EXECUTIVE SUMMARY

COOCHIEMUDLO ISLAND FORMER LANDFILL

The Coochiemudlo Island former landfill site was operated for a period of 22 years between 1972 and 1994. It is estimated the site may have received up to 5,000 m^3 of waste during this period. On completion of landfilling operations, the site was levelled and a permeable soil cover applied across the site. The site is currently used as a waste transfer station and public recreational and sporting facilities.

The assessment undertaken at the Coochiemudlo Island former landfill site over the period between January 2001 to December 2001 has not identified any current significant environmental impact as a result of former landfilling practices.

The most notable impact is that on groundwater quality, with sampling results for downgradient monitoring wells identifying potential minor leachate impaction (although the influence of the wetlands immediately downgradient of the site could not be quantified during this study). Current concentrations do not suggest the need for any immediate remedial actions at this point in time.

Landfill gas monitoring indicates that migration of landfill gas from the site is minimal, and currently unlikely to be an environmental or human health concern. This is confirmed through the absence of any vegetation dieback, which is a typical indicator of methane release from a site. It is noted, however, that gas is migrating from the landfill (albeit at extremely low concentrations), and as such the possibility of accumulation within site structures, etc must be considered during any future work undertaken at the site. Routine monitoring would be considered prudent as a means of establishing long term trends and identifying any potential risk.

The site capping layer consists of a clayey sand/sandy clay material approximately 0.4 to 1.0 m in depth. The observed thicknesses indicate that the capping over some areas of the landfill is marginally less than the EPA guideline of 0.5 m.

Laboratory analysis found only minor concentrations of heavy metals in soil samples collected from the capping. All heavy metals results, with the exception of a marginally elevated zinc concentration, were below the adopted environmental investigation thresholds. No OC/OP pesticides, TPH compounds or phenols were detected in the samples.

Field density and moisture content testing was undertaken at two locations. Dry density ratios of marginally over 100% and 84.5% were recorded at these locations. A dry density ratio of 95% is generally considered to be sufficient to minimise infiltration of stormwater to refuse. The results indicate that the level of compaction of the capping layer varies across the site and is likely to be insufficient at some locations. Laboratory permeability testing results indicated the capping material had a potential coefficient of permeability of 6.0×10^{-10} m/s (ie, remoulded in the laboratory). The result complied with the typical guideline of a maximum of 1×10^{-7} m/s.

It is considered that, based on the short to mid term trends in contaminant concentrations (water quality, gas, etc), the site is suitable for it's current usage as a sporting facility, with minimal risk to site users as a result of the former landfilling practices.

Pages 2 through 5 redacted for the following reasons:
- -
Irrelevant Information

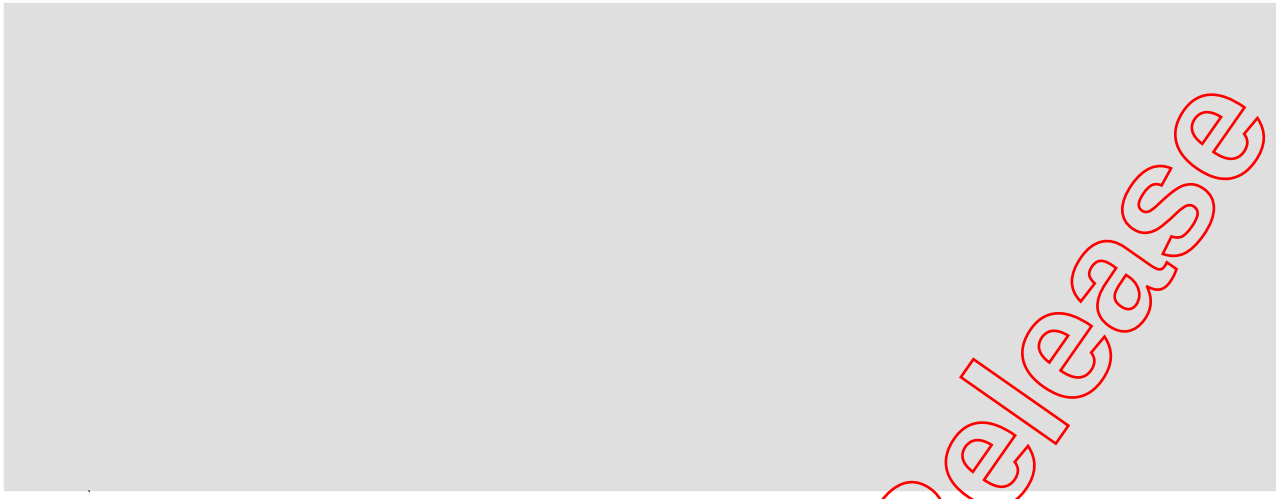
RECOMMENDATIONS

The following specific recommendations were provided for each site:

COOCHIEMUDLO ISLAND FORMER LANDFILL

R1 Continued monitoring of groundwater quality and landfill gas concentrations for a period of two years (biannual monitoring) to allow verification of the results obtained during this investigation while establishing seasonal and long-term trends in contaminant concentrations.

(Note - This is not considered to be an essential implementation, but one that Council may consider to confirm the findings of this report and minimise the likelihood of any future risk [environmental and/or health] associated with the site).



LANDFILL ASSESSMENT COST ESTIMATE	units	qty	$/unit	subtotal	TOTAL
Coochiemudlo Island Landfill - Redland Shire Council					
CONSULTANT EXPENSES					
ROUND 1 (year 1)					
Travel Expenses					
vehicle	km	150	0.62	93	
site engineer - travel to / from site	hrs	3.5	55	192.5	
transfers	lump	1	45	45	330.5
ROUND 2 (year 1)					
Travel Expenses					
vehicle	km	150	0.62	93	
site engineer - travel to / from site	hrs	3.5	55	192.5	
transfers	lump	1	45	45	330.5
ROUND 3 (year 2)					
Travel Expenses					
vehicle	km	150	0.62	93	
site engineer - travel to / from site	hrs	3.5	55	192.5	
transfers	lump	1	45	45	330.5
ROUND 4 (year 2)					
Travel Expenses					
vehicle	km	150	0.62	93	
site engineer - travel to / from site	hrs	3.5	55	192.5	
transfers	lump	1	45	45	330.5
GROUNDWATER MONITORING (biannual monitoring)					
ROUND 1 (year 1)					
Mobilise to well, dip water levels, purge wells, label jars, collect sample, field filter)					
site engineer	hrs	4	55	220	
Laboratory analysis					
full groundwater suite (see below)	lump	4	267	1068	
courier fees for samples to laboratory + preservation (ice)	lump	1	30	30	
					1318
ROUND 2 (year 1)					
Mobilise to well, dip water levels, purge wells, label jars, collect sample, field filter)					
site engineer	hrs	4	55	220	
Laboratory analysis					
full groundwater suite (see below)	lump	4	267	1068	
courier fees for samples to laboratory + preservation (ice)	lump	1	30	30	
					1318
ROUND 3 (year 2)					
Mobilise to well, dip water levels, purge wells, label jars, collect sample, field filter)					
site engineer	hrs	4	55	220	
Laboratory analysis					
full groundwater suite (see below)	lump	4	267	1068	
courier fees for samples to laboratory + preservation (ice)	lump	1	30	30	
					1318
ROUND 4 (year 2)					
Mobilise to well, dip water levels, purge wells, label jars, collect sample, field filter)					
site engineer	hrs	4	55	220	
Laboratory analysis					
full groundwater suite (see below)	lump	4	267	1068	
courier fees for samples to laboratory + preservation (ice)	lump	1	30	30	
					1318
LANDFILL GAS MONITORING (six monthly monitoring)					
ROUND 1 (year 1)					
Subsurface soil atmosphere measurements (4 wells)					
site engineer	hrs	1.5	55	82.5	
Structures (gas accumulation) measurements (if required)					
site engineer	hrs	0.5	55	27.5	
Surface Emmission monitoring (grid measurements)					
site engineer	hrs	3	55	165	
Methane detection meter					
meter hire	lump	1	100	100	
					375

ROUND 2 (year 1)					
Subsurface soil atmosphere measurements (4 wells)					
site engineer	hrs	1.5	55	82.5	
Structures (gas accumulation) measurements (if required)					
site engineer	hrs	0.5	55	27.5	
Surface Emmission monitoring (grid measurements)					
site engineer	hrs	3	55	165	
Methane detection meter					
meter hire	lump	1	100	100	
					375
ROUND 3 (year 2)					
Subsurface soil atmosphere measurements (4 wells)					
site engineer	hrs	1.5	55	82.5	
Structures (gas accumulation) measurements (if required)					
site engineer	hrs	0.5	55	27.5	
Surface Emmission monitoring (grid measurements)					
site engineer	hrs	3	55	165	
Methane detection meter					
meter hire	lump	1	100	100	
					375
ROUND 4 (year 2)					
Subsurface soil atmosphere measurements (4 wells)					
site engineer	hrs	1.5	55	82.5	
Structures (gas accumulation) measurements (if required)					
site engineer	hrs	0.5	55	27.5	
Surface Emmission monitoring (grid measurements)					
site engineer	hrs	3	55	165	
Methane detection meter					
meter hire	lump	1	100	100	
					375
REPORTING					
Report 1 (letter report after year 1 monitoring)					
Collation of results					
project engineer	hrs	2	60	120	
Assessment of results					
project engineer	hrs	2	60	120	
project manager	hrs	2	85	170	
Preparation of draft report					
project engineer	hrs	4	60	240	
Internal review					
project manager	hrs	1	85	85	
Typing					
typist	hrs	1	50	50	
Drafting					
drafter	hrs	2	60	120	
Expenses (copying, collation, binding, etc)					
total expenses	lump	1	45	45	
					950
Report 2 (letter report after year 2 monitoring)					
Collation of results					
project engineer	hrs	2	60	120	
Assessment of results					
project engineer	hrs	2	60	120	
project manager	hrs	2	85	170	
Preparation of draft report					
project engineer	hrs	4	60	240	
Internal review					
project manager	hrs	1	85	85	
Typing					
typist	hrs	1	50	50	
Drafting					
drafter	hrs	2	60	120	
Expenses (copying, collation, binding, etc)					
total expenses	lump	1	45	45	
					950
PROJECT TOTAL					**$9,994.00**

Notes:	
Groundwater Analysis Suite	Ammonia (as N), Bicarbonate (HCO3), Calcium, Chloride, Copper, Iron (total), Lead, Magnesium, Manganese, Nitrate (as N), pH, Potassium, Sodium, Specific conductance, Sulphate, Total Organic Carbon, Zinc, Arsenic, Cadmium, OC/OP Pesticides

Pages 10 through 13 redacted for the following reasons:
- -
Irrelevant Information

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GENERAL

TABLE OF CONTENTS – GENERAL SECTION

1. INTRODUCTION

Egis Consulting Australia Pty Limited (Egis) was commissioned by Redland Shire Council (Council) to assess four former landfill sites under the guidelines of the Landfill Remediation Assessment Program (LRAP). The sites assessed were:

- Coochiemudlo Island Landfill

The assessment criteria for this study was formulated from guidelines established by the DCILGP, and from discussions with Council prior to the commencement of works. This criteria is detailed in the original proposal submitted by Egis, and is summarised below:

- A review of site history and current site details.
- Monitoring of groundwater (both upgradient and down gradient of the landfill unit).
- Monitoring of surface water (upgradient and downgradient/release point monitoring from the landfill).
- Monitoring of sediment adjacent to the landfill site.
- Monitoring of landfill gas migrating from the landfill.

All fieldwork undertaken by Egis personnel was in accordance with Egis Health and Safety Plans and QA/QC protocols.

The purpose of the LRAP assessment is to collect and interpret all relevant information to determine the current status of the former landfill sites with regard to environmental and health related issues. In assessing each site, any requirements for the appropriate management or remediation of each site are to be identified.

1.1 OBJECTIVES

The main objective of the LRAP report for the above four former landfill sites located within the Redland Shire Council region is to:

- Provide an understanding of the current environmental status of the former landfill sites with regard to the associated environmental impacts to both the natural and human environments.

The specific outcomes to achieve this objective include the following:

- Identify all areas of potential concern with regard to environmental/health related issues for local/regional receptors resulting from past landfilling activities at each subject site.
- Specify and define additional assessment requirements, if any, based on the results of this investigation, which are considered necessary to finalise the assessment.
- Detail any management/remedial strategies deemed necessary to minimise environmental/health impacts related to the subject site.

It is noted that the assessment is limited to the original scope of works as detailed in Egis's proposal, the information provided by Council, and the data obtained by Egis during the course of this investigation.

2. METHODOLOGY

The following methodology was adopted in the collection of data and the determination of groundwater, surface water, landfill gas and soil sediment characteristics for all four sites.

2.1 GROUNDWATER MONITORING

Well Installation

Four groundwater wells were installed at each landfill site as detailed in Table 2-1 (refer Figure A3 - Attachment A1, Figure B3 - Attachment B1, Figure C3 - Attachment C1 and Figure D3 - Attachment D1 for well locations). The wells were located upgradient and downgradient of the landfill in order to characterise regional (background) groundwater quality and the quality of groundwater downgradient of the site.

Table 2-1

Groundwater Monitoring Details

Sites	Date Drilled	Upgradient Sites	Downgradient Sites
Coochiemudlo Island	31 January 2001	2	2

Wells were installed to a depth of 1.5 to 2.0 m below the groundwater interface at the time of drilling. The depth to groundwater (measured from ground level) encountered in the monitoring wells during drilling, ranged between:

- Coochiemudlo Island 1.8 to 9.0 m

For each site the monitoring wells were constructed with 50 mm diameter uPVC casing with a base end cap and top gripper plug (to minimise likelihood of interference with wells). The wells were screened (machine slotted) from the base to 1 m below ground level in order to allow sampling for groundwater and landfill gas. The borehole annulus was backfilled with graded sand/gravel and plugged with bentonite 0.5 m above the screening to prevent infiltration of surface waters. The wells were protected by a lockable steel monument cover which was concreted in to ensure long term integrity.

All monitoring wells were developed in accordance with Environmental Protection Agency (EPA) procedures.

Sample Collection

Groundwater samples were collected on a quarterly basis for the detection parameters specified below:

- Ammonia (as N)
- Arsenic
- Bicarbonate (HCO_3)
- Calcium
- Cadmium
- Chloride
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Nitrate (as N)
- pH [A]
- Potassium
- Sodium
- Specific Conductivity[A]
- Sulphate
- Total Organic Carbon
- Zinc

Note:

All heavy metals were filtered (dissolved)

A Field measurement.

In addition, groundwater samples from Coochiemudlo Island, [redacted] were analysed for organochlorine (OC) pesticides and organophosphorous (OP) pesticides.

The collection of samples was undertaken in accordance with the Water Quality Sampling Manual (EPA – Third Edition, December 1999).

Wells were gauged using an electronic interface probe to determine groundwater depths accurate to 0.01 m. A stainless steel bailer was subsequently used to purge a minimum of three well volumes from each bore prior to sampling.

Groundwater samples were collected from the recharged wells and transferred to appropriately preserved and labelled sample jars and containers. Field pH and electrical conductivity (EC) readings were taken using a YSI 63 meter, which was calibrated prior to use. Samples were stored on ice prior to delivery to Australian Laboratory Services Pty Ltd (NATA registered for the required analysis). Sampling equipment was decontaminated with phosphate free detergent and a potable water rinse between sampling events.

2.2 SURFACE WATER MONITORING

Surface water samples were collected from water bodies adjacent to three of the sites. No surface water was observed adjacent to the Coochiemudlo Island site.

2.3 LANDFILL GAS MONITORING

Three methods of landfill assessment were conducted to ensure that all potential means of off-site mitigation had been verified for the presence or absence of landfill gases (refer to Figure A3 – Attachment A1, Figure B3 – Attachment B1, Figure C3 – Attachment C1 and Figure D3 – Attachment D1 for sample locations). The methods adopted were:

- Landfill capping and embankments were monitored for surface gas emissions at a distance of < 0.05 m from the capping surface on traverses spaced at 25 m intervals.
- Dual groundwater/landfill gas monitoring wells were utilised for the monitoring of soil atmosphere gas concentrations around the boundary of each site.
- All site structures in which the potential exists for accumulation of gas (ie, manholes, buildings, drains, collection pits etc) were monitored for ambient gas readings.

The results obtained have been compared to standard guidelines (NSW EPA 'Solid Waste Landfill Guidelines'). Results were obtained using an ATX 620 multi-gas meter for the following parameters:

- Oxygen (%O_2).
- Methane (%CH_4 or ppm by volume).
- Hydrogen sulphide (%H_2S).

Monitoring of the soil atmosphere was undertaken prior to any groundwater sampling. The technique used was as follows:

- The landfill gas was measured from inside the closed well. The highest reading was recorded.
- Once the initial methane concentration was recorded, the well cap was removed to vent the well. Leaving the landfill gas probe inside the well, the highest reading was recorded, and then the gradual reduction in concentrations was noted (the corresponding time during the monitoring was also noted).
- Once the gas reading had stabilised, the time and stabilised concentration was noted.

2.4 SEDIMENT SAMPLING

No surface water was observed adjacent to the Coochiemudlo Island site and consequently no sediment samples were collected.

2.5 LANDFILL MONITORING ASSESSMENT

Groundwater Quality Assessment

To identify the potential leachate impaction of local groundwater and to determine the necessity for further groundwater quality assessment, three criteria were adopted, these being:

- Assessment of variations between upgradient and downgradient groundwater quality:
  - Samples collected from wells were assessed to determine any significant variations in groundwater quality between upgradient and downgradient wells for the current round of sampling.
- Comparison of results with adopted guidelines:
  - Results of groundwater sampling were assessed with respect to recognised guideline levels ("ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters – 1992", and "Environmental Quality Objectives in the Netherlands - 1994").

Surface Water Quality Assessment

Landfill Gas Assessment

To identify potential landfill gas impaction from the landfill, the following criteria were adopted (based on the NSW EPA Guidelines for Solid Waste Landfills):

- 25% of the lower explosive limit (LEL) for methane when measured in facility structures (1.25% methane by volume).
- 25% of the LEL for methane measured in the soil atmosphere at the landfill facility boundary (1.25% methane by volume).
- 500 ppm methane for ambient readings at any spot location.

Sediment Assessment

3. RAPID HAZARD ASSESSMENT

The Rapid Hazard Assessment System is a tool to aid in the evaluation of contaminated sites. Its purpose is to provide scientific and technical assistance in the identification of sites, which may be considered high, medium or low risk. The assessment system is designed to categorise sites based on a requirement for further investigation in a systematic and rational manner, according to their current or potential adverse impact on health or the environment.

The system uses a numerical method that assigns scores to a number of site characteristics or factors. These scores are then used in a way, which is consistent with risk estimation to develop a single score that will indicate a site's **'Known or Potential'** hazard, and the requirement for further action to be taken.

Accordingly, the Rapid Hazard Assessment System is designed to evaluate the hazard, or known hazard potential, of a site by scoring site characteristics that can be grouped under one of three categories:

- **Contaminant Characteristics**: the relative hazard of contaminants present at a site.
- **Exposure Pathways**: the route a contaminant may follow (e.g. groundwater, surface water, direct contact, and/or air) to a receptor.
- **Receptors**: living beings or resources that may be exposed to and affected by contamination (e.g. humans, plants, animals, or environmental resources).

This system is a screening method only. As such, it is beyond the scope of this system to address specific factors such as those of a technological, socioeconomic, political, or legal nature. Additional investigations will therefore usually be required before regulatory requirements or remedial designs can be finalised.

Sufficient 'known' information was available for sensitive environments within close proximity to each of the sites. As such the known value scored for each site has been used to determine the site category and priority for further action. The site category's are defined below.

- **Class 1 (Score of 55 to 100): Further Investigation Required**

  The available information indicates that action (e.g. further site characterisation, risk assessment, remediation, etc) is required to address existing concerns. Typically, Class 1 sites show a propensity to high concerns for adverse impacts on humans, animals and the environment and measured or observed impacts have been documented.

- **Class 2 (Score of 30 to 55): Further Investigation Likely to be Required**

  The available information indicates that there is a high potential for adverse off-site impacts, although the threat to human health and the environment is generally not imminent. There is probably no known off-site contamination, however, the potential for this was rated and therefore some action is likely to be required.

- **Class 3 (Score of 10 to 30): Further Investigation May be Required**

  The available information indicates that this site is currently not a high concern. However, additional investigation may be carried out to confirm the site classification, and some degree of action may be required.

- **Class N (Score of Zero to 10): Further Investigation Not Likely to be Required**

The available information indicates there is probably no significant environmental impact or human health threats. There is likely no need for action unless new information becomes available indicating greater concerns, in which case the site should be re-examined.

Actual rapid hazard assessment values for each site are provided in the specific sections, with details as to the major influencing factors for each location. A summary of the assessment ratings and the assessment questionnaire is included in Appendix B at the back of the report document.

4. LIMITATIONS OF REPORTING

This report has been prepared for use by the client who commissioned the work, in accordance with the project brief only, based on information provided by the client. The advice herein relates only to this project and all results, conclusions and recommendations made should be reviewed by a competent person with experience in undertaking environmental investigations, before being used for any other purpose. Egis accepts no liability for use or interpretation by any person or body other than the client who commissioned the work. This report should not be reproduced or amended in any way without prior approval from the client or Egis.

The extent of soil and groundwater sampling and subsequent analysis has been necessarily limited. Egis has targeted areas where contamination is considered to be most likely based on knowledge of the site history and visual observations. This approach maximises the probability of identifying contaminants. However, it may not identify contamination which occurs in unexpected locations or from unexpected sources.

Soil, rock and aquifer conditions are often variable, resulting in non-homogeneous contaminant distributions across a site. Contaminant concentrations have been identified at chosen sample locations. However, conditions between sample locations can only be inferred on the basis of the estimated geological and hydrogeological conditions and the nature and extent of identified contamination. Boundaries between zones of variable contamination are often indistinct, and thus have to be interpreted on the basis of available information and the application of professional judgement. The accuracy with which subsurface conditions are able to be characterised depends on the frequency and methods of sampling and the uniformity of subsurface conditions and are therefore limited by the scope of work.

Thus, this report does not provide a complete assessment of the environmental status of the site. It is limited to the scope defined herein. Should further information regarding conditions at the site become available, including previously unknown sources of contamination, Egis reserves the right to review the report in the context of the additional information.

SECTION A

COOCHIEMUDLO ISLAND FORMER LANDFILL SITE

TABLE OF CONTENTS – SECTION A

1. DESKTOP STUDY

1.1 SITE DESCRIPTION

The site is located at 43 – 99 Elizabeth Street, Coochiemudlo Island (Lot 45 SL 8606) and covers an area of approximately 0.7 ha (refer Figure A1, Attachment A1). It is understood that the original approval was for land described as Local Government Reserve R 2117, Portion 45. The current RPD (Lot 45 SL 8606) covers the total extent of the landfill footprint and this is the Real Property Description that has been adopted for this assessment program. The site is accessible from Elizabeth Street, adjacent to the Energex station and Fire Service station.

A site inspection was undertaken in conjunction with the field work on 31 January 2001. It was observed that the northern end of the site currently consists of a refuse transfer station and green waste stockpile area. The remainder of the former landfill consists of the 'Laurie Burns Recreational Park' which includes a number of recreation facilities such as a grassed sporting oval, a lawn bowling/croquet green, tennis courts, barbecue area, children's playground and bicycle track.

The site is essentially flat. The extent of landfilling is clearly identifiable by batters and the tree line observed along the eastern and northern extents. The bushland to the east of the site (known as 'Melaleuca Wetlands') is fenced off. An inspection of this area did not identify any surface water. A former Council quarry was located immediately south of the landfill which was subsequently filled and developed into the croquet/bowling green and tennis courts that currently exist on the site. Based on information provided by former site manager Mr Laurie Burns and on investigative drilling undertaken as part of this assessment, it is believed that clay was used as fill in the former quarry area and that no waste was deposited in this area. Some ash may also have been used as fill in this area, however no evidence of such was observed during investigative drilling.

The surrounding land uses are as follows:

- North - Undisturbed bushland.
- South - Residential properties.
- East - Bushland and 'Melaleuca Wetlands'
- West - Fire Service station and Energex facility, followed by Elizabeth Street and residential properties.

1.2 SITE HISTORY

The site history has been derived from a questionnaire completed by relevant Council personnel and from information provided by former site manager and long-time island resident, Mr Laurie Burns.

Landfilling Practices

The Coochiemudlo Island landfill began receiving waste materials in March 1972. The landfill was operated for a period of 22 years before ceasing to receive waste in April 1994. The landfill was operated as a trench and fill operation with soil used as a cover material. It is estimated the site received between 1,000 and 5,000 m^3 of waste throughout landfilling operations. The local population serviced by the landfill was less than 500 people. At present, the waste collected at the refuse transfer station is transported to the mainland while green waste is mulched and used for landscaping purposes around the site.

Before landfill operations commenced the land was relatively flat (0 – 5% slopes across the entire site). At the completion of landfilling the site was levelled and 300 mm – 500 mm permeable cover material (soil and some gravel) placed over the site. No impervious capping was installed prior to the creation of sporting fields for recreation purposes.

Waste Characteristics

The types of waste deposited in the Coochiemudlo Island landfill reportedly include:

- Inert/hardfill materials such as clean fill, concrete, bricks, asphalt and glass which are free from contaminants.
- General (non putrescible) mixed domestic waste, mixed commercial/industrial wastes, trees, garden clippings, shredded tyres, plastics, and materials included in the inert/hardfill category.
- Municipal wastes including inert/hardfill, general and putrescible waste (including minor amounts of regulated waste which has been commingled).

Table 1-1 is an estimate of each waste type deposit in the Coochiemudlo Island Landfill as a percentage of the total waste stream received.

Table 1-1

Estimated Waste Stream Composition for Coochiemudlo Island Landfill

Waste Type	Percentage (%)
Inert/hardfill Waste	11 – 20
General Waste	21 – 30
Municipal Waste	41 – 50

Due to the number of sources and the unsupervised nature of the dumping operation, the actual composition of the landfilled waste is difficult to accurately assess, particularly with regard to the biodegradable fraction.

Council indicated that no known dumping of farm chemicals or containers had occurred based on the fact there was no agriculture undertaken on Coochiemudlo Island. This is supported by groundwater sampling results for the site.

Buffer Zones

An assessment of the landfill site indicated the proximity of the landfill to significant natural and human environments. These have been summarised in Table 1-2.

Table 1-2

Estimated Existing Buffer Zones for Coochiemudlo Island Landfill

Feature	Distance (m)
Human:	
Residential Premises	< 100
Commercial/Industrial Premises	Between 100 and 500
Hospital/School Premises	> 1000
Natural:	
Wetlands	< 100
Tidal Areas	Between 100 and 500

The close proximity of residential premises raises potential environmental and health concerns with regard to nuisance odours, contamination of local waterways and pest and disease threats. Also of concern is the lack of significant buffer zones to adjacent wetland areas given the absence of environmental controls for surface water diversion and leachate treatment throughout the operational lifespan of the landfill. Given that no surface water was observed during site inspection or quarterly site monitoring, sampling in this area was not practical and assessment of any impact on the wetlands has proved difficult.

Construction and Operation

It has been indicated that the site was not fenced throughout its operational lifespan, nor was the site always supervised when receiving wastes. The unsecure nature of the site during operation would enable uncontrolled dumping of materials however, no evidence of such has been identified during this investigation.

Council has indicated that no designated areas were set aside for special waste categories such as asbestos or tyres. No records are available to confirm whether any special wastes were received by the landfill. It has been indicated that there were no adequate surface storage structures for temporarily stored wastes and such waste may have been stored on-site for long periods of time. No plan exists to indicate the location of special waste burial areas. The information provided at the time of compiling this report suggests the landfill did not receive, store or dispose of any categories of special wastes. Separate areas were allocated for the storage of car bodies and green waste located at the southern end of the site.

During normal wet weather conditions, the site was still capable of receiving waste materials. Waste was deposited in trenches which were excavated to the depth of groundwater (approximately 2 m). The deposited wastes were burnt in the trenches before being compacted and covered on a weekly basis using a bulldozer. The material used for intermediate cover was soil, which was obtained from both on-site and off-site sources. It is believed that the off-site materials used were not sourced from an area that would constitute a contaminated site under the specifications of the Environmental Protection Act 1994. The site has no history of below ground fires where waste had been deposited (other than the burning activities described above).

Available information indicates that the Coochiemudlo Island landfill has no engineered control measures for the suitable containment of the waste types and associated by-products (ie, leachate and gas). While the adopted design, environmental controls and records (waste types, volumes and placement) for the operation of the landfill would enable uncontrolled dumping to occur, soil and water samples do not indicate any significant presence of heavy metals, petroleum hydrocarbons or pesticides.

1.3 AERIAL PHOTO INTERPRETATION

Aerial photographs of the site were either supplied by Redland Shire Council or sourced from the Queensland Department of Natural Resources. No earlier photos were available to show the site prior to landfilling operations.

Beenleigh Run 9, July 1973, Photo 7622

An area of cleared land within the site is mostly bare ground with occasional patches of grass. This cleared area represents approximately 30% of the eventual extent of the landfill. An access road from Elizabeth Street to the south-west corner of the site is visible and a building is located approximately half-way along this road. A number of small mounds (possibly refuse) are visible as well as other objects (possibly earthmoving equipment or vehicles).

The land immediately surrounding the site is undisturbed bushland. Immediately adjacent to the site to the north and east is the densely vegetated Melaleuca Wetlands. Further to the south of the site, a few residential premises are located on James Street and Shirley Street. More houses are located to the south-west in Marana and Merindah Streets.

Beenleigh Run 2, April 1974, Photo 101

The extent of the cleared area does not appear to have increased and no significant changes are visible to the site or surrounding land from the previous photo.

Beenleigh Run 3, August 1978, Photo 3316

The cleared area of land has extended slightly to the north and west. A large block of land adjoining the western boundary of the site has been cleared and a building constructed. No other significant changes from the previous photo are obvious.

South East Queensland, Run 10, August 1983, Photo 77

The cleared extent of the site has increased since the previous photograph and a large freshly cleared area is visible at the southern end. There appears to be a new gravel access road joining the north-west corner of the site to Elizabeth Street. The density of housing has increased to the south and south-west of the site and large areas of bushland have been cleared on the western side of Elizabeth Street, opposite the site.

Brisbane Run 5, November 1993, Photo 101

The site has been cleared to its final extent and is mostly bare ground with areas of grass and shrub cover. A large mound of refuse/fill is clearly visible at the northern end of the site and smaller mounds of refuse/fill are visible at the southern end of the site. The density of housing has increased significantly to the south of the site.

Brisbane Run 12, November 1994, Photo 012

No refuse is visible on the site and the extent of grass cover has increased since the previous photo. The central area of the site appears to be in use as a sporting field and a cricket pitch is visible in the middle of the field. A small building has been constructed in the northern corner of the site (transfer station).

Brisbane Run 9, October 1998, Photo 8017

Two tennis courts and a bowling green have been constructed on the southern half of the site. A small area that appears to contain refuse, possibly car bodies is visible in the southern corner of the site.

1.4 LOCAL GEOLOGY

The regional geology of the area was sourced from the Australian 1:100,000 geological map series (Beenleigh Sheet 9542). It indicates that the regions geological deposits consist mainly of sandstone, siltstone, shale and conglomerate. The eastern side of the Coochiemudlo Island is the result of estuarine deposits, mainly mud, silt, sand, clay and coral with minor peat and coral debris.

Soil classification was undertaken during the installation of groundwater monitoring wells and the drilling of investigation boreholes across the site to determine localised geological conditions (refer borehole logs, Attachment A2). Borehole logs are summarised below:

- On the eastern boundary of the site the soil profile consists of clayey sands to a depth of approximately 0.5 m at which it becomes sandy clay extending the depth of the boreholes (up to 4.5 m). The colour of the soil profile varied from orange at the surface to black/grey, becoming red at a depth of 3 m. Groundwater was encountered at approximately 1.8 m below ground level.

- On the southern boundary of the site the soil profile consists of sandy clay becoming clayey sand at a depth of approximately 2.0 m. Groundwater was encountered at a depth of 7.0 m below ground level. Base rock was encountered at a depth of 10.5 m resulting in auger refusal at this depth. The colour of the soil profile varied from dark brown at the surface becoming orange at a depth of 1.0 m and red at 2.0 m.

- On the western boundary of the site the soil profile consists of mostly clayey sand. Intermittent layers of sandstone (between 0.2 and 0.3 m thick) were encountered within the clayey sand between depths of 2.0 and 7.0 m. Groundwater was encountered at a depth of 9.0 m.

- On the northern boundary of the site the soil profile consisted mainly of clayey sand however boreholes in this area were relatively shallow (depths up to 1.5 m).

The soil classification conducted at the site during drilling indicates predominantly natural sandy clay/clayey sand to a depth of at least 10.5 m. The site appears to be underlain by hard bedrock.

1.5 LOCAL HYDROGEOLOGY

Surface Water and Run-off

Information collected during this investigation indicates no systems were in place to divert surface water away from waste disposal areas or completed areas. Surface topography of the Coochiemudlo Island former landfill indicates that the site is relatively flat (less than 5 % gradient) but surface runoff is likely to be shed in a north easterly direction toward the wetlands. No definitive bodies of surface water were observed within the wetlands, thus sampling of surface water could not be undertaken.

Rainfall data for the twelve month period over which monitoring was conducted (January 2001 to December 2001) indicated that approximately 906 mm of rainfall occurred at Brisbane Airport. This is slightly lower than the annual average rainfall at Brisbane airport (1185.4 mm). The lower than average rainfall should be taken into consideration when reviewing the conclusions made from this report, as lower rainfall would be likely to reduce leachate generation and surface water runoff from the landfill. The wettest month in 2001 was November (218.8 mm). The dryest months were August (12.0 mm) and September (12.6 mm).

No evidence of ponding of surface water was observed at the site during the site inspection and monitoring visits.

Council indicated that there were no measures in place to prevent leachate leaving the site and no leachate treatment process was utilised during the operation of the landfill. Council records indicate that complaints of possible leachate seepage and contamination of the adjoining wetland were received in 1992. Inspections by council officers at the time did not find any visible evidence of leachate seepage from the site. No evidence of leachate seepage was observed during Egis site visits or monitoring events.

The site is not within a declared catchment and no use is made of surface water in the vicinity of the site.

Groundwater

Groundwater was initially encountered between the depths of 1.8 – 9.0 m below ground level. A review of the local topography, survey results of gauged wells and the location of the site with respect to Melaleuca Wetlands, suggests the direction of groundwater flow would be in a north easterly direction. The general permeability of the natural sandy clays/clayey sands encountered at the site would be expected to be in the order of $1x10^{-4}$ to $1x10^{-7}$ m/s (obtained from Soil Mechanics, 5th Edition, R F Craig 1994).

To the limit of Council knowledge, groundwater within the vicinity of the site is not used for any purpose. The Department of Natural Resources have indicated there is no requirement for registration of groundwater bores within this region and thus does not have any records of groundwater users within close proximity of the site. A buffer zone of at least 300 m exists in the case of tidal influences.

Local Receptors and Surrounding Land Uses

The closest receptors to the site are the residential houses adjacent to the site to the west and south and the wetlands to the north-east, both of which are within 100 m. Moreton Bay is approximately 300 m east of the site.

1.6 LANDFILL GAS

No landfill gas management system was installed during the operation or closure of the landfill. The surface vegetation on the site consists of grass only and is currently well established and healthy. It is understood that no previous landfill gas investigations have been conducted at the site. No buildings are located over the former landfill where landfill gases could accumulate. As an impermeable cap was not installed over the former landfill, it is considered unlikely that landfill gas would accumulate under the cap.

2. SITE INVESTIGATION

2.1 VISUAL INSPECTION

An initial visual inspection of the Coochiemudlo Island former landfill site was undertaken on 31 January 2001 in conjunction with the investigative drilling program. The purpose of the inspection was to confirm the results of the desktop study and to identify suitable locations for sampling.

The inspection of the site revealed the following:

- The site is surrounded by undisturbed bushland and wetlands to the east and north. Residential properties are located to the south and west of the site.
- The northern end of the site currently consists of a refuse transfer station and green waste stockpile area. The remainder of the former landfill consists of the 'Laurie Burns Recreational Park' and associated public facilities.
- The site is essentially flat.
- The extent of landfilling is clearly identifiable by batters and the tree line observed along the eastern and northern extents.
- No surface water bodies were identified near the site, including the adjacent wetlands.

2.2 INVESTIGATIVE DRILLING PROGRAM

An investigative drilling program was undertaken in order to delineate the extent of filling at the site. Nineteen (19) shallow boreholes between 0.6 and 2.0 m deep were drilled around the assumed filling boundary in order to delineate the edge of deposited fill. Borehole logs are presented in Attachment A2. The extent of filling as determined from the investigation is presented on Figure A1, Attachment A1.

2.3 CAPPING INVESTIGATION

Two capping test holes were drilled through the landfill capping material in order to determine the type of soil, thickness and permeability of the cap. The investigation revealed that the thickness of capping was approximately 0.4 – 1.0 m thick. The cover was predominantly grassed with no major cracking observed.

Field density testing and a constant head permeability test was performed by Earthtech Laboratories, a NATA registered laboratory for the tests carried out. The test locations are indicated on Figure A2, Attachment A1 and the certified results report is included in Appendix A. The results of capping testing and analysis are discussed in section 5.3.

2.4 SELECTION OF MONITORING LOCATIONS

Groundwater well locations were selected based on information obtained during the desktop study. Well locations are indicated on Figure A3, Attachment A1.

Four dual groundwater/soil atmosphere monitoring wells were installed around the perimeter of the filling area. The monitoring wells were installed outside the boundary of the refuse so that they could be used to monitor offsite migration of contaminants and landfill gas.

No surface water or sediment samples were collected as no surface water bodies were observed adjacent to the site.

3. SUMMARY OF SAMPLING

A yearlong sampling program (quarterly monitoring frequency) has been undertaken at the site in order to enable a thorough environmental assessment of the former landfill (including analysis of trends).

A summary of environmental sampling is provided in Table 3-1. Sample locations are identified on Figure A3 - Attachment A1.

Table 3-1

Coochiemudlo Island Former Landfill - Summary of Environmental Sampling

Date	Type of Sampling	Brief Description
12 March 2001	Groundwater	• 4 samples collected from on-site wells
	Landfill Gas Monitoring	• subsurface monitoring conducted from on-site wells • surface gas monitoring conducted from 25 m grid above cap • gas accumulation monitoring conducted within onsite structures
13 June 2001	Groundwater	• 4 samples collected from on-site wells
19 September 2001	Groundwater	• 4 samples collected from on-site wells
	Landfill Gas Monitoring	• subsurface monitoring conducted from on-site wells • surface gas monitoring conducted from 25 m grid above cap • gas accumulation monitoring conducted within onsite structures
12 December 2001	Groundwater	• 4 samples collected from on-site wells

3.1 SAMPLING - GENERAL OBSERVATIONS

3.1.1 GROUNDWATER

Groundwater samples were collected during the field investigation in accordance with the procedures outlined earlier in this report. Specific observations made while on site are detailed in Table 3-2.

Table 3-2

Groundwater Observations

Well ID	Date	Standing Water Level (mAHD)	Groundwater Sample Details	General Observations
CMBH1	12/3/01	2.350	Light brown colour, very turbid, no odour, no sheen.	• The well is located on the north eastern boundary of the site. • Water recharge was rapid, indicating a permeable profile or layer.
	13/6/01	1.694		
	19/9/01	1.363		
	12/12/01	2.478		
CMBH2	12/3/01	2.322	Light brown colour, very turbid, very faint sulphidic odour, no sheen.	• The well is located on the eastern boundary of the site. • Water recharge was rapid, indicating a permeable profile or layer.
	13/6/01	1.709		
	19/9/01	1.466		
	12/12/01	2.672		
CMBH3	12/3/01	3.224	Red colour, very turbid, no odours, no sheen.	• The well is located on the southern boundary of the site. • Water recharge was rapid, indicating a permeable profile or layer.
	13/6/01	2.628		
	19/9/01	2.119		
	12/12/01	2.380		
CMBH4	12/3/01	3.135	Red colour, very turbid, no odours, no sheen.	• The well is located on the western boundary of the site. • Water recharge was rapid, indicating a permeable profile or layer.
	13/6/01	2.599		
	19/9/01	2.091		
	12/12/01	2.569		

3.1.2 LANDFILL GAS

Landfill gas samples were collected during the field investigation in accordance with the procedures outlined earlier in this report. Specific observations made while on site are detailed in Table 3-3.

Table 3-3

Landfill Gas Observations

Well Number	Date	General Observations
CMBH1	12/3/01	no landfill gas odours were detected
	19/9/01	no landfill gas odours were detected
CMBH2	12/3/01	no landfill gas odours were detected
	19/9/01	no landfill gas odours were detected
CMBH3	12/3/01	no landfill gas odours were detected
	19/9/01	no landfill gas odours were detected
CMBH4	12/3/01	no landfill gas odours were detected
	19/9/01	no landfill gas odours were detected

4. RESULTS

Analytical results from groundwater, surface water, landfill gas and sediment samples for Coochiemudlo Island former landfill are presented in the following tables:

Table A1 Groundwater

Table A2 Landfill Gas

Table A3 Capping Material

These tables are contained in Attachment A3. Trend charts for groundwater analysis results have been plotted and are also presented in Attachment A3. Certified laboratory results, sample receipt advises and analysis request documentation are provided in Appendix A.

5. DISCUSSION

5.1 WATER QUALITY

A yearlong sampling program (quarterly monitoring frequency) has been undertaken at the site in order to establish groundwater quality surrounding the landfill. No surface water bodies were observed adjacent to the site.

The following discussion will compare current water quality results from the site with:

- Recognised environmental threshold criteria.
- Upgradient and downgradient results.
- Known groundwater characteristics of other regional sites.
- Typical leachate chemical concentrations.

Based on groundwater gauging results (refer Table 3-2) and the proximity of the Melaleuca Wetlands to the site, it is expected that groundwater at the site flows in a north easterly direction toward the wetlands. Monitoring well CMBH4 is located upgradient of the former landfill area and provides an indication of regional groundwater quality for comparison. Monitoring well CMBH3 is located downgradient of the area believed to be the former Council quarry but it is not expected that groundwater at this location would be impacted by any leachate release from the landfill unit. As such, monitoring well CMBH3 has been treated as a background (ie, upgradient) monitoring well for the purpose of this assessment.

It is possible that the surface water in Moreton Bay is hydraulically connected to the groundwater due to its close proximity (300 m east) and the shallow depth of groundwater encountered at the site. As such, the following guidelines were adopted for comparison of the results:

- ANZECC Guideline for Fresh and Marine Water.

- Environmental Quality Objectives in the Netherlands.

A review of the groundwater analytical results (Table A1, Attachment A3), is provided below:

- **pH.** Slight to moderately acidic pH values below the adopted guideline range of 6.5 – 9.0 (ANZECC) were recorded in all wells over the monitoring period with the exception of the September 2001 result for monitoring well CMBH1, which was close to neutral (pH = 6.89). A review of trend charts (refer Attachment A3) reveals the pH values in upgradient wells CMBH3 and CMBH4 were generally 1-2 pH units lower (ie more acidic) than in downgradient wells CMBH1 and CMBH2. While these results may indicate that groundwater is being impacted by leachate, a review of other results would suggest that any such impact is minor. Furthermore, it is possible that the adjacent wetlands may also influence the pH in downgradient groundwater.

- **Electrical Conductivity, Sodium and Chloride.** Electrical conductivity results recorded in groundwater in all monitoring wells over the monitoring period were below the adopted guideline of 1500 µS/cm (ANZECC). A review of trends indicates the conductivity of groundwater in downgradient wells CMBH1 and CMBH2 was generally similar over the monitoring period but inconsistent with upgradient results. The conductivity in upgradient well CMBH4 steadily decreased (from 823 to 110.9 µS/cm) over the monitoring period recording conductivities that were moderately lower than downgradient results and background well CMBH3 during the September and December 2001 monitoring rounds. The conductivity of groundwater in well CMBH3 generally fluctuated over the monitoring period but was slightly higher than downgradient results in the June and September 2001 monitoring rounds.

  A review of trend charts reveals that sodium and chloride concentrations were generally proportional to, and followed similar trends to the electrical conductivities in all wells over the monitoring period. The concentrations of sodium and chloride were consistently higher in well CMBH3 than in other site monitoring wells.

- **General Water Quality Parameters.** In general, concentrations of calcium, magnesium, potassium, bicarbonate and sulphate were elevated downgradient of the site (wells CMBH1 and CMBH2) relative to upgradient groundwater quality (well CMBH4). A review of trends revealed that concentrations of these parameters generally fluctuated in monitoring well CMBH2 over the monitoring period but were consistently higher in both downgradient wells (CMBH1 and CMBH2) than in upgradient well CMBH4. Concentrations in downgradient well CMBH1 generally remained steady over the monitoring period, at levels higher than that noted in upgradient well CMBH4.

  Concentrations of calcium downgradient of the site were typically in the range of 30-45mg/L (range of 7-47mg/L over the reporting period). Upgradient calcium concentrations were consistently below 5mg/L over the reporting period, suggesting an increase in calcium concentrations in the order of 20 times between upgradient and downgradient concentrations. Calcium can result from naturally occurring geology (shells, etc), and is also found in wastes such as building materials (concrete, gyprock, etc). It is understood that such refuse would only comprise a minor amount of the buried material.

  Concentrations of bicarbonate (reported as calcium carbonate) mirrored the trends reported for calcium (as expected). The increase in concentrations downgradient of the site were more

pronounced than for calcium results, with increases typically in the range of between 10 and 20 times (although an increase of approximately 50 times was noted during monitoring round 2).

Potassium and sulphate levels downgradient of the site were 6 to 15 times higher than in upgradient well CMBH4.

Concentrations of magnesium were between 1.4 to 20 times higher in well CMBH1 than in upgradient well CMBH4.

These results indicate a notable variance in groundwater quality between upgradient and downgradient results. While these parameters are indicators of groundwater quality, they may be influenced by the localised geology, the impact of the wetlands immediately downgradient of the site, or leaching from buried refuse. These results flag the need for close assessment of other parameters analysed during this investigation to identify whether this variance is likely to be naturally occurring, or a result of leaching from buried refuse.

- **Iron.** The concentrations of iron generally fluctuated in all wells over the monitoring period with concentrations in background well CMBH3 consistently higher than in other monitoring wells, including those downgradient of the landfill. Iron concentrations above the adopted guideline of 1 mg/L (ANZECC) were recorded in all wells during the monitoring period. Given that groundwater in well CMBH3 is unlikely to be impacted by the landfill unit (considering the estimated direction of groundwater flow), it is unlikely the elevated iron concentrations are due to leachate impaction. The iron concentrations in downgradient wells CMBH1 and CMBH2 were generally comparable with upgradient well CMBH4.

  It should be noted that the guideline level of 1 mg/L has been derived from the ANZECC guidelines for fresh water based on toxicity to aquatic organisms such as insects and the hatchability rates of specified fish. Obviously this is a stringent guideline to apply to groundwater conditions, and the relevance of this assessment should be to flag the need to closely monitor local surface waters for increases in iron.

  Iron is the fourth most abundant element in the earths crust and may be present in natural waters in varying quantities depending upon the geology of the area and other chemical components within the water (ANZECC Guidelines, 1992). As such the local geology may also be contributing to the recorded levels. The Australian Drinking water Guideline (NHMRC 1996) states that iron concentrations of up to 100 mg/L have been recorded in oxygen depleted groundwater.

- **Copper.** The concentration of copper in background well CMBH3 was above the adopted guideline range of 0.002 – 0.005 mg/L (ANZECC) and generally elevated relative to other site wells over the monitoring period. The elevated copper concentrations recorded in well CMBH3 may be related to the lower pH of groundwater at this location. Metals such as copper generally have increased mobility in acidic environments. In general, downgradient copper results were either comparable with, or lower than in upgradient well CMBH4.

- **Manganese.** The concentrations of manganese in downgradient wells CMBH1 and CMBH2 and background well CMBH3 were consistently marginally higher than in upgradient well CMBH4. The manganese results may indicate impaction of groundwater downgradient of the landfill, although other heavy metals results do not indicate any significant issues.

- **Zinc.** Concentrations of zinc in all wells generally fluctuated over the monitoring period with results above the adopted guideline range of 0.005 – 0.05 mg/L recorded in wells CMBH1 (downgradient) and CMBH3 (background). Zinc concentrations in downgradient well CMBH1 peaked during the June and September 2001 monitoring rounds, at levels higher than upgradient well CMBH4. However, zinc concentrations in downgradient well CMBH2 were consistently either lower than or comparable to upgradient well CMBH4. It should also be noted that all recorded zinc concentrations in all wells were significantly lower than the Dutch environmental intervention limit of 0.80 mg/L, indicating the results recorded to date are unlikely to be of environmental concern.

- **Ammonia.** The ammonia (as N) concentrations in downgradient well CMBH1 were significantly higher than in other site wells (including upgradient well CMBH4) with the exception of the December 2001 monitoring round. Negligible concentrations of ammonia were recorded in wells CMBH2 – CMBH4 over the monitoring period. The ammonia results may indicate leachate impaction of groundwater at location CMBH1 either from leachate migration or associated with the wetlands (where organic matter would presumably be higher than at upgradient locations). It should be noted that all ammonia concentrations were below the adopted guideline range of 0.86 – 1.81 mg/L (ANZECC). As such the results are not considered to be of environmental concern (with the latest results from downgradient wells being similar to that upgradient of the site), however further monitoring is recommended to verify results and establish trends.

- **Nitrate.** Elevated concentrations of nitrate (relative to upgradient groundwater) were recorded in downgradient well CMBH2 during the March and June 2001 monitoring rounds and well CMBH1 in the December 2001 monitoring round. The December 2001 result in CMBH1 and all results recorded in CMBH2 were above the adopted guideline range of 0.01 – 0.06 mg/L. The highest recorded nitrate concentration over the monitoring period was in March 2001 in downgradient well CMBH2 (1.19 mg/L). Only minor or undetectable nitrate concentrations were recorded in wells CMBH3 and CMBH4. These results identify an increase in nitrate loading downgradient of the site (although trends do suggest concentrations are decreasing at the downgradient locations).

- **Total Organic Carbon.** In general, only minor concentrations of TOC were recorded in all monitoring wells over the monitoring period. The highest TOC result was recorded in upgradient well CMBH4 in December 2001 (11 mg/L).

- **Other Parameters.** Only minor or undetectable concentrations of arsenic, cadmium, lead and OC/OP pesticides were recorded in both upgradient and downgradient monitoring wells over the monitoring period.

A review of results identifies a notable variance in groundwater quality downgradient of the landfill as compared to upgradient groundwater. The influence of the wetlands is not known, as this would have required groundwater monitoring within the wetlands at a location outside the zone of influence of the landfill.

Dissolved solids (especially calcium, magnesium, potassium, bicarbonate and sulphate) and ammonia concentrations were generally elevated in downgradient wells CMBH1 and CMBH2 relative to upgradient well CMBH4. Concentrations of calcium, magnesium, potassium, bicarbonate and sulphate in downgradient wells were marginally higher in the February and December 2001 monitoring rounds (compared to June and September 2001) indicating the concentrations of these parameters may be influenced by seasonal factors such as rainfall. With the exception of manganese, heavy metals concentrations in downgradient groundwater were generally comparable with upgradient results.

The results may indicate the existence of a minor contaminant plume extending downgradient of the site. As there were no distinct bodies of water observed adjacent to the site (including the Melaleuca Wetlands), it was not possible to conduct surface water sampling to determine the impact of any potential leachate plume on the adjacent wetlands.

5.2 LANDFILL GAS GENERATION AND MIGRATION ISSUES

Two rounds of landfill gas monitoring were undertaken at the site (March and September 2001). The results from the landfill gas investigation indicated the following:

- **Subsurface Soil Atmospheric Monitoring**. Only minor concentrations of methane gas between 0.1 and 0.3% (by volume) were detected in all soil gas monitoring wells at the site. As such, the results were below the adopted environmental guidelines (5% CH_4 by volume) but indicate that landfill gas may be migrating from the landfill site at minor concentrations.

- **Surface Gas Emissions.** Negligible surface methane gas concentrations were recorded over the landfill cap (ranging between 0 and 50 ppm). The vegetation above the cap was healthy in comparison to off-site vegetation. No vegetation dieback, a typical indicator of elevated methane concentrations, was noted during site visits.

- **Site Structures Monitoring.** Methane monitoring was undertaken within the following structures at the site, in which the potential exists for accumulation of methane (refer Figure A3, Attachment A1).

  - Culvert (C1)
  - Toilet building (S1)
  - Transfer station (S2)

  Only minor concentrations of methane were detected in these structures (between 0.2 and 0.3 % by volume) in the March 2001 round. As such all results were below the adopted guideline of 25% of the lower explosive limit for methane (LEL = 5% ie, guideline limit = 1.25% methane by volume). No methane was recorded in any site structures in the September 2001 monitoring round.

5.3 CAPPING LAYER ASSESSMENT

Capping Material Contaminant Status

Three samples (CMBH17 – CMBH19) of capping material were collected during investigative drilling and submitted for laboratory analysis for heavy metals, organophosphorous and organochlorine (OC/OP) pesticides, total petroleum hydrocarbons (TPH) and total phenols. Results of capping material analysis are presented in Table A3, Attachment A3 while official laboratory documentation is contained in Appendix A. Sample locations are indicated on Figure A2, Attachment A1. A review of the capping material analytical laboratory results is provided below:

- **Zinc.** A zinc concentration of 220 mg/kg was recorded in sample CMBH18 which is marginally above the adopted environmental investigation threshold of 200 mg/kg. This result is well below the health based investigation threshold criteria of 14,000 mg/kg.

- **Other Parameters.** Only minor concentrations of heavy metals were detected in soil samples collected from the capping. All heavy metals results, with the exception of the above mentioned zinc concentration, were below the adopted environmental investigation thresholds. No OC/OP pesticides, TPH compounds or phenols were detected in the samples.

Capping Thickness and Permeability

Observations by Egis personnel during investigative drilling program indicate the capping layer consists of a clayey sand/sandy clay material which is red-brown in colour. Results of the capping material assessment are discussed below:

- **Capping Thickness.** A review of borehole logs for investigative boreholes across the landfill cap indicated that the capping material extended approximately 0.4 to 1.0 m below ground level. The observed thicknesses indicate that the capping over some areas of the landfill is marginally less than the EPA guideline of 0.5 m.

- **Compaction Testing.** Field density and moisture content testing was undertaken at two locations (T1 and T2, refer Figure A2, Attachment A1) over the landfill cap in the field by Earthtech Laboratories technicians. At location T1, testing indicated the field dry density of the capping material was marginally higher than the estimated maximum dry density for the material resulting in a dry density ratio marginally over 100%. Testing at location T2 indicated a dry density ratio of 84.5%. A dry density ratio of 95% is generally considered to be sufficient to minimise infiltration of stormwater to refuse. The results indicate that the level of compaction of the capping layer varies across the site and is likely to be insufficient at some locations.

- **Laboratory Permeability.** The results of field density and moisture content tests also allowed the determination of the laboratory permeability of one of the capping material samples (T1). The laboratory permeability testing results indicated the capping material had a potential coefficient of permeability of 6.0×10^{-10} m/s (ie, remoulded in the laboratory). The result complied with the typical guideline of a maximum of 1×10^{-7} m/s.

6. RAPID HAZARD ASSESSMENT

Historical information and information obtained during the site investigations of the Coochiemudlo Island former landfill site formed the basis of information used to undertake the rapid hazard assessment. The assessment targeted potential environmental and human health hazards the site may pose, considering groundwater, surface water, soil, air emissions, site configuration and existing site management implementations.

The assessment took into account the potential for former landfilling operations at this site to cause both environmental and human health hazards (potential hazard rating), and then refined the analysis to incorporate known site data with respect to monitoring results and known site specific data, providing the known hazard rating. To evaluate the 'known hazard', each of the identified receptor environments were sampled, analysed in a NATA accredited laboratory and compared against recognised environmental criteria.

Based on this methodology, a potential hazard rating of 18.7 (out of a maximum of 100) was calculated, which equates to a Class 3 rating (indicating there is moderate priority for further investigation).

The subsequent refined assessment, taking into account known site specific information from this investigation, yielded a known hazard rating of 2.8 (out of a maximum of 100) which equates to a Class N rating (indicating that there is no priority for further investigation). This result represents the known hazard for the site and is based on current site conditions (ie, with respect to current management).

The primary reason for the site yielding a low hazard score is due to the low levels of contaminants in downgradient groundwater (despite the fact that there was an observed variance in groundwater quality between upgradient and downgradient samples) and the lack of surface water bodies adjacent to the site.

In general, sufficient information was available to adequately assess the environmental and human health hazards associated with the Coochiemudlo Island former landfill.

In summary, the findings of the rapid hazard assessment identified the following:

- Potential hazard rating – 18.7 (Class 3).
- Known hazard rating – 2.8 (Class N)

The results of the rapid hazard assessment suggest the site currently represents negligible concern for environmental and human health. However, the potential hazard rating indicates a moderate risk of environmental or human health issues associated with former landfill, arising in the future. The rapid hazard assessment procedure and results summary are provided in Appendix B.

7. CONCLUSIONS

This environmental assessment of the Coochiemudlo Island former landfill site was undertaken as part of the DCILGP Landfill Remediation Assessment Program (LRAP). The objective of the study, as defined in the GENERAL section of this report, was to:

> *"provide an understanding of the current environmental status of the former landfill site with regards to the associated environmental impacts to both natural and human environments".*

In order to achieve this objective, an assessment of groundwater quality and landfill gas monitoring has been undertaken, and assessed with respect to site specific historical information and potential risk associated with susceptible natural and human receptors. It is noted that no surface water bodies were observed in close proximity to the site and as such, monitoring of surface water quality and sediment contamination was not undertaken. The following provides a summary of the findings of this assessment.

Summary

The assessment undertaken at the Coochiemudlo Island former landfill site over the period between January 2001 to December 2001 has not identified any current significant environmental impact as a result of former landfilling practices.

The most notable impact is that on groundwater quality, with sampling results for downgradient monitoring wells identifying potential minor leachate impaction (although the influence of the wetlands immediately downgradient of the site could not be quantified during this study. Current concentrations do not suggest the need for any immediate remedial actions at this point in time.

It is considered that, based on the short to mid term trends in contaminant concentrations (water quality, gas, etc), the site is suitable for it's current usage as a sporting facility, with minimal risk to site users as a result of the former landfilling practices.

It is difficult to assess the impact on local environmental receptors of any potential groundwater contamination immediately downgradient of the site. The closest downgradient receptor is Melaleuca Wetlands immediately adjacent to the site however no surface water was observed at this location during site visits.

General

The Coochiemudlo Island former landfill site was operated for a period of 22 years between 1972 and 1994. It is estimated the site may have received up to 5,000 m^3 of waste during this period. On completion of landfilling operations, the site was levelled and a 300 – 500 mm thick permeable soil cover applied across the site. The site is currently used as a waste transfer station and public recreational and sporting facilities.

Groundwater

The most notable impact resulting from the former landfilling practice is associated with groundwater quality. Results of monitoring suggest that there may have been minor contamination of groundwater downgradient of the site.

Dissolved solids (especially calcium, magnesium, potassium, bicarbonate and sulphate) and ammonia concentrations were generally elevated in downgradient wells CMBH1 and CMBH2 relative to upgradient well CMBH4. Concentrations of calcium, magnesium, potassium, bicarbonate and sulphate in downgradient wells were marginally higher in the February and December 2001 monitoring rounds (compared to June and September 2001) indicating the concentrations of these parameters may be influenced by seasonal factors such as rainfall. With the exception of manganese, heavy metals concentrations in downgradient groundwater were generally comparable with upgradient results.

The results may indicate the existence of a minor contaminant plume extending downgradient of the site. As there were no distinct bodies of water observed adjacent to the site (including the Melaleuca Wetlands), it was not possible to conduct surface water sampling to determine the impact of any potential leachate plume on the adjacent wetlands.

While contaminant concentrations downgradient of the site are not considered to be a major concern, they are (in many instances) notably higher than that observed upgradient of the landfill site. Based on the relatively minor level of contamination detected in groundwater, it is considered that the potential minor impact on downgradient groundwater does not warrant any immediate remedial action at this stage.

Landfill Capping

Observations during the investigative drilling program indicated that the capping layer consists of a clayey sand/sandy clay material. A review of borehole logs across the landfill cap indicated that the material extends approximately 0.4 to 1.0 m below ground level. The observed thicknesses indicate that the capping over some areas of the landfill is marginally less than the EPA guideline of 0.5 m.

Three samples of capping material were submitted for laboratory analysis for heavy metals, organophosphorous and organochlorine (OC/OP) pesticides, total petroleum hydrocarbons (TPH) and total phenols. Results identified a zinc concentration of 220 mg/kg in sample CMBH18 which is marginally above the adopted environmental investigation threshold of 200 mg/kg. This result is well below the health based investigation threshold criteria of 14,000 mg/kg. Only minor concentrations of heavy metals were detected in soil samples collected from the capping. All heavy metals results, with the exception of the above mentioned zinc concentration, were below the adopted environmental investigation thresholds. No OC/OP pesticides, TPH compounds or phenols were detected in the samples.

Field density and moisture content testing was undertaken at two locations. Dry density ratios of marginally over 100% and 84.5% were recorded at these locations. A dry density ratio of 95% is generally considered to be sufficient to minimise infiltration of stormwater to refuse. The results indicate that the level of compaction of the capping layer varies across the site and is likely to be insufficient at some locations.

Laboratory permeability testing results indicated the capping material had a potential coefficient of permeability of 6.0×10^{-10} m/s (ie, remoulded in the laboratory). The result complied with the typical guideline of a maximum of 1×10^{-7} m/s.

Landfill Gas

Monitoring was undertaken to assess the presence of landfill gas in the soil atmosphere from wells at the site boundary, within site structures (gas accumulation), and above the site capping (to detect migration of landfill gas). During the two rounds of monitoring undertaken over the reporting period:

- Minor concentrations of methane (significantly below guideline trigger levels) were noted in the soil atmosphere during both rounds of monitoring.
- Minor concentrations of methane (significantly below guideline trigger levels) were detected within on site structures, indicating that methane is currently accumulating within the on site structures assessed at levels which are not considered to be a safety/health concern.
- Negligible methane concentrations (maximum of 50 ppm) were detected immediately above the nominal capping layer.

While this monitoring does not provide any information on methane generation rates, they indicate that migration of landfill gas from the site is minimal, and currently not an environmental or human health concern. This is confirmed through the absence of any vegetation dieback; a typical indicator of methane release from a site. It is noted, however, that gas is migrating from the landfill (albeit at extremely low concentrations), and as such the possibility of accumulation within site structures, etc must be considered during any future work undertaken at the site. Routine monitoring would be considered prudent as a means of establishing long term trends and identifying any potential risk.

Rapid Hazard Assessment

Based on this methodology, a potential hazard rating of 18.7 (out of a maximum of 100) was calculated, which equates to a Class 3 rating (indicating there is moderate priority for further investigation).

The subsequent refined assessment, taking into account known site specific information from this investigation, yielded a known hazard rating of 2.8 (out of a maximum of 100) which equates to a Class N rating (indicating that there is no priority for further investigation). This result represents the known hazard for the site and is based on current site conditions (ie, with respect to current management).

The primary reason for the site yielding a low hazard score is due to the low levels of significant contaminants in downgradient groundwater (despite the fact that there was an observed variance in groundwater quality between upgradient and downgradient samples) and the absence of surface water bodies adjacent to the site.

In general, sufficient information was available to adequately assess the existing environmental and human health hazards associated with the Coochiemudlo Island former landfill.

8. RECOMMENDATIONS

As there are no current significant risks to surrounding environments as a result of the former Coochiemudlo Island landfill identified during the LRAP assessment, it is considered that no immediate remedial actions are required at this stage.

It should be noted this environmental monitoring investigation was conducted over a year long period in order to allow an assessment of short to mid term seasonal trends to be undertaken. Given that leachate impaction of groundwater downgradient of the site is possible and that gas accumulation within site structures has been detected (at very low concentrations), the following recommendation is provided:

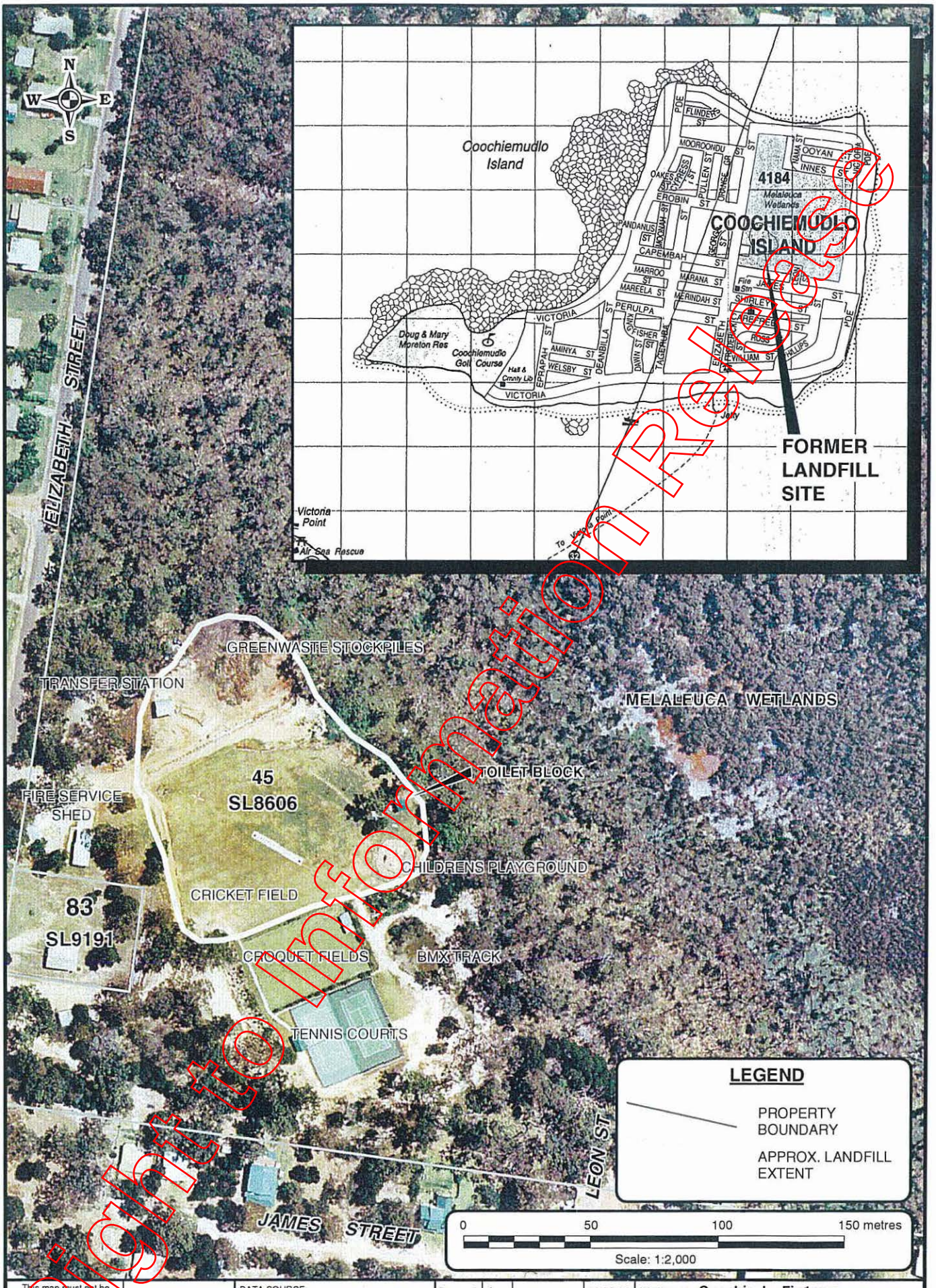
R1 Continued monitoring of groundwater quality and landfill gas concentrations for a period of two years (biannual monitoring) to allow verification of the results obtained during this investigation while establishing seasonal and long-term trends in contaminant concentrations.

(Note - This is not considered to be an essential implementation, but one that Council may consider to confirm the findings of this report and minimise the likelihood of any future risk [environmental and/or health] associated with the site).

It is considered that the current site use (transfer station and sporting fields) is suitable for the site and that there is minimal risk to onsite users resulting from the former landfill. If Council plan to change the current use of the site, a site management plan should be prepared to ensure that appropriate decisions are made in regard to minimising the potential risks associated with future activities conducted on the site.

ATTACHMENT A1

SITE FIGURES



DATA SOURCE:
Field Notes and Field Investigation
Universial Press Pty Ltd

Prepared.	jvc		30.05.01	Workspace	Coochie_Is_Fig1.wor
Checked.	L.F.		30.05.01	Location	W:\Environmental\Projects\VQ\1211\Gis
Approved.	A.M.		30.05.01	Map Grid	AMG Zone 56 (AGD84)

egis consulting
ABN 25 098 135 892 ACN 098 135 892 Australia
66 Eagle Street
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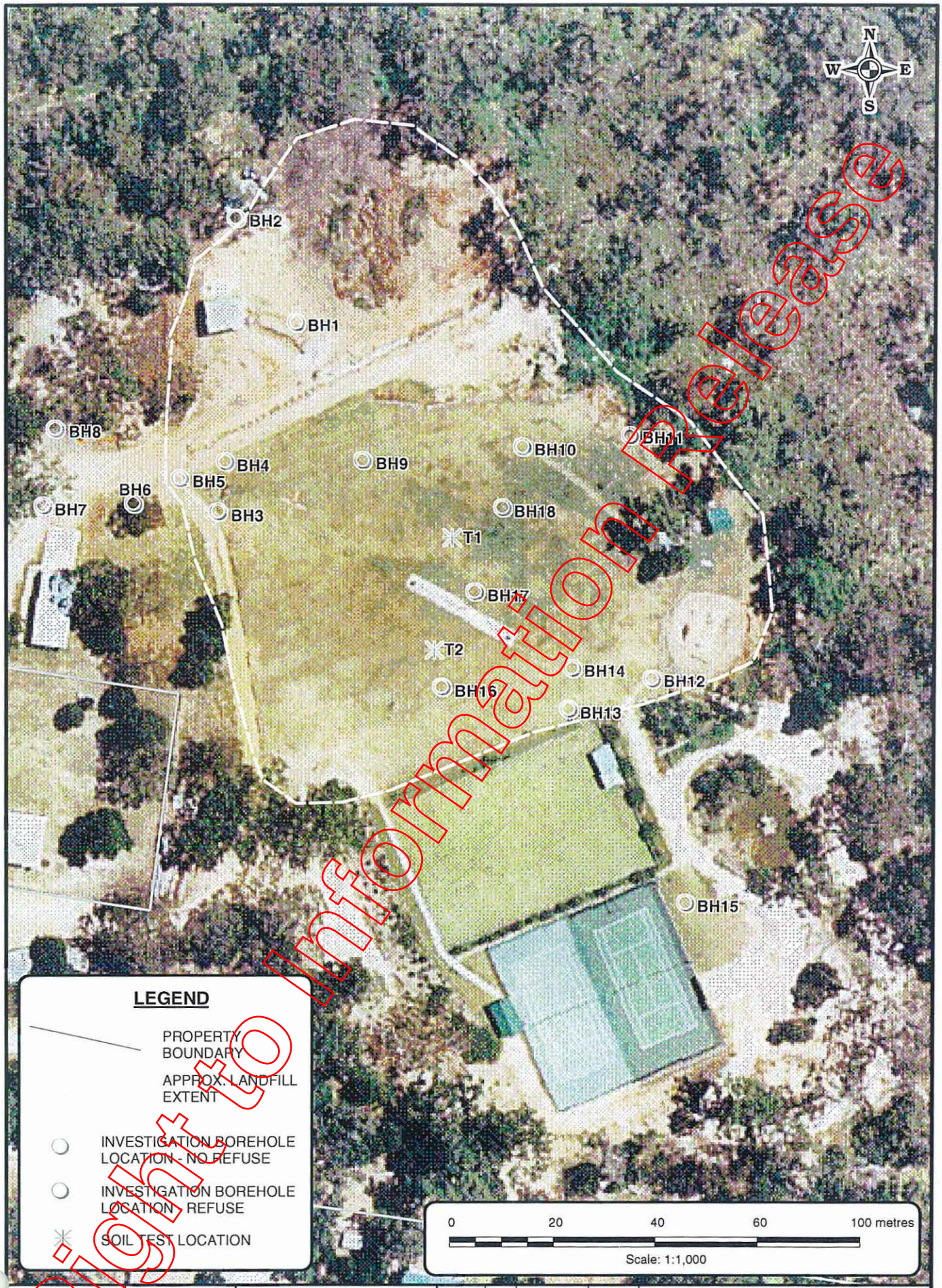
Tel : 61 7 3233 1611
Fax : 61 7 3233 1649

Project: Redlands Shire Council - LRAP Sites

TITLE: COOCHIEMUDLO IS. FORMER LANDFILL - LOCALITY MAP

Project No.	Date.				
VQ1211	30.05.01	A4	FIGURE 1	Sh 1 of 3	Rev. 0



DATA SOURCE: Field Notes and Field Investigation

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Checked.	D.S.		30.05.01	Location	W:\Environmental\Projects\VQ\1211\Gis
Approved.	A.M.		30.05.01	Map Grid	AMG Zone 56 (AGD84)

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66 Eagle Street BRISBANE QLD 4000
Tel : 61 7 3233 1611
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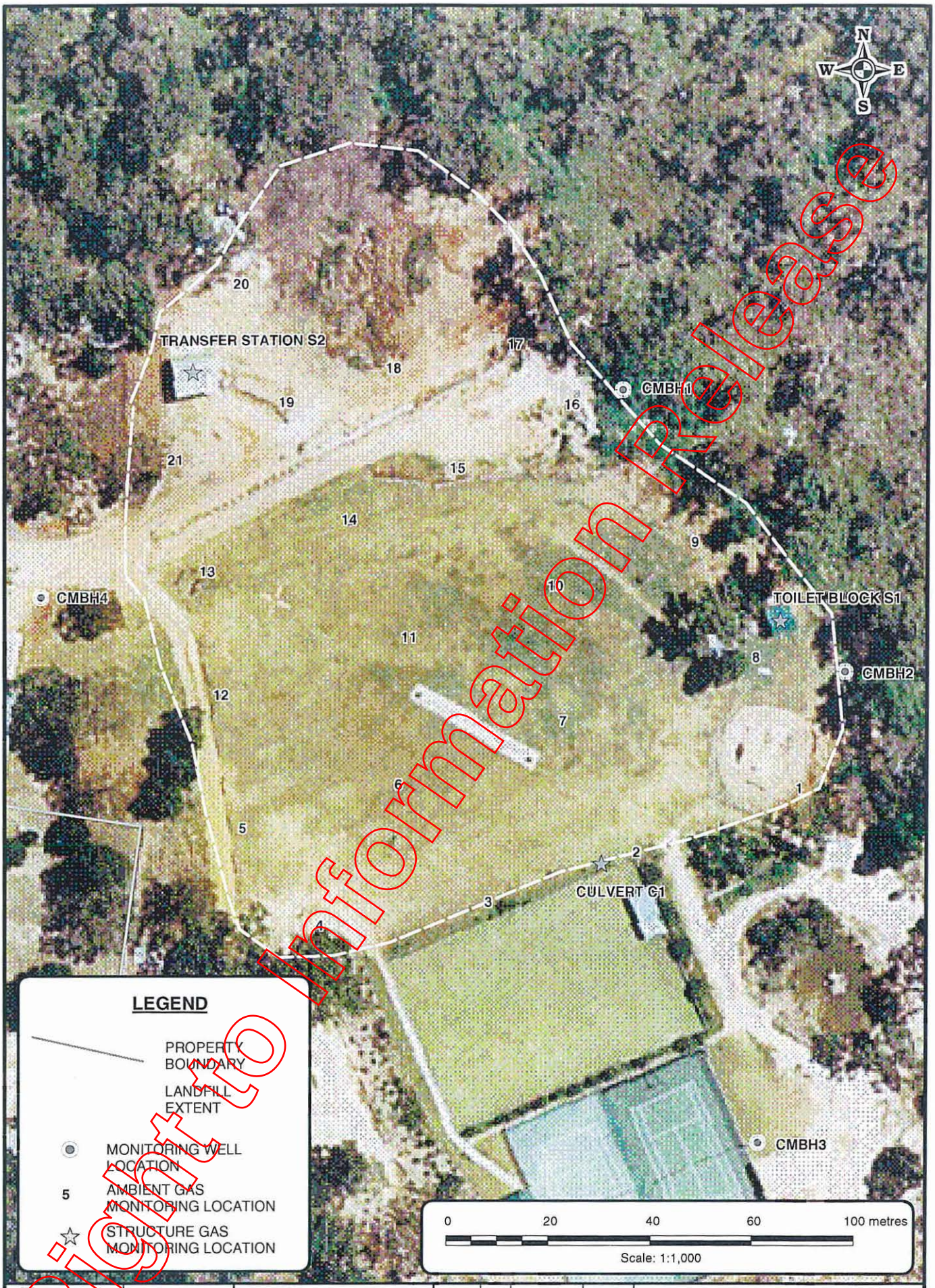
Project: Redlands Shire Council - LRAP Sites

TITLE: COOCHIEMUDLO IS. FORMER LANDFILL - INVESTIGATIVE DRILLING LOCATIONS

Project No.	Date.			
VQ1211	30.05.01	A4	FIGURE 2	Sh 2 of 3 Rev. 0



DATA SOURCE: Field Notes and Field Investigation

Prepared.	jvc		30.05.01	Workspace	Coochie_Is_Fig3.wor
Checked.	D.S		30.05.01	Location	W:\Environmental\Projects\VQ\1211\GIS
Approved.	A.M.		30.05.01	Map Grid	AMG Zone 56 (AGD84)

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Project: Redlands Shire Council - LRAP Sites

TITLE: COOCHIEMUDLO IS. FORMER LANDFILL - QUARTERLY MONITORING LOCATIONS

Project No.	Date.				
VQ1211	30.05.01	A4	FIGURE 3	Sh 3 of 3	Rev. 0

ATTACHMENT A2

INVESTIGATIVE DRILLING AND MONITORING WELL BORELOGS

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	CMBH1
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	
Date	31/01/2001	Drill Rig	Edson 3000
R L Casing	-	Driller	MG
Contractor	Geoprobe	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	Air			0.0	Clayey sand (SC), medium grained, orange, moist		
				0.3	Clayey sand (SC), well graded, black, moist		
0.5				0.5	Sandy clay (CH), high plasticity, coarse sand, well graded, moist grey		
1.0							
1.5			WT				
			1.8		Groundwater encountered		
2.0							
2.5							
3.0				3.0	Sandy clay (CH), high plasticity, red, wet		
3.5							
4.0							
4.5				4.5	BOREHOLE TERMINATED		

Notes:

0.0-0.1m Sample was laboratory analysed

Monitoring Well Construction Legend

Blank casing
Screened interval
Graded sand backfill
Concrete
Backfill
Bentonite plug

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	CMBH2
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	
Date	31/01/2001	Drill Rig	Edson 3000
R L Casing	-	Driller	MG
Contractor	Geoprobe	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	Air			0.0	Clayey sand (SC), medium grained, orange, moist		
				0.3	Clayey sand (SC), well graded, black, moist		
0.5				0.5	Sandy clay (CH), high plasticity, coarse sand, well graded, moist grey		
1.0							
1.5			WT				
			1.8		Groundwater encountered		
2.0							
2.5							
3.0				3.0	Sandy clay (CH), high plasticity, red, wet		
3.5							
4.0							
4.5				4.5	BOREHOLE TERMINATED		

Notes:

0.0-0.1m Sample was laboratory analysed

Monitoring Well Construction Legend

Blank casing
Screened interval
Graded sand backfill
Concrete
Backfill
Bentonite plug

EGIS CONSULTING - ENVIRONMENTAL
BOREHOLE LOG REPORT

Client: Redland Shire Council
Project: LRAP - Site Investigation
Location: Coochiemudlo Island
Borehole No: CMBH3
Job Number: VQ1211

Borehole Location
Logged by: LF
Date: 31/01/2001
R L Casing: -
GPS Coord
Contractor: Geoprobe
Drill Rig: Edson 3000
Driller: MG
Drilling Fluid: NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	Sandy clay (CL), low plasticity, slightly moist, dark brown.		
1.0				1.0	Sandy clay (CL), medium plasticity, moist, orange		
2.0				2.0	Sandy clay/clayey sand (CL/SC), coarse grained, low plasticity, crumbly, moist, red/white mottled		
3.0				2.8	Clayey sand (SC), course grained, well graded, moist, red		
4.0							
5.0							
6.0				6.0	Clayey sand (SC), course grained, well graded, moist to wet		
7.0			WT 7.0	7.0	Groundwater encountered		
8.0							
9.0							
10.0				10.5	ROCK - refusal		
11.0				10.5	BOREHOLE TERMINATED		
12.0							

Notes:
0.0-0.1m: Sample was laboratory analysed

Monitoring Well Construction Legend
Blank casing
Screened interval
Graded sand backfill
Concrete
Backfill
Bentonite plug

EGIS CONSULTING - ENVIRONMENTAL
BOREHOLE LOG REPORT

Client: Redland Shire Council
Project: LRAP - Site Investigation
Location: Coochiemudlo Island
Borehole No: CMBH4
Job Number: VQ1211

Borehole Location
Logged by: LF
Date: 31/01/2001
R L Casing: -
GPS Coord
Contractor: Geoprobe
Drill Rig: Edson 3000
Driller: MG
Drilling Fluid: NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	Clayey sand (SC), fine to medium grained, well graded, red, moist		
1.0				0.5	Clayey sand (SC), medium grained, well graded, brown, dry		
2.0				2.0	ROCK - sandstone layers approximately 0.2 to 0.3 m thick located between clayey sand (SC), red, fine to course, slightly moist		
3.0							
4.0							
5.0							
6.0							
7.0				7.0	Clayey sand (SC), course grained, grey, well graded, moist		
8.0							
9.0			WT 9.0	9.0	Groundwater encountered		
10.0							
11.0							
12.0				12.0	BOREHOLE TERMINATED		

Notes:
0.0-0.1m: Sample was laboratory analysed

Monitoring Well Construction Legend
Blank casing
Screened interval
Graded sand backfill
Concrete
Backfill
Bentonite plug

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH1
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	
Date	31/01/2001	Drill Rig	J100
R L Casing	-	Driller	RT
		Contractor EARTHTECH	Drilling Fluid NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, moist		
0.5							
1.0				0.8	REFUSE - plastic/glass		
1.5				1.2	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH2
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	
Date	31/01/2001	Drill Rig	J100.
R L Casing	-	Driller	RT
		Contractor EARTHTECH	Drilling Fluid NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Clayey sand (SC) brown orange mottled, moist		
0.5							
1.0				0.8	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH3
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 328 62
Date	31/01/2001		J 69 502 76
R L Casing	-	Contractor	EARTHTECH
		Drill Rig	J100
		Driller	RT
		Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Clayey sand (SC), red, fine to medium grained, moist		
0.5							
1.0				1.0	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.4m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH4
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 328 47
Date	31/01/2001		J 69 503 03
R L Casing	-	Contractor	EARTHTECH
		Drill Rig	J100
		Driller	RT
		Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), fine to medium grained, red/brown, moist		
0.5				0.5	REFUSE - glass/tin/carpet		
1.0				0.8	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.5m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH5
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 328 58	Drill Rig	J100
Date	31/01/2001		J 69 503 14	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), red/brown, fine to medium grained, moist		
0.5							
1.0				1.0	REFUSE - plastic, loose		
				1.2	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH6
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 328 19	Drill Rig	J100
Date	31/01/2001		J 69 503 02	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Clayey sand (SC), red/brown, fine, slightly moist		
0.5							
1.0							
				1.2	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH7
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 328 23	Drill Rig	J100
Date	31/01/2001		J 69 503 12	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Sand (SC), brown, fine grained, dry, dense		
0.5				0.6	NATURAL - Sandy clay (CL), red, medium plasticity, moist		
1.0							
1.5				1.2	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH8
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 328 19	Drill Rig	J100
Date	31/01/2001		J 69 503 18	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - sand, brown,fine grained, dry, dense		
0.5				0.6	Clay (CH), red,m high plasticity, moist		
1.0							
1.5				1.2	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH9
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 328 58	Drill Rig	J100
Date	31/01/2001		J 69 503 13	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	Clayey sand (SC), red/brown, fine to medium grained, moist		
0.5							
				0.8	REFUSE - plastic with pieces of glass		
1.0							
1.5				1.5	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.5m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH10
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 329 17	Drill Rig	J100
Date	31/01/2001		J 69 503 13	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, moist		
0.5				0.4	REFUSE - plastic/ash/glass		
1.0				0.8	EOH - Borehole terminated - refusal		
1.5							
2.0							

Notes:

0.0-0.4m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH11
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 329 26	Drill Rig	J100
Date	31/01/2001		J 69 503 40	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, moist, loose, evidence of burnt tree waste		
0.5							
1.0							
1.5							
2.0				2.0	EOH - Borehole terminated		

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council				
Project	LRAP - Site Investigation			Borehole No	BH12
Location	Coochiemudlo Island			Job Number	VQ1211
Borehole Location					
Logged by	LF	GPS Coord	56 5 329 53	Drill Rig	J100
Date	31/01/2001		J 69 502 67	Driller	RT
R L Casing	-	Contractor	EARTHTECH	Drilling Fluid	NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, moist		
0.5							
				0.6	EOH - Borehole terminated - refusal		
1.0							
1.5							
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH13
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 329 03
Date	31/01/2001		J 69 502 63
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Sandy clay (CL), red/orange, medium plasticity, moist		
0.5							
1.0				1.0	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.1 m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH14
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 328 82
Date	31/01/2001		J 69 502 68
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, moist		
0.5							
1.0				0.8	REFUSE - glass/plastic/wire		
1.5				1.6	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1 m Sample was laboratory analysed

EGIS CONSULTING - ENVIRONMENTAL

BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH15
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 329 32
Date	31/01/2001		J 69 502 27
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Sandy clay (CL), red/brown, medium plasticity, moist		
0.5							
1.0				1.0	NATURAL - Sandy clay (CL), red/grey mottled, medium plasticity		
1.5				1.5	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

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BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH16
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 329 34
Date	31/01/2001		J 69 502 36
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Sandy clay (CL) red/brown, moist, medium plasticity		
0.5							
1.0				1.0	NATURAL - Sandy clay, (CL) red/grey mottled, medium plasticity		
1.5				1.2	EOH - Borehole terminated		
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

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BOREHOLE LOG REPORT

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Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH17
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 328 82
Date	31/01/2001		J 69 502 69
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	FILL - Clayey sand (SC), brown, fine to medium grained, slightly moist		
0.5							
1.0							
				1.2	EOH - Borehole terminated		
1.5							
2.0							

Notes:
0.0-0.1m Sample was laboratory analysed

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BOREHOLE LOG REPORT

Page 1 of 1

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH18
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord	56 5 328 85
Date	31/01/2001		J 69 502 76
R L Casing	-	Contractor	EARTHTECH
Drill Rig	J100		
Driller	RT		
Drilling Fluid	NONE		

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Clayey sand (SC), brown, fine grained, slightly moist		
0.5							
				0.8	EOH - Borehole terminated		
1.0							
1.5							
2.0							

Notes:
0.0-0.1m Sample was laboratory analysed

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BOREHOLE LOG REPORT

Client	Redland Shire Council		
Project	LRAP - Site Investigation	Borehole No	BH19
Location	Coochiemudlo Island	Job Number	VQ1211
Borehole Location			
Logged by	LF	GPS Coord 56 5 328 01	Drill Rig J100
Date	31/01/2001	J 69 503 12	Driller RT
R L Casing	-	Contractor EARTHTECH	Drilling Fluid NONE

Depth	Drilling Method	Well	SWL	Strata Change	Material Description	Sample ID Test Depth (m)	Test Results/Field Records
0.0	SF			0.0	NATURAL - Clayey sand (SC), brown, fine, slightly moist		
0.5							
1.0							
				1.2	EOH - Borehole terminated		
1.5							
2.0							

Notes:

0.0-0.1m Sample was laboratory analysed

ATTACHMENT A3

LABORATORY RESULTS AND TREND CHARTS

Table A3
Soil Analyses Results
COOCHIEMUDLO ISLAND FORMER LANDFILL SITE

ANALYTICAL PARAMETERS		UNITS	LOR	SAMPLE RESULTS 9/02/2001			Environmental Investigation Threshold (mg/L)	
				CMBH17	CMBH18	CMBH19		
HEAVY METALS	Arsenic (Total)	mg/kg	1	<1	2	1	20	
	Cadmium (Total)	mg/kg	1	<1	<1	<1	3	
	Chromium (Total)	mg/kg	1	15	17	15	50	
	Copper (Total)	mg/kg	1	1	12	5	60	
	Nickel (Total)	mg/kg	1	2	6	2	60	
	Lead (Total)	mg/kg	1	4	26	19	300	
	Zinc (Total)	mg/kg	1	12	220	69	200	
ORGANOCHLORINE PESTICIDES	alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.05		
	HCB	mg/kg	0.05	<0.05	<0.05	<0.05		
	beta-BHC & gamma-BHC	mg/kg	0.1	<0.1	<0.1	<0.1		
	delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.05		
	Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.05		
	Aldrin	mg/kg	0.05	<0.05	<0.05	<0.05	0.2	(a)
	Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlordane - trans	mg/kg	0.05	<0.05	<0.05	<0.05		
	Endosulfan 1	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlordane - cis	mg/kg	0.05	<0.05	<0.05	<0.05		
	Dieldrin	mg/kg	0.05	<0.05	<0.05	<0.05	0.2	(a)
	DDE	mg/kg	0.05	<0.05	<0.05	<0.05	0.2	(b)
	Endrin	mg/kg	0.05	<0.05	<0.05	<0.05		
	Endosulfan 2	mg/kg	0.05	<0.05	<0.05	<0.05		
	DDD	mg/kg	0.05	<0.05	<0.05	<0.05	0.2	(b)
	Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.05		
	Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.05		
	DDT	mg/kg	0.2	<0.2	<0.2	<0.2	0.2	(b)
	Endrin ketone	mg/kg	0.05	<0.05	<0.05	<0.05		
	Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.2		
ORGANOPHOSPHORUS PESTICIDES	Dichlorvos	mg/kg	0.05	<0.05	<0.05	<0.05		
	Demeton-S-methyl	mg/kg	0.05	<0.05	<0.05	<0.05		
	Monocrotophos	mg/kg	0.2	<0.2	<0.2	<0.2		
	Dimethoate	mg/kg	0.05	<0.05	<0.05	<0.05		
	Diazinon	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlorpyrifos-methyl	mg/kg	0.05	<0.05	<0.05	<0.05		
	Parathion-methyl	mg/kg	0.2	<0.2	<0.2	<0.2		
	Malathion	mg/kg	0.05	<0.05	<0.05	<0.05		
	Fenthion	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlorpyrifos	mg/kg	0.05	<0.05	<0.05	<0.05		
	Parathion	mg/kg	0.05	<0.05	<0.05	<0.05		
	Pirimphos-ethyl	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlorfenvinphos E	mg/kg	0.05	<0.05	<0.05	<0.05		
	Chlorfenvinphos Z	mg/kg	0.05	<0.05	<0.05	<0.05		
	Bromophos-ethyl	mg/kg	0.05	<0.05	<0.05	<0.05		
	Fenamiphos	mg/kg	0.05	<0.05	<0.05	<0.05		
	Prothiofos	mg/kg	0.05	<0.05	<0.05	<0.05		
	Ethion	mg/kg	0.05	<0.05	<0.05	<0.05		
	Carbophenothion	mg/kg	0.05	<0.05	<0.05	<0.05		
	Azinphos-methyl	mg/kg	0.05	<0.05	<0.05	<0.05		
TOTAL PETROLEUM HYDROCARBONS	C_6 - C_9 Fraction	mg/kg	2	<2	<2	<2		
	C_{10} - C_{14} Fraction	mg/kg	50	<50	<50	<50		
	C_{15} - C_{28} Fraction	mg/kg	100	<100	<100	<100		
	C_{29} - C_{36} Fraction	mg/kg	100	<100	<100	<100		
PHENOLS	Total Phenols	mg/kg	1	<1	<1	<1		

Guidelines Environmental Investigation Levels, Investigation thresholds for contaminants in soils - Draft Guidelines for the Assessment & Management of Contaminated Land in Queensland, Queensland Department of Environment, May 1998

Notes

NE No guideline concentration established
NA Not Analysed
Bold and shading indicates exceedance of Environmental Investigation Threshold
(Total) Sample not filtered prior to analysis

(a) Combined total for Aldrin & Dieldrin
(b) Combined total for DDD, DDT, DDE

Table A4 - Part I

Soil Atmosphere Gas Results from Monitoring Wells at Coochiemudlo Island Former Landfill (12/3/01)

Well	Methane (%)		Hydrogen Sulphide (%)		Oxygen (%)	
	Inside	Adjacent	Inside	Adjacent	Inside	Adjacent
CMBH1	0.2	0.2	0	0	21	21
CMBH2	0.3	0.3	0	0	20.1	21
CMBH3	0.3	0.3	0	0	18.6	20.9
CMBH4	0.3	0.2	0	0	17.8	21.1

Notes:
Inside: Gas was measured from inside the well (1m below top of casing) - well cap was closed
Adjacent: Gas was measured from adjacent from the ground adjacent to the well
Guideline limit = 5% methane by volume (ie 100% LEL)

Surface Gas Emission Monitoring Results at Coochiemudlo Island Former Landfill (12/3/01)

Grid Reference	Methane (ppm)	Hydrogen Sulphide (%)	Oxygen (%)
1	0	0	21.1
2	0	0	21.0
3	0	0	21.0
4	0	0	21.1
5	0	0	21.2
6	0	0	21.1
7	0	0	21.1
8	0	0	21.0
9	0	0	21.1
10	0	0	21.0
11	0	0	21.0
12	0	0	21.0
13	0	0	21.1
14	0	0	21.0
15	0	0	21.1
16	50	0	21.0
17	0	0	21.1
18	50	0	21.0
19	0	0	21.0
20	0	0	21.0
21	0	0	21.0

Gas Results from Structures at Coochiemudlo Island Former Landfill (12/3/01)

Structure	Methane %	Hydrogen Sulphide (%)	Oxygen (%)
Culvert C1	0.3	0	21.1
Toilet building S1	0.2	0	21.2
Transfer Station S2	0.2	0	21.1

Notes:
Guideline limit = 1.25% methane by volume (ie 25% LEL)
All measurements were taken in confined areas under or within the structure where methane gas is most likely to accumulate

Table A4 - Part II

Soil Atmospheric Gas Results from Monitoring Wells at Coochiemudlo Island Former Landfill (19/9/01)

Well	Methane (%)		Hydrogen Sulphide (%)		Oxygen (%)	
	Inside	Adjacent	Inside	Adjacent	Inside	Adjacent
CMBH1	0.2	0	0	0	20.1	21.0
CMBH2	0.2	0	0	0	20.4	21.0
CMBH3	0.2	0	0	0	18.6	20.9
CMBH4	0.1	0	0	0	18.1	21.0

Notes:
Inside: Gas was measured from inside the well (1m below top of casing) - well cap was closed
Adjacent: Gas was measured from adjacent from the ground adjacent to the well
Guideline limit = 5% methane by volume (ie 100% LEL)

Surface Gas Emission Monitoring Results at Coochiemudlo Island Former Landfill (19/9/01)

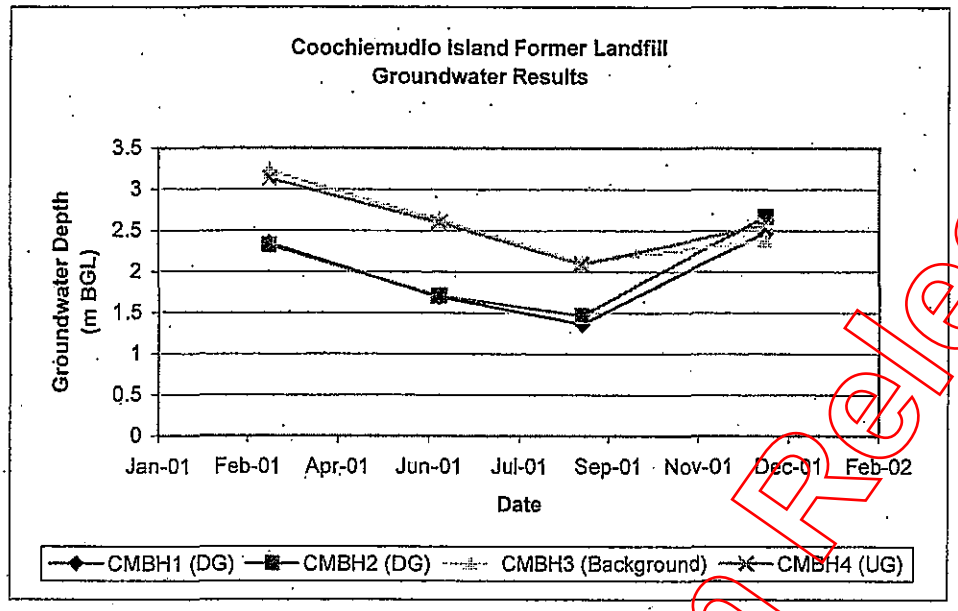
Grid Reference	Methane (ppm)	Hydrogen Sulphide (%)	Oxygen (%)
1	0	0	21.0
2	0	0	21.0
3	0	0	20.9
4	0	0	21.0
5	0	0	20.8
6	0	0	21.0
7	50	0	21.0
8	0	0	21.0
9	0	0	21.0
10	0	0	21.0
11	0	0	21.0
12	0	0	21.0
13	50	0	21.0
14	0	0	21.0
15	50	0	21.0
16	0	0	21.0
17	0	0	20.9
18	50	0	21.0
19	0	0	21.0
20	0	0	21.0
21	0	0	21.0

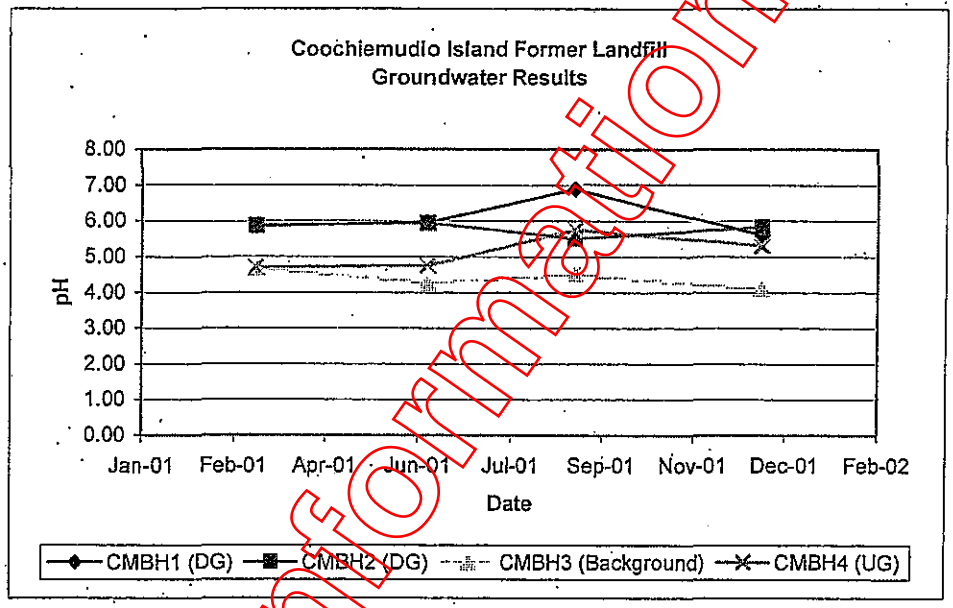
Gas Results from Structures at Coochiemudlo Island Former Landfill (19/9/01)

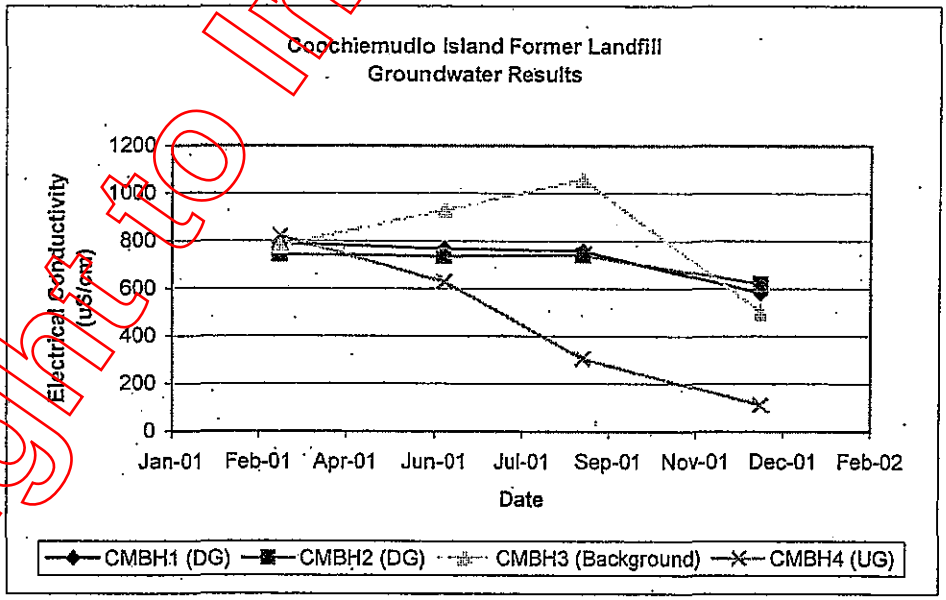
Structure	Methane %	Hydrogen Sulphide (%)	Oxygen (%)
Culvert C2	0	0	21.0
Toilet building S1	0	0	20.9
Transfer Station S2	0	0	21.0

Notes:
Guideline limit = 1.25% methane by volume (ie 25% LEL)
All measurements were taken in confined areas under or within the structure where methane gas is most likely to accumulate

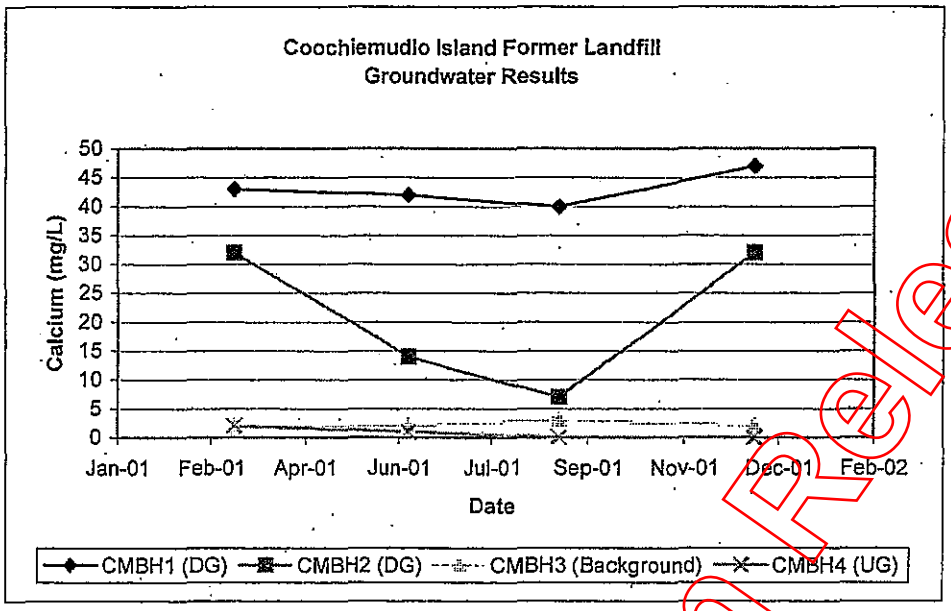
Groundwater Sampling Results

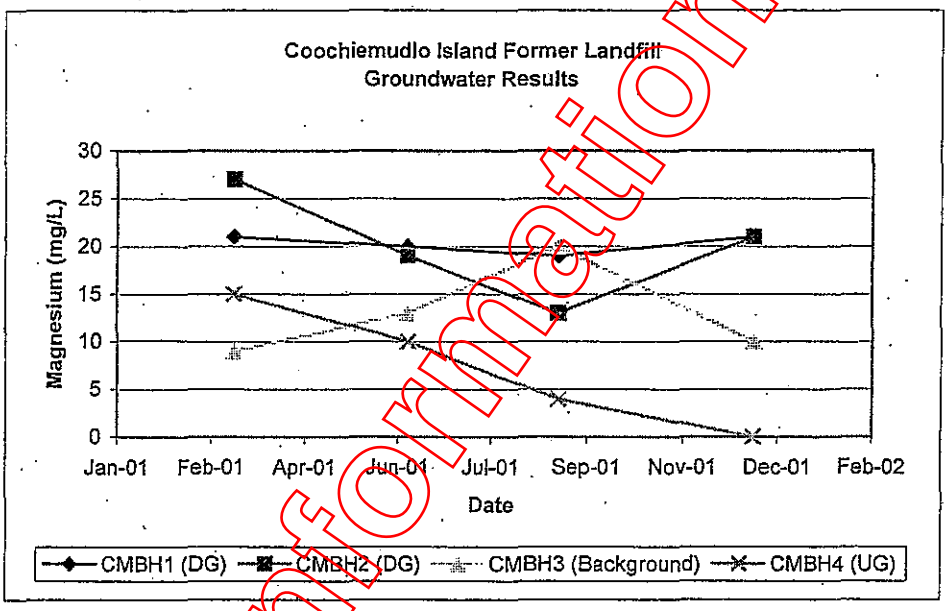


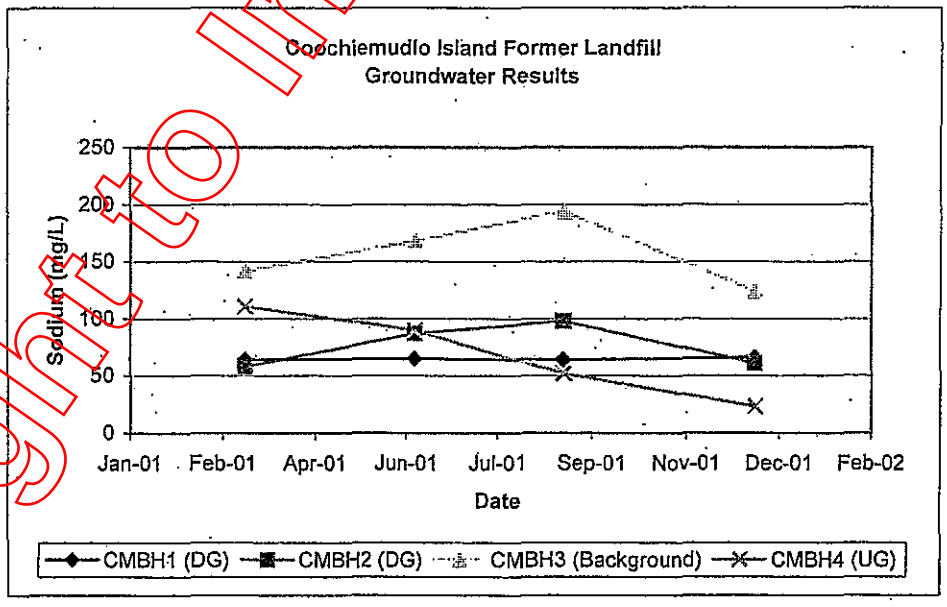




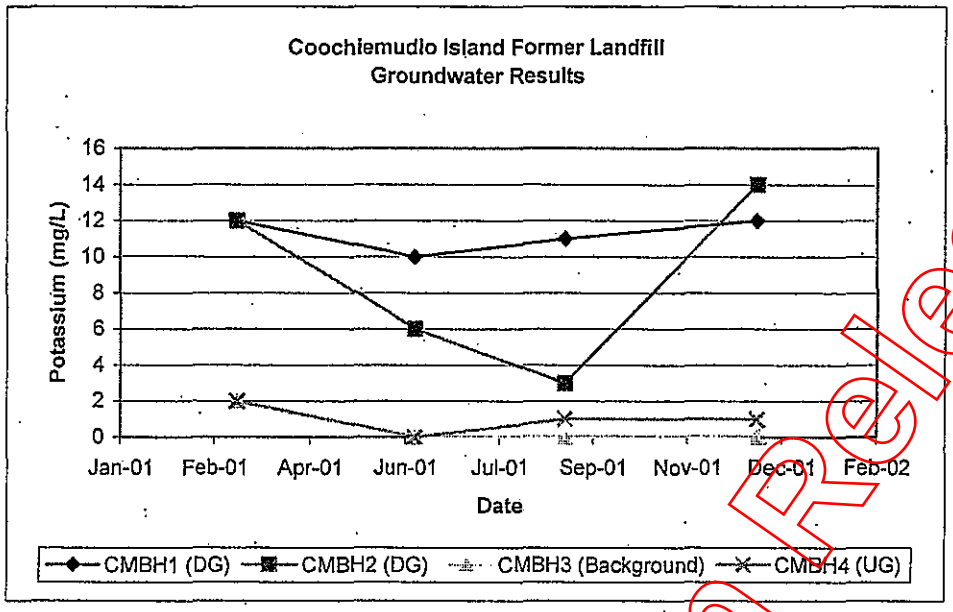
Groundwater Sampling Results

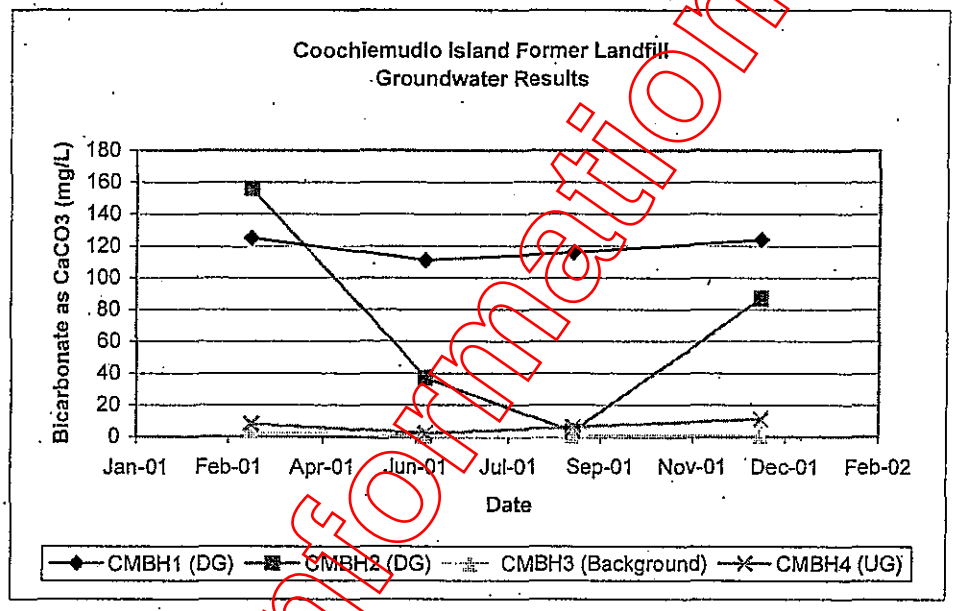


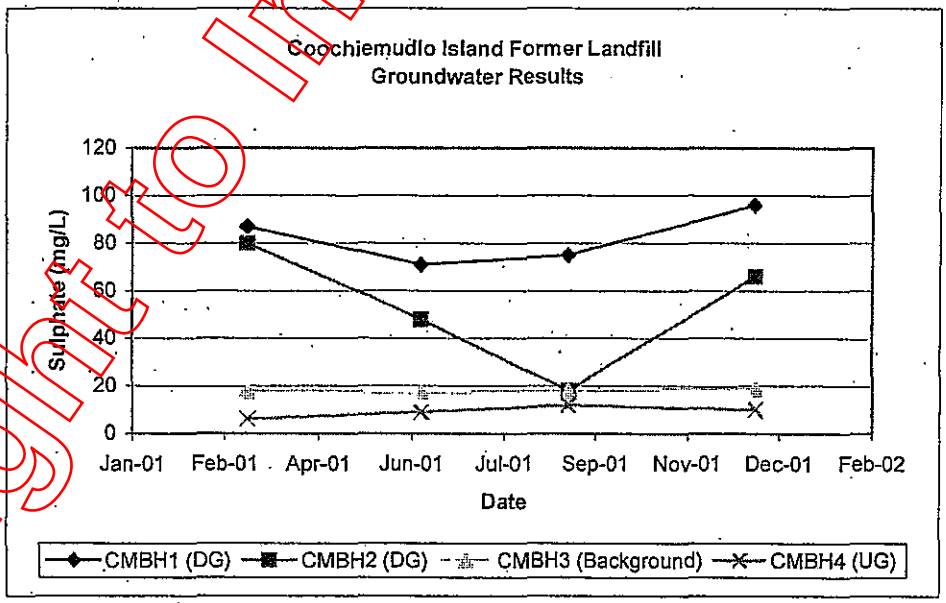




Groundwater Sampling Results







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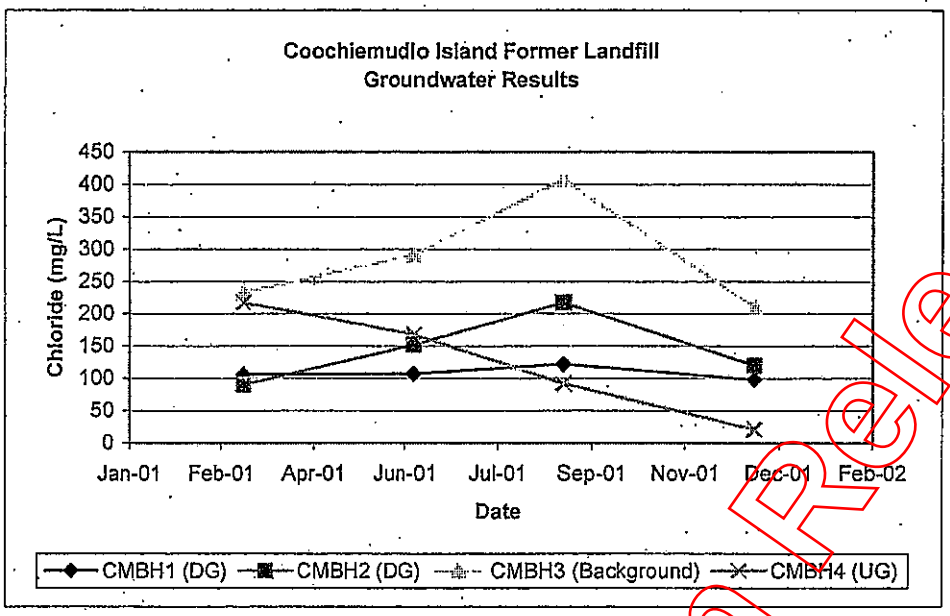
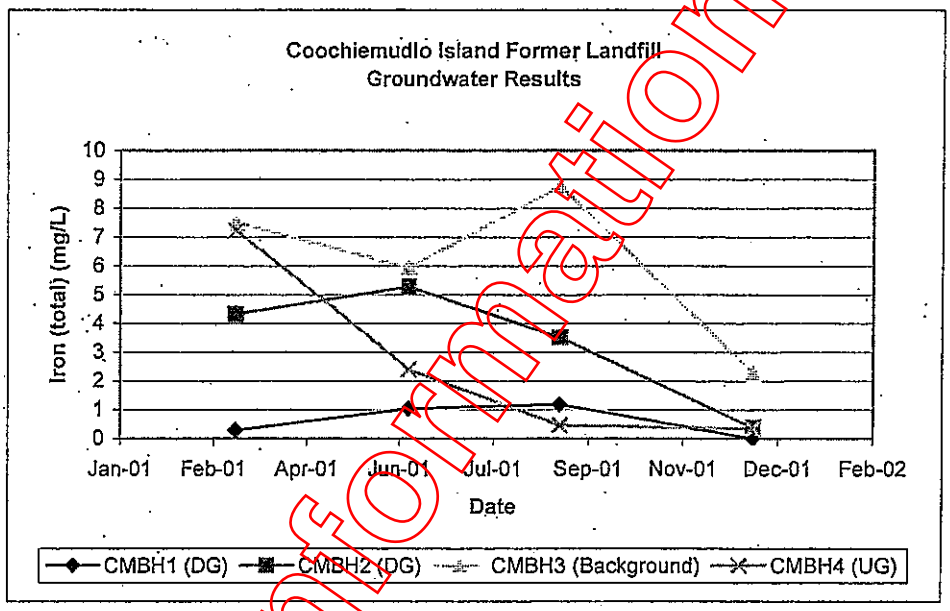
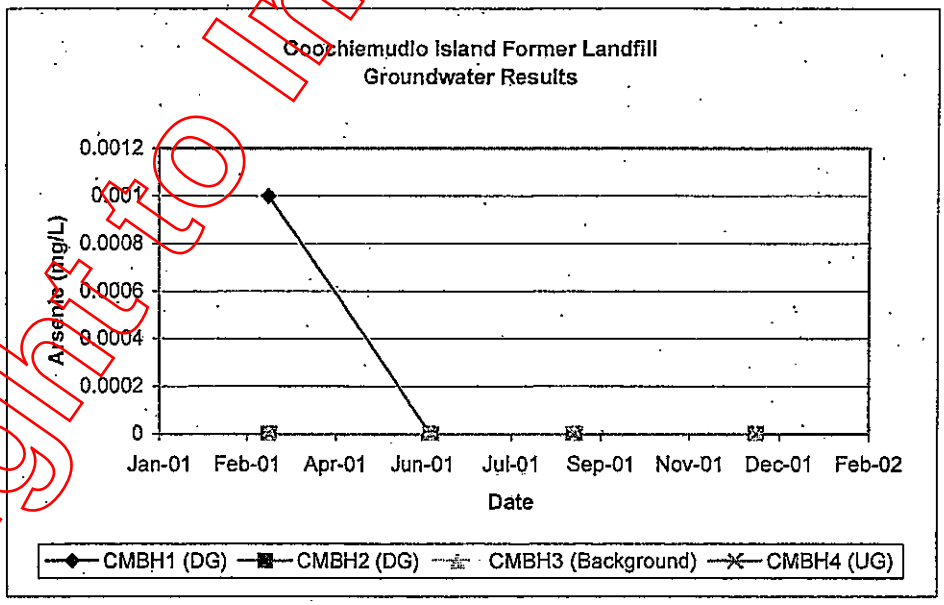
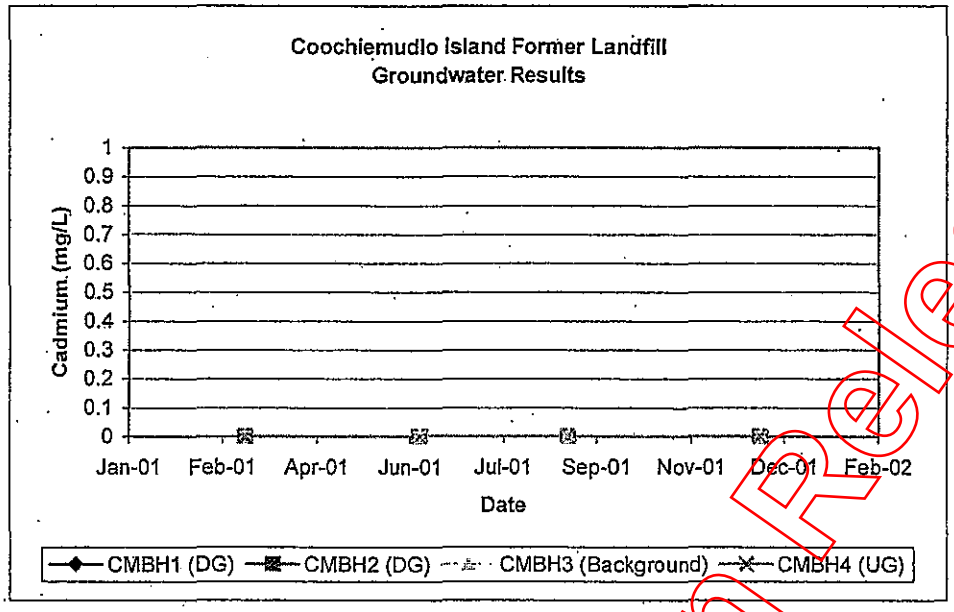
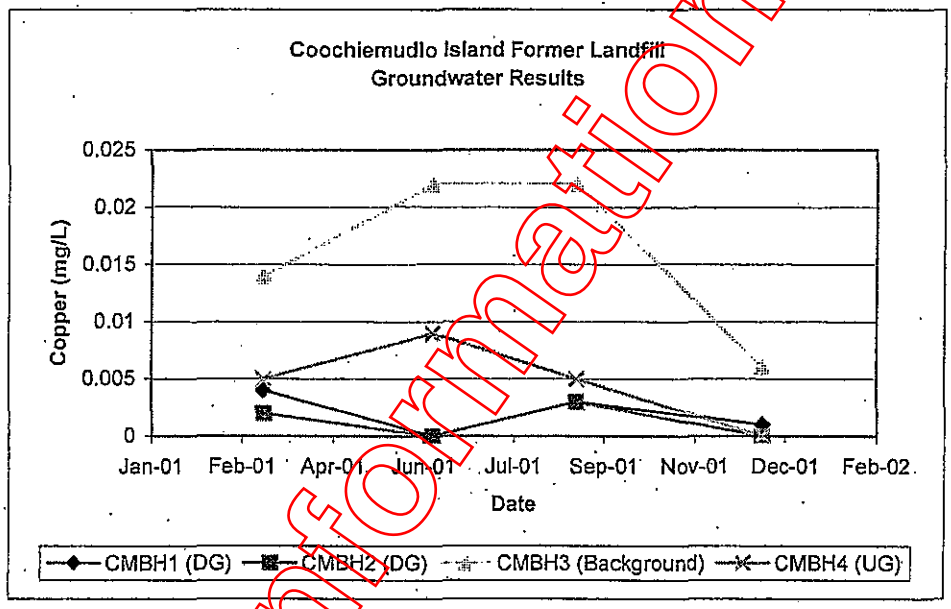


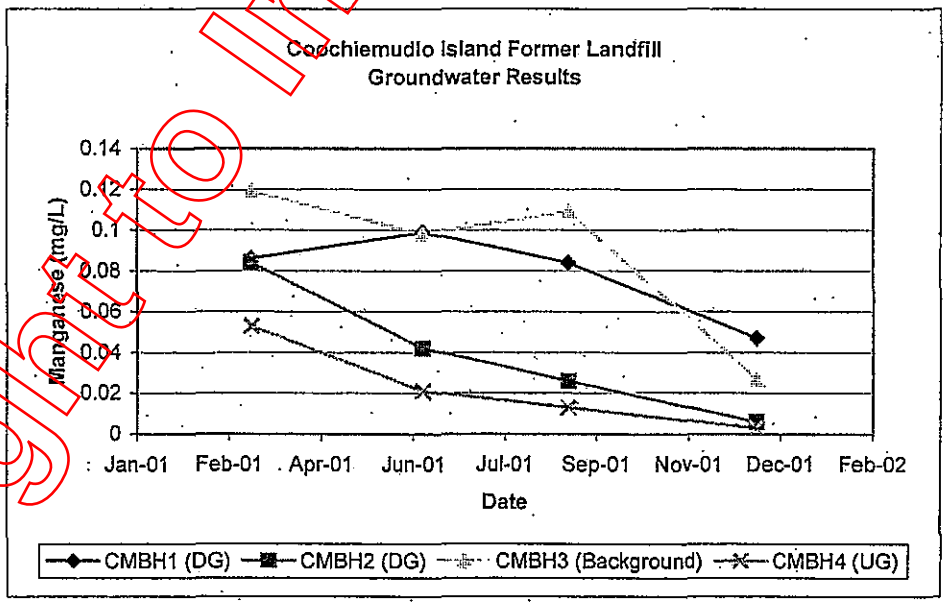




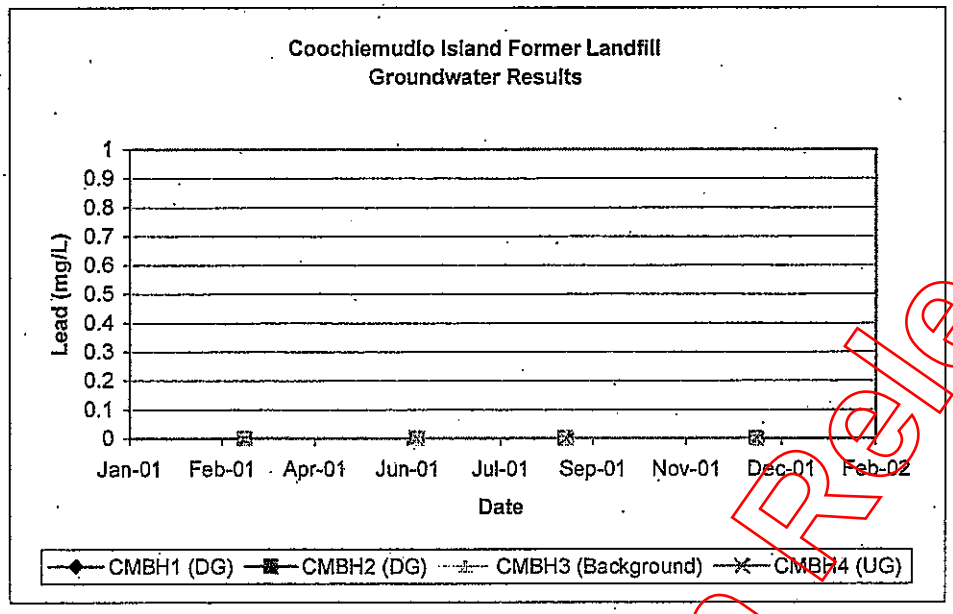
Groundwater Sampling Results

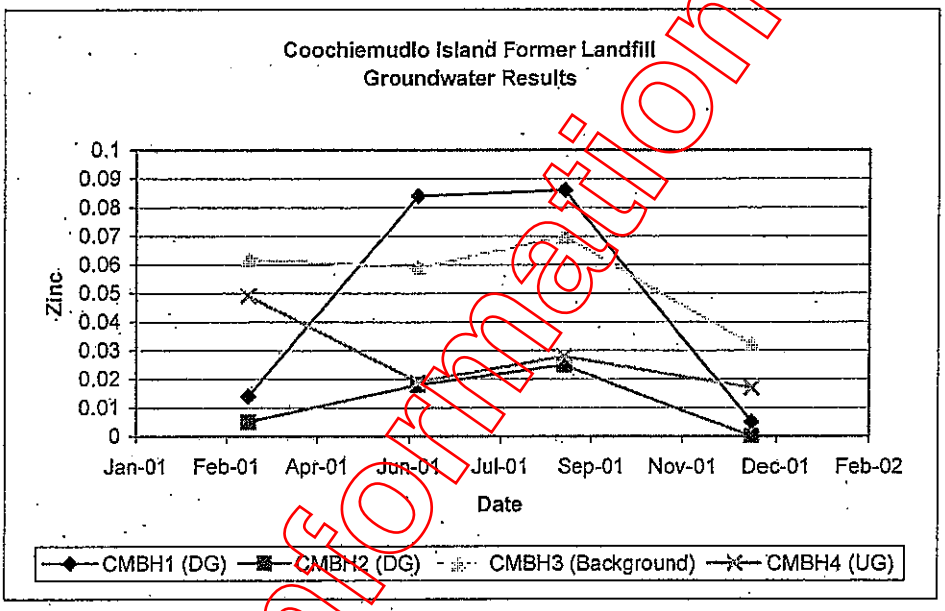


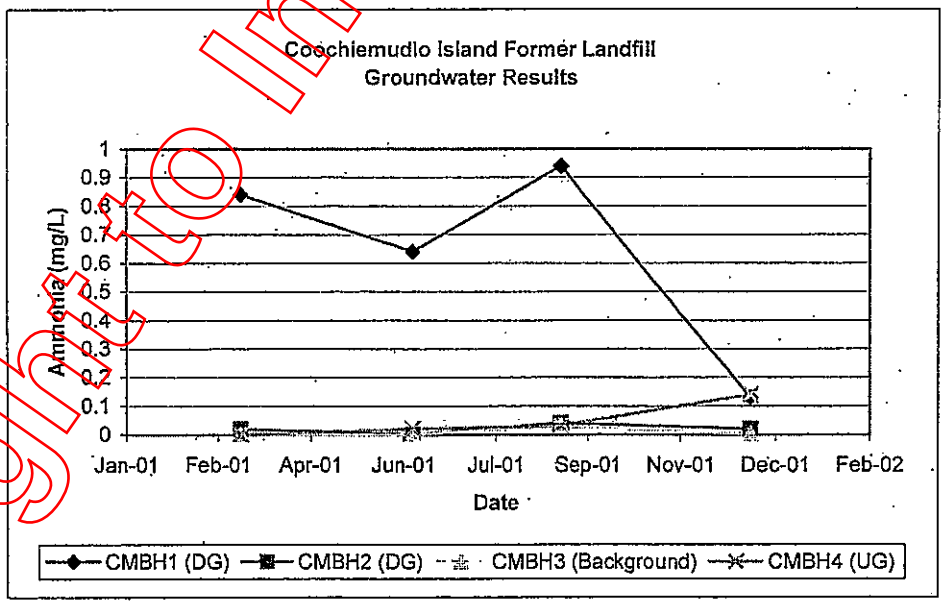




Groundwater Sampling Results







Groundwater Sampling Results