

Australia Pacific LNG Project

Volume 5: Attachments

Attachment 7: Geology, Topography, Geomorphology and Soils Assessment - LNG Facility



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Executive summary

A land assessment was undertaken to identify existing values and characteristics of soils, topography, geomorphology and geology within the area proposed for the Australia Pacific Liquefied Natural Gas (LNG) facility. The area being examined as part of this assessment is located approximately 1km south of Laird Point on Curtis Island, Gladstone.

The purpose of this assessment is to identify potential impacts of the LNG facility development to land-based environmental values. Where appropriate, mitigation measures that would ameliorate potential impacts were identified.

The assessment was completed by using a desktop study that was supplemented by field investigations within the study area bounded by the Australia Pacific LNG property boundary, but also includes the portion of land between the northern study area boundary and Graham Creek to the north at Laird Point. The field assessment involved terrain observations and intrusive soil sampling and subsequent laboratory analysis on the soil samples.

Topography, geology and geomorphology

The topographic assessment indicated that the study area is comprised of level to undulating terrain with tidal mud flats and salt pans on the coast rising to steeply graded (>30% slope) low round hills. The study area is also transected by a local creek system comprising three ephemeral tributaries which drain into Port Curtis.

The geological review indicated that the study area is underlain by Palaeozoic-age Wandilla Formation of the Curtis Island group. Holocene (Quaternary) miscellaneous sediments include 'mudflats, salt pans or swamp deposits' that overlie the Wandilla Formation bedrock in the flat central western area of the LNG plant site and northern areas of the shared gas pipeline corridor.

The Holocene sediments are predominantly soft, low strength and can be easily excavated, but may require suitable support during excavation and may be unsuitable as a foundation base. Holocene sediments below an elevation of five metres AHD are also commonly associated with acid sulfate soils (ASS). Disturbing these sediments may lead to the formation of sulphuric acid, releasing iron, aluminium, and other heavy metals. Rainwater or groundwater can transport these contaminants, which may lead to degradation of the receiving environment.

Where excavations in the low strength Holocene-age miscellaneous sediments or non-compact colluvial deposits are proposed, suitable geotechnical investigations should be performed to assess potential impacts. This information should be used to assist in determining the appropriate designs and techniques to be used during construction. Furthermore, an ASS investigation should be performed in accordance with *State Planning Policy 2/02, Planning and Managing Development involving ASS*.

The Wandilla formation is expected to present a moderate to high excavation constraint. As a result, rock breaking and/or blasting may be required for rock removal. These works should be carried out in accordance with relevant DERM guidelines and AS2885.1 to AS2885.5: Gas and Liquid Petroleum Guidelines, but further geotechnical investigations should be undertaken to quantify the environmental impact (such as increased dust, noise and vibration). It can be expected that the environmental impact would proportionally increase with excavation difficulty. Rock spoil, where encountered, should be reused on the construction site, used for erosion control rip-rap or disposed of at an alternative approved location (either on or off-site).

A review of extractive resources in the region indicated that most existing quarries have a low production output (<80,000tpa). Although this assessment did not identify the material reserves associated with existing quarries, expansion of these quarries and new quarries (both operated by others) may be required to meet the demands of this and other CSG projects. To meet the demands of the Australia Pacific LNG Project, any new quarry would be required to undergo an impact assessment as part of gaining a separate development approval prior to commencing the activity.

Although Curtis Island has a Earthquake Hazard Risk classification of 0.05 – 0.10 and a low liquefaction potential, the presence of fault and past recorded earthquakes indicates a site-specific probabilistic seismic hazard analysis (including a ground motion and liquefaction study) should be undertaken to assess the risk and guide the design of the LNG plant.

Soils

The soils assessment indicated the study area is predominantly comprised of Hydrosols, Sodosols and Rudosols. The Hydrosols occur within the intertidal (soil group 1) and supratidal (soil group 2) flats which comprise 24% (108ha) of the study area. A preliminary assessment of these soils has indicated they contain actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). Further detailed investigations are planned to assess the full extent of the ASS hazard, and an ASS Management Plan should be developed as part of the overall Project Environmental Management Plan in accordance with *Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines*.

The texture contrast soils (mainly Sodosols occurring within soil groups 3 and 4) occur on level to undulating terrain and the low round hills on the western side of the study area. The soils comprise 31% (140ha) of the study area. The remaining soils, Rudosols (soil group 5) also occur on undulating terrain and low round hills. These soils comprise 45% (205ha) of the study area.

Soil groups 3, 4 and 5 ranged from non-sodic to strongly-sodic and have a moderate to high erosion rating. Soil groups 1 and 2 have a low erosion rating due to salinity and in some instances, organic content. A sediment and erosion control plan should be developed to remediate the risks associated with the LNG facility construction, particularly for soil groups 3, 4 and 5 and where steeper slopes occur.

This study has defined areas of erosion risk within the study area. Appropriate erosion control measures (e.g. water diversion, slope management and drainage line management) should be implemented in areas identified as having a moderate to high erosion risk (ratings 2 to 3). Specific controls should be specified within the sediment and erosion control plan. The erosion control plan should also address on-going maintenance and monitoring of erosion levels and the effectiveness of erosion control measures.

Topsoil segregation and handling procedures should aid in successful rehabilitation and minimisation of off-site impacts such as sedimentation of Port Curtis. This should include the addition of nutrients (specifically nitrogen and phosphorus) to supplement rehabilitation of the low to moderate fertility topsoils, which are variable in depth, but on average are 0.2m thick.

Although there is no topsoil associated with soil group 1 and 2, the extreme salinity rating requires diligent soil handling. As noted above, soils identified as AASS or PASS should be managed in accordance with an ASS Management Plan.

Good Quality Agricultural Land

Soils within the study area have been classified as Agricultural Land Class C3 (soil groups 3, 4 and 5) and D (soil groups 1 and 2). The LNG facility development will not result in the loss of good quality agricultural land (GQAL) as the study area is not considered to be GQAL.

Dust

Dust has been identified as an issue in the study area given the shallow soil types (Rudosols) and the presence of bulldust along vehicle tracks. Dust management measures should be included in the Environmental Management Plan and may include the construction of gravel/rock access tracks and controls for vehicle speeds, as well as dust suppression with water trucks unsealed access tracks and existing bulldust areas.

Summary

In summary, the most significant potential adverse impacts associated with the LNG facility development will be unmitigated terrain modification, soil erosion, and ASS disturbance. Erosion has the potential to result in scarring of the landscape, deepening or diversion of local drainage and adverse water quality impacts to Port Curtis. ASSs have the potential to release acidic run-off and mobilise heavy metals when disturbed. The areas within the study area likely to experience the greatest impact will be the areas of shallow gravelly soils (Rudosols) and texture contrast soils with sodic and dispersive subsoils (i.e. Sodosols), particularly on steep slopes. The development, implementation and on-going monitoring of sediment and erosion control plans will be a critical factor in ensuring that these impacts are minimised.

Contents

1.	Introduction	1
1.1	Legislative framework	1
1.1.1	Environmental Protection Act 1994	1
1.1.2	Petroleum and Gas (Production and Safety) Act 2004	1
1.1.3	Environmental Protection (Water) Policy 2009	1
1.1.4	State Planning Policy 1/92	1
1.1.5	State Planning Policy 2/02	2
2.	Methodology.....	4
2.1	Geology	4
2.2	Topography and geomorphology	4
2.3	Soil	4
2.3.1	Desktop review	4
2.3.2	Field investigation.....	5
2.3.3	Soil descriptions	5
2.3.4	Soil sample methods	6
2.3.5	ASS field screening tests	7
2.3.6	Soil sampling and laboratory analysis	7
3.	Existing geology	8
3.1	Study area geology	8
3.2	Surface rock	11
3.3	Geologic Hazards.....	12
3.3.1	Seismic activity	12
3.3.2	Tsunami Hazard	12
3.4	Extractive resources.....	14
4.	Existing topography and geomorphology.....	18
4.1	Desktop topography review.....	18
4.2	Field topography assessment	20
5.	Existing soils	21
5.1	Soil desktop assessment	21
5.1.1	Soil types and occurrence	21
5.1.2	Acid sulfate soils (ASS).....	22

5.2	Soils field assessment.....	23
5.2.1	Soil types and occurrence.....	23
5.2.2	Topsoil thickness.....	26
5.2.3	Sodic soils and dispersion.....	26
5.2.4	Soil erosion potential.....	27
5.2.5	Study area erosion potential	29
5.2.6	Soil pH.....	32
5.2.7	Salinity.....	32
5.2.8	Fertility.....	33
5.2.9	Dust.....	36
5.2.10	Agricultural land capability	37
5.3	Acid sulfate soils	40
5.3.1	ASS assessment criteria	40
5.3.2	Preliminary field screening.....	41
5.3.3	Laboratory analysis	41
5.3.4	Summary	42
6.	Potential impacts.....	43
6.1	Geology.....	43
6.1.1	Excavation.....	43
6.1.2	Seismic activity.....	45
6.1.3	Extractive Resources	45
6.1.4	Sterilisation of resources.....	46
6.2	Topography and geomorphology	46
6.3	Soils.....	46
6.3.1	Topsoil.....	47
6.3.2	Erosion	47
6.3.3	Salinity.....	47
6.3.4	Soil acidification.....	48
6.3.5	Land capability	48
6.3.6	Dust.....	48
7.	Mitigation measures	49
7.1	Geology.....	49
7.1.1	Excavation.....	49

7.1.2	Seismic activity	49
7.1.3	Extractive Resources	50
7.2	Topography and geomorphology	50
7.3	Soil	51
7.3.1	Topsoil and subsoil management	51
7.3.2	Water diversion, sediment and erosion control	53
7.3.3	Slope management	54
7.3.4	Drainage line management	54
7.3.5	Acid sulfate soil management	54
7.3.6	Revegetation, revegetation species and weed control	56
7.3.7	Access tracks and dust mitigation	56
7.3.8	LNG facility decommissioning	56
8.	Summary of environmental values, sustainability principles, potential impacts and mitigation measures	58
9.	Limitations	64

Figures

Figure 1.1	Study area and borehole locations	3
Figure 3.1	Study area geology and cross section profile locations	9
Figure 3.2	Study area geological cross section A to A'	10
Figure 3.3	Historical earthquakes since 1958 and tectonic boundaries	13
Figure 4.1	Digital slope analysis	19
Figure 5.1	Study area soil groups	25
Figure 5.2	Study area erosion potential	31
Figure 5.3	Good Quality Agricultural Land	39
Figure 7.1	Schematic cross-section of a treatment Pad, including a compacted clay layer, guard layer, leachate collection system and containment with bunding (Dear et al., 2002).	56

Tables

Table 2.1	Soil horizon and landscape information	6
Table 2.2	Soil sampling methods	6
Table 3.1	Existing extractive resources sites within 200km of the study area	15
Table 4.1	Field terrain and slope analysis	20

Table 5.1 Study area soil types	21
Table 5.2 Mapped land zones	22
Table 5.3 Soil group descriptions	24
Table 5.4 Sodicity and ESP ratings.....	26
Table 5.5 Erosion potential classification	28
Table 5.6 Soil erosion parameters	29
Table 5.7 Soil group erosion ratings.....	30
Table 5.8 pH classification (Hazelton and Murphy, 2007).....	32
Table 5.9 Salinity ratings for soil based on ECe (Hazelton and Murphy, 2007).....	33
Table 5.10 CEC ratings (Hazelton and Murphy, 2007)	33
Table 5.11 Exchangeable cations classification (Hazelton and Murphy, 2007).....	34
Table 5.12 Exchangeable cation ranges	34
Table 5.13 Soil nutrient level ratings	35
Table 5.14 Agricultural land classes (Source: DHLGP, 1993)	37
Table 5.15 Soil management guidelines action criteria.....	40
Table 6.1 Geology description and construction classification.....	44
Table 6.2 Indicative levels of damage from earthquakes	45
Table 8.1 Summary of environmental values, sustainability principles, potential impacts and mitigation measures	59

Plates

Plate 3.1 Rock outcrop 01	11
Plate 3.2 Rock outcrop 02	11
Plate 5.1 Soil at A03	23
Plate 5.2 Bulldust 001.....	36
Plate 5.3 Bulldust 001 – Close-up	36

Appendices

Appendix A	Abbreviations and Glossary
Appendix B	Summary of field data and results
Appendix C	Laboratory analysis plan
Appendix D	Laboratory certificates
Appendix E	Photographs of soils

1. Introduction

An assessment was undertaken to identify the existing environmental values of soils, geology and topography and geomorphology within the proposed study area located approximately 1km south of Laird Point on Curtis Island, Gladstone (refer Figure 1.1). The study area, located within the Curtis Island Industry Precinct of the Gladstone State Development Area, is bounded by the Australia Pacific LNG property boundary, but also includes the portion of land between the northern Australia Pacific LNG property boundary and Graham Creek to the north at Laird Point. This land is the location of the proposed shared gas pipeline corridor which all proposed LNG project proponents will use.

The purpose of this assessment is to identify potential impacts of the LNG facility development (refer to Figure 1.1) to land-based environmental values by investigating existing site conditions through the collection and evaluation of local soil and terrain data.

This assessment provides a basis for determining management strategies necessary to mitigate potential impacts such as soil erosion while considering potential construction constraints.

1.1 Legislative framework

The following describes the main pieces of legislation applicable to the planning, approval, construction and operation of the pipeline in relation to landform, soils and soil management.

1.1.1 Environmental Protection Act 1994

The primary objectives of the EP Act is to protect environmental values and human health whilst allowing developments that improve the total quality of life both now and in the future in a way that maintains ecological processes. The requirements of the EP Act are administered by the Department of Environment and Resource Management (DERM); formerly the Environmental Protection Agency (EPA).

1.1.2 Petroleum and Gas (Production and Safety) Act 2004

The purpose of this Act is to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry. It also has provisions to carry out activities on land within and outside the area of authority in order to allow access. This includes access to conduct environmental investigations such as soil sampling.

1.1.3 Environmental Protection (Water) Policy 2009

The *Environmental Protection (Water) Policy* 2009 aims to support the Environmental Protection Act 1994 with a range of water management guidelines. This policy develops a framework for identifying environmental values, developing water quality objectives, managing the intent for waters and developing management plans.

1.1.4 State Planning Policy 1/92

State Planning Policy 1/92 states that Good Quality Agricultural Land (GQAL) has a special importance and should not be built on unless there is an overriding need for the development in terms of public benefit and no other site is suitable for the particular purpose (DPI/DHLGP 1992). As defined by *Planning Guidelines: the Identification of Good Quality Agricultural Land* (DPI, 1993). GQAL is:

“...land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources”.

DPI/DHLGP also define agricultural land “...as land used for crop or animal production, but excluding intensive animal uses such as feedlots, piggeries, poultry farms and plant nurseries based on either hydroponics or imported growth media”. GQAL classes for the study area are described in Section 0.

1.1.5 State Planning Policy 2/02

In Queensland, the State Planning Policy (SPP) 2/02 sets out the State’s interest concerning development involving acid sulfate soils (ASS) in low-lying coastal areas. The SPP 2/02 has effect under the *Sustainable Planning Act 2009* (SPA) and applies to all land, soil and sediment at or below 5mAHD where the natural ground level is less than 20mAHD (Queensland Government 2002). Within this area, the SPP2/02 applies to all development involving excavating or removing 100m³ or more of soil or sediment, or filling of land involving 500m³ or more of material with an average depth of 0.5m or greater.

DERM (previously known as NR&M) has published comprehensive guidelines for ASS management, sampling and analysis. These guidelines also provide technical and procedural advice to avoid environmental harm and achieve best practice environmental management. They include:

- Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998, version 4.0 (Ahern et al. 1998)
- Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines, 2002, version 3.8 (Dear et al. 2002).

Methodology for this assessment is guided by the above policies and is presented in Section 2 below.

2. Methodology

2.1 Geology

The geology of the study area was assessed using 1:100,000 scale mapping sourced from the Queensland Department of Mines and Energy's (DME) Geoscience and Resources Database; Mineral and Energy Resources Location and Information Network (MERLIN). This data-set has been used to describe the geology of the study area in order to assess potential construction difficulties which may be encountered. Further geologic information has been sourced from the desktop study completed by Fugro Consultants Inc for ConocoPhillips Company in February 2009 (report number 0410-09-0010). Geological mapping has also been used in combination with topographic data presented in Section 3.3.2 to produce a geological cross-section of the study area. This is illustrated as Figure 3.2. Geologic hazards (including tectonics, faults and earthquakes) have been assessed using mapping sourced from the Geologic Survey of Queensland and Graphical Services Unit, 1997. This is illustrated as Figure 3.3 Historical earthquakes since 1958 and tectonic boundaries Figure 3.3.

2.2 Topography and geomorphology

The terrain characteristics of the proposed study area have been assessed in terms of topography (surface form and slope) and geomorphology (landform).

The assessment was undertaken in two parts, as follows:

- a) Desktop review of major topographic features within study area using the 25m Digital Elevation Model (DEM) supplied by NRW, 2007 to assess slope class. Five metre contours were generated from this data which was used in combination with aerial photography to identify investigation areas for Acid Sulfate Soils (ASS). Land System maps and technical manuals (generally prepared by DERM and previous State government agencies) have not been developed for Curtis Island.
- b) A field assessment across the study area using a stratified sampling pattern to evaluate slope, vegetation and land use in the context of potential instability and engineering constraints (refer Section 4.2).

2.3 Soil

The soils assessment was undertaken in two parts, as follows:

- a) Desktop review of existing information pertaining to the study area such as soils, Regional Ecosystems (REs) and topographic mapping.
- b) A field assessment including soil sampling, classification and erosion categorisation.

2.3.1 Desktop review

The following data sources were used to identify soil types within the study area:

- The major soil types within the study area were identified using data from the Bureau of Rural Sciences (BRS) *Digital Atlas of Australian Soils*. This mapping is at a scale of 1:2,000,000. Due to inaccuracies and scale limitations of this map, it has not been presented for the purposes of identifying soil boundaries within the study area.

- RE mapping also provides a broad overview of the potential soils within the study area. These broad soil types are based upon simplified geology/substrate-landform classification for Queensland and are mapped at a finer scale than the above Commonwealth Scientific and Industrial Research Organisation (CSIRO) mapping.
- Topographic contours and aerial photography were both used to identify areas which may potentially contain ASS. This included the supratidal flats (commonly known as salt pans) which were above the 5m AHD contour.

2.3.2 Field investigation

The field investigation of the study area was undertaken from 14 to 19 July 2009 and consisted of sampling and testing soils for agronomic, physical and ASS parameters at 27 borehole locations (refer Figure 1.1). All borehole locations were initially inspected by cultural heritage monitors in order to identify potentially significant artefacts and relocate borehole locations, if necessary.

Borehole locations tested for physical and agronomic parameters were selected using a 25ha grid across the study area, while borehole locations tested for both agronomic and ASS parameters were selected using a 5ha grid. Borehole locations were adjusted in the field to avoid sampling near creeks and/or drainage lines, accessibility constraints and identified cultural heritage artefacts. This sampling plan provides an adequate assessment of the soils within the study area.

Due to the limited vehicular access, all but five borehole locations were hand augered to a depth between 0.1 to 1.0m Below Ground Level (BGL), depending on hardness of subsurface material and presence of coarse fragments. The remaining five were drilled to a depth ranging from 3.0 to 4.0m BGL using solid stem augers rear mounted on a four wheel drive vehicle. This depth was considered acceptable given that no excavation depth was provided at the time of the field assessment. However, this area will not be subject to excavation, but rather filling activities, so the depth of sampling is considered to be adequate. This sampling intensity was considered adequate for the field investigation.

Eighteen hand augered borehole locations were sampled for physical and agronomic parameters, while the remaining eight borehole locations (five drilled, three hand augered) were sampled for ASS, physical and agronomic parameters. Samples were also collected for heavy metals, pesticides and total petroleum hydrocarbons. These are reported within the Preliminary Site Investigation Report. Soil characteristics were described at all borehole locations and photographed to show the soil profile and the surrounding adjacent landscape setting (refer to Section 3.3.2).

2.3.3 Soil descriptions

Soils at each borehole location were described in accordance with the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990) and Australian Soil Classification (Isbell, 1996). This includes soil horizon and landscape information provided in Table 2.1. A summary of field data is provided in Appendix B.

Table 2.1 Soil horizon and landscape information

Soil horizon descriptions	Landscape information
Subgroup classification	Terrain (slope class)
Horizon name	Predominant slope
Depth	Slope position
Colour (matched to the Munsell Colour Chart paint chip)	Existing erosion
Texture	Drainage
Structure	Aspect
Consistence	Approximate water table depth
Coarse fragments	Universal Transverse Mercator (UTM) coordinates of Zone 55.
Mottles	Vegetation (canopy/understorey)
Presence of carbonates and/or salts	Land use
Rooting description	

2.3.4 Soil sample methods

Field sampling procedures conformed to WorleyParsons' Quality Assurance/Quality Control (QA/QC) protocols to minimise the potential for cross contamination and preserve the sample integrity. The following sections provide a brief description of the testing methods used, while Table 2.2 provides a summary of the soil sampling activities.

Table 2.2 Soil sampling methods

Activity	Details
Borehole locations	Borehole locations were recorded using a Garmin 76 hand held Global Positioning System (GPS) unit with an accuracy of +/-4m.
Soil coring	Manual borehole coring was undertaken by WorleyParsons' staff members using an 82mm diameter hand auger. Mechanical drilling was undertaken by APOD Soil Testing using a 4WD mounted mechanical drill rig with 100mm diameter solid stem augers. Hand augered boreholes were extended to a maximum depth of 1m BGL, while drilled boreholes were extended to a maximum depth of 4m BGL.
Abandonment	Boreholes were backfilled to the existing natural ground level using soil retrieved during soil coring.
Soil logging	Soil profiles were logged based upon the subsoil brought to the surface.
Soil sampling	Soil samples were obtained directly from the auger or borehole using new disposable nitrile gloves. Samples to be tested for agronomic parameters were then placed into resealable plastic bags and stored in eskies for dispatch to laboratory. Samples to be tested for ASS were stored on dry ice for dispatch to laboratory.

Activity	Details
Labelling	Sample containers were labelled with the date, the abbreviated Project title (APLNG) and the location/depth. For instance a sample collected at BH18 at a depth of 0.9 to 1.0m BGL was labelled as follows: APLNG 18/07/09 BH18/0.9-1.0
Dispatch	ASS samples were stored on dry ice and air-freighted overnight under dangerous goods and chain of custody documentation to Brisbane for analysis at Australian Laboratory Services (ALS). Agronomic samples were stored in chilled containers and transported by road under chain of custody documentation to Brisbane for analysis at Australian GeoMechanical Laboratory and ALS.

2.3.5 ASS field screening tests

Screening tests were carried out on a total of 72 samples at 0.25m intervals in each borehole designated for ASS testing (A01 to A08) to provide preliminary assessment of the presence of ASS. The pH of a 1:5 soil/water extract (pH_F) and the pH of an extract after the addition of 30% hydrogen peroxide (pH_{Fox}) were measured using a spear point double reference Ionode IJ44 pH electrode, connected to a Lutron PH-207HA meter. The meter was calibrated to two points of reference (two-point calibration: pH 4 and pH 7) prior to, and randomly throughout sampling.

In addition to recording pH_F and pH_{Fox} , the initial reactions between the soil and the 30% hydrogen peroxide mixture were recorded. Results of field screening tests are provided in Table 3, Appendix B.

2.3.6 Soil sampling and laboratory analysis

Soil samples to be analysed for physical and agronomic parameters were dispatched to Australian Geomechanical Laboratories (AGL) for Emerson Dispersion testing and to ALS for analysis of pH; Electrical Conductivity (EC); available nutrients [Total Kjeldahl Nitrogen (TKN) and Phosphorus (P)]; Cation Exchange Capacity (CEC) and exchangeable cations. ASS samples were also submitted to ALS for Chromium Suite analysis. AGL and ALS are National Association of Testing Authorities (NATA) accredited for the analyses undertaken. The laboratory analysis plan is presented in Appendix C, while laboratory reports are provided in Appendix D.

Agronomic and physical testing

Sampling for agronomic and physical parameters generally included the collection of discrete soil samples within the topsoil (typically surface to 0.2m) and subsoil horizons (typically 0.2m to 4.0m). A total of 18 topsoil and 53 subsoil samples were collected with 10 subsoil samples analysed by laboratory. All 18 topsoil samples were analysed.

ASS testing

A total of 39 discrete soil samples were collected for potential laboratory testing from eight locations. Discrete grab samples were collected approximately every half metre within a uniform horizon or adjusted to take into account specific horizons that were not intercepted within the half metre interval.

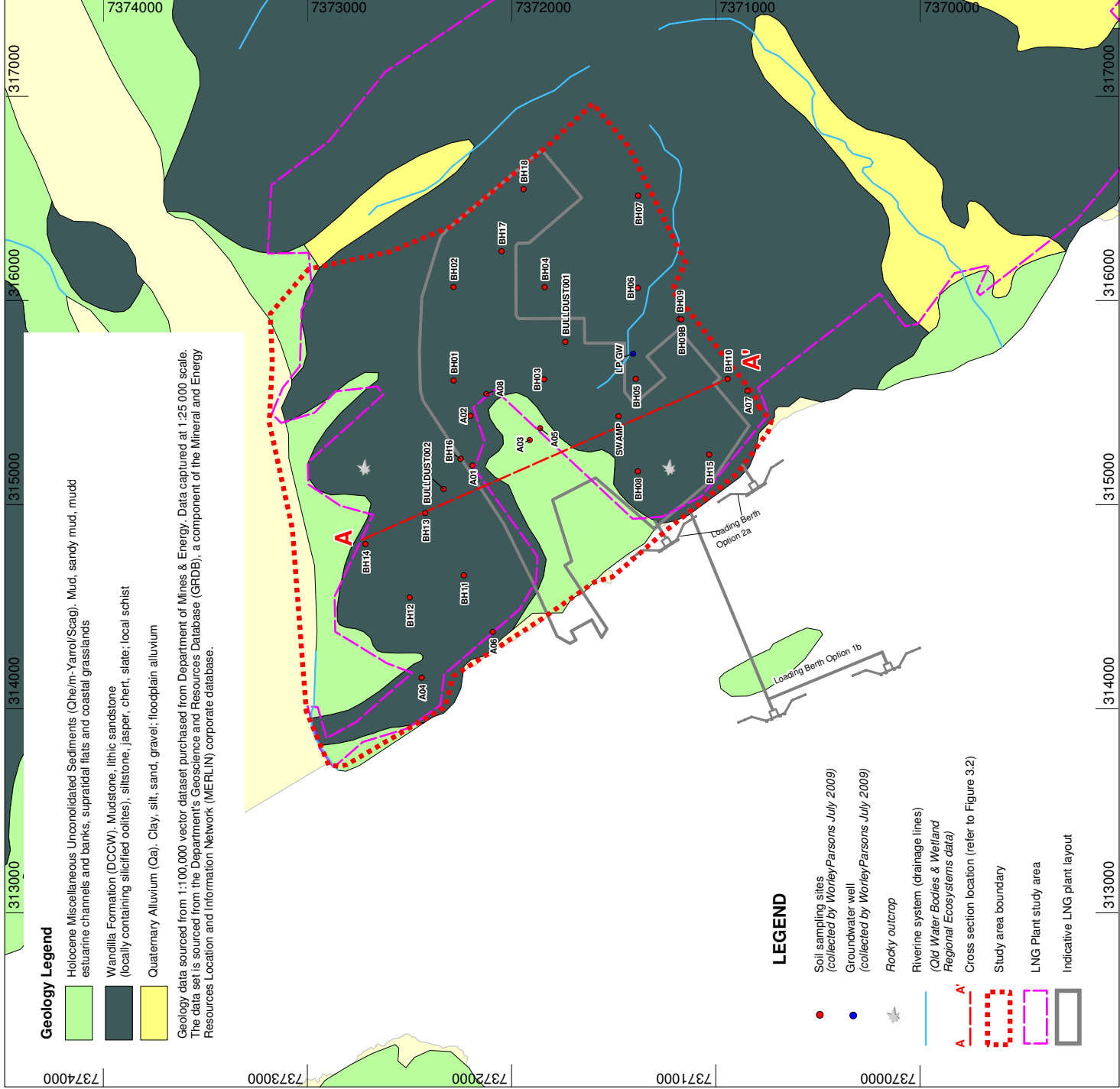
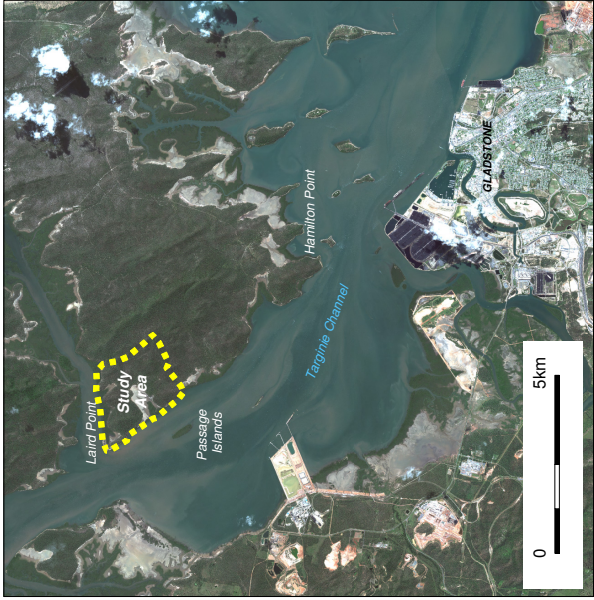
3. Existing geology

3.1 Study area geology

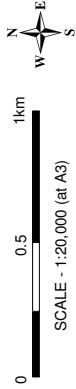
The available geological data and associated mapping indicated three geologic units occur within the south-western portion of Curtis Island. These are the Palaeozoic-age Wandilla Formation (DCcw) of the Curtis Island group; Quaternary alluvium (Qa) and Holocene miscellaneous unconsolidated sediments (Qhe/m) [refer Figure 3.1 and Figure 3.2].

Within the study area, the Holocene miscellaneous sediments ('mudflats, salt pans or swamp deposits') overlie the Wandilla Formation bedrock in the flat central western area of the LNG plant site and northern areas of the LNG pipeline corridor. The Wandilla Formation has been subjected to regional metamorphism and deformation (thrust faulting) and is comprised of mudstone, quartz greywacke, pale grey chert and lithic sandstone (locally containing silicified oolites), siltstone, jasper, chert and slate and local schist. According to information presented within the Fugro Consultants Inc, report (referenced in Section 2.1), the faulting and associated metamorphism account for the north west trending ridges and lineaments evident in the areas of outcrop.

The Quaternary floodplain alluvium, located to the east and south of the study area is typically comprised of clay, silt, sand or gravel.

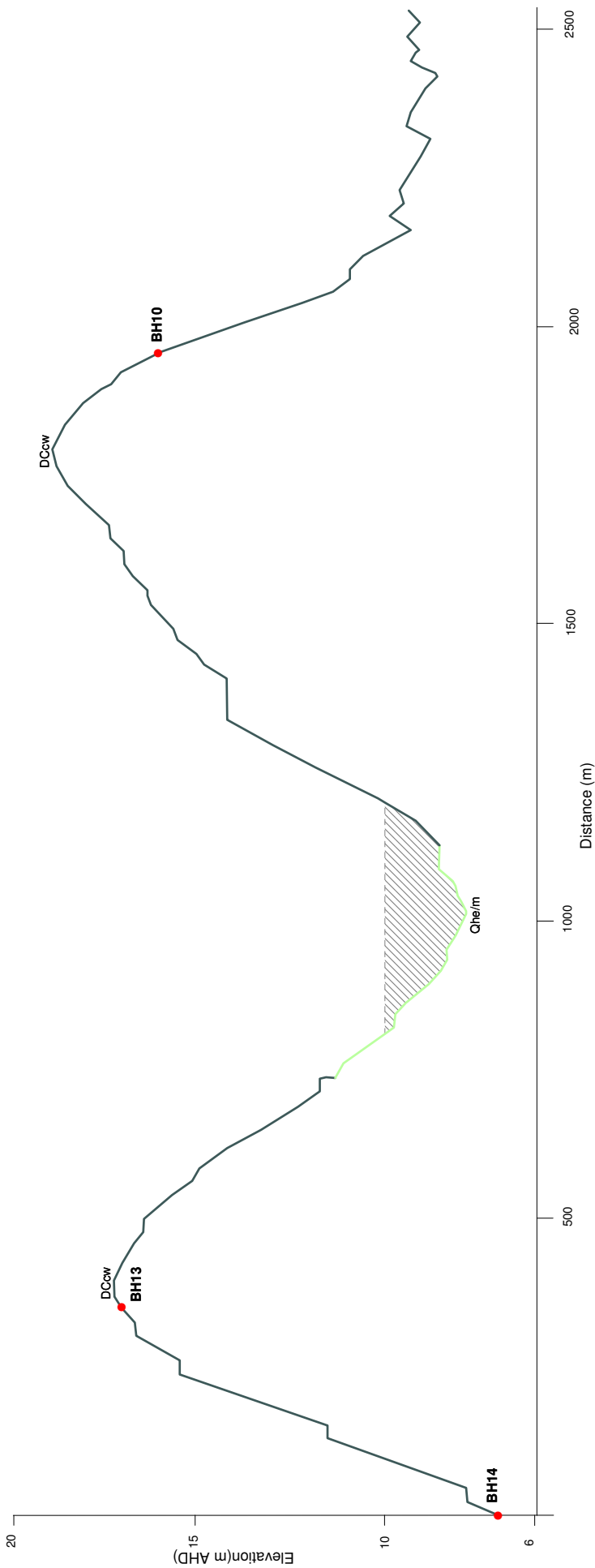


This map incorporates data which is the Commonwealth of Australia (Geoscience Australia) 2010. The Commonwealth places no warranty regarding the accuracy, completeness, currency or suitability for any particular purpose. While every care is taken to ensure the accuracy of this information, the Department of Natural Resources and Mines makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including consequential damage) and costs which might be incurred as a result of the use of this information. © The State of Queensland (Department of Mines and Energy) 2010. Based on data provided by the State of Queensland (Department of Mines and Energy) (2007). In consideration of the State permitting use of this information, the State of Queensland (Department of Mines and Energy) makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including consequential damage) and costs which might be incurred as a result of the use of this information. While every care is taken to ensure the accuracy of this data, WorleyParsons makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including consequential damage) and costs which might be incurred as a result of the data being inaccurate or incomplete. Satellite imagery captured by GeoEye1 on 24 March 2009. Indicative Plant Layout supplied by Bechtel. Drawing No. P1-000-10005



1	10/03/2010	Re-issued for use	MM	KM	DHo	RB
0	02/12/2009	Issued for use	MM	DHe	DHo	
Rev	Date	Revision Description	ORIG	CHK	ENG	APPD
						
WorleyParsons resources & energy						
AUSTRALIA PACIFIC LNG PTY LIMITED						
AUSTRALIA PACIFIC LNG PROJECT						
Figure 3.1 Study area geology						
Project No: 301001-00752			Figure: 00752-00-EN-DAL-0020			Rev: 1

Profile A



Legend

- Late Devonian - Carboniferous**
- DCow: Mudstone, lithic sandstone (locally containing siltified oolites), siltstone, jasper, chert, slate; local schist; Wandilla formation
- Holocene**
- Qhe/m: Mud, sandy mud, muddy sand and minor gravel; estuarine channels and banks, supratidal flats and coastal grasslands; Qhe/m-YARROL/SCAG

Sampling locations

Inferred Holocene and Quaternary sediments

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AUSTRALIA PACIFIC LNG PTY LIMITED		Project No: 301001-00752		Figure:301001-00752-ENV-DAL-0049		Rev: 0	
AUSTRALIA PACIFIC LNG PROJECT		MM		DHe		DHo	
Figure 3.2 Inferred Study Area Geological Cross Section		MM		DHe		DHo	
		ORIG		CHK		ENG	
		Revision Description		APPD			



resources & energy



Elevations expressed in Australian Height Datum (metres)

3.2 Surface rock

Rocky outcrops were identified within the study area (refer Plate 3.1 and Plate 3.2). Although only two significant exposures were noted, surface and near-surface rock is likely to occur throughout the low round hills comprised of the weathered surface layer of the Wandilla Formation within the study area.



Plate 3.1 Rock outcrop 01



Plate 3.2 Rock outcrop 02

Surface and sub-surface stones were also noted at several soil sampling locations as follows:

- Surface stone - BH02, BH03, BH05, BH06–BH09, BH11, BH12, BH14 and BH15.
- Sub-surface stone - BH01–BH08, BH09B and BH10–BH14.

Site observations confirm the geological and soils mapping data (refer Section 3.3.2) which indicate the lowland components of the study area is comprised of mixed alluvial material. In the upland areas, both the surface and sub-surface stones are mainly associated with weathering of the underlying geology (Wandilla Formation).

3.3 Geologic Hazards

3.3.1 Seismic activity

The location of faults and earthquakes in the vicinity of the study area has been illustrated on Figure 3.3. This data indicates a number of faults (including concealed faults) north, east and adjacent to the study area.

This data also indicates a few minor (Richter magnitude >3) earthquakes in the region. This is confirmed by the University of Queensland Australia – Earth Systems Science Computational Centre (ESSCC) which indicates Gladstone lies on the northern edge of an area of recorded seismic activity (ESSCC, 2009). The largest earthquake in Queensland was recorded as a Richter magnitude estimate of ML=6.3 135 km off the Gladstone coast (ESSCC). Data obtained from Geoscience Australia Public Domain Database, Geodata Topo 2.5M, 2003 and presented in the desktop study completed by Fugro Consultants Inc in February 2009 indicates that Curtis Island occurs within a Earthquake Hazard Risk of 0.05 – 0.10. A value of 0.05 indicates that in any 50-year period, there is a 90% chance that the peak ground acceleration will not exceed 0.05.

3.3.2 Tsunami Hazard

A literature review of the tsunami hazard along the northeast coast of Australia completed by William Lettis and Associates, Inc indicated the study area is located within a low level of tsunami hazard (WLA, 2009). This however is based on a qualitative assessment of relative tsunami hazard only and further seismic potential analysis may need to be conducted as recommended by WLA, 2009.

3.4 Extractive resources

The construction of Australia Pacific LNG facility may require extractive materials such as rock, sand and gravel for use as bedding, creation of hardstand areas, access tracks, fill, sediment and erosion control and rehabilitation for example rock armouring for waterways. Furthermore, a source of cement for concrete and bentonite for grouting may also be required from the mainland.

The quantities of extractive materials that would be required for the development of the Australia Pacific LNG facility and other concurrent LNG projects on Curtis Island have not been fully calculated, nor has the quality and type of materials required or the location where they will be sourced and required determined. These calculations and factors are determined during Front-End Engineering and Design (FEED) phases of a project and involve conceptualisation and feasibility of design.

As part of this assessment, a search of existing operating quarries around and within the study area was conducted and the results provided in Table 3.1. This search indicated that most existing quarries currently have a low production rate (<80,000 tpa) and generally provide extractive materials exclusively to the local councils and communities for road maintenance and upgrades and building construction. Although this assessment did not identify the material reserves associated with existing quarries, expansion of existing operations as well as the establishment of new quarries to meet the demands of this Project and other CSG projects may be required.



Table 3.1 Existing extractive resources sites within 200km of the study area

Quarry Name	Operator	Status	Production Rate*	Local Authority (pre 2008 boundaries)	Operation Type	Descriptive Locality
Avondale	R C Lawrie	Suspended	-	Banana	Hard rock	-
Callide Creek (Barnes)	G M & H J Barnes	Operating	low	Banana	Sand & Gravel	Callide Creek 73.8 - 74.5 km NE of Biloela
Fairview Road	Moura Sand & Gravel Pty Ltd	Operating	med	Banana	Hard rock	-
Kianga	Kianga Quarries Pty Ltd	Suspended	-	Banana	Hard rock	20 km south of Banana on Leichhardt H'way; 18 km SE of Moura
Boyne River	Blomfield Excavations	Operating	med	Calliope	Sand & Gravel	Boyne River (at upper limit of tidal reaches)
Boyneglade	Grahame Allen & Sons Pty Ltd	Suspended	-	Calliope	Sand & Gravel	1 km west of intersection of Bruce H'way & Tannum Sands Rd
Calliope River (Bruce)	Blomfield Excavations	Operating	low	Calliope	Sand & Gravel	North bank of Calliope R. 3-4 km upstream of Bruce H'way
H & R Quarry	H & R Quarrying Pty Ltd	Operating	med	Calliope	Hard rock	Quarry Rd 1.5 km W of Yarwun on property owned by DJ Hall PO Box 28 Yarwun
Hurcom	Rayment Excavations	Suspended	-	Calliope	Hard rock	Hurcom Rd, Calliope
Tannum Sands	Grahame Allen & Sons Pty Ltd	Suspended	-	Calliope	Sand	1 km north on Tannum Sands Rd of Bruce H'way
Taragoola	Unimin Australia	Operating	high	Calliope	Hard rock	-

Volume 5: Attachments

Attachment 7: Geology, Topography, Geomorphology and Soils Assessment - LNG Facility



Quarry Name	Operator	Status	Production Rate*	Local Authority (pre 2008 boundaries)	Operation Type	Descriptive Locality
Limited						
Yarwun (GPA)	Central Queensland Ports Authority	Operating	high	Calliope	Hard rock	On Gladstone - Mt Larcom Rd
Bauhinia Downs	Park Equipment Pty Ltd	Suspended	low	Duaringa	Hard rock	2km north of Bauhinia settlement
Bedford Weir	Whitsunday Crushers Pty Ltd	Operating	med	Duaringa	Hard rock	23 km north of Blackwater
Blackhill	Department of Main Roads	Suspended	low	Duaringa	Hard rock	5km North East of Bluff Township
Mimosa Creek	Moura Sand & Gravel Pty Ltd	Operating	low	Duaringa	Sand & Gravel	Mimosa Creek 26.8 - 31.0 km 25km NW of Moura
Hoare	Fitzroy Shire Council	Operating	low	Fitzroy	Hardrock	-
James Bridge	Fitzroy Shire Council	Suspended	-	Fitzroy	Hard rock	-
Kraatz	Fitzroy Shire Council	Operating	low	Fitzroy	Hard rock	-
McEvoy Road	G Halberstater	Operating	med	Fitzroy	Hard rock	McEvoy Rd SW of Gracemere
Moore	Fitzroy Shire Council	Suspended	-	Fitzroy	Hard rock	Gracemere Locality

Volume 5: Attachments

Attachment 7: Geology, Topography, Geomorphology and Soils Assessment - LNG Facility



Quarry Name	Operator	Status	Production Rate*	Local Authority (pre 2008 boundaries)	Operation Type	Descriptive Locality
Pink Lily Sands	Pink Lily Sands	Operating	med	Fitzroy	Sand & Gravel	Fitzroy River 68.8 TO 70 km adopted middle tread distance (amtd), up stream of barrage at Pink Lilly Lagoon/Lotus Reserve
Quarry at Midgee	Hopkins Bros	Operating	med	Fitzroy	Hard rock	59793 Bruce Highway Midgee
Ridgelands Gravel Pit	Fitzroy Shire Council	Operating	low	Fitzroy	Hard rock	1 km down Nicholson Rd, 20 km W of Rockhampton along Ridgelands Rd
Road Paddock	R C Lawrie	Suspended	-	Fitzroy	Hard rock	-
Wigginton	Fitzroy Shire Council	Suspended	-	Fitzroy	Hard rock	Gracemere
Kunwarara	Blomfield Excavations	Operating	low	Livingstone	Hard rock	Bruce H'way approx 35 km north of Yaamba
Nerimbera	Rinker Australia Pty Ltd	Operating	high	Livingstone	Hard rock	Emu Park - Rockhampton Rd/Black Creek Rd
Peak Hill	Earth Commodities Rockhampton	Operating	low	Rockhampton	Hard rock	2 km down Rocky - Yeppoon Rd from Bruce H'way

Note: Extractive industry information obtained for the Australia Pacific LNG gas fields from the Department of Mines and Energy, QRock Database.

*Low Production (<80,000 tpa) Medium Production (80,000 – 200,000 tpa) High Production (>200,000 tpa)

4. Existing topography and geomorphology

4.1 Desktop topography review

The proposed layout of the study area and the general site topography are shown in Figure 1.1.

The topography of Curtis Island is comprised of level to undulating terrain with intertidal mud flats and supratidal salt pans on the coast rising to steeply graded (>30% slope) low round hills. The study area (453ha), located in a small embayment on the south-western portion of Curtis Island just south of Laird Point, is surrounded by steeply sloping (>20%) low round hills to the north, south and east, but is predominantly comprised of gently undulating flats (<2%). The western foreshore flats within the study area extend approximately 200 to 400m from the shore. Several small drainage lines traverse these lowlands.

The maximum elevation within the study area is 62m Australian Height Datum (AHD), in the southeast corner of the study area. The lowest elevation can be found at the intertidal flats (located between low and high tide levels) on the central to western portion of the study area. Here the intertidal flats merge into supratidal flats (located between high and spring tide level).

A digital slope analysis was undertaken to classify slopes across the study area based on the 25m DEM. This slope analysis indicates the majority of the study area is comprised of slopes less than 2%. However, the low round hills surrounding the study area have moderate to steep slopes upward of 20%. The digital slope analysis and resulting slope classes are illustrated in Figure 4.1. This figure also indicates one major drainage line within the study area which starts from the south-east and drains to the centre of the study area then to Port Curtis. However, as described in Chapter 11 of the EIS – Surface Water and Watercourses, the study area is traversed by a local creek system, comprising three ephemeral tributaries which drain into Port Curtis.

4.2 Field topography assessment

This section describes topography and landform according to observations made during the fieldwork assessment undertaken from 14 to 19 July 2009. Terrain assessments were made at 18 locations observed within the study area. At each location, topography was classified in relation to terrain and slope. Terrain was broadly classified using the following descriptions:

- Low: The terrain is flat to gently undulating with slopes generally less than 10%. This unit generally has broadly spaced, mostly shallow, incised drainage channels or gullies.
- Medium: The terrain is dissected land with local relief up to about 50m between crests and adjacent valleys, with surface slopes typically in the range of 10-32%.
- High: The terrain is dissected and/or hilly lands. The local relief is in the range 50-150m between ridge and spur crests and adjacent valley or gully floors, with steep valley side slopes up to 32% or greater.

Predominant slopes were classified as follows:

- Flat: <2 %
- Gentle: 2-5%
- Low slope: 5-10%
- Moderate slope: 10-25%
- Steep slope: 25-50%
- Very steep: >50%

Table 4.1 describes the terrain and predominant slope classifications as noted during fieldwork at each borehole location (refer Figure 4.1)

Table 4.1 Field terrain and slope analysis

Location	Terrain	Predominant slope
BH01 to BH03, BH05, BH06, BH09B, BH10, BH14, BH16, BH17, A01, A02, A03, A04, A05, A06, A07, A08	Low	Flat
BH13	Low	Gentle
BH09, BH09B	Medium	Low
BH04, BH07, BH08, BH11, BH12, BH15, BH18	High	Moderate

5. Existing soils

5.1 Soil desktop assessment

This section provides background information about the soils within the study area.

5.1.1 Soil types and occurrence

Digital Atlas of Australian Soils

The Digital Atlas of Australian Soils mapping (Bureau of Rural Sciences, 1992) indicates the study area is comprised of two main soil types, each covering approximately half of the study area. The northern portion is mapped as tidal mangrove mud flats and salt pans, while the southern portion is mapped as low round hills on metasediments and granites.

As this mapping only provides a very coarse representation of soil types within the study area, the field investigation was required to refine soil mapping and provide background data for soil constraints (refer Section 5.2.1). A description of mapped soil types according to the Digital Atlas of Australian Soils is provided in Table 5.1.

Table 5.1 Study area soil types

General location	Soil unit	Description
North Portion	J5	Tidal mangrove mud flats and salt pans flanking tidal inlets and local creeks:
		Chief soils are shallow saline non-cracking clays over strongly gleyed loam soils. Associated soils are massive earths and duplex soils and similar duplex soils in marginal areas.
South Portion	Tb97	Low round hills on metasediments and granites with slopes of not more than six degrees:
		Chief soils are hard acidic yellow-mottled duplex soils on the slopes with shallow loam soils on some crests. Associated are yellow duplex soils on granitic slopes with sandy soils on sandy accumulations in some lower slope positions. Small areas of massive structured earth soils are found on basic rocks.

Source: Bureau of Rural Sciences, 1992

Land zones

REs are a combination of bioregions (13 in Queensland), land zones and vegetation communities. Of the nine RE's identified within the study area (refer Chapter 8 of EIS – Terrestrial Ecology), only three land zones occur. Land zone designation provides an indication of soil types that are likely to occur in the study area. These are described in Table 5.2 below.

Table 5.2 Mapped land zones

Land zone	Description
1	Quaternary estuarine and marine deposits subject to periodic inundation by saline or brackish marine waters. Includes mangroves, salt pans, off-shore tidal flats and tidal beaches. Soils are predominantly Hydrosols (saline muds, clays and sands) or beach sand.
3	Quaternary alluvial systems, including floodplains, alluvial plains, alluvial fans, terraces, levees, swamps, channels, closed depressions and fine textured palaeo-estuarine deposits. Also includes estuarine plains currently under fresh water influence, inland lakes and associated dune systems (lunettes). Excludes talus slopes, colluvial deposits and pediments. Includes a diverse range of soils, predominantly Vertosols and Sodosols, also with Hydrosols in higher rainfall areas.
11	Primarily lower Permian and older sedimentary formations which are generally moderately to strongly deformed. Includes low to high-grade and contact metamorphics such as phyllites, slates, gneisses of indeterminate origin and serpentinite and interbedded volcanics. Soils are mainly shallow, gravely Rudosols and Tenosols, with Sodosols and Chromosols at lower slopes and gently undulating areas. Soils are typically of low to moderate fertility.

5.1.2 Acid sulfate soils (ASS)

ASS is a term that is generally used to describe both Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). The soils occur naturally across low-lying coastal areas, such as tidal mud flats and estuary marine deposits (refer Table 5.1 and Table 5.2), predominantly below 5m AHD. In southeast Queensland, the upper limit of ASS occurrence is 2.5m AHD, however it has been noted to occur one to three metres higher in northern Australia (Ross, 2002). PASS are typically waterlogged soils, rich in pyrite, which have not been oxidised (Ahern *et al.*, 2004). Exposure of PASS to air causing oxidation can lead to the creation of AASS - extremely acidic soil layers with field pH values of ≤ 4 (Ahern *et al.*, 2004). Actual and potential ASS can occur together in the same profile. Typically however, AASS overlie PASS, but may still have reserves of unoxidised sulfides (Ahern *et al.*, 2004).

The geologic formations most likely to contain ASS relate primarily to deposition that occurred in the Holocene Epoch and in some circumstances deposits from the penultimate interglacial high sea level period in the late Pleistocene period (Golder Associates, 2009). At Curtis Island, Holocene-age deposition is characterised mainly by silt/clay sediments associated with mangrove and other intertidal vegetation areas which currently occupy the embayment within the study area (refer Section 3). This area is easily identifiable from aerial photography (refer Figure 1.1) and has been indicated on Figure 3.1 as unit Qhe/m. This area is also subject to alluvial deposition from local drainage lines which carry sediment from the Wandilla Formation in upland areas.

DERM has completed mapping of ASS for many coastal areas of Queensland. This mapping does not delineate all ASS within the State, but does provide an indication of areas which may contain ASS. A site-specific investigation is usually necessary to provide confirmation of occurrence and distribution of ASS, regardless of mapping. In this case, DERM mapping does not extend to the study area and a site specific investigation was required.

Previous ASS assessments undertaken by Ross (2002), located AASS and PASS within supratidal and intertidal flats at Friend Point, Kangaroo Island which is located to the west of Curtis Island and adjacent to the mainland and also further south at Fisherman's Landing and the Calliope River. Ross (2002) rated these soils as having a high potential for acid generation with the highest concentrations

of potential acidity occurring within 2m of the ground surface. As these landforms are common within and adjacent to the study area, similar levels of acid generation and likely depth of occurrence are expected.

5.2 Soils field assessment

5.2.1 Soil types and occurrence

Soil horizon and landscape information was described at 27 locations within the study Area, the majority of which generally correlated to the broad soil groups described in Section 5.1.1 (refer Table 1, Appendix B). Soil at BH02 and BH03 could not be correlated to mapped soil types as the borehole could not be extended to examine the subsoil due to refusal near the surface. Soil at BH06 and BH09 also could not be correlated as these boreholes were located within local drainage lines where the original soil structure has been lost. Discrete soil samples were collected at all 27 locations.

Based on soil descriptions made in the field, soils were classified using the Australian Soil Classification system (ASC) [Isbell, 1996] (refer Table 1, Appendix B). Using a combination of the ASC; photographs taken in the field (refer Appendix E); land zone mapping and 5m topographic contours generated from the 25m DTM (refer Section 4.1); five soil groups were generated i.e. 1, 2, 3, 4, 5. These are described in Table 5.3 and illustrated in Figure 5.1.

These classifications indicate the majority of soils within the study area are texture contrast soils (KU, SO, CH) and Rudosols, with the exception of soil types 1 and 2. These soils are Hydrosols and likely to be ASS. As indicated within geologic mapping, upslope areas of soil group 2 contain Quaternary alluvium, originating from the Wandilla Formation. This material is not ASS and was confirmed in the field during hand augering and drilling at A05, A07 and A08, where both brown and grey clays and surface colluvium were identified.

Some boreholes designated for ASS sampling were limited to hand augering due to the soft clays which restricted drill rig access. These boreholes included A03, A05 and A06. Soil at A03 in particular was extremely soft and saturated (refer Plate 5.1) and resulted in borehole termination due to collapse.



Plate 5.1 Soil at A03



Table 5.3 Soil group descriptions

Soil group	Desktop mapping			Field assessment		Approx. area (ha)
	Land zone soil class	BRS unit	Geology	Field classification based on sampling	Predominant classification	
1	HY	J5 / Tb97	Qhe/m - Holocene miscellaneous unconsolidated sediments	Sulfidic (EU), Intertidal (CW), Hydrosol (HY)	Mainly gravely Hydrosols	68 (15%)
2	HY	J5 / Tb97	Qhe/m - Holocene miscellaneous unconsolidated sediments Qa – Quaternary Alluvium	Argillaceous (AQ), Supratidal (EW), Hydrosol (HY)	Mainly gravely Hydrosols	40 (9%)
3	RU / TE / SO / CH	J5 / Tb97	Wandilla Formation	Magnesian (DB), Subnatic (ES), Red (AA), Sodosol (SO) Mesotrophic (AG), Hypenatic (CR), Brown (AB), Sodosol (SO) Dystrophic (AF), Brown (AB), Chromosol (CH) Ferric (BU), Dystrophic (AF), Brown (AB) Kurosol (KU)	Gravely texture contrast soils, predominantly Sodosols	107 (24%)
4	VE / SO	J5 / Tb97	Wandilla Formation	Stratic (ER) Rudosol (RU) Dystrophic (AF), Mesonatric (DP), Brown (AB), Sodosol (SO)	Mainly Sodosols	33 (7%)
5	RU / TE / SO / CH	J5 / Tb97	Wandilla Formation	Mottled Sodic (HB), Magnesian (DB), Brown (AB), Kurosol (KU) Ferric (BU), dystrophic (AF), red (AA), Chromosol (CH) Lithosolic (HJ), clastic (HH) Rudosol (RU)	Mainly clastic (consisting of unconsolidated material) Rudosols	205 (45%)
Abbreviations:		HY – Hydrosols, RU – Rudosols, TE – Tenosols, SO – Sodosols, CH – Chromosols, VE – Vertosols, SO – Sodosols				

5.2.2 Topsoil thickness

Within this report, topsoil refers to the surface layer of soil which generally contains organic material and classified as the A1 horizon within Table 1, Appendix B. Topsoil thickness varied throughout the study area ranging from 0.05m BGL to 0.4m BGL. The average topsoil depth was calculated as 0.2m BGL. Topsoil was not noted at boreholes A01 to A03 and A05 to A08.

5.2.3 Sodic soils and dispersion

Sodicity

Sodicity is a measure of exchangeable sodium (Na) in relation to other exchangeable cations. Elevated levels of sodicity lead to clay dispersion in the soil (Hazelton and Murphy, 2007). Sodic soil can cause severe surface crusting, low infiltration and low hydraulic conductivity. It can set very hard and is highly susceptible to gully and tunnel erosion (Hazelton and Murphy, 2007). Sodicity can be rated by calculating the proportion of exchangeable Na cations to the sum of all exchangeable cations, which is referred to Cation Exchange Capacity (CEC). This proportion is known as the Exchangeable Sodium Percentage (ESP):

$$\text{ESP} = \text{Exchangeable Na} / \text{CEC}$$

Table 5.4 provides sodicity ratings proposed by Hazelton and Murphy, which have been applied to the soil results presented in Table 2, Appendix B.

Table 5.4 Sodicity and ESP ratings

Sodicity rating	ESPs proposed for Australian soils (%)
Non-sodic	0-6
Marginally sodic to sodic	6-14
Strongly sodic	>14

Source: Hazelton and Murphy, 2007

ESP ranges were calculated for samples collected within soil groups 3, 4 and 5. Levels ranged from 1% (BH08/0.0-0.1 and BH11/0.1-0.2) to 45.3% (A04/1.0-1.1). This indicates that soils ranged from non-sodic to strongly sodic, with the majority of results indicating soils are sodic to strongly sodic. These results correlate with erosion potential results discussed in Section 5.2.4.

ESP ranges were calculated for samples collected within soil groups 1 and 2. Levels ranged from 65.5% (A07/0.5-0.6) to 77.9% (A01/1.0-1.1). This indicates that soils are strongly sodic. These results correlate with field observations where surface crusting and visible salt was noted and likely result from tidal inundation.

The sodic to strongly sodic soils will require careful management and should be kept separate from non-sodic soils if excavated.

Sodium Adsorption Ratio

Sodium Adsorption Ratio (SAR) describes the activity of the Na ion relative to that of Calcium (Ca) and Magnesium (Mg) [Hazelton and Murphy, 2007]. It is an indirect measurement of sodicity and is calculated as follows:

$$SAR = \frac{Na^+}{(Ca^{2+} + Mg^{2+})^{1/2}}$$

SAR ranges of 0.04 (BH08/0.0-0.1) to 4.42meq/100g (A04/1.0-1.1) were calculated for samples collected within soil groups 3, 4 and 5 (refer Table 2, Appendix B). This range is considered low and with most SAR values reported below 1meq/100g, indicates the majority of samples have low sodium ion activity which, when compared with ESP and salinity concentrations, provides inconclusive dispersion results. ESP and salinity concentrations (combined with Emerson Dispersion tests described later) will provide a better indication of dispersion.

Of the range reported above, only four samples recorded SAR values considered high (>1 meq/100g): BH18/0.4-0.5 (1.74 meq/100g), BH18/0.9-1.0 (2.46 meq/100g), A04/0.5-0.6 (1.6 meq/100g) and A04/1.0-1.1 (4.42 meq/100g). All four samples are strongly sodic (refer: *Sodicity*), however at BH18 this is due to the higher proportion of exchangeable Mg, while at A04 this is due to the lower concentrations of Ca and Mg in comparison with Na. Soil at BH18 is dispersive, while soil at A04, due to the higher concentrations of salts (refer Section 5.2.7), is not.

SAR ranges of 8.87 (A07/0.5-0.6) to 24.06 (A03/0.5-0.6) were calculated for samples collected within soil groups 1 and 2 (refer Table 2, Appendix B). This range is considered very high and is attributed to the deficiencies in Ca and Mg and extremely high concentration of Na. These soils were all reported as strongly sodic, however dispersion will be limited in these soils due to the binding properties of extreme salinity (refer Section 5.2.7) and in some cases, organic content.

Based upon the ESP ranges reported above, soils in groups 3, 4 and 5 will be susceptible to dispersion, despite the results at A04.

Emerson Dispersion results reported for samples collected and analysed within the study area range from slightly-dispersible (3) to very dispersible (1) with the majority of results reported as very-dispersible despite noting negligible erosion (1) during field work. With the exception of non-sodic samples BH03/0.4-0.5, BH04/0.2-0.3, BH14/0.5-0.6 and BH15/0.9-1.0, Emerson Dispersion Class results correlate well with ESP data.

Emerson dispersion tests were not conducted for samples located at A01 to A08, however all samples analysed from these locations, reported strongly sodic soils. The extremely high concentrations of sodium within these soils would normally indicate strong dispersive properties, however the extreme salinity and in some cases, organic content and acidic properties of these soils limits dispersion.

5.2.4 Soil erosion potential

Erosion potential is a measure of the susceptibility of a soil to erode. It is a function of the soils' structural stability and its capacity to absorb rainfall and minimise run-off.

Soils within the study area were assessed in the field according to the classification system described in Table 5.4.



Table 5.5 Erosion potential classification

Field Observation	1 – Nil or minor erosion associated with land use.	1 or 2 – Little erosion, surface slope wash features.	2 – Little erosion, surface slope wash features.	2 or 3 – Slope wash, rill, tunnelling and gully erosion	3 – Slope wash, rill, tunnelling and gully erosion
Emerson Dispersion Class	Class 5-8, soils are slightly or non-dispersible. Aggregates disperse at a water content intermediate between field capacity and that of a suspension. Not highly susceptible to erosion.	Class 4 soils are slightly or non-dispersible. Do not disperse after remoulding but contain minerals such as calcite or gypsum. Not highly susceptible to erosion.	Class 3 means soils are slightly dispersible. After remoulding show dispersion. Soils are generally stable. Gypsum application can reduce crusting.	Class 2 means soils are moderately dispersible. Aggregates slake and partly disperse. Indicate some degree of tunnelling susceptibility	Class 1 means soils are very dispersible. Aggregates slake and disperse completely leaving only sand grains in a cloud of clay. Indicate high tunnelling susceptibility.
Salinity ($\mu\text{S}/\text{cm}$)	< 70–150 (sand soils) to 150–300 (clays), (very low-to-low salinity rating). Sensitive to moderately sensitive crops.	150–340 (sandy soils) to 300–700 (clays), (medium soil salinity rating). Moderately tolerant crops.	340–630 (sands) to 700–1180, (high salinity rating). Tolerant crops	630–930 (sands) to 1180 – 870, (very high salinity rating). Very tolerant crops.	>930 (sands) to >1870 (clays), (extreme salinity rating). Generally too saline for crops.
Erosion Potential Classification based upon field observations and Emerson Dispersion Class	1 (low) –nil/slight potential	1 or 2 (medium) - sheet/wind/small scalds may develop.	2 (medium) – sheet/wind/small scalds may develop.	3 (high) – gully or sheet and significant scalds may develop or 4 (very high) major gullies may develop.	3 – gully or sheet and significant scalds may develop or 4 (very high) major gullies may develop.

Based upon the classification system above, field observations and Emerson Dispersion Class test, results have been used to generate the erosion potential classifications provided in Table 5.6 and illustrated in Figure 5.2. Where vegetative cover has been removed (i.e. for development), soils with an erosion classification of 2 (medium) or 3 (high) should be managed appropriately as they are susceptible to subsurface erosion. The colours in Table 5.6 correlate to soil group classifications on Figure 5.1.

Table 5.6 Soil erosion parameters

Soil unit	Sample Location	Sample	Field Slope Class	Emerson Value	Current landuse	ECe (EC1:5 x conversion factor)	Erosion potential (based on field observations)	Erosion potential if area disturbed (i.e. vegetation removed)
1a	A06	A06/0.1-0.2	1	-	Natural	45600	1	1
2a	A01	A01/1.0-1.1	1	-	Natural	91390	1	1
2a	A02	A02/0.5-0.6	1	-	Natural	57475	1	1
2a	A02	A02/1.0-1.1	1	-	Natural	57285	1	1
2a	A03	A03/0.5-0.6	1	-	Natural	117800	1	1
2a	A05	A05/1.0-1.1	1	-	Natural	45315	1	1
2a	A07	A07/0.5-0.6	1	-	Natural	27075	1	1
2a	A08	A08/1.0-1.1	1	-	Natural	28880	1	1
3a	A04	A04/0.5-0.6	1	-	Natural	5435	1	2
3a	A04	A04/1.0-1.1	1	-	Natural	13932	1	2
3a	BH08	BH08/0.6-0.8	2	1	Natural	112	1	3
3a	BH12	BH12/0.9-1.0	2	1	Natural	574	1	3
3a	BH14	BH14/0.5-0.6	1	2	Natural	162	1	2
3a	BH15	BH15/0.9-1.0	2	2	Natural	390	1	2
4a	BH06	BH06/0.9-1.0	1	3	Natural	285	1	2
4a	BH17	BH17/0.9-1.0	1	1	Natural	276	1	2
5a	BH01	BH01/0.3-0.4	1	1	Natural	2584	1	3
5a	BH01	BH01/0.9-1.0	1	2	Natural	5031	1	3
5a	BH03	BH03/0.4-0.5	1	2	Natural	580	1	2
5a	BH04	BH04/0.2-0.3	3	2	Natural	580	1	2
5a	BH16	BH16/0.4-0.5	1	2	Natural	2648	1	3
5a	BH18	BH18/0.4-0.5	3	1	Natural	3345	1	3
5a	BH18	BH18/0.9-1.0	3	2	Natural	4418	1	3

Note: Sample BH03/0.3-0.4 was collected within the A2 horizon.

5.2.5 Study area erosion potential

The erosion potential classification provided in the last column of Table 5.6 has been used to determine erosion ratings for each soil group (refer Section 5.2.1). These are provided in Table 5.7. Figure 5.2 indicates the overall erosion potential for the study area, taking into account soil erodibility factors and slope (the greater the slope, the greater the erosion potential).

This figure indicates the majority of the study area is of moderate erosion risk. The location of the LNG plant rated from low to moderate. The proposed LNG plant does, however, encroach into high erosion risk areas of steep slope, located on the low round hills.

Table 5.7 Soil group erosion ratings

Soil group	Description	Erosion potential
1	HY	1
2	HY	1
3	Soils on slopes (mainly SO)	3
3	Soils on flats (mainly SO)	2
4	SO	2
5	Soils on slopes (mainly RU)	3
5	Soils on flats (mainly RU)	2

Based on the erosion ratings, soils which have the highest susceptibility to erosion are groups 3, 4 and 5. These soils comprise the majority of the study area.

5.2.6 Soil pH

Soil pH can be used as an indicator of the chemical processes that occur in a soil (i.e. indicate certain nutrient deficiencies and toxic effects) [Hazelton and Murphy, 2007]. Table 5.8 presents pH classification ratings used to assess results, while a summary of all results is presented in Table 2, Appendix B.

Table 5.8 pH classification (Hazelton and Murphy, 2007)

pH	Rating
> 9.0	Very strongly alkaline
9.0 – 8.5	Strongly alkaline
8.4 – 7.9	Moderately alkaline
7.8 – 7.4	Mildly alkaline
7.3 – 6.6	Neutral
6.5 – 6.1	Slightly acid
6.0 – 5.6	Moderately acid
5.5 – 5.1	Strongly acid
5.0 – 4.5	Very strongly acid

The pH ranges reported for samples collected within the study area, ranged from 3.9 (A03/0.5-0.6) to 7.9 (A07/0.5-0.6). This indicates that soils are very strongly acid to moderately alkaline. The central tendency of pH data ranged from 5.3 to 6.3. This indicates that most soils' pH was within the range considered acceptable to plant growth (5 to 7).

Strongly acidic soils located within soil groups 1 and 2 may be the result of the sulfidic materials (refer Section 5.3). Mildly alkaline soils within soil group 2 are likely the result of alluvial and colluvial material transported from the surrounding Wandilla Formation (refer Section 5.1.2). Strongly acidic and alkaline soil located within soil group 3, 4 and 5 reflects the influence of the Wandilla Formation parent material. Soils classified as strongly acid and very strongly alkaline should be kept separate from other soils and require focused management measures.

5.2.7 Salinity

Salinity is the presence of soluble salts in or on soils [particularly Na, but also K, Ca, Mg, Sulfate (SO_4) and Chloride (Cl)]. High salinity levels in soils may result in reduced plant productivity including the elimination of native vegetation which may increase erosion (Hazelton and Murphy, 2007). Table 5.9 presents salinity ratings for soil used to classify results once laboratory EC (1:5) values were converted to EC_e , which is the electrical conductivity of the extract obtained from a saturated soil paste. This is the standard soil salinity measure used to assess plant salt tolerance. A summary of results is presented in Table 2, Appendix B.

Table 5.9 Salinity ratings for soil based on ECe (Hazelton and Murphy, 2007)

Rating	Electrical Conductivity (ECe) (S/cm)
Non-saline	<2,000
Slightly saline	2,000-4,000
Moderately saline	4,000-8,000
Highly saline	8,000-16,000
Extremely saline	>16,000

Salinity reported for samples collected within the study area ranged from 111.8 $\mu\text{S/cm}$ (BH08/0.6-0.8) [non-saline] to 117,800 $\mu\text{S/cm}$ (A03/0.5-0.6) [extremely saline] with the central tendency of salinity ranging from non-saline to slightly saline. Extremely saline samples were collected (as was expected) within soil groups 1 and 2 (tidal flats), while the remaining samples, which are predominantly non-saline, were collected within non-tidal influenced soil groups 3, 4 and 5.

High concentrations of salinity help limit dispersion, however prohibit the growth of plants. Soil at groups 3, 4 and 5 are mainly non-saline to slightly saline and are also predominantly dispersive (refer Section 5.2.3: sodicity). Soil at groups 1 and 2 are extremely saline, however are non-dispersive.

5.2.8 Fertility

Soil fertility is a function of:

- The soil's capacity to attract and release exchangeable ions, which is influenced by the amount and type of organic matter and clay.
- The presence of nutrients which are available for plant growth, or can be available in the future.

In this assessment, Cation Exchange Capacity (CEC), exchangeable ions and Total Kjeldahl Nitrogen (TKN) and Phosphorus (P) were measured as indicators of soil fertility.

Cation Exchange Capacity (CEC)

Cation Exchange Capacity (CEC) is a measure of a soil to hold and exchange cations (Hazelton and Murphy, 2007). A soil which has a high CEC has the ability to buffer the effects of changes in pH, available nutrients and structure. High CEC can also indicate a soil's fertility. Table 5.9 and Table 5.11 present the classification of CEC and exchangeable cations which are used to assess soils within the study area. Table 5.12 presents the ranges of cations within samples. A summary of all results is presented in Table 2, Appendix B.

Table 5.10 CEC ratings (Hazelton and Murphy, 2007)

CEC (meq/100g)	Rating
< 6 (soils low in fertility)	Very low
6 – 12	Low
12 – 25	Moderate
25 – 40	High

CEC (meq/100g)	Rating
> 40	Very high

Table 5.11 Exchangeable cations classification (Hazelton and Murphy, 2007)

Cations	Very low	Low	Moderate	High	Very high
Units	(meq/100g)				
Na	0 – 0.1	0.1 – 0.3	0.3 – 0.7	0.7 – 2.0	> 2
K	0 – 0.2	0.2 – 0.3	0.3 – 0.7	0.7 – 2.0	> 2
Ca	0 – 2	2 – 5	5 -10	10 – 20	> 20
Mg	0 – 0.3	0.3 – 1.0	1 - 3	3 - 8	> 8

Ranges of exchangeable cations reported for samples collected within the study area are presented in Table 5.12:

Table 5.12 Exchangeable cation ranges

Soil group	Analyte	CEC (meq/100g)	Na (meq/100g)	K (meq/100g)	Ca (meq/100g)	Mg (meq/100g)
1a and 2a	Value	28.1–130	18.4–78.9	1.1–2.8	0.7–1.9	5.8–19.6
	Rating	high–very high	very high	high–very high	very low	high to very high
	Central Tendency of Data	high–very high	very high	high	very low	high to very high
3a, 4a and 5a	Value	1.2–30.1	0.1–10.6	0.1–1.3	<0.1–13.7	0.7–21.4
	Rating	Very low-high	Very low–very high	Very low–high	Very low-high	Low – very high
	Central Tendency of Data	Very low–low	Low-high	low - moderate	Very low–low	Moderate-high

High to very high CEC ratings reported for soils within soil groups 1 and 2 are indicative of the silty clays encountered. Although CEC can be used as an indication of a soil's fertility, the extreme saline content in these soils precludes this correlation. In this case, the high to very high CEC ratings are attributed to the very high sodium concentrations.

The very low to high CEC rating results reported for soils within soil groups 3, 4 and 5 are indicative of the silts, gravely silts and clay textured soils that were encountered. The majority of soils encountered in these groups were silty textured soils. These reported very low to low CEC values, while clayey textured soils reported moderate to high CEC values. These results indicate that silty textured soils are less fertile than clayey textured soils and hence would be less likely to respond to changes in pH, nutrients and soil structure resulting from soil additives.

Sodium (Na) values were rated as very high within soil located at soil groups 1 and 2. This is an expected result as these soils are periodically inundated with seawater. Furthermore, these results correlate well with salinity rating for these soils.

The Na values ranged from low to high within soils located at soil groups 3, 4 and 5. These values reflect the data reported for ESP and SAR (refer: Section 5.2.3).

Potassium (K) values were rated as high within soil located at soil groups 1 and 2, while for soils at 3, 4 and 5, K was rated in the low to moderate range.

Calcium (Ca) values were rated as very low for soil located at soil group 1 and 2. This is expected as soil samples were collected from below 0.5m BGL and Ca concentrations usually decline with depth in the profile. Ca values ranged very low to low for soil located at soil groups 3, 4 and 5. These data correlate well with pH data which indicate exchangeable Ca should be high as it generally becomes available to plants at pH levels greater than 5.

Magnesium (Mg) values were rated as high to very high for soil located at soil group 1 and 2. This is expected as soil samples were collected from below 0.5m BGL and Mg concentrations usually increase with depth in the profile. Mg values for soil at soil groups 3, 4 and 5 were rated as moderate to high. These data correlate well with pH data which indicates exchangeable Mg should be high as it generally becomes available to plants at pH levels greater than 5.

Nutrients

Table 5.13 presents TKN and P ratings which are used to assess nutrient levels, while a summary of all results is presented in Table 2, Appendix B.

Table 5.13 Soil nutrient level ratings

Analyte	Very low	Low	Moderate	High	Very high
Nitrogen (total) (N) (% weight)	0.05	0.05–0.15	0.15–0.25	0.25–0.5	>0.5
Phosphorus (P) (mg/kg)	5	5–10	10–17	17–25	>25

Only topsoil samples were analysed for nutrients TKN and P. These concentrations were as follows:

- TKN ranged from 0.043% (BH05/0.0-0.1) [very low] to 0.53% (BH11/0.0-0.02) [very high], while the central tendency of data ranged from 0.07% (low) to 0.2% (moderate).
- Concentrations of P ranged from 0.1mg/kg (BH16/0.0-0.1) [very low] to 301mg/kg (BH07/0.0-0.05) [very high], while the central tendency of data ranged from 0.1mg/kg (very low) to 0.6mg/kg (very low). The very high concentration which occurred at BH07 is considered unusually high as similar soils reported very low P concentrations. However after photographic review it appears there was significant organic matter on the ground surface which, if collected with the soil sample, may have contributed to this high concentration. Otherwise this result may be spurious.

These results correlate well with exchangeable cation data described above and indicate topsoils within the study area are low to moderately fertile.

5.2.9 Dust

Bulldust is a term sometimes used to describe very fine dust generated from soils with high silt and fine sand content as well as those with high calcium carbonate content. Bulldust can be an issue with intensive construction activity and for certain soil types (i.e. soil group 5). It can generate windblown dust and cause dry bogging of vehicles and equipment. Once formed, bulldust is very difficult to manage, although grading and moisture conditioning, then returning it to the track has had some success. Following the generation of bulldust, final rehabilitation and revegetation of the site may be difficult because the soil structure has been destroyed.

Bulldust was observed within the study area along vehicle access tracks (refer Plate 5.2 and Plate 5.3), which have been heavily used over recent months due to the increase development activity associated with LNG projects on Curtis Island. Bulldust development is likely to be associated with the poorly structured A horizon within soil group 5. Since this soil group comprises 45% (205ha) of the study area, where topsoil is not removed, bulldust development will increase with further traffic and has the potential to contribute to dust generation and degradation of soils during construction (refer Section 7.3.6).



Plate 5.2 Bulldust 001



Plate 5.3 Bulldust 001 – Close-up

5.2.10 Agricultural land capability

Agricultural land capability has been assessed based upon the identification of Good Quality Agricultural Land (GQAL). This is necessary to understand the existing status of the land resource likely to be affected by the Project and provide the standard to which rehabilitation should be undertaken.

Agricultural land has been classified into four groups as described in Table 5.14.

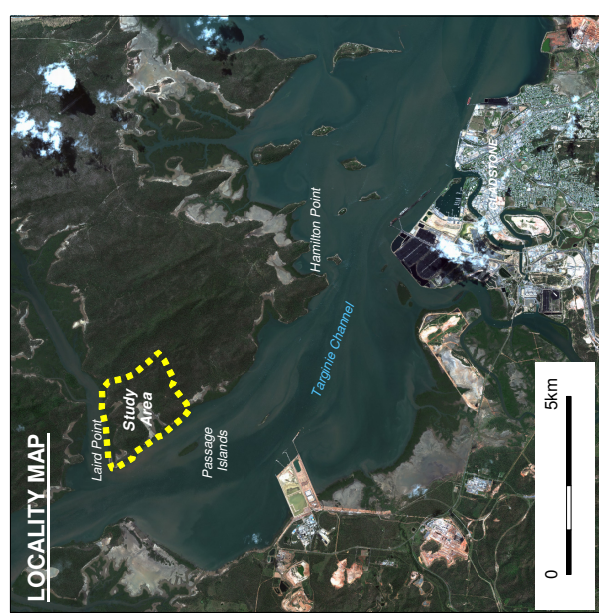
Table 5.14 Agricultural land classes (Source: DHLGP, 1993)

Class	Description
A	Crop land Land that is suitable for current and potential crops with limitations to production, which range from none to moderate levels. There are two sub-classes of crop land: A1 – Crop land suitable for rain-fed cropping A2 – Crop land suitable for horticulture All crop land is considered to be GQAL.
B	Limited crop land Land that is marginal for current and potential crops due to severe limitations and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping. Land marginal for particular crops of local significance is considered to be GQAL.
C	Pasture land Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment. In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be GQAL. There are three sub-classes of pasture land: C1 – Land suitable for sown pastures with moderate limitations. C2 – Land suitable for sown pastures with severe limitations. C3 – Land suitable for light grazing for native pastures in inaccessible areas. For the purposes of this assessment, C1 is considered to be GQAL.
D	Non-agricultural land Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage. These limitations preclude any interference with land or biological resources for the production of agricultural goods.

GQAL classes within the study area are illustrated within Figure 5.3. The current agricultural land use within the study area on Curtis Island is limited to cattle grazing on native pastures. This land is

classified as Agricultural Land Class C3 in accordance with the descriptions provided in Table 5.14. This is confirmed through field data and soil groupings (refer **Error! Reference source not found.**) obtained during this assessment.

The majority of the soils within the study area are Dystrophic (low fertility) and are shallow and stony (soil groups 3, 4, 5) and unsuitable for cropping or important pasture development. These soils occupy approximately 76% (345ha) of the study area (453ha). The remaining soil groups 1 and 2 are comprised of sulfidic intertidal and argillaceous supratidal Hydrosols. Together these soils occupy approximately 24% (108ha) of the study area. Based on salinity, pH, poor drainage and access, these soils are unsuitable for most agricultural uses and are rated as Agricultural Land Class D, i.e. lands with extreme limitations.



This map incorporates data which is Commonwealth of Australia (Commonwealth of Australia) 2009

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Satellite imagery captured by GeoEye-1 on 24 March 2009

Indicative Plant Layout supplied by Bechtel, Drawing No. P1-000-20001
Cardastre from Survey supplied data produced by Fredriksson, Maclean & Associates from Wayne Asnicar 17/06/2009

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Figure 5.3 Study Area Agricultural Land Class

5.3 Acid sulfate soils

Based upon desktop information (geologic mapping, topographic contours, aerial photography and previous investigations) it was identified that the Holocene Miscellaneous sediments had the potential to be ASS. As a result, a limited investigation was undertaken to assess the presence of ASS within soil groups 1 and 2. This investigation was limited to a maximum depth of 4.0mBGL (refer Section 5.1.2) and eight boreholes (refer Figure 5.1), five of which were drilled and three hand augered. All ASS boreholes, with the exception of A04, were located within soil groups 1 and 2, both of which occur in Holocene miscellaneous unconsolidated sediments (refer **Error! Reference source not found.**). This section outlines the ASS criteria and discusses the results of ASS analysis undertaken.

5.3.1 ASS assessment criteria

The Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines, provides action criteria for when ASS is disturbed at a site and should be managed (refer Table 5.15). To account for a soil's natural ability to resist pH change (buffering capacity), generally influenced by clay content, the action criteria have been grouped into the following three broad soil texture categories - coarse, medium and fine.

Table 5.15 Soil management guidelines action criteria

Type of material		Action criteria if 1 to 1000 tonnes of material is disturbed		Action criteria if more than 1000 tonnes of material is disturbed	
		Existing + Potential Acidity		Existing + Potential Acidity	
Texture range (McDonald et al. 1990)	Approx. clay content (%)	Equivalent sulfur (%S) (oven-dry basis)	Equivalent acidity (mol H ⁺ /tonne) (oven-dry basis)	Equivalent sulfur (%S) (oven-dry basis)	Equivalent acidity (mol H ⁺ /tonne) (oven-dry basis)
Coarse texture - Sands to loamy sands	<5	0.03	18	0.03	18
Medium texture - Sandy loams to light clays	5 - 40	0.06	36	0.03	18
Fine texture - Medium to heavy clays and silty clays	>40	0.1	62	0.03	18

(Dear et al., 2002)

Action criteria for disturbances greater than 1,000 tonnes have been selected as the appropriate criteria based on the earthworks that are likely to occur in areas at or below 5mAHD.

In addition to the action criteria above, changes in pH (both pH_F to pH_{FOX} and pH_{KCl} to pH_{OX}) greater than 1 pH unit can be indicative of AASS and PASS. A change greater than 1 pH unit in pH_F to pH_{FOX} can also assist in sample selection for laboratory analysis.

5.3.2 Preliminary field screening

Field screening tests were carried out on 72 discrete soil samples, the results of which are provided in Table 3, Appendix B. This test is used to compare the measured differences between pH_F to pH_{FOX} to assess the presence of actual and potential acidity.

pH_F values for eight samples from A01 and A02 indicated the presence of actual acidity with values less than 4.5. All remaining samples (63) across all ASS investigation locations indicated an absence of actual acidity and ranged from pH_F 4.65 to 7.37.

pH_{FOX} values for 14 samples collected at A01, A02 and A03 indicated the presence of PASS returning values less than 4 and as low as 1.98. All remaining samples (57) across all ASS investigation locations indicated an absence of potential acidity and ranged from pH_{FOX} 4.28 to 8.20.

5.3.3 Laboratory analysis

The 22 discrete soil samples from six ASS borehole locations were submitted for Chromium Reducible Sulfur (S_{CR}) laboratory analysis, the results of which are provided in Table 3, Appendix B.

Actual acidity

Actual acidity is assessed by the measurement of net acidity (i.e. the total sum of potential, actual and retained acidity). The determination of pH_{Kcl} is a means of estimating the actual soil acidity which is used to calculate Titratable Actual Acidity (TAA) [refer: Table 3, Appendix B]. The following results were reported:

- pH_{Kcl} ranged between 4.7 and 8.7 in samples submitted for analysis. This indicates that most soil samples have little or no actual and retained acidity. For samples which returned pH_{Kcl} results greater than 6.5, Acid Neutralising Capacity (ANC) was determined. These samples include A02/1.5-1.6, A03/0.0-0.1, A06/0.0-0.1 and A08/1.0-1.1.
- No soil samples tested returned pH_{Kcl} results below 4.0. As a result, samples were not tested for retained acidity.
- TAA results greater than the QASSIT guideline of 18 moles/tonne were only reported for two samples collected at A01, both within the top 1m of the surface i.e. A01/0.5-0.6 and A01/1.0-1.1. Lower concentrations of TAA were detected at A02, A03, A07 and A08, however these were below the QASSIT guideline.
- Results for A01 provide a positive correlation with preliminary field screening tests, indicating the presence of actual acidity, however lower TAA concentrations detected at A02, A03, A07 and A08 were not conclusive.

Potential acidity

Potential acidity (oxidisable sulfur) is assessed through the measurement of S_{CR} . The following results were reported:

- Results reported for samples submitted for laboratory analysis indicated S_{CR} values greater than the QASSIT guideline of 0.03%S in samples at A01, A02, A03 and A06, with the highest percent sulphur value of 1.52%S reported for sample A01/0.5-0.6. Results for samples collected at A01, A02 and A03 correlate with preliminary field screening test values of pH_{FOX} , however the %S value at A06 does not. The higher pH_{FOX} value is likely the result of the positive ANC reported.

- These results indicate %S values similar to those reported by Ross (2002) for supratidal flats at Friend Point and supratidal flats along the mainland south of Fisherman's Landing. Similarly, with results reported in previous investigations, these results indicate potential acidity decreases with depth.

5.3.4 Summary

Laboratory results indicate the top 1m of soil at A01 has both actual and potential acidity, meaning both unoxidised (PASS) and oxidised (AASS) material exists at this location. However the lower soil horizons of A01 only contain unoxidised material (PASS) which decreases with depth. Laboratory results also indicate PASS exists at A02, A03 and A06.

Adopting best environmental management practice, the 'worst case' scenario must be used for ASS management of the study area. The environmental risk table in Queensland Acid Sulfate Soil Technical – Soil Management Guidelines, 2002, provides requirements for treatment of disturbed soil in locations where ASS have been identified.

The purpose of this ASS investigation was to assess the presence of ASS within the study area and as a result was limited to eight borehole locations and a maximum depth of 4m BGL. This limited investigation did identify both AASS and PASS within soils types 1 and 2. A detailed investigation for both ASS and geotechnical limitations should be conducted prior to construction. This investigation should provide an improved understanding of the extent and risks associated with ASS in the study area and management measures necessary to mitigate any significant risks. An ASS Management Plan (ASSMP) should be prepared as a part of the overall Project Environmental Management Plan. Section 7.3.5 provides general management measures.

6. Potential impacts

Potential impacts to land resources will largely result from the construction phase of the LNG facility development, which will involve both onshore and offshore activities. The onshore construction will mainly include construction of access roads, erosion control, vegetation clearing, earthworks and terrain levelling of the construction site, foundation excavations for main equipment and buildings, construction of the materials off-loading facility (MOF), installation of foundations, installation of plant equipment, pile driving, fencing construction, commissioning and start-up activities.

The offshore construction will mainly include MOF construction, loading platform, mooring/breast dolphins and catwalk, rock dock construction, ferry embarkation point, jetty and trestle construction. Dredging activities will be undertaken by Gladstone Ports Corporation.

Using the information provided in the above existing land resource assessment, this section discusses the associated impacts of the LNG facility development to land; specifically existing geology, topography and geomorphology and soil resources.

6.1 Geology

6.1.1 Excavation

An assessment has been undertaken based upon the geological and terrain models for the study area to establish the potential constraints and associated impacts relating to the excavation of the materials that approximately occur within the upper 2.0m depth below natural ground surface level. The criteria for the basis of the excavation rating assessment are outlined as follows:

- **Rating 1 (low):** Deep soil profile; some low strength extremely weathered to highly weathered soft rock with soil-like properties may occur at low levels. Few excavation problems are envisaged.
- **Rating 2 (moderate):** Shallow to medium-depth soil profile or gravely soils, underlain by medium strength, highly weathered to moderately weathered rock, including closer jointed closely fractured/jointed high strength rock. Rocky soils including cobbles and small to medium size boulders may occur. Material present consists of more difficult excavation conditions. Larger-sized excavators may be necessary to expedite excavation works.
- **Rating 3 (high):** Rock outcrops or skeletal to shallow depth soil profile underlain by high strength moderately weathered to fresh rock, including wider jointed medium strength rock. High strength rock-breaking capability or rock drilling and blasting may be necessary for rock removal.

Based upon the excavation ratings criteria outlined above and reference to the geological (refer **Error! Reference source not found.**) and terrain models (refer

Figure 4.1), an indicative assessment of the excavation conditions likely to be encountered within the upper 2.0m depth below natural ground surface level are described in Table 6.1.

Table 6.1 Geology description and construction classification

Geology	Geological description	Construction excavation
DCcw – Wandilla Formation	Mudstone, quartz greywacke, pale grey chert and lithic sandstone (locally containing silicified oolites), siltstone, jasper, chert and slate; local schist	Moderate to high
Qhe/m – Holocene miscellaneous unconsolidated sediments	Mud, sandy mud, muddy sand and minor gravel	Moderate
Qa – Quaternary Alluvium	Clay, silt, sand and gravel	Low

Based on the geological information, Holocene-age miscellaneous sediments (comprising intertidal and supratidal flats and coastal grasslands) are soft, low strength and can be easily excavated using conventional plant. However due to the high water content of these sediments, it is expected that excavations in these materials may be unstable unless suitably retained. These sediments may also be considered unsuitable as a foundation layer beneath some structures (culverts, bridges, embankments, etc) [refer to Section 7.1.1].

As these sediments are commonly associated with ASS where ground elevations are below 5mAHD in the study area (refer Section 5.3), disturbing (excavation or filling) these sediments may lead to the formation of sulfuric acid, releasing iron, aluminium, and other heavy metals. Rainwater or groundwater can transport these contaminants, which may lead to degradation of the receiving environment.

Where excavations in the low strength Holocene-age miscellaneous sediments or non-compact colluvial deposits are proposed, suitable geotechnical investigations should be performed to assess potential impacts. This information should be used to assist in determining the appropriate designs and techniques to be used during construction (refer to Section 7.1.1). Furthermore, an ASS investigation should be performed in accordance with Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998, version 4.0 (Ahern *et al.*, 1998) [refer to Section 7.3.5].

Although not mapped, colluvial material was encountered at the more than half the soil sampling locations within the soil profile (refer to Section 5.2.1). Colluvial material is expected to present low resistance to excavation as it exists in a non-compact state due to its deposition (i.e. scree [transport down slope by gravity], landslide, creep or sheet flow). Stability of excavations in both alluvial and colluvial profiles may present issues due to the presence of lower strength soils and relatively shallow watertable. As such it is likely that temporary retaining structures such as sheet piles and/or shoring boxes may be necessary, especially below groundwater level (refer Section 7.1.1).

The Wandilla Formation is expected to present a moderate to high excavation constraint due to the predominance of rock at depth. As a result, rock breaking and/or blasting may be required for rock removal. This type of excavation may have more significant (moderate to high) impact upon noise, dust, vibration and the proximity of co-located infrastructure facilities than conventional methods (refer Section 7.1.1).

6.1.2 Seismic activity

A couple of minor (Richter magnitude 3) earthquakes have occurred in the Gladstone region. This is confirmed by the Earthquake Hazard Risk classification of 0.05 – 0.10 given to Curtis Island. A number of faults also occur adjacent to the study area. Given the known seismic activity surrounding the study area, there is a risk of liquefaction which will be dependent upon near surface soil types and density (Fugro Consultants Inc., 2009). Liquefaction will be a non-issue in areas with competent dense residual soils or rock. Estuarine deposits, however, may be liquefiable (Fugro Consultants Inc., 2009). The study area has a low liquefaction potential, however the design of structures should need to consider the risk of earthquakes (Fugro Consultants Inc., 2009).

Should an earthquake occur during the life-cycle of LNG facility development, damage may occur. An indication of potential levels of public nuisance and damage to infrastructure for the approximate range of earthquake magnitude recorded in Queensland is presented in Table 6.2.

Table 6.2 Indicative levels of damage from earthquakes

Modified Mercalli scale		Level of damage	Richter Scale
1-4	Instrumental to moderate	No damage	<= 4.3
5	Rather strong	Damage negligible. Small, unstable objects displaced or upset; windows rattle, felt by some people.	4.3 - 4.8
6	Strong	Damage slight; windows, dishes, glassware broken,, door swing, felt by everyone	4.9 - 5.4
7	Very strong	Damage slight to buildings with plaster cracking and brick falling	5.5 - 6.1
8	Destructive	Cause much building damage and houses move on foundations. Bridges twist, wall fracture, masonry building collapse. Most buildings collapse from 7.4 to 7.9. When greater than 8, total damage with waves seen on the ground surface and object thrown in the air	6.2 - > 8

Source: http://www.ga.gov.au/urban/factsheets/20010919_15.jsp

The table suggests that structural damage could occur during earthquakes of Richter 4.9 or higher. In such instances, damage to the LNG facility could result. A 'worst case scenario' would be that an earthquake was of significant magnitude or duration to cause severe damage to the structures associated with the LNG facility. Whilst such an occurrence may be statistically remote, the potential seismic risk should be appropriately addressed during design.

6.1.3 Extractive Resources

The construction of the LNG Project and associated infrastructure will require the supply of construction material such as cement, bentonite, lime, sand and rock aggregate. At this stage, detailed quantities required are unavailable, as is the required quality and type of materials or where these will be used.

Material requirements will be determined during front-end engineering and design (FEED) phases of the Project. However, an assessment of likely material sources (i.e. quarries) has been undertaken.

The quarry assessment identified numerous existing quarries on the mainland, the details of which are provided in Section 3.4. Most quarries currently supply materials to local councils and communities for road construction, maintenance and building purposes.

This assessment did not identify the material reserves associated with existing quarries. Australia Pacific LNG does not plan to directly develop new quarries as part of the Project. However, new quarries and expansions to existing quarries (operated by others) may be required with development of the proposed LNG Project and changes to land and road use would potentially occur as a result. To meet the demand of the Australia Pacific LNG Project, any new quarry would be required to undergo an impact assessment as part of gaining a separate development approval prior to commencing the activity.

6.1.4 Sterilisation of resources

No extractive industry or mineral resources are likely to be present within the LNG facility study area. This topic, however, is discussed within EIS Volume 5, Attachments 6 and 7.

6.2 Topography and geomorphology

The proposed LNG plant is to be constructed in stages and will extend over an area of approximately 156ha and oriented in such a way as to minimise earthworks. This will result in significant study area landform modification through stormwater diversion, vegetation clearing and earthworks (such as the filling of the intertidal and supratidal flats to RL 6mAHD). This will lead to increased risk of slope instability.

Development of the LNG facility will result in a number of changes in local drainage during construction where stormwater will be diverted to a sedimentation pond located on the eastern side of the study area prior to discharge. During operation, on-site stormwater will be diverted along the northern and southern boundaries of the study area to a basin for reuse or discharged into Port Curtis when basin overflow occurs.

The diversion drains proposed are trapezoidal channels with sloped sides (refer to EIS Chapter 11, Surface Water and Watercourses). Where these drains are not lined (i.e. rock armouring and/or vegetation), there is potential for soil destabilisation.

Landscape stability (i.e. landslide risk) can be an issue where a combination of certain soil and subsoil profiles occurs on slopes greater than 20% or where there is an increase in water infiltration and vegetation removal (such as during construction). There is no evidence of the landscape being prone to landslide, but the assessment of erosion susceptibility (in relation to slope and vegetation removal) and likely Project impacts, is presented in Section 5.2.4 and 6.3.2 respectively. In addition, large volumes of excavated spoil produced during construction may not be suitable for reuse as backfill material (i.e. ASS [refer Section 5.3]) due to settlement. Land clearing, altered landform and changes to land use will also impact visual amenity (refer to EIS Chapter 7, Landscape and Visual Amenity).

The potential for overall impact to terrain is medium.

6.3 Soils

This section discusses potential impacts to soil resources within the study area from the construction of the LNG facility based upon the soil assessment detailed above.

6.3.1 Topsoil

Topsoil protects dispersive subsoils, is critical for erosion prevention and is important for revegetation and weed management. Construction of the LNG plant may impact topsoils if it is not stripped and stockpiled separately to subsoils and topsoil. Should soil inversion (replacement of topsoils with subsoils) occur, and left exposed for extended periods, erosion would be likely. The risk for operational impact would primarily result from poor rehabilitation or drainage management, potentially leading to topsoil and subsoil erosion.

Based upon soil observations, topsoil varied in thickness at soil groups 3, 4 and 5, however the average thickness was calculated as 0.2m. No topsoil was encountered at soil groups 1 and 2. As topsoil is generally stripped down to the subsoil, site specific assessments should be undertaken at the pre-disturbance stage to determine the appropriate removal depth and handling and stockpiling requirements. Additional topsoil may therefore need to be removed from areas with substantial topsoil depths to overcome this possible shortfall. A site-specific topsoil assessment should take this into account.

Fertility of topsoils within the study area was low to moderate. As a result, additional nutrients (specifically N and P) may be required during rehabilitation to improve topsoils, stabilise subsoils, and support vegetation regrowth.

6.3.2 Erosion

The area of greatest potential impact to soils associated with the LNG facility development will be the potential for significant soil erosion to occur. The construction of the LNG plant will require vegetation clearing, which will lead to destabilisation of soils and leave these soils exposed to erosion. Follow-on effects include undermining of structures, pipeline exposure, stream bank erosion (incision of a stream into its banks), sedimentation of Port Curtis, decline in fertility through loss of soil structure and increased dust generation.

Based on the erosion ratings (refer Section 5.2.4), soils which have the highest susceptibility to erosion are groups 3, 4 and 5. These soils comprise the majority of the study area. Soil groups 1 and 2 have been rated with a low erosion potential due to salinity and landscape positions and in some instances organic content, which helps bind soil particles and limit dispersion.

Where concentrated flow is proposed (including diversion of stormwater around construction areas), the greatest potential for erosion impact will occur in unprotected (un-vegetated) coarse textured soils and dispersive fine textured soils (refer Figure 5.2). This channelled run-off flow can lead to gully development and increased sedimentation.

There may be follow on effects where waterway / drainage lines are not reinstated to their original profile. Where this occurs, the bed substrate may erode sufficiently to cause indirect effects such as bank collapse.

With the development and implementation of a comprehensive sediment and erosion control plan, soil erosion impacts can be kept within acceptable levels during the construction phase. Given suitable controls and ongoing monitoring, soil erosion impacts during the operational and decommission phases are likely to be minor.

6.3.3 Salinity

With the exception of soil at A04, subsoils located at groups 3, 4 and 5 were found to be either non-saline or slightly saline. Soils located at groups 1 and 2 however were extremely saline and may be

corrosive to civil structures unless additional precautions are incorporated. Such precautions include undertaking geotechnical investigation of these soils to assess suitable corrosion protection requirements.

Vegetation has a varying tolerance to salinity with only several species tolerating moderate to high salinity (electricity conductivity > 8000 μ S/cm). Suitable handling (refer Section 7.3.1) will minimise potential blending between non-saline and highly saline soils and maintain soil fertility.

6.3.4 Soil acidification

The pH of soils within the study area ranged between strongly acid to slightly acid with the most acidic soils located in soil groups 1 and 2. The low pH measured in these soil groups are attributed to actual acidity from ASS. If these soils are disturbed (that is, subjected to excavation or filling), they are likely to become more acidic through oxidation of sulphides, which may potentially impact the environment and affect civil structures through the mobilisation of acidic runoff and/or groundwater. The low strength of these soils could also result in excessive settlement under the load of structures, services and fill embankments and platforms if these soils were used as foundation material (refer Section 6.1.1).

A detailed ASS investigation should be undertaken and an Acid Sulfate Soil Management Plan (ASSMP) developed to mitigate any potential adverse impacts related to disturbance of ASS (refer Section 7.3.5).

6.3.5 Land capability

This assessment indicates 76% and 24% of the study area has been classified as Agricultural Land Class C3 and D respectively. These soils are not considered GQAL. As the study area has a limited use for agriculture, the LNG plant development is not considered to be impacting the current or future agricultural use of these soils.

6.3.6 Dust

Once vegetative cover is removed, soils are exposed. When subjected to vehicular traffic, the soil structure diminishes and the soils are more prone to generate dust. This is particularly notable in soils with poorly structured A or B horizons, notably in soil group 5 where bulldust was noted (refer Section 5.2.9). Dust generation has the potential to cause ongoing problems as a result of increased traffic during construction. Similarly on existing road, once there has been too much traffic and sub-grade failure occurs, it is difficult to reconstruct roads by backfilling potholes because there will be poor sub-grade drainage into potholes and reworking of the structure of the soils in the sub-grade.

7. Mitigation measures

7.1 Geology

7.1.1 Excavation

The Holocene-age miscellaneous sediments are soft, low strength and can be easily excavated, however must be suitably retained. Adequate foundation support (i.e. foundation piles, stone columns) may also be required beneath LNG facility infrastructure. The stability of these sediments and environmental impacts associated with the preferred construction method should be assessed through geotechnical investigations prior to construction.

Where excavations in low strength Holocene-age miscellaneous sediments or unconsolidated colluvial deposits are proposed, suitable geotechnical-investigations should be conducted to assess design and construction techniques (and include ASS management techniques described in Section 7.3.5).

The Wandilla Formation is expected to present a moderate to high excavation constraint. As a result, rock breaking and/or blasting may be required for rock removal. Blasting should be carried out in accordance with relevant DERM guidelines and AS2885.1 to AS2885.5: Gas and Liquid Petroleum Guidelines. Detailed geotechnical investigation should be undertaken to quantify the environmental impact (such as increased dust, noise and vibration) in relation to excavation within the Wandilla Formation, however it can be expected that the environmental impact would proportionally increase with excavation difficulty. Further detail is provided in EIS chapters 13 and 15 – air quality and noise and vibration respectively. Additionally, where this sort of excavation is carried out on slopes, a geotechnical assessment of slope stability should be undertaken.

Rock spoil, where encountered, should be reused on the construction site, used for erosion control rip-rap or disposed of at an alternative approved location (either on or off-site). Should there be a deficiency of trench backfill material, then suitable material (certified weed and disease free), should be imported. Excess material should be used for rehabilitation purposes or removed to an approved disposal area.

In summary, site-specific geotechnical investigations should be undertaken to establish soil conditions, including depths of near surface soils and environmental risk of acid generation, depths to rock, and groundwater conditions to properly design foundations for the planned structures.

Appropriate construction practices that incorporate soil management, sediment and erosion control, slope management, drainage line management and revegetation (refer Section 7.3), should be implemented.

7.1.2 Seismic activity

A site-specific probabilistic seismic hazard analysis (including a ground motion and liquefaction study) should be conducted to assess the risk and guide the design of the LNG plant. Guidance for the design of structures is provided in Australian Standard/New Zealand Standard AS/NZS 1170.0:2002 Structural design actions – Earthquake actions in Australia. These standards are used in conjunction with AS1170.4:2007, which sets-out data and procedures for determining minimum earthquake loads on structures and related components. This Standard provides the minimum criteria for the protection of life through minimising the likelihood of structures collapsing. Structures excluded from this Standard should be designed in accordance with the appropriate standard relating to that structure.

This Standard does not consider the effect on a structure of related-earthquake phenomena such as settlement, slides, subsidence, liquefaction or faulting. During detailed design, geotechnical and structural engineers should therefore specifically consider the risk of settlements, slides, subsidence, liquefaction or faulting on people and property.

7.1.3 Extractive Resources

Extractive industry operations that supply material to the proposed Australia Pacific LNG Project would be expected to implement mitigation measures to ensure compliance with their operating licence conditions and undertake rehabilitation of extraction areas when extraction is completed. The operation and management of these operations is outside the direct control of Australia Pacific LNG. Australia Pacific LNG intends to work with industry to align with its sustainability principals (refer EIS volume 1, Chapter 3 - Sustainability) The use of borrow material within the study area will necessitate remediation and rehabilitation of treatments where practicable and required. This may include the re-establishment of stable landforms.

To minimise the impacts associated with the extractive resources, the following mitigation measures are proposed:

- FEED phases of the Project should quantify and qualify the need for extractive materials prior to construction, as well as identifying the quality and type of materials required and the location at which it will be required.
- The Australia Pacific LNG has not planned to directly develop new quarries as part of the Project. Businesses which choose to meet the demand for extractive materials for the Project and other developments within the region would be required to follow an approvals process in accordance with applicable legislation.
- Existing quarries should be utilised where possible. However, these should be sufficiently assessed during Project FEED phases to determine the size and local demand for the resources to make an informed assessment on whether there are adequate resources to service the communities and requirements of the Project, taking into consideration estimated future demands of other CSG projects.
- Mobile crushers should be considered for use on the Project so excess rock excavated can be utilised to minimise the need to quarry materials.
- Material used during construction will be reused where feasible to reduce the need for quarried materials.

Environmental issues associated with the extraction of resources within Australia Pacific LNG operating areas if controlled by Australia Pacific LNG should be mitigated through environmental management and operation plans (refer EIS, Volume 4, Chapter 24, Environment Management Plan).

7.2 Topography and geomorphology

Unmitigated clearing and earthworks may have the greatest impact to existing landform through the alteration of drainage paths and soil destabilisation. As a result, landform mitigation measures will be subject to input from flood studies (refer to EIS Chapter 11, Surface Water and Watercourses) and soil characteristics (refer Section 3.3.2).

The general mitigation measures listed below should be addressed throughout the Project to minimise potential impact to water quality of Port Curtis due to erosion and maximise the stabilisation of soils to

prevent potential erosion and sediment run-off, which will assist in minimising landscape impact. Further practices for water diversion, sediment and erosion control are provided in Section 7.3. These sections provide detailed mitigation measures which are also addressed in the Environmental Management Plan (EM Plan) (Chapter 24 of this EIS).

Mitigation measures may include, but not be limited to:

- Redirect/divert surface water run-off from disturbed areas (that is, cleared sites and stockpiles) and manage it to minimise concentrated flows, uncontrolled channelling or impedance of flow (also refer to Chapter 11 of EIS, Surface Water and Watercourses).
- Implementation of sediment and erosion control measures, such as installation of sediment dams, traps and fences to dissipate the velocity of stormwater which runs across the site (refer Section 7.3.2 and the EM Plan within Chapter 24 of the EIS). Disturbed areas and stockpiles which require rehabilitation or stabilisation should be covered with material such as geotextiles or mulch in accordance with the EM Plan.
- Installation of bunding around possible contaminant areas including and wash down areas.
- A sediment and erosion control plan should be developed and implemented during construction and operation (refer EM Plan within Chapter 24 of this EIS).
- Steep or very steep slopes (generally >25%) should be assessed by a geotechnical engineer for overall slope stability as well as a site-specific water diversion, erosion, sediment and revegetation plan.
- Measures given in Section 7.3.4 should be assessed for watercourse crossings.

7.3 Soil

Mitigation measures with respect to soil resources will be largely applicable during construction and rehabilitation of the study area. Although the footprint of the LNG facility will be cleared, levelled and remain occupied by infrastructure, some areas, such as temporary lay down, accommodation areas and access tracks should be restored following cessation of use. General mitigation measures for these areas are addressed below.

7.3.1 Topsoil and subsoil management

The following section outlines topsoil and subsoil management strategies to be implemented during and following the construction of various LNG facility components for all land areas to be disturbed. Management of these soils during operations should largely incorporate monitoring of erosion control measures and rehabilitation. Measures will be outlined within the construction EM Plan. LNG facility decommissioning and rehabilitation will involve the decommissioning and removal of facilities (refer Section 7.3.8) and may incorporate the mitigation measures described below.

Topsoil stripping

Prior to the commencement of topsoil stripping, areas should be cleared of vegetation. Vegetation clearance should be minimised where practicable to reduce the potential for soil erosion and exposure of dispersive soils. Vegetation which is removed should be stockpiled separately. There should be a distinct break of at least 1m between the vegetation and soil stockpiles, and additional stockpile storage areas accounted for any subsoil displaced.

Following clearing, topsoil should be stripped. Any excess displaced spoil must be prevented from mixing with topsoil. Further information regarding vegetation management is contained within Terrestrial Ecology technical report or Chapter 8, within Volume 4 of the EIS. Selected vegetation which is cleared and chipped may be used to provide a thin surface mulch to improve the topsoil productivity and mitigate erosion.

Soil stripping should be undertaken in consultation with information provided in this report and subsequent detailed soil assessments, including designation of recommended topsoil stripping depths. In areas where both the topsoil and subsoil are to be removed, this material should be stripped and stockpiled separately and be located as to minimise loss of material from water and wind erosion. This is necessary to prevent blending of different stockpiled material (i.e. during rain events) as this may impact the success of rehabilitation. The separation of soil groups 1 and 2 from soil groups 3, 4 and 5 at soil type boundaries should also be undertaken.

Earthmoving plant operators should be trained and/or supervised to ensure that stripping operations are conducted in accordance with stripping plans and in-situ soil conditions. This will ensure that suitable topsoil material resources are salvaged. Care should be taken during stripping, stockpiling and/or resspreading to prevent structural degradation of the soil and excessive compaction.

Stockpiling

Where practicable, topsoil material should be resspread directly from stripped areas onto areas being rehabilitated. Where this is not possible, topsoil shall be stored in stockpiles. Where excavation at soil groups 1 and 2 is required, any stockpiles generated should be kept separate from soil groups 3, 4 and 5. Stockpiles should be located in areas that are outside the site disturbance area and at least 50m away from main drainage lines or significant overland flow paths. Drainage from higher areas should be diverted around stockpiles to prevent erosion, while sediment controls should be installed downstream of the stockpiles to collect any washed sediment.

Stockpiles should not exceed 5m in height and be positioned to allow for drainage and permit access. Stockpiles exposed for extended periods should be deep ripped and sown with seed stock compatible with local conditions in order to keep the soil healthy, maintain biological activity and minimise erosion. Surface stabilisers may be used on soils which have been classified as erosive or dispersive and exposed for prolonged periods. Topsoil stockpiles should be clearly sign-posted for easy identification and to avoid any inadvertent losses. Establishment of weeds on the stockpiles should also be monitored and controlled. Rocky surface materials should be removed and stockpiled separately from other material. Information regarding management of weeds is included within the Terrestrial Ecology technical report or Chapter 8 of Volume 4 of the EIS.

Resspreading

Areas which require topsoil resspreading are considered minor compared to other aspects of the Project, however upon completion of construction, wastes should be removed, temporary access tracks should be closed and soils should be replaced in the order in which excavation occurred. If subsoil cannot be reused, then suitable backfill certified material should be imported. Excess soils should be disposed of appropriately e.g. stockpiled for use in future rehabilitation or resspread. During the removal of soil from stockpiles, upper and lower sections of the stockpiles should be mixed to spread seed stock and microfauna.

Topsoil application should only take place following initial reinstatement of the subsoil, compaction and the addition of erosion control measures associated with an environmental management plan. Topsoils should be resspread over watered and scarified/ripped subsoils in even layers at a thickness

appropriate for the intended land use of the area to be rehabilitated, however should be tapered on slopes to account for downward movement.

Topsoil should be compacted firmly but left slightly rough to provide a suitable seed bed and revegetation to be undertaken as soon as possible after topsoil respreading. Cross ripping of topsoils may be undertaken to encourage rainfall infiltration and minimise run-off. On steeper slopes hydroseeding and hydromulching may be used. General access should be restricted to permit vegetation re-establishment.

Rehabilitation of disturbed areas should generally comprise establishment of a stable final landform with revegetation as described in the Terrestrial Ecology technical report or Chapter 8 of the EIS, volume 4. Drainage measures and remediation of soil fertility and structure may also be required.

As mentioned above, maintenance will be described within the EM Plan. It will outline watering, fertilising, weed control, erosion monitoring.

7.3.2 Water diversion, sediment and erosion control

All soils which are to be disturbed should have sediment and erosion control measures adopted throughout construction and rehabilitation.

The following measures are recommended:

- Divert water around the construction site. Within the site, divert water around excavations and stockpiles.
- Construct sediment fences on the downhill side of the excavation areas
- Construction sediment fences around stockpile areas
- Where tracks go down slopes, contour banks should be used at appropriate intervals to produce sheet flow rather than concentrated flow and directed to discharge at multiple locations at low velocities and volumes
- Sediment and erosion control measures should be inspected on a regular basis, replaced where damaged and emptied following rainfall events, if required.
- Clear vegetation progressively, so as to maximise the area of soil protection and minimise disturbance.
- Create stable slopes and revegetate soon after disturbance.
- Topsoil stockpiles should be seeded or mulched (refer Section 7.3.1).
- Diversion sediment and erosion control devices can be put in place before construction commences and should remain in place at rehabilitated areas until the area has stabilised.
- There should be a sediment basin constructed on the downhill side of the site on the uphill side of drainage lines (refer to Chapter 11 of EIS, Surface Water and Watercourses).
- Routine water quality monitoring of pH, electrical conductivity, dissolved oxygen, redox, temperature and turbidity should also be considered to ensure that water quality is maintained.

A comprehensive soil sediment and erosion control and monitoring plan (detailing the measures described above) will be provided in the EM Plan (refer Chapter 24 of EIS volume 4).

7.3.3 Slope management

Due to the slope steepness in parts of the study area, slope management control may be required. This includes shaping where required to maintain slope stability and installing and maintaining temporary sediment and erosion control (contour banks, diversion drains and silt fences). Where clearing slopes adjacent to drainage lines is required (in particular at the southeast and southwest corners of the study area), sediment and erosion control should be incorporated on the down-gradient side prior to clearing, where practical. Clearing in this area should be delayed until construction at the drainage line is imminent.

7.3.4 Drainage line management

A number of local drainage lines are located throughout the study area (refer Section 4.1) and currently dissect the existing access tracks. As dispersive soils are located in the study area, appropriate management of these soils around existing drainage lines and slopes is required in order to minimise sediment laden run-off and impact to adjacent Port Curtis.

Temporary earth banks/contour banks or diversion channels may be installed along the slope on approaches to watercourses, at the boundary between soil groups 1 and 2 and soil groups 3, 4, 5 and adjacent to Port Curtis immediately following vegetation clearing. Where this is not appropriate, run-off should be directed into silt fences installed at the perimeter of the drainage line down slope from disturbed areas to prevent sediment from entering the drainage line. A buffer of vegetation adjacent to the drainage line should also be retained until construction is imminent. If necessary, armouring can be incorporated to minimise soil erosion.

Flow continuity along drainage lines where traversed by access tracks should be maintained through the use of temporary culverts or pipes.

Routine and event-based (e.g. following rainfall) inspections of soils adjacent to drainage lines and Port Curtis should be conducted. These inspections should aim to visually monitor erosion immediately adjacent to the drainage lines and Port Curtis and evidence of sediment run-off. Routine water quality monitoring of pH, electrical conductivity, dissolved oxygen and turbidity may also be conducted upstream and downstream of the crossing to identify trends and water quality degradation. A detailed water quality monitoring plan will be provided in the EM Plan.

7.3.5 Acid sulfate soil management

During excavation and/or filling at soil groups 1 and 2, the oxidation of PASS could occur. This could result in the migration of acidic fines into receiving waters. As discussed in Section 5.3, further assessment is required prior to the LNG facility development to assess the full extent of the ASS hazard, determine treatment techniques (generally liming) for disturbed ASS and geotechnical parameters. This investigation would be used to prepare a detailed ASSMP which should outline techniques to be used for ASS management; neutralisation where alkaline materials (lime) are physically incorporated into the soil and geotechnical recommendations regarding soil stability. This section provides minimum mitigation requirements for ASS management at the study area, based upon the limited assessment undertaken and recommended strategies within Queensland ASS guidelines.

- Soil treatment, when employed should compensate for both actual and potential acidity. Note that this material can be difficult to work, treat and dry and may contain variable levels of sulfide.
- Post-neutralisation, the target soil pH should be 5.5 or greater. Maintaining a pH greater than 5.5 can control leaching of iron and aluminium (Dear et al., 2002).

- Excess neutralising agent should remain within the soil until all acid generation reactions are completed and the soil has no further capacity to generate acidity. Verification samples of the treated soil should be collected and analysed to demonstrate compliance with the performance criteria. If the performance criteria are not met, then the soil must be retreated.
- The type of neutralising agent should be such that insoluble coatings of gypsum, iron and aluminium are minimised. These insoluble coatings which inhibit neutralisation. Neutralising agents should also be slightly alkaline, with a low solubility and have a pH ranging from 7 to 9 (Dear et al., 2002). These products will not flush-out with the first heavy rain event and have minimal potential to contaminate surrounding waterways and groundwater (Dear et al., 2002). The preferred product is fine aglime, CaCO_3 .
- Treatment of ASS should be conducted on a dedicated treatment or liming pad, the exact design requirements of which should be assessed during preconstruction geotechnical and ASS investigations. DERM management guidelines provide an example of a liming pad which should incorporate a guard layer of neutralising agent and a compacted non-ASS clayey material (0.3–0.5 m thick) below the guard layer (refer Figure 7.1). Alternatively a physical barrier may be used as an alternative to a guard layer of neutralising agent as a means of protecting groundwater quality and preventing infiltration of acidic water; e.g. a bunded concrete slab, paved area or layer of bitumen may be placed under a temporary treatment pad.
- Stormwater run-off should be managed to prevent stormwater run-on into the treatment pad, or from the pad into natural watercourses.
- Sufficient space should be provided for the number of treatment pads required to allow adequate drying and treatment of the ASS. Expected rates of drying, mixing, compaction and treatment times must be identified. The earthworks strategy should also ensure that adequate time is available to obtain the results of verification testing before treatment of the next layer begins.
- Accurate spatial tracking of ASS volumes should allow initial soil testing to be correlated with prescribed treatment and any required verification testing.
- Neutralising agents can be applied to artificial drainage lines in the treatment areas. This will assist in neutralising acidic stormwater run-off. Silt fences should be used across the drainage lines to capture and remove sediment. The neutralising agent should not be added to natural drainage lines of waterways as these environments may be pH sensitive.
- Treatment of acidic water maybe required, however should be assessed through the development of an ASSMP. DERM recommendations for acid water treatment involve treating with hydrated lime pre-mixed into slurry before adding. The slurry can be prepared in a concrete truck, cement mixer or large vat with an agitator. Treatment effectiveness should be assessed during and after treatment by in-situ pH (should be between 6.5 and 8.5), in-situ iron testing and other laboratory analysis at a NATA accredited laboratory. Applying the slurry can include the following:
  - Spraying the slurry over the water with a dispersion pump.
  - Pumping the slurry into the water body with air sparging (compressed air delivered through pipes) to improve mixing once added to water.

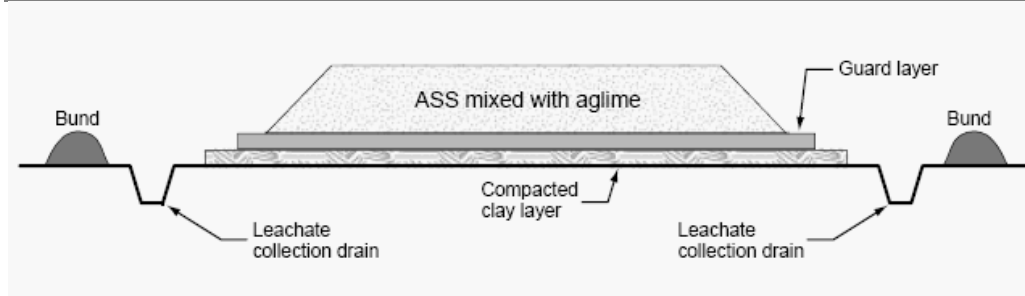


Figure 7.1 Schematic cross-section of a treatment Pad, including a compacted clay layer, guard layer, leachate collection system and containment with bunding (Dear et al., 2002).

7.3.6 Revegetation, revegetation species and weed control

Revegetation issues are addressed within the Terrestrial Ecology technical report and Chapter 8 of Volume 4 of the EIS.

7.3.7 Access tracks and dust mitigation

Dust mitigation measures should be implemented during the construction program. New access tracks should be covered with a thickness of crushed rock appropriate for the sub-grade and for the traffic proposed. Where access tracks are to be temporary and remain unsealed, the construction methods should aim to reduce the exposure periods for non-vegetated areas and undertake revegetation as soon as practical after construction. Vegetation removal should be limited to the immediate construction area to minimise soil resource degradation (assist in retention of soil moisture and nutrients).

Material being transported should be covered as required and speed limitation should be adopted to minimise dust creation. Water can be sprayed from trucks onto exposed soils as required to prevent dust generation. Water supplies should be of an appropriate water quality.

Where dust is of concern for established traffic routes (being maintained throughout the construction period), some watering may be required in extremely dry periods, and in problem areas it may be appropriate to remove additional soil layers down to the harder sub-soils.

Dust generated from soil stockpiles should be minimised by ensuring exposure time is minimised, seeding with local stock or by adding mulch, applying water, covering stockpiles with protective materials on stockpiles or exposed slope batters.

Where it is necessary to retain an access track where bulldust occurs (refer Section 5.2.9), consideration to the laying of crushed rock and diversion of traffic should be given. This area should be rehabilitated if disturbed by the LNG facility development.

7.3.8 LNG facility decommissioning

LNG facility decommissioning activities should comply with regulatory requirements that are in force at the time of decommissioning. This involves the generation of a closure plan to be documented within the EM Plan.

Individual items of equipment and the LNG facility should be decommissioned when its operation is no longer economically viable. Reuse and recycling alternatives should be considered where practicable which may include reuse somewhere else in the operation, sale or scrap. In areas where infrastructure (i.e. roads) cannot be reused, the land should be rehabilitated to a condition that is consistent with the

surrounding environment and local community and Government expectations at the time. This includes the remediation of contamination identified from post-decommissioning land assessments.

The causeway for the MOF and the beginning of the LNG jetty itself will be left in place. This is because the local benthic habitat and the associated flora and fauna will have adapted to its presence over the 30-year operational life of the Project and its removal would result in a greater environmental disturbance than retaining the structure *insitu*. Sub-sea piles will be cut off at the mud-line and the debris removed for disposal on land. The dredged access channel will not be refilled as the resulting environmental impact would be greater than leaving the channel to reach a natural equilibrium.

8. Summary of environmental values, sustainability principles, potential impacts and mitigation measures

A summary of the environmental values, sustainability principles, potential impacts and mitigation measures in relation to waste management is presented below in Table 8.1.

In addition, Table 8.1 includes the residual risk levels for land management. A risk assessment has been undertaken to identify the potential risks, causes and consequences to land from the LNG plant development. Mitigation measures to reduce the risk have been nominated and the residual risk has been calculated. Further details on the risk assessment methodology are provided in Volume 1 Chapter 4.

Table 8.1 Summary of environmental values, sustainability principles, potential impacts and mitigation measures

Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation measure	Residual risk rating
Existing finite resources to be sourced for construction material	Minimising adverse environmental impacts and enhancing environmental benefits associated with our activities, products or services; conserving, protecting, and enhancing where the opportunity exists, the biodiversity values and water resources in our operational areas.	Alteration of topography, drainage, leaching of chemical / minerals, removal of vegetation, changes to land and road use and changed dust, noise and vibration levels.	Demand on local resources for LNG plant development. Development of new and / or expansion of existing quarries.	Reuse materials on site where possible. Use of mobile crushers to minimise need for quarry materials from external sources. FEED phases of the Project should quantify the need for extractive materials prior to construction, as well as identifying the quality, volume and type of materials required and the location at which it will be required. FEED phases should identify size and local demand of existing extractive resources.	Low
Existing landform character and stability	Using resources efficiently, reducing the intensity of materials used and implementing programs for the reduction and reuse of waste. Identify, assess, manage, monitor and review risks to the Project's people and property, and the environment and the communities affected by Project activities.	Slope instability Destabilisation of soils Change to drainage Degraded water quality of Port Curtis Visual amenity	Landform modification through stormwater diversion, vegetation clearing and earthworks (such as the filling of the intertidal and supratidal flats to RL 6mAHd).	Implement sediment and erosion control and redirect and manage runoff to minimise concentrated flows. Undertaken a geotechnical slope analysis.	Medium
Existing soil resource,		Loss of topsoil quality and	Incorrect stripping,	Undertake site-specific topsoil	Low



Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation measure	Residual risk rating
including values for agricultural productivity		quantity	prolonged exposure and erosion Soil inversion (replacement of topsoils with subsoils) Poor rehabilitation and drainage management	assessment. Undertake training with earthmoving staff to ensure correct handling. Stockpile vegetation and soil groups separately. Account for additional soil stockpile storage. Remove rocky material during stripping. Apply nutrients / conditioner or suitable seed stock where required. Undertake progressive clearing and rehabilitation. Implement sediment and erosion control. Monitor weeds. Limit topsoil stockpile heights. Assess point discharge water contaminant levels prior to discharge.	



Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation measure	Residual risk rating
		Soil erosion – soil destabilisation	Vegetation clearing	Undertake monitoring of sediment and erosion devices and rehabilitated areas.	Medium
		Poor rehabilitation and drainage management.	Poor drainage management		
		Sedimentation of Port Curtis	Concentrated flow discharge	Undertake progressive clearing and rehabilitation and create stable slopes and revegetation as soon as practicable.	
		Decline in fertility	Improper sediment and erosion controls	Stockpile vegetation and soil groups separately.	
		Undermining of structures (roads, buildings, fencing) where soil has been washed away through runoff	Inadequate earthworks contractor training and supervision	Sediment and erosion control devices should be installed prior to construction and retained until the area is stabilised.	
		Increased dust generation		Implement sediment and erosion control and redirection and management of runoff to minimise concentrated flows.	
		Exposure of pipelines		Apply suitable seed stock or geotextile on stockpiles and/or exposed soil areas, such as unsealed access tracks, which are exposed for prolonged periods or have been identified as problem soils erosive/dispersive).	



Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation measure	Residual risk rating
		Increased salinity leading to poor rehabilitation and corrosion of civil structures	Poor soil handling (removal, stockpiling and respreading) leading to soil inversion	Undertake routine and event based water quality monitoring.	Low
			Blending of non-saline and highly saline soils	Adopt suitable subsoil handling, minimising blending of non-saline and highly saline soils and soil inversion where practicable.	
			Inadequate monitoring of rehabilitation	Minimise vegetation clearing and stockpile topsoils separately from sub-soils.	
Minimise acid generation associated with potential exposure of ASS		Oxidisation of PASS during excavation and / or filling Degradation of environment and new civil structures from acidic runoff	Undertake geotechnical investigations to assess suitable corrosion protection for civil structures.	Undertake geotechnical investigations to assess suitable corrosion protection for civil structures.	Low
				Adopt an EM Plan which incorporates monitoring of rehabilitated areas.	
			Excavation and / or filling of soil groups 1 and 2 (Holocene miscellaneous sediments)	Undertake suitable geotechnical investigations pre-construction to assess appropriate design and construction techniques.	
				Undertake a detailed ASS investigation in accordance with Queensland Guidelines and develop an ASS Management	



Environmental value	Sustainability principles	Potential impact	Possible cause(s)	Mitigation measure	Residual risk rating
Existing qualities of the air environment, including the life, health and wellbeing of the community		The clearing of vegetation and increased traffic within the study area will destroy soil structure and increase dust generation, particularly within poorly structured A or B horizons (i.e. soil group 5)	Clearing of vegetation and increased traffic	Plan. Assess reuse options of soil groups 1 and 2 as these have limited use for rehabilitation without the input of significant resources. This should be addressed within the ASSMP.	Low
				Assess appropriate access tracks and upgrade if required. Undertake progressive clearing and rehabilitation. Apply speed limitations. Use of special additives in addition to water spraying to control dust and minimise dust generation where required. Where bulldust occurs, consider application of crushed rock, diversion of traffic and rehabilitation of this area. If practicable divert traffic around bulldust, strip area, re-topsoil, fence and revegetate.	

9. Limitations

This assessment of soil conditions within the study area was based upon government supplied information and a limited field assessment. It does not constitute a detailed investigation that can be used for engineering purposes. The information provided in this assessment is directly relevant only to the points in the ground where the samples were obtained at the time of the assessment, considered indicative of field conditions and appropriate to the scale of the study area.

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Appendix A Abbreviations and Glossary

Abbreviations

AASS	Actual acid sulfate soil
ASS	Acid sulfate soil
Ca	Calcium
CEC	Cation exchange capacity
Cl	Chloride
DERM	Department of Environment and Resource Management
DNR	Queensland Department of Natural Resources
DNR&W	Queensland Department of Natural Resources and Water
DNRM	Queensland Department of Natural Resources and Mines
DPI	Queensland Department of Primary Industries
EC	Electrical conductivity
EHS	Extremely high strength
EPA	Environmental Protection Agency
ESP	Exchangeable sodium percentage
Fe	Iron
FEED	Front end engineering and design
GQAL	Good quality agricultural land
HW	Highly weathered
K	Potassium
LS	Low strength
Mg	Magnesium
MS	Medium strength
MW	Moderately weathered
Na	Sodium
P	Phosphorus
PASS	Potential acid sulfate soils
PAWC	Plant available water capacity
SAR	Sodium adsorption ratio
SO ₄	Sulfate
SW	Slightly weathered

TAA	Titratable actual acidity
TKN	Total Kjeldahl Nitrogen
UTM	Universal Transverse Mercator
VHS	Very high strength
XW	Extremely weathered

Glossary

A horizon	The original top layer of mineral soil divided into A ₁ (typically from 5 to 30 cm thick; generally referred to as topsoil with a high content of organic matter, dark colour and maximum biological activity) and A ₂ horizons (usually 5 – 70 cm thick; similar texture to A ₁ but paler in colour, poorer in structure and less fertile).
acid soil	Any soil with a pH of less than 6.5.
aggregate (soil)	A unit of soil structure consisting of primary soil particles held together by cohesive forces or by secondary soil materials such as iron oxides, silica or organic matter. Aggregates may be natural, such as <i>peds</i> .
alkaline soil, alkalinity	Alkaline soils have laboratory measured pH values >8.5. Alkalinity may inhibit the growth of plants.
alluvial terrace	Former floodplain which either no longer floods or rarely floods due to deepening or enlargement of the stream channel.
alluvium	Sediment deposited from the transport by channelled stream flow or over-bank stream flow.
andesite	Fine-grained volcanic rock composed of andesine (plagioclase) with one or more mafic constituents.
apedal	In the moderately moist to moist state, none of the soil material occurs in the form of peds; it is massive or single-grained and when disturbed, separates into fragments or primary particles.
ASC	Australian Soil Classification—It is a multi-category scheme with classes defined on the basis of diagnostic horizons or materials and their arrangement in vertical sequence as seen in an exposed soil profile.
available soil water	That part of the water in the soil that can be absorbed by plant roots that can be held between field capacity and the moisture content at which plant growth ceases.
available water holding capacity	The ability to hold that part of the water in the soil that can be absorbed by plant roots. Available water is the difference between field capacity and permanent wilting point.
B horizon	The layer of soil below the A horizons, usually of finer texture (i.e., more clayey), denser and stronger in colour. Thickness ranges from 10 cm to 2 m thick and is divided into B ₁ and B ₂ horizons.
bolus	A small handful of soil which has been moistened and kneaded into a soil ball which just fails to stick to the fingers.

boundaries (soil)	The boundary between soil horizons defines the nature of the change from one horizon to that below. It is specified by two terms—one a measure of the width of the transition zone between the two horizons, the other a description of its shape.
C horizon	Layers below the B horizon which may be weathered, consolidated or unconsolidated parent material little affected by biological soil-forming processes.
Cainozoic	Geological period 65 million years ago to present.
Chromosol	ASC Soil Order classification—Soils with a clear or abrupt textural B horizon where the major half of the B ₂ horizon is not strongly acid (i.e. >pH5.5) and non-sodic (can be sodic at depth).
clastic	Rocks built up from fragments of pre-existing rocks generated by weathering and erosion and transported to a point of deposition.
colluvium	Unconsolidated soil and rock material transported largely by gravity (i.e., mass movement: landslide, mudflow, creep or sheetflow), deposited on a lower slope and/or at the base of a slope. Does not have bedding structure such as alluvium and is has more variable grain size.
Cretaceous	Period of geological time, 144 – 65 million years before present.
deltaic	Sediments deposited at the mouth of a river where it enters a lake or the sea.
Dermosol	ASC Soil Order classification—Other soils with B ₂ horizons that have structure more developed than weak throughout the major part of the horizon, generally non-sodic subsoil, generally gradational textured soils (gradual boundaries).
Devonian	Geological period 395 – 345 million years ago.
Ferrosol	ASC Soil Order classification—Soils with B ₂ horizons in which the major part has a free iron oxide content greater than 5% Fe in the fine earth fraction (<2 mm). Soils with a B ₂ horizon in which at least 0.3 m has vertic properties are excluded.
fluvial	Material deposited by rivers and streams.
fore-arc	A forearc is a depression in the sea floor located between a subduction zone and an associated volcanic arc.
fossiliferous	Fossil containing rock formations.
gilgai	Microrelief associated with soils containing shrink-swell clays.
granite	A granular igneous rock composed chiefly of feldspar (orthoclase) and quartz, usually with one or more other minerals, as mica, hornblende, etc.
granodiorite	Plutonic rock consisting of potassium feldspar, quartz, plagioclase, biotite and hornblende. Granodiorite is an intermediate between quartz, monzonite and quartz diorite.
gravel	The amount (visual abundance estimate) of gravel-sized (>2 mm) materials that occur on the surface and in the A ₁ horizon and include hard (when moist), coarse fragments and segregations of pedogenic origin.
gravely	Over 60% of surface cover consists of gravel (2 - 60 mm).
GSG	Great Soil Groups of Australia (as defined by Stace <i>et al</i> 1968), described in terms of

	morphology, genesis and land use.
Holocene	Present geological epoch which commenced 10 000 years ago.
Horizon	A layer within the soil profile with morphological characteristics and properties different from layers below and/or above it.
Jurassic	Geological period 295 - 135 million years ago.
Kandosol	ASC Soil Order classification—Other soils that are lacking a strong texture contrast and (i) have well-developed B ₂ horizons in which the major part is massive or has only a weak grade of structure, <i>and</i> (ii) have a maximum clay content in some part of the B ₂ horizon which exceeds 15%.
Kurosol	ASC Soil Order classification—Soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B ₂ horizon (or the major part of the entire B ₂ horizon if less than 0.2 m thick) is strongly acid (i.e. pH<5.5).
lacustrine sediment	Sediment mass deposited from transport by waves and from sediment solution and suspension in still water in a closed depression on land.
Lithosol	GSG classification—A shallow soil showing minimal profile development and dominated by the presence of weathering rock and rock fragments. Lacking horizons other than an A ₁ (one layer only).
loam	A medium, textured soil of approximate composition 10 - 25% clay, 25 - 50% silt and <50% sand.
melonhole	Irregularly distributed large depressions within soil surface, usually greater than 3m in diameter.
mottled horizon	A horizon in which mottle abundance is greater than 10% (visual abundance estimate) and contrast between colours is distinct and prominent.
mottling	The presence of more than one soil colour in the same soil horizon, not including different nodule or cutan colours.
oolitic	Sedimentary rock consisting of ooids
Palaeocene	Period of geological time, 65 – 54.8 million years before present.
paludal	Sediments that accumulated in a march environment.
paralic	Sedimentary basins developed in marginal marine environments, i.e. lagoons, littoral basins.
ped	An individual, natural soil aggregate.
Permian	Period of geological time, 290 – 248 million years before present.
Pleistocene	First epoch of the Quaternary period, from 2 million years ago to 10 000 years ago.
Quaternary	Period of geological time covering the Holocene plus the Pleistocene. Up to 2.6 million years ago.
red earths	GSG classification—Massive, reddish sandy profiles with a gradual increase in clay content with depth over a diffuse to gradual boundary.
Rudosol	ASC Soil Order classification—Soils with negligible pedologic organisation. They are

	usually young soils in the sense that the soil forming factors have had little time to pedologically modify parent rocks or sediments. The component soils can vary widely in terms of texture and depth.
sheet erosion	The removal of the upper layers of soil by raindrop splash and/or runoff.
silt	Fine soil particles in the size range 0.02 - 0.002 mm.
skeletal soils	Thin soils.
Sodosol	ASC Soil Order classification—Soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid.
solum	The upper part of a soil profile above the parent material in which current processes of soil formation are active. This is where the living roots and other plant and animal life characteristics are exhibited.
structure (soil)	Is concerned with the arrangement of all soil particles and refers to the distinctness, size, shape and condition of the peds.
Tertiary	Period of geological time, 2 – 65 million years before present.
texture	A measure of the behaviour of a small handful of soil when moistened and kneaded into a ball (bolus) and then pressed out between the thumb and forefinger.
topsoil	A part of the soil profile, typically the A ₁ horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.
Triassic	Period of geological time, 180 – 230 million years before present.
Vertisol	ASC Soil Order classification—Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Although many soils exhibit gilgai microrelief, this feature is not used in their definition.



Appendix B   Summary of field data and results

General Information			Soil Summary		Soil Type Correlation to Field Descriptions?		Soil Description (texture, structure, consistency, coarse fragments, rooting)		Australian Soil Classification (Isbat1998)		Landscape Information					Comments
Sample Location	Location Description	Notes	Horizon and General Description (mBCL)	Mapped Soil Type	Depth of topsoil	Drainage	Topsoil	Subsoil	1 2 3	4	Predominant Slope	Aspect	Waterable	GPS Coordinates	Vegetation	
											1 2 3 4	F C U M N S E W		Southing	Eastings	
BP61	Slight incline towards the west		A1 0.0-0.05 GZ A2 0.05-0.3 GZ B2 0.7-1.0 CZ B3 1.0-1.1 CZ	Shallow saline non-cracking soils on the slopes with shallow loam soils. Associated are massive earths, and duplex soils in marginal areas.	Yes	0.05	(10YR 5/2) GZ, D, LO, abundant VF-S coarse fragments, abundant VF-S coarse fragments, many F-C roots @ 0.05 (10YR 7/1) @ 1.0 (10YR 5/2)	(10YR 4/3 v 2.5YR 4/8) noddy Zc with minor S, D, F1, VPL, ST, few VF-F coarse fragments, few F-C roots @ 0.7 6.2YR 8/2 w 10YR 8/6 noddy CZ, D, noddy, S, TR	1	I	1	F	W	-	523 45 987	E151 11 447 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Understorey 5-10m Ground status: sparse short grasses
			A 0.0-0.2 GZ	Shallow saline non-cracking clays over strongly gleyed loam soils. Associated are massive earths, and duplex soils in marginal areas.	No	0.2	(10YR 7/1) GZ, D, LO, many C-S coarse fragments, common M roots @ 0.2 refusal on stones	-	1	I	1	L	SW	-	523 45 000	E151 11 217 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
			A1 0.0-0.3 Z A2 0.3-0.5 Z	Shallow saline non-cracking clays over strongly gleyed loam soils. Associated are massive earths, and duplex soils in marginal areas.	No	0.3	(10YR 7/1) Z, D, S, TR, many F-S coarse fragments, abundant VF-C roots @ 0.3 (10YR 4/3) @ 0.5 refusal on stones	-	1	P	1	F	-	-	523 45 237	E151 11 447 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP64	Slight incline towards the west		A 0.0-0.1 ZD B 0.1-0.3 GZ	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils. Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	Yes	0.1	(7.5YR 3M) ZD, D, LO, abundant VF-S coarse fragments, many F-C roots @ 0.3 refusal on stones	(7.5YR 3M) GZ, D, LO, abundant VF-S coarse fragments, many F-C roots @ 0.3 refusal on stones	1	MW	3	M	W	-	523 45 242	E151 11 713 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP65	Location on slight slope		A 0.0-0.3 CZ	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils. Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	Yes	0.3	(10YR 5/1) D, RR, abundant E-S coarse fragments, common VF roots @ 0.3 refusal on stones	-	1	I	1	F	-	-	523 45 480	E151 11 445 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP66	Location within floodplain		A1 0.0-0.3 ZD A3 0.2-0.4 GZ B1 0.4-0.9 Z B2 0.9-1.0 Z	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils on some crests . Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	No	-	(7.5YR 4/3) Z, D, LO, few VF-M coarse fragments, few F roots @ 0.5 (7.5YR 5/2) @ 0.9 (7.5YR 5/2)	(7.5YR 4/3) Z, D, LO, many C coarse fragments @ 0.5 (7.5YR 5/2) @ 0.9 (7.5YR 5/2)	1	MW	1	F	-	-	523 45 489	E151 11 707 Green-tailed blue <i>gum</i> , <i>perfoliatus</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP67			A1 0.0-0.05 ZGL A2 0.05-0.3 GZ	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils on some crests . Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	Yes	0.05	(10YR 3/2) ZGL, D, LO, abundant VF-C coarse fragments @ 0.05 (10YR 6/1) GZ, D, LO, abundant VF-S coarse fragments, many F-C roots @ 0.3 refusal on stones	-	1	I	3	M	WSW	-	523 45 493	E151 11 973 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP68			A 0.0-0.3 ZD A2 0.3-0.6 CZ B2 0.6-0.8 CZ	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils on some crests . Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	Yes	0.3	(10YR 3/1) ZD, D, LO, many F-S coarse fragments, many F roots @ 0.5 (5YR 5/6) @ 0.6 (5YR 4/6)	(5YR 4/6) CZ, D, LO, many C coarse fragments @ 0.5 (5YR 5/6) @ 0.6 (5YR 4/6)	1	P	2	U	W	-	523 45 493	E151 11 178 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses
BP69	Location within local drainage line - cutting of drainage bank		B 0.0-0.7 ZG	Hard acidic yellow modified duplex soils on the slopes with shallow loam soils on some crests . Associated are yellow duplex soils on gamic slopes with sandy soils and massive earths. Small areas of lower slope positions. Small areas of massive structured earth soils are found on basic beds.	No	-	(7.5YR 5/3) ZD, D, LO, abundant VF-S coarse fragments, many F-C roots	(7.5YR 5/3) ZD, D, LO, abundant VF-S coarse fragments, many F-C roots	3	I	2	D	W	-	523 45 598	E151 11 615 Lemon-scented <i>apicalis</i> <i>gum</i> , <i>narrawe</i> - <i>leaved</i> <i>red</i> <i>ironbark</i> <i>open</i> <i>forest</i> Canopy 20m Understorey 5-10m Ground status: sparse short grasses - PQM outcrop evident from erosion

Laird Point



General Information	Soil Summary	Horizon and General Description	Mapped Soil Type	Soil Type Correlation to Field Descriptions?	Depth of Topsoil	Soil Description (texture, structure, consistence, coarse fragments, rootings)	Drainage Erosion									Australian Soil Classification (fabell1996)	Landscape Information										Comments
							Topsoil			Subsoil			Erosion				Aspect Position L D	Waterable GPS Coordinates Souting Easting	Vegetation								
							1	2	3	1	2	3	R	W	M					I	P	V	Class	Slope	1	2	
BH098	A1 0.0-0.2 GZ A2 0.2-0.3 GZ	Location on easy slope adjacent to and above local drainage line / gully	Heard acidic yellow mottled duplex soils on the slopes with shallow loam soils on some crests. Associated as yellow duplex soils on some crests. Shallow saline non-cracking clay over strongly played beam soils. Associated as massive earthy sandy soils on sandy lower slope positions. Small areas of massive structured earth soils are found on basalt rocks.	Yes	0.2	(BYR 3M) GZ, D, LO, abundant F-S coarse fragments, abundant F-M roots @ 0.2 (10YR 5/6) @ 0.3 refect on above	-	1	I	Kurosol*	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Understorey 5-10m Ground strata sparse short grasses	1	1	U	WV	-	S23 45.803	E151 11.815	- Natural - Abundant surface debris								
BH10	A 0.0-0.3 CZ		Heard acidic yellow mottled duplex soils on the slopes with shallow loam soils on some crests. Associated as yellow duplex soils on some crests. Shallow saline non-cracking clay over strongly played beam soils. Associated as massive earthy sandy soils on sandy accumulations in some lower slope positions. Small areas of massive structured earth soils are found on basalt rocks.	Yes	0.3	(BYR 5/H) CZ, D, FR, abundant F-S coarse fragments, common VF roots @ 0.3 refect on above	-	1	I	Kurosol (KU)* * Unknown B horizon Classification based on similarities with BH10	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Understorey 10m Ground strata sparse short grasses	1	1	F	-	-	S23 45.724	E151 11.442	- Natural - Abundant surface debris								
BH11	O1 0.0-0.02 IP A1 0.02-0.3 GZ		Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.3	(BYR 2/D) GZ, D, LO, abundant VF-S coarse fragments, abundant VF-C roots @ 0.3 refect on above	-	1	MW	Sodosol (SO)* * Unknown B horizon Classification based on similarities with BH12	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Understorey 5-10m Ground strata sparse short grasses	1	3	C	W	-	S23 45.077	E151 10.886	- Natural - Selective chalking - Abundant surface stones								
BH12	A 0.0-0.4 GZ B 0.4-1.0 ZC		Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.4	(BYR 3M) GZ, D, LO, abundant VF-S coarse fragments, abundant VF-C roots @ 0.3 refect on above	(2.5YR 3.8w x 2.5Y 7.8 mode) ZC, D, weathered FR, abundant VF-S coarse fragments, abundant VF-M roots	1	I	Magnesian (MA), Subarctic (SC), (SOD) rock (C), gravelly (G), silty (N), silty (N), deep (W)	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Creasey 20m Understorey 5-10m Ground strata sparse short grasses	2	2	M	W	-	S23 44.873	E151 10.823	- Natural - Selective chalking - Abundant surface stones								
BH13	A 0.0-0.3 ZCIC	Adjacent to off vehicle track.	Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.3	(2.5YR 6.0) ZCIC, D, FR, NS, VP, common F-S coarse fragments, common F-C roots @ 0.3 refect on above	-	1	I	Chromosol (CH)* * depth of A and B horizon unknown due to refect	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Creasey 30m Understorey 5-10m Ground strata sparse short grasses	1	2	M	NNE	-	S23 44.818	E151 11.068	- Natural - Abundant surface debris								
BH14	A1 0.0-0.2 ZOL B1 0.2-0.9 ZOL	Location adjacent to local drainage line	Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.2	(2.5YR 4.0) ZOL, D, LO, abundant VF-S coarse fragments, abundant VF-C roots	(BYR 6M) ZOL, D, LO, abundant VF-S coarse fragments, many VF-C roots	1	I	Dystrophic (AF), Brown (AB), Kurosol (KU) medium (B), alipity (AP), silty (N), silty (N), clayey (O), deep (W)	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Creasey 20m Understorey 5-10m Ground strata sparse short grasses	1	1	F	W	-	S23 44.758	E151 10.979	- Natural - Abundant surface debris								
BH15	A1 0.0-0.1 ZL A2 0.1-0.2 ZL B1 0.2-0.8 ZC B2 0.5-1.0 ZC		Heard acidic yellow mottled duplex soils on the slopes with shallow loam soils on some crests. Associated as yellow duplex soils on some crests. Shallow saline non-cracking clay over strongly played beam soils. Associated as massive earthy sandy soils on sandy lower slope positions. Small areas of massive structured earth soils are found on basalt rocks.	Yes	0.1	(BYR 2/H) ZL, D, LO, common F-coarse fragments, many VF-C roots @ 0.3 (2.5YR 3/8) ZC; many VF coarse fragments @ 0.1 (7.5YR 3/4) @ 0.8 (2.5YR 3/8 w 10YR 5/1 mode)	(BYR 3M) ZC, D, ST, PL, FI, common F-M coarse fragments, many VF-C roots @ 0.3 (2.5YR 3/8) ZC; many VF coarse fragments @ 0.1 (7.5YR 3/4)	1	P	Feric (BU), Dystriclic (AF), Brown (AB), Kurosol (KU) medium (B), alipity (AP), silty (N), silty (N), clayey (O), deep (W)	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Creasey 20m Understorey 5-10m Ground strata sparse short grasses	2	2	U	W	-	S23 45.872	E151 11.224	- Natural - Selective chalking - Abundant surface stones								
BH16	A1 0.0-0.3 Z B 0.3-0.8 C	Adjacent to unsealed vehicle track	Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.3	(BYR 6.0) Z, D, FR, common F-M coarse fragments, common F-C roots @ 0.5 initial on roots	(BYR 4.4) C, D, VFI, NS, VP, common F-M coarse fragments, few F roots @ 0.5 initial on roots	1	P	Mottled sodic (HB), Magnesian (BG), Brown (AB), Kurosol (KU) moderately grainy (F), silty (N), clayey (O)? * depth of B horizon unknown due to refect	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Creasey 30m Understorey 5-10m Ground strata dense short grasses	1	1	F	-	-	S23 45.013	E151 11.221	- Natural - Abundant surface debris								
BH17	A1 0.0-0.05 Z B1 0.05-0.7 Z B 0.7-1.2 Z	Adjacent to creek	Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.05	(BYR 4.0) Z, D, LO, common F-M coarse fragments, many F-C roots @ 0.05 (10YR 8/4)	(BYR 6.0) Z, D, FR, common F-M coarse fragments, many F-C roots	1	I	Dystrophic (AF), Mesomorph (BP), Brown (AB), Sodosol (SO) medium (B), grainy (F), silty (N), silty (N) * depth of B horizon unknown	Overland blue gum, peripheral low shrub vegetation (moderate to abundant diversity) Creasey 20m Understorey 5-10m Ground strata sparse short grasses	1	1	F	-	-	S23 45.129	E151 11.818	- Natural								
BH18	A1 0.0-0.05 GZ B1 0.05-0.8 ZC B2 0.8-0.8 ZC B3 0.8-1.0 Z	Location within saddle of midslope	Shallow saline non-cracking clays over strongly played beam soils. Associated as massive earthy, and duplex soils in marginal areas.	Yes	0.05	(BYR 4/H) GZ, D, LO, common VF-C coarse fragments, many M roots @ 0.8 (BY 8/3), no roots @ 0.8 (BY 7/3)	(BYR 4.0) w 10YR 5/1 mode) ZC, FI, PK, ST, few, VF coarse fragments, few VF roots @ 0.8 (BY 8/3), no roots @ 0.8 (BY 7/3)	1	P	Mottled Sodic (HB) L., Moderately grainy (F), silty (N), silty (N), clayey (O), moderate (V)	Lemon-scarfed spotted gum, narrow-leaved red roebuck open forest Understorey 5m Ground strata sparse short grasses	1	3	M	-	-	S23 45.189	E151 11.898	- Natural								

General Information		Soil Summary		Landscape Information										Comments						
General Location	Sample Assessment Location	Location Description Notes	Horizon and General Soil Description (mBGL)	Mapped Soil Type	Soil Type Correlation to Field Descriptions?	Depth of topsoil	Soil Description (texture, structure, consistence, coarse fragments, rooting)		Drainage			Australian Soil Classification (Isbell1996)	Vegetation		GPS Coordinates	Comments				
							Topsoil	Subsoil	Erosion	1	2		3	R			W	MW	I	P
	A01	Location with mud flats	Bt 0.0 - 1.2 ZC Rz 1.4 - 3.0 ZSC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	(Dark grey) ZC: MO, PL, ST, FR @ 1.2 light grey/CS: MO, ST, SRL, F nods @ 1.4 (Orange) brown w dark grey nod ZCC-W, FL abundant VC coarse fragments @ 2.2 (Red w brown nod) @ 3.0 borehole terminated	1	P	Sulfide (EU), superacidic (EW), Hydrosol (MY) thin, clayey, clayey loam, very deep	1	1	F	-	0.4	S29 45.04	E151 11.201	-	Natural
	A02	Location with mud flats	Bt 0.0 - 2.0 ZC Rz 2.0 - 3.0 ZSC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	(Blue) grey w brownish nod ZC: MO, VPL, VPL, VST @ 0.3 W @ 0.5 Jacotie @ 1.0 (Blue) grey w brown/orange nod + jacotie @ 1.6 SLMO @ 1.7 STR @ 2.0 (Orange) brown w grey nod (ZCC:D, FR, SST, SPL, abundant F coarse fragments @ 3.0 borehole terminated	1	P	Sulfide (EU), superacidic (EW), Hydrosol (MY) thin, clayey, clayey very deep	1	1	F	-	0.3	S29 45.00	E151 11.345	-	Natural
	A03	Location with mud flats	Bt 0.0 - 0.2 ZC Rz 0.2 - 0.7 ZC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	(Brown) ZC: MO, FR, VST, SPL, many VF nod @ 0.2 (Grey w dark brown nod) ZC: W, VFR, VST, SPL, many VF nod @ 0.7 borehole collapse	1	P	Sulfide (EU), superacidic (EW), Hydrosol (MY) thin, clayey, clayey very deep	1	1	F	-	0.1	S29 45.197	E151 11.273	-	Natural
	A04	Locations with salt pools within study area	Bt 0.0 - 0.8 ZC Rz 0.0 - 3.8 ZC Rz 3.3 - 3.8 SZC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	(Orange) brown ZC (w some S and G); D, STR, ST, PL, many F nod @ 0.6 (Grey w orange/brown nod) ZC (w some S and G); SLMO, STR, ST, SPL @ 1.2 PL, few F nod @ 3.3 (Grey w orange) brown nod (ZCC:D, STR, weathered rock lenses, ST, PL @ 3.8 borehole terminated on sandstone	1	P	Mesochlois (AC), superacidic (EW), Hydrosol (MY) thin, very gravelly, clay loam, nodulate (AB), Sedcoast (MD)	1	1	F	-	-	S29 44.902	E151 10.990	Lemon scented spotted gum, rainforest, podocarp open forest, Casuarina 20% Understorey: 5m Ground state: sparse shed grasses	Natural
	A05	Location with mud flats	Bt 0.0 - 0.2 ZC Rz 0.2 - 1.0 ZSCZC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	(Dark grey) ZC (w some S and G); D, FR, ST, PL @ 0.2 (Brown w grey nod) GSCZC: SLMO, P, ST, PL, many F-S coarse fragments @ 0.5 (Orange) @ 0.8 (Red) W @ 1.0 soil on stones	1	P	Argillaceous (AQ), Hydrosol (MY) thin, very gravelly, clay loam, nodulate	1	1	F	-	0.8	S29 44.225	E151 11.308	-	Natural
	A06	Location with mud flats	Bt 0.0 - 0.25 SZC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils and similar duplex soils in marginal areas.	Yes	-	-	1	1	P	Sulfide (EU), superacidic (CW), Hydrosol (MY): medium, very gravelly	1	1	L	-	-	S29 45.002	E151 10.721	-	Natural
	A07	Location with inlet to mud flats	Az 0.0 - 0.1 QZS Bt 0.1 - 4.0 ZC	Hard acidic yellow mottled duplex soils on the slopes with shallow beam soils on some craters. Associated are massive earths, sandy soils on gentle slopes with sandy soils on sandy accumulations in same area. Associated are massive earths of massive structured earth soils are found on basic rocks.	No	-	-	(Grey w orange) brown nod ZC: MO, FL, VST, PL, few coarse fragments @ 1.0 Light grey gran w orange) brown nod ZC: D, VPL, ST, PL @ 2.0 (Light grey w white nod) @ 3.5 (Grey w red nod) @ 4.0 borehole terminated	1	P	Argillaceous (AQ), superacidic (EW), Hydrosol (MY) thin, very gravelly, clayey, very deep	1	1	F	-	-	S29 45.777	E151 11.407	-	Natural
	A08	Location with mud flats	Bt 0.0 - 0.3 ZC Rz 0.3 - 3.0 ZC	Shallow saline non-cracking clays over strongly gleyed beam soils. Associated are massive earths, and duplex soils in marginal areas.	Yes	-	-	(Dark orange) ZC (some B); MO, FL, VPL, VST, many F-C coarse fragments @ 0.3 (Yellow w grey nod) @ 1.1 (Green green w orange nod) STR @ 2.2 (Yellow) D, FL, SST, SPL, few F-C coarse fragments @ 3.0 borehole terminated	1	P	Argillaceous (AQ), superacidic (EW), Hydrosol (MY) thin, clayey, clayey, very deep	1	1	F	-	-	S29 45.064	E151 11.407	-	Natural

Laird Point

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Appendix A Table 2: Summary of Analytical Data

Sample Location	Sample	Date	Analytical Data													Ca/Mg ratio	SAR*			
			Soil Group	Moisture Content (dried @ 103°C) %	Emerson Class	pH	EC $\mu S/cm$	ECs (EC:1.5 x conversion factor) $\mu S/cm$	EC rating	Available Nutrients		Exchangeable Sodium Percent (ESP)* %	Sodicity	CEC	Exchangeable Cations					
										TKN	P				Ca			Mg	K	Na
Units			Class number	pH units	$\mu S/cm$	$\mu S/cm$	NS, SS, MS, HS, ES		mg/kg	mg/kg	%	NS, S, SS	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g		
Guideline			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Primary Laboratory Detection Level			1	0.1	1	-	-	-	20	0.5	-	-	0.1	0.1	0.1	0.1	0.1	-		
Secondary Laboratory Detection Level			-	0.1	5	-	-	1	20	2	1	-	0.01	0.01	0.01	0.01	-	-		
BH01	BH01/0.0-0.05	19/07/2009	5	2.2	5.6	40	380	NS	1520	0.436	6.4	S	4.7	2.3	1.6	0.5	0.3	1.44		
BH01	BH01/0.3-0.4	19/07/2009	5		5	272	2584	SS			21.9	SS	13.7	<0.1	10.3	0.4	3	0.07		
BH01	BH01/0.9-1.0	19/07/2009	5		2	5	585	MS			40.2	SS	17.4	<0.1	9.8	0.5	7	0.07		
BH02	BH02/0.0-0.1	17/07/2009	5	7.6	6.4	28	266	NS	520	0.138	11.5	S	2.6	0.3	1.6	0.4	0.3	0.19		
BH03	BH03/0.0-0.1	19/07/2009	5	8.8	5.6	51	485	NS	450	0.134	19.0	SS	2.1	0.3	1.3	0.2	0.4	0.23		
BH03	BH03/0.4-0.5	19/07/2009	5		2	5.8	61	NS												
BH04	BH04/0.0-0.1	19/07/2009	5	5.9	6.3	41	574	NS	2640	0.326	1.3	NS	8	4.7	2.8	0.4	0.1	1.68		
BH04	BH04/0.2-0.3	19/07/2009	5		2	6.2	61	NS			1.8	NS	5.5	2.5	2.6	0.2	0.1	0.96		
BH05	BH05/0.0-0.1	19/07/2009	5	8.5	6.1	25	215	NS	430	0.131	16.7	SS	1.2	0.3	0.7	<0.1	0.2	0.43		
BH06	BH06/0.2-0.3	19/07/2009	4	6.5	6.3	13	182	NS	500	0.138	5.6	NS	5.4	2.2	2.4	0.5	0.3	0.92		
BH06	BH06/0.9-1.0	19/07/2009	4		3	6.3	30	NS			6.1	S	6.6	2.9	2.9	0.4	0.4	1.00		
BH07	BH07/0.0-0.05	19/07/2009	5	5.8							3.2	NS	24.9	13.7	9.5	0.9	0.8	1.44		
BH08	BH08/0.0-0.1	19/07/2009	3	6.4	5.9	36	504	NS	3970	0.362	1.0	NS	10.3	7	2.9	0.3	0.1	2.41		
BH08	BH08/0.6-0.8	19/07/2009	3		1	6.4	13	NS			10.5	S	1.9	0.1	1.5	<0.1	0.2	0.07		
BH09	BH09/0.0-0.1	19/07/2009	5	2.6	5.9	26	364	NS	990	<0.100	4.2	NS	2.4	0.3	1.6	0.4	0.1	0.19		
BH09B	BH09B/0.0-0.1	19/07/2009	5	4.2	5.8	25	350	NS	1810	0.318	ID	ID	2.3	0.8	1	0.4	<0.1	0.80		
BH10	BH10/0.0-0.1	19/07/2009	5	1.7	6	20	172	NS	540	0.14	16.7	SS	1.8	0.3	1.2	0.1	0.3	0.25		
BH11	BH11/0.0-0.02	19/07/2009	3	7.6	6	280	2470	NS	5270	24.1	ID	ID	8	6.2	1.5	0.2	<0.1	4.13		
BH11	BH11/0.1-0.2	19/07/2009	3	5.8	6.3	53	742	NS	2160	5.73	1.0	NS	9.8	7	2.4	0.4	0.1	2.92		
BH12	BH12/0.0-0.1	19/07/2009	3	12.2	6.5	28	392	NS	1850	1.08	1.1	NS	18.1	10.6	6.8	0.5	0.2	1.56		
BH12	BH12/0.9-1.0	19/07/2009	3		1	5.7	41	NS			9.1	S	3.3	0.2	2.6	0.1	0.3	0.08		
BH13	BH13/0.0-0.1	14/07/2009	3	7	6.3	97	922	NS	880	0.504	8.2	S	6.1	3.3	2	0.2	0.5	1.65		
BH14	BH14/0.0-0.1	19/07/2009	3	4.8	6.5	47	447	NS	1660	0.173	1.9	NS	10.7	7.3	2.5	0.8	0.2	2.92		
BH14	BH14/0.5-0.6	19/07/2009	3	17	2	6.6	17	NS												
BH15	BH15/0.0-0.1	18/07/2009	3	10.2	5.3	45	428	NS	1950	0.139	4.5	NS	11	3.6	6.2	0.6	0.5	0.58		
BH15	BH15/0.9-1.0	18/07/2009	3	9.2	2	5.1	52	NS			9.3	NS	5.4	0.2	4.4	0.3	0.5	0.05		
BH16	BH16/0.0-0.1	14/07/2009	5	10.6	5.3	146	1256	NS	1440	0.119	11.6	S	8.6	1.4	5.4	0.8	1	0.26		
BH16	BH16/0.4-0.5	14/07/2009	5		2	5	353	SS			22.9	SS	16.6	<0.1	12	0.7	3.8	0.07		
BH17	BH17/0.0-0.05	18/07/2009	4	2.7	1	5.9	13	NS	960	0.151	5.4	NS	3.7	1.9	1.2	0.4	0.2	1.58		
BH17	BH17/0.9-1.0	18/07/2009	4		1	6.2	29	NS			16.1	SS	5.6	0.2	4.1	0.5	0.9	0.05		
BH18	BH18/0.0-0.05	18/07/2009	5	6	5.9	36	342	NS	2090	0.17	15.8	SS	5.7	0.2	4.1	0.5	0.9	0.05		
BH18	BH18/0.4-0.5	18/07/2009	5		1	4.8	389	SS			20.7	SS	27.6	0.3	21.2	0.4	5.7	0.01		
BH18	BH18/0.9-1.0	18/07/2009	5		2	5	465	MS			26.9	SS	30.1	0.3	21.4	0.3	8.1	0.01		
A01	A01/1.0-1.1	13/07/2009	2			4.2	9620	ES			77.9	SS	75.1	1.8	12.8	2	58.5	0.14		
A02	A02/0.5-0.6	13/07/2009	2			4.5	6050	ES			75.8	SS	47.6	0.7	9.2	1.6	36.1	0.08		
A02	A02/1.0-1.1	13/07/2009	2			5.3	6030	ES			76.6	SS	43.5	0.7	8	1.4	33.3	0.09		
A03	A03/0.5-0.6	14/07/2009	2			3.9	12400	ES			76.6	SS	103	1.9	19.6	2.8	76.9	0.10		
A04	A04/0.5-0.6	13/07/2009	3			7.1	632	MS			32.1	SS	7.8	1.2	3.7	0.5	2.5	0.32		
A04	A04/1.0-1.1	13/07/2009	3			6.8	1620	HS			45.3	SS	23.4	2.2	9.3	1.3	10.6	0.24		
A05	A05/1.0-1.1	14/07/2009	2			7.7	4770	ES			74.1	SS	34.8	0.7	7	1.3	25.8	0.10		
A06	A06/0.1-0.2	14/07/2009	1			7.6	4800	ES			69.4	SS	39.6	1.7	8.6	1.9	27.5	0.20		
A07	A07/0.5-0.6	14/07/2009	2			7.9	2850	ES			85.5	SS	28.1	1.4	7.2	1.1	16.4	0.19		
A08	A08/1.0-1.1	13/07/2009	2			7.4	3040	ES			71.6	SS	28.5	1	5.8	1.3	20.4	0.17		

NOTES
* Calculated Values indicates comparison soil with associated unit time
A Not Detected
nd

** Soil sample could not be collected deep enough for comparison to mapped soil
ID Indeterminable

NS Non-saline
S Slightly saline
SS Moderately Saline
HS Highly Saline
ES Extremely Saline

NS Non Sodic
S Sodic
SS Strongly Sodic

SAR $(Na^{+}) / \sqrt{([Ca^{2+}] + [Mg^{2+}] / 2)}$
ESP $(Na^{+}) / CEC * 100$



Sample	Date	Screening Analysis			Actual Acidity			Potential Acidity			EA033-C: Acid Neutralising			EA033-D: Retained Acidity			EA033-E: Acid Base Accounting		
		pH (F)	pH	Reaction Rate	pH KCl (23A)	Titration Actual (23F)	sulfidic - Titration Actual (23F)	Chromium Reducible Sulfur (22B)	acidicity - Chromium Reducible Sulfur (22B)	acidicity - molar H ⁺ /l	Acid Neutralising Capacity (19A2)	acidicity - molar H ⁺ /l	sulfidic - Acid Neutralising Capacity (19A2)	Net Acid Soluble Sulfur (20J)	acidicity - molar H ⁺ /l	sulfidic - Soluble Sulfur (20J)	ANC Factor	Net Acidity (units)	Limiting Rate
Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998 - Action Criteria (> 1000 tonnes disturbed)																			
Laboratory Detection Limit		0.1	0.1	1	0.1	2	0.02	10	10	0.01	0.01	10	0.01	0.02	10	0.02	0.5	10	1
A010.5-0.6	13/07/2009	4.65	2.35	3	4.7	23	0.04	1.52	948								1.5	1.56	972
A010.75-0.85	13/07/2009	3.50	2.86	1													1.5	1.2	748
A011.0-1.1	13/07/2009	4.00	1.98	3	4.9	18	0.03	1.17	731								1.5	0.16	101
A011.25-1.35	13/07/2009	4.26	3.14	1													1.5	0.06	40
A011.5-1.6	13/07/2009	4.75	3.36	2	6	2	<0.02	0.16	99								1.5	0.16	101
A011.75-1.85	13/07/2009	5.10	3.07	3													1.5	0.06	40
A012.0-2.1	13/07/2009	5.35	3.80	2	6.1	<2	<0.02	0.06	39								1.5	0.16	102
A012.25-2.35	13/07/2009	5.82	4.40	1													1.5	0.19	120
A012.5-2.6	13/07/2009	5.33	3.69	2	6.2	<2	<0.02	0.16	102								1.5	0.65	406
A012.75-2.85	13/07/2009	5.22	3.61	2													1.5	0.25	154
A013.0-3.1	13/07/2009	5.65	4.96	1	5.8	4	<0.02	0.19	116								1.5	<0.02	<10
A020.25-0.35	13/07/2009	4.24	3.73	3													1.5	0.03	21
A020.5-0.6	13/07/2009	3.72	2.14	2	4.9	16	0.03	0.62	390								1.5	<0.02	<10
A020.75-0.85	13/07/2009	3.87	3.62	2													1.5	0.03	21
A021.0-1.1	13/07/2009	3.76	2.63	2	5.4	9	<0.02	0.23	145								1.5	<0.02	<10
A021.25-1.35	13/07/2009	4.46	4.54	1													1.5	<0.02	<10
A021.5-1.6	13/07/2009	6.45	6.77	1	6.8	<2	<0.02	0.03	19								1.5	<0.02	<10
A021.75-1.85	13/07/2009	6.34	6.27	0													1.5	<0.02	<10
A022.0-2.1	13/07/2009	5.38	6.01	1	6.3	<2	<0.02	0.03	19								1.5	<0.02	<10
A022.25-2.35	13/07/2009	5.16	5.50	0													1.5	<0.02	<10
A022.5-2.6	13/07/2009	4.99	5.32	1	6.1	2	<0.02	<0.02	<10								1.5	<0.02	<10
A022.75-2.85	13/07/2009	5.82	5.72	0													1.5	<0.02	<10
A023.0-3.1	13/07/2009	5.38	5.62	0	5.9	3	<0.02	<0.02	<10								1.5	<0.02	<10
A030.0-0.1	13/07/2009	7.20	6.95	0	8.7	<2	<0.02	<0.02	<10								1.5	<0.02	<10
A030.5-0.6	13/07/2009	5.17	4.28	0	5.9	5	<0.02	1.22	764								1.5	1.23	770
A030.75-0.85	13/07/2009	4.92	2.66	0													1.5	<0.02	<10
A040.5-0.6	13/07/2009	5.31	5.46	0													1.5	<0.02	<10
A040.75-0.85	13/07/2009	5.98	4.76	1													1.5	<0.02	<10
A041.0-1.1	13/07/2009	6.31	6.01	0													1.5	<0.02	<10
A041.25-1.35	13/07/2009	6.40	5.91	0													1.5	<0.02	<10
A041.5-1.6	13/07/2009	6.31	5.87	0													1.5	<0.02	<10
A041.75-1.85	13/07/2009	6.21	6.18	0													1.5	<0.02	<10
A042.0-2.1	13/07/2009	6.01	5.79	0													1.5	<0.02	<10
A042.25-2.35	13/07/2009	5.89	5.85	0													1.5	<0.02	<10
A042.5-2.6	13/07/2009	6.09	6.12	0													1.5	<0.02	<10
A042.75-2.85	13/07/2009	6.10	5.94	0													1.5	<0.02	<10
A043.0-3.1	13/07/2009	5.85	5.94	0													1.5	<0.02	<10
A043.25-3.35	13/07/2009	5.85	5.20	1													1.5	<0.02	<10
A043.5-3.6	13/07/2009	6.05	5.39	1													1.5	<0.02	<10
A050.1-0.25	14/07/2009	7.37	7.19	3													1.5	<0.02	<10
A050.5-0.6	14/07/2009	6.98	7.22	3													1.5	<0.02	<10
A050.75-0.85	14/07/2009	6.57	7.00	3													1.5	<0.02	<10
A050.9-1.0	14/07/2009	7.15	7.49	3													1.5	<0.02	<10
A060.0-0.1	13/07/2009	6.22	5.70	0	6.8	<2	<0.02	0.05	29								1.5	<0.02	<10
A070.1-0.25	13/07/2009	6.45	6.42	0													1.5	<0.02	<10
A070.5-0.6	13/07/2009	6.25	6.76	0													1.5	<0.02	<10
A070.75-0.85	13/07/2009	6.42	6.30	0													1.5	<0.02	<10
A071.0-1.1	13/07/2009	6.31	6.42	0	5.8	5	<0.02	<0.02	<10								1.5	<0.02	<10



Sample	Date	Screening Analysis		Actual Acidity		Potential Acidity	EA033-C: Acid Neutralising		EA033-D: Retained Acidity				EA033-E: Acid Base Accounting		
		pH (F)	pH Reaction (Fox)	pH KCl Titration (23A)	sulfidic - Titratable Actual Acidity (23F)	Chromium Reducible Sulfur (22B)	Acid Neutralising Capacity (19A2)	sulfidic - Acid Neutralising Capacity (19A2)	Net Acid Soluble Sulfur (20Je)	sulfidic - Net Acid Soluble Sulfur (20J)	KCl Extractable Sulfur (23Ce)	HCl Extractable Sulfur (20Be)	ANC Factor	Net Acidity (sulfur units)	Limiting Rate
Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998 - Action Criteria (> 1000 tonnes disturbed)															
Laboratory Detection Limit		0.1	0.1	1											
A07/1.1-1.25	13/07/2009	6.16	8.20	0	18	0.03	-	-	-	-	-	-	-	0.03	18
A07/1.5-1.6	13/07/2009	6.54	7.81	0											
A07/1.75-1.85	13/07/2009	6.38	7.84	0											
A07/2.0-2.1	13/07/2009	6.45	7.79	0	6.1	<2	<10						1.5	<0.02	<10
A07/2.1-2.25	13/07/2009	6.00	6.55	0											
A07/2.5-2.6	13/07/2009	6.29	6.68	0											
A07/2.75-2.85	13/07/2009	5.97	6.74	0											
A07/3.0-3.1	13/07/2009	5.97	6.53	0	5.9	3	<10						1.5	<0.02	<10
A07/3.1-3.25	13/07/2009	5.95	6.52	0											
A07/3.5-3.6	13/07/2009	6.09	6.24	0											
A07/3.75-3.85	13/07/2009	6.36	6.63	0											
A07/4.0-4.1	13/07/2009	5.80	6.19	0	5.9	3	<10						1.5	<0.02	<10
A08/0.25-0.35	13/07/2009	6.44	6.37	0											
A08/0.5-0.6	13/07/2009	6.50	6.50	0											
A08/0.75-0.85	13/07/2009	6.24	6.54	0											
A08/1.0-1.1	13/07/2009	6.69	6.33	0	6.7	<2	<10	0.73	145	0.23			1.5	<0.02	<10
A08/1.25-1.35	13/07/2009	6.93	7.85	0											
A08/1.5-1.6	13/07/2009	7.31	7.70	0											
A08/1.75-1.85	13/07/2009	7.28	7.67	0											
A08/2.0-2.1	13/07/2009	7.07	7.85	0	6.4	<2	<10						1.5	<0.02	<10
A08/2.25-2.35	13/07/2009	6.15	6.33	0											
A08/2.5-2.6	13/07/2009	6.24	6.17	0											
A08/2.75-2.85	13/07/2009	6.11	6.37	0											
A08/3.0-3.1	13/07/2009	6.22	6.29	0	6.3	<2	<10						1.5	<0.02	<10

NOTES

- Denotes no criteria for that parameter

Yellow highlighting indicates parameters above applied guideline/criteria.

NT indicates a sample which was not tested for a particular parameter.

Appendix C   Laboratory analysis plan



Sample	Emerson Class	pH / EC	TKN / P	CEC and exchangeable Cations	SCR (ASS)	HOLD
BH01/0.0-0.05		x	x	x		
BH01/0.3-0.4	x	x		x		
BH01/0.9-1.0	x	x		x		
BH02/0.0-0.1		x	x	x		
BH03/0.0-0.1		x	x	x		
BH03/0.4-0.5	x	x				
BH04/0.0-0.1		x	x	x		
BH04/0.2-0.3	x	x		x		
BH05/0.0-0.1		x	x	x		
BH06/0.2-0.3		x	x	x		
BH06/0.9-1.0	x	x		x		
BH07/0.0-0.05		x		x		
BH08/0.0-0.1		x	x	x		
BH08/0.6-0.8	x	x		x		
BH09/0.0-0.1		x	x	x		
BH09B/0.0-0.1		x	x	x		
BH10/0.0-0.1		x	x	x		
BH11/0.0-0.02		x	x	x		
BH11/0.1-0.2		x	x	x		
BH12/0.0-0.1		x	x	x		
BH12/0.9-1.0	x	x		x		
BH13/0.0-0.1		x	x	x		
BH14/0.0-0.1		x	x	x		
BH14/0.5-0.6	x	x				
BH15/0.0-0.1		x	x	x		
BH15/0.9-1.0	x	x		x		
BH16/0.0-0.1		x	x	x		
BH16/0.4-0.5	x	x		x		
BH17/0.0-0.05		x	x	x		
BH17/0.9-1.0	x	x		x		
BH18/0.0-0.05		x	x	x		
BH18/0.4-0.5	x	x		x		
BH18/0.9-1.0	x	x		x		
A01/0.5-0.6					x	
A01/1.0-1.1		x		x	x	
A01/1.5-1.6					x	
A01/2.0-2.1					x	
A01/2.5-2.6					x	
A01/3.0-3.1					x	
A02/0.5-0.6		x		x	x	
A02/1.0-1.1		x		x	x	
A02/1.5-1.6					x	



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Appendix B

Laboratory Analysis Plan

A02/2.0-2.1				x	
A02/2.5-2.6				x	
A02/3.0-3.1				x	
A03/0.0-0.1				x	
A03/0.5-0.6		x		x	x
A04/0.5-0.6		x		x	x
A04/1.0-1.1		x		x	x
A04/1.5-1.6					x
A04/2.0-2.1					x
A04/2.5-2.6					x
A04/3.0-3.1					x
A04/3.5-3.6					x
A05/0.0-0.1					x
A05/0.5-0.6					x
A05/1.0-1.1		x		x	x
A06/0.0-0.1		x		x	x
A07/0.5-0.6		x		x	x
A07/1.0-1.1				x	
A07/1.5-1.6					x
A07/2.0-2.1				x	
A07/2.5-2.6					x
A07/3.0-3.1				x	
A07/3.5-3.6					x
A07/4.0-4.1				x	
A08/0.5-0.6					x
A08/1.0-1.1		x		x	x
A08/1.5-1.6					
A08/2.0-2.1				x	
A08/2.5-2.6					
A08/3.0-3.1				x	



Appendix D   Laboratory certificates

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client: Worley Parsons Pty Ltd

Report No. 9070854-em

Project: 301001-00752
Laird Point

Test Date: 23,24/07/09

Report Date: 24/07/09

Sample No.	9070854	9070855	9070856	9070857	9070858
Client ID:	BH01	BH01	BH03	BH04	BH06
Depth (m):	0.3-0.4	0.9-1.0	0.4-0.5	0.2-0.3	0.9-1.0
Description:	Clay red/brown Orange	Clay pale brown	Sandy Clay pale brown	Sandy Clay red/brown	Sandy Clay brown
Emerson Class No.:	1	2	2	2	3

Sample No.	9070859	9070860	9070861	9070862	9070863
Client ID:	BH08	BH12	BH14	BH15	BH16
Depth (m):	0.6-0.8	0.9-1.0	0.5-0.6	0.9-1.0	0.4-0.5
Description:	Sandy Clay pale brown	Sandy Clay red/brown	Sandy Clay brown	Sandy Clay red/brown	Clay brown
Emerson Class No.:	1	1	2	2	2

Remarks: Tested with distilled water at 24°C

Sample/s supplied by the client

Page: 1 of 1



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Accredited for compliance with ISO/IEC 17025

The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

NATA Accredited Laboratory Number 9926

Form Number: GT007-5

Authorised Signatory

James Russell
J. Russell

Manager

A.G. LABS

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Laboratories P/L
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(Phone) 07 3357 5535

(Fax) 07 3357 5531

windsor@aglabs.com.au

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client: Worley Parsons Pty Ltd

Report No. 9070864-em

Project: 301001-00752
Laird Point

Test Date: 23,24/07/09

Report Date: 24/07/09

Sample No.	9070864	9070865	9070866
Client ID:	BH17	BH18	BH18
Depth (m):	0.9-1.0	0.4-0.5	0.9-1.0
Description:	Sandy Clay pale brown	Sandy Clay brown	Clay pale brown
Emerson Class No.:	1	1	2

Remarks: Tested with distilled water at 24°C

Sample/s supplied by the client

Page: 1 of 1



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The results of the tests, calibrations, and/or
measurements included in this document are traceable
to Australian/National standards

NATA Accredited Laboratory Number 9926

Form Number: GT007-5

Authorised Signatory

J. Russell

Manager



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EB0911579	Page	: 1 of 14
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-JUL-2009
Sampler	: Alex Kochnieff	Issue Date	: 22-SEP-2009
Site	: Laird Pt		
Quote number	: EN/034/09	No. of samples received	: 39
		No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.
Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Carsten Emrich	Senior Organic Chemist	Organics
Kim McCabe	Senior Inorganic Chemist	Inorganics
Phillip Kennedy	2IC Environmental Laboratory	Inorganics
Sarah Ashworth	Organic Chemist	Inorganics
Sarah Ashworth	Organic Chemist	Organics
Stephen Hislop	Senior Inorganic Chemist	Inorganics



Page : 3 of 14
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **EG005T (Total Metals): Sample EB0911566-003 shows poor matrix spike recovery due to matrix interference. Confirmed by visual inspection.**
- **EK061G (TKN), EA010 (Conductivity) and EA002 (pH): Insufficient sample to perform analysis on sample 12 (BH07/0.0-0.05)**
- **EK061G (Total Kjeldahl Nitrogen): Sample BH15/0.0-0.1 shows poor matrix spike due to sample heterogeneity. Confirmed by visual inspection.**
- **LCS recovery for EG020T (Total Metals) fall outside Dynamic Control Limits for Lead. It is, however within ALS Static Control Limits and hence deemed acceptable. No further action is required.**
- **Pesticides: Poor matrix spike recovery due to matrix interference. Confirmed by re-extraction and re-analysis.**
- **This report has been amended as a result of misinterpretation of sample identification numbers (IDs). All analysis results are as per the previous report**
- **This report has been amended due to initial mis-labelling of some samples and subsequent incorrect analysis. The affected samples are BH14/0.0-0.1, BH14/0.5-0.6, BH15/0.0-0.1 and BH15/0.9-1.0. Results for these samples have changed since the previous report.**



Analytical Results

Sub-Matrix: SOIL

Sub-Matrix: SOIL	Client sample ID				Client sampling date / time			
Compound	CAS Number	LOR	Unit	BH01/0.0-0.05	BH01/0.3-0.4	BH01/0.9-1.0	BH02/0.0-0.1	BH03/0.0-0.1
EA002 : pH (Soils)								
pH Value	---	0.1	pH Unit	5.6	---	---	6.4	5.6
EA010: Conductivity								
Electrical Conductivity @ 25°C	---	1	µS/cm	40	---	---	28	51
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	---	1.0	%	2.2	---	---	7.6	8.8
ED007: Exchangeable Cations								
^ Exchangeable Calcium	---	0.1	meq/100g	2.3	<0.1	<0.1	0.3	0.3
^ Exchangeable Magnesium	---	0.1	meq/100g	1.6	10.3	9.8	1.6	1.3
^ Exchangeable Potassium	---	0.1	meq/100g	0.5	0.4	0.5	0.4	0.2
^ Exchangeable Sodium	---	0.1	meq/100g	0.3	3.0	7.0	0.3	0.4
^ Cation Exchange Capacity	---	0.1	meq/100g	4.7	13.7	17.4	2.6	2.1
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	11	---	---	---	<5
Cadmium	7440-43-9	1	mg/kg	<1	---	---	---	<1
Chromium	7440-47-3	2	mg/kg	2	---	---	---	8
Copper	7440-50-8	5	mg/kg	<5	---	---	---	13
Lead	7439-92-1	5	mg/kg	<5	---	---	---	9
Nickel	7440-02-0	2	mg/kg	<2	---	---	---	4
Zinc	7440-66-6	5	mg/kg	7	---	---	---	<5
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	---	---	---	<0.1
EK061G: Total Kjeldahl Nitrogen as N								
Total Kjeldahl Nitrogen as N	---	20	mg/kg	1520	---	---	520	450
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	---	0.100	mg/kg	0.436	---	---	0.138	0.134
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	---	---	---	---
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	---	---	---	---
beta-BHC	319-85-7	0.05	mg/kg	<0.05	---	---	---	---
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	---	---	---	---
delta-BHC	319-86-8	0.05	mg/kg	<0.05	---	---	---	---
Heptachlor	76-44-8	0.05	mg/kg	<0.05	---	---	---	---
Aldrin	309-00-2	0.05	mg/kg	<0.05	---	---	---	---
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	---	---	---	---
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	---	---	---	---
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	---	---	---	---
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	---	---	---	---



Analytical Results

Sub-Matrix: SOIL

Sub-Matrix: SOIL		Client sample ID						
		Client sampling date / time						
Compound	CAS Number	LOR	Unit	BH01/0.0-0.05 19-JUL-2009 15:00	BH01/0.3-0.4 19-JUL-2009 15:00	BH01/0.9-1.0 19-JUL-2009 15:00	BHO2/0.0-0.1 17-JUL-2009 15:00	BH03/0.0-0.1 19-JUL-2009 15:00
EP068A: Organochlorine Pesticides (OC) - Continued								
Dieldrin	60-57-1	0.05	mg/kg	<0.05				
4,4'-DDE	72-55-9	0.05	mg/kg	<0.05				
Endrin	72-20-8	0.05	mg/kg	<0.05				
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05				
4,4'-DDD	72-54-8	0.05	mg/kg	<0.05				
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05				
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05				
4,4'-DDT	50-29-3	0.2	mg/kg	<0.2				
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05				
Methoxychlor	72-43-5	0.2	mg/kg	<0.2				
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05				
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05				
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2				
Dimethoate	60-51-5	0.05	mg/kg	<0.05				
Diazinon	333-41-5	0.05	mg/kg	<0.05				
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05				
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2				
Malathion	121-75-5	0.05	mg/kg	<0.05				
Fenthion	55-38-9	0.05	mg/kg	<0.05				
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05				
Parathion	56-38-2	0.2	mg/kg	<0.2				
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05				
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05				
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05				
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05				
Prothiofos	34643-46-4	0.05	mg/kg	<0.05				
Ethion	563-12-2	0.05	mg/kg	<0.05				
Carbophenothion	786-19-6	0.05	mg/kg	<0.05				
Azinphos Methyl		0.05	mg/kg	<0.05				
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.1	%	80.9				
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	76.8				

Client sample ID

Client sampling date / time

A Campbell Brothers Limited Company



Analytical Results

Sub-Matrix: SOIL

Sub-Matrix: SOIL		Client sample ID						
		Client sampling date / time						
Compound	CAS Number	LOR	Unit	BH07/0.0-0.05	BH08/0.0-0.1	BH08/0.6-0.8	BH09/0.0-0.1	BH09B/0.0-0.1
				19-JUL-2009 15:00	19-JUL-2009 15:00	19-JUL-2009 15:00	19-JUL-2009 15:00	19-JUL-2009 15:00
				EB0911579-012	EB0911579-014	EB0911579-015	EB0911579-016	EB0911579-017
EA002 : pH (Soils)								
pH Value		0.1	pH Unit		5.9		5.9	5.8
EA010: Conductivity								
Electrical Conductivity @ 25°C		1	µS/cm		36		26	25
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)		1.0	%	5.8	6.4		2.6	4.2
ED007: Exchangeable Cations								
^ Exchangeable Calcium		0.1	meq/100g	13.7	7.0	0.1	0.3	0.8
^ Exchangeable Magnesium		0.1	meq/100g	9.5	2.9	1.5	1.6	1.0
^ Exchangeable Potassium		0.1	meq/100g	0.9	0.3	<0.1	0.4	0.4
^ Exchangeable Sodium		0.1	meq/100g	0.8	0.1	0.2	0.1	<0.1
^ Cation Exchange Capacity		0.1	meq/100g	24.9	10.3	1.9	2.4	2.3
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5				
Cadmium	7440-43-9	1	mg/kg	<1				
Chromium	7440-47-3	2	mg/kg	23				
Copper	7440-50-8	5	mg/kg	13				
Lead	7439-92-1	5	mg/kg	7				
Nickel	7440-02-0	2	mg/kg	6				
Zinc	7440-66-6	5	mg/kg	39				
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1				
EK061G: Total Kjeldahl Nitrogen as N								
Total Kjeldahl Nitrogen as N		20	mg/kg		3970		990	1810
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P		0.100	mg/kg	301	0.362		<0.100	0.318
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05				
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05				
beta-BHC	319-85-7	0.05	mg/kg	<0.05				
gamma-BHC	58-89-9	0.05	mg/kg	<0.05				
delta-BHC	319-86-8	0.05	mg/kg	<0.05				
Heptachlor	76-44-8	0.05	mg/kg	<0.05				
Aldrin	309-00-2	0.05	mg/kg	<0.05				
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05				
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05				
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05				
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05				



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID		Client sampling date / time		Unit	
	CAS Number	LOR				
EP068A: Organochlorine Pesticides (OC) - Continued						
Dieldrin	60-57-1	0.05			mg/kg	
4,4'-DDE	72-55-9	0.05			mg/kg	
Endrin	72-20-8	0.05			mg/kg	
beta-Endosulfan	33213-65-9	0.05			mg/kg	
4,4'-DDD	72-54-8	0.05			mg/kg	
Endrin aldehyde	7421-93-4	0.05			mg/kg	
Endosulfan sulfate	1031-07-8	0.05			mg/kg	
4,4'-DDT	50-29-3	0.2			mg/kg	
Endrin ketone	53494-70-5	0.05			mg/kg	
Methoxychlor	72-43-5	0.2			mg/kg	
EP068B: Organophosphorus Pesticides (OP)						
Dichlorvos	62-73-7	0.05			mg/kg	
Demeton-S-methyl	919-86-8	0.05			mg/kg	
Monocrotophos	6923-22-4	0.2			mg/kg	
Dimethoate	60-51-5	0.05			mg/kg	
Diazinon	333-41-5	0.05			mg/kg	
Chlorpyrifos-methyl	5598-13-0	0.05			mg/kg	
Parathion-methyl	298-00-0	0.2			mg/kg	
Malathion	121-75-5	0.05			mg/kg	
Fenthion	55-38-9	0.05			mg/kg	
Chlorpyrifos	2921-88-2	0.05			mg/kg	
Parathion	56-38-2	0.2			mg/kg	
Pirimphos-ethyl	23505-41-1	0.05			mg/kg	
Chlorfenvinphos	470-90-6	0.05			mg/kg	
Bromophos-ethyl	4824-78-6	0.05			mg/kg	
Fenamiphos	22224-92-6	0.05			mg/kg	
Prothiofos	34643-46-4	0.05			mg/kg	
Ethion	563-12-2	0.05			mg/kg	
Carbophenothion	786-19-6	0.05			mg/kg	
Azinphos Methyl		0.05			mg/kg	
EP068S: Organochlorine Pesticide Surrogate						
Dibromo-DDE	21655-73-2	0.1			%	
EP068T: Organophosphorus Pesticide Surrogate						
DEF	78-48-8	0.1			%	



Analytical Results

Sub-Matrix: SOIL

Sub-Matrix: SOIL		Client sample ID						
		Client sampling date / time						
Compound	CAS Number	LOR	Unit	BH10/0.0-0.1	BH11/0.0-0.02	BH11/0.1-0.2	BH12/0.0-0.1	BH12/0.9-1.0
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.0	6.0	6.3	6.5	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	260	53	28	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	1.7	7.6	5.8	12.2	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	0.3	6.2	7.0	10.6	0.2
^ Exchangeable Magnesium	----	0.1	meq/100g	1.2	1.5	2.4	6.8	2.6
^ Exchangeable Potassium	----	0.1	meq/100g	0.1	0.2	0.4	0.5	0.1
^ Exchangeable Sodium	----	0.1	meq/100g	0.3	<0.1	0.1	0.2	0.3
^ Cation Exchange Capacity	----	0.1	meq/100g	1.8	8.0	9.8	18.1	3.3
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	----	----	36	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	<1	----
Chromium	7440-47-3	2	mg/kg	4	----	----	68	----
Copper	7440-50-8	5	mg/kg	7	----	----	50	----
Lead	7439-92-1	5	mg/kg	<5	----	----	<5	----
Nickel	7440-02-0	2	mg/kg	<2	----	----	25	----
Zinc	7440-66-6	5	mg/kg	<5	----	----	34	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	----	<0.1	----
EK061G: Total Kjeldahl Nitrogen as N								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	540	5270	2160	1850	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	----	0.100	mg/kg	0.140	24.1	5.73	1.08	----



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID		Client sampling date / time		Unit	
	CAS Number	LOR				
EA002 : pH (Solis)						
pH Value	---	0.1	pH Unit	6.3	5.3	BH16/0.0-0.1 14-JUL-2009 15:00
EA010: Conductivity						
Electrical Conductivity @ 25°C	---	1	µS/cm	97	45	BH15/0.0-0.1 18-JUL-2009 15:00
EA055: Moisture Content						
^ Moisture Content (dried @ 103°C)	---	1.0	%	7.0	10.2	EB0911579-028 EB0911579-029
ED007: Exchangeable Cations						
^ Exchangeable Calcium	---	0.1	meq/100g	3.3	7.3	3.6
^ Exchangeable Magnesium	---	0.1	meq/100g	2.0	2.5	6.2
^ Exchangeable Potassium	---	0.1	meq/100g	0.2	0.8	0.6
^ Exchangeable Sodium	---	0.1	meq/100g	0.5	0.2	0.5
^ Cation Exchange Capacity	---	0.1	meq/100g	6.1	10.7	11.0
EG005T: Total Metals by ICP-AES						
Arsenic	7440-38-2	5	mg/kg	---	---	11
Cadmium	7440-43-9	1	mg/kg	---	---	<1
Chromium	7440-47-3	2	mg/kg	---	---	15
Copper	7440-50-8	5	mg/kg	---	---	15
Lead	7439-92-1	5	mg/kg	---	---	7
Nickel	7440-02-0	2	mg/kg	---	---	5
Zinc	7440-66-6	5	mg/kg	---	---	18
EG035T: Total Recoverable Mercury by FIMS						
Mercury	7439-97-6	0.1	mg/kg	---	---	<0.1
EK061G: Total Kjeldahl Nitrogen as N						
Total Kjeldahl Nitrogen as N	---	20	mg/kg	880	1660	1950
EK071G: Reactive Phosphorus as P by discrete analyser						
Reactive Phosphorus as P	---	0.100	mg/kg	0.504	0.173	0.139



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID		Client sampling date / time		Unit	
	CAS Number	LOR	BH16/0.4-0.5	BH17/0.0-0.05	BH17/0.9-1.0	BH18/0.0-0.05
EA002 : pH (Solis)			14-JUL-2009 15:00	18-JUL-2009 15:00	18-JUL-2009 15:00	18-JUL-2009 15:00
pH Value		0.1	5.9			
EA010: Conductivity						
Electrical Conductivity @ 25°C		1	13			
EA055: Moisture Content						
^ Moisture Content (dried @ 103°C)		1.0	2.7			
ED007: Exchangeable Cations						
^ Exchangeable Calcium		0.1	<0.1	1.9	0.2	0.2
^ Exchangeable Magnesium		0.1	12.0	1.2	4.1	4.1
^ Exchangeable Potassium		0.1	0.7	0.4	0.5	0.5
^ Exchangeable Sodium		0.1	3.8	0.2	0.9	0.9
^ Cation Exchange Capacity		0.1	16.6	3.7	5.6	5.7
EK061G: Total Kjeldahl Nitrogen as N						
Total Kjeldahl Nitrogen as N		20	960			2090
EK071G: Reactive Phosphorus as P by discrete analyser						
Reactive Phosphorus as P		0.100	0.151			0.170



Analytical Results

Sub-Matrix: SOIL

		Client sample ID		Client sampling date / time	
Compound		CAS Number	LOR	Unit	
EA002 : pH (Solis)					
pH Value			0.1	pH Unit	5.3
EA010: Conductivity					
Electrical Conductivity @ 25°C			1	µS/cm	119
EA055: Moisture Content					
^ Moisture Content (dried @ 103°C)			1.0	%	10.2
ED007: Exchangeable Cations					
^ Exchangeable Calcium			0.1	meq/100g	0.3
^ Exchangeable Magnesium			0.1	meq/100g	21.4
^ Exchangeable Potassium			0.1	meq/100g	0.3
^ Exchangeable Sodium			0.1	meq/100g	8.1
^ Cation Exchange Capacity			0.1	meq/100g	30.1
EG005T: Total Metals by ICP-AES					
Arsenic	7440-38-2	5		mg/kg	10
Cadmium	7440-43-9	1		mg/kg	<1
Chromium	7440-47-3	2		mg/kg	14
Copper	7440-50-8	5		mg/kg	14
Lead	7439-92-1	5		mg/kg	7
Nickel	7440-02-0	2		mg/kg	5
Zinc	7440-66-6	5		mg/kg	17
EG035T: Total Recoverable Mercury by FIMS					
Mercury	7439-97-6	0.1		mg/kg	<0.1
EK061G: Total Kjeldahl Nitrogen as N					
Total Kjeldahl Nitrogen as N		20		mg/kg	1550
EK071G: Reactive Phosphorus as P by discrete analyser					
Reactive Phosphorus as P		0.100		mg/kg	0.111



Analytical Results

Sub-Matrix: **WATER**

Sub-Matrix: WATER		Client sample ID		Client sampling date / time			
Compound	CAS Number	LOR	Unit	LP GW	RB02	RB03	
				18-JUL-2009 15:00	18-JUL-2009 15:00	19-JUL-2009 15:00	
				EB0911579-036	EB0911579-037	EB0911579-038	
EG020T: Total Metals by ICP-MS							
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.004	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	0.003	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	0.005	<0.005	<0.005	
EG035T: Total Recoverable Mercury by FIMS							
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	
EP080/071: Total Petroleum Hydrocarbons							
C6 - C9 Fraction		20	µg/L	<20			
C10 - C14 Fraction		50	µg/L	60			
C15 - C28 Fraction		100	µg/L	300			
C29 - C36 Fraction		50	µg/L	<50			
EP080: BTEX							
Benzene	71-43-2	1	µg/L	<1			
Toluene	108-88-3	2	µg/L	<2			
Ethylbenzene	100-41-4	2	µg/L	<2			
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2			
ortho-Xylene	95-47-6	2	µg/L	<2			
EP080S: TPH(V)/BTX Surrogates							
1,2-Dichloroethane-D4	17060-07-0	0.1	%	111			
Toluene-D8	2037-26-5	0.1	%	100			
4-Bromofluorobenzene	460-00-4	0.1	%	94.7			



Page : 14 of 14
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

Surrogate Control Limits

Sub-Matrix: SOIL			Recovery Limits (%)	
Compound	CAS Number		Low	High
EP068S: Organochlorine Pesticide Surrogate				
Dibromo-DDE	21655-73-2		10	136
EP068T: Organophosphorus Pesticide Surrogate				
DEF	78-48-8		10	110

Sub-Matrix: WATER			Recovery Limits (%)	
Compound	CAS Number		Low	High
EP080S: TPH(V)/BTEX Surrogates				
1,2-Dichloroethane-D4	17060-07-0		80	120
Toluene-D8	2037-26-5		88	110
4-Bromofluorobenzene	460-00-4		86	115



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EB0911579	Page	: 1 of 15
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laund Pt		
C-O-C number	: ---	Date Samples Received	: 22-JUL-2009
Sampler	: Alex Kochnieff	Issue Date	: 22-SEP-2009
Order number	: ---	No. of samples received	: 39
Quote number	: EN/034/09	No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Carsten Emrich	Senior Organic Chemist	Organics
Kim McCabe	Senior Inorganic Chemist	Inorganics
Phillip Kennedy	2IC Environmental Laboratory	Inorganics
Sarah Ashworth	Organic Chemist	Inorganics
Sarah Ashworth	Organic Chemist	Organics
Stephen Hislop	Senior Inorganic Chemist	Inorganics



Page : 3 of 15
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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.

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



Page : 4 of 15
Work Order : EB0911579 Amendment 2
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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

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 (%)
EA010: Conductivity (QC Lot: 1051282)									
EB0911578-149	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	395	390	1.3	0% - 20%
EB0911578-159	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	551	514	6.9	0% - 20%
EA010: Conductivity (QC Lot: 1051288)									
EB0911579-004	BHO2/0.0-0.1	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	28	29	3.5	0% - 20%
EB0911579-020	BH11/0.0-0.02	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	260	261	0.4	0% - 20%
EA010: Conductivity (QC Lot: 1105109)									
EB0911579-026	BH14/0.0-0.1	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	47	45	4.3	0% - 20%
EB0914592-009	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	52	51	1.9	0% - 20%
EA055: Moisture Content (QC Lot: 1050653)									
EB0911579-001	BH01/0.0-0.05	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	2.2	2.4	7.7	No Limit
EB0911579-012	BH07/0.0-0.05	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	5.8	7.1	20.5	No Limit
EA055: Moisture Content (QC Lot: 1050654)									
EB0911579-033	BH18/0.0-0.05	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	6.0	5.2	13.8	No Limit
ED007: Exchangeable Cations (QC Lot: 1051816)									
EB0911579-011	BH06/0.9-1.0	ED007: Exchangeable Calcium	----	0.1	meq/100g	2.9	3.0	0.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	2.9	3.0	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.4	0.4	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.4	0.4	0.0	No Limit
EB0911579-021	BH11/0.1-0.2	ED007: Exchangeable Calcium	----	0.1	meq/100g	7.0	6.8	1.5	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	2.4	2.4	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.4	0.4	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.1	0.1	0.0	No Limit
ED007: Exchangeable Cations (QC Lot: 1051819)									
EB0911579-034	BH18/0.4-0.5	ED007: Exchangeable Calcium	----	0.1	meq/100g	0.3	0.3	0.0	No Limit
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	21.2	20.9	1.4	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.4	0.4	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	5.7	5.7	0.0	0% - 20%
EB0911579-040	DUP02	ED007: Exchangeable Calcium	----	0.1	meq/100g	0.9	0.9	0.0	No Limit
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	6.2	5.8	7.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	1.0	0.9	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	1.4	1.3	9.6	0% - 50%
ED007: Exchangeable Cations (QC Lot: 1053513)									
EB0911579-001	BH01/0.0-0.05	ED007: Exchangeable Calcium	----	0.1	meq/100g	2.3	2.1	8.5	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	1.6	1.5	8.1	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 (%)
ED007: Exchangeable Cations (QC Lot: 1053513) - continued									
EB0911579-001	BH01/0.0-0.05	ED007: Exchangeable Potassium	----	0.1	meq/100g	0.5	0.4	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.3	0.2	0.0	No Limit
		ED007: Exchangeable Calcium	----	0.1	meq/100g	2.2	2.2	0.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	2.4	2.4	0.0	0% - 20%
EB0911579-010		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.3	0.3	0.0	No Limit
ED007: Exchangeable Cations (QC Lot: 1105119)									
EB0911579-026	BH14/0.0-0.1	ED007: Exchangeable Calcium	----	0.1	meq/100g	7.3	7.7	5.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	2.5	2.5	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.8	0.8	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.2	0.2	0.0	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 1052020)									
EB0911566-002	Anonymous	EG005T: Cadmitium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	4	4	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	4	9	81.3	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	26	30	12.6	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	55	45	18.8	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	140	142	1.2	0% - 20%
		EG005T: Cadmitium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	68	80	15.8	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	25	22	14.6	0% - 50%
		EG005T: Arsenic	7440-38-2	5	mg/kg	36	37	5.3	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	50	53	7.4	0% - 50%
EB0911579-022	BH12/0.0-0.1	EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	34	31	11.2	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 1053509)									
EB0911579-012	BH07/0.0-0.05	EG005T: Cadmitium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	23	26	15.1	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	6	6	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	13	15	9.1	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	7	8	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	39	43	9.4	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1052021)									
EB0911566-002	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EB0911583-003	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1053510)									
EB0911579-012	BH07/0.0-0.05	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit



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 (%)
EK061G: Total Kjeldahl Nitrogen as N (QC Lot: 1052045)									
EB0911579-004	BH02/0.0-0.1	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	520	430	18.3	0% - 20%
EB0911579-020	BH11/0.0-0.02	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	5270	4500	15.7	0% - 20%
EK061G: Total Kjeldahl Nitrogen as N (QC Lot: 1052529)									
EB0911579-001	BH01/0.0-0.05	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	1520	1680	10.0	0% - 20%
EK061G: Total Kjeldahl Nitrogen as N (QC Lot: 1105118)									
EB0911579-026	BH14/0.0-0.1	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	1660	1560	5.8	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 1051286)									
EB0911579-001	BH01/0.0-0.05	EK071G: Reactive Phosphorus as P	----	0.100	mg/kg	0.436	0.432	0.8	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 1051289)									
EB0911579-004	BH02/0.0-0.1	EK071G: Reactive Phosphorus as P	----	0.100	mg/kg	0.138	0.147	6.4	No Limit
EB0911579-020	BH11/0.0-0.02	EK071G: Reactive Phosphorus as P	----	0.100	mg/kg	24.1	27.0	11.2	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 1105110)									
EB0911579-026	BH14/0.0-0.1	EK071G: Reactive Phosphorus as P	----	0.100	mg/kg	0.173	0.173	0.0	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 1051103)									
EB0911579-001	BH01/0.0-0.05	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.0	No Limit		
EB0911717-007	Anonymous	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit



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 (%)
EP068A: Organochlorine Pesticides (OC) (QC Lot: 1051103) - continued									
EB0911717-007	Anonymous	EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDE	72-55-9	0.05	mg/kg	0.60	0.58	3.5	0% - 50%
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: 4,4'-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
		EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 1051103)									
EB0911579-001	BH01/0.0-0.05	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Azinphos Methyl	----	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	0.0	No Limit		
EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit		
EB0911717-007	Anonymous	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.0	No Limit



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 (%)
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 1051103) - continued									
EB0911717-007	Anonymous	EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Azinphos Methyl	----	0.05	mg/kg	<0.05	<0.05	0.0	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.0	No Limit
EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	0.0	No Limit		
EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	0.0	No Limit		
Sub-Matrix: WATER									
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 1050450)									
EB0911579-036	LP GW	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.005	<0.005	0.0	No Limit
		EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.149	0.150	0.9	0% - 20%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
EB0911649-007	Anonymous	EG020A-T: Copper	7440-50-8	0.001	mg/L	0.005	0.005	0.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.066	0.066	0.0	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.025	0.023	11.4	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1050852)									
EB0911571-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EB0911571-011	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1050853)									
EB0911579-038	RB03	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit



Sub-Matrix: WATER									
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 1050853) - continued									
EB0911685-003	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 1050710)									
EB0911579-036	LP GW	EP080: C6 - C9 Fraction	---	20	µg/L	<20	<20	0.0	No Limit
EP080: BTEX (QC Lot: 1050710)									
EB0911579-036	LP GW	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	106-42-3	2	µg/L	<2	<2	0.0	No Limit



Page : 10 of 15
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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 Sample (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: Compound	CAS Number	LOR	Unit	Method Blank (MB)		Laboratory Control Spike (LCS) Report			
				Report	Result	Spike Concentration	Spike Recovery (%)	LCS	Recovery Limits (%)
EA002 : pH (Soils) (QCLot: 1051283)	-----	0.1	pH Unit	----		5.2 pH Unit		99.2	96
EA002 : pH (Soils) (QCLot: 1051287)	-----	0.1	pH Unit	----		5.2 pH Unit		98.1	96
EA002 : pH (Soils) (QCLot: 1105108)	-----	0.1	pH Unit	----		5.2 pH Unit		100	96
EA010: Conductivity (QCLot: 1051282)	-----	1	µS/cm	<1		196 µS/cm		103	91
EA010: Conductivity (QCLot: 1051288)	-----	1	µS/cm	<1		196 µS/cm		102	91
EA010: Conductivity (QCLot: 1105109)	-----	1	µS/cm	<1		196 µS/cm		102	91
ED007: Exchangeable Cations (QCLot: 1051816)	-----	0.1	meq/100g	<0.1		1.47 meq/100g		90.1	70.2
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g		92.3	76.4
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g		81.2	70
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1		0.51 meq/100g		80.3	70
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	----		2.95 meq/100g		88.4	70.1
ED007: Exchangeable Cations (QCLot: 1051819)	-----	0.1	meq/100g	<0.1		1.47 meq/100g		90.2	70.2
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g		93.5	76.4
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g		84.2	70
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1		0.51 meq/100g		80.2	70
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	----		2.95 meq/100g		89.0	70.1
ED007: Exchangeable Cations (QCLot: 1053513)	-----	0.1	meq/100g	<0.1		1.47 meq/100g		93.4	70.2
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g		91.7	76.4
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g		83.7	70
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1		0.51 meq/100g		82.9	70
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	----		2.95 meq/100g		90.5	70.1
ED007: Exchangeable Cations (QCLot: 1105119)	-----	0.1	meq/100g	<0.1		1.47 meq/100g		100	70.2
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g		100	76.4
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g		85.9	70



Page : 11 of 15
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

Sub-Matrix: SOIL				Method Blank (MB) Report		Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	LCS	Low	High
ED007: Exchangeable Cations (QCLot: 1105119) - continued									
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.51 meq/100g		84.7	70	104
ED007: Cation Exchange Capacity	----	0.1	meq/100g	---	2.95 meq/100g		96.5	70.1	104
EG005T: Total Metals by ICP-AES (QCLot: 1052020)									
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	13.8 mg/kg		124	78	124
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	2.82 mg/kg		89.4	77	117
EG005T: Chromium	7440-47-3	2	mg/kg	<2	61.6 mg/kg		93.0	83	119
EG005T: Copper	7440-50-8	5	mg/kg	<5	54.7 mg/kg		96.2	82	122
EG005T: Lead	7439-92-1	5	mg/kg	<5	55.5 mg/kg		85.5	83	117
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55.1 mg/kg		86.8	83	121
EG005T: Zinc	7440-66-6	5	mg/kg	<5	105 mg/kg		90.9	82	120
EG005T: Total Metals by ICP-AES (QCLot: 1053509)									
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	13.8 mg/kg		100	78	124
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	2.82 mg/kg		95.2	77	117
EG005T: Chromium	7440-47-3	2	mg/kg	<2	61.6 mg/kg		100	83	119
EG005T: Copper	7440-50-8	5	mg/kg	<5	54.7 mg/kg		104	82	122
EG005T: Lead	7439-92-1	5	mg/kg	<5	55.5 mg/kg		93.5	83	117
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55.1 mg/kg		95.2	83	121
EG005T: Zinc	7440-66-6	5	mg/kg	<5	105 mg/kg		95.4	82	120
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1052021)									
EG035T: Mercury	7439-97-6	0.10	mg/kg	<0.1	1.34 mg/kg		105	73	119
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1053510)									
EG035T: Mercury	7439-97-6	0.10	mg/kg	<0.1	1.34 mg/kg		98.5	73	119
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1052045)									
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	373 mg/kg		118	70	130
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1052529)									
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	373 mg/kg		129	70	130
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1105118)									
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	373 mg/kg		90.9	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1051286)									
EK071G: Reactive Phosphorus as P	----	0.1	mg/kg	<0.100	2.5 mg/kg		98.8	75	119
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1051289)									
EK071G: Reactive Phosphorus as P	----	0.1	mg/kg	<0.100	2.5 mg/kg		97.6	75	119
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1105110)									
EK071G: Reactive Phosphorus as P	----	0.1	mg/kg	<0.100	2.5 mg/kg		81.2	75	119
EP068A: Organochlorine Pesticides (OC) (QCLot: 1051103)									
EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	0.25 mg/kg		66.4	58.4	116
EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	0.25 mg/kg		68.9	57.7	107



Sub-Matrix: SOIL				Method Blank (MB) Report		Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 1051103) - continued									
EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	0.25 mg/kg	71.1	59.3	116	
EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	0.25 mg/kg	70.2	59.1	118	
EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	0.25 mg/kg	72.6	56	117	
EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	0.25 mg/kg	70.6	57.3	119	
EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	0.25 mg/kg	72.5	58.2	113	
EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	0.25 mg/kg	64.4	60.4	113	
EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	0.25 mg/kg	64.0	60.3	114	
EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	0.25 mg/kg	78.7	56	120	
EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	0.25 mg/kg	64.9	60.8	113	
EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	0.25 mg/kg	76.3	58.8	115	
EP068: 4,4'-DDE	72-55-9	0.05	mg/kg	<0.05	0.25 mg/kg	71.8	61.2	116	
EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	0.25 mg/kg	82.1	47	133	
EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	0.25 mg/kg	80.6	58.5	117	
EP068: 4,4'-DDD	72-54-8	0.05	mg/kg	<0.05	0.25 mg/kg	77.1	58.4	118	
EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	0.25 mg/kg	90.5	46.3	115	
EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	0.25 mg/kg	75.0	53.6	120	
EP068: 4,4'-DDT	50-29-3	0.05	mg/kg	---	0.25 mg/kg	80.6	52.6	129	
		0.2	mg/kg	<0.2	---	---	---	---	
EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	0.25 mg/kg	72.4	51.6	124	
EP068: Methoxychlor	72-43-5	0.05	mg/kg	---	0.25 mg/kg	76.4	52.4	129	
		0.2	mg/kg	<0.2	---	---	---	---	
EP068B: Organophosphorus Pesticides (OP) (QCLot: 1051103)									
EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	0.25 mg/kg	82.3	43.9	113	
EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	0.25 mg/kg	77.0	31.8	112	
EP068: Monocrotophos	6923-22-4	0.05	mg/kg	---	0.25 mg/kg	74.0	33	130	
		0.2	mg/kg	<0.2	---	---	---	---	
EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	0.25 mg/kg	# 137	46.4	129	
EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	0.25 mg/kg	91.9	57.1	114	
EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	0.25 mg/kg	75.6	58.9	113	
EP068: Parathion-methyl	298-00-0	0.05	mg/kg	---	0.25 mg/kg	80.0	54.8	112	
		0.2	mg/kg	<0.2	---	---	---	---	
EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	0.25 mg/kg	83.5	57.8	119	
EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	0.25 mg/kg	75.4	68	109	
EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	0.25 mg/kg	80.6	62.2	115	
EP068: Parathion	56-38-2	0.05	mg/kg	---	0.25 mg/kg	73.7	54.7	113	
		0.2	mg/kg	<0.2	---	---	---	---	
EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	0.25 mg/kg	74.4	51.9	121	
EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	0.25 mg/kg	99.4	58	118	
EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	0.25 mg/kg	86.2	59.8	115	



Sub-Matrix: SOIL				Method Blank (MB) Report				Laboratory Control Spike (LCS) Report			
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	Low	High		
EP068B: Organophosphorus Pesticides (OP) (QCLot: 1051103) - continued											
EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	0.25 mg/kg	77.1	32.5	101			
EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	0.25 mg/kg	72.5	59.6	116			
EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	0.25 mg/kg	83.5	58.4	118			
EP068: Carbofenothion	786-19-6	0.05	mg/kg	<0.05	0.25 mg/kg	78.3	56.9	117			
EP068: Azinphos Methyl	---	0.05	mg/kg	<0.05	0.25 mg/kg	90.4	42	130			
Sub-Matrix: WATER											
Method: Compound	CAS Number	LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	Low	High		
EG020T: Total Metals by ICP-MS (QCLot: 1050450)											
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.100 mg/L	106	76	120			
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.100 mg/L	109	84	112			
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.100 mg/L	119	82	124			
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.200 mg/L	112	82	116			
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.100 mg/L	# 114	85	113			
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.100 mg/L	113	81	117			
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.200 mg/L	102	81	123			
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1050852)											
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	113	80	116			
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1050853)											
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.0100 mg/L	108	80	116			
EP080/074: Total Petroleum Hydrocarbons (QCLot: 1049913)											
EP071: C10 - C14 Fraction	---	50	µg/L	<50	600 µg/L	77.9	49	110			
EP071: C15 - C28 Fraction	---	100	µg/L	<100	1020 µg/L	77.6	58	130			
EP071: C29 - C36 Fraction	---	50	µg/L	<50	---	---	---	---			
EP080/074: Total Petroleum Hydrocarbons (QCLot: 1050710)											
EP080: C6 - C9 Fraction	---	20	µg/L	<20	160 µg/L	104	73	135			
EP080: BTEX (QCLot: 1050710)											
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	104	77.6	122			
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	102	74	122			
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	99.5	73	126			
EP080: meta- & para-Xylene	108-38-3	2	µg/L	<2	20 µg/L	100	70.4	129			
	106-42-3										
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	96.6	74.3	126			



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.

Sub-Matrix: **SOIL**

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Spike Recovery (%)	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 1052020)							
EB0911566-003	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	102	70	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	87.6	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	91.8	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	95.6	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	# 300	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	85.5	70	130
EG005T: Zinc	7440-66-6	50 mg/kg	109	70	130		
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1052021)							
EB0911566-003	Anonymous	EG035T: Mercury	7439-97-6	5.0 mg/kg	110	70	130
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1052045)							
EB0911579-005	BH03/0.0-0.1	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	87.8	70	130
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1052529)							
EB0911579-022	BH12/0.0-0.1	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	114	70	130
EK061G: Total Kjeldahl Nitrogen as N (QCLot: 1105118)							
EB0911579-028	BH15/0.0-0.1	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	# 60.8	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1051289)							
EB0911579-005	BH03/0.0-0.1	EK071G: Reactive Phosphorus as P	----	2.0 mg/kg	90.6	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 1105110)							
EB0911579-028	BH15/0.0-0.1	EK071G: Reactive Phosphorus as P	----	2.0 mg/kg	72.5	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 1051103)							
EB0911763-007	Anonymous	EP068: gamma-BHC	58-89-9	0.25 mg/kg	102	70	130
		EP068: Heptachlor	76-44-8	0.25 mg/kg	76.5	70	130
		EP068: Aldrin	309-00-2	0.25 mg/kg	85.4	70	130
		EP068: Dieldrin	60-57-1	0.25 mg/kg	94.7	70	130
		EP068: Endrin	72-20-8	1.0 mg/kg	82.1	70	130
		EP068: 4,4'-DDT	50-29-3	1.0 mg/kg	# 48.9	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 1051103)							
EB0911763-007	Anonymous	EP068: Diazinon	333-41-5	0.25 mg/kg	96.6	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	0.25 mg/kg	87.2	70	130
		EP068: Pirimphos-ethyl	23505-41-1	0.25 mg/kg	78.1	70	130
		EP068: Bromophos-ethyl	4824-78-6	0.25 mg/kg	77.6	70	130
		EP068: Prothiofos	34643-46-4	0.25 mg/kg	75.5	70	130

Sub-Matrix: **WATER**

Matrix Spike (MS) Report



Sub-Matrix: WATER				Matrix Spike (MS) Report			
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Spike Concentration	Spike Recovery (%) MS	Recovery Limits (%) Low	High
EG020T: Total Metals by ICP-MS (QCLot: 1050450)							
EB0911579-037	RB02	EG020A-T: Arsenic	7440-38-2	1.000 mg/L	111	70	130
		EG020A-T: Cadmium	7440-43-9	0.500 mg/L	112	70	130
		EG020A-T: Chromium	7440-47-3	1.000 mg/L	112	70	130
		EG020A-T: Copper	7440-50-8	1.000 mg/L	111	70	130
		EG020A-T: Lead	7439-92-1	1.000 mg/L	111	70	130
		EG020A-T: Nickel	7440-02-0	1.000 mg/L	111	70	130
		EG020A-T: Zinc	7440-66-6	1.000 mg/L	108	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1050852)							
EB0911571-002	Anonymous	EG035T: Mercury	7439-97-6	0.010 mg/L	104	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 1050853)							
EB0911608-001	Anonymous	EG035T: Mercury	7439-97-6	0.010 mg/L	102	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 1050710)							
EB0911621-001	Anonymous	EP080: C6 - C9 Fraction	----	140 µg/L	84.0	70	130
EP080: BTEX (QCLot: 1050710)							
EB0911621-001	Anonymous	EP080: Benzene	71-43-2	10 µg/L	95.0	70	130
		EP080: Toluene	108-88-3	10 µg/L	81.9	70	130



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EB0911579	Page	: 1 of 14
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
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Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt		
C-O-C number	: ---	Date Samples Received	: 22-JUL-2009
Sampler	: Alex Kochnieff	Issue Date	: 22-SEP-2009
Order number	: ---	No. of samples received	: 39
Quote number	: EN/034/09	No. of samples analysed	: 35

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis	
Container / Client Sample ID(s)			Date extracted	Due for extraction	Date analysed	Due for analysis
EA002 : pH (Soils)						
Pulp Bag	BH15/0.0-0.1	18-JUL-2009	18-SEP-2009	25-JUL-2009	18-SEP-2009	18-SEP-2009
Snap Lock Bag	BH13/0.0-0.1,	14-JUL-2009	29-JUL-2009	21-JUL-2009	29-JUL-2009	29-JUL-2009
Snap Lock Bag	BH02/0.0-0.1	17-JUL-2009	29-JUL-2009	24-JUL-2009	29-JUL-2009	29-JUL-2009
Snap Lock Bag	BH17/0.0-0.05,	18-JUL-2009	29-JUL-2009	25-JUL-2009	29-JUL-2009	29-JUL-2009
Snap Lock Bag	BH14/0.0-0.1	19-JUL-2009	18-SEP-2009	26-JUL-2009	18-SEP-2009	18-SEP-2009
Snap Lock Bag	BH01/0.0-0.05, BH04/0.0-0.1, BH06/0.2-0.3, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, DUPO2	19-JUL-2009	29-JUL-2009	26-JUL-2009	29-JUL-2009	29-JUL-2009



Matrix: **SOIL** Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Sample Date	Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010: Conductivity								
Pulp Bag		18-JUL-2009	18-SEP-2009	25-JUL-2009	✗	18-SEP-2009	16-OCT-2009	✓
Snap Lock Bag		14-JUL-2009	29-JUL-2009	21-JUL-2009	✗	29-JUL-2009	26-AUG-2009	✓
Snap Lock Bag		17-JUL-2009	29-JUL-2009	24-JUL-2009	✗	29-JUL-2009	26-AUG-2009	✓
Snap Lock Bag		18-JUL-2009	29-JUL-2009	25-JUL-2009	✗	29-JUL-2009	26-AUG-2009	✓
Snap Lock Bag		19-JUL-2009	18-SEP-2009	26-JUL-2009	✗	18-SEP-2009	16-OCT-2009	✓
Snap Lock Bag		19-JUL-2009	29-JUL-2009	26-JUL-2009	✗	29-JUL-2009	26-AUG-2009	✓
BH03/0.0-0.1, BH05/0.0-0.1, BH08/0.0-0.1, BH09B/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1, DUP02								
EA055: Moisture Content								
Snap Lock Bag		14-JUL-2009	-----	-----	-----	27-JUL-2009	21-JUL-2009	✗
Snap Lock Bag		17-JUL-2009	-----	-----	-----	27-JUL-2009	24-JUL-2009	✗
Snap Lock Bag		18-JUL-2009	-----	-----	-----	18-SEP-2009	25-JUL-2009	✗
Snap Lock Bag		18-JUL-2009	-----	-----	-----	27-JUL-2009	25-JUL-2009	✗
Snap Lock Bag		19-JUL-2009	-----	-----	-----	18-SEP-2009	26-JUL-2009	✗
Snap Lock Bag		19-JUL-2009	-----	-----	-----	27-JUL-2009	26-JUL-2009	✗
BH03/0.0-0.1, BH05/0.0-0.1, BH07/0.0-0.05, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, DUP02								



Matrix: **SOIL** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date		Extraction / Preparation		Analysis			
Container / Client Sample ID(s)				Date extracted	Due for extraction	Evaluation	Due for analysis	Evaluation	
ED007: Exchangeable Cations									
Pulp Bag		BH16/0.0-0.1, BH16/0.4-0.5	14-JUL-2009	29-JUL-2009	10-JAN-2010	✓	30-JUL-2009	10-JAN-2010	✓
Pulp Bag		BHO2/0.0-0.1	17-JUL-2009	29-JUL-2009	13-JAN-2010	✓	30-JUL-2009	13-JAN-2010	✓
Pulp Bag		BH15/0.9-1.0, BH17/0.0-0.05, BH18/0.0-0.05, BH18/0.9-1.0	18-JUL-2009	29-JUL-2009	14-JAN-2010	✓	30-JUL-2009	14-JAN-2010	✓
Pulp Bag		BH01/0.0-0.05, BH01/0.9-1.0, BH04/0.0-0.1, BH05/0.0-0.1, BH06/0.9-1.0, BH08/0.0-0.1, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, BH12/0.0-0.1, BH12/0.9-1.0	19-JUL-2009	29-JUL-2009	15-JAN-2010	✓	30-JUL-2009	15-JAN-2010	✓
Snap Lock Bag		BH14/0.0-0.1	19-JUL-2009	22-SEP-2009	15-JAN-2010	✓	22-SEP-2009	15-JAN-2010	✓
EG005T: Total Metals by ICP-AES									
Pulp Bag		BH01/0.0-0.05	19-JUL-2009	29-JUL-2009	16-AUG-2009	✓	29-JUL-2009	15-JAN-2010	✓
Snap Lock Bag		BH16/0.0-0.1	14-JUL-2009	29-JUL-2009	11-AUG-2009	✓	29-JUL-2009	10-JAN-2010	✓
Snap Lock Bag		BH03/0.0-0.1, BH10/0.0-0.1, DUP02	19-JUL-2009	29-JUL-2009	16-AUG-2009	✓	29-JUL-2009	15-JAN-2010	✓



Matrix: **SOIL** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Date analysed	Due for analysis	
EG035T: Total Recoverable Mercury by FIMS							
Snap Lock Bag BH16/0.0-0.1		14-JUL-2009	29-JUL-2009	11-AUG-2009	29-JUL-2009	11-AUG-2009	✓
Snap Lock Bag BH01/0.0-0.05, BH10/0.0-0.1, DUP02		19-JUL-2009	29-JUL-2009	16-AUG-2009	29-JUL-2009	16-AUG-2009	✓
Snap Lock Bag BH07/0.0-0.05		19-JUL-2009	29-JUL-2009	16-AUG-2009	30-JUL-2009	16-AUG-2009	✓
EK061G: Total Kjeldahl Nitrogen as N							
Pulp Bag BH15/0.0-0.1		18-JUL-2009	18-SEP-2009	---	22-SEP-2009	14-JAN-2010	✓
Pulp Bag BH01/0.0-0.05,		19-JUL-2009	29-JUL-2009	---	29-JUL-2009	15-JAN-2010	✓
Snap Lock Bag BH13/0.0-0.1,		14-JUL-2009	29-JUL-2009	10-JAN-2010	29-JUL-2009	10-JAN-2010	✓
Snap Lock Bag BHO2/0.0-0.1		17-JUL-2009	29-JUL-2009	13-JAN-2010	29-JUL-2009	13-JAN-2010	✓
Snap Lock Bag BH17/0.0-0.05,		18-JUL-2009	29-JUL-2009	14-JAN-2010	29-JUL-2009	14-JAN-2010	✓
Snap Lock Bag BH14/0.0-0.1		19-JUL-2009	18-SEP-2009	15-JAN-2010	22-SEP-2009	15-JAN-2010	✓
Snap Lock Bag BH03/0.0-0.1, BH06/0.2-0.3, BH08/0.0-0.1, BH09B/0.0-0.1, BH11/0.0-0.02, DUP02		19-JUL-2009	29-JUL-2009	15-JAN-2010	29-JUL-2009	15-JAN-2010	✓



Matrix: **SOIL** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis	
Container / Client Sample ID(s)			Date extracted	Due for extraction	Date analysed	Due for analysis
EK071G: Reactive Phosphorus as P by discrete analyser						
Snap Lock Bag BH13/0.0-0.1,	BH16/0.0-0.1	14-JUL-2009	29-JUL-2009	21-JUL-2009	29-JUL-2009	10-JAN-2010
Snap Lock Bag BHO2/0.0-0.1		17-JUL-2009	29-JUL-2009	24-JUL-2009	29-JUL-2009	13-JAN-2010
Snap Lock Bag BH15/0.0-0.1		18-JUL-2009	18-SEP-2009	25-JUL-2009	18-SEP-2009	14-JAN-2010
Snap Lock Bag BH17/0.0-0.05,	BH18/0.0-0.05	18-JUL-2009	29-JUL-2009	25-JUL-2009	29-JUL-2009	14-JAN-2010
Snap Lock Bag BH14/0.0-0.1		19-JUL-2009	18-SEP-2009	26-JUL-2009	18-SEP-2009	15-JAN-2010
Snap Lock Bag BH01/0.0-0.05, BH04/0.0-0.1, BH06/0.2-0.3, BH08/0.0-0.1, BH09B/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1,	BH03/0.0-0.1, BH05/0.0-0.1, BH07/0.0-0.05, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, DUP02	19-JUL-2009	29-JUL-2009	26-JUL-2009	29-JUL-2009	15-JAN-2010
EP068A: Organochlorine Pesticides (OC)						
Snap Lock Bag BH01/0.0-0.05,	BH07/0.0-0.05	19-JUL-2009	28-JUL-2009	02-AUG-2009	28-JUL-2009	06-SEP-2009
EP068B: Organophosphorus Pesticides (OP)						
Snap Lock Bag BH01/0.0-0.05,	BH07/0.0-0.05	19-JUL-2009	28-JUL-2009	02-AUG-2009	28-JUL-2009	06-SEP-2009

Matrix: **WATER** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis	
Container / Client Sample ID(s)			Date extracted	Due for extraction	Date analysed	Due for analysis
EG020T: Total Metals by ICP-MS						
Clear Plastic Bottle - Nitric Acid; Unfiltered LP GW,	RB02	18-JUL-2009	27-JUL-2009	14-JAN-2010	27-JUL-2009	14-JAN-2010
Clear Plastic Bottle - Nitric Acid; Unfiltered RB03		19-JUL-2009	27-JUL-2009	15-JAN-2010	27-JUL-2009	15-JAN-2010
EG035T: Total Recoverable Mercury by FIMS						
Clear Plastic Bottle - Nitric Acid; Unfiltered LP GW,	RB02	18-JUL-2009	-----	-----	27-JUL-2009	15-AUG-2009
Clear Plastic Bottle - Nitric Acid; Unfiltered RB03		19-JUL-2009	-----	-----	27-JUL-2009	16-AUG-2009



Matrix: WATER							Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.			
Method		Sample Date	Extraction / Preparation		Analysis					
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation		
EP080/071: Total Petroleum Hydrocarbons										
Amber Glass Bottle - Unpreserved LP GW		18-JUL-2009	24-JUL-2009	25-JUL-2009	✔	28-JUL-2009	05-SEP-2009	✔		
Amber VOC Vial - HCl or NaHSO4 LP GW		18-JUL-2009	-----	-----	-----	27-JUL-2009	01-AUG-2009	✔		
EP080: BTEX										
Amber VOC Vial - HCl or NaHSO4 LP GW		18-JUL-2009	-----	-----	-----	27-JUL-2009	01-AUG-2009	✔		



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(where) 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		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Electrical Conductivity (1:5)	EA010	6	52	11.5	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
	ED007	7	32	21.9	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	EA055-103 EP068	3	22	13.6	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Moisture Content		2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EK071G	4	21	19.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK061G	4	22	18.2	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EG035T	3	20	15.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG005T	3	20	15.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES							
Laboratory Control Samples (LCS)							
Electrical Conductivity (1:5)	EA010	3	52	5.8	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	4	32	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	3	42	7.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	3	21	14.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	3	22	13.6	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	20	10.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	20	10.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Electrical Conductivity (1:5)	EA010	3	52	5.8	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	4	32	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	3	21	14.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	3	22	13.6	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Mercury by FIMS	EG035T	2	20	10.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	20	10.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Pesticides by GCMS	EP068	1	20	5.0	5.0	✓	ALS QCS3 requirement
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	2	20	10.0	5.0	✓	ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	3	22	13.6	5.0	✓	ALS QCS3 requirement
Total Mercury by FIMS	EG035T	1	19	5.3	5.0	✓	ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	19	5.3	5.0	✓	ALS QCS3 requirement

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)		Quality Control Specification	
Analytical Methods		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							



Matrix: **WATER** Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Method	Count		Rate (%)		Quality Control Specification
Analytical Methods			QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP) - Continued							
Total Mercury by FIMS		EG035T	4	40	10.0	10.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A		EG020A-T	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX		EP080	1	4	25.0	10.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Total Mercury by FIMS		EG035T	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A		EG020A-T	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction		EP071	1	15	6.7	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX		EP080	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Total Mercury by FIMS		EG035T	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-MS - Suite A		EG020A-T	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction		EP071	1	15	6.7	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX		EP080	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Total Mercury by FIMS		EG035T	2	40	5.0	5.0	ALS QCS3 requirement
Total Metals by ICP-MS - Suite A		EG020A-T	1	20	5.0	5.0	ALS QCS3 requirement
TPH Volatiles/BTEX		EP080	1	4	25.0	5.0	ALS QCS3 requirement



Page : 10 of 14
Work Order : EB0911579 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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
pH (1:5)	EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)	EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 104)
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (1999) Schedule B(3) (Method 102)
Exchangeable Cations	ED007	SOIL	Rayment & Higginson (1992) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (1999) Schedule B(3) (Method 301)
Total Metals by ICP-AES	EG005T	SOIL	(APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3)
TKN as N By Discrete Analyser	EK061G	SOIL	APHA 21st ed., 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	SOIL	APHA 21st ed., 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with orthophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Pesticides by GCMS	EP088	SOIL	(USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)



Page : 11 of 14
 Work Order : EB0911579 Amendment 2
 Client : WORLEY PARSONS - INFRASTRUCTURE MWIE
 Project : 301001-00752

Analytical Methods		Method	Matrix	Method Descriptions
TPH - Semivolatile Fraction		EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
TPH Volatiles/BTEX		EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Preparation Methods		Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method		ED007PR	SOIL	Rayment & Higginson (1992) method 15A1. A 1M NH ₄ Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
TKN/TP Digestion		EK061/EK067	SOIL	APHA 21st ed., 4500 Norg- D; APHA 21st ed., 4500 P - H. Macro Kjeldahl digestion.
1:5 solid / water leach for soluble analytes		EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges		EN69	SOIL	USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)
Tumbler Extraction of Solids (Option A - Concentrating)		ORG17A	SOIL	In-house, Mechanical agitation (tumbler). 20g of sample, Na ₂ SO ₄ and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.
Digestion for Total Recoverable Metals		EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Separatory Funnel Extraction of Liquids		ORG14	WATER	USEPA SW 846 - 3510B 500 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	1208206-002	----	Dimethoate	60-51-5	137 %	46.4-129%	Recovery greater than upper control limit
Matrix Spike (MS) Recoveries							
EG005T: Total Metals by ICP-AES	EB0911566-003	Anonymous	Lead	7439-92-1	300 %	70-130%	Recovery greater than upper data quality objective
EK061G: Total Kjeldahl Nitrogen as N	EB0911579-028	BH15/0.0-0.1	Total Kjeldahl Nitrogen as N	----	60.8 %	70-130%	Recovery less than lower data quality objective
EP068A: Organochlorine Pesticides (OC)	EB0911763-007	Anonymous	4,4'-DDT	50-29-3	48.9 %	70-130%	Recovery less than lower data quality objective

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EG020T: Total Metals by ICP-MS	1207561-002	----	Lead	7439-92-1	114 %	85-113%	Recovery greater than upper control limit

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **SOIL**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis	
	Date extracted	Due for extraction	Days overdue	Date analysed	Days overdue
EA002 : pH (Soils)					
Pulp Bag BH15/0.0-0.1	18-SEP-2009	25-JUL-2009	55	----	----
Snap Lock Bag BH13/0.0-0.1,	29-JUL-2009	21-JUL-2009	8	----	----



Matrix: **SOIL**

Method		Extraction / Preparation			Analysis	
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Days overdue
EA002 : pH (Soils) - Analysis Holding Time Compliance						
Snap Lock Bag BHO2/0.0-0.1		29-JUL-2009	24-JUL-2009	5		
Snap Lock Bag BH17/0.0-0.05, BH18/0.0-0.05		29-JUL-2009	25-JUL-2009	4		
Snap Lock Bag BH14/0.0-0.1		18-SEP-2009	26-JUL-2009	54		
Snap Lock Bag BH03/0.0-0.1, BH05/0.0-0.1, BH08/0.0-0.1, BH09B/0.0-0.1, BH10/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1, DUP02		29-JUL-2009	26-JUL-2009	3		
EA010: Conductivity						
Pulp Bag BH15/0.0-0.1		18-SEP-2009	25-JUL-2009	55		
Snap Lock Bag BH13/0.0-0.1,		29-JUL-2009	21-JUL-2009	8		
Snap Lock Bag BHO2/0.0-0.1		29-JUL-2009	24-JUL-2009	5		
Snap Lock Bag BH17/0.0-0.05,		29-JUL-2009	25-JUL-2009	4		
Snap Lock Bag BH14/0.0-0.1		18-SEP-2009	26-JUL-2009	54		
Snap Lock Bag BH03/0.0-0.1, BH05/0.0-0.1, BH08/0.0-0.1, BH09B/0.0-0.1, BH10/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1,		29-JUL-2009	26-JUL-2009	3		
EA055: Moisture Content						
Snap Lock Bag BH13/0.0-0.1,					27-JUL-2009	21-JUL-2009
Snap Lock Bag BHO2/0.0-0.1					27-JUL-2009	24-JUL-2009
Snap Lock Bag BH15/0.0-0.1					18-SEP-2009	25-JUL-2009
Snap Lock Bag BH17/0.0-0.05,					27-JUL-2009	25-JUL-2009



Matrix: **SOIL**

Method		Extraction / Preparation		Analysis	
Container / Client Sample ID(s)		Date extracted	Due for extraction	Date analysed	Days overdue
EA055: Moisture Content - Analysis Holding Time Compliance					
Snap Lock Bag BH14/0.0-0.1					
Snap Lock Bag BH01/0.0-0.05, BH04/0.0-0.1, BH06/0.2-0.3, BH08/0.0-0.1, BH09B/0.0-0.1, BH10/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1, DUP02	BH03/0.0-0.1, BH05/0.0-0.1, BH07/0.0-0.05, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, DUP02				
EK071G: Reactive Phosphorus as P by discrete analyser					
Snap Lock Bag BH13/0.0-0.1,	BH16/0.0-0.1	29-JUL-2009	21-JUL-2009		8
Snap Lock Bag BH02/0.0-0.1		29-JUL-2009	24-JUL-2009		5
Snap Lock Bag BH15/0.0-0.1		18-SEP-2009	25-JUL-2009		55
Snap Lock Bag BH17/0.0-0.05,	BH18/0.0-0.05	29-JUL-2009	25-JUL-2009		4
Snap Lock Bag BH14/0.0-0.1		18-SEP-2009	26-JUL-2009		54
Snap Lock Bag BH03/0.0-0.1, BH05/0.0-0.1, BH07/0.0-0.05, BH09/0.0-0.1, BH10/0.0-0.1, BH11/0.1-0.2, DUP02	BH04/0.0-0.1, BH06/0.2-0.3, BH08/0.0-0.1, BH09B/0.0-0.1, BH10/0.0-0.1, BH11/0.0-0.02, BH12/0.0-0.1, DUP02	29-JUL-2009	26-JUL-2009		3

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)
Comprehensive Report

Work Order : **EB0911579**

Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: 106 WICKHAM STREET FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32449600	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	Page	: 1 of 4
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2009WORPAR0223 (EN/034/09)
Site	: Laind Pt		
Sampler	: Alex Kochnieff	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 22-JUL-2009	Issue Date	: 24-JUL-2009 16:06
Client Requested Due Date	: 29-JUL-2009	Scheduled Reporting Date	: 29-JUL-2009

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 20.0,20.4,18.8 C
No. of coolers/boxes	: 3 MEDIUM	No. of samples received	: 39
Security Seal	: Intact.	No. of samples analysed	: 35

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Sample containers do not comply to pretreatment / preservation standards (AS, APHA, USEPA). Please refer to the Sample Container(s)/Preservation Non-Compliance Log at the end of this report for details.**
- **Sample(s) have been received within recommended holding times.**
- **Sample(s) requiring volatile organic compound analysis received in airtight containers (ZHE).**
- **Please be advised that both Maroon vials for sample TBO1 were broken in transit.**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Maggie Kahi.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.



Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method	Sample Container Received	Preferred Sample Container for Analysis
<i>Client sample ID</i>		
EP068 : Pesticides by GCMS		
BH01/0.0-0.05	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH07/0.0-0.05	- Snap Lock Bag	- Soil Glass Jar - Unpreserved

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Matrix: **SOIL**

<i>Laboratory sample ID</i>	<i>Client sampling date / time</i>	<i>Client sample ID</i>	(On Hold) SOIL No analysis requested	SOIL - EA002 pH (1:5)	SOIL - EA010 (solids): Electrical Conductivity (1:5) Electrical Conductivity (1:5)	SOIL - EA055-103 Moisture Content	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - EK061G (Solids) Total Kjeldahl Nitrogen as N (TKN) By Discrete Analyser	SOIL - EK071G (solids) Reactive Phosphorus as P By Discrete Analyser	SOIL - S-02 8 Metals (incl. Digestion)
EB0911579-001	19-JUL-2009 15:00	BH01/0.0-0.05		✓	✓		✓	✓	✓	✓
EB0911579-002	19-JUL-2009 15:00	BH01/0.3-0.4					✓			
EB0911579-003	19-JUL-2009 15:00	BH01/0.9-1.0					✓			
EB0911579-004	17-JUL-2009 15:00	BH02/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-005	19-JUL-2009 15:00	BH03/0.0-0.1		✓	✓		✓	✓	✓	✓
EB0911579-006	19-JUL-2009 15:00	BH03/0.4-0.5	✓							
EB0911579-007	19-JUL-2009 15:00	BH04/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-008	19-JUL-2009 15:00	BH04/0.2-0.3					✓			
EB0911579-009	19-JUL-2009 15:00	BH05/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-010	19-JUL-2009 15:00	BH06/0.2-0.3		✓	✓	✓	✓	✓	✓	
EB0911579-011	19-JUL-2009 15:00	BH06/0.9-1.0					✓			
EB0911579-012	19-JUL-2009 15:00	BH07/0.0-0.05		✓	✓		✓	✓	✓	✓
EB0911579-013	19-JUL-2009 15:00	BH07/0.2-0.3	✓							
EB0911579-014	19-JUL-2009 15:00	BH08/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-015	19-JUL-2009 15:00	BH08/0.6-0.8					✓			
EB0911579-016	19-JUL-2009 15:00	BH09/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-017	19-JUL-2009 15:00	BH09B/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-018	19-JUL-2009 15:00	BH09B/0.2-0.3	✓							
EB0911579-019	19-JUL-2009 15:00	BH10/0.0-0.1		✓	✓		✓	✓	✓	✓
EB0911579-020	19-JUL-2009 15:00	BH11/0.0-0.02		✓	✓	✓	✓	✓	✓	
EB0911579-021	19-JUL-2009 15:00	BH11/0.1-0.2		✓	✓	✓	✓	✓	✓	
EB0911579-022	19-JUL-2009 15:00	BH12/0.0-0.1		✓	✓		✓	✓	✓	✓
EB0911579-023	19-JUL-2009 15:00	BH12/0.9-1.0					✓			
EB0911579-024	14-JUL-2009 15:00	BH13/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-025	19-JUL-2009 15:00	BH14/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-026	19-JUL-2009 15:00	BH14/0.5-0.6	✓							
EB0911579-027	18-JUL-2009 15:00	BH15/0.0-0.1		✓	✓	✓	✓	✓	✓	
EB0911579-028	18-JUL-2009 15:00	BH15/0.9-1.0					✓			
EB0911579-029	14-JUL-2009 15:00	BH16/0.0-0.1		✓	✓		✓	✓	✓	✓
EB0911579-030	14-JUL-2009 15:00	BH16/0.4-0.5					✓			
EB0911579-031	18-JUL-2009 15:00	BH17/0.0-0.05		✓	✓	✓	✓	✓	✓	
EB0911579-032	18-JUL-2009 15:00	BH17/0.9-1.0					✓			
EB0911579-033	18-JUL-2009 15:00	BH17/0.0-0.05		✓	✓	✓	✓	✓	✓	



			(On Hold) SOIL No analysis requested	SOIL - EA002 pH (1:5)	SOIL - EA010 (solids): Electrical Conductivity (1:5) Electrical Conductivity (1:5)	SOIL - EA055-103 Moisture Content	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - EK061G (Solids) Total Kjeldahl Nitrogen as N (TKN) By Discrete Analyser	SOIL - EK071G (solids) Reactive Phosphorus as P By Discrete Analyser	SOIL - S-02 8 Metals (incl. Digestion)
EB0911579-034	18-JUL-2009 15:00	BH18/0.4-0.5					✓			
EB0911579-035	18-JUL-2009 15:00	BH18/0.9-1.0					✓			
EB0911579-040	19-JUL-2009 15:00	DUP02		✓	✓		✓	✓	✓	✓

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - S-12 OC/OP Pesticides
EB0911579-001	19-JUL-2009 15:00	BH01/0.0-0.05	✓
EB0911579-012	19-JUL-2009 15:00	BH07/0.0-0.05	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - W-02T 8 metals (Total)	WATER - W-05T TPH/BTEX/8 Metals (Total)
EB0911579-036	18-JUL-2009 15:00	LP GW		✓
EB0911579-037	18-JUL-2009 15:00	RB02	✓	
EB0911579-038	19-JUL-2009 15:00	RB03	✓	



Requested Deliverables

MR ALEX KOCHNIEFF

- *AU Certificate of Analysis - NATA (COA)	Email	alex.kochnieff@worleyparsons.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	alex.kochnieff@worleyparsons.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	alex.kochnieff@worleyparsons.com
- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	alex.kochnieff@worleyparsons.com
- A4 - AU Tax Invoice (INV)	Email	alex.kochnieff@worleyparsons.com
- Default - Chain of Custody (COC)	Email	alex.kochnieff@worleyparsons.com
- EDI Format - ENMRG (ENMRG)	Email	alex.kochnieff@worleyparsons.com
- EDI Format - XTab (XTAB)	Email	alex.kochnieff@worleyparsons.com

09/7 02 P1 of 4

CHAIN OF CUSTODY DOCUMENTATION

CLIENT:	WorkPavers	SAMPLER:	Alex Kachniuff
ADDRESS / OFFICE:	14/10, Ann St, Brisbane City	MOBILE:	0419615539
PROJECT MANAGER (PM):	Alex Kachniuff	PHONE:	3319 3940
PROJECT ID:	301001-00752	EMAIL REPORT TO:	alex.kachniuff@workpavers.com.au
SITE:	Levee Pt	EMAIL INVOICE TO: (if different to report)	above
P.O. NO.:			



RESULTS REQUIRED (Date): Standard. QUOTE NO.:

FOR LABORATORY USE ONLY		COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:	
COOLER SEAL (circle appropriate)			
Intact Yes No N/A			
SAMPLE TEMPERATURE			
CHILLED Yes No			

SAMPLE INFORMATION (note: S = Soil, W = Water)			CONTAINER INFORMATION	
ALS ID	SAMPLE ID	MATRIX	DATE	Time
1	BH01/0.0-0.05	S	17/7	
2	BH01/0.3-0.4		17/7	
3	BH01/0.9-1.0		17/7	
4	BH02/0.0-0.1		17/7	
5	BH03/0.0-0.1		17/7	
6	BH03/0.4-0.5		17/7	
7	BH04/0.0-0.1		17/7	
8	BH04/0.2-0.3		17/7	
9	BH05/0.0-0.1		17/7	
10	BH06/0.2-0.3		17/7	
11	BH06/0.9-1.0		17/7	
12	BH07/0.0-0.05		17/7	

RELINQUISHED BY:		RECEIVED BY:	
Name:	Alex Kachniuff	Name:	L. Angeles
Of:	WorkPavers	Of:	ALS
Date:	16/7/09	Date:	22/7/09
Time:	00:01	Time:	14:20
Name:		Name:	
Of:		Of:	
Date:		Date:	
Time:		Time:	

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; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulphuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

Environmental Division
Brisbane
Work Order
EB0911579



Telephone : + 61-7-3243 7222

METHOD OF SHIPMENT

23 for

CHAIN OF CUSTODY DOCUMENTATION									
CLIENT: <u>Whitby Parsons</u>		SAMPLER: <u>Alex Korbneff</u>		 Australian Laboratory Services Pty Ltd					
ADDRESS/OFFICE: <u>14/10, Ann St, Brisbane City</u>		MOBILE: <u>0419645639</u>							
PROJECT MANAGER (PM): <u>Alex Korbneff</u>		PHONE: <u>3319 3940</u>							
PROJECT ID: <u>301001-00752</u>		EMAIL REPORT TO: <u>alex.korbneff@whitby-parsons.com.au</u>							
SITE: <u>Leavitt Pt</u>		P.O. NO.:		EMAIL INVOICE TO: (if different to report) <u>above</u>					
RESULTS REQUIRED (Date): <u>Standard</u>		QUOTE NO.:		ANALYSIS REQUIRED INCLUDING SUITES (note - suite codes must be listed to attract suite prices)					
FOR LABORATORY USE ONLY COOLER SEAL (only appropriate) Fract: Yes No NA SAMPLE TEMPERATURE OFFILED: Yes No		COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:		TKZ Reactor Phosphorus CEC (Ca, Mg, K) TP4 / BTEX Heavy Metals * AC OP Notes: e.g. Highly contaminated samples, Extra volume for QC or trace LORs etc. * As, Cd, Cr, Cu, Ni, Pb, Zn, Hg					
SAMPLE INFORMATION (note: S = Soil, W = Water)		CONTAINER INFORMATION							
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles			
13	BH07/0.2-0.3	S	18/7						
14	BH08/0.0-0.1								
15	BH08/0.6-0.8								
16	BH09/0.0-0.1								
17	BH09B/0.0-0.1								
18	BH09B/0.2-0.3								
19	BH10/0.0-0.1								
20	BH10/0.0-0.02		19/7						
21	BH11/0.1-0.2								
22	BH12/0.0-0.1								
23	BH12/0.9-1.0								
24	BH13/0.0-0.1		14/7						
RELINQUISHED BY:				RECEIVED BY:					
Name: <u>Alex Korbneff</u>		Date: <u>16/7/09</u>		Name: <u>L. Ankles</u>		Date: <u>22/7/09</u>		Con' Note No:	
Of: <u>Whitby Parsons</u>		Time: <u>am</u>		Of: <u>MS</u>		Time: <u>1430</u>			
Name:		Date:		Name:		Date:		Transport Co:	
Of:		Time:		Of:		Time:			

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved;
 V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric 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 Bad for Acid Sulphate Solids; B = Unpreserved Bag.

ALS Environmental

CHAIN OF CUSTODY DOCUMENTATION

CLIENT:	WaterParsers	SAMPLER:	Alex Kachniuff
ADDRESS / OFFICE:	18/10, Ann St, Brisbane City	MOBILE:	0419645639
PROJECT MANAGER (PM):	Alex Kachniuff	PHONE:	3319 3940
PROJECT ID:	301001-00752	EMAIL REPORT TO:	alex.kachniuff@waterparsers.com
SITE:	Land Pt	EMAIL INVOICE TO: (if different to report)	above
P.O. NO.:			



RESULTS REQUIRED (Date): Standard. QUOTE NO.:

FOR LABORATORY USE ONLY:		COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:
COOLER SEAL (circle appropriate)		
Intact:	Yes No N/A	
SAMPLE TEMPERATURE		
CHILLED:	Yes No	

SAMPLE INFORMATION (note: S = Soil, W=Water)			CONTAINER INFORMATION		
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Total bottles
25	BH14/0.0-0.1	S	19/7		
26	BH14/0.5-0.6		↓		
27	BH15/0.0-0.1		18/7		
28	BH15/0.9-1.0		↓		
29	BH16/0.0-0.1		14/7		
30	BH16/0.4-0.5		↓		
31	BH17/0.0-0.05		18/7		
32	BH17/0.9-1.0				
33	BH18/0.0-0.05				
34	BH18/0.4-0.5				
35	BH18/0.9-1.0	↓			
36	LP GW	W	↓		

Notes: e.g. Highly contaminated samples, Extra volume for QC or trace LORs etc.
* As, Cd, Cr, Cu, Ni, Pb
Zn, Hg

RELINQUISHED BY:		RECEIVED BY:	
Name:	Alex Kachniuff	Name:	L. Angeles
Of:	WaterParsers	Of:	Ms.
Date:	16/7/09	Date:	22/7/09
Time:	am	Time:	1430
Name:		Name:	
Of:		Of:	
Date:		Date:	
Time:		Time:	

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; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulphuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bad for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: <u>Worky Parsons</u>	SAMPLER: <u>Alex Kechinoff</u>
ADDRESS / OFFICE: <u>1411 10, 333 Am St, Br's City</u>	MOBILE: <u>0494645629</u>
PROJECT MANAGER (PM): <u>Alex Kechinoff</u>	PHONE: <u>3719 39440</u>
PROJECT ID: <u>301001-00752.1</u>	EMAIL REPORT TO: <u>alex@als.com</u>
SITE: <u>Wind Pt.</u>	EMAIL INVOICE TO: (if different to report) <u>alex@als.com</u>
P.O. NO.:	

Australian Laboratory Services Pty Ltd



RESULTS REQUIRED (Date): <u>Stacked</u> QUOTE NO.:				ANALYSIS REQUIRED INCLUDING SUITES (note - suite codes must be listed to attract suite prices)														
FOR LABORATORY USE ONLY				Notes: e.g. Highly contaminated samples, Extra volume for QC or trace LORs etc.														
COOLER SEAL (circle appropriate)				*As, Cd, Cr, Cu, Ni, Pb, Zn, Hg														
Intact: Yes No N/A																		
SAMPLE TEMPERATURE																		
CHILLED: Yes No																		
SAMPLE INFORMATION (note: S = Soil, W=Water)																		
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type	Code	Total bottles	PH	EC	TKN	Recl	Prop	CEL (Ca, Mg, K, Na)	TPH/STEX	# Heavy Metals	ACOP	Hold	
37	RB02	W	18/7															
38	RB03	W	18/7															
39	TR01	W	19/7															
40	Depo2	S	19/7															

RELINQUISHED BY:		RECEIVED BY:	
Name: <u>Alex Kechinoff</u>	Date: <u>20/7</u>	Name: <u>L. Angeles</u>	Date: <u>22/7/09</u>
Of: <u>Worky Parsons</u>	Time: <u>am</u>	Of: <u>ALS</u>	Time: <u>1420</u>
Name:	Date:	Name:	Date:
Of:	Time:	Of:	Time:

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulfuric Preserved Plastic; 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 Bad for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EB0914592	Page	: 1 of 6
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 15-SEP-2009
C-O-C number	: Email	Issue Date	: 23-SEP-2009
Sampler	: ----	No. of samples received	: 13
Site	: Laird Pt	No. of samples analysed	: 13
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Phillip Kennedy	21C Environmental Laboratory	Inorganics

Environmental Division Brisbane

Part of the **ALS Laboratory Group**

32 Shand Street Stafford QLD Australia 4053

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Page : 3 of 6
Work Order : EB0914592 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- This report has been amended as a result of misinterpretation of sample identification numbers BH14 0.5-0.6 and BH15 0.9-1.0. All analysis results are as per the previous report



Analytical Results

Sub-Matrix: SOIL

Compound	CAS Number		LOR		Client sampling date / time		Client sample ID	
EA002 : pH (Solis)								
pH Value	---		0.1		5.0		pH Unit	
EA010: Conductivity								
Electrical Conductivity @ 25°C	---		1		272		µS/cm	
					585			
					61			
					5.8			
					6.2			
					6.3			
					61			
					30			



Analytical Results

Sub-Matrix: SOIL

Compound	CAS Number		LOR		Client sampling date / time		Client sample ID	
EA002 : pH (Soils)								
pH Value	---		0.1		pH Unit			
EA010: Conductivity								
Electrical Conductivity @ 25°C	---		1		µS/cm			

Environmental Division

QUALITY CONTROL REPORT

Work Order	: EB0914592	Page	: 1 of 5
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laird Pt		
C-O-C number	: Email	Date Samples Received	: 15-SEP-2009
Sampler	: ----	Issue Date	: 23-SEP-2009
Order number	: ----	No. of samples received	: 13
Quote number	: EN/034/09	No. of samples analysed	: 13

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025

Signatories

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

Signatories	Position	Accreditation Category
Phillip Kennedy	21C Environmental Laboratory	Inorganics



Page : 2 of 5
Work Order : EB0914592 Amendment 2
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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.

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 (%)
EA010: Conductivity (QC Lot: 1105109)									
EB0911579-026	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	47	45	4.3	0% - 20%
EB0914592-009	BH15/0.9-1.0	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	52	51	1.9	0% - 20%



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 Sample (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: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report		Laboratory Control Spike (LCS) Report			
				Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)		
EA002 : pH (Soils) (QCLot: 1105108)									
EA002: pH Value	----	0.1	pH Unit	----	5.2 pH Unit	100	96	104	
EA010: Conductivity (QCLot: 1105109)									
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	196 µS/cm	102	91	111	



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) Results are required to be reported.**



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EB0914592	Page	: 1 of 6
Amendment	: 2		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laird Pt		
C-O-C number	: Email	Date Samples Received	: 15-SEP-2009
Sampler	: ---	Issue Date	: 23-SEP-2009
Order number	: ---	No. of samples received	: 13
Quote number	: EN/034/09	No. of samples analysed	: 13

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

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The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW-846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Evaluation: **x** = Holding time breach ; **✓** = Within holding time.

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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(where) 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		Method	Count		Rate (%)		Quality Control Specification	
Analytical Methods			QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)								
Electrical Conductivity (1:5)		EA010	2	15	13.3	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)								
Electrical Conductivity (1:5)		EA010	1	15	6.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)		EA002	1	15	6.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)								
Electrical Conductivity (1:5)		EA010	1	15	6.7	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



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
pH (1:5)	EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)	EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 104)
Preparation Methods	Method	Matrix	Method Descriptions
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: SOIL

Method	Extraction / Preparation				Analysis	
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002 : pH (Soils)						
Snap Lock Bag						
BH01/0.3-0.4, BH03/0.4-0.5, BH06/0.9-1.0, BH12/0.9-1.0, BH15/0.9-1.0, BH17/0.9-1.0, BH18/0.9-1.0	18-SEP-2009	26-JUL-2009	54			
EA010: Conductivity						
Snap Lock Bag						
BH01/0.3-0.4, BH03/0.4-0.5, BH06/0.9-1.0, BH12/0.9-1.0, BH15/0.9-1.0, BH17/0.9-1.0, BH18/0.9-1.0	18-SEP-2009	26-JUL-2009	54			

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.



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

Maggie Kahi

From: Bryn Stephens
Sent: Tuesday, 15 September 2009 2:52 PM
To: Maggie Kahi
Cc: Matthew Goodwin; Cecilia Taylor
Subject: EB0911579 Rebatch & Ammendment

Hi Maggie,

Can you rebatch these samples from EB0911579 as per Alex's request below please?

Cecilia – Can you please amend sample 33 of EB0911579, currently labelled as BH17/0.0-0.05 but it should be **BH18/0.0-0.05**.

Thanks,

Bryn Stephens
 Customer Service Officer
ALS Laboratory Group
Environmental Division
 Brisbane, Australia
 Phone +61 7 3243 7222
 Direct +61 7 3243 7125
 Fax +61 7 3243 7181
www.alsglobal.com

Environmental Division
 Brisbane
 Work Order
EB0914592



Telephone : + 61-7-3243 7222

From: Kochnieff, Alex (Brisbane) [mailto:Alex.Kochnieff@WorleyParsons.com]
Sent: Tuesday, 15 September 2009 1:38 PM
To: Bryn Stephens
Cc: Jodie Hancock
Subject: EB0911579

Hi Byrn,

Hope your well.

Just wondering if you could get a few samples analysed for me and fix up a typo for the above work order?

I need to get all the samples listed below analysed for pH and EC. I'm aware that the holding times have probably expired. This is ok.

BH01/0.3-0.4	1
BH01/0.9-1.0	2
BH03/0.4-0.5	3
BH04/0.2-0.3	4
BH06/0.9-1.0	5
BH08/0.6-0.8	6
BH12/0.9-1.0	7
BH14/0.5-0.6	8
BH15/0.9-1.0	9
BH16/0.4-0.5	10
BH17/0.9-1.0	11
BH18/0.4-	12

15/09/2009

0.5	
BH18/0.9-	
1.0	13

Also there is a typo on ALS sample ID 33. It is currently labelled as BH17/0.0-0.05 but it should be **BH18/0.0-0.05**.

Could you please action and advise the turnaround times for the analysis above.

Cheers.

PS. We have move for the final time and are located at the address below.

Alex Kochnieff
Environmental Engineer
WorleyParsons
Telephone: +61 7 3319 3982
Direct: +61 7 3319 3940
Facsimile: +61 7 3319 7791
E-Mail: alex.kochnieff@worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812
Level 3, 60 Ann Street
Brisbane, QLD 4000
www.worleyparsons.com

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Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EB0914789	Page	: 1 of 5
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 15-SEP-2009
C-O-C number	: ----	Issue Date	: 25-SEP-2009
Sampler	: Alex Kichnieff	No. of samples received	: 10
Site	: Laind Pt	No. of samples analysed	: 8
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

Environmental Division Brisbane

Part of the **ALS Laboratory Group**

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Page : 3 of 5
Work Order : EB0914789
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001 - 00752

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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



Analytical Results

Sub-Matrix: SOIL

Compound	CAS Number		LOR		Unit		Client sample ID			
	Client sampling date / time		A01/I.0-1.1		A02/0.5-0.6		A02/I.0-1.1		A03/0.5-0.6	
EA002 : pH (Solis)	13-JUL-2009 15:00		EB0914789-001		EB0914789-002		EB0914789-003		EB0914789-004	
pH Value	---		0.1		pH Unit		4.2		4.5	
EA010: Conductivity	13-JUL-2009 15:00		1		µS/cm		6030		12400	
Electrical Conductivity @ 25°C	---		1		µS/cm		6030		12400	
ED007: Exchangeable Cations	13-JUL-2009 15:00		0.1		meq/100g		1.8		0.7	
^ Exchangeable Calcium	---		0.1		meq/100g		12.8		8.0	
^ Exchangeable Magnesium	---		0.1		meq/100g		2.0		1.4	
^ Exchangeable Potassium	---		0.1		meq/100g		58.5		33.3	
^ Exchangeable Sodium	---		0.1		meq/100g		75.1		43.5	
^ Cation Exchange Capacity	---		0.1		meq/100g		47.6		103	
	14-JUL-2009 15:00		A05/I.0-1.1		A05/I.0-1.1		14-JUL-2009 15:00		A05/I.0-1.1	
	---		7.7		7.7		7.7		7.7	
	14-JUL-2009 15:00		EB0914789-005		EB0914789-005		EB0914789-005		EB0914789-005	



Analytical Results

Sub-Matrix: SOIL

Compound	CAS Number		Client sample ID		Client sampling date / time	
	LOR	Unit	A06/0.0-0.1	A07/0.5-0.6	A08/1.0-1.1	
EA002 : pH (Solis)			EB0914789-006	EB0914789-007	EB0914789-008	
pH Value	0.1	pH Unit	7.6	7.9	7.4	
EA010: Conductivity						
Electrical Conductivity @ 25°C	1	µS/cm	4800	2850	3040	
ED007: Exchangeable Cations						
^ Exchangeable Calcium	0.1	meq/100g	1.7	1.4	1.0	
^ Exchangeable Magnesium	0.1	meq/100g	8.6	7.2	5.8	
^ Exchangeable Potassium	0.1	meq/100g	1.9	1.1	1.3	
^ Exchangeable Sodium	0.1	meq/100g	27.5	18.4	20.4	
^ Cation Exchange Capacity	0.1	meq/100g	39.6	28.1	28.5	



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EB0914789	Page	: 1 of 5
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt	Date Samples Received	: 15-SEP-2009
C-O-C number	: ----	Issue Date	: 25-SEP-2009
Sampler	: Alex Kichnieff	No. of samples received	: 10
Order number	: ----	No. of samples analysed	: 8
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics



Page : 2 of 5
Work Order : EB0914789
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001 - 00752

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.

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 (%)
EA010: Conductivity (QC Lot: 1105453)									
EB0914789-001	A01/1.0-1.1	EA010: Electrical Conductivity @ 25° C	----	1	µS/cm	9620	9600	0.2	0% - 20%
ED007: Exchangeable Cations (QC Lot: 1109744)									
EB0914789-001	A01/1.0-1.1	ED007: Exchangeable Calcium	----	0.1	meq/100g	1.8	1.9	6.9	0% - 50%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	12.8	14.0	8.5	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	2.0	2.2	11.2	0% - 20%
		ED007: Exchangeable Sodium	----	0.1	meq/100g	58.5	61.8	5.4	0% - 20%



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 Sample (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**

Sub-Matrix: SOIL					Laboratory Control Spike (LCS) Report				
Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
				Result		LCS	Low	High	
EA002 : pH (Soils) (QCLot: 1105452)									
EA002: pH Value	-----	0.1	pH Unit	-----	5.2 pH Unit	99.2		96	104
EA010: Conductivity (QCLot: 1105453)									
EA010: Electrical Conductivity @ 25°C	-----	1	µS/cm	<1	196 µS/cm	101		91	111
ED007: Exchangeable Cations (QCLot: 1109744)									
ED007: Exchangeable Calcium	-----	0.1	meq/100g	<0.1	1.47 meq/100g	95.7		70.2	105
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1	0.77 meq/100g	95.5		76.4	110
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1	0.20 meq/100g	73.8		70	95.3
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1	0.51 meq/100g	77.4		70	104
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	-----	2.95 meq/100g	91.0		70.1	104



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) Results are required to be reported.**



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EB0914789	Page	: 1 of 5
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt	Date Samples Received	: 15-SEP-2009
C-O-C number	: ----	Issue Date	: 25-SEP-2009
Sampler	: Alex Kichnieff	No. of samples received	: 10
Order number	: ----	No. of samples analysed	: 8
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Environmental Division Brisbane

Part of the **ALS Laboratory Group**

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis	
Container / Client Sample ID(s)			Date extracted	Due for extraction	Date analysed	Due for analysis
EA002 : pH (Soils)						
Snap Lock Bag A01/1.0-1.1, A02/1.0-1.1,	A02/0.5-0.6, A08/1.0-1.1	13-JUL-2009	18-SEP-2009	20-JUL-2009	18-SEP-2009	18-SEP-2009
					✖	✔
Snap Lock Bag A03/0.5-0.6, A06/0.0-0.1,	A05/1.0-1.1, A07/0.5-0.6	14-JUL-2009	18-SEP-2009	21-JUL-2009	18-SEP-2009	18-SEP-2009
					✖	✔
EA010: Conductivity						
Snap Lock Bag A01/1.0-1.1, A02/1.0-1.1,	A02/0.5-0.6, A08/1.0-1.1	13-JUL-2009	18-SEP-2009	20-JUL-2009	18-SEP-2009	16-OCT-2009
					✖	✔
Snap Lock Bag A03/0.5-0.6, A06/0.0-0.1,	A05/1.0-1.1, A07/0.5-0.6	14-JUL-2009	18-SEP-2009	21-JUL-2009	18-SEP-2009	16-OCT-2009
					✖	✔
ED007: Exchangeable Cations						
Pulp Bag A01/1.0-1.1, A02/1.0-1.1,	A02/0.5-0.6, A08/1.0-1.1	13-JUL-2009	23-SEP-2009	---	24-SEP-2009	09-JAN-2010
					---	✔
Pulp Bag A03/0.5-0.6, A06/0.0-0.1,	A05/1.0-1.1, A07/0.5-0.6	14-JUL-2009	23-SEP-2009	---	24-SEP-2009	10-JAN-2010
					---	✔



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(where) 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		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Electrical Conductivity (1:5)	EA010	1	8	12.5	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	1	8	12.5	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Electrical Conductivity (1:5)	EA010	1	8	12.5	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	1	8	12.5	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	1	8	12.5	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Electrical Conductivity (1:5)	EA010	1	8	12.5	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	1	8	12.5	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Page : 4 of 5
Work Order : EB0914789
Client : WORLEY PARSONS - INFRASTRUCTURE MWEE
Project : 301001 - 00752

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
pH (1:5)		EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)		EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 104)
Exchangeable Cations		ED007	SOIL	Rayment & Higginson (1992) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (1999) Schedule B(3) (Method 301)
Preparation Methods		Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method		ED007PR	SOIL	Rayment & Higginson (1992) method 15A1. A 1M NH ₄ Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
1:5 solid / water leach for soluble analytes		EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: SOIL

Method		Extraction / Preparation			Analysis	
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Days overdue
EA002 : pH (Soils)						
Snap Lock Bag						
A01/1.0-1.1, A02/1.0-1.1, A08/1.0-1.1	A02/0.5-0.6, A08/1.0-1.1	18-SEP-2009	20-JUL-2009	60		
Snap Lock Bag						
A03/0.5-0.6, A06/0.0-0.1,	A05/1.0-1.1, A07/0.5-0.6	18-SEP-2009	21-JUL-2009	59		
EA010: Conductivity						
Snap Lock Bag						
A01/1.0-1.1, A02/1.0-1.1,	A02/0.5-0.6, A08/1.0-1.1	18-SEP-2009	20-JUL-2009	60		
Snap Lock Bag						
A03/0.5-0.6, A06/0.0-0.1,	A05/1.0-1.1, A07/0.5-0.6	18-SEP-2009	21-JUL-2009	59		

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



Environmental Division

QUALITY CONTROL REPORT

Work Order	: EB0914789	Page	: 1 of 5
Amendment	: 1		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt		
C-O-C number	: ---	Date Samples Received	: 15-SEP-2009
Sampler	: Alex Kichnieff	Issue Date	: 29-SEP-2009
Order number	: ---	No. of samples received	: 10
Quote number	: EN/034/09	No. of samples analysed	: 10

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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



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Signatories

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Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics



Page : 2 of 5
Work Order : EB0914789 Amendment 1
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001 - 00752

General Comments

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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.

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 (%)
EA010: Conductivity (QC Lot: 1105453)									
EB0914789-001	A01/1.0-1.1	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	9620	9600	0.2	0% - 20%
EA010: Conductivity (QC Lot: 1113339)									
EB0914789-009	AO4_0.5-0.6	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	632	650	2.8	0% - 20%
ED007: Exchangeable Cations (QC Lot: 1109744)									
EB0914789-001	A01/1.0-1.1	ED007: Exchangeable Calcium	----	0.1	meq/100g	1.8	1.9	6.9	0% - 50%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	12.8	14.0	8.5	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	2.0	2.2	11.2	0% - 20%
		ED007: Exchangeable Sodium	----	0.1	meq/100g	58.5	61.8	5.4	0% - 20%
ED007: Exchangeable Cations (QC Lot: 1113331)									
EB0914789-009	AO4_0.5-0.6	ED007: Exchangeable Calcium	----	0.1	meq/100g	1.2	1.2	0.0	0% - 50%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	3.7	3.8	3.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.5	0.5	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	2.5	2.5	0.0	0% - 20%



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 Sample (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: Compound	CAS Number	LOR	Unit	Method Blank (MB)		Laboratory Control Spike (LCS) Report			
				Report	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
EA002 : pH (Soils) (QCLot: 1105452)	-----	0.1	pH Unit	-----		5.2 pH Unit	99.2	96	104
EA002 : pH (Soils) (QCLot: 1113338)	-----	0.1	pH Unit	-----		5.2 pH Unit	100	96	104
EA010: Conductivity (QCLot: 1105453)	-----	1	µS/cm	<1		196 µS/cm	101	91	111
EA010: Conductivity (QCLot: 1113339)	-----	1	µS/cm	<1		196 µS/cm	99.0	91	111
ED007: Exchangeable Cations (QCLot: 1109744)	-----	0.1	meq/100g	<0.1		1.47 meq/100g	95.7	70.2	105
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g	95.5	76.4	110
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g	73.8	70	95.3
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1		0.51 meq/100g	77.4	70	104
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	----		2.95 meq/100g	91.0	70.1	104
ED007: Exchangeable Cations (QCLot: 1113331)	-----	0.1	meq/100g	<0.1		1.47 meq/100g	94.1	70.2	105
ED007: Exchangeable Magnesium	-----	0.1	meq/100g	<0.1		0.77 meq/100g	97.1	76.4	110
ED007: Exchangeable Potassium	-----	0.1	meq/100g	<0.1		0.20 meq/100g	79.8	70	95.3
ED007: Exchangeable Sodium	-----	0.1	meq/100g	<0.1		----	----	----	----
ED007: Cation Exchange Capacity	-----	0.1	meq/100g	----		2.95 meq/100g	88.3	70.1	104



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) Results are required to be reported.**



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EB0914789	Page	: 1 of 6
Amendment	: 1		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt		
C-O-C number	: ---	Date Samples Received	: 15-SEP-2009
Sampler	: Alex Kichnieff	Issue Date	: 29-SEP-2009
Order number	: ---	No. of samples received	: 10
Quote number	: EN/034/09	No. of samples analysed	: 10

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Environmental Division Brisbane

Part of the **ALS Laboratory Group**

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation		Analysis			
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002 : pH (Soils)								
Pulp Bag		13-JUL-2009	27-SEP-2009	20-JUL-2009		28-SEP-2009	27-SEP-2009	✗
AO4_0.5-0.6, AO4_1.0-1.1								✗
Snap Lock Bag		13-JUL-2009	18-SEP-2009	20-JUL-2009	✗	18-SEP-2009	18-SEP-2009	✓
AO1/1.0-1.1, AO2/1.0-1.1, AO8/1.0-1.1								
Snap Lock Bag		14-JUL-2009	18-SEP-2009	21-JUL-2009	✗	18-SEP-2009	18-SEP-2009	✓
AO3/0.5-0.6, AO6/0.0-0.1, AO7/0.5-0.6								
EA010: Conductivity								
Pulp Bag		13-JUL-2009	27-SEP-2009	20-JUL-2009	✗	28-SEP-2009	25-OCT-2009	✓
AO4_0.5-0.6, AO4_1.0-1.1								
Snap Lock Bag		13-JUL-2009	18-SEP-2009	20-JUL-2009	✗	18-SEP-2009	16-OCT-2009	✓
AO1/1.0-1.1, AO2/1.0-1.1, AO8/1.0-1.1								
Snap Lock Bag		14-JUL-2009	18-SEP-2009	21-JUL-2009	✗	18-SEP-2009	16-OCT-2009	✓
AO3/0.5-0.6, AO6/0.0-0.1, AO7/0.5-0.6								
ED007: Exchangeable Cations								
Pulp Bag		13-JUL-2009	23-SEP-2009	---	----	24-SEP-2009	09-JAN-2010	✓
AO1/1.0-1.1, AO2/1.0-1.1, AO8/1.0-1.1								
Pulp Bag		13-JUL-2009	27-SEP-2009	09-JAN-2010	✓	28-SEP-2009	09-JAN-2010	✓
AO4_0.5-0.6, AO4_1.0-1.1								
Pulp Bag		14-JUL-2009	23-SEP-2009	---	----	24-SEP-2009	10-JAN-2010	✓
AO3/0.5-0.6, AO6/0.0-0.1, AO7/0.5-0.6								



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(where) 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		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Electrical Conductivity (1:5)	EA010	2	10	20.0	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	2	10	20.0	10.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Electrical Conductivity (1:5)	EA010	2	10	20.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	2	10	20.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	2	10	20.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Electrical Conductivity (1:5)	EA010	2	10	20.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	2	10	20.0	5.0	✔	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



Page : 4 of 6
Work Order : EB0914789 Amendment 1
Client : WORLEY PARSONS - INFRASTRUCTURE MWEE
Project : 301001 - 00752

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
pH (1:5)	EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)	EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 104)
Exchangeable Cations	ED007	SOIL	Rayment & Higginson (1992) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (1999) Schedule B(3) (Method 301)
Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method	ED007PR	SOIL	Rayment & Higginson (1992) method 15A1. A 1M NH ₄ Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

- For all regular sample matrices, no surrogate recovery outliers occur.

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Method		Extraction / Preparation				Analysis	
Container / Client Sample ID(s)		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002 : pH (Soils)							
Pulp Bag							
AO4_0.5-0.6,	AO4_1.0-1.1	27-SEP-2009	20-JUL-2009	69	28-SEP-2009	27-SEP-2009	1
Snap Lock Bag							
A01/1.0-1.1,	A02/0.5-0.6,	18-SEP-2009	20-JUL-2009	60			
A02/1.0-1.1,	A08/1.0-1.1						
Snap Lock Bag							
A03/0.5-0.6,	A05/1.0-1.1,	18-SEP-2009	21-JUL-2009	59			
A06/0.0-0.1,	A07/0.5-0.6						
EA010: Conductivity							
Pulp Bag							
AO4_0.5-0.6,	AO4_1.0-1.1	27-SEP-2009	20-JUL-2009	69			
Snap Lock Bag							
A01/1.0-1.1,	A02/0.5-0.6,	18-SEP-2009	20-JUL-2009	60			
A02/1.0-1.1,	A08/1.0-1.1						
Snap Lock Bag							
A03/0.5-0.6,	A05/1.0-1.1,	18-SEP-2009	21-JUL-2009	59			
A06/0.0-0.1,	A07/0.5-0.6						

The following report highlights breaches in the Frequency of Quality Control Samples.



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



Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)
Comprehensive Report

Work Order	: EB0914789		
Amendment	: 1		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	Page	: 1 of 2
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2009WORPAR0223 (EN/034/09)
Site	: Laind Pt		
Sampler	: Alex Kichnieff	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 15-SEP-2009	Issue Date	: 25-SEP-2009 13:12
Client Requested Due Date	: 29-SEP-2009	Scheduled Reporting Date	: 29-SEP-2009

Delivery Details

Mode of Delivery	: Samples on hand	Temperature	: AMBEINT
No. of coolers/boxes	: REBATCH	No. of samples received	: 10
Security Seal	: Intact.	No. of samples analysed	: 10

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Breaches in recommended extraction / analysis holding times may occur.**
- **We do not have sample ID's of A05/0.9-1.0 and A06/0.1-0.2 as listed on Rebatch email received.**
We do however have sample ID's of A05/1.0-1.1 and A06/0.0-0.1 as per listing on previous COC. We have assigned these samples with analysis as per email. Please advise if this is incorrect.
- **25/09/09 - This Work order has been amended to add pH, EC and CEC analysis to hold samples "A04_0.5-0.6" and "A04_1.0-1.1" per Alex Kochnieff's request.**
- **The recommended extraction time for pH and EC on soil samples is 7 days from the date of sampling.**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Maggie Kahi.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.



Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- No sample container / preservation non-compliance exist.

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Matrix: SOIL

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA002 pH (1:5)	SOIL - EA010 (solids): Electrical Conductivity (1:5) Electrical Conductivity (1:5)	SOIL - ED007 CEC / Exchangeable Cations (ED007)
EB0914789-001	13-JUL-2009 15:00	A01/1.0-1.1	✓	✓	✓
EB0914789-002	13-JUL-2009 15:00	A02/0.5-0.6	✓	✓	✓
EB0914789-003	13-JUL-2009 15:00	A02/1.0-1.1	✓	✓	✓
EB0914789-004	14-JUL-2009 15:00	A03/0.5-0.6	✓	✓	✓
EB0914789-005	14-JUL-2009 15:00	A05/1.0-1.1	✓	✓	✓
EB0914789-006	14-JUL-2009 15:00	A06/0.0-0.1	✓	✓	✓
EB0914789-007	14-JUL-2009 15:00	A07/0.5-0.6	✓	✓	✓
EB0914789-008	13-JUL-2009 15:00	A08/1.0-1.1	✓	✓	✓
EB0914789-009	13-JUL-2009 15:00	AO4_0.5-0.6	✓	✓	✓
EB0914789-010	13-JUL-2009 15:00	AO4_1.0-1.1	✓	✓	✓

Requested Deliverables

MR ALEX KOCHNIEFF

- *AU Certificate of Analysis - NATA (COA)	Email	alex.kochnieff@worleyparsons.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	alex.kochnieff@worleyparsons.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	alex.kochnieff@worleyparsons.com
- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	alex.kochnieff@worleyparsons.com
- A4 - AU Tax Invoice (INV)	Email	alex.kochnieff@worleyparsons.com
- Default - Chain of Custody (COC)	Email	alex.kochnieff@worleyparsons.com
- EDI Format - ENMRG (ENMRG)	Email	alex.kochnieff@worleyparsons.com
- EDI Format - XTab (XTAB)	Email	alex.kochnieff@worleyparsons.com



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EB0914789	Page	: 1 of 6
Amendment	: 1		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: LEVEL 3, 60 ALBERT STREET PO BOX 15081 CITY EAST BRISBANE QLD, AUSTRALIA 4000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3319 3940	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 3319 7791	Facsimile	: +61-7-3243 7218
Project	: 301001 - 00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 15-SEP-2009
C-O-C number	: ----	Issue Date	: 29-SEP-2009
Sampler	: Alex Kichnieff	No. of samples received	: 10
Site	: Laind Pt	No. of samples analysed	: 10
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

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Page : 3 of 6
Work Order : EB0914789 Amendment 1
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001 - 00752

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- This batch has been amended to add additional analysis to samples AO4_0.5-0.6 and AO4_1.0-1.1 as per client request.



Analytical Results

Sub-Matrix: PULP

Compound	CAS Number		Client sample ID		Client sampling date / time	
	LOR	Unit	AO4_0.5-0.6	AO4_1.0-1.1	13-JUL-2009 15:00	13-JUL-2009 15:00
EA002 : pH (Solis)			EB0914789-009	EB0914789-010		
pH Value	0.1	pH Unit	7.1	6.8		
EA010: Conductivity						
Electrical Conductivity @ 25°C	1	µS/cm	632	1620		
ED007: Exchangeable Cations						
^ Exchangeable Calcium	0.1	meq/100g	1.2	2.2		
^ Exchangeable Magnesium	0.1	meq/100g	3.7	9.3		
^ Exchangeable Potassium	0.1	meq/100g	0.5	1.3		
^ Exchangeable Sodium	0.1	meq/100g	2.5	10.6		
^ Cation Exchange Capacity	0.1	meq/100g	7.8	23.4		

Sub-Matrix: SOIL

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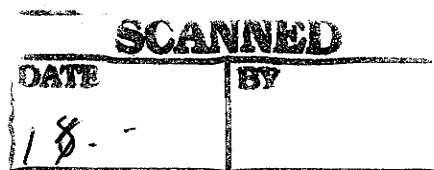
Analytical Results

Sub-Matrix: SOIL

Compound	CAS Number		Client sample ID		Client sampling date / time	
	LOR	Unit	A06/0.0-0.1	A07/0.5-0.6	A08/1.0-1.1	
EA002 : pH (Solis)			EB0914789-006	EB0914789-007	EB0914789-008	
pH Value	0.1	pH Unit	7.6	7.9	7.4	
EA010: Conductivity						
Electrical Conductivity @ 25°C	1	µS/cm	4800	2850	3040	
ED007: Exchangeable Cations						
^ Exchangeable Calcium	0.1	meq/100g	1.7	1.4	1.0	
^ Exchangeable Magnesium	0.1	meq/100g	8.6	7.2	5.8	
^ Exchangeable Potassium	0.1	meq/100g	1.9	1.1	1.3	
^ Exchangeable Sodium	0.1	meq/100g	27.5	18.4	20.4	
^ Cation Exchange Capacity	0.1	meq/100g	39.6	28.1	28.5	

Maggie Kahi

From: Bryn Stephens
Sent: Tuesday, 15 September 2009 6:15 PM
To: Maggie Kahi
Cc: Matthew Goodwin; Cecilia Taylor
Subject: EB0911356 Rebatches



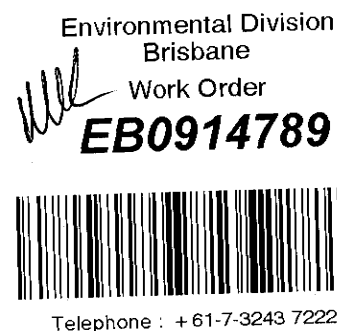
Hi Maggie,

Can you please perform this additional rebatch as per Alex's instruction below? You may need to look in bulk storage for the original A.S.S bags.

Cecilia – Can you please amend the ID for EB0911356 sample 6, current label is A02/3.0-3.1. It should be **A01/3.0-3.1**.

Thanks,

Bryn Stephens
 Customer Service Officer
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Environmental Division
 Brisbane, Australia
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 Fax +61 7 3243 7181
www.alsglobal.com



From: Kochnieff, Alex (Brisbane) [mailto:Alex.Kochnieff@WorleyParsons.com]
Sent: Tuesday, 15 September 2009 6:04 PM
To: Bryn Stephens
Subject: RE: EB0911579

As discussed,

I would like additional samples (see below) analysed for EC, pH, CEC and exchangeable cations from a separate batch (EB0911356) which were originally sampled for ASS.

- 1 A01/1.0-1.1
- 2 A02/0.5-0.6
- 3 A02/1.0-1.1
- 4 A03/0.5-0.6
- 5 A05/0.9-1.0
- 6 A06/0.1-0.2
- 7 A07/0.5-0.6
- 8 A08/1.0-1.1

Note there is a typo on the ALS sample ID 6. The current label is A02/3.0-3.1. It should be **A01/3.0-3.1**.

Could you also let me know the turn around times for the analysis?

Cheers for your help mate.

Alex Kochnieff
Environmental Engineer
WorleyParsons
 Telephone: +61 7 3319 3982
 Direct: +61 7 3319 3940
 Facsimile: +61 7 3319 7791
 E-Mail: alex.kochnieff@worleyparsons.com
 WorleyParsons Services Pty Ltd
 ABN 61 001 279 812
 Level 3, 60 Ann Street
 Brisbane, QLD 4000
www.worleyparsons.com

16/09/2009

29/9 Mb due to extra analysis.

Maggie Kahi

From: Matthew Goodwin
Sent: Wednesday, 23 September 2009 12:14 PM
To: Maggie Kahi
Subject: FW: Further analysis request - EB0914789

Matthew Goodwin
 Production Coordinator
ALS Laboratory Group
Environmental Division
 Brisbane, Australia
 Phone: +61 7 3243 7104
www.alsglobal.com

Environmental Division
 Brisbane
 Work Order
EB0914789



Telephone : +61-7-3243 7222

From: Tim Kilmister
Sent: Monday, 21 September 2009 11:04 AM
To: Matthew Goodwin
Cc: Kochnieff, Alex (Brisbane)
Subject: FW: Further analysis request - EB0914789

Matt

9 210

Could you take care of the request below to add analyses for samples A04_0.5+0.6 and A04_1.0-1.1 to work order EB0914789 (note it is a rebatch of EB0911356 which contains the required samples as hold).

Please reset the due date and resend the SRN.

I will take care of the second query.

thanks

Tim Kilmister
 Laboratory Manager
ALS Laboratory Group
 Brisbane, Australia
 Phone: + 61 7 3243 7222
 Fax: + 61 7 3243 7259
www.alsglobal.com

From: Kochnieff, Alex (Brisbane) [mailto:Alex.Kochnieff@WorleyParsons.com]
Sent: Monday, September 21, 2009 8:44 AM
To: Tim Kilmister
Subject: FW: Further analysis request - EB0914789

Morning Tim,

I received Carsten's out of Office reply. Hope you can help.

See below.

Alex Kochnieff
Environmental Engineer
WorleyParsons
 Telephone: +61 7 3319 3982
 Direct: +61 7 3319 3940
 Facsimile: +61 7 3319 7791
 E-Mail: alex.kochnieff@worleyparsons.com

23/09/2009

WorleyParsons Services Pty Ltd
ABN 61 001 279 812
Level 3, 60 Albert Street
Brisbane, QLD 4000
www.worleyparsons.com

From: Kochnieff, Alex (Brisbane)
Sent: Sunday, 20 September 2009 5:48 PM
To: Carsten Emrich
Subject: Further analysis request - EB0914789

Carsten,

I have a further request for one of the work orders you have been sorting out for me.

EB0914789

- Please analyse samples A04/0.5-0.6 and A04/1.0-1.1 for pH, EC, exchangeable cations and CEC
- Please check the pH result for A03/0.5-0.6? In the original analysis request for ASS chromium suite the pH was 5.9. The latest results report it as 3.9??

Thanks for your help with this annoying and confusing job.

Alex Kochnieff
Environmental Engineer
WorleyParsons
Telephone: +61 7 3319 3982
Direct: +61 7 3319 3940
Facsimile: +61 7 3319 7791
E-Mail: alex.kochnieff@worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812
Level 3, 60 Albert Street
Brisbane, QLD 4000
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*****
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23/09/2009



Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: EB0911356	Page	: 1 of 7
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Klimister
Address	: 106 WICKHAM STREET FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32449600	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 17-JUL-2009
C-O-C number	: ----	Issue Date	: 24-JUL-2009
Sampler	: Alex Kochnieff	No. of samples received	: 39
Site	: Laind Pt	No. of samples analysed	: 22
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics

Environmental Division Brisbane

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Page : 2 of 7
Work Order : EB0911356
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO₃) 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'.**
- **Retained Acidity not required because pH KCl greater than or equal to 4.5**

Sub-Matrix: SOIL

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Analytical Results

Sub-Matrix: SOIL

Sub-Matrix: SOIL		Client sample ID				Client sampling date / time			
Compound	CAS Number	LOR	Unit	A02/3.0-3.1	A02/0.5-0.6	A02/1.0-1.1	A02/1.5-1.6	A02/2.0-2.1	
				13-JUL-2009 15:00	13-JUL-2009 15:00	13-JUL-2009 15:00	13-JUL-2009 15:00	13-JUL-2009 15:00	
EB0911356-006									
EB0911356-007									
EB0911356-008									
EB0911356-009									
EB0911356-010									
EA033-A: Actual Acidity									
pH KCl (23A)	----	0.1	pH Unit	5.8	4.9	5.4	6.8	6.3	
Titratable Actual Acidity (23F)	----	2	mole H+ / t	4	16	9	<2	<2	
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	0.03	<0.02	<0.02	<0.02	
EA033-B: Potential Acidity									
Chromium Reducible Sulfur (22B)	----	0.02	% S	0.19	0.62	0.23	0.03	0.03	
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	116	390	145	19	19	
EA033-C: Acid Neutralising Capacity									
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	----	0.93	----	
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	----	186	----	
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	----	0.30	----	
EA033-E: 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	0.19	0.65	0.25	<0.02	0.03	
Net Acidity (acidity units)	----	10	mole H+ / t	120	406	154	<10	21	
Liming Rate	----	1	kg CaCO3/t	9	30	12	<1	2	



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID		Client sampling date / time		Unit	
	CAS Number	LOR	A02/2.5-2.6 13-JUL-2009 15:00	A03/0.0-0.1 13-JUL-2009 15:00	A03/0.5-0.6 13-JUL-2009 15:00	A06/0.0-0.1 13-JUL-2009 15:00
EA033-A: Actual Acidity						
pH KCl (23A)	----	0.1	6.1	8.7	5.9	6.8
Titratable Actual Acidity (23F)	----	2	2	<2	5	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity						
Chromium Reducible Sulfur (22B)	----	0.02	<0.02	<0.02	1.22	0.05
acidity - Chromium Reducible Sulfur (a-22B)	----	10	<10	<10	764	29
EA033-C: Acid Neutralising Capacity						
Acid Neutralising Capacity (19A2)	----	0.01	----	5.06	----	0.88
acidity - Acid Neutralising Capacity (a-19A2)	----	10	----	1010	----	176
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	----	1.62	----	0.28
EA033-E: Acid Base Accounting						
ANC Fineness Factor	----	0.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	<0.02	<0.02	1.23	<0.02
Net Acidity (acidity units)	----	10	<10	<10	770	<10
Liming Rate	----	1	<1	<1	58	<1



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID		Client sampling date / time		Unit	
	CAS Number	LOR	A07/1.0-1.1 13-JUL-2009 15:00	A07/2.0-2.1 13-JUL-2009 15:00	A07/3.0-3.1 13-JUL-2009 15:00	A07/4.0-4.1 13-JUL-2009 15:00
EA033-A: Actual Acidity						
pH KCl (23A)	----	0.1	5.8	6.1	5.9	5.9
Titratable Actual Acidity (23F)	----	2	5	<2	3	3
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity						
Chromium Reducible Sulfur (22B)	----	0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity						
Acid Neutralising Capacity (19A2)	----	0.01	----	----	----	0.73
acidity - Acid Neutralising Capacity (a-19A2)	----	10	----	----	----	145
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	----	----	----	0.23
EA033-E: Acid Base Accounting						
ANC Fineness Factor	----	0.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	<10	<10	<10	<10
Liming Rate	----	1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL

Compound	Client sample ID			Client sampling date / time		
	CAS Number	LOR	Unit	A08/2.0-2.1 13-JUL-2009 15:00	A08/3.0-3.1 13-JUL-2009 15:00	
EA033-A: Actual Acidity						
pH KCl (23A)		0.1	pH Unit			
Titratable Actual Acidity (23F)		2	mole H+ / t	6.4	6.3	
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<2	<2	
				<0.02	<0.02	
EA033-B: Potential Acidity						
Chromium Reducible Sulfur (22B)		0.02	% S	<0.02	<0.02	
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t	<10	<10	
EA033-E: 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	

Environmental Division

QUALITY CONTROL REPORT

Work Order	: EB0911356	Page	: 1 of 5
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: 106 WICKHAM STREET FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32449600	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt	Date Samples Received	: 17-JUL-2009
C-O-C number	: ----	Issue Date	: 24-JUL-2009
Sampler	: Alex Kochnieff	No. of samples received	: 39
Order number	: ----	No. of samples analysed	: 22
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

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



NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	Position	Accreditation Category
Kim McCabe	Senior Inorganic Chemist	Inorganics

Environmental Division Brisbane

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Page : 2 of 5
Work Order : EB0911356
Client : WORLEY PARSONS - INFRASTRUCTURE MWE
Project : 301001-00752

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.

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**

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 (%)
EA033-A: Actual Acidity (QC Lot: 1047812)									
EB0911356-001	A01/0.5-0.6	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	0.04	0.04	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	23	23	0.0	0% - 50%
		EA033: pH KCl (23A)	----	0.1	pH Unit	4.7	4.7	0.0	0% - 20%
EB0911356-011	A02/2.5-2.6	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.1	6.2	1.6	0% - 20%
EA033-A: Actual Acidity (QC Lot: 1047813)									
EB0911356-037	A08/2.0-2.1	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.4	6.3	1.6	0% - 20%
EA033-B: Potential Acidity (QC Lot: 1047812)									
EB0911356-001	A01/0.5-0.6	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	1.52	1.58	4.0	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	948	987	4.0	0% - 20%
EB0911356-011	A02/2.5-2.6	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EA033-B: Potential Acidity (QC Lot: 1047813)									
EB0911356-037	A08/2.0-2.1	EA033: Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	<0.02	0.0	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.0	No Limit



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 Sample (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**

Sub-Matrix: SOIL				Method Blank (MB) Report		Laboratory Control Spike (LCS) Report					
Method: Compound		CAS Number	LOR	Unit	Result	Spike Concentration		Spike Recovery (%)		Recovery Limits (%)	
EA033-A: Actual Acidity (QCLot: 1047812)											
EA033: Titratable Actual Acidity (23F)		1047812	2	mole H+ / t	<2	1000000	1000000	1000000	1000000	1000000	1000000
EA033: sulfidic - Titratable Actual Acidity (s-23F)		1047812	0.02	% pyrite S	<0.02	1000000	1000000	1000000	1000000	1000000	1000000
EA033-A: Actual Acidity (QCLot: 1047813)											
EA033: Titratable Actual Acidity (23F)		1047813	2	mole H+ / t	<2	1000000	1000000	1000000	1000000	1000000	1000000
EA033: sulfidic - Titratable Actual Acidity (s-23F)		1047813	0.02	% pyrite S	<0.02	1000000	1000000	1000000	1000000	1000000	1000000
EA033-B: Potential Acidity (QCLot: 1047812)											
EA033: Chromium Reducible Sulfur (22B)		1047812	0.02	% S	<0.02	1000000	1000000	1000000	1000000	1000000	1000000
EA033: acidity - Chromium Reducible Sulfur (a-22B)		1047812	10	mole H+ / t	<10	1000000	1000000	1000000	1000000	1000000	1000000
EA033-B: Potential Acidity (QCLot: 1047813)											
EA033: Chromium Reducible Sulfur (22B)		1047813	0.02	% S	<0.02	1000000	1000000	1000000	1000000	1000000	1000000
EA033: acidity - Chromium Reducible Sulfur (a-22B)		1047813	10	mole H+ / t	<10	1000000	1000000	1000000	1000000	1000000	1000000
EA033-C: Acid Neutralising Capacity (QCLot: 1047812)											
EA033: Acid Neutralising Capacity (19A2)		1047812	0.01	% CaCO3	<0.01	1000000	1000000	1000000	1000000	1000000	1000000
EA033: acidity - Acid Neutralising Capacity (a-19A2)		1047812	10	mole H+ / t	<10	1000000	1000000	1000000	1000000	1000000	1000000
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)		1047812	0.01	% pyrite S	<0.01	1000000	1000000	1000000	1000000	1000000	1000000



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) Results are required to be reported.**



Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: EB0911356	Page	: 1 of 6
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: 106 WICKHAM STREET FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32449600	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: Laind Pt	Date Samples Received	: 17-JUL-2009
C-O-C number	: ----	Issue Date	: 24-JUL-2009
Sampler	: Alex Kochnieff	No. of samples received	: 39
Order number	: ----	No. of samples analysed	: 22
Quote number	: EN/034/09		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Environmental Division Brisbane

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Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: SOIL

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date		Extraction / Preparation		Analysis	
Container / Client Sample ID(s)				Date extracted	Due for extraction	Date analysed	Due for analysis
EA033-A: Actual Acidity							
Snap Lock Bag - frozen		13-JUL-2009	17-JUL-2009	13-JUL-2010	24-JUL-2009	22-OCT-2009	✓
A01/0.5-0.6, A01/1.5-1.6, A01/2.5-2.6, A02/0.5-0.6, A02/1.0-1.1, A02/2.0-2.1, A02/3.0-3.1, A03/0.5-0.6, A07/1.0-1.1, A07/3.0-3.1, A08/1.0-1.1, A08/3.0-3.1							
EA033-B: Potential Acidity							
Snap Lock Bag - frozen		13-JUL-2009	17-JUL-2009	13-JUL-2010	24-JUL-2009	22-OCT-2009	✓
A01/0.5-0.6, A01/1.5-1.6, A01/2.5-2.6, A02/0.5-0.6, A02/1.5-1.6, A02/2.5-2.6, A03/0.0-0.1, A06/0.0-0.1, A07/2.0-2.1, A07/4.0-4.1, A08/2.0-2.1							



Matrix: **SOIL** Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method		Sample Date		Extraction / Preparation		Analysis			
Container / Client Sample ID(s)				Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-C: Acid Neutralising Capacity									
Snap Lock Bag - frozen			13-JUL-2009	17-JUL-2009	13-JUL-2010	✓	24-JUL-2009	22-OCT-2009	✓
A01/0.5-0.6, A01/1.5-1.6, A01/2.5-2.6, A02/0.5-0.6, A02/1.5-1.6, A02/2.5-2.6, A03/0.0-0.1, A06/0.0-0.1, A07/2.0-2.1, A07/4.0-4.1, A08/2.0-2.1,		A01/1.0-1.1, A01/2.0-2.1, A02/3.0-3.1, A02/1.0-1.1, A02/2.0-2.1, A02/3.0-3.1, A03/0.5-0.6, A07/1.0-1.1, A07/3.0-3.1, A08/1.0-1.1, A08/3.0-3.1							
EA033-D: Retained Acidity									
Snap Lock Bag - frozen			13-JUL-2009	17-JUL-2009	13-JUL-2010	✓	24-JUL-2009	22-OCT-2009	✓
A01/0.5-0.6, A01/1.5-1.6, A01/2.5-2.6, A02/0.5-0.6, A02/1.5-1.6, A02/2.5-2.6, A03/0.0-0.1, A06/0.0-0.1, A07/2.0-2.1, A07/4.0-4.1, A08/2.0-2.1,		A01/1.0-1.1, A01/2.0-2.1, A02/3.0-3.1, A02/1.0-1.1, A02/2.0-2.1, A02/3.0-3.1, A03/0.5-0.6, A07/1.0-1.1, A07/3.0-3.1, A08/1.0-1.1, A08/3.0-3.1							
EA033-E: Acid Base Accounting									
Snap Lock Bag - frozen			13-JUL-2009	17-JUL-2009	13-JUL-2010	✓	24-JUL-2009	22-OCT-2009	✓
A01/0.5-0.6, A01/1.5-1.6, A01/2.5-2.6, A02/0.5-0.6, A02/1.5-1.6, A02/2.5-2.6, A03/0.0-0.1, A06/0.0-0.1, A07/2.0-2.1, A07/4.0-4.1, A08/2.0-2.1,		A01/1.0-1.1, A01/2.0-2.1, A02/3.0-3.1, A02/1.0-1.1, A02/2.0-2.1, A02/3.0-3.1, A03/0.5-0.6, A07/1.0-1.1, A07/3.0-3.1, A08/1.0-1.1, A08/3.0-3.1							



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(where) 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		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	3	22	13.6	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	22	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement



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
Chromium Suite for Acid Sulphate Soils		EA033	SOIL	Ahem et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Preparation Methods		Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)		EN020PR	SOIL	In house



Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QW/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- For all matrices, no Method Blank value outliers occur.
- For all matrices, no Duplicate outliers occur.
- For all matrices, no Laboratory Control outliers occur.
- For all matrices, no Matrix Spike outliers occur.

Regular Sample Surrogates

- For all regular sample matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- No Quality Control Sample Frequency Outliers exist.



Environmental Division

SAMPLE RECEIPT NOTIFICATION (SRN)
Comprehensive Report

Work Order	: EB0911356		
Client	: WORLEY PARSONS - INFRASTRUCTURE MWE	Laboratory	: Environmental Division Brisbane
Contact	: MR ALEX KOCHNIEFF	Contact	: Tim Kilmister
Address	: 106 WICKHAM STREET FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: alex.kochnieff@worleyparsons.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 32449600	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 301001-00752	Page	: 1 of 3
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2009WORPAR0223 (EN/034/09)
Site	: Laind Pt		
Sampler	: Alex Kochnieff	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 17-JUL-2009	Issue Date	: 20-JUL-2009 13:28
Client Requested Due Date	: 24-JUL-2009	Scheduled Reporting Date	: 24-JUL-2009

Delivery Details

Mode of Delivery	: Carrier	Temperature	: -31 C - -16 C - Ice present
No. of coolers/boxes	: 4 MEDIUM	No. of samples received	: 39
Security Seal	: Intact.	No. of samples analysed	: 22

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Sample(s) have been received within recommended holding times.**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Maggie Kahi.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.



Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- No sample container / preservation non-compliance exist.

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	(On Hold) SOIL No analysis requested	SOIL - EA033 Chromium Suite for Acid Sulphate Soils
EB0911356-001	13-JUL-2009 15:00	A01/0.5-0.6		✓
EB0911356-002	13-JUL-2009 15:00	A01/1.0-1.1		✓
EB0911356-003	13-JUL-2009 15:00	A01/1.5-1.6		✓
EB0911356-004	13-JUL-2009 15:00	A01/2.0-2.1		✓
EB0911356-005	13-JUL-2009 15:00	A01/2.5-2.6		✓
EB0911356-006	13-JUL-2009 15:00	A02/3.0-3.1		✓
EB0911356-007	13-JUL-2009 15:00	A02/0.5-0.6		✓
EB0911356-008	13-JUL-2009 15:00	A02/1.0-1.1		✓
EB0911356-009	13-JUL-2009 15:00	A02/1.5-1.6		✓
EB0911356-010	13-JUL-2009 15:00	A02/2.0-2.1		✓
EB0911356-011	13-JUL-2009 15:00	A02/2.5-2.6		✓
EB0911356-012	13-JUL-2009 15:00	A02/3.0-3.1		✓
EB0911356-013	13-JUL-2009 15:00	A03/0.0-0.1		✓
EB0911356-014	13-JUL-2009 15:00	A03/0.5-0.6		✓
EB0911356-015	13-JUL-2009 15:00	A04/0.5-0.6	✓	
EB0911356-016	13-JUL-2009 15:00	A04/1.0-1.1	✓	
EB0911356-017	13-JUL-2009 15:00	A04/1.5-1.6	✓	
EB0911356-018	13-JUL-2009 15:00	A04/2.0-2.1	✓	
EB0911356-019	13-JUL-2009 15:00	A04/2.5-2.6	✓	
EB0911356-020	13-JUL-2009 15:00	A04/3.0-3.1	✓	
EB0911356-021	13-JUL-2009 15:00	A04/3.5-3.6	✓	
EB0911356-022	13-JUL-2009 15:00	A05/0.0-0.1	✓	
EB0911356-023	13-JUL-2009 15:00	A05/0.5-0.6	✓	
EB0911356-024	13-JUL-2009 15:00	A05/1.0-1.1	✓	
EB0911356-025	13-JUL-2009 15:00	A06/0.0-0.1		✓
EB0911356-026	13-JUL-2009 15:00	A07/0.5-0.6	✓	
EB0911356-027	13-JUL-2009 15:00	A07/1.0-1.1		✓
EB0911356-028	13-JUL-2009 15:00	A07/1.5-1.6	✓	
EB0911356-029	13-JUL-2009 15:00	A07/2.0-2.1		✓
EB0911356-030	13-JUL-2009 15:00	A07/2.5-2.6	✓	
EB0911356-031	13-JUL-2009 15:00	A07/3.0-3.1		✓
EB0911356-032	13-JUL-2009 15:00	A07/3.5-3.6	✓	
EB0911356-033	13-JUL-2009 15:00	A07/4.0-4.1		✓
EB0911356-034	13-JUL-2009 15:00	A08/0.5-0.6	✓	
EB0911356-035	13-JUL-2009 15:00	A08/1.0-1.1		✓



			(On Hold) SOIL No analysis requested	SOIL - EA033 Chromium Suite for Acid Sulphate Soils
EB0911356-036	13-JUL-2009 15:00	A08/1.5-1.6	✓	
EB0911356-037	13-JUL-2009 15:00	A08/2.0-2.1		✓
EB0911356-038	13-JUL-2009 15:00	A08/2.5-2.6	✓	
EB0911356-039	13-JUL-2009 15:00	A08/3.0-3.1		✓

Requested Deliverables

MR ALEX KOCHNIEFF

- *AU Certificate of Analysis - NATA (COA)
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)
- A4 - AU Sample Receipt Notification - Environmental (SRN)
- A4 - AU Tax Invoice (INV)
- Default - Chain of Custody (COC)
- EDI Format - ENMRG (ENMRG)
- EDI Format - XTab (XTAB)

Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com
Email	alex.kochnieff@worleyparsons.com

24/7

CHAIN OF CUSTODY DOCUMENTATION



Australian Laboratory Services Pty Ltd

CLIENT: WaterPurvers
ADDRESS / OFFICE: 14/10, Ann St, Brisbane City
PROJECT MANAGER (PM): Alex Kochmiev
PROJECT ID: 301001-00752
SITE: Saint Pt
P.O. NO.:
SAMPLER: Alex Kochmiev
MOBILE: 0419645639
PHONE: 3319 3940
EMAIL REPORT TO: alex.kochmiev@waterpurvers.com.au
EMAIL INVOICE TO: (if different to report) above

RESULTS REQUIRED (Date): Standard QUOTE NO.:
ANALYSIS REQUIRED INCLUDING SUITES (note - suite codes must be listed to attract suite prices)

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
CHILLED: Yes No

Notes: e.g. Highly contaminated samples,
Extra volume for QC or trace LORs etc.

SAMPLE INFORMATION (note: S = Soil, W=Water)				CONTAINER INFORMATION	
ALS ID	SAMPLE ID	MATRIX	DATE	Type / Code	Total bottles
1	A01/0.5-0.6	S	13/7		
2	A01/1.0-1.1				
3	A01/1.5-1.6				
4	A01/2.0-2.1				
5	A01/2.5-2.6				
6	A01/3.0-3.1				
7	A02/0.5-0.6				
8	A02/1.0-1.1				
9	A02/1.5-1.6				
10	A02/2.0-2.1				
11	A02/2.5-2.6				
12	A02/3.0-3.1				

RELINQUISHED BY: Alex Kochmiev Date: 16/7/09
Name: WaterPurvers Time: am
Of: Date: Time:
Name: Date: Time:
Of: Date: Time:

RECEIVED BY: C. Bryant Date: 17/7/09
Name: ALS Time: 1445
Of: Date: Time:
Name: Date: Time:
Of: Date: Time:

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved;
V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Plastic; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bad for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division
Brisbane
Work Order
EB0911356



Telephone : + 61-7-3243 7222

ALS Environmental

CHAIN OF CUSTODY DOCUMENTATION



Australian Laboratory Services Pty Ltd

SAMPLER: Alex Kachniuff

MOBILE: 0419645639

PHONE: 3319 3940

EMAIL REPORT TO: alex.kachniuff@australianservices.com

EMAIL INVOICE TO: (if different to report) above

P.O. NO.:

RESULTS REQUIRED (Date): Standard QUOTE NO.:

FOR LABORATORY USE ONLY

COOLER SEAL (circle appropriate)

Intact: Yes No N/A

SAMPLE TEMPERATURE

CHILLED: Yes No

SAMPLE INFORMATION (note: S = Soil, W = Water)

CONTAINER INFORMATION

ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles
13	A03/0.0-0.1	S	14/7			
14	A03/0.5-0.6	S	14/7			
15	A04/0.5-0.6	S	13/7			
16	A04/1.0-1.1	S	13/7			
17	A04/1.5-1.6					
18	A04/2.0-2.1					
19	A04/2.5-2.6					
20	A04/3.0-3.1					
21	A04/3.5-3.6					
22	A05/0.0-0.1		14/7			
23	A05/0.5-0.6		14/7			
24	A05/1.0-1.1		14/7			

Notes: e.g. Highly contaminated samples, Extra volume for QC or trace LORs etc.

RELINQUISHED BY:

Name: Alex Kachniuff Date: 16/7/09
 Of: Whaley Parsons Time: am
 Name: Time:
 Name: Time:

RECEIVED BY:

Name: Date:
 Of: Time:
 Name: Date:
 Of: Time:

METHOD OF SHIPMENT

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; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulphuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag.

ALS Environmental

CHAIN OF CUSTODY DOCUMENTATION



Australian Laboratory Services Pty Ltd

CLIENT:	Whitby Parsons
ADDRESS / OFFICE:	16/110, Ann St, Brisbane City
PROJECT MANAGER (PM):	Alex Kochmireff
PROJECT ID:	301001-00752
SITE:	Land P4
P.O. NO.:	
EMAIL REPORT TO:	alex.kochmireff@whitby-parsons.com
EMAIL INVOICE TO: (if different to report)	above

RESULTS REQUIRED (Date): Standard				QUOTE NO.:			
FOR LABORATORY USE ONLY				COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL			
COOLER SEAL (circle appropriate)							
Intact: Yes No N/A							
SAMPLE TEMPERATURE							
CHILLED: Yes No							
SAMPLE INFORMATION (note: S = Soil, W = Water)				CONTAINER INFORMATION			
ALS ID	SAMPLE ID	MATRIX	DATE	Time	Type / Code	Total bottles	
25	A06/00-0.1	S	14/7				
26	A07/0.5-0.6						
27	A07/1.0-1.1						
28	A07/1.5-1.6						
29	A07/2.0-2.1						
30	A07/2.5-2.6						
31	A07/3.0-3.1						
32	A07/3.5-3.6						
33	A07/4.0-4.1						
34	A08/0.5-0.6		13/7				
35	A08/1.0-1.1						
36	A08/1.5-1.6						

RELINQUISHED BY:		RECEIVED BY:	
Name: Alex Kochmireff	Date: 16/7/09	Name: [Signature]	Date: [Signature]
Of: Whitby Parsons	Time: 9:00	Of: [Signature]	Time: [Signature]
Name: [Signature]	Date: [Signature]	Name: [Signature]	Date: [Signature]
Of: [Signature]	Time: [Signature]	Of: [Signature]	Time: [Signature]

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; V = VOA Vial HCl Preserved; VS = VOA Vial Sulphuric Preserved; SG = Sulphuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulphuric 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.

ALS Environmental

Australian Laboratory services Pty Ltd

CLIENT:	WaterParsons
ADDRESS / OFFICE:	18110, Ann St, Brisbane City
PROJECT MANAGER (PM):	Alex Kachnareff
PROJECT ID:	301001-00752
SITE:	Levin Rd Pt
SAMPLER:	Alex Kachnareff
MOBILE:	0419645639
PHONE:	3319 3940
EMAIL REPORT TO:	alex.kachnareff@waterparsons.com.au
EMAIL INVOICE TO: (if different to report)	above

ANALYSIS REQUIRED (Date): 10/10/11	SUITE NO.: 5000

RESULT IS REQUIRED (date):	STATION #	CONTAINER:	COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:
FOR LABORATORY USE ONLY			
COOLER SEAL (circle appropriate)			
Intact	Yes	No	N/A
SAMPLE TEMPERATURE			
CHILLED	Yes	No	

[illegible]

RELINQUISHED BY:		RECEIVED BY:	
Name: Alex Kachnoff	Date: 11/2/09	Name: 	Date:
Of: Wally Parsons	Time: a.m.	Of:	Time:
Name:	Date:	Name:	Date:
Of:	Time:	Of:	Time:

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; V = Vial Vial HCl Preserved; VS = VOA Vial HCl Preserved; 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.

ALS Environmental

Appendix E   Photographs of soils



Photo 1: BH01 / 0.0 - 1.0 m



Photo 2: BH02 / 0.0 - 0.2m



Photo 3: BH03 / 0.2 – 0.5m



Photo 4: BH04 / 0.1 – 0.3m



Photo 5: BH05 / 0.0 – 0.3m



Photo 6: BH06 / 0.7 – 1.0m



Photo 7: BH07 / 0.0 – 0.3m



Photo 8: BH08 / 0.0 – 0.8m



Photo 9: BH09 / 0.0 – 0.7m



Photo 10: BH09B / 0.0 – 0.3m



Photo 11: BH10 / 0.0 – 0.3m



Photo 12: BH11 / 0.0 – 0.3m



Photo 13: BH12 / 0.3 – 0.5m



Photo 12: BH13 / 0.0 – 0.3m



Photo 13: BH14 / 0.4 – 0.6m



Photo 14: BH15 / 0.0 – 1.0m



Photo 15: BH16 / 0.0 – 0.5m



Photo 16: BH17 / 0.6 – 0.7m



Photo 17: BH18 / 0.0 – 0.2m



Photo 16: BH18 / 0.05 – 0.5m



Photo 17: BH18 / 0.6 – 0.8m



Photo 18: BH18 / 0.8 – 1.0m



Photo 19: A01 / 0.0 – 1.0m



Photo 20: A02 / 0.0 – 1.5m



Photo 21: A03



Photo 22: A04 / 0.0 – 1.0m



Photo 23: A05 / 0.0 – 1.0m



Photo 22: A06 / 0.0 – 1.0m



Photo 23: A07 / 0.0 – 1.0m



Photo 24: A08 / 0.0 – 1.0m