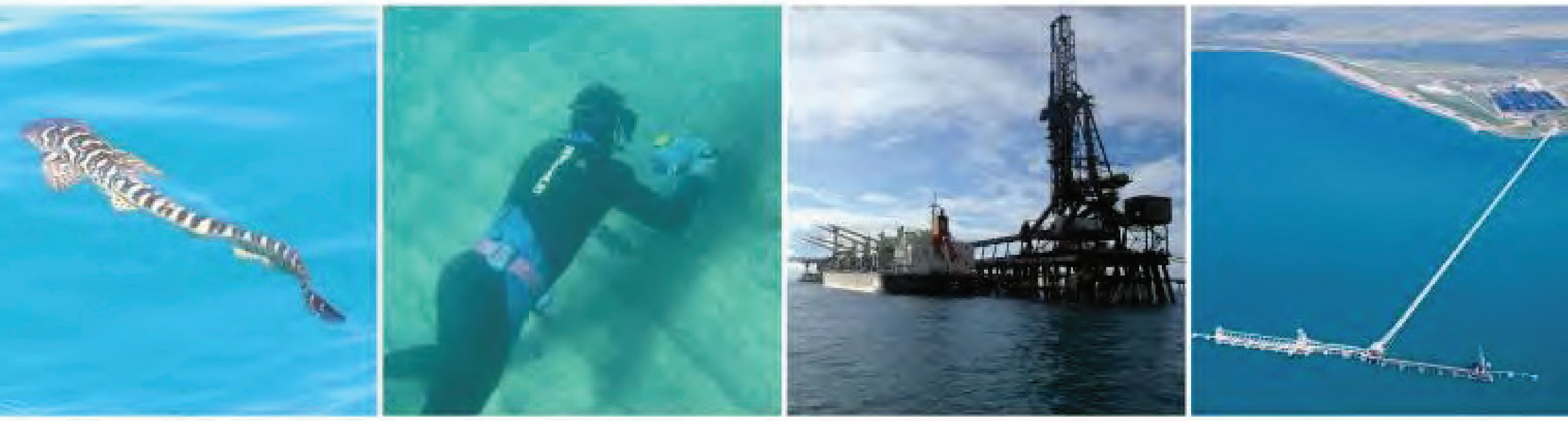
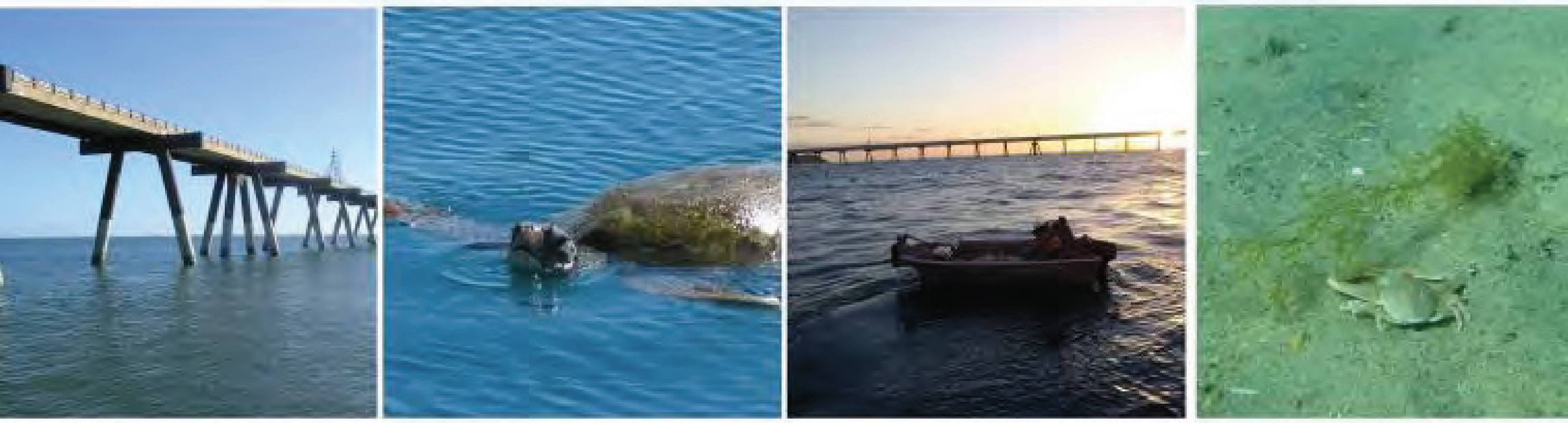
North Queensland Bulk Ports Corporation



Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report



July 2012

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List of Abbreviations

Abbreviation	Description
AAA	Advanced Analytical Australia
Adani	Adani Abbot Point Terminal Pty Ltd
Ag	Silver
AHD	Australian Height Datum
Al	Aluminium
ALS	Australian Laboratory Services
ANCBT	Acid Neutralising Capacity by Back-Titration
ANZECC	Australian and New Zealand Environment Conservation Council
APCT	Abbot Point Coal Terminal
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standards
As	Arsenic
ASS	Acid Sulfate Soils
AVS	Acid Volatile Sulfide
BHPB	BHP Billiton
BP	Before Present
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
Cd	Cadmium
Co	Cobalt
CoC	Chain of Custody
COPC	Contaminants of Potential Concern
Cr	Chromium
Cu	Copper
DAE	Dilute Acid Extraction
DBT	Dibutyltin
DBYD	Dial Before You Dig
DEHP	Department of Environment and Heritage Protection
DoE	(Queensland) Department of Environment
DRMA	Dredged Material Relocation Area

Abbreviation	Description
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIL	Environmental Investigation Limits
EMP	Environmental Management Plan
Fe	Iron
GBRMPA	Great Barrier Reef Marine Park Authority
GPS	Global Positioning System
GSQ	Geological Survey of Queensland
HCIPL	Hancock Coal Infrastructure Pty Ltd (a wholly owned subsidiary of GVK Hancock)
Hg	Mercury
HIL	Health-based Investigation Level
HSEP	Health, Safety and Environment Plan
ID	Identification
kg	Kilogram
L	Litre
LAT	Lowest Astronomical Tide
LOR	Limit of Reporting
m	Metre
mbss	Meters Below Seabed Surface
MBT	Monobutyltin
MCA	Multi Criteria Analysis
MCF	Multi Cargo Facility
mg	Milligram
Mm	Millimetre
Mn	Manganese
m/s	Metres per second
mtpa	Million tonnes per annum
NA	Not Applicable
NAGD	National Assessment Guidelines for Dredging
NATA	National Association of Testing Authorities
ND	Not Detected
NEPM	National Environment Protection (Assessment of Site Contamination) Measure

Abbreviation	Description
NEPC	National Environment Protection Council
Ni	Nickel
NODGDM	National Ocean Disposal Guidelines for Dredged Material
NQBP	North Queensland Bulk Ports Corporation
NRME	Department of Natural Resources, Mines and Energy
OCPs	Organochlorine Pesticides
OPPs	Organophosphorous Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulfate Soils
Pb	Lead
PER	Public Environment Report
PCBs	Polychlorinated Biphenyls
PQLs	Practical Quantitation Limits
PSD	Particle Size Distribution
QASSIT	Queensland Acid Sulfate Soils Investigation Team
QA/QC	Quality Assurance/Quality Control
QLD	Queensland
Qr	Quaternary-aged colluvial/residual deposits
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SAP	Sampling and Analysis Plan
Sb	Antimony
SD	Standard Deviations
Se	Selenium
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfur
T0	Terminal 0
T2	Terminal 2
T3	Terminal 3
TAA	Titratable Actual Acidity
TBT	Tributyltin
TOC	Total Organic Carbon

Abbreviation	Description
TPA	Titratable Peroxide Acidity
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
µg	Microgram
USEPA	United States Environmental Protection Agency
V	Vanadium
Zn	Zinc

This Sediment Sampling and Analysis Plan Implementation Report:

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- *The Qualifications detailed in Section 9*

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Executive Summary

Introduction

North Queensland Bulk Ports Corporation Ltd (NQBP) is responsible for the management and development of various trading ports throughout Queensland (QLD). BHP Billiton (BHPB) and Hancock Coal Infrastructure Pty Ltd (HCIPL), a wholly owned subsidiary of GVK Group, were awarded 'preferred developer status' by NQBP for the development of Terminal 2 (T2) and Terminal 3 (T3), respectively, at the Port of Abbot Point. Adani Abbot Point Terminal Pty Ltd (Adani), the current operator of the existing Terminal 1 (T1), is proposing to expand this terminal with the addition of Terminal 0 (T0). These projects include the development of the offshore infrastructure including jetty structures and wharfs and onshore infrastructure including coal stockpiles and associated works. Berth and apron capital dredging is required to support the efficient operation of these terminals. The Port Authority, NQBP, is the proponent for the proposed dredging works on behalf of the terminal deverlopers. Proposed dredge depths range from -20 and -21 metres (m) Lowest Astronomical Tide (LAT) for berth areas, and between -18 and -18.5 m LAT for apron areas (not inclusive of a 0.5 m over dredging allowance).

A Sediment Sampling and Analysis Plan (SAP) was prepared for the Abbot Point, T0, T2 and T2 Capital Dredging Project (EPBC 2011/6213 / GBRMPA G34987.1.) (herein referred to as the Project), in accordance with the National Assessment Guidelines for Dredging (NAGD; Commonwealth of Australia, 2009) by GHD on behalf of NQBP and submitted to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the Great Barrier Reef Marine Park Authority (GBRMPA) for approval. This report describes the implementation of the SAP and assesses the physical and chemical suitability of the proposed dredged material in relation to possible relocation and reuse options.

Methodology

Sampling density and sampling depths were calculated based on the requirements of the NAGD, with 69 sampling locations within the dredge area selected randomly and sampled to the required depths. Additionally, 10 sampling locations were tested in the proposed offshore dredged material relocation area as part of the 'Port of Abbot Point Offshore Dredge Material Relocation Area Site Selection Study' (BMT WBM 2012). Within the dredge area, it was considered that potentially contaminated material was limited to 1 m below the seabed surface (mbss) only. This was due to an assessment of existing information relating to geology, hydrodynamic processes and contaminant sources, and the dredging operations being capital in nature. However, particle size distribution (PSD), nutrients and heavy metals and metalloids were analysed in deeper sediments to 0.5 m below the proposed dredge depth, or until refusal of the coring equipment was encountered on consolidated sediments. Potential acid sulfate soils (PASS) were assessed to 1 m below the dredge depth unless refusal of the sediment core on consolidated sediments was encountered. At the proposed offshore dredged material relocation area, surface sediments were tested for PSD by sieve and hydrometer, heavy metals and metalloids and nutrients.

Sediment cores within the dredge area were extracted using a vibracore manoeuvred from a tripod located at the stern of a marine vessel. At each of the 69 sampling locations, at least two cores were collected to ensure the collection of sufficient sample. Environmental field information was recorded and primary cores from each location were logged as per the Australian Standards (AS) for Geotechnical Site Investigations (AS 1726-1993). Following core logging, the cores were mixed to ensure samples were homogenised, with the exception of samples collected for volatile analysis. Sediment samples were collected in 0.5 m intervals (i.e. 0 to 0.5 m, 0.5 to 1.0 m etc.) to the required depth.

Sediment samples were collected from the proposed offshore dredged material relocation area (DMRA) using a stainless steel 0.028 m^2 Van Veen Grab.

All collected sediment samples were stored as per the requirements of the NAGD and the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (National Environment Protection Council (NEPC), 1999). All collected samples were transported from Abbot Point to the primary laboratory [Australian Laboratory Services (ALS)] and secondary laboratory [Advanced Analytical Australia (AAA)] for analysis of the required physical and chemical properties.

Physical Properties Results

Sediment cores collected within the dredge area generally consisted of a mixture of terrigineous sandy clay, clayey sand or silty clay. Some straight clays, sands and gravely sands were also noted. Fine to medium sand, however, was the predominant sediment type. Surface sediment, within the first 1 m, tended to be dark grey to grey-brown in colour, grading typically to an orange-brown mottled pale grey, dark brown or green-grey sandy clay or sandy silty clay. Clay content typically increased with depth, largely typifying lithology beyond 1.5 mbss. Sediments were typically wet and loose near the surface of the seabed, grading to moist with depth. Consistency of clays varied from very soft to very stiff, with increasing stiffness with depth, which likely caused the coring refusals. Shell grit was encountered throughout the majority of the sediment cores, particularly near the surface, with occasional lenses of whole and broken shells, coral pieces and terrestrial gravels. Overall, these visual observations indicate that natural residual geologic materials (as opposed to recently transported geologic materials) are present below 0.5 to 1 m. Additionally, cores showed low variability among sampling locations and the increase of clays from the underlying geology of sediment below 1 m was relatively homogenous throughout the dredge area.

PSD analysis demonstrated that sediments were relatively homogenous within the 0 to 0.5 m depth interval across the dredge area, with the exception of a decreased sand content recorded in surface sediments from the eastern part of the dredge area. As with the variations in particle size from eastern surface sediments, particle size showed higher variation with increasing depth. Sand content generally decreased with depth, whilst clay and silt content increased. From the deepest sampling intervals (e.g. 3 to 3.5 and 4 to 4.5 m), silt and sand content was similar. Unlike surface sediments, there was no obvious trend in particle size distribution along the western-eastern gradient. Overall, results demonstrated that the sediments within the dredge area contained an average of 8 % gravel (>2 mm), 54 % sand (0.06-2 mm), 19 % silt (2-60 µm) and 20 % clay (<2 µm).

Sediments within the proposed offshore dredged material relocation area were dark brown clay-silts, having medium plasticity and a 5 mm layer of light brown silt at the sediment/water interface. Surface sediments at the proposed offshore dredged material relocation area consisted primarily of silts (average 50.5 %), followed by clays (36.5 %) and sands (12.6 %) This differed to the particle size of the surface sediments within the dredge area, which had a greater percentage of sands. A relatively small proportion of the sediments within the proposed offshore dredged material relocation area were gravels, and no cobbles were found. The difference in PSD results suggest that the proposed offshore dredged material relocation area is a lower energy environment than the dredge area, which would be typical of an area with a significantly greater depth (-39 to -44 m LAT compared to dredge area depths of -16 m to -18.5 m LAT). Additionally, as benthic mapping demonstrated the proposed offshore dredged material relocation area was within a large ‘mud’ area offshore from Abbot Point, it was likely that this area would record finer grained particles (BMT WBM 2012). Composition of surface sediments was relatively similar across the proposed offshore dredged material relocation area.

Chemical Properties Results

At the dredge area, benzene, toluene, ethyl benzene and xylenes (BTEX), organochlorine pesticides (OCP), organophosphorous pesticides (OPP), polychlorinated biphenyls (PCB) and total cyanide all had concentrations less than the NAGD screening levels and the practical quantitation limit (PQL). These results suggest that there are no anthropogenic sources of these contaminants at the dredge area. Total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH) had concentrations less than the NAGD screening levels, though low concentrations were detected in some surface samples. Further laboratory analysis suggested that the TPH concentrations were due to natural vegetable oils present in surface sediments. Although anthropogenic sources of PAH exist at the terminal and these analytes were detected in sediments, the total concentration was negligible, being less than 1 % of the NAGD screening level.

With the exception of manganese and arsenic concentrations in a low number of samples, all individual samples analysed in the dredge area for heavy metals and metalloids had concentrations less than NAGD screening levels and where applicable, the NEPM (1999) environmental investigation levels (EIL). For manganese, all four exceeded samples had concentrations less than natural background level reported in NEPM (1999) and the overall 95 % upper confidence limit (UCL) was less than the NAGD screening level. As such, it is assumed that the overall concentrations in tested sediments were within naturally occurring background levels and were not due to contamination from anthropogenic sources.

For arsenic, a single location at 0.5 to 1.0 mbss reported a concentration of 29.6 mg/kg, which exceeds the NAGD screening level (20 mg/kg) and NEPM (1999) EIL (20 mg/kg), but not the NAGD sediment quality high value (70 mg/kg) or the NEPM (1999) health-based investigation level A for standard residential use (HIL A) (100 mg/kg). Due to this exceedance, the sample was retested in triplicate by the laboratory to determine the validity of the result. Upon being retested, the sample returned a similar concentration to the original value and the original result was therefore considered valid. The reasons for this elevated arsenic concentration are unknown, however, it could be related to a localised difference in geology at that location, since As concentrations are noted in the NAGD as being common within Australian sediments.

Heavy metal and metalloid concentrations from sampling depths greater than 1.0 mbss demonstrated no discernible trend in concentrations, indicating homogeneity throughout the sediment profile for these analytes. This result indicates that there is negligible variability in heavy metal and metalloid concentrations within the dredge area, as surface sediments and sediments at depth contained similar concentrations.

Tributyltin (TBT) concentrations in two samples [normalised to 1% total organic carbon (TOC)] from the dredge area were greater than the NAGD screening level, however the 95% UCL was less than the NAGD screening level.

For sediments at the proposed offshore dredged material relocation area, all samples analysed for heavy metals and metalloids reported concentrations less than the NAGD screening levels, and, where applicable, the NEPM (1999) EIL’s and NEPM (1999) HIL A’s. With the exception of As, all heavy metal and metalloid concentrations within the proposed offshore dredged material relocation area were greater than those from the dredge area. These results are likely due to the smaller sediment size at the proposed offshore dredged material relocation area (e.g. silt and clay) increasing the ability for these analytes to bind to sediments (Sudhanandh *et al.* 2011, ANZECC/ARMCANZ 2000). Arsenic was the only metal or metalloid that recorded a greater mean concentration from the dredge area in comparison to the 80th percentile within the proposed offshore dredged material relocation area (NAGD 2009). However, when normalised to iron or aluminium, all heavy metal concentrations become more comparable between the two areas. Within the dredge area and proposed offshore dredged material relocation area, the 95 % UCL for all heavy metals and metalloids were less than the NAGD screening levels, and, where applicable, the NEPM (1999) EIL's and NEPM (1999) HIL A's.

Nutrient concentrations at the proposed offshore dredged material relocation area were generally greater at the dredge area. Ammonia and nitrite results were comparable, with very low levels at both sites and total nitrogen and total phosphorus recorded greater average concentrations at the proposed offshore dredged material relocation area. This increase in concentration was likely due to differences in sediment characteristics. Finer sediments, such as those found at the dredged material relocation area tend to have higher concentrations of nutrients due to increased total organic carbon content. In addition, nutrient concentrations were only recorded in surface sediments from the proposed offshore dredged material relocation area and it is likely that these concentrations would reduce with depth, as generally occurred at the dredge area.

Acid Sulfate Soils Results

Acid sulfate soils (ASS) analysis on sediments within the dredge area showed that the potential acidity (SCr) exceeded the QASSIT (1998) action criterion in 92 % of samples. However, total actual acidity (TAA) results were less than the PQL for all samples, and the acid neutralizing capacity (by back titration) ranged between 0.3 % S and 18.5 %S. Therefore, although results were greater than the QASSIT (1998) action criteria (demonstrating that sulfur is present in the soil), the potential acid neutralising capacity of the soil exceeds the acid generating potential. Due to the excess neutralising capacity in all samples, there is no requirement for liming of the dredged material if it undergoes oxidisation. Oxidisation may occur if the dredged material is relocated onshore, used within reclamation activities, or washed onshore following offshore relocation. If the dredged material was to be oxidised, the monitoring of ASS would be required and potentially the implementation of management measures would be required to minimise risks to the environment. However, as the dredging operations will relocate dredged material to an offshore relocation ground, sediments will remain saturated and unlikely to oxidise.

Data Validation

Data validation analyses showed that the quality assurance and quality control (QA/QC) procedures and results were acceptable and complied with the data quality objectives for the SAP implementation program. No analytes were detected in laboratory blanks. Laboratory control spikes were generally within the laboratory adopted criteria (75 to 125 %) for most of the compounds analysed. A number of matrix spikes, surrogate spikes and laboratory control spike recoveries recorded non-compliances due to matrix interference or recoveries outside control limits and data quality objectives. Overall, these non-compliances were low and results were within acceptable quality objectives.

All field intra laboratory 'field duplicate' and inter laboratory 'field split' duplicate results were within the relative percentage difference (RPD) data quality criterion limit of 50 %. Two replicates recorded a relative standard deviation (RSD) outside this quality criterion of 50 % for heavy metals and metalloids. For inter batch duplicates and triplicate samples, nine samples recorded RSD values outside the data quality criterion limit of 50 %. However, exceedances came from inorganics and nutrients, with these results likely due to the high natural variability of these analytes. For all RSD values greater than 50 %, analyte concentrations were less than the respective screening levels (e.g. NAGD screening levels).

QA/QC results place confidence in the quality of the data collected throughout the dredge area, as 98 % of results were within data quality control limits. The results of this program, therefore, are considered acceptable for use in the assessment of the suitability of the dredged material for unconfined relocation at sea or reuse on land.

Conclusions

The objective of the SAP was to provide an assessment on the physical and chemical suitability of the proposed dredge material in relation to relocation and reuse options in accordance with the NAGD. The Phase II sediment assessment showed that the material to be dredged passed screening level assessments according to the NAGD assessment framework. Following the framework, more detailed assessments (Phase III and Phase IV) of sediment quality were not required. Based on the results of the SAP implementation program, the following was concluded:

- The sediment composition of Abbot Point is relatively homogenous across the dredge area comprising predominantly fine sands and silts and clays.
- The material to be dredged is suitable for unconfined placement at sea in an approved offshore relocation area on the basis that the 95% UCLs of analysed contaminant substances were less than their respective NAGD screening levels.
- The material to be dredged is suitable for unrestricted use on land on the basis the contaminant substances had concentrations less than the NEPM EILs and HIL A.
- Sediments were considered to be PASS based on an assessment against the QASSIT (1998) guidelines. However, the potential acid neutralising capacity of the sediment was greater than the acid generating potential, though if fines were separated from the sediment matrix, the acid generating potential may increase. Additionally, as the dredge material relocation method is offshore, PASS in sediments will not be oxidised. As such, potential risks to the environment from ASS are considered negligible.
- The physical and chemical properties at the proposed dredged material relocation area differed slighty to the dredge area. The proposed dredged material relocation area had finer sediments, with generally greater concentrations of nutrients and heavy metals and metalloids. The presence of finer sediments is attributed to the low energy environment associated with greater depth at this location and the greater concentrations of nutrients and the heavy metals and metalloids are likely due to the presence of these finer sediments. Though sediment characteristics did differ in the proposed dredged material relocation area, this area is still considered the most suitable, due to having the least impact on the marine environment compared to alternative offshore relocation area options.

1. Introduction

1.1 Background

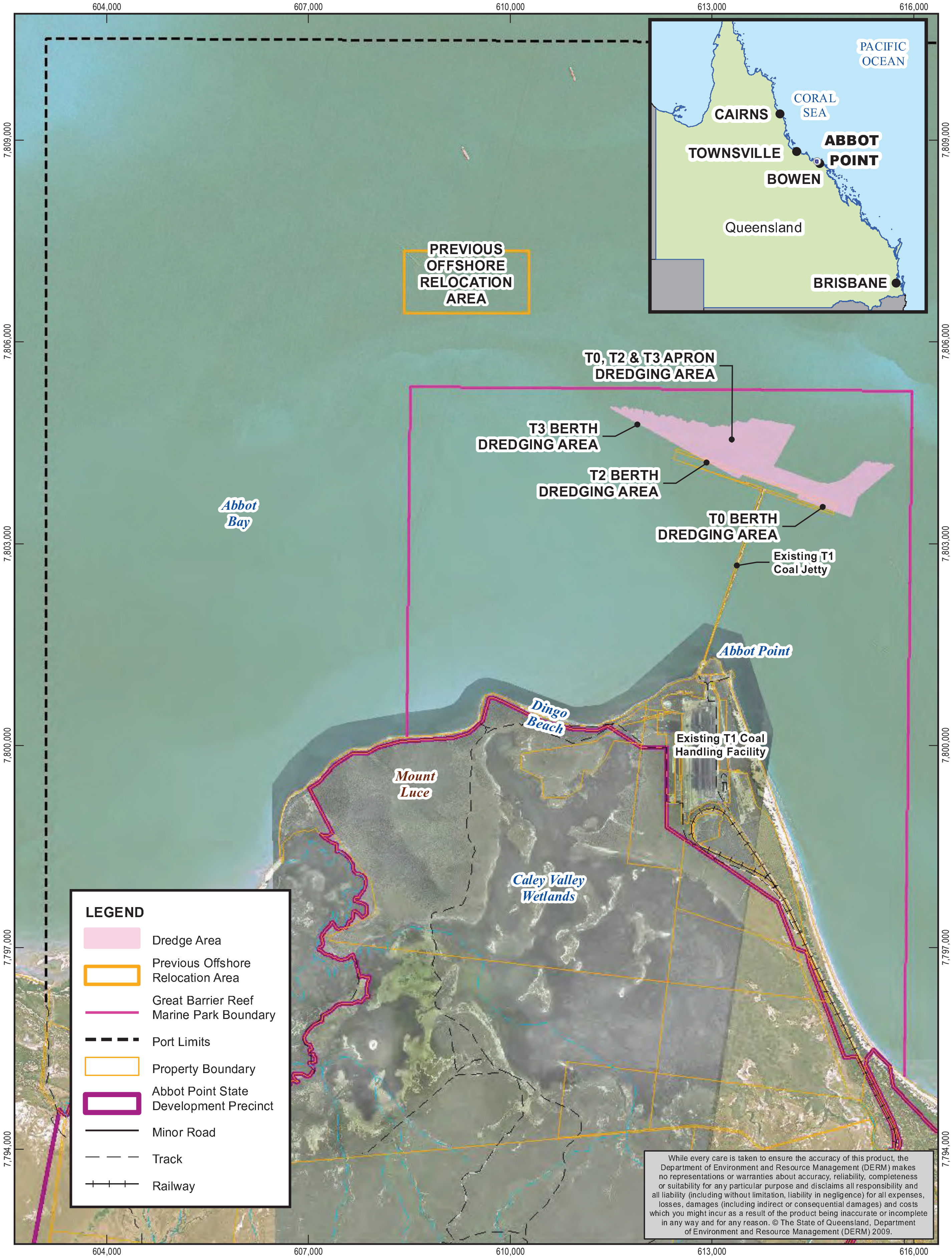
North Queensland Bulk Ports Corporation Ltd (NQBP) is responsible for the management and development of four trading ports throughout Queensland (QLD), including Weipa, Hay Point, Mackay and Abbot Point. The Port of Abbot Point has been in operation since 1984 and the current terminal (T1) has a capactiy of approximately 50 Million tonnes per annum (Mtpa).

BHP Billiton (BHPB) and Hancock Coal Infrastructure Pty Ltd (HCIPL), a wholly owned subsidiary of GVK Group were awarded ‘preferred developer status’ by NQBP for the development of Terminal 2 (T2) and Terminal 3 (T3), respectively, at the Port of Abbot Point. Adani Abbot Point Terminal Pty Ltd (Adani), the current operator of the existing Terminal 1 (T1), is proposing to develop another terminal (T0), adjacent to T1. These projects include the development of both the offshore infrastructure (e.g. jetty structures and associated berths), including berth and apron capital dredging, and onshore infrastructure including coal stockpiles and associated works. Proposed dredge depths range between -20 and -21 metres (m) Lowest Astronomical Tide (LAT) for berth areas, and between -18 and -18.5 m LAT for apron areas (not inclusive of a 0.5 m over dredging allowance).

In early 2012, the Abbot Point, T0, T2 and T3 Capital Dredging Project (herein referred to as the Project) was deemed a controlled action under the *Environment Protection, Biodiversity and Conservation* (EPBC) *Act 1999,* requiring assessment by a Public Environment Report (PER). To meet the requirements of both the PER and the acquisition of a sea dumping permit, an assessment of proposed dredged material in accordance with the National Assessment Guidelines for Dredging (NAGD; Commonwealth of Australia 2009) was required.

This report describes the implementation of the Sediment Sampling and Analysis Plan (SAP) that was prepared in accordance with the NAGD and was approved by the Great Barrier Reef Marine Park Authority (GBMRPA) and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). A copy of the SAP is provided in Appendix A.

A locality map for Abbot Point is provided in Figure 1-1.



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0 1 2 3

Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North Queensland Bulk Ports Corporation Limited
Abbot Point, QLD, T0, T2 and T3 Capital Dredging,
Sediment Sampling and Analysis Plan
Implementation Report

Job Number	41-23701/11
Revision	C
Date	16 Jul 2012

Locality Plan

Figure 1-1

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Level 6, 145 Eagle Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: Geoscience: Road, Rail - 250K; DERM: cadastre (2009) and aerial (1995); Fugro: aerial (2009); DIP: State Devel. Precinct (2010). Created by: jvc, bw.

1.2 Project Objective

The objective of the SAP implementation program was to achieve the objectives outlined in the Sediment Sampling and Analysis Plan (GHD 2012). The SAP aimed to provide an assessment on the physical and chemical suitability of the proposed dredged material for relocation or reuse.

1.3 Scope of Works

The scope of works that were undertaken during the SAP implementation program are provided in Section 5. In summary this involved:

- Collection of sediment samples from 69 sampling locations including field quality assurance and quality control samples (QA/QC)
- Recording field measurements, logging of cores and processing of samples
- Laboratory analysis of samples for physical and chemical properties

The results of the above scope of works are provided in this SAP implementation report.

Comparison is made with sediment analyses results from material collected by BMT WBM (2012) from the proposed dredge material relocation area.

2. Description of Proposed Dredging

2.1 Dredging Description

Capital dredging will be required for the proposed berths and apron areas of T0, T2 and T3.

2.2 Approximate Dredging Specification

The approximate dredging specifications for the berth and apron areas for T0, T2 and T3 are provided in Table 2-1

Figure 2-1 provides details on the bathymetric contours for Abbot Point and in particular the dredge area footprint.

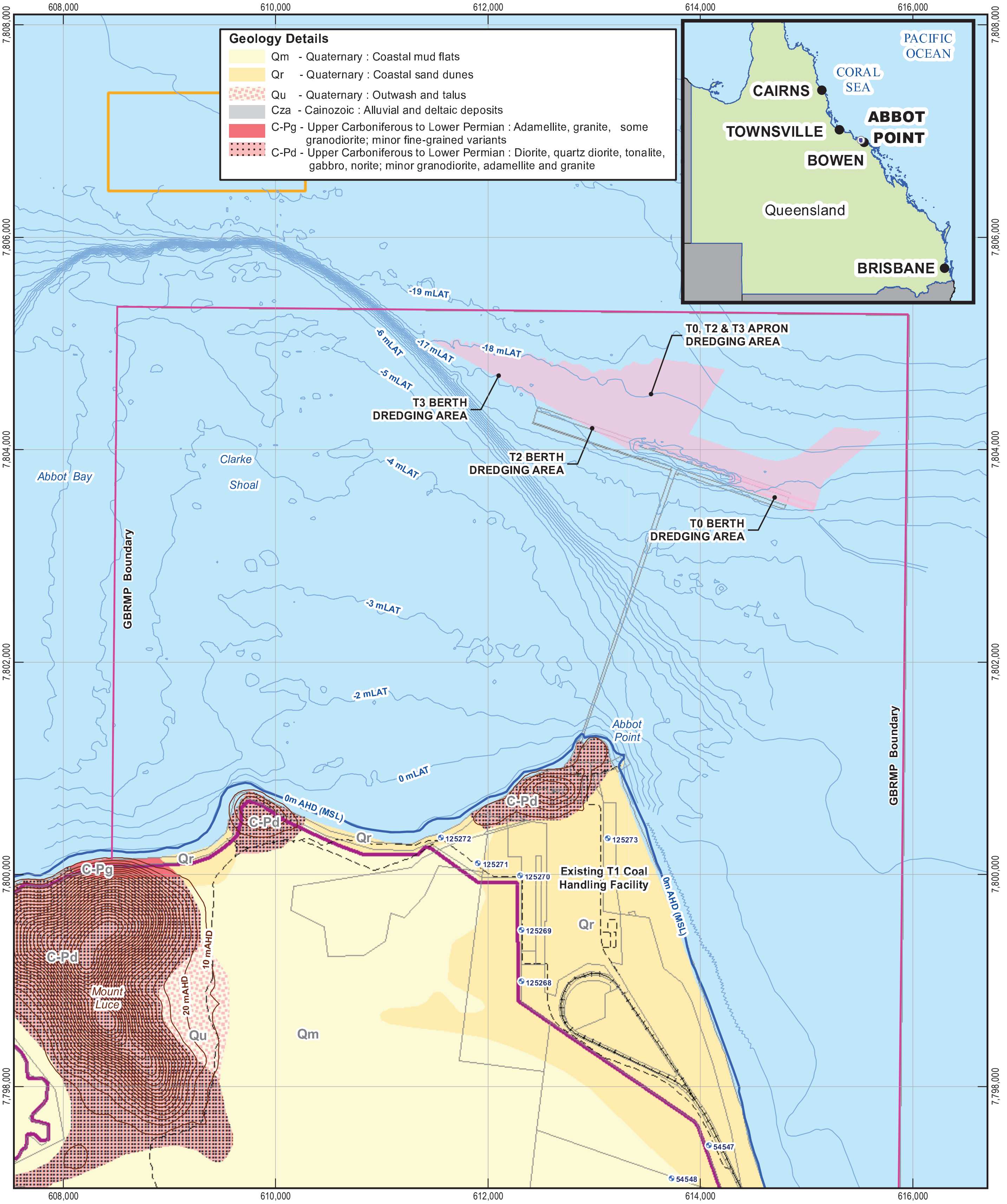
Table 2-1 Approximate Dredge Specifications for T0, T2 and T3

Specifications	T0 (Adani)	T2 (BHPB)	T3 (HCIPL)	Total
Approximate depth of water (LAT)	-17.0 to -18.5 m	-17.0 to -18.5 m	-17 to -18.0 m	NA
Depth of dredging within berths[1] (LAT)[1]	-21.0 m	-20.0 m	-20.0 m	NA
Depth of dredging within apron[1] (LAT)[1]	-18.5 m	-18.5 m	-18.0 m	NA
Area of dredging[2]	621,000 m^2	986,400 m^2	228,700 m^2	1,836,100 m^2
Volume of proposed dredged material (approximate)	860,510 m^3	1,384,880 m^3	410,545 m^3	2,655,935 m^3 (with an allowance of up to 3,000,000 m^3 for anticipated contingency allowance)

Notes:

1: Dredging depth does not include 0.5 m over dredging depth

2: Areas presented in the table are the actual dredge footprint. The areas assessed in the SAP (see Section 5.6) are greater than these values due to the conservative approach to sampling which allows for some engineering design changes



LEGEND

- ┼┼ Railway
- – – Track
- Great Barrier Reef Marine Park Boundary
- Mean Sea Level, 0.0 mAHD (1.63 mLAT)
- Bathymetric Contour mLAT, (1 m interval)
- Topographic Contour mAHD, (10 m interval)
- Capital Dredging Footprint
- Previous Offshore Relocation Area
- Property Boundary
- Abbot Point State Development Precinct

DATUMS
Australian Height Datum (AHD)
Lowest Astronomical Tide (LAT)
0.0 mAHD = 1.63 mLAT
0.0 m LAT = -1.63 mAHD

1:50,000 (at A4)
0 0.5 1 1.5 2
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North Queensland Bulk Ports Corporation Limited
Abbot Point, QLD, T0, T2 and T3 Capital Dredging,
Sediment Sampling and Analysis Plan
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Geology and
Bathymetric Contours

Job Number	41-23701/11
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Figure 2-1

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Data Source: Geoscience: Road, Rail - 250K; DERM: cadastre (2009), aerial (1995) and 100k geology (2007); DIP: State Devel. Precinct (2010). Created by: jvc, bw.

3. The Assessment Process

3.1 Commonwealth Legislative Requirements

There are three key Commonwealth Acts relevant to the relocation of dredged material at sea. These include:

- The *Environment Protection (Sea Dumping) Act 1981* (referred to as the Sea Dumping Act)
- The *EPBC Act*
- The *Great Barrier Reef Marine Park Act 1975*

The objectives under the Sea Dumping Act are to protect and preserve the marine environment from pollution related to dumping at sea, minimising impacts on marine living resources, human health and other uses of the marine environment. The NAGD provides a framework for environmental impact assessment and permitting of ocean disposal under the Sea Dumping Act. These guidelines are applied to ensure the impacts of loading and relocation of dredged material are adequately and consistently assessed and, when offshore relocation is permitted, that impacts are managed responsibly and effectively.

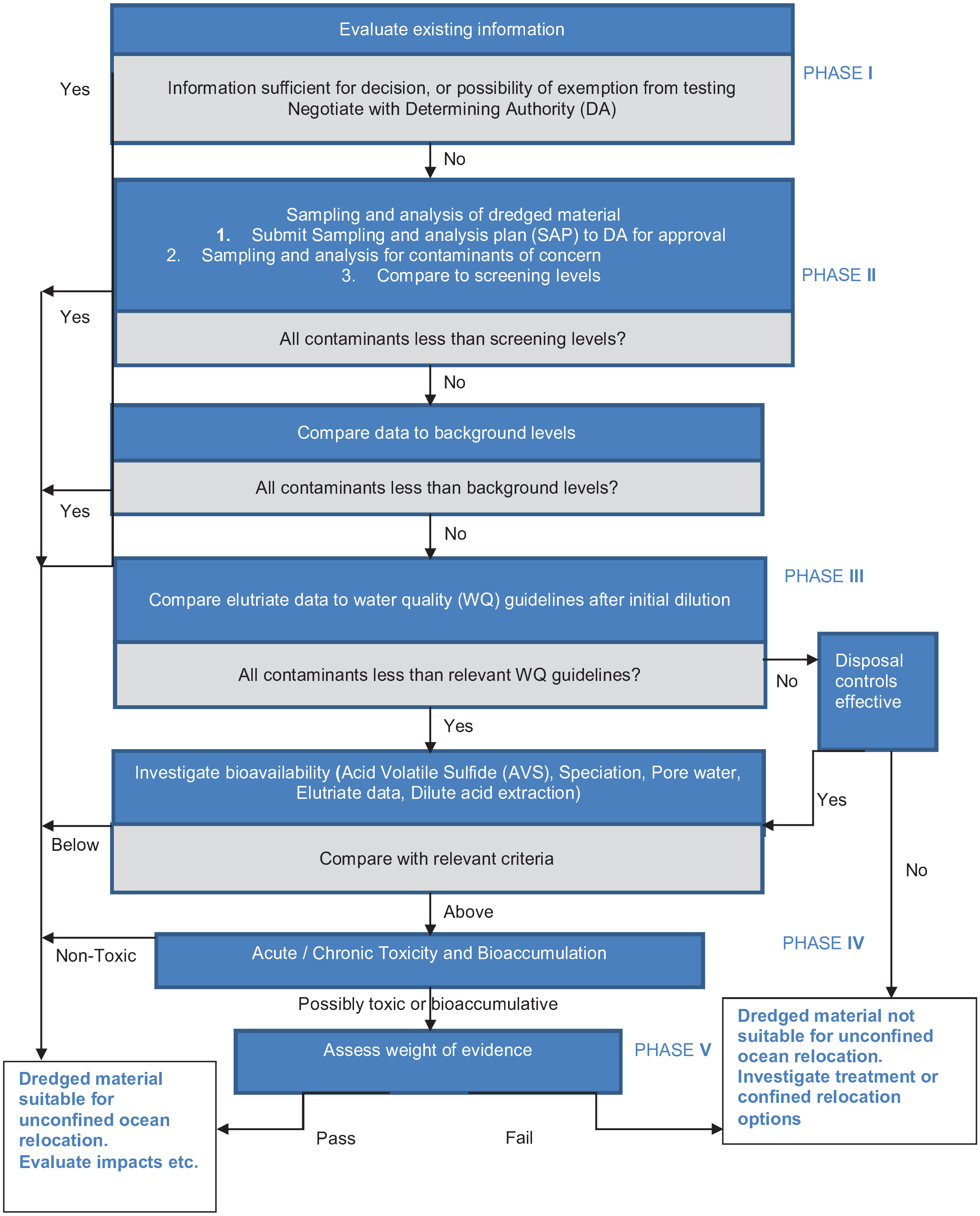
Dredged material relocation projects in Australian waters require consideration under the EPBC Act. The EPBC Act aims to protect the environment; including regulation of materials disposed at sea, and is administered by DSEWPaC. If the offshore relocation project has the potential to impact upon Matters of National Environmental Significance (MNES), an EPBC referral is required to be submitted to DSEWPaC. If DSEWPaC determines that there will be a significant impact to MNES, the project will undergo an EPBC Act assessment process (including submission of preliminary documentation, or an Environmental Impact Statement or Public Environment Report), advice under Section 160 of the EPBC Act, and, in the case of offshore relocation, a decision on the Sea Dumping Permit.

The GBRMPA regulates the activities within the Great Barrier Reef Marine Park (GBRMP). For offshore relocation projects that may occur within the boundaries of the marine park, or have the potential to impact upon the marine park, GBRMPA is the delegated authority under the Sea Dumping Act and has legislative responsibilities under the *Great Barrier Reef Marine Park Act 1975*.

3.2 NAGD Assessment Process

The assessment of sediment quality is depicted in the decision tree approach provided in Figure 3-1 below [adapted from Figure 3 of the NAGD].

Figure 3-1 Assessment of Potential Contaminants (Adapted from Figure 3, NAGD, 2009)



4. Existing Information on the Sediments of Abbot Point

4.1 Evaluation of Existing Information

The NAGD specifies that a review of existing information for the dredged material should be conducted, as part of Phase I of the assessment process (Figure 3-1) Consistent with the NAGD, the objective of the Phase I assessment is to determine:

- The contaminants that require investigation
- Whether there is sufficient data for an informed assessment
- Whether further testing is required

The information below provides a summary of the Phase I assessment in the SAP.

4.2 Geology

4.2.1 Regional Geology

The regional geology of Abbot Point consists of Carboniferous to Permian aged granitoid rock, by Quaternary-aged colluvial/residual deposits (Qr), and alluvium and coastal mud flats. Mount Luce, approximately 5 kilometres (km) to the west of the existing Abbot Point Coal Terminal, is a significant local topographic feature that reaches over 250 m Australian Height Datum (AHD), with the underlying granitoid geology possibly extending offshore. Offshore surface and near surface sediments of Abbot Point consist of Holocene-aged marine mud and sand, with shell fragments common.

The Project dredge area is located adjacent to Clark Shoal. Clark Shoal is derived from coarse-grained coastal deposits and developed as a result of sedimentation processes during and following the rise in sea level that occurred *c.* 6,000 years Before Present (BP). Throughout this time, coarse sediments from the Don River were transported northwards by longshore currents, with some of these reaching Abbot Point. Given the low energy conditions of the area, these sediments were subsequently deposited within Abbot Point (Department of Natural Resources, Mines and Energy (NRME) 2007, Geological Survey of Queensland (GSQ) 1982).

4.2.2 Local Geology

Current information on local geology collected during this SAP implementation program is provided in Section 6.1.

4.2.3 Acid Sulfate Soils (ASS)

The dredge area is located below 5 m AHD, which therefore triggers the assessment of ASS as per the QASSIT guidelines (Ahern et al.1998, hereafter referred to as the QASSIT 1998). This is because sediments located below 5 m AHD may contain sulfidic sediments.

4.3 Sediment Transport

The transport of sediments at the dredge area is considered to be minimal based upon an assessment of hydrodynamic processes. The dredge area is located approximately 2 km from the shoreline and therefore well away from the influence of breaking waves and sediment movement that occurs close to the coastline. Also, the existing natural depth at the dredge area is -17 m to -18.5 m LAT, which is beyond the depth at which the ambient waves will have any effects on sediments. At this depth, only long period waves in excess of 5 m would have any effect on the sediments present and the likelihood of occurrence of waves in excess of 5 m is very small (< 0.01 % based on the derived ambient wave climate for Abbot Point). Tidal currents reach up to 0.4 metres per second (m/s) at the water surface at the dredge area, however, the currents near the seabed at -18 m LAT are much less (in the order of 0.02 m/s). Under these conditions, it is unlikely that fine sediment will be transported, but in the event that sediment movement was initiated, the rate of transport will be very low. Furthermore, the presence of fine sediments at the dredge area is evidence that significant sediment transport is not occurring. This is further supported by the fact that only one maintenance dredging event (during 2008) has been required to maintain the required depths at the existing T1 berth since it was originally dredged in 1984.

4.4 Previous Investigations

4.4.1 List of Previous Studies

A number of previous studies undertaken at the Port of Abbot Point have included sediment quality investigations of relevance to the Project. Chronologically, these include:

- Assessment of the Status of Marine Sediments at Abbot Point (Ecowise Environmental 2004)
- Sampling and Analysis Plan for Capital Dredging Material (WBM 2005)
- Abbot Point Coal Terminal Stage 3 Expansion, Environmental Impact Statement (WBM 2006)
- Port of Abbot Point: Sediment Quality Assessment Report (Worley Parsons 2007)
- Report for Proposed Multi Cargo Facility, Abbot Point: Preliminary Sediment Quality Assessment (GHD 2009a)
- Port of Abbot Point X110 Apron and Berth Capital Dredging: Sediment Sampling and Analysis Program (GHD 2009b)

A summary of these previous studies are provided below.

4.4.2 Summary of Individual Previous Studies

2004

In 2004, Ecowise Environmental collected surface sediments from Abbot Point (Ecowise Environmental 2004). The sediment samples were analysed for heavy metals and metalloids. Results indicated that the mean concentration for heavy metals and metalloids were less than the screening levels provided in the National Ocean Disposal Guidelines for Dredged Material (NODGDM; Commonwealth of Australia 2002). Additionally, the heavy metal and metalloid concentrations were less than the Guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment (DoE), 1998) Environmental Investigation Levels (EILs).

2006

Sediment sampling was conducted in 2005 for the X50 expansion dredging (WBM 2006). Sediments mainly consisted of silty sands to 0.5 m, underlain by stiff clays. Analysis was undertaken for heavy metals and metalloids, tributyltin (TBT), polycyclic aromatic hydrocarbons (PAHs) and nutrients. The 95 % upper confidence limit (UCL) of the mean for TBT in the proposed new berth (Berth 2) was greater than the NODGDM (2002) screening level (5 µg Sn/g), following normalisation to 1 % total organic carbon (TOC). The report inferred that this was probably the result of a high concentration recorded in a single sample. Heavy metals, metalloids and PAH concentrations were less than the NODGDM (2002) screening levels, and nutrient levels (total nitrogen and total phosphorus) were comparable with natural background concentrations.

Further analysis was undertaken to determine the potential toxicity of sediments from the proposed Berth 2. The 95 % UCL concentration of TBT in additional sediment samples were less than the screening level. Additionally, pore water and elutriate concentrations were less than the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 95 % species protection for marine water trigger values [Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ 2000)]. Therefore, the sediments were assessed as suitable for unconfined ocean relocation in accordance with the NODGDM (2002).

Sampling and analysis was also undertaken in the Abbot Point offshore relocation area for nutrients, heavy metals, metalloids and TBT. These contaminant concentrations were less than the NODGDM (2002) screening levels. The concentrations of TBT were also less than the laboratory limit of reporting (LOR), also refered to as practical quantitation limits (PQL).

2007

In 2007 a Sediment Quality Assessment was conducted at Abbot Point in accordance with an approved SAP for maintenance dredging of Berth 1, capital dredging of Berth 2, a new apron area adjacent to Berth 2 and a depositional area adjacent to Berth 2 (WorleyParsons 2007). The concentrations of all but one of the contaminants were less than the NODGDM (2002) screening levels in samples collected from the existing berth and the adjacent depositional high spot and apron area (WorleyParsons 2007).

The exception was TBT in the existing berth and the adjacent depositional high spot area, as the 95 % UCL was greater than the NODGDM (2002) screening levels. Elutriate testing for TBT demonstrated that relevant ANZECC and ARMCANZ (2000) marine water trigger values could be achieved with additional dilution following release at the Abbot Point Offshore Disposal Area. As pore water TBT concentrations were less than the laboratory PQL, it was considered that TBT was unlikely to be bioavailable (WorleyParsons 2007).

A number of PAH compounds were present at concentrations greater than the laboratory PQL in Berth 1 and the adjacent depositional area (WorleyParsons 2007). The concentration of one PAH compound (acenaphthene) was greater than the NODGDM (2002) screening level in a single sample from Berth 1. The 95 % UCLs for all PAHs were less than the screening level, although it is noted that the concentrations were not normalised to 1 % TOC as required by the NODGDM (2002).

In accordance with the NODGDM (2002), it was considered that sediments located within the existing berth, the adjacent depositional high spot area and the approach/departure apron area at the Port of Abbot Point were suitable for unconfined ocean relocation.

2009a

In 2009 a preliminary Sediment Quality Assessment was undertaken to assess the quality of proposed dredged material for the construction of a proposed Multi Cargo Facility (MCF) site (GHD 2009a). Sediment samples were analysed for heavy metals, metalloids, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), PAHs, TOC, organochlorine pesticides (OCPs), organophosphorous pesticides (OPPs), organotins, particle size distribution (PSD) by sieve and hydrometer and ASS.

The dominant particle sizes of sediment samples collected from the site were medium to coarse-grained sands and fine gravels. No contaminant staining, anthropogenic materials or contaminant odours were observed in the sediment throughout sampling.

Where applicable, contaminant concentrations in sediment samples were less than the contaminant investigation thresholds for land based relocation [National Environmental Protection Measure (NEPM) 1999]. Also, contaminants not naturally occurring on the site (i.e. hydrocarbons, pesticides and organotins) had contaminant concentrations less than the laboratory PQL.

Based on the ASS assessment and the natural buffering capacity of the sediment, there were no additional neutralisation requirements of the sediment analysed if dredged and used for land reclamation purposes.

2009b

To assess the suitability of the proposed dredged material for unconfined ocean relocation, in 2009 GHD undertook a second Sediment Quality Assessment in accordance with an approved SAP for the X110 apron and Berth 3 and 4 capital dredging project (GHD 2009b). This sampling was conducted adjacent to the current T2 and T3 dredging footprint, though there is some overlap with the current T2 berths dredging footprint. It is important to note that the current T2 (Berth 3 and 4 and apron area) footprint is different to the 2009 X110 apron and Berth 3 and 4 footprint. Sampling was also undertaken at the previously used Abbot Point Offshore Relocation Area, which was proposed to be used for relocation of dredged material. Sediment samples were tested for PSD, moisture content, TOC, PAH, metals (including trace metals for selected samples), organotins, TPH, BTEX, OCPs, OPPs and nutrients.

The results showed that concentrations of TBT were greater than the NAGD screening level in some samples. Overall, the 95 % UCL for TBT was less than the NAGD screening level. Based on these results, the sediments were considered suitable for unconfined ocean relocation.

4.4.3 Overall Summary of Sediments based on Previous Studies

The aforementioned studies generally found that contaminant concentrations were less than screening levels, with many analytes being less than the laboratory PQL. The exception to this was found for TBT and PAHs in a small number of samples (refer 2007 and 2009b above). These studies, however, concluded that the sediments sampled in the Abbot Point area are suitable for relocation at sea, as per the NODGDM (2002) (for studies prior to 2009) and the NAGD.

4.5 Potential Pollution Sources

4.5.1 Catchment Sources of Contamination in Abbot Point

Land within the Abbot Point region is utilised or has been designated for the following:

- Conservation areas and environmental buffers
- Local agricultural and aquaculture activities
- Port activities associated with the Port of Abbot Point

The land use activities with the greatest potential to introduce contaminants into the marine environment include port activities (e.g. coal stockpiles and ship loading) and minor agricultural and aquaculture activities. At Abbot Point there are no major agricultural, urban or industrial pollutant sources in the area that are likely to result in the introduction of significant quantities of contaminants into the environment. The management of the existing coal terminal at Abbot Point is such that stormwater is captured and managed on site and there is no discharge into the marine environment except during extreme flooding events.

Within the dredge area, previous sediment studies (WBM 2005, Worley Parsons 2007b, GHD 2009b) have indicated that TBT (from anti fouling paints used in shipping) and PAHs (from possible coal and/or engine oil sources) are present. These compounds have been found to have concentrations greater than background levels or one tenth of the NAGD screening levels. Based on the evaluation of existing information and the aforementioned previous studies, these substances may impact on sediment quality at Abbot Point and have therefore been included for testing in the SAP. Other substances, though unlikely to occur at greater than natural levels, were also included for testing in the SAP to gather baseline information and for comparison against the chemical properties of the proposed dredged material relocation area. These included heavy metals and metalloids, hydrocarbons, pesticides and nutrients, details of which are listed in Table 4-1.

Table 4-1 Chemical Substances and Sources

Chemicals	Potential Sources (not specific to Abbot Point)	Notes
Heavy Metals and Metalloids Arsenic (As), Antimony (Sb), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Silver (Ag), Vanadium (V), Zinc (Zn)	Antifouling paints Stormwater and catchment runoff Trace levels present in coal particles Pesticides and fertilisers Marine fabrication metals Natural presence in marine sediments	Some levels of Cu, Cr and Zn are possible from antifouling paints and corrosion of marine metals Catchment, urban and industry sources are not likely
Organotins Monobutyltin (MBT), Dibutyltin (DBT), TBT	Antifouling paints	Can occur in sediment as paint flakes from shipping May dissolve into the water column and attach to sediment particles, which later settle out. Likely to be present at existing shipping berths
Nutrients Phosphorus, Nitrogen	Fertiliser runoff from agricultural areas Nutrients runoff from aquaculture areas	Some catchment inputs, but of low/natural concentrations in offshore areas

Chemicals	Potential Sources (not specific to Abbot Point)	Notes
	Nutrients attached to sediment eroded from catchment Natural presence in marine sediments	
Hydrocarbons TPHs, BTEX, PAHs, Phenols, Polychlorinated Biphenyls (PCBs)	Fuel oils Lubricants Ballast water Coal spillage during ship loading Dielectric and coolant fluids Natural presence in marine sediments (TPH and PAH only)	Unlikely to be present in elevated concentrations due to an absence of fuelling facilities at the berths and no reported spills
Pesticides OCPs, OPPs	Runoff from agricultural areas	Some catchment inputs, but unlikely to be found offshore

5. Sampling and Analysis Program

5.1 General

As stated in the NAGD, the Phase II assessment aims to collect and analyse representative samples that adequately characterise the sediments to be dredged. Where a Phase II assessment identifies contaminants of potential concern (COPC) (i.e. where the 95 % UCL of a contaminant is greater than the screening level) a Phase III assessment is required. The Phase III assessment involves elutriate and bioavailability testing of samples that contain COPC.

The sampling and analysis conducted to achieve Phase II is summarised below, with the investigation thresholds and results presented in Section 5.12 and 6 respectively.

5.2 Health, Safety and Environment

The SAP implementation program was undertaken in reference to a suitable Health, Safety and Environment Plan (HSEP) prepared in accordance with relevant legislation and standards. The HSEP included travel to and from site, sample collection (via vibracoring), processing and handling of samples, and was supplemented by health and safety documentation provided by the subcontractor and person in charge of the marine vessel.

The purpose of the HSEP was to ensure the safety, health and welfare of GHD employees for all work performed within the contracted work-scope, and that the safety, health and welfare of others (including the public and the natural environment), were maintained in a way to minimise impacts from these works.

An Environmental Management Plan (EMP) was also prepared for the works and provided mitigation measures for impacts that may occur to the environment as a result of the sampling program.

5.2.1 Underground Services

Prior to vibracoring, Dial Before You Dig (DBYD) searches were undertaken and plans from all services providers were reviewed to confirm that underwater services were not present within the T0, T2 and T3 dredge footprint.

5.3 Vessel and Personnel Requirements

Sampling was conducted from registered surveyed marine vessels that had appropriate areas for sample processing (i.e. free of debris and residue and removed from motors and exhaust to minimise the potential for sample contamination). The sample processing area was washed down with decontamination solution (Decon 90 or Decon Neutracon) and freshwater prior to use. Personnel included:

- Crew associated with the vessel sub-contractor including skipper, deck hands and chef (Pacific Marine Group, Barrier Reef Services)
- Crew associated with the vibracoring sub-contractor including at least three personnel experienced with operating the sampling equipment (Geocoastal/Abyss Commercial Diving)
- Appropriately qualified and experienced environmental scientists on board the vessel to direct, log and record sampling and process and package samples in accordance with the NAGD. The

environmental scientists were also responsible for ensuring the handover of samples to the analytical laboratory for the necessary analyses to be conducted within required holding times.

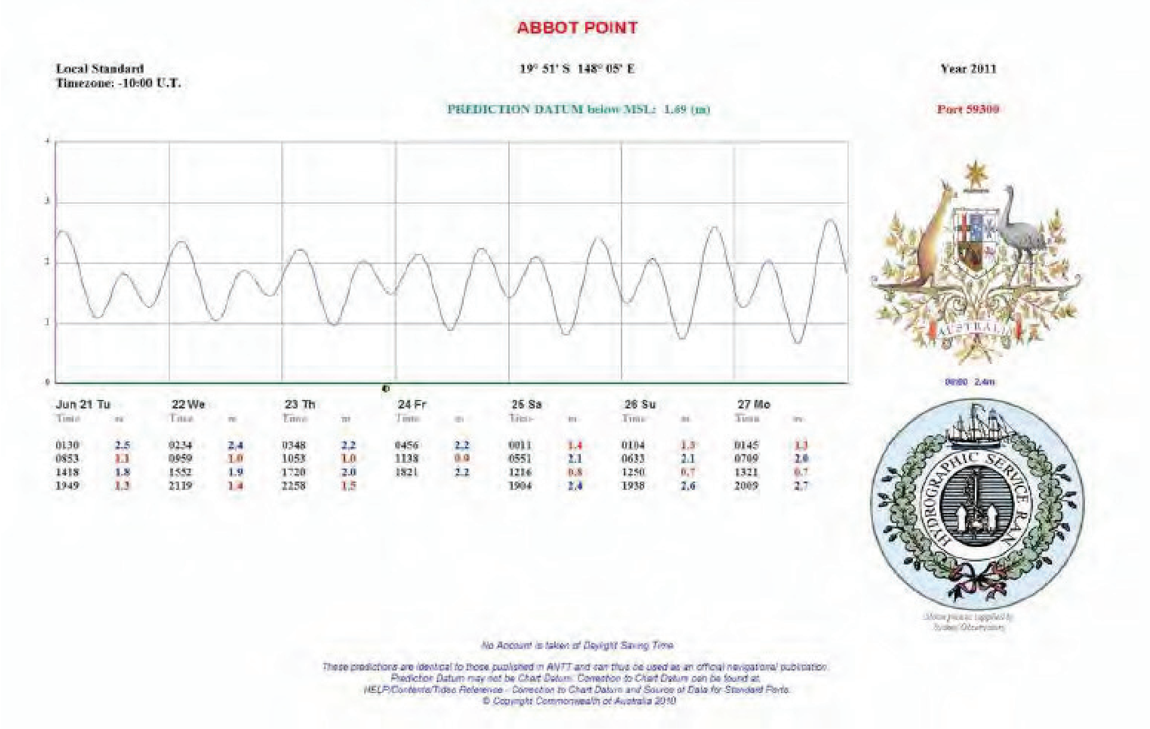
5.4 Sampling Dates

The SAP implementation program was undertaken between 22 to 27 June 2011, 16 to 20 September 2011, 20 to 23 February 2012 and the 22 to 23 March 2012. The sediment sampling occurred over separate months principally due to unfavourable weather conditions.

5.5 Tides, Weather and Sea Conditions

Tides were recorded during the SAP implementation program to confirm the depth (in LAT) of sampling locations on tide charts and calculate the required depth of sampling to reach required depths. In addition, if weather allowed, sampling was proposed during and around neap tides to reduce vessel drift off sampling locations. The tide charts for Abbot Point during the SAP implementation program are included in Figure 5-1, Figure 5-2, Figure 5-3 and Figure 5-4 below.

Figure 5-1 Tide Chart for SAP Implementation Program – June 2011



ABBOT POINT

Local Standard
Timezone: -10:00 U.T.

19° 51' S 148° 05' E

Year 2011

PREDICTION DATUM below MSL: 1.69 (m)

Port 59300

Jun 21 Tu		22 We		23 Th		24 Fr		25 Sa		26 Su		27 Mo	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0130	2.5	0234	2.4	0348	2.2	0456	2.2	0011	1.4	0104	1.3	0145	1.3
0853	1.1	0959	1.0	1053	1.0	1138	0.9	0551	2.1	0633	2.1	0709	2.0
1418	1.8	1552	1.9	1720	2.0	1821	2.2	1216	0.8	1250	0.7	1321	0.7
1949	1.3	2119	1.4	2258	1.5			1904	2.4	1938	2.6	2009	2.7

No Account is taken of Daylight Saving Time

These predictions are identical to those published in ANTT and can thus be used as an official navigational publication.
Prediction Datum may not be Chart Datum. Correction to Chart Datum can be found at:
HELP/Contents/Tides Reference - Correction to Chart Datum and Source of Data for Standard Ports.
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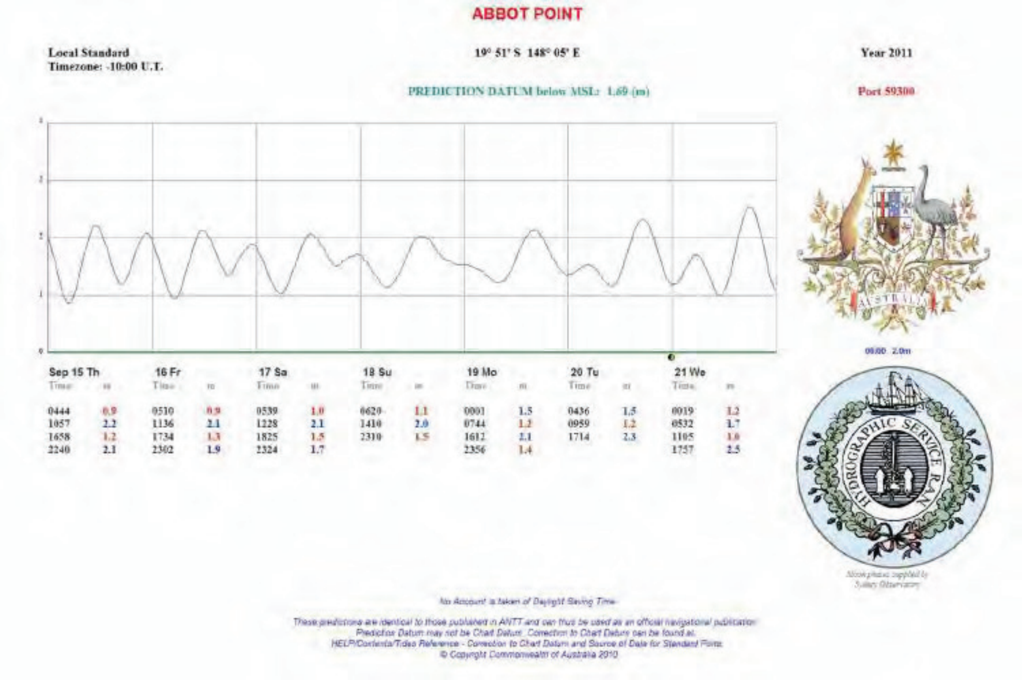
Figure 5-2 Tide Chart for SAP Implementation Program – September 2011



ABBOT POINT

Local Standard
Timezone: -10:00 U.T.

19° 51' S 148° 05' E

Year 2011

PREDICTION DATUM below MSL: 1.69 (m)

Port 59300

Sep 15 Th		16 Fr		17 Sa		18 Su		19 Mo		20 Tu		21 We	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0444	0.9	0510	0.9	0539	1.0	0620	1.1	0001	1.5	0436	1.5	0019	1.2
1057	2.2	1136	2.1	1228	2.1	1410	2.0	0744	1.2	0959	1.2	0532	1.7
1658	1.2	1734	1.3	1825	1.5	2310	1.5	1612	2.1	1714	2.3	1105	1.0
2240	2.1	2302	1.9	2324	1.7			2356	1.4			1757	2.5

No Account is taken of Daylight Saving Time

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HELP/Contents/Tides Reference - Correction to Chart Datum and Source of Data for Standard Ports
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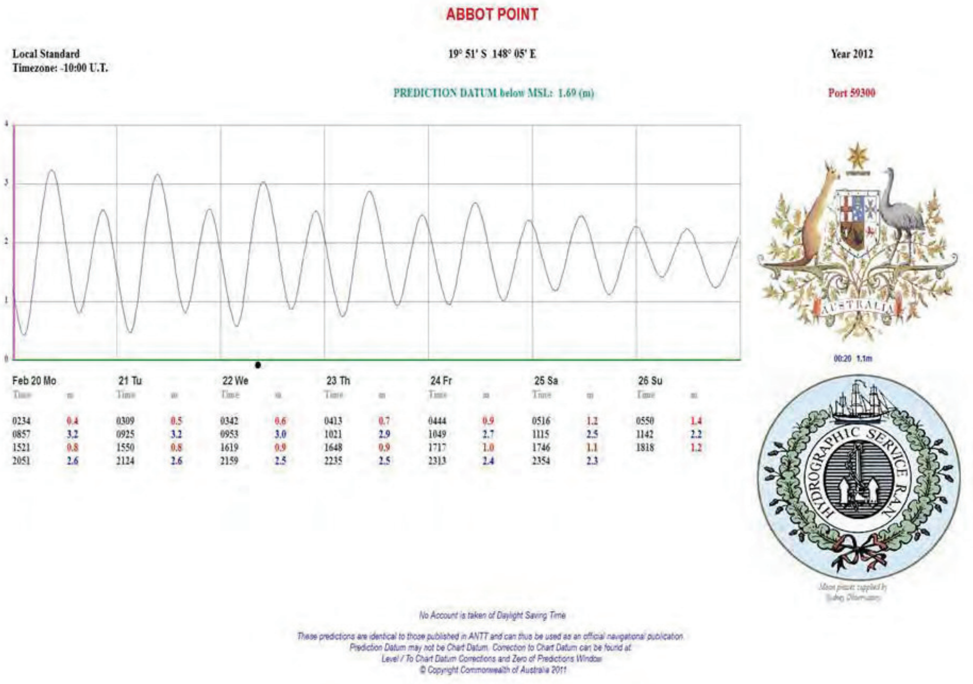
Figure 5-3 Tide Chart for SAP Implementation Program – February 2012



ABBOT POINT

Local Standard
Timezone: -10:00 U.T.

19° 51' S 148° 05' E

Year 2012

PREDICTION DATUM below MSL: 1.69 (m)

Port 59300

Feb 20 Mo		21 Tu		22 We		23 Th		24 Fr		25 Sa		26 Su	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0234	0.4	0309	0.5	0342	0.6	0413	0.7	0444	0.9	0516	1.2	0550	1.4
0857	3.2	0925	3.2	0953	3.0	1021	2.9	1049	2.7	1115	2.5	1142	2.2
1521	0.8	1550	0.8	1619	0.9	1648	0.9	1717	1.0	1746	1.1	1818	1.2
2051	2.6	2124	2.6	2159	2.5	2235	2.5	2313	2.4	2354	2.3		

No Account is taken of Daylight Saving Time

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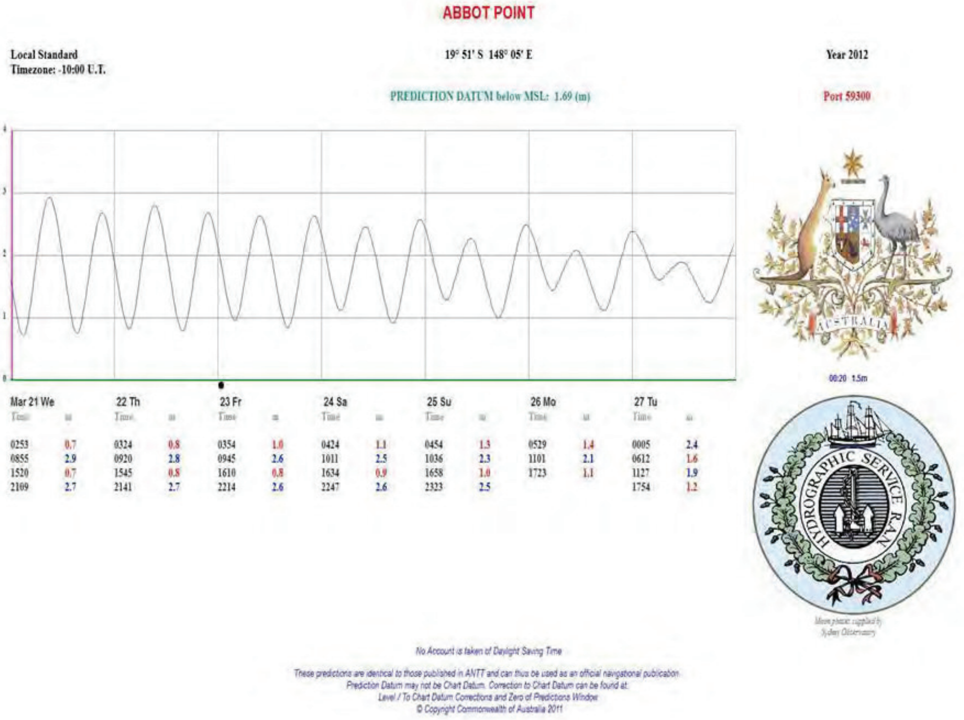
Figure 5-4 Tide Chart for SAP Implementation Program – March 2012



ABBOT POINT

Local Standard
Timezone: -10:00 U.T.

19° 51' S 148° 05' E

Year 2012

PREDICTION DATUM below MSL: 1.69 (m)

Port 59300

Mar 21 We		22 Th		23 Fr		24 Sa		25 Su		26 Mo		27 Tu	
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
0253	0.7	0324	0.8	0354	1.0	0424	1.1	0454	1.3	0529	1.4	0005	2.4
0855	2.9	0920	2.8	0945	2.6	1011	2.5	1036	2.3	1101	2.1	0612	1.6
1520	0.7	1545	0.8	1610	0.8	1634	0.9	1658	1.0	1723	1.1	1127	1.9
2109	2.7	2141	2.7	2214	2.6	2247	2.6	2323	2.5			1754	1.2

No Account is taken of Daylight Saving Time

These predictions are identical to those published in ANTT and can thus be used as an official navigational publication
Prediction Datum may not be Chart Datum. Correction to Chart Datum can be found at:
Level / To Chart Datum Corrections and Zero of Predictions Window

Weather conditions during the sampling periods were generally sunny with some cloud; with slight to moderate winds frequently in the range of 10 to 15 nautical miles per hour (knots) (sampling was unable to be conducted when wind speed exceeded 20 knots). Swell varied in height and direction throughout the program. Weather and sea conditions during the SAP implementation program are summarised in Table 5-1 below.

Table 5-1 Weather and Sea Conditions during Sampling

Date	Weather	Sea Conditions	Sample Locations Achieved
22.06.2011	Sunny. NNE Wind 0 to 10 knots	Swell N 0.5 to 1 m	SC13
23.06.2011	Sunny. Wind SE 10 to 15 knots	Swell ESE 0. To 1.5 m	SC02, SC03, SC10, SC05
24.06.2011	Sunny. Wind SSE 15 knots	Swell SE 1 to 1.5 m	SC11, SC09, SC06
25.06.2011	Sunny. Wind SE 20 knots	Swell SE 1 to 2 m	SC20, SC07, SC08, SC15, SC14
26.06.2011	Some cloud and showers. Wind SE 15 to 20 knots	Swell SE 1 to 1.5 m	SC19, SC18
16.09.2011	Sunny. SE 15 knots	Swell SE 0.5 to 1 m	SC25, SC26

Date	Weather	Sea Conditions	Sample Locations Achieved
17.09.2011	Sunny. SE 15 knots	Swell SE 1 m	SC16, SC17, SC21, SC22, SC23
18.09.2011	Mostly sunny with some cloud. SE 15 to 17 knots	Swell ESE 1 to 1.2 m	SC04, SC12, SC24, SC27, SC28
19.09.2011	Sunny. ESE - SE 13 to 15 knots	Swell ESE 1 m	SC29, SC31, T7/T8, SC35, SC36, SC01
20.09.2011	Sunny. Wind SE 10 knots	Swell SE 0.5 m	SC30, SC32, SC33, SC34
20.02.2012	Sunny, some cloud. Wind SE 10 to 15 knots.	Swell SE 0.5 m	SC37, SC43, SC47, SC48, SC49, SC50
21.02.2012	Sunny, some cloud. Wind SE 5 to 10 knots	Swell SE 0.5 m	SC42, SC44, SC51, SC53, SC62, SC64
22.02.2012	Sunny, some cloud. Wind NE 10 to 15 knots	Swell SE 0.5 m	SC40, SC46, SC52, SC54, SC60, SC63
23.02.2012	Sunny, some could. Wind NW 5 knots to SE 10 to 15 knots	Swell mixed 0.5 m	SC38, SC39, SC41, SC45, SC56
22.03.2012	Sunny, cloud cover Wind N 10 to 15 knots	Swell N 0.5 to 1 m	SC57, SC58, SC59, SC61
23.03.2012	Sunny, some cloud. Wind WNW 0 to 15 knots to calm	Swell N 0.2 to 0.5 m	SC55, SC65, SC66, SC67, SC68, SC69

5.6 Sampling Density and Locations

In 2009, GHD completed a SAP implementation program for the X110 berth and apron capital dredging project on behalf of NQBP at the Port of Abbot Point in accordance with the requirements of the NODGDM (2002). The current T2 dredge area footprint partially overlaps the X110 apron and berth dredge area footprint. As a result, the area where sampling had previously been conducted (GHD 2009b), was excluded from further sampling and analysis. The results of the previous sampling locations (GHD 2009b) remained current as they were less than five years old. The related report is summarised Section 4.4.2 of this report.

In calculating the number of sample locations required for assessment against the NAGD for the current SAP implementation program, the following was considered:

- The volume of potentially contaminated material within the dredge area may be up to 2,130,000 m^3, although the greater dredging volume that approval is being sought for is 3,000,000 m^3. This is based on an approximate dredge footprint area of 2,130,000 m^2 (which is more conservative than that specified in Section 2.2 (1,836,100 m^2) to allow for potential engineering changes), and an approximate depth of 1 m of potentially contaminated material. This follows the NAGD that states: “where a project involves capital dredging with existing contamination, rather than the total dredge volume, the number of sample locations should be based on the volume of contaminated and potentially contaminated material”. It is considered that the top 1 m of sediment is potentially contaminated material as the GHD (2009b) X110, Abbot Point, QLD, SAP implementation program confirmed the presence of TBT in the surface sediments only. All samples containing TBT greater than laboratory PQL were from the surface interval (0 to 0.5 m) in the former T2 Berth 3 and Berth 4 footprint, with the exception of one sample at depth interval 0.5 m to 1 m. In addition, the top 1 m of sediment overlies natural geological materials, based on information provided in the sediment core logs from the GHD (2009b) program and confirmed in this program (refer to Sections 4.3 and 6). In accordance with the NAGD, the 1 m interval of the core was analysed for chemical properties, with deeper intervals (e.g. 1 to 1.5 m) proposed to be analysed if contaminants were identified in the surface 1 m interval. Samples were collected every 0.5 m interval to at least 2 m below the sea bed surface for chemical properties analysis. The depth of the core was at least 0.5 m below the required dredge depth at each location unless refusal was encountered on consolidated sediments. As such, the depth of the cores would be likely to vary due to the existing seabed depths.

- The combined areas of T0, T2 and T3 were used to calculate the required number of sample locations. As the areas are continuous and are likely to be uniform in physical characteristics, the dredge area was not divided for the purpose of sample location number determination.
- In accordance with the NAGD, physical properties of the full depth of sediment proposed to be dredged (including natural geological materials) would be assessed in order to provide relevant data on the behaviour of the dredged material during and after dredging and relocation.
- Heavy metals and metalloids were only sampled in the surface 0.5 m. However, to assess naturally occurring background concentrations, selected samples collected below 0.5 m were analysed for heavy metals and metalloids.

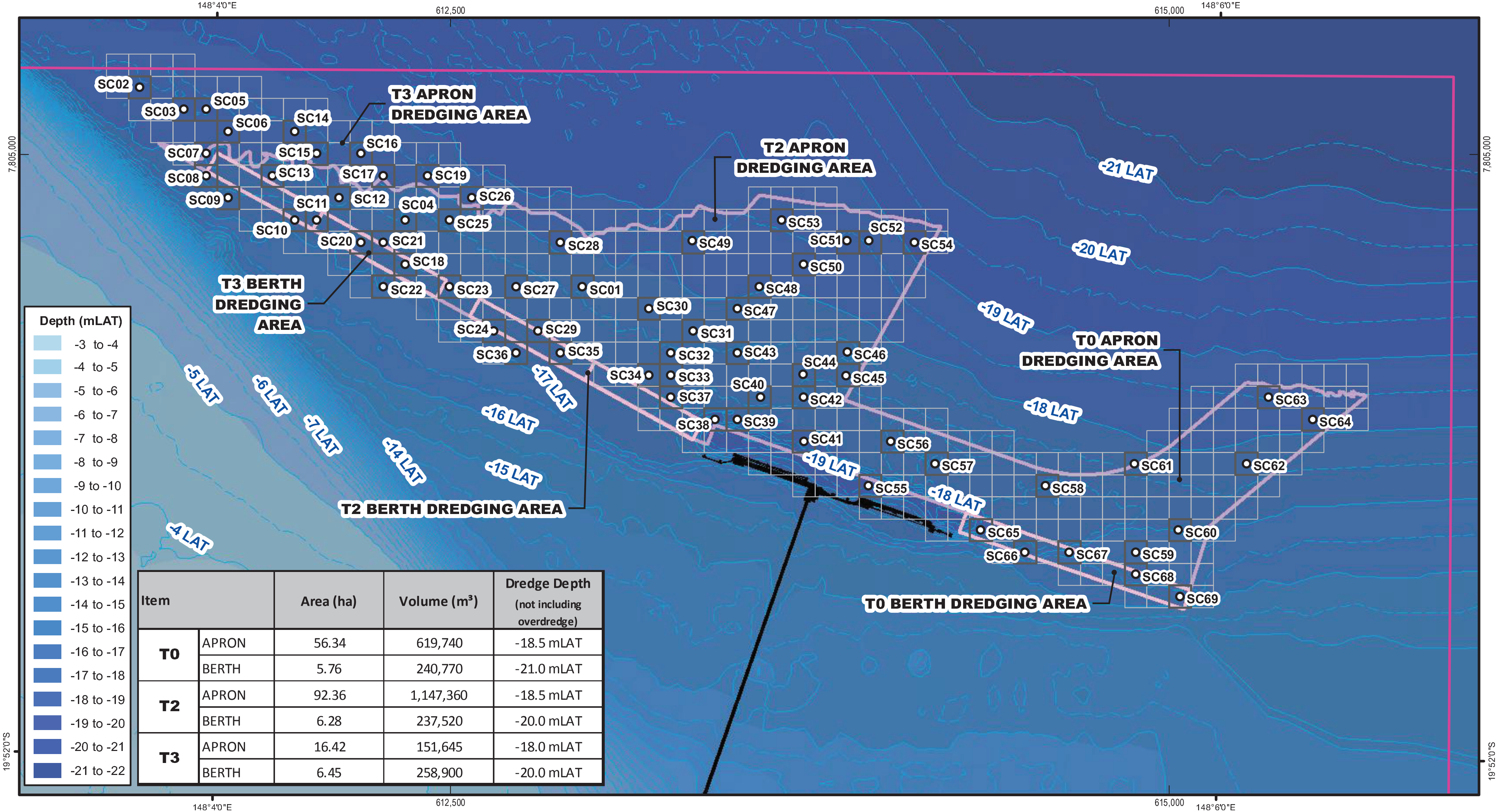
In consideration of the above, 69 locations within the dredge area were collected and analysed. The number of sample locations were calculated using the combined amount of potentially contaminated material from T0, T2 and T3. The calculation follows the linear equation in Appendix D of the NAGD:

$$y = 0.025x + 15.547$$

[Where y is the number of sampling stations and x is the volume of dredge material (x 1000 cubic metres)]

According to the NAGD, sample locations should be selected on a random basis by laying a grid square over the area to be dredged, sized so that there are at least five times the number of grid squares as the number of sampling locations required (i.e. 69 sample locations, therefore 345 grid squares over the entire Study Area). Grid squares are then numbered and random numbers used to select the specific grid squares where sampling will occur.

Figure 5-5 shows the sample grids and proposed sample locations, and Figure 5-6 shows the actual sample locations for the dredge area. It should be noted that the position of some of the sample locations varied slightly to those identified in the SAP due to inherent positioning inaccuracy presented by field conditions (see Section 7.2). The GPS co-ordinates of proposed and actual sampling locations are provided in Appendix B.



Item		Area (ha)	Volume (m³)	Dredge Depth (not including overdredge)
T0	APRON	56.34	619,740	-18.5 mLAT
	BERTH	5.76	240,770	-21.0 mLAT
T2	APRON	92.36	1,147,360	-18.5 mLAT
	BERTH	6.28	237,520	-20.0 mLAT
T3	APRON	16.42	151,645	-18.0 mLAT
	BERTH	6.45	258,900	-20.0 mLAT

1:18,000 (at A4)

0 200 400 600
metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Great Barrier Reef Marine Park Boundary
Bathymetric Contour mLAT, (0.5 m interval)
Bathymetric Contour mLAT, (1.0 m interval)
T0, T2 & T3 Apron Footprint
○ Sample Location
☐ Sampling Grid
Randomly Selected Sample Cell

North Queensland Bulk Ports Corporation Limited
Abbot Point, QLD, T0, T2 and T3 Capital Dredging,
Sediment Sampling and Analysis Plan
Implementation Report

Job Number	41-23701/11
Revision	B
Date	03 Jul 2012

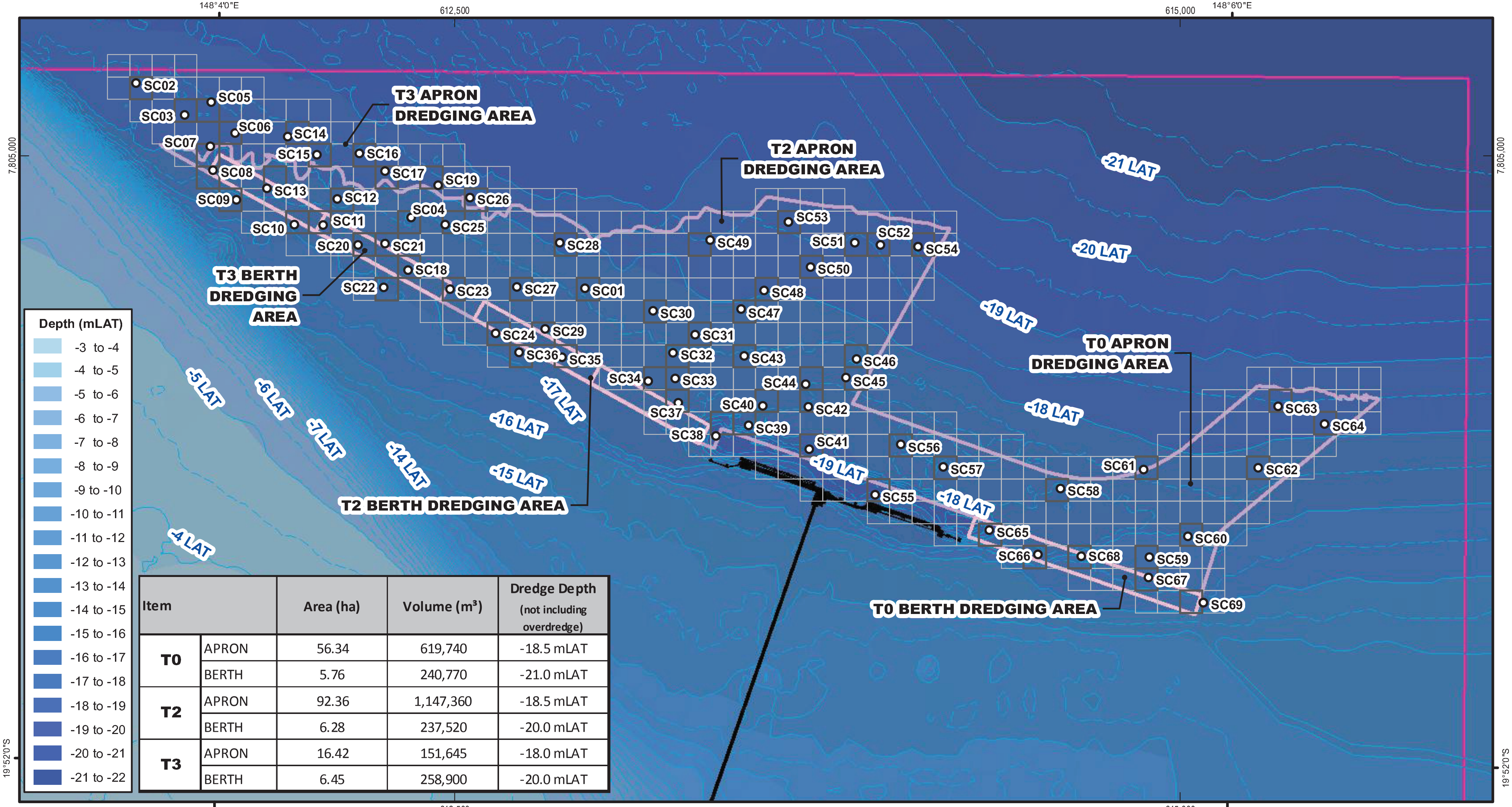
Proposed Sampling Locations

Figure 5-5

G:\41\24541\Tech\GIS\Maps\PDFs_MXDs\41-24541-010_Samp2011and2012_revB.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Features\2007, DERM: DCDB\2010, Aurecon: dredge areas (APT2-SK-W-4012 et al)\2011. Created : jvc



Item		Area (ha)	Volume (m³)	Dredge Depth (not including overdredge)
T0	APRON	56.34	619,740	-18.5 mLAT
	BERTH	5.76	240,770	-21.0 mLAT
T2	APRON	92.36	1,147,360	-18.5 mLAT
	BERTH	6.28	237,520	-20.0 mLAT
T3	APRON	16.42	151,645	-18.0 mLAT
	BERTH	6.45	258,900	-20.0 mLAT

1:18,000 (at A4)

0 200 400 600

metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

▬	Great Barrier Reef Marine Park Boundary	▭	T0, T2 & T3 Apron Footprint
—	Bathymetric Contour mLAT, (1.0 m interval)	○	Sample Location
- -	Bathymetric Contour mLAT, (0.5 m interval)	☐	Sampling Grid
		▭	Randomly Selected Sample Cell

North Queensland Bulk Ports Corporation Limited
Abbot Point, QLD, T0, T2 and T3 Capital Dredging,
Sediment Sampling and Analysis Plan
Implementation Report

Job Number | 41-23701/11
Revision | A
Date | 03 Jul 2012

Actual Sampling Locations

Figure 5-6

G:\41\24541\Tech\GIS\Maps\PDFs_MXDs\41-24541-026_ActualSamp2011and2012_revA.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GA: Features\2007, DERM: DCDB\2010, Aurecon: dredge areas (APT2-SK-W-4012 et al)\2011. Created : jvc

5.7 Acid Sulfate Soils Sampling

In calculating the number of sampling locations required for assessment against the QASSIT (1998), the requirement for sites greater than 1 hectare (ha) is two sampling locations per ha. As the combined area to be dredged for T0, T2 and T3 is approximately 213 ha (2,130,000 m^2) (using a conservative overestimate of the actual 183.61 ha), a total of 416 locations would be required to meet the QASSIT (1998) guidelines. The QASSIT (1998) guidelines also state that additional samples may be required in areas of more intensive disturbance, in which sampling should be taken on a 50 to 75 m grid.

However, as this is a pilot program for ASS, ASS was tested only at the 69 locations selected for sampling in accordance with the NAGD. Further analysis may be required if onshore relocation of dredged material is ultimately selected.

The proposed ASS sampling locations provided in the SAP are identified in Figure 5-5 with actual ASS sampling locations provided in Figure 5-6. All locations were sampled during the SAP implementation program, although some coring did not achieve depth to 1 m below dredge depth, as required under the QASSIT (1998) due to refusal of the vibracore on consolidated sediments.

5.8 Collection of Sediment Samples

5.8.1 Sample Collection and Core Retrieval

For the dredge area, sample collection was undertaken using a vibracorer deployed from a marine vessel. The vibracorer was deployed from the stern of the vessel via a tripod, to ensure that the corer remained upright on the seabed. A vibrating head was locked on top of the corer unit (within a tripod) and the tubing was ‘vibrated’ into the seabed to the required depth, or until refusal on consolidated sediments. Core tubes of 60 millimetre (mm), 70 mm and 88 mm in diameter were used. Samples were then retrieved from the stainless steel corer using air pressure.

A minimum of two cores (one primary core to maximum depth and one secondary core to 2 mbss) were collected at each location to allow for collection of sufficient sample. Due to environmental factors (e.g. currents), some locations of the secondary cores differed marginally (less than 10 m for all locations) from primary cores.

Where triplicate locations were sampled (SC06, SC18, SC28, SC31, SC53, SC54, SC69), additional cores were collected (refer to Section 5.10.3 for detail on triplicate locations).

Sediment cores were extruded into sterile plastic sleeves which were subsequently placed into sediment trays. Cores were then examined to determine if material had been lost or greatly disturbed (e.g. deformation of sediment layers). GHD field personnel assessed the acceptability of the core following collection. The criteria for acceptance of the core included:

- Minimal loss of the uppermost 0.5 m of the core
- The core must have entered the profile vertically
- Minimal gaps in the stratigraphy
- Minimal disturbance of the sediment stratigraphy
- The core reached into the consolidated sediments to at least 0.5 to 1.0 m if it did not reach the required depth (refer to Section 7.2)

5.8.2 Sample Identification

Upon collection, each sample was assigned a unique identification (ID) code based on site location, depth and type of sample (Table 5-2).

Table 5-2 Identification of Samples

Sample Type	Prefix for Labelling if from Site 01
Sediment Cores	SC (i.e. SC01)
Triplicates	T (i.e. T01)
Duplicates (field duplicates, field splits, inter-batch duplicates)	FD, FS, BS (i.e. FD01, FS01, BS01)
Trip Blank	TB (i.e. TB01)

5.8.3 Processing of Samples

Field Information and Sample Logging

The following field measurements were recorded for each sampling location:

- Date and time of sampling of each core
- Personnel conducting sampling, client, project, sample location ID, type of sediment sampler used and GPS coordinates of sampling location (see Section 5.3)
- Core logs – prior to processing samples, each primary core was logged in accordance with Australian Standards (AS) for Geotechnical Site Investigations (AS 1726-1993). Details recorded include depth, physical appearance, colour, contaminant odour and staining, plasticity, lithology (clay, sandy clay, clayey sand etc), sand grain size, presence of organic matter, marine organisms, shell layers, fill material, and other relevant features.
- Digital photographs – documented the sampling program, methods and the sediment cores. The photographs taken during logging included details such as a coring plate stating date and time, location, and sample ID.
- Oceanographic information – tides (refer to tide charts in Figure 5-1 to Figure 5-4) and water depth were recorded at the time of sampling (see Section 5.5)
- Weather – relevant conditions including wind speed, sea state and atmospheric conditions (e.g cloud cover) for each day of sampling were recorded (see Section 5.5)
- General comments – issues which may have affected the SAP implementation program and/or interpretation of results

Sampling location details are summarised in Table 5-3 below, and sediment core logs containing much of the information above and digital photographs are provided in Appendix C.

Table 5-3 Sampling Location Details

Sampling Locations	Area	Date Undertaken	Depth of Water (m LAT)	Sediment Core Depth (m)	Sediment Core Depth (m LAT)	Required Dredge Depth (m LAT)	Core Depth Achieved for Chemical Properties	Core Depth Achieved for ASS
SC01	T2 Apron	19.09.2011	-17.7	2.3	-20.0	-18.5	✓	✓
SC02	T3 Apron	23.06.2011	-18.3	2.35	-20.65	-18.0	✓	✓
SC03	T3 Apron	23.06.2011	-18.5	1.5	-20.0	-18.0	✓	✓
SC04	T3 Apron	18.09.2011	-17.5	2.0	-19.5	-18.0	✓	✓
SC05	T3 Apron	23.06. 2011	-18.35	2.2	-20.55	-18.0	✓	✓
SC06	T3 Apron	24.06.2011	-18.0	2.55	-20.55	-18.0	✓	✓
SC07	T3 Berth	25.06.2011	-18.3	2.6	-20.9	-20.0	✓	x
SC08	T3 Berth	25.06.2011	-17.9	2.6	-20.5	-20.0	✓	x
SC09	T3 Berth	24.06.2011	-17.3	4.3	-21.6	-20.0	✓	✓
SC10	T3 Berth	23.06.2011	-17.1	4.7	-21.8	-20.0	✓	✓
SC11	T3 Berth	24.06.2011	-17.3	4.3	-21.6	-20.0	✓	✓
SC12	T3 Apron	18.06.2011	-17.7	2.3	-20.1	-18.0	✓	✓
SC13	T3 Berth	22.09.2011	-17.7	4.4	-22.1	-20.0	✓	✓
SC14	T3 Apron	25.06.2011	-18.5	2.6	-21.1	-18.0	✓	✓
SC15	T3 Apron	25.06.2011	-18.3	2.6	-20.9	-18.0	✓	✓
SC16	T3 Apron	17.09.2011	-18.4	2.1	-20.5	-18.0	✓	✓
SC17	T3 Apron	17.09.2011	-18.4	2.1	-20.5	-18.0	✓	✓
SC18	T3 Berth	26.09.2011	-17.1	4.5	-21.6	-20.0	✓	✓

Sampling Locations	Area	Date Undertaken	Depth of Water (m LAT)	Sediment Core Depth (m)	Sediment Core Depth (m LAT)	Required Dredge Depth (m LAT)	Core Depth Achieved for Chemical Properties	Core Depth Achieved for ASS
SC19	T3 Apron	26.09.2011	-18.3	2.2	-20.5	-18.0	✓	✓
SC20	T3 Berth	25.06. 2011	-17.1	4.25	-21.35	-20.0	✓	✓
SC21	T3 Berth	17.09.2011	-17.2	4.5	-21.7	-20.0	✓	✓
SC22	T3 Berth	17.09.2011	-17.1	4.0	-21.1	-20.0	✓	✓
SC23	T3 Berth	17.09.2011	-17.2	3.6	-20.8	-20.0	✓	✓
SC24	T2 Berth	18.09.2011	-17.2	2.85	-20.05	-20.0	✓	x
SC25	T3 Apron	16.09.2011	-17.5	2.35	-19.85	-18.0	✓	✓
SC26	T3 Apron	16.09.2011	-18.3	1.5	-19.8	-18.0	✓	✓
SC27	T2 Apron	18.09.2011	-17.4	2.5	-19.9	-18.5	✓	✓
SC28	T2 Apron	18.09.2011	-18.2	2.1	-20.3	-18.5	✓	✓
SC29	T2 Berth	19.09.2011	-17.5	3.1	-20.6	-20.0	✓	x
SC30	T2 Apron	20.09.2011	-17.7	1.75	-19.45	-18.5	✓	x
SC31	T2 Apron	19.09.2011	-17.6	2.35	-19.95	-18.5	✓	✓
SC32	T2 Apron	20.09.2011	-17.5	2.35	-19.85	-18.5	✓	✓
SC33	T2 Apron	20.09.2011	-17.2	2.15	-19.35	-18.5	✓	x
SC34	T2 Apron	20.09.2011	-17.4	2.45	-19.85	-18.5	✓	✓
SC35	T2 Berth	19.09.2011	-17.3	2.4	-19.7	-20.0	✓	x
SC36	T2 Berth	19.09.2011	-17.2	4.1	-21.3	-20.0	✓	✓
SC37	T2 Berth	20.02.2012	-17.7	2.0	-19.7	-20.0	✓	x

Sampling Locations	Area	Date Undertaken	Depth of Water (m LAT)	Sediment Core Depth (m)	Sediment Core Depth (m LAT)	Required Dredge Depth (m LAT)	Core Depth Achieved for Chemical Properties	Core Depth Achieved for ASS
SC38	T2 Apron	23.02.2012	-20.6	0.8	-21.4	-18.5	✓	✓*
SC39	T2 Apron	23.02.2012	-18.4	1.5	-19.9	-18.5	✓	✓*
SC40	T2 Apron	22.02.2012	-17.8	1.95	-19.75	-18.5	✓	✓
SC41	T2 Apron	23.02.2012	-18.8	1.1	-19.9	-18.5	✓	✓*
SC42	T2 Apron	21.02.2012	-18.0	1.8	-19.8	-18.5	✓	✓
SC43	T2 Apron	20.02.2012	-18.0	1.2	-19.2	-18.5	✓	x
SC44	T2 Apron	21.02.2012	-17.8	1.4	-19.2	-18.5	✓	x
SC45	T2 Apron	23.02.2012	-17.9	2.65	-19.55	-18.5	✓	✓*
SC46	T2 Apron	22.02.2012	-18.1	2.3	-20.4	-18.5	✓	✓
SC47	T2 Apron	20.02.2012	-18.2	1.7	-19.9	-18.5	✓	✓
SC48	T2 Apron	20.02.2012	-18.5	1.1	-19.6	-18.5	✓	✓
SC49	T2 Apron	20.02.2012	-18.9	1.1	-20.0	-18.5	✓	✓
SC50	T2 Apron	20.02.2012	-18.8	1.35	-20.15	-18.5	✓	✓
SC51	T2 Apron	21.02.2012	-19.3	0.9	-20.2	-18.5	✓	✓
SC52	T2 Apron	22.02.20.12	-19.3	2.3	-21.6	-18.5	✓	✓
SC53	T2 Apron	21.02.2012	-19.4	1.0	-20.4	-18.5	✓	✓
SC54	T2 Apron	22.02.2012	-19.0	1.4	-20.4	-18.5	✓	✓
SC55	T0 Apron	23.03.2012	-21.3	0.5	-21.8	-18.5	x	✓
SC56	T0 Apron	23.02.2012	-18.0	1.3	-19.3	-18.5	✓	x*

Sampling Locations	Area	Date Undertaken	Depth of Water (m LAT)	Sediment Core Depth (m)	Sediment Core Depth (m LAT)	Required Dredge Depth (m LAT)	Core Depth Achieved for Chemical Properties	Core Depth Achieved for ASS
SC57	T0 Apron	22.03.2012	-18.2	1.0	-19.2	-18.5	✓	x
SC58	T0 Apron	22.03.2012	-18.4	1.3	-19.7	-18.5	✓	✓
SC59	T0 Apron	22.03.2012	-18.6	2.4	-21.0	-18.5	✓	✓
SC60	T0 Apron	22.02.2012	-17.6	0.9	-18.5	-18.5	x	x
SC61	T0 Apron	22.03.2012	-19.3	0.9	-20.2	-18.5	x	✓
SC62	T0 Apron	21.02.2012	-18.4	1.5	-19.9	-18.5	✓	✓
SC63	T0 Apron	22.02.2012	-18.8	0.95	-19.75	-18.5	x	✓
SC64	T0 Apron	21.02.2012	-18.8	1.2	-20.0	-18.5	✓	✓
SC65	T0 Berth	23.03.2012	-19.0	0.6	-19.6	-21.0	x	x
SC66	T0 Berth	23.03.2012	-17.9	0.6	-18.5	-21.0	x	x
SC67	T0 Berth	23.03.2012	-16.0	2.3	-18.3	-21.0	✓	x
SC68	T0 Berth	23.03.2012	-17.3	2.0	-19.3	-21.0	✓	x
SC69	T0 Berth	23.03.2012	-15.8	2.2	-18.0	-21.0	✓	x

Notes:
Target Depths: Berth - T0; -21.0 m LAT, T2 and T3; -20.5 m LAT; Apron Area: T0 and T2; -18.5 m LAT; T3; -18.0 m LAT

* denotes sampling locations that were not tested for ASS due to breach of holding times prior to laboratory analysis

A number of sampling locations in the T0 berth and apron area did not reach depth required for chemical properties analysis. This was because of refusal of corer on consolidated sediments and as such does not affect the validity of the data.

Sample Processing

Once individual cores were collected and field information and logging was completed, sediment from each sample interval (e.g. 0 to 0.5 m and 0.5 to 1.0 m) from the primary and secondary core were mixed to ensure a thoroughly homogenised sample. An exception to this process occurred when collecting samples for volatile analysis, which were collected from the midway point of each sample interval and not homogenised as per the NAGD. It is important to note that 0.5 m intervals were selected, as this provides an approximate measure for the thinnest layer of sediment that can be dredged reliably and handled selectively using standard equipment. As such, sub-sampling down the core at intervals smaller than this measurement is redundant. Following mixing, sediment was placed directly into pre-treated (solvent washed, acid rinsed glass jars with Teflon lined lids) laboratory supplied jars and/or air tight zip lock bags, depending on the analyses required. For organic analyses, sediment was placed into the jars with zero headspace to prevent volatilisation. Where field QA/QC samples were required, sediment sampling procedures followed those outlined above.

Samples were stored in chilled eskies before being consigned under chain-of-custody documentation to the National Association of Testing Authorities (NATA) accredited analytical ALS and Advanced Analytical Australia (AAA). Samples being tested for ASS were kept on ice on board the vessel to negate the chance of sample spoilage. Samples were then collected by a laboratory representative at the start or end of each day and couriered to arrive within 48 hours to ALS. In order to conduct inter laboratory 'field split' analysis, ALS forwarded the required samples to AAA. Following receipt at the laboratories, samples were refrigerated or frozen prior to analysis.

The type of containers required and volume of material for individual analyses are provided in Table 5-4.

Table 5-4 Required Sample Container and Volumes

Analytical Parameter	Required Container	Required Volume [grams (g), wet weight]
Moisture Content	Glass jar	10-50
PSD by sieve and hydrometer	Plastic ziplock bag	50-200
TOC	Glass jar	10-50
Heavy metals and metalloids	Glass jar	10-100
Organotins	Glass jar	50-200
Nutrients	Glass jar	50-200
Ammonia (in solids)	Glass jar	
TPH, BTEX	Glass jar	100-250
Phenol, Phenolics	Glass jar	
OCP	Glass jar	
OPP	Glass jar	
PCB	Glass jar	
PAH	Glass jar	

Analytical Parameter	Required Container	Required Volume [grams (g), wet weight]
ASS	Plastic ziploc bag	500

Contingency Planning

To limit impacts on the timing of the field program, the sub-contractors employed to undertake sampling were required to have contingency plans in place for adverse weather conditions, stand down, demobilisation, remobilisation and equipment failure.

Weather and sea conditions (swell) prevented the program being completed in one session. Minimal delays were experienced due to equipment issues.

5.9 Sediment Analysis

5.9.1 General

In accordance with the NAGD Phase II assessment process, sediment samples were analysed with reference to Table 1 and Table 2 of the NAGD. Samples were also analysed with reference to the QASSIT (1998) for ASS analysis.

5.9.2 Practical Quantitation Limits

Practical Quantitation Limits (PQLs) are defined by the NAGD as ‘the lowest chemical analysis level that can be reliably achieved within specified limits of precision and accuracy during routine operating conditions’. The PQLs set out in Table 1 of Appendix A of the NAGD were used as a comparative measure of certain contaminants in relation to natural or expected levels. Additionally, PQLs can provide a reliable measure for organic substances that may have impacts at very low environmental concentrations. The relevant PQLs are shown in Table 5-5. It should be noted that some PQLs cannot be met by Australian laboratories (e.g. some pesticides). In these cases, the laboratory was able to achieve a laboratory equivalent of PQL less than the NAGD screening level.

Table 5-5 PQLs for Typical Sediment Contaminants and Other Analytical Parameters

Analyte	PQL
Moisture Content	0.1 %
Particle size (by sieve and hydrometer)	Size distribution (sieve + hydrometer) and rates of settlement after 50 % and 90 % of settlement in seawater if possible.
TOC	0.1 %
Heavy metals and metalloids	mg/kg (As, Cu, Cr, Pb, Zn, Ni: 1, Cd: 0.1, Hg: 0.01, M:10, Al; 200, Sb: 0.5, Fe:100, Ag: 0.1, Co: 0.5, V: 2, Se 0.1)
Organotins (MBT, DBT, TBT)	1 µg Sn/kg
Nutrients	0.1 milligram (mg)/kilogram (kg)
Ammonia (in solids)	0.1 mg/kg (NAGD 2009) 1 mg/ kg (ALS)
TPH	100 mg/kg
BTEX	200 µg/kg
Phenol/Phenolics	1 mg/kg
OCP	1 µg/kg
Total PCB	5 µg/kg
Non-OCPs including OPPs	10-100 µg/kg(each individual)
PAH	Individual - 5 µg/kg Sum of PAHs - 100 µg/kg
Chromium Suite, SPOCAS	As per QASSIT (1998)

Notes:

µg Sn/kg*, microgram tin per kilogram

5.9.3 Analysis of Sediment Samples

Sixty-nine sediment samples, plus QA/QC samples (including triplicates, field duplicates, field splits and batch split samples) were collected from the surface interval (0 to 0.5 mbss) and analysed for the detailed suite (Table 5-6). Sixty-seven samples (plus QA/QC samples) were collected from the 0.5 to 1.0 mbss and analysed for the basic suite.

To gain a better understanding of the physical properties of the proposed dredged material, as required by the NAGD, 80 additional samples collected from 1 mbss to the required dredge depth (where possible) were analysed for PSD by sieve and hydrometer and nutrients. Additionally, 32 samples were analysed for PSD by sieve and hydrometer using seawater collected from Abbot Point, as this method provided an understanding for sediment behaviour following release during dredging activities.

Sixty-four out of 69 locations were analysed for ASS, with all 64 samples (excluding QA/QC samples) analysed for the Chromium Suite. Five locations (SC38, SC39, SC41, SC45 and SC56) were not tested due to breach of holding times prior to analysis by the primary laboratory (see Section 7.5). Additionally, one sample (SC65-2) was not tested due to insufficient sediment being retrieved from the interval 0.5 to

1 m due to core refusal (refusal occurred at 0.6 m). This was unlikely to affect the results, as the ASS sampling was preliminary and undertaken to provide an estimate for its presence within the dredge area. Samples were analysed at every 0.5 m interval within the sediment cores, to 1 m below the dredge depth where possible. A total of 260 samples were analysed using the Chromium Suite of tests. In addition, 34 samples were also analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) for analytical comparison purposes.

Lastly, to allow an assessment for heavy metals and metalloids beyond the surface 0.5 m of sediment cores, an additional 53 samples were tested for locations SC37 to SC69 collected during February and March 2012.

A summary of the sediment analysis is provided in Table 5-6 below.

Table 5-6 Sediment Analytical Suites

Suite / Analyte	% of samples analysed
Detailed Suite: ◗ Moisture content ◗ Heavy metals and metalloids (arsenic, aluminium, antimony, cadmium, chromium, copper, cobalt , iron, lead, mercury, manganese, selenium, nickel, silver, vanadium and zinc) ◗ Nutrients and ammonia ◗ TOC ◗ PSD by sieve and hydrometer ◗ TPH and BTEX ◗ Phenol, Phenolics ◗ OCPs, OPPS and PCBs ◗ PAHs (naphthalene, acenapthalene, acenapthene, flourene, phenanthene, anthracene, total flouranthene, benzo [a] anthracene, benzo [a] pyrene, chrysene, dibenz [a,h] anthracene, pyrene, 2-methylnapthalene and sum of PAHs) ◗ Organotins (MBT, DBT and TBT)	100 % of samples from the 0 to 0.5 m sampling interval.
Basic Suite: ◗ Moisture content ◗ Nutrients and ammonia ◗ TOC ◗ PSD by hydrometer ◗ PAHs (naphthalene, acenaphthalene, acenapthene, flourene, phenanthene, anthracene, total flouranthene, benzo [a] anthracene, benzo [a] pyrene, chrysene, dibenz [a,h] anthracene, pyrene, 2-methylnapthalene and sum of	100 % of samples from the 0.5 to 1 m sampling interval.

Suite / Analyte	% of samples analysed
PAHs) ◗ Organotin (MBT, DBT, TBT) compounds	
Heavy metals and metalloids	20 % of all samples collected from 0.5 m sampling intervals and deeper
PSD by sieve and hydrometer and nutrients	56 % of all samples collected
PSD by sieve and hydrometer using seawater	12 % of all samples collected
ASS Chromium Suite	95 % of all samples collected
ASS SPOCAS Suite	12 % of all samples collected

Although some chemicals have not been identified in previous studies, the top 0.5 m of sediment was analysed for a detailed suite (detailed above in Table 5-6) to ascertain baseline conditions of the sediment. Also, as PAHs and organotins were identified in previous studies within the top 1 m of sediment, analysis during this program included PAH and organotins in the 0.5 to 1.0 m sediment core interval.

A full list of analyses conducted on each sample is provided in Appendix D.

5.10 Quality Assurance/Quality Control

5.10.1 Quality Assurance/Quality Control Procedures

QA/QC procedures were conducted in accordance with the NAGD and the NEPM (1999).

In summary:

- Weather and shipping movements were monitored daily (refer to Section 5.3).
- The vessel GPS along with a hand held GPS were used to locate and verify sampling locations.
- Samples were collected on a washed and pre-inspected survey vessel, with any sources of contamination stowed away.
- To prevent any cross contamination, samples were processed by personnel wearing disposable, nitrile, powder free gloves.
- Field observations and sediment characteristics were logged (refer to Section 5.8).
- Stainless steel, uPVC or Teflon equipment was used to minimise the risk of cross contamination of samples. The following four-step procedure was used to clean/decontaminate sampling equipment prior to obtaining each sample:
  - An initial rinse with freshwater
  - A decontamination solution (Decon 90, Decon Neutracon) scrub
  - A freshwater rinse

  - A final distilled water rinse
- Sediment samples were placed in sterilised laboratory jars and bags, then stored in eskies and refrigerated overnight. Samples were placed on ice during courier transport to the laboratory. Chain of Custody (CoC) documentation accompanied all samples.

5.10.2 Laboratory QA/QC Sample Analysis

As part of the NATA requirements, and in accordance with Appendix F of the NAGD, the primary laboratory (ALS) and secondary laboratory (AAA) incorporate a range of QA/QC methods to ensure accuracy of data. This includes the analyses of internal laboratory QA/QC samples (Table 5-7).

Table 5-7 Laboratory QA/QC Sample Details

Laboratory QA/QC sample	Details
Laboratory Blank	Laboratory blanks are samples submitted by the laboratory during sample analysis, to enable the identification of cross contamination of samples during laboratory preparation, extraction or analysis. Analysis of laboratory blank samples should result in a concentration not exceeding the detection limit for a particular contaminant.
Laboratory Standard (Control)	Standard samples are sediments of known composition that are included in each batch as a check on analysis accuracy.
Laboratory Spike (Surrogate and Matrix)	Surrogate spikes are known additions to each sample. The compounds are similar in composition to the target analyte, but are not likely to be present within the environment. Samples are spiked with the surrogate material and a calculation of the per cent recovery of the spiked amount against the returned concentration is performed. The per cent recovery result provides an indication of the ability of the laboratory to extract a specified contaminant type from the sample matrix. Typically surrogate spikes are performed only on organic compounds. Matrix spikes are undertaken by the laboratory to identify the amount of interference from the sediment matrix on contaminant recovery. Samples collected from the field are split from the base sample and spiked with a known contaminant concentration. The per cent recovery of the contaminant is then calculated.
Laboratory Duplicates	The precision of analysis performed by the laboratory is determined by the calculation of the relative per cent difference (RPD). The RPD is calculated based on a comparison of an intra-laboratory split of the sample material. Results from this methodology represent the per cent difference between two sample concentrations for a specific contaminant. As per the NAGD, if three or more samples are taken from one location, the use of relative standard deviation (RSD) is employed.

Data quality criteria for laboratory QA/QC samples are provided in Table 5-8.

Table 5-8 Data Quality Criteria for Laboratory QA/QC Samples

Data Type	Collection/Analysis Rate	Data Quality Limit
Laboratory Blank	One sample per batch of 20 samples or fewer	At or near detection limit of the method used.
Laboratory Standard	One sample per batch of 20 samples or fewer	NAGD states recovery limits of 80-120 %.
Laboratory Spike	One sample per batch of 20 samples or fewer	NAGD states that recovery limits of 75-125 % are generally acceptable for surrogate spikes.
Laboratory Duplicates	One sample per batch of 10 samples or fewer	NAGD states that the RPD should be within ±35 %.

5.10.3 Field QA/QC Sampling and Analysis

In addition to the internal laboratory QA/QC procedures, field QA/QC samples were collected and analysed during the fieldwork. Field QA/QC sampling was conducted in accordance with the NAGD requirements. The type of QA/QC samples collected is outlined below (Table 5-9).

Table 5-9 Field QA/QC Sample Details

Field QA/QC sample	Details
Field Triplicate	Field triplicate samples were taken from two replicate cores collected at the same location as a primary core and analysed to determine the variability of the physical and chemical characteristics of the sediment. Replicate cores were not homogenised with each other or with the primary core. In some instances, at least two additional cores per replicate core were collected to achieve sufficient sample for analysis.
Intra Laboratory Field Duplicate, Inter Laboratory Field Duplicate and Inter Batch Duplicate	Intra laboratory an inter laboratory field duplicate samples were replicate samples (at 0.5 m sampling interval) collected from the same homogenised sediment as a primary sample. These were analysed by the primary laboratory and secondary laboratory to identify variation associated with sub sample handling and variation in analytical protocol. One to two extra cores were collected at the primary location to allow for sufficient sample size.
Trip Blank	Field trip blank samples provide an indication of cross contamination from volatile substances during field sampling.

The data quality criteria for field QA/QC samples is presented in Table 5-10.

Table 5-10 Data Quality Criteria for Field QA/QC Samples

Data Type	Collection/Analysis Rate	Data Quality Limit
Field Triplicates	10 % of all sample locations	Contaminant results will be compared through calculation of the RSD, following the NAGD: "Field replicates (that is, two separate samples taken at the same location) should agree within an RPD (or for three samples at the one location, the RSD) of ±50 %, although they may not always do so where the sediments are very inhomogeneous or greatly differing in grain size."
Field Intra Laboratory (field duplicates) and Inter Laboratory Duplicates (field split)	5 % of all locations	RPD or RSD is to be less than 50 %. Samples were mixed and split to assess laboratory variation (samples collected for volatile analysis were not mixed), with one of the three samples sent to the secondary laboratory.
Inter Batch Duplicates (batch split)	One if more than one batch	One sample that was analysed in a previous batch was sent to determine the analytical variation between batches. Variability was accepted if the difference between samples was within 35 %.
Trip Blank	One per day of sampling	At or less than the detection limit for analysed contaminants (TPH C_6-C_9, BTEX).

Triplicates were collected from 10 % of all sampling locations, field duplicates and field splits were collected from 16 % of all sampling locations and field blanks were taken from 3 % of all sampling locations. Information on the parent sample locations and respective field QA/QC samples collected during the field program are provided in Table 5-11 below.

Table 5-11 Field QA/QC Samples

Parent Sampling Location	QA/QC Sample ID	Date	QA/QC Sample Type
SC09-1	FD01	24.06.2011	Field duplicate
SC08-2	FD02	25.06.2011	Field duplicate
SC15-2	FD03	25.06.2011	Field duplicate
SC23-1	FD05	17.09.2011	Field duplicate
SC24-1	FD06	18.09.2011	Field duplicate
SC24-2	FD07	18.09.2011	Field duplicate
SC01-1	FD08	19.09.2011	Field duplicate
SC42-1	FD09	21.02.2012	Field duplicate
SC45-1	FD10	23.02.2012	Field duplicate

Parent Sampling Location	QA/QC Sample ID	Date	QA/QC Sample Type
SC68-1	FD11	23.03.2012	Field duplicate
SC68-2	FD12	23.03.2012	Field duplicate
SC09-2	FS01	24.06.2011	Field split
SC08-1	FS02	25.06.2011	Field split
SC14-2	FS03	26.06.2011	Field split
SC23-1	FS05	17.09.2011	Field split
SC24-1	FS06	18.09.2011	Field split
SC24-2	FS07	18.09.2011	Field split
SC01-1	FS08	19.09.2011	Field split
SC42-1	FS09	21.02.2012	Field split
SC45-1	FS10	23.02.2012	Field split
SC68-1	FS11	23.03.2012	Field Split
SC68-2	FS12	23.03.2012	Field Split
SC35-1	BS01	19.09.2011	Batch split
SC45-2	BS02	23.02.2012	Batch split
SC06	T1, T2	24.06.2011	Triplicate
SC18	T3, T4	26.06.2011	Triplicate
SC28	T5, T6	18.09.2011	Triplicate
SC31	T7, T8	19.09.2011	Triplicate
SC53	T9, T10	21.02.2012	Triplicate
SC54	T11, T12	22.02.2012	Triplicate
SC69	T13, T14	23.03.2012	Triplicate

5.10.4 Validation of Laboratory and Field QA/QC Results

Upon receipt of laboratory results, QA/QC results were checked and reviewed for inconsistencies or illogical values. Validation of the laboratory data and field quality control samples were undertaken with reference to the requirements of NAGD, with results presented in Section 7. For the calculations of field RPD and RSD between parent samples and duplicate/triplicate samples, if the concentration of an analyte was greater than 10 times the PQL for that analyte, the RPD/RSD values were considered to be acceptable if differences were less than 50 % (as per NAGD and ALS Environmental 2005). When concentrations were less than 10 times the PQL, no limit to RPD or RSD values are applicable (ALS Environmental 2005).

5.11 Proposed Offshore Dredged Material Relocation Area

As well as the aforementioned sampling in the dredge area, 10 locations were sampled by BMT WBM on 19 June 2012 during an associated study of potential offshore dredge material relocation areas. This did not form part of the current SAP, as the selection of this dredged material relocation area was an outcome of the multi criteria analysis (MCA) workshop held for the assessment of dredged material relocation and reuse options (GHD 2012).

The objectives of the sampling and analysis of the proposed offshore dredged material relocation area in relation to this report, was to compare ambient baseline levels for sediments at the dredge area to those of comparable grain size at the relocation area in accordance with the NAGD. This would then allow determination of the suitability of the relocation area for acceptance of the dredged material in relation to potential impacts that may be caused by substantial differences in sediment type (e.g. calcareous versus terrigineous), sediment grain size (if greatly differing) and heavy metal and metalloid and nutrient concentrations.

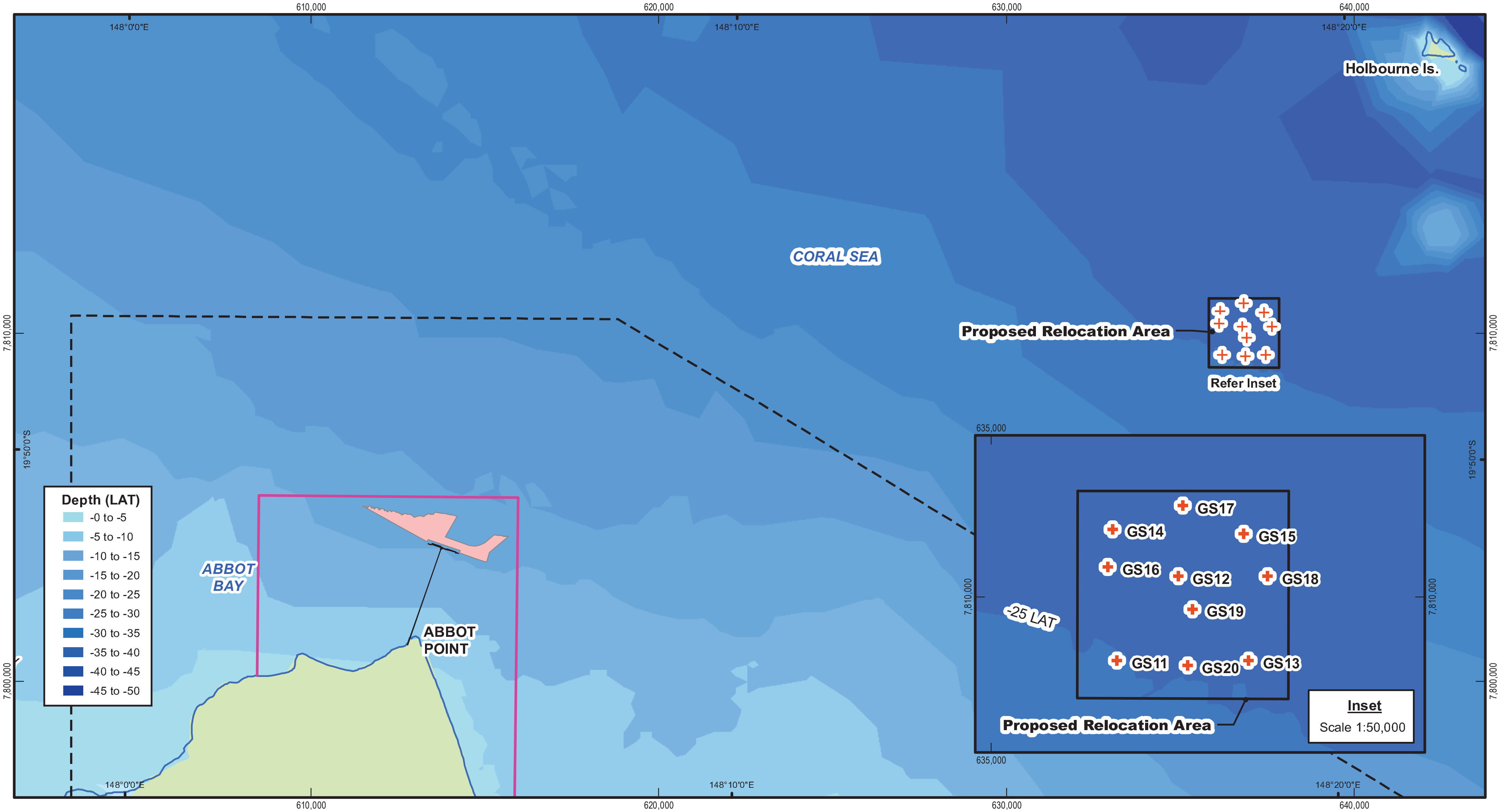
The proposed offshore dredged material relocation area is approximately 24 km north-north-west of the dredge area. This area is located within the GBRMP and the GBRWHA and has approximate depths of water ranging from -39 m and -44 m LAT. The current footprint of the relocation area is approximately 400 ha with approximate dimensions of 2 km^2 (Figure 5-7). A detailed description of the proposed offshore dredged material relocation area's environmental values is provided in the Project Public Environment Report (EPBC 2011/6213 / GBRMPA G34987.1.).

Sampling was conducted in accordance with the requirements of the NAGD. At each sampling location, a 0.028 m^2 Van Veen Grab was used to collect a sample of surface sediment (0 to 0.5 m depth interval). All equipment was cleaned prior to use as per the requirements outlined in Section 5.10.1. Sampling locations within the proposed offshore dredged material relocation area are shown on Figure 5-7. The prefix GS refers to all locations were grab samples were taken e.g. GS-01.

Sediments were processed and transported to the laboratories ALS and AAA as per the requirements outlined in Section 5.8 to 5.10. One field triplicate location (GS11) and one intra-laboratory duplicate (GS12) were also collected in accordance with the requirements of the NAGD. Sediments were assessed for:

- PSD by sieve and hydrometer
- Heavy metals and metalloids
- Nutrients

The proposed offshore dredged material relocation area results are discussed in Section 6.3.1 and 6.3.3 with tabulated results provided in Appendix G. For PSD by sieve and hydrometer values, results were compared between the average sediment compositions from both the dredge area and the proposed offshore dredged material relocation area. Additionally, the concentrations of heavy metals and metalloids and nutrients were compared between the two areas. This comparison was undertaken as per the NAGD, with the mean concentrations of the aforementioned analytes from the dredge area, compared to the 80th percentile concentrations for corresponding analytes within the proposed offshore dredged material relocation area.



1:150,000 (at A4)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

✚	Sediment Sampling (BTM WBM, May 2012)	🟥	Dredge Area
━	Great Barrier Reef Marine Park Boundary	━	Terminal 1 Infrastructure
- - -	Port Limits		

North Queensland Bulk Ports Corporation Limited
Abbot Point, QLD, T0, T2 and T3 Capital Dredging
Sediment Sampling and Analysis Plan
Implementation Report

Job Number	41-24541
Revision	A
Date	03 Jul 2012

Sediment Sampling at Proposed Offshore Relocation Area

Figure 5-7

G:\41\24541\Tech\GIS\Maps\PDFs_MXDs\41-24541-067_OffshoreSamps1Area_revA.mxd

Level 4, 201 Charlotte St Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: Aurecon: dredge areas - 2012; Aurecon & GHD: bathymetric contours - 2012. Created : jvc

5.12 Investigation Thresholds

5.12.1 Chemical Investigation Thresholds for Sediment

The adopted sediment investigation thresholds for this project were selected based on the possible end used for the sediment after dredging. The sediment investigation thresholds (Table 5-12) are based on the following guidelines:

- Offshore relocation of dredged material – NAGD screening levels and sediment quality high values. The NAGD requires normalisation of organic contaminants (such as hydrocarbons, pesticides and organotins) to 1 % TOC prior to comparison to the screening levels. This was undertaken to enable a comparative measure of the bioavailability of the analytes. From these values, and all other relevant analytes, the 95 % UCL were compared to the corresponding NAGD screening levels. This was conducted using ProUCL 4.0 (2007), as ProUCL calculates the most reliable 95 % UCL value based on the specific distribution of data points within each data set. For data sets that appear normally distributed, a Student's t-Test was used to calculate each 95 % UCL, while for data sets that appear log-normal or with a gamma distribution, a non-parametric jack-knife UCL test was used to calculate the 95 % UCL. For determinations of the 95 % UCL, where analytes recorded concentrations less than the laboratory PQL, these concentrations were multiplied by 0.5, with the resultant concentration being used in the dataset to produce 95 % UCL (NAGD 2009). Only parent samples were considered in the calculation of the 95 % UCL.
- Onshore relocation or reuse of dredged material – NEPM (1999) environmental investigation levels (EILs). These are ecological based investigation levels that allow the significance of identified contamination to be determined. They are a requirement for a risk based site assessment and assist in determining the need for additional investigation. Where EILs have not been established the health-based investigation level (HIL) A for 'standard residential use' was adopted.

Table 5-12 Contaminant Screening and Investigation Levels for Sediment

Chemicals	NAGD (2009) Screening Levels (High Values in brackets)	NEPM (1999) Investigation Levels	
		EIL	HIL A
Heavy Metals and Metalloids (mg/kg)			
Arsenic	20 (70)	20	100
Cadmium	1.5 (10)	3	20
Chromium	80 (370)	400	III = 12 % VI = 100
Copper	65 (270)	100	1000
Lead	50 (220)	600	300
Mercury	0.15 (1)	1	15
Nickel	21 (52)	60	600
Zinc	200 (410)	200	7000

Chemicals	NAGD (2009) Screening Levels (High Values in brackets)	NEPM (1999) Investigation Levels	
		EIL	HIL A
Nutrients (mg/kg)			
Total Phosphorus	NE	NE	NE
Total Nitrogen	NE	NE	NE
TPH (mg/kg)			
TPH $C_6 – C_9$	NE	100[1]	NE
TPH $C_{10} – C_{14}$	NE	100[1]	NE
TPH $C_{15} – C_{28}$	NE	1000[1]	NE
TPH $C_{29} – C_{36}$	NE	1000[1]	NE
TPH	550[2]	NE	NE
BTEX (mg/kg)			
BTEX	NE	7[1]	NE
Benzene	NE	1	NE
PAHs (µg/kg)			
Total PAHs	10,000 [2] (45,000-50,000) [2]	NE	20,000
Benzo(a)pyrene	NE	NE	1
OCP (µg/kg)			
Total Chlordane	0.5 [2] (6) [2]	NE	50,000
DDE	2.2 [2] (27) [2]	NE	NE
4.4 DDD	2 [2] (20) [2]	NE	NE
DDT Total	1.6 [2] (46) [2]	0.2	200
Dieldrin	0.280 [2]	0.2	10
Endrin	10 [2]	NE	NE
G BHC (lindane)	0.32 [2] (1.0) [2]	NE	NE
Aldrin	NE	NE	NE
Aldrin + Dieldrin	NE	200	10000
Heptachlor	NE	NE	10000
Radionuclides (Bq/g)			
Radionuclides	35	NE	NE
Organotins			
MBT	NE	NE	NE
DBT	NE	NE	NE

Chemicals	NAGD (2009) Screening Levels (High Values in brackets)	NEPM (1999) Investigation Levels	
		EIL	HIL A
TBT	9 µg Sn/kg [2] (70 µg Sn/kg [2])	NE	NE
Miscellaneous			
Phenols	NE	NE	8500
Sulfate	NE	200	NE

Notes:
NE: Not established
1: QLD EPA unpublished guidelines for hydrocarbons in soil (QLD EPA 1999).
2: Normalized to 1 % TOC.

5.12.2 ASS Investigation Thresholds

In Queesnland, action criteria state that if ASS are disturbed at a site, the area needs to be carefully managed. Action criteria are based on the net acidity, calculated as the sum of existing and potential acidity, less any neutralising capacity. This is usually calculated as equivalent sulfur (eg. s- Titratable Actual Acidity (TAA) + S_{POS} in %S units) or equivalent acidity (eg. TAA + a-S_{POS} in mol H^+/tonne units). As clay content tends to influence a soil's natural buffering capacity, the action criteria are grouped by three broad texture categories; coarse, medium and fine. The action criteria for medium and fine textured soils are reduced to 0.03 % oxidisable sulfur (S) in cases where greater than 1000 tonnes (t) of soil is being disturbed.

The highest laboratory result is used to compare against the action criteria. Soils that require treatment are those that contain acid (mol H^+/tonne) or oxidisable sulfur levels (%S) in excess of the action criteria. As the proposed dredging will disturb greater than 1000 t of sediment, the action criteria for the site is, therefore, 0.03 % sulfur equivalent and 18 mol H^+/t acidity equivalent.

An explanation of the analytical measurements that are used in conjunction with the guidelines to determine if the soils are actual or potential ASS, is provided in Table 5-13.

The chromium reducible sulfur (SCR) method (otherwise known as the Chromium Suite) is the preferred technique for estimating acid-producing inorganic sulfur in ASS, particularly near the action limits and for organic-rich samples. If differences occur between results from various sulfur methods used to predict sulfidic acidity (eg. Chromium Suite, SPOCAS), then the Chromium Suite result should take precedence for use in the acid base account.

5.12.3 Outliers

As stated in the NAGD, it is common for outliers to occur in chemical data sets, particularly for TBT and these may be due to laboratory or other errors. Outliers can be detected by standard statistical means, such as box or scatter plots, or values exceeding two standard deviations (SD). For the present sampling program, where outliers were detected, the stored portion of the sample was reanalysed in triplicate, and if the original result is not confirmed, it can be discarded (TBT only) in favour of the mean of the triplicates. This occurred for a single sample (SC38-2) that recorded a high concentration of Arsenic. On resampling, however, the high original concentration was confirmed.

Table 5-13 Analytical Measurements for ASS

Analytical Methods	Definition
SPOCAS	The SPOCAS method involves the measurement of pH, titratable acidity, sulfur and cations on two soil sub-samples. SPOCAS analysis enabled the sulfur and acid trails of ASS to be directly compared using a single method. Where agreement between the acid and sulfur trails was poor, data provided by analysis of calcium (Ca) and magnesium (Mg) (indicating the presence of shell or naturally occurring carbonate) often accounted for the apparent discrepancy. Samples were pre-treated with KCl in preparation for extraction. KCl neutralises lightly extractable substances that are outside determined analytical parameters. The pH (pHKCl) is then measured in preparation for titration. The Titratable Actual Acidity (TAA) (the first component of the 'acidity trail') is a measure of the soluble and exchangeable acidity already present in the soil, often as a consequence of previous oxidation of sulfides. The Titratable Peroxide Acidity measurement (TPA) (the second part of the acid trail) is the net result of the reactions between the acidifying and neutralising components in the soil (following peroxide digestion). A TPA of zero indicates that for a finely ground sample (under laboratory oxidation conditions), the soil's buffering/acid neutralising capacity is equal to or exceeds the potential acidity from oxidation of sulfides. A valuable feature of the TPA peroxide digestion component is that for soils with pHOX >6.5, any excess acid neutralising capacity (ANC) can be quantified by means of an HCl titration. The sulfidic acidity component, termed Titratable Sulfidic Acidity (TSA), is determined by the difference between TPA and TAA. The 'sulfur trail' of SPOCAS (ie. SPOS) gives a measure of the maximum 'oxidisable' sulfur (usually predominantly sulfides) present in the soil sample. The chemical oxidising conditions employed in the laboratory are often more rigorous than those experienced in the field. As a result the SPOS may, as a consequence, include some of the sulfur from the organic fraction in soil layers with appreciable organic matter. In such soil samples, SPOS is often slightly greater than SCR (which specifically excludes organic forms of sulfur). Generally, SCR and SPOS results are well correlated for reduced or Potential Acid Sulfate Soils (PASS) samples, but may differ on partially oxidised and surface samples. In the SPOCAS method, the SPOS (sulfur trail) result can be compared to the TSA (acid trail) result, provided the two quantities are expressed in equivalent units. In soil where the acid trail is lower than the sulfur trail (but the TPA is >0), calculation of the reacted calcium (CaA) and magnesium (MgA) can provide strong evidence for the presence of acid neutralising components in the soil.
Chromium Suite	The Chromium suite is a set of independent analytical methods, each of which determines a component of the acid base account. For all cases, the initial step in the chromium suite is to measure the reduced inorganic sulfur content (by the chromium reducible sulfur method), to estimate the potential sulfidic acidity (the first component of the ABA equation).

Analytical Methods	Definition
	If pHKCl is >6.5, the presence of carbonates (or other minerals/compounds capable of providing acid neutralising) is possible. The greater the pH (i.e.. greater than 6.5), the more likely acid neutralising will occur. Determining the ANC is desirable, as this will decrease the net acidity, and may even reveal that there is no net acidity present within the soil (ie. that there is net neutralising). If this is the case, it indicates that the soil may not require liming. An estimate of ANC can be made from: the inorganic carbon CIN, the net acid soluble calcium, CaNAS (and MgNAS if dolomite/magnesite is present) if non-carbonate forms of neutralising are suspected, or from acid neutralising capacity by back-titration (ANCBT).

6. Discussion of Results

6.1 Field Observations of Sedimentary Characteristics

A summary of the field observations of sedimentary characteristics are provided below. Details of individual sediment cores are provided on the sediment logs and photographs in Appendix C.

6.1.1 Visual Observations

Sediment cores collected within the dredge area generally consisted of a mixture of terrigineous sandy clay, clayey sand or silty clay. Some straight clays, sands and gravely sands were also noted. Fine to medium sand, however, was the predominant sediment type. Surface sediment, within the first 1 m, tended to be dark grey to grey-brown in colour, grading typically to an orange-brown mottled pale grey, dark brown or green-grey coloured sandy clay or sandy silty clay. Clay content typically increased with depth, largely typifying lithology beyond 1.5 mbss. Sediments were typically wet and loose near the surface of the seabed, grading to moist with depth. Consistency of clays varied from very soft to very stiff, with increasing stiffness with depth, which caused the majority of core refusals. Shell grit was encountered throughout the majority of the sediment cores, particularly near the surface, with occasional lenses of whole and broken shells, coral pieces and terrestrial gravels. Overall, these results indicate that natural residual geologic materials (as opposed to recently transported geologic materials) are present below 0.5 to 1 m. Additionally, cores showed low variability among sampling locations and the increase of clays from the underlying geology of sediment below 1 m was relatively homogenous throughout the dredge area.

With the exception of two cores that recorded the presence of coal pieces in surface sediments (SC20 and SC24), there were no visual or olfactory indications of contamination (e.g. fill material, contaminant staining or odours) detected during sediment logging and sampling. The presence of these coal pieces however, was not confirmed by laboratory analysis. Excluding these samples, some sediment layers recorded faint to strong organic odours, largely from decaying organic material. When odours were encountered, the lithology was typically characterised by silts and fine sands in the surface 1 m.

Sediments within the proposed offshore dredged material relocation area were dark brown, having medium plasticity and with a 5 mm layer of light brown silt. These sediments consisted primarily of silt and clay with some fine to coarse grained sands. The overall sand composition in these sediments was less than the dredge area, with the sediment at the proposed offshore dredged material relocation area being part of a large, terrigenous, offshore band of fine sediments.

6.2 Physical Analysis

Tabulated results are provided in Appendix E. Laboratory documentation associated with PSD by sieve and hydrometer analysis is provided in Appendix H, and laboratory issued PSD graphs are provided in Appendix I.

6.2.1 Moisture Content

The moisture content of sediment samples from the dredge area ranged from 6.5 % to 54.6 %, with an average moisture content of 26 %. Overall, moisture content generally decreased with depth.

At the proposed offshore dredged material relocation area, moisture content ranged from 49 % to 57 %, with an average moisture content of 53.1 %. This higher moisture content at this area in comparison to the dredge area was likely due to the grab sampling only capturing surface sediments.

6.2.2 Particle Size Distribution

In addition to sediment logging in the field, PSD by sieve and hydrometer was conducted for 212 of 236 sediment samples from the dredge area (not including QA/QC) (Appendix E). PSD analysis demonstrated that sediments were relatively homogenous across sampling locations within the 0 to 0.5 m depth interval. However, a decrease in sand content was observed at the eastern sampling locations within the T0 berth and apron area.

As with the variations in particle size from eastern surface sediments, particle size showed higher variation with increasing depth. Sand content, while still generally predominant, did decrease, whilst clay and silt content increased. From the deepest sampling intervals (e.g. 3 to 3.5 and 4 to 4.5 m), silt and sand content was similar. Unlike surface sediments, there was no obvious trend in particle size distribution along the western-eastern gradient.

Overall, results demonstrated that the sediments contained an average of 7.7 % gravel (>2 mm), 54 % sand (0.06-2 mm), 19 % silt (2-60 µm) and 20 % clay (<2 µm) (Table 6-1). No cobbles were present in the sediments. Graphical representation of PSD in individual samples is provided in Figure 6-1 to Figure 6-15. It should be noted that for comparison among sampling locations, PSD figures are presented for every sampling interval of homogenised cores. Figures are presented with sampling locations arranged from western-most locations to eastern-most locations across the dredge area, with sample intervals (e.g. 0 to 0.5 m) grouped together.

Surface sediments at the proposed offshore dredged material relocation area (BMT WBM 2012) consisted primarily of silts (average 50.5 %), followed by clays (36.5 %), sands (12.6 %) and gravel (0.5%) (Table 6-1 and Appendix G). This differed to the PSD results of the surface sediments within the dredge area, which had a greater percentage of sands. A relatively small proportion of the sediments were gravels, and no cobbles were found. The difference in PSD results suggest that the proposed offshore dredged material relocation area is a lower energy environment than the dredge area, which would be typical of an area with a significantly greater depth (-39 to -44 m LAT compared to dredge area depths of -16 m to -18.5 m LAT). Additionally, as benthic mapping demonstrated the proposed offshore dredged material relocation area was within a large ‘mud’ area offshore from Abbot Point, it was likely that this area would record finer grained particles (BMT WBM 2012).

Composition of surface sediments was relatively similar across the proposed offshore dredged material relocation area (Figure 6-16).

Table 6-1 Statistical Summary of Sediment Particle Size Distribution by Hydrometer

Particle Size		% PSD at Dredge Area	% PSD using seawater at Dredge Area	% PSD at Proposed Offshore Dredged Material Relocation Area
Cobbles (>6cm)	Minimum	0	0	0
	Maximum	0	0	0
	Average	0	0	0
	Standard Deviation	0	0	0
Gravel (>2 mm)	Minimum	1	2	0
	Maximum	35	21	5
	Average	7.7	5.2	0.5
	Standard Deviation	5.4	4.2	1.4
Sand (0.06 mm -2.00 mm)	Minimum	25	31	7.0
	Maximum	83	83	26.0
	Average	54	52	12.6
	Standard Deviation	11	10	5.4
Silt (2.00 µm - 60 µm)	Minimum	2	15	34.0
	Maximum	47	66	59.0
	Average	19	43	50.5
	Standard Deviation	8.2	9.6	6.5
Clay (<2 µm)	Minimum	7	<1	29.0
	Maximum	41	<1	40.0
	Average	20	<1	36.5
	Standard Deviation	5.4	0	2.9

Figure 6-1 Particle Size Distribution for 0 to 0.5 m sampling interval: SC02-1, SC03-1, SC05-1 to SC17-1

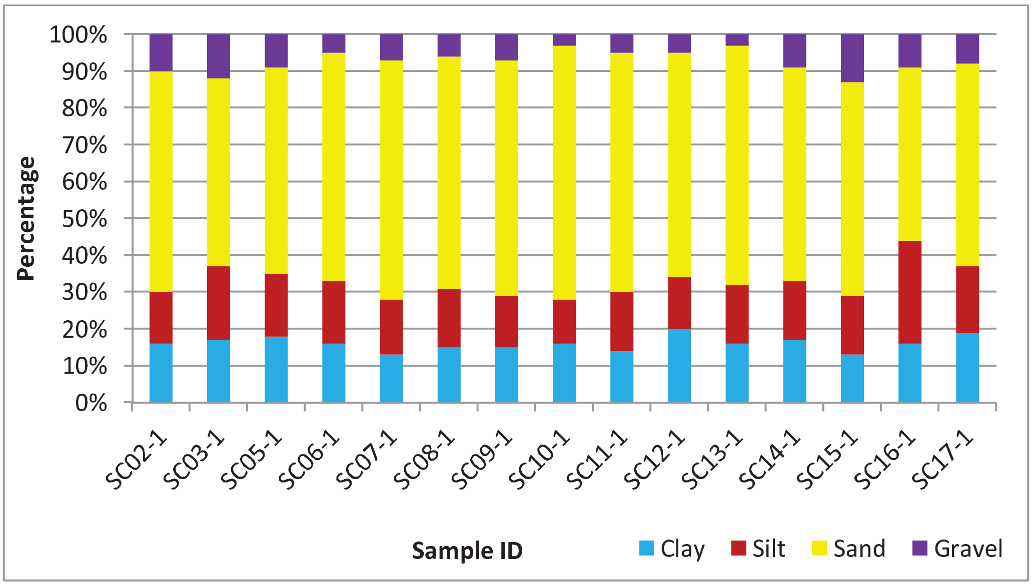


Figure 6-2 Particle Size Distribution for 0 to 0.5 m sampling interval: SC04-1, SC18-1 to SC29-1

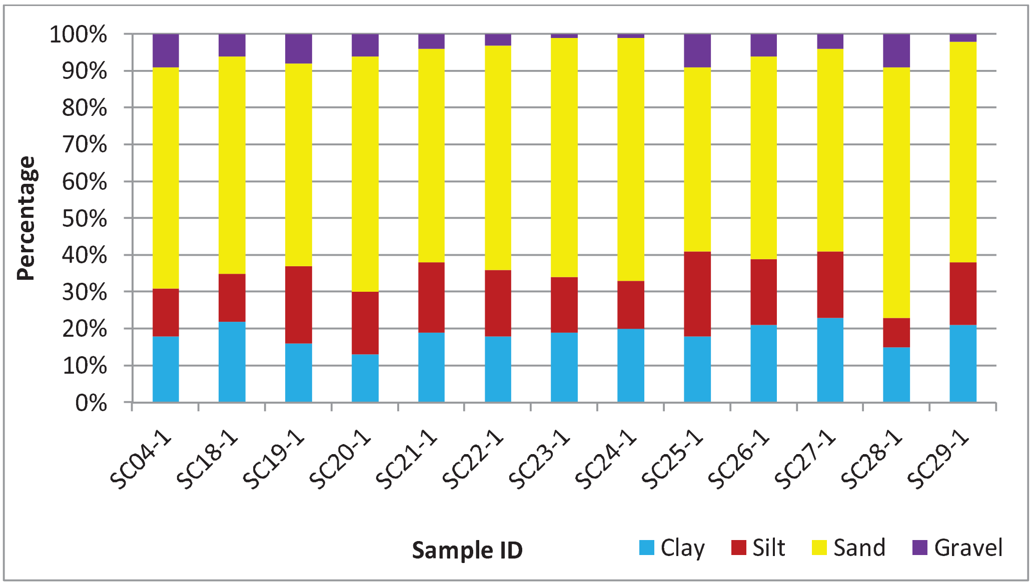


Figure 6-3 Particle Size Distribution for 0 to 0.5 m sampling interval: SC01-1, SC30-1 to SC39-1, SC43-1, SC47-1, SC49-1

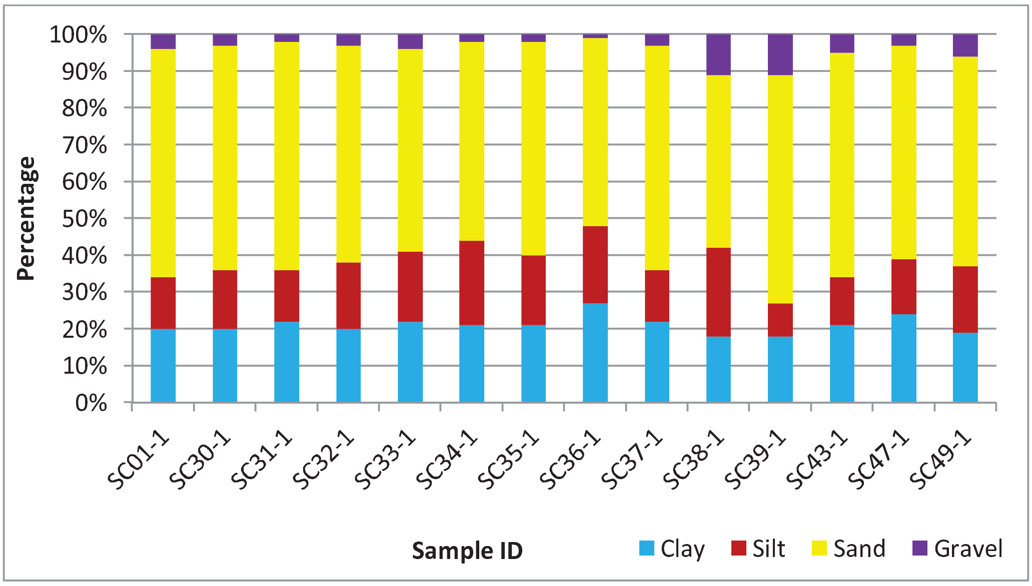


Figure 6-4 Particle Size Distribution for 0 to 0.5 m sampling interval: SC40-1 to SC42-1, SC44-1 to SC46-1, SC48-1, SC50-1 to SC55-1

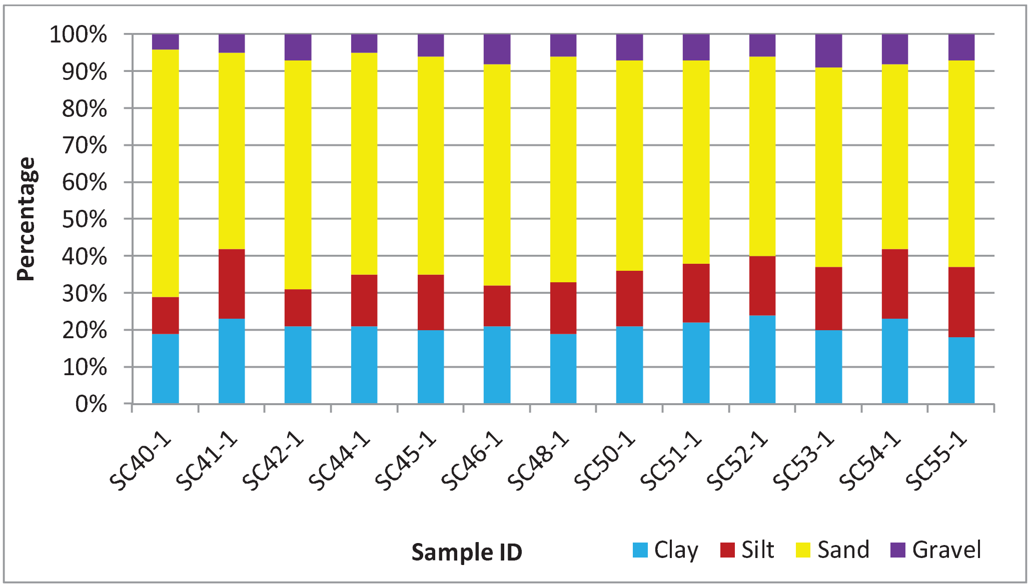


Figure 6-5 Particle Size Distribution for 0 to 0.5 m interval: SC56-1 to SC59-1, SC61-1, SC65-1 to SC67-1, SC60-1, SC62-1 to SC64-1, SC68-1, SC69-1

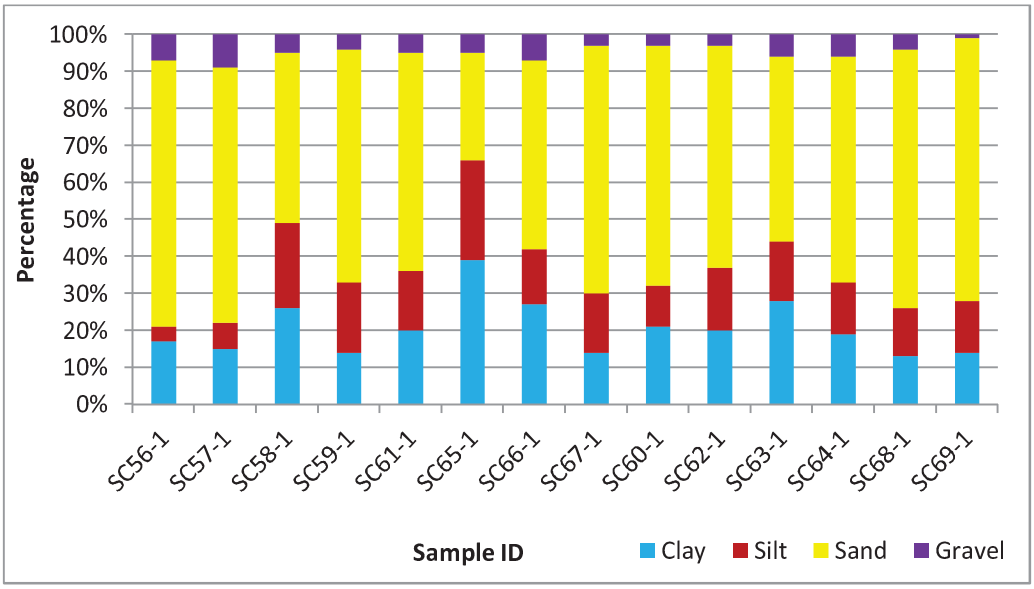


Figure 6-6 Particle Size Distribution for 0.5 to 1.0 m sampling interval: SC02-2, SC03-2, SC05-2 to SC15-2, SC04-2, SC16-2, SC17-2

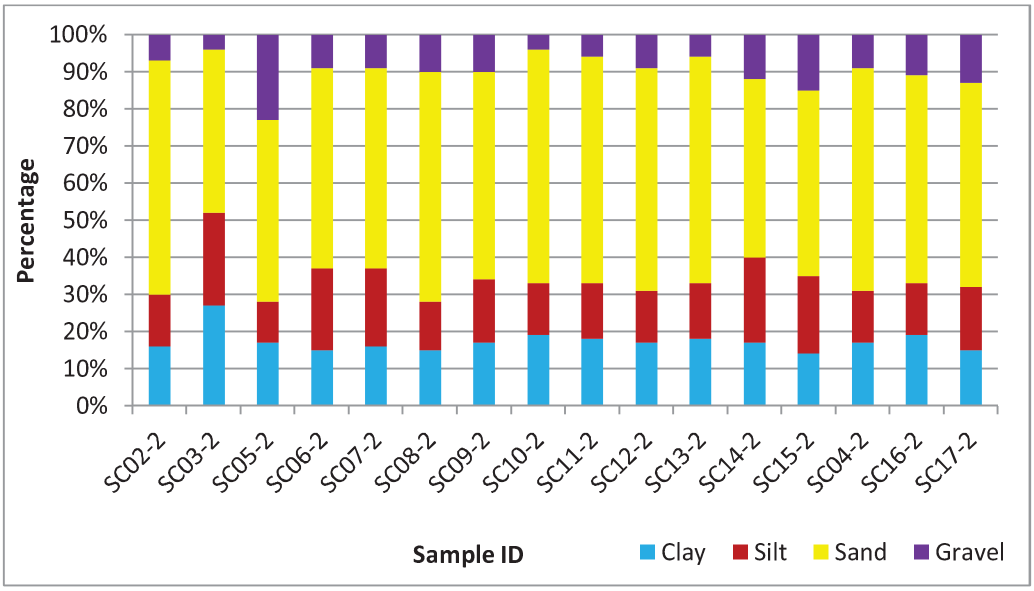


Figure 6-7 Particle Size Distribution 0.5 to 1.0 m sampling interval: SC18-2 to SC29-2, SC01-2, SC30-2, SC31-2

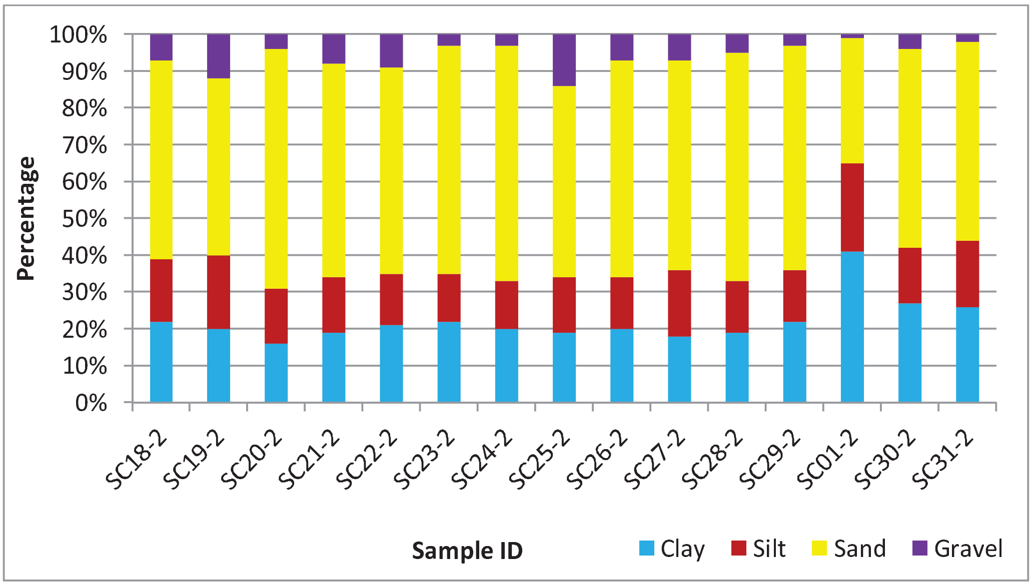


Figure 6-8 Particle Size Distribution 0.5 to 1.0 m sampling interval: SC32-2 to SC39-2, SC43-2, SC47-2, SC49-2, SC40-2 to SC42-2, SC44-2, SC45-2

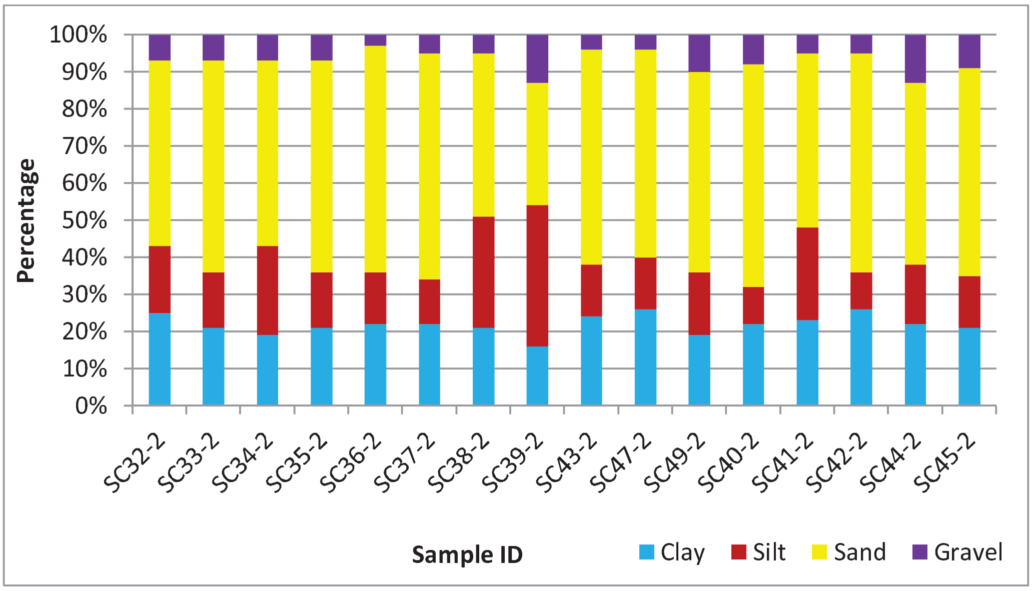


Figure 6-9 Particle Size Distribution 0.5 to 1.0 m sampling interval: SC46-2, SC48-2, SC50-2 to SC52-2, SC57-2 to SC64-2, SC67-2 to SC69-2

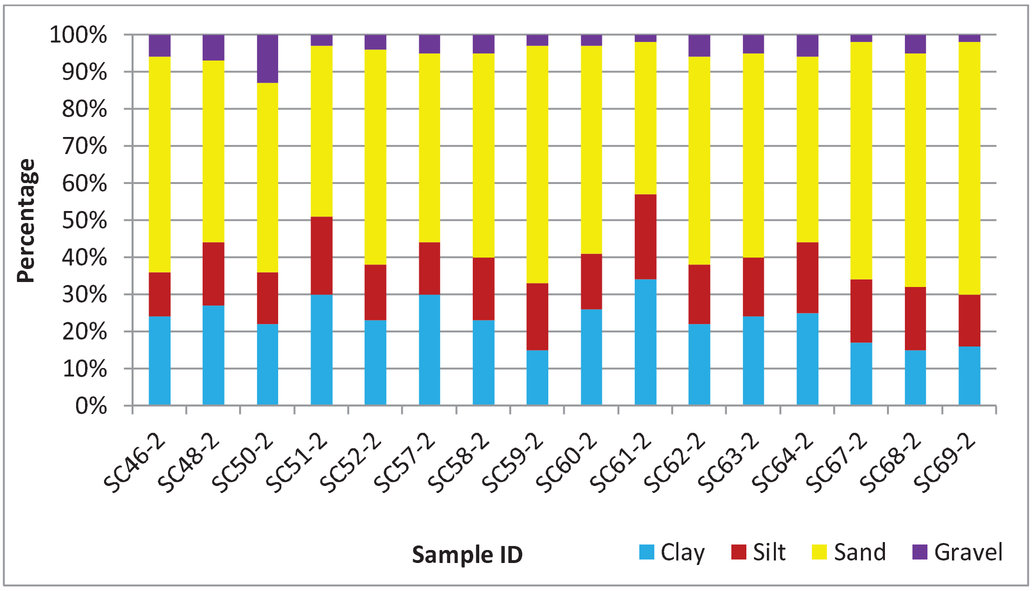


Figure 6-10 Particle Size Distribution 1.0 to 1.5 m sampling interval: SC02-3, SC03-3, SC05-3 to SC13-3, SC15-3 to SC17-3

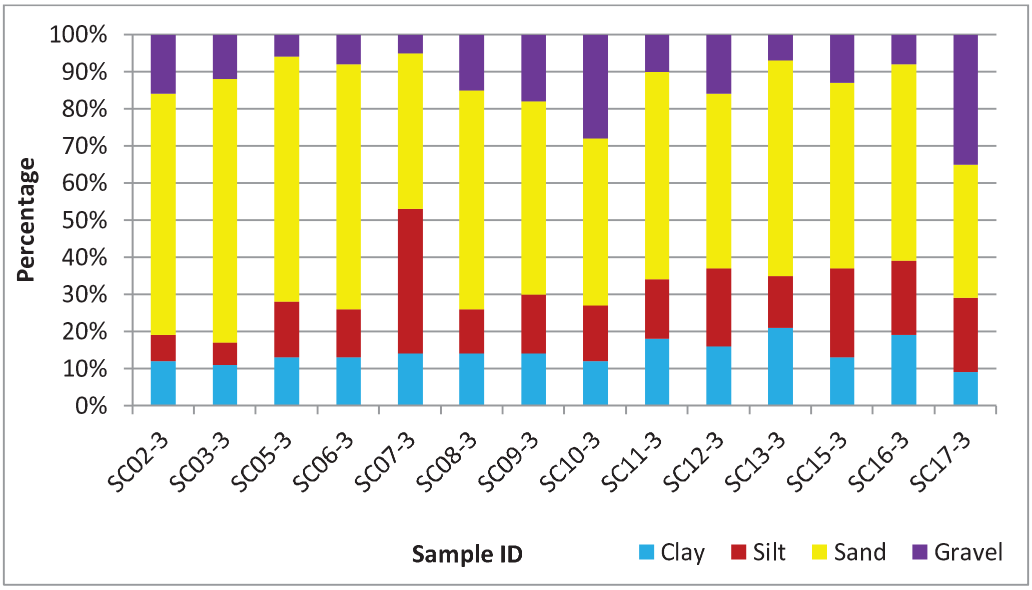


Figure 6-11 Particle Size Distribution 1.0 to 1.5 m sampling interval: SC04-3, SC18-3 to SC30-3

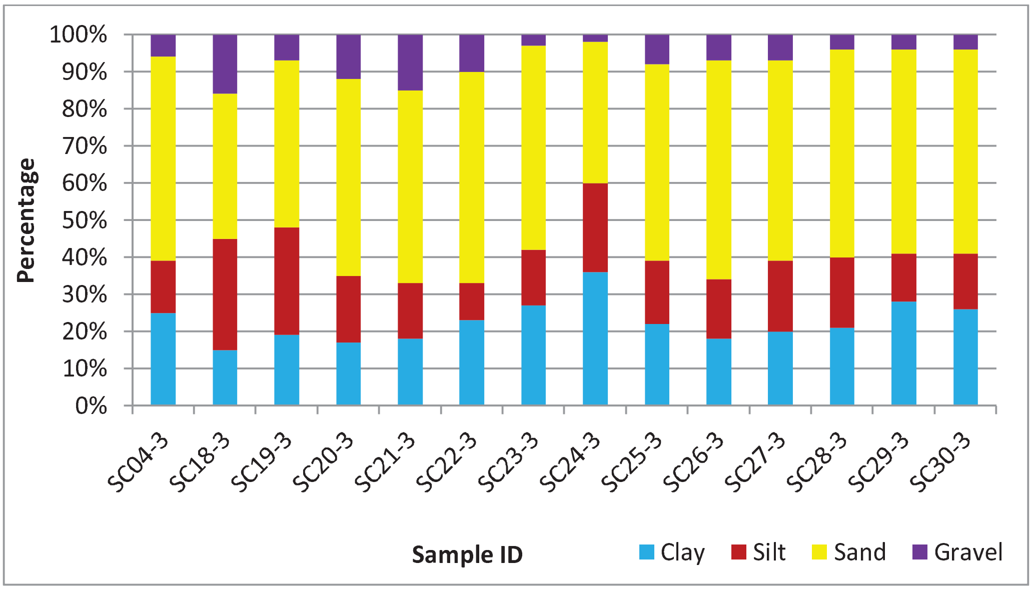


Figure 6-12 Particle Size Distribution 1.0 to 1.5 m sampling interval: SC01-3, SC31-3 to SC36-3, SC40-3, SC44-3, SC59-3, SC60-3, SC62-3, SC67-3 to SC69-3

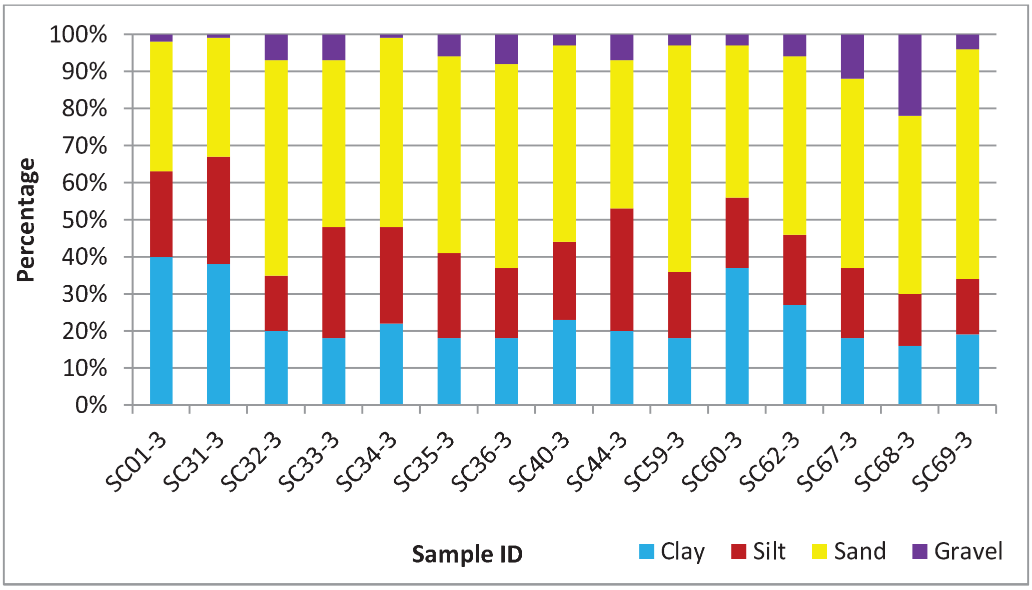


Figure 6-13 Particle Size Distribution 2.0 to 2.5 m sampling interval: SC09-5 to SC11-5, SC13-5, SC18-5, SC20-5 to SC24-5, SC27-5

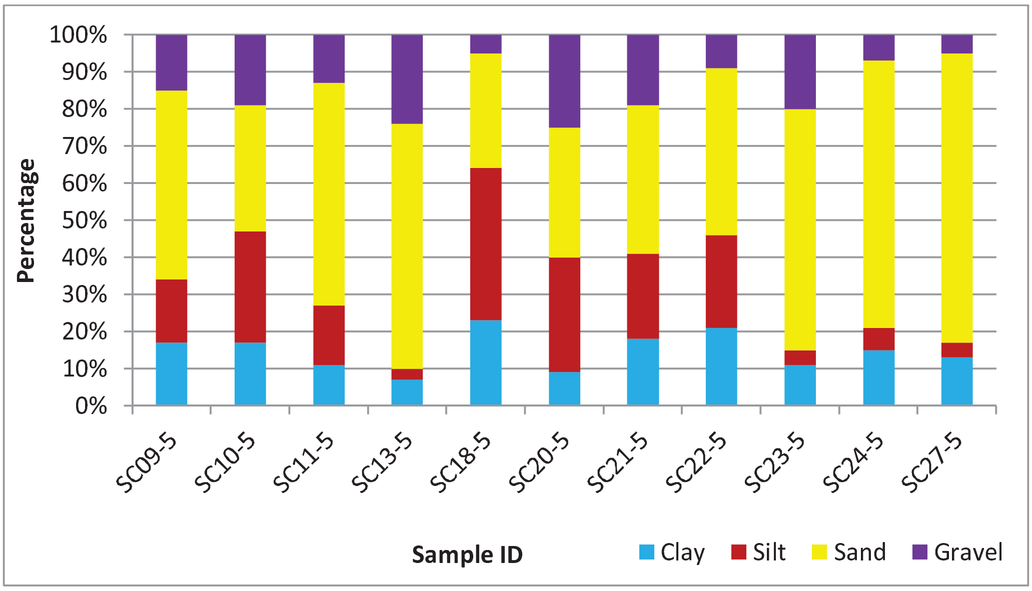


Figure 6-14 Particle Size Distribution 2.0 to 2.5 m and 3.0 to 3.5 m sampling interval: SC29-5, SC33-5 to SC36-5, SC59-5, SC67-5, SC09-7 to SC11-7, SC13-7, SC18-7

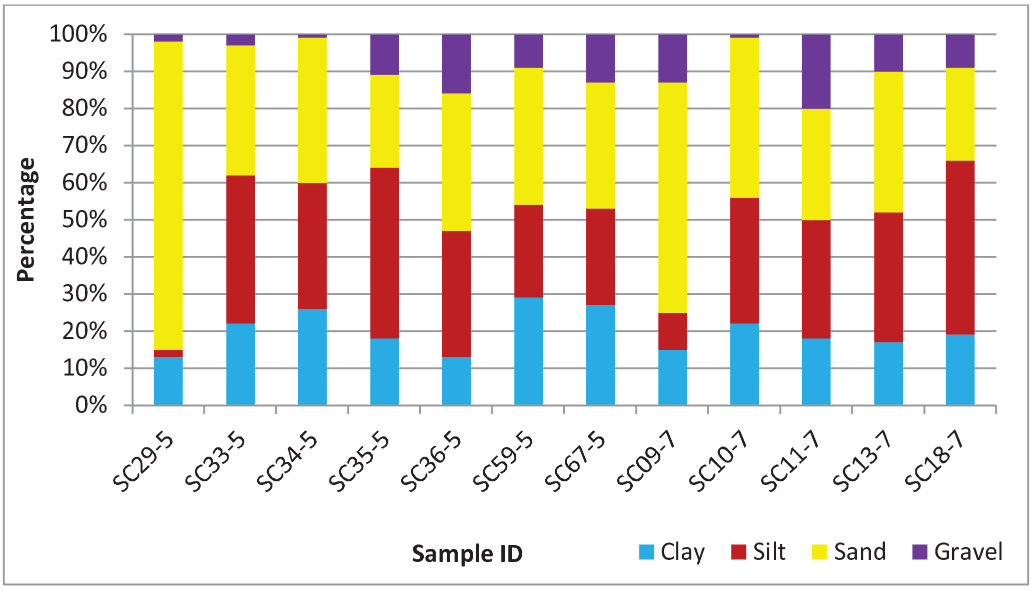


Figure 6-15 Particle Size Distribution for 3.0 to 3.5 m and 4.0 to 4.5 m sampling interval: SC20-7 to SC23-7, SC29-7, SC36-7, SC09-9 to SC11-9, SC20-9, SC21-9, SC36-9

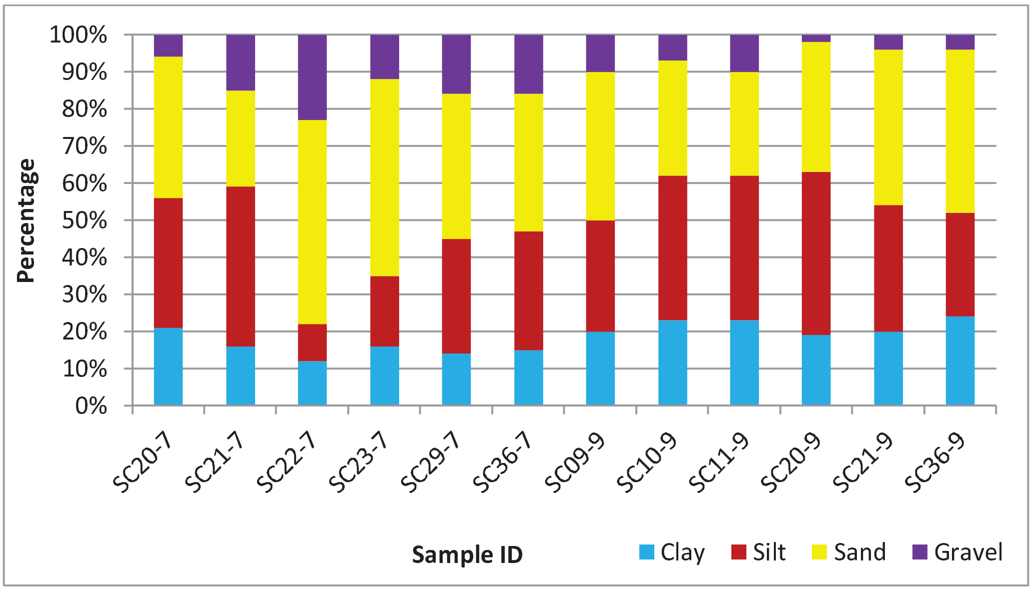
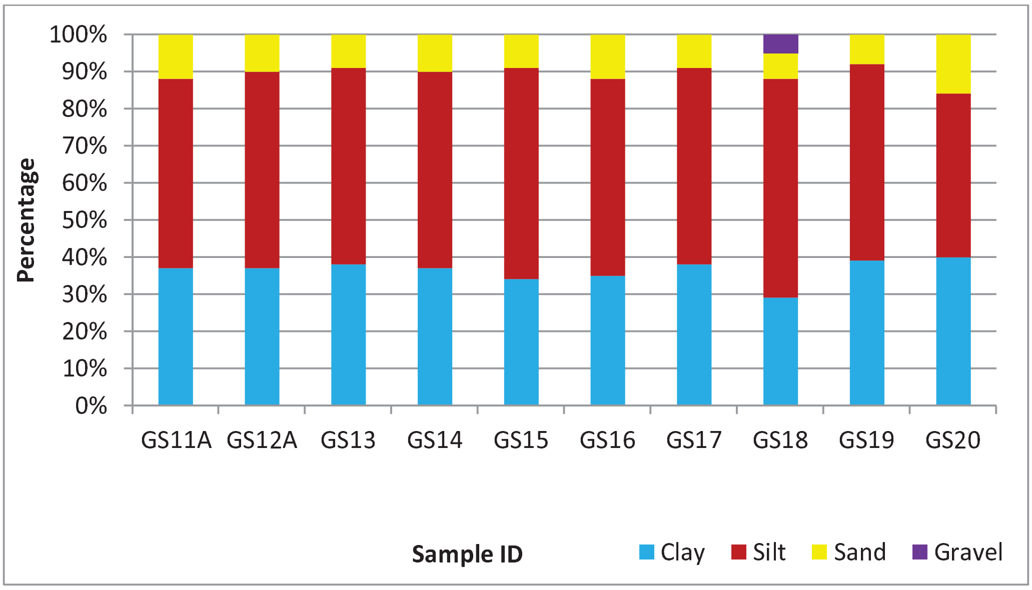


Figure 6-16 Particle Size Distribution for surface sediments sampled at the Proposed Offshore Dredged Material Relocation Area (by van veen grab): GS11A, GS12A, GS13, GS14, GS15, GS16, GS17, GS18, GS19, GS20



PSD by sieve and hydrometer was also undertaken on 32 samples from the dredge area using a medium of seawater collected from Abbot Point, with no dispersion agent added. Results showed that the sediment contained an average of 5.2 % gravel, 52 % sand and 43 % silt (Table 6-1). As with regular PSD, sediment compositions from the surface intervals were relatively consistent, with sands being predominant. As depth increased, sediment composition became more varied. There was no obvious trend in PSD across the western-eastern gradient. The results of the PSD by sieve and hydrometer using seawater are presented in Figure 6-17 to Figure 6-20. It should be noted that clay particles were not identified using this method. When seawater is used as a dispersion solution for PSD analysis, it acts as a flocking agent that causes the majority of the sediment to fall out of suspension over a short period of time. In addition, PSD by sieve and hydrometer using seawater generally demonstrated an increased percentage of silts within the sediment (due to clay flocking), and a decrease in the overall percentage of sands.

Although regular PSD analysis provides a better representation of the overall sediment composition, the value of undertaking PSD analysis by sieve and hydrometer using seawater is that it provides a more realistic representation of fine sediment fraction behaviours following release to the marine environment. Hence, this method provided a better representation of suspended solids plume behaviour for dredging and disposal plume modelling scenarios undertaken for the Project.

Figure 6-17 Particle Size Distribution using Seawater (SW) and, where replicated, regular methodology for 0 to 0.5 m interval: SC12-1, SC17-1, SC04-1, SC22-1, SC24-1, SC26-1, SC29-1, SC31-1

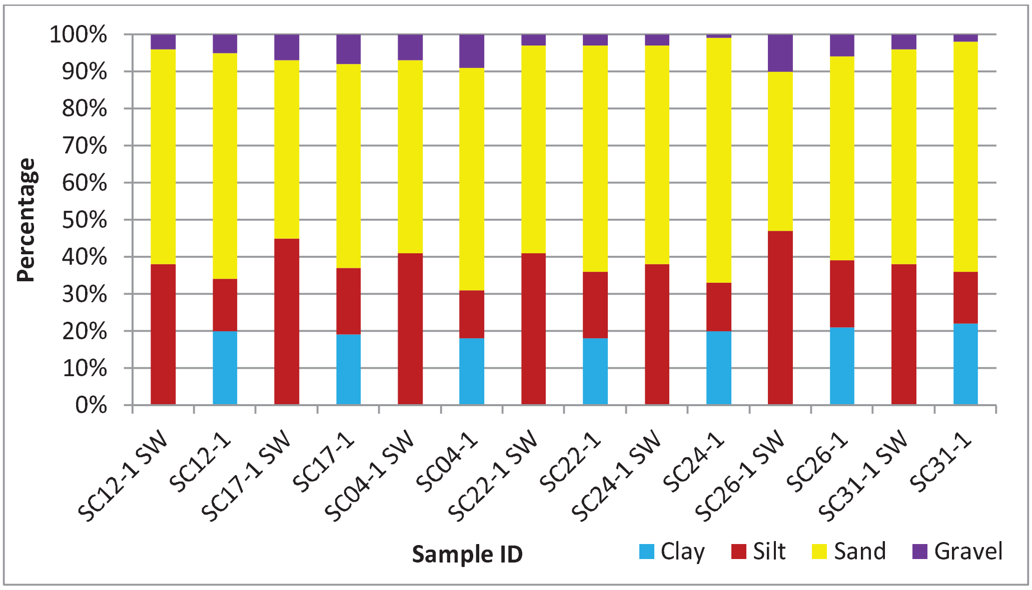


Figure 6-18 Particle Size Distribution using Seawater (SW) and, where replicated, regular methodology for 0 to 0.5 m and 0.5 to 1.0 m sampling interval: SC32-1, SC35-1, SC16-2, SC21-2, SC23-2, SC27-2, SC28-2

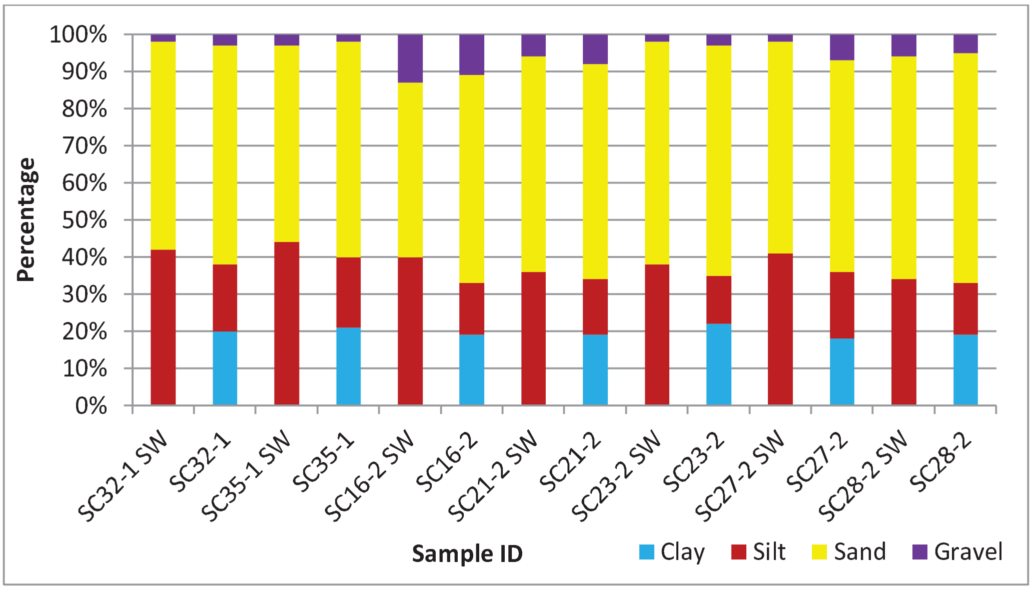


Figure 6-19 Particle Size Distribution using Seawater (SW) and, where replicated, regular methodology for 0.5 to 1.0 m and 1.0 to 1.5 m sampling interval: SC01-2, SC30-2, SC34-2, SC36-2, SC52-2, SC54-2, SC12-3, SC25-3

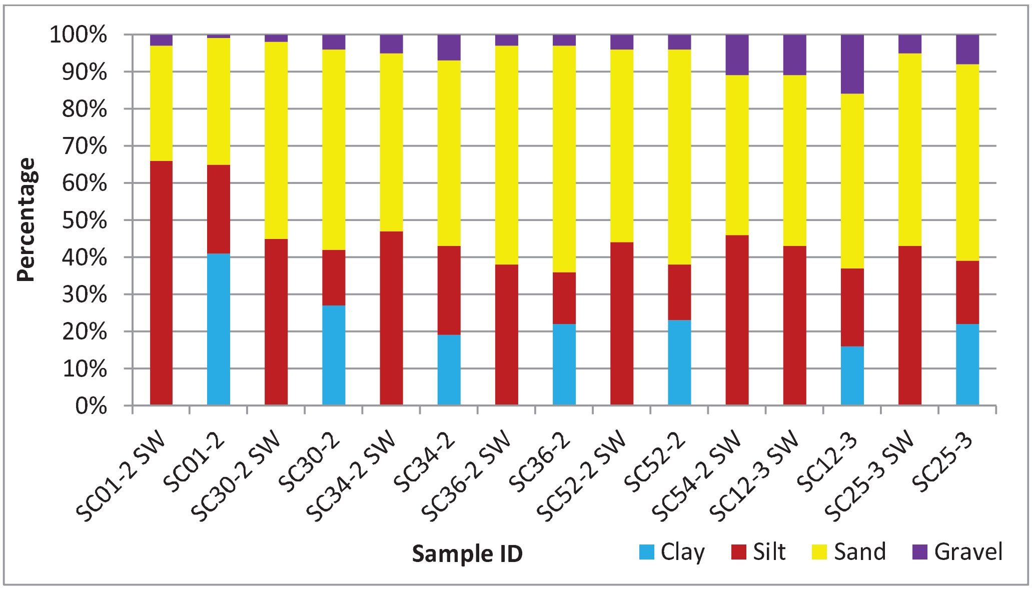
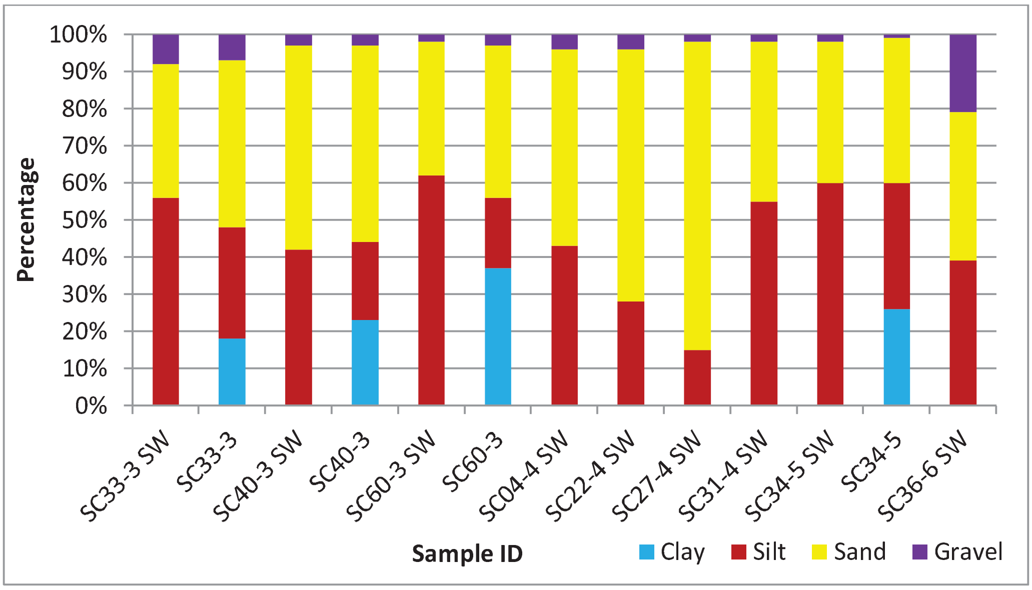


Figure 6-20 Particle Size Distribution using Seawater (SW) and, where replicated, regular methodology for 1.0 to 1.5 m, 1.5 to 2.0 m, 2.0 to 2.5 m and 2.5 to 3.0 m sampling interval: SC33-3, SC40-3, SC60-3, SC04-4, SC22-4, SC27-4, SC31-4, SC34-5, SC36-6.



6.3 Chemical Analysis

Tabulated chemical results are provided in Appendix E (dredge area) and Appendix G (proposed offshore dredged material relocation area). Official Laboratory Documentation for both areas is provided in Appendix H.

6.3.1 Heavy Metals and Metalloids

With the exception of manganese (Mn) and arsenic (As) concentrations in a low number of samples, all individual samples analysed for heavy metals and metalloids had concentrations less than NAGD screening levels and, where applicable the NEPM (1999) EILs (Table 6-2). For Mn, the four exceedances were reported at SC08-1, SC11-1, SC61-2 and SC67-3 and were greater than the NEPM (1999) EIL guideline value (500 mg/kg), but less than the NEPM (1999) HIL A guideline value of 1500 mg/kg. Given that all four samples had concentrations less than the 850 mg/kg natural background level reported in NEPM (1999) and the overall 95 % UCL for Mn was 249.5 mg/kg, it is assumed that Mn concentrations in tested sediments were within naturally occurring background levels and were not due to anthropogenic sources.

For As, a single location at 0.5 to 1.0 mbss (SC38-2) reported a concentration of 29.6 mg/kg which exceeds the NAGD screening level (20 mg/kg) and NEPM (1999) EIL (20 mg/kg), but not the NAGD sediment quality high value (70 mg/kg) or the NEPM (1999) HIL A guideline (100 mg/kg). Due to this exceedance, the sample was retested in triplicate by ALS to determine the validity of the result. Upon being retested, however, the sample returned a similar concentration and the original results were therefore considered valid. The reasons for this elevated As concentration are unknown, however, it could be related to a localised difference in geology at that location, and it should be noted that elevated As concentrations are common within Australian sediments (NAGD 2009).

Heavy metal and metalloid concentrations from sampling depths deeper than 1.0 mbss demonstrated that no discernible trend in concentrations, indicating homogeneity throughout the sediment profile for these analytes. This result indicates that there is negligible heavy metal and metalloid concentrations within the dredge area, as surface sediments and sediments at depth contained similar concentrations.

All heavy metal and metalloid concentrations had 95 % UCLs less than the NAGD screening levels and NEPM (1999) EILs and HIL A guidelines where applicable.

For sediments at the proposed offshore dredged material relocation area, all samples analysed for heavy metals and metalloids reported concentrations less than the NAGD screening levels, and, where applicable, the NEPM (1999) EIL’s and NEPM (1999) HIL A’s. With the exception of As, all heavy metal and metalloid average concentrations within the proposed offshore dredged material relocation area were greater than those from the dredge area (Table 6-3 and Appendix G). These results are likely due to the smaller sediment size at proposed offshore dredged material relocation area (e.g. silt and clay) increasing the ability for these analytes to bind to sediments (Sudhanandh *et al.* 2011, ANZECC/ARMCANZ 2000). However, when normalised to iron or aluminium, heavy metal concentrations become more comparable. For As, this analyte was the only metal or metalloid that recorded a greater mean concentration from the dredge area in comparison to the 80th percentile within the proposed offshore dredged material relocation area (NAGD 2009). Within the dredge area and proposed offshore dredged material relocation area, however, the 95 % UCL for all metals and metalloids were less than the NAGD screening levels, and, where applicable, the NEPM (1999) EIL’s and NEPM (1999) HIL A’s.

A statistical summary of heavy metal and metalloid results for the dredge area and proposed offshore dredged material relocation area are provided in Table 6-2 and Table 6-3, respectively.

Table 6-2 Statistical Summary of Heavy Metals and Metalloid Results from the Dredge Area

	Aluminium	Antimony	Arsenic	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PQL	5	0.5	0.4	0.1	0.1	0.5	0.1	5	0.5	0.5	0.01	0.1	0.1	0.1	0.1	0.5
NAGD screening levels		2	20	1.5	80		65		50		0.15	21		1		200
NAGD Sediment Quality High Values		25	70	10	370		270		220		1	52		3.7		410
NEPM EIL			**20**	**3**	**400 (III)**		**100**		**600**	**500**	**1**	**60**			**50**	**200**
NEPM HIL A			*100*	*20*	*100 (VI)*	*100*	*1000*		*300*	*1500*	*15*	*600*				*7000*
Statistical Summary																
Number of Results	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122	122
Number of Detects	122	0	122	0	122	122	122	122	122	122	4	122	115	5	122	122
Minimum Concentration	3,100	<0.5	2.5	<0.1	4.9	2.1	1.3	3,770	2.2	66	<0.01	1.1	<0.1	<0.1	8.8	4.4
Minimum Detect	3,100	ND	2.5	ND	4.9	2.1	1.3	3,770	2.2	66	0.01	1.1	0.2	0.1	8.8	4.4
Maximum Concentration	22,900	<0.5	29.6	<0.1	22	16.1	5.4	16,500	9.6	684	0.01	10	0.7	0.2	26.6	38.4

	Aluminium	Antimony	Arsenic	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc
Maximum Detect	22,900	ND	29.6	ND	22	16.1	5.4	16,500	9.6	684	0.01	10	0.7	0.2	26.6	38.4
Average Concentration	8,558	<0.5	5.4	<0.1	13	4.6	3.6	10,404	4.2	236	0.005	5.1	0.3	0.05	18	12
Median Concentration	7,995	<0.5	5.0	<0.1	13.6	4.5	3.5	10,700	3.8	221	0.005	5.2	0.3	0.05	17.3	12.5
Standard Deviation	3,208	0	2.6	0	3.3	1.3	0.9	2183	1.3	87	0.001	1.2	0.1	0.02	3.2	4.2
Number of Guideline Exceedances	0	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0
95 % UCL	9,040[1]	NA	5.8[1]	NA	13.5[1]	4.8[1]	3.7[1]	10,731[1]	4.4[1]	249.5[1]	0.005[1]	5.2[1]	0.4[1]	0.06[1]	18.3[2]	13.1[1]

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.

ND: Non Detect.

1: Jacknife UCL for non-normally distributed data (for a mix of detects and non-detects, non-detects are calculated at 0.5 x PQL).

2: Student's UCL for normally distributed data

Table 6-3 Statistical Summary of Heavy Metals and Metalloids Results from the Proposed Offshore Dredged Material Relocation Area

	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercruy	Nickel	Selenium	Silver	Vanadium	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PQL	50	0.5	1	0.1	1	0.5	1	50	1	10	0.01	1	0.1	0.1	2	1
NAGD screening level		2	20	1.5	80		65		50		0.15	21		1		200
NAGD Sediment Quality High Values		25	70	10	370		270		220		1	52		3.7		410
NEPM EIL			**20**	**3**	**400 (III)**		**100**		**600**	**500**	**1**	**60**			**50**	**200**
NEPM HIL A			*100*	*20*	*100 (VI)*	*100*	*1000*		*300*	*1500*	*15*	*600*				*7000*
Statistical Summary																
Number of Results	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Number of Detects	10	0	10	0	10	10	10	10	10	10	4	10	10	0	10	10
Minimum Concentration	11,700	<0.5	2.8	<0.1	24.4	5	4.7	12,600	5.6	245	<0.01	8.8	0.4	<0.1	21.2	22.2
Minimum Detect	11,700	ND	2.8	ND	24.4	5	4.7	12,600	5.6	245	0.01	8.8	0.4	ND	21.2	22.2
Maximum Concentration	15,700	<0.5	3.8	<0.1	31.9	6.6	6.3	17,200	7.3	312	0.02	11.7	0.6	<0.1	28.4	29.2
Maximum Detect	15,700	ND	3.8	ND	31.9	6.6	6.3	17,200	7.3	312	0.02	11.7	0.6	ND	28.4	29.2

	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercruy	Nickel	Selenium	Silver	Vanadium	Zinc
Average Concentration	12,960	<0.5	3.2	<0.1	26.9	5.6	5.4	14,340	6.2	268.9	0.009	9.8	0.5	<0.1	23.7	24.8
Median Concentration	12,600	<0.5	3.1	<0.1	26.5	5.4	5.2	14,100	6.1	265	0.005	9.5	0.5	<0.1	23.4	24.1
Standard Deviation	1,269	0	0.3	0	2.2	0.5	0.5	1,399	0.5	21.1	0.006	1.0	0.1	0	2.3	2.4
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95 % UCL	13,695[2]	NA	3.3[2]	NA	28.2[2]	5.9[2]	5.7[2]	15,151[2]	6.5[2]	281.1[2]	0.013[1]	10.3[2]	0.6[1]	NA	25[2]	26.3[2]

Notes:

ND: Non Detect

1: Jackknife UCL for non-normally distributed data (for a mix of detects and non-detects,non-detects are calculated at 0.5* the PQL)

2: Student's UCL for normally distributed data

6.3.2 Organotins

The TBT concentrations (normalised to 1 % TOC) in sediment samples ranged from <0.5 to 21.1 µg Sn/kg. All but two of 136 samples analysed for TBT had concentrations less than the adopted NAGD screening level of 9 µg Sn/kg. Overall, the 95 % UCL of TBT (normalised to 1 % TOC) in sediment samples was 0.8 µg Sn/kg, which is less than the NAGD screening level of 9 µg Sn/kg. For TBT, the 95 % UCL was below the minimum detect, as there were a high number of samples that recorded a concentration less than the PQL. In order to achieve a final 95 % UCL, the concentration of these samples was treated as 0.5 x PQL.

Spatially, all samples that recorded concentration detects for TBT (normalised to 1 % TOC) were within the T2 apron and berth area and were in close proximity to the existing T1 berths. This included two samples (SC39-1 and SC40-1) that recorded TBT (normalised to 1 % TOC) concentrations greater than the NAGD screening level. Additionally, all samples that recorded concentrations greater than the PQL for TBT were from sediments within the 0 to 0.5 m surface interval.

The DBT (normalised to 1 % TOC where detected at greater than the PQL) concentrations in sediment samples ranged from 4.6 to 14.3 µg Sn/kg, with an overall 95 % UCL of 0.6 µg Sn/kg. The MBT concentrations in sediments samples were less than the laboratory PQL. No criteria for DBT or MBT are presented in the NAGD or the NEPM (1999).

Table 6-4 provides a statistical summary of the organotin results.

Table 6-4 Statistical Summary of Organotin Results from the Dredge Area

	TOC	DBT	MBT	TBT	DBT normalised to 1% TOC	TBT normalised to 1% TOC
	%	µgSn/kg	µgSn/kg	µgSn/kg	µgSn/kg	µgSn/kg
PQL	0.01	1	1	0.5	-	-
NAGD Screening Level						9
NAGD Sediment Quality High Value						70
Statistical Summary						
Number of Results	136	136	136	136	136	136
Number of Detects	135	4	0	8	4	8
Minimum Concentration	<0.02	<1	<1	<0.5	<1	<0.5
Minimum Detect	0.03	1	ND	0.6	4.6	1.3
Maximum Concentration	1.3	2	<1	4.6	14.3	21.1
Maximum Detect	1.3	2	ND	4.6	14.3	21.1
Average Concentration	0.2	0.5	<1	0.4	0.8	0.7
Median Concentration	0.2	0.5	<1	0.3	0.5	0.3
Standard Deviation	0.1	0.2	0	0.5	1.8	2.2
Number of Guideline Exceedances	0	0	0	0	0	2
95 % UCL	-	0.6[1]	NA	0.2[1]	1.0[1]	0.8[1]

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.
ND: None detect.
1: Jacknife UCL determined for non-normal distributed data (for a mix of detects and non-detects, non-detects are calculated at 0.5 x PQL).

6.3.3 Nutrients

The nutrient results in the dredge area showed that ammonia concentrations ranged from <1 to 4 mg/kg, total oxidised nitrogen concentrations ranged from <0.1 to 0.9 mg/kg and total nitrogen concentrations ranged from <20 to 520 mg/kg. Only one sample recorded a concentration over PQL for nitrite. All samples analysed for phosphorus were less than the NEPM (1999) EIL of 2000 mg/kg, and ranged between 73 and 1290 mg/kg. Reactive phosphorous results ranged from <0.1 to 2.0 mg/kg. Overall, nutrient levels were generally higher in surface sediments.

A statistical summary of the nutrients results in the dredge area is provided in Table 6-5.

Nutrient results for sediments at the proposed offshore dredged material relocation area (BMT WBM 2012) are provided in Appendix G. A statistical summary of these results are provided in Table 6-6. Ammonia and nitrite results were comparable to the concentrations found in the dredge area, with very low levels at both locations. Although ammonia recorded a limited number of concentrations greater than the PQL, this was the only analytye that recorded a higher mean concentration from the dredge area in comparison to the 80th percentile from the proposed offshore dredged material relocation area (NAGD 2009). Total nitrogen and total phosphorus, however, recorded greater average concentrations than those found in the dredge area. Total nitrogen concentrations had a greater range in the proposed offshore dredged material relocation area, 290 to 860 mg/kg, while total phosphorus concentrations had a lower range 139 to 502 mg/kg than that from the dredge area. For phosphorus, all results from the proposed offshore dredged material relocation area were less than the NEPM (1999) EIL of 2000 mg/kg. Reactive phosphorus ranged from 0.5 to 0.7 mg/kg within the proposed offshore dredged material relocation area (Table 6-6). As with heavy metal concentrations, the comparatively higher concentrations at the proposed offshore dredged material relocation area are likely due to the smaller sediment sizes present in the area (e.g. silt and clay), increasing the ability for nutrients to bind to sediments (Sudhanandh *et al.* 2011, ANZECC/ARMCANZ 2000, Anderson *et al* 1981).

Table 6-5 Statistical Summary of Nutrient Results from the Dredge Area

	Ammonia	Nitrate	Nitrite	Nitrogen (Total Oxidised)[1]	Kjeldahl Nitrogen (Total)[1]	Nitrogen (Total)[1]	Total Phosphorus	Reactive Phosphorus
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PQL	1	0.1	0.1	0.1	20	20	1	0.1
NEPM EIL							**2000**	
Statistical Summary								
Number of Results	136	216	216	216	216	216	216	216
Number of Detects	12	54	1	55	211	211	216	166
Minimum Concentration	<1	<0.1	<0.1	<0.1	<20	<20	73	<0.1
Minimum Detect	3	0.1	0.1	0.1	20	20	73	0.1
Maximum Concentration	4	0.9	0.1	0.9	520	520	1290	2
Maximum Detect	4	0.9	0.1	0.9	520	520	1290	2
Average Concentration	0.8	0.1	0.05	0.1	166	166	259	0.3
Median Concentration	0.5	0.1	0.05	0.1	180	180	251	0.2
Standard Deviation	0.9	0.1	0.003	0.1	102	102	117	0.3
Number of Guideline Exceedances	0	0	0	0	0	0	0	0
95 % UCL	0.9[2]	0.1[2]	NA	0.1[2]	177.4[2]	177.4[2]	272.5[2]	0.4[2]

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.
ND: Non detect.
1: Summation assumes for a mix of detects and non-detects, each non-detect was treated as 0.5 x PQL.
2: Jacknife UCL for non-normally distributed data (for a mix of detects and non-detects, non-detects are calculated at 0.5 x PQL).

Table 6-6 Statistical Summary of Nutrient Results from the Proposed Offshore Dredged Material Relocation Area

	Ammonia	Nitrate	Nitrite	Nitrogen (Total Oxidised) [1]	Kjeldahl Nitrogen (Total) [1]	Nitrogen (Total) [1]	Total Phosphorus	Reactive Phosphorus
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PQL	1	0.1	0.1	0.1	20	20	2	0.1
NEPM EIL							2000	
Statistical Summary								
Number of Results	10	10	10	10	10	10	10	10
Number of Detects	1	9	0	9	10	10	10	10
Minimum Concentration	<1	<0.1	<0.1	<0.1	290	290	139	0.5
Minimum Detect	1	0.05	ND	0.05	290	290	139	0.5
Maximum Concentration	1	0.9	<0.1	0.9	860	860	502	0.7
Maximum Detect	1	0.9	ND	0.9	860	860	502	0.7
Average Concentration	0.6	0.22	<0.1	0.22	754	754	411.2	0.5
Median Concentration	0.5	0.2	<0.1	0.15	830	830	428	0.5
Standard Deviation	0.2	0.25	0	0.25	174	174	101.6	0.7
Number of Guideline Exceedances	0	0	0	0	0	0	0	0
95 % UCL	NA	0.36[2]	NA	0.36[2]	854.9[2]	854.9[2]	470.1[2]	0.6[2]

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.
ND: Non detect.

1: Summation assumes for a mix of detects and non-detects, each non-detect was treated as 0.5 x PQL.
2: Jacknife UCL for non-normally distributed data (for a mix of detects and non-detects, non-detects are calculated at 0.5 x PQL).

6.3.4 Total Petroleum Hydrocarbons and Benzene, Toluene, Ethylbenzene and Xylenes

All samples analysed for TPH and BTEX (normalised to 1 % TOC where detected at greater than the PQL) had concentrations less than the NAGD screening levels, as well as the NEPM (1999) EILs (or QLD EPA unpublished hydrocarbon guidelines for TPH).

BTEX concentrations and TPH fractions C_6-C_9 and C_{10}-C_{14} concentrations were less than the PQL for all samples. TPH fraction C_{15}-C_{28} concentrations ranged from <3 to 22 mg/kg, while TPH fraction C_{29}-C_{36} concentrations ranged from <5 to 18 mg/kg. As all samples analysed for TPH and BTEX were surface samples (0 to 0.5 mbss) it is likely that the low TPH concentrations recorded can be contributed to vegetation oil. This was further supported by the primary laboratory (ALS) who conducted a qualitative review of the chromatograms. This qualitative review demonstrated that the consistent chromatogram peaks were most likely fatty acids, amides and alkanes, which are not consistent with any reference anthropogenic hydrocarbon products present in the ALS library.

A statistical summary of the TPH and BTEX results is provided in Table 6-7.

Table 6-7 Statistical Summary of TPH and BTEX Results from the Dredge Area

	TOC	Benzene	Ethylbenzene	Toluene	Xylenes	BTEX	TPH C_6 - C_9	TPH C_{10} - C_{14}	TPH C_{15} - C_{28} Fraction	TPH C_{15} - C_{28} Fraction (normalised 1%)	TPH C_{29} - C_{36} Fraction	TPH C_{29} - C_{36} Fraction (normalised 1%)	TPH C_{10} - C_{36} (sum of total)[1]	TPH C_{10} - C_{36} (Sum of Total)- normalised 1%
	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
PQL	0.01	0.2	0.2	0.2	0.5	0.2	3	3	3	-	5	-	3	-
NAGD Screening Level										-		-		550
QLD EPA[3]		**1**				**7**	**100**	**100**	**1000**	**-**	**1000**	**-**		**-**
Statistical Summary														
Number of Results	69	69	69	69	69	69	69	69	69	69	69	69	69	69
Number of Detects	69	0	0	0	0	0	0	0	48	48	8	8	48	48
Minimum Concentration	0.07	<0.2	<0.2	<0.2	<0.5	<0.2	<3	<3	<3	<3	<5	<5	<3	<3
Minimum Detect	0.07	ND	ND	ND	ND	ND	ND	ND	4	6.8	6	14.6	4	6.77
Maximum Concentration	1.33	<0.2	<0.2	<0.2	<0.5	<0.2	<3	<3	22	100	18	100	36	200
Maximum Detect	1.33	ND	ND	ND	ND	ND	ND	ND	22	100	18	100	36	200
Average Concentration	0.28	<0.2	<0.2	<0.2	<0.5	<0.2	<3	<3	6.7	26.3	3.2	6.6	7.7	30.8
Median Concentration	0.25	<0.2	<0.2	<0.2	<0.5	<0.2	<3	<3	7	23.5	2.5	2.5	7	24.1
Standard Deviation	0.16	0	0	0	0	0	0	0	4.6	24.1	2.4	14.6	6.7	34.6
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	TOC	Benzene	Ethylbenzene	Toluene	Xylenes	BTEX	TPH C_6 - C_9	TPH C_{10} - C_{14}	TPH C_{15} - C_{28} Fraction	TPH C_{15} - C_{28} Fraction (normalised 1%)	TPH C_{29} - C_{36} Fraction	TPH C_{29} - C_{36} Fraction (normalised 1%)	TPH C_{10} - C_{36} (sum of total)^1	TPH C_{10} - C_{36} (Sum of Total)- normalised 1%
Number of Guideline Exceedances (Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95 % UCL	-	NA	NA	NA	NA	NA	NA	NA	7.6^2	31.2^2	3.7^2	9.6^2	9^2	37.7^2

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.

ND: Non Detect.

1: Summation assumes for a mix of detects and non-detects, each non-detect was treated as 0.5 * PQL.

2: Jacknife UCL for non-normally log distributed data (for a mix of detects and non-detects, each non-detect was treated as 0.5 * PQL).

3: As the NEPM 1999 Guidelines do not have EILs for these parameters, the investigation thresholds have been adapted from the QLD EPA Unpublished TPH Guidelines (QLD EPA 1999).

6.3.5 Organochlorine Pesticides, Organophosphorous Pesticides, Polychlorinated Biphenyls, Phenols and Cyanide

All OCP, OPP, PCB, phenols and cyanide results were less than their PQLs, and therefore the NAGD screening levels and NEPM (1999) EILs. As the results were less than the PQL, normalisation to 1 % TOC was not warranted.

Table 6-8 provides a statistical summary of the OCP, OPP, PCB, phenols and cyanide results.

Table 6-8 Statistical Summary of OCP, OPP, PCB, Phenols and Cyanide Results from the Dredge Area

	4,4-DDE	chlordane	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endrin	g-BHC (Lindane)	Heptachlor	Total OCPs[1]	Total OPPs[1]	Total Phenols[2]	PCBs (Total)[2]	Total Cyanide*
	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	mg/kg
PQL	0.5	0.25	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5	10	0.5	5	1
NAGD Screening Levels	2.2	0.5	2	1.6		280	10	0.32					23	
NAGD Sediment Quality High Values	27	6	20	46		620	220	1						
NEPM HIL A		*50000*	*200000*	*200000*	*200000*				*10000*				*10000*	*500*
Statistical Summary														
Number of Results	69	69	69	69	69	69	69	69	69	69	69	69	69	15
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Concentration	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.25	<0.5	<0.5	<10	<0.5	<5	<1
Minimum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.25	<0.5	<0.5	<10	<0.5	<5	<1
Maximum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Average Concentration	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.25	<0.5	<0.5	<10	<0.5	<5	<1
Median Concentration	<0.5	<0.25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.25	<0.5	<0.5	<10	<0.5	<5	<1
Standard Deviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	4,4-DDE	chlordane	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endrin	g-BHC (Lindane)	Heptachlor	Total OCPs[1]	Total OPPs[1]	Total Phenols[2]	PCBs (Total)[2]	Total Cyanide*
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95 % UCL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.

ND: Non Detect.

* Complexed Cyanide. This analyte was only tested for a selected number of samples.

1: Summation assumes for a mix of detects and non-detects, each non-detect was treated as 0.5 * PQL.

2: Summation computed from individual analyte detections at or above the level of reporting.

6.3.6 Polycyclic Aromatic Hydrocarbons

With the exception of six samples, all samples analysed for PAHs had concentrations for individual analytes less than the PQL. Of these six samples, four (SC32-1, SC34-1, SC37-1, SC38-1) were within the T2 Apron area from the upper 0.5 m of the sediment, in close proximity to the T2 berth. The remaining two samples that returned high PAH concentrations were located in the 0.5 to 0.1 mbss interval in the T3 Apron (SC15-2) and the 0 to 0.5 mbss interval in the T0 Berth (SC55-1). Overall, the maximum total PAH concentration (normalised to 1 % TOC) recorded for the aforementioned samples was 83.3 µg/kg (SC55-1), which is less than one per cent of the NAGD screening level of 10,000 µg/kg.

Table 6-9 provides a statistical summary of the PAH results.

Table 6-9 Statistical Summary of PAH Results from the Dredge Area

	2-methylnaphthalene	Benzo(e)pyrene	Coronene	Perylene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAHs[1]	Total PAHs normalised to 1% TOC
	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PQL	5	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	
NAGD Screening Level																						10000
NAGD Sediment Quality High Values																					50000	
NEPM EIL									**1000**												**20000**	
NEPM HIL A									*1000*												*20000*	
Statistical Summary																						
Number of Results	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136	136
Number of Detects	0	0	0	0	1	0	0	0	1	3	1	1	2	0	2	0	0	1	2	3	6	6
Minimum Concentration	<5	<4	<5	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<5	<4	<4	<4	<4
Minimum Detect	ND	ND	ND	ND	6	ND	ND	ND	5	4	6	4	4	ND	7	ND	ND	13	6	7	6	37.1
Maximum Concentration	<5	<4	<5	<4	6	<4	<4	<4	5	6	6	4	6	<4	8	<4	<4	13	6	9	30	83.3
Maximum Detect	ND	ND	ND	ND	6	ND	ND	ND	5	6	6	4	6	ND	8	ND	ND	13	6	9	30	83.3
Average Concentration	<5	<4	<5	<4	2	<4	<4	<4	2	2.1	2	2	2	<4	2.1	<4	<4	2.6	2.1	2.1	2.7	4.3
Median Concentration	<5	<4	<5	<4	2	<4	<4	<4	2	2	2	2	2	<4	2	<4	<4	2.5	2	2	2	2
Standard Deviation	0	0	0	0	0.3	0	0	0	0.3	0.4	0.4	0.2	0.4	0	0.7	0	0	0.9	0.5	0.9	3.7	11.4
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
95 % UCL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.2[2]	5.9[2]

Notes:
NA: Not applicable, insufficient range in dataset. A recording of NA assumes individual analytes are less than the relevant screening levels.
ND : Non detect.
1: Summation assumes for a mix of detects and non-detects, each non-detect was treated as 0.5 * PQL.

2: Jacknife UCL for non-normally log distributed data (for a mix of detects and non-detects, each non-detect was treated as 0.5 * PQL).

6.4 Acid Sulfate Soils

With the Chromium Suite, the pH values (pHKCl) were greater than 8.9 pH units. The potential acidity (SCr) ranged between <0.005 %S and 0.529 %S, exceeding the QASSIT (1998) action criterion of 0.03 %S in 92 % of samples. The TAA results were less than the PQL for all samples, with the acid neutralising capacity by back titration (ANCBT) of the samples ranging between 0.3 %S and 18.5 %S. The net acidity was typically less than the PQL, with only one sample (SC68-4), at a depth of 1.5 to 2.0 mbss, reported greater than the PQL at 0.13 %S. A liming rate of 6 kg/$CaCO_3$ t was identified for this location, however, as the surrounding locations at similar depths had no net acidity reported, results indicated that the soils had sufficient neutralising capacity to prevent acidification of the surrounding environment.

The SPOCAS suite results supported the Chromium suite results, with minimal variability between SPOCAS and Chromium suite results for the same samples. The pH values of the soil after treatment with KCl ranged between 9.2 to 9.4 pH units, and after oxidation was greater than 7.8 (pHOX). SPOS results greater than the QASSIT (1998) action criteria (0.03 %S) ranged from 0.03 %S to 0.26 %S. TAA and TPA results were less than the PQL, which indicates that the potential excess acid neutralising capacity is greater than the potential acid generating capacity. This was supported by the acid neutralising capacity results of between 2.7 %S and 15.5 %S (for results with SPOS greater than the QASSIT (1998) action criteria) and the net acidity results of less than the PQL.

The results of the ASS testing indicate there are sediments present which have the potential to be ASS if oxidised (QASSIT 1998). The natural neutralising capacity in these sediments, however, was greater than the acid generating capacity, likely due to the presence of shell and other calcareous materials throughout the sediment. As these sediments will be transported to the proposed offshore dredged material relocation area, PASS in sediments will not be oxidised as the sediments will remain saturated in a slurry within the dredger hopper prior to release.

Table 6-10 and Table 6-11 provide a statistical summary of the Chromium Suite results and SPOCAS Suite results, respectively.

Table 6-10 Statistical Summary of ASS Chromium Results from the Dredge Area

	ASS-pH		ASS-Acidity Trail			ASS – Acid Base Accounting		ASS – BT ANC		ASS - Potential Acidity		
	pH KCl (23A)	sulfidic - TAA (s-23F)	Titratable Actual Acidity	ANC Fineness Factor	Liming Rate	Net Acidity (acidity units)	Net Acidity (sulphur) units)	a-ANCBT	ANCBT	s-ANCBT	a-SCr	SCr
	pH Unit	% pyrite S	moleH+/t	-	kg CaCO3/t	moleH+/t	% S	mole H+/t	% CaCO3	% pyrite S	mole H+/t	% S
PQL	0.1	0.02	2	0.5	1	10	0.02	10	0.01	0.01	10	0.005
QASSIT												0.03
Statistical Summary												
Number of Results	260	260	260	260	260	260	260	260	260	260	260	260
Number of Detects	260	0	0	260	1	1	1	260	260	260	231	240
Minimum Concentration	8.9	<0.02	<2	1.5	<1	<10	<0.02	188	0.94	0.3	<10	<0.005
Minimum Detect	8.9	ND	ND	1.5	6	82	0.13	188	0.94	0.3	10	0.005
Maximum Concentration	10.8	<0.02	<2	1.5	6	82	0.13	11,500	57.7	18.5	330	0.529
Maximum Detect	10.8	ND	ND	1.5	6	82	0.13	11,500	57.7	18.5	330	0.529
Average Concentration	9.3	<0.02	<2	1.5	0.52	5.3	0.01	5,629	28	9	79	0.13
Median Concentration	9.3	<0.02	<2	1.5	0.5	5	0.01	5,845	29.3	9.4	79.5	0.128
Standard Deviation	0.2	0	0	0	0.34	4.8	0.01	2,497	13	4	51	0.083
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	221

Notes:

ND: Non detect.

Table 6-11 Statistical Summary of ASS SPOCAS Results from the Dredge Area

	ASS- pH				ASS- Acidity Trail				ASS- Sulfur Trail				ASS – Excess ANC				ASS – Acid Base Accounting			
	pH KCl (23A)	pHOX	sulfidic - TAA (s-23F)	Titratable Actual Acidity (23F)	s-TPA	s-TSA	TPA	TSA	a-SPOS	SKCl	SP	SPOS	s-MgA	a-ANCE	ANCE	s-ANCE	ANC Fineness Factor	Liming Rate	Net Acidity (acidity units)	Net Acidity (sulfur units)
	pH Unit	pH Unit	% pyrite S	moleH+/t	% pyrite S	% pyrite S	mole H+/t	mole H+/t	mole H+/t	% S	% S	% S	% S	mole H+/t	% CaCO3	% S	-	kg $CaCO^3$/t	moleH+/t	% S
PQL	0.1	0.1	0.02	2	0.02	0.02	2	2	10	0.02	0.02	0.02	0.02	10	0.02	0.02	0.5	1	10	0.02
QASSIT							18	18				0.03								
Number of Results	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Number of Detects	34	34	0	0	0	0	0	0	32	33	34	32	34	34	34	34	34	0	0	0
Minimum Concentration	9.1	7.8	<0.02	<2	<0.02	<0.02	<2	<2	<10	<0.02	0.08	<0.02	0.06	1,690	8.44	2.7	1.5	<1	<10	<0.02
Minimum Detect	9.1	7.8	ND	ND	ND	ND	ND	ND	17	0.04	0.08	0.03	0.06	1,690	8.44	2.7	1.5	ND	ND	ND
Maximum Concentration	9.5	8.9	<0.02	<2	<0.02	<0.02	<2	<2	166	0.18	0.37	0.26	0.53	9,660	48.4	15.5	1.5	<1	<10	<0.02
Maximum Detect	9.5	8.9	ND	ND	ND	ND	ND	ND	166	0.18	0.37	0.26	0.53	9,660	48.4	15.5	1.5	ND	ND	ND
Average Concentration	9.3	8.2	<0.02	<2	0.01	0.01	1	1	74	0.1	0.21	0.12	0.24	4,105	21	6.6	1.5	<1	<10	<0.02
Median Concentration	9.3	8.2	<0.02	<2	0.01	0.01	1	1	82	0.09	0.21	0.14	0.24	3,740	18.7	5.99	1.5	<1	<10	<0.02
Standard Deviation	0.1	0.3	0	0	0	0	0	0	34	0.04	0.06	0.05	0.11	1,841	9.2	3	0	0	0	0
Number of exceedances	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0

Notes:

ND: Non detect.

7. Data Validation

7.1 General

Validation of the analytical data was undertaken in accordance with Appendix A of the NAGD. Laboratory and field QA/QC results tables are provided in Appendix F and Appendix G and Official Laboratory Documentation in Appendix H.

7.2 Deviations from the SAP

Listed below are deviations from the SAP that occurred during the SAP implementation program:

- Every effort was made to position the vessel on the proposed sampling locations identified in the SAP using the vessels GPS. Although actual sampling locations (Figure 5-6) showed some deviation from proposed locations (Figure 5-5), none of the sampling locations extended beyond the sampling grid cell boundary (40 m by 40 m grid cells). The largest deviation between proposed and actual sampling location was 35 m. This is not considered to impact the validity of the program, as sampling locations were selected randomly in accordance with the NAGD.
- Although 69 sampling locations were proposed for ASS testing, only 64 sampling locations were assessed for it. ASS analysis was not conducted on samples collected from five sampling locations on 23 February 2012 (SC38, SC39, SC41, SC45 and SC56) due to a breach in holding time (see Section 7.5). For the remaining sample, insufficient sample for ASS analysis was received for the depth interval 0.5 to 0.6 m at one location (SC65), due to refusal of vibracore. However, the 0 to 0.5 m sample interval at this location was analysed for ASS and therefore, this deviation is not considered to impact the validity of the program.
- 8.7 % of sampling locations did not achieve the required core depth for the assessment of chemical properties. All locations, however, were tested within the surface 0 to 0.5 m interval. As this interval was the most likely to contain contaminants, results are considered to provide an accurate representation of the area.
- At 18 out of 64 locations, the required depth (1 m below dredge depth) was not achieved for assessment of acid sulfate soils (ASS). This was due to refusal of the vibracorer on stiff clays and silts. The required and achieved depth for each location is shown in Table 5-3. As the ASS testing was a pilot study, data are not being used to delineate the locality of ASS in the dredge area. As such, the refusal of cores prior to required depth for ASS is not considered to impact the validity of the program, as information gained provides a representation of the possible ASS presence in the dredge area.
- Five samples collected on 23 February 2012 (SC38, SC39, SC41, SC45 and SC56) were not analysed by the primary laboratory (ALS) within the standard holding times (14 days) for some chemical parameters (organics). On consultation with ALS, reviewing relevant literature and analysing QA/QC results, however, results gained from these samples are considered valid in the current report and suitable for making an assessment of suitability for relocation of dredged material at sea or reuse on land (Refer Section 7.5). Additionally, although some analytes recorded higher 95 % UCL concentrations with these samples included in the data (e.g. TBT due to a detection in one of these samples, which is likely due to its proximity to the existing T1 facility), all final concentrations were

significantly less than their relevant screening levels. For example, TBT recorded a 95 % UCL approximately ten times lower than the NAGD screening level.

7.3 Laboratory Quality Assurance/Quality Control Results

7.3.1 Summary

Data compliance was generally within accepted levels, and all inter laboratory matrix and laboratory were within accepted data quality objectives for analytes tested. Detailed QA/QC results for the dredge area from the primary laboratory ALS and the secondary laboratory AAA are presented in further detail below. For the proposed offshore dredged material relocation area, laboratory analyses conducted by ALS did not report any QA/QC breaches.

7.3.2 Laboratory Blanks

Analysis of laboratory blank samples should result in a concentration not exceeding the detection limit for a particular contaminant. No analytes were detected in the laboratory blanks. This confirms the laboratory testing methods were accurate and there was no cross-contamination of samples during laboratory preparation, extraction or analysis.

7.3.3 Laboratory Standard

The NAGD specifies that the values found by the laboratory should be 80 to 120 % of the certified value for the individual standard. Organotins reported the highest proportion of laboratory standard recoveries outside the control limits (3.8 %), followed by phenols (2.9 %) and acidity trail (0.5 %). For the organotin and phenol compounds, these were reported as non-compliances as recoveries were greater than the upper control limit in all instances. However, all organotin and phenol results are considered valid as the final concentrations in all cases were less than the PQL. For the single acidity trail that returned a non-compliance, this result was deemed valid as the recovery percentage was equal to the lower control limit. All other analytes did not report laboratory standard recoveries outside control limits.

Overall, 2.0 % of all laboratory standards returned valid non-compliant recoveries.

7.3.4 Surrogate Spikes

Surrogate spikes are known additions to each sample that are not expected to occur, and provide a means for checking that no gross errors have occurred during any stage of analysis. Surrogate spikes provide an indication of the ability of a laboratory to extract a specified contaminant type from the sample matrix. The NAGD indicates that surrogate spike recovery rates should be within the limits specified for the analysis method, typically 75-125 %.

Only five work orders from ALS reported surrogate spike recoveries outside data quality objectives. Base/neutral extractable surrogates reported spike recoveries greater than the data quality objective on four occasions, and one PAH surrogate reported a spike recovery greater than the data quality objective.

For the secondary laboratory, AAA, only two of 21 PAH surrogate tests and one of seven phenol tests (the analyte 2,4-dimethylphenol) returned a non-compliance due to matrix interference. On consultation with the laboratory these non-compliances were considered to be due to sample heterogeneity and all data are considered valid.

7.3.5 Matrix Spikes

Matrix spikes identify the amount of interference from the sediment matrix on contaminant recovery. When the recovery of a matrix spike is below that expected for the analytical method performance this may indicate matrix interference or heterogeneity.

From the primary laboratory ALS, analytes that reported matrix spike recoveries with non-compliance included PCBs (8.6 %), organotins (6.6 %), total phosphorus (2.9 %), metals and metalloids (0.6 %), phenol compounds (0.6 %), OCPs (0.4 %) and OPPs (0.3 %). These non-compliances included matrix recoveries outside control limits and data quality objectives. PCBs recorded the highest percentage of non-compliance (8.6 % of all PCB matrix spike samples), however this may be reflected by the comparatively small number of overall samples for this compound group, as only one analyte was used in matrix spike analysis for PCBs (specifically Aroclor 1254).

On nine occasions, matrix spikes were unable to be determined due to sample matrix interference, with six of these reporting background levels greater than or equal to four times the spike level. Upon consultation with ALS, these occasions were not considered non-compliances as matrix spikes cannot be determined when the target analyte is present in high concentrations within the sample. The NAGD states that matrix spike data should not be reported if naturally occurring levels in the samples are greater than twice the spiking level (NEPC,3B 1999), therefore these results are not considered to be breaches in laboratory QA/QC results.

Overall, 0.9 % of matrix spike tests performed by ALS reported a valid non-compliance.

From the secondary lab, AAA, six of seven tests for Fe and Al and two out of seven tests for Mn could not accurately determine matrix recoveries due to significant background concentrations. Upon consultation with AAA, the results given for these analytes are considered valid, as high background concentrations for these analytes are common for Australian sediments.

The NAGD criteria range is likely based on matrix spike recoveries from ‘clean’ matrix free samples. In field samples, the range of recoveries can be much greater and often lower due to matrix interference. Matrix interference occurs when samples contain certain properties such as high moisture content and high salinity. Additionally, samples can contain substances such as plant sterols, waxes, lipids or other organic matter content that can inhibit the full extrusion of a contaminant during laboratory surrogate extraction. Consequently, reported contaminant concentrations by the laboratory are likely to be lower than actual contaminant concentrations found within sediment samples.

7.3.6 Laboratory Duplicates

In general, RPDs for laboratory duplicates were within the data quality criteria of an RPD less than 35 % (as per Appendix A of the NAGD, 2009). The laboratory RPD is the per cent difference in contaminant concentration between inter-laboratory splits of the same sample, and indicates the precision of laboratory analysis. RPDs exceeded 35 % for Mn and total phosphorus on two and one occasion, respectively. All RPD exceedances for Mn and total phosphorous were considered to be due to sample heterogeneity, which was confirmed by visual inspection by ALS. Overall, 4.2 % of laboratory duplicates recorded RPDs outside the 35 %.

7.4 Field Quality Assurance/Quality Control Results

7.4.1 Intra Laboratory and Inter Laboratory Field Duplicates and Splits

RPDs for intra and inter laboratory duplicates, indicate there were no analytes outside recommended data quality criterion limit as specified in the NAGD. Appendix A of the NAGD states that “field replicates should agree within an RPD (or RSD) of +/- 50 %, although they may not always do so where the sediments are very heterogeneous or greatly differing in grain size.” RSD calculations demonstrated that only two samples from inter and intra laboratory field duplicates exceeded the recommended criterion in the NAGD (Table 7-1). For these samples, as exceedances were not consistent across a single location or for particular analytes, it can be assumed that the parent results are within acceptable ranges, and no results warranted adjustment. Additionally, the concentrations for chromium (Cr) and selenium (Se) in all inter and intra laboratory samples reflected variability that is within expected background levels (NEPM 1999). For all RPD and RSD calculations, where the duplicate and primary sample results were less than ten times the PQL, no RPD or RSD limit is applicable (ALS Environmental 2005) and are therefore not included in the tables below (all RPD and RSD calculations are provided in Appendix F and Appendix G).

For parent sample SC45-1 and intra and inter laboratory duplicates FD10 and FS10, both SC45-1 and FD10 were tested outside the laboratory holding times. However, all results for these samples returned RSD values less than the recommended data quality criterion in the NAGD. This indicates that the breach in holding times did not significantly affect the analyte concentrations within the sample, and that the overall results for these samples should be considered valid.

The field duplicate sample from the proposed offshore dredged material relocation area (BMT WBM 2012) did not report an RPD greater than 50 %, when analyte concentrations were greater than 10 times the PQL (provided in Appendix F).

Table 7-1 Inter Laboratory and Intra Laboratory Results with RSDs greater than the Data Quality Criteria

Analyte	Unit	PQL	Parent	Duplicate	Split	RSD%
			SC23-1	**FD05**	**FS05**	
Chromium (III+VI)	mg/kg	1	7.7	3.5	15	**67**
			SC42-1	**FD09**	**FS09**	
Selenium	mg/kg	0.1	0.3	0.3	2.1	**116**

7.4.2 Inter Batch Duplicates

The RPD for inter batch duplicate BS01 was within the recommended NAGD of less than 50 % for the majority of results, with the exception of nutrients (total Kjeldahl nitrogen and total nitrogen) (Table 7-2). Although the parent sample for BS02 was not tested within recommended laboratory holding times, only one analyte (Phosphorus) recorded an RPD outside the recommended limits given in the NAGD. This indicates that the results were not outside expected limits and that the results for the analytes of samples tested outside the recommended holding times should be considered to remain valid (as discussed further in Section 7.4). Additionally, for BS02, heavy metal and metalloid analysis demonstrated no RPD values outside the recommended data quality criteria.

Table 7-2 Inter Batch Duplicate Results with RPDs greater than the Data Quality Criteria

Analyte	Unit	PQL	Parent	Duplicate	RPD%
			SC35-1	**BS01**	
Kjeldahl Nitrogen (Total)	mg/kg	20	300	560	**60**
Nitrogen (Total)	mg/kg	20	300	560	**60**
			SC45-2	**BS02**	
Phosphorus	mg/kg	2	486	263	**60**

7.4.3 Field Triplicates

Triplicate samples from seven primary locations were collected from; SC06 (T1 and T2), SC18 (T3 and T4), SC28 (T5 and T6) and SC31 (T7 and T8), SC53 (T9 and T10), SC54 (T11 and T12) and SC69 (T13 and T14). The respective depths of collected cores is summarised in Table 7-3.

Table 7-3 Parent Locations, Triplicates and Sampling Depths from Abbot Point

Sample location	Parent depth (mbss)	Triplicate 1	Triplicate 1 depth (mbss)	Triplicate 2	Triplicate 2 depth (mbss)
SC06	1.3	T1	1.3	T2	1.3
SC18	4.4	T3	3.5	T4	3.5
SC28	1.3	T5	1.3	T6	1.3
SC31	1.9	T7	1.9	T8	1.85
SC53	1.0	T9	1.1	T10	1.2
SC54	1.4	T11	1.0	T12	1.0
SC69	2.2	T13	1.9	T14	1.37

Total organic carbon (TOC) and nutrient concentrations were the only exceedances of the RSD in triplicate samples from the dredge area (Table 7-4). As nutrient and TOC concentrations are highly dependent on sediment particle size (i.e. finer sediments tend to have higher concentrations of nutrients and TOC), the variability in the nutrient and TOC concentrations may be due to considerable variation in sedimentary layers over short distances.

The triplicate samples from the proposed offshore dredged material relocation area (BMT WBM 2012) did not report any RSD values greater than 50 %, when analyte concentrations were greater than 10 times the PQL (provided in Appendix G).

Table 7-4 Triplicate Results with RSDs greater than the Data Quality Criteria

Analyte	Unit	PQL	Parent	Triplicate 1	Triplicate 2	RSD
			SC06-1	**T1-1**	**T2-1**	
Phosphorus	mg/kg	2	134	388	230	**51**
			SC06-2	**T1-2**	**T2-2**	
Kjeldahl Nitrogen (Total)	mg/kg	20	120	240	40	**76**
TOC	%	0.02	0.24	0.17	0.07	**53**
Nitrogen (Total)	mg/kg	20	120	240	40	**76**
Phosphorus	mg/kg	2	138	330	114	**61**
			SC06-3	**T1-3**	**T2-3**	
Kjeldahl Nitrogen Total	mg/kg	20	70	210	30	**92**
Nitrogen (Total)	mg/kg	20	70	210	30	**92**
Phosphorus	mg/kg	2	142	354	169	**52**
			SC18-1	**T4-1**	**T3-1**	
Kjeldahl Nitrogen (Total)	mg/kg	20	160	440	100	**78**
TOC	%	0.02	0.16	0.5	0.12	**80**
Nitrogen (Total)	mg/kg	20	160	440	100	**78**
			SC18-2	**T4-2**	**T3-2**	
Phosphorus	mg/kg	2	236	89	129	**50**
			SC54-1	**T11-1**	**T12-1**	
Phosphorus	mg/kg	2	1290	271	453	**81**
			SC69-2	**T13-2**	**T14-2**	
Kjeldahl Nitrogen (Total)	mg/kg	20	190	40	220	**64**
Phosphorus	mg/kg	2	243	51	386	**74**
Nitrogen (Total)	mg/kg	20	190	40	220	**64**

7.4.4 Trip Blanks

Field trip blank samples were analysed for BTEX, TPH (fractions C_6-C_9) and naphthalene during the SAP implementation program. All trip blanks recorded concentrations less than the PQL. This indicates that cross contamination from volatile substances did not occur during field sampling or transportation.

7.5 Holding Times

All sample analyses were undertaken within required holding times by the primary laboratory (ALS) and the secondary laboratory (AAA) with the exception of five samples collected on 23 February 2012. These samples included SC38, SC39, SC41, SC45 and SC56. For samples collected on the 23 February, all analyses were conducted excluding ASS analysis due to the 24 hour holding time breach.

The five samples collected on the 23 February 2012 were not analysed by the primary laboratory within the standard holding 14 day holding times. However, on consultation with ALS, and on reviewing relevant literature most results are considered valid in the current report (see below). An exception to this was testing for ASS, as these must be tested within 24 hours of sampling. As such, they were omitted from the analysis conducted on the samples taken on the 23 February.

The following list provides an example of analytes that can be tested at prolonged periods outside the standard 14 days:

- TBT, DBT and MBT: Sediment concentrations demonstrate low variation under prolonged (approximately 1 month) wet storage in sediments (Quevauviller and Donard, 1991) and up to eight weeks if stored frozen (NAGD 2009).
- PAH and PCB: Sediment concentrations demonstrate low variation up to 92 to 153 days when stored at 4°C (USEPA 2005).

The breached samples were stored at ambient temperature and not 4°C. However, all tested analytes recorded results that were within an expected range based on those from other sampling locations and all sediments recorded 95 % UCL concentrations less than the NAGD and NEPM (1999) EIL and HIL A screening levels. Additionally, the breach time is well below the 92 day sampling for PAHs and PCBs and equivalent to the 1 month wet storage in sediments. Lastly, two parent samples SC45-1 and SC45-2 and their respective duplicates, FS10 and BS02, were collected on the 23 February 2012, with the parent samples tested outside recommended holding times and the duplicates tested within recommended holding times. From both parent samples, only one analyte (Phosphorus) from the SC45-2 and BS02 comparison recorded an RPD outside the recommended limits given in the NAGD. This suggests that for samples collected on this day, the concentrations of most analytes were within expected limits and that the results remain valid.

Given that the results of analytes from these samples were within the expected range, and little variation is expected to occur within the period that they were held, the results were were included in the analysis and presentation of results in this report.

7.6 Suitability of Data

Based on the results of the laboratory and field QA/QC analyses, it is considered that the quality of data is suitable to characterise the sediments to be dredged. Overall, laboratory and field QA/QC results recorded compliance of 98 % (Table 7-5). Laboratory QA/QC analyses showed that a relatively small percentage of samples and analytes reported non-compliant results (Table 7-5), with 100 % of laboratory blanks recording compliance. This demonstrates that overall laboratory procedures have maintained accurate procedures and the results may be considered to be valid. For field inter and intra laboratory field duplicates QA/QC analyses, 100 % of samples with RPD calculations were within accepted data quality objectives. For samples with RSD calculations, the only values outside accepted data quality objectives came from the metals and metalloids (Table 7-5). All other analytes recorded 100 % compliance. For inter batch duplicates and triplicates, the only values outside accepted data quality objectives came from nutrients and inorganics (Table 7-5). All other analytes recorded 100 % compliance.

Table 7-5 Overall Proportion of Data Compliance from Laboratory and Field QA/QC

Test	Compliance (%)
Laboratory Blanks	100
Laboratory Standards	98.0
Matrix Spikes	99.1
Laboratory Duplicates	95.8
Inter and Intra Laboratory Duplicates and Splits – Inorganics	100
Inter and Intra Laboratory Duplicates and Splits - Metals	98.8
Inter and Intra Laboratory Duplicates and Splits - Organotins	100
Inter and Intra Laboratory Duplicates and Splits - Nutrients	100
Inter and Intra Laboratory Duplicates and Splits - Total Petroleum	100
Inter and Intra Laboratory Duplicates and Splits - OCP, OPP, PCB, phenols and cyanide	100
Inter and Intra Laboratory Duplicates and Splits - Polycyclic Aromatic Hydrocarbons	100
Inter Batch Duplicates - Inorganics	100
Inter Batch Duplicates - Metals	98.8
Inter Batch Duplicates - Organotins	100
Inter Batch Duplicates - Nutrients	81.3
Inter Batch Duplicates - Total Petroleum	100

Test	Compliance (%)
Inter Batch Duplicates - OCP, OPP, PCB, phenols and cyanide	100
Inter Batch Duplicates - Polycyclic Aromatic Hydrocarbons	100
Triplicates - Inorganics	94.1
Triplicates - Metals	100
Triplicates - Organotins	100
Triplicates - Nutrients	90.0
Triplicates – Total Petroleum	94.1
Triplicates - OCP, OPP, PCB, phenols and cyanide	100
Triplicates - Polycyclic Aromatic Hydrocarbons	100
Overall Compliance	**98**

8. Conclusions

The objective of the SAP was to provide an assessment on the physical and chemical suitability of the proposed dredge material in relation to possible relocation and reuse options in accordance with the NAGD. The Phase II sediment assessment showed that the material to be dredged passes screening level assessment according to the NAGD assessment framework. Following the framework, Phase III and Phase IV assessment of sediment quality was not required. Based on the results of the SAP implementation program the following was concluded:

- The sediment composition of Abbot Point is relatively homogenous across the dredge area comprising predominantly fine sands, and silts and clays.
- The material to be dredged is suitable for unconfined placement at sea in an approved offshore relocation area on the basis that the 95% UCLs of analysed contaminant substances were less than their respective NAGD screening levels.
- The material to be dredged is suitable for unrestricted use on land on the basis the contaminant substances had concentrations less than the NEPM EILs and HIL A.
- Sediments were considered to be PASS based on an assessment against the QASSIT (1998) guidelines. However, the potential acid neutralising capacity of the sediment was greater than the acid generating potential, though if fines were separated from the sediment matrix, the acid generating potential may increase in the fines. Additionally, as the dredge material relocation method is offshore, PASS in sediments will not be oxidised. As such, potential impacts from ASS are considered negligible to the Project.
- The physical and chemical properties at the proposed dredged material relocation area differed slighty to the dredge area. The proposed dredged material relocation area had finer sediments, with generally greater concentrations of nutrients and heavy metals and metalloids. The presence of finer sediments is attributed to the low energy environment associated with greater depth at this location and the greater concentrations of nutrients and the heavy metals and metalloids are likely due to the presence of these finer sediments. Though sediment characteristics did differ in the proposed dredged material relocation area, this area is still considered the most suitable, due to having the least impact on the marine environment compared to alternative offshore relocation area options.

9. Qualifications of Reporting

The Qualifications of this report should be read in conjunction with the entire report.

This report presents the results of a sediment implementation report that was implemented to assess the presence of a restricted and specific range of potential contaminants in site sediments, as well the potential for acid sulfate soil generation. This report was produced specifically for NQBP, Adani, BHPB and HCIPL for the purposes of this commission. No warranties, expressed or implied, are offered to any third parties and no liability will be accepted for use of this report by any third party.

The work conducted by GHD Pty Ltd (GHD), as commissioned by Adani, BHPB and HCIPL, met the standards required of a professional environmental consulting firm within the state of Queensland. Although strenuous effort has been made to assess significant contamination and acid sulfate soil generation required by the brief, we cannot, however, guarantee that other issues arose outside of the scope of work undertaken by GHD.

The data and report relates only to the sediment implementation report and structures described, and must be reviewed by a competent and appropriate Environmental Scientist or Engineer, experienced in sediment quality assessments, before being used for any other purposes. GHD accepts no responsibility for other use of the data.

It should be noted, that in gathering information for the study, GHD relied on third party information, on site records, and on a single visual inspection of the site, which may not have been independently verified. Where laboratory tests and similar work have been performed and recorded by others, the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The advice tendered in this report is based on information obtained from sample collection at discrete locations across the site and may not fully represent the conditions that may be encountered across the entire site. It is emphasised that the actual characteristics of the sub-surface and surface materials may vary significantly between adjacent test points and sample intervals and at locations other than where observations, explorations and investigations have been made. Sub-surface conditions and contaminant concentrations can change over a short timeframe. This should be considered when assessing the data.

It should be noted that due to inherent uncertainties in the sub-surface evaluations, changing or unanticipated sub-surface conditions may occur that could affect the recommendation GHD has expressed in this report. As such, these may need to be re-examined and altered. GHD does not accept responsibility for the consequences of significant variations in the physical and biological conditions of the dredge area.

An understanding of the site conditions depends on the integration of numerous pieces of information, including regional, site specific, structure-specific and experienced based information. Hence this report must be read in full and should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior written consent and approval by GHD. GHD accepts no responsibility for any circumstances that arise from the issue of the report that has been modified without the consent and approval by GHD.

Lastly, the contents of this report must not be copied, used or relied upon by any person other than NQBP, Adani, BHPB and HCIPL without the prior written consent of GHD.

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