDIX M - Table 11 (Part A)
Summary of Baseline Groundwater Analytical Results (2008)

Baseline Groundwater Monitoring and Management plan
Cygna Cove

Sample ID								MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference								08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled								28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGT)	LOR (SGS)	Drinking Water Guidelines (ADWG) ¹	Drinking Water Guidelines (ADWG)X10 ²	Fresh Waters-Rivers Guidelines FWG ³	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Heavy Metals																								
Aluminium	0.01	0.001	0.2*	2	0.055	5	20	0.25	0.1	0.1		0.11		0.07	< 0.01	0.04	< 0.01	0.01	0.04	0.01	0.02	0.05	1.5	0.02
Arsenic	0.0007	0.001	0.007	0.07	0.013	0.1	2	<0.0007	<0.0007	<0.0007	«	<0.0007	«	<0.0007	<0.0007	0.0027	0.0058	0.0029	<0.0007	0.0059	<0.0007	<0.0007	<0.0007	<0.0007
Cadmium	0.0002	0.0001	0.002	0.02	0.0002	0.01	0.05	< 0.0002	< 0.0002	< 0.0002	«	<0.0001	«	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
Calcium	5	0.1	NE	NE	NE	NE	NE	13	18	18	«	18	«	22	11	30	82	35	38	< 5	26	19	35	< 5
Chromium	0.001	0.001	0.05	0.5	0.01	0.1	1	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.002	< 0.001
Copper	0.001	0.001	2 (1.0*)	20 (10*)	0.0014	0.2	5	0.004	0.002	0.002	«	<0.001	16.67	0.004	0.003	0.003	0.005	0.003	0.001	0.002	0.006	0.003	0.003	0.003
Iron	0.05	0.005	0.3*	3	NV	0.2	10	0.25	0.15	0.19	5.88	0.024	38.79	0.56	61	3.6	39	1.9	3.2	80	0.31	0.8	0.61	2.8
Lead	0.001	0.001	0.01	0.1	0.0034	2	5	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001
Magnesium	5	0.1	NE	NE	NE	NE	NE	7.1	5.7	5.8	0.43	5.6	0.88	6.3	19	11	240	11	13	11	7.8	< 5	27	11
Manganese	0.005	0.001	0.5 (0.1*)	5 (1.0*)	1.9	0.2	10	0.01	< 0.005	< 0.005	«	0.001	33.33	< 0.005	0.28	0.044	0.42	0.01	0.023	0.02	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.0005	0.001	0.01	0.00006	0.002	0.002	< 0.0001	< 0.0001	< 0.0001	«	<0.0005	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	0.001	0.02	0.2	0.011	0.2	2	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	0.008	0.001	0.001	0.002	0.001	< 0.001	0.004	< 0.001
Potassium	5	0.2	NE	NE	NE	NE	NE	< 5	8.9	7.4	4.60	7.6	0.67	5.8	11	13	93	5.1	5.1	5.5	< 5	7.3	6.6	< 5
Selenium	0.001	0.002	0.01	0.1	0.005	0.02	0.05	0.002	< 0.001	0.002	16.67	<0.002	«	< 0.001	0.002	< 0.001	0.02	< 0.001	0.001	0.003	< 0.001	0.002	0.001	< 0.001
Sodium	0.5	0.1	NE	NE	NE	NE	NE	100	58	57	0.43	43	7.00	55	100	110	1600	68	120	80	75	60	230	56
Zinc	0.001	0.001	3*	30	0.008	2	5	0.1	0.091	0.085	1.70	0.082	0.90	0.068	0.07	0.039	0.068	0.052	0.049	0.075	0.084	0.061	0.071	0.072
Carbamate Pesticides																								
Aldicarb	0.01	-	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	-	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Bendiocarb	0.01	0.001	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	<0.001	«	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Carbaryl	0.01	0.001	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	<0.001	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Carbofuran	0.01	-	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	-	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Methomyl	0.01	0.001	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	<0.001	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Oxamyl	0.01	0.001	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	<0.001	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Thiobencarb	0.01	0.001	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	«	<0.001	«	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
OC/OP Pesticides																								
4,4'-DDD	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
4,4'-DDE	0.00001	0.0002	0.2 ⁵	2	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
4,4'-DDT	0.0001	0.0002	NV	0.02	0.000006	NV	NV	< 0.0001	< 0.0001	< 0.0001	«	<0.0002	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Aldrin	0.00001	0.0002	0.0003 ⁴	NV	0.00001	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
b-BHC	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Chlordane	0.0002	0.0002	0.001	NV	0.00003	NV	NV	< 0.0002	< 0.0002	< 0.0002	«	<0.0002	«	< 0.0002	< 0.0005	< 0.0005	< 0.002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0002	< 0.0005
d-BHC	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Dieldrin	0.00001	0.0002	0.0003 ⁴	3	0.002	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Endosulfan I	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Endosulfan II	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002	
Endosulfan sulphate	0.0001	0.0002	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	«	<0.0002	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002	
Endrin aldehyde	0.00001	0.0002	NV	NV	NV	NV	NV	< 0.00001	<															

APPENDIX M - Table 11 (Part B)
Summary of Baseline Groundwater Analytical Results (2008)
Baseline Groundwater Monitoring Management Plan, Cygnia Cove

Sample ID								MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference								08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled								28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGT)	LOR (SGS)	Drinking Water Guidelines (ADWG) ¹	Drinking Water GuideLines (ADWG)X10 ²	Fresh Waters Rivers Guidelines FWG ³	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
OC/OP Pesticides																								
Bolstar	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Chlorpyrifos	0.002	0.0002	0.01	NV	0.00001	NV	NV	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	-	0.003	NV	0.00001	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	0.0002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	0.0002	0.01	NV	0.0002	NV	NV	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	-	0.01	NV	0.000004	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	-	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Monocyclic Aromatic Hydrocarbons																								
Benzene	0.001	N/A	0.001	NV	0.95	NV	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	0.001	N/A	0.8 (0.025*)	NV	0.003	NV	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	0.001	N/A	0.3 (0.003*)	NV	NV	NV	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes(o,m,p)	0.001	N/A	0.6 (0.02*)	NV	NV	NV	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Recoverable Hydrocarbons																								
TRH C ₆ -C ₉	0.02	N/A	NV	NV	NV	NV	NV	< 0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRH C ₁₀ -C ₁₄	0.05	N/A	NV	NV	NV	NV	NV	< 0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRH C ₁₅ -C ₂₈	0.1	N/A	NV	NV	NV	NV	NV	< 0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRH C ₂₉ -C ₃₆	0.1	N/A	NV	NV	NV	NV	NV	< 0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenolics																								
2-Chlorophenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
2-Methylphenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
2-Nitrophenol	0.0005	N/A	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-
2,4-Dichlorophenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
2,4-Dimethylphenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
2,4,6-Trichlorophenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
2,6-Dichlorophenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
3&4-Methylphenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
4-Chloro-3-methylphenol	0.0001	N/A	NV	NV	NV	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
Pentachlorophenol	0.0005	N/A	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-
Phenol	0.0001	N/A	NV	NV	0.32	NV	NV	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-

Notes:
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated
b Conversion factor applied (Nmg/L = 14/62xNO3mg/L-1)

References:
1 DoE (2003) and ARMCANZ (1996)
2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
4 Australian and New Zealand Guideiines for Fresh and Marine Water Quality (2000)

APPENDIX M - Table 11 (Part C)
Summary of Baseline Groundwater Analytical Results (2008)
Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Sample ID								MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13	
Laboratory Reference								08-Oct1070	08-Oct1067	08-Oct1069		65170		08-Oct1068	08-Oct1081	08-Oct1080	08-Oct1079	08-Oct1073	08-Oct1078	08-Oct1077	08-Oct1065	08-Oct1066	08-Oct1071	08-Oct1072	
Date Sampled								28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGT)	LOR (SGS)	Drinking Water Guidelines (ADWG) ¹	Drinking Water Guidelines (ADWG)X10 ²	Fresh Waters- Rivers Guidelines FWG ³	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Polycyclic Aromatic Hydrocarbons																									
Acenaphthene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Acenaphthylene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Anthracene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Benz(a)anthracene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Benzo(a)pyrene	0.00001	-	0.00001	NV	NV	NV	NV	< 0.00001	-	-	-	-	-	-	< 0.00001	-	-	-	-	-	-	-	-	-	
Benzo(b)fluoranthene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Benzo(g,h,i)perylene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Benzo(k)fluoranthene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Chrysene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Dibenz(a,h)anthracene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Fluoranthene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Fluorene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Indeno(1,2,3-cd)pyrene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Naphthalene	0.0005	-	NV	NV	0.016	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Phenanthrene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Pyrene	0.0005	-	NV	NV	NV	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Total PAH	0.0005	-	NV	NV	0.003	NV	NV	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-	
Major Anions & Cations																									
Acidity	0.01	0.01	NV	NV	NV	NV	NV	53	50	40	22.22	33	40.96	23	190	80	150	53	83	190	53	23	43	350	
Ammonia(N)	0.05	0.01	0.5	NV	0.08	NV	NV	< 0.05	< 0.05	0.19	116.67	<0.01	«	0.05	1.1	6	0.37	0.08	0.15	1.3	< 0.05	< 0.05	< 0.05	0.58	
Chloride	0.1	0.5	250 [*]	NV	NV	40	NV	150	78	80	2.53	77	1.29	85	200	170	3100	110	190	160	110	70	460	88	
Hydrogen Sulphide	0.05	0.5	0.05	NV	0.001	NV	NV	< 0.05	< 0.05	< 0.05	«	<0.5	«	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
Nitrate & Nitrite (N)	0.05	0.05	NV	NV	NV	NV	NV	3.2	8.5	7.1	17.95	7	19.35	3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5.7	2.3	0.12	0.53	
Nitrate (N)	0.02	0.05	NV	NV	0.16	NV	NV	3.1	8.5	7.1	17.95	7	19.35	3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	5.7	2.3	0.11	0.52	
Nitrite (N)	0.02	0.05	NV	NV	NV	NV	NV	< 0.02	< 0.02	< 0.02	«	<0.05	«	< 0.02	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	
Phosphate total (P)	0.05	0.05	NV	NV	0.065	0.05	0.8-12 [‡]	0.14	0.12	0.17	34.48	0.06	66.67	0.27	< 0.05	0.18	< 0.05	0.07	< 0.05	< 0.05	0.35	0.12	< 0.05	0.05	
Sulphate (S)	5	-	250	NV	NV	NV	NV	11	10	11	9.52	-	N/A	9.9	10	5	65	13	30	21	16	13	30	13	
Total Dissolved Solids	10	5	500	NV	NV	NV	NV	360	250	280	11.32	270	7.69	270	510	470	5600	360	510	430	310	240	950	240	
Total Kjeldahl Nitrogen (N)	0.1	0.2	NV	NV	NV	NV	NV	0.8	0.7	0.6	15.38	0.3	80.00	0.5	1.2	6.6	0.7	0.3	1.1	1.3	0.3	0.4	0.3	0.3	
Total Nitrogen (N)	0.2	0.2	NV	NV	1.2	5	25-125 [‡]	4	9.2	7.7	17.75	7.3	23.03	3.5	1.2	6.6	0.7	0.3	1.1	1.3	6	2.7	0.4	0.8	
Bicarbonate Alkalinity-mg CaCO3/L	10	2.00	NV	NV	NV	NV	NV	20	30	30	«	52	53.66	44	140	150	32	100	56	70	38	42	< 10	10	
Carbonate Alkalinity-mg CaCO3/L	10	2.00	NV	NV	NV	NV	NV	< 10	< 10	< 10	«	<2	«	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	
Total Alkalinity as CaCO3	20	2.00	NV	NV	NV	NV	NV	20	30	30	«	42	42	33.33	44	140	150	32	100	56	70	38	42	< 20	< 20

Notes:
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) drinking water guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:
1 DoE (2003) and ARMCANZ (1996)
2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
4 Australian and New Zealand Guideleins for Fresh and Marine Water Quality (2000)
5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 12
Baseline Groundwater Analytical Results in Excess of ADWG and ADWGX10 (for non recreational use) (2008)
Baseline Groundwater Monitoring and Management Plan, Cygna Cove

Sample ID					MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference					08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled					28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MG/T)	LOR (SGS)	Drinking Water Guidelines (ADWG) ¹	Drinking Water Guidleines (ADWG)X10 ²	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminium	0.01	0.001	0.2 ³	2	0.25	0.1	0.1		0.11		0.07	< 0.01	0.04	< 0.01	0.01	0.04	0.01	0.02	0.05	1.5	0.02
Arsenic	0.001	0.001	0.007	0.07	<0.0007	<0.0007	<0.0007	«	<0.0007	«	<0.0007	<0.0007	0.0027	0.0058	0.0029	<0.0007	0.0059	<0.0007	<0.0007	<0.0007	<0.0007
Cadmium	0.0002	0.0001	0.002	0.02	< 0.0002	< 0.0002	< 0.0002	«	<0.0001	«	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	0.001	0.05	0.5	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.002	< 0.001
Copper	0.001	0.001	2 (1.0 ⁴)	20 (10 ⁴)	0.004	0.002	0.002	«	<0.001	16.67	0.004	0.003	0.003	0.005	0.003	0.001	0.002	0.002	0.006	0.003	0.003
Iron	0.05	0.005	0.3 ⁴	3	0.25	0.15	0.19	5.88	0.024	38.79	0.56	61	3.6	39	1.9	3.2	80	0.31	0.8	0.61	2.8
Lead	0.001	0.001	0.01	0.1	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001
Magnesium	5	0.1	NE	NE	7.1	5.7	5.8	0.43	5.6	0.88	6.3	19	11	240	11	13	11	7.8	< 5	27	11
Manganese	0.005	0.001	0.5 (0.1 ⁴)	5 (1.0 ⁴)	0.01	< 0.005	< 0.005	«	0.001	33.33	< 0.005	0.28	0.044	0.42	0.01	0.023	0.02	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.0005	0.001	0.01	< 0.0001	< 0.0001	< 0.0001	«	<0.0005	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	0.001	0.02	0.2	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	0.008	0.001	0.001	0.002	0.001	< 0.001	0.004	< 0.001
Selenium	0.001	0.002	0.01	0.1	0.002	< 0.001	0.002	16.67	<0.002	«	< 0.001	0.002	< 0.001	0.02	< 0.001	0.001	0.003	< 0.001	0.002	0.001	< 0.001
Zinc	0.001	0.001	3 ⁴	30	0.1	0.091	0.085	1.70	0.082	0.90	0.068	0.07	0.039	0.068	0.052	0.049	0.075	0.084	0.061	0.071	0.072
4,4'-DDD	0.00001	0.0002	0.2 ⁵	2	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
4,4'-DDE	0.00001	0.0002	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
4,4'-DDT	0.0001	0.0002	NV	0.02	< 0.0001	< 0.0001	< 0.0001	«	<0.0002	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	0.0002	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Aldrin	0.00001	0.0002	0.0003 ⁴	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
b-BHC	0.00001	0.0002	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Chlordane	0.0002	0.0002	0.001	NV	< 0.0002	< 0.0002	< 0.0002	«	<0.0002	«	< 0.0002	< 0.0005	< 0.0005	< 0.002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0002	< 0.0005
d-BHC	0.00001	0.0002	NV	NV	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Dieldrin	0.00001	0.0002	0.0003 ⁴	3	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Chlorpyrifos	0.002	0.0002	0.01	NV	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	-	0.003	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	0.0002	0.01	NV	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	-	0.01	NV	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Benzene	0.001	-	0.001	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	0.001	-	0.8 (0.025 ⁴)	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	0.001	-	0.3 (0.003 ⁴)	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes(o,m, p)	0.001	-	0.6 (0.02 ⁴)	NV	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	0.0005	-	0.00001	NV	< 0.00001	-	-	-	-	-	-	< 0.00001	-	-	-	-	-	-	-	-	-
Ammonia(N)	0.05	0.01	0.5	NV	< 0.05	< 0.05	0.19	116.67	<0.01	«	0.05	1.1	6	0.37	0.08	0.15	1.3	< 0.05	< 0.05	< 0.05	0.58
Chloride	0.1	0.5	250 ⁴	NV	150	78	80	2.53	77	1.29	85	200	170	3100	110	190	160	110	70	460	88
Hydrogen Sulphide	0.05	0.5	0.05	NV	< 0.05	< 0.05	< 0.05	«	< 0.05	«	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sulphate (S)	5	-	250	NV	11	10	11	9.52	-	N/A	9.9	10	5	65	13	30	21	16	13	30	13
Total Dissolved Solids	10	5	500	NV	360	250	280	11.32	270	7.69	270	510	470	5600	360	510	430	310	240	850	240

Assessment of analytes with ILs only summarised.
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) drinking water guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:
1 DoE (2003) and ARMCANZ (1996)
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4 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 13
Baseline Groundwater Analytical Results in Excess of FWG (2008)
Baseline Groundwater Monitoring Management Plan, Cygnia Cove

Sample ID				MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference				08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled				28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGT)	LOR (SGS)	Fresh Waters- Rivers Guidelines FWG ³	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminium	0.01	0.001	0.055	0.25	0.1	0.1		0.11		0.07	< 0.01	0.04	< 0.01	0.01	0.04	0.01	0.02	0.05	1.5	0.02
Arsenic	0.001	0.001	0.013	<0.0007	<0.0007	<0.0007	«	<0.0007	«	<0.0007	<0.0007	0.0027	0.0058	0.0029	<0.0007	0.0059	<0.0007	<0.0007	<0.0007	<0.0007
Manganese	0.005	0.001	1.9	0.01	< 0.005	< 0.005	«	0.001	33.33	< 0.005	0.28	0.044	0.42	0.01	0.023	0.02	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.0005	0.00006	< 0.0001	< 0.0001	< 0.0001	«	<0.0005	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Selenium	0.001	0.002	0.005	0.002	< 0.001	0.002	16.67	<0.002	«	< 0.001	0.002	< 0.001	0.02	< 0.001	0.001	0.003	< 0.001	0.002	0.001	< 0.001
4,4'-DDT	0.0001	0.0002	0.000006	< 0.0001	< 0.0001	< 0.0001	«	<0.0002	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldrin	0.00001	0.0002	0.00001	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Chlordane	0.0002	0.0002	0.00003	< 0.0002	< 0.0002	< 0.0002	«	<0.0002	«	< 0.0002	< 0.0005	< 0.0005	< 0.002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0002	< 0.0005
Dieldrin	0.00001	0.0002	0.002	< 0.00001	< 0.00001	< 0.00001	«	<0.0002	«	< 0.00001	< 0.00005	< 0.00005	< 0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00001	< 0.00002
Chlorpyrifos	0.002	0.0002	0.00001	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	-	0.00001	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	0.0002	0.0002	< 0.002	< 0.002	< 0.002	«	<0.0002	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	-	0.000004	< 0.002	< 0.002	< 0.002	«	-	«	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Benzene	0.001	-	0.95	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	0.001	-	0.003	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	0.0001	-	0.32	< 0.0001	-	-	-	-	-	-	< 0.0001	-	-	-	-	-	-	-	-	-
Naphthalene	0.0005	-	0.016	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-
Total PAH	0.0005	-	0.003	< 0.0005	-	-	-	-	-	-	< 0.0005	-	-	-	-	-	-	-	-	-
Ammonia(N)	0.05	0.01	0.08	< 0.05	< 0.05	0.19	116.67	<0.01	«	0.05	1.1	6	0.37	0.08	0.15	1.3	< 0.05	< 0.05	< 0.05	0.58
Hydrogen Sulphide	0.05	0.5	0.001	<0.05	<0.05	<0.05	«	<0.5	«	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05
Nitrate (N)	0.02	0.05	0.16	3.1	8.5	7.1	17.95	7	19.35	3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	5.7	2.3	0.11	0.52
Phosphate total (P)	0.05	-	0.065	0.14	0.12	0.17	34.48	0.06	66.67	0.27	< 0.05	0.18	< 0.05	0.07	< 0.05	< 0.05	0.35	0.12	< 0.05	0.05
Total Nitrogen (N)	0.2	0.2	1.2	4	9.2	7.7	17.75	7.3	23.03	3.5	1.2	6.6	0.7	0.3	1.1	1.3	6	2.7	0.4	0.8

Assessment of analytes with ILs only summarised.

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) drinking water guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:

1 DoE (2003) and ARMCANZ (1996)

2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

4 Australian and New Zealand Guideielines for Fresh and Marine Water Quality (2000)

5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 14
Baseline Groundwater Analytical Results in Excess of FWG with HMF Assessment (2008)
Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF	FWG	FWGHMF
	Cadmium (mg/L)		Chromium (mg/L)		Copper (mg/L)		Lead (mg/L)		Nickel (mg/L)		Zinc (mg/L)	
MW1(A)	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		< 0.001		0.004		< 0.001		< 0.001		0.1	
MW2(A)	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
	< 0.0002		< 0.001		0.002		< 0.001		< 0.001		0.091	
MW3	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
	< 0.0002		< 0.001		0.004		< 0.001		< 0.001		0.068	
MW4	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
	< 0.0002		0.003		0.003		< 0.001		0.003		0.07	
MW5	0.0002	0.002	0.01	0.084	0.0014	0.0126	0.0034	0.09078	0.011	0.099	0.008	0.072
	< 0.0002		0.003		0.003		< 0.001		0.003		0.039	
MW6	0.0002	0.002	0.01	0.084	0.0014	0.0126	0.0034	0.09078	0.011	0.099	0.008	0.072
	< 0.0002		< 0.001		0.005		< 0.001		0.008		0.068	
MW7	0.0002	0.00054	0.01	0.025	0.0014	0.0035	0.0034	0.0136	0.011	0.0275	0.008	0.02
	< 0.0002		< 0.001		0.003		< 0.001		0.001		0.052	
MW8	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		< 0.001		0.001		< 0.001		0.001		0.049	
MW9	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		0.002		0.002		< 0.001		0.002		0.075	
MW10	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		< 0.001		0.002		< 0.001		0.001		0.084	
MW11	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		< 0.001		0.006		< 0.001		< 0.001		0.061	
MW12	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		0.002		0.003		0.002		0.004		0.071	
MW13	0.0002	0.0002	0.01	0.01	0.0014	0.0014	0.0034	0.0034	0.011	0.011	0.008	0.008
	< 0.0002		< 0.001		0.003		< 0.001		< 0.001		0.072	

	Exceeds FWG (Fresh Water-Rivers guidelines (FWGs) for Aquatic Ecosystems (utilising Lowland Rivers values where available) as specified within Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)).
	Exceeds FWGHMF (Fresh Water-Rivers guidelines Hardness Modification Factor for Aquatic Ecosystems (utilising Lowland Rivers values where available) as specified within Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)).

APPENDIX M - Table 15
Baseline Groundwater Analytical Results in Excess of LTIWG (2008)
Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Sample ID				MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference				08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled				28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGT)	LOR (SGS)	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminium	0.01	0.001	5	0.25	0.1	0.1	0	0.11	2.38	0.07	< 0.01	0.04	< 0.01	0.01	0.04	0.01	0.02	0.05	1.5	0.02
Arsenic	0.001	0.001	0.1	<0.0007	<0.0007	<0.0007	«	<0.0007	«	<0.0007	<0.0007	0.0027	0.0058	0.0029	<0.0007	0.0059	<0.0007	<0.0007	<0.0007	<0.0007
Cadmium	0.0002	0.0001	0.01	< 0.0002	< 0.0002	< 0.0002	«	<0.0001	«	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	0.001	0.1	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.002	< 0.001
Copper	0.001	0.001	0.2	0.004	0.002	0.002	«	<0.001	16.67	0.004	0.003	0.003	0.005	0.003	0.001	0.002	0.002	0.006	0.003	0.003
Iron	0.05	0.005	0.2	0.25	0.15	0.19	5.88	0.024	38.79	0.56	61	3.6	39	1.9	3.2	80	0.31	0.8	0.61	2.8
Lead	0.001	0.001	2	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001
Manganese	0.005	0.001	0.2	0.01	< 0.005	< 0.005	«	0.001	33.33	< 0.005	0.28	0.044	0.42	0.01	0.023	0.02	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.0005	0.002	< 0.0001	< 0.0001	< 0.0001	«	<0.0005	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	0.001	0.2	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	0.008	0.001	0.001	0.002	0.001	< 0.001	0.004	< 0.001
Selenium	0.001	0.002	0.02	0.002	< 0.001	0.002	16.67	<0.002	«	< 0.001	0.002	< 0.001	0.02	< 0.001	0.001	0.003	< 0.001	0.002	0.001	< 0.001
Zinc	0.001	0.001	2	0.1	0.091	0.085	1.70	0.082	0.90	0.068	0.07	0.039	0.068	0.052	0.049	0.075	0.084	0.061	0.071	0.072
Chloride	0.1	0.5	40	150	78	80	2.53	77	1.29	85	200	170	3100	110	190	160	110	70	460	88
Phosphate total (P)	0.05	-	0.05	0.14	0.12	0.17	34.48	0.06	66.67	0.27	< 0.05	0.18	< 0.05	0.07	< 0.05	< 0.05	0.35	0.12	< 0.05	0.05
Total Nitrogen (N)	0.2	0.2	5	4	9.2	7.7	17.75	7.3	23.03	3.5	1.2	6.6	0.7	0.3	1.1	1.3	6	2.7	0.4	0.8

Assessment of analytes with ILs only summarised.

- = Analysis not completed

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) drinking water guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:

1 DoE (2003) and ARMCANZ (1996)

2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

4 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 16
Baseline Groundwater Analytical Results in Excess of STIWG (2008)
Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Sample ID				MW1(A)	MW2(A)	QC1 (Duplicate of MW2(A))	RPD	QC2 (Triplicate of MW2(A))	RPD	MW3	MW4	MW5	MW6	MW7	ASSMW8	ASSMW9	ASSMW10	ASSMW11	ASSMW12	ASSMW13
Laboratory Reference				08-Oc11070	08-Oc11067	08-Oc11069		65170		08-Oc11068	08-Oc11081	08-Oc11080	08-Oc11079	08-Oc11073	08-Oc11078	08-Oc11077	08-Oc11065	08-Oc11066	08-Oc11071	08-Oc11072
Date Sampled				28/10/2008	28/10/2008	28/10/2008		28/10/2008		28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008	28/10/2008
Analytes	LOR (MGY)	LOR (SGS)	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	%	mg/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aluminium	0.01	0.001	20	0.25	0.1	0.1	0	0.11	2.38	0.07	< 0.01	0.04	< 0.01	0.01	0.04	0.01	0.02	0.05	1.5	0.02
Arsenic	0.001	0.001	2	<0.0007	<0.0007	<0.0007	«	<0.0007	«	<0.0007	<0.0007	0.0027	0.0058	0.0029	<0.0007	0.0059	<0.0007	<0.0007	<0.0007	<0.0007
Cadmium	0.0002	0.0001	0.05	< 0.0002	< 0.0002	< 0.0002	«	<0.0001	«	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	0.001	1	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.002	< 0.001
Copper	0.001	0.001	5	0.004	0.002	0.002	«	<0.001	16.67	0.004	0.003	0.003	0.005	0.003	0.001	0.002	0.002	0.006	0.003	0.003
Iron	0.05	0.005	10	0.25	0.15	0.19	5.88	0.024	38.79	0.56	61	3.6	39	1.9	3.2	80	0.31	0.8	0.61	2.8
Lead	0.001	0.001	5	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001
Manganese	0.005	0.001	10	0.01	< 0.005	< 0.005	«	0.001	33.33	< 0.005	0.28	0.044	0.42	0.01	0.023	0.02	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.0005	0.002	< 0.0001	< 0.0001	< 0.0001	«	<0.0005	«	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	0.001	2	< 0.001	< 0.001	< 0.001	«	<0.001	«	< 0.001	0.003	0.003	0.008	0.001	0.001	0.002	0.001	< 0.001	0.004	< 0.001
Selenium	0.001	0.002	0.05	0.002	< 0.001	0.002	16.67	<0.002	«	< 0.001	0.002	< 0.001	0.02	< 0.001	0.001	0.003	< 0.001	0.002	0.001	< 0.001
Zinc	0.001	0.001	5	0.1	0.091	0.085	1.70	0.082	0.90	0.068	0.07	0.039	0.068	0.052	0.049	0.075	0.084	0.061	0.071	0.072
Phosphate total (P)	0.05	-	0.8-12 [#]	0.14	0.12	0.17	34.48	0.06	66.67	0.27	< 0.05	0.18	< 0.05	0.07	< 0.05	< 0.05	0.35	0.12	< 0.05	0.05
Total Nitrogen (N)	0.2	0.2	25-125 [#]	4	9.2	7.7	17.75	7.3	23.03	3.5	1.2	6.6	0.7	0.3	1.1	1.3	6	2.7	0.4	0.8

Assessment of analytes with ILs only summarised.
- = Analysis not completed
NV = No Value / IL
NA = Not Applicable
^ Value for both dieldrin and aldrin
Requires site specific assessment. Lowest value considered in this instance.
* indicates aesthetic (not health) drinking water guideline
« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:
1 DoE (2003) and ARMCANZ (1996)
2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)
3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).
4 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 17
Baseline Groudwater Monitoring Quality Control (2008)
Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Sample ID							QC3	QC4	QC5	QC6	QC7	QC8
Laboratory Reference							08-Oc11074	08-Oc11075	08-Oc11076	08-Oc11082	08-Oc11083	08-Oc11084
Date Sampled							28/10/2008	28/10/2008	28/10/2008	29/10/2008	29/10/2008	29/10/2008
Sample Type							Equipment Rinsate	Field Blank	Trip Blank	Equipment Rinsate	Field Blank	Trip Blank
Analytes	LOR (MGT)	Drinking Water Guidelines (ADWG) ¹	Drinking Water Guidleines (ADWG)X10 ²	Fresh Waters- Rivers Guidelines FWG ³	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Heavy Metals												
Aluminium	0.01	0.2*	2	0.055	5	20	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic	0.001	0.007	0.07	0.013	0.1	2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	0.002	0.02	0.0002	0.01	0.05	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Calcium	5	NE	NE	NE	NE	NE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chromium	0.001	0.05	0.5	0.01	0.1	1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	2 (1.0*)	20 (10*)	0.0014	0.2	5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Iron	0.05	0.3*	3	NV	0.2	10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Lead	0.001	0.01	0.1	0.0034	2	5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Magnesium	5	NE	NE	NE	NE	NE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Manganese	0.005	0.5 (0.1*)	5 (1.0*)	1.9	0.2	10	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	0.001	0.01	0.00006	0.002	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	0.02	0.2	0.011	0.2	2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Potassium	5	NE	NE	NE	NE	NE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Selenium	0.001	0.01	0.1	0.005	0.02	0.05	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sodium	0.5	NE	NE	NE	NE	NE	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	0.001	3*	30	0.008	2	5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Carbamate Pesticides												
Aldicarb	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Bendiocarb	0.01	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.005
Carbaryl	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbofuran	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methomyl	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Oxamyl	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Thiobencarb	0.01	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Organochlorine Pesticides												
4,4'-DDD	0.00001	0.2 ⁵	2	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
4,4'-DDE	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
4,4'-DDT	0.0001	NV	0.02	0.000006	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Aldrin	0.00001	0.0003 ^a	NV	0.00001	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
b-BHC	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chlordane	0.0002	0.001	NV	0.00003	NV	NV	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
d-BHC	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Dieldrin	0.00001	0.0003 ^a	3	0.002	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan I	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan II	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endosulfan sulphate	0.0001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin aldehyde	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin ketone	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
g-BHC (Lindane)	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Heptachlor epoxide	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Hexachlorobenzene	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Methoxychlor	0.00001	NV	NV	NV	NV	NV	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Toxophene	0.0002	NV	NV	NV	NV	NV	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) drinking water guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:

1 DoE (2003) and ARMCANZ (1996)

2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

4 Australian and New Zealand Guidleines for Fresh and Marine Water Quality (2000)

5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

APPENDIX M - Table 17

Baseline Groudwater Monitoring Quality Control (2008)

Baseline Groundwater Monitoring and Management Plan, Cygnia Cove

Sample ID							QC3	QC4	QC5	QC6	QC7	QC8
Laboratory Reference							08-Oc11074	08-Oc11075	08-Oc11076	08-Oc11082	08-Oc11083	08-Oc11084
Date Sampled							28/10/2008	28/10/2008	28/10/2008	29/10/2008	29/10/2008	29/10/2008
Sample Type							Equipment Rinsate	Field Blank	Trip Blank	Equipment Rinsate	Field Blank	Trip Blank
Analytes	LOR (MGT)	Drinking Water Guidelines (ADWG) ¹	Drinking Water Guidleines (ADWG)X10 ²	Fresh Waters- Rivers Guidelines FWG ³	Long Term Irrigation Water GuideLines (LTIWG) ^{1/4}	Short Term Irrigation Water Guidelines (STIWG) ⁴	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Organophosphorous Pesticides												
Bolstar	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Chlorpyrifos	0.002	0.01	NV	0.00001	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	0.003	NV	0.00001	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	0.01	NV	0.0002	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	0.01	NV	0.000004	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	NV	NV	NV	NV	NV	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Major Anions & Cations												
Acidity	0.01	NV	NV	NV	NV	NV	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ammonia(N)	0.05	0.5	NV	0.08	NV	NV	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chloride	5	250*	NV	NV	40	NV	< 5	< 5	< 5	< 5	< 5	< 5
Hydrogen Sulphide	0.05	0.05	NV	0.001	NV	NV	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	NV	NV	NV	NV	NV	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (N)	0.02	NV	NV	0.16	NV	NV	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (N)	0.02	NV	NV	NV	NV	NV	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (P)	0.05	NV	NV	0.065	0.05	0.8-12 [#]	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sulphate (S)	5	250	NV	NV	NV	NV	< 5	< 5	< 5	< 5	< 5	< 5
Total Dissolved Solids	10	500	NV	NV	NV	NV	< 10	< 10	< 10	< 10	< 10	< 10
Total Kjeldahl Nitrogen (N)	0.1	NV	NV	NV	NV	NV	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Nitrogen (N)	0.2	NV	NV	1.2	5	25-125 [#]	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Bicarbonate Alkalinity-mg CaCO3/L	10	NV	NV	NV	NV	NV	< 10	< 10	< 10	< 10	< 10	< 10
Carbonate Alkalinity-mg CaCO3/L	10	NV	NV	NV	NV	NV	< 10	< 10	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO3	20	NV	NV	NV	NV	NV	< 20	< 20	< 20	< 20	< 20	< 20

NV = No Value / IL

NA = Not Applicable

^ Value for both dieldrin and aldrin

Requires site specific assessment. Lowest value considered in this instance.

* indicates aesthetic (not health) drinking water guideline

« = All constituent analyte concentrations are less than LOR and RPD cannot be calculated

References:

1 DoE (2003) and ARMCANZ (1996)

2 National Health and Medical Research Council and Natural Resource Management Ministerial Council (2005)

3 Fresh Water and Lowland Rivers guidelines, from ANZECC (2000).

4 Australian and New Zealand Guideleines for Fresh and Marine Water Quality (2000)

5 USEPA. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (2008)

Appendix N

Chain of Custody Documentation and Laboratory Certificates (2008)

Groundwater Monitoring and Management Plan
Cygnia Cove, Waterford, WA

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

80286



☐ Philippines: Tel (+63) (2) 636 8287 Fax (+63) (2) 687 3518
3rd Floor, JMT Building, ADB Avenue, Ortigas Centre,
Pasig City, Metro Manila; Philippines

☐ Adelaide: Tel (08) 7221 3500 Fax (08) 8172 1968
Level 1, 2-3 Greenhill Road, Wayville SA 5034

☐ Brisbane: Tel (07) 3608 2500 Fax (07) 3852 2805
47 Doggett Street, Newstead QLD 4006
Email: Brisbane.Admin@coffey.com.au

☐ Hobart: Tel (03) 6208 6860 Fax (03) 6208 6869
Suite 2, 31-33 Tower Road, New Town TAS 7008

☐ Melbourne: Tel (03) 9473 1400 Fax (03) 9473 1450
126 Trenerry Crescent, Abbotsford VIC 3067

☒ Perth: Tel (08) 9355 7100 Fax (08) 9355 7197
89-91 Burswood Road, Burswood WA 6100

☐ Sydney: Tel: (02) 8083 1600 Fax (02) 8765 0762
Level 1, 3 Rider Boulevard, Rhodes, NSW 2138

☐ Lane Cove: Tel: (02) 9911 1000 Fax (02) 9911 1002
8/12 Mars Road, Lane Cove West, NSW 2066

☐ ACT: Tel: (02) 6248 7366 Fax (02) 6248 7157
2/54 Northbourne Avenue, Canberra ACT 2601

☐ Dilhorn House: Tel: (08) 9328 3488 Fax (08) 9328 3588
Dilhorn House, 2 Bulwer Street, Perth, WA 6000

Project No: ENVIBURW11899AA Task No:
Project Name: Cynia Cove Laboratory: MGT
Samplers Name: Project Manager:
Special Instructions: Metals: arsenic, cadmium, chromium, copper, manganese, mercury, nickel, lead, selenium, zinc

Analysis Request Section

Lab. No.	Sample ID	Sample Location	Sample Depth	Sample Date	Time	Matrix (Soil ... etc)	Container Type & Preservative*	T-A-T (Specify)	BTEX / TPH	METALS (Specify)	PAHs / PHENOLS	OCs / OPs	major anions	major cations	total acidity / alkalinity	Aluminum	Hydrogen	Ammonia - N	TKN	Total Nitrogen	Total Phosphorus	NOTES
	ASEMW10			28/10/08		GW	1 red, 1 green, 1 amber 1 plastic (x1L)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	ASEMW11			28/10/08		GW	1 red, 1 green, 1 amber 1 plastic (x1L)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MW2(A)			28/10/08		GW	1 red, 1 green, 3 amber 1 plastic (x1L)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MW3			28/10/08		GW	1 red, 1 green, 3 amber 1 plastic (x1L)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC1			28/10/08		GW	1 red, 1 green, 3 amber 1 plastic (x1L)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

RELINQUISHED BY:

Signature: Phil Coffey
Company: Coffey Env.
Date: 29/10/08
Time:
Date:
Time:

RECEIVED BY:

Signature: Gary Wong
Company: MGT
Date: 30/10/08
Time: 9am
Date:
Time:

Sample Receipt Advice: (Lab Use Only)

All Samples Received in Good Condition ... ☒

All Documentation is in Proper Order ☒

Samples Received Properly Chilled ☒

Lab. Ref/Batch No.

236251

* Container Type & Preservation Codes: P - Plastic, G - Solvent Washed Acid Rinsed Glass Bottle, V - Vial, N - Nitric Acid Preserved
C - Hydrochloric Acid Preserved, S - Sulphuric Acid Preserved, I - Ice

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

80287



☐ Philippines: Tel (+63) (2) 636 8287 Fax (+63) (2) 687 3518
3rd Floor, JMT Building, ADB Avenue, Ortigas Centre,
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☐ Adelaide: Tel (08) 7221 3500 Fax (08) 8172 1968
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2/54 Northbourne Avenue, Canberra ACT 2601

☐ Dillhorn House: Tel: (08) 9328 3488 Fax (08) 9328 3588
Dillhorn House, 2 Bulwer Street, Perth, WA 6000

Project No: ENVIBUTW11899AA

Project Name: Cynia Cove

Samplers Name:

Special Instructions: Metals: arsenic, cadmium, chromium, copper, manganese
mercury, nickel, lead, selenium, zinc

Task No:

Laboratory: MGT

Project Manager:

Analysis Request Section

Lab. No.	Sample ID	Sample Location	Sample Depth	Sample Date	Time	Matrix (Soil ... etc)	Container Type & Preservative*	T-A-T (Specify)	BTEX	METAL	PAHs	OCs	meq	total	Hum	Hyd	Amn	TK	TOC	NOTES
	MW1		26/10/08			GW	1 red, 1 green, 3 amber, 1 plastic 2 vials		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	ASSMW12		26/10/08			GW	1 red, 1 green, 3 amber, 1 plastic			✓		✓	✓	✓	✓	✓	✓	✓	✓	
	ASSMW13		26/10/08			GW	1 red, 1 green, 1 amber, 1 plastic			✓		✓	✓	✓	✓	✓	✓	✓	✓	
	MW7		26/10/08			GW	1 red, 1 green 1 amber, 1 plastic			✓		✓	✓	✓	✓	✓	✓	✓	✓	
	QC3		26/10/08			W	↓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC4		26/10/08			W			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC5		26/10/08			W			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	

RELINQUISHED BY:

Signature: Phil Coffey BW Date: 29/10/08
Company: Time:
Signature: Date:
Company: Time:

RECEIVED BY:

Signature: Gary Wong Date: 30/10
Company: MGT Time: 9am
Signature: Date:
Company: Time:

Sample Receipt Advice: (Lab Use Only)

All Samples Received in Good Condition ... ☒
All Documentation is in Proper Order ... ☒
Samples Received Properly Chilled ... ☒

Lab. Ref/Batch No.

236251

* Container Type & Preservation Codes: P - Plastic, G - Solvent Washed Acid Rinsed Glass Bottle, V - Vial, N - Nitric Acid Preserved
C - Hydrochloric Acid Preserved, S - Sulphuric Acid Preserved, I - Ice

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

80288



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☐ Dilhorn House: Tel: (08) 9328 3488 Fax (08) 9328 3588
Dilhorn House, 2 Bulwer Street, Perth, WA 6000

Project No: **ENV1BW118991AA** Task No:

Project Name: **Eygnia Cove** Laboratory: **MGT**

Samplers Name: Project Manager:

Special Instructions: **metals: arsenic, cadmium, chromium, copper, manganese, mercury, nickel, lead, selenium, zinc**

Analysis Request Section

Lab. No.	Sample ID	Sample Location	Sample Depth	Sample Date	Time	Matrix (Soil ... etc)	Container Type & Preservative*	T-A-T (Specify)	BTEX / TPH	METALS (Specify)	PAHs / PHENOLS	OCs / OPS	major anions	major cations	total acidity / alkalinity	aluminum	hydrogen sulphide	Ammonia - N	TK-N	Total Nitrogen	NOTES
	ASSMW9			29/10/08		GW	1 red, 1 green, 1 amber, 1 plastic		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	ASSMW8								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MW6								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MW5								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	MW4								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC6			29/10/08		GW			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC7			29/10/08		GW			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	QC8			29/10/08		GW			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

RELINQUISHED BY:

Signature: **P. Lee** Date: **29/10/08**

Company: **coffey env.** Time:

Signature: _____ Date: _____

Company: _____ Time: _____

RECEIVED BY:

Signature: **Gary Wang** Date: **30/10**

Company: **MGT** Time: **9am**

Signature: _____ Date: _____

Company: _____ Time: _____

Sample Receipt Advice: (Lab Use Only)

All Samples Received in Good Condition ... ☒

All Documentation is in Proper Order ... ☒

Samples Received Properly Chilled ... ☒

Lab. Ref/Batch No.

236251

* Container Type & Preservation Codes: P - Plastic, G - Solvent Washed Acid Rinsed Glass Bottle, V - Vial, N - Nitric Acid Preserved
C - Hydrochloric Acid Preserved, S - Sulphuric Acid Preserved, I - Ice

CERTIFICATE OF ANALYSIS

Coffey Environments Pty Ltd WA
89-91 Burswood Road
Burswood
Western Australia 6100
Site: CYGNIA COVE ENVIBURW11899AA

Report Number: 236251 Page 1 of 37
Order Number:
Date Received: Oct 30, 2008
Date Sampled: Oct 28, 2008
Date Reported: Nov 25, 2008
Contact: Pamela Lee

Methods

- USEPA 8270C Phenols
- USEPA NCP 632 Carbamate Pesticides
- USEPA 8141A Organophosphorus Pesticides
- USEPA 8081A Organochlorine Pesticides
- USEPA 8270C Polycyclic Aromatic Hydrocarbons
- USEPA 8260B - MGT 350A Monocyclic Aromatic Hydrocarbons
- MGT100A-GC (based on USEPA8015)Total Recoverable Hydrocarbons
- USEPA 6020 Heavy Metals & USEPA 7470/71 Mercury
- APHA 4500-Cl (Cl by Discrete Analyser)
- APHA 4500-NH3 Ammonia Nitrogen by FIA
- APHA 4500-NO3 Nitrate Nitrogen by FIA
- APHA 4500-NO2 Nitrite Nitrogen by FIA
- APHA 4500 TKN
- APHA 4500-P E. Phosphorous
- APHA 2540C Total Dissolved Solids
- APHA 4500-SO4 (SO4 by Discrete Analyser)
- APHA 2310 Acidity
- APHA 4500-NO3/NO2 Nitrate-Nitrite Nitrogen by FIA
- APHA 2320 Alkalinity by Titration

Comments

Notes

1. The results in this report supersede any previously corresponded results.
2. All Soil Results are reported on a dry basis.
3. Samples are analysed on an as received basis.
4. LOR's are matrix dependent. Stated LOR's may be raised where sample extracts are diluted due to interferences.

ABBREVIATIONS

mg/kg : milligrams per kilograms, mg/L : milligrams per litre, ppm : parts per million,

LOR : Limit of Reporting

RPD : Relative Percent Difference

CRM : Certified Reference Material

LCS : Laboratory Control Sample

Authorised

Report Number: 236251

Michael Wright
Laboratory Manager
NATA Signatory

Onur Mehmet
Client Manager
NATA Signatory

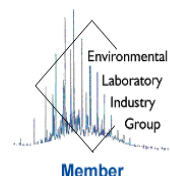
Orlando Scalzo
Chief Organic Chemist
NATA Signatory

Tammy Lakeland
Chief Inorganic Chemist



NATA Accredited
Laboratory Number 1261

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced, except in full.





Environmental Consulting Pty. Ltd.

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Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW10	ASSMW11	MW2(A)	MW3
	Lab Number		08-Oc11065	08-Oc11066	08-Oc11067	08-Oc11068
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Heavy Metals						
Calcium	0.5	mg/L	26	19	18	22
Magnesium	0.5	mg/L	7.8	< 5	5.7	6.3
Potassium	0.5	mg/L	< 5	7.3	8.9	5.8
Sodium	0.5	mg/L	75	60	58	55
Organochlorine Pesticides						
4,4'-DDD	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
4,4'-DDE	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
4,4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Aldrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
b-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Chlordane	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0002	< 0.0002
d-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Dieldrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Endosulfan I	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Endosulfan II	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Endrin aldehyde	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Endrin ketone	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
g-BHC (Lindane)	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Heptachlor	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Heptachlor epoxide	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Hexachlorobenzene	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Methoxychlor	0.00001	mg/L	< 0.00005	< 0.00005	< 0.00001	< 0.00001
Toxophene	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0002	< 0.0002
Dibutylchlorendate (surr.)	1	%	51	64	58	60
Tetrachloro-m-xylene (surr.)	1	%	59	61	50	68
Organophosphorous Pesticides						
Bolstar	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002

COMMENTS:

MGT Report No. 236251
 Page 2 of 37

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW10	ASSMW11	MW2(A)	MW3
	Lab Number		08-Oc11065	08-Oc11066	08-Oc11067	08-Oc11068
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Chlorpyrifos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Triphenylphosphate (surr.)	1	%	90	62	88	148
Carbamate Pesticides*						
Aldicarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Bendiocarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbaryl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbofuran	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Methomyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Oxamyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Thiobencarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW10	ASSMW11	MW2(A)	MW3
	Lab Number		08-Oc11065	08-Oc11066	08-Oc11067	08-Oc11068
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Acidity	0.01	mg/L	53	23	50	23
Ammonia(N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	0.05
Chloride	5	mg/L	110	70	78	85
Hydrogen Sulphide	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	mg/L	5.7	2.3	8.5	3.0
Nitrate (N)	0.02	mg/L	5.7	2.3	8.5	3.0
Nitrite (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (P)	0.05	mg/L	0.35	0.12	0.12	0.27
Sulphate (S)	5	mg/L	16	13	10	9.9
Total Dissolved Solids	10	mg/L	310	240	250	270
Total Kjeldahl Nitrogen (N)	0.1	mg/L	0.3	0.4	0.7	0.5
Total Nitrogen (N)	0.2	mg/L	6.0	2.7	9.2	3.5
Alkalinity						
Bicarbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	38	42	30	44
Carbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO ₃	20	mg/L	38	42	30	44
Heavy Metals						
Aluminium	0.01	mg/L	0.02	0.05	0.10	0.07
Arsenic	0.0007	mg/L	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.002	0.006	0.002	0.004
Iron	0.05	mg/L	0.31	0.80	0.15	0.56
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	0.001	mg/L	< 0.001	0.002	< 0.001	< 0.001

COMMENTS:



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Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW10	ASSMW11	MW2(A)	MW3
	Lab Number		08-Oc11065	08-Oc11066	08-Oc11067	08-Oc11068
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Zinc	0.001	mg/L	0.084	0.061	0.091	0.068

COMMENTS:

Coffey Environments Pty Ltd WA

Coffey Environments Pty Ltd WA	Client Sample ID		QC1	MW1(A)	ASSMW12	ASSMW13
89-91 Burswood Road Burswood Western Australia 6100	Lab Number		08-Oc11069	08-Oc11070	08-Oc11071	08-Oc11072
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
	Analysis Type	LOR	Units			
Heavy Metals						
Calcium	0.5	mg/L	18	13	35	< 5
Magnesium	0.5	mg/L	5.8	7.1	27	11
Potassium	0.5	mg/L	7.4	< 5	6.6	< 5
Sodium	0.5	mg/L	57	100	230	56
Total Recoverable Hydrocarbons						
TRH C6-C9 Fraction by GC	0.02	mg/L	-	< 0.02	-	-
TRH C10-C14 Fraction by GC	0.05	mg/L	-	< 0.05	-	-
TRH C15-C28 Fraction by GC	0.1	mg/L	-	< 0.1	-	-
TRH C29-C36 Fraction by GC	0.1	mg/L	-	< 0.1	-	-
Monocyclic Aromatic Hydrocarbons						
Benzene	0.001	mg/L	-	< 0.001	-	-
Toluene	0.001	mg/L	-	< 0.001	-	-
Ethylbenzene	0.001	mg/L	-	< 0.001	-	-
Xylenes(ortho.meta and para)	0.001	mg/L	-	< 0.001	-	-
Fluorobenzene (surr.)	1	%	-	127	-	-
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.0001	mg/L	-	< 0.0005	-	-
Acenaphthylene	0.0001	mg/L	-	< 0.0005	-	-
Anthracene	0.0001	mg/L	-	< 0.0005	-	-
Benz(a)anthracene	0.0001	mg/L	-	< 0.0005	-	-
Benzo(a)pyrene	0.00001	mg/L	-	< 0.00001	-	-
Benzo(b)fluoranthene	0.0001	mg/L	-	< 0.0005	-	-
Benzo(g,h,i)perylene	0.0001	mg/L	-	< 0.0005	-	-
Benzo(k)fluoranthene	0.0001	mg/L	-	< 0.0005	-	-
Chrysene	0.0001	mg/L	-	< 0.0005	-	-
Dibenz(a,h)anthracene	0.0001	mg/L	-	< 0.0005	-	-
Fluoranthene	0.0001	mg/L	-	< 0.0005	-	-
Fluorene	0.0001	mg/L	-	< 0.0005	-	-
Indeno(1.2.3-cd)pyrene	0.0001	mg/L	-	< 0.0005	-	-
Naphthalene	0.0001	mg/L	-	< 0.0005	-	-

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		QC1	MW1(A)	ASSMW12	ASSMW13
	Lab Number		08-Oc11069	08-Oc11070	08-Oc11071	08-Oc11072
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Phenanthrene	0.0001	mg/L	-	< 0.0005	-	-
Pyrene	0.0001	mg/L	-	< 0.0005	-	-
Total PAH	0.0001	mg/L	-	< 0.0005	-	-
Chrysene-d12 (surr.)	1	%	-	65	-	-
2-Fluorobiphenyl (surr.)	1	%	-	52	-	-
Organochlorine Pesticides						
4,4'-DDD	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
4,4'-DDE	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
4,4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Aldrin	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
b-BHC	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Chlordane	0.0001	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0005
d-BHC	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Dieldrin	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Endosulfan I	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Endosulfan II	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Endrin aldehyde	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Endrin ketone	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
g-BHC (Lindane)	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Heptachlor	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Heptachlor epoxide	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Hexachlorobenzene	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Methoxychlor	0.00001	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00002
Toxophene	0.0001	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0005
Dibutylchloroendate (surr.)	1	%	72	68	80	56
Tetrachloro-m-xylene (surr.)	1	%	83	87	69	62

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		QC1	MW1(A)	ASSMW12	ASSMW13
	Lab Number		08-Oc11069	08-Oc11070	08-Oc11071	08-Oc11072
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Organophosphorous Pesticides						
Bolstar	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Chlorpyrifos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Triphenylphosphate (surr.)	1	%	110	119	67	61
Carbamate Pesticides*						
Aldicarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Bendiocarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbaryl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbofuran	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Methomyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		QC1	MW1(A)	ASSMW12	ASSMW13
	Lab Number		08-Oc11069	08-Oc11070	08-Oc11071	08-Oc11072
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Oxamyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Thiobencarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Phenols						
2-Chlorophenol	0.0001	mg/L	-	< 0.0001	-	-
2-Methylphenol (o-Cresol)	0.0001	mg/L	-	< 0.0001	-	-
2-Nitrophenol	0.0005	mg/L	-	< 0.0005	-	-
2,4-Dichlorophenol	0.0001	mg/L	-	< 0.0001	-	-
2,4-Dimethylphenol	0.0001	mg/L	-	< 0.0001	-	-
2,4,6-Trichlorophenol	0.0001	mg/L	-	< 0.0001	-	-
2,6-Dichlorophenol	0.0001	mg/L	-	< 0.0001	-	-
3&4-Methylphenol (m&p-Cresol)	0.0001	mg/L	-	< 0.0001	-	-
4-Chloro-3-methylphenol	0.0001	mg/L	-	< 0.0001	-	-
Pentachlorophenol	0.0005	mg/L	-	< 0.0005	-	-
Phenol	0.0001	mg/L	-	< 0.0001	-	-
Phenol-d6 (surr.)	1	%	-	50	-	-
Acidity	0.01	mg/L	40	53	43	350
Ammonia(N)	0.05	mg/L	0.19	< 0.05	< 0.05	0.58
Chloride	5	mg/L	80	150	460	88
Hydrogen Sulphide	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	mg/L	7.1	3.2	0.12	0.53
Nitrate (N)	0.02	mg/L	7.1	3.1	0.11	0.52
Nitrite (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (P)	0.05	mg/L	0.17	0.14	< 0.05	0.05
Sulphate (S)	5	mg/L	11	11	30	13
Total Dissolved Solids	10	mg/L	280	360	950	240
Total Kjeldahl Nitrogen (N)	0.1	mg/L	0.6	0.8	0.3	0.3
Total Nitrogen (N)	0.2	mg/L	7.7	4.0	0.4	0.8
Alkalinity						

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		QC1	MW1(A)	ASSMW12	ASSMW13
	Lab Number		08-Oc11069	08-Oc11070	08-Oc11071	08-Oc11072
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Bicarbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	30	20	< 10	10
Carbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO ₃	20	mg/L	30	20	< 20	< 20
Heavy Metals						
Aluminium	0.01	mg/L	0.10	0.25	1.5	0.02
Arsenic	0.0007	mg/L	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	0.002	< 0.001
Copper	0.001	mg/L	0.002	0.004	0.003	0.003
Iron	0.05	mg/L	0.19	0.25	0.61	2.8
Lead	0.001	mg/L	< 0.001	< 0.001	0.002	< 0.001
Manganese	0.005	mg/L	< 0.005	0.010	< 0.005	< 0.005
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.001	< 0.001	0.004	< 0.001
Selenium	0.001	mg/L	0.002	0.002	0.001	< 0.001
Zinc	0.001	mg/L	0.085	0.10	0.071	0.072

COMMENTS:

Coffey Environments Pty Ltd WA

Client Sample ID		MW7	QC3	QC4	QC5
89-91 Burswood Road	Lab Number	08-Oc11073	08-Oc11074	08-Oc11075	08-Oc11076
Burswood	Matrix	Groundwater	Water	Water	Water
Western Australia 6100	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units			
Heavy Metals					
Calcium	0.5	mg/L	35	< 0.5	< 0.5
Magnesium	0.5	mg/L	11	< 0.5	< 0.5
Potassium	0.5	mg/L	5.1	< 0.5	< 0.5
Sodium	0.5	mg/L	68	< 0.5	< 0.5
Organochlorine Pesticides					
4,4'-DDD	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
4,4'-DDE	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
4,4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Aldrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
b-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Chlordane	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0005
d-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Dieldrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Endosulfan I	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Endosulfan II	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Endrin aldehyde	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Endrin ketone	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
g-BHC (Lindane)	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Heptachlor	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Heptachlor epoxide	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Hexachlorobenzene	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Methoxychlor	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Toxophene	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0005
Dibutylchloroendate (surr.)	1	%	53	93	53
Tetrachloro-m-xylene (surr.)	1	%	53	115	51
Organophosphorous Pesticides					
Bolstar	0.002	mg/L	< 0.002	< 0.002	< 0.002

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW7	QC3	QC4	QC5
	Lab Number		08-Oc11073	08-Oc11074	08-Oc11075	08-Oc11076
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Chlorpyrifos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Triphenylphosphate (surr.)	1	%	61	67	54	70
Carbamate Pesticides*						
Aldicarb	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Bendiocarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbaryl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Carbofuran	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Methomyl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Oxamyl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Thiobencarb	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW7	QC3	QC4	QC5
	Lab Number		08-Oc11073	08-Oc11074	08-Oc11075	08-Oc11076
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Acidity	0.01	mg/L	53	< 0.01	< 0.01	< 0.01
Ammonia(N)	0.05	mg/L	0.08	< 0.05	< 0.05	< 0.05
Chloride	5	mg/L	110	< 5	< 5	< 5
Hydrogen Sulphide	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (P)	0.05	mg/L	0.07	< 0.05	< 0.05	< 0.05
Sulphate (S)	5	mg/L	13	< 5	< 5	< 5
Total Dissolved Solids	10	mg/L	360	< 10	< 10	< 10
Total Kjeldahl Nitrogen (N)	0.1	mg/L	0.3	< 0.1	< 0.1	< 0.1
Total Nitrogen (N)	0.2	mg/L	0.3	< 0.2	< 0.2	< 0.2
Alkalinity						
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	100	< 10	< 10	< 10
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO3	20	mg/L	100	< 20	< 20	< 20
Heavy Metals						
Aluminium	0.01	mg/L	0.01	< 0.01	< 0.01	< 0.01
Arsenic	0.0007	mg/L	0.0029	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.003	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	1.9	< 0.05	< 0.05	< 0.05
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.010	< 0.005	< 0.005	< 0.005
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

COMMENTS:



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Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW7	QC3	QC4	QC5
	Lab Number		08-Oc11073	08-Oc11074	08-Oc11075	08-Oc11076
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	LOR	Units				
Zinc	0.001	mg/L	0.052	< 0.001	< 0.001	< 0.001

COMMENTS:

Coffey Environments Pty Ltd WA

Coffey Environments Pty Ltd WA	Client Sample ID		ASSMW9	ASSMW8	MW6	MW5
89-91 Burswood Road Burswood Western Australia 6100	Lab Number		08-Oc11077	08-Oc11078	08-Oc11079	08-Oc11080
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
	Analysis Type	LOR	Units			
Heavy Metals						
Calcium	0.5	mg/L	< 5	38	82	30
Magnesium	0.5	mg/L	11	13	240	11
Potassium	0.5	mg/L	5.5	5.1	93	13
Sodium	0.5	mg/L	80	120	1600	110
Organochlorine Pesticides						
4,4'-DDD	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
4,4'-DDE	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
4,4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Aldrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
b-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Chlordane	0.0001	mg/L	< 0.0005	< 0.0005	< 0.002	< 0.0005
d-BHC	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Dieldrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Endosulfan I	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Endosulfan II	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Endrin aldehyde	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Endrin ketone	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
g-BHC (Lindane)	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Heptachlor	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Heptachlor epoxide	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Hexachlorobenzene	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Methoxychlor	0.00001	mg/L	< 0.00005	< 0.00005	< 0.0001	< 0.00005
Toxophene	0.0001	mg/L	< 0.0005	< 0.0005	< 0.002	< 0.0005
Dibutylchlorendate (surr.)	1	%	51	71	59	57
Tetrachloro-m-xylene (surr.)	1	%	66	74	68	56
Organophosphorous Pesticides						
Bolstar	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW9	ASSMW8	MW6	MW5
	Lab Number		08-Oc11077	08-Oc11078	08-Oc11079	08-Oc11080
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
Chlorpyrifos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fensulfothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Triphenylphosphate (surr.)	1	%	59	67	88	70
Carbamate Pesticides*						
Aldicarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Bendiocarb	0.01	mg/L	< 0.01	< 0.01	< 0.02	< 0.01
Carbaryl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Carbofuran	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Methomyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Oxamyl	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Thiobencarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW9	ASSMW8	MW6	MW5
	Lab Number		08-Oc11077	08-Oc11078	08-Oc11079	08-Oc11080
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
Acidity	0.01	mg/L	190	83	150	80
Ammonia(N)	0.05	mg/L	1.3	0.15	0.37	6.0
Chloride	5	mg/L	160	190	3100	170
Hydrogen Sulphide	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (N)	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
Phosphate total (P)	0.05	mg/L	< 0.05	< 0.05	< 0.05	0.18
Sulphate (S)	5	mg/L	21	30	65	5.0
Total Dissolved Solids	10	mg/L	430	510	5600	470
Total Kjeldahl Nitrogen (N)	0.1	mg/L	1.3	1.1	0.7	6.6
Total Nitrogen (N)	0.2	mg/L	1.3	1.1	0.7	6.6
Alkalinity						
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/L	70	56	32	150
Carbonate Alkalinity-mg CaCO3/L	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO3	20	mg/L	70	56	32	150
Heavy Metals						
Aluminium	0.01	mg/L	0.01	0.04	< 0.01	0.04
Arsenic	0.0007	mg/L	0.0059	< 0.0007	0.0058	0.0027
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.002	< 0.001	< 0.001	0.003
Copper	0.001	mg/L	0.002	0.001	0.005	0.003
Iron	0.05	mg/L	80	3.2	39	3.6
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.020	0.023	0.42	0.044
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	0.002	0.001	0.008	0.003
Selenium	0.001	mg/L	0.003	0.001	0.020	< 0.001

COMMENTS:



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Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		ASSMW9	ASSMW8	MW6	MW5
	Lab Number		08-Oc11077	08-Oc11078	08-Oc11079	08-Oc11080
	Matrix		Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
Zinc	0.001	mg/L	0.075	0.049	0.068	0.039

COMMENTS:

Coffey Environments Pty Ltd WA

Client Sample ID		MW4	QC6	QC7	QC8
89-91 Burswood Road	Lab Number	08-Oc11081	08-Oc11082	08-Oc11083	08-Oc11084
Burswood	Matrix	Groundwater	Water	Water	Water
Western Australia 6100	Sample Date	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units			
Heavy Metals					
Calcium	0.5	mg/L	11	< 0.5	< 0.5
Magnesium	0.5	mg/L	19	< 0.5	< 0.5
Potassium	0.5	mg/L	11	< 0.5	< 0.5
Sodium	0.5	mg/L	100	< 0.5	< 0.5
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.0001	mg/L	< 0.0005	-	-
Acenaphthylene	0.0001	mg/L	< 0.0005	-	-
Anthracene	0.0001	mg/L	< 0.0005	-	-
Benz(a)anthracene	0.0001	mg/L	< 0.0005	-	-
Benzo(a)pyrene	0.00001	mg/L	< 0.00001	-	-
Benzo(b)fluoranthene	0.0001	mg/L	< 0.0005	-	-
Benzo(g,h,i)perylene	0.0001	mg/L	< 0.0005	-	-
Benzo(k)fluoranthene	0.0001	mg/L	< 0.0005	-	-
Chrysene	0.0001	mg/L	< 0.0005	-	-
Dibenz(a,h)anthracene	0.0001	mg/L	< 0.0005	-	-
Fluoranthene	0.0001	mg/L	< 0.0005	-	-
Fluorene	0.0001	mg/L	< 0.0005	-	-
Indeno(1,2,3-cd)pyrene	0.0001	mg/L	< 0.0005	-	-
Naphthalene	0.0001	mg/L	< 0.0005	-	-
Phenanthrene	0.0001	mg/L	< 0.0005	-	-
Pyrene	0.0001	mg/L	< 0.0005	-	-
Total PAH	0.0001	mg/L	< 0.0005	-	-
Chrysene-d12 (surr.)	1	%	115	-	-
2-Fluorobiphenyl (surr.)	1	%	62	-	-
Organochlorine Pesticides					
4,4'-DDD	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
4,4'-DDE	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
4,4'-DDT	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001
a-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001
Aldrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW4	QC6	QC7	QC8
	Lab Number		08-Oc11081	08-Oc11082	08-Oc11083	08-Oc11084
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
b-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Chlordane	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
d-BHC	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Dieldrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Endosulfan I	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Endosulfan II	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Endosulfan sulphate	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Endrin	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Endrin aldehyde	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Endrin ketone	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
g-BHC (Lindane)	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Heptachlor	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Heptachlor epoxide	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Hexachlorobenzene	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Methoxychlor	0.00001	mg/L	< 0.00005	< 0.0001	< 0.0001	< 0.0001
Toxophene	0.0001	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibutylchloroendate (surr.)	1	%	95	55	65	55
Tetrachloro-m-xylene (surr.)	1	%	55	54	68	62
Organophosphorous Pesticides						
Bolstar	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Chlorpyrifos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Coumaphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Demeton-O	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Diazinon	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Dichlorvos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Disulfoton	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ethoprop	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenitrothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW4	QC6	QC7	QC8
	Lab Number		08-Oc11081	08-Oc11082	08-Oc11083	08-Oc11084
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
Fensulfothion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Fenthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Merphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl azinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Methyl parathion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Mevinphos	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Naled	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Phorate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Ronnel	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Tokuthion	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Trichloronate	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Triphenylphosphate (surr.)	1	%	98	78	51	93
Carbamate Pesticides*						
Aldicarb	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Bendiocarb	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.005
Carbaryl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Carbofuran	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Methomyl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Oxamyl	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Thiobencarb	0.01	mg/L	< 0.01	< 0.002	< 0.002	< 0.002
Phenols						
2-Chlorophenol	0.0001	mg/L	< 0.0001	-	-	-
2-Methylphenol (o-Cresol)	0.0001	mg/L	< 0.0001	-	-	-
2-Nitrophenol	0.0005	mg/L	< 0.0005	-	-	-
2,4-Dichlorophenol	0.0001	mg/L	< 0.0001	-	-	-
2,4-Dimethylphenol	0.0001	mg/L	< 0.0001	-	-	-
2,4,6-Trichlorophenol	0.0001	mg/L	< 0.0001	-	-	-
2,6-Dichlorophenol	0.0001	mg/L	< 0.0001	-	-	-
3&4-Methylphenol (m&p-Cresol)	0.0001	mg/L	< 0.0001	-	-	-

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW4	QC6	QC7	QC8
	Lab Number		08-Oc11081	08-Oc11082	08-Oc11083	08-Oc11084
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
4-Chloro-3-methylphenol	0.0001	mg/L	< 0.0001	-	-	-
Pentachlorophenol	0.0005	mg/L	< 0.0005	-	-	-
Phenol	0.0001	mg/L	< 0.0001	-	-	-
Phenol-d6 (surr.)	1	%	70	-	-	-
Acidity	0.01	mg/L	190	< 0.01	< 0.01	< 0.01
Ammonia(N)	0.05	mg/L	1.1	< 0.05	< 0.05	< 0.05
Chloride	5	mg/L	200	< 5	< 5	< 5
Hydrogen Sulphide	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate & Nitrite (N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (P)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Sulphate (S)	5	mg/L	10	< 5	< 5	< 5
Total Dissolved Solids	10	mg/L	510	< 10	< 10	< 10
Total Kjeldahl Nitrogen (N)	0.1	mg/L	1.2	< 0.1	< 0.1	< 0.1
Total Nitrogen (N)	0.2	mg/L	1.2	< 0.2	< 0.2	< 0.2
Alkalinity						
Bicarbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	140	< 10	< 10	< 10
Carbonate Alkalinity-mg CaCO ₃ /L	10	mg/L	< 10	< 10	< 10	< 10
Total Alkalinity as CaCO ₃	20	mg/L	140	< 20	< 20	< 20
Heavy Metals						
Aluminium	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic	0.0007	mg/L	< 0.0007	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.003	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.003	< 0.001	< 0.001	< 0.001
Iron	0.05	mg/L	61	< 0.05	< 0.05	< 0.05
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID		MW4	QC6	QC7	QC8
	Lab Number		08-Oc11081	08-Oc11082	08-Oc11083	08-Oc11084
	Matrix		Groundwater	Water	Water	Water
	Sample Date		Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	LOR	Units				
Manganese	0.005	mg/L	0.28	< 0.005	< 0.005	< 0.005
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	0.003	< 0.001	< 0.001	< 0.001
Selenium	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Zinc	0.001	mg/L	0.070	< 0.001	< 0.001	< 0.001

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	ASSMW10	ASSMW10	RPD	SPIKE	LCS	Method blank
	Lab Number	08-Oc11065	08-Oc11065	08-Oc11065	08-Oc11065	Batch	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	% Recovery	
	Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	Units			% RPD	% Recovery	% Recovery	mg/L
Chloride		110	110	< 1	104	-	-
Hydrogen Sulphide		< 0.05	< 0.1	< 1	-	-	-
Sulphate (S)		16	16	< 1	108	-	-
Organochlorine Pesticides							
4.4'-DDD		-	-	< 1	76	93	< 0.0001
4.4'-DDE		-	-	< 1	119	88	< 0.0001
4.4'-DDT		-	-	< 1	107	91	< 0.0001
a-BHC		-	-	< 1	99	91	< 0.0001
Aldrin		-	-	< 1	78	93	< 0.0001
b-BHC		-	-	< 1	115	91	< 0.0001
Chlordane		-	-	< 1	-	-	< 0.001
d-BHC		-	-	< 1	116	104	< 0.0001
Dieldrin		-	-	< 1	113	87	< 0.0001
Endosulfan I		-	-	< 1	120	88	< 0.0001
Endosulfan II		-	-	< 1	121	88	< 0.0001
Endosulfan sulphate		-	-	< 1	94	94	< 0.0001
Endrin		-	-	< 1	117	98	< 0.0001
Endrin aldehyde		-	-	< 1	107	87	< 0.0001
Endrin ketone		-	-	< 1	114	118	< 0.0001
g-BHC (Lindane)		-	-	< 1	95	99	< 0.0001
Heptachlor		-	-	< 1	76	112	< 0.0001
Heptachlor epoxide		-	-	< 1	118	83	< 0.0001
Hexachlorobenzene		-	-	< 1	123	102	< 0.0001
Methoxychlor		-	-	< 1	117	128	< 0.0001
Toxophene		-	-	< 1	118	-	< 0.001
Heavy Metals							
Arsenic		< 0.0007	< 0.0007	< 1	107	-	-
Cadmium		< 0.0002	< 0.0002	< 1	108	-	-
Chromium		< 0.001	< 0.001	< 1	113	-	-

COMMENTS:

Zinc

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Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	RPD	SPIKE	LCS	Method blank
	Lab Number	Batch	Batch	Batch	Batch
	QA Description		Spike % Recovery	% Recovery	
	Matrix	Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	Units		% Recovery	% Recovery	mg/L
Total Recoverable Hydrocarbons					
TRH C6-C9 Fraction by GC		< 1	120	-	< 0.02
TRH C10-C14 Fraction by GC		< 1	94	-	< 0.05
TRH C15-C28 Fraction by GC		< 1	-	-	< 0.1
TRH C29-C36 Fraction by GC		< 1	-	-	< 0.1
Monocyclic Aromatic Hydrocarbons					
Benzene		< 1	105	116	< 0.001
Toluene		< 1	125	108	< 0.001
Ethylbenzene		< 1	125	102	< 0.001
Xylenes(ortho.meta and para)		< 1	123	111	< 0.001
Polycyclic Aromatic Hydrocarbons					
Acenaphthene		< 1	72	72	< 0.0001
Acenaphthylene		< 1	85	81	< 0.0001
Anthracene		< 1	78	84	< 0.0001
Benz(a)anthracene		< 1	126	94	< 0.0001
Benzo(a)pyrene		< 1	91	93	< 0.00001
Benzo(b)fluoranthene		< 1	84	81	< 0.0001
Benzo(g,h,i)perylene		< 1	83	83	< 0.0001
Benzo(k)fluoranthene		< 1	78	81	< 0.0001
Chrysene		< 1	105	83	< 0.0001
Dibenz(a,h)anthracene		< 1	94	103	< 0.0001
Fluoranthene		< 1	114	82	< 0.0001
Fluorene		< 1	82	78	< 0.0001
Indeno(1,2,3-cd)pyrene		< 1	93	100	< 0.0001
Naphthalene		< 1	105	90	< 0.0001
Phenanthrene		< 1	72	92	< 0.0001
Pyrene		< 1	105	75	< 0.0001
Phenols					
2-Chlorophenol		< 1	71	118	< 0.0001

COMMENTS:

Analysis Type

Phenols

2-Methylphenol (o-Cresol)

2-Nitrophenol

2.4-Dichlorophenol

2.4-Dimethylphenol

2.4.6-Trichlorophenol

2.6-Dichlorophenol

3&4-Methylphenol (m&p-Cresol)

4-Chloro-3-methylphenol

Pentachlorophenol

Phenol

[illegible]

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	MW7	MW7	RPD	SPIKE
	Lab Number	08-Oc11073	08-Oc11073	08-Oc11073	08-Oc11073
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery
	Matrix	Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	Units			% RPD	% Recovery
Heavy Metals					
Mercury		< 0.0001	< 0.0001	12	87

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	QC3	QC3	RPD	SPIKE
	Lab Number	08-Oc11074	08-Oc11074	08-Oc11074	08-Oc11074
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery
	Matrix	Water	Water	Water	Water
	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	Units			% RPD	% Recovery
Phosphate total (P)		< 0.05	< 0.05	< 1	109
Heavy Metals					
Calcium		< 0.5	< 0.5	< 1	106
Magnesium		-	-	< 1	99
Potassium		< 0.5	< 0.5	< 1	113
Sodium		-	-	< 1	100

COMMENTS:

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	QC5	QC5	RPD	SPIKE
	Lab Number	08-Oc11076	08-Oc11076	08-Oc11076	08-Oc11076
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery
	Matrix	Water	Water	Water	Water
	Sample Date	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008	Oct 28, 2008
Analysis Type	Units			% RPD	% Recovery
Ammonia(N)		< 0.05	< 0.05	< 1	117
Nitrate & Nitrite (N)		< 0.05	< 0.05	< 1	96
Nitrate (N)		< 0.02	< 0.02	< 1	96
Nitrite (N)		< 0.02	< 0.02	< 1	103
Phosphate total (P)		< 0.05	< 0.05	< 1	113

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	ASSMW9	ASSMW9	RPD	SPIKE	LCS	Method blank
	Lab Number	08-Oc11077	08-Oc11077	08-Oc11077	08-Oc11077	Batch	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	% Recovery	
	Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	Units			% RPD	% Recovery	% Recovery	mg/L
Acidity		190	210	8.0	-	-	-
Organophosphorous Pesticides							
Bolstar		-	-	< 1	80	-	< 0.002
Chlorpyrifos		-	-	< 1	-	-	< 0.002
Coumaphos		-	-	< 1	82	-	< 0.002
Demeton-O		-	-	< 1	77	-	< 0.002
Diazinon		-	-	< 1	-	75	< 0.002
Dichlorvos		-	-	< 1	79	-	< 0.002
Disulfoton		-	-	< 1	74	-	< 0.002
Ethion		-	-	< 1	-	102	< 0.002
Ethoprop		-	-	< 1	86	-	< 0.002
Fenitrothion		-	-	< 1	-	101	< 0.002
Fensulfothion		-	-	< 1	82	-	< 0.002
Fenthion		-	-	< 1	-	-	< 0.002
Merphos		-	-	< 1	80	-	< 0.002
Methyl azinphos		-	-	< 1	-	-	< 0.002
Methyl parathion		-	-	< 1	-	114	< 0.002
Mevinphos		-	-	< 1	-	120	< 0.002
Naled		-	-	< 1	72	-	< 0.002
Phorate		-	-	< 1	78	-	< 0.002
Ronnel		-	-	< 1	-	-	< 0.002
Tokuthion		-	-	< 1	74	-	< 0.002
Trichloronate		-	-	< 1	79	-	< 0.002

COMMENTS:

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	MW4	MW4	RPD	SPIKE	LCS	Method blank
	Lab Number	08-Oc11081	08-Oc11081	08-Oc11081	08-Oc11081	Batch	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	% Recovery	
	Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	Sample Date	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	Units			% RPD	% Recovery	% Recovery	mg/L
Acidity		190	180	7.0	-	-	< 0.01
Phosphate total (P)		< 0.05	< 0.05	< 1	93	-	-
Heavy Metals							
Mercury		< 0.0001	< 0.0001	4.8	-	105	< 0.0001

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	QC6	QC6	RPD	SPIKE
	Lab Number	08-Oc11082	08-Oc11082	08-Oc11082	08-Oc11082
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery
	Matrix	Water	Water	Water	Water
	Sample Date	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	Units			% RPD	% Recovery
Ammonia(N)		< 0.05	< 0.05	< 1	100
Nitrate & Nitrite (N)		< 0.05	< 0.05	< 1	95
Nitrate (N)		< 0.02	< 0.02	< 1	95
Nitrite (N)		< 0.02	< 0.02	< 1	107
Phosphate total (P)		< 0.05	< 0.05	< 1	105

COMMENTS:

COMMENTS:

Coffey Environments Pty Ltd WA 89-91 Burswood Road Burswood Western Australia 6100	Client Sample ID	QC8	QC8	RPD	SPIKE	LCS	Method blank
	Lab Number	08-Oc11084	08-Oc11084	08-Oc11084	08-Oc11084	Batch	Batch
	QA Description		Duplicate	Duplicate % RPD	Spike % Recovery	% Recovery	
	Matrix	Water	Water	Water	Water	Water	Water
	Sample Date	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008	Oct 29, 2008
Analysis Type	Units			% RPD	% Recovery	% Recovery	mg/L
Ammonia(N)		< 0.05	< 0.05	< 1	101	102	< 0.05
Chloride		< 5	< 5	< 1	100	110	< 5
Hydrogen Sulphide		< 0.05	< 0.1	< 1	-	-	< 0.1
Nitrate & Nitrite (N)		< 0.05	< 0.05	< 1	91	90	< 0.05
Nitrate (N)		< 0.02	< 0.02	< 1	91	90	< 0.02
Nitrite (N)		< 0.02	< 0.02	< 1	107	103	< 0.02
Sulphate (S)		< 5	< 5	< 1	97	122	< 5
Total Kjeldahl Nitrogen (N)		< 0.1	< 0.1	< 1	93	98	< 0.1
Carbamate Pesticides*							
Aldicarb		-	-	-	-	-	< 0.001
Bendiocarb		-	-	-	-	-	< 0.005
Carbaryl		-	-	-	-	-	< 0.001
Carbofuran		-	-	-	-	-	< 0.001
Methomyl		-	-	-	-	-	< 0.001
Oxamyl		-	-	-	-	-	< 0.001
Thiobencarb		-	-	-	-	-	< 0.001
Heavy Metals							
Calcium		< 0.5	< 0.5	< 1	103	97	< 0.5
Magnesium		< 0.5	-	< 1	-	97	< 0.5
Potassium		< 0.5	< 0.5	< 1	111	104	< 0.5
Sodium		< 0.5	-	< 1	-	120	< 0.5

COMMENTS:

Sample Receipt Advice

Company name: Coffey Environments Pty Ltd WA
Contact name: Pamela Lee
Client job number: CYGNIA COVE ENVIBURW11899AA
COC number: 80286-8
Turn around time: Five day
Date received: Oct 30, 2008
MGT lab reference: 236251

Sample information

- ☒ All samples have been received as described on the above COC.
- ☒ COC has been completed correctly.
- ☒ All samples were provided chilled.
- ☒ Appropriately preserved sample containers have been used.
- ☒ All samples were received in good condition.
- ☒ Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.

Contact notes

If you have any questions with respect to these samples please contact:

Onur Mehmet on the above number or by e.mail: mehmeto@mgtenv.com.au

Results will be delivered electronically via e.mail to Pamela Lee - Pamela_Lee@coffey.com.

mgt Sample Receipt

ANALYTICAL REPORT

10 November 2008

Coffey Environments Pty Ltd
Level 1, 89-91 Burswood Road
BURSWOOD
WA 6100

Attention: Pamela Lee

Your Reference: ENVIBURW11899AA - Cygnia Cove

Our Reference: 65170

Samples: 1 Water

Received: 30/10/08

Preliminary Report Sent: 10/11/08

These samples were analysed in accordance with your written instructions.

For and on Behalf of:
SGS ENVIRONMENTAL SERVICES

Client Services:	Simon Matthews	Simon.Matthews@sgs.com
Sample Receipt:	Angela Mamalicos	AU.SampleReceipt.Sydney@sgs.com
Laboratory Manager:	Edward Ibrahim	Edward.Ibrahim@sgs.com
Business Manager:	Con Benikos	Con.Benikos@sgs.com

Results Approved and/or Authorised by:



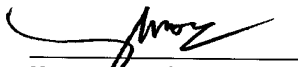
Edward Ibrahim
Laboratory Manager



Nick Salarinis
Inorganics Signatory



Ly Kim Ha
Organics Signatory



Huong Crawford
Metals Signatory

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OC Pesticides in Water Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted		3/11/2008
Date Analysed		3/11/2008
HCB	µg/L	<0.2
<i>alpha</i> -BHC	µg/L	<0.2
<i>gamma</i> -BHC(lindane)	µg/L	<0.2
Heptachlor	µg/L	<0.2
Aldrin	µg/L	<0.2
<i>beta</i> -BHC	µg/L	<0.2
<i>delta</i> -BHC	µg/L	<0.2
Heptachlor Epoxide	µg/L	<0.2
<i>o,p</i> -DDE	µg/L	<0.2
<i>alpha</i> -Endosulfan	µg/L	<0.2
<i>trans</i> -Chlordane	µg/L	<0.2
<i>cis</i> -Chlordane	µg/L	<0.2
<i>trans</i> -Nonachlor	µg/L	<0.2
<i>p,p</i> -DDE	µg/L	<0.2
Dieldrin	µg/L	<0.2
Endrin	µg/L	<0.2
<i>o,p</i> -DDD	µg/L	<0.2
<i>o,p</i> -DDT	µg/L	<0.2
<i>beta</i> -Endosulfan	µg/L	<0.2
<i>p,p</i> -DDD	µg/L	<0.2
<i>p,p</i> -DDT	µg/L	<0.2
Endosulfan Sulphate	µg/L	<0.2
Endrin Aldehyde	µg/L	<0.2
Methoxychlor	µg/L	<0.2
Endrin Ketone	µg/L	<0.2
2,4,5,6-Tetrachloro-m-xylene (<i>Surrogate</i>)	%	77



OP Pesticides in Water Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted		3/11/2008
Date Analysed		3/11/2008
Chlorpyrifos	µg/L	<0.2
Fenitrothion	µg/L	<0.2
Bromofos Ethyl	µg/L	<0.2
Ethion	µg/L	<0.2
OP_Surrogate 1	%	77



Inorganics Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted (TKN)		3/11/2008
Date Analysed (TKN)		3/11/2008
Total Kjeldahl Nitrogen	mg/L	0.3
Date Extracted (Ammonia)		31/10/2008
Date Analysed (Ammonia)		31/10/2008
Ammonia as N	mg/L	<0.01
Date Extracted (Total P)		3/11/2008
Date Analysed (Total P)		3/11/2008
Total Phosphorus	mg/L	0.06
Total Nitrogen (by Calc.)	mg/L	7.3



Anions in water Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted		31/10/2008
Date Analysed		31/10/2008
Chloride, Cl	mg/L	77
Nitrite as N	mg/L	<0.05
Nitrate as N	mg/L	7.0
Total NOx (by Calc.)	mg/L	7.0



Inorganics Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted (Acidity)		31/10/2008
Date Analysed (Acidity)		31/10/2008
Acidity as CaCO ₃	mg/L	33
Date Extracted (Alkalinity)		31/10/2008
Date Analysed (Alkalinity)		31/10/2008
Total Alkalinity as CaCO ₃	mg/L	42
Bicarbonate, HCO ₃ ⁻	mg/L	52
Carbonate, CO ₃ ²⁻	mg/L	<2.0
Date Extracted (TDS)		3/11/2008
Date Analysed (TDS)		3/11/2008
Total Dissolved Solids	mg/L	270
Date Extracted (Sulphide)		31/10/2008
Date Analysed (Sulphide)		31/10/2008
Sulphide expressed as H ₂ S	mg/L	<0.5



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Metals in water by ICP-OES		
Our Reference:	UNITS	65170-1
Your Reference	-----	QC2
Sample Matrix	-----	WATER
Date Sampled		28/10/2008
Depth		
Date Extracted (Metals)		30/10/2008
Date Analysed (Metals)		30/10/2008
Calcium (Dissolved)	mg/L	18
Magnesium (Dissolved)	mg/L	5.6
Potassium (Dissolved)	mg/L	7.6
Sodium (Dissolved)	mg/L	43



Trace HM (ICP-MS)-Dissolved Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted (Metals-ICPMS)		31/10/2008
Date Analysed (Metals-ICPMS)		31/10/2008
Arsenic	µg/L	<1
Cadmium	µg/L	<0.1
Chromium	µg/L	<1
Copper	µg/L	<1
Manganese	µg/L	1
Nickel	µg/L	<1
Lead	µg/L	<1
Selenium	µg/L	<2
Zinc	µg/L	82
Aluminium	µg/L	110
Iron	µg/L	24



Mercury Cold Vapor/Hg Analyser Our Reference: Your Reference Sample Matrix Date Sampled Depth	UNITS ----- -----	65170-1 QC2 WATER 28/10/2008
Date Extracted (Mercury)		31/10/2008
Date Analysed (Mercury)		31/10/2008
Mercury (Dissolved)	mg/L	<0.0005



Carbamates in Water		
Our Reference:	UNITS	65170-1
Your Reference	-----	QC2
Sample Matrix	-----	WATER
Date Sampled		28/10/2008
Depth		
Carbaryl	µg/L	<1.0
Bendiocarb	µg/L	<1.0
Methomyl	µg/L	<1.0
Oxamyl	µg/L	<1.0
Thiodcarb	µg/L	<1.0



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Method ID	Methodology Summary
SEO-005	OC/OP/PCB - Determination of a suite of Organochlorine Pesticides, Chlorinated Organo-phosphorus Pesticides and Polychlorinated Biphenyls (PCB's) by liquid-liquid extraction using dichloromethane for waters, or mechanical extraction using acetone / hexane for soils, followed by instrumentation analysis using GC/ECD. Based on USEPA 8081/8082.
AN292	Total Kjeldahl Nitrogen (TKN) - Determined by colourimetric technique using discrete analyser following digestion with Sulphuric Acid, K ₂ SO ₄ and CuSO ₄ . Based on APHA 21st Edition, 4500-Norg D / USEPA 351.2.
SEI-037	Ammonia - Determined by salicylate colourimetric method using Discrete Analyser.
AN293	Total Phosphorus - Determined by colourimetric technique using discrete analyser following digestion with Sulphuric Acid, K ₂ SO ₄ and CuSO ₄ . Based on APHA 21st Edition, 4500-P E / USEPA 365.4.
SEI-033	Total Kjeldahl Nitrogen - determined titrimetrically, in accordance with APHA 20th ED, 4500-Norg B.
SEI-038	Anions - a range of anions are determined by Ion Chromatography, in accordance with APHA 21st Edition, 4110B.
SEI-013	Acidity - determined by titration with standard sodium hydroxide, in accordance with APHA 21st Edition, 2310B.
SEI-012	Alkalinity - determined by titration with standard hydrochloric acid, in accordance with APHA 21st Edition, 2320B.
AN113	Total Dissolved Solids (TDS) - determined gravimetrically by evaporating the filtered sample to dryness at 180C, in accordance with APHA 21st Edition, 2540C. Total Solids (TS) - determined gravimetrically by evaporating the well-mixed sample to dryness at 105C, in accordance with APHA 21st Edition, 2540B.
AN149	Sulphide - determined titrimetrically using an iodometric titration following a zinc acetate treatment to overcome interferences. Based on APHA 21st Edition, 4500-S2-F.
SEM-010	Determination of elements by ICP-OES following appropriate sample preparation / digestion process. Based on USEPA 6010C / APHA 21st Edition, 3120B.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
SEM-005	Mercury - determined by Cold-Vapour AAS following appropriate sample preparation or digestion process. Based on APHA 21st Edition, 3112B.
Ext-041	Analysis subcontracted to Advanced Analytical Australia Pty Ltd. NATA Accreditation No. 15109.



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QUALITY CONTROL	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
OC Pesticides in Water								
Date Extracted				03/11/08	[NT]	[NT]	LCS	03/11/08%
Date Analysed				03/11/08	[NT]	[NT]	LCS	03/11/08%
HCB	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>alpha</i> -BHC	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>gamma</i> -BHC(lindane)	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Heptachlor	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	103%
Aldrin	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	118%
<i>beta</i> -BHC	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>delta</i> -BHC	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	95%
Heptachlor Epoxide	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>o,p</i> -DDE	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>alpha</i> -Endosulfan	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>trans</i> -Chlordane	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>cis</i> -Chlordane	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>trans</i> -Nonachlor	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>p,p</i> -DDE	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Dieldrin	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	100%
Endrin	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	100%
<i>o,p</i> -DDD	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>o,p</i> -DDT	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>beta</i> -Endosulfan	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>p,p</i> -DDD	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
<i>p,p</i> -DDT	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	89%
Endosulfan Sulphate	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Methoxychlor	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Endrin Ketone	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
2,4,5,6-Tetrachloro-m-xy lene (<i>Surrogate</i>)	%	0	SEO-005	107	[NT]	[NT]	LCS	105%



QUALITY CONTROL OP Pesticides in Water	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted				03/11/08	[NT]	[NT]	LCS	03/11/08%
Date Analysed				03/11/08	[NT]	[NT]	LCS	03/11/08%
Chlorpyrifos	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	LCS	121%
Fenitrothion	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Bromofos Ethyl	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
Ethion	µg/L	0.2	SEO-005	<0.2	[NT]	[NT]	[NR]	[NR]
OP_Surrogate 1	%	0	SEO-005	107	[NT]	[NT]	LCS	105%
QUALITY CONTROL Inorganics	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted (TKN)				3/11/2008	[NT]	[NT]	LCS	3/11/2008%
Date Analysed (TKN)				3/11/2008	[NT]	[NT]	LCS	3/11/2008%
Total Kjeldahl Nitrogen	mg/L	0.2	AN292	<0.2	[NT]	[NT]	LCS	103%
Ammonia as N	mg/L	0.01	SEI-037	<0.01	[NT]	[NT]	LCS	92%
Date Extracted (Total P)				3/11/2008	[NT]	[NT]	LCS	3/11/2008%
Date Analysed (Total P)				3/11/2008	[NT]	[NT]	LCS	3/11/2008%
Total Phosphorus	mg/L	0.05	AN293	<0.05	[NT]	[NT]	LCS	112%
Total Nitrogen (by Calc.)	mg/L	0.2	SEI-033	<0.20	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL Anions in water	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted				31/10/08	[NT]	[NT]	LCS	31/10/08%
Date Analysed				31/10/08	[NT]	[NT]	LCS	31/10/08%
Chloride, Cl	mg/L	0.08	SEI-038	<0.1	[NT]	[NT]	LCS	102%
Nitrite as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	101%
Nitrate as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	103%
Total NOx (by Calc.)	mg/L	0.1	SEI-038	<0.10	[NT]	[NT]	[NR]	[NR]



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QUALITY CONTROL Inorganics	UNITS	LOR	METHOD	Blank
Acidity as CaCO ₃	mg/L	0	SEI-013	0.0
Date Extracted (Alkalinity)				31/10/08
Date Analysed (Alkalinity)				31/10/08
Total Alkalinity as CaCO ₃	mg/L	2	SEI-012	<2.0
Bicarbonate, HCO ₃ ⁻	mg/L	2	SEI-012	<2.0
Carbonate, CO ₃ ²⁻	mg/L	2	SEI-012	<2.0
Date Extracted (TDS)				3/11/08
Date Analysed (TDS)				3/11/08
Total Dissolved Solids	mg/L	5	AN113	<5
Date Extracted (Sulphide)				31/10/08
Date Analysed (Sulphide)				31/10/08
Sulphide expressed as H ₂ S	mg/L	0.5	AN149	<0.5

QUALITY CONTROL Metals in water by ICP-OES	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted (Metals)				30/10/2008	[NT]	[NT]	LCS	30/10/2008%
Date Analysed (Metals)				30/10/2008	[NT]	[NT]	LCS	30/10/2008%
Calcium (Dissolved)	mg/L	0.1	SEM-010	<0.1	[NT]	[NT]	LCS	110%
Magnesium (Dissolved)	mg/L	0.1	SEM-010	<0.1	[NT]	[NT]	LCS	110%
Potassium (Dissolved)	mg/L	0.2	SEM-010	<0.2	[NT]	[NT]	LCS	112%
Sodium (Dissolved)	mg/L	0.1	SEM-010	<0.1	[NT]	[NT]	LCS	117%
QUALITY CONTROL Trace HM (ICP-MS)-Dissolved	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted (Metals-ICPMS)				31/10/2008	[NT]	[NT]	65170-1	31/10/2008%
Date Analysed (Metals-ICPMS)				31/10/2008	[NT]	[NT]	65170-1	31/10/2008%
Arsenic	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	105%
Cadmium	µg/L	0.1	AN318	<0.1	[NT]	[NT]	65170-1	98%
Chromium	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	96%
Copper	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	96%
Manganese	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	100%
Nickel	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	94%
Lead	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	100%

QUALITY CONTROL Trace HM (ICP-MS)-Dissolved	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Selenium	µg/L	2	AN318	<2	[NT]	[NT]	65170-1	106%
Zinc	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	98%
Aluminium	µg/L	1	AN318	<1	[NT]	[NT]	65170-1	99%
Iron	µg/L	5	AN318	<5	[NT]	[NT]	65170-1	104%
QUALITY CONTROL Mercury Cold Vapor/Hg Analyser	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted (Mercury)				31/10/2 008	[NT]	[NT]	LCS	31/10/2008%
Date Analysed (Mercury)				31/10/2 008	[NT]	[NT]	LCS	31/10/2008%
Mercury (Dissolved)	mg/L	0.0005	SEM-005	<0.000 5	[NT]	[NT]	LCS	105%
QUALITY CONTROL Carbamates in Water	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Carbaryl	µg/L	1	Ext-041	<1.0	[NT]	[NT]	65170-1	108%
Bendiocarb	µg/L	1	Ext-041	<1.0	[NT]	[NT]	65170-1	116%
Methomyl	µg/L	1	Ext-041	<1.0	[NT]	[NT]	65170-1	122%
Oxamyl	µg/L	1	Ext-041	<1.0	[NT]	[NT]	65170-1	112%
Thiodcarb	µg/L	1	Ext-041	<1.0	[NT]	[NT]	65170-1	104%



Result Codes

[INS]	: Insufficient Sample for this test	[RPD]	: Relative Percentage Difference
[NR]	: Not Requested	*	: Not part of NATA Accreditation
[NT]	: Not tested	[N/A]	: Not Applicable

Report Comments

OC/OP/PCB-Surrogate not reported due to sample matrix interference.

Carbamates analysed by AAA, report no. A08/2730.

Samples analysed as received. Solid samples expressed on a dry weight basis.

Date Organics extraction commenced: 03/11/08

NATA Corporate Accreditation No. 2562, Site No 4354

Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).

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Quality Control Protocol

Method Blank: An analyte free matrix to which all reagents are added in the same volume or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. A method blank is prepared every 20 samples.

Duplicate: A separate portion of a sample being analysed that is treated the same as the other samples in the batch. One duplicate is processed at least every 10 samples.

Surrogate Spike: An organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples. Surrogates are added to samples before extraction to monitor extraction efficiency and percent recovery in each sample.

Internal Standard: Added to all samples requiring analysis for organics (where relevant) or metals by ICP after the extraction/digestion process; the compounds/elements serve to give a standard of retention time and/or response, which is invariant from run-to-run with the instruments.

Laboratory Control Sample: A known matrix spiked with compound(s) representative of the target analytes. It is used to document laboratory performance. When the results of the matrix spike analysis indicates a potential problem due to the sample matrix itself, the LCS results are used to verify that the laboratory can perform the analysis in a clean matrix.

Matrix Spike: An aliquot of sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. A matrix spike is used to document the bias of a method in a given sample matrix.

Quality Acceptance Criteria

The QC criteria are subject to internal review and can be provided on request.

W041-042

T-5-7°C

coffey  environments

- ☐ **Dilhorn House:** Tel: (08) 9328 3488 Fax (08) 9328 3588
Dilhorn House, 2 Bulwer Street, Perth, WA 6000

ISSUE DATE: 31/05/07



SGS Environmental Services
Unit 16, 33 Maddox St. Alexandria NSW 2015
Telephone Number : (+61 2) 8594 0400
Fax Number : (+61 2) 8594 0499

SAMPLE RECEIPT CONFIRMATION

COMPANY	:	Coffey Environments Pty Ltd	FAX NO.	:	08 9355 7111
ATTENTION	:	Pamela Lee	PAGES	:	1
FROM	:	Sample Receipt	DATE	:	31/10/08

This is to confirm that samples for Project **ENVIBURW11899AA - Cygnia Cove** were received on **30/10/08** the results are expected to be ready on **10/11/2008**. Please quote SGS Reference: **65170** when making enquiries regarding this project. Please refer to below which details information about the integrity of the samples and other useful information.

Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples, unless otherwise instructed.

Samples received in good order:	YES
Samples received in correct containers:	YES
Samples received without headspace:	YES
Sufficient quantity supplied:	YES
Upon receipt sample temperature:	Cool
Cooling Method:	Ice Pack
Sample containers provided by:	Other Lab
Samples Clearly Labelled:	YES
Turnaround time requested:	Standard
Completed documentation received:	YES

Comments:

Carbamates subcontracted to Advance Analytical Australia.

Terms and conditions are available from www.au.sgs.com

The signed chain of custody will be returned to you with the original report.

The contents of this facsimile (including attachments) are privileged and confidential. Any unauthorised use of the contents is expressly prohibited. If you have received the document in error, please advise by telephone (reverse charges) immediately then shred the document. Thank you.