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Mangles Bay Marina-Based Tourist Precinct

Baseline Data Report

January 2012

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Baseline Data Report

Prepared for

Cedar Woods Properties Limited

Prepared by

Oceanica Consulting Pty Ltd

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Quality Assurance

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Level	Definition	Status
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B: Partial	Some data and underlying calculations have been checked. Report format has been checked. Review has been undertaken by a third-party.	☐
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Cover

Main image: Mangles Bay and current boat moorings along the coastline (Oceanica Consulting).
Minor images: A moored boat, Mangles Bay (Oceanica Consulting);
Mooring scars, Mangles Bay (Oceanica Consulting).

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1. Introduction

1.1 Background

In March 2006 the Cape Peron Tourist Precinct Steering Committee submitted a Strategic Environmental Review (SER) to the Environmental Protection Authority (EPA) for a proposed tourist-based inland marina in Mangles Bay, Cockburn Sound. The proposed marina was to accommodate approximately 500 boats and the surrounding land developed for mixed uses (e.g. tourist facilities and residential areas). The work undertaken included the examination of two marina configurations; one with a single opening and one with a dual opening. EPA advice (EPA 2006) on the concept of an inland marina development at Mangles Bay identified the following primary environmental issues:

- seagrass and water quality – direct loss through construction of the project footprint and indirect loss through changes in water quality, sand bypassing activities and coastal processes;
- Lake Richmond – indirect impact on the Lake and its key attributes (two threatened ecological communities (TEC)) through potential changes in hydrogeology, modifying the Lake's water quality and water level, potentially threatening the TECs; and
- terrestrial vegetation – direct loss of vegetation and additional indirect loss through fragmentation, edge effects and changes in hydrology of the site.

A revised option with a single opening (the Mangles Bay Marina Based Tourist Precinct) with a reduced environmental footprint was subsequently referred to the EPA on 25 August 2010. The level of assessment for the Proposal was set as a Public Environmental Review (PER).

Cedar Woods Properties Limited (Cedar Woods) is the Proponent for the Mangles Bay Marina Based Tourist Precinct (the Proposal). The Western Australian Government endorsed the progressing of the Proposal, and the Western Australian Land Development Authority, LandCorp (Government's Land Development Agency), appointed Cedar Woods as its private sector partner to progress this project.

As seagrass and water quality are key environmental aspects of the Proposal, preliminary environmental work for the Proposal was undertaken to determine the water quality and seagrass health in the region prior to the proposed development. Seagrass and water quality surveys, and an analysis of historical seagrass loss due to mooring scar damage in Mangles Bay, were initiated by LandCorp (prior to the appointment of Cedar Woods as the Proponent) in April to May 2010, and were undertaken by Oceanica Consulting Pty Ltd (Oceanica). Seagrass rehabilitation was further identified as an offset required for the Proposal, so seagrass transplant rehabilitation trials in Mangles Bay (project managed by Oceanica and undertaken by Murdoch University) were also initiated by LandCorp in April to May 2010, to provide local data on the success rate of seagrass transplanting. Transplanting was carried out within mooring scars after the moorings had been replaced by seagrass-friendly moorings.

The Environmental Scoping Document (ESD; Strategen 2011) for the Proposal also identified the following marine studies and investigations:

- sampling and analysis of sediments in the area to be dredged to create an access channel to the marina (undertaken by Oceanica);
- modelling of dredge plume and return water plume dispersion characteristics (undertaken by Asia-Pacific Applied Science Associates (APASA));
- hydrodynamic modelling of the marina and adjacent waters in Mangles Bay, including residence times of waters of the marina waters (undertaken by APASA); and
- equilibrium ('box') modelling of nutrient-based water quality in the marina, based on the residence times from APASA's hydrodynamic modelling (undertaken by Oceanica).

The purpose of this document is to provide a stand-alone report of the methods used and results obtained for those components of marine work undertaken by Oceanica. The dredge plume modelling and hydrodynamic modelling undertaken by APASA is the subject of a separate stand-alone report (APASA 2011).

1.2 Relevant legislation, policies and guidelines

1.2.1 State Environmental (Cockburn Sound) Policy

The State Environmental (Cockburn Sound) Policy 2005 (Cockburn Sound SEP) establishes the framework within which Cockburn Sound and the adjacent land (the Cockburn Sound catchment) are to be managed to protect environmental quality in the Sound. The Cockburn Sound SEP establishes a risk-based approach to environmental management, which is underpinned by Environmental Values (EVs) and spatially defined Environmental Quality Objectives (EQOs) (Government of Western Australia 2005) to ensure the EVs are protected (Table 1.1). The Cockburn Sound Management Council (CSMC) is responsible for managing the environmental quality of Cockburn Sound, according to the Cockburn Sound SEP.

Table 1.1 Environmental quality values and environmental quality objectives for Cockburn Sound

Environmental value	Environmental quality objective
Ecosystem health	Maintenance of ecosystem integrity in terms of structure (e.g. biodiversity, biomass and abundance of biota) and function e.g. food chains and nutrient cycles).
Seafood safe for eating	Maintenance of aquatic life for human consumption, such that seafood is safe for human consumption when collected or grown.
Aquaculture	Maintenance of aquaculture, such that water is of a suitable quality for aquaculture purposes.
Recreation and aesthetics	Maintenance of primary contact recreation values, such that primary contact recreation (e.g. swimming) is safe. Maintenance of secondary contact recreation values, such that secondary contact recreation (e.g. boating) is safe. Maintenance of aesthetic values, such that the aesthetic values are protected.
Industrial water supply	Maintenance of industrial water supply values, such that water is of suitable quality for industrial water supply purposes.

Environmental Quality Criteria (EQC) have been developed for Cockburn Sound to provide the quantitative benchmarks for measuring success in achieving the EQOs set in the SEP (EPA 2005a). There are two types of EQC:

- Environmental Quality Guidelines (EQGs) - threshold numerical values which, if met, indicate that there is a high degree of certainty that the EQO has been met. If an EQG is exceeded there is a level of uncertainty that the EQO has been met, and further assessment against the EQS is carried out.
- Environmental Quality Standards (EQSs) are threshold numerical values that indicate a level beyond which there is a significant risk that the EQO has not been met, and a management response is triggered.

The ecological EV of ecosystem health has different EQC for zones of high, moderate and low ecological protection: the area of Mangles Bay adjacent to the Proposal lies within the area zoned for high ecological protection. The social EVs (Seafood Safe for Eating, Aquaculture, Recreation and Aesthetics, and Industrial Water Supply) have the same EQC applied throughout Cockburn Sound. The SEP has EQC for both water quality and sediment quality for the EV of Ecosystem Health and water quality EQC for the social EVs.

There is a nutrient-enrichment EQG for water quality (using chlorophyll-a concentrations as a measure of phytoplankton growth) and an associated nutrient-enrichment EQS for seagrass shoot density (based on the assumption that increased phytoplankton growth will reduce water clarity and may shade seagrass sufficiently to cause reductions in plant density). Compliance with the nutrient-enrichment chlorophyll-a EQG is based on data for all the CSMC's routine monitoring sites in the high ecological protection area, whereas the seagrass EQS is applied on a site-specific basis. There are also EQG and EQS for phytoplankton biomass, measured as chlorophyll-a concentrations: compliance with these can be based on data for all the CSMC's routine monitoring sites in the HEPA ('ambient value'), or on a site-specific basis. These water quality EQGs and EQSs are shown in Table 1.2.

Table 1.2 EQG and EQS for water quality and seagrass health established under the State (Cockburn Sound) Environmental Policy

Environmental Quality Indicator	Environmental Quality Guideline		Environmental Quality Standard	
	Moderate Protection	High Protection	Moderate Protection	High Protection
Nutrient Enrichment: Chlorophyll-a and Light Attenuation	Ambient value of the defined area during the non river-flow period is not to exceed: a) **1.3 µgL^{-1}** for Chlorophyll-a b) **0.10 m^{-1}** for Light Attenuation	Ambient value of the defined area during the non river-flow period is not to exceed: c) **0.8 µgL^{-1}** for Chlorophyll-a d) **0.09 m^{-1}** for Light Attenuation	Not applicable. The EQS for nutrient enrichment is assessed in terms of seagrass health, not chlorophyll and light attenuation.	
Nutrient Enrichment: Seagrass			1. Ambient values for seagrass meadow shoot density during January and in two consecutive years is greater than the 5th percentile of seagrass meadow shoot density at an appropriate reference site 2. Ambient values for seagrass meadow shoot density during January and in two consecutive years is greater than the 1st percentile of seagrass meadow shoot density at an appropriate reference site	3. Ambient values for seagrass meadow shoot density during January and in two consecutive years is greater than the 20th percentile of seagrass meadow shoot density at an appropriate reference site 4. Ambient values for seagrass meadow shoot density during January and in two consecutive years is greater than the 5th percentile of seagrass meadow shoot density at an appropriate reference site
Phytoplankton Biomass	1. Ambient value for phytoplankton biomass measured as chlorophyll-a does not exceed **2.4 µgL^{-1}** on any occasion during the non river-flow period. 2. Phytoplankton biomass measured as chlorophyll-a at <u>any site</u> does not exceed **2.4 µgL^{-1}** on 25% or more occasions during the non-river flow period.	1. Ambient value for phytoplankton biomass measured as chlorophyll-a does not exceed **1.7 µgL^{-1}** on any occasion during the non river-flow period. 2. Phytoplankton biomass measured as chlorophyll-a at <u>any site</u> does not exceed **1.7 µgL^{-1}** on 25% or more occasions during the non-river flow period.	1. Ambient value for phytoplankton biomass measured as chlorophyll-a does not exceed **2.4 µgL^{-1}** on more than once occasion during the non river-flow period and in two consecutive years. 2. Phytoplankton biomass measured as chlorophyll-a at <u>any site</u> does not exceed **2.4 µgL^{-1}** on ≥50% occasions during the non-river flow period and in two consecutive years.	1. Ambient value for phytoplankton biomass measured as chlorophyll-a does not exceed **1.7 µgL^{-1}** on more than three occasions during the non river-flow period and in two consecutive years. 2. Phytoplankton biomass measured as chlorophyll-a at <u>any site</u> does not exceed **1.7 µgL^{-1}** on ≥25% occasions during the non-river flow period and in two consecutive years.

1.2.2 State Contaminated Sites Act 2003

The Proposal will involve the dredging of sediments in Mangles Bay to create a marina access channel, and these sediments may contain contaminants from past or present boating activities. Marine sediment contamination in state waters (as well as contamination in terrestrial soils) is addressed under the Contaminated Sites Act 2003. Relevant guidance on contaminated sites investigations is provided in the DEC Contaminated Sites Management Series (DEC 2010), but sampling requirements for marine sediments are also typically guided by the National Assessment Guidelines for Dredging (see below).

The Contaminated Sites Management Series (DEC 2010) was developed to provide guidance for risk assessments prior to activities governed under the Act. Land disposal of dredged material is not dealt with specifically in the guidelines, but falls under the Act in that land is created, and potential human and environmental impacts must be subject to a risk assessment.

Ecological Investigation Levels (EILs) for soil, defined in the Assessment Levels for Soil, Sediment and Water (DEC 2010), are used as an initial screening assessment to determine whether there is potential risk to the environment. Health Investigation Levels (HILs) are also defined in the Assessment Levels for Soil, Sediment and Water as contaminated soils disposed to land can pose a risk to human health through direct exposure (such as ingestion and inhalation) or indirect exposure (such as through groundwater contamination). HILs for 'D' (residential with minimal opportunities for soil access: includes dwellings with fully or permanently paved yard space such as high-rise apartments and flats), 'E' (parks, recreational open space and playing fields, includes secondary schools) and 'F' (commercial/industrial, includes premises such as shops and offices as well as factories and industrial sites) are typically deemed the most appropriate to use when spoil material is used in a development.

1.2.3 National Assessment Guidelines for Dredging (NAGD)

Although sea dumping of dredged material is not planned as part of the Proposal, the National Assessment Guidelines for Dredging (Commonwealth of Australia 2009) provide a useful reference for the assessment and management of dredging operations, i.e. the potential impacts on the receiving marine environment from the disturbance of the sediment and the sediment metals, nutrients and hydrocarbons. The NAGD screening levels for sediment quality are based on the national environmental quality guidelines for sediments (ANZECC/ARMCANZ 2000). The national environmental quality guidelines for sediments (ANZECC/ARMCANZ 2000) are also adopted as EQGs in the Cockburn Sound SEP.

1.2.4 EPA Guidelines

EPA Environmental Assessment Guidelines No. 3

EPA Environmental Assessment Guideline No. 3 'Protection of Benthic Primary Producer Habitats in Western Australia's Marine Environment' (EAG3; EPA 2009) recognises the fundamental ecological importance of benthic primary producer habitats (BPPH) and the potential consequences of their loss for marine ecological integrity. BPPHs are defined as seabed communities within which algae, seagrass, mangroves, corals or mixtures of these groups are prominent components; and also include areas of the seabed that can support these communities.

EAG No. 3 provides a risk-based spatial assessment framework for evaluating cumulative irreversible loss of and/or serious damage to BPPHs. The EPA has termed the areas within which to calculate cumulative losses 'Local Assessment Units' (LAU). There are six categories of marine ecosystem protection (category A through to F) defined in EAG No. 3 and used to define the cumulative percentage loss threshold for BPPH within any defined LAU. In order to apply an appropriate protection category, the following calculations of the spatial extent of BPPH are required (EPA 2009b):

- prior to all human induced disturbance (i.e. prior to European habitation);
- estimate of existing losses at the time of the proposal; and
- the additional loss or damage as a result of the proposal (i.e. cumulative losses of BPPH).

Cockburn Sound is defined by EPA as a LAU with an area of 105.7 km2 (10 570 ha); and includes the region bounded by the east coast of Garden Island, a line drawn from the north end of Garden Island across to Woodman Point, along the eastern shore of Cockburn Sound and the causeway linking Rockingham to Garden Island. The proposed loss and previous habitat loss are totalled to determine a cumulative impact that is assessed by the EPA in light of the ecosystem's level of protection.

EAG3 classifies Cockburn Sound as a Category F: areas where cumulative loss guidelines have been significantly exceeded. Due to the application of this category, proposals in Cockburn Sound (including Mangles Bay) must therefore not cause any net damage/loss of seagrass. For this reason, seagrass transplantation is being considered as an offset for the seagrass loss associated with the Proposal.

EPA Environmental Assessment Guidelines No. 7

EPA Environmental Assessment Guideline No. 7 'Environmental Assessment Guideline for Marine Dredging Proposals' (EAG7, EPA 2011) sets out guidance for predicting impacts to benthic communities and habitats due to significant dredging activities, to ensure these are presented in a clear and consistent manner. In particular, it advocates a spatially-based zonation scheme for the predicted extent, severity and duration of impacts, as follows:

- Zone of High Impact (ZoHI) - the area where impacts on benthic communities are predicted to be irreversible (defined as lacking a capacity to return or recover to a pre-dredging state within a timeframe of five years or less).
- Zone of Moderate Impact (ZoMI) - the area where predicted impacts on benthic communities are expected to be sub-lethal, and/or the impacts recoverable within a period of five years following completion of the dredging activities.
- Zone of Influence (ZoI) - the area where changes in environmental quality associated with dredge plumes are predicted, but these changes are not expected to result in a detectible impact on benthic communities.

The marine sediment characterisation undertaken in the baseline studies for the Proposal include the sediment particle size data required for modelling predictions of the extent of dredge plumes over benthic communities.

1.3 This document

This document is structured as follows:

- Section 2 – benthic primary producer habitat (BPPH) studies:
  - Seagrass health measurements
  - Seagrass transplantation in mooring scars, including an historical analysis of seagrass loss in mooring scars
- Section 3 – marine water quality studies
  - Water quality survey in Mangles Bay 2009/20010
  - Equilibrium ('box') modelling of nutrient-related water quality in the marina
- Section 4 – marine sediment quality studies

2. Benthic Primary Producer Habitat (Seagrass)

2.1 Seagrass health

2.1.1 Introduction

Seagrass health measurements were undertaken in the shallow flats of Mangles Bay to establish baseline seagrass health prior to development. A preliminary assessment of seagrass health was undertaken in 2010 to see if there were major differences between seagrass shoot densities in shallow waters (1.4–2.4 m depth) on either side of the Causeway. This was followed with an assessment of seagrass health in 2011 that established four baseline monitoring sites in slightly deeper waters (1.5–3.0 m depth) adjacent to the proposed marina access channel. Mangles Bay is classified as an area of high ecological protection under the Cockburn Sound SEP, so high protection EQC apply (Section 1.2.1).

2.1.2 Preliminary assessment of seagrass health in 2010

Methods

Seagrass monitoring was undertaken on 6th January 2010 by commercially-qualified divers from Oceanica that were experienced in seagrass monitoring techniques. The seagrass shoot density counts were undertaken in *Posidonia sinuosa* meadows at one site west of the Garden Island Causeway (MB_West, water depth 2.6 m) and one site to the east of the Causeway in Mangles Bay (MB_East, water depth 1.4 m) (Figure 2.1).

Shoot density counts were documented within 20 replicate haphazardly placed quadrats (25 cm x 25 cm) within *Posidonia sinuosa* meadows at each site, similar to the EPA's Standard Operation Procedures (SOP) Manual for Cockburn Sound (EPA 2005b). The methodology differed from EPA (2005b) only in the use of haphazard quadrats rather than permanent quadrats and the use of 20 rather than 24 quadrats. Quadrats were laid on the seagrass meadow, and seagrass shoots gently pulled through the quadrat (so that the quadrat could lie on the sediment with no shoots covered by the quadrat) and the number of shoots counted. All shoot densities for *P. sinuosa* were normalised to 1 m^2.

Figure 2.1 Seagrass health monitoring sites in Mangles Bay, summer 2010

Results

In January 2010, the average shoot density for *Posidonia sinuosa* at the site west of the Causeway (656 ± 76 shoots/m^2) was greater than the site east of the Causeway in Mangles Bay (399 ± 40 shoots/m^2). The median shoot density count for *P. sinuosa* in Mangles Bay west was 544/m^2 and east of Mangles Bay was 376/m^2 (Table 2.1). The median for the reference site (MB West) met the 1 year shoot density EQSs for high ecological protection, but the potential impact site (MB East) did not (Table 2.1).

Table 2.1 Seagrass shoot density counts (per m^2) at Mangles Bay, January 2010

Site	Mangles Bay West (water depth 2.6 m)[2]	Mangles Bay East (water depth 1.4 m)[3]
High protection EQS for 1 year[1]	**375**	**458**
Mean ± S.E.	656 ± 76	399 ± 40
Median	544	376

Notes:
1. Cockburn Sound EQSs are derived from seagrass data obtained between 2003 and 2010 from Warnbro Sound.
2. Warnbro Sound EQS for 2.0 to 3.0 m water depth used. Data supplied courtesy of the CSMC.
3. Warnbro Sound EQS for 1.5 to 2.0 m depth used. Data supplied courtesy of the CSMC.

2.1.3 Baseline measurements of seagrass health in 2011

Methods

Seagrass monitoring was undertaken on 2 March 2011 by commercially-qualified divers from Oceanica that were experienced in seagrass monitoring techniques, using standard operating procedures as described in EPA (2005b). The seagrass shoot density counts were undertaken in *P. sinuosa* meadows at four seagrass health sites set up using 24 fixed quadrats (Figure 2.2). Shoot density counts were documented within each quadrat (20 cm x 20 cm) and shoot counts were recorded as per the methods described above.

The 2011 sites adjacent to the proposed marina were located in deeper water than the 2010 survey (where shoot densities easily met the 1 year EQS for a high ecological protection area), as these were expected to be more sensitive to lesser water quality. Although attempts were made to locate all sites along the 2.5–3.0 m depth contour, this was not possible for the western-most site due to rapid shallowing of waters towards the Causeway.

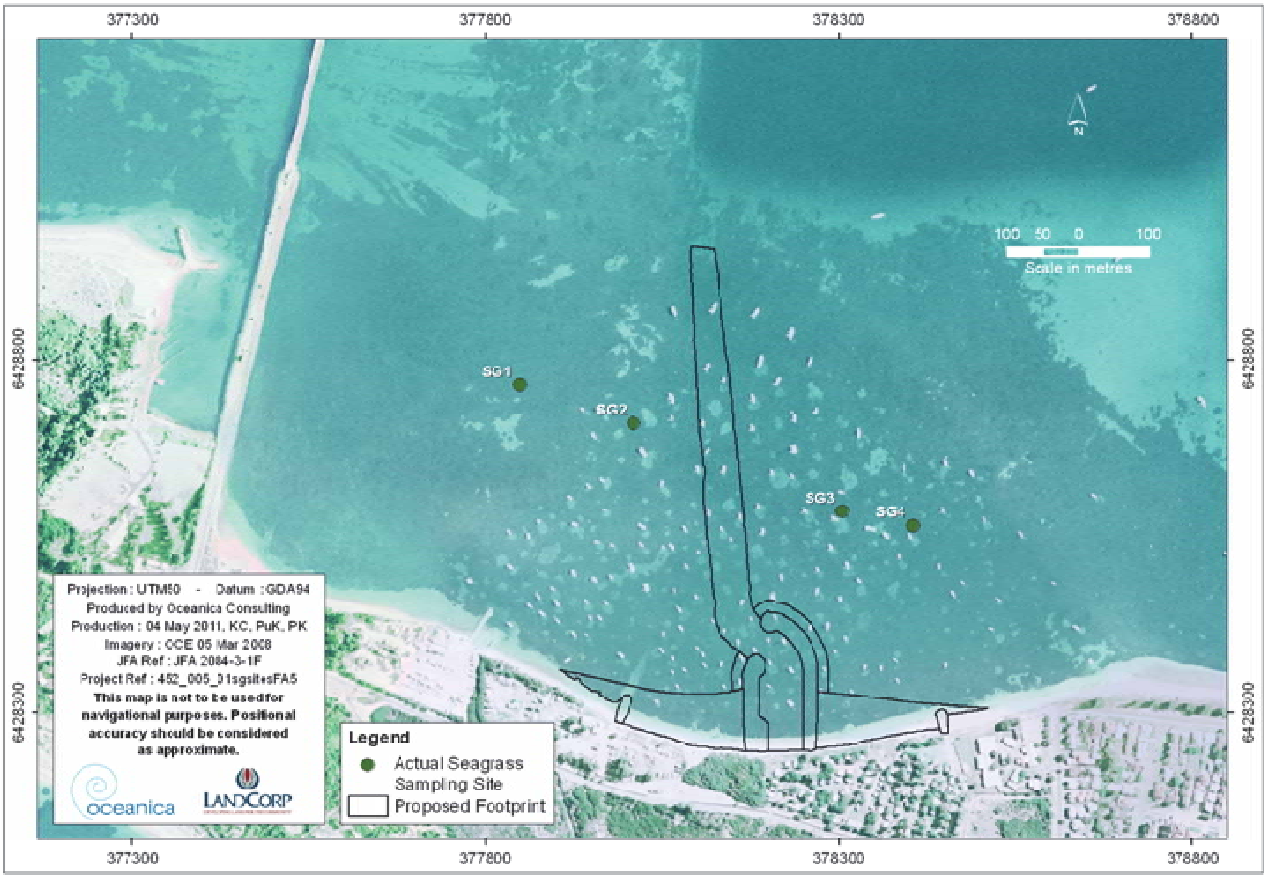

Figure 2.2 Seagrass health monitoring sites in Mangles Bay, summer 2011

Results

In March 2011, the average shoot density for *P. sinuosa* was lowest at site SG4 (447 ± 57 shoots/m^2) and highest at site SG1 (707 ± 73 shoots/m^2) (Table 2.2). Sites SG1, SG2 and SG3 met the 1 year EQS for high ecological protection, and site SG4 did not (Table 2.2).

Table 2.2 Seagrass shoot density counts (per m^2) at Mangles Bay, March 2011

Site	SG1 (water depth 1.5 m)	SG2 (water depth 2.5 m)	SG3 (water depth 3.0 m)	SG4 (water depth 3.0 m)
High protection EQS for 1 year	438[1]	390[2]	390[2]	390[2]
Mean ± S.E.	707 ± 73	822 ± 100	531 ± 64	447 ± 57
Median	713	913	438	363

Notes:
1. Cockburn Sound EQS are derived from seagrass data obtained between 2003 and 2011 from Warnbro Sound (1.5 to 2.0 m water depth). Data supplied courtesy of the CSMC.
2. Cockburn Sound EQS are derived from seagrass data obtained between 2003 and 2011 from Warnbro Sound (2.0 to 3.0 m water depth). Data supplied courtesy of the CSMC.

2.1.4 Conclusions

The reference site (MBW) in the 2010 study met the 1 year EQS for high ecological protection, but the potential impact site (MBE) did not. Three sites in the 2011 study (SG1, SG2 and SG3) met the 1 year EQS for a high ecological protection, and one site (SG4) did not.

The CSMC routine seagrass monitoring site in Mangles Bay – located in a water depth of 3.2 m approximately 0.5 km east of site SG4 examined in this report – has also occasionally exceeded the high protection EQS in the past. A review of the Environmental Management of Cockburn Sound in the Western Australian Auditor General's Report Environmental Management of Cockburn Sound (Auditor General 2010) showed that seagrass shoot density

at Mangles Bay met the EQS between 2005 and 2007, but did not meet the EQS between 2008 and 2010. The report notes that Mangles Bay seagrass health has been a known problem for many years, but there is no clearly identifiable single source contributing to excessive nutrient loads. The report identified Lake Richmond stormwater drain as a significant contributing factor to the nutrient enrichment at Mangles Bay, but also highlighted poor water circulation. Shoot density at the CSMC's Mangles Bay site improved in 2011, and although the 1 year EQS was met the 2 year EQS was still exceeded (information supplied courtesy of the CSMC).

In addition to the temporal variability noted by the Auditor General's Report (Auditor General 2010), considerable spatial variability in the 'health' of the seagrass meadows in Mangles Bay (as assessed using shoot density counts) was indicated in the above results for seagrass health for the four sites monitored in 2011 during this study. This spatial and temporal variability in seagrass shoot density (and associated non-compliance with EQSs) indicates that site-specific monitoring of seagrass health adjacent to the Proposal will be needed before and after development, to ascertain the degree to which outflow of water from the marina affects seagrass health in the Mangles Bay region.

2.2 Seagrass transplantation in mooring scars

2.2.1 Historical analysis of seagrass loss due to mooring scars

Introduction

Documentation of historical changes in the number of moorings and associated seagrass loss in Mangles Bay was undertaken for the two-fold purpose of emphasising the need for better management of boating activities, and assessing the potential area of mooring scars available for seagrass transplantation. This analysis was undertaken using historical aerial photography to produce a time series of mooring scar damage of seagrass in Mangles Bay.

Methods

Available aerial images for the Mangles Bay region were inspected for quality of the imagery and the visibility of mooring scars (according to factors such as water clarity, presence of sun glint, effect of cloud cover and surface ripples due to waves, etc). Aerial imagery from March 1967, May 1972, June 1981, March 1999, March 2002 and March 2008 were considered suitable for further analysis, but were of variable image quality and spatial accuracy.

The 2008 imagery was the best quality in terms of both image quality and spatial accuracy. As a result, analysis of mooring scars was first undertaken on the 2008 imagery: mooring scars were digitised, counted and the area of seagrass loss calculated. For earlier years, the approach taken – in sequence beginning with the 2002 imagery – was to overlay the 2008 mooring scars on the 2002 imagery: this enabled mooring scars present in both years to be aligned, assisting in improving the spatial accuracy of the earlier imagery.

Results

Results of analysis of aerial imagery from 1967, 1972, 1981, 1999, 2002 and 2008 are tabulated below, showing the increase in the number of mooring scars and subsequent increase in the area of seagrass loss (Table 2.3). The change in mooring scars between 1967 and 2008 are shown in Figure 2.3 to Figure 2.8. It should be noted that in some cases one mooring scar might cover two or more moorings, while some moorings in the Mangles Bay region are of environmentally friendly design and have no associated mooring scar, hence the disparity with the ~ 650 moorings presently registered with the Department of Transport.

Table 2.3 Historical changes in number of mooring scars and associated seagrass loss in Mangles Bay, Cockburn Sound

Characteristic	Year					
	1967	1972	1981	1999	2002	2008
No. of mooring scars	93	93	114	199	249	312
Area of seagrass loss (ha)	1.06	1.60	2.14	2.71	3.04	3.20

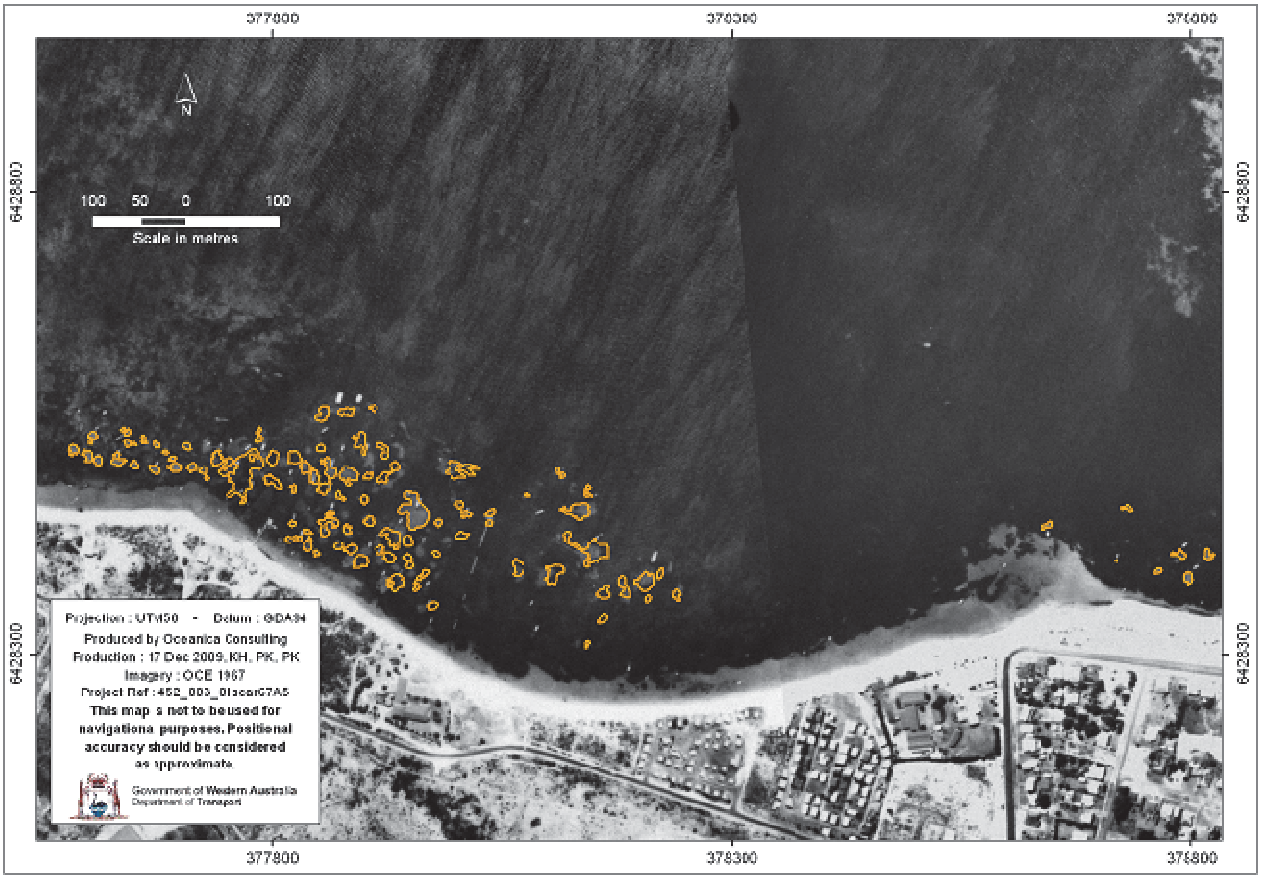

Figure 2.3 1967 aerial imagery with digitised mooring scars

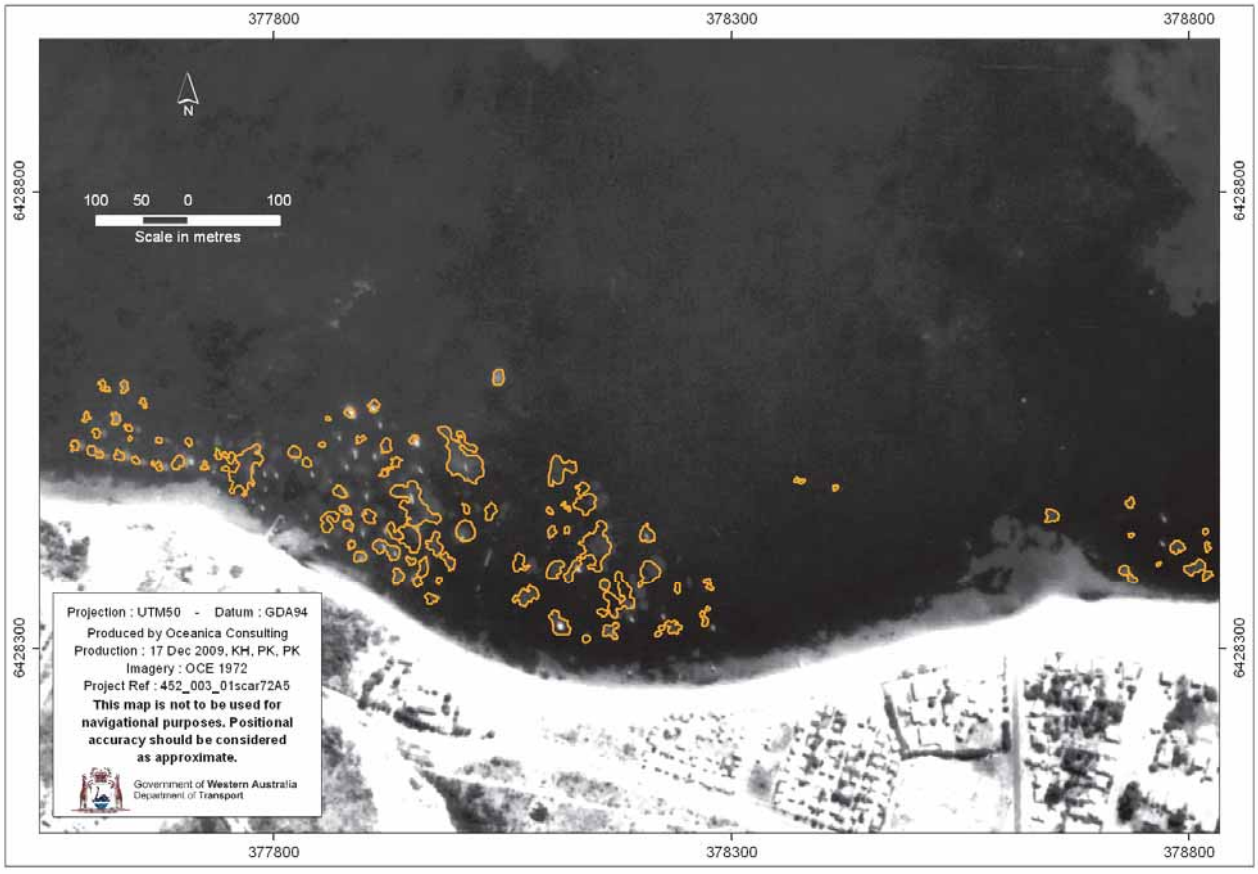

Figure 2.4 1972 aerial imagery with digitised mooring scars

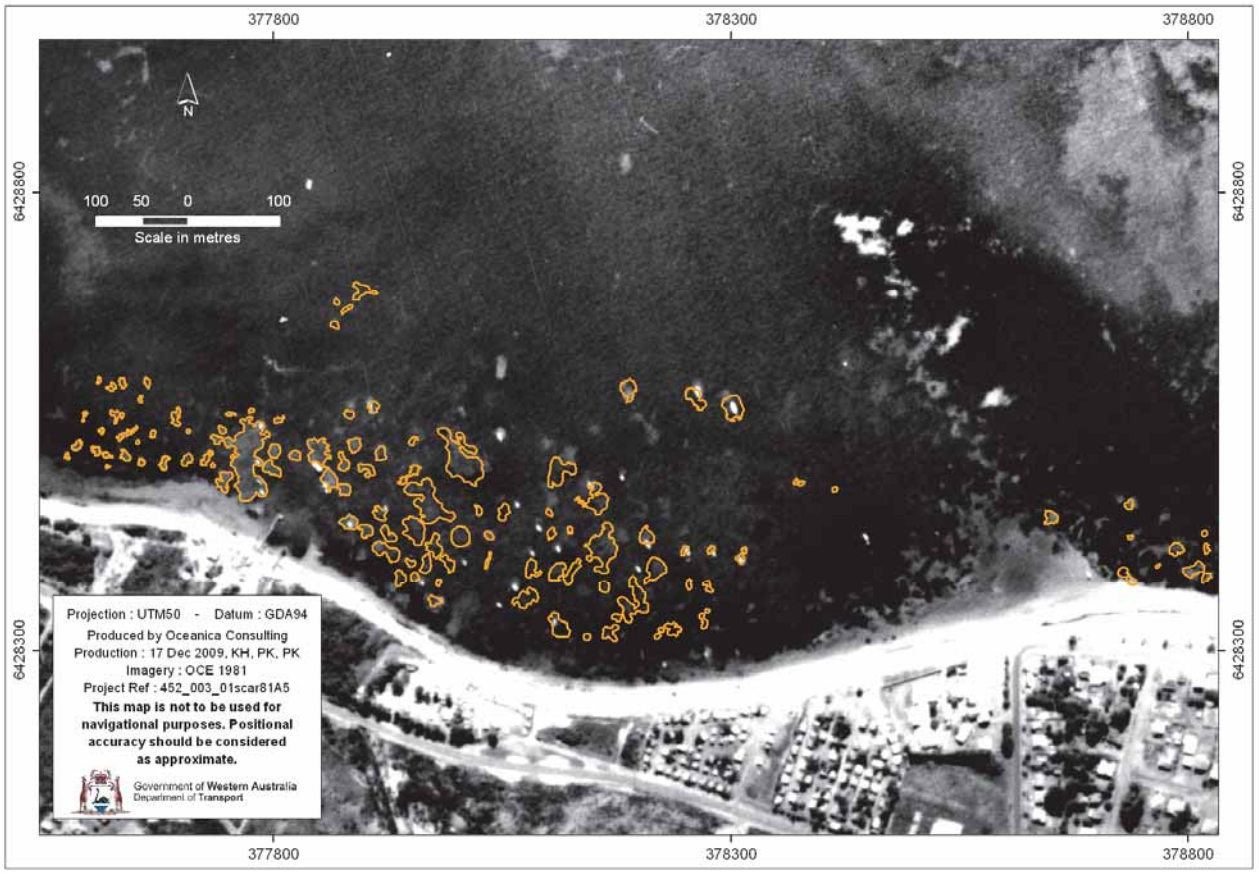

Figure 2.5 1981 aerial imagery with digitised mooring scars

Figure 2.6 1999 aerial imagery with digitised mooring scars

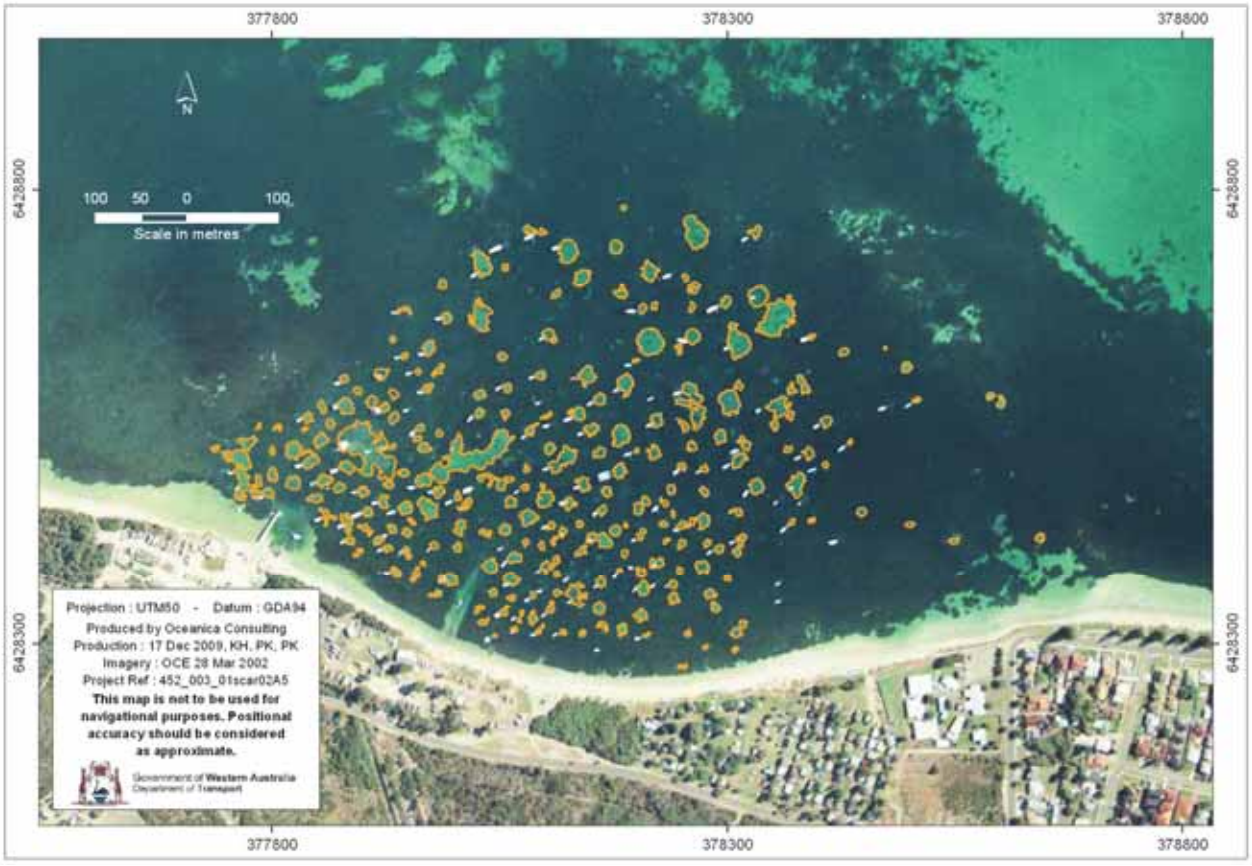

Figure 2.7 2002 aerial imagery with digitised mooring scars

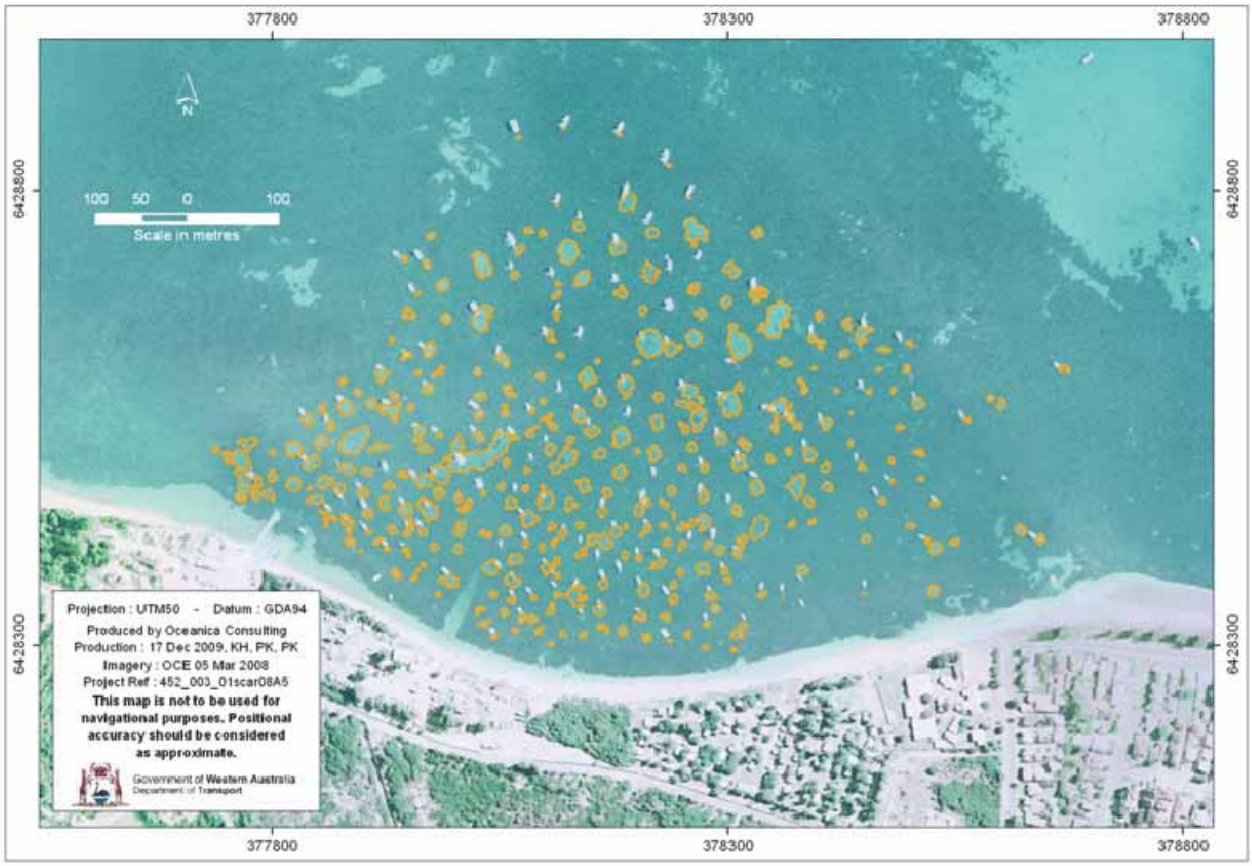

Figure 2.8 2008 aerial imagery with digitised mooring scars

2.2.2 Transplantation trials in mooring scars

Introduction

Seagrass transplant rehabilitation trials in Mangles Bay were initiated in April 2010 to provide local data on the success rate of seagrass transplanting. Seagrass transplantation requires suitable bare substrate to transplant into, and potential areas for this purpose included the mooring scars left by the numerous moorings deployed in the seagrass meadows of Mangles Bay. The heavy mooring chains of traditional-style moorings 'scythe' seagrass meadow when a boat swings around on its mooring, and this leaves a characteristic circular bare patch within the seagrass meadow. If traditional-style moorings are replaced by more modern, environmentally-friendly moorings, then the 'scything' effect no longer occurs and the mooring scar is potentially suitable for seagrass to re-grow. Natural re-growth of seagrass meadows into mooring scars can also occur, but is not guaranteed and can be very slow even if it does occur.

Methods

Ezyrider Moorings

On 16 March 2010, Franmarine installed new environmentally-friendly 'Ezyrider' moorings (Figure 2.9) at three mooring scars (mooring scars 8184, 8185 and 8304). The co-ordinates of the location of the moorings are shown in Table 2.4. The vessel moorings were inspected by a Franmarine three man diving team, operating in accordance with Australian Standard AS2299. At the time of the inspections, the divers certified the moorings as safe.

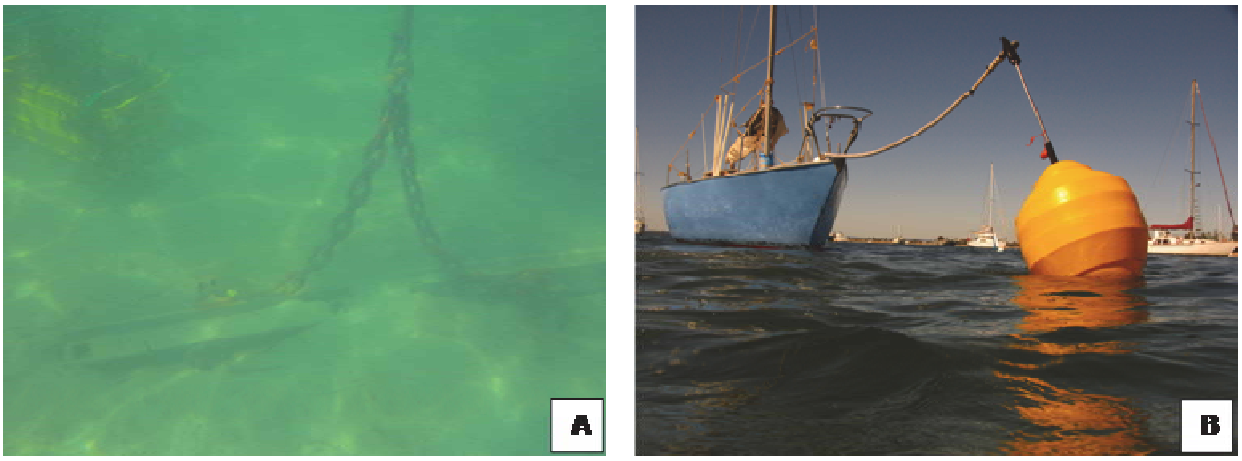

Figure 2.9 Ezyrider moorings bases (a) beneath and (b) above the water at Mangles Bay

Seagrass transplantation techniques

In March 2010, seagrass transplantation occurred in the three moorings scars selected for this purpose (Figure 2.10). The three mooring scars selected by Murdoch University's Marine and Freshwater Research Laboratory (MAFRL) were all in similar water depth (2.7 m), had a similar size scar (~10 m), and were all surrounded by meadows of the seagrass *Posidonia sinuosa*. The scars were marked out with star pickets with small net floats to mark the outer edges.

Figure 2.10 Aerial photograph showing the mooring scars in Mangles Bay used for seagrass transplantation trials

In recent years the large-scale seagrass rehabilitation techniques developed by MAFRL have undergone considerable improvements in seagrass sprig harvesting, handling and tying techniques, sprig spacing, alignment of plant growth axes into the dominant direction of the swell, retaining the harvested sprigs underwater and protection from the sun at all times. Based on MAFRL's results, the target species used for the transplanting exercise was *Posidonia australis*, since its greater biomass means that it is more robust for handling and anchoring than *P. sinuosa*. Natural colonisation processes are, however, likely to result in *P. sinuosa* ultimately invading and out-competing the transplanted *P. australis* in the longer-term.

Donor sprig material (*P. australis*) was harvested from an area that has been partially dredged on Parmelia Bank at a depth of 5-6 m (Figure 2.11a). Note that MAFRL's seagrass rehabilitation research has shown that donor meadows readily recover from harvesting within approximately two years, and the area used for donor material was also within an area approved for dredging by Cockburn Cement Limited.

Sprigs were harvested from the donor material after it was brought to the surface. Each sprig was then tied to a purpose-designed wire peg (30 cm in length) using two or three biodegradable cable-ties (Figure 2.11b). Sprigs (also referred to as a Planting Unit, PU) were kept under water as much as possible and wire pegs were collated into groups of five before being secured with string to enable accurate quantification, transport, handling and planting at the recipient site (Figure 2.11c and d). Details on the seagrass transplantation of the three mooring scars, including scar diameter, number of sprigs (*P. australis*) planted and spacing of sprigs is provided in Table 2.4. The size difference of the sprig and the differing planting densities resulted in a varying amount of sprigs planted in the individual mooring scars.

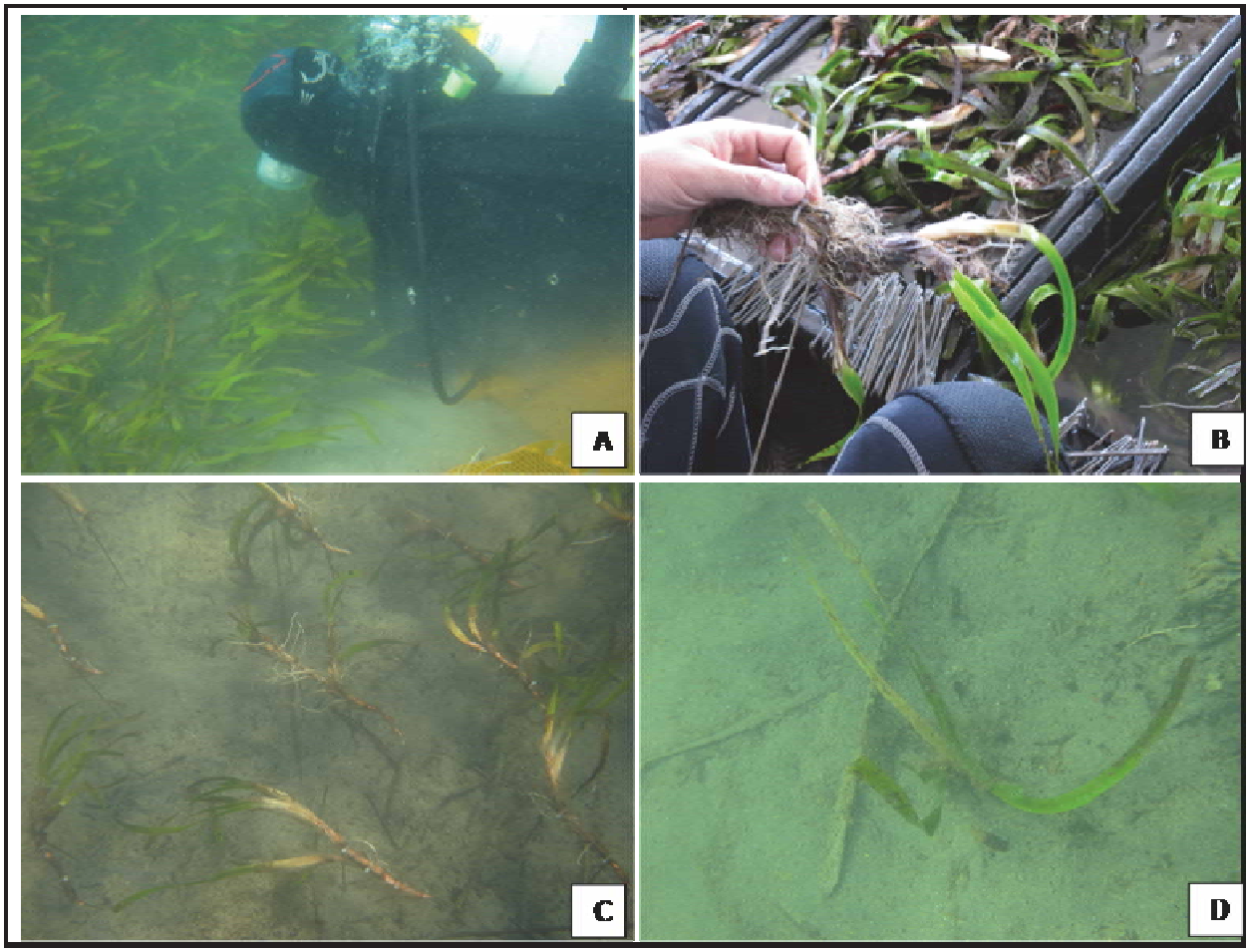

Figure 2.11 **Seagrass rehabilitation techniques showing (a) diver harvesting seagrass material from meadow edge, (b) tying sprig onto wire peg, (c) sprigs prior to burial and (d) transplanted seagrass sprig in mooring scar**

Table 2.4 **Seagrass transplantation details for mooring scars in Mangles Bay**

Mooring scar	Easting[1]	Northing[1]	Scar diameter	Number sprigs transplanted	Spacing of transplanted sprigs[2]
8184	378139.94	6428551.25	9 m	934	0.25 m
8185	378150.82	6428534.32	8 m	600	Between 0.25 m and 0.5 m
8304	378105.62	6428515.58	9.5 m	607	Between 0.25 m and 0.5 m

Notes:
1. Co-ordinates of mooring sites in Mangles Bay (UTM50_GDA94)
2. Sprigs initially spaced at 0.5 m and were then filled in with remaining sprigs, resulting in a density between 0.25 m and 0.5 m.

Results

Monitoring of seagrass transplants was conducted by MAFRL at three, six and 12 months after planting to confirm survival and growth of sprigs. The results of monitoring to date are summarised in Table 2.5.

Table 2.5 **Survival of seagrass transplants (% survival)**

Mooring Scar	July 2010 (3 months)	September 2010 (6 months)	March 2011 (12 months)
8184	74.5	56.4	46.7
8185	63.7	50.6	59.1
8304	70.2	58.8	38.8

Notes:
1. Survival expressed as percentage of original number of sprigs initially planted in March 2010.

In July 2010, three months after initial planting, survival ranged between 63.7% (scar 8185) and 74.5% (scar 8184), with an overall survival of 70%. Casual observations showed bioturbation, low hydrodynamic activity and low light availability as potential threats to survival in this area. The plants showed little growth at the three month stage, probably due to the late planting in March with little time for the plants to adjust to their recipient sites prior to winter.

In September 2010, six months after the initial planting, overall survival was 55.3% (ranging from 50.6% at scar 8185 to 58.8% at scar 8304), with a decline of nearly 15% since July 2010. Surviving shoot had grown: the number of shoots per Planting Unit (PU) increased from the initial 2.4 ± 0.1 shoots/sprig in March 2010 to 4.8 shoots/sprig ± 0.63 (mean ± SE) in September 2010. Several shoots were observed to be flowering. Casual observations showed growth into the mooring scars from the established seagrass beds surrounding the perimeter of the scars. Casual observations indicated that bioturbation, low hydrodynamic activity and low light availability were again potential threats to survival of newly planted sprigs in this area, as well as large areas of algal growth.

In March 2011, one year after planting, survival ranged from 38.8% (scar 8304) and 59.1% (scar 8185), with an overall survival of 48.2% and decline of nearly 7% since September 2010. Surviving shoots increased from the original 2.4 ± 0.1 shoots/sprig in March 2010 to 7.5 ± 0.7 shoots/sprig (mean ± SE) in March 2011 (Figure 2.12). Casual observations noted growth into the mooring scars from the surrounding seagrass beds around the perimeter of the scars, with growth of 25-50 cm from the base markings (Figure 2.12d).

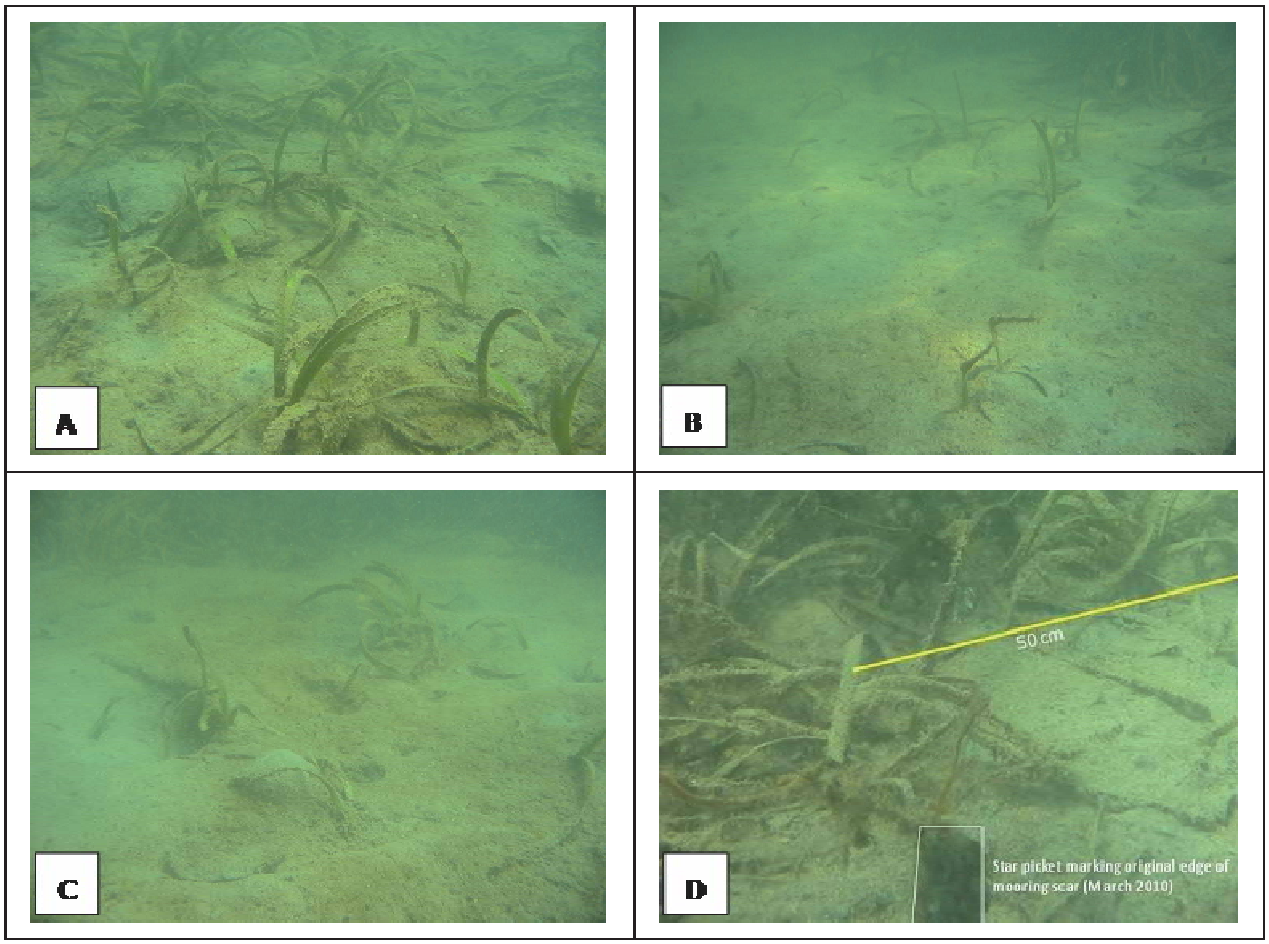

Figure 2.12 Transplanted shoots at mooring (a) 8184, (b) 8304, (c) 8185 and (d) extension of growth into scar 8184 from surrounding seagrass

Conclusions

Based on the natural regrowth of existing mature plants into the scars alone, MAFRL estimates that the "infilling" of the scars would take approximately seven years. The combination of growth of seagrass transplants and natural regrowth into the scars was estimated by MAFRL to reduce the time taken to fill in the scars to around four to five years.

3. Marine Water Quality

3.1 Marine water quality survey, 2009/2010

3.1.1 Introduction

Water quality measurements were undertaken in the shallow flats of Mangles Bay to establish baseline water quality prior to development, and to see if water quality was similar to that of the CSMC's routine monitoring site in the deep basin of Mangles Bay (site 11, refer Figure 3.1). A baseline survey of nutrient-related water quality was undertaken adjacent to the Proposal area during summer 2009/10, according to protocols used by the CSMC Standard Operating Procedures (EPA 2005b). These data were made available to the CSMC, and are included as the 'MB' site in the CSMC 2009/10 report (Wienczugow et al 2010).

3.1.2 Methods

The monitoring was conducted each Monday, between December 2009 and March 2010 inclusive. The CSMC's routine water quality monitoring is undertaken by MAFRL; however MAFRL was initially uncertain whether the MB site could be included in their routine program (due to logistic constraints). Initially (December 2009 and January 2010), Oceanica obtained a shore-based five litre water sample from Mangles Bay at site MB. Samples for water quality monitoring were collected at ~08.00 each Monday morning (the same day as the CSMC's routine water quality monitoring program), and delivered to MAFRL for analysis the same morning. Collection methods later changed to boat-based sampling by MAFRL in February and March 2010.

Figure 3.1 Water quality monitoring site 'MB' and CSMC routine monitoring site 11

MAFRL analysed each sample for:

- Nutrients (ammonia, nitrate+nitrite, orthophosphate, total nitrogen, total phosphorus);
- Primary production (measured as chlorophyll-a[1], b and c) and phaeophytin (a degradation product of chlorophyll-a); and
- Total suspended solids (TSS).

Chlorophyll-a data were compared with Cockburn Sound EQC (EPA 2005a) (refer Table 1.2). As noted previously (Section 1.2.1), compliance with the nutrient-enrichment chlorophyll-a EQG is based on data for all the CSMC's routine monitoring sites in the high ecological protection area (there is no nutrient-enrichment EQS for chlorophyll-a). Compliance with EQG and EQS for phytoplankton biomass, measured as chlorophyll-a, can be based on data for all CSMC's routine monitoring sites in the high ecological protection area ('ambient value'), or on a site-specific basis. For phytoplankton biomass the same trigger value is used for the EQG and the EQS: the EQG is based on exceedance of the trigger value for one year, and the EQS is based on exceedance of the trigger value for two consecutive years. In the strictest sense, therefore, chlorophyll-a data for the Mangles Bay site could not be compared to the nutrient-enrichment EQG, and only partial assessment was possible against the phytoplankton biomass EQC (as only one year's data were available).

Mangles Bay is classified as an area of high ecological protection under the Cockburn Sound SEP, so high protection EQC apply (Section 1.2.1). It is, however, anticipated that the marine waters offshore of the existing shoreline that will be bounded by the proposal breakwaters (an area about 50 m by 180 m; see Figure 2.1) will be zoned for moderate ecological protection under the Cockburn Sound SEP, and relevant EVs and EQOs will apply. For this reason chlorophyll-a data have been compared to both high protection EQC and moderate protection EQC.

3.1.3 Results

Median nutrient concentrations obtained at site MB in the summer 2009/2010 survey met the default national (ANZECC/ARMCANZ (2000) trigger values for nearshore marine waters in south-west Australia (Table 3.1). There are no Cockburn Sound EQC for nutrient concentrations.

Table 3.1 Median nutrient concentrations (µg/L) obtained at site MB in summer 2009/2010

	Ammonia	Nitrate + nitrite	Ortho-phosphate	Total nitrogen	Total phosphorus
Laboratory limit of reporting (LoR)	<3	<2	<2	<50	<5
ANZECC/ARMCANZ guideline	5	5	5	230	20
Median for site MB	4	2	5	190	19

Notes:
1. Default trigger values for inshore marine waters in south-west Australia for slightly disturbed ecosystems, according to ANZECC/ARMCANZ (2000).
2. Where values were reported as <LoR, the LoR was used to calculate the median.

The median chlorophyll-a concentration at site MB was 1.65 µg/L, which 'exceeded' the nutrient-enrichment EQG for high ecological protection (0.8 µg/L) and the EQG for moderate ecological protection (1.2 µg/L) (Table 3.2). The CSMC's routine monitoring site CS11 in the deep basin of Mangles Bay and several other routine monitoring sites along the eastern shore of Cockburn Sound also routinely 'exceed' both nutrient-enrichment EQGs (Wienczugow et al 2010). The median for site MB was, however, appreciably higher than the median for site CS11 (Table 3.2).

[1] *Due to a laboratory error, chlorophyll-a was measured using two different methods during the sampling, which resulted in a slightly higher number for one method therefore a correction factor had to be applied to the data.*

Table 3.2 Median concentrations of chlorophyll, phaeophytin and total suspended solids (TSS) obtained at site MB and CS11 (chlorophyll-a only) in summer 2009/2010

	Chl.-a (µg/L)	Chl.-b (µg/L)	Chl.-c (µg/L)	Phaeophytin (µg/L)	TSS (mg/L)
Laboratory limit of reporting (LoR)	**<0.1**	**<0.1**	**<0.1**	**<0.2**	**<0.5**
Nutrient-enrichment EQG	**0.8 (high protection)** **1.3 (mod. protection)**	**n/a**	**n/a**	**n/a**	**n/a**
Median for site MB	1.65	0.3	0.1	0.3	2.2
Median for site CS11	1.15	-	-	-	-

Chlorophyll-a concentrations for site MB also exceeded the site-specific phytoplankton biomass EQG for high ecological protection, with the trigger value exceeded on more than 25% of sampling occasions (Table 3.3). Chlorophyll-a concentrations at site MB were equal to or greater than the trigger value on 50% of occasions: this did not occur at the CSMC's routine monitoring site CS11 (19%) but did occur at CS13 (38%) (Wienczugow et al 2010). Chlorophyll-a concentrations at site MB did meet the phytoplankton biomass EQG for moderate ecological protection (trigger value of 2.4 µg/L not exceeded for more than 50% of sampling occasions). There are no EQC available for chlorophyll-b, chlorophyll-c, phaeophytin or TSS.

Table 3.3 Chlorophyll concentrations (µg/L) and Total Suspended Solids (mg/L)

Date	**Chlorophyll-a[1]**	**Chlorophyll-b**	**Chlorophyll-c**	**Phaeophytin-a**	**TSS[2]**
Reporting Limit	**<0.1**	**<0.1**	**<0.1**	**<0.2**	**<0.5**
Phytoplankton biomass EQG/EQS trigger value	**1.7 (high protection)** **2.4 (mod. protection)**	**n/a**	**n/a**	**n/a**	**n/a**
07/12/2009	1.6	-	-	0.4	4.0
14/12/2009	1.3	-	-	<0.2	2.2
21/12/2009	1.6	-	-	<0.2	2.3
04/01/2010	1.3	0.2	0.2	0.4	2.6
11/01/2010	3.3	0.3	0.6	0.3	2.2
18/01/2010	3.6	0.1	1.2	-	3.0
25/01/2010	1.7	0.1	0.4	-	1.9
01/02/2010	2.1	0.1	0.4	-	1.5
08/02/2010	1.0	0.1	0.2	-	-
15/02/2010	1.7	0.2	0.3	-	-
22/02/2010	0.6	0.1	0.1	-	-
02/03/2010	1.9	0.3	0.4	-	-
08/03/2010	0.7	0.1	0.1	-	-
15/03/2010	2.1	0.1	0.4	-	-
22/03/2010	1.8	0.1	0.3	-	-
29/03/2010	1.3	0.1	0.3	-	2.0
Median	1.65	0.3	0.1	0.3	2.2

Notes:
1. Due to a laboratory oversight, chlorophyll-a was measured using two different methods during the sampling. As a result, not all data are available for chlorophyll-b and -c and phaeophytin on all sampling occasions.
2. TSS was not measured for water samples collected between 8th February and 22nd March due to an oversight by the analytical laboratory.
3. Where values were reported as <LoR, the LoR was used to calculate the median.

3.1.4 Conclusions

Water quality in the area immediately adjacent to the proposed marina at Cape Peron exceeded the site-specific phytoplankton biomass EQG for high ecological protection, but met the EQG for moderate ecological protection. The data provided in this report also indicated

that water quality immediately adjacent to the proposed marina is lesser than at the CSMC's routine water quality monitoring site 11 in Mangles Bay. These findings indicate that:

- Water quality data from CSMC routine monitoring site 11 (deep basin of Mangles Bay) cannot be used to predict water quality in the shallow flats adjacent to the proposed marina
- Site-specific monitoring of water quality adjacent to the Proposal will be needed before and after development, to ascertain the degree to which outflow of water from the marina affects water quality in the Mangles Bay region.

3.2 Equilibrium ('box') modelling of marina water quality

3.2.1 Background

An indication of water quality (in terms of phytoplankton growth as indicated by chlorophyll-a concentrations) in the proposed marina was obtained with an equilibrium (or 'box') model, using dissolved inorganic nitrogen (DIN) as the modelled constituent. Studies in Perth's coastal waters have conclusively shown that phytoplankton growth is limited by nitrogen (e.g. DEP 1996), and so incorporation of DIN into phytoplankton biomass provides a conservative estimate of potential phytoplankton growth. This technique provides a guide to potential water quality (in terms of chlorophyll-a levels) in relative rather than absolute terms, and is best used to approximate chlorophyll levels in regions where they are likely to be moderate.

The ratios of chlorophyll-a to carbon, and of carbon to nitrogen in phytoplankton are relatively uniform (50C:1Chl a, and 41C:1N; by mass) and if it is conservatively assumed that all available DIN is utilised by phytoplankton, the chlorophyll-a concentration will be approximately 0.117 times the predicted DIN concentration. Relationships between chlorophyll-a and other water quality parameters (e.g. light attenuation) in Cockburn Sound are not consistent or always strong, and so weren't attempted.

Nitrogen inputs to model

Nitrogen inputs from groundwater and sediment release were used in the model. The sediment DIN release rate was based on those measured by Lavery et al (1993) for sediments from Shoalwater Bay (2.4 mg $N/m^2/d$) as part of the Perth Coastal Waters study, and comparable to published rates for sandy, carbonate sediments. This rate was also consistent with results from more recent work by Forehead (2006) in Cockburn Sound at sites in water depths of 1.5 m, 4 m, 8 m and 14 m: DIN fluxes ranged from an uptake of 0.75 $mg/m^2/day$ to a release of 14 $mg/m^2/day$, and averaged 2 $mg/m^2/day$. However as Forehead's (2006) work indicated that net uptake of DIN was common in Cockburn Sound sediments, a zero sediment flux was also simulated.

The flux of DIN from the local groundwater system to the marina was based on data provided by ERM (2011a, b) for groundwater modelling undertaken for the Mangles Bay marina. Groundwater inputs of DIN to the marina that were used were:

- Summer – DIN load of 0.1 kg/day, based on a groundwater flow of 270 m^3/day and a DIN concentration of 0.37 mg/L;
- Autumn - DIN load of 0.2 kg/day, based on a groundwater flow of 620 m^3/day and a DIN concentration of 0.33 mg/L; and
- Winter - DIN load of 0.7 kg/day, based on a groundwater flow of 940 m^3/day and a DIN concentration of 0.78 mg/L.

Stormwater inputs were not considered, given that they are largely confined to the winter months and consist of organic forms (which are unavailable for immediate phytoplankton uptake and use) rather than DIN (Strategen 2006).

Input parameters

The use of a chlorophyll-a to DIN ratio of 0.117 is conservative (i.e. it assumes that all DIN is utilised by phytoplankton), as the efficiency with which DIN is converted to carbon depends on a range of other parameters such as availability of other nutrients, light, temperature, phytoplankton species, mixing and phytoplankton numbers. For the simulations described

below, this conservative assumption (DIN:chlorophyll conversion efficiency of 1.0) was used for summer and autumn scenarios, but for the winter scenario it was assumed that the conversion efficiency was 0.5, based on the results of RPS (2009). RPS (2009) collected water quality data at seven sites in the region of the proposed Port Rockingham marina site in both summer and winter, and found similar levels of dissolved inorganic nutrient in both seasons, but chlorophyll-a concentrations in winter were about half of those in summer: the lesser growth of phytoplankton in winter (reflected in lower chlorophyll-a levels) was attributed to the lower temperatures and available light.

The background DIN in 'source' waters used in the model was 6 µg/L, based on data for concentrations of ammonium and nitrate+nitrite in southern Cockburn Sound sites obtained in the CSMC's routine water quality monitoring program for 2009/2010 (Wienczugow et al 2010). It was assumed that DIN concentrations were similar in summer, autumn and winter based on the results of RPS (2009). The chlorophyll-a concentrations in 'source' waters used in simulations for summer and autumn were the 20th percentile, median and 80th percentile values obtained for the shallow waters of Mangles Bay in 2009/2010 (refer Section 3.1.3), which are also reported as site MB in the CSMC routine water quality monitoring program for 2009/2010 (Wienczugow et al 2010). The chlorophyll-a concentrations in the 'source' waters used in simulations for winter were half those of summer and autumn, based on the results of RPS (2009).

The input parameters for the equilibrium model are tabulated below (Table 3.4). The model assumes that all input parameters remain constant in time. The flushing times ('e-folding times') chosen (six days and eight days) were typical values for the majority of marina waters in the three seasons (APASA 2011).

Table 3.4 Input parameters used in equilibrium ('box') modelling of marina water quality

Parameter	Scenario		
	Summer	Autumn	Winter
Volume of marina waters	Approx. 420,000 m^3	Approx. 420,000 m^3	Approx. 420,000 m^3
DIN load from groundwater	0.1 kg/day	0.2 kg/day	0.7 kg/day
DIN load from sediments (over 12 ha area of marina waters)	0 kg/day	0 kg/day	0 kg/day
	0.29 kg/day	0.29 kg/day	0.29 kg/day
e-folding time	6 days	6 days	6 days
	8 days	8 days	8 days
Conversion efficiency of DIN to chlorophyll-a	1.0	1.0	0.5
DIN concentration in source waters (Mangles Bay)	6 µg/L	6 µg/L	6 µg/L
Chlorophyll-a concentrations in source water (Mangles Bay)	1.3 µg/L (20th %ile)	1.3 µg/L (20th %ile)	0.6 µg/L (20th %ile)
	1.7 µg/L (median)	1.7 µg/L (median)	0.8 µg/L (median)
	2.1 µg/L (80th %ile)	2.1 µg/L (80th %ile)	1.0 µg/L (80th %ile)

3.2.2 Results

Modelling results are summarised below (Table 3.5), with typical chlorophyll-a concentrations in marina waters predicted as follows:

- summer, 2.1–3.5 µg/L (1.6 to 2.1-fold increase above 'source' waters in Mangles Bay)
- autumn, 2.3–3.7 µg/L (1.5 to 2.2-fold increase above 'source' waters in Mangles Bay)
- winter, 1.5–2.4 µg/L (1.8 to 3.1-fold increase above 'source' waters in Mangles Bay)

Table 3.5 Predicted chlorophyll-a concentrations in Mangles Bay marina waters for summer, autumn and winter

e-folding time	Ground-water DIN load	Sediment DIN load	Background chl.-a	Predicted increase in chl.-a	Final chl.-a	Level of increase in chl.-a
Summer (DIN to chlorophyll conversion efficiency of 1.0)						
Six days	0.1 kg/day	0	1.3 µg/L	0.8 µg/L	2.1 µg/L	1.6
			1.7 µg/L	0.8 µg/L	2.5 µg/L	1.5
			2.1 µg/L	0.8 µg/L	2.9 µg/L	1.4
		0.29 kg/day	1.3 µg/L	1.2 µg/L	2.5 µg/L	1.9
			1.7 µg/L	1.2 µg/L	2.9 µg/L	1.7
			2.1 µg/L	1.2 µg/L	3.3 µg/L	1.6
Eight days	0.1 kg/day	0	1.3 µg/L	0.8 µg/L	2.1 µg/L	1.6
			1.7 µg/L	0.8 µg/L	2.5 µg/L	1.5
			2.1 µg/L	0.8 µg/L	2.9 µg/L	1.4
		0.29 kg/day	1.3 µg/L	1.4 µg/L	2.7 µg/L	2.1
			1.7 µg/L	1.4 µg/L	3.1 µg/L	1.8
			2.1 µg/L	1.4 µg/L	3.5 µg/L	1.7
Autumn (DIN to chlorophyll conversion efficiency of 1.0)						
Six days	0.2 kg/day	0	1.3 µg/L	1.0 µg/L	2.3 µg/L	1.8
			1.7 µg/L	1.0 µg/L	2.7 µg/L	1.6
			2.1 µg/L	1.0 µg/L	3.1 µg/L	1.5
		0.29 kg/day	1.3 µg/L	1.4 µg/L	2.7 µg/L	2.1
			1.7 µg/L	1.4 µg/L	3.1 µg/L	1.8
			2.1 µg/L	1.4 µg/L	3.5 µg/L	1.7
Eight days	0.2 kg/day	0	1.3 µg/L	1.1 µg/L	2.4 µg/L	1.8
			1.7 µg/L	1.1 µg/L	2.8 µg/L	1.6
			2.1 µg/L	1.1 µg/L	3.2 µg/L	1.5
		0.29 kg/day	1.3 µg/L	1.4 µg/L	2.9 µg/L	2.2
			1.7 µg/L	1.4 µg/L	3.3 µg/L	2.0
			2.1 µg/L	1.4 µg/L	3.7 µg/L	1.8
Winter (DIN to chlorophyll conversion efficiency of 0.5)						
Six days	0.7 kg/day	0	0.6 µg/L	0.9 µg/L	1.5 µg/L	2.4
			0.8µg/L	0.9 µg/L	1.7 µg/L	2.1
			1.0 µg/L	0.9 µg/L	1.9 µg/L	1.8
		0.29 kg/day	0.6 µg/L	1.1 µg/L	2.4 µg/L	2.7
			0.8µg/L	1.1 µg/L	1.8 µg/L	2.3
			1.0 µg/L	1.1 µg/L	2.0 µg/L	2.1
Eight days	0.7 kg/day	0	0.6 µg/L	1.1 µg/L	1.7 µg/L	2.6
			0.8µg/L	1.1 µg/L	1.9 µg/L	2.3
			1.0 µg/L	1.1 µg/L	2.1 µg/L	2.0
		0.29 kg/day	0.6 µg/L	1.3 µg/L	2.0 µg/L	3.1
			0.8µg/L	1.3 µg/L	2.2 µg/L	2.6
			1.0 µg/L	1.3 µg/L	2.4 µg/L	2.3

3.2.3 Conclusions

Equilibrium modelling result indicate chlorophyll-a concentrations in marina waters will be about 2–3 times higher than the waters of Mangles Bay. These results are consistent with data for other marinas in Perth's coastal waters. For example, data for summer 1999/2000 in Hillary's Boat harbour give a median of 3.4 µg/L (~3.4 times the value of 'outside' waters), and a median of 2.1 µg/L for Success Harbour (~2.1 times the value of 'outside' waters) (BBG, 2001).

The relatively modest increase in chlorophyll-a concentrations in the Mangles Bay marina can be attributed to a combination of marina design, the relatively small size and simple configuration of the marina (*cf* other marinas in WA), and the small scale of groundwater nutrient inputs.

4. Marine Sediment Quality

4.1 Introduction

4.1.1 Project background

The Mangles Bay Marina proposal requires excavation of approximately 50,000 m^3 of marine sediments to a depth of approximately -4.0 mAHD[2] to create an access channel to the marina that is suitable for large (up to 25 m) power and sail crafts. The channel will be dredged using a 'cutter suction dredge' in winter, and the works are anticipated to take less than three months. If dredged material is of suitable quality, it will be pumped to settlement and infiltration basins located within the Proposal area adjacent to the coast. The seawater will infiltrate into the shallow groundwater system (which discharges into Mangles Bay) and solid material will be treated and disposed offsite, where necessary.

The dredging will result in suspension of sediment (and any associated contaminants) into the water column, and there is the potential for effects on marine biota due to both turbidity and contaminants. There is also some potential for dissolved and particulate contaminants in the sediment to enter Mangles Bay through settlement and infiltration ponds. An investigation of sediment characteristics and contaminant levels in the area to be excavated was therefore undertaken, to determine the appropriate management of dredging and disposal of dredge spoil.

4.1.2 Potential sources of contaminants in sediments

Historic contamination in Cockburn Sound

Cockburn Sound is a sheltered marine embayment located approximately 20 km south of the Perth-Fremantle area and is sheltered from ocean swells along almost its entire western side by Garden Island. As a result of these features, it is also the most intensively used marine embayment in Western Australia: it is popular for fishing and recreation; and the site of a busy port, an industrial area that depends on port facilities, and a strategic naval base.

Potential contamination within Cockburn Sound is likely to be due to historic uses by industry. In 1954 an oil refinery commenced development at James Price, shortly followed by the construction of iron, steel, alumina and nickel refining/processing plants; chemical and fertiliser production plants; and a bulk grain terminal (DCE 1979). Wharves and groynes were built and channels dredged within Cockburn Sound for shipping access, bringing with it the environmental issues related to shipping activities. In 1966, at the northern end of the Sound, a wastewater treatment plant was commissioned to treat sewage from Perth's southern suburbs (DCE 1979).

Historically Cockburn Sound has suffered poor water quality and contaminated sediment due to industrial discharge (DCE 1979), but with increasing improvements to industrial practice in the region, discharge of contaminants has decreased substantially. Nutrient inputs have also declined markedly due to the cessation of nutrient-rich industrial discharge and sewage discharge, and management of major groundwater sources of nutrients. Presently around 300 tonnes nitrogen/year are discharged into Cockburn Sound, mainly via groundwater (DAL & PPK 2001), and nutrient-related water quality remains the focus of the CSMC's water quality monitoring program.

Some contaminant input from industrial sources (process water discharge, cooling water discharge, desalination plant discharge) still occurs, but there are also inputs from diffuse sources: such as groundwater, stormwater discharge and recreational boat use. For example, the Department of Transport currently has registered 650 swing moorings in Mangles Bay, and these represent potential sources of contaminant such as fuel and oil from spills during re-fuelling, discharge of contaminated bilge water, incorrect disposal of waste, illegal sullage disposal, and chemical/contaminants entering the water from boat maintenance and/or antifoulants.

[2] *Australian Height Datum, equivalent to mean sea level.*

Also within the vicinity of the Proposal is Lake Richmond, which is located to the southeast of the project area and separated from it by Safety Bay Road. The lake is a marine relic which was once part of Cockburn Sound, but was separated from the ocean about 4,000 years ago by seaward advancement of the coastline. The presence of this coastal lake presents the potential for acid sulfate soils (ASS) in the region. As dredge spoil is expected to be settled and allowed to drain on-site via infiltration ponds (see Section 4.1.1), if ASS are present there is the risk of oxidisation and acid generation both within soils and within the water that infiltrates into the groundwater.

Receiving environment

The Proposal is located adjacent to the shallow flats of Mangles Bay, an area that is sheltered by Garden Island, the Garden Island Causeway and Cape Peron. As a result the waters in this area are relatively calm and poorly 'flushed' by marine waters (compared to other areas of Cockburn Sound) under most circumstances. The construction of the Garden Island Causeway has also disrupted natural patterns of sediment movement within the Mangles Bay area, resulting in sediment accumulation (west of the Causeway) and erosion (east of the Causeway) along the Mangles Bay foreshore.

Review of existing information on sediment contamination

Sediment sampling in the Mangles Bay region was last undertaken in 1994 during a baseline study of pollutants and metals in sediments and mussels of the southern metropolitan coastal waters of Perth (Burt et al. 1995). This study found that all organochlorine pesticides, polychlorinated biphenyls (PCBs) and hydrocarbons were below laboratory limits of reporting (LOR) at all sites within Mangles Bay, with the exception of DDT, which was only slightly above LOR at one of the five sites. Metals, polycyclic aromatic hydrocarbons (PAHs) and the high toxic boat antifoulant ingredient tributyltin (TBT) were common contaminants in the sediment samples, but only TBT exceeded relevant guidelines.

Sediment sampling by Burt et al. (1995) found that Mangles Bay was characterised by medium to fine sands with significant amounts of silt and moderate to high total organic carbon content; further suggesting the probability of acid sulfate soils occurring.

In 2005 the CSMC commissioned a study of TBT levels in sediment and imposex in marine snails throughout the Cockburn Sound area (Oceanica 2006). No sediment samples were taken in Mangles Bay due to the lack of marine snails at this site (the marine snails used for imposex surveys are intertidal organisms that occur on hard (i.e. reef) substrate). This represents a data gap, as the area contains permanent boat moorings, and sediments may have residual TBT contamination. Although the use of TBT on recreational boats <25 m in length was banned in Western Australia in 1992, TBT is slow to break down in sediments and may persist for many years (Oceanica 2006).

4.2 Methods

Relevant guidelines for the sampling and analysis of sediments include the National Assessment Guidelines for Dredging (NAGD; Commonwealth of Australia, 2009), the Contaminated Sites Act 2003 (WA) and associated Contaminated Sites Management Series (DEC 2010), and EQC for Cockburn Sound (EPA 2005a), as outlined in Section 1.2.

4.2.1 Sampling design

Sediment sampling was undertaken on 28 February and 1 March 2011. As per NAGD requirements for 50,000 m^3 of dredged material (Commonwealth of Australia 2009), a total of twelve sites (S1–S12) representative of the proposed channel footprint were sampled, with sediment cores taken to the full depth of dredging[3] and split into layers of 0.5 m for analysis (Table 4.1 and Figure 4.1). Sites were located randomly within the area to be dredged, with the majority of sample sites located closer to shore as less material will be dredged at the

[3] *The NAGD indicate "For capital dredging, samples are needed from the full depth of contaminated as well as potentially contaminated sediment. Full depth is taken to mean at least the top 1 metre of sediment, and more if contamination could be found deeper..." It is reasonable to anticipate that the surface sediments contain the highest potential for any contamination and thus represent worst-case contamination. Therefore, it was anticipated that no cores would be deeper than 150 cm.*

deeper sites. Sites were also slightly relocated to the closest mooring scar (i.e. the bare sand areas within seagrass meadows caused by boat moorings) for the following reasons:

- it allowed for straightforward sediment core extraction;
- it provided a conservative approach to sediment assessment, as sediments in mooring scars (i.e. directly under moored boats) were likely to be more contaminated than sites under seagrass meadows; and
- it minimised damage to existing seagrass meadows.

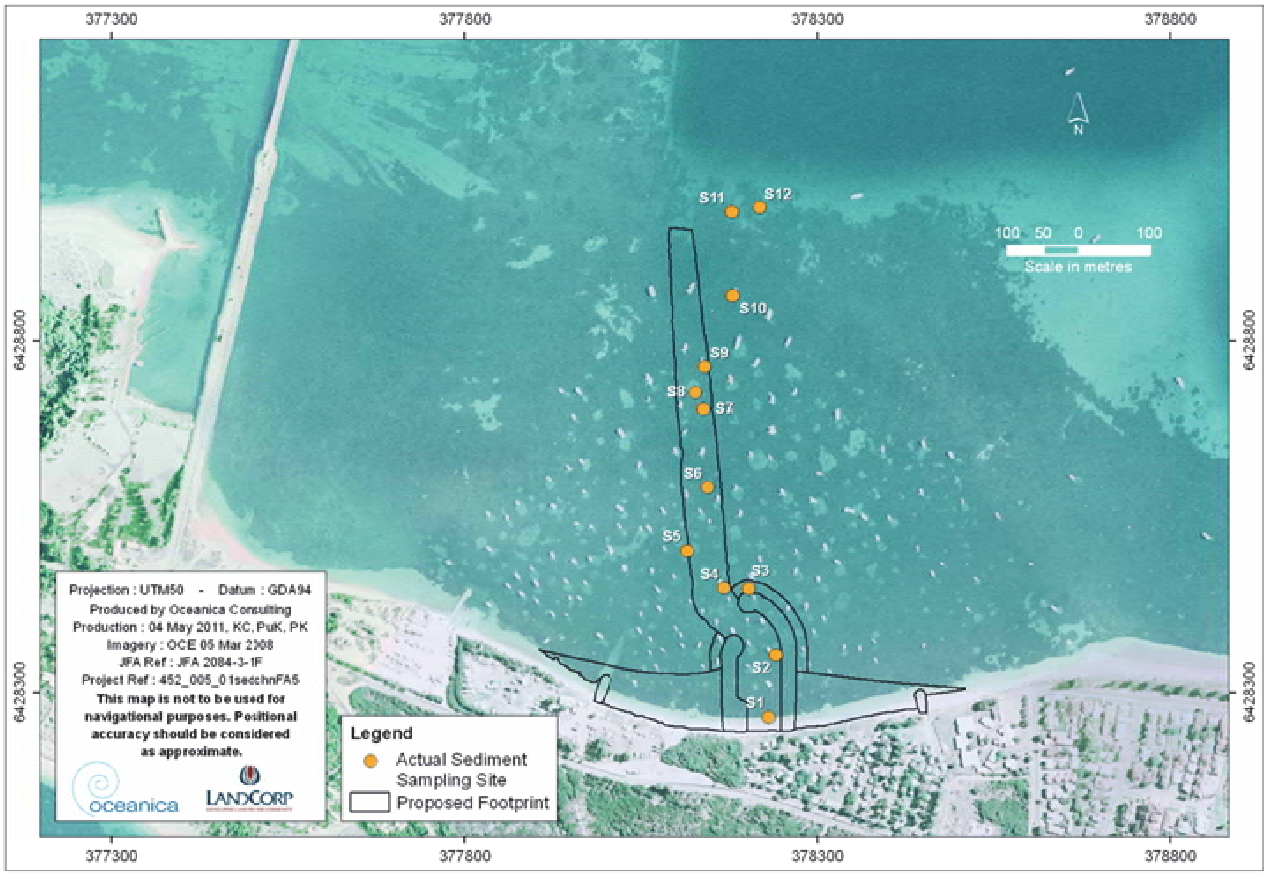

Figure 4.1 Sediment sampling sites within the vicinity of the proposed channel footprint

Sediments were sampled at a further four sites (S13–S16) located approximately 100 m and 200 m either side of the proposed marina channel to establish baseline sediment quality in the region before construction of the Proposal (Table 4.1 and Figure 4.2). This baseline sediment sampling was undertaken in line with the methodology described in the Manual of Standard Operating Procedures for Cockburn Sound (EPA 2005b). One sample was taken at each site, with the top 2 cm of sediment analysed (Table 4.1). The sample from each site is a composite from five sub-sample cores, obtained from the four corners and the centre of a 1 m^2 quadrat. Sediment cores were also sampled within mooring scars to reduce further damage to seagrass meadows.

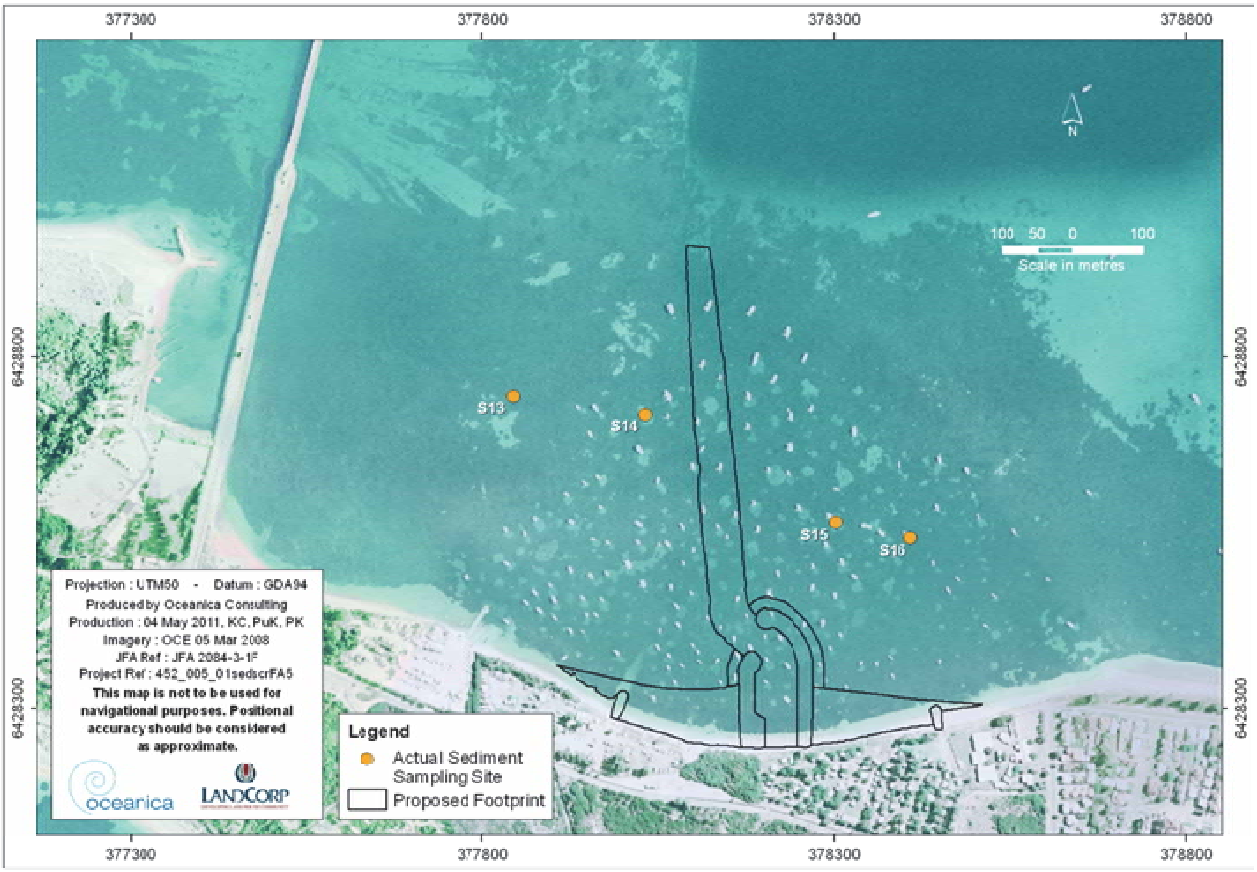

Figure 4.2 Baseline sediment sampling sites

4.2.2 Sample analysis

Physical tests

Particle size analysis of sediments at each of the sampling locations in the proposed access channel (sites S1–S12; refer to Figure 4.1) was carried out to assess potential impacts due to turbidity during dredging and disposal, and post-disposal behaviour of dredged material.

Contaminants of concern

The contaminants of concern analysed in sediments (Table 4.1) were selected based on the potential contamination sources and the existing data reviewed in Section 4.1.2. If NAGD screening levels for any analyte were triggered in a sample, then dilute acid extraction and elutriate testing for that analyte were also undertaken on that sample, as per Commonwealth of Australia (2009) protocols.

Metals
Metal contamination previously detected in sediments at Mangles Bay indicated the need to analyse all samples to ensure metal levels were within guideline levels.

TBT
The likelihood of TBT in Mangles Bay area sediments was unresolved, so TBT analysis was undertaken on all samples.

Hydrocarbons
Polycyclic Aromatic Hydrocarbons (PAHs) are common contaminants in the marine environment, mainly due to traces of fuel associated with boating activities. Based on the history of boating activities in the area, all samples were analysed for PAHs.

Acid Sulfate Soils
The acid generating potential of the sediments within the proposal area has never been analysed. Although ASS is not a problem with marine disposal, it is a potential problem with land disposal. As it is proposed to dispose dredged sediments on land, ASS analysis was undertaken on all samples in the access channel footprint, to the full depth of dredging.

Nutrients
Given the focus on nutrient-related water quality in Cockburn Sound, nutrient concentrations in sediments (as total kjeldahl nitrogen and total phosphorus) were analysed to ensure levels were within the range expected for coastal marine waters. To assess the potential impacts on water quality as a result of dredging and spoil disposal to land, sediment elutriates were also analysed for inorganic nutrients (ammonia, nitrate+nitrite and orthophosphate).

Organochlorine pesticides
Historical data indicated that these contaminants are not found in the sediment within the proposed channel footprint, and there is no new source of organochlorine pesticides in the area of Mangles Bay (i.e. agricultural run-off). Therefore sediments were not analysed for organochlorine pesticides.

Table 4.1 Sediment sampling details including sites, core depths and analyses

Site and core depth[1]	Analyses undertaken								
	Metals	Organics	Nutrients	Elutriate nutrients	**Elutriate Organotins[2]**	Particle size	TBT	Total organic carbon	ASS
Characterisation of sediments to be dredged									
S1a– 1.5 m	X	X					X	X	X
S1b– 1.5 m	X	X					X	X	X
S1c– 1.5 m	X	X	X	X		X	X	X	X
S2 – 1.0 m	X	X	X	X		X	X	X	X
S3 – 1.5 m	X	X	X	X	S3 Bottom	X	X	X	X
S4 R1 – 1.5 m	X	X	X	X			X	X	X
S4 R2 – 1.5 m	X	X				X	X	X	
S4 R3 – 1.5 m	X	X					X	X	
S5 – 1.5 m	X	X	X	X		X	X	X	X
S6 – 1.5 m	X	X	X	X	S6 Top	X	X	X	X
S7 – 1.5 m	X	X	X	X		X	X	X	X
S8 R1 – 1.5 m	X	X	X	X			X	X	X
S8 R2 – 1.5 m	X	X				X	X	X	
S8 R3 – 1.5 m	X	X					X	X	
S9 – 1.5 m	X	X	X	X		X	X	X	X
S10 – 1.5 m	X	X	X	X		X	X	X	X
S11 – 1.5 m	X	X	X	X		X	X	X	X
S12 – 1.5 m	X	X	X	X		X	X	X	X

Site and core depth[1]	Analyses undertaken								
	Metals	Organics	Nutrients	Elutriate nutrients	**Elutriate Organotins[2]**	Particle size	TBT	Total organic carbon	ASS
Characterisation of baseline sediment (surface 2 cm sediments only)									
S13	X	X				X	X	X	
S14	X	X				X	X	X	
S15	X	X				X	X	X	
S16	X	X				X	X	X	

Notes:
1. Depending on the depth of core obtained the sample number varies, i.e. a 1 m core yields two samples while a 1.5 m core yields 3 samples. Note sites S13 – S16 were 10 cm cores (refer to Section 4.2.1). Multiple samples for sites S1, S4 and S8 were replicates taken for quality assurance/quality control (refer to Section 4.2.3)
2. Only sites with elevated levels of tributyltin were analysed for elutriate concentrations of organotins.

4.2.3 Quality assurance and quality control (QA/QC)

Field QA/QC

For quality assurance and quality control purposes the field sampling included two types of QA/QC samples, as recommended by the NAGD (Commonwealth of Australia 2009), namely:

- At 10% of locations, field triplicates (that is, three separate samples taken at the same location) were taken to determine the small-scale spatial variability of the sediment physical and chemical characteristics; and
- At 5% of locations, samples were thoroughly mixed then split into three containers to assess laboratory variation, with one of the three samples sent to a second (reference) laboratory for analysis.

Site and sample numbers for the QA/QC sampling are outlined in Table 4.2.

Table 4.2 Number of field QA/QC sites and samples

Type of sampling	No of locations	No of extra samples[1]
Triplicate sampling	at 2 sites (S4 and S8)	18
Field split sampling	at 1 site (S1)	6

Notes:
1. In addition to the samples required at each of the 12 sites. Depending on the depth of core obtained the sample number could vary, i.e. a 1 m core yields two samples while a 1.5 m core yields 3 samples.

Laboratory QA/QC

Particle Size Distribution (PSD) was undertaken by Microanalysis Australia Pty Ltd[4]. Analysis of contaminants was undertaken by National Association of Testing Authorities (NATA) accredited laboratories. Advanced Analytical (AA) undertook analyses for the metals, nutrient, organics, organotins and ASS. For the analysis of field split samples the National Measurement Institute (NMI) was used for metals, organics, organotins and ASS. There are no specific guidelines for nutrient contents in sediments; therefore, nutrient analysis was not undertaken on the field splits.

As part of their procedures all laboratories undertook the required testing of blanks, spikes and standards and complete laboratory duplicates as required by the NAGD (Commonwealth of Australia 2009) and to the satisfaction of NATA requirements.

[4] *No commercial laboratory in Australia is NATA accredited for PSD analysis. Microanalysis Australia Pty Ltd is a reputable laboratory with good QA/QC.*

4.2.4 Data Analysis

Normalisation

In accordance with NAGD (Commonwealth of Australia 2009), sediment TBT and PAH levels were standardised to 1% Total Organic Carbon (TOC) prior to reporting, within a TOC range of 0.2-10%. In samples where the TOC was <0.2% or >10% the outer boundary values (0.2 or 10%) were used. If a TBT or PAH concentration was below the LOR, half the LOR value was used for normalisation purposes.

Calculation of 95% UCL for sediments in area to be dredged

In accordance with NAGD (Commonwealth of Australia 2009), the sediment core data for sediments in the area to be dredged were pooled for assessment purposes. The 95% upper confidence limit of the mean (95% UCL) was calculated for each contaminant and compared against the NAGD screening level.

Acid sulfate soils

The reduced inorganic sulphur content (%chromium reducible sulfur) for each individual sample was compared to the ASS Action Criteria of 0.03% (DEC 2009). If the Action Criteria was exceeded in any sample, acid based accounting calculations were done to determine the net acidity of the sample.

QA/QC assessment

The results of the field QA/QC sampling were analysed as described in the NAGD by calculating the Relative Percent Difference (RPD) between three split samples from one core, and Relative Standard Deviation (RSD) between three replicate samples taken at any one site. The required RPD or RSD was ±50 per cent or less, although the NAGD (Commonwealth of Australia 2009) notes that this may not always be the case where the sediments are very heterogeneous or greatly differing in grain size.

The required RPD or RSD for laboratory QA/QC results was ±35% or less.

4.2.5 Assessment

Assessment of contaminants

The suitability of material in the access channel footprint for dredging and land disposal was assessed by comparing the 95% UCLs of analytes against relevant guidelines (NAGD screening levels, EILs and HILs; refer Section 1.2). If 95% UCLs did not meet relevant guidelines, further testing potentially included dilute acid extraction and elutriate testing to assess the risk of introducing contaminants to the marine or groundwater environment via the infiltration ponds, and leachate testing to assess the risk of contaminants leaching from the land disposal site over time.

Contaminant data in baseline sediment samples (i.e. those collected adjacent to the access channel footprint) were compared against Cockburn Sound EQGs for high ecological protection (EPA 2005a). EQG values are the same as the NAGD screening levels apart from TBT: the NAGD screening level (9 µg Sn/ kg sediment) is higher than the Cockburn Sound EQG (5.0 µg Sn/ kg sediment).

Assessment of ASS

The potential for ASS in the sediments of the access channel footprint was assessed using chromium reducible sulfur (%SCR) results, with values below the Action Criteria of 0.03% indicating low risk, and no further analysis being required. Samples with %SCR values above the Action Criteria were further assessed using acid base accounting calculations, with negative net acidity indicating sediments suitable for land disposal (any acid generated would be effectively neutralised by the in situ buffering capacity of the sediments), and positive net acidity indicating the need for ASS management options to be investigated.

4.2.6 Sampling, sample handling and storage

Sampling in access channel footprint

Sampling sites were located using a GPS system, and a surface marker was deployed to mark the site. Sediment samples were obtained by a single tethered diver using hand-cores made from 50 mm diameter acid-washed PVC pipe. The diver obtained the sediment by hammering the core into the seabed: when corer refusal occurred at a shallower depth than the target sampling depth, the core was sampled to the maximum possible depth.

A bung was inserted in the top of the corer before extraction from the seabed, and another inserted into the bottom of the corer when the opening was still just below the seabed surface to avoid sediment loss due to any washing effect from the surrounding water.

Upon recovery the core was pushed out onto a core tray. A photograph was taken of the core before extracting the sediment. The length of the core was noted on the field log along with any apparent sediment characteristics such as change in sediment layers and particular odour associated with the core. Particular note was taken of any monosulfidic characteristics (e.g. sulphurous odour, dark colour and texture).

The sediment cores from the area to be dredged was separated into 0.5 m sections, each section homogenised within a pyrex glass bowl and then sub-sampled as required into laboratory sample containers.

Sampling at baseline monitoring sites

Sediment sampling at the baseline monitoring sites was also undertaken by divers using hand-cores, but in line with the methodology described in the Manual of Standard Operating Procedure for Cockburn Sound (EPA 2005b). One sample was taken at each site, comprising a composite from five sub-samples obtained from cores taken at the four corners and the centre of a 1 m^2 quadrat. Only the top 2 cm of sediment was analysed.

Sample handling and storage

To avoid cross contamination between sampling events, all sample gear was washed in Decon 90 after each sampling event. The PVC corer was thoroughly washed with seawater to remove remnant sediment. Sediment samplers wore a pair of inert gloves, which were changed between each sampling event.

Data and metadata collected in the field were entered onto a field log, including:

- Date and time of sampling;
- Site number;
- GPS co-ordinates of each location at which samples are taken;
- Depth of sampling;
- Identity of the diver;
- Core penetration and core length;
- Sediment characteristics, including colour, odour, sediment type, presence of foreign material, vegetation and shell fragments; and
- Sample identification.

All sample containers were clearly labelled with sample ID (including replicate number if applicable), date and time of collection and project number, on the container using an indelible marker.

The required sample volumes, storage and transport requirements, in accordance with the NAGD (Commonwealth of Australia 2009), are given in Table 4.3. The sample containers were stored on ice until taken to a fridge or freezer on land on completion of the day's sampling. The samples remained in the fridge/freezer until being transported to the analytical laboratory. During transport the samples were kept in eskies with ice blocks to keep the temperature low.

Table 4.3 Sampling, storage, holding time and transport of samples

Parameter	Typical volume	Sample Container	Preservation technique	Storage conditions	Storage Duration
Sediment					
Particle size distribution (PSD)	50-100 mL	Whirlpac bag	Refrigeration	<4°C	Undetermined.
Metals	100 mL	Pre-cleaned polyethylene jar	Refrigeration (or freezer for extended storage)	≤4°C	6 months (Hg 28 days unless frozen).
Organics (PAHs)	250 mL	Solvent rinsed glass jar with Teflon lid	Refrigeration (or freezer for extended storage)	≤4°C, in the dark	14 days if refrigerated.
TOC	50 mL	Heat-treated glass vial with Teflon-lined lid	Refrigeration (or freezer for extended storage)	<4°C	Undetermined.
Organotins (TBT, DBT, MBT)	125 mL	Glass jar	Refrigeration (or freezer for extended storage)	≤4°C	14 days unless frozen.
Nutrients (TKN)	70 mL	Plastic or glass	Refrigeration (or freezer for extended storage)	≤4°C	24 hours if refrigerated. 1 month if frozen.
Nutrients (TP)	70 mL				
Seawater and elutriate					
Metals (elutriate only)	1 L	Acid-rinsed polyethylene or glass jar	pH <2 with HNO_3, refrigerate	4°C	Hg – 14 days, Others 6 months.
Total Nitrogen (TN) and Total Phosphorus	2x125mL (seawater) 2x125mL (elutriate)	Plastic or glass	H_2SO_4 to pH <2, refrigerate	4°C	24 hours (TKN) 7 days (TP).
Ammonia Nitrate+nitrite Ortho-phosphate	2x10mL (seawater) 2x10mL (elutriate)	Plastic or glass	Filter on site (0.45 µm cellulose acetate membrane filter) and either: (i) Refrigerate; or (ii) Freeze	≤4°C	24 hours if refrigerated. 1 month if frozen.

A detailed chain of custody (CoC) form was prepared and accompanied the samples to each laboratory, to keep track of each individual sample to ensure that correct analysis and storage was undertaken, and that the recommended holding times were adhered to. The CoC forms included the following information:

- Place of sampling;
- Sample ID, client name and project reference number;
- Sampling date;
- Requested analysis;
- Sample storage request; and
- Sample transport details including date of dispatch.

4.2.7 Data Management Procedures

All data was validated prior to reporting, and screened for possible outliers/erroneous results.

4.2.8 Health and Safety

Diving was conducted to AS/NZS 2299.1:2007. A minimum of four commercial divers qualified to ADAS Level 1 (minimum of 1 ADAS trained dive supervisor; trained to AS 2815.5) or above were present throughout the diving operation, as required under AS/NZS 2299.1:2007.

A Job Safety Analysis report was completed prior to commencement of the diving. A dive plan was also be prepared prior to commencement of the diving operation, and a dive log maintained throughout the dive operations.

No chemicals were used in the field, apart from Decon 90 for decontamination purposes. This is a biodegradable concentrate combining anionic and non-anionic surface active agents with stabilising agents, alkalis and non-phosphate detergent builders. Latex gloves were worn by personnel involved in the handling of sediments, and safety boots will be worn by all field personnel.

4.3 Results

The results of the sediment sampling and analysis are summarised below, with the laboratory data reports provided in full in Appendix A.

4.3.1 Particle size analysis

The sediments in the area to be excavated primarily comprised fine to median grained sands, with only small percentages of silts and clays. Representative data for the surface, middle and bottom layers of four sites are shown in Table 4.4: distributions in the 0-0.5 m layer (S), the 0.5-1 m layer (M) and the 1-1.5 m layer (B) of each site were generally similar with the exception of site S11, which had more silt and clay in the surface and middle sediment layers than in the bottom layer. The low percentage of silt and clay indicated a low potential for the generation of turbidity during dredging.

Table 4.4 Particle size distributions (% volume in each size class) for sites S2, S5, S8 and S11

Fraction	Size category	S2 S	S2 M	S5 S	S5 M	S5 B	S8R2 S	S8R2 M	S8R2 B	S11 S	S11 M	S11 B
Gravel	(>2 mm)	1.7	0.9	4.1	3.9	0.9	10.5	5.0	0.6	9.2	14.1	4.8
Sand fractions	Very coarse (1–2 mm)	8.8	1.5	1.9	2.2	1.1	2.3	2.0	1.7	4.6	4.0	2.3
	Coarse (0.5–1 mm)	5.9	5.9	6.8	9.8	6.2	10.9	9.2	18.1	11.6	11.0	12.5
	Medium (250–500 µm)	47.8	42.3	45.2	47.1	56.5	35.7	48.5	55.4	19.5	24.6	57.3
	Fine (125–250 µm)	24.5	39.7	31.8	32.4	32.0	28.3	29.4	20.0	21.6	20.4	17.7
	Very fine (63–125 µm)	1.2	3.3	1.6	1	0.3	2.5	1.0	0.2	9.7	8.1	0.2
Sand	63 µm-2 mm	88.3	92.7	87.2	92.7	96.0	79.8	90.1	95.4	67.0	68.1	90.0
Silt fractions	Coarse (31–63 µm)	2.4	1.0	2.5	1	0.9	2.6	1.0	1.2	5.8	4.6	1.6
	Medium (16–31 µm)	2.1	1.5	2.2	1	0.7	2.4	1.1	0.8	4.9	3.3	0.7
	Fine (8–16 µm)	1.9	1.4	1.7	1	0.7	2.0	1.1	0.9	4.8	3.4	1.1
	Very fine (4–8 µm)	1.4	1.5	1.4	1	0.7	1.6	1.1	0.8	4.1	3.1	1.1
Silt	(4–63 µm)	7.7	5.4	7.9	3	3.0	8.6	4.3	3.7	19.6	14.4	4.5
Clay	(<4 µm)	0.7	1.0	0.8	0	0.1	1.1	0.6	0.4	4.2	3.5	0.8

4.3.2 Sediment contaminants

Metals

Concentrations of metals within the sediments met NAGD screening levels, EILs, HILs and EQGs (Table 4.5), indicating that there was a low risk of adverse ecological effects due to dredging or disposal, and that the material was suitable for use on land. Due to the low concentrations found, dilute acid extraction and elutriate tests were not required.

Table 4.5 Metal concentrations in Mangles Bay sediments (mg/kg)

Analyte	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NAGD screening levels / EQG value	**1**	**20**	**1.5**	**80**	**65**	**0.15**	**21**	**50**	**200**
EQG re-sampling trigger	**3.7**	**70**	**10**	**370**	**270**	**1**	**52**	**220**	**410**
EIL	**n/a**	**20**	**3**	**400**	**100**	**1**	**60**	**600**	**200**
HIL 'D'	**n/a**	**400**	**80**	**480000**	**4000**	**60**	**2400**	**1200**	**28000**
HIL 'E'	**n/a**	**200**	**40**	**240000**	**2000**	**30**	**600**	**600**	**14000**
HIL 'F'	**n/a**	**400**	**100**	**600000**	**5000**	**75**	**3000**	**1500**	**35000**
Sites sampled for dredged sediment characterisation									
S1a S	0.68	3.6	0.21	13	2.8	<0.01	0.93	2.5	5.6
S1a M	0.74	5.8	0.2	13	0.8	<0.01	0.97	1	1.5
S1a B	0.75	6.6	0.17	13	0.57	<0.01	0.88	0.61	0.96
S1b S	0.7	8.3	0.2	14	0.96	<0.01	1	0.88	1.6
S1b M	0.72	5.4	0.18	12	0.78	<0.01	0.92	1.2	1.6
S1b B	0.76	6.8	0.16	13	0.59	<0.01	0.92	0.57	0.89
S2 S	0.68	3.5	0.19	13	2.1	<0.01	0.96	2.4	5.4
S2 M	0.73	10	0.21	14	0.52	<0.01	1.1	0.74	0.85
S3 S	0.7	7.7	0.2	14	32	0.03	0.89	8.2	5.6
S3 M	0.72	12	0.22	14	3.6	<0.01	0.96	1.3	1
S3 B	0.7	12	0.2	14	2	0.01	0.89	1.5	0.91
S4 R1 S	0.67	6.7	0.25	13	2.8	<0.01	1.3	1.6	6
S4 R1 M	0.7	10	0.19	13	0.42	<0.01	0.81	0.57	1.2
S4 R1 B	0.68	12	0.2	14	0.39	<0.01	0.87	0.6	0.61
S4 R2 S	0.69	7.3	0.23	13	2.1	<0.01	1.1	1.2	3.7
S4 R2 M	0.73	10	0.19	14	0.42	<0.01	0.83	0.6	0.68
S4 R2 B	0.70	11	0.2	14	0.64	<0.01	0.96	0.63	1
S4 R3 S	0.68	6.2	0.19	13	2	<0.01	1.1	1.3	3.8
S4 R3 M	0.70	8.1	0.18	14	0.72	<0.01	0.9	0.72	1.1
S4 R3 B	0.71	9.5	0.19	14	0.48	<0.01	0.86	0.57	0.75
S4 R3 B – lab duplicate	0.71	9.1	0.18	14	0.48	<0.01	0.83	0.64	0.71
S5 S	0.68	5.8	0.19	13	2.1	<0.01	0.88	0.93	3.5
S5 M	0.69	8.2	0.22	14	0.48	<0.01	1	0.63	0.69
S5 B	0.67	12	0.25	14	0.36	<0.01	1.4	0.61	0.58
S6 S	0.69	4.4	0.16	13	2.4	<0.01	0.79	0.96	2.3
S6 M	0.81	7.8	0.2	14	0.44	<0.01	0.87	0.62	0.61
S6 B	0.65	9.2	0.25	14	0.42	<0.01	0.91	0.51	0.65
S7 S	0.67	5.5	0.17	14	0.69	<0.01	0.72	0.97	1.3
S7 M	0.66	7.5	0.17	13	0.36	<0.01	0.88	0.58	0.51
S7 B	0.64	9.4	0.21	14	0.31	<0.01	0.96	0.54	0.57
S8 R1 S	0.70	5.5	0.17	14	0.79	<0.01	0.83	0.8	1.5
S8 R1 S – lab duplicate	0.70	5.4	0.17	13	0.72	<0.01	0.76	0.75	1.5
S8 R1 M	0.69	7.4	0.17	13	0.42	<0.01	0.74	0.6	0.59
S8 R1 B	0.64	11	0.19	13	0.39	<0.01	1	0.52	0.53
S8 R2 S	0.70	5.5	0.17	14	0.92	<0.01	0.83	0.87	2.7
S8 R2 M	0.68	7.7	0.18	13	0.33	<0.01	0.73	0.57	0.62
S8 R2 B	0.63	11	0.2	13	0.31	<0.01	1	0.53	0.51
S8 R3 S	0.70	5.5	0.17	14	1.6	<0.01	0.85	0.95	2
S8 R3 M	0.65	9.9	0.19	14	0.35	<0.01	0.92	0.63	0.53
S8 R3 B	0.60	11	0.18	13	0.32	<0.01	0.77	0.58	0.54
S9 S	0.66	6.7	0.2	14	1.5	<0.01	1.1	1.1	3.6
S9 M	0.78	8.6	0.21	13	0.52	<0.01	1.2	0.66	0.78
S9 M – lab duplicate	0.77	8.7	0.21	13	0.53	<0.01	1.2	0.7	0.73
S9 B	0.77	8.7	0.22	12	0.47	<0.01	1.2	0.61	0.59
S10 S	0.72	4	0.21	13	6.7	<0.01	1.3	1.6	8
S10 M	0.74	7.1	0.19	13	0.42	<0.01	1	0.53	0.61
S10 B	0.72	11	0.25	14	0.39	<0.01	1	0.56	0.64
S11 S	0.75	4.7	0.17	13	0.96	<0.01	1.2	0.92	1.8
S11 M	0.73	6	0.18	13	0.52	<0.01	1.1	0.55	0.52
S11 B	0.72	5.4	0.17	14	0.4	<0.01	0.88	0.61	0.64

Analyte	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NAGD screening levels / EQG value	**1**	**20**	**1.5**	**80**	**65**	**0.15**	**21**	**50**	**200**
EQG re-sampling trigger	**3.7**	**70**	**10**	**370**	**270**	**1**	**52**	**220**	**410**
EIL	**n/a**	**20**	**3**	**400**	**100**	**1**	**60**	**600**	**200**
HIL 'D'	**n/a**	**400**	**80**	**480000**	**4000**	**60**	**2400**	**1200**	**28000**
HIL 'E'	**n/a**	**200**	**40**	**240000**	**2000**	**30**	**600**	**600**	**14000**
HIL 'F'	**n/a**	**400**	**100**	**600000**	**5000**	**75**	**3000**	**1500**	**35000**
S12 S	0.74	5	0.17	12	0.99	<0.01	1.1	1	2.9
S12 M	0.74	5.4	0.17	13	0.6	<0.01	1	0.66	0.67
S12 B	0.72	7.3	0.18	13	0.4	<0.01	0.94	0.51	0.59
Mean[1]	**0.71**	**7.5**	**0.20**	**13.4**	**2.0**	**<0.01**	**0.98**	**1.1**	**1.8**
Standard deviation[1]	**0.04**	**2.5**	**0.02**	**0.6**	**5.4**	**n/a**	**0.15**	**1.3**	**1.9**
95% UCL[1]	**0.72**	**8.3**	**0.20**	**13.6**	**3.8**	**<0.01**	**1.03**	**1.5**	**2.4**
QA/QC check – inter-laboratory comparison									
S1c S	<0.2	2.2	0.15	15	2.5	<0.01	1.8	2.8	8
S1c M	<0.2	3.6	0.11	14	0.78	<0.01	1.1	0.98	1.7
S1c B	<0.2	4.4	<0.1	14	0.61	<0.01	1.2	0.61	1
Sites sampled for baseline sediment quality (surface 2 cm sediments only)									
S13	0.72	4.2	0.15	13	1.1	<0.01	0.76	0.99	2.3
S14	0.79	4.3	0.16	13	1.7	<0.01	0.84	1.3	5.6
S15	0.76	4.2	0.15	15	19	<0.01	1.8	1.1	5.1
S16	0.78	3.4	0.15	13	1.3	<0.01	0.78	1	2.3

Notes:
1. Only AA laboratory results were used in calculations. Where duplicate results were available for a sample, the average value was used. For values <LoR, a value of half the LoR was used.

Nutrients

Concentrations of Total Kjeldahl Nitrogen (TKN) and Total Phosphorus (TP) in sediments were 56¬440 mg/kg and 370–420 mg/kg, respectively (Appendix A). No trigger values exist for nutrients in sediments, however these values were within the ranges range previously reported for sediments of Cockburn Sound and Warnbro Sound: 80–2,150 mg/kg for TKN and 350–500 mg/kg for total phosphorus, with the higher values associated with siltier sediments in the deep basins (DEP 1996).

Concentrations of ammonia in sediment elutriates did not exceed the EQG for high ecological protection (EPA 2005a) (Table 4.6). Sediment elutriate results (Table 4.6) also indicated a slight potential for nutrient-enrichment effects (e.g. enhanced phytoplankton growth) due to release of inorganic nutrients during dredging, but the risk is considered small due to the small volume of sediment to be dredged, and the proposed timing for dredging in winter (when temperatures and light availability for algal growth are low).

Table 4.6 Concentrations of nutrients in Mangles Bay sediments and sediment elutriates

Analyte	Ammonia	Nitrate+Nitrite	Orthophosphate
Units	**µg.N/L**	**µg.N/L**	**µg.P/L**
EQG for high ecological protection	**1,700**	**n/a**	**n/a**
S1a S	740	15	37
S1a M	94	9	24
S1a B	100	11	24
S2 S	200	10	73
S2 M	120	9	38
S3 S	390	12	67
S3 M	76	6	36
S3 B	80	7	35
S4 R1 S	680	9	120
S4 R1 M	70	8	23
S4 R1 B	56	8	38
S4 R2 S	510	9	83
S4 R2 M	86	8	26

Analyte	Ammonia	Nitrate+Nitrite	Orthophosphate
Units	µg.N/L	µg.N/L	µg.P/L
EQG for high ecological protection	1,700	n/a	n/a
S4 R2 B	160	7	34
S4 R3 S	910	11	120
S4 R3 M	99	7	31
S4 R3 B	82	9	35
S5 S	670	6	42
S5 M	81	5	41
S5 B	55	6	38
S6 S	580	15	86
S6 M	84	9	40
S6 B	63	7	53
S7 S	490	10	62
S7 M	34	6	30
S7 B	12	7	23
S8 R1 S	350	12	60
S8 R1 M	43	10	30
S8 R1 B	22	8	24
S8 R2 S	200	12	120
S8 R2 M	59	6	36
S8 R2 B	59	5	33
S8 R3 S	260	11	74
S8 R3 M	87	6	51
S8 R3 B	72	6	37
S9 S	720	9	70
S9 M	71	5	34
S9 B	62	5	31
S10 S	1500	5	34
S10 M	57	6	41
S10 B	63	5	43
S11 S	340	7	96
S11 M	77	4	41
S11 B	53	7	30
S12 S	710	6	86
S12 M	100	4	48
S12 B	52	6	32

TBT and TOC

Total Organic Carbon (TOC) values (0.1–0.5%) were within the range previously reported for sediments of Cockburn Sound and Warnbro Sound (DEP 1996) (Table 4.7).

Concentrations of tributyltin (TBT) were below laboratory reporting limits at nearly all sites and depths, and the 95% UCL concentration of TBT met the NAGD screening level (Commonwealth of Australia 2009) (Table 4.7), indicating a low risk of adverse ecological effects due to dredging or disposal. The median TBT concentration at baseline sediment sampling sites also met the EQG (Table 4.7), indicating a low risk of adverse ecological effects. There are no EILs or HILs for TBT (Table 4.7).

Although the NAGD screening level for dredged sediments was met, as a precautionary measure further testing was undertaken on the two individual samples that 'exceeded' the NAGD Screening Level. Samples for the bottom layer of site S3 and the surface layer of site S6 were re-analysed for sediment TBT concentrations and elutriate TBT concentrations. Re-analysis of the bottom layer of site S3 found sediment TBT concentration and elutriate TBT concentrations below laboratory reporting limits (and NAGD screening levels). Re-analysis of the surface layer of site S6 confirmed the same sediment concentration of TBT, and an elutriate concentrations exceeded the EQG for high ecological protection (Commonwealth of Australia 2009; EPA 2005a). Although the dredged material will be placed in land-based

infiltration ponds at the Proposal site (i.e. removed from the marine environment) and meets the TBT screening level, the results for site S6 surface sediment indicate it would be prudent to undertake monitoring of water in the infiltration ponds to confirm predictions that overall TBT concentrations will meet marine guidelines.

Table 4.7 Concentrations of total organic carbon (TOC) and tributyltin (TBT) in Mangles Bay sediments

Analyte	TOC (%)	Original analysis (µg Sn/kg)		Reanalysis (µg Sn/kg)		Elutriate TBT (µg/L)
		TBT	normalised TBT	TBT	normalised TBT	
NAGD sediment screening level / EQG value	**n/a**		**9.0 / 5.0**		**9.0**	
Water quality EQG	**n/a**		**0.006**		**0.006**	
Sites sampled for dredged sediment characterisation						
S1a S	0.3	<0.5	0.8	-	-	-
S1a M	0.3	<0.5	1.0	-	-	-
S1a B	0.3	<0.5	1.9	-	-	-
S1b S	0.5	<0.5	1.8	-	-	-
S1b M	0.2	<0.5	1.0	-	-	-
S1b B	0.3	<0.5	2.0	-	-	-
S2 S	0.3	<0.5	0.9	-	-	-
S2 M	0.2	<0.5	1.1	-	-	-
S3 S	0.3	0.8	2.5	-	-	-
S3 M	0.2	0.6	2.7	-	-	-
S3 B	0.2	1.1	**6.9**	<0.50	1.3	<0.005
S4 R1 S	0.5	<0.5	0.5	-	-	-
S4 R1 M	0.2	<0.5	1.3	-	-	-
S4 R1 B	0.2	<0.5	1.3	-	-	-
S4 R2 S	0.5	<0.5	0.5	-	-	-
S4 R2 M	0.2	<0.5	1.3	-	-	-
S4 R2 B	0.2	<0.5	1.3	-	-	-
S4 R3 S	0.5	<0.5	0.5	-	-	-
S4 R3 M	0.2	<0.5	1.3	-	-	-
S4 R3 B	0.1	<0.5	1.3	-	-	-
S4 R3 B – lab duplicate	0.1	<0.5	1.3	-	-	-
S5 S	0.2	<0.5	1.0	-	-	-
S5 M	0.2	<0.5	1.3	-	-	-
S5 B	0.1	<0.5	1.3	-	-	-
S6 S	0.3	11	**34.4**	11	**34.4**	**0.74**
S6 M	0.2	<0.5	1.3	-	-	-
S6 B	0.2	<0.5	1.3	-	-	-
S7 S	0.3	<0.5	0.9	-	-	-
S7 M	0.2	<0.5	1.3	-	-	-
S7 B	0.2	<0.5	1.3	-	-	-
S8 R1 S	0.3	<0.5	0.8	-	-	-
S8 R1 S – lab duplicate	0.3	<0.5	0.8	-	-	-
S8 R1 M	0.2	<0.5	1.3	-	-	-
S8 R1 B	0.2	<0.5	1.3	-	-	-
S8 R2 S	0.4	<0.5	0.7	-	-	-
S8 R2 M	0.2	<0.5	1.3	-	-	-
S8 R2 B	0.1	<0.5	1.3	-	-	-
S8 R3 S	0.2	<0.5	1.1	-	-	-
S8 R3 M	0.2	<0.5	1.3	-	-	-
S8 R3 B	0.2	<0.5	1.3	-	-	-
S9 S	0.5	<0.5	0.5	-	-	-
S9 M	0.2	<0.5	1.3	-	-	-

Analyte	TOC (%)	Original analysis (µg Sn/kg)		Reanalysis (µg Sn/kg)		Elutriate TBT (µg/L)
		TBT	normalised TBT	TBT	normalised TBT	
NAGD sediment screening level / EQG value	**n/a**		**9.0 / 5.0**		**9.0**	
Water quality EQG	**n/a**		**0.006**		**0.006**	
S9 M – lab duplicate	0.2	<0.5	1.3	-	-	-
S9 B	0.5	<0.5	0.5	-	-	-
S10 S	0.2	<0.5	1.3	-	-	-
S10 M	0.2	<0.5	1.3	-	-	-
S10 B	0.5	<0.5	0.5	-	-	-
S11 S	0.3	<0.5	0.7	-	-	-
S11 M	0.2	<0.5	1.3	-	-	-
S11 B	0.4	<0.5	0.6	-	-	-
S12 S	0.4	<0.5	0.7	-	-	-
S12 M	0.2	<0.5	1.3	-	-	-
S12 B	0.2	<0.5	1.3	-	-	-
Mean[1]	**n/a**	**n/a**	**2.3**	**-**	**-**	**-**
Standard deviation[1]	**n/a**	**n/a**	**5.7**	**-**	**-**	**-**
95% UCL[1]	**n/a**	**n/a**	**4.2**	**-**	**-**	**-**
QA/QC check – inter-laboratory comparison						
S1c S	0.5	<0.5	0.9	-	-	-
S1c M	0.3	<0.5	0.8	-	-	-
S1c B	0.4	<0.5	1.3	-	-	-
Sites sampled for baseline sediment quality (surface 2 cm of sediments only)						
S13	0.4	<0.5	0.6	-	-	-
S14	0.4	<0.5	0.7	-	-	-
S15	0.3	1.1	3.5	-	-	-
S16	0.3	<0.5	0.9	-	-	-

Notes:
1. Only AA laboratory results were used in calculations. Where duplicate results were available for a sample, the average value was used. For values <LoR, a value of half the LoR was used.

Organics

Concentrations of total polycyclic aromatic hydrocarbons (PAHs) and each constituent PAH within sediments were all below the limits of reporting at all sites and depths (LOR 5 µg/kg and 100 µg/kg for individual PAH and total PAHs, respectively). Results are provided in full in the laboratory data reports in Appendix A.

Acid Sulfate Soils

At all sites and across all depths, values for sediment pH_{KCl} (pH of potassium chloride suspension) were greater than 9, indicating none of the samples were acidic (Table 4.8). This conclusion was supported by the Titratable Actual Acidity (TAA), which was zero at every site and depth. Just under half of the sediment layers analysed (16 out of the 35) had chromium reducible sulfur (%SCR) values in excess of the Action Criteria value for soils (0.03%; Table 4.8), and so were potential acid sulfate soils (PASS). However the net acidity data indicated that the potential acidity within the PASS samples would be buffered by alkaline components within the samples, as they had sufficient neutralising capacity to result in negative net acidity (Table 4.8). Results therefore indicated that any acid produced following land disposal of sediments excavated to create the marina access channel would be effectively neutralised by the *in situ* buffering capacity of the sediments.

Table 4.8 Acid sulfate soils (ASS) and acid base accounting (ABA) results for Mangles Bay sediments

Site	pH_{kcl}	Potential Sulfidic Acidity			Acid Neutralising Capacity (ANC)			Net Acidity
		%S (SCR)	Equiv. acidity (mol H^+/ tonne)	Existing Acidity	ANCBT (% $CaCO_3$)	ANC (mol H^+/ tonne)	Fitness Factor	Net Acidity (mol H^+/ tonne)
S1a S	9.8	0.01	8.11	None	n/m	n/m	2	n/m
S1a S[1]	9.8	0.01	8.11	None	n/m	n/m	2	n/m
S1a M	9.8	0.03	17.46	None	n/m	n/m	2	n/m
S1a B	9.8	0.03	15.59	None	n/m	n/m	2	n/m
S1b S	9.8	0.01	6.86	None	n/m	n/m	2	n/m
S1b M	9.8	0.03	20.58	None	n/m	n/m	2	n/m
S1b B	9.8	0.03	16.84	None	n/m	n/m	2	n/m
S2 S	9.8	0.05	28.69	None	86	17182.8	2	-8562.71
S2 M	9.8	0.05	31.81	None	84	16783.2	2	-8359.79
S3 S	9.8	0.05	28.07	None	85	16983	2	-8463.43
S3 M	9.8	0.05	32.43	None	86	17182.8	2	-8558.97
S3 B	9.8	0.05	28.69	None	85	16983	2	-8462.81
S3 B[1]	9.8	0.05	33.68	None	88	17582.4	2	-8757.52
S4 S	9.7	0.04	22.45	None	83	16583.4	2	-8269.25
S4 M	9.8	0.04	22.45	None	82	16383.6	2	-8169.35
S4 B	9.8	0.05	33.68	None	84	16783.2	2	-8357.92
S5 S	9.8	0.04	21.83	None	85	16983	2	-8469.67
S5 M	9.9	0.04	24.95	None	87	17382.6	2	-8666.35
S5 B	9.8	0.04	27.44	None	88	17582.4	2	-8763.76
S6 S	9.8	0.02	13.72	None	n/m	n/m	2	n/m
S6 M	9.9	0.02	11.85	None	n/m	n/m	2	n/m
S6 B	9.8	0.03	21.21	None	n/m	n/m	2	n/m
S7 S	9.8	0.02	11.23	None	n/m	n/m	2	n/m
S7 S[1]	9.9	0.02	9.36	None	n/m	n/m	2	n/m
S7 M	9.9	0.04	23.08	None	85	16983	2	-8468.42
S7 B	9.8	0.05	28.69	None	85	16983	2	-8462.81
S8 R1 S	9.8	0.02	14.97	None	n/m	n/m	2	n/m
S8 R1 M	9.9	0.03	18.71	None	n/m	n/m	2	n/m
S8 R1 B	9.8	0.05	28.69	None	76	15184.8	2	-7563.71
S9 S	9.7	0.03	20.58	None	n/m	n/m	2	n/m
S9 M	9.8	0.03	20.58	None	n/m	n/m	2	n/m
S9 B	9.9	0.05	28.07	None	70	13986	2	-6964.93
S10 S	9.7	0.02	14.97	None	n/m	n/m	2	n/m
S10 M	9.8	0.03	16.84	None	n/m	n/m	2	n/m
S10 M[1]	9.8	0.02	14.97	None	n/m	n/m	2	n/m
S10 B	9.8	0.04	27.44	None	69	13786.2	2	-6865.66
S11 S	9.8	0.02	12.47	None	n/m	n/m	2	n/m
S11 M	9.8	0.03	17.46	None	n/m	n/m	2	n/m
S11 B	9.9	0.02	11.23	None	n/m	n/m	2	n/m
S12 S	9.7	0.03	16.84	None	n/m	n/m	2	n/m
S12 M	9.8	0.03	16.22	None	n/m	n/m	2	n/m
S12 B	9.9	0.04	23.08	None	81	16183.8	2	-8068.82

Notes:
1. * Laboratory duplicate.

4.3.3 QA/QC assessment

The Relative Standard Deviation (RSD) between three replicate samples taken at sites S4 and S8 were less than 30% for metal and TBT results at all sites and all depths, and therefore within the ±50% limit (refer also Table 4.5 and Table 4.7).

The Relative Percent Difference (RPD) between three split samples (two of the three samples analysed by AA and one sample by NMI) were generally within the ±50 percent limit. Those RPDs that were greater than 50% were considered to be more due to the low concentrations of metals present (which magnifies relative differences) plus small scale spatial variability in sediments, rather than lack of reliability in analytical results.

Table 4.9 Relative Percent Difference (RPD) between three split samples taken for QA/QC checks

Analyte	RPD for AA (sample 'a') and AA (sample 'b')			RPD for AA (sample 'a') and NMI (sample 'c')			RPD for AA (sample 'b') and NMI (sample 'c')		
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Silver	-2.0	2.7	-1.3	**109.1**	**114.9**	**115.8**	**111.1**	**113.0**	**116.7**
Arsenic	**-79.0**	7.1	-3.0	48.3	46.8	40.0	**116.2**	40.0	42.9
Cadmium	4.9	10.5	6.1	33.3	**58.1**	**51.9**	28.6	48.3	46.2
Chromium	-7.4	8.0	0.0	14.3	-7.4	-7.4	-6.9	-15.4	-7.4
Copper	**97.9**	2.5	-3.4	11.3	2.5	-6.8	**-89.0**	0.0	-3.3
Lead	**95.9**	-18.2	6.8	-11.3	2.0	0.0	**-104.3**	20.2	-6.8
Mercury	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Nickel	-7.3	5.3	-4.4	**-63.7**	-12.6	-30.8	**-57.1**	-17.8	-26.4
Zinc	**111.1**	-6.5	7.6	-35.3	-12.5	-4.1	**-133.3**	6.1	-11.6
Tributyltin	0	0	0	0	0	0	0	0	0

Notes:
1. Results greater than 50% in bold font.

Based on the QA/QC results, laboratory results were deemed sufficiently reliable for purpose.

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Appendix A

Laboratory data reports for sediment analysis

REPORT OF ANALYSIS

Laboratory Reference: A11/1055-A [R00]

Client: Oceanica Consulting Pty Ltd
Lev 1, 353 Cambridge Street
Wembley WA 6913

Contact: Karen Crawley

Order No: 452_005
Project: Mangles Bay
Sample Type: sediment
No. of Samples: 55
Date Received: 3/03/2011
Date Completed: 21/03/2011

Laboratory Contact Details:

Client Services Manager: Jane Struthers
Technical Enquiries: Andrew Bradbury
Telephone: +61 8 9325 9799
Fax: +61 8 9325 4299
Email: perth@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	1 S1a Top 28/2/2011- 1/3/2011	2 S1a Middle 28/2/2011- 1/3/2011	3 S1a Bottom 28/2/2011- 1/3/2011	4 S1b Top 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	28.2	23.5	25.0	27.4
Trace Elements						
Silver	04-001	mg/kg	0.68	0.74	0.75	0.70
Arsenic	04-001	mg/kg	3.6	5.8	6.6	8.3
Cadmium	04-001	mg/kg	0.21	0.20	0.17	0.20
Chromium	04-001	mg/kg	13	13	13	14
Copper	04-001	mg/kg	2.8	0.80	0.57	0.96
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.93	0.97	0.88	1.0
Phosphorus	04-001	mg/kg	420	390	370	[NA]
Lead	04-001	mg/kg	2.5	1.0	0.61	0.88
Zinc	04-001	mg/kg	5.6	1.5	0.96	1.6
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	1 S1a Top 28/2/2011- 1/3/2011	2 S1a Middle 28/2/2011- 1/3/2011	3 S1a Bottom 28/2/2011- 1/3/2011	4 S1b Top 28/2/2011- 1/3/2011
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	78	88	89	86
Surrogate 2 Recovery	04-022	%	101	109	109	96
Surrogate 3 Recovery	04-022	%	93	95	96	96
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	0.90
Dibutyl tin	04-026	µgSn/kg	1.5	0.70	1.0	2.4
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	0.50	0.90
Surrogate 1 Recovery	04-026	%	89	94	96	91
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.30	0.25	0.26	0.49
Total Kjeldahl Nitrogen	SUB	mg/kg	260	190	160	[NA]

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Project Reference: Mangles Bay

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	5 S1b Middle 28/2/2011- 1/3/2011	6 S1b Bottom 28/2/2011- 1/3/2011	7 S2 Top 28/2/2011- 1/3/2011	8 S2 Middle 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	24.6	30.5	26.6	24.2
Trace Elements						
Silver	04-001	mg/kg	0.72	0.76	0.68	0.73
Arsenic	04-001	mg/kg	5.4	6.8	3.5	10
Cadmium	04-001	mg/kg	0.18	0.16	0.19	0.21
Chromium	04-001	mg/kg	12	13	13	14
Copper	04-001	mg/kg	0.78	0.59	2.1	0.52
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.92	0.92	0.96	1.1
Phosphorus	04-001	mg/kg	[NA]	[NA]	400	390
Lead	04-001	mg/kg	1.2	0.57	2.4	0.74
Zinc	04-001	mg/kg	1.6	0.89	5.4	0.85
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	5 S1b Middle 28/2/2011- 1/3/2011	6 S1b Bottom 28/2/2011- 1/3/2011	7 S2 Top 28/2/2011- 1/3/2011	8 S2 Middle 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	88	83	83	87
Surrogate 2 Recovery	04-022	%	107	105	105	107
Surrogate 3 Recovery	04-022	%	97	92	96	96
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	0.80	1.0	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	90	90	91	89
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.24	0.25	0.28	0.22
Total Kjeldahl Nitrogen	SUB	mg/kg	[NA]	[NA]	150	150

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	10 S3 Top 28/2/2011- 1/3/2011	11 S3 Middle 28/2/2011- 1/3/2011	12 S3 Bottom 28/2/2011- 1/3/2011	13 S4 R1 Top 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	25.1	25.7	23.2	32.3
Trace Elements						
Silver	04-001	mg/kg	0.70	0.72	0.70	0.67
Arsenic	04-001	mg/kg	7.7	12	12	6.7
Cadmium	04-001	mg/kg	0.20	0.22	0.20	0.25
Chromium	04-001	mg/kg	14	14	14	13
Copper	04-001	mg/kg	32	3.6	2.0	2.8
Mercury	04-002	mg/kg	0.03	<0.01	0.01	<0.01
Nickel	04-001	mg/kg	0.89	0.96	0.89	1.3
Phosphorus	04-001	mg/kg	410	400	400	420
Lead	04-001	mg/kg	8.2	1.3	1.5	1.6
Zinc	04-001	mg/kg	5.6	1.0	0.91	6.0
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

Laboratory Reference: **Client Reference:** **Date Sampled:** **Analysis Description**	- - - **Method**	- - - **Units**	**10** **S3 Top** **28/2/2011-** **1/3/2011**	**11** **S3 Middle** **28/2/2011-** **1/3/2011**	**12** **S3 Bottom** **28/2/2011-** **1/3/2011**	**13** **S4 R1 Top** **28/2/2011-** **1/3/2011**
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	81	83	87	83
Surrogate 2 Recovery	04-022	%	99	102	105	102
Surrogate 3 Recovery	04-022	%	92	91	93	94
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	1.7	1.0	1.4	<0.50
Dibutyl tin	04-026	µgSn/kg	3.0	3.4	3.4	1.4
Tributyl tin	04-026	µgSn/kg	0.80	0.60	1.1	<0.50
Surrogate 1 Recovery	04-026	%	89	84	92	103
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.32	0.22	0.16	0.51
Total Kjeldahl Nitrogen	SUB	mg/kg	190	130	93	410

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	14 S4 R1 Middle 28/2/2011- 1/3/2011	15 S4 R1 Bottom 28/2/2011- 1/3/2011	16 S4 R2 Top 28/2/2011- 1/3/2011	17 S4 R2 Middle 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	25.1	26.1	32.6	24.9
Trace Elements						
Silver	04-001	mg/kg	0.70	0.68	0.69	0.73
Arsenic	04-001	mg/kg	10	12	7.3	10
Cadmium	04-001	mg/kg	0.19	0.20	0.23	0.19
Chromium	04-001	mg/kg	13	14	13	14
Copper	04-001	mg/kg	0.42	0.39	2.1	0.42
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.81	0.87	1.1	0.83
Phosphorus	04-001	mg/kg	390	400	[NA]	[NA]
Lead	04-001	mg/kg	0.57	0.60	1.2	0.60
Zinc	04-001	mg/kg	1.2	0.61	3.7	0.68
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	14 S4 R1 Middle 28/2/2011- 1/3/2011	15 S4 R1 Bottom 28/2/2011- 1/3/2011	16 S4 R2 Top 28/2/2011- 1/3/2011	17 S4 R2 Middle 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	84	80	82	86
Surrogate 2 Recovery	04-022	%	106	100	101	102
Surrogate 3 Recovery	04-022	%	93	92	93	94
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	1.0	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	90	91	87	98
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.18	0.15	0.52	0.17
Total Kjeldahl Nitrogen	SUB	mg/kg	120	100	[NA]	[NA]

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	18 S4 R2 Bottom 28/2/2011- 1/3/2011	19 S4 R3 Top 28/2/2011- 1/3/2011	20 S4 R3 Middle 28/2/2011- 1/3/2011	21 S4 R3 Bottom 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	22.7	31.7	24.9	26.1
Trace Elements						
Silver	04-001	mg/kg	0.70	0.68	0.70	0.71
Arsenic	04-001	mg/kg	11	6.2	8.1	9.5
Cadmium	04-001	mg/kg	0.20	0.19	0.18	0.19
Chromium	04-001	mg/kg	14	13	14	14
Copper	04-001	mg/kg	0.64	2.0	0.72	0.48
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.96	1.1	0.90	0.86
Lead	04-001	mg/kg	0.63	1.3	0.72	0.57
Zinc	04-001	mg/kg	1.0	3.8	1.1	0.75
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5
Perylene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	18 S4 R2 Bottom 28/2/2011- 1/3/2011	19 S4 R3 Top 28/2/2011- 1/3/2011	20 S4 R3 Middle 28/2/2011- 1/3/2011	21 S4 R3 Bottom 28/2/2011- 1/3/2011
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	89	78	5.0	80
Surrogate 2 Recovery	04-022	%	103	99	103	97
Surrogate 3 Recovery	04-022	%	99	89	95	94
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	1.4	0.60	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	98	92	99	94
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.18	0.50	0.20	0.14

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	22 S5 Top 28/2/2011- 1/3/2011	23 S5 Middle 28/2/2011- 1/3/2011	24 S5 Bottom 28/2/2011- 1/3/2011	25 S6 Top 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	27.5	25.3	23.0	24.7
Trace Elements						
Silver	04-001	mg/kg	0.68	0.69	0.67	0.69
Arsenic	04-001	mg/kg	5.8	8.2	12	4.4
Cadmium	04-001	mg/kg	0.19	0.22	0.25	0.16
Chromium	04-001	mg/kg	13	14	14	13
Copper	04-001	mg/kg	2.1	0.48	0.36	2.4
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.88	1.0	1.4	0.79
Phosphorus	04-001	mg/kg	400	390	410	390
Lead	04-001	mg/kg	0.93	0.63	0.61	0.96
Zinc	04-001	mg/kg	3.5	0.69	0.58	2.3
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	22 S5 Top 28/2/2011- 1/3/2011	23 S5 Middle 28/2/2011- 1/3/2011	24 S5 Bottom 28/2/2011- 1/3/2011	25 S6 Top 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	79	86	86	90
Surrogate 2 Recovery	04-022	%	108	93	106	106
Surrogate 3 Recovery	04-022	%	99	95	100	103
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	0.60
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	0.90
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	11
Surrogate 1 Recovery	04-026	%	97	100	96	95
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.24	0.17	0.14	0.32
Total Kjeldahl Nitrogen	SUB	mg/kg	170	87	56	240

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	26 S6 Middle 28/2/2011- 1/3/2011	27 S6 Bottom 28/2/2011- 1/3/2011	28 S7 Top 28/2/2011- 1/3/2011	29 S7 Middle 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	22.2	22.1	24.6	23.9
Trace Elements						
Silver	04-001	mg/kg	0.81	0.65	0.67	0.66
Arsenic	04-001	mg/kg	7.8	9.2	5.5	7.5
Cadmium	04-001	mg/kg	0.20	0.25	0.17	0.17
Chromium	04-001	mg/kg	14	14	14	13
Copper	04-001	mg/kg	0.44	0.42	0.69	0.36
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.87	0.91	0.72	0.88
Phosphorus	04-001	mg/kg	400	400	400	380
Lead	04-001	mg/kg	0.62	0.51	0.97	0.58
Zinc	04-001	mg/kg	0.61	0.65	1.3	0.51
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	26 S6 Middle 28/2/2011- 1/3/2011	27 S6 Bottom 28/2/2011- 1/3/2011	28 S7 Top 28/2/2011- 1/3/2011	29 S7 Middle 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	92	88	82	76
Surrogate 2 Recovery	04-022	%	109	101	99	85
Surrogate 3 Recovery	04-022	%	98	101	92	84
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	98	100	102	109
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.18	0.17	0.27	0.16
Total Kjeldahl Nitrogen	SUB	mg/kg	160	59	210	96

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Moisture Content						
Moisture Content	04-004	%	21.3	26.1	22.5	20.2
Trace Elements						
Silver	04-001	mg/kg	0.64	0.70	0.69	0.64
Arsenic	04-001	mg/kg	9.4	5.5	7.4	11
Cadmium	04-001	mg/kg	0.21	0.17	0.17	0.19
Chromium	04-001	mg/kg	14	14	13	13
Copper	04-001	mg/kg	0.31	0.79	0.42	0.39
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.96	0.83	0.74	1.0
Phosphorus	04-001	mg/kg	410	390	390	410
Lead	04-001	mg/kg	0.54	0.80	0.60	0.52
Zinc	04-001	mg/kg	0.57	1.5	0.59	0.53
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	30 S7 Bottom 28/2/2011- 1/3/2011	31 S8 R1 Top 28/2/2011- 1/3/2011	32 S8 R1 Middle 28/2/2011- 1/3/2011	33 S8 R1 Bottom 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	86	85	84	83
Surrogate 2 Recovery	04-022	%	92	102	91	98
Surrogate 3 Recovery	04-022	%	94	93	92	91
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	95	93	107	102
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.15	0.33	0.16	0.16
Total Kjeldahl Nitrogen	SUB	mg/kg	100	240	130	96

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	34 S8 R2 Top 28/2/2011- 1/3/2011	35 S8 R2 Middle 28/2/2011- 1/3/2011	36 S8 R2 Bottom 28/2/2011- 1/3/2011	37 S8 R3 Top 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	27.9	24.2	21.1	21.8
Trace Elements						
Silver	04-001	mg/kg	0.70	0.68	0.63	0.70
Arsenic	04-001	mg/kg	5.5	7.7	11	5.5
Cadmium	04-001	mg/kg	0.17	0.18	0.20	0.17
Chromium	04-001	mg/kg	14	13	13	14
Copper	04-001	mg/kg	0.92	0.33	0.31	1.6
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.83	0.73	1.0	0.85
Lead	04-001	mg/kg	0.87	0.57	0.53	0.95
Zinc	04-001	mg/kg	2.7	0.62	0.51	2.0
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5
Perylene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	34 S8 R2 Top 28/2/2011- 1/3/2011	35 S8 R2 Middle 28/2/2011- 1/3/2011	36 S8 R2 Bottom 28/2/2011- 1/3/2011	37 S8 R3 Top 28/2/2011- 1/3/2011
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	71	79	77	75
Surrogate 2 Recovery	04-022	%	99	95	88	90
Surrogate 3 Recovery	04-022	%	93	91	88	88
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	99	100	103	100
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.37	0.16	0.14	0.22

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	38 S8 R3 Middle 28/2/2011- 1/3/2011	39 S8 R3 Bottom 28/2/2011- 1/3/2011	40 S9 Top 28/2/2011- 1/3/2011	41 S9 Middle 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	23.7	23.5	28.6	25.1
Trace Elements						
Silver	04-001	mg/kg	0.65	0.60	0.66	0.78
Arsenic	04-001	mg/kg	9.9	11	6.7	8.6
Cadmium	04-001	mg/kg	0.19	0.18	0.20	0.21
Chromium	04-001	mg/kg	14	13	14	13
Copper	04-001	mg/kg	0.35	0.32	1.5	0.52
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	0.92	0.77	1.1	1.2
Phosphorus	04-001	mg/kg	[NA]	[NA]	420	400
Lead	04-001	mg/kg	0.63	0.58	1.1	0.66
Zinc	04-001	mg/kg	0.53	0.54	3.6	0.78
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Batch Number: A11/1055-A [R00]
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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	38 S8 R3 Middle 28/2/2011- 1/3/2011	39 S8 R3 Bottom 28/2/2011- 1/3/2011	40 S9 Top 28/2/2011- 1/3/2011	41 S9 Middle 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	75	72	71	81
Surrogate 2 Recovery	04-022	%	82	82	100	90
Surrogate 3 Recovery	04-022	%	86	5	82	95
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	96	107	103	100
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.16	0.16	0.49	0.17
Total Kjeldahl Nitrogen	SUB	mg/kg	[NA]	[NA]	410	100

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Moisture Content						
Moisture Content	04-004	%	27.1	26.5	24.6	21.7
Trace Elements						
Silver	04-001	mg/kg	0.77	0.72	0.74	0.72
Arsenic	04-001	mg/kg	8.7	4.0	7.1	11
Cadmium	04-001	mg/kg	0.22	0.21	0.19	0.25
Chromium	04-001	mg/kg	12	13	13	14
Copper	04-001	mg/kg	0.47	6.7	0.42	0.39
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	1.2	1.3	1.0	1.0
Phosphorus	04-001	mg/kg	400	410	400	400
Lead	04-001	mg/kg	0.61	1.6	0.53	0.56
Zinc	04-001	mg/kg	0.59	8.0	0.61	0.64
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	42 S9 Bottom 28/2/2011- 1/3/2011	43 S10 Top 28/2/2011- 1/3/2011	44 S10 Middle 28/2/2011- 1/3/2011	45 S10 Bottom 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	74	80	80	78
Surrogate 2 Recovery	04-022	%	90	101	96	91
Surrogate 3 Recovery	04-022	%	92	89	97	93
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	102	101	106	98
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.17	0.51	0.18	0.16
Total Kjeldahl Nitrogen	SUB	mg/kg	120	440	120	99

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	46 S11 Top 28/2/2011- 1/3/2011	47 S11 Middle 28/2/2011- 1/3/2011	48 S11 Bottom 28/2/2011- 1/3/2011	49 S12 Top 28/2/2011- 1/3/2011
Moisture Content						
Moisture Content	04-004	%	31.7	27.0	22.9	28.1
Trace Elements						
Silver	04-001	mg/kg	0.75	0.73	0.72	0.74
Arsenic	04-001	mg/kg	4.7	6.0	5.4	5.0
Cadmium	04-001	mg/kg	0.17	0.18	0.17	0.17
Chromium	04-001	mg/kg	13	13	14	12
Copper	04-001	mg/kg	0.96	0.52	0.40	0.99
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	1.2	1.1	0.88	1.1
Phosphorus	04-001	mg/kg	390	370	400	380
Lead	04-001	mg/kg	0.92	0.55	0.61	1.0
Zinc	04-001	mg/kg	1.8	0.52	0.64	2.9
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	46 S11 Top 28/2/2011- 1/3/2011	47 S11 Middle 28/2/2011- 1/3/2011	48 S11 Bottom 28/2/2011- 1/3/2011	49 S12 Top 28/2/2011- 1/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	76	79	80	75
Surrogate 2 Recovery	04-022	%	97	92	100	97
Surrogate 3 Recovery	04-022	%	92	92	89	94
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	96	101	97	91
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.53	0.34	0.19	0.42
Total Kjeldahl Nitrogen	SUB	mg/kg	300	130	76	330

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	50 S12 Middle 28/2/2011- 1/3/2011	51 S12 Bottom 28/2/2011- 1/3/2011	52 S13 Top 2/3/2011	53 S14 Top 2/3/2011
Moisture Content						
Moisture Content	04-004	%	25.9	23.7	30.0	32.4
Trace Elements						
Silver	04-001	mg/kg	0.74	0.72	0.72	0.79
Arsenic	04-001	mg/kg	5.4	7.3	4.2	4.3
Cadmium	04-001	mg/kg	0.17	0.18	0.15	0.16
Chromium	04-001	mg/kg	13	13	13	13
Copper	04-001	mg/kg	0.60	0.40	1.1	1.7
Mercury	04-002	mg/kg	<0.01	<0.01	<0.01	<0.01
Nickel	04-001	mg/kg	1.0	0.94	0.76	0.84
Phosphorus	04-001	mg/kg	370	400	[NA]	[NA]
Lead	04-001	mg/kg	0.66	0.51	0.99	1.3
Zinc	04-001	mg/kg	0.67	0.59	2.3	5.6
Poly Aromatic Hydrocarbons						
Naphthalene	04-022	µg/kg	<5	<5	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5	<5	<5
Fluorene	04-022	µg/kg	<5	<5	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5	<5	<5
Anthracene	04-022	µg/kg	<5	<5	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5	<5	<5
Pyrene	04-022	µg/kg	<5	<5	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5	<5	<5
Chrysene	04-022	µg/kg	<5	<5	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5	<5	<5
Coronene	04-022	µg/kg	<10	<10	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5	<5	<5

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	50 S12 Middle 28/2/2011- 1/3/2011	51 S12 Bottom 28/2/2011- 1/3/2011	52 S13 Top 2/3/2011	53 S14 Top 2/3/2011
Perylene	04-022	µg/kg	<5	<5	<5	<5
Total PAHs (as above)	04-022	µg/kg	<100	<100	<100	<100
Surrogate 1 Recovery	04-022	%	79	74	80	77
Surrogate 2 Recovery	04-022	%	93	89	100	98
Surrogate 3 Recovery	04-022	%	92	92	92	93
Date Extracted	04-022	-	8/3/11	8/3/11	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11	9/3/11	9/3/11
Organotins						
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	<0.50	<0.50	<0.50
Surrogate 1 Recovery	04-026	%	101	92	92	95
Date Extracted	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11	10/3/11	10/3/11
Subcontract Analysis						
Total Organic Carbon	SUB	%	0.37	0.18	0.44	0.36
Total Kjeldahl Nitrogen	SUB	mg/kg	150	90	[NA]	[NA]

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Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	54 S15 Top 2/3/2011	55 S16 Top 2/3/2011
Moisture Content				
Moisture Content	04-004	%	30.6	28.9
Trace Elements				
Silver	04-001	mg/kg	0.76	0.78
Arsenic	04-001	mg/kg	4.2	3.4
Cadmium	04-001	mg/kg	0.15	0.15
Chromium	04-001	mg/kg	15	13
Copper	04-001	mg/kg	19	1.3
Mercury	04-002	mg/kg	<0.01	<0.01
Nickel	04-001	mg/kg	1.8	0.78
Lead	04-001	mg/kg	1.1	1.0
Zinc	04-001	mg/kg	5.1	2.3
Poly Aromatic Hydrocarbons				
Naphthalene	04-022	µg/kg	<5	<5
1-Methylnaphthalene	04-022	µg/kg	<5	<5
2-Methylnaphthalene	04-022	µg/kg	<5	<5
Acenaphthylene	04-022	µg/kg	<5	<5
Acenaphthene	04-022	µg/kg	<5	<5
Fluorene	04-022	µg/kg	<5	<5
Phenanthrene	04-022	µg/kg	<5	<5
Anthracene	04-022	µg/kg	<5	<5
Fluoranthene	04-022	µg/kg	<5	<5
Pyrene	04-022	µg/kg	<5	<5
Benz(a)anthracene	04-022	µg/kg	<5	<5
Chrysene	04-022	µg/kg	<5	<5
Benzo(b)&(k)fluoranthene	04-022	µg/kg	<10	<10
Benzo(a)pyrene	04-022	µg/kg	<5	<5
Indeno(1,2,3-cd)pyrene	04-022	µg/kg	<5	<5
Dibenz(a,h)anthracene	04-022	µg/kg	<5	<5
Benzo(g,h,i)perylene	04-022	µg/kg	<5	<5
Coronene	04-022	µg/kg	<10	<10
Benzo(e)pyrene	04-022	µg/kg	<5	<5
Perylene	04-022	µg/kg	<5	<5

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Project Reference: Mangles Bay

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	54 S15 Top 2/3/2011	55 S16 Top 2/3/2011
Total PAHs (as above)	04-022	µg/kg	<100	<100
Surrogate 1 Recovery	04-022	%	89	85
Surrogate 2 Recovery	04-022	%	108	102
Surrogate 3 Recovery	04-022	%	97	96
Date Extracted	04-022	-	8/3/11	8/3/11
Date Analysed	04-022	-	9/3/11	9/3/11
Organotins				
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	0.60	<0.50
Tributyl tin	04-026	µgSn/kg	1.1	<0.50
Surrogate 1 Recovery	04-026	%	95	86
Date Extracted	04-026	-	10/3/11	10/3/11
Date Analysed	04-026	-	10/3/11	10/3/11
Subcontract Analysis				
Total Organic Carbon	SUB	%	0.31	0.29

Method	Method Description
04-004	Moisture by gravimetric, %
04-001	Metals by ICP-OES, mg/kg
04-002	Mercury by CVAAS, mg/kg
04-022	Low level PAHs & Phenols by GCMS, µg/kg
04-026	Organotins by GCMS, µgSn/kg
SUB	Subcontracted Analyses

Result Comments
[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required
Solid sample results are reported on a dry weight basis.
SUB analyses were subcontracted to Sydney Analytical Laboratories (NATA Number 1884); reference SAL report number SAL23393.

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QUALITY ASSURANCE REPORT

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Silver	mg/kg	<0.1	A11/1055-A-1	0.68 || 0.68 || RPD: 0	A11/1055-A-1	110%
Arsenic	mg/kg	<0.4	A11/1055-A-1	3.6 || 3.8 || RPD: 5	A11/1055-A-1	129%
Cadmium	mg/kg	<0.1	A11/1055-A-1	0.21 || 0.21 || RPD: 0	A11/1055-A-1	124%
Chromium	mg/kg	<0.1	A11/1055-A-1	13 || 13 || RPD: 0	A11/1055-A-1	93%
Copper	mg/kg	<0.1	A11/1055-A-1	2.8 || 2.6 || RPD: 7	A11/1055-A-1	117%
Mercury	mg/kg	<0.01	A11/1055-A-1	<0.01 || <0.01	A11/1055-A-1	87%
Nickel	mg/kg	<0.1	A11/1055-A-1	0.93 || 0.93 || RPD: 0	A11/1055-A-1	82%
Phosphorus	mg/kg	<1	A11/1055-A-1	420 || 410 || RPD: 2	A11/1055-A-1	119%
Lead	mg/kg	<0.5	A11/1055-A-1	2.5 || 2.5 || RPD: 0	A11/1055-A-1	82%
Zinc	mg/kg	<0.5	A11/1055-A-1	5.6 || 5.7 || RPD: 2	A11/1055-A-1	81%

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Naphthalene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	95%
1-Methylnaphthalene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	95%
2-Methylnaphthalene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	99%
Acenaphthylene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	89%
Acenaphthene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	99%
Fluorene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	100%
Phenanthrene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	110%
Anthracene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	106%
Fluoranthene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	113%
Pyrene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	107%
Benz(a)anthracene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	107%
Chrysene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	101%
Benzo(b)&(k)fluoranthene	µg/kg	<10	A11/1055-A-1	<10 || <10	A11/1055-A-1	93%
Benzo(a)pyrene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	89%
Indeno(1,2,3-cd)pyrene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	85%
Dibenz(a,h)anthracene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	82%
Benzo(g,h,i)perylene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	85%
Coronene	µg/kg	<10	A11/1055-A-1	<10 || <10	A11/1055-A-1	86%
Benzo(e)pyrene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	89%
Perylene	µg/kg	<5	A11/1055-A-1	<5 || <5	A11/1055-A-1	94%
Total PAHs (as above)	µg/kg	<100	A11/1055-A-1	<100 || <100	A11/1055-A-1	97%
Surrogate 1 Recovery	%	88	A11/1055-A-1	78 || 84 || RPD: 7	A11/1055-A-1	80%
Surrogate 2 Recovery	%	103	A11/1055-A-1	101 || 107 || RPD: 6	A11/1055-A-1	105%
Surrogate 3 Recovery	%	89	A11/1055-A-1	93 || 95 || RPD: 2	A11/1055-A-1	91%

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TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Monobutyl tin	µgSn/kg	<0.50	A11/1055-A-1	<0.50 || 0.50	A11/1055-A-1	69%
Dibutyl tin	µgSn/kg	<0.50	A11/1055-A-1	1.5 || 1.5 || RPD: 0	A11/1055-A-1	90%
Tributyl tin	µgSn/kg	<0.50	A11/1055-A-1	<0.50 || <0.50	A11/1055-A-1	88%
Surrogate 1 Recovery	%	98	A11/1055-A-1	89 || 89 || RPD: 0	A11/1055-A-1	97%

TEST	UNITS	Blank
Total Organic Carbon	%	<0.01
Total Kjeldahl Nitrogen	mg/kg	<20

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Silver	mg/kg	<0.1	A11/1055-A-11	0.72 || 0.73 || RPD: 1	A11/1055-A-21	108%
Arsenic	mg/kg	<0.4	A11/1055-A-11	12 || 12 || RPD: 0	A11/1055-A-21	126%
Cadmium	mg/kg	<0.1	A11/1055-A-11	0.22 || 0.21 || RPD: 5	A11/1055-A-21	124%
Chromium	mg/kg	<0.1	A11/1055-A-11	14 || 14 || RPD: 0	A11/1055-A-21	91%
Copper	mg/kg	<0.1	A11/1055-A-11	3.6 || 3.1 || RPD: 15	A11/1055-A-21	121%
Mercury	mg/kg	<0.01	A11/1055-A-11	<0.01 || <0.01	A11/1055-A-21	88%
Nickel	mg/kg	<0.1	A11/1055-A-11	0.96 || 0.95 || RPD: 1	A11/1055-A-21	81%
Phosphorus	mg/kg	<1	A11/1055-A-11	400 || 410 || RPD: 2	A11/1055-A-21	114%
Lead	mg/kg	<0.5	A11/1055-A-11	1.3 || 1.3 || RPD: 0	A11/1055-A-21	80%
Zinc	mg/kg	<0.5	A11/1055-A-11	1.0 || 0.98 || RPD: 2	A11/1055-A-21	78%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Naphthalene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	91%
1-Methylnaphthalene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	96%
2-Methylnaphthalene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	103%
Acenaphthylene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	88%
Acenaphthene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	83%
Fluorene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	96%
Phenanthrene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	99%
Anthracene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	106%
Fluoranthene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	92%
Pyrene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	92%
Benz(a)anthracene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	103%
Chrysene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	98%
Benzo(b)&(k)fluoranthene	µg/kg	<10	A11/1055-A-11	<10 || <10	A11/1055-A-21	90%
Benzo(a)pyrene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	87%
Indeno(1,2,3-cd)pyrene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	92%
Dibenz(a,h)anthracene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	85%
Benzo(g,h,i)perylene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	82%
Coronene	µg/kg	<10	A11/1055-A-11	<10 || <10	A11/1055-A-21	88%
Benzo(e)pyrene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	91%

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TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Perylene	µg/kg	<5	A11/1055-A-11	<5 || <5	A11/1055-A-21	94%
Total PAHs (as above)	µg/kg	<100	A11/1055-A-11	<100 || <100	A11/1055-A-21	93%
Surrogate 1 Recovery	%	81	A11/1055-A-11	83 || 84 || RPD: 1	A11/1055-A-21	78%
Surrogate 2 Recovery	%	99	A11/1055-A-11	102 || 102 || RPD: 0	A11/1055-A-21	107%
Surrogate 3 Recovery	%	82	A11/1055-A-11	91 || 93 || RPD: 2	A11/1055-A-21	91%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Monobutyl tin	µgSn/kg	<0.50	A11/1055-A-11	1.0 || 0.90 || RPD: 11	A11/1055-A-21	83%
Dibutyl tin	µgSn/kg	<0.50	A11/1055-A-11	3.4 || 3.5 || RPD: 3	A11/1055-A-21	93%
Tributyl tin	µgSn/kg	<0.50	A11/1055-A-11	0.60 || 0.60 || RPD: 0	A11/1055-A-21	91%
Surrogate 1 Recovery	%	93	A11/1055-A-11	84 || 83 || RPD: 1	A11/1055-A-21	100%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Total Organic Carbon	%	<0.01	A11/1055-A-20	0.20 || 0.23 || RPD: 14
Total Kjeldahl Nitrogen	mg/kg	<20	[NT]	[NT]

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Silver	mg/kg	[NT]	A11/1055-A-21	0.71 || 0.71 || RPD: 0	A11/1055-A-41	112%
Arsenic	mg/kg	[NT]	A11/1055-A-21	9.5 || 9.1 || RPD: 4	A11/1055-A-41	126%
Cadmium	mg/kg	[NT]	A11/1055-A-21	0.19 || 0.18 || RPD: 5	A11/1055-A-41	123%
Chromium	mg/kg	[NT]	A11/1055-A-21	14 || 14 || RPD: 0	A11/1055-A-41	93%
Copper	mg/kg	[NT]	A11/1055-A-21	0.48 || 0.48 || RPD: 0	A11/1055-A-41	120%
Mercury	mg/kg	<0.01	A11/1055-A-21	<0.01 || <0.01	A11/1055-A-41	91%
Nickel	mg/kg	[NT]	A11/1055-A-21	0.86 || 0.83 || RPD: 4	A11/1055-A-41	84%
Phosphorus	mg/kg	[NT]	[NT]	[NT]	A11/1055-A-41	117%
Lead	mg/kg	[NT]	A11/1055-A-21	0.57 || 0.64 || RPD: 12	A11/1055-A-41	83%
Zinc	mg/kg	[NT]	A11/1055-A-21	0.75 || 0.71 || RPD: 5	A11/1055-A-41	82%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Naphthalene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	93%
1-Methylnaphthalene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	98%
2-Methylnaphthalene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	102%
Acenaphthylene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	93%
Acenaphthene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	84%
Fluorene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	102%
Phenanthrene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	104%
Anthracene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	109%
Fluoranthene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	98%
Pyrene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	99%
Benz(a)anthracene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	109%

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TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Chrysene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	104%
Benzo(b)&(k)fluoranthene	µg/kg	<10	A11/1055-A-21	<10 || <10	A11/1055-A-41	97%
Benzo(a)pyrene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	95%
Indeno(1,2,3-cd)pyrene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	83%
Dibenz(a,h)anthracene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	98%
Benzo(g,h,i)perylene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	85%
Coronene	µg/kg	<10	A11/1055-A-21	<10 || <10	A11/1055-A-41	85%
Benzo(e)pyrene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	100%
Perylene	µg/kg	<5	A11/1055-A-21	<5 || <5	A11/1055-A-41	104%
Total PAHs (as above)	µg/kg	<100	A11/1055-A-21	<100 || <100	A11/1055-A-41	97%
Surrogate 1 Recovery	%	87	A11/1055-A-21	80 || 84 || RPD: 5	A11/1055-A-41	85%
Surrogate 2 Recovery	%	105	A11/1055-A-21	97 || 109 || RPD: 12	A11/1055-A-41	110%
Surrogate 3 Recovery	%	87	A11/1055-A-21	94 || 101 || RPD: 7	A11/1055-A-41	97%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Monobutyl tin	µgSn/kg	<0.50	A11/1055-A-21	<0.50 || <0.50	A11/1055-A-41	76%
Dibutyl tin	µgSn/kg	<0.50	A11/1055-A-21	<0.50 || <0.50	A11/1055-A-41	96%
Tributyl tin	µgSn/kg	<0.50	A11/1055-A-21	<0.50 || <0.50	A11/1055-A-41	95%
Surrogate 1 Recovery	%	95	A11/1055-A-21	94 || 98 || RPD: 4	A11/1055-A-41	100%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Total Organic Carbon	%	[NT]	A11/1055-A-30	0.15 || 0.14 || RPD: 7
Total Kjeldahl Nitrogen	mg/kg	[NT]	A11/1055-A-30	100 || 110 || RPD: 10

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Silver	mg/kg	[NT]	A11/1055-A-31	0.70 || 0.70 || RPD: 0
Arsenic	mg/kg	[NT]	A11/1055-A-31	5.5 || 5.4 || RPD: 2
Cadmium	mg/kg	[NT]	A11/1055-A-31	0.17 || 0.17 || RPD: 0
Chromium	mg/kg	[NT]	A11/1055-A-31	14 || 13 || RPD: 7
Copper	mg/kg	[NT]	A11/1055-A-31	0.79 || 0.72 || RPD: 9
Mercury	mg/kg	[NT]	A11/1055-A-31	<0.01 || <0.01
Nickel	mg/kg	[NT]	A11/1055-A-31	0.83 || 0.76 || RPD: 9
Phosphorus	mg/kg	[NT]	A11/1055-A-31	390 || 390 || RPD: 0
Lead	mg/kg	[NT]	A11/1055-A-31	0.80 || 0.75 || RPD: 6
Zinc	mg/kg	[NT]	A11/1055-A-31	1.5 || 1.5 || RPD: 0

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TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Naphthalene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	96%
1-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	101%
2-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	102%
Acenaphthylene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	90%
Acenaphthene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	100%
Fluorene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	100%
Phenanthrene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	102%
Anthracene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	111%
Fluoranthene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	95%
Pyrene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	96%
Benz(a)anthracene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	106%
Chrysene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	104%
Benzo(b)&(k)fluoranthene	µg/kg	[NT]	A11/1055-A-31	<10 || <10	External	91%
Benzo(a)pyrene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	89%
Indeno(1,2,3-cd)pyrene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	86%
Dibenz(a,h)anthracene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	90%
Benzo(g,h,i)perylene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	93%
Coronene	µg/kg	[NT]	A11/1055-A-31	<10 || <10	External	86%
Benzo(e)pyrene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	89%
Perylene	µg/kg	[NT]	A11/1055-A-31	<5 || <5	External	100%
Total PAHs (as above)	µg/kg	[NT]	A11/1055-A-31	<100 || <100	External	96%
Surrogate 1 Recovery	%	[NT]	A11/1055-A-31	85 || 81 || RPD: 5	External	88%
Surrogate 2 Recovery	%	[NT]	A11/1055-A-31	102 || 95 || RPD: 7	External	107%
Surrogate 3 Recovery	%	[NT]	A11/1055-A-31	93 || 89 || RPD: 4	External	91%

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

TEST	Units	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Monobutyl tin	µgSn/kg	[NT]	A11/1055-A-31	<0.50 || <0.50	External	90%
Dibutyl tin	µgSn/kg	[NT]	A11/1055-A-31	<0.50 || <0.50	External	97%
Tributyl tin	µgSn/kg	[NT]	A11/1055-A-31	<0.50 || <0.50	External	95%
Surrogate 1 Recovery	%	[NT]	A11/1055-A-31	93 || 104 || RPD: 11	External	97%

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Total Organic Carbon	%	[NT]	A11/1055-A-40	0.49 || 0.50 || RPD: 2
Total Kjeldahl Nitrogen	mg/kg	[NT]	A11/1055-A-40	410 || 390 || RPD: 5

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Silver	mg/kg	[NT]	A11/1055-A-41	0.78 || 0.77 || RPD: 1
Arsenic	mg/kg	[NT]	A11/1055-A-41	8.6 || 8.7 || RPD: 1
Cadmium	mg/kg	[NT]	A11/1055-A-41	0.21 || 0.21 || RPD: 0
Chromium	mg/kg	[NT]	A11/1055-A-41	13 || 13 || RPD: 0
Copper	mg/kg	[NT]	A11/1055-A-41	0.52 || 0.53 || RPD: 2
Mercury	mg/kg	[NT]	A11/1055-A-41	<0.01 || <0.01
Nickel	mg/kg	[NT]	A11/1055-A-41	1.2 || 1.2 || RPD: 0
Phosphorus	mg/kg	[NT]	A11/1055-A-41	400 || 390 || RPD: 3
Lead	mg/kg	[NT]	A11/1055-A-41	0.66 || 0.70 || RPD: 6
Zinc	mg/kg	[NT]	A11/1055-A-41	0.78 || 0.73 || RPD: 7

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Naphthalene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
1-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
2-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Acenaphthylene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Acenaphthene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Fluorene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Phenanthrene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Anthracene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Fluoranthene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Pyrene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Benz(a)anthracene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Chrysene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Benzo(b)&(k)fluoranthene	µg/kg	[NT]	A11/1055-A-41	<10 || <10
Benzo(a)pyrene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Indeno(1,2,3-cd)pyrene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Dibenz(a,h)anthracene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Benzo(g,h,i)perylene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Coronene	µg/kg	[NT]	A11/1055-A-41	<10 || <10
Benzo(e)pyrene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Perylene	µg/kg	[NT]	A11/1055-A-41	<5 || <5
Total PAHs (as above)	µg/kg	[NT]	A11/1055-A-41	<100 || <100

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Batch Number: A11/1055-A [R00]
Project Reference: Mangles Bay

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Surrogate 1 Recovery	%	[NT]	A11/1055-A-41	81 || 80 || RPD: 1
Surrogate 2 Recovery	%	[NT]	A11/1055-A-41	90 || 80 || RPD: 12
Surrogate 3 Recovery	%	[NT]	A11/1055-A-41	95 || 89 || RPD: 7

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Monobutyl tin	µgSn/kg	[NT]	A11/1055-A-41	<0.50 || <0.50
Dibutyl tin	µgSn/kg	[NT]	A11/1055-A-41	<0.50 || <0.50
Tributyl tin	µgSn/kg	[NT]	A11/1055-A-41	<0.50 || <0.50
Surrogate 1 Recovery	%	[NT]	A11/1055-A-41	100 || 102 || RPD: 2

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Total Organic Carbon	%	[NT]	A11/1055-A-50	0.37 || 0.34 || RPD: 8
Total Kjeldahl Nitrogen	mg/kg	[NT]	A11/1055-A-50	150 || 150 || RPD: 0

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Silver	mg/kg	[NT]	A11/1055-A-51	0.72 || 0.73 || RPD: 1
Arsenic	mg/kg	[NT]	A11/1055-A-51	7.3 || 7.4 || RPD: 1
Cadmium	mg/kg	[NT]	A11/1055-A-51	0.18 || 0.18 || RPD: 0
Chromium	mg/kg	[NT]	A11/1055-A-51	13 || 14 || RPD: 7
Copper	mg/kg	[NT]	A11/1055-A-51	0.40 || 0.42 || RPD: 5
Mercury	mg/kg	[NT]	A11/1055-A-51	<0.01 || <0.01
Nickel	mg/kg	[NT]	A11/1055-A-51	0.94 || 1.0 || RPD: 6
Phosphorus	mg/kg	[NT]	A11/1055-A-51	400 || 390 || RPD: 3
Lead	mg/kg	[NT]	A11/1055-A-51	0.51 || 0.54 || RPD: 6
Zinc	mg/kg	[NT]	A11/1055-A-51	0.59 || 1.1 || RPD: 60

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Naphthalene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
1-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
2-Methylnaphthalene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Acenaphthylene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Acenaphthene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Fluorene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Phenanthrene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Anthracene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Fluoranthene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Pyrene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Benz(a)anthracene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Chrysene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Benzo(b)&(k)fluoranthene	µg/kg	[NT]	A11/1055-A-51	<10 || <10
Benzo(a)pyrene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Indeno(1,2,3-cd)pyrene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Dibenz(a,h)anthracene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Benzo(g,h,i)perylene	µg/kg	[NT]	A11/1055-A-51	<5 || <5

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Batch Number: A11/1055-A [R00]
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TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Coronene	µg/kg	[NT]	A11/1055-A-51	<10 || <10
Benzo(e)pyrene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Perylene	µg/kg	[NT]	A11/1055-A-51	<5 || <5
Total PAHs (as above)	µg/kg	[NT]	A11/1055-A-51	<100 || <100
Surrogate 1 Recovery	%	[NT]	A11/1055-A-51	74 || 81 || RPD: 9
Surrogate 2 Recovery	%	[NT]	A11/1055-A-51	89 || 89 || RPD: 0
Surrogate 3 Recovery	%	[NT]	A11/1055-A-51	92 || 89 || RPD: 3

TEST	Units	Blank	Duplicate Sm#	Duplicate Results
Monobutyl tin	µgSn/kg	[NT]	A11/1055-A-51	<0.50 || <0.50
Dibutyl tin	µgSn/kg	[NT]	A11/1055-A-51	<0.50 || <0.50
Tributyl tin	µgSn/kg	[NT]	A11/1055-A-51	<0.50 || <0.50
Surrogate 1 Recovery	%	[NT]	A11/1055-A-51	92 || 93 || RPD: 1

Comments:
RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants
Acceptable replicate reproducibility limit or RPD: Results < 10 times LOR: no limits.
Results >10 times LOR: 0% - 50%.
Acceptable matrix spike & LCS recovery limits: Trace elements 70-130%
Organic analyses 50-150%
SVOC & speciated phenols 10-140%
Surrogates 10-140%
When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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REPORT OF ANALYSIS

Laboratory Reference: A11/1055-B [R00]

Client: Oceanica Consulting Pty Ltd
Lev 1, 353 Cambridge Street
Wembley WA 6913

Contact: Karen Crawley

Order No: 452_005
Project: Mangles Bay - ASS
Sample Type: sediment
No. of Samples: 55
Date Received: 3/03/2011
Date Completed: 18/03/2011

Laboratory Contact Details:

Client Services Manager: Jane Struthers
Technical Enquiries: Andrew Bradbury
Telephone: +61 8 9325 9799
Fax: +61 8 9325 4299
Email: perth@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
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Batch Number: A11/1055-B [R00]
Project Reference: Mangles Bay - ASS

Laboratory Reference:	-	-	1	2	3	4
Client Reference:	-	-	S1a Top	S1a Middle	S1a Bottom	S1b Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	5	6	7	8
Client Reference:	-	-	S1b Middle	S1b Bottom	S2 Top	S2 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	10	11	12	13
Client Reference:	-	-	S3 Top	S3 Middle	S3 Bottom	S4 R1 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	14	15	22	23
Client Reference:	-	-	S4 R1 Middle	S4 R1 Bottom	S5 Top	S5 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

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Batch Number: A11/1055-B [R00]
Project Reference: Mangles Bay - ASS

Laboratory Reference:	-	-	24	25	26	27
Client Reference:	-	-	S5 Bottom	S6 Top	S6 Middle	S6 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	28	29	30	31
Client Reference:	-	-	S7 Top	S7 Middle	S7 Bottom	S8 R1 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	32	33	40	41
Client Reference:	-	-	S8 R1 Middle	S8 R1 Bottom	S9 Top	S9 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	42	43	44	45
Client Reference:	-	-	S9 Bottom	S10 Top	S10 Middle	S10 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

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Batch Number: A11/1055-B [R00]
Project Reference: Mangles Bay - ASS

Laboratory Reference:	-	-	46	47	48	49
Client Reference:	-	-	S11 Top	S11 Middle	S11 Bottom	S12 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Chromium Reducible Suite	SUB		See Report	See Report	See Report	See Report

Laboratory Reference:	-	-	50	51
Client Reference:	-	-	S12 Middle	S12 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**		
Subcontract Analysis				
Chromium Reducible Suite	SUB		See Report	See Report

Method	Method Description
SUB	Subcontracted Analyses

Result Comments

[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required

Chromium Suite analysis was subcontracted to Envirolab Services (NATA Number 2901); reference Envirolab MPL certificate of analysis 109494.

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Batch Number: A11/1055-B [R00]
Project Reference: Mangles Bay - ASS

QUALITY ASSURANCE REPORT

Comments:
RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants

Acceptable replicate reproducibility limit or RPD:	Results < 10 times LOR: no limits.
	Results >10 times LOR: 0% - 50%.
Acceptable matrix spike & LCS recovery limits:	Trace elements 70-130%
	Organic analyses 50-150%
	SVOC & speciated phenols 10-140%
	Surrogates 10-140%

When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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Envirolab Services (WA) Pty Ltd ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 109494

Client:
Advanced Analytical Aust WA
7 Forrest Ave
East Perth
WA 6004

Attention: Jane Struthers

Sample log in details:

Your Reference:	**A11/1055-B**
No. of samples:	38 sediments
Date samples received:	4/3/11
Date completed instructions received:	4/3/11
Location:	

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	17/03/11
Date of Preliminary Report:	N/A
Issue Date:	18/03/11

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Tests not covered by NATA are denoted with *.

Results Approved By:

Stacey Hawkins
Acid Soils/Acid Mine Drainage Supervisor

Chromium Suite Our Reference: Your Reference Sample Description Date Sampled	UNITS ---------- ----------	109494-1 A11/1055-B-1 S1a Top 28/02/2011	109494-2 A11/1055-B-2 S1a Middle 28/02/2011	109494-3 A11/1055-B-3 S1a Bottom 28/02/2011	109494-4 A11/1055-B-4 S1b Top 28/02/2011	109494-5 A11/1055-B-5 S1b Middle 28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH kcl	pH units	9.8	9.8	9.8	9.8	9.8
TAA	moles H^+/t	<5	<5	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.013	0.028	0.025	0.011	0.033
ANC_{BT}	% $CaCO_3$	81	81	85	81	84
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	8.1	17	16	6.9	21
a-ANC_{BT}	moles H^+/t	16,110.01319	16,227.46916	17,049.66092	16,256.83315	16,697.29302
s-ANC_{BT}	%w/w S	26	26	27	26	27
Fineness Factor		2	2	2	2	2
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-8,046.89850	-8,096.27098	-8,509.23796	-8,121.55587	-8,328.06441
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	<10	17	16	<10	21
Liming rate without ANCE	kg $CaCO_3$/t	<0.75	1.3	1.2	<0.75	1.5

Chromium Suite Our Reference: Your Reference	UNITS ----------	109494-6 A11/1055-B-6	109494-7 A11/1055-B-7	109494-8 A11/1055-B-8	109494-9 A11/1055-B-10	109494-10 A11/1055-B-11
Sample Description	----------	S1b Bottom	S2 Top	S2 Middle	S3 Top	S3 Middle
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH $_{kcl}$	pH units	9.8	9.8	9.8	9.8	9.8
TAA	moles H^+/t	<5	<5	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.027	0.046	0.051	0.045	0.052
ANC_{BT}	% $CaCO_3$	85	86	84	85	86
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	17	29	32	28	32
a-ANC_{BT}	moles H^+/t	16,893.05297	17,118.17690	16,795.17300	16,912.62896	17,137.75290
s-ANC_{BT}	%w/w S	27	27	27	27	27
Fineness Factor		2	2	2	2	2
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-8,429.68658	-8,530.39825	-8,365.77780	-8,428.24798	-8,536.44405
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	17	29	32	28	32
Liming rate without ANCE	kg $CaCO_3$/t	1.3	2.2	2.4	2.1	2.4

Chromium Suite						
Our Reference:	UNITS	109494-11	109494-12	109494-13	109494-14	109494-15
Your Reference	----------	A11/1055-B-12	A11/1055-B-13	A11/1055-B-14	A11/1055-B-15	A11/1055-B-22
Sample Description	----------	S3 Bottom	S4 R1 Top	S4 R1 Middle	S4 R1 Bottom	S5 Top
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH kcl	pH units	9.8	9.7	9.8	9.8	9.8
TAA	moles H^+/t	<5	<5	<5	<5	<5
SKCl	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.046	0.036	0.036	0.054	0.035
ANCBT	% $CaCO_3$	85	83	82	84	85
SHCl	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	29	22	22	34	22
a-ANCBT	moles H^+/t	17,020.29693	16,618.98905	16,403.65311	16,775.59700	17,049.66092
s-ANCBT	%w/w S	27	27	26	27	27
Fineness Factor		2	2	2	2	2
SNAS	%w/w S	NT	NT	NT	NT	NT
a-SNAS	moles H^+/t	NT	NT	NT	NT	NT
s-SNAS	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-8,481.45827	-8,287.04132	-8,179.37335	-8,354.11870	-8,503.00096
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	29	22	22	34	22
Liming rate without ANCE	kg $CaCO_3$/t	2.2	1.7	1.7	2.5	1.6

Chromium Suite						
Our Reference:	UNITS	109494-16	109494-17	109494-18	109494-19	109494-20
Your Reference	----------	A11/1055-B-23	A11/1055-B-24	A11/1055-B-25	A11/1055-B-26	A11/1055-B-27
Sample Description	----------	S5 Middle	S5 Bottom	S6 Top	S6 Middle	S6 Bottom
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH $_{kcl}$	pH units	9.9	9.8	9.8	9.9	9.8
TAA	moles H^+/t	<5	<5	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.040	0.044	0.022	0.019	0.034
ANC_{BT}	% $CaCO_3$	87	88	85	84	86
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	25	27	14	12	21
a-ANC_{BT}	moles H^+/t	17,421.60482	17,578.21277	16,981.14494	16,794.38880	17,194.61218
s-ANC_{BT}	%w/w S	28	28	27	27	28
Fineness Factor		2	2	2	2	2
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-8,685.85441	-8,761.66359	-8,476.85107	-8,385.34410	-8,576.10029
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	25	27	14	12	21
Liming rate without ANCE	kg $CaCO_3$/t	1.9	2.1	1.0	0.89	1.6

Chromium Suite						
Our Reference:	UNITS	109494-21	109494-22	109494-23	109494-24	109494-25
Your Reference	----------	A11/1055-B-28	A11/1055-B-29	A11/1055-B-30	A11/1055-B-31	A11/1055-B-32
Sample Description	----------	S7 Top	S7 Middle	S7 Bottom	S8 R1 Top	S8 R1 Middle
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH $_{kcl}$	pH units	9.8	9.9	9.8	9.8	9.9
TAA	moles H^+/t	<5	<5	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.018	0.037	0.046	0.024	0.030
ANC_{BT}	% $CaCO_3$	84	85	85	82	80
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	11	23	29	15	19
a-ANC_{BT}	moles H^+/t	16,861.01531	17,032.57941	16,889.60932	16,463.24031	15,987.97301
s-ANC_{BT}	%w/w S	27	27	27	26	26
Fineness Factor		2	2	2	2	2
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-8,419.28105	-8,493.21281	-8,416.11446	-8,216.65136	-7,975.27550
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	11	23	29	15	19
Liming rate without ANCE	kg $CaCO_3$/t	0.84	1.7	2.2	1.1	1.4

Chromium Suite						
Our Reference:	UNITS	109494-26	109494-27	109494-28	109494-29	109494-30
Your Reference	----------	A11/1055-B-33	A11/1055-B-40	A11/1055-B-41	A11/1055-B-42	A11/1055-B-43
Sample Description	----------	S8 R1 Bottom	S9 Top	S9 Middle	S9 Bottom	S10 Top
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH kcl	pH units	9.8	9.7	9.8	9.9	9.7
TAA	moles H^+/t	<5	<5	<5	<5	<5
SKCl	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.046	0.033	0.033	0.045	0.024
ANCBT	% $CaCO_3$	76	76	71	70	81
SHCl	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	29	21	21	28	15
a-ANCBT	moles H^+/t	15,246.55601	15,208.53462	14,144.56456	14,030.18849	16,279.60362
s-ANCBT	%w/w S	24	24	23	22	26
Fineness Factor		2	2	2	2	2
SNAS	%w/w S	NT	NT	NT	NT	NT
a-SNAS	moles H^+/t	NT	NT	NT	NT	NT
s-SNAS	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-7,594.58780	-7,583.68521	-7,051.70018	-6,987.02774	-8,124.83301
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	29	21	21	28	15
Liming rate without ANCE	kg $CaCO_3$/t	2.2	1.5	1.5	2.1	1.1

Chromium Suite						
Our Reference:	UNITS	109494-31	109494-32	109494-33	109494-34	109494-35
Your Reference	----------	A11/1055-B-44	A11/1055-B-45	A11/1055-B-46	A11/1055-B-47	A11/1055-B-48
Sample Description	----------	S10 Middle	S10 Bottom	S11 Top	S11 Middle	S11 Bottom
Date Sampled		28/02/2011	28/02/2011	28/02/2011	28/02/2011	28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011	4/3/2011	4/3/2011
pH $_{kcl}$	pH units	9.8	9.8	9.8	9.8	9.9
TAA	moles H^+/t	<5	<5	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.027	0.044	0.020	0.028	0.018
ANC_{BT}	% $CaCO_3$	70	69	80	81	80
S_{HCl}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	17	27	12	17	11
a-ANC_{BT}	moles H^+/t	13,925.34376	13,810.96769	16,031.78880	16,241.47826	16,016.48904
s-ANC_{BT}	%w/w S	22	22	26	26	26
Fineness Factor		2	2	2	2	2
S_{NAS}	%w/w S	NT	NT	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-6,945.83198	-6,878.04104	-8,003.42040	-8,103.27553	-7,997.01792
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	17	27	12	17	11
Liming rate without ANCE	kg $CaCO_3$/t	1.3	2.1	0.94	1.3	0.84

Chromium Suite Our Reference: Your Reference Sample Description Date Sampled	UNITS ---------- ----------	109494-36 A11/1055-B-49 S12 Top 28/02/2011	109494-37 A11/1055-B-50 S12 Middle 28/02/2011	109494-38 A11/1055-B-51 S12 Bottom 28/02/2011
Date Sampled	-	28/2/2011	28/2/2011	28/2/2011
Date Extracted	-	4/3/2011	4/3/2011	4/3/2011
pH kcl	pH units	9.7	9.8	9.9
TAA	moles H^+/t	<5	<5	<5
S_{KCl}	%w/w S	<0.005	<0.005	<0.005
Chromium Reducible Sulfur	%w/w	0.027	0.026	0.037
ANC_{BT}	% $CaCO_3$	78	80	81
S_{HCl}	%w/w S	<0.005	<0.005	<0.005
s-TAA	%w/w S	NT	NT	NT
a-Chromium Reducible Sulfur	moles H^+/t	17	16	23
a-ANC_{BT}	moles H^+/t	15,550.72708	16,045.00508	16,244.61735
s-ANC_{BT}	%w/w S	25	26	26
Fineness Factor		2	2	2
S_{NAS}	%w/w S	NT	NT	NT
a-S_{NAS}	moles H^+/t	NT	NT	NT
s-S_{NAS}	%w/w S	NT	NT	NT
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01
a-Net Acidity	moles H^+/t	-7,758.52364	-8,006.28634	-8,099.23178
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75
s-Net Acidity without ANCE	% w/w S	<10	<10	<10
a-Net Acidity without ANCE	moles H^+/t	17	16	23
Liming rate without ANCE	kg $CaCO_3$/t	1.3	1.2	1.7

Method ID	Methodology Summary
WILAB 27	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS)
LAB.68	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL Chromium Suite	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD
Date Sampled	-			[NT]	109494-1	28/2/2011 || 28/2/2011
pH kcl	pH units		WILAB 27	[NT]	109494-1	9.8 || 9.8 || RPD: 0
TAA	moles H^+/t	5	WILAB 27	[NT]	109494-1	<5 || <5
SKCl	%w/w S	0.005	WILAB 27	[NT]	109494-1	<0.005 || <0.005
Chromium Reducible Sulfur	%w/w	0.01	LAB.68	[NT]	109494-1	0.013 || 0.013 || RPD: 0
ANCBT	% $CaCO_3$	0.05	LAB.68	[NT]	109494-1	81 || 81 || RPD: 0
SHCl	%w/w S	0.005	LAB.68	[NT]	109494-1	<0.005 || <0.005
s-TAA	%w/w S	0.01	LAB.68	[NT]	109494-1	NT || NT
a-Chromium Reducible Sulfur	moles H^+/t	5	LAB.68	[NT]	109494-1	8.1 || 8.1 || RPD: 0
a-ANCBT	moles H^+/t	0.05	LAB.68	[NT]	109494-1	16,110.01319 || 16,090.43720
s-ANCBT	%w/w S	0.05	LAB.68	[NT]	109494-1	26 || 26 || RPD: 0
Fineness Factor			WILAB 27	[NT]	109494-1	2 || 2 || RPD: 0
SNAS	%w/w S	0.005	LAB.68	[NT]	109494-1	NT || NT
a-SNAS	moles H^+/t	5	WILAB 27	[NT]	109494-1	NT || NT
s-SNAS	%w/w S	0.01	WILAB 27	[NT]	109494-1	NT || NT
s-Net Acidity	%w/w S	0.01	WILAB 27	[NT]	109494-1	<0.01 || <0.01
a-Net Acidity	moles H^+/t	10	WILAB 27	[NT]	109494-1	-8,046.89850 || -8,037.11050
Liming rate	kg $CaCO_3$/t	0.75	LAB.68	[NT]	109494-1	<0.75 || <0.75
s-Net Acidity without ANCE	% w/w S	10	WILAB 27	[NT]	109494-1	<10 || <10
a-Net Acidity without ANCE	moles H^+/t	10	WILAB 27	[NT]	109494-1	<10 || <10
Liming rate without ANCE	kg $CaCO_3$/t	0.75	WILAB 27	[NT]	109494-1	<0.75 || <0.75

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date Sampled	-	109494-11	28/2/2011 || 28/2/2011
pH kcl	pH units	109494-11	9.8 || 9.8 || RPD: 0
TAA	moles H^+/t	109494-11	<5 || <5
SKCl	%w/w S	109494-11	<0.005 || <0.005

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Chromium Reducible Sulfur	%w/w	109494-11	0.046 || 0.054 || RPD: 16
ANCBT	% $CaCO_3$	109494-11	85 || 88 || RPD: 3
SHCl	%w/w S	109494-11	<0.005 || <0.005
s-TAA	%w/w S	109494-11	NT || NT
a-Chromium Reducible Sulfur	moles H^+/t	109494-11	29 || 34 || RPD: 16
a-ANCBT	moles H^+/t	109494-11	17,020.29693 || 17,636.94075
s-ANCBT	%w/w S	109494-11	27 || 28 || RPD: 4
Fineness Factor		109494-11	2 || 2 || RPD: 0
SNAS	%w/w S	109494-11	NT || NT
a-SNAS	moles H^+/t	109494-11	NT || NT
s-SNAS	%w/w S	109494-11	NT || NT
s-Net Acidity	%w/w S	109494-11	<0.01 || <0.01
a-Net Acidity	moles H^+/t	109494-11	-8,481.45827 || -8,784.79058
Liming rate	kg $CaCO_3$ /t	109494-11	<0.75 || <0.75
s-Net Acidity without ANCE	% w/w S	109494-11	<10 || <10
a-Net Acidity without ANCE	moles H^+/t	109494-11	29 || 34 || RPD: 16
Liming rate without ANCE	kg $CaCO_3$ /t	109494-11	2.2 || 2.5 || RPD: 13

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date Sampled	-	109494-21	28/2/2011 || 28/2/2011
pH kcl	pH units	109494-21	9.8 || 9.9 || RPD: 1
TAA	moles H^+/t	109494-21	<5 || <5
SKCl	%w/w S	109494-21	<0.005 || <0.005
Chromium Reducible Sulfur	%w/w	109494-21	0.018 || 0.015 || RPD: 18
ANCBT	% $CaCO_3$	109494-21	84 || 85 || RPD: 1
SHCl	%w/w S	109494-21	<0.005 || <0.005
s-TAA	%w/w S	109494-21	NT || NT
a-Chromium Reducible Sulfur	moles H^+/t	109494-21	11 || 9.4 || RPD: 16
a-ANCBT	moles H^+/t	109494-21	16,861.01531 || 17,080.23611

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
s-ANC_{BT}	%w/w S	109494-21	27 || 27 || RPD: 0
Fineness Factor		109494-21	2 || 2 || RPD: 0
S_{NAS}	%w/w S	109494-21	NT || NT
a-S_{NAS}	moles H^+/t	109494-21	NT || NT
s-S_{NAS}	%w/w S	109494-21	NT || NT
s-Net Acidity	%w/w S	109494-21	<0.01 || <0.01
a-Net Acidity	moles H^+/t	109494-21	-8,419.28105 || -8,530.76255
Liming rate	kg $CaCO_3$/t	109494-21	<0.75 || <0.75
s-Net Acidity without ANCE	% w/w S	109494-21	<10 || <10
a-Net Acidity without ANCE	moles H^+/t	109494-21	11 || <10
Liming rate without ANCE	kg $CaCO_3$/t	109494-21	0.84 || <0.75

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date Sampled	-	109494-31	28/2/2011 || 28/2/2011
pH $_{kcl}$	pH units	109494-31	9.8 || 9.8 || RPD: 0
TAA	moles H^+/t	109494-31	<5 || <5
S_{KCl}	%w/w S	109494-31	<0.005 || <0.005
Chromium Reducible Sulfur	%w/w	109494-31	0.027 || 0.024 || RPD: 12
ANC_{BT}	% $CaCO_3$	109494-31	70 || 69 || RPD: 1
S_{HCl}	%w/w S	109494-31	<0.005 || <0.005
s-TAA	%w/w S	109494-31	NT || NT
a-Chromium Reducible Sulfur	moles H^+/t	109494-31	17 || 15 || RPD: 12
a-ANC_{BT}	moles H^+/t	109494-31	13,925.34376 || 13,734.71697
s-ANC_{BT}	%w/w S	109494-31	22 || 22 || RPD: 0
Fineness Factor		109494-31	2 || 2 || RPD: 0
S_{NAS}	%w/w S	109494-31	NT || NT
a-S_{NAS}	moles H^+/t	109494-31	NT || NT
s-S_{NAS}	%w/w S	109494-31	NT || NT
s-Net Acidity	%w/w S	109494-31	<0.01 || <0.01
a-Net Acidity	moles H^+/t	109494-31	-6,945.83198 || -6,852.38969

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Liming rate	kg $CaCO_3$ /t	109494-31	<0.75 || <0.75
s-Net Acidity without ANCE	% w/w S	109494-31	<10 || <10
a-Net Acidity without ANCE	moles H^+/t	109494-31	17 || 15 || RPD: 12
Liming rate without ANCE	kg $CaCO_3$ /t	109494-31	1.3 || 1.1 || RPD: 17

Report Comments:

Visual inspection of samples indicates that they are composed predominately of shell grit and shell fragements.

This report R01 replaces the original R00 due to correction in sample ID's

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform & E.coli levels are less than 1cfu/100mL.
The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC& ARMC 2004.

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

INS: Insufficient sample for this test; NT: Not tested; PQL: Practical Quantitation Limit; <: Less than; >: Greater than
RPD: Relative Percent Difference; NA: Test not required; LCS: Laboratory Control Sample; NR: Not requested
NS: Not specified; NEPM: National Environmental Protection Measure
DOL: Sample rejected due to particulate overload

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however were analysed at a frequency to meet of exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD a matrix spike recoveries for the sample batch were within laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spike and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and Speciated Phenols is acceptable.
Surrogates: 60-140% is acceptable for general organics and 10-140% for SVOC and Speciated Phenols.

REPORT OF ANALYSIS

Laboratory Reference: A11/1055-C [R00]

Client: Oceanica Consulting Pty Ltd
Lev 1, 353 Cambridge Street
Wembley WA 6913

Contact: Karen Crawley

Order No: 452_005
Project: Mangles Bay - Elutriate Nutrients
Sample Type: sediment
No. of Samples: 56
Date Received: 3/03/2011
Date Completed: 28/03/2011

Laboratory Contact Details:

Client Services Manager: Jane Struthers
Technical Enquiries: Andrew Bradbury
Telephone: +61 8 9325 9799
Fax: +61 8 9325 4299
Email: perth@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

Laboratory Reference:	-	-	1	2	3	7
Client Reference:	-	-	S1a Top	S1a Middle	S1a Bottom	S2 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	740	94	100	200
Nitrate+Nitrite	SUB	µg.N/L	15	9	11	10
Orthophosphate	SUB	µg.P/L	37	24	24	73

Laboratory Reference:	-	-	8	10	11	12
Client Reference:	-	-	S2 Middle	S3 Top	S3 Middle	S3 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	120	390	76	80
Nitrate+Nitrite	SUB	µg.N/L	9	12	6	7
Orthophosphate	SUB	µg.P/L	38	67	36	35

Laboratory Reference:	-	-	13	14	15	16
Client Reference:	-	-	S4 R1 Top	S4 R1 Middle	S4 R1 Bottom	S4 R2 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	680	70	56	510
Nitrate+Nitrite	SUB	µg.N/L	9	8	8	9
Orthophosphate	SUB	µg.P/L	120	23	38	83

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

Laboratory Reference:	-	-	17	18	19	20
Client Reference:	-	-	S4 R2 Middle	S4 R2 Bottom	S4 R3 Top	S4 R3 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	86	160	910	99
Nitrate+Nitrite	SUB	µg.N/L	8	7	11	7
Orthophosphate	SUB	µg.P/L	26	34	120	31

Laboratory Reference:	-	-	21	22	23	24
Client Reference:	-	-	S4 R3 Bottom	S5 Top	S5 Middle	S5 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	82	670	81	55
Nitrate+Nitrite	SUB	µg.N/L	9	6	5	6
Orthophosphate	SUB	µg.P/L	35	42	41	38

Laboratory Reference:	-	-	25	26	27	28
Client Reference:	-	-	S6 Top	S6 Middle	S6 Bottom	S7 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	580	84	63	490
Nitrate+Nitrite	SUB	µg.N/L	15	9	7	10
Orthophosphate	SUB	µg.P/L	86	40	53	62

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

Laboratory Reference:	-	-	29	30	31	32
Client Reference:	-	-	S7 Middle	S7 Bottom	S8 R1 Top	S8 R1 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	34	12	350	43
Nitrate+Nitrite	SUB	µg.N/L	6	7	12	10
Orthophosphate	SUB	µg.P/L	30	23	60	30

Laboratory Reference:	-	-	33	34	35	36
Client Reference:	-	-	S8 R1 Bottom	S8 R2 Top	S8 R2 Middle	S8 R2 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	22	200	59	59
Nitrate+Nitrite	SUB	µg.N/L	8	12	6	5
Orthophosphate	SUB	µg.P/L	24	120	36	33

Laboratory Reference:	-	-	37	38	39	40
Client Reference:	-	-	S8 R3 Top	S8 R3 Middle	S8 R3 Bottom	S9 Top
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	260	87	72	720
Nitrate+Nitrite	SUB	µg.N/L	11	6	6	9
Orthophosphate	SUB	µg.P/L	74	51	37	70

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

Laboratory Reference:	-	-	41	42	43	44
Client Reference:	-	-	S9 Middle	S9 Bottom	S10 Top	S10 Middle
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	71	62	1,500	57
Nitrate+Nitrite	SUB	µg.N/L	5	5	5	6
Orthophosphate	SUB	µg.P/L	34	31	34	41

Laboratory Reference:	-	-	45	46	47	48
Client Reference:	-	-	S10 Bottom	S11 Top	S11 Middle	S11 Bottom
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	63	340	77	53
Nitrate+Nitrite	SUB	µg.N/L	5	7	4	7
Orthophosphate	SUB	µg.P/L	43	96	41	30

Laboratory Reference:	-	-	49	50	51	56
Client Reference:	-	-	S12 Top	S12 Middle	S12 Bottom	Elutriate Seawater Blank
Date Sampled:	-	-	28/2/2011-1/3/2011	28/2/2011-1/3/2011	28/2/2011-1/3/2011	
Analysis Description	**Method**	**Units**				
Subcontract Analysis						
Ammonia	SUB	µg.N/L	710	100	52	26
Nitrate+Nitrite	SUB	µg.N/L	6	4	6	15
Orthophosphate	SUB	µg.P/L	86	48	32	6

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

Method	Method Description
SUB	Subcontracted Analyses

Result Comments
[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required
SUB Analysis was subcontracted to Marine and Freshwater Research Laboratory, Environmental Science (NATA Number 10603); reference MAFRL report number AAA11-1.

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Batch Number: A11/1055-C [R00]
Project Reference: Mangles Bay - Elutriate Nutrients

QUALITY ASSURANCE REPORT

Comments:

RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants

Acceptable replicate reproducibility limit or RPD:	Results < 10 times LOR: no limits.
	Results >10 times LOR: 0% - 50%.
Acceptable matrix spike & LCS recovery limits:	Trace elements 70-130%
	Organic analyses 50-150%
	SVOC & speciated phenols 10-140%
	Surrogates 10-140%

When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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REPORT OF ANALYSIS

Laboratory Reference: A11/1480-B [R00]

Client: Oceanica Consulting Pty Ltd
Lev 1, 353 Cambridge Street
Wembley WA 6913

Contact: Karen Crawley

Order No: 452_005
Project: Mangles Bay - Elutriate TBT
Sample Type: sediment
No. of Samples: 3
Date Received: 30/03/2011
Date Completed: 5/04/2011

Laboratory Contact Details:

Client Services Manager: Jane Struthers
Technical Enquiries: Andrew Bradbury
Telephone: +61 8 9325 9799
Fax: +61 8 9325 4299
Email: perth@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
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Batch Number: A11/1480-B [R00]
Project Reference: Mangles Bay - Elutriate TBT

Laboratory Reference: Client Reference: Date Sampled: Analysis Description	- - - Method	- - - Units	1 S3 Bottom 28/02/2011	2 S6 Top 28/02/2011	3 Elutriate Blank
Elutriate - Organotins					
Tributyl tin	04-061	µgSn/L	<0.005	0.74	<0.005
Surrogate 1 Recovery	04-061	%	94	77	107
Date Extracted	04-061	-	4/4/11	4/4/11	4/4/11
Date Analysed	04-061	-	4/4/11	4/4/11	4/4/11

Method	Method Description
04-061	Tributyltin in saline waters by GCMS, µgSn/L

Result Comments
[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required

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Batch Number: A11/1480-B [R00]
Project Reference: Mangles Bay - Elutriate TBT

QUALITY ASSURANCE REPORT

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Tributyl tin	µgSn/L	<0.005	[NT]	[NT]	External	99%
Surrogate 1 Recovery	%	97	[NT]	[NT]	External	106%

Comments:
RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants
Acceptable replicate reproducibility limit or RPD: Results < 10 times LOR: no limits.
Results >10 times LOR: 0% - 50%.
Acceptable matrix spike & LCS recovery limits: Trace elements 70-130%
Organic analyses 50-150%
SVOC & speciated phenols 10-140%
Surrogates 10-140%
When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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REPORT OF ANALYSIS

Laboratory Reference: A11/1480-A [R00]

Client: Oceanica Consulting Pty Ltd
Lev 1, 353 Cambridge Street
Wembley WA 6913

Contact: Karen Crawley

Order No: 452_005
Project: Mangles Bay - TBT
Sample Type: sediment
No. of Samples: 2
Date Received: 30/03/2011
Date Completed: 11/04/2011

Laboratory Contact Details:

Client Services Manager: Jane Struthers
Technical Enquiries: Andrew Bradbury
Telephone: +61 8 9325 9799
Fax: +61 8 9325 4299
Email: perth@advancedanalytical.com.au
andrew.bradbury@advancedanalytical.com.au

Attached Results Approved By:

Ian Eckhard
Technical Director

Comments:
All samples tested as submitted by client. All attached results have been checked and approved for release.
This is the Final Report and supersedes any reports previously issued with this batch number.
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Batch Number: A11/1480-A [R00]
Project Reference: Mangles Bay - TBT

Laboratory Reference: **Client Reference:** **Date Sampled:** **Analysis Description**	- - - **Method**	- - - **Units**	**1** **S3 Bottom** **28/02/2011**	**2** **S6 Top** **28/02/2011**
Organotins				
Monobutyl tin	04-026	µgSn/kg	<0.50	<0.50
Dibutyl tin	04-026	µgSn/kg	1.9	<0.50
Tributyl tin	04-026	µgSn/kg	<0.50	11
Surrogate 1 Recovery	04-026	%	82	74
Date Extracted	04-026	-	1/4/11	1/4/11
Date Analysed	04-026	-	4/4/11	4/4/11

Method	Method Description
04-026	Organotins by GCMS, µgSn/kg

Result Comments
[<] Less than
[INS] Insufficient sample for this test
[NA] Test not required
Samples were extracted and analysed outside the recommended holding time. Client requested samples to be reanalysed and instructions were not received within sufficient timeframe.

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Batch Number: A11/1480-A [R00]
Project Reference: Mangles Bay - TBT

QUALITY ASSURANCE REPORT

TEST	UNITS	Blank	Duplicate Sm#	Duplicate Results	Spike Sm#	Spike Results
Monobutyl tin	µgSn/kg	<0.50	[NT]	[NT]	External	79%
Dibutyl tin	µgSn/kg	<0.50	[NT]	[NT]	External	86%
Tributyl tin	µgSn/kg	<0.50	[NT]	[NT]	External	84%
Surrogate 1 Recovery	%	100	[NT]	[NT]	External	101%

Comments:
RPD = Relative Percent Deviation
[NT] = Not Tested
[N/A] = Not Applicable
'#' = Spike recovery data could not be calculated due to high levels of contaminants
Acceptable replicate reproducibility limit or RPD: Results < 10 times LOR: no limits.
Results >10 times LOR: 0% - 50%.
Acceptable matrix spike & LCS recovery limits: Trace elements 70-130%
Organic analyses 50-150%
SVOC & speciated phenols 10-140%
Surrogates 10-140%
When levels outside these limits are obtained, an investigation into the cause of the deviation is performed before the batch is accepted or rejected, and results are released.

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Australian Government

National Measurement Institute

INTERIM REPORT OF ANALYSIS

Report No. RN844538

Client	: OCEANICA CONSULTING PTY LTD	Job No.	: OCEA26_W/110304
	LEVEL 1	Quote No.	: QT-01780
	353 CAMBRIDGE STREET	Order No.	: 452_004
	WEMBLEY WA 6913	Date Sampled	: 28-FEB-2011
		Date Received	: 3-MAR-2011
Attention	: KAREN CRAWLEY	Sampled By	: CLIENT
Project Name	:		
Your Client Services Manager	: Koon-Bay Ho	Phone	: (08) 9368 8460

Lab Reg No.	Sample Ref	Sample Description
W11/003716	S1c Top	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003717	S1c Middle	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003718	S1c Bottom	Mangles Bay SEDIMENT 28/02 & 1/03/11

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Poly Aromatic Hydrocarbons						
Naphthalene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Acenaphthylene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Acenaphthene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Fluorene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Phenanthrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Fluoranthene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benz(a)anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Chrysene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benzo(b + k)fluoranthene	mg/kg	< 0.02	< 0.02	< 0.02		WL206
Benzo(a)pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Indeno(1,2,3,c,d)pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Dibenz(a,h)anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benzo(g,h,i)perylene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Total PAH's (as above)	mg/kg	< 0.16	< 0.16	< 0.16		WL206
Dates						
Date extracted		4-MAR-2011	4-MAR-2011	4-MAR-2011		
Date analysed		10-MAR-2011	10-MAR-2011	10-MAR-2011		
Sample condition on receipt		COLD	COLD	COLD		

Leigh Boyd - Analyst
Organics - WA
Accreditation No. 2474

10-MAR-2011

INTERIM REPORT OF ANALYSIS

All results are expressed on a dry weight basis.

Australian Government

National Measurement Institute

INTERIM REPORT OF ANALYSIS

Report No. RN845528

Client	: OCEANICA CONSULTING PTY LTD	Job No.	: OCEA26_W/110304
	LEVEL 1	Quote No.	: QT-01780
	353 CAMBRIDGE STREET	Order No.	: 452_004
	WEMBLEY WA 6913	Date Sampled	: 28-FEB-2011
		Date Received	: 3-MAR-2011
Attention	: KAREN CRAWLEY	Sampled By	: CLIENT
Project Name	:		
Your Client Services Manager	: Koon-Bay Ho	Phone	: (08) 9368 8460

Lab Reg No.	Sample Ref	Sample Description
W11/003716	S1c Top	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003717	S1c Middle	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003718	S1c Bottom	Mangles Bay SEDIMENT 28/02 & 1/03/11

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Trace Elements						
Arsenic	mg/kg	2.2	3.6	4.4		NT2_49
Cadmium	mg/kg	0.15	0.11	< 0.1		NT2_49
Chromium	mg/kg	15	14	14		NT2_49
Copper	mg/kg	2.5	0.78	0.61		NT2_49
Lead	mg/kg	2.8	0.98	0.61		NT2_49
Mercury	mg/kg	< 0.01	< 0.01	< 0.01		NT2_49
Nickel	mg/kg	1.8	1.1	1.2		NT2_49
Silver	mg/kg	< 0.2	< 0.2	< 0.2		NT2_49
Zinc	mg/kg	8	1.7	1		NT2_49

Anna Zheng, Analyst
Inorganics - NSW
Accreditation No. 198

16-MAR-2011

All results are expressed on a dry weight basis. TE ref. 11Sm48-02. QA

INTERIM REPORT OF ANALYSIS

1 Suakin Street, Pymble NSW 2073 Tel: +61 2 9449 0111 Fax: +61 2 9449 1653 www.measurement.gov.au

REPORT OF ANALYSIS

Client	: OCEANICA CONSULTING PTY LTD	Job No.	: OCEA26_W/110304
	LEVEL 1	Quote No.	: QT-01780
	353 CAMBRIDGE STREET	Order No.	: 452_004
	WEMBLEY WA 6913	Date Sampled	: 28-FEB-2011
		Date Received	: 3-MAR-2011
Attention	: KAREN CRAWLEY	Sampled By	: CLIENT
Project Name	:		
Your Client Services Manager	: Koon-Bay Ho	Phone	: (08) 9368 8460

Lab Reg No.	Sample Ref	Sample Description
W11/003716	S1c Top	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003717	S1c Middle	Mangles Bay SEDIMENT 28/02 & 1/03/11
W11/003718	S1c Bottom	Mangles Bay SEDIMENT 28/02 & 1/03/11

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Organotins						
Monobutyltin as Sn	ng/g	3.0	0.79	0.55		NR_35
Dibutyltin as Sn	ng/g	1.5	0.69	0.90		NR_35
Tributyltin as Sn	ng/g	0.51	< 0.5	0.53		NR_35
Surrogate Tripropyltin Rec.	%	97	106	107		NR_35
Dates						
Date extracted		15-MAR-2011	15-MAR-2011	15-MAR-2011		
Date analysed		17-MAR-2011	17-MAR-2011	17-MAR-2011		

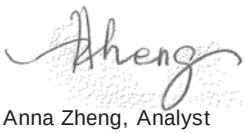
Danny Slee, Section Manager
Organics - NSW
Accreditation No. 198

25-MAR-2011

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Trace Elements						
Arsenic	mg/kg	2.2	3.6	4.4		NT2_49
Cadmium	mg/kg	0.15	0.11	< 0.1		NT2_49
Chromium	mg/kg	15	14	14		NT2_49
Copper	mg/kg	2.5	0.78	0.61		NT2_49
Lead	mg/kg	2.8	0.98	0.61		NT2_49
Mercury	mg/kg	< 0.01	< 0.01	< 0.01		NT2_49
Nickel	mg/kg	1.8	1.1	1.2		NT2_49
Silver	mg/kg	< 0.2	< 0.2	< 0.2		NT2_49

REPORT OF ANALYSIS

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Trace Elements						
Zinc	mg/kg	8	1.7	1		NT2_49



Anna Zheng, Analyst
Inorganics - NSW
Accreditation No. 198

25-MAR-2011

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Miscellaneous						
Carbon - Total Organic	mg/kg	5470	3080	4040		NW_S15

Wei Huang, Analyst
Inorganics - NSW
Accreditation No. 198

25-MAR-2011

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Poly Aromatic Hydrocarbons						
Naphthalene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Acenaphthylene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Acenaphthene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Fluorene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Phenanthrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Fluoranthene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benz(a)anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Chrysene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benzo(b + k)fluoranthene	mg/kg	< 0.02	< 0.02	< 0.02		WL206
Benzo(a)pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Indeno(1,2,3,c,d)pyrene	mg/kg	< 0.01	< 0.01	< 0.01		WL206

REPORT OF ANALYSIS

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Poly Aromatic Hydrocarbons						
Dibenz(a,h)anthracene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Benzo(g,h,i)perylene	mg/kg	< 0.01	< 0.01	< 0.01		WL206
Total PAH's (as above)	mg/kg	< 0.16	< 0.16	< 0.16		WL206
Dates						
Date extracted		4-MAR-2011	4-MAR-2011	4-MAR-2011		
Date analysed		10-MAR-2011	10-MAR-2011	10-MAR-2011		
Sample condition on receipt		COLD	COLD	COLD		

Leigh Boyd - Analyst
Organics - WA
Accreditation No. 2474

25-MAR-2011

Lab Reg No.		W11/003716	W11/003717	W11/003718		
Sample Reference	Units	S1c Top	S1c Middle	S1c Bottom		Method
Inorganics						
ANC bt as CaCO3	%	Not Tested	Not Tested	22		WL281-19A2
Moisture	%	29	27	32		WL170
pH kcl		9.7	9.7	9.7		WL281-23A
Scr	%	0.03	0.03	0.06		WL281-22B
TAA	molH per t	< 1	< 1	< 1		WL281-23F

W11/003716
to W11/003718

Acid sulfate soil analytes were determined on the as-received (wet weight) sample and reported on a dry weight basis.

Peter Anstis, Analyst
Inorganics - WA
Accreditation No. 2474

25-MAR-2011

REPORT OF ANALYSIS

All results (except moisture) are expressed on a dry weight basis. Unless notified to the contrary, the above samples will be disposed of one month from the reporting date.

This report is issued in accordance with NATA's accreditation requirements.
Accreditated for compliance with ISO/IEC 17025.
This report shall not be reproduced except in full.
Results relate only to the sample(s) tested.

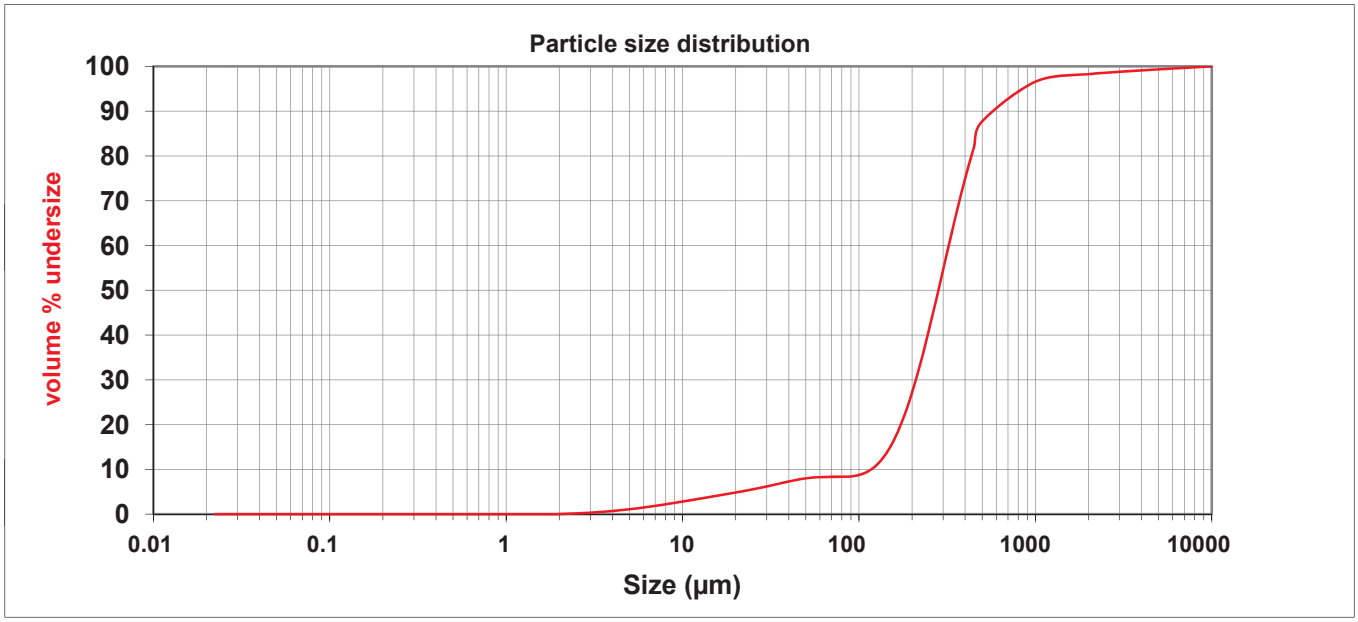
This Report supersedes reports: RN844538 RN845528 RN845848 RN846489 RN846632

Suite 6
642 Albany Hwy
Victoria Park

Client:	Oceanica
Sample Name :	S2 Top 28/02
Batch No :	11_124
Lab ID No :	11_124_04

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.55	**Vol. Wighted mean D[4,3]:**	390.75 µm	**d(0.1)**	115.00 µm
		Surface weighted mean D[3,2]	86.15 µm	**d(0.5)**	280.00 µm
				d(0.9)	550.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	1.88	50.238	8.00	355.66	67.01
0.022	0.00	0.159	0.00	1.125	0.00	7.962	2.18	56.368	8.23	399.05	74.84
0.025	0.00	0.178	0.00	1.262	0.00	8.934	2.50	63.246	8.33	447.74	81.82
0.028	0.00	0.200	0.00	1.416	0.00	10.024	2.82	70.963	8.33	500.00	87.74
0.032	0.00	0.224	0.00	1.589	0.00	11.247	3.15	79.621	8.33	1000.00	96.56
0.036	0.00	0.252	0.00	1.783	0.00	12.619	3.48	89.337	8.40	2000.00	98.29
0.040	0.00	0.283	0.00	2.000	0.02	14.159	3.81	100.237	8.75	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.09	15.887	4.14	112.468	9.54		
0.050	0.00	0.356	0.00	2.518	0.17	17.825	4.47	126.191	11.00		
0.056	0.00	0.399	0.00	2.825	0.27	20.000	4.81	141.589	13.34		
0.063	0.00	0.448	0.00	3.170	0.38	22.440	5.17	158.866	16.77		
0.071	0.00	0.502	0.00	3.557	0.52	25.179	5.55	178.250	21.36		
0.080	0.00	0.564	0.00	3.991	0.69	28.251	5.97	200.000	27.14		
0.089	0.00	0.632	0.00	4.477	0.88	31.698	6.40	224.404	34.02		
0.100	0.00	0.710	0.00	5.024	1.09	35.566	6.85	251.785	41.77		
0.112	0.00	0.796	0.00	5.637	1.33	39.905	7.28	282.508	50.10		
0.126	0.00	0.893	0.00	6.325	1.59	44.774	7.68	316.979	58.64		

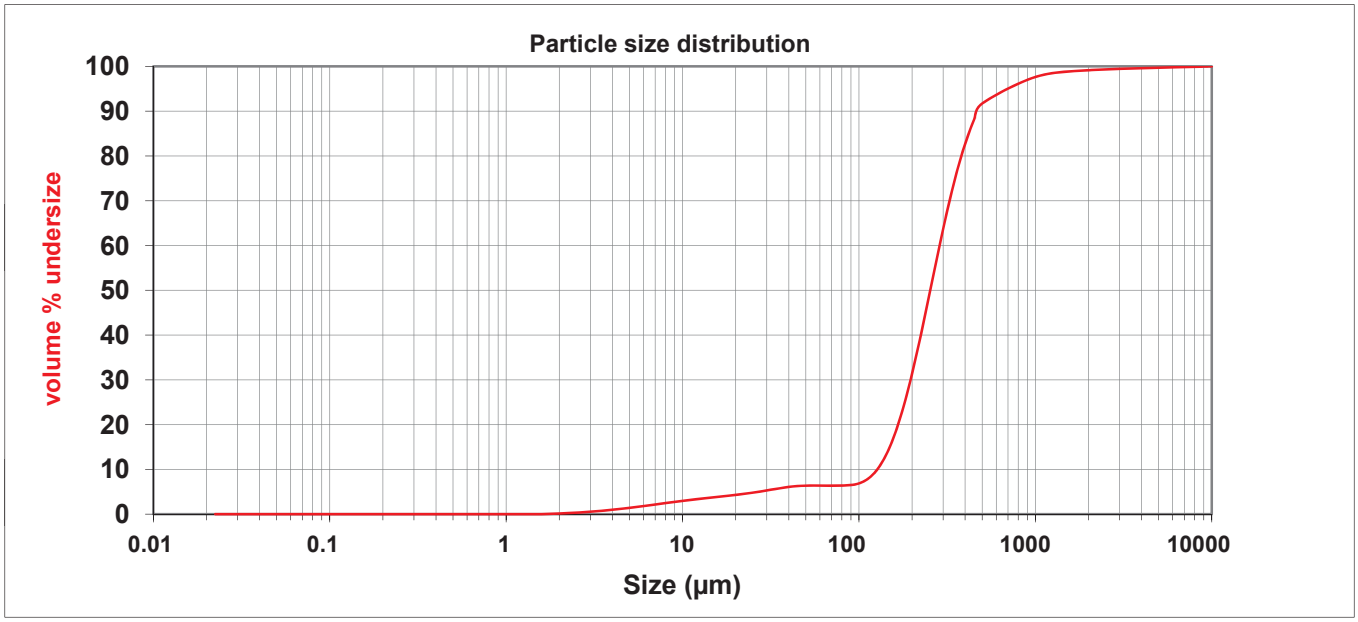
Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
642 Albany Hwy
Victoria Park

Client:	Oceanica
Sample Name :	S2 Middle 28/02
Batch No :	11_124
Lab ID No :	11_124_05

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.28	**Vol. Wighted mean D[4,3]:**	328.32 µm	**d(0.1)**	130.00 µm
		Surface weighted mean D[3,2]	81.44 µm	**d(0.5)**	250.00 µm
				d(0.9)	450.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	2.18	50.238	6.38	355.66	75.88
0.022	0.00	0.159	0.00	1.125	0.00	7.962	2.44	56.368	6.40	399.05	82.62
0.025	0.00	0.178	0.00	1.262	0.00	8.934	2.70	63.246	6.40	447.74	87.89
0.028	0.00	0.200	0.00	1.416	0.00	10.024	2.96	70.963	6.40	500.00	91.71
0.032	0.00	0.224	0.00	1.589	0.00	11.247	3.19	79.621	6.40	1000.00	97.61
0.036	0.00	0.252	0.00	1.783	0.05	12.619	3.42	89.337	6.47	2000.00	99.13
0.040	0.00	0.283	0.00	2.000	0.13	14.159	3.63	100.237	6.88	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.22	15.887	3.84	112.468	7.89		
0.050	0.00	0.356	0.00	2.518	0.33	17.825	4.05	126.191	9.83		
0.056	0.00	0.399	0.00	2.825	0.46	20.000	4.28	141.589	12.99		
0.063	0.00	0.448	0.00	3.170	0.61	22.440	4.53	158.866	17.62		
0.071	0.00	0.502	0.00	3.557	0.78	25.179	4.82	178.250	23.76		
0.080	0.00	0.564	0.00	3.991	0.97	28.251	5.12	200.000	31.33		
0.089	0.00	0.632	0.00	4.477	1.18	31.698	5.45	224.404	40.03		
0.100	0.00	0.710	0.00	5.024	1.41	35.566	5.77	251.785	49.38		
0.112	0.00	0.796	0.00	5.637	1.65	39.905	6.05	282.508	58.84		
0.126	0.00	0.893	0.00	6.325	1.91	44.774	6.26	316.979	67.84		

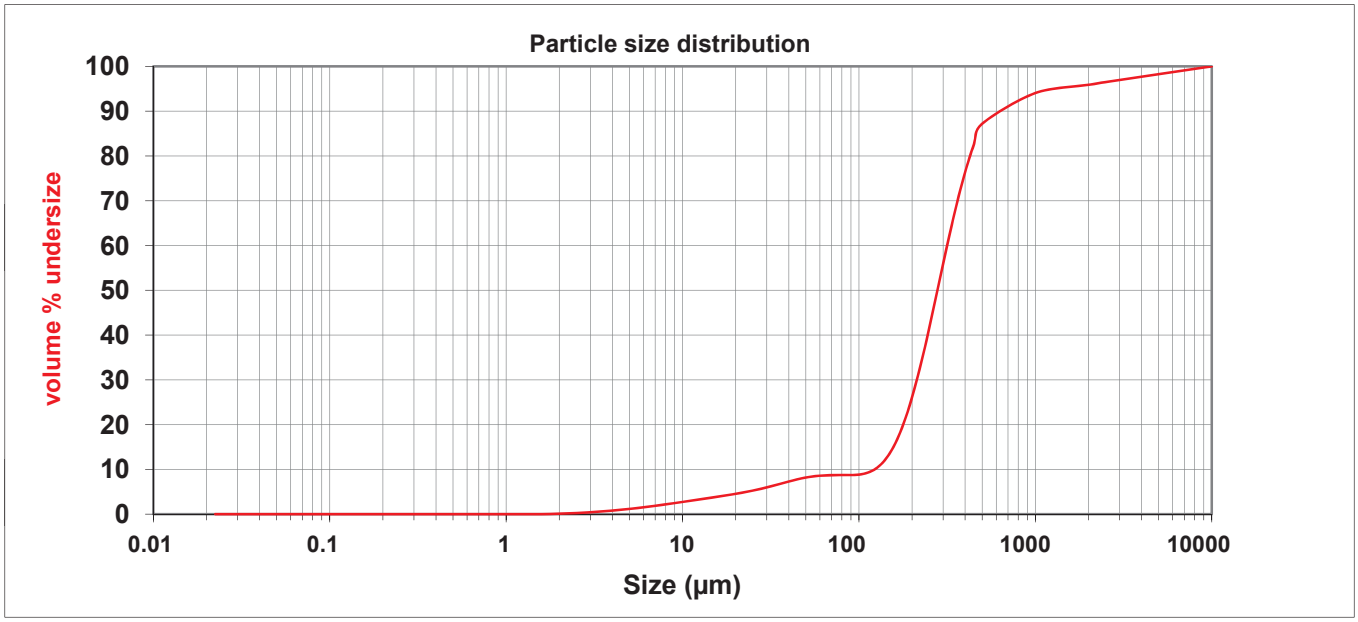
Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
642 Albany Hwy
Victoria Park

Client:	Oceanica
Sample Name :	S5 Top 28/02
Batch No :	11_124
Lab ID No :	11_124_12

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	0
Sonication:	0 minutes sonication		

Span:	1.78	**Vol. Wighted mean D[4,3]:**	481.07 µm	**d(0.1)**	120.00 µm
		Surface weighted mean D[3,2]	85.07 µm	**d(0.5)**	270.00 µm
				d(0.9)	600.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	1.89	50.238	8.18	355.66	68.74
0.022	0.00	0.159	0.00	1.125	0.00	7.962	2.16	56.368	8.49	399.05	76.28
0.025	0.00	0.178	0.00	1.262	0.00	8.934	2.44	63.246	8.66	447.74	82.47
0.028	0.00	0.200	0.00	1.416	0.00	10.024	2.73	70.963	8.70	500.00	87.20
0.032	0.00	0.224	0.00	1.589	0.00	11.247	3.02	79.621	8.70	1000.00	94.04
0.036	0.00	0.252	0.00	1.783	0.04	12.619	3.31	89.337	8.71	2000.00	95.91
0.040	0.00	0.283	0.00	2.000	0.10	14.159	3.60	100.237	8.83	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.17	15.887	3.89	112.468	9.28		
0.050	0.00	0.356	0.00	2.518	0.26	17.825	4.19	126.191	10.32		
0.056	0.00	0.399	0.00	2.825	0.36	20.000	4.52	141.589	12.26		
0.063	0.00	0.448	0.00	3.170	0.48	22.440	4.88	158.866	15.42		
0.071	0.00	0.502	0.00	3.557	0.62	25.179	5.28	178.250	19.99		
0.080	0.00	0.564	0.00	3.991	0.78	28.251	5.72	200.000	26.06		
0.089	0.00	0.632	0.00	4.477	0.96	31.698	6.21	224.404	33.51		
0.100	0.00	0.710	0.00	5.024	1.17	35.566	6.74	251.785	42.00		
0.112	0.00	0.796	0.00	5.637	1.39	39.905	7.27	282.508	51.09		
0.126	0.00	0.893	0.00	6.325	1.63	44.774	7.76	316.979	60.19		

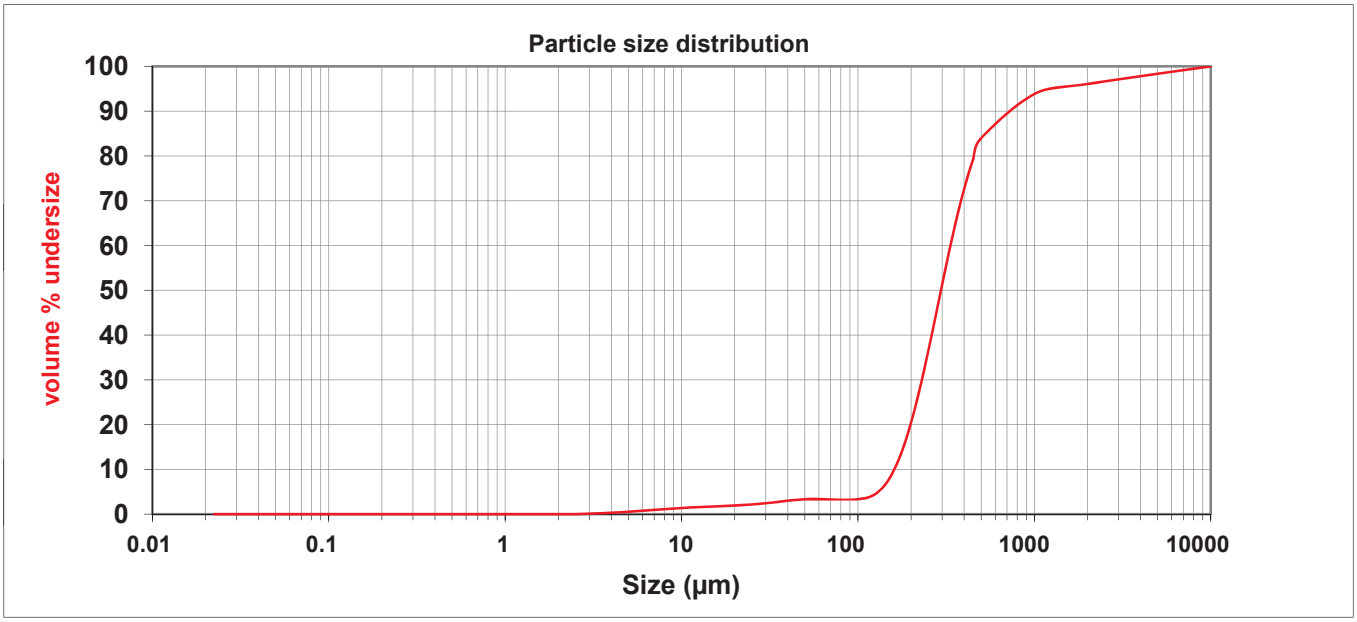
Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
642 Albany Hwy
Victoria Park

Client:	Oceanica
Sample Name :	S5 Middle 28/02
Batch No :	11_124
Lab ID No :	11_124_13

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.86	**Vol. Wighted mean D[4,3]:**	507.30 µm	**d(0.1)**	160.00 µm
		Surface weighted mean D[3,2]	145.86 µm	**d(0.5)**	290.00 µm
				d(0.9)	700.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	0.95	50.238	3.30	355.66	64.63
0.022	0.00	0.159	0.00	1.125	0.00	7.962	1.09	56.368	3.32	399.05	72.51
0.025	0.00	0.178	0.00	1.262	0.00	8.934	1.23	63.246	3.32	447.74	79.01
0.028	0.00	0.200	0.00	1.416	0.00	10.024	1.36	70.963	3.32	500.00	84.00
0.032	0.00	0.224	0.00	1.589	0.00	11.247	1.48	79.621	3.32	1000.00	93.82
0.036	0.00	0.252	0.00	1.783	0.00	12.619	1.58	89.337	3.32	2000.00	96.06
0.040	0.00	0.283	0.00	2.000	0.00	14.159	1.67	100.237	3.35	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.00	15.887	1.74	112.468	3.64		
0.050	0.00	0.356	0.00	2.518	0.00	17.825	1.82	126.191	4.56		
0.056	0.00	0.399	0.00	2.825	0.05	20.000	1.91	141.589	6.42		
0.063	0.00	0.448	0.00	3.170	0.13	22.440	2.01	158.866	9.57		
0.071	0.00	0.502	0.00	3.557	0.21	25.179	2.15	178.250	14.20		
0.080	0.00	0.564	0.00	3.991	0.31	28.251	2.33	200.000	20.41		
0.089	0.00	0.632	0.00	4.477	0.42	31.698	2.53	224.404	28.07		
0.100	0.00	0.710	0.00	5.024	0.54	35.566	2.76	251.785	36.85		
0.112	0.00	0.796	0.00	5.637	0.67	39.905	2.99	282.508	46.27		
0.126	0.00	0.893	0.00	6.325	0.81	44.774	3.18	316.979	55.73		

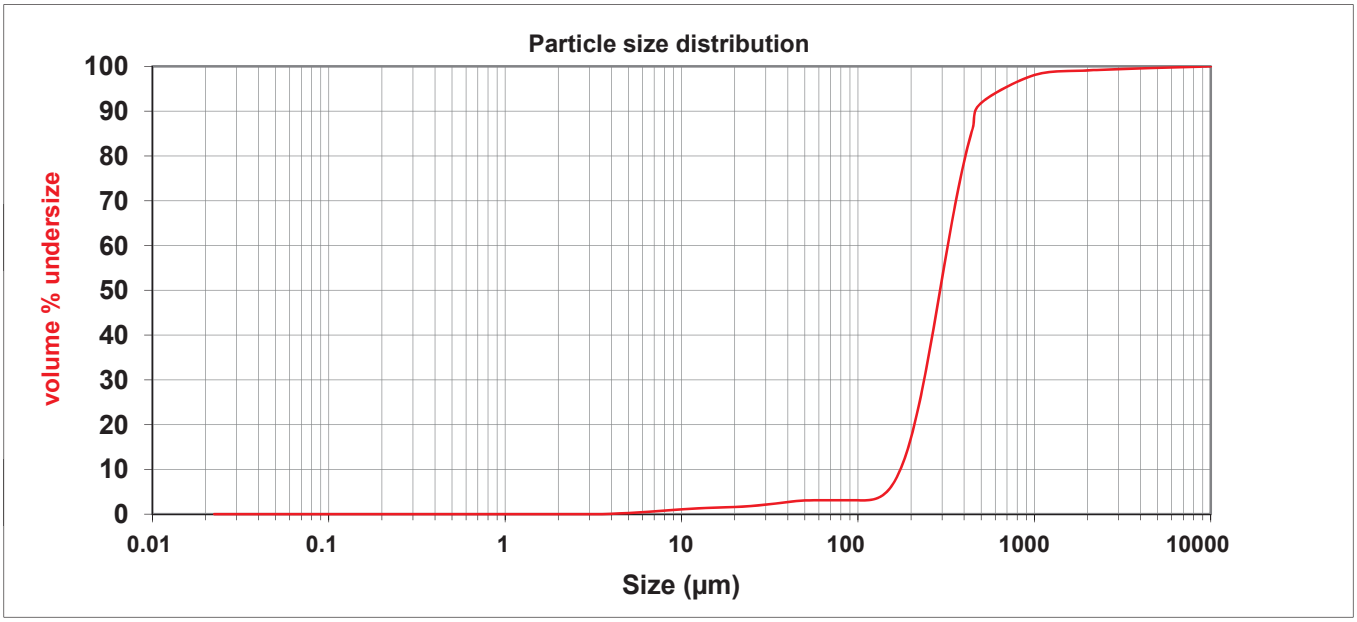
Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
642 Albany Hwy
Victoria Park

Client:	Oceanica
Sample Name :	S5 Bottom 28/02
Batch No :	11_124
Lab ID No :	11_124_14

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	0.97	**Vol. Wighted mean D[4,3]:**	360.70 µm	**d(0.1)**	170.00 µm
		Surface weighted mean D[3,2]	164.84 µm	**d(0.5)**	290.00 µm
				d(0.9)	450.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	0.65	50.238	3.06	355.66	69.08
0.022	0.00	0.159	0.00	1.125	0.00	7.962	0.80	56.368	3.09	399.05	78.62
0.025	0.00	0.178	0.00	1.262	0.00	8.934	0.94	63.246	3.09	447.74	86.26
0.028	0.00	0.200	0.00	1.416	0.00	10.024	1.08	70.963	3.09	500.00	91.85
0.032	0.00	0.224	0.00	1.589	0.00	11.247	1.20	79.621	3.09	1000.00	98.04
0.036	0.00	0.252	0.00	1.783	0.00	12.619	1.31	89.337	3.09	2000.00	99.10
0.040	0.00	0.283	0.00	2.000	0.00	14.159	1.40	100.237	3.09	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.00	15.887	1.47	112.468	3.10		
0.050	0.00	0.356	0.00	2.518	0.00	17.825	1.54	126.191	3.45		
0.056	0.00	0.399	0.00	2.825	0.00	20.000	1.61	141.589	4.54		
0.063	0.00	0.448	0.00	3.170	0.00	22.440	1.70	158.866	6.89		
0.071	0.00	0.502	0.00	3.557	0.01	25.179	1.83	178.250	10.96		
0.080	0.00	0.564	0.00	3.991	0.08	28.251	2.00	200.000	17.09		
0.089	0.00	0.632	0.00	4.477	0.16	31.698	2.21	224.404	25.34		
0.100	0.00	0.710	0.00	5.024	0.26	35.566	2.45	251.785	35.39		
0.112	0.00	0.796	0.00	5.637	0.38	39.905	2.70	282.508	46.61		
0.126	0.00	0.893	0.00	6.325	0.51	44.774	2.92	316.979	58.15		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
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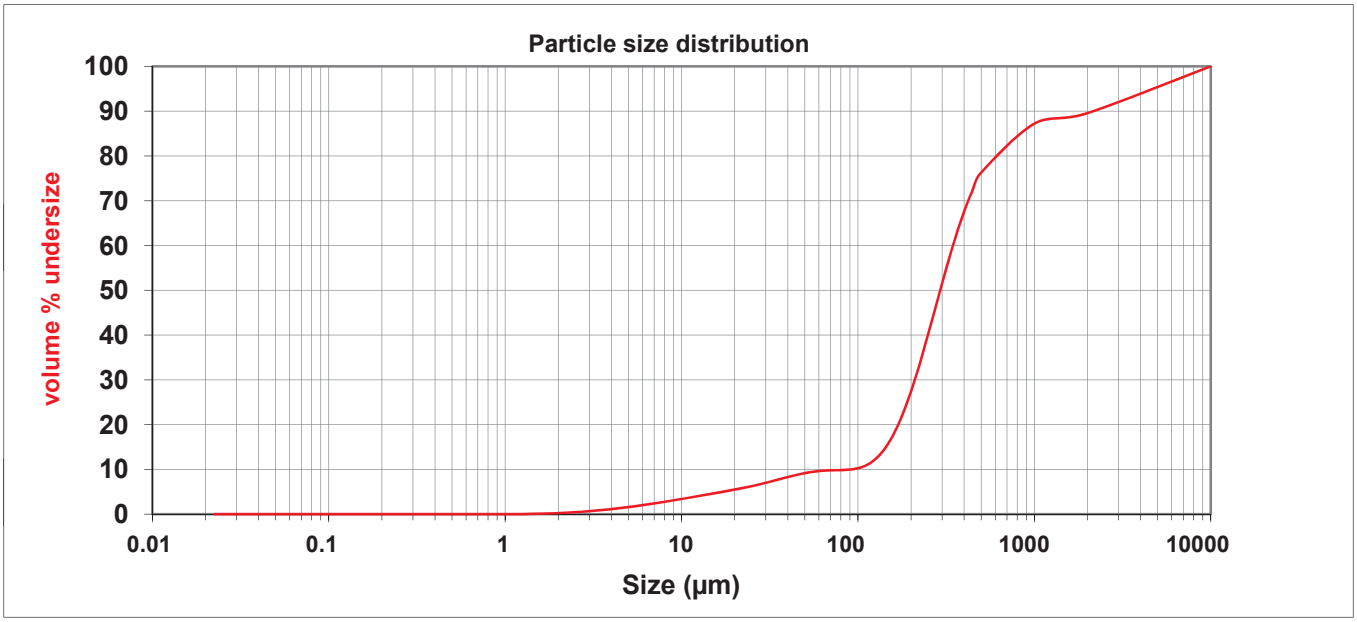
Client:	Oceanica
Sample Name :	S8 R2 Top 01/03
Batch No :	11_124
Lab ID No :	11_124_21

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	6.59	**Vol. Wighted mean D[4,3]:**	761.57 µm	**d(0.1)**	90.00 µm
		Surface weighted mean D[3,2]	71.78 µm	**d(0.5)**	290.00 µm
				d(0.9)	2000.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	2.43	50.238	9.18	355.66	61.59
0.022	0.00	0.159	0.00	1.125	0.00	7.962	2.75	56.368	9.50	399.05	67.51
0.025	0.00	0.178	0.00	1.262	0.01	8.934	3.07	63.246	9.70	447.74	72.45
0.028	0.00	0.200	0.00	1.416	0.06	10.024	3.41	70.963	9.80	500.00	76.31
0.032	0.00	0.224	0.00	1.589	0.11	11.247	3.74	79.621	9.84	1000.00	87.21
0.036	0.00	0.252	0.00	1.783	0.17	12.619	4.08	89.337	9.95	2000.00	89.55
0.040	0.00	0.283	0.00	2.000	0.25	14.159	4.42	100.237	10.26	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.34	15.887	4.75	112.468	10.99		
0.050	0.00	0.356	0.00	2.518	0.46	17.825	5.10	126.191	12.36		
0.056	0.00	0.399	0.00	2.825	0.59	20.000	5.46	141.589	14.56		
0.063	0.00	0.448	0.00	3.170	0.74	22.440	5.85	158.866	17.78		
0.071	0.00	0.502	0.00	3.557	0.91	25.179	6.27	178.250	22.07		
0.080	0.00	0.564	0.00	3.991	1.11	28.251	6.73	200.000	27.42		
0.089	0.00	0.632	0.00	4.477	1.33	31.698	7.23	224.404	33.68		
0.100	0.00	0.710	0.00	5.024	1.57	35.566	7.75	251.785	40.58		
0.112	0.00	0.796	0.00	5.637	1.84	39.905	8.27	282.508	47.78		
0.126	0.00	0.893	0.00	6.325	2.12	44.774	8.76	316.979	54.91		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

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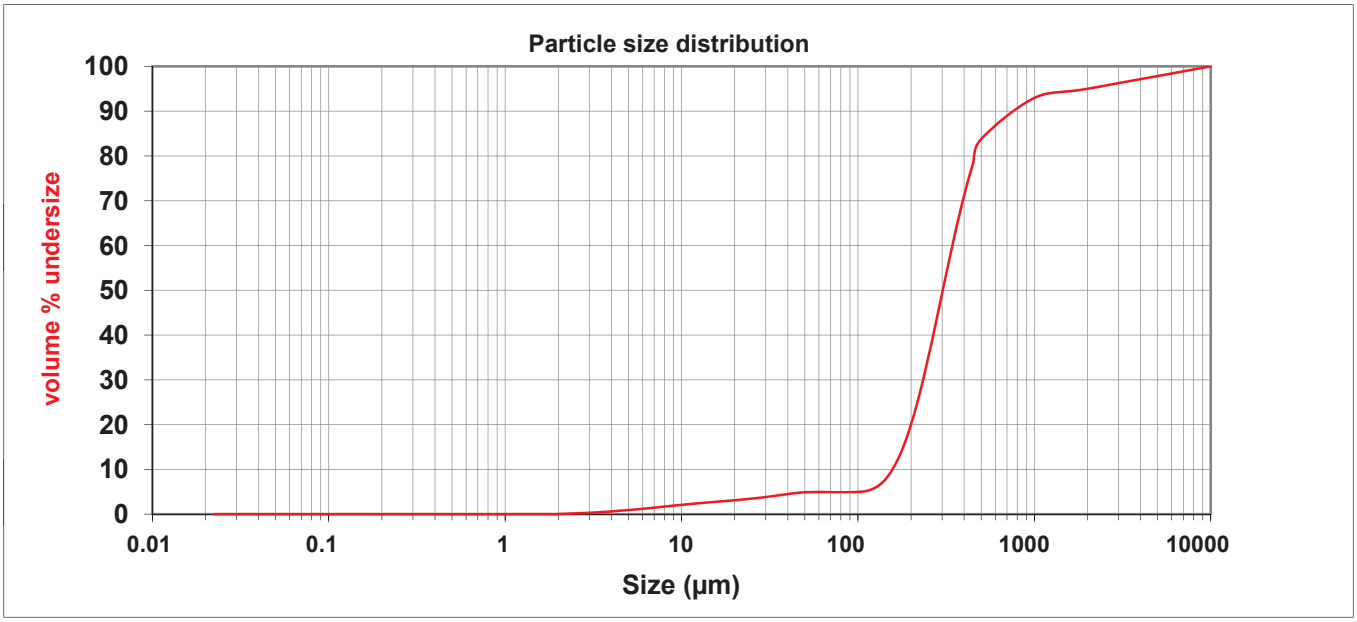
Client:	Oceanica
Sample Name :	S8 R2 Middle 01/03
Batch No :	11_124
Lab ID No :	11_124_22

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.90	**Vol. Wighted mean D[4,3]:**	548.42 µm	**d(0.1)**	160.00 µm
		Surface weighted mean D[3,2]	111.13 µm	**d(0.5)**	310.00 µm
				d(0.9)	750.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	1.47	50.238	4.88	355.66	62.78
0.022	0.00	0.159	0.00	1.125	0.00	7.962	1.67	56.368	4.93	399.05	71.04
0.025	0.00	0.178	0.00	1.262	0.00	8.934	1.88	63.246	4.93	447.74	78.12
0.028	0.00	0.200	0.00	1.416	0.00	10.024	2.08	70.963	4.93	500.00	83.79
0.032	0.00	0.224	0.00	1.589	0.00	11.247	2.27	79.621	4.93	1000.00	92.95
0.036	0.00	0.252	0.00	1.783	0.00	12.619	2.45	89.337	4.93	2000.00	94.99
0.040	0.00	0.283	0.00	2.000	0.02	14.159	2.62	100.237	4.95	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.09	15.887	2.78	112.468	5.20		
0.050	0.00	0.356	0.00	2.518	0.17	17.825	2.94	126.191	5.97		
0.056	0.00	0.399	0.00	2.825	0.26	20.000	3.10	141.589	7.57		
0.063	0.00	0.448	0.00	3.170	0.36	22.440	3.27	158.866	10.31		
0.071	0.00	0.502	0.00	3.557	0.47	25.179	3.47	178.250	14.42		
0.080	0.00	0.564	0.00	3.991	0.60	28.251	3.70	200.000	20.03		
0.089	0.00	0.632	0.00	4.477	0.75	31.698	3.95	224.404	27.09		
0.100	0.00	0.710	0.00	5.024	0.91	35.566	4.21	251.785	35.34		
0.112	0.00	0.796	0.00	5.637	1.09	39.905	4.48	282.508	44.40		
0.126	0.00	0.893	0.00	6.325	1.27	44.774	4.71	316.979	53.73		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

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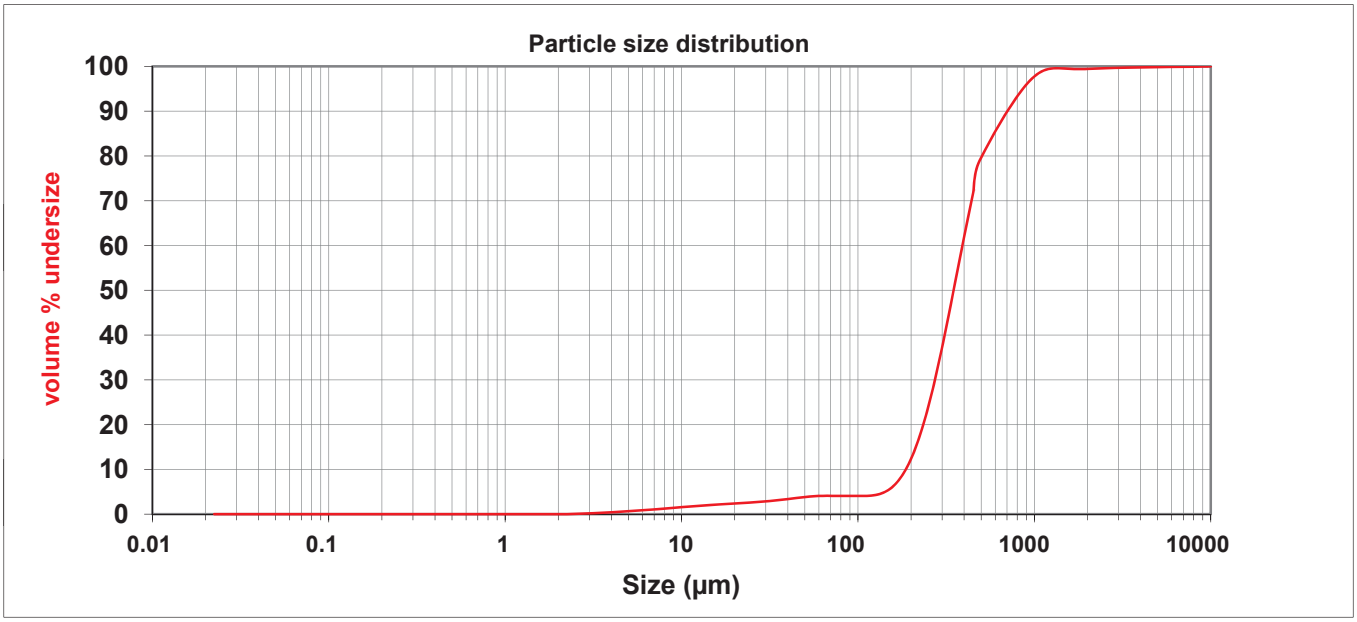
Client:	Oceanica
Sample Name :	S8 R2 Bottom 01/03
Batch No :	11_124
Lab ID No :	11_124_23

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.49	**Vol. Wighted mean D[4,3]:**	419.32 µm	**d(0.1)**	190.00 µm
		Surface weighted mean D[3,2]	139.78 µm	**d(0.5)**	350.00 µm
				d(0.9)	710.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	1.07	50.238	3.81	355.66	51.78
0.022	0.00	0.159	0.00	1.125	0.00	7.962	1.23	56.368	4.00	399.05	61.79
0.025	0.00	0.178	0.00	1.262	0.00	8.934	1.39	63.246	4.09	447.74	71.27
0.028	0.00	0.200	0.00	1.416	0.00	10.024	1.56	70.963	4.09	500.00	79.70
0.032	0.00	0.224	0.00	1.589	0.00	11.247	1.72	79.621	4.09	1000.00	97.77
0.036	0.00	0.252	0.00	1.783	0.00	12.619	1.87	89.337	4.09	2000.00	99.44
0.040	0.00	0.283	0.00	2.000	0.00	14.159	2.01	100.237	4.09	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.01	15.887	2.14	112.468	4.09		
0.050	0.00	0.356	0.00	2.518	0.07	17.825	2.26	126.191	4.29		
0.056	0.00	0.399	0.00	2.825	0.14	20.000	2.38	141.589	4.92		
0.063	0.00	0.448	0.00	3.170	0.23	22.440	2.49	158.866	6.28		
0.071	0.00	0.502	0.00	3.557	0.31	25.179	2.62	178.250	8.65		
0.080	0.00	0.564	0.00	3.991	0.41	28.251	2.77	200.000	12.35		
0.089	0.00	0.632	0.00	4.477	0.52	31.698	2.94	224.404	17.55		
0.100	0.00	0.710	0.00	5.024	0.65	35.566	3.14	251.785	24.31		
0.112	0.00	0.796	0.00	5.637	0.78	39.905	3.36	282.508	32.51		
0.126	0.00	0.893	0.00	6.325	0.92	44.774	3.60	316.979	41.82		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

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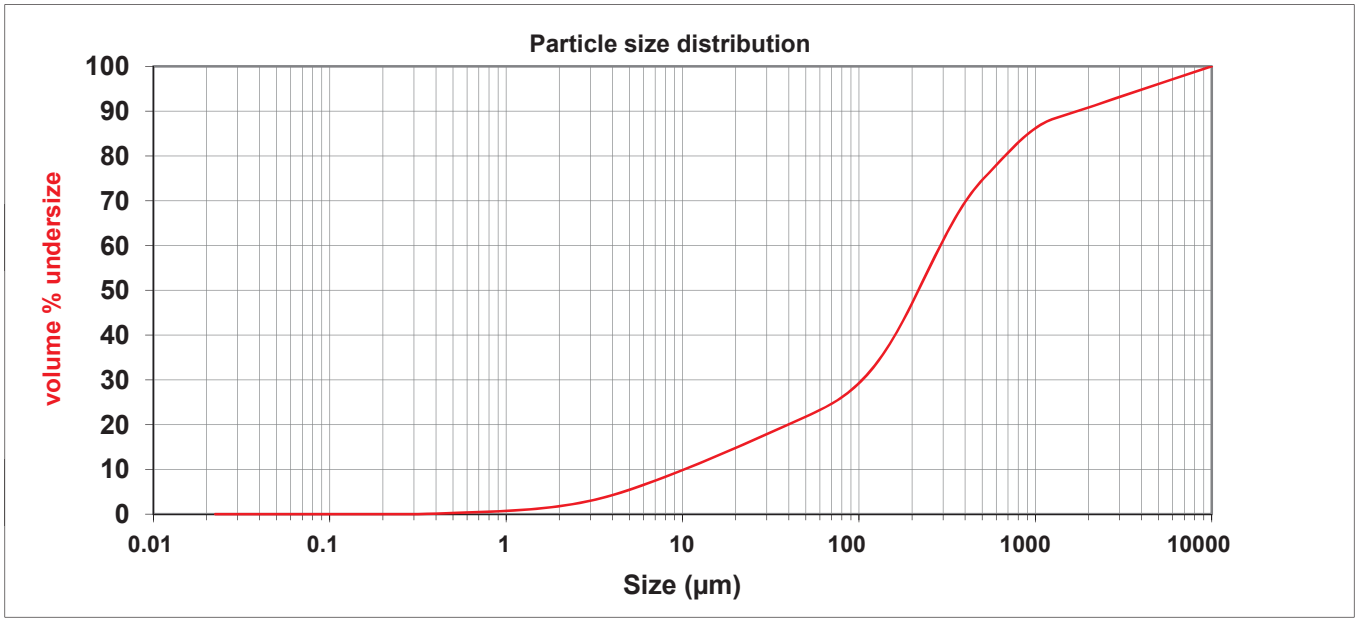
Client:	Oceanica
Sample Name :	S11 Top 01/03
Batch No :	11_124
Lab ID No :	11_124_30

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	7.68	**Vol. Wighted mean D[4,3]:**	680.34 µm	**d(0.1)**	10.00 µm
		Surface weighted mean D[3,2]	21.39 µm	**d(0.5)**	220.00 µm
				d(0.9)	1700.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.74	7.096	7.56	50.238	21.81	355.66	66.50
0.022	0.00	0.159	0.00	1.125	0.85	7.962	8.31	56.368	22.73	399.05	69.67
0.025	0.00	0.178	0.00	1.262	0.98	8.934	9.07	63.246	23.72	447.74	72.39
0.028	0.00	0.200	0.00	1.416	1.13	10.024	9.86	70.963	24.82	500.00	74.62
0.032	0.00	0.224	0.00	1.589	1.30	11.247	10.65	79.621	26.07	1000.00	86.20
0.036	0.00	0.252	0.00	1.783	1.51	12.619	11.46	89.337	27.53	2000.00	90.80
0.040	0.00	0.283	0.00	2.000	1.76	14.159	12.28	100.237	29.26	10000.00	100.00
0.045	0.00	0.317	0.01	2.244	2.05	15.887	13.10	112.468	31.32		
0.050	0.00	0.356	0.06	2.518	2.39	17.825	13.94	126.191	33.75		
0.056	0.00	0.399	0.11	2.825	2.77	20.000	14.79	141.589	36.56		
0.063	0.00	0.448	0.17	3.170	3.21	22.440	15.65	158.866	39.76		
0.071	0.00	0.502	0.24	3.557	3.70	25.179	16.52	178.250	43.29		
0.080	0.00	0.564	0.31	3.991	4.24	28.251	17.39	200.000	47.09		
0.089	0.00	0.632	0.38	4.477	4.83	31.698	18.27	224.404	51.07		
0.100	0.00	0.710	0.46	5.024	5.46	35.566	19.15	251.785	55.12		
0.112	0.00	0.796	0.55	5.637	6.13	39.905	20.03	282.508	59.12		
0.126	0.00	0.893	0.64	6.325	6.83	44.774	20.91	316.979	62.95		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

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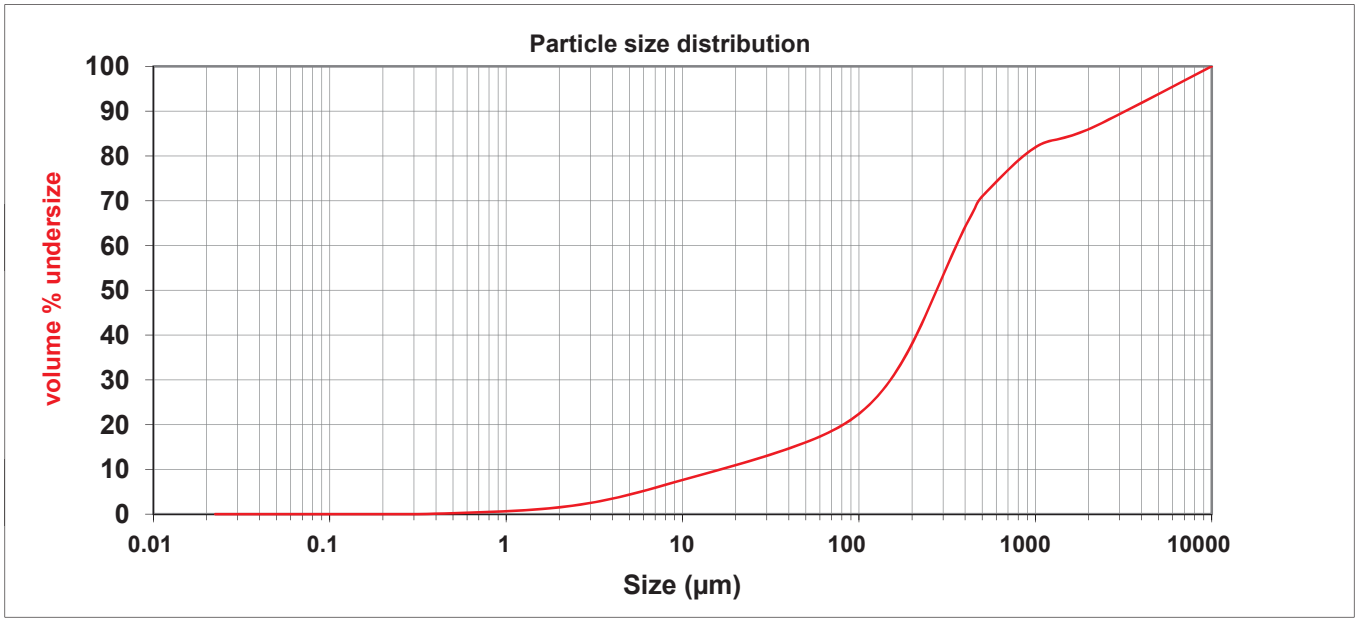
Victoria Park

Client:	Oceanica
Sample Name :	S11 Middle 01/03
Batch No :	11_124
Lab ID No :	11_124_31

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	11.73	**Vol. Wighted mean D[4,3]:**	899.67 µm	**d(0.1)**	15.00 µm
		Surface weighted mean D[3,2]	26.22 µm	**d(0.5)**	280.00 µm
				d(0.9)	3300.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.65	7.096	5.95	50.238	16.06	355.66	59.90
0.022	0.00	0.159	0.00	1.125	0.75	7.962	6.50	56.368	16.86	399.05	64.06
0.025	0.00	0.178	0.00	1.262	0.86	8.934	7.05	63.246	17.73	447.74	67.79
0.028	0.00	0.200	0.00	1.416	0.99	10.024	7.61	70.963	18.69	500.00	70.97
0.032	0.00	0.224	0.00	1.589	1.14	11.247	8.17	79.621	19.77	1000.00	81.95
0.036	0.00	0.252	0.00	1.783	1.31	12.619	8.73	89.337	21.00	2000.00	85.94
0.040	0.00	0.283	0.00	2.000	1.51	14.159	9.29	100.237	22.44	10000.00	100.00
0.045	0.00	0.317	0.01	2.244	1.75	15.887	9.85	112.468	24.13		
0.050	0.00	0.356	0.05	2.518	2.02	17.825	10.41	126.191	26.13		
0.056	0.00	0.399	0.10	2.825	2.32	20.000	10.97	141.589	28.50		
0.063	0.00	0.448	0.15	3.170	2.67	22.440	11.54	158.866	31.27		
0.071	0.00	0.502	0.21	3.557	3.05	25.179	12.12	178.250	34.46		
0.080	0.00	0.564	0.27	3.991	3.46	28.251	12.71	200.000	38.09		
0.089	0.00	0.632	0.34	4.477	3.91	31.698	13.32	224.404	42.09		
0.100	0.00	0.710	0.41	5.024	4.39	35.566	13.95	251.785	46.40		
0.112	0.00	0.796	0.49	5.637	4.89	39.905	14.62	282.508	50.91		
0.126	0.00	0.893	0.57	6.325	5.41	44.774	15.32	316.979	55.46		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
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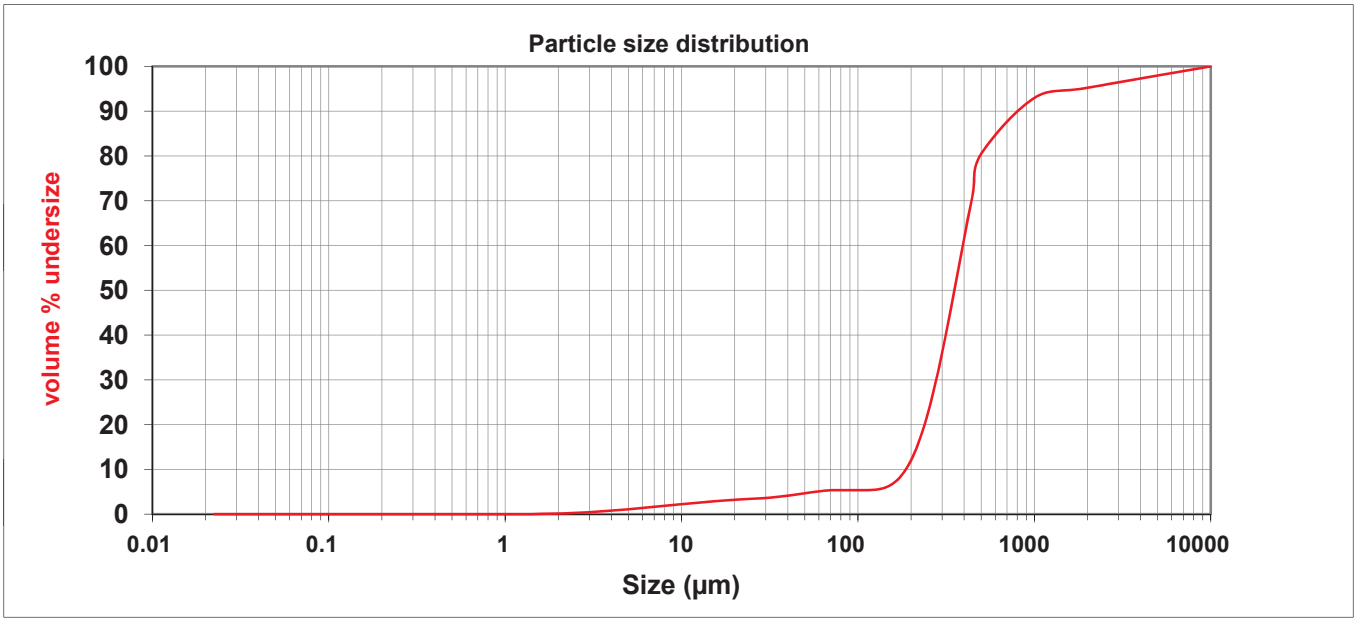
Victoria Park

Client:	Oceanica
Sample Name :	S11 Bottom 01/03
Batch No :	11_124
Lab ID No :	11_124_32

Analysis :	Size distribution by laser diffraction following ISO13320-1:1999 and wet sieving	**Result units:**	Volume
Dispersant:	Water	**Analysis model:**	General purpose
Additives:	10 millilitres Sodium hexametaphosphate	**Total sample wt (g):**	160.26
Sonication:	0 minutes sonication		

Span:	1.77	**Vol. Wighted mean D[4,3]:**	581.07 µm	**d(0.1)**	180.00 µm
		Surface weighted mean D[3,2]	106.85 µm	**d(0.5)**	350.00 µm
				d(0.9)	800.00 µm



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.00	7.096	1.62	50.238	4.67	355.66	50.89
0.022	0.00	0.159	0.00	1.125	0.00	7.962	1.82	56.368	4.95	399.05	61.40
0.025	0.00	0.178	0.00	1.262	0.00	8.934	2.03	63.246	5.19	447.74	71.47
0.028	0.00	0.200	0.00	1.416	0.00	10.024	2.23	70.963	5.35	500.00	80.49
0.032	0.00	0.224	0.00	1.589	0.05	11.247	2.43	79.621	5.36	1000.00	92.96
0.036	0.00	0.252	0.00	1.783	0.10	12.619	2.62	89.337	5.36	2000.00	95.21
0.040	0.00	0.283	0.00	2.000	0.16	14.159	2.79	100.237	5.36	10000.00	100.00
0.045	0.00	0.317	0.00	2.244	0.23	15.887	2.95	112.468	5.36		
0.050	0.00	0.356	0.00	2.518	0.31	17.825	3.08	126.191	5.46		
0.056	0.00	0.399	0.00	2.825	0.40	20.000	3.20	141.589	5.88		
0.063	0.00	0.448	0.00	3.170	0.51	22.440	3.31	158.866	6.89		
0.071	0.00	0.502	0.00	3.557	0.63	25.179	3.41	178.250	8.83		
0.080	0.00	0.564	0.00	3.991	0.76	28.251	3.54	200.000	12.03		
0.089	0.00	0.632	0.00	4.477	0.91	31.698	3.69	224.404	16.77		
0.100	0.00	0.710	0.00	5.024	1.07	35.566	3.88	251.785	23.18		
0.112	0.00	0.796	0.00	5.637	1.24	39.905	4.11	282.508	31.23		
0.126	0.00	0.893	0.00	6.325	1.43	44.774	4.38	316.979	40.62		

Note: Data from 500µm to 10000µm by wet screening, from 0.02µm to 500µm by laser diffraction.

Suite 6
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Victoria Park
WA 6100

Client: Oceanica Consulting Pty Ltd
Job number: 11_124
Sample: 11_124_01 through to 11_124_39
Client ID: **452_005**
Date: 16th March 2011
Analysis: Sieving at client specified sizes

Sample preparation
The samples were supplied to Microanalysis Australia as chilled sediment in ~500mL capacity zip-lock plastic bags. All samples were kept refrigerated until analysed.

The samples were allowed to warm to room temperature over night before being sieved at the client specified sizes.

Analysis
A representative sub-sample (typically ~200mL) was taken from each sample and dispersed in approximately 1L of water. The resultant suspension was then washed through the sieve stack using a low pressure water spray.

Summary
The results are presented in the following table as percent retained in the size interval.

		Percent retained at size (%)						
LAB ID	Client ID	2000 µm	1000 µm	500 µm	250 µm	125 µm	63 µm	< 63 µm
11_124_01	S1 top	5.8	1.9	12.7	48.0	26.8	3.7	1.0
11_124_02	S1 middle	4.9	3.4	10.8	33.1	37.2	6.6	3.9
11_124_03	S1 bottom	9.1	1.6	4.2	21.0	47.5	10.9	5.7
11_124_04	S2 top	1.7	1.7	8.8	87.7 % < 500µm - laser diffraction analysis			
11_124_05	S2 middle	0.9	1.5	5.9	91.7 % < 500µm - laser diffraction analysis			
11_124_06	S3 top	3.6	1.9	5.6	32.2	52.5	3.7	0.5
11_124_07	S3 middle	0.8	0.8	4.6	30.6	57.9	4.7	0.5
11_124_08	S3 bottom	0.2	0.5	2.9	26.0	66.2	3.8	0.3
11_124_09	S4 top	6.4	1.7	6.3	32.6	46.1	4.1	2.7
11_124_10	S4 middle	1.1	0.8	5.0	31.6	57.4	3.6	0.5
11_124_11	S4 bottom	0.7	0.6	4.2	34.9	56.8	2.6	0.3
11_124_12	S5 top	4.1	1.9	6.8	87.2 % < 500µm - Laser diffraction analysis			
11_124_13	S5 middle	3.9	2.2	9.8	84.0 % < 500µm - Laser diffraction analysis			
11_124_14	S5 bottom	0.9	1.1	6.2	91.9 % < 500µm - Laser diffraction analysis			
11_124_15	S6 top	2.9	2.0	5.6	31.2	52.8	4.6	0.9
11_124_16	S6 middle	1.3	1.8	7.4	39.6	46.6	2.9	0.5
11_124_17	S6 bottom	0.6	1.0	5.5	49.2	42.3	1.3	0.2
11_124_18	S7 top	2.2	2.0	7.8	47.3	38.0	1.7	0.9
11_124_19	S7 middle	2.7	2.5	11.7	48.4	32.5	1.8	0.4

11_124_20	S7 bottom	0.5	3.8	9.0	61.7	24.4	0.4	0.1
11_124_21	S8 top	4.2	1.9	5.3	88.6 % < 500µm - Laser diffraction analysis			
11_124_22	S8 middle	5.0	2.0	9.2	83.8 % < 500µm - Laser diffraction analysis			
11_124_23	S8 bottom	0.6	1.7	18.1	79.7 % < 500µm - Laser diffraction analysis			
11_124_24	S9 top	3.3	2.7	10.3	45.1	30.0	3.9	4.7
11_124_25	S9 middle	5.3	2.2	18.0	52.2	20.3	1.6	0.5
11_124_26	S9 bottom	1.1	3.5	21.6	50.4	21.9	1.1	0.4
11_124_27	S10 top	14.0	5.5	14.0	41.5	16.6	4.1	4.3
11_124_28	S10 middle	10.6	2.4	11.1	49.1	23.1	3.0	0.8
11_124_29	S10 bottom	2.8	1.7	12.5	66.9	14.3	1.6	0.3
11_124_30	S11 top	9.2	4.6	11.6	74.6 % < 500µm - Laser diffraction analysis			
11_124_31	S11 middle	14.1	4.0	11.0	71.0 % < 500µm - Laser diffraction analysis			
11_124_32	S11 bottom	4.8	2.2	12.5	80.5 % < 500µm - Laser diffraction analysis			
11_124_33	S12 top	9.6	5.7	11.4	41.0	19.2	9.3	3.8
11_124_34	S12 middle	6.9	4.3	13.5	44.8	22.1	5.7	2.7
11_124_35	S12 bottom	2.2	2.0	15.4	57.7	18.7	2.8	1.2
11_124_36	S13 top	8.4	3.4	9.9	45.5	29.0	2.5	1.5
11_124_37	S14 top	6.2	3.9	8.7	49.4	26.1	3.7	2.0
11_124_38	S15 top	2.2	1.9	8.5	59.5	25.6	1.8	0.5
11_124_39	S16 top	1.0	3.6	8.2	58.9	26.1	1.7	0.4

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