Gladstone Ports Corporation

Sediment Characterisation Report
PoG Sustainable Sediment Management Project

August 2019

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Acronyms List

Abbreviation	Description
AMA	Australasian Marine Associates
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid Sulfate Soils
COA	Certificate of Analysis
COC	Chain of Custody
CQU	Central Queensland University
CSD	Cutter Suction Dredge
DoEE	Department of Environment and Energy
EBSDS	East Banks Sea Disposal Site
GBRMP	Great Barrier Reef Marine Park
GBRWHA	Great Barrier Reef World Heritage Area
GPC	Gladstone Ports Corporation
GPS	Global Positioning System
HSE	Health, Safety and Environment
JSEA	Job Safety and Environmental Assessment
NAGD	National Assessment Guidelines for Dredging
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
Nm	Nautical mile
PASS	Potential Acid Sulfate Soil
PCDD	Polychlorinated Dibenzodioxins
PCDF	Polychlorinated Dibenzofurans
PoG	Port of Gladstone
PSD	Particle Size Distribution
QASSTM	Queensland Acid Sulfate Soil Technical Manual
QA/QC	Quality Assurance / Quality Control
QC	Quality Control
QCI	QA/QC Compliance
RPD	Relative Percentage Difference
SAP	Sediment Analysis Plan
TBT	Tributyltin
TEQ	Toxicity Equivelant
TOC	Total Organic Carbon
UCL	Upper Confidence Limit
WHO	World Health Organisation
WQA	Water Quality Action

1. Introduction

1.1 Background

Gladstone Ports Corporation (GPC) provide and operate the Port of Gladstone (PoG) under the provisions of the *Transport Infrastructure Act 1994* which include maintaining and providing navigational channels through annual maintenance dredging campaigns. The PoG lies within Port Curtis and within the boundaries of the Great Barrier Reef World Heritage Area (GBRWHA). However all PoG activities including channels and the East Banks Sea Disposal Site (EBSDS) are inside the Port Limits and not within the Great Barrier Reef Marine Park (GBRMP).

A five year Deed of Agreement was agreed between GPC and the Department of the Environment and Energy (DoEE) on 14 August 2015, regarding maintenance dredging. Specifically related to this project the Deed includes that GPC investigates the possibility of avoiding or reducing the need for further dumping of maintenance dredge material into the marine environment. In addition, two specific Water Quality Actions (WQA) of the Reef 2050 Long-Term Sustainability Plan (Commonwealth of Australia, 2018) are relevant to this project:

- WQA 17 – Understand the port sediment characteristics and risks at the four major ports and how they interact and contribute to broader catchment contributions within the GBRMP.
- WQA 16 – Develop a state-wide coordinated maintenance dredging strategy.

The objective of this Project is to assist GPC to meet their obligations and commitments within the Deed of Agreement and Implementation Strategy to enable ongoing maintenance dredging.

GHD Pty Ltd (GHD) was engaged by GPC to undertake a sampling and analysis program to develop an understanding of the engineering properties of maintenance dredge material. The results and understanding will subsequently be used to develop a comprehensive options analysis of the opportunities for beneficial reuse maintenance dredge material within the PoG. Specific objectives have been categorised into three key components:

- Task 1a – Sediment Sampling Strategy to assess engineering properties of the maintenance dredge material.
- Task 1b – Sediment Characterisation Report of the engineering properties of the collected material from Task 1a (this document).
- Task 2 – Comprehensive Options Analysis Report outlining the opportunities for beneficial reuse.

1.2 Purpose of this Report

This Sediment Characterisation Report aligns with Task 1b of the Scope of Works. The purpose of this report is to present the findings of the sediment sampling, subsequent engineering properties, and to inform further studies for the beneficial reuse of maintenance dredging material in the PoG.

This report provides:

- An overview of the most recent Sediment Analysis Plan (SAP) sampling program and key contaminant sources of relevance to the investigation areas (Section 2)
- Description of the field methods of this sampling program, including sample locations (Section 3)

- Interpretation of results for sediment characterisation and engineering properties (Section 4)
- Information for the future development of a comprehensive options analysis for the beneficial reuse of the maintenance dredge material associated with Task 2.

1.3 Scope and Limitations

This report has been prepared by GHD for GPC and may only be used and relied on by GPC for the purpose agreed between GHD and the GPC as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than GPC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by GPC and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Existing Information

This section briefly describes the most resent sampling programs undertaken for the PoG and key contaminant sources of relevance to the investigation areas.

2.1 Sediment Analysis Plan and Implementation Reports (2017)

Sediment Analysis Plans (SAPs) are developed and implemented every five years to support maintenance dredging approval processes at the PoG, with the most recent SAP being completed in 2017 by BMT. Following this, GPC contracted Australasian Marine Associates (AMA) to complete:

- The SAP sampling outlined by BMT
- Additional sampling and analysis as requested by GPC of locations strategically selected within the PoG to detail sediment properties of the more commonly dredged areas which were not selected in the SAP.

Field work was undertaken between 21-23 November 2017, and included grab samples and core samples from PoG Main Channels, Gatcombe Heads Harbour, Upper Auckland Inlet, Lower Auckland Inlet and Gladstone Marina.

The following reports were issued to GPC and are referenced in this document:

- Port of Gladstone Maintenance Dredging Sampling and Analysis Plan (BMT WBM, 2017)
- Implementation Report Sediment Sampling and Analysis Plan for the Port of Gladstone Maintenance Dredging 2017 (AMA, 2018)
- Implementation Report Sediment Analysis Plan for the Port of Gladstone Maintenance Dredging 2017: Additional Port of Gladstone Main Channel Sampling Report (AMA, 2017).

Results of the sampling were compared various guidelines and sources summarised as follows:

- National Assessment Guidelines for Dredging (NAGD) (Commonwealth of Australia, 2009)
- National Environmental Protection Measure (NEPM) (National Environmental Protection Council (NEPC), 1999)
- Queensland Acid Sulfate Soil Technical Manual (QASSTM) (Dear, et al., 2002)
- *Handbook for Sediment Quality Assessment* (Simpson, et al., 2005).

Based on their findings, AMA (2018) reported an indication of no industrial contamination in the proposed maintenance dredging areas.

2.1.1 Physical Characteristics

The physical characteristics determined by the sampling was particle size distribution. The average clay, silt, sand and gravel percentages for each of the main dredge areas within the PoG channel are included in Table 1.

Table 1 2017 Particle Size Distribution Averages

Channel Area	Site ID	Clay (<2 µm)	Silt (2-60 µm)	Sand (0.06-2.00 mm)	Gravel (>2 mm)
Wild Cattle	MC7, MC10, MC11, MC45, MC46	17.8	14	55.6	12.6
Boyne	MC1, MC5, MC6, MC8, MC44	27.4	21.6	38.2	14.2
Golding	MC2, MC19, MC39, MC40, MC41, MC43	22.3	12	58.5	7.2
Gatcombe	MC16, MC17, MC18	2.3	0.6	60.6	36.3
Auckland	MC37	7	1	61	31
Clinton	MC23, MC24, MC32, MC33, MC35	13.8	6.2	54.8	25.2
WICET	MC31 MC22	16.5	9.5	52.5	21.5
Jacobs Channel	MC20, MC25, MC26, MC27, MC28, MC29	35.3	24.3	34.5	5.8
Fishermans Landing	MC30	47	36	17	0

2.1.2 Analytical Results Screening

A range of chemicals were analysed from all sites with no major contamination reported.

Heavy Metals

The heavy metal concentrations 95% upper confidence limit (UCL) of the main channel sediments were lower than respective screening levels (AMA, 2018).

Gladstone Marina and Lower Auckland Inlet samples returned a higher 95% UCL for iron, aluminium and manganese as those referenced in the approved SAP and reference sites, however are not considered a concern as they are naturally abundant (AMA, 2018).

Tributyltin (TBT) concentrations in samples from Gladstone Marina and Lower Auckland Inlet reported a higher 95% UCL in the 0.5-1 m sediment horizon than the screening level from NAGD (predominately affected by the Lower Auckland results), however the concentration was below the ANZECC/ARMCANZ (2000) marine water quality trigger values for 95% species protection (AMA, 2018).

Hydrocarbons

The hydrocarbon concentrations 95% upper confidence limit (UCL) of the main channel sediments were lower than respective screening levels (AMA, 2018).

2.1.3 Potential Acid Sulfate Soils

Fifteen of the main channel samples were submitted for acid sulfate soils (ASS) analysis by AMA. The average chromium reducible sulphur (S) was 0.071% S, which is above the adopted action criteria of 0.03% S. Due to the average sulfidic acid neutralising capacity within the sediments of 2.20% S the net acidity of the sediments was reported as <0.02% S (i.e. the soils have capacity to neutralise acid that may be produced) (AMA, 2018).

2.1.4 Nutrients

Nutrient sampling at PoG Main Channels and Gatcombe Heads Harbour indicated lower levels of mean total nitrogen concentration, total phosphorus concentration and percentage total organic carbon when compared to the Upper Auckland Inlet, Lower Auckland Inlet and Gladstone Marina samples (AMA, 2017; AMA, 2018). These findings are consistent with the natural accumulation of sediments and organic matter being greater in lower-flowing estuarine areas such as Auckland Inlet and Gladstone Marina (AMA, 2017; AMA, 2018).

Although there are no guidelines to compare against for nutrients and organic carbon in marine sediments, AMA (2017, 2018) considered the National Land and Water Resource Audit of Australian Estuaries and Coastal Waterways for typical total nitrogen concentrations, total phosphorus concentrations and percentage total organic carbon. All results were within the ranges considered typical for Australian marine sediments (AMA, 2017; AMA, 2018).

Ammonia was detected in a majority of samples from each area, however AMA (2018) reported that the approved SAP trigger value of 4mg/kg could not reasonably be applied as it referred to porewater ammonia concentration and not the bulk sediment that the levels from the AMA reports originate (AMA 2017; AMA, 2018).

Table 2 provides the mean results from the AMA (2017,2018).

Table 2 Mean Nutrient Concentrations within the PoG Main Channel Sediments

Nutrient	Units	SAP Implementation	SAP Additional
Nitrite as N (Sol.)	mg/kg	0.1	0.4
Nitrate as N (Sol.)	mg/kg	0.12	0.4
Nitrite + Nitrate as N (Sol.)	mg/kg	0.12	0.12
Total Kjeldahl Nitrogen as N	mg/kg	358	470
Total Nitrogen as N	mg/kg	358	470
Total Phosphorus as P	mg/kg	277	209
Ammonia as N	mg/kg	13	10.5
Total Organic Carbon	%	0.55	0.60

2.1.5 Dioxins & Furans Pilot Study

Dioxins and furans, more specifically polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzodioxins (PCDDs), were analysed in samples taken from reference sites, EBSDS and 20% of the maintenance dredge locations (AMA, 2018). Toxicity Equivalent (TEQ) was determined by quantifying dioxin/furan congener levels with toxicity equivalents from the World Health Organisation (WHO).

PCDF concentrations were lower than the Limit of Reporting (LOR) at all sites (AMA, 2018).

PCDD concentrations showed high levels of variability, however differences to this degree are considered not unusual (AMA, 2018). The most toxic PCDD, known as 3,7,8-TetraCDD, was not detected in any samples (AMA, 2018).

2.2 CQU Mapping

Mapping was completed by Central Queensland University (CQU) of recent and historical sampling sites throughout the Gladstone port limits. Sites were plotted using the Shepard's Classification System (initially published within Shepard, 1954) which colour-codes sampling locations by percentage of sand, silt, clay and gravel. Colours on this map indicated a large proportion of sediment sites around the EBSDS and outer channel area comprising of sand with some silt, clay and gravel.

Sediments within the shipping channel and in the middle channel areas were mostly gravelly sediments. Whereas sites in the upper channel and harbour areas, including the marina, were comprised mostly of silt with some sand and clay. This mapping indicates that a majority of the areas where current flows are higher present sediments of coarser materials with consistently more sand and gravel than those areas of lower current flows which indicate higher amounts of silty sediments.

3. Field Methods and Analytical Procedures

This section provides a description of the field methods and analytical procedures undertaken for this sampling program.

3.1 Sediment Sampling Locations

Sediment sampling locations were selected based on their spatial separation and representation of the key sediment types present in the PoG. More specifically samples were selected in consideration of:

- Sediment properties and particle size distribution (PSD) results detailed in the previous sampling programs
- Targeting highest extraction volume of dredge material
- Utilising sediment accumulation data
- Locations in the PoG known to have a gravel sediment were specifically not chosen for grab sampling as it is understood that this material is not dredged as a part of the annual GPC maintenance dredge program.

GPC identified that the Gladstone Marina does not form part of the routine maintenance dredging program, but rather included on an as-needed basis. Trailer Hopper Suction Dredge (THSD) *Brisbane* performs the routine maintenance, approximately every five years, by employing a Cutter Suction Dredge (CSD) to land methodology. As a result of this, a location was selected in the Gladstone Marina based on the above.

Additional samples were collected from the hopper dredge "*Brisbane*" that was undertaking the maintenance dredging in the PoG at that time. Samples were collected by the dredge operators with the dredge slurry being collected into large plastic buckets with solid lids. Locations of these samples were based on general locations only due to dredge methods.

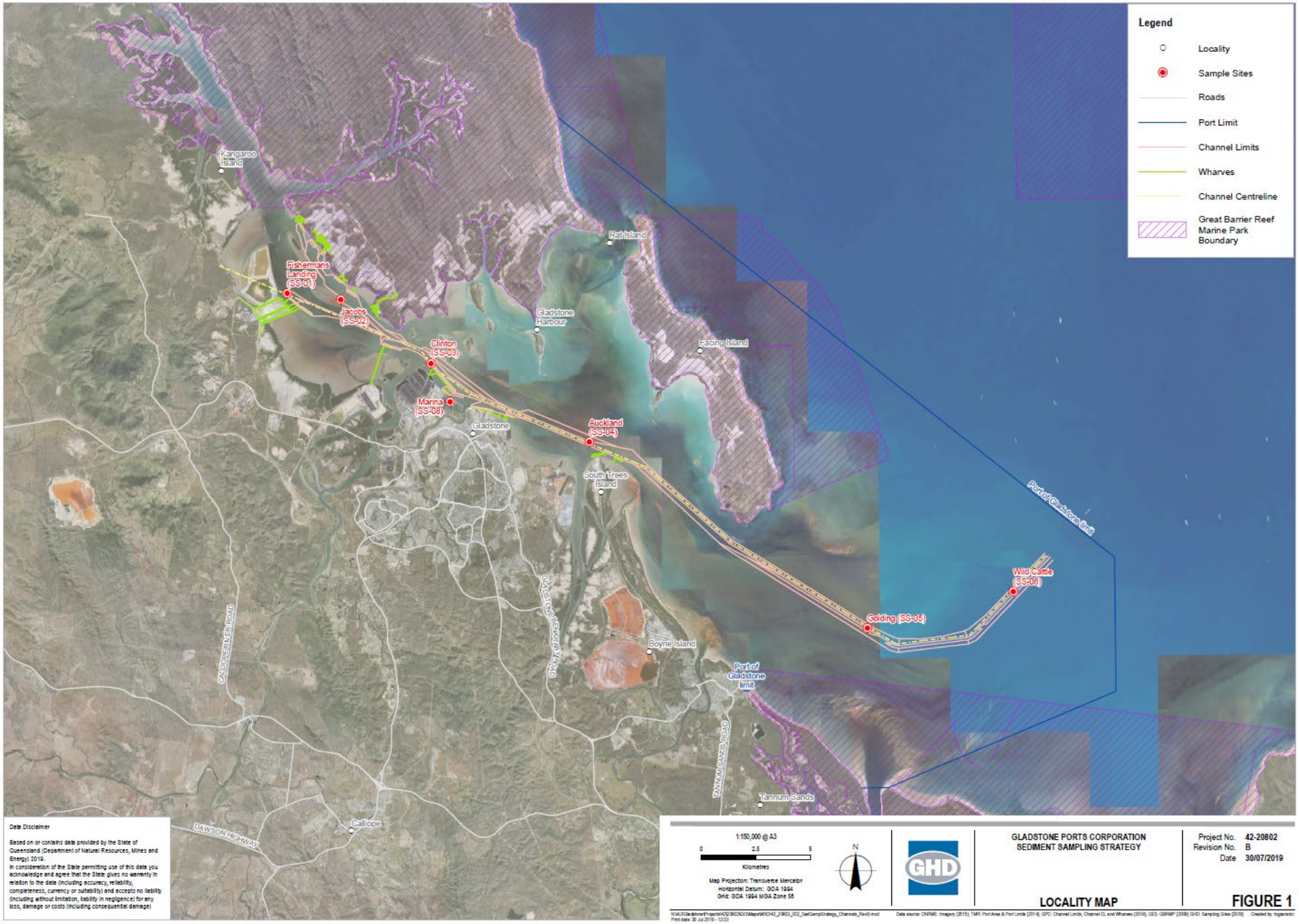
Prior to sampling, GHD were informed by GPC that the previously selected GPS coordinates for the location "Auckland" would yield insufficient sediment for sampling due to large amounts of coral and rock. Therefore, a more suitable location was selected within approximately 1.5 Nm of the original location.

Nine sites were sampled, including samples from the dredge, and are detailed in Table 3, Figure 3-1 and on field notes in Appendix A, along with their respective Site ID and GPS coordinates.

Table 3 Sampling locations and GPS coordinates

Location	Site ID	Easting (m)	Northing (m)
Fishermans	SS-01	313872	7368505
Jacobs	SS-02	316319	7368193
Clinton	SS-03	320454	7365318
Auckland	SS-04	327690	7361709
Golding	SS-05	340409	7353194
Wild Cattle	SS-06	340334	7352974
Marina	SS-08	321328	7363551
Wild Cattle South Side*	DS-01	N/A*	N/A*
Jacobs Channel GLNG Swing Basin South Side*	DS-02	N/A*	N/A*

*samples collected from "*Brisbane*" hopper dredge; GPS coordinates unknown.


Legend
Locality
Sample Sites
Roads
Port Limit
Channel Limits
Wharves
Channel Centreline
Great Barrier Reef Marine Park Boundary
Kangaroo Island
Rat Island
Fishermans Landing (SS-01)
Jacobs (SS-02)
Gladstone Harbour
Clinton (SS-03)
Facing Island
Marina (SS-08)
Gladstone
Auckland (SS-04)
South Trees Island
Port of Gladstone limit
Wild Cattle (SS-06)
Golding (SS-05)
Boyne Island
Port of Gladstone limit
Tannum Sands
Calliope
DAWSON HIGHWAY
CALIOPE RIVER ROAD
GLADSTONE BENARAWA ROAD
TANNUM SANDS ROAD
Data Disclaimer
Based on or contains data provided by the State of Queensland (Department of Natural Resources, Mines and Energy) 2019.
In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage)
1:150,000 @ A3
0 2.5 5
Kilometres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56
N
GHD
GLADSTONE PORTS CORPORATION
SEDIMENT SAMPLING STRATEGY
LOCALITY MAP
Project No. 42-20802
Revision No. B
Date 30/07/2019
FIGURE 1

3.2 Collection of Sediment Samples

3.2.1 HSE

Sediment sampling was undertaken in accordance with GHD's site specific Health, Safety and Environment (HSE) Plan (Job Safety and Environmental Assessment (JSEA) and daily pre-work risk assessments) and AB Marine safety procedures.

All field personnel undertook the required GPC contractor induction prior to undertaking any work. No safety incidents occurred during the implementation of the sampling.

3.2.2 Personnel and Vessel Requirements

Appropriately qualified and experienced personnel conducted all field work and adhered to appropriate safety controls. The vessel used was appropriate for surveys and skipper adequately trained for tasks. A vessel induction was completed by all staff and reviews of weather conditions were completed at multiple stages during the day to confirm safe work conditions.

A suitable sub-contractor was sourced by GHD for the provision of a vessel for sampling in the PoG, i.e. motorboat. AB Marine were the chosen vessel operators. Communication protocols with the PoG Harbour Master (when required) was established in accordance with the latest version of GPC's PoG Information Handbook.

3.2.3 Sample Retrieval and Processing

Field work was undertaken on Wednesday 14 November 2018, using a stainless steel Van Veen grab deployed from the boat with rope and a davit. The sample was then collected in the following steps:

1. The Van Veen was set into place and gently lowered to the seabed for sediment collection. The Van Veen was then pulled up and onto the boat and any sediment collected was emptied into a clean bucket. This was repeated several times at the same location until sufficient volume was collected.
2. Field notes were logged with descriptions following the Australian Standard Geotechnical Site Investigations 1726-1993 (Standards Australia, 1993). Sediment was then mixed well to obtain a homogenous sample and placed into appropriately labelled sterile glass jars and zip lock plastic bags, as per laboratory requirements. Sufficient sample was collected to ensure extra material was available for further testing if required.
3. Samples were stored in an esky (chilled for Total Organic Carbon (TOC) and ASS samples) in the field and en-route to the nominated laboratory.
4. Sample equipment was scrubbed and rinsed free of remaining sediment between each location.
5. Chain of Custody (COC) documentation was completed and samples delivered to the nominated laboratories within holding times.

Sampling, handling, transportations, storage, preservation and labelling techniques were conducted in accordance with appropriate geotechnical standards.

Field reporting included the following information:

- Client name and project
- GHD sample team names
- Site ID

- Location
- Date and Time of sample collection
- Latitude, Longitude, Northing and Easting of sample location
- Weather and sea conditions; depth (m), wind (kn), swell (m)
- Total number of grab samples collected
- Sediment characteristics: Colour; Plasticity; Odour; Texture; Stones (%); Shell (%); Fine Silt/Clay (%); Silt (%); Sand (%); Marine fauna/flora
- Digital photographs of sample
- General observations/comments (e.g. variances in sediment between grab samples, shipping traffic, QA/QC sample, other noteworthy materials in sample)

QA/QC sample was collected at one location and was extracted from the sediment post mixing. Refer to Section 5 for details on QA/QC procedures followed for this Project.

3.3 Sediment Analyses

3.3.1 Analytical Suite

Physical analysis of sediment samples were undertaken at NATA accredited laboratories (Butler Partners and ALS Environmental) and included analysis of the parameters listed below in Table 4.

Table 4 Physical analysis of sediment samples

Analyte	Sample Location	Laboratory
Particle Size Distribution (PSD) by Hydrometer	All Sites	Butler Partners
Atterberg Limits		
Moisture Content		
Bulk Particle Density		
Petrographic Analysis	SS-05	
Shape Analysis		
Total Organic Carbon (TOC)	All sites except DS-01 and DS-02*	ALS Environmental
Acid Sulfate Soil (ASS)		

* DS-01 and DS-02 samples collected from "*Brisbane*" hopper dredge

4. Results and Discussion

4.1 Field Sampling

Field sampling was undertaken on Wednesday 14 November 2018, a copy of the field notes are provided In Appendix A. Samples were collected from six locations in the PoG in addition to one duplicate sample and two dredge spoil samples (collected on separate days). Sample locations were the following:

- Fishermans (SS-01) and Jacobs (SS-02) – upper channel
- Clinton (SS-03) and Auckland (SS-04) – middle channel
- Golding (SS-05) and Wild Cattle (SS-06) – outer channel
- Marina (SS-08)

Samples collected from the THSD *Brisbane* dredge were collected from Wild Cattle South Side (DS-01) on Monday 26 November 2018, and Jacobs Channel GLNG Swing Basin South Side (DS-02) on Sunday 18 November 2018.

Wind and wave conditions at the time of sampling, along with sample depths are provided below in Table 5; field sampling data is not available for the locations DS-01 and DS-02 of the samples collected from the "*Brisbane*" dredge. Tides on this day in Gladstone harbour were low at 6:06 am (1.64 m), high at 1:35 pm (3.258 m) and low at 8:23 pm (1.63 m) (www.bom.gov.au).

Field observations collected at the time of sampling are provided below in Table 6 and indicate that sediments in areas of typically lower current flows (i.e. upper channel and outer channel) and the Marina consisted mainly of fine silty sediments of a dark grey/brown colour with anoxic odours. However, sediments in areas of typically higher current flows (i.e. middle channel) consisted mainly of sandy sediments which were brown in colour with a marine/salty odour.

Table 5 Wind, swell and depth of samples during field survey

Location	Site ID	Wind (kn)	Swell (m)	Depth (m)
Fishermans	SS-01	5	<1	11.4
Jacobs	SS-02	5 - 10	<1	14.1
Clinton	SS-03	5	<1	18.5
Auckland	SS-04	10	<1	18.2
Golding	SS-05	10 - 15	1	17
Wild Cattle	SS-06	10 - 15	1 - 2	17.6
Marina	SS-08	<5	<1	5

Table 6 Field observations of sediment composition, colour and odour

Location	Site ID	Composition	Colour	Odour
Fishermans	SS-01	Fine silt	Dark grey/brown	Slight anoxic
Jacobs	SS-02	Fine silt	Dark grey/brown	Anoxic
Clinton	SS-03	Sand	Brown	Marine
Auckland	SS-04	Sand	Brown sand	Marine
Golding	SS-05	Fine silt, sand and clayey sand	Dark brown	Marine
Wild Cattle	SS-06	Fine silt and sand	Dark brown, some black	Marine
Marina	SS-08	Fine silt	Dark grey	Anoxic

4.2 PoG Sediment Results

4.2.1 Engineering / Physical Properties

The results of the engineering and physical properties are provided in this section. The full Butler Partners laboratory results are provided in Appendix C.

Particle Size Distribution

PSD by sieve and hydrometer analysis, undertaken by Butler Partners, indicated that silt and clay dominated the samples collected from the Marina and upper reaches of the PoG (Fishermans and Jacobs), whereas sand dominated all other samples from the middle (Clinton and Auckland) to the outer reaches of the PoG (Golding and Wild Cattle) (Figure 4-1).

These findings support the results reported by AMA (2017, 2018) and the indication that sediments in areas of faster current flows (Clinton, Auckland, Golding and Wild Cattle) are largely comprised of sand and some gravel, whereas areas of lower current flows (Fishermans, Jacobs and Marina) are more comprised of finer sediments.

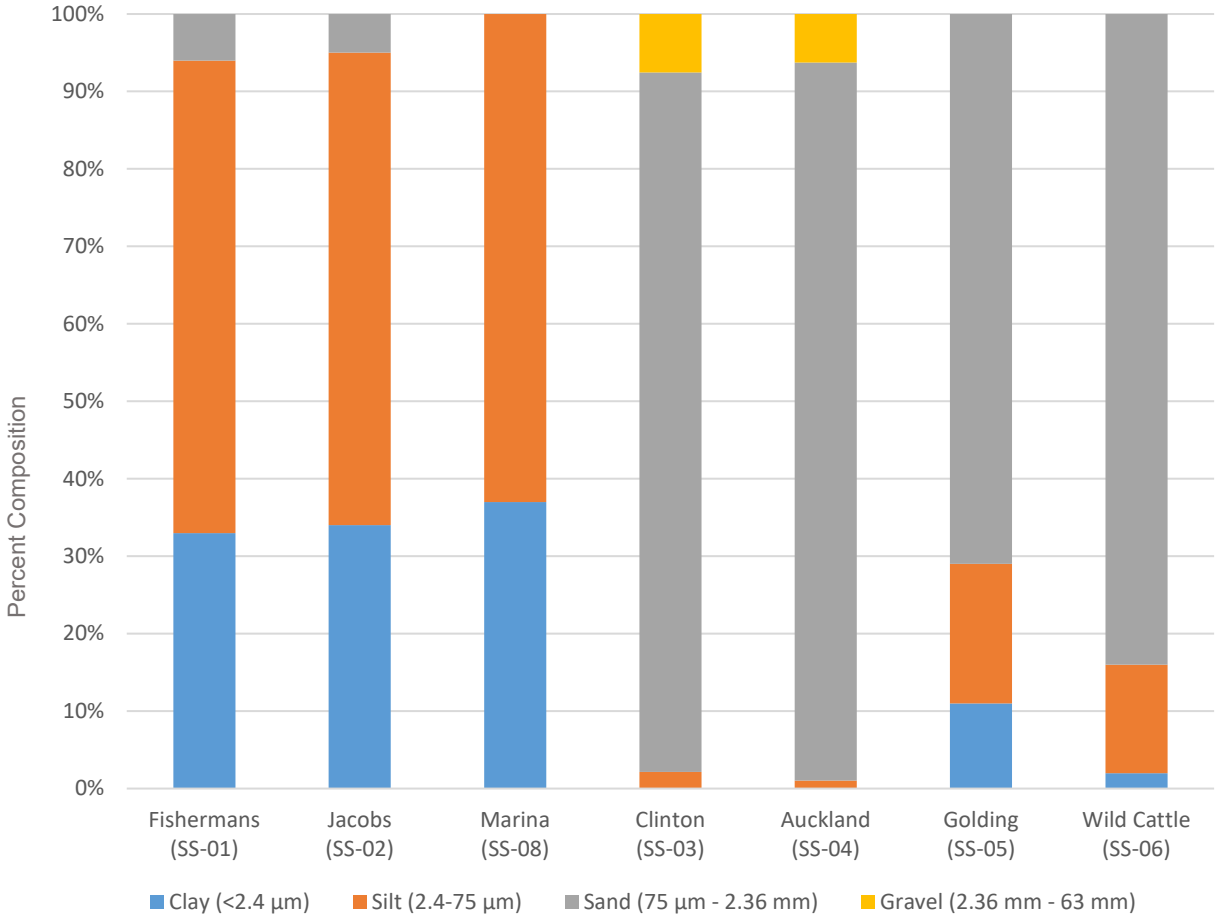


Figure 4-1 PSD results of sediment grab samples

Moisture Content

The moisture content is defined as the ratio of the mass of water to the mass of solids. The moisture content is important to determine the amount of effort required to dry out sediment material.

Moisture content of sediments ranged from 179% (Fishermans and Jacobs, the finer grained sediments) to 21% (Clinton), refer to Table 7. Average moisture content was 179% in the upper reaches of PoG, 24.05 % in the middle reaches, 33.15% in the outer reaches.

Material sourced from the upper reaches of the PoG is expected to be very difficult to use as an earthworks material in its current state due to the high moisture content. Significant moisture conditioning by drying or mixing with other products may be required to enable use.

Table 7 Moisture content results on sediment grab samples

Location	Site ID	Moisture Content (%)
Fishermans	SS-01	179.0
Jacobs	SS-02	179.0
Clinton	SS-03	21.0
Auckland	SS-04	27.1
Golding	SS-05	31.3
Wild Cattle	SS-06	35.0
Marina	SS-08	149.0

Atterberg Limit

Atterberg limit and plastic limit tests are designed to reflect the influence of water content, grain size and mineral composition on mechanical behaviour of clays and silts. Table 8 provides the Atterberg results, with the results also plotted on the plasticity chart (Figure 4-2). Not obtainable, or non-plastic was recorded for samples with <12% fines content. The moisture content of the samples tested was found to be higher than the samples' liquid limit indicating the sediments were very wet.

MH/OH soils are classified as medium to high plasticity fine grained soils, either organic clays (OH) or inorganic silts (MH) classification (Shepard, 1954). CH soils are high plasticity clays of inorganic origin. All samples tested plotted above 50% Liquid Limit line and either side of the A-Line, putting them in the MH/OH group or CH group.

Table 8 Atterberg limit results on sediment grab samples

Location	Site ID	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Classification
Fishermans	SS-01	55	24	31	CH
Jacobs	SS-02	57	26	31	CH
Clinton	SS-03	Not Obtainable	Not Obtainable	Non Plastic	-
Auckland	SS-04	Not Obtainable	Not Obtainable	Non Plastic	-
Golding	SS-05	Not Obtainable	Not Obtainable	Non Plastic	-
Wild Cattle	SS-06	Not Obtainable	Not Obtainable	Non Plastic	-
QA/QC Sample	SS-07				CH
Marina	SS-08	60	33	27	MH/OH

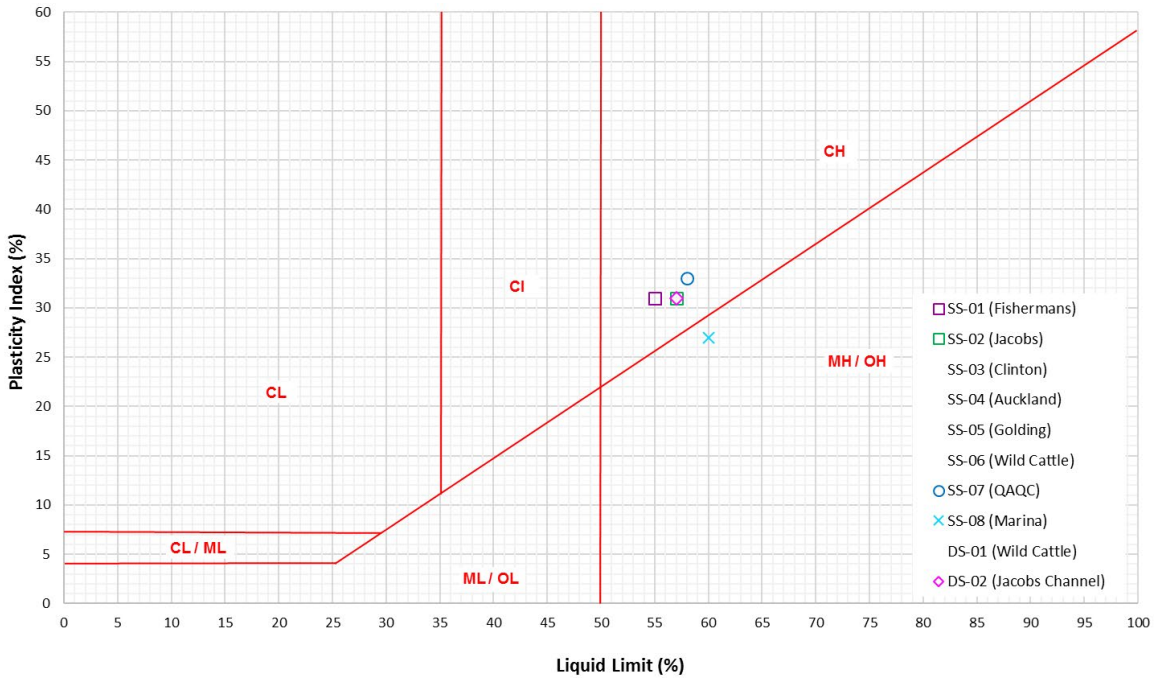


Figure 4-2 Plasticity chart

Linear Shrinkage

Linear shrinkage was analysed in conjunction with Atterberg limit, therefore some linear shrinkage results could not be obtained due to non-obtainable Atterberg limits; results are provided in Table 9. No cracking crumbling curling was detected in any sample.

Based on work conducted by Altmeyer (1955) cited in Carter and Bentley (1991), a linear shrinkage above 8% indicates a material with a critical potential for expansion. While there is some limitation to using shrinkage limit results to predict potential for swelling, the high linear shrinkage results recorded on the fine grained soils highlights a potential for swelling.

Table 9 Linear shrinkage results on sediment grab samples

Location	Site ID	Linear Shrinkage (%)	Cracking Crumbling Curling
Fishermans	SS-01	13.5	None
Jacobs	SS-02	14.0	None
Clinton	SS-03	-	None
Auckland	SS-04	-	None
Golding	SS-05	-	None
Wild Cattle	SS-06	-	None
Marina	SS-08	14.5	None

Note: - represents linear shrinkage unable to be determined due to Atterberg limits

Bulk Density Aggregate

The uncompacted bulk density results under dry conditions are provided in Table 10.

Table 10 Bulk density aggregate results on sediment grab samples

Location	Site ID	Uncompacted (t/m3)	Moisture Condition	Nominal Size
Fishermans	SS-01	0.88	Dry	Fine Sand
Jacobs	SS-02	0.88	Dry	Fine Sand
Clinton	SS-03	1.26	Dry	Fine Sand
Auckland	SS-04	1.36	Dry	Fine Sand
Golding	SS-05	1.02	Dry	Fine Sand
Wild Cattle	SS-06	1.08	Dry	Fine Sand
Marina	SS-08	0.88	Dry	Fine Sand

Additional Properties – Petrographic and Shape Analysis of Golding (SS-05)

Additional properties which included petrographic analysis and shape analysis, were undertaken on one sample only, Golding (SS-05).

The results indicated that the sediment from Golding was poorly consolidated sand in a clay-rich matrix. Sand was composed of grey translucent quartz, dark grey to white feldspars, granitic fragments and some shell fragments. A majority of the sediment (54%) was classified as coarse (>1.18 mm) with a free silica content of approximately 38%. Shape analysis indicated the dried sediment had an average roundness of 0.46 and an average sphericity of 0.68, where 0.8-1.0 is well rounded with a high sphericity.

Butler laboratory results are provided in Appendix D.

4.2.2 Total Organic Carbon

TOC analysis, undertaken by ALS, indicated a higher TOC percentage in the upper PoG areas (Fishermans and Jacobs) and in the Marina, where lower current flows are present and the sediment is dominated by fine silt and clay. Higher currents dominating the middle reaches of the PoG support the results indicating the lowest percentage of TOC was in the Clinton sample, becoming slightly higher in the Auckland, Golding and Wild Cattle samples (Figure 4-3).

ALS laboratory results are provided in Appendix C.

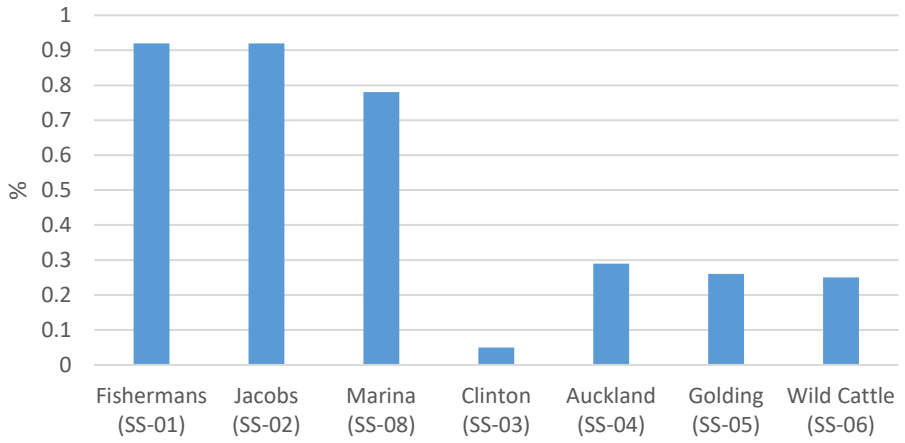


Figure 4-3 Total Organic Carbon results of sediment grab samples

4.2.3 Acid Sulfate Soil

Consistent with other Australian states and territories, Queensland has adopted the value of 0.03 %S net acidity (oven dried basis) as the action criterion level to define whether there is a need to manage the soils as ASS. The greatest measured %S net acidity value from the soil / sediment sampling program is used to determine whether the critical level of 0.03 %S net acidity has been exceeded. The figure of 0.03 %S (or 18 mol H+ / tonne) is the action criterion for sediment disturbances greater than 1,000 tonnes and does not consider soil texture and buffering capacity. This is the most conservative action criterion. Criteria for determining whether soils are classified as ASS are provided in the QASSIT Guidelines.

Table 11 includes the key results from the ASS analyses. The results are comparable with the AMA (2017) sampling. It shows that sediments can be classified as potential ASS, however the sediments contain excess acid neutralising capacity (this may be as a result of shell presence). This means that if sediments are oxidised (e.g. onshore placement), it is likely that neutralisation will naturally occur however sediment engineering properties may change.

ALS laboratory results are provided in Appendix C.

Table 11 Acid sulfate soil results

Site ID	Titratable Actual Acidity (% S)	Peroxide Oxidisable Sulfur (% S)	Excess Acid Neutralising Capacity (% S)	Net Acidity (% S)	Liming Rate (kg CaCO3/t)
SS-01	<0.020	0.223	0.35	<0.02	<1
SS-02	<0.020	0.188	0.427	<0.02	<1
SS-03	<0.020	<0.020	0.272	<0.02	<1
SS-04	<0.020	<0.020	1.25	<0.02	<1
SS-05	<0.020	0.052	2.02	<0.02	<1
SS-06	<0.020	0.063	3.74	<0.02	<1
SS-08	<0.020	0.154	0.502	<0.02	<1

4.3 Dredge Spoil Results

The sediments engineering properties are known to alter between the different stages of dredging. Therefore, samples from the THSD *Brisbane* hopper where collected at two locations to review the potential engineering property changes between the natural/sediment bed state and the dredged state. The method of sample recovery was collection from the surface of the hopper. The surface of the hopper is likely to contain a higher percentage of suspended fines than the bulk of material within the hopper.

It is accepted that further alterations would occur during and after placement onshore.

The results are discussed in this section, with the Butler Partners laboratory results provided in Appendix C.

4.3.1 Engineering / Physical Properties

Particle Size Distribution

PSD by sieve and hydrometer analysis, undertaken by Butler Partners, mirrored the PSD results of the sediment grab samples in that the upper PoG sample from Jacobs Channel GLNG Swing Basin South Side comprised mostly of clay and silt with some sand, whereas the outer PoG sample from Wild Cattle South Side was made up of mostly sand with some silt and clay (Figure 4-4). The comparison sediment grab sample locations are Jacobs and Wild Cattle, respectively.

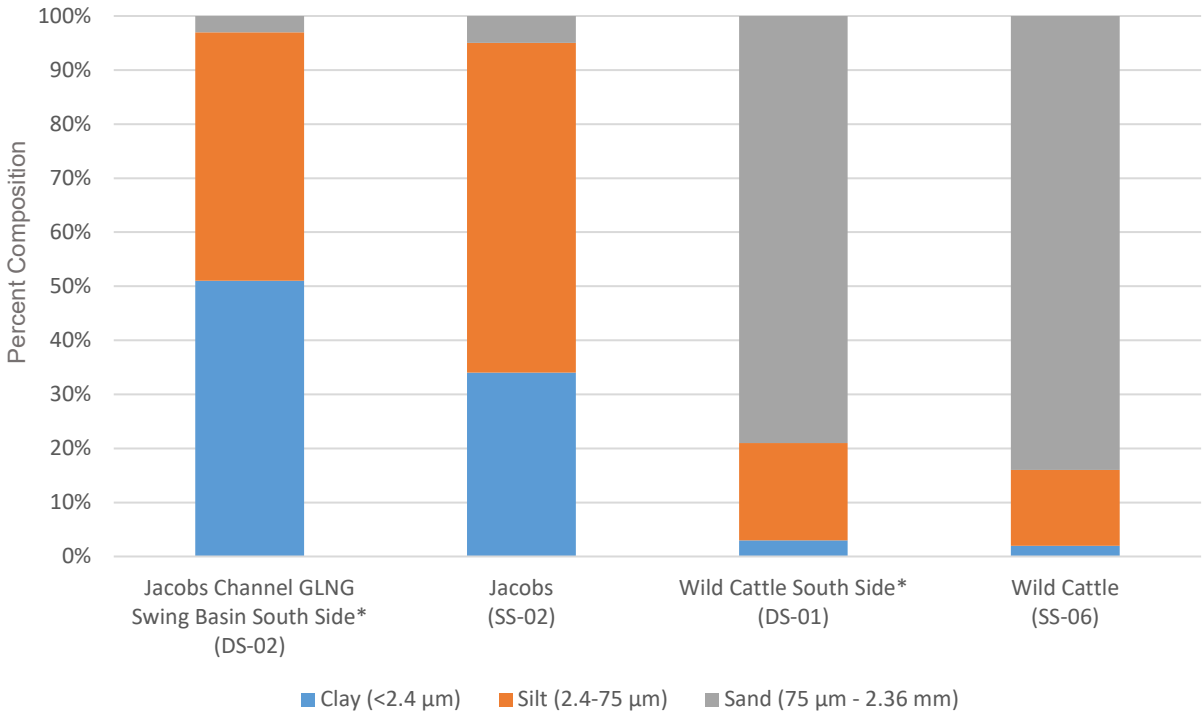


Figure 4-4 PSD results of dredge spoil samples

*samples collected from hopper dredge THSD *Brisbane*

Moisture Content

Moisture content of the dredge spoil sample taken from Wild Cattle South Side (41.9%) was slightly higher than the sediment grab sample at the comparison location (35%), whereas the dredge spoil sample taken from Jacobs Channel GLNG Swing Basin South Side (155%) was slightly lower than the comparison sediment grab sample (179%) (Table 12).

Table 12 Moisture content results on dredge spoil samples

Location	Moisture Content (%)	
	DS	SS
Wild Cattle South Side	41.9 (DS-01)	35 (SS-06)
Jacobs Channel GLNG Swing Basin South Side	155 (DS-02)	179 (SS-02)

DS – Dredge sample

SS – Sediment sample

Atterberg Limit

Atterberg limit results indicated no difference between the sampling methods of sediment grab sample to dredge spoil sample, refer to Table 13 and Figure 4-2. Results were unable to be assessed in the sample taken from Wild Cattle South Side due to low fine sediment fraction, whereas results were identical in the Jacobs Channel GLNG Swing Basin South Side to the comparison location sample.

Table 13 Atterberg limit results on dredge spoil samples

Location	Liquid Limit (%)		Plastic Limit (%)		Plasticity Index (%)	
	DS-02	SS-02	DS-02	SS-02	DS-02	SS-02
Jacobs Channel GLNG Swing Basin South Side	57	57	26	26	31	31

Linear Shrinkage

Linear shrinkage results were slightly higher from the sediment collected in the dredge spoil sample in comparison with the sediment grab sample collected, as presented below in Table 14. No cracking crumbling curling was detected in either sample.

Table 14 Linear shrinkage results on dredge spoil samples

Location	Linear Shrinkage (%)		Cracking Crumbling Curling	
	DS-02	SS-02	DS-02	SS-02
Jacobs Channel GLNG Swing Basin South Side	19.5	14	None	None

Bulk Density Aggregate

The uncompacted bulk density results under dry conditions were similar in the dredge spoil samples and the comparison sites' sediment grab samples, as presented below in Table 15. Moisture condition and nominal sizes were identical in all samples.

Table 15 Bulk density aggregate results for dredge spoil samples

Location	Uncompacted (t/m3)		Moisture Condition		Nominal Size	
	DS	SS	DS	SS	DS	SS
Wild Cattle South Side	0.88 (DS-01)	1.08 (SS-06)	Dry (DS-01)	Dry (SS-06)	Fine Sand (DS-01)	Fine Sand (SS-06)
Jacobs Channel GLNG Swing Basin South Side	0.99 (DS-02)	0.87 (SS-02)	Dry (DS-02)	Dry (SS-02)	Fine Sand (DS-02)	Fine Sand (SS-02)

DS – Dredge sample

SS – Sediment sample

5. Quality Control and Quality Assurance Procedures

5.1 Field Measurements

All field samples were collected using methods appropriate to avoid cross contamination. Information with regards to the procedures applied to provide quality assurance and control over field measurements and sample processing is provided in Section 3.2.

5.2 Decontamination

Prior to use, the survey vessel was thoroughly inspected and washed down. Any evident sources of contamination (such as copper or brass, or galvanised or oily surfaces) were cleaned, covered in plastic and taped down to avoid accidental contamination. Lead weights were stowed away.

Sampling equipment was cleaned between sites to avoid cross contamination. This process involved scrubbing all equipment with a brush to loosen attached sediment then thoroughly rinsing in seawater.

Samples were collected wearing disposable nitrile, powder free gloves that were changed between each sampling location, or if a glove was punctured, to prevent any cross contamination.

5.3 Sample Preservation

Once samples were collected and labelled, they were promptly stored away from any sources of light, below 4°C (required for TOC and ASS samples only) and transported to the testing laboratory within the specified holding times. Samples were collected, preserved, stored and transported according to the requirements of the relevant standards and instructions given by the analytical laboratory.

5.4 Chain of Custody Documentation

All samples were transported under Chain of custody (COC) documentation to confirm traceability of samples during all stages of the program. Copies of the completed COC forms are provided In Appendix E.

5.5 Analytical Testing Laboratories

All laboratories used for analysis were NATA accredited and experienced in the chemical and physical analysis of marine sediments.

Laboratories held current NATA registration for the specific chemical and physical parameters analysed.

5.6 Field QA/QC Sampling and Analysis

Field sampling QA/QC involved one duplicate sample which was collected at one location (Jacobs SS-02). The duplicate sample was collected by retrieving one extra grab sample from the same location, through identical methods as described in step 1 of Section 3.2.3 above. The duplicate sample was placed into the respective laboratory bags/bottles following the mixing of sediment (step 2 of Section 3.2.3) and transported to the laboratory for analysis (step 3 and 5 of Section 3.2.3).

Relative Percentage Difference (RPD) was calculated for all samples using the equation below in Figure 5-1. All results were within acceptable limits (≤20%) (DES, 2018)

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

Where: RPD is relative percentage difference
C_1 is the concentration of analyte from sample 1
C_2 is the concentration of analyte from sample 2

Figure 5-1 Relative Percentage Difference (RPD) equation

5.7 Laboratory QA/QC Results

Laboratory QA/QC procedures for duplicates, method blanks, laboratory control samples, and matrix spikes were generally within data quality criteria.

All samples were delivered to the laboratories within holding times with the exception of:

- EA037: ASS Field Screening Analysis; Soil Glass Jar – Unpreserved, which has a holding time of 24 hours unfrozen. However, this is not considered to have affected any sample analysis or results due to the specific analyses undertaken.

ALS Laboratory QA/QC results are shown in Appendix F.

6. Conclusion

The purpose of this report is to present the findings of the sediment sampling, subsequent engineering properties and to inform further studies for the beneficial reuse of the maintenance dredging material in the PoG. Field samples were collected from six (6) sites in the PoG in addition to one (1) duplicate sample and two (2) dredge spoil samples.

Samples were analysed for engineering/physical properties, TOC and ASS. The results are summarised as follows:

- Particle size distribution results reported that sediments in the outer and middle channel locations consisted of coarser materials (sand and gravel) than those sediments found in the upper channel reaches and in the Marina.
- Current flow is suggested to be the factor affecting these findings, that is, areas of higher current flow (middle and outer channel) suspend the finer materials in the water column therefore leaving sand and gravel materials in the sediment. Finer silty sediment was reported in the locations of lower current flow (upper channel and Marina) along with a higher TOC concentration.
- Material sourced from the upper reaches of the PoG is expected to be very difficult to use as an earthworks material in its current state due to the high moisture content.
- Atterberg limit and plastic limit where able to be analysed on samples with >12% fines (three samples). When plotted the samples were found to be medium to high plasticity (MH/OH) and high plasticity.
- Linear shrinkage on the three samples (above) was determined to be >8% indicating material with a critical potential for expansion.
- ASS was identified in five of the samples, however due to the acid neutralising capacity of the soils ASS may not present a high risk. Pending sediment purpose, additional sampling is recommended.

Physical properties of the dredge spoil samples collected from the THSD *Brisbane* presented slight differences:

- 2-5% less sand in the dredge spoil sampled when compared to the sediment grab samples, with the Jacobs Channel dredge spoil containing 51% clay (compared to 34%)
- Lower moisture content in the Jacobs Channel dredge spoil (155 % compared to 179%)
- Atterberg limits where comparable
- Linear shrinkage results in the Jacobs Channel dredge spoil was higher (19.5 % compared to 14%) indicating a higher potential for expansion.

Whilst there are differences, overall the samples collected from the THSD *Brisbane* and the sediment grab samples present similar engineering properties for the two locations, noting that sampling methodology may require greater scrutiny for increased accuracy).

7. References

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Appendices

Appendix A – Sampling Field Notes

GPC Dredge Material Sediment Sampling Field Notes

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-01	Location: Fishermans	Date: 14/ 11 /2018
Latitude: -23° 47.032' S	Northing: 7368505	Time: 1500
Longitude: 151° 10.397' E	Easting: 313872	Depth: 11.4
	Wind: 5kn	Swell: <1m

Sediment Analysis	Total no. of grab samples: 1							
Colour: Dark Grey/brown	Plasticity: None.						Odour: Slight anoxic	
Texture: Fine	(Fine silt)	Clay	Sand	Clayey sand	Solid clay	Loamy clay	Rocky	Other:
Stones (%): 0	Shell (%): 0						Fine Silt/Clay (%): 0	
Silt (%): 100	Sand (%): 0						Marine fauna/flora: 0	
Photo Record:								
Observations: Thin light brown surface layer.								

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-02	Location: Jacobs	Date: 14 / 11 /2018
Latitude: -23° 47.218' S	Northing: 7368193	Time: 1520
Longitude: 151° 11.835' E	Easting: 316319	Depth: 14.1m
	Wind: 5-10kn	Swell: <1m

Sediment Analysis	Total no. of grab samples: 1							
Colour: Dark grey/brown	Plasticity: NONE						Odour: Anoxic	
Texture: Fine	(Fine silt)	Clay	Sand	Clayey sand	Solid clay	Loamy clay	Rocky	Other: —
Stones (%): 0	Shell (%): 0						Fine Silt/Clay (%): 0	
Silt (%): 100	Sand (%): 0						Marine fauna/flora: 0	
Photo Record:								
Observations: QA/QC Sample collected here. ID: SS-07 1530								

GPC Dredge Material Sediment Sampling Field Notes

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-03	Location: Clinton	Date: 14 / 11 /2018
Latitude: -23° 48·803' S	Northing: 7365318	Time: 1417
Longitude: 151° 14·248' E	Easting: 320454	Depth: 18·5m
	Wind: 5kn	Swell: <1m

Sediment Analysis				Total no. of grab samples: 5					
Colour: Brown				Plasticity: None				Odour: Marine	
Texture: Fine	Fine silt	Clay	(Sand)	Clayey sand	Solid clay	Loamy clay	Rocky	Other:	
Stones (%): 0			Shell (%): 15					Fine Silt/Clay (%): 0	
Silt (%): 0			Sand (%): 85					Marine fauna/flora: Turfing algae on rocks.	
Photo Record:									
Observations: Shipping movement through area right before grabs were collected.									

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-04	Location: Auckland	Date: 14 / 11 /2018
Latitude: -23° 50·806' S	Northing: 7361709	Time: 1330
Longitude: 151° 18·483' E	Easting: 327690	Depth: 18·2m
	Wind: 10kn	Swell: <1m

Sediment Analysis				Total no. of grab samples: 4					
Colour: Brown sand				Plasticity: –				Odour: Marine	
Texture: Fine	Fine silt	Clay	(Sand)	Clayey sand	Solid clay	Loamy clay	Rocky	Other: Shell	
Stones (%): 5			Shell (%): 25 (up to 2cm)					Fine Silt/Clay (%): –	
Silt (%): 0			Sand (%): 70					Marine fauna/flora: Invertebrate presence	
Photo Record:									
Observations: Some coal, shells sharp, some evidence of wear. 1cm²									

GPC Dredge Material Sediment Sampling Field Notes

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-05	Location: Golding	Date: 14/ 11 /2018
Latitude: -23° 55.498' S	Northing: 7 353994	Time: 12:00
Longitude: 151° 25.919' E	Easting: 3 40409	Depth: 17m
	Wind: 10 - 15 kn	Swell: 1m

Sediment Analysis	Total no. of grab samples: 4	
Colour: Dark brown	Plasticity: None	Odour: Marine
Texture: Fine / (Fine silt) / Clay / (Sand) / (Clayey sand) / Solid clay / Loamy clay / Rocky / Other:		
Stones (%): 0	Shell (%): 5 1x2cm shell 1x 4cm	Fine Silt/Clay (%):
Silt (%): 10	Sand (%): 90	Marine fauna/flora: 0
Photo Record: 7-8		
Observations: Small clumps of sandy clay		

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-06	Location: Wild Cattle	Date: 14 / 11 /2018
Latitude: -23° 54.617 S	Northing: 7 352974	Time: 10:15am -1120
Longitude: 151° 29.873' E	Easting: 3 40334	Depth: 17-6
	Wind: 10-15kn	Swell: 1-2m

Sediment Analysis	Total no. of grab samples: 4	
Colour: Dark brown some black	Plasticity: None	Odour: ~~None~~ Marine Odour
Texture: Fine / (Fine silt) / Clay / (Sand) / Clayey sand / Solid clay / Loamy clay / Rocky / Other:		
Stones (%): 0	Shell (%): <5	Fine Silt/Clay (%):
Silt (%): 10	Sand (%): 90	Marine fauna/flora: 0
Photo Record:		
Observations: Weather o/cast, no shipping		

GPC Dredge Material Sediment Sampling Field Notes

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID: SS-08	Location: Marina	Date: 14/ 11 /2018
Latitude: -23° 49.766' S	Northing: 7363551	Time: 16:15
Longitude: 151° 14.750' E	Easting: 321328	Depth: 5m
	Wind: SLIGHT <5kn	Swell: —

Sediment Analysis				Total no. of grab samples: 2					
Colour: DARK GREY				Plasticity: —				Odour: ANOXIC	
Texture: Fine	Fine silt	Clay	Sand	Clayey sand	Solid clay	Loamy clay	Rocky	Other:	
Stones (%): —				Shell (%): —				Fine Silt/Clay (%): —	
Silt (%): 100				Sand (%): —				Marine fauna/flora: —	
Photo Record:									
Observations: SOME ORGANICS, ANOXIC ODOUR									

Client: GPC	Project: PoG Sediment Properties and Beneficial Reuse	Team: E Smith, T Coffin
Site ID:	Location:	Date: / 11 /2018
Latitude: -23° S	Northing: 7	Time:
Longitude: 151° E	Easting: 3	Depth:
	Wind:	Swell:

Sediment Analysis				Total no. of grab samples:				
Colour:				Plasticity:				Odour:
Texture: Fine	Fine silt	Clay	Sand	Clayey sand	Solid clay	Loamy clay	Rocky	Other:
Stones (%):				Shell (%):				Fine Silt/Clay (%):
Silt (%):				Sand (%):				Marine fauna/flora:
Photo Record:								
Observations:								

Appendix B – Photo Log

SS-01 Fishermans


14/11/2018
SS-02 Jacobs

14/11/2018

SS-03 Clinton


14/11/2018
SS-04 Auckland


14/11/2018
SS-05 Golding

14/11/2018

SS-06 Wild Cattle

SS-08 Marina

DS-01 Wild Cattle

DS-02 Jacobs Channel

Appendix C – Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1827718**	Page	: 1 of 6
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS AMANDA SMEDLEY	Contact	: Caroline Hill
Address	: PO BOX 373 GLADSTONE QLD 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 4973 1613	Telephone	: +61 7 3552 8662
Project	: 4220802	Date Samples Received	: 16-Nov-2018 14:00
Order number	: 4220802	Date Analysis Commenced	: 21-Nov-2018
C-O-C number	: ----	Issue Date	: 23-Nov-2018 16:55
Sampler	: EMMA SMITH, Tristram Coffin		
Site	: GPC Dredge Material Beneficial Reuse		
Quote number	: EN/005/18		
No. of samples received	: 8		
No. of samples analysed	: 8		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SS-01	SS-02	SS-03	SS-04	SS-05
			Client sampling date / time	14-Nov-2018 15:00	14-Nov-2018 15:20	14-Nov-2018 14:17	14-Nov-2018 13:30	14-Nov-2018 12:00
Compound	CAS Number	LOR	Unit	EB1827718-001	EB1827718-002	EB1827718-003	EB1827718-004	EB1827718-005
				Result	Result	Result	Result	Result
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	8.5	8.6	9.6	9.7	9.4
pH OX (23B)	----	0.1	pH Unit	7.3	7.2	8.6	9.8	8.8
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	<2	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	<0.020	<0.020	<0.020	<0.020	<0.020
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	<0.020	<0.020	<0.020	<0.020	<0.020
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	<0.020	<0.020	<0.020	<0.020	<0.020
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	0.186	0.235	0.031	0.029	0.054
Peroxide Sulfur (23De)	----	0.020	% S	0.409	0.423	0.034	0.043	0.105
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	0.223	0.188	<0.020	<0.020	0.052
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	139	117	<10	<10	32
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	0.313	0.368	0.117	0.147	0.177
Peroxide Calcium (23Wh)	----	0.020	% Ca	0.642	0.733	0.331	1.69	2.48
Acid Reacted Calcium (23X)	----	0.020	% Ca	0.328	0.366	0.215	1.54	2.30
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	164	183	107	771	1150
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	0.263	0.293	0.172	1.24	1.84
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	0.301	0.364	0.041	0.038	0.076
Peroxide Magnesium (23Tm)	----	0.020	% Mg	0.397	0.442	0.060	0.060	0.213
Acid Reacted Magnesium (23U)	----	0.020	% Mg	0.096	0.078	<0.020	0.022	0.138
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	79	64	15	18	113
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	0.126	0.103	0.025	0.028	0.182
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.020	% CaCO3	1.10	1.33	0.850	3.91	6.31
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	219	266	170	782	1260
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.020	% S	0.350	0.427	0.272	1.25	2.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS-01	SS-02	SS-03	SS-04	SS-05
				Client sampling date / time	14-Nov-2018 15:00	14-Nov-2018 15:20	14-Nov-2018 14:17	14-Nov-2018 13:30	14-Nov-2018 12:00
Compound	CAS Number	LOR	Unit		EB1827718-001	EB1827718-002	EB1827718-003	EB1827718-004	EB1827718-005
					Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued									
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t		<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		**0.22**	**0.19**	<0.02	<0.02	**0.05**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**139**	**117**	<10	<10	**32**
Liming Rate excluding ANC	----	1	kg CaCO3/t		**10**	**9**	<1	<1	**2**
EA037: Ass Field Screening Analysis									
ø pH (F)	----	0.1	pH Unit		**8.1**	**7.9**	**7.8**	**7.9**	**8.6**
ø pH (Fox)	----	0.1	pH Unit		**6.4**	**6.4**	**6.8**	**8.3**	**7.2**
ø Reaction Rate	----	1	-		**4**	**4**	**2**	**4**	**4**
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.92**	**0.92**	**0.05**	**0.29**	**0.26**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SS-06	SS-07	SS-08	----	----
			Client sampling date / time	14-Nov-2018 11:20	14-Nov-2018 15:30	14-Nov-2018 16:15	----	----
Compound	CAS Number	LOR	Unit	EB1827718-006	EB1827718-007	EB1827718-008	--------	--------
				Result	Result	Result	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**9.5**	----	**8.8**	----	----
pH OX (23B)	----	0.1	pH Unit	**8.9**	----	**7.9**	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	<2	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	<2	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.020	% pyrite S	<0.020	----	<0.020	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.020	% pyrite S	<0.020	----	<0.020	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.020	% pyrite S	<0.020	----	<0.020	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.020	% S	**0.059**	----	**0.165**	----	----
Peroxide Sulfur (23De)	----	0.020	% S	**0.122**	----	**0.319**	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.020	% S	**0.063**	----	**0.154**	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	**39**	----	**96**	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.020	% Ca	**0.184**	----	**0.279**	----	----
Peroxide Calcium (23Wh)	----	0.020	% Ca	**4.32**	----	**0.629**	----	----
Acid Reacted Calcium (23X)	----	0.020	% Ca	**4.13**	----	**0.350**	----	----
acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	**2060**	----	**175**	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.020	% S	**3.31**	----	**0.280**	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.020	% Mg	**0.068**	----	**0.277**	----	----
Peroxide Magnesium (23Tm)	----	0.020	% Mg	**0.314**	----	**0.398**	----	----
Acid Reacted Magnesium (23U)	----	0.020	% Mg	**0.245**	----	**0.121**	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	**202**	----	**100**	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.020	% S	**0.323**	----	**0.160**	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.020	% CaCO3	**11.7**	----	**1.57**	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	**2340**	----	**314**	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.020	% S	**3.74**	----	**0.502**	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS-06	SS-07	SS-08	----	----
				Client sampling date / time	14-Nov-2018 11:20	14-Nov-2018 15:30	14-Nov-2018 16:15	----	----
Compound	CAS Number	LOR	Unit		EB1827718-006	EB1827718-007	EB1827718-008	--------	--------
					Result	Result	Result	----	----
EA029-F: Excess Acid Neutralising Capacity - Continued									
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		<10	----	<10	----	----
Liming Rate	----	1	kg CaCO3/t		<1	----	<1	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		**0.06**	----	**0.15**	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**39**	----	**96**	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		**3**	----	**7**	----	----
EA037: Ass Field Screening Analysis									
ø pH (F)	----	0.1	pH Unit		**8.3**	----	**8.5**	----	----
ø pH (Fox)	----	0.1	pH Unit		**7.5**	----	**6.5**	----	----
ø Reaction Rate	----	1	-		**4**	----	**2**	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.25**	**0.92**	**0.78**	----	----

Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240A
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5501
Time Sampled: 15:00

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NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Joshua Hamilton
Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	179

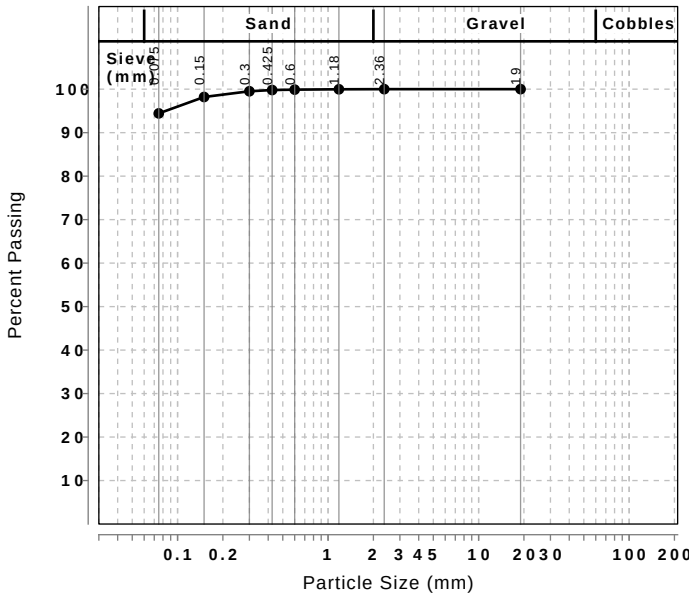
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**100**			0		
0.3 mm	**100**			0		
0.15 mm	**98**			1		
0.075 mm	**94**			4		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	55		
Plastic Limit (%)	24		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.5		
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.88**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240B
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5502
Time Sampled: 15:20

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Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	179

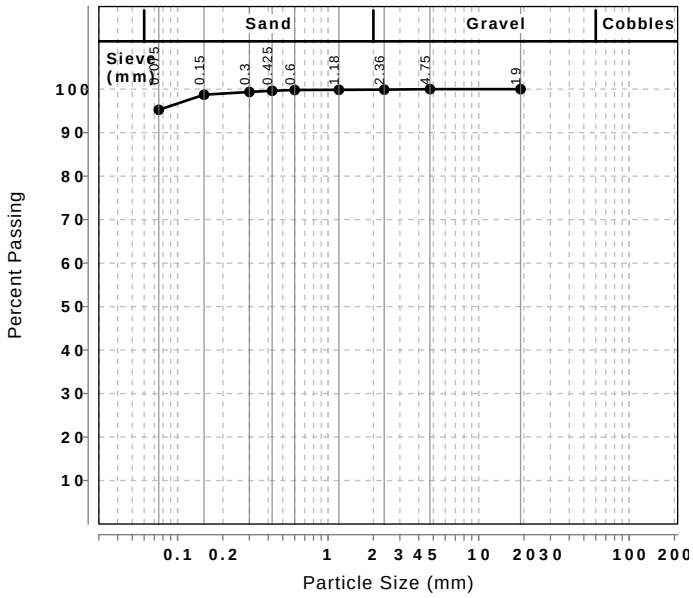
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
4.75 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**100**			0		
0.3 mm	**99**			0		
0.15 mm	**99**			1		
0.075 mm	**95**			3		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	57		
Plastic Limit (%)	26		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.0		
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.87**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240C
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5503
Time Sampled - 14:17

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Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	21.0

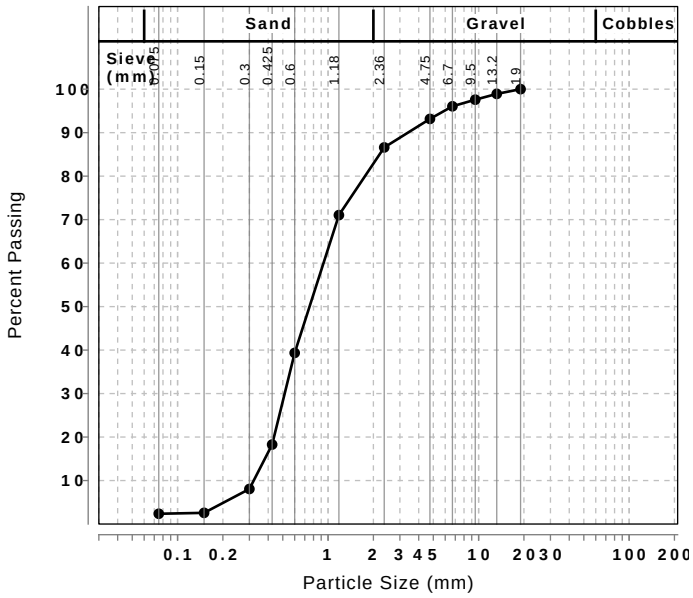
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**99**			1		
9.5 mm	**98**			1		
6.7 mm	**96**			2		
4.75 mm	**93**			3		
2.36 mm	**87**			7		
1.18 mm	**71**			16		
0.6 mm	**39**			32		
0.425 mm	**18**			21		
0.3 mm	**8**			10		
0.15 mm	**3**			5		
0.075 mm	**2**			0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)			
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**1.26**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240D
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5504
Time Sampled - 13:30

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Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	27.1

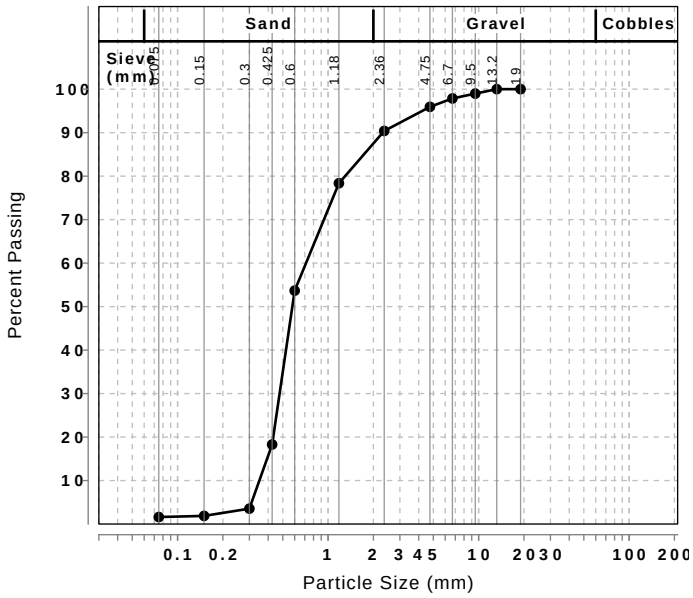
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**100**			0		
9.5 mm	**99**			1		
6.7 mm	**98**			1		
4.75 mm	**96**			2		
2.36 mm	**90**			6		
1.18 mm	**78**			12		
0.6 mm	**54**			25		
0.425 mm	**18**			35		
0.3 mm	**4**			15		
0.15 mm	**2**			2		
0.075 mm	**2**			0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)			
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**1.36**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240E
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5505
Time Sampled - 12:00

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Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	31.3

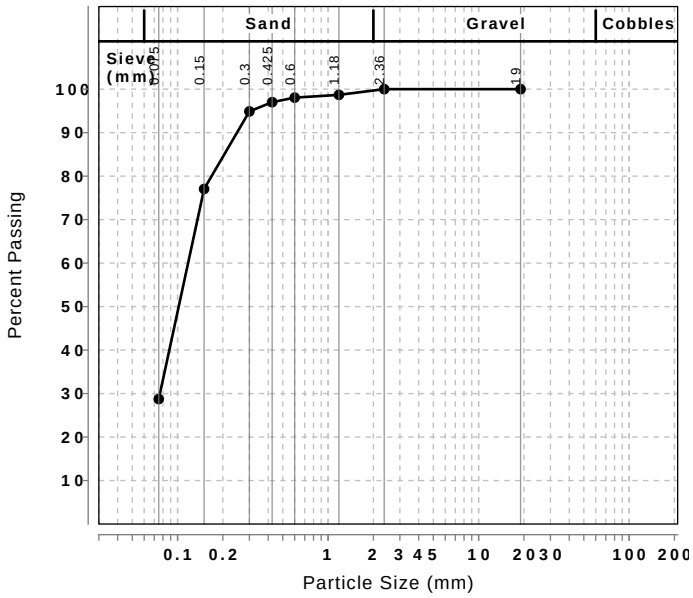
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**99**			1		
0.6 mm	**98**			1		
0.425 mm	**97**			1		
0.3 mm	**95**			2		
0.15 mm	**77**			18		
0.075 mm	**29**			48		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)			
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**1.02**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240F
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 11:20
Time Sampled - 11:20

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Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	35.0

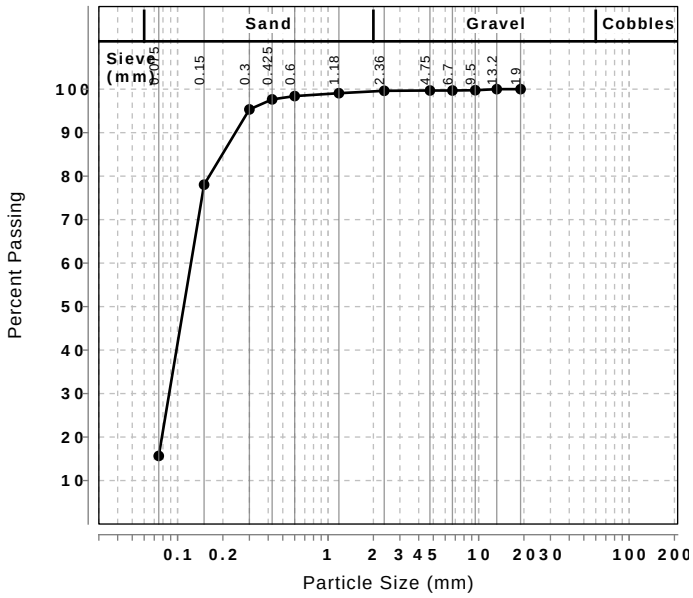
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
13.2 mm	**100**			0		
9.5 mm	**100**			0		
6.7 mm	**100**			0		
4.75 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**99**			1		
0.6 mm	**98**			1		
0.425 mm	**98**			1		
0.3 mm	**95**			2		
0.15 mm	**78**			17		
0.075 mm	**16**			62		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)			
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**1.08**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240G
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5507
Time Sampled - 15:30

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Butler Partners (Regional) Pty Ltd
Rockhampton Laboratory
246 Kent Street Rockhampton QLD 4700
Phone: (07) 4927 1400
Email: jhamilton@butlerpartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Joshua Hamilton
Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	188

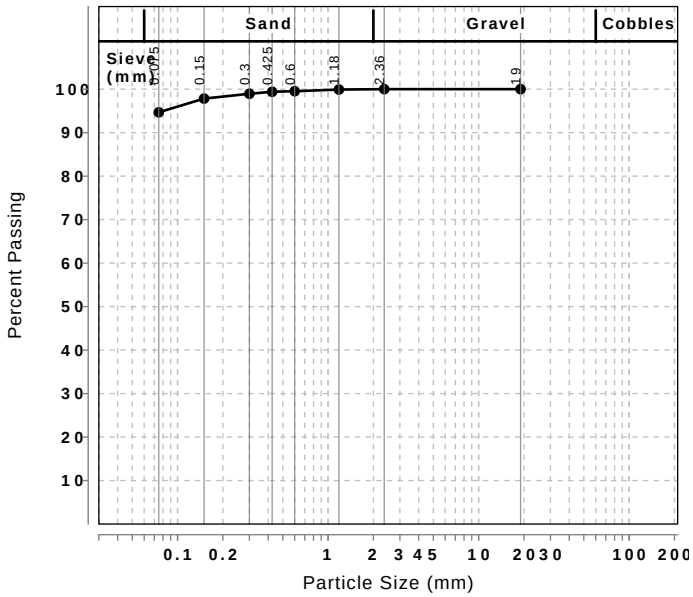
Particle Distribution (AS1141.11.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**99**			0		
0.3 mm	**99**			0		
0.15 mm	**98**			1		
0.075 mm	**95**			3		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	58		
Plastic Limit (%)	25		
Plasticity Index (%)	**33**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	15.0		
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.87**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-1
Issue Number: 1
Date Issued: 07/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 240
Sample Number: R18-240H
Date Sampled: 14/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Remarks: Sample ID - 5508
Time Sampled - 16:15

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Approved Signatory: Joshua Hamilton
Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	149

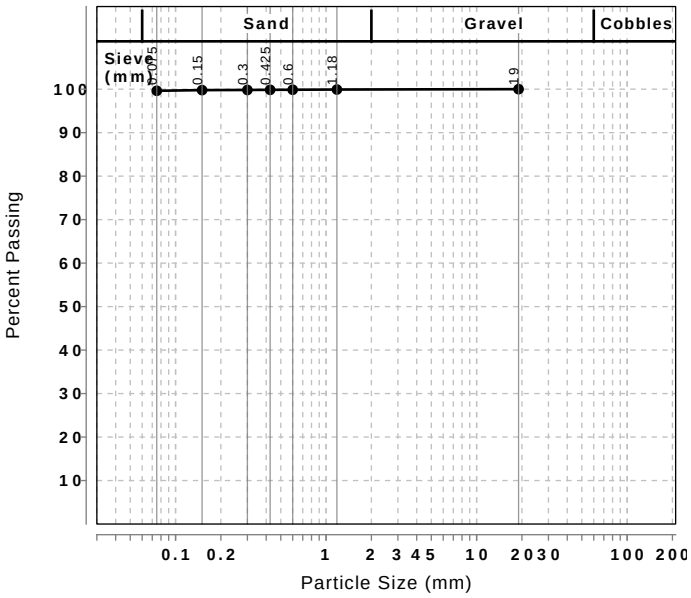
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**100**			0		
0.3 mm	**100**			0		
0.15 mm	**100**			0		
0.075 mm	**100**			0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	60		
Plastic Limit (%)	33		
Plasticity Index (%)	**27**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.5		
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.88**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: G18-139A-2
Issue Number: 1
Date Issued: 10/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 368
Sample Number: R18-368A
Date Sampled: 26/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Lot No: **DS-01**

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WORLD RECOGNISED ACCREDITATION

Approved Signatory: Joshua Hamilton
Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	41.9

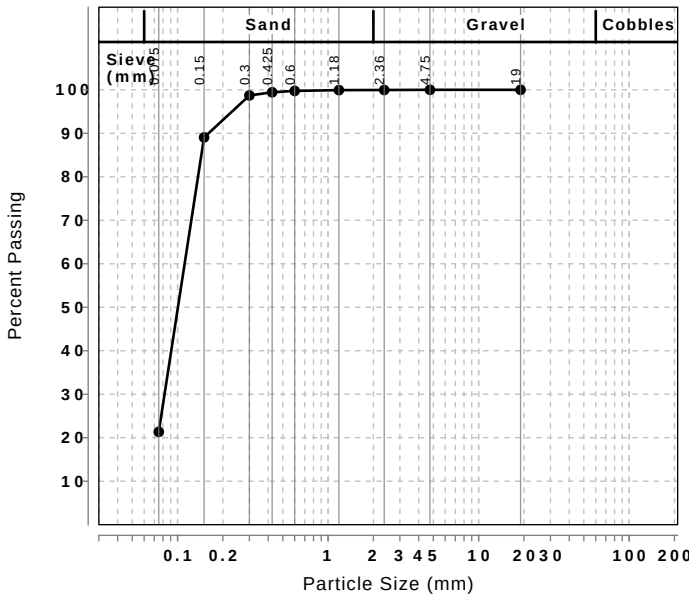
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
19 mm	**100**			0		
4.75 mm	**100**			0		
2.36 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**99**			0		
0.3 mm	**99**			1		
0.15 mm	**89**			10		
0.075 mm	**21**			68		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)			
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.88**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Material Test Report

Report Number: **G18-139A-2**
Issue Number: 1
Date Issued: 10/01/2019
Client: GHD Pty Ltd
PO Box 373, Gladstone Qld 4680
Contact: Hayden Warren
Project Number: G18-139A
Project Name: GPC PoG Sediment Properties Beneficial Reuse
Project Location: Port of Gladstone, Gladstone
Work Request: 368
Sample Number: R18-368B
Date Sampled: 26/11/2018
Sampling Method: Sampled by Client
The results apply to the sample as received
Lot No: **DS-02**

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Approved Signatory: Joshua Hamilton
Laboratory Manager
NATA Accredited Laboratory Number: 19665

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	155

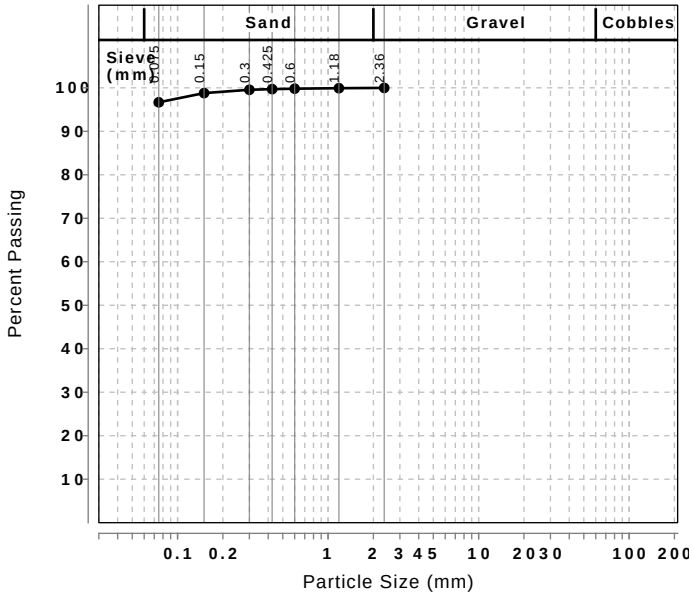
Particle Distribution (AS1289 3.6.1)						
Sieve	Passed %	Passing Limits		Retained %	Retained Limits	
2.36 mm	**100**			0		
1.18 mm	**100**			0		
0.6 mm	**100**			0		
0.425 mm	**100**			0		
0.3 mm	**100**			0		
0.15 mm	**99**			1		
0.075 mm	**97**			2		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	57		
Plastic Limit (%)	26		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	19.5		
Cracking Crumbling Curling	None		

Bulk Density of Aggregate (AS 1141.4)		Min	Max
Uncompacted (t/m^3)	**0.99**		
Compacted (t/m^3)			
Moisture Condition	Dry		
Nominal Size	Fine Sand		

Particle Size Distribution



Appendix D – Petrographic Analysis and Shape Analysis

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Butler Partners (Regional) Pty Ltd
ABN 43 603 849 305
3/197 Kent Street
Rockhampton Qld 4700
PO Box 1400
Rockhampton Qld 4700

Ph: 61 7 **4927 1400**
Fx: 61 7 4927 1800

Project No.: G18-139A

07 January 2019

GHD Pty Ltd
GPC PoG Sediment Properties Beneficial Reuse
Port of Gladstone, Gladstone

Email: emma.smith@ghd.com

Attention: Ms. Emma Smith

Dear Emma,

RE: PETROGRAPHIC REPORT & SHAPE ANALYSIS

As requested, please find attached the Petrographic Report & Shape Analysis Report performed, Butler Partners sample number R18-240E, from the above mentioned project.

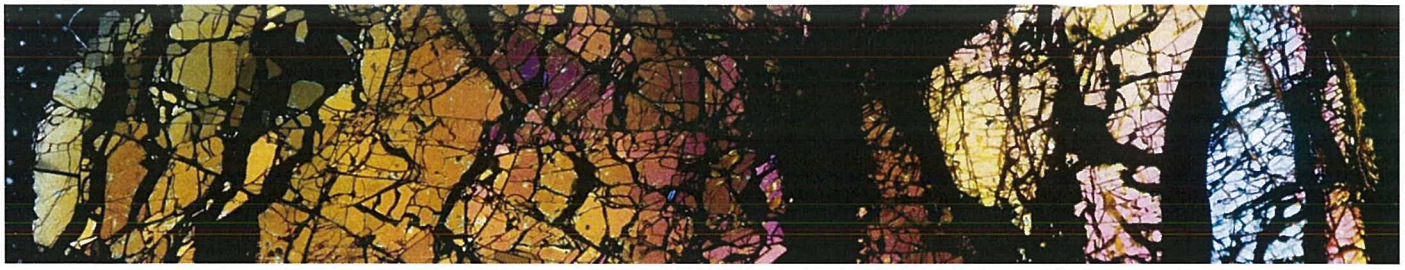
Both the Petrographic Report and the Shape Analysis was completed by Geochempet Services in the attached reports, report numbers Bp181202 and Bp181203d, dated 17 December 2018.

Please do not hesitate to contact us if you require any additional information.

Yours faithfully

BUTLER PARTNERS (REGIONAL) PTY LTD

JOSHUA HAMILTON
Laboratory Manager



Geochempet Services

ABN 980 6945 3445
PETROLOGICAL and GEOCHEMICAL CONSULTANTS
Principals: K.E. Spring B.Sc. (Hons), MAppSc and H.M. Spring B.Sc.

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Clontarf, QLD 4019

Telephone: (07) 3284 0020

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT ON A FINE SAND SAMPLE (R18-240E)

prepared for

BUTLER PARTNERS (REGIONAL) PTY LTD ROCKHAMPTION, QLD

Purchase Order: BP5787

Invoice Number: 00008519

Client Ref: Josh Hamilton

Issued by

C. A. Nix BAppSc, MEngSC, MIEAust
17 December 2018

Reviewed by

K. E. Spring BSc (Hons), MAppSc
17 December 2018

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GEOCHEMPET SERVICES, BRISBANE

Sample Number:	R18-240E	**Date Sampled**:	14/11/2018
Sample Type:	Bulk	**Date Received**:	03/12/2018

Project Name: GPC PoG Sediment Properties Beneficial Reuse

Work Requested Petrographic Analysis; Colour by Munsells chart

Methods Adapted from ASTM C295 Standard Guide for Petrographic Assessment of Aggregates for Concrete the AS1141 Standard Guide for the *Method for sampling and testing aggregates*

Identification Quartzofeldspathic and bioclastic sand

Description

The supplied sample consisted of 1 kg of moist to wet, poorly consolidated sand in a clay-rich matrix. When dry, the supplied sample was observed to be dark yellowish brown in colour (10YR 4/2 according to the Geological Rock-Color Chart produced by Munsell Color, 2009 revision). The sand is composed of grey translucent quartz, dark grey to white feldspars, and granitic fragments. A few shell fragments were also noted in the fraction.

Figure 1: Image of sub-sample from supplied sand.

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In a crude, dry sieving test of small subsample these results were tabulated;

Sieve Size	Wt % of sample
Coarse (>1.18mm)	54.0%
Medium (>0.3mm)	6.8%
Fine (>0.075mm)	35.0%
Silt (<0.075mm)	4.2%

The coarse fraction is dominated by clay cemented balls with entrained quartzofeldspathic, lithic and bioclastic material, along with minor free shell fragments and plant material.

When a sub-sample was stirred in water (allowing partial break down clay balls), it generated a dark brown turbidity which settled slowly to produce a thick suspension of brownish jelly, indicating the presence of significant clay.

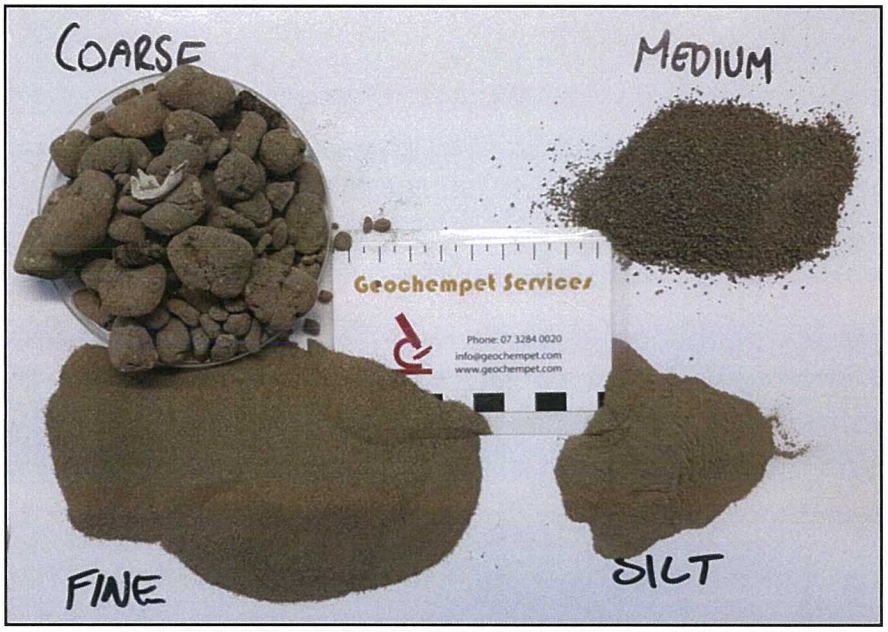

Figure 2: Sieve fractions as listed above.

Figure 3: Micrograph of part of the coarse sieve fraction showing a large clay cemented grain, plant matter and a broken shell fragment. *Field of view width ~20 mm*

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A thin section was prepared of the sample to permit detailed microscopic examination in transmitted polarised light. An approximate mineralogical composition of the sediment, expressed in volume percent and based on a brief count of 100 widely spaced observation points, is:

32%	quartz
3%	quartzite
8%	plagioclase feldspar
6%	K-feldspar (orthoclase / micro-perthite / microcline)
<1%	opaque oxide
<1%	other accessory minerals (tourmaline, sphene, apatite and zircon)
1%	free grains of epidote
<1%	free grains of muscovite
<1%	free grains of biotite
2%	free grains of hornblende
7%	free grains of calcite
1%	free grains of haematite/goethite
5%	lithic clasts of granitic fragments (2% quartz)
3%	lithic clasts of acid volcanic / tuffaceous rock (1% microcrystalline quartz)
2%	lithic clasts of intermediate volcanics
1%	lithic clasts of micaceous schist
1%	lithic clasts of meta-pelite
14%	argillaceous matrix (composed of low birefringent illite/chlorite and moderate-high birefringent sericite)
2%	argillaceous clasts
9%	bioclasts
<1%	undifferentiated carbonate clasts
3%	carbonaceous material
<1%	pyrite

In thin section, the sample is seen to consist of sub-rounded grains of quartz, feldspar, bioclasts, and granitic fragments supported in a clay matrix (undifferentiated clay, low birefringent illite/chlorite and moderate-high birefringent sericite. Grains of unstrained to mildly strained quartz amount to 32% and simple crystalline composite grains of similar quartz amount to <1%.

Fresh to slightly weathered free grains of feldspar amounted to 14%. In more detail they comprise 6% K-feldspar (orthoclase / micro-perthite / microcline) and 8% plagioclase. Other free mineral grains comprise <1% biotite, 2% hornblende, 7% calcite, 1% epidote, <1% muscovite, and 1% haematite/limonite.

Fresh to slightly weathered lithic clasts, derived from fine to medium-grained granite, amounted to 5%, with the general mineral distribution describing a granite rock (or more specifically adamellite). Individual lithic clasts are composed of two or more of the minerals quartz (mildly to moderately strained), plagioclase, orthoclase, and rare brown biotite and opaque oxide (magnetite and/or ilmenite). Other lithic clasts include 3% quartzite, 3% acid volcanics, 2%

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intermediate volcanics, 1% micaceous schist, 1% meta-pelite and 2% argillaceous clasts. Pyrite is also present, mostly in a framboidal habit and rarely expressed as rhombic crystals.

Many grains are cemented by argillaceous matrix (composed of low birefringent illite/chlorite and moderate-high birefringent sericite), which also occurs as grain coatings.

Fragments of shells were seen as 9% of the sample, with <1% of undifferentiated carbonate clasts, derived from other carbonate allochems.

Carbonaceous material is seen as 3% of the sample, being mostly plant material with minor lignite / charcoal.

Comments and Interpretations:

The supplied fine silty sample (labelled R18-240E) may be described broadly for engineering purposes as an argillaceous quartzofeldspathic sand with a minor bioclastic fraction.

The **total free silica content** (or quartz plus chert content) of the sand is **about 38%**, comprising 32% free grains or simple crystalline composite grains of quartz, 5% quartz locked within sand-sized quartzite and granitic lithic clasts and 1% microcrystalline quartz within acid volcanics.

Free Silica Content

The free silica content is about 38%.

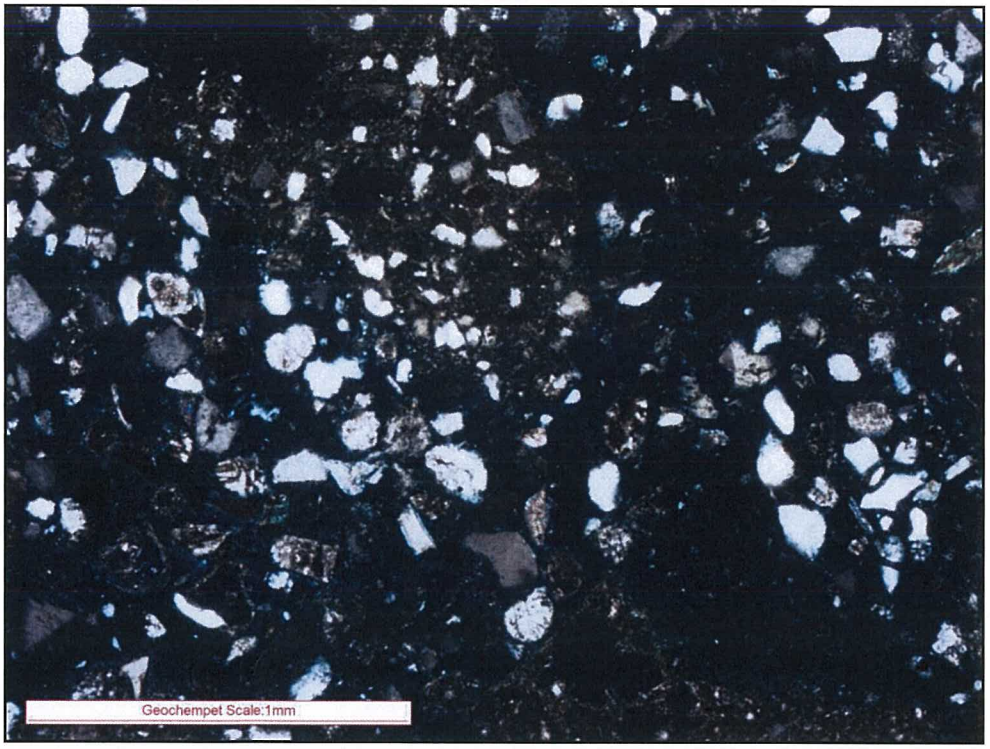

Figure 4: Micrograph taken at low magnification in cross polarised transmitted light of the sand. The image is dominated by typical quartz along with minor lithic clasts and bioclasts.

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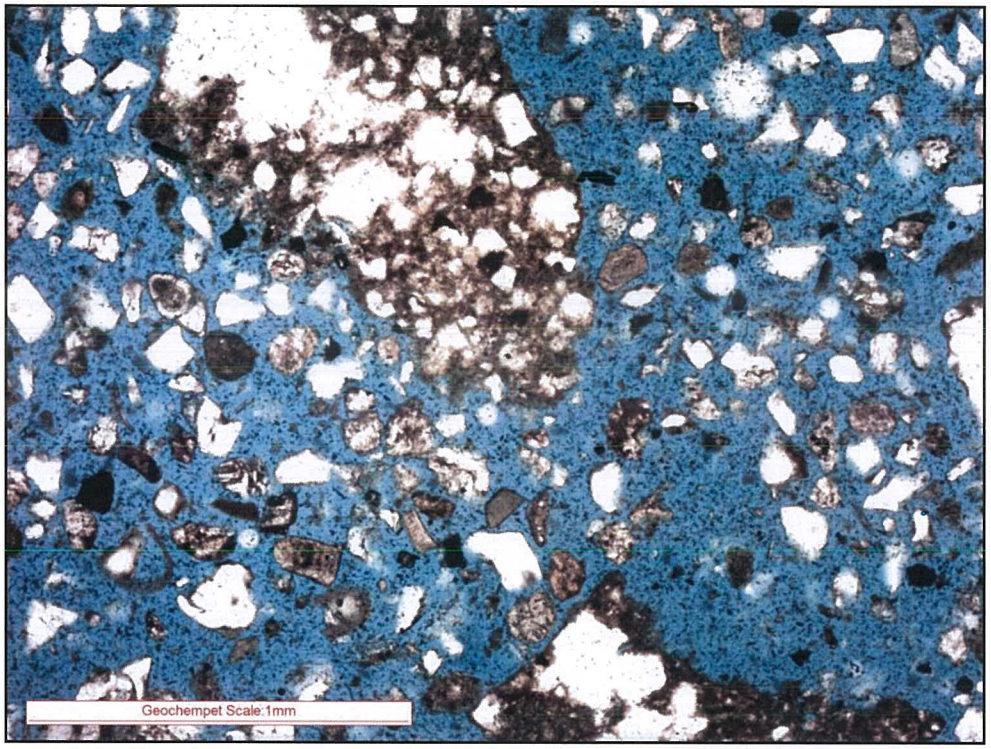

Figure 5: Micrograph taken at low magnification in plane transmitted light of the sand. The image shows the argillaceous matrix and grain coatings within the sample.

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Geochempet Services

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PETROLOGICAL and GEOCHEMICAL CONSULTANTS
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SHAPE ANALYSIS
ON A FINE SAND SAMPLE (R18-240E)

prepared for

BUTLER PARTNERS (REGIONAL) PTY LTD
ROCKHAMPTION, QLD

Purchase Order: BP5787

Invoice Number: 00008519

Client Ref: Josh Hamilton

Issued by CNix

C. A. Nix BAppSc, MEngSC, MIEAust
17 December 2018

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GEOCHEMPET SERVICES, BRISBANE

Sample Number:	R18-240E	**Date Sampled**:	14/11/2018
Sample Type:	Bulk	**Date Received**:	03/12/2018

Project Name: GPC PoG Sediment Properties Beneficial Reuse

Work Requested Particle Shape Analysis

Methods Shape analysis was performed by measuring roundness and then sphericity each for 100 grains per sample observed with binocular microscopy in random linear traverses of prepared subsample. It is important to note that the supplied sample was dried and then crushed with firm hand pressure. The sample was also not washed and therefore contained clay coatings derived from the argillaceous matrix.

Figure 1: Image of dried sub-sample from supplied sand.

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Roundness and sphericity are different shape attributes, but they do tend to show sympathetic variation in rock/mineral samples. The index for roundness varies between 0 and 1 as fragments vary from completely angular to completely rounded; the index for sphericity varies between 0 and 1 as fragments vary from thin plates or slivers to very equidimensional pieces. The difference between roundness and sphericity can be illustrated by noting that a cube and a sphere both have high sphericity, but the cube has zero roundness and the sphere has perfect roundness: similarly, a capsule shape (or cylinder with rounded ends) may have perfect roundness, but low sphericity.

There are mathematical models behind the indices for roundness and sphericity, but in practice the indices are estimated by visual comparison with a reference chart of fragments of varied roundness and sphericity (from a text by Krumbein and Sloss, 1963). The concepts, recommended procedures and the reference chart are available in the American Petroleum Institute Section 5 of the American Petroleum Institute – API19C, Recommended Practices for Testing Sand Used in Hydraulic Fracturing Operations.

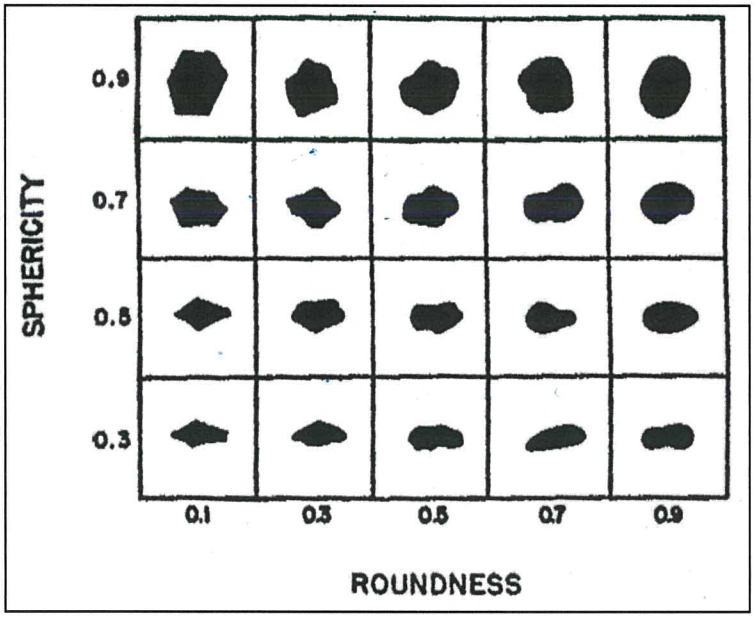

Figure 2: Visual chart for estimation of sphericity and roundness (From Krumbein and Sloss, 1963)

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Results:

- Results are summarised in Table 1 (simple averages) and in graphical form (frequency distributions for roundness and sphericity).

Table 1. Average Roundness and Sphericity for the Nickel Slag

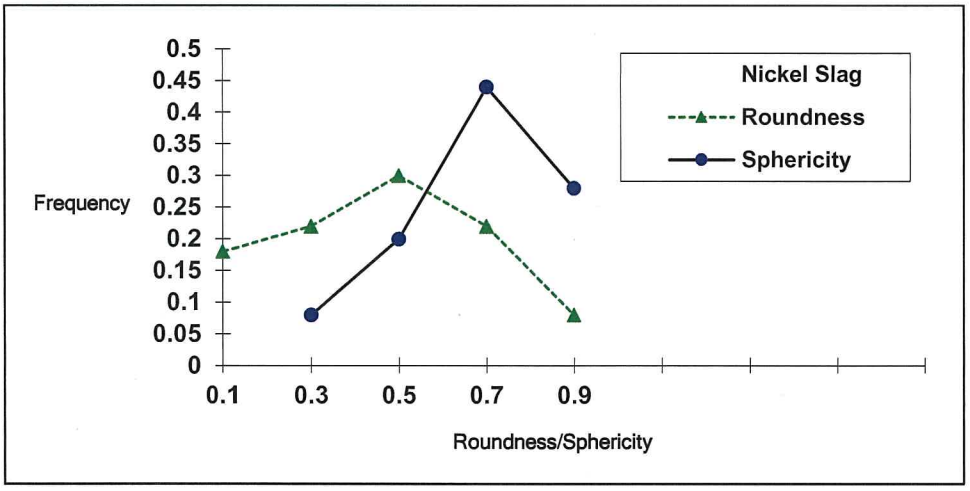
Sample	Average Roundness	Average Sphericity
R18-240E	0.46	0.68

- Averages based on 100 observations per characteristic

Qualitative terms which can be applied are:

Roundness
0.0-0.2 Angular
0.2-0.4 Subangular
0.4-0.6 Subrounded
0.6-0.8 Rounded
0.8-1.0 Well Rounded

Sphericity
0.0-0.4 Low Sphericity
0.4-0.6 Moderately Low Sphericity
0.6-0.8 Moderately High Sphericity
0.8-1.0 High Sphericity



Graph 1: Distribution of Roundness and Sphericity for the Nickel Slag

Ten representative sub-samples were photographed to identify various grain sizes as requested.

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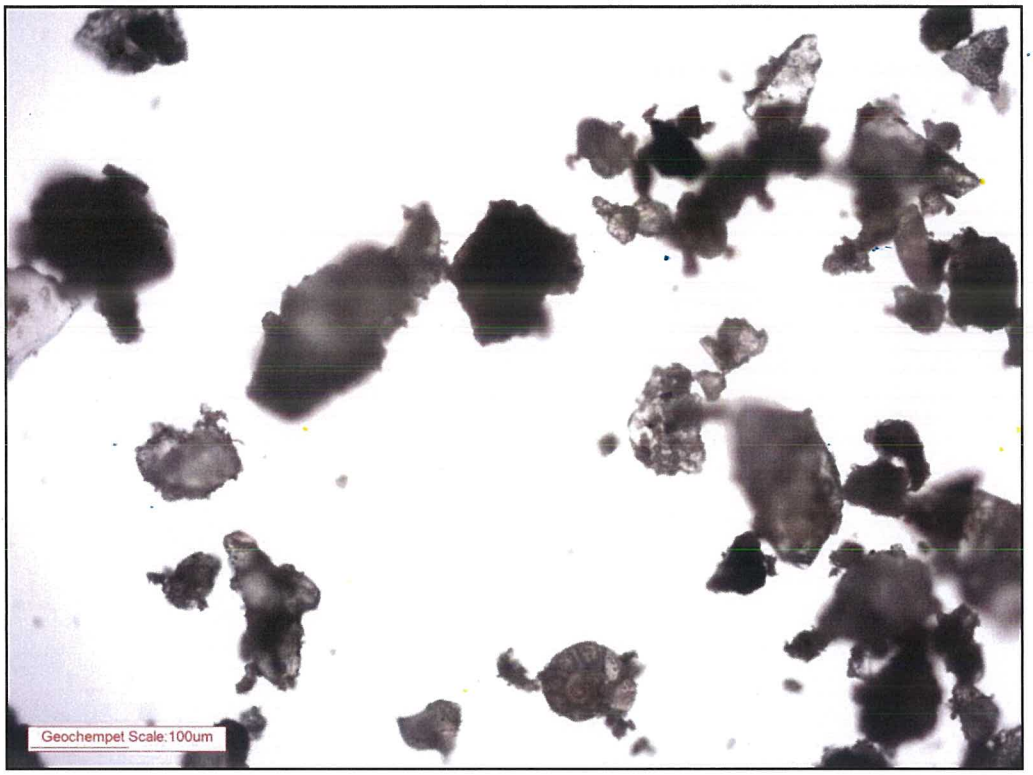

Figure 3: Microscopic image at medium magnification in transmitted, plane light.

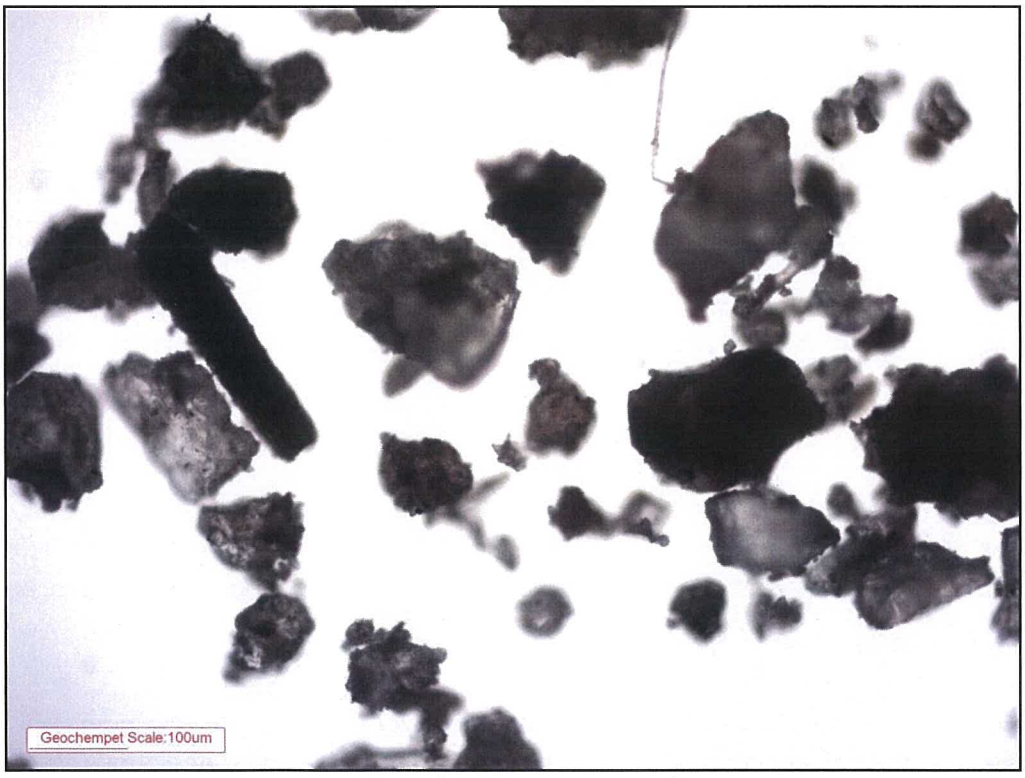

Figure 4: Microscopic image at medium magnification in transmitted, plane light.

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Appendix E – Laboratory Chain of Custody (COC)

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GROUND TESTING SERVICES

LABORATORY TEST REQUEST

Client:	GHD.	**Date:**	
Project:	GHD-4220802	**Requested by:**	Emma Smith
Location:		**Results Required by:**	ASAP
Project No.:			
Sample sent to:		**Date:**	22/11/18

BORE / TEST PIT NO.:	SS01	SS02	SS03	SS04	SS05	SS06	SS07
DEPTH (m):							
SAMPLE TYPE:	DS						
SAMPLE NO:							
EASTING:							
NORTHING:							
RL (m):							
DATE SAMPLED:	14/11/18						
SAMPLING METHOD:	Supplied by client.						
time sampled:	15:00	15:20	14:17	13:30	12:00	11:20	15:30
Moisture Content:	**Moisture contents need to be taken ON ALL SAMPLES as a matter of course. If you see that there may need to be some exception to this please clear it with the person submitting this request.**						
Petrographic Analysis	X	X	X	X	X	X	X
PSD							
PSD by Hydrometer	X	X	X	X	X	X	X
Atterberg Limits	X	X	X	X	X	X	X
Shape Analysis	X	X	X	X	X	X	X

REMARKS: *[Include details of any departures from standard test methods here]*

Test Method:	Australian Standard:	☒ AS	QMR:	☐ Q	Other:	☐
Review:	Have test requirements been checked?				☑ No	☐ Yes
	Are sufficient resources available to complete testing in the required timeframe or a negotiated alternative?				☐ No	☑ Yes
Reviewed by:	Dwain C.	**Signed:**			**Date:**	22/11/18

Butler Partners
geotechnical • geo-environmental • groundwater

GROUND TESTING SERVICES

LABORATORY TEST REQUEST

Client:	GHD	**Date:**	
Project:	GHD-4220802	**Requested by:**	Emma Smith.
Location:		**Results Required by:**	ASAP.
Project No.:			
Sample sent to:		**Date:**	22/11/18

BORE / TEST PIT NO.:	SS08						
DEPTH (m):							
SAMPLE TYPE:	DS						
SAMPLE NO:							
EASTING:							
NORTHING:							
RL (m):							
DATE SAMPLED:	14/11/18						
SAMPLING METHOD:	supplied by client.						
time sampled.	16:15						
Moisture Content:	**Moisture contents need to be taken ON ALL SAMPLES as a matter of course. If you see that there may need to be some exception to this please clear it with the person submitting this request.**						
Petrographic Analysis	x						
PSD							
PSD by Hydrometer	x						
Atterberg Limits	x						
Shape Analysis	x						

REMARKS: *[Include details of any departures from standard test methods here]*

Test Method:	Australian Standard:	☒ AS	QMR:	☐ Q	Other:	☐	
Review:	Have test requirements been checked?					☑ No	☐ Yes
	Are sufficient resources available to complete testing in the required timeframe or a negotiated alternative?					☐ No	☑ Yes
Reviewed by:	Dwain Cardan	**Signed:**			**Date:**	22/11/18	

GROUND TESTING SERVICES

Chain of Custody

Received by/Date	Client	Client Phone Number	Project	Project Location	Project Number	Sampled By	No. of Samples	Sample Type (BS, SPT, DS)	Test Required	Other Comments
DC	GHD Emma Smith.	0407289902	GHD-42208 02	—	—	Client	8	DS	as per test request.	8 Samples Supplied to Rockhampton lab.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 48 Callemondah Drive Clinton QLD 4680 Ph: 07 49787 944 E: ALSEnviro.Gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

NOWRA 4/12 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: GHD	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Gladstone		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: GPC Dredge Material Beneficial Reuse **PROJECT NO** 4220802	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:** Australia	COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Amanda Smedley **CONTACT PH:** 4973 1613		OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Emma Smith, Tristram Coffin **SAMPLER MOBILE:** 0407 289 902	**RELINQUISHED BY:** E.Smith	**RECEIVED BY:** KSchafer	**RELINQUISHED BY:** K. BURRIDGE
COC Emailed to ALS? (YES / NO) **EDD FORMAT (or default):**	**DATE/TIME:** 15/11/18 1123	**DATE/TIME:** 15-11-18 1123	**DATE/TIME:** 15/11/18 1600
Email Reports to : amanda.smedley@ghd.com.au; emma.smith@ghd.com.au			**RECEIVED BY:** DAN.B
Email Invoice to :			**DATE/TIME:** 16/11/18 1400

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	TOC	ASS - field pH, SPOCAS							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	SS-01	14/11/2018 3:00pm	Soil	ST, ASS	2	1	1							
2	SS-02	14/11/2018 3:20pm	Soil	ST, ASS	2	1	1							
3	SS-03	14/11/2018 2:17pm	Soil	ST, ASS	2	1	1							
4	SS-04	14/11/2018 1:30pm	Soil	ST, ASS	2	1	1							
5	SS-05	14/11/2018 12:00pm	Soil	ST, ASS	2	1	1							
6	SS-06	14/11/2018 11:20am	Soil	ST, ASS	2	1	1							
7	SS-07	14/11/2018 3:30pm	Soil	ST	1	1								
8	SS-08	14/11/2018 4:15pm	Soil	ST, ASS	2	1	1							
				TOTAL	15	8	7							

Environmental Division
Brisbane
Work Order Reference
EB1827718

Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

GHD CLIENTS|PEOPLE|PERFORMANCE

GHD Pty Ltd ABN 39 008 488 373
71 Stanley Street Townsville Queensland PO Box 930 Townsville QLD 4810 Australia
T 61 7 4720 0400 **F** 61 7 4772 6514 **E** tsvmail@ghd.com **W** www.ghd.com

ANALYSIS REQUEST FORM/CHAIN OF CUSTODY DOCUMENTATION

PROJECT ID:	4220802		**QUOTE:**	-
PROJECT:	GPC PoG Sediment Properties Beneficial Reuse			
CLIENT:	GHD Pty Ltd			
POSTAL ADDRESS:	Level 2, 100 Goondoon Street, Gladstone Q 4680			
CONTACT:	Emma Smith / Amanda Smedley			
PHONE:	07 4973 1604 / 07 4973 1613			
EMAIL:	emma.smith@ghd.com; amanda.smedley@ghd.com			
DATA NEEDED BY:	Standard			
REPORT FORMAT:	EMAIL			
EMAIL FORMAT:	EXCEL & PDF			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Please mix sample well prior to analysis

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes / No / Broken / Intact

COOLER TEMP: deg C

DESPATCHED TO: Butler Partners
4/3 Kingdon St, Gladstone Q 4680

ANALYSIS REQUIRED

SAMPLE DATA

SAMPLE ID	SAMPLE DATE	MATRIX		PRESERVATION	PSD by Hydrometer	Atterberg Limits	Moisture Content	Bulk Particle Density									NOTES
DS-01	26/11/2018	S		N/A	X	X	X	X									GHD Note: DS-01 (Wild Cattle South Side)
DS-02	18/11/2018	S		N/A	X	X	X	X									GHD Note: DS-02 (Jacobs Channel GLNG Swing Basin South Side)

RELINQUISHED BY:

NAME: Emma Smith DATE: 05/12/18
OF: GHD TIME: 1445

RECEIVED BY:

NAME: Jacob Gillespie DATE: 5-12-18
OF: TIME: 14.45

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: emma.smith@ghd.com; amanda.smedley@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle;
VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle;
O = Other.

Appendix F – Laboratory QA/QC

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1827718**	Page	: 1 of 6
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS AMANDA SMEDLEY	Contact	: Caroline Hill
Address	: PO BOX 373 GLADSTONE QLD 4680	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 4973 1613	Telephone	: +61 7 3552 8662
Project	: 4220802	Date Samples Received	: 16-Nov-2018
Order number	: 4220802	Date Analysis Commenced	: 21-Nov-2018
C-O-C number	: ----	Issue Date	: 23-Nov-2018
Sampler	: EMMA SMITH, Tristram Coffin		
Site	: GPC Dredge Material Beneficial Reuse		
Quote number	: EN/005/18		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-A: pH Measurements (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: pH KCl (23A)	----	0.1	pH Unit	4.0	4.0	0.00	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	3.2	3.1	3.17	0% - 20%
ES1834040-002	Anonymous	EA029: pH KCl (23A)	----	0.1	pH Unit	5.3	5.2	1.90	0% - 20%
		EA029: pH OX (23B)	----	0.1	pH Unit	5.3	5.3	0.00	0% - 20%
EA029-B: Acidity Trail (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.254	0.259	2.04	0% - 50%
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	0.420	0.412	2.02	0% - 20%
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	0.166	0.153	8.57	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	158	162	2.04	0% - 20%
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	262	257	2.02	0% - 20%
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	104	95	8.57	0% - 20%
ES1834040-002	Anonymous	EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.020	0.021	0.00	No Limit
		EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	0.024	0.023	0.00	No Limit
		EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.020	<0.020	0.00	No Limit
		EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	13	13	0.00	No Limit
		EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	15	14	0.00	No Limit
		EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	0.00	No Limit
EA029-C: Sulfur Trail (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.020	<0.020	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA029-C: Sulfur Trail (QC Lot: 2046475) - continued									
EB1827693-003	Anonymous	EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	<10	0.00	No Limit
ES1834040-002	Anonymous	EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Sulfur (23De)	----	0.02	% S	0.029	0.030	0.00	No Limit
		EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	0.029	0.030	0.00	No Limit
		EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	18	18	0.00	No Limit
EA029-D: Calcium Values (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.020	<0.020	0.00	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.00	No Limit
ES1834040-002	Anonymous	EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	0.119	0.121	1.50	No Limit
		EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	0.131	0.126	4.13	No Limit
		EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EA029-E: Magnesium Values (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.00	No Limit
ES1834040-002	Anonymous	EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	0.062	0.062	0.00	No Limit
		EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	0.071	0.068	4.02	No Limit
		EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.020	<0.020	0.00	No Limit
		EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.020	<0.020	0.00	No Limit
		EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EA029-H: Acid Base Accounting (QC Lot: 2046475)									
EB1827693-003	Anonymous	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.00	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	0.25	0.26	0.00	0% - 50%
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.25	0.26	0.00	0% - 50%
		EA029: Liming Rate	----	1	kg CaCO3/t	12	12	0.00	0% - 50%
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	12	12	0.00	0% - 50%
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	158	162	2.04	0% - 50%

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA029-H: Acid Base Accounting (QC Lot: 2046475) - continued									
EB1827693-003	Anonymous	EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	158	162	2.04	0% - 50%
ES1834040-002	Anonymous	EA029: ANC Fineness Factor	----	0.5	-	1.5	1.5	0.00	No Limit
		EA029: Net Acidity (sulfur units)	----	0.02	% S	0.05	0.05	0.00	No Limit
		EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.05	0.05	0.00	No Limit
		EA029: Liming Rate	----	1	kg CaCO3/t	2	2	0.00	No Limit
		EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	2	2	0.00	No Limit
		EA029: Net Acidity (acidity units)	----	10	mole H+ / t	31	32	0.00	No Limit
		EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	31	32	0.00	No Limit
EA037: Ass Field Screening Analysis (QC Lot: 2047061)									
EB1827718-001	SS-01	EA037: pH (F)	----	0.1	pH Unit	8.1	7.9	2.50	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	6.4	6.3	1.57	0% - 20%
EB1828064-009	Anonymous	EA037: pH (F)	----	0.1	pH Unit	5.1	5.0	1.98	0% - 20%
		EA037: pH (Fox)	----	0.1	pH Unit	3.5	3.5	0.00	0% - 20%
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 2050792)									
EB1827718-001	SS-01	EP003: Total Organic Carbon	----	0.02	%	0.92	0.80	13.8	0% - 20%
EP1813351-034	Anonymous	EP003: Total Organic Carbon	----	0.02	%	0.36	0.34	5.52	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA029-A: pH Measurements (QCLot: 2046475)								
EA029: pH KCl (23A)	----	0.1	pH Unit	<0.1	4.5 pH Unit	97.8	70	130
EA029: pH OX (23B)	----	0.1	pH Unit	<0.1	4.5 pH Unit	95.6	70	130
EA029-B: Acidity Trail (QCLot: 2046475)								
EA029: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	24.6 mole H+ / t	88.9	70	130
EA029: Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	29.1 mole H+ / t	102	70	130
EA029: Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
EA029: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029: sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029: sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.02	% pyrite S	<0.020	----	----	----	----
EA029-C: Sulfur Trail (QCLot: 2046475)								
EA029: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.020	0.052 % S	87.9	70	130
EA029: Peroxide Sulfur (23De)	----	0.02	% S	<0.020	0.145 % S	91.0	70	130
EA029: Peroxide Oxidisable Sulfur (23E)	----	0.02	% S	<0.020	----	----	----	----
EA029: acidity - Peroxide Oxidisable Sulfur (a-23E)	----	10	mole H+ / t	<10	----	----	----	----
EA029-D: Calcium Values (QCLot: 2046475)								
EA029: KCl Extractable Calcium (23Vh)	----	0.02	% Ca	<0.020	0.151 % Ca	102	70	130
EA029: Peroxide Calcium (23Wh)	----	0.02	% Ca	<0.020	0.296 % Ca	93.2	70	130
EA029: Acid Reacted Calcium (23X)	----	0.02	% Ca	<0.020	----	----	----	----
EA029: acidity - Acid Reacted Calcium (a-23X)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Calcium (s-23X)	----	0.02	% S	<0.020	----	----	----	----
EA029-E: Magnesium Values (QCLot: 2046475)								
EA029: KCl Extractable Magnesium (23Sm)	----	0.02	% Mg	<0.020	0.176 % Mg	95.7	70	130
EA029: Peroxide Magnesium (23Tm)	----	0.02	% Mg	<0.020	0.175 % Mg	97.5	70	130
EA029: Acid Reacted Magnesium (23U)	----	0.02	% Mg	<0.020	----	----	----	----
EA029: Acidity - Acid Reacted Magnesium (a-23U)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Acid Reacted Magnesium (s-23U)	----	0.02	% S	<0.020	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity (QCLot: 2046475)								
EA029: Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	<0.020	----	----	----	----
EA029: acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	<10	----	----	----	----
EA029: sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	<0.020	----	----	----	----
EA029-H: Acid Base Accounting (QCLot: 2046475)								
EA029: ANC Fineness Factor	----	0.5	-	<0.5	----	----	----	----
EA029: Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EA029-H: Acid Base Accounting (QCLot: 2046475) - continued								
EA029: Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA029: Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
EA029: Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
EA029: Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
EA029: Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 2050792)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	0.44 %	100	70	130

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1827718**	Page	: 1 of 5
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS AMANDA SMEDLEY	Telephone	: +61 7 3552 8662
Project	: 4220802	Date Samples Received	: 16-Nov-2018
Site	: GPC Dredge Material Beneficial Reuse	Issue Date	: 23-Nov-2018
Sampler	: EMMA SMITH, Tristram Coffin	No. of samples received	: 8
Order number	: 4220802	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA037: Ass Field Screening Analysis						
Soil Glass Jar - Unpreserved						
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	21-Nov-2018	15-Nov-2018	**6**	21-Nov-2018	15-Nov-2018	**6**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-A: pH Measurements							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-B: Acidity Trail							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-C: Sulfur Trail							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA029-D: Calcium Values							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-E: Magnesium Values							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-F: Excess Acid Neutralising Capacity							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-G: Retained Acidity							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA029-H: Acid Base Accounting							
80* dried soil (EA029)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	09-Aug-2021	✓	**21-Nov-2018**	19-Feb-2019	✓
EA037: Ass Field Screening Analysis							
Soil Glass Jar - Unpreserved (EA037)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-08	**14-Nov-2018**	**21-Nov-2018**	15-Nov-2018	×	**21-Nov-2018**	15-Nov-2018	×
EP003: Total Organic Carbon (TOC) in Soil							
Pulp Bag (EP003)							
SS-01, SS-02, SS-03, SS-04, SS-05, SS-06, SS-07, SS-08	**14-Nov-2018**	**22-Nov-2018**	12-Dec-2018	✓	**22-Nov-2018**	12-Dec-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
ASS Field Screening Analysis	EA037	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
ASS Field Screening Analysis	* EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.
Total Organic Carbon	EP003	SOIL	In house C-IR17. Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a LECO furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automaticaly measured by infra-red detector.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Dry and Pulverise (up to 100g)	GEO30	SOIL	#

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	E. Smith	J Brett C Dengate	*JBrett* *CDengate*	A Smedley	*ASmedley*	19/04/2019

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