Revision	Details	Date	Amended By
A	Original	18 April 2012	John Throssell

Author: Mr John Throssell

Signed: .....

Distribution: City of Casey, EPA Victoria, Waraplus Pty Ltd, Parsons Brinckerhoff

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ENVIRONMENT PROTECT ACT 1970
STATEMENT OF ENVIRONMENTAL AUDIT

I, John Throssell of Parsons Brinckerhoff Australia Pty Ltd, a person appointed by the Environmental Protection Authority ('the Authority') under the *Environmental Protection Act* 1970 ('the Act') as an environmental auditor for the purpose of the Act, having:

1. been requested by Waraplus Lty Ltd to issue a certificate of environmental audit in relation to the site located at Western Precinct, 980 Cranbourne-Frankston Road, Cranbourne, Victoria, being the property described as Lot 1 of PS540326F and owned by Australian International Property Corporation Pty Ltd (Waraplus Pty Ltd are the site developers).

2. had regard to, among other things,

   i) guidelines issued by the Authority for the purposes of Part IXD of the Act,

   ii) the beneficial uses that may be made of the site, and

   iii) relevant State environment protection policies/ industrial waste management policies, namely,

   - State Environment Protection Policy (Prevention and Management of Contamination of Land)
   - State Environment Protection Policy (Groundwaters of Victoria).
   - State Environment Protection Policy (Waters of Victoria).

   in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment which may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and

3. completed an environmental audit report in accordance with Section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY STATE that I am of the opinion that
The site is suitable for the beneficial uses associated with: sensitive use (including medium to high density); commercial; industrial; recreation and open space

subject to the following conditions attached thereto:

a) Groundwater at the site is polluted and must not be used for beneficial uses associated with; *agriculture, parks and gardens*; and *primary contact recreation*; without prior testing.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts to the extent that relevant beneficial uses of groundwater are restored.

Other related information

- Groundwater at the site is polluted with ammonia and nitrate. The site is not the source of the pollution and it is not considered to affect any beneficial uses of the land at the site.
- The auditor is satisfied that the groundwater has been cleaned up to the extent practicable.
- Groundwater at the site contains concentrations of cadmium, copper, iron, manganese, nickel, selenium and zinc above the adopted criteria. The concentrations are considered to be typical of the regional groundwater quality surrounding the site and do not constitute pollution in accordance with clause 10(2)(c) of the State Environmental Protection Policy (Groundwater of Victoria).
- Groundwater bores present at the site (MW01, MW02 and MW03) should be decommissioned in accordance with the requirements of "Minimum Construction Requirements for Water Bores in Australia", published by the Land and Water Biodiversity Committee, 2012.
- In accordance with section 53Z of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of this Statement to any person who becomes or proposes to become an occupier of the site.

This Statement forms part of environmental audit report Parsons Brinckerhoff, Western Precinct, 980 Cranbourne-Frankston Road, Cranbourne, Victoria, 2171147A-RTP-001A-WESTERN, April 2012. Further details regarding the condition of the site may be found in the environmental audit report.

Dated: 18 April 2012

Signed: _____

John Throssell

ENVIRONMENTAL AUDITOR

Glossary

Acronym	Definition
ANZECC	Australian & New Zealand Environment & Conservation Council
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CCME	Canadian Council of Ministers of the Environment
CoC	Chain-of-Custody
DCNR	Department of Conservation and Natural Resources
EIL	Ecological Investigation Level
EPA	Environment Protection Authority; Environmental Protection Agency
ESA	Environmental Site Assessment
GoV	Groundwaters of Victoria
HIL	Health-based Investigation Level
LOR	Limit of Reporting
mBGL	Metres Below Ground Level
mg/kg	Milligram per kilogram
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NSW EPA	New South Wales Environment Protection Authority
OCP	Organochlorine Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
SEPP	State Environment Protection Policy
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons

Executive summary

Mr John Throssell of Parsons Brinckerhoff Australia Pty Limited (Parsons Brinckerhoff), an Environmental Auditor (Contaminated Land) appointed pursuant to the Environment Protection Act 1970 (Section 53S, Part IXD), was requested by Waraplus Pty Ltd (Waraplus) on 10 April 2011 to undertake an Environmental Audit of the parcel of land known as the Western Precinct, 980 Cranbourne-Frankston Road, Cranbourne, Victoria (the site).

The site is currently vacant and Waraplus is proposing to develop the site for medium-high density residential use. The Statutory Environmental Audit has been requested by the City of Casey Council as part of planning permit (P584/08) approval.

This report has been prepared in accordance with Section 53X of the Act and other Victorian Environment Protection Authority (EPA) guidelines and should be read in conjunction with the environmental assessment report prepared by Coffee Environments. Further details pertaining to the site are provided in Table E1 below.

Table E.1 Summary of Environmental Audit Information

EPA file reference number	69347-1
Auditor	John Throssell
Auditor term of appointment	7 October 2011 to 7 May 2012
Name of person requesting certificate	Gilbert Kerr of Waraplus
Relationship to site	Developer
Date of request	10 April 2011
Date EPA notified of audit	19 April 2011
Completion date of the audit	20 April 2012
Reason for Audit	Requirement of Planning Permit
Current land use zoning	R1Z
EPA Region	Southern Metro
Municipality	City of Casey
Dominant – Lot on title plan	Lot 1 PS540326F
Additional – Lot on title plan(s)	Not applicable
Site / Premises name	Amstel Golf Course – Western Precinct
Street / Lot – Upper No.	980
Street Name	Cranbourne-Frankston
Street type (road, court, etc)	Road
Suburb	Cranbourne
Postcode	3977
GIS Coordinate of Site centroid[1] **Longitude (GDA94)** **Latitude (GDA94)**	145.254722E 38.108889S

[1] *Longitude and latitude (decimal degrees) co-ordinates in the 1994 Geocentric Datum of Australia (GDA94) is required to six decimal places*

Site area (hectares)	6.15 ha
Members and categories of support team utilised	na
Outcome of the Audit	Statement of Environmental Audit
Further work or requirements	na
Nature and extent of continuing risk	Regional groundwater impacts by nitrate, ammonia and some metals that preclude the beneficial uses.
Site aquifer information	Quaternary (Holocene) aged sedimentary lagoon, swamp and dune deposits overlying Tertiary aged Baxter Sandstone Aquifer comprising silty to sandy clays, commonly with sand and gravel units.
Average depth to groundwater	6.6m to 9.7mBGL
Groundwater segment	B
Groundwater flow direction	North west
Past use/site history	Current use: golf course including practice fairway and bunkers, golf course buffer Historic uses: farming land
Surrounding land use:	
North:	Cranbourne-Frankston Road also known as Sladen Street (RDZ1), on the other side of which is an educational facility (St Peter's College) and childcare centre (Future Kids) (both R1Z)
East:	Amstel Golf Course administrative centre and car-park (R1Z and FZ2)
South:	Amstel Golf Course (Farming zone - FZ2)
West:	Cranbourne-Frankston Road (RDZ1) beyond which is currently vacant land zone Urban Growth zone 1 (UGZ1) which has a Development Contributions Plan Overlay (DCPO12) for the Cranbourne West Precinct Structure Plan.
Proposed future use	Medium – high density residential use

1. Introduction

The site known as the Western Precinct, 980 Cranbourne-Frankston Road, Cranbourne, Victoria (**Figure 1, Appendix A**) has been the subject of a Statutory Environmental Audit (Audit), by an Auditor appointed by the Environmental Protection Authority of Victoria (EPA) under the *Environment Protection Act 1970* (the Act).

Waraplus Pty Ltd (Waraplus) intends to redevelop the site for medium-high density residual use. Site development is being managed by the Potter Group Pty Ltd on behalf of Waraplus. The Audit was requested by the City of Casey Council as a condition of the planning permit (**Appendix B**), in part due to the site being located within 1000m of the Stevenson's Road Closed Landfill (**Figure 2, Appendix A**). Waraplus commissioned Mr John Throssell of Parsons Brinckerhoff Australia Pty Limited (Parsons Brinckerhoff) to conduct a Statutory Environmental Audit. Coffey Environments Pty Ltd (Coffey) was engaged to conduct the environmental site assessment works in support of the Audit.

Waraplus are developing the whole northern margin of the Amsel Golf Course, which for the purposes of development has been divided into the Eastern and Western Precincts. This audit covers only the Western Precinct. The Eastern precinct is the subject of a separate environmental site assessment and audit which is expected to be completed in 2012.

This Audit has been undertaken in accordance with the *Environmental Auditor (Contaminated Land) Guidelines for Issue of Certificates and Statements of Environmental Audit,* EPA Publication 759.1, September 2007. Cognisance has also been given to the relevant State Environmental Protection Policies (SEPPs), waste management policies, guidelines and other relevant guidance documents.

1.1 The Audit process

The purpose of the Audit is to ensure that the site is suitable for the intended medium-high density use and to also consider the suitability of the site for all beneficial uses.

Environmental Audits of contaminated land provide certification that a site is suitable for one or more uses. This certification is in the form of either a Certificate of Environmental Audit or a Statement of Environmental Audit. A certificate is issued if the contamination status of the site is not detrimental to any beneficial use of the site. A statement is issued where the contamination makes the site suitable for a restricted range of uses. In cases where statements are issued, they are generally conditional upon measures being taken to maintain the site as suitable for certain nominated uses. Further detail on the audit process and the limitations on the meaning and uses of audit reports are contained in the cover document titled "Information Regarding Environmental Audit Reports" EPA, September 2007 and the limitations outlined in Section 15 of this Audit report.

1.2 Reports supporting this Audit

The Auditor relied upon investigation reports prepared for the site during the period August 2005 to February 2012 by Coffey. A review of the audit report completed for the Stevensons Road Landfill was also undertaken so the Auditor could familiarise himself with the geology, hydrogeology and potential offsite sources of contamination that may impact the audit site.

All the environmental assessment reports and information supporting this Audit are listed in Table 1.1 below and the complete site reports are attached in **Appendix C, D and E**.

Table 1.1 List of investigation reports and documentation supporting this Audit

Date	Consultant/Authority	Title of Report	Appendix
8 August 2005	Coffey Geosciences Pty Ltd (Coffey)	Stage 1 Environmental Site Assessment Amstel Golf Course, Cranbourne-Frankston Road, Cranbourne, E16663/1 AC. Report for Watson Pty Ltd.	C
12 April 2012	Coffey Environments Pty Ltd (Coffey)	Environmental Site Assessment Proposed Amstel Golf Course Development (Western Precinct) 980 Frankston-Cranbourne Road, Cranbourne, Victoria, ENAUABTF00207AA. R04 Report for Waraplus Pty Ltd.	D
14 February 2012	Coffey Environments Pty Ltd (Coffey)	Letter report: Groundwater condition at Proposed Amstel Golf Course redevelopment, report No. ENAUABTF00207AA-L1.	E

2. Site details

The site comprises an area of approximately 6.15 ha and is located approximately 40 km southeast of the Melbourne CBD, on the south western corner of the intersection of Cranbourne-Frankston Road and Sladen Street.

At the commencement of the Audit in April 2011, the site was part of the Amstel Golf Course and consisted of a practice fairway and bunkers. **Figures 1, 2 and 3 (Appendix A)** identify the site, including the Audited area.

A summary of relevant background information compiled from the investigation reports, referenced as part of this Audit, as well as the Auditors own observations regarding the site are provided in **Table 2.1** below.

Table 2.1 Summary of site details

Parameter	Detail
Site Address/Location:	Western Precinct, 980 Cranbourne-Frankston Road, Cranbourne, Victoria. Refer **Figure 3, Appendix A.**
Certificate of Title:	The site comprises Lot 1 of plan of subdivision PS540326F. The parent titles comprise Volume 10423 Folio 145. Certificates of title are provided in **Appendix B**.
Site Area:	Approximately 6.15 ha.
Zoning:	Residential Zone RZ1
Topography:	The site and its surrounds are relatively flat with no significant topographical features.
Proposed Development:	Predominantly medium-high density residential use, draft development plans are contained in **Appendix B** and **Figure 4** (Appendix A). Planning Permit included in **Appendix B.**
Surrounding Land Uses:	The land-use surrounding the site is summarised as follows (see **Figure 2, Appendix A**): North - Cranbourne-Frankston Road also known as Sladen Street (RDZ1), on the other side of which is an educational facility (St Peter's College) and childcare centre (Future Kids) (both R1Z) East – Amstel Golf Course administrative centre and car-park (R1Z and FZ2). South – Amstel Golf Course (Farming zone - FZ2) West – Cranbourne-Frankston Road (RDZ1) beyond which is currently vacant land zone Urban Growth zone 1 (UGZ1) which has a Development Contributions Plan Overlay (DCPO12) for the Cranbourne West Precinct Structure Plan.
Site Condition at Commencement of Audit:	Part of the Amstel Golf Course including buffer land, practice fairway and bunkers.
Site Condition at Completion of Audit:	Amstel Golf Course including practice fairway and bunkers.

2.1 Site history information

The site history review undertaken by Coffey for both precincts indicated that previously the site was primarily used for grazing (with two small buildings located on the Eastern Precinct likely to be farm houses) prior to the redevelopment of the site as a golf course in the late 1960s to early 1970s. The eastern precinct is the subject of a separate audit.

By 1970 both fairways, bunkers and the Amstel golf clubhouse were present on site and a large dam was present to the south of the site (within the golf course). By 1980 a large dam was present adjacent to the southern boundary of the site and by 1991 a dam was present on the western portion of the site.

2.2 Planning considerations

The site is currently zoned 'Residential Zone 1'. The site is proposed to be redeveloped for medium-high density residential use; the surrounding area contains a mixture of low density residential properties, farmland, commercial properties and reserves.

2.3 Review of nearby completed audit reports

The following summary is taken from the environmental site assessment report for the site (Coffey, January 2012), and has been verified by the Auditor.

Table 2.2 Summary of surrounding audits

Audit Site	CARMS Number	Auditor (Date)	Distance / Direction from the Audit Site	Summary of Findings
O'Tooles Road, Cranbourne	31521-1	Jonathan Crockett (1999) GHD	1220 m east	HISTORY: The audit site was formerly a council works depot. At the time of the audit, the site was being used by two mobile telephone providers. SOIL: Areas of hydrocarbon and low-level PCB contamination were found. The City of Casey was to continue removing illegally-dumped waste on the site to prevent the occurrence of contamination from this dumped waste. GROUNDWATER: Minor petroleum hydrocarbon contamination is present but is understood to be attenuating. Groundwater was anticipated to be 4 to 17 m beneath the surface. Perched groundwater was at 1 to 3 m below natural surface. Groundwater flow direction was to the northwest. No Groundwater Segment classification was noted. AUDIT OUTCOME: There was no evidence of hydrocarbon contamination having migrated beyond the site boundary. There was no evidence of contamination remaining on the site that could compromise beneficial uses. Certificate of Environmental Audit issued.
150 Stevensons Road, Cranbourne	56450-1	Rick Graham (2005) SKM	1200 m southeast	HISTORY: The audit site was part of a chicken farm from 1960 until the early 1990s. During the 1990s the audit site was redeveloped into a horse stables and training facility. SOIL: Concentrations of manganese and nickel were found in excess of the NEPM EIL's for potential ecological impacts. GROUNDWATER: No site groundwater investigation was required as part of this audit because no sources of

Audit Site	CARMS Number	Auditor (Date)	Distance / Direction from the Audit Site	Summary of Findings
				potential groundwater contamination were identified on site and the potential off site sources (landfills) to the north were deemed unlikely to cause pollution on site. Groundwater flow direction was likely to be to the north or to the north-west. No Groundwater Segment classification was noted. AUDIT OUTCOME: The past use of the site and its current condition do not present a significant risk of contamination of surface waters or the air environment, nor did it contain any significant aesthetic impacts that would constrain the current or future site uses. Certificate of Environmental Audit issued.
Stevensons Road Landfill, Cranbourne	53V Groundwater Quality Audit	Anthony Lane (2009) Lane Piper	1000 m southeast	SOIL: No soil investigation was required as part of this audit. GROUNDWATER: Groundwater at the site was classified as Segment A1. Groundwater levels in the Brighton Group aquifer range from 69.5 mAHD in the southeast to 62 mAHD in the northwest Groundwater flow direction in the Brighton Group aquifer was likely to be to the northwest. Groundwater at the site was classified as Segment A1 with the corresponding beneficial uses (including Potable Water Supply) set out in the Groundwater SEPP. The groundwater beneficial uses of Maintenance of Ecosystems, Agriculture, Parks and Gardens and Industrial Water Use were not precluded at the site. The groundwater beneficial uses of Potable Water Supply and Primary Contact Recreation were precluded at the site by ammonia, chloride, iron, manganese, sodium, TDS and pH. The groundwater beneficial use of Stock Watering was precluded at the site by ammonia, iron and TDS. Concentrations of ammonia and TDS measured in groundwater in the Brighton Group aquifer in off-site wells to the west of the site indicated there was little evidence of contaminated groundwater moving off-site in that direction. AUDIT OUTCOME: The risks to groundwater beneficial uses were unacceptable, largely due to the landfill being unlined and leachate within the landfill mounding above the surrounding watertable level and potentially discharging contaminated water into the groundwater off-site.
Stevensons Road Landfill, Cranbourne	53V 2010 Landfill Gas Audit	Anthony Lane (2011) Lane Piper	1000 m southeast	AUDIT OUTCOME: Using the methodology of risk prescribed by EPA, the risks to the beneficial uses of land due to landfill gas may be precluded although supplementary assessments indicate a lower risk of harm to users of land offsite than assessed via the EPA method. Air beneficial uses are precluded by LFG emanating from the former landfill site. Recommendations are made to further delineate and monitor LFG and assess the risk of gas accumulation in a typical house.

The Stevenson Road Landfill is potentially a source of groundwater and landfill gas impacts to the Audit site. During 2008, methane gas levels, derived from the breakdown of waste in the landfill, were found to be affecting residents in the nearby Brookland Greens Estate. Since this time, mitigation measures have been undertaken by the City of Casey to contain

and manage the methane leak. These measures have included; a new engineered landfill cap, significant upgrades to the gas and leachate extraction systems and the implementation of a deep trench wall.

Based upon the findings of recent groundwater and landfill gas audits conducted on the former landfill site, risks to the beneficial uses of air, land and groundwater were identified from contaminants emanating from the landfill site.

In order to manage these risks on 8 December 2010, an updated Pollution Abatement Notice (PAN) was issued by the EPA Victoria to the City of Casey. The PAN outlines the requirements for City of Casey to undertake in regards to the ongoing monitoring and upkeep of the closed landfill. Included in the PAN are requirements to; manage the gas and leachate release from the landfill, monitor gasses, groundwater, stormwater discharge and landfill flare emissions on- and off-site and to go through an annual review and adhere to the current Stevensons Road Landfill Management Plan. All of this is bound by stringent incident, compliance community engagement reporting across the life of the PAN.

It is noted that as of 2011 all major infrastructure works on the landfill have been completed and only minor upgrades to the stormwater drainage system are now required.

2.4 Regional and site geology and hydrogeology

The Auditor has conducted a review of the regional and local site geology and hydrogeology, Based on the Geological Survey of Victoria Cranbourne Map (1:63,360) 1967, the DPI GeoVic website (See **Figure 5**, **Appendix A**), the DSE Water Resources Data Warehouse (See **Figure 6, Appendix A**), and the DCNR (1995), *Victoria Groundwater Beneficial Use Map Series*, *South Western Victoria* (1:250,000 scale), the regional and site geology and hydrogeology of the area is summarised in **Table 2.3** below.

Table 2.3 Site geology and Hydrogeology

Age	Unit	Geological description	Hydrogeological information*
Quaternary (Pleistocene - Holocene)	Quaternary Sands	**Regional:** Aeolian siliceous sand dune and sheet deposits including the Cranbourne Sand as well as non-marine swamp deposits of peats, silts and clays. **Site:** Based on the geological map, the Quaternary Sands are not present on site, however, the soil bore and test pit logs indicate well sorted loose sands of up to 1.5m thick in some locations. These may represent a thin veneer of Quaternary Sands and swamp deposits or unconsolidated sediments of the older Tertiary aged Baxter Sandstone Formation. If present on site, this lithology is likely to have been reworked during the landscaping of the golf course.	Forms a local water table aquifer of the inter-granular porosity type. **Site information (Jan 2012):** SWL (mBTOC): 6.6 (MW2) to 9.7 (MW5) SWL (mAHD): 45.1 (MW4) T0 50.9 (MW5) Hydraulic gradient (between MW4 and MW5): 0.030 Sandy clay aquifer effective porosity: 0.4 to 0.7 (Freeze & Cherry, 1979) Hydraulic conductivity: 0.001-0.1m/day Seepage velocity: 0.016 to 2.7m/day Groundwater flow direction: north west toward Patterson River (~10km northwest of the site)

Age	Unit	Geological description	Hydrogeological information*
Cainozoic (Upper Tertiary)	Brighton Group	**Regional:** Fluvial Baxter Sandstone Formation. Sandstone, conglomerate, siltstone, ironstone. **Site:** The geological map indicates this formation is present on the eastern portion of the site. Given the sandy and clayey nature of the formation it is difficult to differentiate between the Baxter Sandstone Formation and the younger Quaternary Sands and swamp deposits. Intrusive investigations no site indicate interbedded sands, clayey sands, and sandy clays to a maximum depth of approximately 6.5mBGL.	Forms a regional water table "inter-granular porosity aquifer" type. The Baxter Formation and Quaternary Sands where present together, may be connected and act as a single watertable aquifer. **Site information (Jan 2012):** SWL (mBTOC): 6.6 (MW2) to 9.7 (MW5) SWL (mAHD): 45.1 (MW4) T0 50.9 (MW5) Hydraulic gradient (between MW4 and MW5): 0.030 Sandy clay aquifer effective porosity: 0.4 to 0.7 (Freeze & Cherry, 1979) Hydraulic conductivity: 0.001-0.1m/day Seepage velocity: 0.016 to 2.7m/day Groundwater flow direction: north west toward Patterson River (~10km northwest of the site)
Cainozoic (Lower Tertiary)	Older Volcanics (OV)	**Regional:** Basalt lava flow from volcanic eruptions (Tertiary). Fractured rock and clays (weathered basalt). Most likely an aquitard. **Site:** Two groundwater monitoring wells report the presence of basalt (either as fragments or rock), while many investigation locations recorded dense residual clays representing highly weathered basalt. Basalt was reported between 6.5 and 12.2mBGL (the maximum limit of investigations).	Forms a local confined "fractured rock aquifer" type in the region but more likely an **aquitard** in the area.
Cainozoic (Lower Tertiary)	Werribee Formation	**Regional:** Terrestrial – coarse alluvial, fluvial and fine lacustrine deposits including peat, wood, and coal seams (Lower Tertiary). Significant hiatus prior to Silurian Bedrock deposition **Site:** The depth limit of field investigations did not intersect the Werribee Formation.	Forms a regional confined "inter-granular porosity aquifer" type.
Palaeozoic	Silurian Bedrock (Murrindindi Supergroup)	**Regional:** Marine Sedimentary Bedrock (Middle Palaeozoic). Fractured rock (mainly siltstone) and saprolite. **Site:** The depth limit of field investigations did not intersect the Silurian bedrock.	Forms a regional confined "fractured rock aquifer" type which is unconfined in areas of outcrop.

Note:

`*Source: Leonard (1992)

A summary of groundwater quality parameters collected at the site by Coffey (January, 2012) is provided in **Table 2.4** below.

Table 2.4 Site groundwater quality parameters

Parameter	Range	Comment
Dissolved oxygen (DO) mg/L	0.39 to 3.94	Neutral to mildly anoxic conditions
Redox Potential (Eh) mV	112 to 133	Neutral to mildly oxidising conditions
Electrical conductivity (EC) uS/cm	628 to 11330	See TDS comments below
Total Dissolved Solids (TDS) mg/L	Regional: Victorian Groundwater Beneficial Use Map (DCNR, 1995) indicates that the water table beneath the site is likely to have a salinity range between 1,001 mg/L – 3,500 mg/L total dissolved solids (TDS) Lab: 410 to 7200 Field calculation (EC *0.65): 408 to 7365	Regional groundwater salinity data would suggest that groundwater beneath the site should fall into Segment B according to the SEPP Groundwaters of Victoria (1997) Laboratory and field TDS concentrations classifies the groundwater as Segment A1.
pH	5.64 to 6.08	Neutral to weakly acidic
Temperature (°C)	15.6 to 17.3	

The Auditor has verified the above information and has found it to be generally consistent with geological and hydrogeological maps for the area and observed site conditions.

2.5 Review of Victorian groundwater database

A search of the Victorian Water Resources Data Warehouse was undertaken by Coffey in 2005 (**Appendix C**). A search conducted by the Auditor in February 2012 reported approximately 81 registered bores within a 2 km radius of the site (**Figure 6, Appendix A**). Of these 40 are known to have been stock, domestic or stock and domestic bores (approximately 14 of which could be considered to be down hydraulic gradient of the site), 3 are irrigation bores and the rest are either observation or investigation bores, or bores of unknown use. It is noted that two registered bores appear to be present on the Western Precinct site and one located immediately south of the site. The two onsite bores (Bore 76297 and Bore 133339) are both irrigation bores and Bore 76253 has an unknown use. The current status (use) of the registered bores is unknown and the two onsite bores have not been found during field investigations.

The registered bore depths varied from 6mBGL to 93mBGL and the TDS concentrations ranged from 128 to 768mg/L. The Auditor notes that the range of bore depths indicates the likelihood that groundwater from the bedrock (Silurian aged mudstone) and the overlying Werribee Formation (Tertiary aged sandstone and mudstone) aquifers has been utilised for various purposes.

2.6 Topography and surface water

The site is located at the head of the Morning Peninsula on the north western side of a surface watershed between Port Phillip Bay to the northwest and Western Port Bay to the south east. Regionally the area slopes to the northwest towards Port Phillip Bay from

approximately 66mAHD on the south eastern corner of the golf course to approximately 50mAHD on the north western corner of the golf course. The local high point is located approximately 2km south east of the site in the Cranbourne Botanical Gardens at a height of 101mAHD.

The site topography is flat with a gentle slope to the northwest. Based on site plans provided by the client (contained in Coffey, January 2012, Appendix O), the Western Precinct elevation ranges between approximately 48mAHD to 52mAHD. The Western Precinct is dominated by a golf practice fairway, with the lower lying areas of the site being swampy indicating poor drainage.

Rodds Drain is the local drainage line from south of the Former Stevensons Road Landfills, north westerly through the Brookland Greens Estate, through the southern portion of the golf course (where one of the golf course dams may capture some of the flow) and onward into paddocks on the western side of the Cranbourne-Frankston Road and then north along Evans Road.

A small (probably party manmade) dam/swamp is located on the Western Precinct Stage 3 and 4 area while a larger dam is located 150m south of the Stage 2 area and an elongate dam is located less than 40m form the southernmost extent of the Stage 3 and 4 area. A large dam is located on the southern portion of the Eastern Precinct approximately 300m east of the Western Precinct.

Surface water from the site appears to drain to the northwest via surface drains such as Rodds Drain and ultimately discharges to Port Phillip Bay.

3. Potential sources of contamination

3.1 On-site sources

Based on the site history provided by Coffey and the auditors review of site activities, potential on site sources of contamination may include:

- Pesticide, herbicide and fertiliser use associated with past farming practices or the upkeep of the golf course;
- Fuel (petroleum products) use and storage on site associated with either farming practices or maintenance of the golf course; and
- The importation of potentially contaminated fill, particularly during the development and landscaping of the golf course.

3.2 Off-site sources

The past uses of the surrounding land was predominantly farming. However quarrying (sand and aggregate) activities have also taken place to the south and east of the site (see **Figure 2, Appendix A**). **Table 3.1** below is a summary of the surrounding land uses, whether they are up or down hydraulic gradient of the site and whether they have the potential to be a source or receptor of contamination.

Table 3.1 Summary of surrounding land uses

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
The site		R1Z	Residential	The site	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
		SBO	Special building overlay along Cranbourne-Frankston Road		
North (down hydraulic gradient)	adjacent	RDZ1 – road	Cranbourne-Frankston Road (becomes Sladen Street approximately 300m to the north east of the site)	Source	▪ Fuels (PAHs, TPHs, BTEXs) ▪ Chlorinated hydrocarbons
	50m	R1Z - residential	Residential properties, child care facility (Future Kids Childcare & Kindergarten Cranbourne Central	Receptor	
North East (across or down hydraulic gradient)	70m	PPRZ	St Peter's College	Receptor	▪ Fuels (PAHs, TPHs, BTEXs)
East (up and/or across hydraulic gradient)	adjacent	FZ2 - farming	Amstel golf course clubhouse	Source/ Receptor	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Chlorinated hydrocarbons
	60m	R1Z	Eastern Precinct Containing a septic system and areas where fuels were used and stored.	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Chlorinated hydrocarbons ▪ Sewage (nutrients) ▪ Fuels (TPHs, PAHs, BTEX)
	60-800m	R1Z	High voltage power line easement, Brookland Greens Estate	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
East	Beyond Stevensons Road Landfills	PPRZ-public park and recreation zone	Cranbourne Racecourse and Recreational Reserve	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
South East (up and/or across hydraulic gradient)	800m	FZ2	Former Casey Landfill - originally a sand/gravel quarry (LIC837) from 1968 to 1996. Then a municipal landfill (under Work Authority WA465) from 1996 to 2001. Northern portion of Landfill is currently used as a Transfer Station.	Source	Various including: ▪ Methane ▪ Hydrocarbons ▪ Metals ▪ Nutrients ▪ OCPs/OPPs
			Former Casey-Frankston Landfill - original a sand/gravel quarry (LIC837) up until 1996. then a municipal landfill (under Work Authority WA465) from 1996 to 2005.	Source	
	900m	PPRZ-public park and recreation zone	EL1065 & WA1203 Former sand/gravel quarry (under Work Authority WA1203) from 2003 -2009. Unclear if the site was quarried and if so how the void was filled. Currently sports ground.	Source	Unknown
	700m	LDRZ- low density residential	Currently horse adjestment paddocks	Source	▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Fuels (PAHs, TPHs, BTEXs)
South (up hydraulic gradient)	adjacent	FZ2	Amstel golf course	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
	300m	R1Z	Residential properties	Source	
	400m	R1z	Ballarto Road	Source	▪ Fuels (PAHs, TPHs, BTEXs)
South (up hydraulic gradient)	Over Ballarto Road	PCRZ-public conservation & resource zone	Cranbourne Royal Botanical gardens	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Fuels (PAHs, TPHs, BTEXs)
	1600m		LIC730 & WA441 Sand/gravel quarry	Source	▪ Fuels (PAHs, TPHs, BTEXs)
West and north west (across or down hydraulic gradient)	adjacent	RDZ1	Cranbourne-Frankston Road	Source/ Receptor	▪ Fuels (PAHs, TPHs, BTEXs)
	50m	UGZ-urban growth zone	Currently vacant farm land	Source/ Receptor	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic)

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
					▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
South west (up hydraulic gradient)	200m	GWZ6 – green wedge schedule 6	Currently vacant farm land	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
	2000m	GWZ6 – green wedge schedule 6	LIC 1450 & WA121 Sand/gravel quarry	Source	▪ Fuels (PAHs, TPHs, BTEXs)

3.3 Potential receptors

Based on the analysis provided in **Table 3.1** above, potential receptors to contamination that may be emanating from the site are listed below.

- Current and future users/occupants of the site.
- Onsite and immediately offsite surface water bodies.
- Rodds Drain and any surrounding natural waterways located offsite to the west and north west.
- Residential properties located offsite to the west and north west.
- School and child care facilities to the north (down hydraulic gradient) of the site.
- Groundwater beneath the site and in the vicinity of the site that may be used of domestic, stock or irrigation purposes.
- Local vegetation both on and off site.

3.4 Contaminants of potential concern

The following contaminants may be present based on the knowledge of current and past activities undertaken at and in the vicinity of the site.

- Herbicides, pesticides (including OCPs, OPPs, arsenic).
- Fertilisers (ammonia, nitrate, nitrite, phosphorous and trace metals) associated with past farming practices and golf course application.
- Chlorinated hydrocarbons associated with maintenance of farm or golf course machinery (tractor, mowers) (chlorobenzene, chloromethane, trichloroethene).
- Fuels associated with farm or golf course machinery and cars (PAH, TPH, BTEX).
- Other hydrocarbons such as PAH, phenolic compounds possibly associated with imported fill.
- Metals (arsenic, chromium, copper, lead, mercury, tin, zinc) associated with imported fill.
- Methane associated with the former Stevensons Road Landfill.

3.5 Potential for groundwater impact

As noted in **Table 3.1** above, there are a number of potential off-site sources of groundwater contamination. No significant onsite sources were noted although a number of potentially contaminating activities were considered including; importation of fill; use and/or disposal of pesticides, herbicides, fertilisers; former buildings and structures.

4. Protected beneficial uses

4.1 Beneficial uses of land

With respect to the environment, the SEPP- Prevention and Management of Contamination of Land (Land SEPP) identifies the following beneficial uses that would need to be protected for unrestricted use of the site (i.e. Certificate of Environmental Audit). Table **4.1** below identifies the beneficial uses of land.

Table 4.1 Protected beneficial uses of land

Beneficial use	Land use						
			Sensitive use				
	Parks & Reserves	Agriculture	High-density	Other	Recreation/ Open space	Commercial	Industrial
Maintenance of ecosystems							
Natural ecosystems	✓						
Modified ecosystems	✓	✓	✓	✓	✓		
Highly modified ecosystems		✓	✓	✓	✓	✓	✓
Human health	✓	✓	✓	✓	✓	✓	✓
Buildings & structures	✓	✓	✓	✓	✓	✓	✓
Aesthetics	✓	✓	✓	✓	✓	✓	
Production of food and flora	✓	✓		✓			

Notes:

1. The above table is a reproduction of Table 1 from the Land SEPP (June, 2002).
2. Shading denotes the beneficial uses required to be protected for the purpose of the proposed development.

The Auditor notes that in accordance with the Land SEPP, the proposed development (medium to high density residential) is classified as a sensitive land use (other).Therefore beneficial uses that must be protected include; maintenance of modified and highly modified ecosystems, human health, buildings & structures, aesthetics and production of food, flora and fibre. Maintenance of natural ecosystems is not required to be protected for the proposed development however; cognisance is given to this beneficial use in order to consider unrestricted use of the site.

4.2 Beneficial uses of groundwater

The protected beneficial uses of groundwater are defined in the SEPP *Groundwaters of Victoria* (1997) (Groundwater SEPP), by the inherent capacity of the groundwater (i.e.TDS concentrations) at the site to support specific uses.

The 2011 groundwater monitoring event reported a TDS value of 410 mg/L in MW6 which is located adjacent to a large dam (on the Eastern Precinct) and fresh water infiltration from that dam is probable, thereby lowering the TDS concentration. Therefore based on a TDS range of 1,300mg/L to 7,200mg/L in the remaining wells, it is considered that groundwater

beneath the site falls under Segment B. Based on the salinity of the groundwater, the beneficial uses protected under the Groundwater SEPP are summarised in **Table 4.2** below.

Table 4.2 Protected beneficial uses of groundwater

Beneficial Uses	Segments (mg/L) TDS				
	A1 (0-500)	A2 (501-1,000)	B (1,001 – 3,500)	C (3,501-13,000)	D (greater than 13,000)
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply					
▪ Desirable	✓				
▪ Acceptable		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks and gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation (e.g. bathing, swimming)	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

Notes:

1. The above table is a reproduction of Table 2 from the SEPP GoV (1997).
2. Shading denotes the required beneficial uses to be protected under Segment B.

While cognisance has been given to the assessment of groundwater beneficial uses conducted by the Assessor (Coffey) for the site, the Auditor considers that the use of the median of measured groundwater salinities is a more appropriate approach in determining the segment to which groundwater should be assigned. In the event that an abstraction bore is installed at the site, the median of measured groundwater salinities is considered to best represent the long term quality of groundwater from a pumping well. As it is probable that monitoring well MW6 is influenced by the nearby dam, the measured salinity in this well has been excluded from the calculation. As such it is considered that Coffey's classification of groundwater at the site as *segment A1* is overly conservative.

The Auditor has conducted an independent appraisal of the relevance of beneficial uses to be protected for Segment B groundwater and the likelihood of each beneficial use being realised both on-site and off-site. This appraisal is provided in **Table 4.3** below.

Table 4.3 Relevance of protected beneficial uses of groundwater

Protected Beneficial Use	Relevance On-site	Relevance Off-site
Maintenance of ecosystems	**Not relevant** No on-site aquatic ecosystem likely to receive groundwater. Perched water beneath the site is considered to be localised and ephemeral but may feed water bodies on and near the site seasonally.	**Existing** Rodds Drain located approximately 80m west of the site which drains into Eumemmerring Creek/Patterson River (approximately 9km northwest of the site) and ultimately to Port Phillip Bay 10km north west of the site. Perched water beneath the site is considered to be localised and ephemeral but may feed water bodies on and near the site seasonally.
Stock watering	**Unlikely** No evidence of stock grazing under existing use. A medium-high density residential development is proposed for the site.	**Possible** There are a number of stock and/or domestic groundwater bores registered with a 2km radius of the site. Therefore there is potential for groundwater to be used in this way. However, given the increasing urbanisation of the area, the abstraction of groundwater for stock watering purposes is considered increasingly unlikely in the future.
Industrial use	**Not relevant** Not consistent with local zoning and the site is being redeveloped for medium-high density residential purposes.	**Unlikely** It is considered that a reticulated water supply would be available for this area of Melbourne. Yields of the superficial aquifer are unlikely to sustain an industrial scale water supply.
Agriculture, parks and gardens	**Possible** There are two irrigation bores registered onsite. It is noted however, that these bores where not found during extensive site works and may no longer exist. Future use of groundwater for irrigation of open space areas is possible.	**Possible** One registered irrigation bore was identified within a 2km radius of the site, although the specific use of numerous bores was not specified. Therefore there is potential for groundwater to be used for irrigation purposes.
Primary contact recreation	**Possible** There is potential for the use of groundwater to fill swimming pools or spas at the site under the proposed residential development scheme, although the availability of reticulated scheme water makes this scenario less likely.	**Possible** There is potential for the use of groundwater to fill swimming pools or spas within the surrounding area.
Buildings & structures	**Unlikely** Development likely to comprise slab on ground construction. Groundwater beneath the site is located between 6.5-9.7 mBGL and is therefore unlikely to impact on underground services or building structures.	**Unlikely** Based on the depth to the local groundwater system to range between 9.7 mBGL and 36.5mBGL

4.3 Beneficial uses of surface water

Beneficial uses of surface water that need to be protected are considered to be those associated with freshwater ecosystems, as specified in the SEPP *Waters of Victoria* (2003). The site is located within the cleared hills and coastal plains segment for which the following beneficial uses are protected:

- Slightly to moderately modified ecosystems.
- Primary and secondary contact recreation and aesthetic enjoyment.
- Indigenous and non-indigenous cultural and spiritual values.
- Agriculture and irrigation.
- Aquaculture, human consumption after appropriate treatment and fish, crustacean and molluscs for human consumption.
- Industrial and commercial use.

The Auditor notes that there are no onsite surface water bodies likely to receive groundwater, and surface water in the area appears to drain to Rodd's Drain (a highly modified channel drain) and ultimately Patterson's River. Therefore the most relevant beneficial uses of surface water are likely to be: maintenance of ecosystems; agriculture and irrigation; and primary and secondary contact recreation and aesthetic enjoyment.

Coffey have calculated groundwater seepage velocity to be less than 3 meters per year and therefore direct impact to the Patterson River from discharge of groundwater emanating from the vicinity of the site is unlikely to occur.

5. Site conceptual hydrogeological model

The preceding sections describe the Audited site, the local and regional geology and hydrogeology, potential sources of contamination identified on the site as well as from off-site sources. Also described are the beneficial uses of the land and groundwater as they apply to the site and its surrounds. In combination, this information can be used to describe the source – pathway – receptor relationship for exposure to potential contaminants of concern.

The potential sources of contamination identified at the site by Coffey include:

- The use and storage of fertilisers, chemicals and fuels associated with the upkeep of the golf course.

Off-site sources of impact to the development site include;

- Maintenance of the Amstel Golf Course.
- Current and historical quarrying activities to the south and southeast.
- The Cranbourne landfill to the southeast.

The main exposure pathways to potential on-site impacts include:

- Direct contact and ingestion of shallow soils.
- Direct contact or ingestion of groundwater.

Exposure to off-site sources of impact is considered to be largely associated with migration of contaminated groundwater onto the site from sources to the south and southeast.

Potential groundwater impacts sourced from the Cranbourne Landfill are considered to be nutrients, metals and landfill gasses

In the scenario were the site is considered to be a source of impacts, exposure of off-site receptors to site-sourced impacts is likely to be via groundwater flow in a north or north westerly direction.

Figure 7 (Appendix A) is a generalised cross section adapted from Coffey (January 2012) showing groundwater and geological information taken from both the Western and Eastern Precincts.

6. Soil screening criteria

With respect to assessing the contamination status of soil at the site, the hierarchy (consistent with the objectives presented in Table 2 of the Land SEPP) of investigation criteria adopted for this audit are detailed in **Sections 6.1 and 6.2 below. Table 6.1** summarises the criteria adopted (including alternative criteria) to assess the site's suitability for unrestricted use (i.e. Certificate of Environmental Audit).

6.1 Ecological/Environmental

The following guidelines were adopted by Coffey and/or the Auditor to assess the impact on the local environment:

- NEPM Ecological Investigation Levels (interim Urban): NEPM-EIL.
- ANZECC 1992 – Investigation 'B' levels for dieldrin.
- New South Wales EPA Service Station Criteria for BTEX and TPH.
- Dutch 2000 (Target Levels) in the absence of NEPM EILs and ANZECC B levels for total PAHs and phenol.
- Canadian Soil Quality Guidelines (CCME, 2007) for the protection of Environmental Health - Agricultural, for benzo[a]pyrene.

6.2 Human health

In accordance with the Land SEPP, the proposed development is defined as sensitive use (other) and includes medium density residential use. The Auditor notes that in evaluating the potential impact to the protection of human health in the context of unrestricted site use, the NEPM standard residential (exposure setting A) criteria were adopted. As such, the following guidelines were adopted to assess the impact on the beneficial use human health:

- NEPM Health Investigation Levels (HIL) A: Standard residential use setting with substantial access to soils.
- NSW EPA Guidelines for Service Station Sites – for sensitive land use (where no NEPM criteria are available (i.e. BTEX and TPH).
- CRC CARE Technical Report No. 10. September 2011. Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater by E. Friebel & P. Nadebaum (i.e. BTEX, TPH) for low density residential. 0 to <1mBGL in sand.

6.3 Buildings and structures

The Land SEPP states that "*contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or buildings materials*". Where structures are likely to come into contact with extreme soils, criteria for pH, chloride and sulphate can be adopted from the Piling Code, AS 2159-2009.

6.4 Aesthetics

The Land SEPP currently states that "*contamination must not cause the land to be offensive to the senses of human beings".* Currently there are no concentration based aesthetic criteria for soil however, while aesthetic observations are subjective, it is considered that if there is discolouration or noticeable odours from the soil, or if waste materials such as rubble, slag or similar wastes are present, then a potential aesthetic concern exists.

6.5 Production of food, flora and fibre

The Land SEPP states that "*contamination must not adversely affect the produce quality or yield or effect the level of any indicator in food, flora and fibre produced at the site (or that may be produced), such that the level of the indicator is greater than that specified by the Australia New Zealand Food Authority, Food Standards Code".*

In consideration of the above, the Auditor has primarily assessed the protection of the beneficial use: *Production of food, flora and fibre* with reference to the phytotoxicity based interim urban EILs (NEPM, 1999).

The soil criteria adopted by Coffey were considered appropriate to make an assessment of the potential impact to the beneficial uses of the site. The Auditor has also considered alternate criteria, where appropriate, in assessing the results and potential impacts to beneficial uses. **Table 6.1** below lists the criteria adopted.

Table 6.1 Adopted soil assessment criteria

Analyte	Maintenance of Ecosystems [A] (mg/kg)	Protection of Human Health – Standard Residential/ Sensitive Use [F] (mg/kg)	Protection of Buildings & Structures (mg/kg)
Primary adopted investigation reference	**NEPM (1999) EILs**	**NEPM (1999) – HIL-A**	**AS2159 (2009)**
Arsenic	20	100	-
Barium	300	-	-
Cadmium	3	20	-
Chromium (III)	400	120,000	
Chromium (VI)	1	100	
Chromium (total)	50[B]	-	-
Copper	100	1,000	-
Lead	600	300	-
Mercury (inorganic)	1	15	-
Nickel	60	600	-
Vanadium	50	-	-
Zinc	200	7,000	-
Nitrate (as N)	-	-	-
Nitrite (as N)	-	-	-
Total nitrogen	-	-	-

Analyte	Maintenance of Ecosystems [A] (mg/kg)	Protection of Human Health – Standard Residential/ Sensitive Use [F] (mg/kg)	Protection of Buildings & Structures (mg/kg)
Benzene	1[D]	1[D] / 0.5 [I]	-
Toluene	1.4[D]	130[D] / 160 [I]	-
Ethyl benzene	3.1[D]	50[D] / 57 [I]	-
Total xylenes	14[D]	25[D] / 40 [I]	-
Benzo[a]pyrene	0.1[C]	1	-
Total PAHs	1[E]	20	-
Phenol	0.05[E]	8,500	-
TPH C_6-C_9	65[D]	65[D] / 44 [I]	-
TPH C_{10}-C_{14}	1,000[D]	1,000[D] / 110 [I]	-
Aldrin + Dieldrin	0.2 (dieldrin)[B]	10	-
Chlordane	–	50	-
DDT + DDD + DDE	–	200	-
Heptachlor	–	10	-
Chlorinated hydrocarons	-	-	-
Sulphate	–	–	2,000[G]
pH	–	–	>4.5[H]

Notes:

'-'denotes no investigation level available.

A. NEPM Schedule B (1) (NEPC 1999) Ecological Investigation Levels (EILs) – Interim EILs for urban setting – unless otherwise specified.

B. ANZECC B adopted in the absence of NEPM EILs.

C. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Canadian Council of Ministers of the Environment (CCME) 2007 (protection of Environmental Health – Agricultural), adopted in the absence of NEPM EIL or ANZECC B levels.

D. NSW EPA (1994) Guidelines for Assessing Service Station Sites.

E. Dutch 2000 (Target Value) adopted in the absence of NEPM EIL and ANZECC B levels. Target level for PAH is for PAH (sum of 10) i.e. the total of anthracene, benzo(a)anthracene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, phenantrene, fluoroanthene, indeno(1,2,3-cd)pyrene, naphthalene and benzo(ghi)perylene.

F. NEPM Schedule B (1) (NEPC 1999) Health investigation Levels (HILs) (A) – Standard Residential/sensitive use – unless otherwise specified.

G. NEPM Schedule B (1) (NEPC 1999) – Interim Urban for protection of built structures.

H. AS2159 (2009) – Piling Design and installation: Severe to very severe soil exposure conditions for concrete piling.

I. CRC CARE Technical report No. 10. September 2011. Health Screening levels for petroleum hydrocarbons in soil and groundwater by E. Friebel & P. Nadebaum: Soil criteria for low density residential 0 to <1mBGL in sandy soil.

7. Groundwater screening criteria

With respect to assessing the contamination status of groundwater at the site, the hierarchy (consistent with the objectives presented in Table 2 of the Groundwater SEPP) of investigation criteria adopted for the protection of all applicable groundwater beneficial uses (as detailed in **Section 4.2**) are presented in **Sections 7.1 to 7.5** below.

Table 7.1 summarises the criteria adopted (including alternative criteria) to determine the condition of groundwater beneath the site and assess the site's suitability with respect to each applicable groundwater beneficial use. The Auditor notes that in some instances alternative criteria have not been adopted in the Coffey ESA report. Therefore the findings and conclusions regarding the contamination status of groundwater beneath the site, as detailed in the Coffey ESA report, may vary slightly to those identified by the Auditor.

7.1 Maintenance of ecosystems

The following guidelines were adopted by Coffey and the Auditor to assess the impact on the beneficial use *Maintenance of Ecosystems*:

- ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 95% Level of Protection.*

7.2 Stock watering

The primary reference adopted for assessing impacts to the beneficial use *Stock Watering* is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Water* – Livestock Criteria. For organic analytes the ANZECC (1992) Raw Water for Drinking Purposes criteria have been adopted. The secondary reference adopted was ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Water* – Livestock Drinking Water Criteria.

7.3 Agriculture, parks and gardens

The primary reference adopted for assessing impacts to the beneficial use *Agriculture, parks and gardens* is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Water* – Irrigation Criteria. The secondary reference adopted was ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Water* – Agricultural Irrigation Water (short term use) Criteria.

7.4 Industrial water use

The ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters* - Industrial Use, provide various water quality parameters in relation to heating and cooling processes and power generation. Given that the criteria detailed in Chapter 6 of the ANZECC (1992) guidelines are highly specific to the type of industry process, criteria for industrial water use have not been included in **Table 7.1** below. For the purpose of this Audit, it has been assumed that the criteria for 'primary contact recreation' would be adequately protective of people who may encounter the groundwater at this site in most industrial scenarios.

7.5 Primary contact recreation

The primary reference adopted is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters* – Recreational Water Quality and Aesthetics. This reverts to the ANZECC (1992) Raw Water for Drinking Purposes criteria for organic analytes.

7.6 Buildings and structures

The Groundwater SEPP states that "*introduced contaminants shall not cause groundwater to become corrosive to structures or building materials*". Currently there are no available concentration based criteria for groundwater. However, field based measurements including pH, redox and sulphate analytical results have been used to assess for the presence of any extreme conditions (i.e. acidity) that may have the potential to impact on buildings and structures. In addition, where any buildings or structures may come into contact with groundwater, criteria for pH, chloride and sulphate can be adopted from Australian Standard AS2159-2009 *Piling Design and Installation*

Table 7.1 Adopted Groundwater Screening Criteria (mg/L)

Applicable Beneficial Use		Maintenance of Ecosystems [A]	Agriculture, Parks and Gardens [K,L]		Stock Watering [B,C]		Primary Contact Recreation [D]	Building and Structures [E]
Primary Adopted Screening Criteria		ANZECC 2000 Fresh Water 95% Protection	ANZECC 1992 Irrigation Water Quality	ANZECC 2000 Agricultural Irrigation (short term use)	ANZECC 1992 Livestock Watering	ANZECC 2000 Livestock Drinking Water	ANZECC 1992 Raw Water for Drinking Water Supply	AS2159-2009
Arsenic (III)		0.024	0.1	2	0.5	0.5	0.05	-
Cadmium		0.0002	0.01	0.05	0.01	0.01	0.005	-
Chromium (III)		-	-	-	-	-	-	-
Chromium (VI)		0.001	-	-	-	-	-	-
Chromium (Total)		-	-	1	1	1	0.05	-
Copper		0.0014	0.2	5	0.5-5 [G]	0.4-5 [G]	1	-
Lead		0.0034	0.2	5	0.1	0.1	0.05	-
Manganese		1.9	2	10	-	Not sufficiently toxic	0.1	-
Mercury	Inorganic	0.0006	-	-	-	-	-	-
	Methyl	-	-	-	-	-	-	-
	Total	-	0.002	0.002	0.002	0.002	0.001	
Nickel		0.011	0.2	2	1	1	0.1	-
Selenium		0.011	0.02	0.05	0.02	0.02	0.01	-
Vanadium		-	0.1	0.5	-	-	-	-
Zinc		0.008	2	5	20	20	5	-
pH		-		6-9	-	-	6.5-8.5	>5.5
Sulphate		-	-	-	-	-	-	<1,000

Applicable Beneficial Use	Maintenance of Ecosystems [A]	Agriculture, Parks and Gardens[K,L]		Stock Watering [B,C]		Primary Contact Recreation [D]	Building and Structures [E]
Primary Adopted Screening Criteria	ANZECC 2000 Fresh Water 95% Protection	ANZECC 1992 Irrigation Water Quality	ANZECC 2000 Agricultural Irrigation (short term use)	ANZECC 1992 Livestock Watering	ANZECC 2000 Livestock Drinking Water	ANZECC 1992 Raw Water for Drinking Water Supply	AS2159-2009
TDS	-	-	-	3,000	2,000	1,000	-
Nitrate (as N)	0.7	-	-	30	400	10	-
Ammonia (as N)	0.9	-	-	-	-	0.01	-
TPH C_6-C_9	-	-	-	-	-	-	-
TPH C_{10}-C_{36}	0.6	-	-	-	-	-	-
Benzene	0.95	-	-	0.01	0.001	0.01	-
Toluene	1[F]	-	-	-	0.8	-	-
Ethylbenzene	0.15 [F]	-	-	-	0.3	-	-
Xylenes	0.2	-	-	-	0.6	-	-
Phenol	0.432	-	-	300[H]	0.01	0.01	-
2-chlorphenol	0.49	-	-	0.0001	-	0.0001	-
2-nitrophenol	0.002	-	-	-	-	-	-
2,4-dimethylphenol	0.002	-	-	-	-	-	-
2,4-dichlorphenol	0.16	-	-	0.0003	-	0.0003	-
2,4,5-trichlorophenol	0.003	-	-	0.002	-	0.002	-
2,4,6-trichlorophenol	0.0038	-	-	0.01	-	0.01	-
Pentachlorophenol	-	-	-	-	-		-
Benzo(a)pyrene (BaP)	0.05[F]	-	-	0.0000001[H]	-	1E-07	-
Naphthalene	0.016	-	-	-	-	-	-
Total PAH	0.003	-	-	-	-	-	-
1,1,-dichloroethene	-	-	-	0.00003	-	0.00003	-

Applicable Beneficial Use	Maintenance of Ecosystems [A]	Agriculture, Parks and Gardens[K,L]		Stock Watering [B,C]		Primary Contact Recreation [D]	Building and Structures [E]
Primary Adopted Screening Criteria	ANZECC 2000 Fresh Water 95% Protection	ANZECC 1992 Irrigation Water Quality	ANZECC 2000 Agricultural Irrigation (short term use)	ANZECC 1992 Livestock Watering	ANZECC 2000 Livestock Drinking Water	ANZECC 1992 Raw Water for Drinking Water Supply	AS2159-2009
1,2-dichloroethane	-	-	-	-	-	0.01	-
1,1,2-trichloroethane	6.5	-	-	-	-	-	-
cis-1,2-dichloroethene	0.02 [F]	-	-	-	0.06[I]	-	-
trans-1,2-dichloroethene	0.02 [F]	-	-	-	-	-	-
Trichloroethene (TCE)	0.5 [F]	-	-	0.03	-	0.03	-
Tetrachloroethene	-	-	-	0.001		0.001	
Vinyl chloride	-	-	-	-	0.0003[J]	-	-
1,2-dibromoethane	-	-	-	-	-	-	-
1,2-dochlorobenzene	0.16	-	-	0.001	-	0.001	-
1,3-dichloropropane	0.26	-	-	0.02	-	0.02	-
1,4-dichlorobenzene	0.06	-	-	0.003	-	0.003	-
Carbon tetrachloride	-	-	-	0.003	-	0.003	-
Chlorobenzene	-	-	-	0.01	-	0.01	-
Dichloromethane	-	-	-	-	-	-	-
Chlordane	0.00008	-	-	0.006	-	0.006	-
DDT	0.00001	-	-	0.003	-	0.003	-
Dieldrin	-	-	-	0.001	-	0.001	-
Endrin	0.00002	-	-	0.001	-	0.001	-
g-BHC	0.0002	-	-	0.01	-	0.01	-
Heptachlor	0.00009	-	-	0.003	-	0.003	-
Methoxychlor	-	-	-	-	-	-	-

Applicable Beneficial Use	Maintenance of Ecosystems (A)	Agriculture, Parks and Gardens(K,L)		Stock Watering (B,C)		Primary Contact Recreation (D)	Building and Structures (E)
Primary Adopted Screening Criteria	ANZECC 2000 Fresh Water 95% Protection	ANZECC 1992 Irrigation Water Quality	ANZECC 2000 Agricultural Irrigation (short term use)	ANZECC 1992 Livestock Watering	ANZECC 2000 Livestock Drinking Water	ANZECC 1992 Raw Water for Drinking Water Supply	AS2159-2009
Toxaphene	2E-07	-	-	-	-	-	-
Azinophos methyl	0.00002	-	-	0.01	-	0.01	-
Bolstar	-	-	-	0.02	-	0.02	-
CHlorpyrifos	0.00001	-	-	0.002	-	0.002	-
Diazinon	0.00001	-	-	0.01	-	0.01	-
Dichlorovos	-	-	-	0.02	-	0.02	-
Disulfoton	-	-	-	0.006	-	0.006	-
Ethion	-	-	-	0.006	-	0.006	-
Ethoprop	-	-	-	0.001	-	0.001	-
Fenitrothion	0.0002	-	-	0.02	-	0,.02	-
Fensulfothion	-	-	-	0.02	-	0.02	-
Methyl parathion	-	-	-	-	-	0.006	-
Mevinphos	-	-	-	0.006	-	0.006	-
Ronnel	-	-	-	0.06	-	0.06	-
Aroclor 1242	0.0006	-	-	-	-	-	-
Aroclor 1254	0.00003	-	-	-	-	-	-
Sum total	-	-	-	0.0001	-	0.0001	-

'-' denotes no screening criteria available.

A. ANZECC (2000) National Water Quality Management Strategy. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. 95% trigger values for Fresh Waters – unless otherwise specified.

B. ANZECC (1992) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters 'Livestock Watering' – unless otherwise specified.

C. ANZECC (2000) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters 'Livestock Drinking Water Quality' – unless otherwise specified.

D. ANZECC (1992) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters 'Raw Waters' – unless otherwise specified.
E. Australian Standard (2009) Piling – Design and Installation – AS2159-2009.
F. Netherlands (2000) Circular on Target Values and Intervention Values for soil remediation. Ministry of Housing, Spatial Planning and the Environment, Netherlands Government (Dutch Intervention Value).
G. Concentration for copper ranges from 0.5 mg/L for sheep, 1 mg/L for pigs and poultry and 5 mg/L for cattle.
H. ANZECC (1992) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters – 'Raw Waters'.
I. NHMRC/NHMMC (2004) – Australian Drinking Water Guideline (ADWG) for 1,2-DCE adopted in the absence of ANZECC 2000 or ANZECC 1992 criteria for cis-1,2-DCE.
J. NHMRC/NHMMC (2004) - Australian Drinking Water Guideline (ADWG) for Vinyl chloride adopted in the absence of ANZECC 2000 or ANZECC 1992 criteria for Vinyl chloride.
K. ANZECC (1992) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters 'Irrigation use – unless otherwise specified.
L. ANZECC (2000) National Water Quality Management Strategy. Australian Water Quality Guidelines for Fresh and Marine Waters 'Agricultural irrigation (short term use) – unless otherwise specified.

8. Surface water

Whilst no surface water body is present on the site, the protection of off-site surface water bodies has been considered as part of the Audit. Surface water receptors under consideration are those located at the expected point of groundwater discharge. The nearest surface water bodies is the Rodd Drain located approximately 80m to the west of the site. It has been assumed that local groundwater flow mimics local surface water drainage and hence, the Patterson river is assumed to be the main receptor of the local groundwater flow.

The following screening criteria are considered relevant for the protection of the Patterson River:

- ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 95% Level of Protection.*

9. Soil investigation

One round of soil investigation was undertaken at the site by Coffey between May and September 2011, and the findings are summarised below. The site (Western Precinct) was divided into four stages for the purposes of the assessment; this was based on the potential sequencing of the development. Conclusions on site status generally refer to the western precinct as a whole. The environmental site assessment report (Coffey, January 2012) is provided as **Appendix D** of this Audit Report.

9.1 Scope and analytical program

Soil assessment works comprised of the excavation of 90 test pits set out in a grid pattern, three groundwater monitoring wells (of which no soil samples were tested)and three stockpile sample locations (of which eight soil samples were analysed). **Figure 8 (Appendix A)** shows the location of the soil investigation locations and **Table 9.1** below summaries pertinent information regarding the investigation and sampling program.

Table 9.1 Soil sampling locations

Western Precinct Stage & area (ha)	Sample density: AS4482.1 -2005 Completed test pit locations Test pit numbers	Depth of investigation, dominant lithology & anomalies	Comment
Stage 1 1.0ha	AS4482-1-2005: 21 Actual: 16 TP1 to TP16 AS4482-1-2005 satisfied: No	1mBGL Lithology: Clay, sand, topsoil, clayey sand, silt, moist to wet	Given the understanding of previous site activities and the consistent nature of the geology, the Auditor is satisfied that this area has been adequately assessed and characterised.
	Monitoring Well: MW1	5.0mBGL Fill material (bricks) noted at 1mBGL Wet at 1.0mBGL Screened in predominantly sandy clay	Saturated conditions encountered at 1m were considered to be ephemeral and localised perching of infiltrating rainfall on clayey soil horizons, and was not considered to represent a perched aquifer. Coffey noted that with hindsight the well should have been drilled deeper.
Stage 2 2.4ha	AS4482-1-2005: 35 Actual: 35 TP17 to TP51 AS4482-1-2005 satisfied: Yes	1mBGL Lithology: Clay, sand, topsoil, clayey sand, silt, moist to wet TP49: dry gravelly clay	
	Monitoring Well: MW3	5.0mBGL Wet at 1.0mBGL Screened in predominantly sandy clay	
	Stockpile sample location: SB2	6.0mBGL deepest sample analysed Maximum depth of SB2 was 7.3mBGL.	
Stage 3 & 4	AS4482-1-2005: 40	1mBGL	Given the understanding of previous site activities and the

Western Precinct Stage & area (ha)	Sample density: AS4482.1 -2005 Completed test pit locations Test pit numbers	Depth of investigation, dominant lithology & anomalies	Comment
2.75ha	Actual: 39 TP52 to TP90 AS4482-1-2005 satisfied: No	Lithology: Clay, sand, topsoil, clayey sand, silt, moist to wet TP60: moist gravelly clay TP79: only went to 0.05mBGL TP67: noted visible oil on surface water pooling at the location.	consistent nature of the geology, the Auditor is satisfied that this area has been adequately assessed and characterised.
	Monitoring Well: MW2	10.9mBGL Screened in predominantly silty clay Rock fragments noted at 6.9mBGL	
	Stockpile sample location: SB1 & SB3	SB1: 2.0mBGL deepest sample analysed SB3: 4.0mBGL deepest sample analysed. Maximum depth of SB3 was 5.6mBGL.	

A review of the test pit and drilling logs by the Auditor indicate that no odours or staining were noted during the intrusive investigation works. The highest PID reading was 11.3ppmv from sample TP46-1. This sample was not analysed for petroleum hydrocarbons, however not odour or staining was noted during sampling.

The soil analytical program undertaken by Coffe is summarised in **Table 9.2**.

Table 9.2 Analytical program - soil

Analysis	Percentage of samples analysed		Comments
	Shallow samples (0.05mBGL)	Deeper samples (1.0mBGL)	
Pesticides (OPPs & OCPs)	100% (89 out of 89)	44% (35 out of 79)	Pesticides and herbicides are likely to have been topically applied. Therefore this sampling program is considered appropriate.
Herbicides	56% (50 out of 89)	9% (7 out of 79)	
Petroleum hydrocarbons	22% (20 out of 89)	51% (40 out of 79)	Vehicle maintenance and car park areas were considered the most likely to be impacted with hydrocarbons. Given the likely volatile loss in the shallow soil profile, the distribution of samples analysed is considered appropriate.

Analysis	Percentage of samples analysed		Comments
	Shallow samples (0.05mBGL)	Deeper samples (1.0mBGL)	
Chlorinated hydrocarbons	56% (50 out of 89)	10% (8 out of 79)	The potential source of these contaminants was considered imported fill, therefore this mix of shallow and deep sampling is considered appropriate to characterise any potential fill material on site.
PAHs	100% (89 out of 89)	75% (59 out of 79)	
Phenolic compounds	15% (13 out of 89)	14% (11 out of 79)	
Metals	55% (49 out of 89)	73% (58 out of 79)	
PCBs	21% (19 out of 89)	13% (10 out of 70)	
Inorganics	15% (13 out of 89)	10% (8 out of 79)	

9.2 Soil results exceeding adopted criteria

The following soil samples reported analyte concentrations above the selected criteria. Only two soil samples returned TPH results above the laboratory limit of reporting (LOR) and these have been include in the table below.

Table 9.3 Soil results above the selected criteria

Analyte (or Analyte Group)	No. of Samples Analysed	Reported Conc. Range	Beneficial Uses Precluded by Exceedance of IL (shaded cell)		Samples Exceeding Adopted Criteria	Samples above LOR
			Maintenance of Ecosystems	Human Health (HIL-A)		
Test Pit Soil Results						
Arsenic	108	<2 - 32	**20**	100	TP10-2, TP60-2, TP63-1	
Nickel	108	<5 - 110	**60**	600	TP49-2, TP51-2, TP58-2, TP68-1, TP73-1, TP73-2, TP83-2, TP85-1, TP87-1, TP87-2,	
Vanadium	108	<10 - 200	**50**	-	TP1-2, TP9-1, TP9-2, TP10-2, TP23-2, TP29-1, TP40-2, TP41-2, TP43-1, TP43-2, TP45-2, TP49-2, TP50-1, TP51-2, TP53-2, TP55-2, TP57-2, TP58-2, TP60-2, TP61-2, TP62-2, TP63-2, TP64-2, TP65-1, TP66-2, TP68-1, TP68-2, TP70-2, TP73-1, TP73-2, TP79-1, TP81-2, TP82-2, TP83-2, TP84-1, TP85-1, TP86-2, TP87-1, TP87-2, TP88-2, TP90-2	
TPH (C10-C14)		<20 - 75	-	1000	-	TP57-1
TPH (C15-C28)		<50-69	-	1000	-	TP76-1
Soil Bore Results						
Manganese	4	40 - 980	**500**	1500	SB1-0.5, SB3-1.0	

Analyte (or Analyte Group)	No. of Samples Analysed	Reported Conc. Range	Beneficial Uses Precluded by Exceedance of IL (shaded cell)		Samples Exceeding Adopted Criteria	Samples above LOR
			Maintenance of Ecosystems	Human Health (HIL-A)		
Nickel	8	12 - 139	**60**	600	SB1-0.5, SB1-2.0, SB2-3.0, SB2-4.0, SB3-1.0	
Vanadium	2	58 - 84	**50**	-	SB2-4.0, SB2-6.0	

The Auditor notes that the exceedences of arsenic, nickel and vanadium were reported in both shallow and deep soil samples. It is noted that most soils encountered at the site were logged as 'natural', suggesting that these analytical results are indicative of naturally occurring background concentrations.

10. Groundwater investigation

Prior to commencing on-site groundwater investigations, Coffey conducted a review of the regional hydrogeology. Coffey reported that salinity in the regional aquifer was likely to range between 501 to 1,000mg/L TDS.

The groundwater investigation undertaken by Coffey targeted the surficial Quaternary aged dune (sand) and swamp (silty clay) deposits, the underlying Baxter Sandstone aquifer, and the top of the highly weather Older Volcanics basalt beneath the site. Groundwater monitoring wells MW1 and MW3 were drilled and installed in mid June 2011 and MW2 was installed in August 2011. All three wells were developed in early September and sampled along with MW4, MW5 and MW6 on the Eastern precinct in late September 2011 (see **Figures 9 and 10, Appendix A** for groundwater well locations).

The groundwater monitoring wells were installed at depths between 5 mBGL and 10.9 mBGL, within the Surficial Quaternary sediments, underlying Baxter Sandstone and top of the weathered basalt which together form the water table aquifer. The locations of groundwater monitoring wells present on both the Western and Eastern Precincts are presented on **Figure 9, Appendix A.**

During well development and gauging prior to well sampling, MW1 and MW3 were found to be dry and therefore no groundwater elevation could be calculated and no groundwater samples were collected from them. In order to gain an understanding of the groundwater conditions beneath the site and the contiguous environment, Coffey in consultation with the Auditor, utilised the assessment of data collected from MW2 located on the Western Precinct and MW4, MW5 and MW6 located on the Eastern Precinct.

10.1 Groundwater sampling program

One groundwater monitoring event (GME) was conducted as part of the groundwater investigative works undertaken by Coffey in September 2011. Wells MW2, MW4, MW5 and MW6 were sampled using a low-flow micropurge method.

A summary of the analytes reported to exceed the adopted screening criteria for protected beneficial uses of groundwater during the groundwater investigation are provided in **Table 10.1 and 10.2** below.

Table 10.1 On-site groundwater impacts (ug/L)

Analyte (or Analyte Group)	On site well	Reported Conc. Range	Protected Beneficial Uses Precluded (Shaded Cell)			
			Maintenance of Ecosystems	Agriculture, Parks and Gardens	Stock Watering	Primary Contact Recreation[1]
Arsenic	-	2	-	100	500	50
Cadmium	MW2	0.4	0.2	10	10	5
Copper	MW2	74	1.4	200	400	1000
Chromium (total)	-	7	-	-	1000	-
Iron	MW2	680	-	200	-	300
Manganese	MW2	940	1900	200	-	100
Nickel	MW2	210	11	200	1000	-
Selenium	MW2	21	11	20	20	10
Zinc	MW2	200	8	2000	20000	500

Analyte (or Analyte Group)	On site well	Reported Conc. Range	Protected Beneficial Uses Precluded (Shaded Cell)			
			Maintenance of Ecosystems	Agriculture, Parks and Gardens	Stock Watering	Primary Contact Recreation(1)
Ammonia (as N)	MW2	50	900	-	-	10
Nitrate (as N)	MW2	880	700	-	400000	10000

Notes:

(1) Also considered to be protective of human health in an industrial scenario.

Table 10.2 Off-site groundwater impacts (ug/L)

Analyte (or Analyte Group)	Off site wells	Reported Conc. Range	Protected Beneficial Uses Precluded (Shaded Cell)			
			Maintenance of Ecosystems	Agriculture, Parks and Gardens	Stock Watering	Primary Contact Recreation(1)
Arsenic		<LOR	-	100	500	50
Cadmium		<LOR	0.2	10	10	5
Copper	MW4, MW5 & MW6	6-21	1.4	200	400	1000
Chromium (total)		2-3	-	-	1000	-
Iron	MW4	<LOR-280	-	200	-	300
Manganese	MW4	12-200	1900	200	-	100
Nickel	MW4 & MW5	3-240	11	200	1000	-
Selenium	MW4 & MW5	<LOR-2	11	20	20	10
Zinc	MW4, MW5 & MW6	69-260	8	2000	20000	500
Ammonia (as N)	MW4	<10-110	900	-	-	10
Nitrate (as N)	MW4 & MW5	670-63000	700	-	400000	10000

Notes:

(1) Also considered to be protective of human health in an industrial scenario.

As shown in **Table 10.1** above, the following beneficial use criteria for groundwater were exceeded on Western Precinct site:

- **Maintenance of ecosystems**: Elevated concentrations of cadmium, copper, manganese, nickel, selenium, zinc and nitrate reported in groundwater beneath the site, above the adopted ANZECC 2000 criteria for maintenance of ecosystems.
- **Agriculture, Parks and Gardens**: Elevated iron, manganese, nickel and selenium above the criteria.
- **Stock watering**: Selenium exceeds the adopted criteria.
- **Primary contact recreation**: Iron, manganese, selenium and ammonia.
- **Industrial**: Iron, manganese, selenium and ammonia.

With respect to the elevated metal concentrations reported in groundwater, the Auditor notes the following:

- Concentrations of metals were generally reported uniformly across both the Western and Eastern Precincts, including monitoring well MW6 (Eastern Precinct) which is

considered to represent background groundwater conditions for both precincts. It is considered that the identified metal concentrations do not constitute an impact to groundwater sourced from the site.

- The observed metals concentrations may be either naturally elevated as a result of mildly acidic groundwater conditions, a function of aquifer lithology, or due to agricultural and golf course maintenance activities to the south and southeast of the site (e.g. trace elements in fertilisers).
- In consideration of the Stevenson Road landfill as a potential source of the observed metals, the observed concentrations of metals appear to represent background conditions and a point source such as the landfill cannot be solely attributed to these impacts. Regional groundwater flow also suggests that impacts from the landfill, if present, would tend to pass to the east of the audit site.
- The Auditor undertook a review of groundwater data provided in Environmental Audit Reports for properties in the Cities of Casey and Frankston where there were similar land uses and similar hydrogeological settings. Where identified point sources of groundwater impact were not present, concentrations of metals in the upper (water table) aquifer were generally consistent with the observations on the Western and Eastern Pecincts.

With respect to the elevated nitrate and ammonia concentrations in groundwater (see **Figures 9 and 10**, Appendix A), the following is noted:

- Concentrations of nitrate, above the adopted assessment criteria for maintenance of ecosystems of 0.7 mg/L, were reported in onsite well MW2 and just below the adopted criteria in offsite well MW6. Nitrate is elevated in offsite well MW5 (63mg/L) which is located adjacent to a septic tank and leach field, and nitrate is also elevated in monitoring well MW4 (9.4mg/L) located down gradient of this location. In the absence of any other point sources of nitrate impact, the concentrations around the adopted ecosystems protection criteria are considered to represent background groundwater conditions at the site.
- Ammonia concentrations are more variable than nitrate, but in the absence of any identified point sources on the site, it is considered that concentrations in the vicinity of the adopted primary contact recreation criteria are probably typical of the region, and not representative of impacts specifically sourced from the site. This is supported by groundwater data derived from Environmental Audits in the broader region, and is not unexpected given that the area surrounding the site was, until recently, largely used for agricultural purposes, and golf courses in more recent times.
- The septic tank and associated leach field identified on the Eastern Precinct is a potential source of nutrient impacts to groundwater at the audit site, although based on the inferred direction of groundwater flow, dissolved impacts from the leach field would probably pass to the east of the site.
- It is plausible that the Stevenson Road Landfill is a co-contributor of nutrient impacts to the site.

Based on the above, the Auditor considers that the reported metals, ammonia and nitrate concentrations in groundwater are either:

- Representative of naturally occurring background concentrations, or
- Representative of regional conditions and not sourced from the site.

As such, concentrations of metals, ammonia and nitrate are not considered to represent groundwater pollution sourced from the site.

11. Quality of environmental assessment

The following section reviews the quality and completeness of the environmental assessment works performed by Coffey. The quality of the available data relating to the site was assessed as follows:

- Site investigation reports were audited against the relevant SEPPs, EPA publications and guidelines and other relevant national standards and guidelines in order to verify the quality and completeness of the assessment.
- The Auditor's assistant attended the site on 10 May 2011 to inspect the site conditions and to observe sampling and investigation protocols.
- The quality assurance/quality control (QA/QC) system adopted by Coffey has also been audited. The quality system is intended to ensure that conclusions drawn with respect to the suitability of the site for its intended use as well as unrestricted use are able to be supported by the dataset.

The results of the quality review are provided in **Sections 11.1 to 11.6** below.

11.1 Review of site history information

The following table (**Table 11.1**) below presents information pertaining to the review of site history information for the site.

Table 11.1 Quality of site history review

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, 2012 unless otherwise noted)
Title plan/clear description of site	Yes. The current title information indicates the current owners of the site are Australian International Property Corporation PTY LTD.	Detailed site description provided in Appendix N (Coffey Geosciences Pty Ltd, 8 August 2005. Stage 1 Environmental site assessment Amstel Golf Course Cranbourne-Frankston Road, Cranbourne, Report No. E16663/1 AC. Report for Watsons Pty Ltd) Title information provided in Appendix B.
Zone planning information provided	Yes. The site is currently zoned Residential One Zone (R1Z).	The zoning status was provided in Appendix L.
Identified beneficial uses to be protected	Yes. The beneficial uses of both land and groundwater were clearly defined.	Section 6.1.1. page 23 Section 6.2.1. page 25
Historic site uses	Yes. The site was used for farming until it was developed as a golf course between 1960 and 1970.	Section 3. page 9

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, 2012 unless otherwise noted)
Historic uses offsite	Quarrying and landfilling activities offsite were identified as having a potential to impact upon the site. However infrastructure located on the Eastern Precinct (located up hydraulic gradient) and adjacent to the Western Precinct are more likely to influence soil and groundwater quality onsite. These activities included the presence of clubhouses and various out-houses and shed used for the storage of chemicals (pesticides, fertilisers, fuels)and maintenance of equipment such as mowers etc. Anecdotal evidence indicates that a septic tank is located on the Eastern precinct along with a former fuel storage tank (unknown if this was an above or below ground tank). The Auditor notes that the area around the site was largely rural prior to the recent urban development of the area.	Section 3. page 9
Aerial photographs inspected	Yes. Photographs dated from 1998, 2004, 2006 and 2011 were reviewed.	Section 3.1. page 9 Appendix J.
Geological survey maps inspected	Yes. The geological survey map was referenced as Geological Survey of Victoria Cranbourne map sheet.	Section 2.2 page 5 Appendix K
Groundwater database inspected	Yes. A search of the groundwater database was conducted. The search identified 81 bores within a 2 km radius.	Section 2.2 page 5 Appendices K, L, N
Visual inspections and description provided	Yes	Section 5.1 page 15
Site interviews conducted	Yes. Anecdotal information was collected by Coffey.	Section 3.4 page 12
Description of current and historical structures	Yes. Current and historical structures were clearly described in the Environmental Site Assessment report.	Section 3. page 9
Potentially contaminating uses identified	Yes, with the exception that fertilisers were not identified as a potential contaminant of concern and were not tested for in the soil samples	Section 4. page 14
	OVERALL AUDIT SUMMARY – Overall, the auditor is satisfied with the level of site history review conducted by Coffey.	

11.2 Review of soil investigations

Comments relating to the quality of on-site soil investigations undertaken by Coffey are detailed in Table 11.2 below.

Table 11.2 Quality of soil investigations

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
Sampling frequency	90 test pit grid sampling locations were advanced across the site.	Section 5.2 page 17
Sampling pattern	90 grid sampling locations were advanced across the site. Two stockpiles were also sampled via three soil bores	Section 5.2 page 17 Section 5.2.2. page 18
	OVERALL AUDIT SUMMARY – The sampling pattern and frequency was considered suitable to address potential onsite sources of contamination. It is noted that the sample density, while not strictly in accordance with AS4482.1 is considered appropriate by the auditor given the history and current use of the site.	
Point sources targeted	No point source was identified therefore a grid approach was adopted and deemed appropriate by the Auditor. The stockpiles noted on site were assumed by Coffey to be comprised of material that originated onsite and therefore are not considered a point source for contamination.	Section 5.2.2. page 18
Sampling method	Soil samples were collected from the centre of the excavator bucket while test pitting and from push tube cores while drilling. The auditor considers that the methodology adopted for collection of soil samples from soil bores and excavations were conducted in accordance with procedures outlined in AS4482.1.	Section 5.2 page 17 Section 5.2.2. page 18 Appendix F
	OVERALL AUDIT SUMMARY – Information provided by Coffey in relation to the sampling methodology has given cognisance to AS4482.1 and other relevant guidelines and is considered appropriate for describing the final condition of the site.	

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
Depth of samples	The gridded test pit locations were advanced to a maximum depth of 1mBGL. All sampling locations targeted near-surface fill material and the natural soil profile encountered across the site. In test pits except one, the distinction between 'fill' material and 'natural' material was indistinct. It is likely that minimal or no soil was imported onto the site and any landscaping of the site used soil native to the site. One location TP11/MW1 reported some brick fragments above 1mBGL.	Section 5.2 page 17 Section 7.1. page 31 Appendices D & E
Contaminants analysed consistent with operations, history or EPA screen	The analysis program adopted by Coffey gave appropriate consideration to background information including site and surrounding site historical data, visual inspections and previous investigations with the exception that fertilisers were not identified as a potential contaminant of concern and were not tested for in the soil samples.	Section 5.2 page 17 Section 7.1 page 31 Appendix B
	OVERALL AUDIT SUMMARY – The analytes tested for are considered to adequately address potential contamination issues identified from the site history review as well as visual inspections of the site.	
Asbestos considered	The potential for asbestos containing materials to be present on the Western Precinct was not identified due to the site history – no buildings had been identified on the site. The absence of any buildings on the site, or known to be previously present on the site, and the absence of evidence of importation of fill on the site, or dumping of fill or building materials, suggests asbestos containing materials are unlikely to be present at the site. Only one test pit reported brick rubble, no asbestos was noted in this test pit.	
Vertical and lateral delineation of impacts	All test pits extended into natural soil.	Appendices D & E
Assessment conclusions	The conclusions of the environmental assessment report are considered acceptable in relation to the final condition of soils at the site and the suitability of the site for the proposed residential land-use.	Section 9 page 41

11.3 Review of groundwater investigations

Comments relating to the quality of on-site groundwater investigations are detailed in Table 10.3 below.

Table 11.3 Quality of groundwater investigations

Objective	Comments	Environmental Site Assessment Report Reference (Coffey 2012 unless otherwise noted)
Point sources targeted	Yes. No point sources were identified onsite. The Auditor notes that while the groundwater well network on the Western Precinct is not ideal, in conjunction with the three wells located on the Eastern Precinct, the level of characterisation is considered appropriate.	
	OVERALL AUDIT SUMMARY – The groundwater well network was considered sufficient to characterise groundwater quality in the water table aquifer below the site.	
Well screen depths	Bore construction details provided for monitoring wells were considered appropriate for intercepting the regional aquifer and groundwater impacts. Monitoring wells were drilled to between 5 and 10.9mBGL. As noted above, two wells were dry when gauged and with hindsight, these wells should have been drilled deeper.	Table 9 Appendix B Bore logs and related information provided in Appendix D.
Sampling method/s	Groundwater samples were collected via low flow sampling techniques (micropurge).	Section 5.3 page 19 Field sheets contained in Appendix R
	OVERALL AUDIT SUMMARY – The Auditor considers that the sampling methodologies employed during the groundwater investigative works are appropriate for the purposes of the Audit.	
Measured field parameters	Measured field parameters collected throughout the GME were generally consistent with the parameters specified within EPA publication 669 – *Groundwater Sampling Guidelines*.	Section 5.4.3.1 page 22 Field sheets contained in Appendix R
Groundwater flow – direction/elevation determined	Yes. With the incorporation of groundwater data from the adjacent eastern precinct, the distribution of monitoring wells was considered adequate to characterise groundwater flow direction beneath the site as well as identifying any potential anthropogenic influences on groundwater flow and quality. The groundwater flow was determined to be in a general northwesterly direction.	Section5.4.3. page 21 Appendix A, **Figure 6**
Analytical suite consistent with operations, history or regulatory requirements	Yes. The analytes selected were considered to adequately address potential contamination issues associated with the sites previous use for farming and a golf course. The groundwater analytical suite comprised a range or inorganic and organic analytes including: TDS, metals and alkali metals, fluoride, TPH, OCPs, OPPs, PAHs, PCBs, phenols, chlorinated hydrocarbons.	Section 5.3.1.2. page 19 Table 12, Appendix B

Objective	Comments	Environmental Site Assessment Report Reference (Coffey 2012 unless otherwise noted)
Background samples collected	Based upon the groundwater flow direction, wells MW6 located on the Eastern Precinct and MW2 located on the Western Precinct are considered to represent background conditions.	
Have groundwater impacts been delineated?	Elevated metal concentrations in groundwater are considered to be indicative of background conditions as they reflect well the background soil conditions and there is no evidence of their use on site in the past. Ammonia and nitrate concentrations have the potential to impact upon the beneficial use 'primary contact recreation' in offsite site well MW4 and onsite well MW2. Nitrate concentrations above primary contact recreation criteria were reported in offsite wells MW4 and MW5, while onsite well MW2 reported a nitrate concentration above the ecosystem protection criteria. Nitrate and ammonia impacts have not been fully delineated, however the location of the point source on the Eastern Precinct is known and will be removed as part of remedial works on the Eastern Precinct. Therefore ammonia and nitrate impacts reported on the Western Precinct are considered to be from an offsite source.	Coffey 14 February 2012 letter report (contained in **Appendix E** herein)
	OVERALL AUDIT SUMMARY – The Auditor considers that the distribution of monitoring wells on-site provided adequate characterisation of the groundwater quality beneath the site.	
Conclusions – groundwater investigation	The conclusions of the environmental assessment report are considered acceptable in relation to the final condition of groundwater at the site.	Section 9. page 41 Coffey 14 February 2012 letter report (contained in **Appendix E** herein)

11.4 Review of QA/QC data – Soil

A number of soil quality control samples including duplicate and split samples were collected by Coffey during the course of fieldworks in 2011. **Table 11.4** below outlines the Auditor's consideration of quality control information provided as part of Coffey's soil investigation. The information presented in the table below is based the following information:

- Five days of soil sampling
- A total of 181 soil samples were analysed (173 test pit samples and 8 soil bore samples)

Table 11.4 Evaluation of soil QA/QC data

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
QA/QC Samples: Intra-laboratory (blind) duplicates Inter-laboratory (split) duplicates	Blind duplicates: AS4482.1 recommends 1 blind duplicate per 20 primary samples. The Coffey report states that 6 blind duplicates were collected and tested during field works. The blind duplicate was analysed for a broad selection of analytes to reflect that of the primary sample. Split duplicates: AS4482.1 recommends 1 split duplicate per 20 primary samples. 7 split duplicates were collected during field works and 7 spilt duplicate was tested. The split duplicate was analysed for a broad selection of analytes to reflect that of the primary sample.	Appendix C. Section 8. page 40 Table 7, Appendix B
Rinsate samples	2 rinsate blanks were collected and analysed for a broad selection of contaminants of concern.	Appendix C Table 8, Appendix B
Trip blanks and field blanks	9 trip blanks were collected and analysed for BTEX	Appendix C Table 8, Appendix B
Total QA/QC samples analysed: *Primary samples: 181* *Blind duplicates: 6* *Split duplicates: 7* *Rinsates: 2* *Trip blanks: 9* *Field blanks: 0* *Equipment blanks: 0*	***OVERALL AUDIT SUMMARY***- The frequency of blind duplicate and split samples collected and analysed did not meet the minimum requirements specified within AS4482.1. However based on the uniformity of the local ground conditions encountered and the lack of obvious contaminating activities on the site the Auditor is satisfied with the level of QA/QC. Due to an absence of reported volatile analyte concentrations within primary samples, the Auditor considers that the lack of field blanks collected for the site would not affect the conclusions of this Audit.	
Background samples	No background soil samples were collected.	

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
Relative percent difference (RPD) calculations	100% of intralab duplicates reported acceptable RPDs. All unacceptable RPDs were calculated between the primary and interlab sample for metals, with 18% of RPDs outside the acceptable limits. These RPDs have been attributed to heterogeneity of the sample, and the Auditor does not believe they significantly impact on the overall quality of the data.	Appendix C. Table 7, Appendix B
NATA accredited laboratories and NATA endorsed analytical methods	The use of laboratories accredited by the National Association of Testing Authorities, Australia (NATA) for the analysis of soil samples was undertaken. Laboratory certificates were provided by Coffey to validate the results of sampling programs.	Appendix G.
Chain-of-Custody (CoC) documentation	CoC forms have been provided for all samples collected during the assessment works.	Appendices G & H
Holding times	No discussion of holding times presented in Appendix C, however an Auditor 10% check of the laboratory certificates indicates that all samples were analysed within the holding time.	
Laboratory report limits	No discussion of LORs were presented in Appendix C. The Auditor has check LORs against the criteria for the key contaminants and found them to be acceptable.	
Laboratory quality assurance procedures	Spike recoveries: A review of the quality assurance information contained within laboratory reports for the soil analysis, confirmed that percentage recoveries for spike samples ranged between 71% - 129%. Duplicate samples: A review of the quality assurance information contained within the laboratory reports confirmed that RPDs for duplicate samples were within the acceptable range of 0%- 34%.With the exception of the following samples & analytes: • Duplicate of M11-My130006 – chromium • Duplicate of M11-My13026 – various metals • Duplicate of M11-My13086 – chromium MGT noted that the RPD reported passes MGT acceptance criteria as stipulated in AS-POL-002.	Appendix C.
Method blanks	All the method blank samples analysed by the primary and secondary laboratories reported concentrations below the detection limit for the analytical method.	

Objective	Comments	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
	OVERALL AUDIT SUMMARY – An appraisal of the laboratory quality assurance results demonstrates an adequate degree of consistency within and between laboratories. As such, it is considered that the laboratory quality control data is adequate to provide confidence in the laboratory results.	
Transcription of data	An Auditor 10% check of the transcribed data did not identify any major issues.	

11.5 Review of QA/QC data – Groundwater

A number of groundwater quality control samples including duplicate, triplicate and rinsate samples were collected by Coffey during the course of fieldworks. **Table 11.5** below outlines the Auditor's consideration of quality control information provided as part of Coffey's environmental site assessment.

Table 11.5 Evaluation of groundwater QA/QC data

Objective	Comment	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
QA/QC Samples: Intra-laboratory (blind) duplicates Inter-laboratory (split) duplicates	Blind duplicates: 1 blind duplicate sample was collected and analysed during field works completed for the groundwater investigation. Split duplicates: 1 split duplicate sample was collected and analysed for the analytes of concern within the primary samples.	Appendix C Table 13, Appendix B
Rinsate samples	2 resinate samples were collected and for the primary contaminants of concern. All analytes were reported below the laboratory LOR for all rinsate samples collected and analysed during groundwater investigative works.	Appendix C Table 14, Appendix B
Trip blanks	2 trip blanks were collected and analysed for BTEX and THP. Reported analytical results for all trip blank samples were reported below the laboratory detection limits.	Appendix C Table 14, Appendix B
Field blanks	No field blanks were collected or analysed Due to an absence of reported volatile analyte concentrations within primary samples, the Auditor considers that the lack of field blanks collected for the site would not affect the conclusions of this Audit.	Appendix C
Total QA/QC samples analysed: *Primary samples: 4* *Blind duplicates: 1*	***OVERALL AUDIT SUMMARY –*** The Auditor considers that the frequency of blind, split, rinsate, field and trip blank samples collected and analysed for the site is adequate for the purposes of the Audit.	

Objective	Comment	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
Split duplicates: 1 *Rinsates: 2* *Trip blanks: 2* *Field blanks: 0*		
Relative percent difference (RPD) calculations	Calculated RPD results for all blind and split duplicate analysis was provided for in appendix C and Table 13 (Appendix B) and all results were within the acceptable limits.	Appendix C Table 13, Appendix B
	OVERALL AUDIT SUMMARY – All RDPs, resinate and trip blanks were within acceptable limits. Due to an absence of reported volatile analyte concentrations within primary samples, the Auditor considers that the lack of field blanks collected for the site would not affect the conclusions of this Audit.	
NATA accredited laboratories and NATA endorsed analytical methods	The use of laboratories accredited by NATA for the analysis of groundwater samples was undertaken. Laboratory certificates were provided by Coffey to validate the results of the groundwater sampling programs.	Appendix G.
Chain-of-Custody (CoC) documentation	CoC forms have been provided for all samples	Appendix H.
Holding times	No discussion of holding times presented in Appendix C, however an Auditor 10% check of the laboratory certificates indicates that all samples were analysed within the holding time.	
Laboratory reporting limits	No discussion of LORs were presented in Appendix C. The Auditor has check LORs against the criteria for the key contaminants and found them to be acceptable.	
Laboratory quality assurance procedures	Spike recoveries: A review of the quality assurance information contained within the laboratory reports for the groundwater analysis, confirmed that percentage recoveries were within acceptable recovery limits, as specified by the laboratory. Duplicate samples: A review of the quality assurance information contained within the laboratory reports confirmed that RPDs for duplicate samples were within the range 0%-30% with the exception of: • M11-Se11236 for Mercury MGT noted that the RPD reported passes MGT acceptance criteria as stipulated in AS-POL-002.	
Method Blanks	All the method blank samples analysed by the primary and secondary laboratories reported concentrations below the detection limit for the analytical method.	
Transcription of data	An Auditor 10% check of the transcribed data did not identify any major issues.	
	OVERALL AUDIT SUMMARY – An appraisal of the laboratory quality assurance results demonstrates an adequate degree of	

Objective	Comment	Environmental Site Assessment Report Reference (Coffey, Jan 2012 unless otherwise noted)
	consistency within and between laboratories. The spike recoveries and laboratory duplicates were generally reported within acceptable limits and method blank samples were reported below the limit of detection. As such, it is considered that the laboratory quality control data is adequate to provide confidence in the laboratory results.	

11.6 Adequacy of environmental site assessment

Based on the above information, the Auditor considers that assessment works undertaken by Coffey during the Environmental Audit were of a sufficient quality and completeness to support the enclosed Certificate of Environmental Audit, and were generally conducted in accordance with the relevant guidelines, policies and standards referenced throughout this report.

11.7 Auditor verification activities

The Auditor's representative conducted one site inspection in order to verify the environmental quality of the site as reported by the Assessor (Coffey). The table below summarises the site inspection conducted by the Auditor's Representative. A copy of the site inspection record is provided in **Appendix F**.

Activity	Date	Comment
Auditor's assistant initial site condition inspection.	10 May 2011	An inspection conducted by the Auditor's assistant of test pitting conducted by Coffey. No soil samples were collected during the site inspection.

12. Discussion

12.1 Soil

The results of the soil assessment and remediation works confirmed that the majority of soil across the site generally contained analyte concentrations below the adopted ecological and health-based screening criteria, with the exception of arsenic, manganese, nickel and vanadium concentrations which exceeded the adopted ecological criteria at selected locations across the site. Based on the above information, the Auditor notes the reported arsenic, nickel and vanadium concentrations are:

- Within the NEPM Background Range, and
- Below the adopted health-based criteria for the site – NEPM HIL A criteria.

In summary, concentrations of arsenic, manganese, nickel and vanadium are considered to be naturally occurring, associated with background concentrations and the beneficial uses of land at the site are not considered to be precluded by the identified concentrations.

12.2 Beneficial uses of land

This section outlines the Auditor's opinion on the likelihood of impact to the beneficial uses of the land, due to residual soil impacts identified at the site. In accordance with Appendix 4 of EPA Publication 759.1 (2007), *Environmental Auditor (Contaminated Land) Guidelines for Issue of Certificates and Statements of Environmental Audit*, the development is classified as medium-high density residential and falls under the land use *Sensitive Use: Other* under the Land SEPP. In order for a *Certificate* of *Environmental Audit* to be issued, it must be demonstrated that the site is neither detrimental nor potentially detrimental to any one or more of the relevant beneficial uses of the land.

In accordance with the Land SEPP, '*Maintenance of Natural Ecosystems*' is not required to be protected for the proposed medium-high density residential development, however cognisance is given to this beneficial use in order to consider unrestricted use of the site.

Table 12.1 below summarises the likelihood of relevant beneficial uses of the land being precluded.

Table 12.1 Likelihood of relevant beneficial uses of the land being precluded

Beneficial Use	Likelihood	Comment
Maintenance of natural, modified and highly modified ecosystems	Unlikely	Natural soils contain some exceedances of the adopted environmental criteria for arsenic, nickel and vanadium however these concentrations are considered to be representative of background ranges at the site and the beneficial use maintenance of ecosystems is unlikely to be adversely impacted.
Human health	Unlikely	All analytes are below the adopted HIL A criteria protective of a standard residential land-use. Hence, there would be no unacceptable human health risks for the proposed medium-high density residential land-use. It is considered that the site conditions determined by the Audit are unlikely to pose any other unacceptable human health risks for other land uses. Therefore site conditions do not preclude the beneficial use of human health.

Beneficial Use	Likelihood	Comment
Buildings and structures	Unlikely	No evidence of acidic or other corrosive soil conditions were observed that could impact upon buried structures or building foundations. Therefore this beneficial use is considered to be protected at the site.
Aesthetics	Unlikely	Minor inert waste was identified at one location in the fill during soil investigation works including occasional brick and concrete fragments, root matter. No odours or staining were noted at any sampling location. The beneficial use of aesthetics was not considered to be precluded by the minor identified inert waste reported. There was no other evidence of imported fill material onsite. Any landscaping appears to have utilised onsite materials. Therefore this beneficial use is considered to be protected at the site.
Production of food & flora	Unlikely	While arsenic, nickel and vanadium concentrations were present in soils above the adopted environmental criteria, it is considered unlikely that the indicator levels in food, flora and fibre produced in a residential setting at the site would be greater than that specified by the Australian New Zealand Food Authority, Food Standards Code. Therefore this beneficial is not considered to be precluded.

12.3 Groundwater

Groundwater investigative works conducted at the site identified exceedences of the adopted criteria for the following protected beneficial uses:

- **Maintenance of ecosystems**: Elevated concentrations of cadmium, copper, manganese, nickel, selenium, zinc and nitrate reported in groundwater beneath the site, above the adopted ANZECC 2000 criteria for maintenance of ecosystems.
- **Agriculture, Parks and Gardens**: Elevated iron, manganese, nickel and selenium above the criteria.
- **Stockwatering**: Selenium exceed the adopted criteria.
- **Primary contact recreation**: Iron, manganese, selenium and ammonia.
- **Industrial (protection of human health)**: Iron, manganese, selenium and ammonia.

12.4 Process for considering groundwater pollution

In accordance with Section 13 of the *Environmental Auditor (Contaminated Land) Guidelines for Issue of Certificates and Statements of Environmental Audit,* EPA Publication 759.1, September 2007, the Auditor must address the following questions to determine the potential for groundwater beneath the site to be polluted.

Is groundwater likely to be polluted?

In other words, is there any significant risk that groundwater at the site is contaminated to the extent it may be polluted from on-site or off-site sources?

The former agricultural use of the site and its surrounds, and more recent use of the site to the south as a golf course suggested there is a risk of groundwater pollution from the use of agricultural chemicals and fertilisers. Such impacts are known to exist in the region surrounding the site and therefor a groundwater investigation was justified on this basis.

Is groundwater polluted?

In other words, does any groundwater contamination found at the site constitute pollution of groundwater in accordance with the definition in SEPP Groundwaters of Victoria?

In answering the above questions, Coffey's environmental site assessment incorporated a desktop hydrogeological study as well as an intrusive groundwater investigation that included the installation of three onsite wells and the sampling of one on-site and three off-site wells.

12.5 Beneficial uses of groundwater precluded by pollution

The following discussion presents the Auditor's analysis of the degree of compliance with the objectives in SEPP Groundwaters of Victoria.

Table 10.1 and **Table 10.2,** summarised the findings of the groundwater assessment, and identified the adopted criteria for protected beneficial uses that are exceeded by groundwater conditions at the site. **Table 12.2** below summarises which protected beneficial uses are relevant to the site, i.e. are an existing use, or could be considered likely to be realised at the site.

Table 12.2 Summary of on-site groundwater pollution

Protected Beneficial Use	Does the use Exist?	Is the use likely to be realised in the future?	Relevance to site	Use precluded
Maintenance of ecosystems	no	no	Not relevant	No
Stock watering	no	unlikely	Unlikely	No
Agriculture Parks and Gardens	possible	possible	Possible	Yes-metals
Industrial use	no	no	Not relevant	No
Primary contact recreation	no	possible	Possible	Yes-metals and ammonia
Buildings & structures	no	unlikely	Unlikely	No

The analysis indicates that of the all protected uses precluded by groundwater pollution, only *Primary Contact Recreation and Agriculture Parks and Gardens (on-site)* were considered to be relevant (i.e. existing or likely to be realised) to the site.

Metals

As discussed in Section 10, the site is not considered to represent a source of the observed metals concentrations in groundwater at the site The reported metals concentrations are considered to be:

- Representative of naturally occurring background concentrations, or

- Representative of regional conditions and not sourced from the site.

Nitrate and ammonia

Based a review of groundwater data for background well MW2, elevated concentrations of nitrate and ammonia are also likely to be representative of regional conditions supported by the former agricultural and golf course maintenance activities in the area. In addition, the concentration of nitrate above the adopted criteria for primary contact recreation in offsite well MW5 is likely to reflect a point source for contamination located on the Eastern Precinct (septic tank) (see Figure 10, Appendix A). The nitrate concentration in MW4, down hydraulic gradient of MW5, while above ecosystem protection criteria is below the primary contact recreation criteria suggesting attenuation of a point source contaminant.

As such, protected beneficial uses of groundwater down gradient of the site are not at risk from current or past activities specifically associated with the site, beyond those that are common (e.g. agricultural and green keeping activities) to the site and the surrounding region.

As the site is not considered to be the source of the observed pollution, preclusion of protected beneficial uses of groundwater off-site are not considered further

13. Conclusions

This Environmental Audit was undertaken to assess the suitability of the land for all potential land-uses.

The Auditor has concluded the following with respect to the adequacy of the assessment works completed at the site by Coffey:

- The site history information provided was considered sufficient to identify potentially contaminating activities.
- The regional and local geological setting identified during investigative works was generally consistent with the geological setting for the site.
- The soil sampling programs conducted 2011 is considered to adequately characterise the site for the purposes of the Audit. The sampling methodology was generally consistent with Australian Standard AS4482.1 and other relevant guidelines and is considered appropriate for describing the final condition of the site. The analytes tested adequately addressed potential contamination issues identified from the site history review as well as visual inspections of the site.
- The groundwater well network, while not ideal, was sufficient to target all potential point sources of groundwater impacts and characterise regional groundwater quality. The sampling methodologies employed during the groundwater investigative works were appropriate for the purposes of the Audit.
- The QA/QC procedures employed were adequate to provide confidence in the laboratory results.

Based on the above information, the Auditor considers that assessment works undertaken in the Environmental Site Assessment by Coffey in support of the Environmental Audit were of a sufficient quality and completeness to support the enclosed Statement of Environmental Audit, and were generally conducted in accordance with the relevant guidelines, policies and standards referenced throughout this report.

The findings of the environmental assessment indicated that the final land surface contains concentrations of arsenic, manganese, nickel and vanadium in excess of the adopted environmental criteria (i.e. NEPM EIL or ANZECC B). These elevated metal concentrations are considered to be associated with naturally occurring background concentrations at the site. All analytes were reported below the adopted health-based criteria protective of a sensitive land-use (i.e. NEPM HIL A).

Based on the findings of this Environmental Audit, the Auditor is of the opinion that the site, in its current condition, does not preclude any beneficial uses of the land, including medium to high density residential use.

Groundwater investigative works conducted at the site identified concentrations of iron, manganese, nickel, selenium and zinc above the adopted criteria for the use of groundwater for irrigation purposes (agriculture, parks and gardens). Concentrations of iron, manganese, selenium and ammonia also exceeded the adopted criteria for primary contact recreation, for example where groundwater may be used to fill a swimming pool or spar. The Auditor considers that these are the only two beneficial uses of groundwater that are relevant to the site.

The Auditor also considers that the site is not a specific source of the reported metals, ammonia and nitrate concentrations in groundwater, which are considered to be either:

- Representative of naturally occurring background concentrations, or
- Representative of regional conditions and not sourced from the site.

13.1 Audit outcome

In view of the assessment works completed by Coffey the site is the site is suitable for the beneficial uses associated with:

- Sensitive use (medium to high density)
- Commercial
- Industrial
- Open space

subject to the following conditions attached thereto:

- Groundwater at the site is polluted and must not be used for beneficial uses associated with; agriculture, parks and gardens; and primary contact recreation; without prior testing.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, the Auditor has not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are as set out as follows:

- Remediation of residual groundwater impacts to the extent that relevant beneficial uses of groundwater are restored.

Other related information

- Groundwater at the site is polluted with ammonia and nitrate. The site is not the source of the pollution and is not considered to affect any beneficial uses of the land at the site.
- The auditor is satisfied that the groundwater has been cleaned up to the extent practicable.
- Groundwater at the site contains concentrations of cadmium, copper, iron, manganese, nickel, selenium and zinc above adopted criteria. The concentrations are considered to be typical of the regional groundwater quality surrounding the site and do not constitute pollution in accordance with clause 10(2)(c) of the State Environmental Protection Policy (Groundwater of Victoria).
- Groundwater bores present at the site (MW01, MW02 and MW03) should be decommissioned in accordance with the requirements of "Minimum Construction Requirements for Water Bores in Australia", published by the Land and Water Biodiversity Committee, 2012.

- In accordance with section 53Z of the Environment Protection Act 1970 the owner/occupier of the site must provide a copy of this Statement to any person who becomes or proposes to become an occupier of the site.

13.2 Support team involvement

No specialist support team members were required during the preparation of this report.

14. References

Australian and New Zealand Environment and Conservation Council/National Health and Medical Research Council (1992), *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*.

Canadian Council of Ministers of the Environment (2007), *Canadian Environmental Quality Guidelines*.

Coffey Geosciences Pty Ltd, 8 August 2005. Stage 1 Environmental site assessment Amstel Golf Course Cranbourne-Frankston Road, Cranbourne, Report No. E16663/1 AC. Report for Watsons Pty Ltd.

Coffey Environments Australia Pty Ltd, 12 April 2012. Environmental site assessment Proposed Amstel Golf Course development (Western Precinct) 980 Frankston-Cranbourne Road, Cranbourne, Victoria, report No ENAUABTF00207AA-R04. Report for Waraplus Pty Ltd.

Coffey Environments Australia Pty Ltd, 14 February 2012. Letter report: Groundwater condition at Proposed Amstel golf Course redevelopment, report No. ENAUABTF00207AA-L1.

CRC CARE Technical Report No. 10. September 2011. Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater by E. Friebel & P. Nadebaum

DCNR (1995), *Victoria Groundwater Beneficial Use Map Series*, *South Western Victoria* (1:250,000 scale). Department of Conservation and Natural Resources.

Environment Protection Act 1970 Victoria. Act No. 8056/1970. (*EPA* 1970).

EPA Victoria (2006), *Publication 1037 – Environmental Audit of Unimin Lime (Victoria) Pty Ltd*.

EPA Victoria (2007), *Publication 1147 - Environmental Auditor Guidelines - Provision of environmental audit reports, certificates and statements*.

EPA Victoria (2007), *Publication 860.1 - Environmental Auditing of Contaminated Land*.

EPA Victoria (2007) *Environmental Auditor (Contaminated Land) – Guidelines for Issue of Certificates and Statements of Environmental Audit, Publication 759.1*.

Geological Survey of Victoria *1:63,360 Cranbourne Map Sheet.*

VANDENBERG, A.H.M., 1997. QUEENSCLIFF SJ 55-9 Edition 2, 1:250 000 Geological Map Series 1:250,000 geological map. Geological Survey of Victoria.

HSDB (2011) *Hazardous Substances Data Bank.*
http://toxnet.nlm.nih.gov/cgibin/sis/htmlgen?HSDB

Lane Piper Pty Ltd, 20 December 2010. Environmental Audit report (Groundwater Quality) 2010 Stevensons Road Landfill, Cranbourne, Vic, Doc Ref: 0664AReport04.2. Report for Casey City Council.

National Environmental Protection Council (1999), *National Environment Protection (Assessment of Site Contamination) Measure*.

Netherlands (2000), *Circular on Target Values and Intervention Values for Soil Remediation*, *Ministry of Housing, Spatial Planning and Environment*.

NSW Environment Protection Authority (1994), Guidelines *for Assessing Service Station Sites*.

State Environment Protection Policy (SEPP) (2002) (*Prevention and Management of Contamination of Land*), *EPA* 1970, Victoria.

State Environment Protection Policy (SEPP) (1997) (*Groundwaters of Victoria*), *EPA* 1970, Victoria.

Standards Australia (2005), Guide to the Sampling and Investigation of Potentially Contaminated Soil Part 1: Non-volatile and Semi-volatile Compounds. Australian Standard AS 4482.1-2005.

Standards Australia (2009), *Piling Design and Installation.* Australian Standard AS2159-2009.

15. Limitations of this Environmental Audit Report

This Environmental Audit Report and Certificate of Environmental Audit have been prepared under Part IXD Section 53W (1) of the *Environment Protection Act 1970*, and in accordance with relevant State Environmental Protection Policies (SEPPs) and EPA Victoria guidelines. The Certificate of Environmental Audit represents the auditor's opinion of the environmental condition of the site and its suitability for specified beneficial uses at the date that the Certificate is signed.

In forming his opinion of the site, the auditor has assessed the data and information supplied by Coffey Environments Pty Ltd and has also undertaken a number of independent verification activities. He has accepted that the information supplied represents a fair and reasonable assessment of site conditions, taking into account the limitations inherent to all site assessment processes.

This report has been prepared specifically for use by EPA Victoria, the City of Casey Council and Waraplus Pty Ltd (the current site developer). Should another party rely on the information and conclusions presented in this report, they do so at their own risk.

In the event that changes to the state or condition of the site and/or surrounding area occur after the date of signing of the Certificate of Environmental Audit, the Environmental Audit Report may no longer be valid.

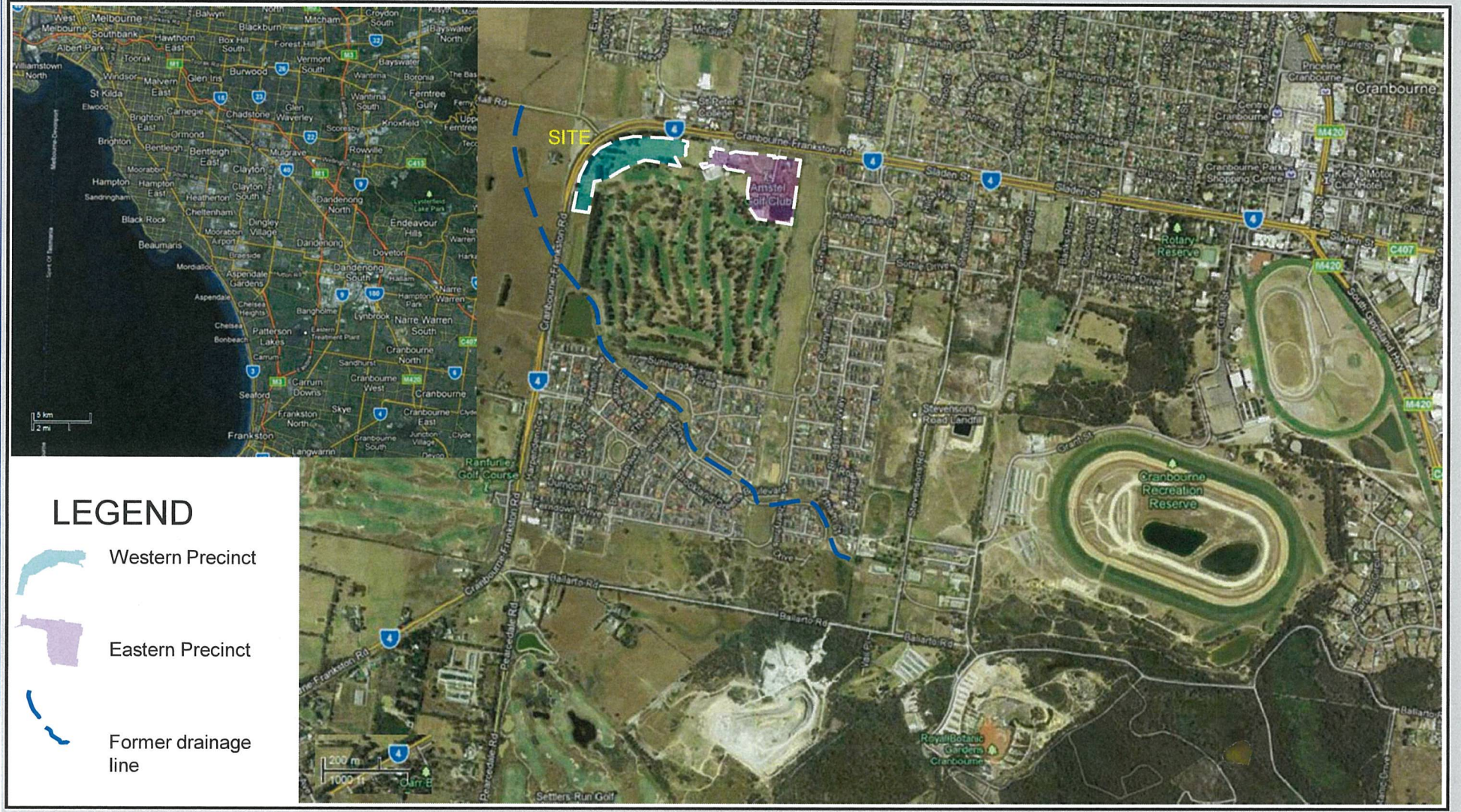
Appendix A

Figures

PB PARSONS BRINCKERHOFF

Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 1– Site Location Plan



LEGEND

- Western Precinct
- Eastern Precinct
- Former drainage line

0 400m (approx.)

Source: Coffey, 2011

N W E S

Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2011

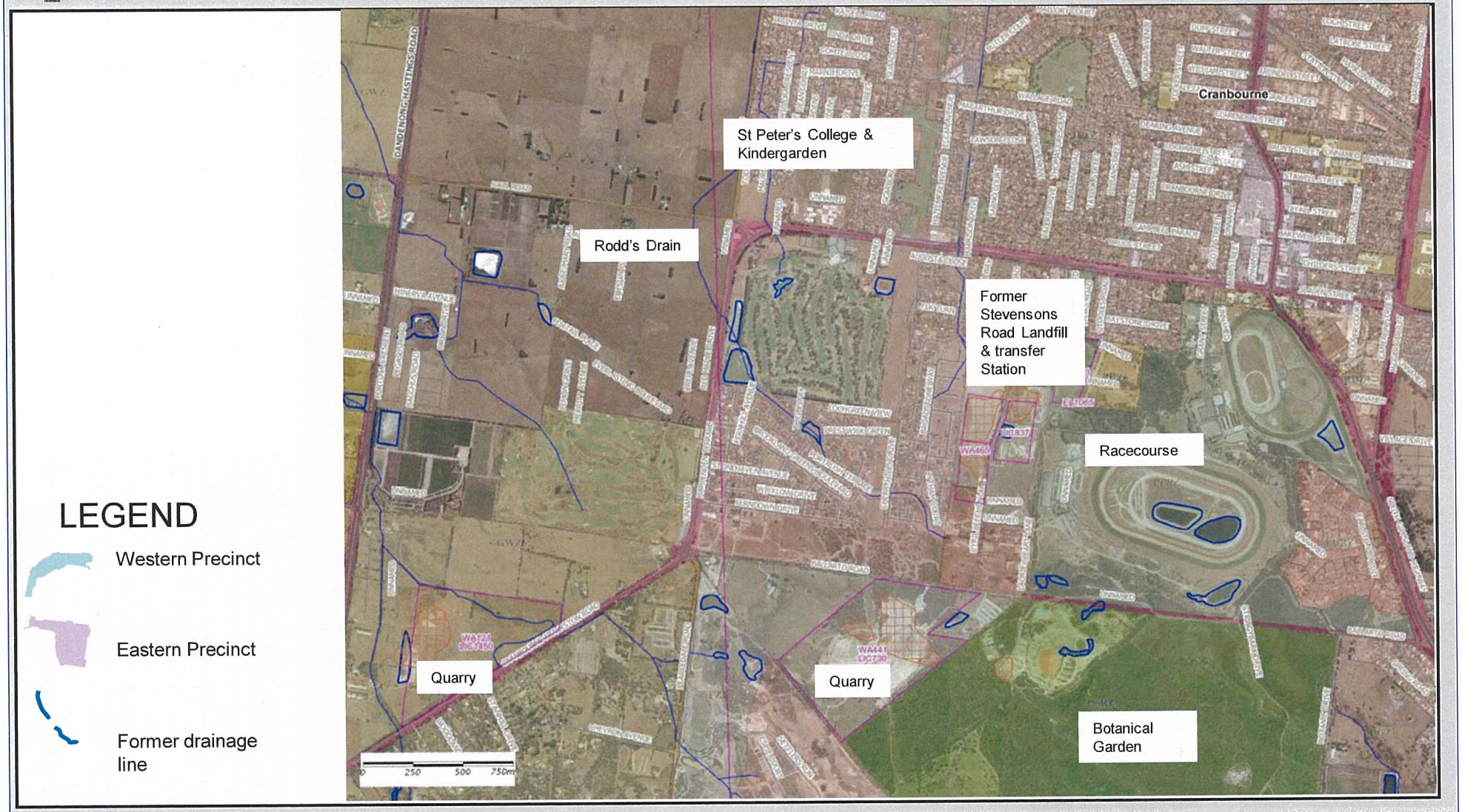
PARSONS BRINCKERHOFF

NCSI certified Quality System to ISO 9001

PB PARSONS BRINCKERHOFF

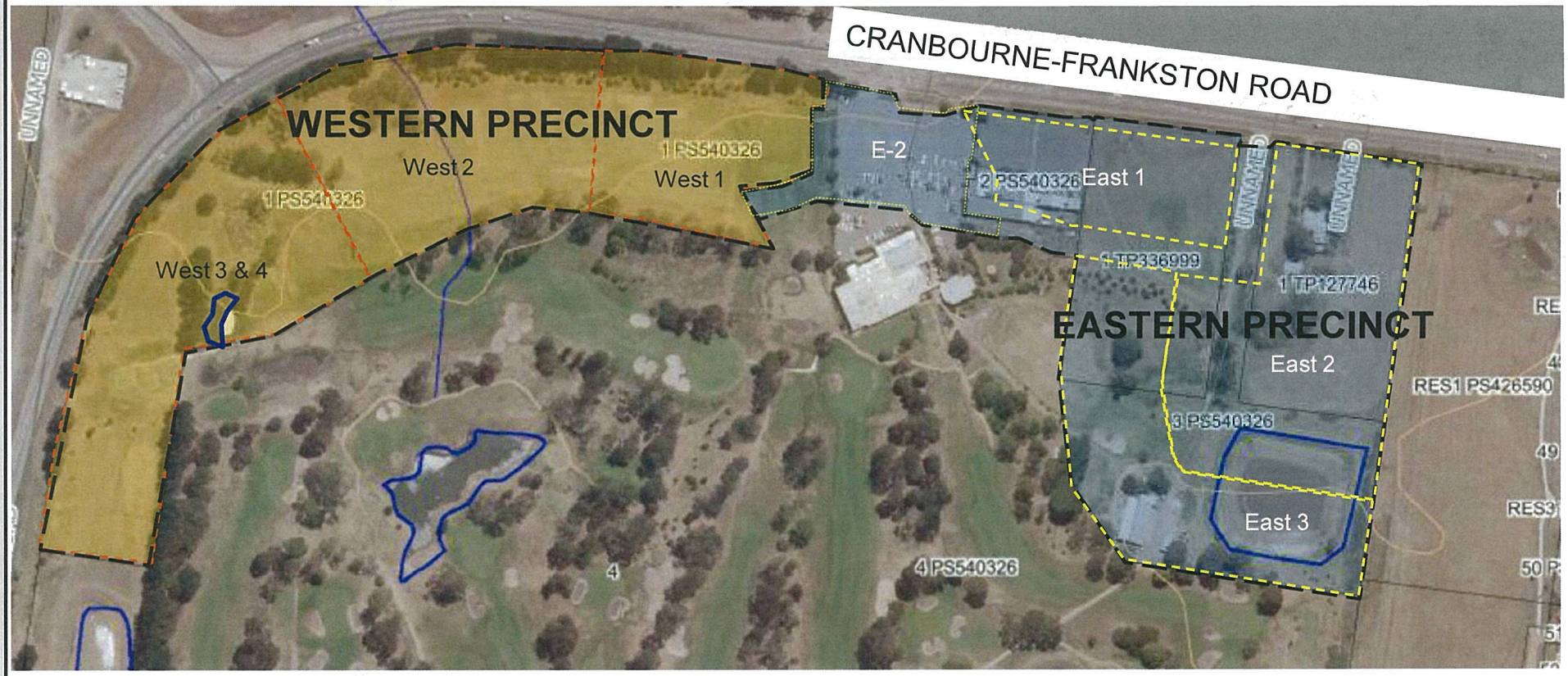
Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 2– Surrounding landuses



PARSONS BRINCKERHOFF

Figure 3 – Amstel Golf Course Audit Boundary



0 65m (approx.)

Source: Coffey, 2011

N W E S

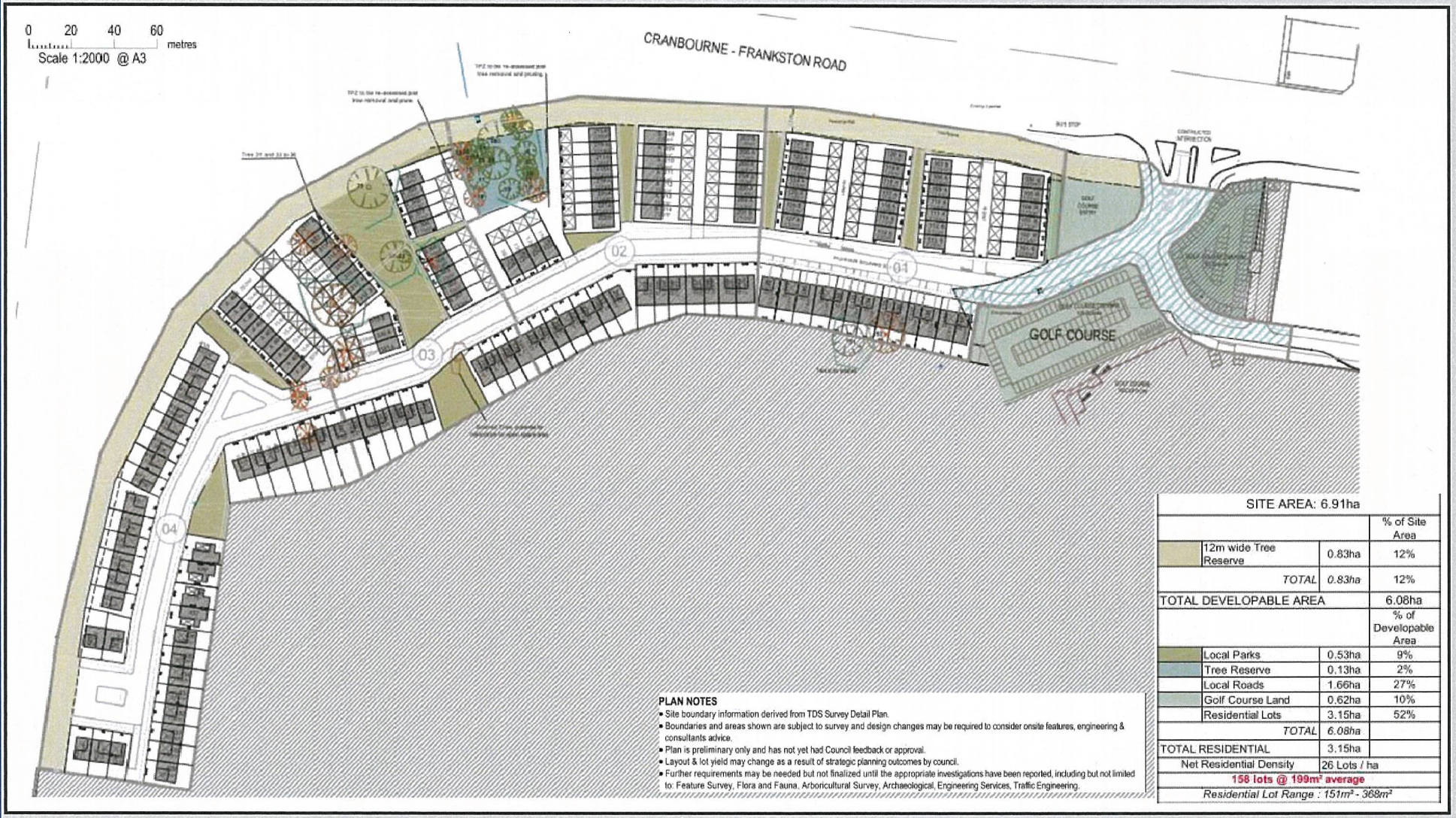
Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2011

PARSONS BRINCKERHOFF

PB PARSONS BRINCKERHOFF

Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 4 – Proposed development plan



SITE AREA: 6.91ha		
		% of Site Area
12m wide Tree Reserve	0.83ha	12%
TOTAL	*0.83ha*	12%
TOTAL DEVELOPABLE AREA		6.08ha
		% of Developable Area
Local Parks	0.53ha	9%
Tree Reserve	0.13ha	2%
Local Roads	1.66ha	27%
Golf Course Land	0.62ha	10%
Residential Lots	3.15ha	52%
TOTAL	*6.08ha*	
TOTAL RESIDENTIAL	3.15ha	
Net Residential Density	26 Lots / ha	
158 lots @ 199m² average		
Residential Lot Range : 151m² - 368m²		

PLAN NOTES

- Site boundary information derived from TDS Survey Detail Plan.
- Boundaries and areas shown are subject to survey and design changes may be required to consider onsite features, engineering & consultants advice.
- Plan is preliminary only and has not yet had Council feedback or approval.
- Layout & lot yield may change as a result of strategic planning outcomes by council.
- Further requirements may be needed but not finalized until the appropriate investigations have been reported, including but not limited to: Feature Survey, Flora and Fauna, Arboricultural Survey, Archaeological, Engineering Services, Traffic Engineering.

0 60m (approx.)

Source:
Waraplus PTY LTD 2012

N W E S

Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2012

PARSONS BRINCKERHOFF

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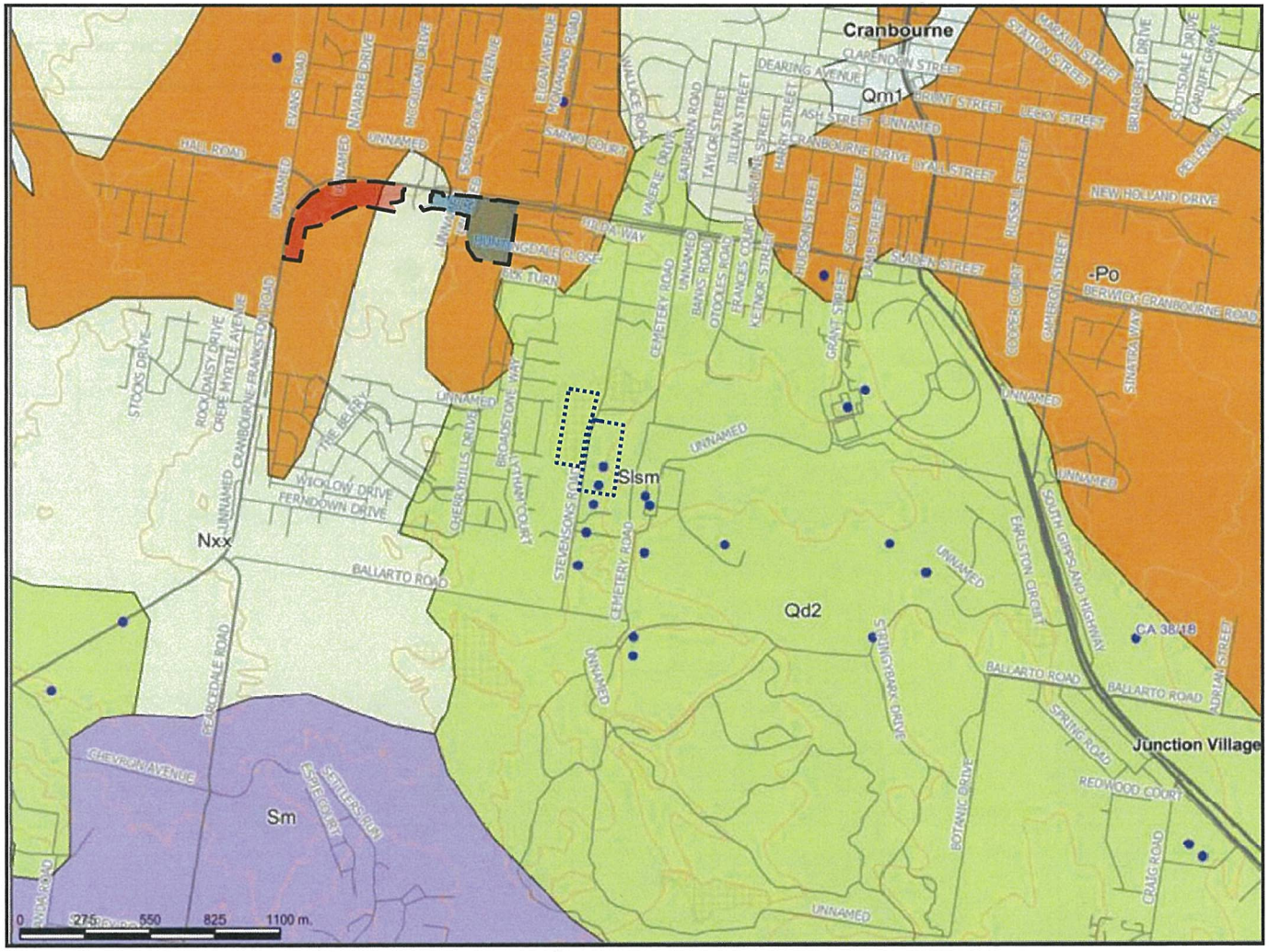
Stevensons Road Landfill, Casey City Council

Figure 5 – Regional Geology



GEOLOGICAL LEGEND

- Quaternary Sands
- Older Volcanic Group
- Brighton Group (Baxter Sandstone)
- Silurian Mudstone (bedrock)
- Western Precinct
- Eastern Precinct
- Cranbourne Landfill

0 1100m

Source: GeoVic (DPI) website 2011

N W E S

Project No: 2171109A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 11-03-11

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NCSI certified Quality System to ISO 9001

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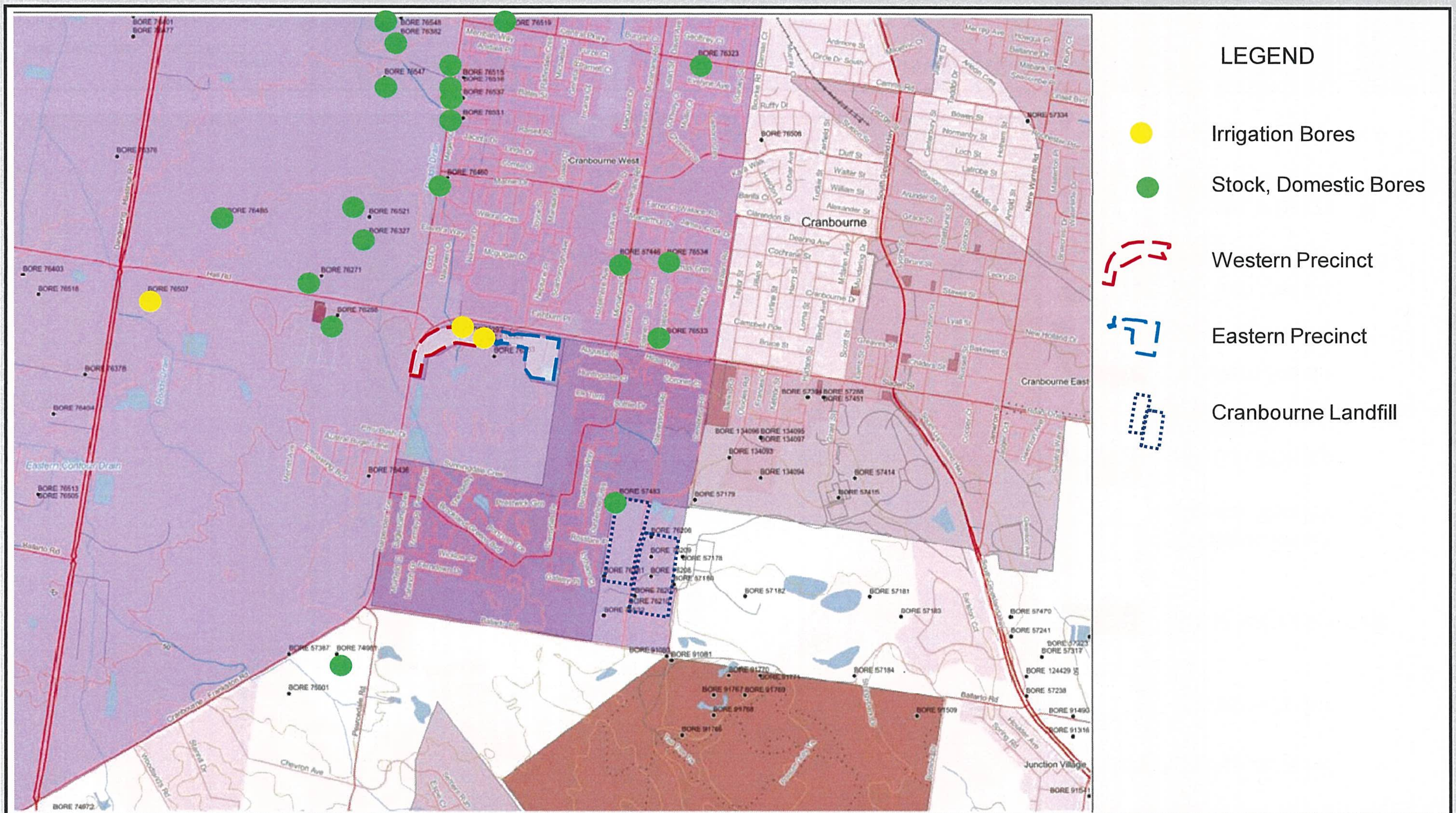
Stevensons Road Landfill, Casey City Council

Figure 6– Registered Bores



Source:
GeoVic (DPI) website 2011

Project No: 2171109A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 11-03-11

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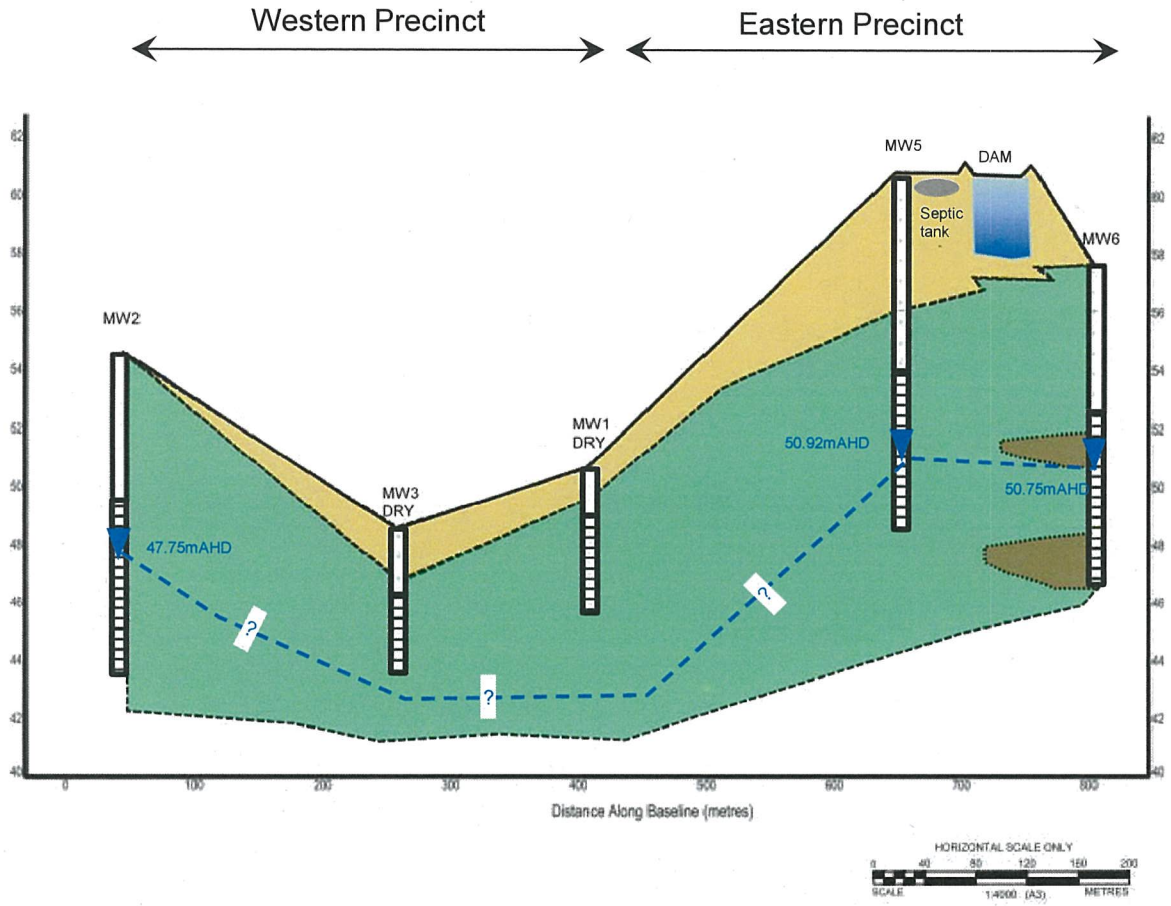
Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 7 – Site conceptual model (Sept 2011)

Cross Section A-A'



SITE PLAN

1:10,000 (A3)

LEGEND

- Sandy sediments
- Clayey sediments
- Highly weathered basalt
- SWL in mAHD

0 200m (approx.)

Source: Coffey, Feb 2012

Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2012

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Figure 8 – Soil sampling locations

LEGEND

- TEST PIT LOCATIONS
- STOCKPILE SOIL BORE LOCATION
- MONITORING WELL LOCATION

N

0 75m (approx.)

Source: Coffey, 2012

N W E S

Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2011

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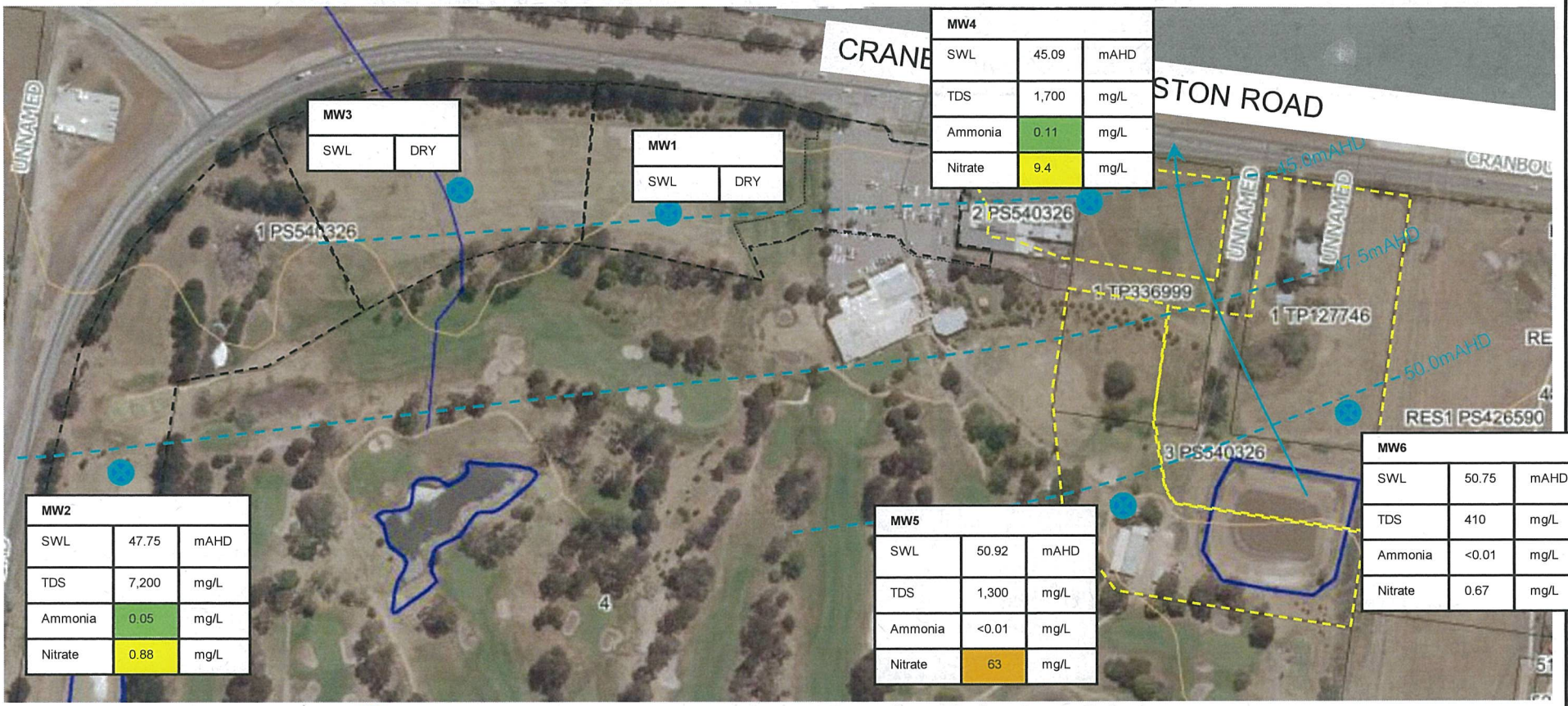
Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 9 – Groundwater monitoring results (Sept 2011)



LEGEND

SWL – standing water level in mAHD

Groundwater monitoring well

Inferred groundwater elevation contour (mAHD)

Inferred groundwater flow direction

Concentration above criteria

Primary contact recreation

Ecosystem protection

Ecosystem protection & primary contact recreation

0 65m (approx.)

Source: Coffey, 2012

N W E S

Project No: 2171147A
Revision: 0
Drawn: CLS
Verify: CLS
Date: 2012

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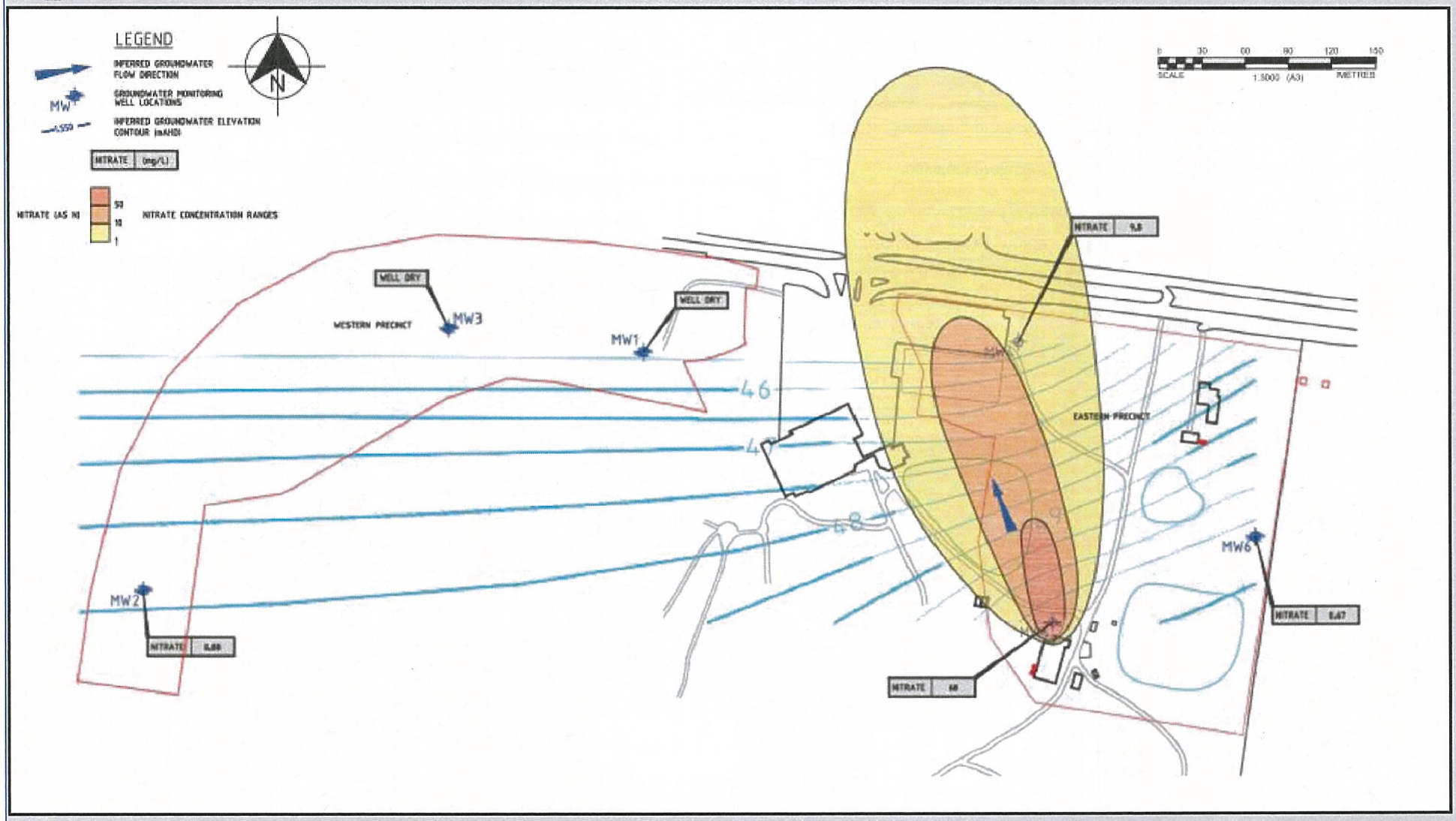
Frankston-Cranbourne Road, Waraplus Pty Ltd

Figure 10 – Coffey nitrate groundwater plume (Sept 2011)



0 150m (approx.)

Source: Coffey, Feb 2012

roject No: 2171147A
evision: 0
rawn: CLS
erify: CLS
Date: 2012

PARSONS BRINCKERHOFF

NCSI certified Quality System to ISO 9001

INFORMATION REGARDING ENVIRONMENTAL AUDIT REPORTS

August 2007

VICTORIA'S AUDIT SYSTEM

An environmental audit system has operated in Victoria since 1989. The *Environment Protection Act 1970* (the Act) provides for the appointment by the Environment Protection Authority (EPA Victoria) of environmental auditors and the conduct of independent, high quality and rigorous environmental audits.

An environmental audit is an assessment of the condition of the environment, or the nature and extent of harm (or risk of harm) posed by an industrial process or activity, waste, substance or noise. Environmental audit reports are prepared by EPA-appointed environmental auditors who are highly qualified and skilled individuals.

Under the Act, the function of an environmental auditor is to conduct environmental audits and prepare environmental audit reports. Where an environmental audit is conducted to determine the condition of a site or its suitability for certain uses, an environmental auditor may issue either a certificate or statement of environmental audit.

A certificate indicates that the auditor is of the opinion that the site is suitable for any beneficial use defined in the Act, whilst a statement indicates that there is some restriction on the use of the site.

Any individual or organisation may engage appointed environmental auditors, who generally operate within the environmental consulting sector, to undertake environmental audits. The EPA administers the environmental audit system and ensures its ongoing integrity by assessing auditor applications and ensuring audits are independent and conducted with regard to guidelines issued by EPA.

AUDIT FILES STRUCTURE

Environmental audit reports are stored digitally by EPA in three parts: the audit report (part A), report appendices (part B) and, where applicable, the certificate or statement of environmental audit and an executive summary (part C). A report may be in colour and black-and-white formats. Generally, only black-and-white documents are text searchable.

Report executive summaries, findings and recommendations should be read and relied upon only in the context of the document as a whole, including any appendices and, where applicable, any certificate or statement of environmental audit.

AUDIT REPORT CURRENCY

Audit reports are based on the conditions encountered and information reviewed at the time of preparation and do not represent any changes that may have occurred since the date of completion. As it is not possible for an audit to present all data that could be of interest to all readers, consideration should be made to any appendices or referenced documentation for further information.

When information regarding the condition of a site changes from that at the time an audit report is issued, or where an administrative or computation error is identified, environmental audit reports, certificates and statements may be withdrawn or amended by an environmental auditor. Users are advised to check EPA's website to ensure the currency of the audit document.

PDF SEARCHABILITY AND PRINTING

EPA Victoria can only certify the accuracy and correctness of the audit report and appendices as presented in the hardcopy format. EPA is not responsible for any issues that arise due to problems with PDF files or printing.

Except where PDF normal format is specified, PDF files are scanned and optical character recognised by machine only. Accordingly, while the images are consistent with the scanned original, the searchable hidden text may contain uncorrected recognition errors that can reduce search reliability. Therefore, keyword searches undertaken within the document may not retrieve all references to the queried text.

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FURTHER INFORMATION

For more information on Victoria's environmental audit system, visit EPA's website or contact EPA's Environmental Audit Unit.

Web: www.epa.vic.gov.au/envaudit

Email: environmental.audit@epa.vic.gov.au

Environmental Audit Report - Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria (CARMS #69347-2)

February 2013

Waraplus Pty Ltd

PARSONS BRINCKERHOFF

Parsons Brinckerhoff Australia Pty Limited
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Email melbourne@pb.com.au

Certified to ISO 9001, ISO 14001, AS/NZS 4801
A+ GRI Rating: Sustainability Report 2010

Revision	Details	Date	Amended By
A	Original	21 February 2013	John Throssell

Author: Mr John Throssell

Signed: .....

Distribution: City of Casey, EPA Victoria, Waraplus Pty Ltd, Parsons Brinckerhoff

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Appendices

ENVIRONMENT PROTECT ACT 1970 CERTIFICATE OF ENVIRONMENTAL AUDIT

I, John Throssell of Parsons Brinckerhoff Australia Pty Ltd, a person appointed by the Environmental Protection Authority ('the Authority') under the *Environmental Protection Act* 1970 ('the Act') as an environmental auditor for the purpose of the Act, having:

1. been requested by Waraplus Lty Ltd to issue a certificate of environmental audit in relation to the site located at Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria, being the property described as Lots 2 and 3 on PS540326F, Lot 1 on TP336999B and Lot 1 on TP127746Y ('the site') owned by Australian International Property Corporation Pty Ltd (Waraplus Pty Ltd are the site developers).

2. had regard to, among other things,

   i) guidelines issued by the Authority for the purposes of Part IXD of the Act,

   ii) the beneficial uses that may be made of the site, and

   iii) relevant State environment protection policies/ industrial waste management policies, namely, State Environment Protection Policy (Prevention and Management of Contamination of Land) and State Environment Protection Policy (Groundwaters of Victoria).

   in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment which may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and

3. completed an environmental audit report in accordance with Section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY CERTIFY that I am of the opinion that the condition of the site is neither detrimental nor potentially detrimental to any beneficial use of the site.

Other related information:

- Groundwater at the site contains concentrations of copper, iron, manganese, nickel and zinc above adopted criteria. The concentrations are considered to be typical of the regional groundwater quality surrounding the site and do not constitute pollution in accordance with clause 10(2)(c) of the State Environmental Protection Policy (Groundwater of Victoria).

- Groundwater bores present at the site (MW4 to MW6) should be decommissioned in accordance with the requirements of "Minimum Construction Requirements for Water Bores in Australia", published by the Land and Water Biodiversity Committee, 2012.

- Removal and disposal of asbestos containing materials in the derelict house must be done by a removalist licensed by WorkSafe Victoria.

This Certificate forms part of environmental audit report Parsons Brinckerhoff, Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria, 2171147B-RTP-001 eastern, February 2013. Further details regarding the condition of the site may be found in the environmental audit report.

Dated: 21 February 2013

Signed: 

John Throssell

ENVIRONMENTAL AUDITOR

Glossary

Acronym	Definition
ANZECC	Australian & New Zealand Environment & Conservation Council
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CCME	Canadian Council of Ministers of the Environment
CoC	Chain-of-Custody
DCNR	Department of Conservation and Natural Resources
EIL	Ecological Investigation Level
EPA	Environment Protection Authority; Environmental Protection Agency
ESA	Environmental Site Assessment
GoV	Groundwaters of Victoria
HIL	Health-based Investigation Level
LOR	Limit of Reporting
mBGL	Metres Below Ground Level
mg/kg	Milligram per kilogram
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NSW EPA	New South Wales Environment Protection Authority
OCP	Organochlorine Pesticide
OPP	Organophosphorous Pesticide
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
SEPP	State Environment Protection Policy
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons

Executive summary

Mr John Throssell of Parsons Brinckerhoff Australia Pty Limited (Parsons Brinckerhoff), an Environmental Auditor (Contaminated Land) appointed pursuant to the Environment Protection Act 1970 (Section 53S, Part IXD), was requested by Waraplus Pty Ltd (Waraplus) on 10 April 2011 to undertake an Environmental Audit of the parcel of land known as the Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria (the site).

The site is currently vacant and Waraplus is proposing to develop the site for medium-density residential and commercial use. The Statutory Environmental Audit has been requested by the City of Casey Council as part of planning permit (P584/08) approval.

This report has been prepared in accordance with Section 53X of the Act and other Victorian Environment Protection Authority (EPA) guidelines and should be read in conjunction with the environmental assessment report prepared by Coffee Environments. Further details pertaining to the site are provided in **Table E.1** below.

Table E.1 Summary of Environmental Audit Information

EPA file reference number	69347-2
Auditor	John Throssell
Auditor term of appointment	8 August 2012 to 7 August 2014
Name of person requesting certificate	Gilbert Kerr of Waraplus
Relationship to site	Developer
Date of request	10 April 2011
Date EPA notified of audit	Initial notification on 19 April 2011. Notification that site was to be split into Eastern and Western Precinct on 23 February 2012.
Completion date of the audit	21 February 2013
Reason for Audit	Requirement of Planning Permit
Current land use zoning	R1Z
EPA Region	Southern Metro
Municipality	City of Casey
Dominant – Lot on title plan	Lot 2, PS540326F Lot 3, PS540326F Lot 1, TP336999B Lot 1, TP127746Y
Additional – Lot on title plan(s)	Not applicable
Site / Premises name	Amstel Golf Course – Eastern Precinct
Street / Lot – Upper No.	1016-1030
Street Name	Cranbourne-Frankston
Street type (road, court, etc)	Road
Suburb	Cranbourne
Postcode	3977

GIS Coordinate of Site centroid[1] **Longitude (GDA94)** **Latitude (GDA94)**	145.26070E 38.11168S
Site area (hectares)	5.7 ha
Members and categories of support team utilised	na
Outcome of the Audit	Certificate of Environmental Audit
Further work or requirements	na
Nature and extent of continuing risk	None.
Site aquifer information	Quaternary (Holocene) aged sedimentary lagoon, swamp and dune deposits overlying Tertiary aged Baxter Sandstone Aquifer comprising silty to sandy clays, commonly with sand and gravel units.
Average depth to groundwater	6.1m to 9.2mBGL
Groundwater segment	B
Groundwater flow direction	North west
Past use/site history	Current use: Part of the Amstel Golf Course including buffer land, practice fairway and bunkers, maintenance sheds and two water storage dams. Abandoned, derelict, house. Historic uses: farming land
Surrounding land use: **North:**	Cranbourne-Frankston Road also known as Sladen Street (RDZ1), on the other side of which is an educational facility (St Peter's College) and childcare centre (Future Kids) (both R1Z).
East:	Electricity easement with residential properties beyond.
South:	Amstel Golf Course (Farming zone - FZ2).
West:	Amstel Golf Course Western Precinct and Cranbourne-Frankston Road (RDZ1) beyond which is currently vacant land zone Urban Growth zone 1 (UGZ1; also covered by a Development Contributions Plan Overlay (DCPO12) for the Cranbourne West Precinct Structure Plan).
Proposed future use	Medium density residential and commercial use with buffer land.

[1] *Longitude and latitude (decimal degrees) co-ordinates in the 1994 Geocentric Datum of Australia (GDA94) is required to six decimal places*

1. Introduction

The site known as the Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria (**Figure 1, Appendix A**) has been the subject of a Statutory Environmental Audit (Audit), by an Auditor appointed by the Environmental Protection Authority of Victoria (EPA) under the *Environment Protection Act 1970* (the Act).

Waraplus Pty Ltd (Waraplus) intends to redevelop the site for medium density residual and commercial use. Site development is being managed by the Potter Group Pty Ltd on behalf of Waraplus. The Audit was requested by the City of Casey Council as a condition of the planning permit (**Appendix B**), in part due to the site being located within 1,000m of the Stevenson's Road Closed Landfill (**Figure 2, Appendix A**). Waraplus commissioned Mr. John Throssell of Parsons Brinckerhoff Australia Pty Limited (Parsons Brinckerhoff) to conduct a Statutory Environmental Audit. Coffey Environments Pty Ltd (Coffey) was engaged to conduct the environmental site assessment works in support of the Audit.

Waraplus are developing the whole northern margin of the Amsel Golf Course, which for the purposes of development has been divided into the Eastern and Western Precincts. This audit covers only the Eastern Precinct. The Western precinct was the subject of a separate environmental site assessment and audit (CARMS Ref. 69347-1) which was completed in April 2012.

This Audit has been undertaken in accordance with the *Environmental Auditor (Contaminated Land) Guidelines for Issue of Certificates and Statements of Environmental Audit,* EPA Publication 759.1, September 2007. Cognisance has also been given to the relevant State Environmental Protection Policies (SEPPs), waste management policies, guidelines and other relevant guidance documents.

1.1 The Audit process

The purpose of the Audit is to ensure that the site is suitable for the intended medium density residential and commercial use, and to also consider the suitability of the site for all beneficial uses.

Environmental Audits of contaminated land provide certification that a site is suitable for one or more uses. This certification is in the form of either a Certificate of Environmental Audit or a Statement of Environmental Audit. A certificate is issued if the contamination status of the site is not detrimental to any beneficial use of the site. A statement is issued where the contamination makes the site suitable for a restricted range of uses. In cases where statements are issued, they are generally conditional upon measures being taken to maintain the site as suitable for certain nominated uses. Further detail on the audit process and the limitations on the meaning and uses of audit reports are contained in the cover document titled "Information Regarding Environmental Audit Reports" EPA, September 2007 and the limitations outlined in Section 15 of this Audit report.

1.2 Documentation supporting this Audit

The Auditor relied upon investigation reports prepared for the site during the period August 2005 to December 2012 by Coffey. A review of the audit report completed for the Stevensons Road Landfill was also undertaken so the Auditor could familiarise himself with the geology, hydrogeology and potential offsite sources of contamination that may impact the audit site.

All the environmental assessment reports and information supporting this Audit are listed in **Table 1.1** below and the complete site reports are provided in **Appendices C to E**.

Additional documentation supporting the Audit is provided in **Appendices F and G**.

Table 1.1 List of investigation reports and documentation supporting this Audit

Date	Organisation (citation)	Title of document	Appendix
8 August 2005	Coffey Geosciences Pty Ltd (Coffey, 2005)	Stage 1 Environmental Site Assessment Amstel Golf Course, Cranbourne-Frankston Road, Cranbourne, E16663/1 AC. Report for Watson Pty Ltd.	Provided in Appendix N of Coffey (2012c) i.e. in Appendix E of this report.
20 August 2012	Coffey Environments Pty Ltd (Coffey, 2012a)	Hazadous Materials Report, Disused Land and Dilapidated Structures, 1030 Cranbourne-Frankston Road, Cranbourne, Victoria, ENAUABTF00207AA. Report for Waraplus Pty Ltd.	C
7 November 2012	Coffey Environments Pty Ltd (Coffey, 2012b)	CUTEP Report: Proposed Amstel Golf Course Development (Eastern Precinct) 1016-1030 Cranbourne-Frankston Road, Cranbourne, ENAUABTF00207AA-R09 Report for Waraplus Pty Ltd.	D
11 December 2012	Coffey Environments Pty Ltd (Coffey, 2012c)	Environmental Site Assessment Proposed Amstel Golf Course Development (Eastern Precinct) 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria, ENAUABTF00207AA. R09 Report for Waraplus Pty Ltd.	E
20 December 2012	Coffey Environments Pty Ltd (Coffey, 2012d)	RE: Amstel East: TP148 vs TP152	F
10 December 2012	EPA Victoria	CUTEP 1016-1030 Cranbourne-Frankston Road (CARMS 69347-2)	G

2. Site details

The site comprises an area of approximately 5.7 ha and is located approximately 40 km southeast of the Melbourne CBD, on the south western corner of the intersection of Cranbourne-Frankston Road and Sladen Street.

At the commencement of the Audit in April 2011, the site was part of the Amstel Golf Course and consisted of a practice fairway and bunkers, two dams used for water storage, an abandoned derelict house, and four golf course related buildings used for the storage of equipment. **Figures 1, 2 and 3 (Appendix A)** identify the site, including the Audited area.

A summary of relevant background information compiled from the investigation reports, referenced as part of this Audit, as well as the Auditors own observations regarding the site are provided in **Table 2.1** below.

Table 2.1 Summary of site details

Parameter	Detail
Site Address/Location:	Eastern Precinct, 1016-1030 Cranbourne-Frankston Road, Cranbourne, Victoria. Refer **Figures 1 to 3, Appendix A.**
Certificate of Title:	The site comprises: - Lot 2 on plan of subdivision PS540326F. The parent titles comprise Volume 10581, Folio 404. - Lot 1 on plan of subdivision TP336999B. The parent titles comprise Volume 10423, Folio 146. - Lot 3 on plan of subdivision PS540326F. The parent titles comprise Volume 10962, Folio 850. - Lot 1 on plan of subdivision TP127746Y. The parent titles comprise Volume 7763, Folio 098. Certificates of title are provided in **Appendix B**.
Site Area:	5.7 ha comprising: - Area 1 – 0.9 ha. - Area 2 – 2.04 ha. - Area 3 – 1.78 ha. - Buffer/easement areas: 0.98 ha.
Zoning:	Residential Zone RZ1
Topography:	The site and its surrounds are relatively flat with no significant topographical features.
Proposed Development:	Predominantly medium density residential and commercial use with buffer land. The Planning Permit and draft development plans are provided in **Appendix B.**

Parameter	Detail
Surrounding Land Uses:	The land-use surrounding the site is summarised as follows (see **Figure 2, Appendix A**): North - Cranbourne-Frankston Road also known as Sladen Street (RDZ1), on the other side of which is an educational facility (St Peter's College) and childcare centre (Future Kids) (both R1Z). East – Electricity easement with residential properties beyond. South – Amstel Golf Course (Farming zone - FZ2). West – Amstel Golf Course Western Precinct and Cranbourne-Frankston Road (RDZ1) beyond which is currently vacant land zone Urban Growth zone 1 (UGZ1) which has a Development Contributions Plan Overlay (DCPO12) for the Cranbourne West Precinct Structure Plan.
Site Condition at Commencement of Audit:	Part of the Amstel Golf Course including buffer land, practice fairway and bunkers, maintenance sheds, including septic tank and leach pad and two water storage dams. Abandoned, derelict, house.
Site Condition at Completion of Audit:	Unchanged from conditions at the time of the commencement of the audit, aside from the removal of the septic tank and leach pad.

2.1 Site history information

The site history review undertaken by Coffey for both precincts indicated that previously the site was primarily used for grazing (with two small buildings located on the Eastern Precinct likely to be farm houses) prior to the redevelopment of the site as a golf course in the late 1960s to early 1970s. The eastern precinct is the subject of a separate audit.

By 1970 the fairways, bunkers and the Amstel golf clubhouse were present on site and a large dam was present to the south of the site (within the golf course). By 1980 a large dam was present adjacent to the southern boundary of the site and by 1991 a dam was present on the western portion of the site.

2.2 Planning considerations

The site is currently zoned 'Residential Zone 1'. The site is proposed to be redeveloped for medium-high density residential use; the surrounding area contains a mixture of low density residential properties, farmland, commercial properties and reserves.

2.3 Review of nearby completed audit reports

The following summary (**Table 2.2**) is taken from the environmental site assessment report for the site (Coffey, 2012c), and has been verified by the Auditor.

Table 2.2 Summary of surrounding audits

Audit Site	CARMS Number	Auditor (Date)	Distance / Direction from the Audit Site	Summary of Findings
O'Tooles Road, Cranbourne	31521-1	Jonathan Crockett (1999) GHD	1220 m east	HISTORY: The audit site was formerly a council works depot. At the time of the audit, the site was being used by two mobile telephone providers. SOIL: Areas of hydrocarbon and low-level polychlorinated byphenyl (PCB) contamination were found. The City of Casey was to continue removing illegally-dumped waste on the site to prevent the occurrence of contamination from this dumped waste. GROUNDWATER: Minor petroleum hydrocarbon contamination is present but is understood to be attenuating. Groundwater was anticipated to be 4 to 17 m beneath the surface. Perched groundwater was at 1 to 3 m below natural surface. Groundwater flow direction was to the northwest. No Groundwater Segment classification was noted. AUDIT OUTCOME: There was no evidence of hydrocarbon contamination having migrated beyond the site boundary. There was no evidence of contamination remaining on the site that could compromise beneficial uses. Certificate of Environmental Audit issued.
150 Stevensons Road, Cranbourne	56450-1	Rick Graham (2005) SKM	1200 m southeast	HISTORY: The audit site was part of a chicken farm from 1960 until the early 1990s. During the 1990s the audit site was redeveloped into a horse stables and training facility. SOIL: Concentrations of manganese and nickel were found in excess of the NEPM EIL's for potential ecological impacts.

Audit Site	CARMS Number	Auditor (Date)	Distance / Direction from the Audit Site	Summary of Findings
				GROUNDWATER: No site groundwater investigation was required as part of this audit because no sources of potential groundwater contamination were identified on site and the potential off site sources (landfills) to the north were deemed unlikely to cause pollution on site. Groundwater flow direction was likely to be to the north or to the north-west. No Groundwater Segment classification was noted. AUDIT OUTCOME: The past use of the site and its current condition do not present a significant risk of contamination of surface waters or the air environment, nor did it contain any significant aesthetic impacts that would constrain the current or future site uses. Certificate of Environmental Audit issued.
Stevensons Road Landfill, Cranbourne 53V Groundwater Quality Audit		Anthony Lane (2009) Lane Piper	1000 m southeast	SOIL: No soil investigation was required as part of this audit. GROUNDWATER: Groundwater at the site was classified as Segment A1. Groundwater levels in the Brighton Group aquifer range from 69.5 mAHD in the southeast to 62 mAHD in the northwest Groundwater flow direction in the Brighton Group aquifer was likely to be to the northwest. Groundwater at the site was classified as Segment A1 with the corresponding beneficial uses (including Potable Water Supply) set out in the Groundwater SEPP. The groundwater beneficial uses of Maintenance of Ecosystems, Agriculture, Parks and Gardens and Industrial Water Use were not precluded at the site. The groundwater beneficial uses of Potable Water Supply and Primary Contact Recreation were precluded at the site by ammonia, chloride, iron, manganese, sodium, TDS and pH.

Audit Site	CARMS Number	Auditor (Date)	Distance / Direction from the Audit Site	Summary of Findings
				The groundwater beneficial use of Stock Watering was precluded at the site by ammonia, iron and TDS. Concentrations of ammonia and TDS measured in groundwater in the Brighton Group aquifer in off-site wells to the west of the site indicated there was little evidence of contaminated groundwater moving off-site in that direction. AUDIT OUTCOME: The risks to groundwater beneficial uses were unacceptable, largely due to the landfill being unlined and leachate within the landfill mounding above the surrounding watertable level and potentially discharging contaminated water into the groundwater off-site.
Stevensons Road Landfill, Cranbourne	53V 2010 Landfill Gas Audit	Anthony Lane (2011) Lane Piper	1000 m southeast	AUDIT OUTCOME: Using the methodology of risk prescribed by EPA, the risks to the beneficial uses of land due to landfill gas may be precluded although supplementary assessments indicate a lower risk of harm to users of land offsite than assessed via the EPA method. Air beneficial uses are precluded by LFG emanating from the former landfill site. Recommendations are made to further delineate and monitor LFG and assess the risk of gas accumulation in a typical house.

The Stevenson Road Landfill is potentially a source of groundwater and landfill gas impacts to the Audit site. During 2008, methane gas levels, derived from the breakdown of waste in the landfill, were found to be affecting residents in the nearby Brookland Greens estate. Since this time, mitigation measures have been undertaken by the City of Casey to contain and manage the methane leak. These measures have included; a new engineered landfill cap, significant upgrades to the gas and leachate extraction systems and the implementation of a deep trench wall.

Based upon the findings of recent groundwater and landfill gas audits conducted on the former landfill site, risks to the beneficial uses of air, land and groundwater were identified from contaminants emanating from the landfill site.

In order to manage these risks on 8 December 2010, an updated Pollution Abatement Notice (PAN) was issued by the EPA Victoria to the City of Casey. The PAN outlines the requirements for City of Casey to undertake in regards to the ongoing monitoring and upkeep of the closed landfill. Included in the PAN are requirements to; manage the gas and leachate release from the landfill, monitor gasses, groundwater, stormwater discharge and landfill flare emissions on- and off-site and to go through an annual review and adhere to the current Stevensons Road Landfill Management Plan. All of this is bound by stringent incident, compliance community engagement reporting across the life of the PAN.

Groundwater investigations undertaken in support of this audit considered the potential for groundwater impacts derived from the Stevenson Road site to impact the Amstel golf course development site.

2.4 Regional and site geology and hydrogeology

The Auditor has conducted a review of the regional and local site geology and hydrogeology, Based on the Geological Survey of Victoria Cranbourne Map (1:63,360) 1967, the DPI GeoVic website (See **Figure 4**, **Appendix A**), the DSE Water Resources Data Warehouse (See **Figure 5, Appendix A**), and the DCNR (1995), *Victoria Groundwater Beneficial Use Map Series*, *South Western Victoria* (1:250,000 scale), the regional and site geology and hydrogeology of the area is summarised in **Table 2.3** below.

Table 2.3 Regional and site geology and hydrogeology

Age	Unit	Geological description	Hydrogeological information*
Water table aquifer investigated as part of this audit			
Quaternary (Pleistocene - Holocene)	Quaternary Sands	**Regional:** Aeolian siliceous sand dune and sheet deposits including the Cranbourne Sand as well as non-marine swamp deposits of peats, silts and clays. **Site:** Based on the geological map, the Quaternary Sands are not present on site, however, the soil bore and test pit logs indicate well sorted loose sands of up to 2.4m thick in some locations. These may represent a thin veneer of Quaternary Sands and swamp deposits or unconsolidated sediments of the older Tertiary aged Baxter Sandstone Formation. If present on site, this lithology is likely to have been reworked during the landscaping of the golf course.	Where present together, the Baxter Formation and Quaternary Sands, may be connected and act as a single regional water table ("inter-granular porosity aquifer" type). Site information (Jan 2012): SWL (mBTOC): 6.6 (MW2) to 9.7 (MW5) SWL (mAHD): 45.1 (MW4) T0 50.9 (MW5) Hydraulic gradient (between MW4 and MW5): 0.030 Sandy clay aquifer effective porosity: 0.4 to 0.7 (Freeze & Cherry, 1979) Hydraulic conductivity: 0.001-0.1m/day Seepage velocity: 0.016 to 2.7m/day Groundwater flow direction: north west toward Patterson River (~9km northwest of the site)
Cainozoic (Upper Tertiary)	Brighton Group	**Regional:** Fluvial Baxter Sandstone Formation. Sandstone, conglomerate, siltstone, ironstone. **Site:** The geological map indicates this formation is present on the eastern portion of the site. Given the sandy and clayey nature of the formation it is difficult to differentiate between the Baxter Sandstone Formation and the younger Quaternary Sands and swamp deposits. Intrusive investigations on site indicate interbedded sands, clayey sands, and sandy clays to a maximum depth of approximately 12.8 mBGL.	

Age	Unit	Geological description	Hydrogeological information*
Aquifers not investigated as part of this audit			
Cainozoic (Lower Tertiary)	Older Volcanics (OV)	**Regional:** Basalt lava flow from volcanic eruptions (Tertiary). Fractured rock and clays (weathered basalt). Most likely an aquitard. **Site:** Three groundwater monitoring wells (MW2 – Western Precinct and MW4 and MW6 – Eastern Precinct) reported the presence of basalt (either as fragments or rock), while many investigation locations recorded dense residual clays representing highly weathered basalt. Basalt was reported between 6.5 and 12.2mBGL (the maximum limit of investigations). Hard rock was also identified at the limit of investigation at location LFG1.	Forms a local confined "fractured rock aquifer" type in the region but more likely an aquitard in the area.
Cainozoic (Lower Tertiary)	Werribee Formation	**Regional:** Terrestrial – coarse alluvial, fluvial and fine lacustrine deposits including peat, wood, and coal seams (Lower Tertiary). Significant hiatus prior to Silurian Bedrock deposition **Site:** The depth limit of field investigations did not intersect the Werribee Formation.	Forms a regional confined "inter-granular porosity aquifer" type.
Palaeozoic	Silurian Bedrock (Murrindindi Supergroup)	**Regional:** Marine Sedimentary Bedrock (Middle Palaeozoic). Fractured rock (mainly siltstone) and saprolite. **Site:** The depth limit of field investigations did not intersect the Silurian bedrock.	Forms a regional confined "fractured rock aquifer" type which is unconfined in areas of outcrop.

Note:

*Source: Leonard (1992)

A summary of groundwater quality parameters collected at the site by Coffey (September 2011 to August, 2012; including well MW2 located on the Western Precinct) is provided in **Table 2.4** below.

Table 2.4 Site groundwater quality parameters

Parameter	Range	Comment
Dissolved oxygen (DO) mg/L	0.39 to 3.94	Neutral conditions
Redox Potential (Eh) mV	112 to 240	Neutral to mildly oxidising conditions
Electrical conductivity (EC) µS/cm	628 to 11,330	See TDS comments below
Total Dissolved Solids (TDS) mg/L	Regional: Victorian Groundwater Beneficial Use Map (DCNR, 1995) indicates that the water table beneath the site is likely to have a salinity range between 1,001 mg/L – 3,500 mg/L total dissolved solids (TDS) Lab: 410 to 7,200 Field calculation (EC *0.65): 408 to 7,365	Regional groundwater salinity data would suggest that groundwater beneath the site should fall into Segment B according to the SEPP Groundwaters of Victoria (1997). TDS values in the range 410 mg/L to 460 mg/L were reported for well MW6 which is located adjacent to a large dam and fresh water infiltration from that dam is probable, thereby lowering the TDS concentration. Therefore based on a TDS range of 1,100mg/L to 7,200mg/L in the remaining wells, it is considered that groundwater beneath the site falls under Segment B
pH	5.64 to 8.28	Weakly acidic to basic
Temperature (°C)	15.0 to 17.3	-

The Auditor has verified the above information and has found it to be generally consistent with geological and hydrogeological maps for the area and observed site conditions.

2.5 Review of Victorian groundwater database

A search of the Victorian Water Resources Data Warehouse was undertaken by Coffey in 2005 (**Appendix E**). A search conducted by the Auditor in February 2012 reported approximately 81 registered bores within a 2 km radius of the site (**Figure 5, Appendix A**). Of these 40 are known to have been stock, domestic or stock and domestic bores (approximately 14 of which could be considered to be down hydraulic gradient of the site), 3 are irrigation bores and the rest are either observation or investigation bores, or bores of unknown use. It is noted that two registered bores appear to be present on the Western Precinct site and one located immediately south of the site. The two onsite bores (Bore 76297 and Bore 133339) are both irrigation bores and Bore 76253 has an unknown use. The current status (use) of the registered bores is unknown and the two onsite bores have not been found during field investigations.

The registered bore depths varied from 6mBGL to 93mBGL and the TDS concentrations ranged from 128 to 768mg/L. The Auditor notes that the range of bore depths indicates the likelihood that groundwater from the bedrock (Silurian aged mudstone) and the overlying Werribee Formation (Tertiary aged sandstone and mudstone) aquifers has been utilised for various purposes.

2.6 Topography and surface water

The site is located at the head of the Morning Peninsula on the north western side of a surface watershed between Port Phillip Bay to the northwest and Western Port Bay to the south east. Regionally the area slopes to the northwest towards Port Phillip Bay from approximately 66mAHD on the south eastern corner of the golf course to approximately 50mAHD on the north western corner of the golf course. The local high point is located approximately 2km south east of the site in the Cranbourne Botanical Gardens at a height of 101mAHD.

The site topography is flat with a gentle slope to the northwest. Based on site plans provided by the client (contained in Coffey, 2012c; Appendix O), the Eastern Precinct elevation ranges between approximately 51 mAHD to 62mAHD. The Eastern Precinct is dominated by a golf practice fairway, with the lower lying areas of the site being swampy indicating poor drainage.

Rodds Drain is the local drainage line from south of the Former Stevensons Road Landfills, north westerly through the Brookland Greens Estate, through the southern portion of the golf course (where one of the golf course dams may capture some of the flow) and onward into paddocks on the western side of the Cranbourne-Frankston Road and then north along Evans Road.

One large dam (probably partly manmade and used for supplying water to the golf course) occupied the southeastern corner of the Easter Precinct, with a small dam located to the north of the large dam. Three dams are located on the neighbouring Western precinct - a small (probably party manmade) dam/swamp in Stage 3 and 4 area, a larger dam located 150m south of the Stage 2 area and an elongate dam located less than 40m form the southernmost extent of the Stage 3 and 4 area.

Surface water from the site appears to drain to the northwest via surface drains such as Rodds Drain and ultimately discharges to Port Phillip Bay.

3. Potential sources of contamination

3.1 On-site sources

Based on the site history provided by Coffey and the Auditor's review of site activities, potential on site sources of contamination may include:

- Pesticide, herbicide and fertiliser use associated with past farming practices or the upkeep of the golf course;
- Nutrient impacts from sewage disposal to septic tank systems.
- Fuel (petroleum products) use and storage on site associated with either farming practices or maintenance of the golf course; and
- The importation of potentially contaminated fill, particularly during the development and landscaping of the golf course.

3.2 Off-site sources

The past uses of the surrounding land were predominantly farming. However quarrying (sand and aggregate) activities have also taken place to the south and east of the site (see **Figure 2, Appendix A**). **Table 3.1** below is a summary of the surrounding land uses, whether they are up or down hydraulic gradient of the site and whether they have the potential to be a source or receptor of contamination.

Table 3.1 Summary of surrounding land uses

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
The site		R1Z	Residential	The site	▪ Herbicides, pesticides (including organochlorine pesticides -OCPs, organophosphorous pesticides - OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous, potassium) ▪ Petroleum products
		DPO	Development plan overlay along Cranbourne-Frankston Road		
North (down hydraulic gradient)	adjacent	RDZ1 – road	Cranbourne-Frankston Road (becomes Sladen Street approximately 400m to the northeast of the site)	Source	▪ Fuels (polyaromatic hydrocarbons - PAHs, total petroleum hydrocarbons - TPHs, benzene, toluene, ethylbenzene and xylenes - BTEXs) ▪ Chlorinated hydrocarbons
Northwest (across or down hydraulic gradient)	100m	PPRZ-public park and recreation	St Peter's College	Receptor	▪ Fuels (PAHs, TPHs, BTEXs) from potential presence of maintenance facilities
	150m	R1Z - residential	Residential properties, child care facility (Future Kids Childcare & Kindergarten Cranbourne Central	Receptor	
East (up and/or across hydraulic gradient)	Adjacent	R1Z - residential	High voltage power line easement, Brookland Greens Estate	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
East	Beyond Stevensons Road Landfills	PPRZ-public park and recreation	Cranbourne Racecourse and Recreational Reserve	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
Southeast (up and/or across hydraulic gradient)	830m	FZ2 - farming	Former Casey Landfill - originally a sand/gravel quarry (LIC837) from 1968 to 1996. Then a municipal landfill (under Work Authority WA465) from 1996 to 2001. Northern portion of Landfill is currently used as a Transfer Station.	Source	Various including: ▪ Methane ▪ Hydrocarbons ▪ Metals ▪ Nutrients ▪ OCPs/OPPs
Southeast (up and/or across hydraulic gradient)			Former Casey-Frankston Landfill - original a sand/gravel quarry (LIC837) up until 1996. Then a municipal landfill (under Work Authority WA465) from 1996 to 2005.	Source	

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
Southeast (up and/or across hydraulic gradient)	1,220m	PPRZ-public park and recreation	EL1065 & WA1203 Former sand/gravel quarry (under Work Authority WA1203) from 2003 -2009. Unclear if the site was quarried and if so how the void was filled. Currently sports ground.	Source	▪ Unknown
Southeast (up and/or across hydraulic gradient)	750m	LDRZ- low density residential	Currently horse agistment paddocks	Source	▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Fuels (PAHs, TPHs, BTEXs)
South (up hydraulic gradient)	Adjacent	FZ2 - farming	Amstel golf course	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
South (up hydraulic gradient)	400m	R1Z - residential	Residential properties	Source	
South (up hydraulic gradient)	800m	R1Z - residential	Ballarto Road	Source	▪ Fuels (PAHs, TPHs, BTEXs)
South (up hydraulic gradient)	Over Ballarto Road	PCRZ-public conservation & resource	Cranbourne Royal Botanical gardens	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Fuels (PAHs, TPHs, BTEXs)
South (up hydraulic gradient)	1,570m	FZ2 - farming	LIC730 & WA441 Sand/gravel quarry	Source	▪ Fuels (PAHs, TPHs, BTEXs)
West	Adjacent	FZ2 - farming	Amstel golf course clubhouse	Source/ Receptor	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Chlorinated hydrocarbons
	60m	R1Z - residential	Western Precinct Containing a septic system and areas where fuels were used and stored.	Source/Receptor	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous) ▪ Chlorinated hydrocarbons ▪ Fuels (TPHs, PAHs, BTEX)

Direction	Distance from site	Zoning	Description	Source or Receptor	Potential contaminants of concern
West and northwest (across or down hydraulic gradient)	600	RDZ1 - road	Cranbourne-Frankston Road	Source/ Receptor	▪ Fuels (PAHs, TPHs, BTEXs)
West and northwest (across or down hydraulic gradient)	600m	UGZ-urban growth	Currently vacant farm land	Source/ Receptor	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
Southwest (up hydraulic gradient)	800m	GWZ6 – green wedge schedule 6	Currently vacant farm land	Source	▪ Herbicides, pesticides (including OCPs, OPPs, arsenic) ▪ Fertilisers (ammonia, nitrate, nitrite, phosphorous)
Southwest (up hydraulic gradient)	1,840m	GWZ6 – green wedge schedule 6	LIC 1450 & WA121 Sand/gravel quarry	Source	▪ Fuels (PAHs, TPHs, BTEXs)

3.3 Potential receptors

Based on the analysis provided in **Table 3.1** above, potential receptors to contamination that may be emanating from the site are listed below.

- Current and future users/occupants of the site.
- Onsite and immediately offsite surface water bodies.
- Rodds Drain and any surrounding natural waterways located offsite to the west and northwest.
- Residential properties located offsite to the east.
- School and child care facilities to the north (down hydraulic gradient) of the site.
- Groundwater beneath the site and in the vicinity of the site that may be used of domestic, stock or irrigation purposes.
- Local vegetation both on and off site.

3.4 Contaminants of potential concern

The following contaminants may be present based on the knowledge of current and past activities undertaken at and in the vicinity of the site.

- Herbicides, pesticides (including OCPs, OPPs, arsenic).
- Fertilisers (ammonia, nitrate, nitrite, phosphorous, potassium and trace metals) associated with past farming practices and golf course application.
- Chlorinated hydrocarbons associated with maintenance of farm or golf course machinery (tractor, mowers) (chlorobenzene, chloromethane, trichloroethene).
- Fuels associated with farm or golf course machinery and cars (PAH, TPH, BTEX, phenols).
- Other hydrocarbons such as PAH, phenolic compounds possibly associated with imported fill.
- Metals (arsenic, chromium, copper, lead, mercury, tin, zinc) associated with imported fill.
- Methane associated with the former Stevensons Road Landfill.

3.5 Potential for groundwater impact

As noted in **Table 3.1** above, there are a number of potential off-site sources of groundwater contamination. The septic system associated with the maintenance shed located to the west of the main dam was identified as a potential onsite source of groundwater impacts. In addition, a number of potentially contaminating activities were considered including; importation of fill; use and/or disposal of pesticides, herbicides, fertilisers; former buildings and structures.

4. Protected beneficial uses

4.1 Beneficial uses of land

With respect to the environment, the SEPP- Prevention and Management of Contamination of Land (Land SEPP) identifies the following beneficial uses that would need to be protected for unrestricted use of the site (i.e. Certificate of Environmental Audit). **Table 4.1** below identifies the beneficial uses of land.

Table 4.1 Protected beneficial uses of land

Beneficial use	Land use						
			Sensitive use				
	Parks & Reserves	Agriculture	High-density	Other	Recreation/ Open space	Commercial	Industrial
Maintenance of ecosystems							
Natural ecosystems	✓						
Modified ecosystems	✓	✓	✓	✓	✓		
Highly modified ecosystems		✓	✓	✓	✓	✓	✓
Human health	✓	✓	✓	✓	✓	✓	✓
Buildings & structures	✓	✓	✓	✓	✓	✓	✓
Aesthetics	✓	✓	✓	✓	✓	✓	
Production of food and flora	✓	✓		✓			

Notes:

1. The above table is a reproduction of Table 1 from the Land SEPP (June, 2002).
2. Shading denotes the beneficial uses required to be protected for the purpose of the proposed development.

The Auditor notes that in accordance with the Land SEPP, the proposed development (medium to high density residential) is classified as a sensitive land use (other).Therefore beneficial uses that must be protected include; maintenance of modified and highly modified ecosystems, human health, buildings & structures, aesthetics and production of food, flora and fibre. Maintenance of natural ecosystems is not required to be protected for the proposed development however; cognisance is given to this beneficial use in order to consider unrestricted use of the site.

4.2 Beneficial uses of groundwater

The protected beneficial uses of groundwater are defined in the SEPP *Groundwaters of Victoria* (1997) (Groundwater SEPP), by the inherent capacity of the groundwater (i.e.TDS concentrations) at the site to support specific uses.

TDS values in the range 410 mg/L to 460 mg/L were reported for well MW6 which is located adjacent to a large dam and fresh water infiltration from that dam is probable, thereby lowering the TDS concentration. Therefore based on a TDS range of 1,100mg/L to 7,200mg/L in the remaining wells, it is considered that groundwater beneath the site falls under Segment B. Based on the salinity of the groundwater, the beneficial uses protected under the Groundwater SEPP are summarised in **Table 4.2** below.

Table 4.2 Protected beneficial uses of groundwater

Beneficial Uses	Segments (mg/L) TDS				
	A1 (0-500)	A2 (501-1,000)	B (1,001 – 3,500)	C (3,501-13,000)	D (greater than 13,000)
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply					
▪ Desirable	✓				
▪ Acceptable		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks and gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation (e.g. bathing, swimming)	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

Notes:

1. The above table is a reproduction of Table 2 from the SEPP GoV (1997).
2. Shading denotes the required beneficial uses to be protected under Segment B.

The beneficial uses to be protected for Segment B groundwater, and the likelihood of each beneficial use being realised both on-site and off-site, is summarised in **Table 4.3** below.

Table 4.3 Relevance of protected beneficial uses of groundwater

Protected Beneficial Use	Relevance On-site	Relevance Off-site
Maintenance of ecosystems	**Not relevant** No on-site aquatic ecosystem likely to receive groundwater. Perched water beneath the neighbouring Western Precinct site is likely to be localised and ephemeral (given it was not identified beneath the Easter Precinct) however perched water may feed water bodies on and near the site seasonally.	**Existing** Rodd's Drain located approximately 80m west of the site which drains into Eumemmerring Creek/Patterson River (approximately 9km northwest of the site) and ultimately to Port Phillip Bay 10km north west of the site. The water table is considered to be well below the invert of Rodd's Drain, as such it is not a "gaining stream" in the vicinity of the site.
Potable mineral water supply	**Not relevant** Site is not in a mineral spring district.	**Not relevant** Site is not in a mineral spring district.
Stock watering	**Unlikely** No evidence of stock grazing under existing use. A medium density residential /commercial development is proposed for the site.	**Possible** There are a number of stock and/or domestic groundwater bores registered with a 2km radius of the site. Therefore there is potential for groundwater to be used in this way. However, given the increasing urbanisation of the area, the abstraction of groundwater for stock watering purposes is considered increasingly unlikely in the future.
Industrial use	**Not relevant** Not consistent with local zoning and the site is being redeveloped for medium density residential/commercial purposes.	**Unlikely** It is considered that a reticulated water supply would be available for this area of Melbourne. Yields of the superficial aquifer are unlikely to sustain an industrial scale water supply.
Agriculture, parks and gardens	**Possible** There are two irrigation bores registered on the Western Precinct. It is noted however, that these bores where not found during extensive site works and may no longer exist. Future use of groundwater for irrigation of open space areas is possible.	**Possible** One registered irrigation bore was identified within a 2km radius of the site, although the specific use of numerous bores was not specified. Therefore there is potential for groundwater to be used for irrigation purposes.
Primary contact recreation	**Possible** There is potential for the use of groundwater to fill swimming pools or spas at the site under the proposed residential development scheme, although the availability of reticulated scheme water makes this scenario less likely.	**Possible** There is potential for the use of groundwater to fill swimming pools or spas within the surrounding area.
Buildings & structures	**Unlikely** Development likely to comprise slab on ground construction. Groundwater beneath the site is located between 6.1-8.8 mBGL and is therefore unlikely to impact on underground services or building structures.	**Unlikely** Based on the depth to the local groundwater system to range between 6.1-8.8 mBGL.

4.3 Beneficial uses of surface water

Beneficial uses of surface water that need to be protected are considered to be those associated with freshwater ecosystems, as specified in the SEPP *Waters of Victoria* (2003). The site is located within the cleared hills and coastal plains segment for which the following beneficial uses are protected:

- Slightly to moderately modified ecosystems.
- Primary and secondary contact recreation and aesthetic enjoyment.
- Indigenous and non-indigenous cultural and spiritual values.
- Agriculture and irrigation.
- Aquaculture, human consumption after appropriate treatment and fish, crustacean and molluscs for human consumption.
- Industrial and commercial use.

The Auditor notes that there are no natural onsite surface water bodies likely to receive groundwater, and surface water in the area appears to drain to Rodds Drain (a highly modified channel drain) and ultimately Eumemmerring Creek/Patterson's River. Therefore the most relevant beneficial uses of surface water are likely to be: maintenance of ecosystems; agriculture and irrigation; and primary and secondary contact recreation and aesthetic enjoyment.

5. Site conceptual hydrogeological model

The preceding sections describe the Audited site, the local and regional geology and hydrogeology, potential sources of contamination identified on the site as well as from off-site sources. Also described are the beneficial uses of the land and groundwater as they apply to the site and its surrounds. In combination, this information can be used to describe the source – pathway – receptor relationship for exposure to potential contaminants of concern.

A generalised cross section (adapted from Coffey (2012) showing groundwater and geological information taken from both the Western and Eastern Precincts) and site conceptual model are presented on **Figures 6 and 10 (Appendix A)**.

The potential sources of contamination identified at the site by Coffey include:

- The use and storage of fertilisers, chemicals and fuels associated with the upkeep of the golf course and the machinery storage.
- The septic tank and soak at the maintenance shed located to the west of the main dam.

Off-site sources of impact to the development site include;

- Maintenance of greens and fairways of the Amstel Golf Course.
- Current and historical quarrying activities to the south and southeast.
- The Cranbourne landfill to the southeast.

The main exposure pathways to potential on-site impacts include:

- Direct contact with or ingestion of shallow soils.
- Direct contact with or ingestion of groundwater.
- Inhalation of vapours sourced from impacts in soil or groundwater.

Groundwater is present at 6.1 to 8.8 mBGL within clayey sediments. A tributary of Rodd's Drain is located approximately 320 m west of the site, however based on the depth to groundwater, and the shallow nature of the tributary of the drain (likely to be incised to less than 1 m below the land surface), groundwater discharge into this feature is unlikely. This tributary eventually joins Rodd's Drain proper approximately 1,040 m of the site prior to discharging into Eumemmerring Creek/Patterson River approximately 9 km northwest of the site. Eumemmerring Creek/Patterson River is therefore considered to be the likely receiving water body for groundwater beneath the site.

On the basis of the above, in the scenario where the site is considered to be a source of impacts, exposure of off-site receptors to site-sourced impacts is likely to be via groundwater flow in a north westerly direction.

Exposure to off-site sources of impact is considered to be largely associated with migration of contaminated groundwater onto the site from sources to the south and southeast. Potential groundwater impacts sourced from the Cranbourne Landfill are considered to be nutrients, metals and landfill gasses.

6. Soil screening criteria

With respect to assessing the contamination status of soil at the site, the hierarchy (consistent with the objectives presented in Table 2 of the Land SEPP) of investigation criteria adopted for this audit are detailed in **Section 6.1 and Section 6.2** below**. Table 6.1** summarises the criteria adopted (including alternative criteria) to assess the site's suitability for unrestricted use (i.e. Certificate of Environmental Audit).

6.1 Ecological/Environmental

The following guidelines were adopted by Coffey and/or the Auditor to assess the impact on the local environment:

- NEPM Ecological Investigation Levels (interim Urban): NEPM-EIL.
- ANZECC 1992 – Investigation 'B' levels for dieldrin.
- New South Wales EPA Service Station Criteria for BTEX and TPH.
- Dutch 2000 (Target Levels) in the absence of NEPM EILs and ANZECC B levels for total PAHs and phenol.
- Canadian Soil Quality Guidelines (CCME, 2007) for the protection of Environmental Health - Agricultural, for benzo[a]pyrene.

6.2 Human health

In accordance with the Land SEPP, the proposed development is defined as sensitive use (other) and includes medium density residential use. The Auditor notes that in evaluating the potential impact to the protection of human health in the context of unrestricted site use, the NEPM standard residential (exposure setting A) criteria were adopted. As such, the following guidelines were adopted to assess the impact on the beneficial use human health:

- NEPM Health Investigation Levels (HIL) A: Standard residential use setting with substantial access to soils.
- NSW EPA Guidelines for Service Station Sites – for sensitive land use (where no NEPM criteria are available (i.e. BTEX and TPH).
- CRC CARE Technical Report No. 10. September 2011. Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater by E. Friebel & P. Nadebaum (i.e. BTEX, TPH) for sand and low density residential use.

6.3 Buildings and structures

The Land SEPP states that "*contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or buildings materials".* Where structures are likely to come into contact with extreme soils, criteria for pH, chloride and sulphate can be adopted from the Piling Code, AS 2159-2009.

6.4 Aesthetics

The Land SEPP currently states that "*contamination must not cause the land to be offensive to the senses of human beings".* Currently there are no concentration based aesthetic criteria for soil however, while aesthetic observations are subjective, it is considered that if there is discolouration or noticeable odours from the soil, or if waste materials such as rubble, slag or similar wastes are present, then a potential aesthetic concern exists.

6.5 Production of food, flora and fibre

The Land SEPP states that "*contamination must not adversely affect the produce quality or yield or effect the level of any indicator in food, flora and fibre produced at the site (or that may be produced), such that the level of the indicator is greater than that specified by the Australia New Zealand Food Authority, Food Standards Code".*

In consideration of the above, the Auditor has primarily assessed the protection of the beneficial use: *Production of food, flora and fibre* with reference to the phytotoxicity based interim urban EILs (NEPM, 1999).

The soil criteria adopted by Coffey were considered appropriate to make an assessment of the potential impact to the beneficial uses of the site. The Auditor has also considered alternate criteria, where appropriate, in assessing the results and potential impacts to beneficial uses. **Table 6.1** below lists the criteria adopted.

Table 6.1 Adopted soil assessment criteria

Analyte	Maintenance of Ecosystems [A] (mg/kg)	Protection of Human Health – Standard Residential/ Sensitive Use [F] (mg/kg)	Protection of Buildings & Structures (mg/kg)
Primary adopted investigation reference	**NEPM (1999) EILs**	**NEPM (1999) – HIL-A**	**AS2159 (2009)**
Arsenic	20	100	-
Barium	300	-	-
Cadmium	3	20	-
Chromium (III)	400	120,000	
Chromium (VI)	1	100	
Chromium (total)	50[B]	-	-
Copper	100	1,000	-
Lead	600	300	-
Mercury (inorganic)	1	15	-
Nickel	60	600	-
Vanadium	50	-	-
Zinc	200	7,000	-
Nitrate (as N)	-	-	-
Nitrite (as N)	-	-	-
Total nitrogen	-	-	-
Benzene	1[D]	1[D] / 0.5[I]	-

Analyte	Maintenance of Ecosystems [A] (mg/kg)	Protection of Human Health – Standard Residential/ Sensitive Use [F] (mg/kg)	Protection of Buildings & Structures (mg/kg)
Toluene	1.4[D]	130[D] / 160[I]	-
Ethyl benzene	3.1[D]	50[D] / 57[I]	-
Total xylenes	14[D]	25[D] / 40[I]	-
Benzo[a]pyrene	0.1[C]	1	-
Total PAHs	1[E]	20	-
Phenol	0.05[E]	8,500	-
TPH C_6-C_9	65[D]	65[D] / 44[I]	-
TPH >C_9	1,000[D]	1,000[D]	-
TPH >C_{10}-C_{16}	-	110[I]	
TPH >C_{16}-C_{34}	-	4,500[I]	
TPH >C_{24}-C_{40}	-	6,300[I]	
Aldrin + Dieldrin	0.2 (dieldrin)[B]	10	-
Chlordane	–	50	-
DDT + DDD + DDE	–	200	-
Heptachlor	–	10	-
Chlorinated hydrocarons	-	-	-
Sulphate	–	–	2,000[G]
pH	–	–	>4.5[H]

Notes:

'-'denotes no investigation level available.

A. NEPM Schedule B (1) (NEPC 1999) Ecological Investigation Levels (EILs) – Interim EILs for urban setting – unless otherwise specified.

B. ANZECC B adopted in the absence of NEPM EILs.

C. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Canadian Council of Ministers of the Environment (CCME) 2007 (protection of Environmental Health – Agricultural), adopted in the absence of NEPM EIL or ANZECC B levels.

D. NSW EPA (1994) Guidelines for Assessing Service Station Sites.

E. Dutch 2000 (Target Value) adopted in the absence of NEPM EIL and ANZECC B levels. Target level for PAH is for PAH (sum of 10) i.e. the total of anthracene, benzo(a)anthracene, benzo(k)fluoroanthene, benzo(a)pyrene, chrysene, phenantrene, fluoroanthene, indeno(1,2,3-cd)pyrene, naphthalene and benzo(ghi)perylene.

F. NEPM Schedule B (1) (NEPC 1999) Health investigation Levels (HILs) (A) – Standard Residential/sensitive use – unless otherwise specified.

G. NEPM Schedule B (1) (NEPC 1999) – Interim Urban for protection of built structures.

H. AS2159 (2009) – Piling Design and installation: Severe to very severe soil exposure conditions for concrete piling.

I. CRC CARE Technical report No. 10. September 2011. Health Screening levels for petroleum hydrocarbons in soil and groundwater by E. Friebel & P. Nadebaum: Soil HSLs for low density residential use; vapour intrusion, 0 to <1mBGL in sandy soil and direct contact (most conservative value adopted for screening purposes).

7. Groundwater screening criteria

With respect to assessing the contamination status of groundwater at the site, the hierarchy (consistent with the objectives presented in Table 2 of the Groundwater SEPP) of investigation criteria adopted for the protection of all applicable groundwater beneficial uses (as detailed in **Section 4.2**) are presented in **Sections 7.1 to 7.6** below.

Table 7.1 summarises the criteria adopted (including alternative criteria) to determine the condition of groundwater beneath the site and assess the site's suitability with respect to each applicable groundwater beneficial use. The Auditor notes that in some instances alternative criteria have not been adopted in the Coffey ESA report. Therefore the findings and conclusions regarding the contamination status of groundwater beneath the site, as detailed in the Coffey ESA report, may vary slightly to those identified by the Auditor.

7.1 Maintenance of ecosystems

The following guidelines were adopted by Coffey and the Auditor to assess the impact on the beneficial use *Maintenance of Ecosystems*:

- ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 95% Level of Protection.*
- SEPP (2003) *Waters of Victoria.*

7.2 Stock watering

The primary reference adopted for assessing impacts to the beneficial use *Stock Watering* is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Water* – Livestock Criteria. For organic analytes the ANZECC (1992) Raw Water for Drinking Purposes criteria have been adopted. The secondary reference adopted was ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Water* – Livestock Drinking Water Criteria.

7.3 Agriculture, parks and gardens

The primary reference adopted for assessing impacts to the beneficial use *Agriculture, parks and gardens* is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Water* – Irrigation Criteria. The secondary reference adopted was ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Water* – Agricultural Irrigation Water (short term use) Criteria.

7.4 Industrial water use

The ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters* - Industrial Use, provide various water quality parameters in relation to heating and cooling processes and power generation. Given that the criteria detailed in Chapter 6 of the ANZECC (1992) guidelines are highly specific to the type of industry process, criteria for industrial water use have not been included in **Table 7.1** below. For the purpose of this Audit, it has been assumed that the criteria for 'primary contact recreation' would be adequately protective of people who may encounter the groundwater at this site in most industrial scenarios.

7.5 Primary contact recreation

The primary reference adopted is the ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters* – Recreational Water Quality and Aesthetics. This reverts to the ANZECC (1992) Raw Water for Drinking Purposes criteria for organic analytes.

7.6 Buildings and structures

The Groundwater SEPP states that "*introduced contaminants shall not cause groundwater to become corrosive to structures or building materials*". Currently there are no available concentration based criteria for groundwater. However, field based measurements including pH, redox and sulphate analytical results have been used to assess for the presence of any extreme conditions (i.e. acidity) that may have the potential to impact on buildings and structures. In addition, where any buildings or structures may come into contact with groundwater, criteria for pH, chloride and sulphate can be adopted from Australian Standard AS2159-2009 *Piling Design and Installation*