



Appendix H

**Surface Water and
Freshwater Aquatic Ecology
Characterisation -
Yalu to Wagang**

DISCLAIMER

This disclaimer applies to and governs the disclosure and use of this Environmental Impact Statement (“EIS”), and by reading, using or relying on any part(s) of the EIS you accept this disclaimer in full.

This Environmental Impact Statement, including the Executive Summary, and all chapters of and attachments and appendices to it and all drawings, plans, models, designs, specifications, reports, photographs, surveys, calculations and other data and information in any format contained and/or referenced in it, is together with this disclaimer referred to as the “EIS”.

Purpose of EIS

The EIS has been prepared by, for and on behalf of Wafi Mining Limited and Newcrest PNG 2 Limited (together the “**WGJV Participants**”), being the participants in the Wafi-Golpu Joint Venture (“**WGJV**”) and the registered holders of exploration licences EL 440 and EL1105, for the sole purpose of an application (the “**Permit Application**”) by them for environmental approval under the Environment Act 2000 (the “**Act**”) for the proposed construction, operation and (ultimately) closure of an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (the “**Project**”) in Morobe Province, Independent State of Papua New Guinea. The EIS was prepared with input from consultants engaged by the WGJV Participants and/or their related bodies corporate (“**Consultants**”).

The Permit Application is to be lodged with the Conservation and Environment Protection Authority (“**CEPA**”), Independent State of Papua New Guinea.

Ownership and Copyright

The EIS is the sole property of the WGJV Participants, who reserve and assert all proprietary and copyright ©2018 interests.

Reliance and Use

The EIS is intended and will be made available to CEPA, for review by CEPA and other applicable agencies of the Government of the Independent State of Papua New Guinea (“**Authorised Agencies**”), for the purpose of considering and assessing the Permit Application in accordance with the Act (“**Authorised Purpose**”), and for no other purpose whatsoever.

The EIS shall not be used or relied upon for any purpose other than the Authorised Purpose, unless express written approval is given in advance by the WGJV Participants.

Except for the Authorised Purpose, the EIS, in whole or in part, must not be reproduced, unless express written approval is given in advance by the WGJV Participants.

This disclaimer must accompany every copy of the EIS.

The EIS is meant to be read as a whole, and any part of it should not be read or relied upon out of context.

Limits on investigation and information

The EIS is based in part on information not within the control of either the WGJV Participants or the Consultants. While the WGJV Participants and Consultants believe that the information contained in the EIS should be reliable under the conditions and subject to the limitations set forth in the EIS, they do not guarantee the accuracy of that information.

No Representations or Warranties

While the WGJV Participants, their Related Bodies Corporate and Consultants believe that the information (including any opinions, forecasts or projections) contained in the EIS should be reliable under the conditions and subject to the limitations set out therein, and provide such information in good faith, they make no warranty, guarantee or promise, express or implied, that any of the information will be correct, accurate, complete or up to date, nor that such information will remain unchanged after the date of issue of the EIS to CEPA, nor that any forecasts or projections will be realised. Actual outcomes may vary materially and adversely from projected outcomes.

The use of the EIS shall be at the user’s sole risk absolutely and in all respects. Without limitation to the foregoing, and to the maximum extent permitted by applicable law, the WGJV Participants, their Related Bodies Corporate and Consultants:

- do not accept any responsibility, and disclaim all liability whatsoever, for any loss, cost, expense or damage (howsoever arising, including in contract, tort (including negligence) and for breach of statutory duty) that any person or entity may suffer or incur caused by or resulting from any use of or reliance on the EIS or the information contained therein, or any inaccuracies, misstatements, misrepresentations, errors or omissions in its content, or on any other document or information supplied by the WGJV Participants to any Authorised Agency at any time in connection with the Authorised Agency’s review of the EIS; and
- expressly disclaim any liability for any consequential, special, contingent or penal damages whatsoever.

The basis of the Consultants’ engagement is that the Consultants’ liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of their engagement with the WGJV Participants and/or their related bodies corporate.

Disclosure for Authorised Purpose

The WGJV Participants acknowledge and agree that, for the Authorised Purpose, the EIS may be:

- copied, reproduced and reprinted;
- published or disclosed in whole or in part, including being made available to the general public in accordance with section 55 of the Act. All publications and disclosures are subject to this disclaimer.

Development of Project subject to Approvals, Further Studies and Market and Operating Conditions

Any future development of the Project is subject to further studies, completion of statutory processes, receipt of all necessary or desirable Papua New Guinea Government and WGJV Participant approvals, and market and operating conditions.

Engineering design and other studies are continuing and aspects of the proposed Project design and timetable may change.

NEWCREST MINING LIMITED DISCLAIMER

Newcrest Mining Limited (“**Newcrest**”) is the ultimate holding company of Newcrest PNG 2 Limited and any reference below to “Newcrest” or the “Company” includes both Newcrest Mining Limited and Newcrest PNG 2 Limited.

Forward Looking Statements

The EIS includes forward looking statements. Forward looking statements can generally be identified by the use of words such as “may”, “will”, “expect”, “intend”, “plan”, “estimate”, “anticipate”, “continue”, “outlook” and “guidance”, or other similar words and may include, without limitation, statements regarding plans, strategies and objectives of management, anticipated production or construction commencement dates and expected costs or production outputs. The Company continues to distinguish between outlook and guidance. Guidance statements relate to the current financial year. Outlook statements relate to years subsequent to the current financial year.

Forward looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the Company’s actual results, performance and achievements to differ materially from statements in this EIS. Relevant factors may include, but are not limited to, changes in commodity prices, foreign exchange fluctuations and general economic conditions, increased costs and demand for production inputs, the speculative nature of exploration and project development, including the risks of obtaining necessary licences and permits and diminishing quantities or grades of reserves, political and social risks, changes to the regulatory framework within which the Company operates or may in the future operate, environmental conditions including extreme weather conditions, recruitment and retention of personnel, industrial relations issues and litigation.

Forward looking statements are based on the Company’s good faith assumptions as to the financial, market, regulatory and other relevant environments that will exist and affect the Company’s business and operations in the future.

The Company does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of the Company. Readers are cautioned not to place undue reliance on forward looking statements. Forward looking statements in the EIS speak only at the date of issue. Except as required by applicable laws or regulations, the Company does not undertake any obligation to publicly update or revise any of the forward looking statements or to advise of any change in assumptions on which any such statement is based.

Non-IFRS Financial Information

Newcrest results are reported under International Financial Reporting Standards (IFRS) including EBIT and EBITDA. The EIS also includes non-IFRS information including Underlying profit (profit after tax before significant items attributable to owners of the parent company), All-In Sustaining Cost (determined in accordance with the World Gold Council Guidance Note on Non-GAAP Metrics released June 2013), AISC Margin (realised gold price less AISC per ounce sold (where expressed as USD), or realised gold price less AISC per ounce sold divided by realised gold price (where expressed as a %), Interest Coverage Ratio (EBITDA/Interest payable for the relevant period), Free cash flow (cash flow from operating activities less cash flow related to investing activities), EBITDA margin (EBITDA expressed as a percentage of revenue) and EBIT margin (EBIT expressed as a percentage of revenue). These measures are used internally by Management to assess the performance of the business and make decisions on the allocation of resources and are included in the EIS to provide greater understanding of the underlying performance of Newcrest's operations. The non-IFRS information has not been subject to audit or review by Newcrest's external auditor and should be used in addition to IFRS information.

Ore Reserves and Mineral Resources Reporting Requirements

As an Australian Company with securities listed on the Australian Securities Exchange (ASX), Newcrest is subject to Australian disclosure requirements and standards, including the requirements of the Corporations Act 2001 and the ASX. Investors should note that it is a requirement of the ASX listing rules that the reporting of Ore Reserves and Mineral Resources in Australia comply with the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) and that Newcrest's Ore Reserve and Mineral Resource estimates comply with the JORC Code.

Competent Person's Statement

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

HARMONY GOLD MINING COMPANY LIMITED DISCLAIMER

Harmony Gold Mining Company Limited ("Harmony") is the ultimate holding company of Wafi Mining Limited and any reference below to "Harmony" or the "Company" includes both Harmony Gold Mining Company Limited and Wafi Mining Limited.

Forward Looking Statements

These materials contain forward-looking statements within the meaning of the safe harbor provided by Section 21E of the Securities Exchange Act of 1934, as amended, and Section 27A of the Securities Act of 1933, as amended, with respect to our financial condition, results of operations, business strategies, operating efficiencies, competitive positions, growth opportunities for existing services, plans and objectives of

management, markets for stock and other matters. These include all statements other than statements of historical fact, including, without limitation, any statements preceded by, followed by, or that include the words "targets", "believes", "expects", "aims", "intends", "will", "may", "anticipates", "would", "should", "could", "estimates", "forecast", "predict", "continue" or similar expressions or the negative thereof.

These forward-looking statements, including, among others, those relating to our future business prospects, revenues and income, wherever they may occur in this EIS and the exhibits to this EIS, are essentially estimates reflecting the best judgment of our senior management and involve a number of risks and uncertainties that could cause actual results to differ materially from those suggested by the forward-looking statements. As a consequence, these forward-looking statements should be considered in light of various important factors, including those set forth in these materials. Important factors that could cause actual results to differ materially from estimates or projections contained in the forward-looking statements include, without limitation: overall economic and business conditions in South Africa, Papua New Guinea, Australia and elsewhere, estimates of future earnings, and the sensitivity of earnings to the gold and other metals prices, estimates of future gold and other metals production and sales, estimates of future cash costs, estimates of future cash flows, and the sensitivity of cash flows to the gold and other metals prices, statements regarding future debt repayments, estimates of future capital expenditures, the success of our business strategy, development activities and other initiatives, estimates of reserves statements regarding future exploration results and the replacement of reserves, the ability to achieve anticipated efficiencies and other cost savings in connection with past and future acquisitions, fluctuations in the market price of gold, the occurrence of hazards associated with underground and surface gold mining, the occurrence of labour disruptions, power cost increases as well as power stoppages, fluctuations and usage constraints, supply chain shortages and increases in the prices of production imports, availability, terms and deployment of capital, changes in government regulation, particularly mining rights and environmental regulation, fluctuations in exchange rates, the adequacy of the Group's insurance coverage and socio-economic or political instability in South Africa and Papua New Guinea and other countries in which we operate.

For a more detailed discussion of such risks and other factors (such as availability of credit or other sources of financing), see the Company's latest Integrated Annual Report and Form 20-F which is on file with the Securities and Exchange Commission, as well as the Company's other Securities and Exchange Commission filings. The Company undertakes no obligation to update publicly or release any revisions to these forward-looking statements to reflect events or circumstances after the date of this EIS or to reflect the occurrence of unanticipated events, except as required by law.

Competent Person's Statement

The Wafi-Golpu Joint Venture is an unincorporated joint venture between a wholly-owned subsidiary of Harmony Gold Mining Company Limited and a wholly-owned subsidiary of Newcrest Mining Limited.

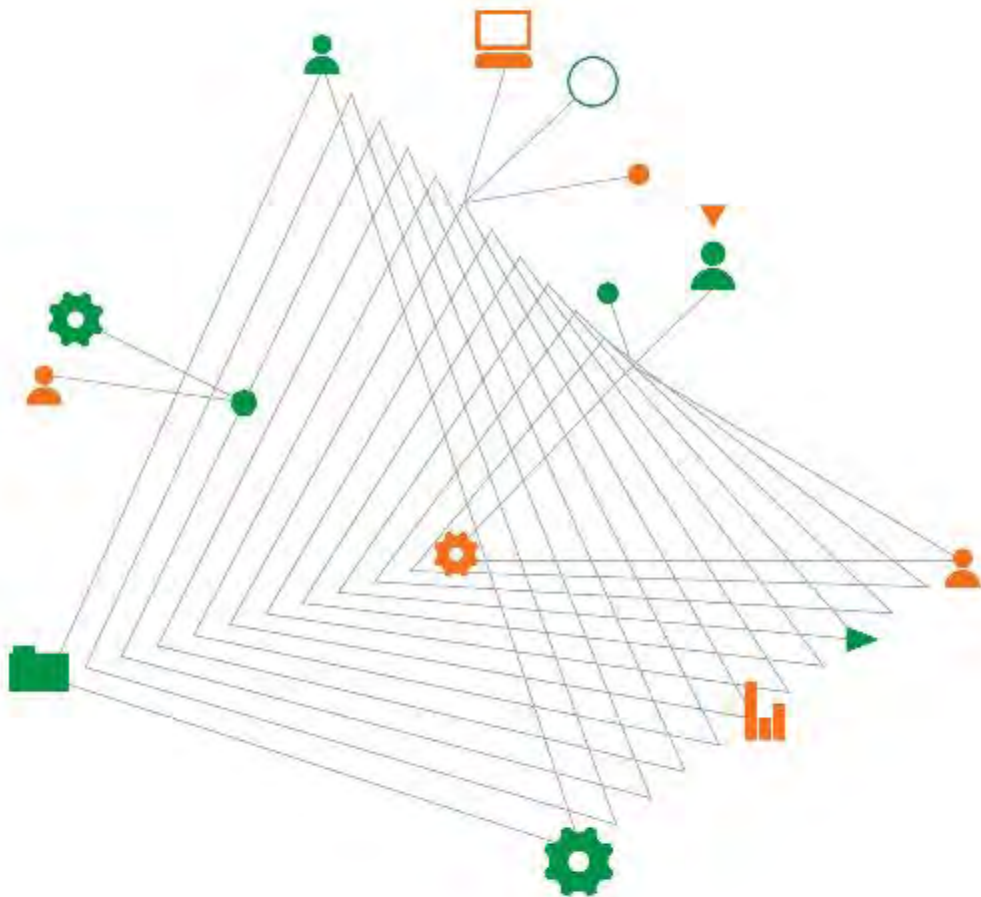
The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

Wafi-Golpu Joint Venture

Wafi-Golpu Project

Surface Water and Freshwater Aquatic Ecology
Characterisation – Yalu to Wangang

25 June 2018



Experience
comes to life
when it is
powered by
expertise

This page has been left intentionally blank

Wafi-Golpu Project

Prepared for
Wafi-Golpu Joint Venture

Prepared by
Coffey Environments Australia Pty Ltd
Level 1, 436 Johnston St
Abbotsford, VIC 3067 Australia
t: +61 3 9290 7000 f: +61 3 9290 7499
ABN: 65 140 765 902

25 June 2018

Document authorisation

Our ref: ENAUABTF100520_17_v5
Client ref: 532-1208-PF-REP-0017_E

Quality information

Revision history

Revision	Description	Date	Author	Reviewer	Signatory
Rev A	Draft	27 March 2018	Travis Wood (Coffey)	Daniel Moriarty	Daniel Moriarty
Rev B	Final	25 June 2018	Travis Wood (Coffey)	Daniel Moriarty	Daniel Moriarty

This page has been left intentionally blank

Executive Summary

Background

Wafi Mining Limited and Newcrest PNG 2 Limited (WGJV Participants) are equal participants in the Wafi-Golpu Joint Venture (the WGJV). The WGJV is investigating the feasibility of constructing, operating and (ultimately) closing the Wafi-Golpu Project (the Project), an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management and related support facilities and services located beneath Mt Golpu, approximately 300 kilometres (km) north-northwest of Port Moresby and 65 km southwest of Lae in the Morobe Province of the Independent State of Papua New Guinea (PNG). The Project includes ore processing, concentrate transport and handling, power generation, water management, a deep sea tailings placement (DSTP) system for tailings management, access roads to the mine and related support facilities. The WGJV has commissioned a range of studies to inform the Project's Feasibility Study Update and to prepare an Environmental Impact Statement (EIS).

This report describes the findings of the freshwater ecology characterisation study conducted along part of the Infrastructure Corridor comprising the section from Yalu to the Coastal Area. Surveys at reference sites are also described in this report to provide regional context. In other words, the reference area findings allow understanding, on a regional level, as to whether there is anything unique or particularly unusual about the freshwater ecology along the Infrastructure Corridor. Together these areas comprise the 'study area'.

Objectives

The objectives of the freshwater ecology study were to:

- Characterise the freshwater ecology in terms of freshwater and sediment quality, and aquatic habitats within the study area.
- Identify sensitive freshwater ecological values within the study area including indicators of habitat condition, to inform the impact assessment to be presented in the EIS.

The assessment of freshwater ecology impacts will be conducted and described in the EIS.

Characterisation of the uses of freshwater resources, including and identifying freshwater fishing areas, are addressed in a separate socio-economic baseline study (Coffey, 2018).

Study area and survey timing

The study area covers the part of the Infrastructure Corridor comprising the section from Yalu to the Coastal Area, along the south-western side of the Atzera Mountain Range. The remainder of the Project Area, including the Mine Area and the length of the Infrastructure Corridor not surveyed as part of these investigations, has been characterised as part of earlier investigations (BMT WBM, 2016) and was not part of the scope of this study. The exception is along the Infrastructure Corridor from the Markham River crossing to Yalu. It is expected that the freshwater ecology environment will be similar in this area to the two study areas assessed to date. As a result, a high level desktop characterisation of that section of the Infrastructure Corridor will be provided in the EIS.

Sites investigated for this study included rivers and streams that intersect or run downstream of the Infrastructure Corridor from Yalu to the Coastal Area, and a number of reference sites (in most

instances, upstream of streams and rivers that intersect the Infrastructure Corridor). Note the reference sites are not intended to act as control sites. The reference sites are described in this report to provide information as a point of reference to the area of interest (the Infrastructure Corridor) to provide regional context. The study surveyed a total of 18 sites.

The study investigated sites to characterise stream types across the study area. These were of differing sizes, but similar in substrate and gradient. The streams can be roughly grouped as small, medium and large based on their width.

Key findings

The key findings of the freshwater ecology study are summarised as follows:

- Water quality at the sites sampled is typical of PNG freshwater streams, being alkaline with a calcium carbonate influence and high, but variable, turbidity. The high turbidity and total suspended solids concentrations can be attributed to resuspended bottom sediments and eroding banks observed along all the streams visited, with these parameters being more pronounced after rainfall events. Other natural areas of terrestrial erosion and stormwater runoff contribute to the turbidity and high TSS in the streams. During the survey in March 2017 there was heavy, widespread rainfall during most nights prior to sampling. During the survey in June 2017, nightly rainfall was highly localised, with only S/Site 3, S/Site 4 and S/Site 8 being sampled the morning after rainfall.
- No water quality parameters exceeded PNG ambient water quality criteria (PNG Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 – Water Quality Criteria for Aquatic Life Protection) or ANZECC/ARMCANZ (2000) water quality guidelines except ammonia, which exceeded the PNG criterion of 0.3mg/L at site BUMB1 and site S/Site 9; and dissolved manganese, which exceeded the PNG criterion of 0.5 mg/L at S/Site 9. The origin of the elevated concentration of ammonia at BUMB1 is not known as there was no discernible source upstream of this site. S/Site 9 is downstream of a heavily populated area and the high ammonia and dissolved manganese concentrations are not unexpected.
- S/Site 1, S/Site 4 and S/Site 9 were downstream of settlements known to discharge household waste into those watercourses. Household wastes included sewage, discarded food scraps and rubbish (primarily plastics, aluminium cans and used clothes). The high ammonia at S/Site 9 could indicate the disposal of domestic cleaning chemicals upstream. The relatively low dissolved oxygen concentration (5.7 mg/L) at S/Site 4 could be potentially attributed, in part, to sewage disposal into the stream.
- WATR1 and BUMB3 contained noticeable rubbish and laundry washing was observed downstream of WATR1 and YALU1. Only one site (BUMB3) was located downstream of an obvious potential source of water contamination in the form of a large open stormwater drain. Notwithstanding, no parameters exceeded PNG criteria or ANZECC/ARMCANZ (2000) guidelines at site BUMB3.
- Opportunistic recordings were made of any freshwater fishing by local residents observed at the time of the sampling events. Observations were recorded at S/Site 5 on Pumpkin Creek, S/Site 6 on Pumpkin Creek and S/Site 8 on the Markham River and BUMB3 on the Bumbu River. We note that this observation was opportunistic and further studies to support the EIS will investigate water resources used by local communities (e.g., for fishing) that may be impacted by Project activities.
- Riparian condition at most sites was highly modified due to the presence of gardens, settlements access tracks and roads. Site WAMI1 was the only site with no observable riparian modification.
- The streams associated with S/Sites 1 to 9 were typically of low-energy (the exception being Markham River). Woody debris and aquatic plants were more common in these streams. However the slow flow, combined with a lack of cobbles and boulders meant that riffle habitats were absent

and silty deposits meant that stream beds were devoid of interstitial spaces suitable for a diverse community of macroinvertebrates to inhabit.

- Substrates in the reference site streams were dominated by sand and gravel. The high proportions of sands and gravels at all reference sites occupy the interstitial spaces (i.e., habitats) between larger materials such as pebbles and cobbles, thereby providing unsuitable habitat for many macroinvertebrate species, particularly larger macroinvertebrates such as the creeping water bugs (Naucoridae).
- The combination of naturally high turbidity, high erosion and the mobility of the river beds at all the reference sites results in a low abundance and diversity of in-stream habitats such as woody debris, aquatic plants, leaf packs and algal mats.

This page has been left intentionally blank

Contents

Executive Summary	iii
Glossary	xi
1. Introduction	1
1.1. Background	1
1.2. Objectives.....	3
2. Study method	4
2.1. Study area, site selection and survey timing.....	4
2.2. Water quality	6
2.2.1. In situ measurements	6
2.2.2. Sampling methods.....	6
2.2.3. Stream flow rate estimates.....	7
2.3. Water sample storage	7
2.4. Water sample analysis	7
2.5. Water sampling and analysis quality control.....	7
2.6. Riparian assessment.....	8
2.7. Assessment of streambed composition and in-stream habitat	8
3. Results.....	10
3.1. Water quality	10
3.1.1. In situ parameters and suspended solids.....	10
3.1.2. Dissolved and total metals	13
3.1.3. Major ions and nutrients.....	13
3.2. Water quality control results.....	20
3.3. Riparian habitat	21
3.4. Stream bed composition and in-stream habitat	37
4. Discussion	41
4.1. Water quality	41
4.2. Riparian habitat	43
4.3. Stream bed composition and in-stream habitat	43
4.3.1. Sampling Sites	43
4.3.2. Reference sites	44
5. References	45

Figures

1.1: Freshwater ecology characterisation sites	2
3.1: Embeddedness descriptions for sites sampled	39
3.2: Substrate composition at the sample sites	40

Tables

2.1: Summary of sampled sites	5
2.2: Sample collection containers used	6
3.1: In situ and total suspended solids results – S/Sites	11
3.2: In situ and total suspended solids results – reference sites	12
3.3: Dissolved metals results – S/Sites (all values are in mg/L)	14
3.4: Dissolved metals results – reference sites (all values are in mg/L)	15
3.5: Total metals results – S/Sites (all units are in mg/L)	16
3.6: Total metals results – reference sites (all units are in mg/L)	17
3.7: Major ions and nutrients – S/Sites (all units are in mg/L)	18
3.8: Major ions and nutrients – reference sites (all units are in mg/L)	19
3.9: Levels of riparian modification at sites and the likely contributing factors to the levels of modification	22
3.10: In-stream habitat features identified at S/Sites 1 to 9	37

Plates

3.1: Looking downstream from S/Site 1 (Busanem Creek)	23
3.2: Swampy conditions near S/Site 1	23
3.3: S/Site 2 on Amburinu Creek	24
3.4: The vegetation at Buambub Creek (S/Site 3) comprised thick grass to the stream's edge	24
3.5: Riparian conditions at S/Site 4 on Pumpkin Creek	25
3.6: Riparian conditions on Pumpkin Creek at S/Site 5	25
3.7: Woody debris along stream's edge at S/Site 5 (foreground and in the right of picture)	26
3.8: Riparian conditions at Pumpkin Creek at S/Site 6	26
3.9: Looking across from S/Site 6	26
3.10: Looking downstream from S/Site 7 on Pumpkin Creek	27
3.11: Looking downstream from S/Site 8 on the Markham River	27
3.12: Looking upstream from S/Site 8 on the Markham River	28
3.13: Highly modified riparian vegetation at S/Site 9 (Maiwara Creek)	28
3.14: Grasses to the stream's edge at S/Site 9	28
3.15: Eroding cliffs along the eastern bank of the Yalu River at YALU1 (looking upstream)	29

3.16: Modified riparian vegetation (garden areas and roads) at YALU1 (looking downstream).....	29
3.17: Eroding cliff at YALU2 with modified riparian vegetation (looking downstream)	30
3.18: Riparian vegetation on the eastern bank of Yalu River at YALU2.....	30
3.19: Looking downstream from site YALU2	30
3.20: Thick, unmodified riparian vegetation at WAMI1 (Wamin Creek).....	31
3.21: Erosion and slumping observed along Wamin Creek.....	31
3.22: Dense riparian vegetation along the western bank of Bumbu River at BUMB1	32
3.23: Riparian conditions at BUMB1 (looking downstream)	32
3.24: Looking upstream from site BUMB2 on the Bumbu River	33
3.25: Looking downstream from site BUMB2 on the Bumbu River	33
3.26: Gardens dominated by banana trees along the Bumbu River at BUMB2	34
3.27: Highly modified riparian condition at BUMB3 on the Bumbu River (looking downstream).....	34
3.28: Highly modified riparian condition at BUMB3 on the Bumbu River (looking upstream)	35
3.29: Erodible banks at site GOV1 on an un-named creek (looking upstream)	35
3.30: A house and garden area was immediately adjacent to site GOV1 along the eastern bank (as can be seen in the background)	35
3.31: Typically muddy erodible bank seen at WATR1 (Waterise Creek)	36
3.32: Modified riparian conditions at WATR1	36
3.33: Looking downstream from site MARA1	37
3.34: Looking upstream from site MARA1	37
4.1: Open stormwater drain upstream of BUMB3.....	42

Appendices

A – Field notes from each survey site

B – Laboratory water quality results

This page has been left intentionally blank

Glossary

Abbreviations

°C	degrees Celsius
%	percent
µm	micrometres
µS/cm	Micro-Siemens per centimetre
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand
AUSRIVAS	Australian River Assessment System
DO	dissolved oxygen
DSTP	deep sea tailings placement
EC	electrical conductivity
EIS	environmental impact statement
ERL	Effects Range-Low
ERM	Effects Range-Median
FNU	Formazin Nephelometric Turbidity Units
HCl	hydrochloric acid
ISQG	Interim Sediment Quality Guideline
m	metres
m ASL	metres above sea level
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mL	millilitres
m/s	metres per second
m ³ /s	cubic metres per second
NATA	National Association of Testing Authorities, Australia
NMDS	non-metric multi-dimensional scaling
NTU	Nephelometric Turbidity Units
PNG	Independent State of Papua New Guinea
ppm	parts per million
SQGs	sediment quality guidelines
S/Site	Sampling Site
STRM DEM	shuttle radar topography mission digital elevation model
TSS	total suspended solids
US EPA	United States Environmental Protection Agency
WGJV	Wafi-Golpu Joint Venture

Terms

algal mat	Microbial mat formed on the water surface or on the surface of rocks.
macrophyte	Aquatic plant that grows in or near water.
benthic macroinvertebrate	Macroinvertebrates that live on the bottom of streams, rivers and lakes.
Coastal Area	The Coastal Area includes the proposed Port Facilities Area and the proposed Outfall Area.
concentrate pipeline	Pipeline to deliver concentrate from the Mine Area to the Port Facilities Area.
embeddedness	The degree of infilling of river bed stone or pebble interstices with fine sediments.
field blank	Samples filled with de-ionised water under sampling conditions.
field duplicate	Independent samples which are collected as close as possible to the same point in space and time.
Galvanotaxis or electrotaxis	Movement of an organism in a particular direction in response to an electric current.
Infrastructure Corridor	The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
interstitial spaces	Void spaces which provide habitat for macroinvertebrate species.
laboratory blank	Analysis of de-ionised water to check for the presence of laboratory contamination.
laboratory duplicate	Repeated analysis of a sample to check for analytical precision.
laboratory spike	Analysis of samples with known added concentration of analyte.
leaf pack	Accumulation of leaves and sticks in the slow flow areas behind rocks.
macroinvertebrate	Organisms, without backbones that are visible to the eye without the aid of a microscope.
morpho-type	Any of a group of different types of individuals of the same species in a population.
reference sites	Sites surveyed in this freshwater characterisation study located upstream of streams and rivers that intersect the Infrastructure Corridor. The survey results from these sites are discussed in order to provide regional context of the freshwater aquatic environment.
Outfall System	Includes mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines. Located in the Outfall Area.
riffle habitat	Rocky substrates covered by fast moving water.
riparian vegetation	Plant habitats and communities along river margins and banks.
study area	The area encompassing the nine sites located along the Infrastructure Corridor from Yalu to the Coastal Area and nine reference sites away from the Infrastructure Corridor.
Sampling Site (S/Site)	These include the nine sites investigated in the vicinity of the Infrastructure Corridor and not the reference sites. The abbreviated term (S/Site) is also used for the site identifiers.
terrestrial tailings pipeline	Pipeline to deliver tailings from the Mine Area to the Outfall Area.
total Kjeldahl nitrogen	Refers to the nitrogen in the form of organics and ammonia (i.e., total nitrogen minus nitrite and nitrate).

1. Introduction

1.1. Background

Wafi Mining Limited and Newcrest PNG 2 Limited (WGJV Participants) are equal participants in the Wafi-Golpu Joint Venture (the WGJV). The WGJV is investigating the feasibility of constructing, operating and (ultimately) closing the Wafi-Golpu Project (the Project), an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management and related support facilities and services located beneath Mt Golpu, approximately 300 kilometres (km) north-northwest of Port Moresby and 65 km southwest of Lae in the Morobe Province of the Independent State of Papua New Guinea (PNG). The Project includes ore processing, concentrate transport and handling, power generation, water management, a deep sea tailings placement (DSTP) system for tailings management, access roads to the mine and related support facilities.

Geographically, the Project occupies a mine to port footprint that extends from the Mine Area to the Coastal Area with an Infrastructure Corridor that links the two areas. Together these discrete areas make up the proposed Project Area:

- **Mine Area.** The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
- **Infrastructure Corridor.** The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
- **Coastal Area.** The Coastal Area includes the proposed Port Facilities Area and the proposed Outfall Area:
 - **Port Facilities Area.** Located at, or in proximity to, the Port of Lae, with a site adjacent to Berth 6 (also known as Tanker Berth) nominated as the preferred option. The proposed facilities will include the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline.
 - **Outfall Area.** Located approximately six kilometres east of the port. The proposed facilities will include the Outfall System comprising the mix/de-aeration tank and associated facilities, seawater intake pipelines and DSTP outfall pipelines, pipeline laydown area, choke station, access track and parking turnaround area.

The WGJV has commissioned a range of studies to inform the Project's Feasibility Study Update and to prepare an Environmental Impact Statement (EIS).

This report describes the findings of the freshwater ecology characterisation study. The study area for this report includes sites on rivers and streams that intersect or run downstream of the Infrastructure Corridor from Yalu to the Coastal Area, as well as a number of reference sites (in most instances, upstream of streams and rivers that intersect the Infrastructure Corridor). Note the reference sites are not intended to act as to control sites. The reference sites are described in this report to provide regional context to the area of interest (the Infrastructure Corridor). The study surveyed a total of 18 sites (Figure 1.1).



LEGEND

- Freshwater ecology characterisation site
- Village/Settlement
- Landmark
- Road
- Watercourse

PROPOSED INFRASTRUCTURE

- Outfall Area
- DSTP outfall
- Port Facilities Area
- Infrastructure Corridor
- Infrastructure footprint

MXD Reference: 0520CC_17_GIS001_v0.5

Source:
 Freshwater ecology characterisation sites from Coffey.
 Villages/Settlements, landmarks and infrastructure from WGJV and Coffey.
 Roads and watercourses from NSO.
 Imagery from ArcGIS Online (capture date unknown) and WGJV (capture date 2016).



coffey
A TETRA TECH COMPANY

Date:
22.03.2018

Project:
754-ENAUABTF100520DD

File Name:
0520DD_17_F01.01_GIS



WAFI-GOLPU
JOINT VENTURE

Wafi-Golpu Project

Freshwater ecology characterisation sites

Figure No:
1.1

Future development of the Project remains subject to ongoing deep orebody drilling and definition (after underground access has been achieved), technical studies, completion of statutory permitting processes and securing Government and WGJV Participants' approvals.

Engineering design and other studies, including environmental studies, are continuing and there is potential that aspects of the proposed Project design, layout and timetable may change.

1.2. Objectives

The objectives of the freshwater ecology study were to:

- Characterise the freshwater ecology (in terms of water quality and aquatic habitats) within the study area, as defined in Section 2.1.
- Identify sensitive freshwater ecological values, including, indicators of habitat condition, to inform the impact assessment to be presented in the EIS.

The extent of the study scope is commensurate to the level of risk to aquatic ecology due to construction and operation of the Infrastructure Corridor, which is expected to be temporary and low impact.

The assessment of freshwater ecology impacts will be described in the EIS.

Characterisation of the uses of freshwater resources and identifying freshwater fishing areas are addressed in a separate socio-economic baseline study (Coffey, 2018).

2. Study method

2.1. Study area, site selection and survey timing

The study area covers part of the Infrastructure Corridor comprising the section from Yalu to the Coastal Area, along the south-western side of the Atzera Mountain Range. The remainder of the Project Area, including the Mine Area and the part of the length of the Infrastructure Corridor not surveyed as part of these investigations, has been characterised as part of other studies (including BMT WBM (2016)) and was not part of the scope of this study.

Figure 1.1 shows the study area and locations of the 18 sites.

S/Sites 1 to 9 are located within rivers and streams that intersect or run downstream of the Infrastructure Corridor from Yalu to the Coastal Area. The reference sites are located away from the Infrastructure Corridor and in most instances, upstream of streams that intersect the Infrastructure Corridor.

The nine reference sites surveyed in March 2017 form a subset of an array of data collected through investigations into alternate pipeline alignment options undertaken during a route selection process. On review of the location of the reference sites and survey methods used to gather the data, it was determined that the information collected will serve the purpose of providing regional context for this study.

S/Sites 1 to 9 were sampled by WGJV environmental personnel, with direction and support from Coffey, in June 2017. The reference sites were sampled by Coffey and The Waterbug Company in March 2017.

The March 2017 survey was conducted within the dry season and characterised the streams in terms of water quality, stream habitat and riparian condition.

The June 2017 was carried out in the wet season, characterised the streams in terms of water quality, stream habitat and riparian condition.

Selected sites were sampled to characterise stream types found across the study area. These streams were of differing sizes, but similar in substrate composition and gradient. The streams can be roughly grouped as small, medium and large based on their width.

Table 2.1 summarises the location, stream size and time and date for each of the sites investigated.

Table 2.1: Summary of sampled sites

Site	Location	Stream size ^a	Easting (m) ^b	Northing (m) ^b	Elevation (m ASL) ^c	Sample Date	Sample Time
S/Site 1	Busanem Creek approx. 30 m downstream of the Infrastructure Corridor.	Small	487594	9266978	27	07/06/2017	10:45
S/Site 2	Amburinu Creek approx. 250 m downstream of the Infrastructure Corridor.	Small	487811	9264910	27	07/06/2017	12:15
S/Site 3	Buambub Creek approx. 100 m downstream of the Infrastructure Corridor.	Small	488812	9263285	24	06/06/2017	8:50
S/Site 4	Pumpkin Creek approx. 340 m downstream of the Infrastructure Corridor.	Medium	488964	9261794	21	06/06/2017	14:35
S/Site 5	Pumpkin Creek approx. 430 m downstream of the Infrastructure Corridor.	Large	491891	9259012	21	07/06/2017	15:40
S/Site 6	Pumpkin Creek approx. 530 m downstream of the Infrastructure Corridor.	Large	491885	9258909	15	07/06/2017	15:20
S/Site 7	Pumpkin Creek approx. 500 m downstream of the Infrastructure Corridor.	Large	493861	9257576	17	06/06/2017	10:15
S/Site 8	Markham River approx. 1 km downstream of the Infrastructure Corridor.	Large	495644	9256040	6	06/06/2017	11:10
S/Site 9	Maiwara Creek approx. 80 m downstream of the Infrastructure Corridor.	Small	496351	9257045	8	07/06/2017	14:07
YALU1	Yalu River approx. 3 km upstream of the Infrastructure Corridor	Large	486347	9271912	68	02/03/2017	13:10
YALU2	Yalu River approx. 5 km upstream of the Infrastructure Corridor	Large	486502	9270279	47	02/03/2017	9:45
WAMI1	Wamin Creek. This creek drains to Yalu River.	Small	487374	9270178	80	05/03/2017	12:20
BUMB1	Bumbu River approx. 8 km upstream of BUMB2.	Large	492355	9267809	85	04/03/2017	10:10
BUMB2	Bumbu River approx. 200 m downstream of Waterise Creek confluence.	Large	497231	9262933	58	03/03/2017	13:30
BUMB3	Bumbu River approx. 50 m downstream of bridge to Buimo prison and approx. 2.5 km downstream of site BUMB2.	Large	498372	9261333	47	03/03/2017	10:15
GOV1	Un-named creek that drains to Bumbu River. This site is about 1.5 km upstream of Bumbu River confluence.	Small	493767	9268558	93	04/03/2017	13:10
WATR1	Waterise Creek approx. 1 km upstream of the Bumbu River confluence.	Medium	496516	9263162	69	03/03/2017	14:50
MARA1	Marambi River. This is a headwater tributary to the Busu River.	Large	502836	9269286	152	05/03/2017	9:30

a 'Large' denotes a stream where its bank to bank distance was greater than 25 m, 'Medium' denotes a stream where its bank to bank distance was between 10 to 25 m, and 'Small' denotes a stream where its bank to bank distance was less than 10 m.

b Coordinates given in PNG94 PNGMG94 Zone 55.

c Elevations extracted from 30 m resolution STRM DEM and given as metres above sea level (m ASL).

2.2. Water quality

2.2.1. In situ measurements

Two models of water quality instrument were used for in situ measurements. A HANNA Instruments HI 9829 model was used in March 2017 and a TPS 90 FLT model was used in June 2017.

At each site, a hand-held water quality meter was used to take in situ measurements of:

- pH.
- Conductivity ($\mu\text{S}/\text{cm}$; micro-Siemens per centimetre).
- Temperature ($^{\circ}\text{C}$, degrees Celsius).
- Dissolved oxygen (DO) (mg/L and percentage saturation).
- Turbidity (HANNA instrument - FNU, formazin nephelometric turbidity units; TPS instrument – NTU, nephelometric turbidity units). The units FNU and NTU are roughly equivalent (US Geological Survey, 2006) and therefore appropriate for this study.

In situ measurement readings were taken by immersing probes beneath the surface layer (about 10 cm below the surface) and allowing several minutes for the readings to stabilise. Readings were then recorded in a waterproof notebook and logged in the instruments internal memory. When not in use the probes were stored as per the supplier's instructions (e.g., pH probe in pH 4 buffer; conductivity probe in fresh water, DO probe in a damp enclosed casing).

The instruments were pre-calibrated by the supplier prior to use and the calibration checked frequently (using standard solutions) during the survey to ensure the calibration was maintained.

2.2.2. Sampling methods

Water samples were taken by hand either from the banks of streams or within the streams. Powder-free nitrile gloves were worn at all times to minimise the risk of sample contamination. Samples were taken while facing upstream.

The bottles without preservative (Table 2.2) were pre-rinsed with native water three times prior to filling with sample. Bottles with preservative were filled up without pre-rinsing.

Field filtering was performed to obtain samples of dissolved metals. This was achieved by passing the sample through a syringe fitted with a $0.45\ \mu\text{m}$ plastic membrane filter. Filtrate was used to pre-rinse the sample bottle prior to sample collection.

Table 2.2: Sample collection containers used

Container	Label	Preservative	Analysis
500 mL plastic bottle	Green	None	Total suspended solids, alkalinity, cations, chloride, sulphate, fluoride, nitrite, nitrate, reactive phosphate
60 mL plastic bottle	Purple	Sulfuric acid	Ammonia, total Kjeldahl ^a nitrogen, total nitrogen and total phosphorus
60 mL plastic bottle	Red and green	None	Dissolved metals
60 mL plastic bottle	Red and green	None	Total metals

Note: These sampling bottles were supplied by ALS Laboratories Brisbane.
a Kjeldahl nitrogen refers to total nitrogen present in organic form and as ammonia.

2.2.3. Stream flow rate estimates

Stream flow rates were estimated for each of the sites at the same time as sampling. This was done simply by measuring the time required for a float (stick, leaf, etc.) to be transported over a given distance. This was repeated three times and the average surface flow rate (m/s) calculated. The width and depth of each stream was also estimated by either using a measuring stick or wading through the water and counting the number of steps. This estimate was completed for the main channel flow and did not include any side pools or stagnant water.

The flow rate was calculated (in m³/s) by using the formula:

$$\text{Flow (m}^3\text{/s)} = W \times D \times V \times C_f$$

Where,

W = width of flow channel

D = depth of flow channel

V = surface flow rate of channel in m/s

C_f = Correction factor, which accounts for the surface flow being faster than the near-bed flow of the water column, due to friction effects from the stream beds.

A correction factor of 0.9 was used for the S/Sites 1 to 9. A correction factor of 0.8 was used for the reference sites. The 0.8 value is used for streams with a rocky bottom, while the 0.9 value is used for streams with a muddy bottom, as recommended by the United States Environmental Protection Agency (US EPA, 2012).

Appendix A provides additional notes on stream flow as well as other environmental observations made at each site.

2.3. Water sample storage

The collected water samples were transferred into eskies containing frozen freezer bricks. Upon returning to the WGJV camp at 11 Mile the samples were transferred to a refrigerator where they were stored at 4°C until immediately prior to shipment to the laboratory. The samples were dispatched to the laboratory in eskies containing freshly frozen freezer bricks. The March 2017 survey samples were shipped on 6 March 2017 and arrived at the laboratory on 8 March 2017. The June 2017 survey samples were shipped on 8 June 2017 and arrived at the laboratory on 12 June 2017.

2.4. Water sample analysis

The water samples were analysed by ALS Laboratories (ALS) in Brisbane. ALS is accredited by NATA (National Association of Testing Authorities, Australia).

The laboratory analysis methods for water samples are outlined in the laboratory reports in Appendix B.

2.5. Water sampling and analysis quality control

Quality control measures were implemented in the field and in the laboratory. These measures included:

- Field duplicate sample collection – where a sample was taken at the same site in succession of the original sample. This was performed to check the precision of both the sampling technique and laboratory analytical technique. Field duplicate samples were collected for water (at site GOV1 and at site S/Site 8).
- Field blank sample collection – where a suite of sample bottles was filled with de-ionised water under sampling conditions. This was performed to check for the presence of contamination. Field blank water sample collection was performed at site MARA1 in March 2017 and at S/Site 8 in June 2017. The field blanks included bottle blanks (filling the bottles directly with blank water) as well as filter blanks (which filter the blank water in the same way dissolved metals samples are prepared). The field blank samples were labelled as 'FBX1' (see Appendix A).
- Laboratory duplicates – where analysis of a sample was repeated to check for analytical precision.
- Laboratory spikes – where analysis of a sample was conducted with a known concentration of analyte added. This is done in order to check the effect of sample matrix interference on the analysis result (matrix spike). This is also done for diluted samples with no matrix interference where the sample is spiked with known amounts of certified reference materials to check for analytical accuracy and precision (laboratory control spike).
- Laboratory blanks – where de-ionised water was analysed to check for the presence of laboratory contamination.

Appendix B provides further detail on the laboratory quality control methods.

The water quality meter was calibrated prior to use. Spot checks of the water quality calibration were then performed on a daily basis. On 3 March 2017, a multi-parameter calibration was performed. After checking the meter calibration, no calibration was needed in the June 2017 sampling.

2.6. Riparian assessment

Riparian condition can strongly influence in-stream ecology in tropical freshwater ecosystems (Dudgeon, 1994). At each site, observations about the riparian vegetation condition (i.e., level of modification) and anthropogenic influences were recorded (including photographs and field notes). Observations were made of the presence of gardens, urban influences or nearby dwellings/settlements as well as roads and tracks. An overall rating of low, medium or high modification was given for each site. Observations of natural erosion along the stream banks in the riparian zone were also made.

The assessment of riparian condition was also supported by a review of GoogleEarth aerial imagery from July 2016.

2.7. Assessment of streambed composition and in-stream habitat

Rivers provide a variety of different habitats that can be colonised by instream fauna and flora. These can include the more obvious deep, slow-flowing areas around woody debris (velocity shelters) that are used by fish but, they also include smaller habitats, such as the gaps between rocks (voids) in the river where much of the freshwater macroinvertebrate fauna can be found.

Observations of instream habitat were made by estimating the percentage cover of the streambed that was made up by rock and stony substrates of different sizes. This was achieved by observing the size groups of bed material during kick-netting, over an area of about 10m². Where the water was too turbid to see the bottom, the composition of streambed material was estimated by feeling the bottom with feet and with the pole of a net. The categories of streambed materials assessed were boulders (greater than 256 mm in diameter), cobbles (between 256 and 64 mm in diameter), pebbles (between 64 and 16 mm in diameter), gravels (between 16 and 2 mm in diameter), sands (between 2 and

0.063 mm in diameter) and silts (less than 0.063 mm in diameter). A measure of embeddedness (the degree of infilling of river bed stone or pebble interstices with fine sediments) was also estimated at each site, providing information on whether the larger rock components in the river are available to instream fauna as habitat, or whether they have been smothered by sedimentation, which can occur naturally.

As the streams during the June 2017 sampling were not suitable for wading, the assessment of streambed composition during that survey was made from visual observations where possible.

Observations of in-stream structural diversity were also made at each of the sites. Structures such as woody debris and aquatic macrophytes can provide additional habitat for fish and freshwater macroinvertebrates. Collections of loose organic matter such as leaves and sticks, and algal mats were also surveyed as they can provide additional food and habitat resources for fish and macroinvertebrates.

3. Results

3.1. Water quality

This section presents the water quality results from the in situ measurements and laboratory analysis of the riverine waters sampled during the surveys.

Water quality results are compared to the PNG Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 – Water Quality Criteria for Aquatic Life Protection (fresh water).

To support the characterisation, water quality results are also compared, where relevant, to guidelines recommended in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000). These guidelines are the trigger values outlined for freshwater aquatic ecosystem protection (slightly-to-moderately disturbed aquatic systems). Comparison to these guidelines allows further understanding of the existing water quality within the study area given that some PNG criteria for aquatic ecosystem protection are less stringent than the guidelines in ANZECC/ARMCANZ (2000).

3.1.1. In situ parameters and suspended solids

Table 3.1 and Table 3.2 present the results of the in situ measurements. For comparative purposes, laboratory measured total suspended solids (TSS) are presented alongside turbidity results.

Table 3.1 and Table 3.2 show that all sites were slightly alkaline, with pH ranging from 7.1 to 8.1. The lowest pH was recorded at BUMB2 (pH 7.1) and BUMB3 (pH 7.2). The pH ranged from 7.3 to 8.1 at all other sites.

Water temperature ranged from 21.4°C (MARA1) to 33.7°C (WATR1) with most sites having a temperature between 25 to 28°C.

Electrical conductivity (EC) across all sites ranged from 229 µS/cm (site GOV1) to 745 µS/cm (S/Site 1). S/Sites 1 to 9 had higher EC, ranging from 309 to 745 µS/cm. The EC at the reference sites ranged from 249 to 479 µS/cm.

Water hardness ranged from 85 mg/L CaCO₃ (GOV1) to 257 mg/L CaCO₃ (S/Site 1). Using the hardness categories outlined in ANZECC/ARMCANZ (2000) water is classified as moderate hardness at most reference sites (i.e., hardness between 60 and 119 mg/L CaCO₃; sites YALU1, YALU2, BUMB1, BUMB2, BUMB3, GOV1 and MARA1). At site WATR1 (123 mg/L CaCO₃) water was hard and site WAMI1 (195 mg/L CaCO₃) water was very hard. In the S/Sites 1 to 9, water was hard (i.e., hardness between 120 to 179 mg/L CaCO₃) or very hard (i.e., hardness between 180 to 240 mg/L CaCO₃) at most sites. The exception was site S/Site 8, which had a moderate hardness (105 mg/L CaCO₃).

Dissolved oxygen (DO) concentrations ranged from 3.8 mg/L (S/Site 5) to 8.9 mg/L (YALU1), which equated to 50% and 115% saturation, respectively. Dissolved oxygen concentrations were generally lower in S/Sites 1 to 9 (ranging from 3.8 to 7.9 mg/L) than at the reference sites (7.0 to 8.9 mg/L). Dissolved oxygen concentrations at S/Site 4, S/Site 5 and S/Site 6 were below the PNG criterion of 6 mg/L for ambient water quality.

Turbidity ranged from 1.8 NTU (S/Site 1) to 690 NTU (YALU2), with corresponding TSS concentrations of less than 5 mg/L and 1,180 mg/L, respectively, at these sites. Yalu River was the most turbid of the rivers and streams sampled with turbidity of 649 to 690 FNU and TSS from 731 to 1,180 mg/L. Wide ranges in background turbidity are typical of many rivers in PNG subject to natural flooding-related sediment load.

Table 3.1: In situ and total suspended solids results – S/Sites

	PNG criteria ^a	S/Site 1	S/Site 2	S/Site 3	S/Site 4	S/Site 5	S/Site 6	S/Site 7	S/Site 8	S/Site 9
Date		7/6/2017	7/6/2017	6/6/2017	6/6/2017	7/6/2017	7/6/2017	6/6/2017	6/6/2017	7/6/2017
Flow discharge (m³/s)	-	0.03	4.5	0.5	18.7	12.3	45	48	54*	0.7
Temp. (°C)	-	25.2	24.5	25.3	24.8	25.7	25.7	25.3	25.9	27.6
pH	no change ^b	7.7	7.9	7.4	7.9	7.4	7.8	7.7	7.6	7.3
EC (µS/cm)	-	745	644	351	378	625	601	382	309	653
TDS (mg/L)	-	342	399	346	351	386	376	301	409	322
Hardness (as mg/L CaCO₃)	-	257	225	143	194	217	176	132	105	157
DO (mg/L)	>6.0 ^c	7.3	6.7	7.9	5.7	3.8	5.3	6.3	7.0	7.1
DO (%)	-	77	83	68	68	50	66	62	68	70
Turbidity (NTU)	no change >25 NTU ^d	1.8	20.5	30.2	43.9	39.2	64.2	654	671	11.1
TSS (mg/L)	-	<5	30	20	54	44	650	833	1,050	7

– denotes no applicable criterion.

Exceedance of PNG criteria is shown in bold.

* This flow discharge estimate was made only for the eastern branch of the Markham River where water sampling was conducted. Other branches of the river could not be accessed.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Criterion is no alteration to background concentration.

c Criterion is that dissolved oxygen must be not less than 6 mg/L.

d Criterion is no change greater than 25 NTU from background turbidity. The turbidity unit FNU used in this report is roughly equivalent to NTU.

Table 3.2: In situ and total suspended solids results – reference sites

	PNG criteria^a	YALU1	YALU2	WAMI1	BUMB1	BUMB2	BUMB3	GOV1	WATR1	MARA1
Date		2/3/2017	2/3/2017	5/3/2017	4/3/2017	3/3/2017	3/3/2017	4/3/2017	3/3/2017	5/3/2017
Flow discharge (m³/s)	-	6.4	6.7	0.03	3.0	16.0	28.8	0.9	0.64	38.4
Temp. (°C)	-	27.8	27.8	26.4	27.8	27.6	26.1	29.5	33.7	21.4
pH	no change ^b	7.8	7.9	8.1	7.7	7.1	7.2	7.8	7.7	8.0
EC (µS/cm)	-	310	316	479	295	244	231	229	316	249
TDS (mg/L)	-	155	158	240	147	122	115	114	158	124
Hardness (as mg/L CaCO₃)	-	100	100	195	115	101	92	85	123	90
DO (mg/L)	>6.0 ^c	8.9	8.8	7.4	7.0	8.0	8.3	7.1	7.7	8.5
DO (%)	-	115	114	93	91	102	104	96	110	98
Turbidity (FNU)	no change >25 NTU ^d	649	690	37.6	71.1	162	270	8.2	109	106
TSS (mg/L)	-	731	1,180	20	58	116	213	<5	94	88

– denotes no applicable criterion.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Criterion is no alteration to background concentration.

c Criterion is that dissolved oxygen must be not less than 6 mg/L.

d Criterion is no change greater than 25 NTU from background turbidity. The turbidity unit FNU used in this report is roughly equivalent to NTU.

S/Site 8 on the Markham River (eastern branch) had the highest flow rate (54 m³/s), which was after rainfall the previous night. The lower reaches of Pumpkin Creek (S/Site 6 and S/Site 7) had the next highest flow rates of 48 m³/s and 45 m³/s, respectively. Flow rates in the small tributaries south of the Infrastructure Corridor (S/Site 1, Busanem Creek; S/Site 2, Amburinu Creek; S/Site 3 Buambub Creek; S/Site 9, Maiwara Creek) ranged from 0.03 to 4.5 m³/s.

The upstream sites on the Bumbu River had flow rates of 3 m³/s (BUMB1) and 16 m³/s (BUMB2). Flow rates in the Yalu River were similar at the upstream site (YALU1) and downstream site (YALU2) with flow of 6.4 and 6.7 m³/s respectively. Flow rates in the smaller tributaries Wamin Creek (WAMI1), small creek with unknown name (GOV1), and Waterise Creek (WATR1) were much lower being 0.03 m³/s, 0.9 m³/s and 0.64 m³/s respectively.

3.1.2. Dissolved and total metals

Table 3.3 and Table 3.4 present the dissolved metals results (defined as filtered through a 0.45 µm filter). For simplicity, the metalloids antimony, arsenic and boron are included with the metals results. Where results exceed PNG water quality criteria they are shown in bold. Where results exceed ANZECC/ARMCANZ (2000) guidelines they are shown in grey highlight.

Table 3.5 and Table 3.6 present the total metals results. There are no applicable criteria or guidelines for total metals in the water column.

For S/Sites 1 to 9 (Table 3.3), most dissolved metals were below detection limits and most were below PNG criteria and ANZECC/ARMCANZ guidelines. The only exception was manganese at S/Site 9 on Maiwara Creek (0.53 mg/L), which slightly exceeded the PNG criterion of 0.5 mg/L. Dissolved manganese was noticeably higher in the Sampling Sites (0.009 to 0.53 mg/L) than the reference sites e (0.001 to 0.009 mg/L).

Table 3.4 shows, for the reference sites, most dissolved metal concentrations were below detection limits. All dissolved metal concentrations were below the PNG criteria and ANZECC/ARMCANZ guidelines.

For S/Site 1 to 9, total aluminium and total iron were also the highest metals concentrations, being highest in the Markham River at 38.9 and 46.4 mg/L for aluminium and iron, respectively (Table 3.5). There are no PNG water quality criteria or ANZECC/ARMCANZ guidelines for total metals in the water column.

Table 3.6 shows, for the reference sites, total aluminium (ranging from 0.69 to 59.5 mg/L) and total iron (ranging from 0.64 to 53.9 mg/L) had the greatest concentrations across all sites, with these concentrations correlating with higher suspended sediment concentrations.

Across all sites, relatively low concentrations were measured for total arsenic (ranging from 0.001 mg/L to 0.009 mg/L), chromium (0.002 to 0.041 mg/L), cobalt (<0.001 to 0.040 mg/L), copper (0.003 to 0.107 mg/L), lead (0.002 to 0.010 mg/L), manganese (0.009 to 1.21 mg/L), nickel (<0.001 to 0.058 mg/L) and zinc (<0.005 to 0.084 mg/L).

Total cadmium, mercury, molybdenum, selenium, silver and tin concentrations were at or below detection limits at all sites.

3.1.3. Major ions and nutrients

Table 3.7 and Table 3.8 present the results for major ions and nutrients.

Table 3.3: Dissolved metals results – S/Sites (all values are in mg/L)

	PNG criteria ^a	ANZECC ^b	S/Site 1	S/Site 2	S/Site 3	S/Site 4	S/Site 5	S/Site 6	S/Site 7	S/Site 8	S/Site 9
Aluminium	-	0.055	<0.01	<0.01	0.03	0.02	<0.01	0.03	0.05	0.05	0.02
Antimony	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	0.05	0.013	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.002	0.002	0.002
Barium	1.0	-	<0.001	<0.001	0.002	<0.001	<0.001	0.001	0.002	0.002	0.002
Cadmium	0.01	0.00084 ^c	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	0.05	0.0037 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	1.0	0.0035 ^c	<0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.002	<0.001
Lead	0.005	0.026 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.5	1.9	0.065	0.059	0.020	0.025	0.090	0.066	0.028	0.009	0.53
Molybdenum	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	0.0002	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	1.0	0.0429 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	0.05	0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	0.5	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	5.0	0.031 ^c	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	1.0	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	1.0	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12

- denotes no applicable guideline

All units are in mg/L.

Exceedance of PNG criteria is shown in bold. Exceedance of ANZECC/ARMCANZ (2000) guidelines are shown in grey highlight.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (slightly-to-moderately disturbed aquatic ecosystems) (ANZECC/ARMCANZ, 2000).

c Guideline is a 'hardness modified trigger value' as per section 3.4.3.2 of ANZECC/ARMCANZ (2000). This guideline takes into account the 'hard' hardness of the water.

Table 3.4: Dissolved metals results – reference sites (all values are in mg/L)

	PNG criteria^a	ANZECC^b	YALU1	YALU2	WAMI1	BUMB1	BUMB2	BUMB3	GOV1	WATR1	MARA1
Aluminium	-	0.055	0.03	0.03	<0.01	0.01	0.02	0.02	0.05	0.01	0.02
Antimony	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	0.05	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	1.0	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	0.01	0.00054 ^c	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	0.05	0.0025 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Cobalt	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	1.0	0.0035 ^c	0.002	0.002	0.001	0.002	0.002	0.003	0.001	0.001	<0.001
Lead	0.005	0.0136 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.5	1.9	0.002	0.002	0.003	0.003	0.009	0.006	0.001	0.002	0.002
Molybdenum	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	0.0002	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	1.0	0.0275 ^c	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	0.05	0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	0.5	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	5.0	0.02 ^c	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	1.0	0.37	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	1.0	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

- denotes no applicable guideline

All units are in mg/L.

Exceedance of PNG criteria is shown in bold. Exceedance of ANZECC/ARMCANZ (2000) guidelines are shown in grey highlight.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (slightly-to-moderately disturbed aquatic ecosystems) (ANZECC/ARMCANZ, 2000).

c Guideline is a 'hardness modified trigger value' as per section 3.4.3.2 of ANZECC/ARMCANZ (2000). This guideline takes into account the 'moderate' hardness of the water.

Table 3.5: Total metals results – S/Sites (all units are in mg/L)

	S/Site 1	S/Site 2	S/Site 3	S/Site 4	S/Site 5	S/Site 6	S/Site 7	S/Site 8	S/Site 9
Aluminium	0.12	1.41	1.76	2.90	1.97	18.5	26.8	38.9	0.19
Arsenic	<0.001	<0.001	<0.001	0.001	0.001	0.004	0.008	0.009	0.002
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001
Chromium	<0.001	0.001	0.002	0.003	0.004	0.018	0.025	0.040	<0.001
Cobalt	<0.001	<0.001	<0.001	0.002	0.001	0.011	0.017	0.025	<0.001
Copper	<0.001	0.004	0.006	0.008	0.006	0.039	0.060	0.087	0.002
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.006	0.010	<0.001
Manganese	0.094	0.146	0.064	0.179	0.179	0.610	0.894	1.21	0.534
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	<0.001	0.002	0.004	0.004	0.004	0.027	0.036	0.058	0.001
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	<0.005	0.007	0.012	<0.005	0.006	0.035	0.055	0.084	<0.005
Iron	0.17	1.52	1.87	3.20	2.33	20.5	29.5	46.4	0.58

Note: there are no applicable PNG criteria or ANZECC/ARMCANZ (2000) guidelines for total metals in the water column.

Table 3.6: Total metals results – reference sites (all units are in mg/L)

	YALU1	YALU2	WAMI1	BUMB1	BUMB2	BUMB3	GOV1	WATR1	MARA1
Aluminium	43.5	59.5	1.45	4.61	7.64	13.4	0.69	5.26	4.38
Arsenic	0.002	0.003	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Cadmium	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001
Chromium	0.026	0.041	0.002	0.007	0.011	0.018	0.002	0.007	0.003
Cobalt	0.019	0.028	<0.001	0.003	0.004	0.008	<0.001	0.003	0.002
Copper	0.074	0.107	0.004	0.010	0.018	0.031	0.003	0.012	0.008
Lead	0.003	0.004	<0.001	<0.001	<0.001	0.002	0.002	<0.001	<0.001
Manganese	0.816	1.21	0.041	0.101	0.244	0.401	0.009	0.133	0.082
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	0.037	0.055	0.001	0.005	0.009	0.015	<0.001	0.006	0.006
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.055	0.076	<0.005	0.008	0.013	0.022	0.031	0.008	<0.005
Iron	36.6	53.9	1.75	4.95	8.95	15.0	0.64	6.29	3.92

Note: there are no applicable PNG criteria or ANZECC/ARMCANZ (2000) guidelines for total metals in the water column.

Table 3.7: Major ions and nutrients – S/Sites (all units are in mg/L)

	PNG criteria ^a	ANZECC ^b	S/Site 1	S/Site 2	S/Site 3	S/Site 4	S/Site 5	S/Site 6	S/Site 7	S/Site 8	S/Site 9
Major ions											
Calcium	-	-	80	62	44	53	59	49	38	32	43
Magnesium	-	-	14	17	8	15	17	13	9	6	12
Sodium	-	-	46	49	10	41	44	35	26	21	19
Potassium	5	-	1	2	2	2	2	2	2	1	3
Chloride	-	-	36	2	1	2	2	2	2	1	4
Sulphate	400	-	5	6	4	6	6	8	10	12	13
Total alkalinity as CaCO ₃	-	-	310	330	168	285	320	227	185	145	198
Nutrients											
Ammonia (total, as N)	0.3 ^c	0.9	<0.01	0.02	0.05	0.01	0.06	0.14	0.30	0.10	0.51
Nitrite	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Nitrate	45.0	0.7	<0.01	0.04	0.21	0.02	0.02	0.66	0.05	0.05	0.07
Total Kjeldahl nitrogen	-	-	0.2	0.3	0.5	0.3	0.4	0.6	0.8	0.8	0.8
Total nitrogen	-	-	0.2	0.3	0.7	0.3	0.4	1.3	0.8	0.8	0.9
Total phosphorus	-	-	0.06	0.09	0.26	0.15	0.15	0.87	0.80	0.87	0.27
Reactive phosphorus	-	-	0.07	0.08	0.25	0.11	0.13	0.08	0.10	0.05	0.21

All units are in mg/L unless otherwise noted.

Exceedances of PNG criteria are shown in bold. Exceedances of ANZECC/ARMCANZ (2000) guidelines are shown in grey highlight.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000).

c Criterion is temperature and pH dependent (criterion selected based on pH of 8 and temperature of 30°C).

Table 3.8: Major ions and nutrients – reference sites (all units are in mg/L)

	PNG criteria ^a	ANZECC ^b	YALU1	YALU2	WAMI1	BUMB1	BUMB2	BUMB3	GOV1	WATR1	MARA1
Major ions											
Calcium	-	-	30	30	55	33	29	27	24	36	28
Magnesium	-	-	6	6	14	8	7	6	6	8	5
Sodium	-	-	24	25	26	13	9	8	11	15	14
Potassium	5	-	<1	<1	1	<1	1	1	<1	1	<1
Chloride	-	-	<1	<1	1	<1	<1	1	2	<1	1
Sulphate	400	-	6	6	10	4	4	4	3	6	9
Total alkalinity as CaCO ₃	-	-	160	162	249	143	121	110	106	156	116
Nutrients											
Ammonia (total, as N)	0.3 ^c	0.9	<0.01	0.03	0.01	0.61	<0.01	0.02	<0.01	0.02	<0.01
Nitrite	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate	45.0	0.7	0.15	0.11	0.19	0.11	0.12	0.08	0.06	0.10	0.05
Total Kjeldahl nitrogen	-	-	0.3	0.6	<0.1	0.2	0.3	0.4	0.1	0.2	<0.1
Total nitrogen	-	-	0.4	0.7	0.2	0.3	0.4	0.5	0.2	0.3	<0.1
Total phosphorus	-	-	0.83	1.06	0.11	0.23	0.22	0.31	0.11	0.17	0.14
Reactive phosphorus	-	-	0.08	0.07	0.08	0.12	0.12	0.12	0.10	0.07	0.03

All units are in mg/L unless otherwise noted.

Exceedances of PNG criteria are shown in bold. Exceedances of ANZECC/ARMCANZ (2000) guidelines are shown in grey highlight.

a Source: Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection (PNG, 2002).

b Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000).

c Criterion is temperature and pH dependent (criterion selected based on pH of 8 and temperature of 30°C).

Table 3.7 and Table 3.8 show that the dominant ions in the waters were calcium and carbonates, typical of streams with karstic (limestone) influence. Busanem Creek (S/Site 1) and Amburinu Creek (S/Site 2) showed the greatest karstic influence with the highest calcium (80 mg/L and 63 mg/L) and total alkalinity (310 and 330 mg/L CaCO₃) concentrations.

Ammonia concentrations were below ANZECC/ARMCANZ (2000) guidelines and PNG criteria except at BUMB1 where 0.61 mg/L was recorded – exceeding the PNG criterion of 0.3 mg/L but below the ANZECC/ARMCANZ criterion of 0.9 mg/L – and at S/Site 9 where 0.51 mg/L was recorded, exceeding the PNG criterion. Nitrite concentrations were below detection at all sites except at S/Site 9 where 0.04 mg/L was detected. Nitrate ranged from less than 0.01 mg/L (S/Site 1) to 0.66 mg/L (S/Site 6) with all concentrations well below the PNG criterion of 45 mg/L and the ANZECC/ARMCANZ guideline of 0.7 mg/L. Total nitrogen ranged from less than 0.1 mg/L (MARA1) to 1.3 mg/L (S/Site 6) and total Kjeldahl nitrogen from less than 0.1 mg/L (MARA1 and WAMI1) to 0.8 mg/L (S/Site 7, S/Site 8 and S/Site 9).

Total Kjeldahl nitrogen is the nitrogen in the form of organics and ammonia (i.e., total nitrogen minus nitrite and nitrate). The similar concentrations of total nitrogen and total Kjeldahl nitrogen are reflective of the low concentrations of nitrate and nitrite in the samples.

Total phosphorus was highest at YALU2 (1.06 mg/L) and lowest at S/Site 1 (0.06 mg/L). Reactive phosphorus concentrations were low at all sites, ranging from 0.03 mg/L (MARA1) to 0.25 mg/L (S/Site 3).

3.2. Water quality control results

This section provides a summary of the quality control results for water quality sampling and analysis. The full quality control data is presented in Appendix B.

The results of the quality control regime were generally very good and are summarised as follows:

- Field water sample duplicate results in March 2017 (samples GOV1 and GOV1D) showed good agreement between the two samples demonstrating good precision of sampling method. Field duplicate results in June 2017 (sample S/Site 8 and S/Site 8 DUP) also showed good agreement between the two samples.
- Field blank results in March 2017 (sample FBX1) showed most parameters to be below detection limits demonstrating avoidance of contamination during sampling. The exceptions were low concentrations of alkalinity, total phosphorus and ammonia. A low concentration of ammonia (0.09 mg/L) and total phosphorus (0.03 mg/L) were detected in the field blank; however, these do not indicate significant contamination. Field blank results in June 2017 (sample FBx 1) also showed most parameters to be below detection limits. The exception was the detection of a low concentration of total phosphorus (0.02 mg/L) in the field blank.
- Laboratory duplicate results in both March and June 2017 showed no duplicate outliers.
- Laboratory method blank results in both March and June 2017 showed no outliers.
- Laboratory control spike results in both March and June 2017 showed no outliers.
- Laboratory matrix spike results in March 2017 showed some outliers. These occurred for dissolved copper and manganese for an anonymous laboratory control sample. The reason for this is that the matrix spike recovery could not be determined as the background concentrations of these parameters were more than four times the spike concentration. This is not uncommon in laboratory matrix spike analysis. Laboratory matrix spike results in June 2017 showed no outliers.

- There were some exceedance of holding times in both March and June 2017 for nitrite (all samples, overdue by up to 5 days) and reactive phosphorus (all samples, overdue by up to 5 days). However, this was unavoidable given the location of the survey area and the requirement to transport samples to Australia for analysis at a NATA-accredited laboratory. This is common to all baseline water quality studies where samples have to be transported from PNG to Australian laboratories if NATA-accredited facilities are to be used. It is likely the effect of this exceedance on the results would not be material given that the exceedance was short in duration and the concentrations of the analytes were low.

3.3. Riparian habitat

Table 3.9 lists observations used to assess the riparian modification. These observations include the presence of gardens, roads and tracks, settlements or urban influence at sites, as well as areas of unmodified riparian vegetation.

The criteria used to designate the levels of riparian modification are as follows:

- Low – little or no modification of any riparian habitat was observed at the site.
- Medium – some of the riparian habitat was modified at the site; although large sections of unmodified habitat were present.
- High – most or all of the riparian habitat was modified at the site.

The riparian conditions assigned above are further detailed below for each of the sites.

Table 3.9: Levels of riparian modification at sites and the likely contributing factors to the levels of modification

	S/Site 1	S/Site 2	S/Site 3	S/Site 4	S/Site 5	S/Site 6	S/Site 7	S/Site 8	S/Site 9	YALU1	YALU2	WAMI1	BUMB1	BUMB2	BUMB3	GOV1	WATR1	MARA1
Gardens	X	X	X	X	X	X	X	-	X	X	X	-	X	X	X	X	X	X
Villages/ settlements	-	-	X	X	X	X	-	-	X	-	X	-	-	-	X	X	-	-
Urban land use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Roads and tracks	-	X	X	X	X	-	X	X	X	X	X	-	X	-	X	X	X	X
Unmodified riparian vegetation only	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Riparian modification	High	Medium	High	Medium	Medium	Medium	High	High	High	High	High	Low	Medium	Medium	High	Medium	Medium	Medium

X denotes feature present.
 - denotes feature not present.

S/Site 1

Plate 3.1 shows the riparian condition at S/Site 1, surrounded by gardens. Plate 3.2 shows the typical swampy conditions observed in the area.



Plate 3.1: Looking downstream from S/Site 1 (Busanem Creek)



Plate 3.2: Swampy conditions near S/Site 1

S/Site 2

Plate 3.3 shows the riparian condition at S/Site 2. The riparian zone comprised sections of thick vegetation but also included cleared areas due to gardens and tracks.



Plate 3.3: S/Site 2 on Amburinu Creek

S/Site 3

Plate 3.4 shows the riparian condition at S/Site 3. Note the plants growing in the creek.



Plate 3.4: The vegetation at Buambub Creek (S/Site 3) comprised thick grass to the stream's edge

S/Site 4

Plate 3.5 shows the riparian condition at S/Site 4. Riparian zone was influenced by access tracks, settlements and gardens. Note the grasses growing in the creek (right of picture).



Plate 3.5: Riparian conditions at S/Site 4 on Pumpkin Creek

S/Site 5

Plate 3.6 and Plate 3.7 show the riparian condition at S/Site 5.



Plate 3.6: Riparian conditions on Pumpkin Creek at S/Site 5

Plate 3.7: Woody debris along stream's edge at S/Site 5 (foreground and in the right of picture)



S/Site 6

Plate 3.8 and Plate 3.9 show the riparian condition at S/Site 6. Note the inflow from a branch of the Markham River in the right Plate 3.8. Plate 3.9 shows the visible eroding, silty bank typical of the creek.

Plate 3.8: Riparian conditions at Pumpkin Creek at S/Site 6



Plate 3.9: Looking across from S/Site 6



S/Site 7

Plate 3.10 shows the riparian condition at S/Site 7. The riparian zone was highly modified gardens and access tracks along the eastern bank.



Plate 3.10: Looking downstream from S/Site 7 on Pumpkin Creek

S/Site 8

Plate 3.11 and Plate 3.12 show the riparian condition at S/Site 8. Not visible in Plate 3.11 is the highly modified riparian zone along the eastern bank due to a road (left of picture). Note the section of steep, muddy bank on the right of Plate 3.12.



Plate 3.11: Looking downstream from S/Site 8 on the Markham River



Plate 3.12: Looking upstream from S/Site 8 on the Markham River

S/Site 9

Plate 3.13 and Plate 3.14 show the riparian condition at S/Site 9. Note the muddy clay banks in Plate 3.14.



Plate 3.13: Highly modified riparian vegetation at S/Site 9 (Maiwara Creek)



Plate 3.14: Grasses to the stream's edge at S/Site 9

YALU1

Plate 3.15 and Plate 3.16 show the riparian condition at site YALU1. Garden areas were present along the western side of the river. A local person can be seen washing clothing in the river in the background in Plate 3.16.

Plate 3.15: Eroding cliffs along the eastern bank of the Yalu River at YALU1 (looking upstream)



Plate 3.16: Modified riparian vegetation (garden areas and roads) at YALU1 (looking downstream)



YALU2

Plate 3.17, Plate 3.18 and Plate 3.19 show the riparian condition at site YALU2. The western bank (left side of picture in Plate 3.18) was more heavily modified with a small settlement present and garden areas. Note the cleared riparian zone in the background of Plate 3.19 (which is the eastern side of river) due gardens and roads. The visible row of palm trees follows the Highlands Highway.

Plate 3.17: Eroding cliff at YALU2 with modified riparian vegetation (looking downstream)



Plate 3.18: Riparian vegetation on the eastern bank of Yalu River at YALU2



Plate 3.19: Looking downstream from site YALU2



WAMI1

Plate 3.20 and Plate 3.21 show the riparian condition at site WAMI1.

Plate 3.20: Thick, unmodified riparian vegetation at WAMI1 (Wamin Creek)



Plate 3.21: Erosion and slumping observed along Wamin Creek



BUMB1

Plate 3.22 and Plate 3.23 show the riparian condition at site BUMB1. Although difficult to see in Plate 3.22, the western banks (left side of picture) comprised eroding muddy banks. Access roads and garden areas were present along the eastern edge (left side of Plate 3.23) of this river near this site.

Plate 3.22: Dense riparian vegetation along the western bank of Bumbu River at BUMB1



Plate 3.23: Riparian conditions at BUMB1 (looking downstream)



BUMB2

Plate 3.24, Plate 3.25 and Plate 3.26 show the riparian condition at site BUMB2. Numerous gardens were present along this section of river. Note the flatter profile with a lack of eroding banks and cliffs along this section of the Bumbu River (Plate 3.24). Thick vegetation was present along the northern bank at BUMB2 as visible in Plate 3.25, although gardens dominated by banana trees were present at this site. The banana trees can be seen in the background of Plate 3.26.

Plate 3.24: Looking upstream from site BUMB2 on the Bumbu River



Plate 3.25: Looking downstream from site BUMB2 on the Bumbu River





Plate 3.26: Gardens dominated by banana trees along the Bumbu River at BUMB2

BUMB3

Plate 3.27 and Plate 3.28 show the riparian condition at site BUMB3. Riparian cover at BUMB3 was mainly grasses with clearings for gardens and buildings. There were also walking tracks along both sides of the river. In the right of Plate 3.28 a vehicle parking area and walking track is visible along the eastern bank.



Plate 3.27: Highly modified riparian condition at BUMB3 on the Bumbu River (looking downstream)

Plate 3.28: Highly modified riparian condition at BUMB3 on the Bumbu River (looking upstream)



GOV1

Plate 3.29 and Plate 3.30 show the riparian condition at site GOV1. Some sections of thick riparian vegetation are present.

Plate 3.29: Erodible banks at site GOV1 on an un-named creek (looking upstream)



Plate 3.30: A house and garden area was immediately adjacent to site GOV1 along the eastern bank (as can be seen in the background)



WATR1

Plate 3.31 and Plate 3.32 show the riparian condition at site WATR1.



Plate 3.31: Typically muddy erodible bank seen at WATR1 (Waterise Creek)



Plate 3.32: Modified riparian conditions at WATR1

MARA1

Plate 3.33 and Plate 3.34 show the riparian condition at site MARA1. Riparian vegetation was more established at MARA1, with a lower presence of human settlement and gardens. However roads and walking tracks were adjacent to the river on both sides resulting in some modification of the riparian zone.



Plate 3.33: Looking downstream from site MARA1



Plate 3.34: Looking upstream from site MARA1

3.4. Stream bed composition and in-stream habitat

This section presents the results for stream bed composition and in-stream habitat. A more intensive assessment of stream bed was carried out for the reference sites as these sites were sufficiently shallow to wade.

Table 3.10 presents the observations made for in-stream habitat for S/Sites 1 to 9.

Table 3.10: In-stream habitat features identified at S/Sites 1 to 9

Site	Riffles	Rocks with interstitial spaces*	Algae	Leaf mats	Aquatic plants	Woody debris
S/Site 1	No	No	No	No	Yes	Yes
S/Site 2	No	No	No	No	No	Yes
S/Site 3	No	No	No	No	Yes	No
S/Site 4	No	No	No	No	No	Yes
S/Site 5	No	No	No	No	Yes	Yes
S/Site 6	No	No	No	No	No	Yes
S/Site 7	No	No	No	No	No	Yes
S/Site 8	No	Yes	No	No	No	No
S/Site 9	No	No	No	No	Yes	Yes

* This refers to the presence of larger rocks such as pebbles, cobbles and boulders which could provide interstitial spaces for macroinvertebrates.

As shown in Table 3.10, the lack of large rocks in these streams meant that there were no noticeable riffles or algae present at any of the S/Sites. As the stream beds were dominated by silts, there was a lack interstitial spaces for benthic macroinvertebrates to inhabit. No leaf mats were observed, however aquatic plants were present at several sites (S/Site 1, S/Site 3, S/Site 5 and S/Site 9) and woody debris was present at all sites except S/Site 3 and S/Site 8.

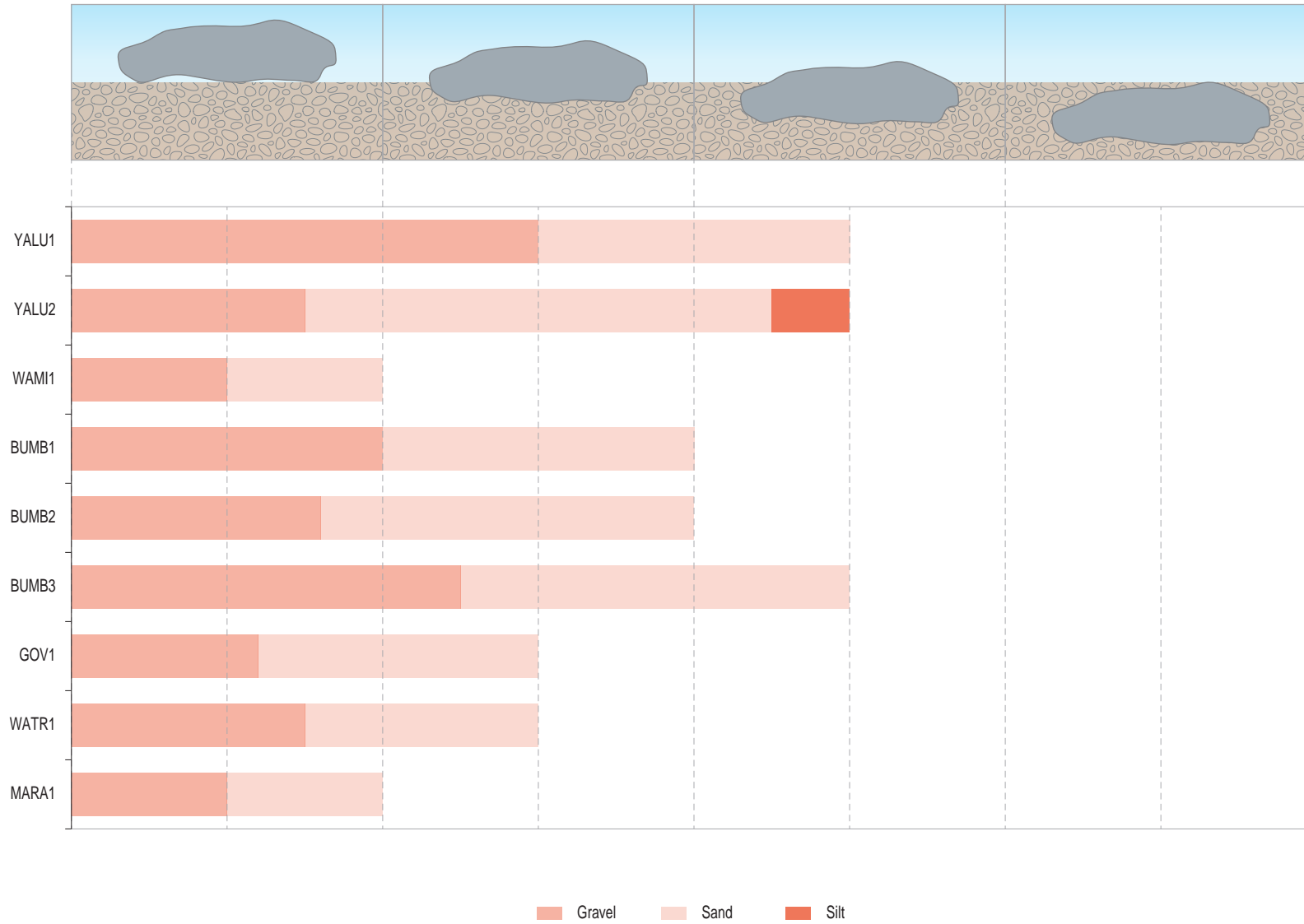
This section also presents the results for the total streambed substrate cover measured at the reference sites (i.e., including the estimates of percent cover of finer sediments of less than 2 mm, up to cobbles and boulders).

Figure 3.1 shows the measure of stream bed embeddedness for each of the reference sites. Embeddedness describes the degree to which coarser components are surrounded by finer ones (Gordon *et al.* 2004). Four categories of embeddedness (infilling of river bed stone or pebble interstices with fine sediments) are shown in the Figure 3.1.

Site description data included measurements of the composition of the stream bed at the reference sites. This is expressed as a percentage, with the contributions from each grain size from silt to boulder (Figure 3.2) totalling 100% cover. This figure shows that many of these rivers and creeks have beds that are dominated by smaller substrate sizes such as sand and gravel and these stream beds are therefore naturally quite mobile.

None of the reference sites visited provided a diversity of in-stream habitats. Woody debris was all but absent from many of the rivers, and aquatic macrophytes were restricted to slower flowing areas adjacent to those sampled.

Leaf packs and algal cover were not recorded at any of the sites.



Note: The length of the bars is embeddedness category as illustrated at the top of the figure. Sub-divisions within each bar demonstrate the proportions contributed by each sediment size.

AI Reference: 0520_17_GRA001.a1.v3

Source:
The Waterbug Company



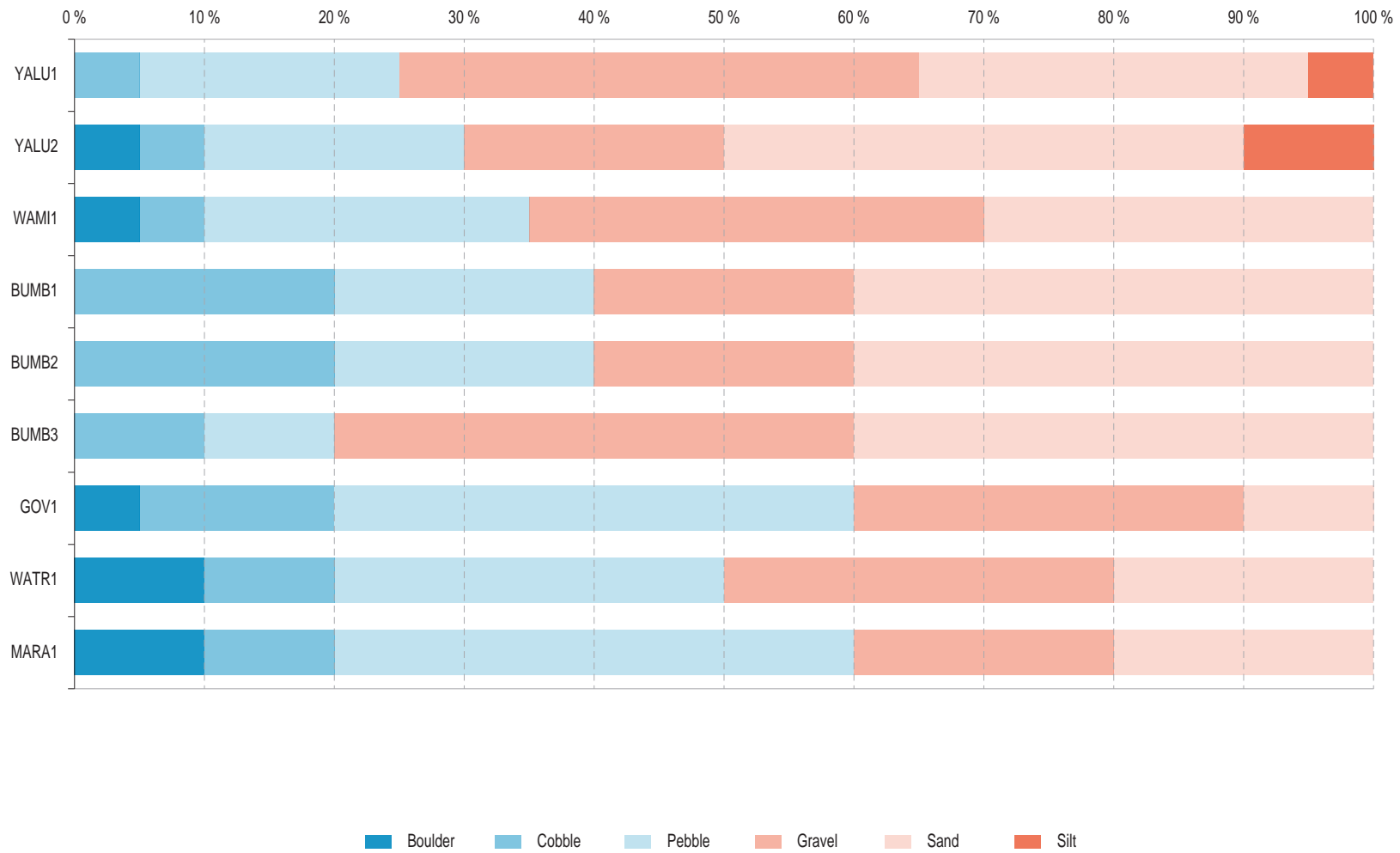
Date:
12.10.2017
Project:
754-ENAUABTF100520CC
File Name:
0520CC_17_F03.01_GRA



Wafi-Golpu Project

Embeddedness descriptions for sites sampled

Figure No:
3.1



AI Reference: 0520_17_GRA002.a1.v2

Source:
The Waterbug Company



Date: 04.05.2017
Project: 754-ENAUABTF100520CC
File Name: 0520CC_17_F03.02_GRA



Wafi-Golpu Project

Substrate composition at the sample sites

Figure No:
3.2

4. Discussion

This section discusses the results presented in Section 3 for:

- Water quality.
- Riparian habitat.
- Stream bed composition and in-stream habitat.

4.1. Water quality

Water quality was typical of freshwater streams in PNG where the geomorphology has karstic influence. This was reflected by the water at all sites being slightly alkaline, with the dominant ions being calcium and carbonate.

The S/Sites 1 to 9 showed evidence of greater karstic influence than those north of the Atzera Mountain Range (i.e., reference sites). This was evidenced by higher alkalinity, conductivity, hardness and calcium concentrations at the sites south of the Atzera Mountain Range.

During the survey at the reference sites in March 2017 there was heavy, widespread rainfall during most nights prior to sampling. As a result, the streams were turbid due to suspended sediment. Of these sites, Yalu and Bumbu rivers were the most turbid and had the highest TSS concentrations. Both of these rivers became progressively more turbid with distance downstream. This reflects the additional sediment input from erodible banks along the river as well as sediment input from tributaries.

Marambi River (site MARA1) had a relatively low turbidity and TSS concentration given that this was a high energy, fast-flowing river. This is reflective of a lower portion of finer sediments (clays and silts) in the catchment.

Site GOV1 on an un-named creek draining to the Bumbu River had the lowest turbidity and TSS. This can be attributed to a combination of its relatively low surface flow and low proportion of fine particles.

During the survey in June 2017, nightly rainfall was highly localised, with only S/Site 3, S/Site 4 and S/Site 8 being sampled the morning after rainfall. The smaller streams (S/Site 1, Busanem Creek; S/Site 2, Amburinu Creek; S/Site 3, Buambub Creek; and S/Site 9, Maiwara Creek) had moderate turbidity and TSS concentrations. The larger Pumpkin Creek and Markham River (671 NTU; 1,050 mg/L TSS) were highly turbid. The stream banks and beds at S/Sites 1 to 9 were dominated by muddy clays and silts. Such material is easily re-suspended in flowing waters and explains the turbid nature of the streams.

The streams at S/Site 1-9 were lower-gradient watercourses than those north of the range, resulting in slower flowing streams that were more 'swampy' in nature. This, combined with a lack of riffles, meant that these streams had lower dissolved oxygen concentrations than the reference sites. Across all sites, dissolved oxygen ranged from 50% to 80% saturation, which is below the ANZECC/ARMCANZ guideline range for freshwater ecosystems. At S/Site 4, S/Site 5 and S/Site 6, dissolved oxygen was below the PNG lower-limit criterion of 6 mg/L.

All reference site streams were well oxygenated due to turbulent flows (riffles), which introduce atmospheric oxygen into the water. Dissolved oxygen ranged from 91% saturation (7.0 mg/L) to 115% (i.e., supersaturated) (8.9 mg/L) across all sites. This is within the guideline range of 80% to 120% given for freshwater ecosystem protection in ANZECC/ARMCANZ (2000), indicating the oxygen concentrations are supportive of freshwater aquatic ecosystem health. The concentrations were also above the PNG lower-limit criterion of 6 mg/L at all of these sites.

Most dissolved metals concentrations were below the PNG criteria and ANZECC/ARMCANZ (2000) guidelines. The only exception was manganese at S/Site 9 (0.53 mg/L), which exceeded the PNG criterion of 0.5 mg/L. The generally low concentrations indicates that the existing freshwater ecology is not exposed to acute or chronic toxicity effects due to dissolved metals. The low dissolved metals concentrations are consistent with the alkalinity of the waters. Typically, it is under acidic conditions where the mobilisation of dissolved metals is prevalent.

Low total metal concentrations were measured for arsenic, chromium, cobalt, copper, lead, manganese, nickel and zinc. These results, along with the corresponding dissolved metals concentrations, indicate that these total concentrations are mostly due to metals in the particulate phase (i.e., bound to sediment particles), as the above-mentioned total metals were generally at or below detection for the dissolved phase with the exception of copper and manganese which had maxima of 0.003 mg/L and 0.53 mg/L, respectively.

Nutrients concentrations were generally low (being close to or below detection limits) and mostly below PNG criteria and ANZECC/ARMCANZ guidelines. The exception was ammonia at site BUMB1 (0.61 mg/L) and at S/Site 9 (0.51 mg/L), which exceeded the PNG criterion of 0.3 mg/L (although these concentrations were below the ANZECC/ARMCANZ guideline of 0.9 mg/L). The origin of the elevated concentration is not known as there was no discernible source of elevated ammonia at these sites.

Household waste was discharged upstream of S/Site 1, S/Site 4 and S/Site 9. These discharges included sewage, food waste, used clothes and food and drink packaging. The high ammonia at S/Site 9 could indicate the disposal of domestic cleaning chemicals upstream. The relatively low dissolved oxygen concentration (5.7 mg/L) at S/Site 4 could be potentially attributed, in part, to sewage disposal into the stream; however, given the low concentrations of nutrients at this site, the slow flow and lack of riffles is the more likely explanation for low dissolved oxygen. At S/Site 1, there were no parameters in exceedance of ANZECC/ARMCANZ (2000) guidelines or PNG criteria.

There were no obvious potential sources of water contamination (e.g., wastewater discharge) observed at any of the reference sites except for a large open stormwater drain upstream of site BUMB3 (Plate 4.1). This drain discharges runoff from an industrial area at Taraka. Notwithstanding, no parameters exceeded PNG criteria or ANZECC/ARMCANZ (2000) guidelines at site BUMB3. Sites WATR1 and BUMB3 contained noticeable rubbish (mostly plastic bags and packaging). Washing of laundry was observed in Waterise Creek and Yalu River; although the washing was downstream of sites WATR1 and YALU1, respectively. It was not clear if soaps, detergents or other chemicals were being used.



Plate 4.1: Open stormwater drain upstream of BUMB3

This drain flows through an industrial area at Taraka to the Bumbu River.

4.2. Riparian habitat

Due to the large population in and around Lae, the riparian habitat was largely modified at most of the sites visited in the form of gardens, settlements and roads. Other infrastructure, such as overhead powerlines, meant that vegetation was relatively cleared in some areas, mostly in the vicinity of sites YALU2 and BUMB3. The riparian zone along the lower reach of the Markham River was cleared due to the presence of a road.

The lowest riparian modification was observed at WAMI1 (Wamin Creek), which had uninterrupted native vegetation along the riparian zone. However, gardens were present further downstream from this site near the confluence with Yalu River. The Yalu and Bumbu rivers showed relatively high modification in riparian condition due to the extensive gardens, settlements and roads adjacent to these rivers.

Erosion was naturally high across the survey area with most streams having areas with exposed banks and actively eroding edges. This was most evident in Wamin Creek (see Plate 3.21), which was incised in thick sedimentary substrate with highly erodible cliffs along the creek. Erodible banks were a feature of Yalu River (see Plate 3.15) and the upstream section of Bumbu River (BUMB1). Pumpkin Creek and Markham River also had actively eroding, steep, muddy banks.

4.3. Stream bed composition and in-stream habitat

This section discusses stream bed composition and in-stream habitat. A more intensive assessment of stream bed was carried out for the reference sites as these sites were sufficiently shallow to wade.

4.3.1. Sampling Sites

The streams associated with S/Sites 1 to 9 were lower-gradient and slower-flowing than the reference sites to the north of the Atzera Mountain Range. These streams were typically swampy, with beds and banks dominated by muddy clays and silts. These characteristics meant that in-stream habitat was notably different between to the sites north of the Atzera Mountain Range, which were higher-energy, faster flowing streams with beds and banks dominated by gravels and sands.

The lower-energy streams allow finer particles such as silts and clays to settle on the beds and banks. The domination of fine sediments in the streams in the S/Sites 1 to 9, combined with the lack of pebbles, cobbles and boulders, results in a lack of interstitial spaces for benthic macroinvertebrates to inhabit. The only exception was S/Site 8 on the Markham River, where cobbles and boulders were noted along the bed and banks, and as such this river provides benthic habitat suitable for macroinvertebrates.

The lack of coarser substrate, coupled with the lower gradient in these streams meant there were few riffles.

The lower-energy streams also provide conditions more conducive to aquatic plant growth, as the beds are not highly mobile (like they are in higher-energy streams) and this allows plant roots to establish themselves in the stream bed. Aquatic plants were sparse in the streams north of the Atzera Mountain Range; however, they were more abundant (typically along the stream edges) at S/Site 1, S/Site 3, S/Site 4 and S/Site 9.

Woody debris was a more common feature at S/Site 1, S/Site 2, S/Site 4, S/Site 5, S/Site 7 and S/Site 9 because the streams lack the typical high energies required to transport decaying logs, sticks and branches.

4.3.2. Reference sites

All of the reference sites had at least 40% of their streambed represented by sand or gravel. The sand and gravel components take less water force to move than coarser bed elements making these river beds more mobile (Gordon *et al.*, 2004). This in turn provides unstable habitat for in-stream fauna and flora. Furthermore, these high proportions of sands and gravels at all sites occupy the interstitial spaces (i.e., habitats) between larger materials (such as pebbles and cobbles) thereby providing unsuitable habitat for many macroinvertebrate species.

Such natural smothering of coarser substrates, filling of interstitial spaces, and reduction of available habitat for riffle dwelling animals would likely affect most of the larger stream invertebrates in the upstream area, especially the Naucoridae. These observations are drawn from literature findings that report on river systems exposed to heavy sedimentation, both in nearby tropical ecosystems (Yule, 1995; Yule *et al.*, 2010) and in Australia (Davey *et al.*, 1987; Doeg and Koehn, 1994).

No algal cover (e.g., periphyton, diatoms or filamentous algae) was observed on any of the rocks at any sites. The absence of algae supports the conclusion that these streams are of high energy with highly mobile beds that prevent the algae from establishing as mats. The high turbidity in these systems is also likely to contribute to the absence of the algae as it effectively blocks light from reaching the substrates upon which they would grow.

Naturally high turbidity, high erosion and the mobility of the river bed at these sites combine to reduce the availability of in-stream habitats across all sites sampled as part of this survey.

The absence of woody debris and aquatic macrophytes at many of the sites sampled is likely to be linked to the overall mobility of the stream bedload. Rivers with gravel and sand dominated stream beds coupled with the high-energy flows generally do not retain structures such as woody debris as they are dislodged and washed downstream during higher flows (Dudgeon, 2008). Similarly, aquatic macrophytes need stable substrate around their roots to persist in rivers, and these conditions were not observed at any of the sites.

Leaf packs (accumulations of leaves and sticks in the slow flow areas behind rocks) were not recorded at any of the reference sites. This is consistent with the dominance and dynamic movement of sand and gravel dominated systems, so inhibiting organic material from lodging and accumulating between rocks.

5. References

- ANZECC/ARMCANZ. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.
- BMT WBM. (2016). Wafi Golpu Project Aquatic Ecology Assessment, Downstream Impact Assessment, and Sediment Characterisation and Transport Studies.
- Coffey. (2018). Wafi-Golpu Project. Socio-economic Baseline. March. Prepared by Coffey Environments for WGJV.
- Davey G.W., Doeg T.J., Blyth J.D. (1987). Changes in benthic sediment in the Thomson River, Southeastern Australia, during construction of the Thomson Dam. *Regulated Rivers: Research and Management* **1**, 71-84.
- Doeg T.J., Koehn J.D. (1994). Effects of draining and desilting a small weir on downstream fish and macroinvertebrates. *Regulated Rivers: Research and Management* **9**, 263-277.
- Dudgeon, D. (1994). The influence of riparian vegetation on macroinvertebrate community structure and functional organization in six new Guinea streams. *Hydrobiologia* **294**(1), 65-85.
- Dudgeon, D. (2008). *Tropical stream ecology*. Academic Press. London, England.
- Gordon N. D., McMahon, T. A., Finlayson B. L., Gippel, C.J., Nathan, R.J. (2004). *Stream Hydrology: An Introduction for Ecologists*, 2nd Edition, 448 pp Wiley international.
- PNG. (2002). *Environment (Water Quality Criteria) Regulation 2002 – Schedule 1 Water Quality Criteria for Aquatic Life Protection*.
- US EPA. (2012). Water Monitoring and Assessment. Section 5.1 - Stream Flow: *What is stream flow and why is it important?* A WWW publication accessed on 24 April 2017 at <https://archive.epa.gov/water/archive/web/html/vms51.html>
- US Geological Survey. (2006). National Field Manual for the Collection of Water-Quality Data. A WWW publication accessed on 16 June 2017 at <http://water.usgs.gov/owq/FieldManual/Chapter6/conversion.html>.
- Yule C. (1995). The impact of sediment pollution on the benthic invertebrate fauna of the Kelian River, East Kalimantan, Indonesia. *Tropical limnology* **3**, 61-75.
- Yule C.M., Boyero L., Marchant R. (2010). Effects of sediment pollution on food webs in a tropical river (Borneo, Indonesia). *Marine and Freshwater Research* **61**, 204-213.

**Appendix A – Field notes from each survey
site**

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
YALU1	02/03/2017	13:10	486347	9271912	67	Yalu River	<p>Heavy rain previous night. Weather partly cloudy. Fast flowing, milky turbid water. Steep erodible banks on east bank with riparian vegetation all along the bank. River was an incised channel into the broader, flat river bed and was braided in sections. Riffles present. Some small side pools present. On average, stream approx. 50 cm deep, 8 m wide and surface flow rate 2 m/s. Flow discharge estimated to be 6.4 m³/s. Clothes washing area observed 100 m downstream.</p> <p>Stream bed and banks comprised randomly sorted cobbles, pebbles, gravels and sands. Finer sands and clay-like material were interspersed along the banks.</p>
YALU2	02/03/2017	9:45	486502	9270279	48	Yalu River	<p>Heavy rain previous night. Weather partly cloudy. Fast flowing, milky turbid water. Erodible, steep cliffs on the eastern river bank. River an incised channel into the broader flat river bed and was braided in sections. Riffles present. Some small side pools present. Sample site was under powerlines. A small house and garden present approximately 100 m to the east site. On average, stream was 30 cm deep, 14 m wide and surface flow rate 2 m/s. Flow discharge estimated to be 6.7 m³/s.</p> <p>Stream bed and banks comprised randomly sorted cobbles, pebbles, gravels and sands. Finer sands and clay-like material were interspersed along the banks.</p>
WAMI1	05/0317	12:20	487374	9270178	92	Wamin Creek	<p>No known rain the previous night. Weather fine and sunny.</p> <p>Slow flowing, shallow and slightly turbid water. At sampling site, creek was on average, approx.1 m wide and 15 cm deep with surface flow about 0.3 m/s. Flow discharge estimated to be 0.03 m³/s. Stream bed comprised gravel and fine sediments. Riparian vegetation was thick to stream edge. Stream bed and banks dominated by pebbles, cobbles and gravels. Numerous large boulders present in some sections. Erodible cliffs in sections of the creek.</p>

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
BUMB1	04/03/17	10:10	492355	9267809	88	Bumbu River	Heavy rain previous night. Weather fine. River comprised a fast-flowing narrow channel within a broader flat river bed. The broader drainage comprised shallower stagnant to slow flowing water. Water turbid. Bed and banks dominated by coarse, sandy sediment with some fine sediment sections. Cobbles, pebbles interspersed throughout the bed and banks. Erodible banks with dense riparian vegetation along southern edge of river. Riffle sections present. Main flow channel was approx. 5 m wide and 60 cm deep with surface flow of 1.25 m/s. Flow discharge estimated to be 3 m ³ /s.
BUMB2	03/03/17	13:30	497231	9262933	60	Bumbu River	Heavy rain previous night. Weather fine. Water turbid. Riffles present. Bed and banks dominated by coarse, sandy sediment with some fine sediment sections. Sampled from large gravel bar. Thick grass and dense vegetation on north and south banks. Large garden areas adjacent to sampling site to the south. Site about 150 m upstream of the outskirts of the suburb East Taraka and about 200 m downstream of confluence with Waterise Creek. On average, stream depth approximately 40 cm (although with some deeper sections to about 70 cm) and width 40 m with surface flow of 1.25 m/s. Flow discharge estimated to be 16 m ³ /s.
BUMB3	03/03/17	10:15	498372	9261333	48	Bumbu River	Heavy rain previous night. Weather fine. River water level much higher than normal according to locals. Turbid water. Riffle sections present. Children observed fishing 100 m upstream using large nets. The small fish caught are eaten by locals. Kunai grass banks to river's edge on both sides. Sampled 80 m downstream of bridge to Buimo prison. Lots of rubbish observed in the water (including aluminium cans, soiled nappies, plastic bags and clothing). According to locals there is some Industrial discharges of wastewater upstream of this site although the details could not be verified. River 60 m wide and 40 cm deep on average. Surface flow rate 1.5 m/s. Flow discharge estimated to be 28.8 m ³ /s.

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
GOV1	04/03/17	13:10	493767	9268558	96	Un-named creek	Heavy rain the previous night. Weather fine. Reference site away from pipeline route. Small stream, name unknown, drains southward to the Bumbu River. Clear water. Riffle sections present. Site is adjacent to Morobe Governor's house and garden area. Stream was 8 m wide, approximately 15 cm deep on average (up to about 30 cm in some parts) with surface flow approx. 0.9 m/s. Site was 30 m upstream of road, which passes through the stream. Bed and banks comprised cobbles, pebbles and gravel. Apparent lack of fine sediments. A water pipeline crosses river 40 m downstream near the road crossing. Flow discharge estimated to be 0.9 m ³ /s.
WATR1	03/03/17	14:50	496516	9263162	70	Waterise Creek	Heavy rain the previous night. Weather fine. Small but fast flowing turbid creek which drains to the Bumbu River. Bed comprised cobbles and pebbles interspersed with coarse sandy sediment. Sections of clay muddy banks observed on southern bank. Turbid water. Rubbish (including plastic bags and bottles) present. Sampled approx. 80 m upstream of road through the river and 600 m upstream of the confluence with the Bumbu River. Stream approx. 2 m wide and 20 cm deep (wider and shallower in some parts) with surface flow approx. 2 m/s. Flow discharge estimated to be 0.64 m ³ /s.
MARA1	05/03/17	9:30	502836	9269286	158	Marambi River	No known rain the previous night. Weather fine and sunny. Reference site. Large headwater tributary to the Busu River. Sampled 100 m upstream of bridge. Car wash area nearby, approximately 30 m away. Stream bed dominated by large boulders, cobbles and some finer material along the edges. River was about 40 m wide and 80 cm deep on average (although this was difficult to confirm as it was unsafe to wade in this river due to depth and fast flow). Electrofishing was deemed to be unsafe at this site. Surface flow approximately 1.5 m/s. Many riffle sections. Flow discharge estimated to be 33.6 m ³ /s.

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
S/Site 1	07/06/2017	10:45	487594	9266978	27	Busanem Creek	<p>No known rain the previous night. Weather fine and sunny. Swampy drainage. Villages, gardens and access roads near the site. Upstream settlement discharges household waste into Busanem Creek. Bed comprised fine sands and silts and banks were muddy and eroding. Water was running clear. Stream contained abundant woody debris.</p> <p>Stream was about 0.5 m wide and 0.2 m deep. Estimated surface flow was 0.4 m/s and flow discharge estimated to be 0.03 m³/s.</p>
S/Site 2	07/06/2017	12:15	487811	9264910	27	Amburinu Creek	<p>No known rain the previous night. Weather fine and sunny. Access tracks and gardens adjacent to the site. Site was approximately 400 m from large settlements along the Highlands Highway. Water was a milky brown colour and turbid. Stream bed comprised silt material and banks were muddy and eroding.</p> <p>Stream was about 8 m wide and 3.2 m deep. Estimated surface flow was 0.2 m/s and flow discharge estimated to be 4.5 m³/s.</p>
S/Site 3	06/06/2017	8:50	486869	9263122	22	Buambub Creek	<p>Rainfall previous night. Weather overcast. Access tracks, gardens and farming activity surrounding the site. Stream bed comprised sand and silt material and banks were muddy. Riparian zone was dominated by long grasses. Water was a light brown colour and turbid.</p> <p>Stream was about 2.5 m wide and 0.45 m deep. Estimated surface flow was 0.45 m/s and flow discharge estimated to be 0.5 m³/s.</p>
S/Site 4	06/06/2017	14:35	488964	9261794	21	Pumpkin Creek	<p>Rainfall previous night. Weather fine and sunny. Site downstream of Wau road, settlement and garden areas. Settlement discharges household wastes into Pumpkin Creek. No bank or bed features visible but likely to comprise fine silts. Riparian zone was dominated by long grasses. Water had a turbid appearance.</p> <p>Stream was about 10.5 m wide and 2.2 m deep. Estimated surface flow was 0.9 m/s and flow discharge estimated to be 18.7 m³/s.</p>

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
S/Site 5	07/06/2017	15:40	491891	9259012	21	Pumpkin Creek	<p>No known rain the previous night. Weather fine and sunny. Gardens and houses in vicinity of the site. A crocodile farm located about 240 m from the site. Stream banks were steep, muddy and eroding. Stream bed comprised silt material. Water was noticeably turbid. Riparian zone was a mixture of dense sections with larger trees, as well as cleared areas and sections of thick grasses.</p> <p>Stream was about 35 m wide and 3 m deep. Estimated surface flow was 0.13 m/s and flow discharge estimated to be 12.3 m³/s.</p>
S/Site 6	07/06/2017	15:20	491885	9258909	15	Pumpkin Creek	<p>No known rain the previous night. Weather fine and sunny. This section of Pumpkin Creek receives flow from a branch of the Markham River. Gardens and houses in vicinity of the site. A crocodile farm located about 200 m from the site. Stream banks muddy and eroding. Stream beds comprised some pebbles, gravels, sands and silts. Water turbid. Riparian zone was a mixture of dense sections with larger trees, as well as cleared areas and sections of thick grasses.</p> <p>Stream was about 35 m wide and 1.8 m deep. Estimated surface flow was 0.8 m/s and flow discharge estimated to be 45 m³/s.</p>
S/Site 7	06/06/2017	10:15	493861	9257576	17	Pumpkin Creek	<p>No known rain the previous night. Weather fine and sunny. Gardens, tracks and farming areas (animals and vegetables) surrounding the site. Stream banks muddy and eroding. Beds comprised muddy silts. Water turbid. Some woody debris observed in stream. Riparian zone was highly modified due to tracks and gardens. Riparian zone consisted mainly of grasses.</p> <p>Stream was about 45 m wide and 1.5 m deep. Estimated surface flow was 0.8 m/s and flow discharge estimated to be 48 m³/s.</p>
S/Site 8	06/06/2017	11:10	495644	9256040	6	Markham River	<p>Rainfall previous night. Weather fine and sunny. Sampled eastern channel of Markham River. River braided with sand and gravel bar islands. River banks muddy and eroding with some boulders, gravels and sands present. Banks were low gradient. Bed comprised muddy silts interspersed with</p>

Site ID	Date	Time	Eastings (m)	Northings (m)	Elevation (m)	Stream name	Notes
							<p>boulders, gravels and sands. Water turbid. Riparian zone largely cleared with sections of low density grass.</p> <p>River (across eastern channel) was about 50 m wide and 1.2 m deep. Estimated surface flow was 0.75 m/s and flow discharge estimated to be 54 m³/s.</p>
S/Site 9	07/06/2017	14:07	496351	9257045	8	Maiwara Creek	<p>No known rain the previous night. Weather fine and sunny. Small swampy creek with muddy clay banks and beds. Water only slightly turbid. This creek collects drainage from a highly populated urban area where household wastes are discharged into this drainage. Gardens, settlements and roads about 250 upstream of the site. Riparian vegetation was modified (old garden areas) and comprised palm trees and shrubs. Woody debris and some aquatic vegetation observed in the stream.</p> <p>Stream was about 5 m wide and 0.8 m deep. Estimated surface flow was 0.2 m/s and flow discharge estimated to be 0.76 m³/s.</p>

This page has been left intentionally blank

**Appendix B – Laboratory water quality
results**

This page has been left intentionally blank

CERTIFICATE OF ANALYSIS

Work Order	: EB1704569	Page	: 1 of 17
Client	: COFFEY ENVIRONMENTS PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: TRAVIS WOOD	Contact	: Jenny Bevan
Address	: LEVEL 1, 436 JOHNSTON STREET ABBOTSFORD VIC, AUSTRALIA 3067	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: +61-7-3243 7222
Project	: 520 - WAFI	Date Samples Received	: 08-Mar-2017 15:10
Order number	: ----	Date Analysis Commenced	: 09-Mar-2017
C-O-C number	: ----	Issue Date	: 12-Apr-2017 15:34
Sampler	: TRAVIS WOOD		
Site	: ----		
Quote number	: BN/288/16 V6		
No. of samples received	: 41		
No. of samples analysed	: 31		



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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

- It is recognised that EK061G (Total Kjeldahl Nitrogen) is less than EK055G (Ammonia). However, the difference is within experimental variation of the methods.
- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- MS results attached to run #1397284



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				YALU1 <63µm Fraction	YALU2 <63µm Fraction	BUMB2 <63µm Fraction	BUMB3 <63µm Fraction	GOV1 <63µm Fraction
Client sampling date / time				02-Mar-2017 13:15	02-Mar-2017 10:15	03-Mar-2017 12:30	03-Mar-2017 10:30	04-Mar-2017 13:15
Compound	CAS Number	LOR	Unit	EB1704569-022	EB1704569-023	EB1704569-024	EB1704569-025	EB1704569-026
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	38600	37600	38400	36300	40600
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	120	110	120	110	100
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	46	49	62	68	86
Cobalt	7440-48-4	2	mg/kg	21	20	23	24	25
Copper	7440-50-8	5	mg/kg	78	70	87	75	113
Iron	7439-89-6	50	mg/kg	45300	46900	49400	52100	69000
Lead	7439-92-1	5	mg/kg	5	<5	<5	11	6
Manganese	7439-96-5	5	mg/kg	727	702	902	856	820
Nickel	7440-02-0	2	mg/kg	45	41	52	51	66
Zinc	7440-66-6	5	mg/kg	69	70	81	83	98
EG020T: Total Metals by ICP-MS								
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	7440-31-5	0.1	mg/kg	0.4	0.4	0.5	0.6	0.7
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	0.02	0.01	0.02	0.02	0.02
GEO26: Sieving								
-63µm	----	0.01	%	17.7	23.1	15.0	19.4	8.11



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				BUMB1 <63µm Fraction	WATR1 <63µm Fraction	WAMI1 <63µm Fraction	MARA1 <63µm Fraction	MARA1D <63µm Fraction
Client sampling date / time				04-Mar-2017 09:50	03-Mar-2017 15:00	05-Mar-2017 12:00	05-Mar-2017 09:00	05-Mar-2017 09:30
Compound	CAS Number	LOR	Unit	EB1704569-027	EB1704569-028	EB1704569-029	EB1704569-030	EB1704569-031
				Result	Result	Result	Result	Result
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	40800	42000	37900	34400	33000
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	130	110	130	60	60
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	73	70	60	85	94
Cobalt	7440-48-4	2	mg/kg	25	28	24	31	32
Copper	7440-50-8	5	mg/kg	94	114	88	103	105
Iron	7439-89-6	50	mg/kg	63600	68600	53600	70800	73300
Lead	7439-92-1	5	mg/kg	5	6	6	6	<5
Manganese	7439-96-5	5	mg/kg	829	956	897	865	886
Nickel	7440-02-0	2	mg/kg	55	70	51	101	99
Zinc	7440-66-6	5	mg/kg	83	91	78	92	95
EG020T: Total Metals by ICP-MS								
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	0.1	0.1
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	7440-31-5	0.1	mg/kg	0.5	0.7	0.6	0.7	0.6
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.01	mg/kg	0.02	0.02	0.02	0.01	0.01
GEO26: Sieving								
-63µm	----	0.01	%	9.11	7.86	18.3	5.35	5.97



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				YALU1 <2000µm Fraction	YALU2 <2000µm Fraction	BUMB2 <2000µm Fraction	BUMB3 <2000µm Fraction	GOV1 <2000µm Fraction
Client sampling date / time				02-Mar-2017 13:15	02-Mar-2017 10:15	03-Mar-2017 12:30	03-Mar-2017 10:30	04-Mar-2017 13:15
Compound	CAS Number	LOR	Unit	EB1704569-032	EB1704569-033	EB1704569-034	EB1704569-035	EB1704569-036
				Result	Result	Result	Result	Result
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	21700	19700	14400	11500	11100
Arsenic	7440-38-2	1	mg/kg	1.2	1.5	1.2	<1.0	<1.0
Barium	7440-39-3	1	mg/kg	32.9	30.7	44.1	32.2	24.4
Cadmium	7440-43-9	0.1	mg/kg	0.1	0.1	0.2	0.1	<0.1
Cobalt	7440-48-4	0.5	mg/kg	6.2	6.0	9.2	6.6	5.2
Chromium	7440-47-3	1	mg/kg	3.5	3.5	5.7	4.4	4.3
Copper	7440-50-8	1	mg/kg	22.1	20.2	24.3	18.8	14.8
Iron	7439-89-6	50	mg/kg	9510	8960	10600	8040	7160
Lead	7439-92-1	1	mg/kg	<1.0	<1.0	1.0	4.0	<1.0
Manganese	7439-96-5	10	mg/kg	264	251	429	309	212
Nickel	7440-02-0	1	mg/kg	8.4	7.9	10.7	7.9	5.8
Silver	7440-22-4	1	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	7440-62-2	2	mg/kg	20.2	19.5	24.1	18.0	15.3
Zinc	7440-66-6	1	mg/kg	19.3	20.2	21.8	20.6	15.8
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	41100	35100	38600	30300	29100
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	110	90	110	70	60
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	31	29	43	45	44
Cobalt	7440-48-4	2	mg/kg	17	14	24	20	16
Copper	7440-50-8	5	mg/kg	57	48	65	51	49
Iron	7439-89-6	50	mg/kg	38400	33600	44600	40900	38300
Lead	7439-92-1	5	mg/kg	<5	<5	<5	6	<5
Manganese	7439-96-5	5	mg/kg	629	522	916	680	554
Nickel	7440-02-0	2	mg/kg	33	28	48	40	32
Zinc	7440-66-6	5	mg/kg	55	48	63	58	58
EG020-SDH: 1M HCl Extractable metals by ICPMS								
Selenium	7782-49-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Tin	7440-31-5	2	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0
EG020T: Total Metals by ICP-MS								
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	YALU1 <2000µm Fraction	YALU2 <2000µm Fraction	BUMB2 <2000µm Fraction	BUMB3 <2000µm Fraction	GOV1 <2000µm Fraction
Client sampling date / time					02-Mar-2017 13:15	02-Mar-2017 10:15	03-Mar-2017 12:30	03-Mar-2017 10:30	04-Mar-2017 13:15
Compound	CAS Number	LOR	Unit		EB1704569-032	EB1704569-033	EB1704569-034	EB1704569-035	EB1704569-036
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Antimony	7440-36-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Tin	7440-31-5	0.1	mg/kg		0.4	0.3	0.4	0.4	0.4
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.10	<0.10	<0.10	<0.10	<0.10
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	<0.01
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		0.2	0.4	0.2	<0.1	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.2	0.4	0.2	<0.1	<0.1
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		60	60	160	130	90
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		60	60	160	130	90
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		329	431	375	397	436
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg		0.7	0.4	0.8	0.9	0.8
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		0.96	0.18	0.23	0.14	0.08
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%		1.60	0.63	0.36	0.25	0.14
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		0.64	0.45	0.13	0.11	0.06
GEO26: Sieving									
-2000µm	----	0.01	%		97.0	87.0	77.4	87.8	75.7



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Client sample ID

				BUMB1 <2000µm Fraction	WATR1 <2000µm Fraction	WAMI1 <2000µm Fraction	MARA1 <2000µm Fraction	MARA1D <2000µm Fraction
Client sampling date / time				04-Mar-2017 09:50	03-Mar-2017 15:00	05-Mar-2017 12:00	05-Mar-2017 09:00	05-Mar-2017 09:30
Compound	CAS Number	LOR	Unit	EB1704569-037	EB1704569-038	EB1704569-039	EB1704569-040	EB1704569-041
				Result	Result	Result	Result	Result
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	13000	11400	14500	11400	11000
Arsenic	7440-38-2	1	mg/kg	1.1	<1.0	<1.0	1.2	1.1
Barium	7440-39-3	1	mg/kg	30.8	27.3	34.7	10.4	9.5
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1
Cobalt	7440-48-4	0.5	mg/kg	5.5	5.2	9.6	3.5	4.0
Chromium	7440-47-3	1	mg/kg	3.5	3.4	5.4	2.1	2.4
Copper	7440-50-8	1	mg/kg	14.2	15.8	24.7	18.2	18.1
Iron	7439-89-6	50	mg/kg	6820	7220	10800	5330	5030
Lead	7439-92-1	1	mg/kg	<1.0	<1.0	1.3	<1.0	<1.0
Manganese	7439-96-5	10	mg/kg	286	231	407	139	137
Nickel	7440-02-0	1	mg/kg	5.7	6.2	10.2	6.2	6.9
Silver	7440-22-4	1	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	7440-62-2	2	mg/kg	14.4	14.0	23.9	9.4	9.7
Zinc	7440-66-6	1	mg/kg	16.3	16.3	24.9	7.3	7.9
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	33600	29000	39300	32000	29000
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	100	70	140	30	30
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	38	32	41	52	53
Cobalt	7440-48-4	2	mg/kg	15	16	21	23	22
Copper	7440-50-8	5	mg/kg	43	48	68	60	51
Iron	7439-89-6	50	mg/kg	34100	36000	42700	46200	46400
Lead	7439-92-1	5	mg/kg	<5	<5	5	<5	<5
Manganese	7439-96-5	5	mg/kg	574	618	915	673	640
Nickel	7440-02-0	2	mg/kg	27	32	37	74	70
Zinc	7440-66-6	5	mg/kg	48	53	64	53	53
EG020-SDH: 1M HCl Extractable metals by ICPMS								
Selenium	7782-49-2	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Tin	7440-31-5	2	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0
EG020T: Total Metals by ICP-MS								
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BUMB1 <2000µm Fraction	WATR1 <2000µm Fraction	WAMI1 <2000µm Fraction	MARA1 <2000µm Fraction	MARA1D <2000µm Fraction
Client sampling date / time				04-Mar-2017 09:50	03-Mar-2017 15:00	05-Mar-2017 12:00	05-Mar-2017 09:00	05-Mar-2017 09:30	
Compound	CAS Number	LOR	Unit	EB1704569-037	EB1704569-038	EB1704569-039	EB1704569-040	EB1704569-041	
				Result	Result	Result	Result	Result	
EG020T: Total Metals by ICP-MS - Continued									
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
Tin	7440-31-5	0.1	mg/kg	0.4	0.4	0.4	0.4	0.4	
EG035-SDH: 1M HCl extractable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	0.01	<0.01	<0.01	
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	<0.1	<0.1	<0.1	0.1	<0.1	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	<0.1	<0.1	0.1	<0.1	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg	70	40	110	20	20	
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg	70	40	110	20	20	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg	366	416	412	461	431	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	1.1	0.7	0.7	0.3	0.2	
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%	0.06	0.06	0.15	0.03	0.02	
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	TC	0.02	%	0.15	0.19	0.37	0.30	0.28	
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%	0.09	0.13	0.22	0.27	0.26	
GEO26: Sieving									
-2000µm	----	0.01	%	85.4	93.1	78.7	97.2	99.0	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	YALU1	YALU2	BUMB2	BUMB3	GOV1
Client sampling date / time				02-Mar-2017 13:10	02-Mar-2017 10:00	03-Mar-2017 12:20	03-Mar-2017 10:00	04-Mar-2017 13:10	
Compound	CAS Number	LOR	Unit	EB1704569-001	EB1704569-002	EB1704569-003	EB1704569-004	EB1704569-005	
				Result	Result	Result	Result	Result	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	731	1180	116	213	<5	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	160	162	121	110	106	
Total Alkalinity as CaCO3	----	1	mg/L	160	162	121	110	106	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	6	6	4	4	3	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	<1	<1	<1	1	2	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	30	30	29	27	24	
Magnesium	7439-95-4	1	mg/L	6	6	7	6	6	
Sodium	7440-23-5	1	mg/L	24	25	9	8	11	
Potassium	7440-09-7	1	mg/L	<1	<1	1	1	<1	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	100	100	101	92	85	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	0.03	0.03	0.02	0.02	0.05	
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	
Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.002	0.003	0.001	
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
Manganese	7439-96-5	0.001	mg/L	0.002	0.002	0.009	0.006	0.001	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	YALU1	YALU2	BUMB2	BUMB3	GOV1
Client sampling date / time				02-Mar-2017 13:10	02-Mar-2017 10:00	03-Mar-2017 12:20	03-Mar-2017 10:00	04-Mar-2017 13:10	
Compound	CAS Number	LOR	Unit	EB1704569-001	EB1704569-002	EB1704569-003	EB1704569-004	EB1704569-005	
				Result	Result	Result	Result	Result	
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	43.5	59.5	7.64	13.4	0.69	
Arsenic	7440-38-2	0.001	mg/L	0.002	0.003	<0.001	0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0001	<0.0001	0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	0.026	0.041	0.011	0.018	0.002	
Copper	7440-50-8	0.001	mg/L	0.074	0.107	0.018	0.031	0.003	
Cobalt	7440-48-4	0.001	mg/L	0.019	0.028	0.004	0.008	<0.001	
Nickel	7440-02-0	0.001	mg/L	0.037	0.055	0.009	0.015	<0.001	
Lead	7439-92-1	0.001	mg/L	0.003	0.004	<0.001	0.002	0.002	
Zinc	7440-66-6	0.005	mg/L	0.055	0.076	0.013	0.022	0.031	
Manganese	7439-96-5	0.001	mg/L	0.816	1.21	0.244	0.401	0.009	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Iron	7439-89-6	0.05	mg/L	36.6	53.9	8.95	15.0	0.64	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.03	<0.01	0.02	<0.01	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.15	0.11	0.12	0.08	0.06	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.15	0.11	0.12	0.08	0.06	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.6	0.3	0.4	0.1	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	0.4	0.7	0.4	0.5	0.2	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	YALU1	YALU2	BUMB2	BUMB3	GOV1
Client sampling date / time				02-Mar-2017 13:10	02-Mar-2017 10:00	03-Mar-2017 12:20	03-Mar-2017 10:00	04-Mar-2017 13:10	
Compound	CAS Number	LOR	Unit	EB1704569-001	EB1704569-002	EB1704569-003	EB1704569-004	EB1704569-005	
				Result	Result	Result	Result	Result	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.83	1.06	0.22	0.31	0.11	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.08	0.07	0.12	0.12	0.10	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	3.32	3.36	2.50	2.31	2.24	
Total Cations	----	0.01	meq/L	3.03	3.08	2.44	2.21	2.17	
Ionic Balance	----	0.01	%	4.51	4.40	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BUMB1	GOV1D	WATR1	WAMI1	MARA1
Client sampling date / time				04-Mar-2017 09:30	04-Mar-2017 13:30	03-Mar-2017 14:50	05-Mar-2017 12:00	05-Mar-2017 09:00	
Compound	CAS Number	LOR	Unit	EB1704569-006	EB1704569-007	EB1704569-008	EB1704569-009	EB1704569-010	
				Result	Result	Result	Result	Result	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	58	6	94	20	88	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	15	2	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	143	108	156	233	113	
Total Alkalinity as CaCO3	----	1	mg/L	143	108	156	249	116	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	3	6	10	9	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	<1	2	<1	1	1	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	33	24	36	55	28	
Magnesium	7439-95-4	1	mg/L	8	6	8	14	5	
Sodium	7440-23-5	1	mg/L	13	11	15	26	14	
Potassium	7440-09-7	1	mg/L	<1	<1	1	1	<1	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	115	85	123	195	90	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	0.01	0.04	0.01	<0.01	0.02	
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.002	0.001	0.001	0.001	<0.001	
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
Manganese	7439-96-5	0.001	mg/L	0.003	0.001	0.002	0.003	0.002	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BUMB1	GOV1D	WATR1	WAMI1	MARA1
Client sampling date / time				04-Mar-2017 09:30	04-Mar-2017 13:30	03-Mar-2017 14:50	05-Mar-2017 12:00	05-Mar-2017 09:00	
Compound	CAS Number	LOR	Unit	EB1704569-006	EB1704569-007	EB1704569-008	EB1704569-009	EB1704569-010	
				Result	Result	Result	Result	Result	
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	4.61	0.69	5.26	1.45	4.38	
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	0.007	0.002	0.007	0.002	0.003	
Copper	7440-50-8	0.001	mg/L	0.010	0.002	0.012	0.004	0.008	
Cobalt	7440-48-4	0.001	mg/L	0.003	<0.001	0.003	<0.001	0.002	
Nickel	7440-02-0	0.001	mg/L	0.005	<0.001	0.006	0.001	0.006	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	0.008	<0.005	0.008	<0.005	<0.005	
Manganese	7439-96-5	0.001	mg/L	0.101	0.007	0.133	0.041	0.082	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Iron	7439-89-6	0.05	mg/L	4.95	0.60	6.29	1.75	3.92	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.61	0.14	0.02	0.01	<0.01	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.11	0.07	0.10	0.19	0.05	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.11	0.07	0.10	0.19	0.05	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.2	0.2	<0.1	<0.1	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	0.3	0.3	0.3	0.2	<0.1	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BUMB1	GOV1D	WATR1	WAMI1	MARA1
Client sampling date / time				04-Mar-2017 09:30	04-Mar-2017 13:30	03-Mar-2017 14:50	05-Mar-2017 12:00	05-Mar-2017 09:00	
Compound	CAS Number	LOR	Unit	EB1704569-006	EB1704569-007	EB1704569-008	EB1704569-009	EB1704569-010	
				Result	Result	Result	Result	Result	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.23	0.12	0.17	0.11	0.14	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.12	0.10	0.07	0.08	0.03	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	2.94	2.28	3.24	5.21	2.53	
Total Cations	----	0.01	meq/L	2.87	2.17	3.13	5.05	2.42	
Ionic Balance	----	0.01	%	----	----	1.71	1.54	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID			FBX1	----	----	----	----
Client sampling date / time		05-Mar-2017 09:50			----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1704569-011	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	2	----	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	2	----	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	<1	----	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	----
Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	----
Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	----
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	<1	----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----	----
Barium	7440-39-3	0.001	mg/L	<0.001	----	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order : EB1711949 Amendment : 1 Client : WAFI GOLPU SERVICES LIMITED Contact : TRAVIS WOOD Address : WAFI GOLPU JV PO BOX 4015 LAE 411 MOROBE PROVINCE PAPUA NEW GUINEA Telephone : +61 03 9290 7000 Project : 520 Wafi-Golpu Project Order number : 712184 C-O-C number : ---- Sampler : A.T. Site : ---- Quote number : BN/288/16 No. of samples received : 11 No. of samples analysed : 11	Page : 1 of 11 Laboratory : Environmental Division Brisbane Contact : Customer Services EB Address : 2 Byth Street Stafford QLD Australia 4053 Telephone : +61-7-3243 7222 Date Samples Received : 12-Jun-2017 14:20 Date Analysis Commenced : 13-Jun-2017 Issue Date : 23-Jun-2017 07:48
---	--



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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

- It is recognised that EK067G (Total Phosphorus) is less than EK071G (Reactive Phosphorus) for sample EB1711949_001. However, the difference is within experimental variation of the methods.
- Amendment (DD/MM/YYYY): This report has been amended as a result of the client being changed from Coffey to Wafi-Golpu Services. All analysis results are as per the previous report.



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 1	S/ Site 2	S/ Site 3	S/ Site 4	S/ Site 5
Client sampling date / time					07-Jun-2017 10:45	07-Jun-2017 12:15	06-Jun-2017 08:50	06-Jun-2017 14:35	07-Jun-2017 15:40
Compound	CAS Number	LOR	Unit	EB1711949-001	EB1711949-002	EB1711949-003	EB1711949-004	EB1711949-005	
				Result	Result	Result	Result	Result	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	<5	30	20	54	44	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	310	330	168	285	320	
Total Alkalinity as CaCO3	----	1	mg/L	310	330	168	285	320	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	5	6	4	6	6	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	36	2	1	2	2	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	80	62	44	53	59	
Magnesium	7439-95-4	1	mg/L	14	17	8	15	17	
Sodium	7440-23-5	1	mg/L	46	49	10	41	44	
Potassium	7440-09-7	1	mg/L	1	2	2	2	2	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	257	225	143	194	217	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.03	0.02	<0.01	
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.002	<0.001	<0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.002	0.002	0.001	
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
Manganese	7439-96-5	0.001	mg/L	0.065	0.059	0.020	0.025	0.090	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 1	S/ Site 2	S/ Site 3	S/ Site 4	S/ Site 5
Client sampling date / time					07-Jun-2017 10:45	07-Jun-2017 12:15	06-Jun-2017 08:50	06-Jun-2017 14:35	07-Jun-2017 15:40
Compound	CAS Number	LOR	Unit	EB1711949-001	EB1711949-002	EB1711949-003	EB1711949-004	EB1711949-005	
				Result	Result	Result	Result	Result	
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	0.12	1.41	1.76	2.90	1.97	
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	0.001	0.001	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	0.001	0.002	0.003	0.004	
Copper	7440-50-8	0.001	mg/L	<0.001	0.004	0.006	0.008	0.006	
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.002	0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	0.002	0.004	0.004	0.004	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	0.007	0.012	<0.005	0.006	
Manganese	7439-96-5	0.001	mg/L	0.094	0.146	0.064	0.179	0.179	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Iron	7439-89-6	0.05	mg/L	0.17	1.52	1.87	3.20	2.33	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.1	0.2	<0.1	0.1	0.2	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	0.02	0.05	0.01	0.06	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.04	0.21	0.02	0.02	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.04	0.21	0.02	0.02	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.3	0.5	0.3	0.4	



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 1	S/ Site 2	S/ Site 3	S/ Site 4	S/ Site 5
Client sampling date / time					07-Jun-2017 10:45	07-Jun-2017 12:15	06-Jun-2017 08:50	06-Jun-2017 14:35	07-Jun-2017 15:40
Compound	CAS Number	LOR	Unit		EB1711949-001	EB1711949-002	EB1711949-003	EB1711949-004	EB1711949-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.2	0.3	0.7	0.3	0.4
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.06	0.09	0.26	0.15	0.15
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.07	0.08	0.25	0.11	0.13
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		7.31	6.77	3.47	5.88	6.57
Total Cations	----	0.01	meq/L		7.17	6.68	3.34	5.71	6.31
Ionic Balance	----	0.01	%		0.98	0.74	1.88	1.40	2.07



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 6	S/ Site 7	S/ Site 8	S/ Site 9	S/ Site 8_DUP
Client sampling date / time					07-Jun-2017 15:20	06-Jun-2017 10:15	06-Jun-2017 11:10	07-Jun-2017 14:07	06-Jun-2017 11:10
Compound	CAS Number	LOR	Unit	EB1711949-006	EB1711949-007	EB1711949-008	EB1711949-009	EB1711949-010	
				Result	Result	Result	Result	Result	
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	650	833	1050	7	1070	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	227	185	145	198	146	
Total Alkalinity as CaCO3	----	1	mg/L	227	185	145	198	146	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8	10	12	13	12	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	2	2	1	4	1	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	49	38	32	43	31	
Magnesium	7439-95-4	1	mg/L	13	9	6	12	6	
Sodium	7440-23-5	1	mg/L	35	26	21	19	20	
Potassium	7440-09-7	1	mg/L	2	2	1	3	1	
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	176	132	105	157	102	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	0.03	0.05	0.05	0.02	0.04	
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.002	0.002	0.002	
Barium	7440-39-3	0.001	mg/L	0.001	0.002	0.002	0.002	0.002	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Copper	7440-50-8	0.001	mg/L	0.001	0.002	0.002	<0.001	0.001	
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
Manganese	7439-96-5	0.001	mg/L	0.066	0.028	0.009	0.530	0.009	
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 6	S/ Site 7	S/ Site 8	S/ Site 9	S/ Site 8_DUP
Client sampling date / time					07-Jun-2017 15:20	06-Jun-2017 10:15	06-Jun-2017 11:10	07-Jun-2017 14:07	06-Jun-2017 11:10
Compound	CAS Number	LOR	Unit		EB1711949-006	EB1711949-007	EB1711949-008	EB1711949-009	EB1711949-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	0.12	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		18.5	26.8	38.9	0.19	38.3
Arsenic	7440-38-2	0.001	mg/L		0.004	0.008	0.009	0.002	0.009
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	0.0001	0.0001	<0.0001	0.0002
Chromium	7440-47-3	0.001	mg/L		0.018	0.025	0.040	<0.001	0.039
Copper	7440-50-8	0.001	mg/L		0.039	0.060	0.087	0.002	0.086
Cobalt	7440-48-4	0.001	mg/L		0.011	0.017	0.025	<0.001	0.024
Nickel	7440-02-0	0.001	mg/L		0.027	0.036	0.058	0.001	0.055
Lead	7439-92-1	0.001	mg/L		0.004	0.006	0.010	<0.001	0.010
Zinc	7440-66-6	0.005	mg/L		0.035	0.055	0.084	<0.005	0.078
Manganese	7439-96-5	0.001	mg/L		0.610	0.894	1.21	0.534	1.21
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L		20.5	29.5	46.4	0.58	45.1
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		0.2	0.1	0.1	0.1	0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.14	0.30	0.10	0.51	0.16
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	0.04	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.66	0.05	0.05	0.07	0.05
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.66	0.05	0.05	0.11	0.05
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.6	0.8	0.8	0.8	0.8



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	S/ Site 6	S/ Site 7	S/ Site 8	S/ Site 9	S/ Site 8_DUP
Client sampling date / time				07-Jun-2017 15:20	06-Jun-2017 10:15	06-Jun-2017 11:10	07-Jun-2017 14:07	06-Jun-2017 11:10	
Compound	CAS Number	LOR	Unit	EB1711949-006	EB1711949-007	EB1711949-008	EB1711949-009	EB1711949-010	
				Result	Result	Result	Result	Result	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	1.3	0.8	0.8	0.9	0.8	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.87	0.80	0.87	0.27	0.90	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.08	0.10	0.05	0.21	0.05	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	4.76	3.96	3.18	4.34	3.20	
Total Cations	----	0.01	meq/L	5.09	3.82	3.03	4.04	2.94	
Ionic Balance	----	0.01	%	3.35	1.82	2.34	3.62	4.22	



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)		Client sample ID			FBx 1	----	----	----	----
Client sampling date / time		07-Jun-2017 16:00			----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1711949-011	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	----	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	----	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	<1	----	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	----
Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	----
Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	----
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L	<1	----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----	----
Barium	7440-39-3	0.001	mg/L	<0.001	----	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----	----



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	FBx 1	----	----	----	----
Client sampling date / time				07-Jun-2017 16:00	----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1711949-011	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	<0.1	----	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	----	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----	----



Analytical Results

Sub-Matrix: FRESH WATER (Matrix: WATER)				Client sample ID	FBx 1	----	----	----	----
Client sampling date / time				07-Jun-2017 16:00	----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1711949-011	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.02	----	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	<0.01	----	----	----	----	----
Total Cations	----	0.01	meq/L	<0.01	----	----	----	----	----

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1704569	Page	: 1 of 21
Client	: COFFEY ENVIRONMENTS PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: TRAVIS WOOD	Telephone	: +61-7-3243 7222
Project	: 520 - WAFI	Date Samples Received	: 08-Mar-2017
Site	: ----	Issue Date	: 12-Apr-2017
Sampler	: TRAVIS WOOD	No. of samples received	: 41
Order number	: ----	No. of samples analysed	: 31

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

- **NO** Method Blank value outliers occur.
- **NO** Duplicate outliers occur.
- **NO** Laboratory Control outliers occur.
- Matrix Spike outliers exist - please see following pages for full details.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.



Outliers : Quality Control Samples

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
Matrix Spike (MS) Recoveries							
EG005-SDH: 1M HCl-Extractable Metals by ICPAES	EB1704569--033	YALU2 <2000µm Fraction	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005T: Total Metals by ICP-AES	EB1704569--023	YALU2 <63µm Fraction	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EK067G: Total Phosphorus as P by Discrete Analyser	EB1704569--033	YALU2 <2000µm Fraction	Total Phosphorus as P	----	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020F: Dissolved Metals by ICP-MS	EB1704478--002	Anonymous	Copper	7440-50-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG020F: Dissolved Metals by ICP-MS	EB1704478--002	Anonymous	Manganese	7439-96-5	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method	Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EP003: Total Organic Carbon (TOC) in Soil							
Pulp Bag YALU1 - <2000µm Fraction,	YALU2 - <2000µm Fraction	03-Apr-2017	30-Mar-2017	4	03-Apr-2017	30-Mar-2017	4
Pulp Bag BUMB2 - <2000µm Fraction, WATR1 - <2000µm Fraction	BUMB3 - <2000µm Fraction,	03-Apr-2017	31-Mar-2017	3	03-Apr-2017	31-Mar-2017	3
Pulp Bag GOV1 - <2000µm Fraction,	BUMB1 - <2000µm Fraction	03-Apr-2017	01-Apr-2017	2	03-Apr-2017	01-Apr-2017	2
Pulp Bag WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	MARA1 - <2000µm Fraction,	03-Apr-2017	02-Apr-2017	1	03-Apr-2017	02-Apr-2017	1
EP003TC: Total Carbon (TC) in Soil							
Pulp Bag YALU1 - <2000µm Fraction,	YALU2 - <2000µm Fraction	03-Apr-2017	30-Mar-2017	4	03-Apr-2017	30-Mar-2017	4



Matrix: **SOIL**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis			
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue	
EP003TC: Total Carbon (TC) in Soil - Analysis Holding Time Compliance							
Pulp Bag BUMB2 - <2000µm Fraction, WATR1 - <2000µm Fraction	BUMB3 - <2000µm Fraction,	03-Apr-2017	31-Mar-2017	3	03-Apr-2017	31-Mar-2017	3
Pulp Bag GOV1 - <2000µm Fraction,	BUMB1 - <2000µm Fraction	03-Apr-2017	01-Apr-2017	2	03-Apr-2017	01-Apr-2017	2
Pulp Bag WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	MARA1 - <2000µm Fraction,	03-Apr-2017	02-Apr-2017	1	03-Apr-2017	02-Apr-2017	1

Matrix: **WATER**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis			
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue	
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural YALU1,	YALU2	----	----	----	09-Mar-2017	04-Mar-2017	5
Clear Plastic Bottle - Natural BUMB2, WATR1	BUMB3,	----	----	----	09-Mar-2017	05-Mar-2017	4
Clear Plastic Bottle - Natural GOV1, GOV1D	BUMB1,	----	----	----	09-Mar-2017	06-Mar-2017	3
Clear Plastic Bottle - Natural WAMI1, FBX1	MARA1,	----	----	----	09-Mar-2017	07-Mar-2017	2
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural YALU1,	YALU2	----	----	----	09-Mar-2017	04-Mar-2017	5
Clear Plastic Bottle - Natural BUMB2, WATR1	BUMB3,	----	----	----	09-Mar-2017	05-Mar-2017	4
Clear Plastic Bottle - Natural GOV1, GOV1D	BUMB1,	----	----	----	09-Mar-2017	06-Mar-2017	3
Clear Plastic Bottle - Natural WAMI1, FBX1	MARA1,	----	----	----	09-Mar-2017	07-Mar-2017	2

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	



Matrix: **SOIL**

Quality Control Sample Type Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Control Samples (LCS)					
Total Metals by ICP-MS - Suite Y	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
1M HCl Extractable Metals by ICPMS	0	10	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite X	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Y	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Z	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **SOIL**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EG005-SDH: 1M HCl-Extractable Metals by ICPAES								
Pulp Bag (-2000µm) (EG005-SDH) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	04-Apr-2017	30-Sep-2017	✓	05-Apr-2017	30-Sep-2017	✓
EG005T: Total Metals by ICP-AES								
Pulp Bag (-2000µm) (EG005T) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	27-Mar-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
Pulp Bag (-63µm) (EG005T) YALU1 - <63µm Fraction, BUMB2 - <63µm Fraction, GOV1 - <63µm Fraction, WATR1 - <63µm Fraction, MARA1 - <63µm Fraction,	YALU2 - <63µm Fraction, BUMB3 - <63µm Fraction, BUMB1 - <63µm Fraction, WAMI1 - <63µm Fraction, MARA1D - <63µm Fraction	03-Apr-2017	27-Mar-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓



Matrix: SOIL

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EG020-SDH: 1M HCl Extractable metals by ICPMS								
Pulp Bag (-2000µm) (EG020-SDH) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	04-Apr-2017	30-Sep-2017	✓	05-Apr-2017	30-Sep-2017	✓
EG020T: Total Metals by ICP-MS								
Pulp Bag (-2000µm) (EG020Z-T) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	27-Mar-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
Pulp Bag (-63µm) (EG020Z-T) YALU1 - <63µm Fraction, BUMB2 - <63µm Fraction, GOV1 - <63µm Fraction, WATR1 - <63µm Fraction, MARA1 - <63µm Fraction,	YALU2 - <63µm Fraction, BUMB3 - <63µm Fraction, BUMB1 - <63µm Fraction, WAMI1 - <63µm Fraction, MARA1D - <63µm Fraction	03-Apr-2017	27-Mar-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Pulp Bag (-2000µm) (EG035-SDH) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	04-Apr-2017	01-May-2017	✓	05-Apr-2017	01-May-2017	✓
EG035T: Total Recoverable Mercury by FIMS								
Pulp Bag (-2000µm) (EG035T-LL) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	27-Mar-2017	01-May-2017	✓	07-Apr-2017	01-May-2017	✓
Pulp Bag (-63µm) (EG035T-LL) YALU1 - <63µm Fraction, BUMB2 - <63µm Fraction, GOV1 - <63µm Fraction, WATR1 - <63µm Fraction, MARA1 - <63µm Fraction,	YALU2 - <63µm Fraction, BUMB3 - <63µm Fraction, BUMB1 - <63µm Fraction, WAMI1 - <63µm Fraction, MARA1D - <63µm Fraction	03-Apr-2017	27-Mar-2017	01-May-2017	✓	07-Apr-2017	01-May-2017	✓



Matrix: SOIL

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK055: Ammonia as N								
Pulp Bag (-2000µm) (EK055) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	----	----	----	16-Mar-2017	30-Sep-2017	✓
EK057G: Nitrite as N by Discrete Analyser								
Pulp Bag (-2000µm) (EK057G) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	05-Apr-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Pulp Bag (-2000µm) (EK059G) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	05-Apr-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Pulp Bag (-2000µm) (EK061G) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	03-Apr-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Pulp Bag (-2000µm) (EK067G) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	03-Apr-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Pulp Bag (-2000µm) (EK071G) YALU1 - <2000µm Fraction, BUMB2 - <2000µm Fraction, GOV1 - <2000µm Fraction, WATR1 - <2000µm Fraction, MARA1 - <2000µm Fraction,	YALU2 - <2000µm Fraction, BUMB3 - <2000µm Fraction, BUMB1 - <2000µm Fraction, WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	03-Apr-2017	05-Apr-2017	30-Sep-2017	✓	06-Apr-2017	30-Sep-2017	✓



Matrix: **SOIL**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EP003: Total Organic Carbon (TOC) in Soil								
Pulp Bag (EP003) YALU1 - <2000µm Fraction,	YALU2 - <2000µm Fraction	02-Mar-2017	03-Apr-2017	30-Mar-2017	✘	03-Apr-2017	30-Mar-2017	✘
Pulp Bag (EP003) BUMB2 - <2000µm Fraction, WATR1 - <2000µm Fraction	BUMB3 - <2000µm Fraction,	03-Mar-2017	03-Apr-2017	31-Mar-2017	✘	03-Apr-2017	31-Mar-2017	✘
Pulp Bag (EP003) GOV1 - <2000µm Fraction,	BUMB1 - <2000µm Fraction	04-Mar-2017	03-Apr-2017	01-Apr-2017	✘	03-Apr-2017	01-Apr-2017	✘
Pulp Bag (EP003) WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	MARA1 - <2000µm Fraction,	05-Mar-2017	03-Apr-2017	02-Apr-2017	✘	03-Apr-2017	02-Apr-2017	✘
EP003TC: Total Carbon (TC) in Soil								
Pulp Bag (EP003TC) YALU1 - <2000µm Fraction,	YALU2 - <2000µm Fraction	02-Mar-2017	03-Apr-2017	30-Mar-2017	✘	03-Apr-2017	30-Mar-2017	✘
Pulp Bag (EP003TC) BUMB2 - <2000µm Fraction, WATR1 - <2000µm Fraction	BUMB3 - <2000µm Fraction,	03-Mar-2017	03-Apr-2017	31-Mar-2017	✘	03-Apr-2017	31-Mar-2017	✘
Pulp Bag (EP003TC) GOV1 - <2000µm Fraction,	BUMB1 - <2000µm Fraction	04-Mar-2017	03-Apr-2017	01-Apr-2017	✘	03-Apr-2017	01-Apr-2017	✘
Pulp Bag (EP003TC) WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	MARA1 - <2000µm Fraction,	05-Mar-2017	03-Apr-2017	02-Apr-2017	✘	03-Apr-2017	02-Apr-2017	✘
GEO26: Sieving								
Pulp Bag (-63µm) (GEO26C) YALU1 - <63µm Fraction, BUMB2 - <63µm Fraction, GOV1 - <63µm Fraction, WATR1 - <63µm Fraction, MARA1 - <63µm Fraction,	YALU2 - <63µm Fraction, BUMB3 - <63µm Fraction, BUMB1 - <63µm Fraction, WAMI1 - <63µm Fraction, MARA1D - <63µm Fraction	03-Apr-2017	03-Apr-2017	30-Sep-2017	✔	----	----	----
Snap Lock Bag (GEO26) YALU1 - <2000µm Fraction,	YALU2 - <2000µm Fraction	02-Mar-2017	03-Apr-2017	29-Aug-2017	✔	----	----	----
Snap Lock Bag (GEO26) BUMB2 - <2000µm Fraction, WATR1 - <2000µm Fraction	BUMB3 - <2000µm Fraction,	03-Mar-2017	03-Apr-2017	30-Aug-2017	✔	----	----	----
Snap Lock Bag (GEO26) GOV1 - <2000µm Fraction,	BUMB1 - <2000µm Fraction	04-Mar-2017	03-Apr-2017	31-Aug-2017	✔	----	----	----
Snap Lock Bag (GEO26) WAMI1 - <2000µm Fraction, MARA1D - <2000µm Fraction	MARA1 - <2000µm Fraction,	05-Mar-2017	03-Apr-2017	01-Sep-2017	✔	----	----	----

Matrix: **WATER**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation



Matrix: **WATER**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA025: Total Suspended Solids dried at 104 ± 2°C								
Clear Plastic Bottle - Natural (EA025H) YALU1, YALU2	YALU2	02-Mar-2017	----	----	----	09-Mar-2017	09-Mar-2017	✓
Clear Plastic Bottle - Natural (EA025H) BUMB2, WATR1	BUMB3,	03-Mar-2017	----	----	----	09-Mar-2017	10-Mar-2017	✓
Clear Plastic Bottle - Natural (EA025H) GOV1, GOV1D	BUMB1,	04-Mar-2017	----	----	----	09-Mar-2017	11-Mar-2017	✓
Clear Plastic Bottle - Natural (EA025H) WAMI1, FBX1	MARA1,	05-Mar-2017	----	----	----	09-Mar-2017	12-Mar-2017	✓
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P) YALU1,	YALU2	02-Mar-2017	----	----	----	11-Mar-2017	16-Mar-2017	✓
Clear Plastic Bottle - Natural (ED037-P) BUMB2, WATR1	BUMB3,	03-Mar-2017	----	----	----	11-Mar-2017	17-Mar-2017	✓
Clear Plastic Bottle - Natural (ED037-P) GOV1, GOV1D	BUMB1,	04-Mar-2017	----	----	----	11-Mar-2017	18-Mar-2017	✓
Clear Plastic Bottle - Natural (ED037-P) WAMI1, FBX1	MARA1,	05-Mar-2017	----	----	----	11-Mar-2017	19-Mar-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G) YALU1,	YALU2	02-Mar-2017	----	----	----	09-Mar-2017	30-Mar-2017	✓
Clear Plastic Bottle - Natural (ED041G) BUMB2, WATR1	BUMB3,	03-Mar-2017	----	----	----	09-Mar-2017	31-Mar-2017	✓
Clear Plastic Bottle - Natural (ED041G) GOV1, GOV1D	BUMB1,	04-Mar-2017	----	----	----	09-Mar-2017	01-Apr-2017	✓
Clear Plastic Bottle - Natural (ED041G) WAMI1, FBX1	MARA1,	05-Mar-2017	----	----	----	09-Mar-2017	02-Apr-2017	✓



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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G) YALU1, YALU2	02-Mar-2017	----	----	----	09-Mar-2017	30-Mar-2017	✓	
Clear Plastic Bottle - Natural (ED045G) BUMB2, WATR1	03-Mar-2017	----	----	----	09-Mar-2017	31-Mar-2017	✓	
Clear Plastic Bottle - Natural (ED045G) GOV1, GOV1D	04-Mar-2017	----	----	----	09-Mar-2017	01-Apr-2017	✓	
Clear Plastic Bottle - Natural (ED045G) WAMI1, FBX1	05-Mar-2017	----	----	----	09-Mar-2017	02-Apr-2017	✓	
ED093F: Dissolved Major Cations								
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) YALU1, YALU2	02-Mar-2017	----	----	----	13-Mar-2017	30-Mar-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) BUMB2, WATR1	03-Mar-2017	----	----	----	13-Mar-2017	31-Mar-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) GOV1, GOV1D	04-Mar-2017	----	----	----	13-Mar-2017	01-Apr-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) WAMI1, FBX1	05-Mar-2017	----	----	----	13-Mar-2017	02-Apr-2017	✓	
ED093F: SAR and Hardness Calculations								
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) YALU1, YALU2	02-Mar-2017	----	----	----	13-Mar-2017	30-Mar-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) BUMB2, WATR1	03-Mar-2017	----	----	----	13-Mar-2017	31-Mar-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) GOV1, GOV1D	04-Mar-2017	----	----	----	13-Mar-2017	01-Apr-2017	✓	
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (ED093F) WAMI1, FBX1	05-Mar-2017	----	----	----	13-Mar-2017	02-Apr-2017	✓	



Matrix: WATER

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG020B-F) YALU1, YALU2	02-Mar-2017	----	----	----	13-Mar-2017	29-Aug-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG020B-F) BUMB2, BUMB3, WATR1	03-Mar-2017	----	----	----	13-Mar-2017	30-Aug-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG020B-F) GOV1, BUMB1, GOV1D	04-Mar-2017	----	----	----	13-Mar-2017	31-Aug-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG020B-F) WAMI1, MARA1, FBX1	05-Mar-2017	----	----	----	13-Mar-2017	01-Sep-2017	✓
EG020T: Total Metals by ICP-MS							
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG020B-T) YALU1, YALU2	02-Mar-2017	10-Mar-2017	29-Aug-2017	✓	10-Mar-2017	29-Aug-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG020B-T) BUMB2, BUMB3, WATR1	03-Mar-2017	10-Mar-2017	30-Aug-2017	✓	10-Mar-2017	30-Aug-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG020B-T) GOV1, BUMB1, GOV1D	04-Mar-2017	10-Mar-2017	31-Aug-2017	✓	10-Mar-2017	31-Aug-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG020B-T) WAMI1, MARA1, FBX1	05-Mar-2017	10-Mar-2017	01-Sep-2017	✓	10-Mar-2017	01-Sep-2017	✓
EG035F: Dissolved Mercury by FIMS							
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG035F) YALU1, YALU2	02-Mar-2017	----	----	----	13-Mar-2017	30-Mar-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG035F) BUMB2, BUMB3, WATR1	03-Mar-2017	----	----	----	13-Mar-2017	31-Mar-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG035F) GOV1, BUMB1, GOV1D	04-Mar-2017	----	----	----	13-Mar-2017	01-Apr-2017	✓
Clear HDPE (U-T ORC) - Filtered; Lab-acidified (EG035F) WAMI1, MARA1, FBX1	05-Mar-2017	----	----	----	13-Mar-2017	02-Apr-2017	✓



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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T) YALU1, YALU2	02-Mar-2017	----	----	----	10-Mar-2017	30-Mar-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T) BUMB2, WATR1, BUMB3,	03-Mar-2017	----	----	----	10-Mar-2017	31-Mar-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T) GOV1, GOV1D, BUMB1,	04-Mar-2017	----	----	----	10-Mar-2017	01-Apr-2017	✓
Clear HDPE (U-T ORC) - Unfiltered; Lab-acidified (EG035T) WAMI1, FBX1, MARA1,	05-Mar-2017	----	----	----	10-Mar-2017	02-Apr-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) YALU1, YALU2	02-Mar-2017	----	----	----	10-Mar-2017	30-Mar-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) BUMB2, WATR1, BUMB3,	03-Mar-2017	----	----	----	10-Mar-2017	31-Mar-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) GOV1, GOV1D, BUMB1,	04-Mar-2017	----	----	----	10-Mar-2017	01-Apr-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) WAMI1, FBX1, MARA1,	05-Mar-2017	----	----	----	10-Mar-2017	02-Apr-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) YALU1, YALU2	02-Mar-2017	----	----	----	09-Mar-2017	04-Mar-2017	✗
Clear Plastic Bottle - Natural (EK057G) BUMB2, WATR1, BUMB3,	03-Mar-2017	----	----	----	09-Mar-2017	05-Mar-2017	✗
Clear Plastic Bottle - Natural (EK057G) GOV1, GOV1D, BUMB1,	04-Mar-2017	----	----	----	09-Mar-2017	06-Mar-2017	✗
Clear Plastic Bottle - Natural (EK057G) WAMI1, FBX1, MARA1,	05-Mar-2017	----	----	----	09-Mar-2017	07-Mar-2017	✗



Matrix: **WATER**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G) YALU1, YALU2	02-Mar-2017	----	----	----	10-Mar-2017	30-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK059G) BUMB2, WATR1	03-Mar-2017	----	----	----	10-Mar-2017	31-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK059G) GOV1, GOV1D	04-Mar-2017	----	----	----	10-Mar-2017	01-Apr-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK059G) WAMI1, FBX1	05-Mar-2017	----	----	----	10-Mar-2017	02-Apr-2017	✓	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G) YALU1, YALU2	02-Mar-2017	11-Mar-2017	30-Mar-2017	✓	11-Mar-2017	30-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK061G) BUMB2, WATR1	03-Mar-2017	11-Mar-2017	31-Mar-2017	✓	11-Mar-2017	31-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK061G) GOV1, GOV1D	04-Mar-2017	11-Mar-2017	01-Apr-2017	✓	11-Mar-2017	01-Apr-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK061G) WAMI1, FBX1	05-Mar-2017	11-Mar-2017	02-Apr-2017	✓	11-Mar-2017	02-Apr-2017	✓	
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G) YALU1, YALU2	02-Mar-2017	11-Mar-2017	30-Mar-2017	✓	11-Mar-2017	30-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK067G) BUMB2, WATR1	03-Mar-2017	11-Mar-2017	31-Mar-2017	✓	11-Mar-2017	31-Mar-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK067G) GOV1, GOV1D	04-Mar-2017	11-Mar-2017	01-Apr-2017	✓	11-Mar-2017	01-Apr-2017	✓	
Clear Plastic Bottle - Sulfuric Acid (EK067G) WAMI1, FBX1	05-Mar-2017	11-Mar-2017	02-Apr-2017	✓	11-Mar-2017	02-Apr-2017	✓	

Page : 13 of 21
 Work Order : EB1704569
 Client : COFFEY ENVIRONMENTS PTY LTD
 Project : 520 - WAFI



Matrix: **WATER**

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G) YALU1, YALU2	YALU2	02-Mar-2017	----	----	----	09-Mar-2017	04-Mar-2017	✘
Clear Plastic Bottle - Natural (EK071G) BUMB2, WATR1	BUMB3,	03-Mar-2017	----	----	----	09-Mar-2017	05-Mar-2017	✘
Clear Plastic Bottle - Natural (EK071G) GOV1, GOV1D	BUMB1,	04-Mar-2017	----	----	----	09-Mar-2017	06-Mar-2017	✘
Clear Plastic Bottle - Natural (EK071G) WAMI1, FBX1	MARA1,	05-Mar-2017	----	----	----	09-Mar-2017	07-Mar-2017	✘



Quality Control Parameter Frequency Compliance

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

Matrix: **SOIL**

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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
1M HCl Extractable Mercury by FIMS	EG035-SDH	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals	EG005-SDH	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals by ICPMS	EG020-SDH	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Buchi Ammonia	EK055	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Carbon	EP003TC	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite X	EG020X-T	4	20	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Y	EG020Y-T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Z	EG020Z-T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus By Discrete Analyser	EK067G	1	10	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
1M HCl Extractable Mercury by FIMS	EG035-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals	EG005-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals by ICPMS	EG020-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Buchi Ammonia	EK055	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Carbon	EP003TC	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite X	EG020X-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Y	EG020Y-T	0	20	0.00	5.00	✗	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Z	EG020Z-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus By Discrete Analyser	EK067G	2	10	20.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							



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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB) - Continued							
1M HCl Extractable Mercury by FIMS	EG035-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals	EG005-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals by ICPMS	EG020-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Buchi Ammonia	EK055	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Carbon	EP003TC	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite X	EG020X-T	2	20	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Y	EG020Y-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Z	EG020Z-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP003	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
1M HCl Extractable Mercury by FIMS	EG035-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals	EG005-SDH	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
1M HCl Extractable Metals by ICPMS	EG020-SDH	0	10	0.00	5.00	*	NEPM 2013 B3 & ALS QC Standard
Buchi Ammonia	EK055	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS (Low Level)	EG035T-LL	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite X	EG020X-T	0	20	0.00	5.00	*	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Y	EG020Y-T	0	20	0.00	5.00	*	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite Z	EG020Z-T	0	20	0.00	5.00	*	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	10	10.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard

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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER**

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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reular	Actual	Expected	Evaluation	
Analytical Methods							
Laboratory Duplicates (DUP) - Continued							
Chloride by Discrete Analyser	ED045G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	23	13.04	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	23	13.04	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	3	23	13.04	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	3	30	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	17	11.76	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	4	23	17.39	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	30	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	17	5.88	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard



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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB) - Continued							
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	30	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	17	5.88	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	8.70	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	30	6.67	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	17	5.88	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
1M HCl Extractable Metals	EG005-SDH	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined via ICPAES following weak acid extraction. 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 (2013) Schedule B(3). LORs per NAGD. ALS is not NATA accredited for the analysis of Barium, Boron, Molybdenum and Strontium by this method.
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. 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 (2013) Schedule B(3)
1M HCl Extractable Metals by ICPMS	EG020-SDH	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020. Metals are determined via ICPMS following weak acid extraction. 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. Analyte list and LORs per NAGD. ALS is not NATA accredited for the analysis of Tin, Uranium, Barium, Boron and Strontium by this method.
Total Metals by ICP-MS - Suite X	EG020X-T	SOIL	In house: Referenced to APHA 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 Metals by ICP-MS - Suite Y	EG020Y-T	SOIL	In house: Referenced to APHA 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 Metals by ICP-MS - Suite Z	EG020Z-T	SOIL	In house: Referenced to APHA 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.
1M HCl Extractable Mercury by FIMS	EG035-SDH	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B. Mercury is determined via FIMS following weak acid extraction. 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 (2013) Schedule B(3)
Total Mercury by FIMS (Low Level)	EG035T-LL	SOIL	In house: Referenced to AS 3550, APHA 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 (2013) Schedule B(3)



Analytical Methods	Method	Matrix	Method Descriptions
Buchi Ammonia	EK055	SOIL	In house: Referenced to APHA 4500-NH3 B&G, H Samples are steam distilled (Buchi) prior to analysis and quantified using titration, FIA or Discrete Analyser.
Nitrite as N - Soluble by Discrete Analyser	EK057G	SOIL	In house: Referenced to APHA 4500-NO3- B. Nitrite in a water extract is determined by direct colourimetry by Discrete Analyser.
Nitrate as N - Soluble by Discrete Analyser	EK058G	SOIL	In house: Referenced to APHA 4500-NO3- F. Nitrate in the 1:5 soil:water extract is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	SOIL	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) in a water extract is determined by Chemical Reduction, and direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Total Nitrogen as N (TKN + NOx) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500 Norg/NO3- Total Nitrogen is determined as the sum of TKN and Oxidised Nitrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.
Reactive Phosphorus as P-Soluble By Discrete Analyser	EK071G	SOIL	In house: Referenced to APHA 4500 P-F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate 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 (2013) Schedule B(3) (
Total Organic Carbon	EP003	SOIL	In house C-IR17. Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a LECO furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automatically measured by infra-red detector.
Total Carbon	EP003TC	SOIL	In house C-IR07. Dried and pulverised sample is combusted in a LECO furnace in the presence of strong oxidants / catalysts. The evolved Carbon (as CO2) is measured by infra-red detector
Total Inorganic Carbon	EP003TIC	SOIL	In house C-CAL15. Determined as the difference between Total Carbon and Organic Carbon.
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003



Analytical Methods	Method	Matrix	Method Descriptions
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. 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 Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 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.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. 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 Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 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.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered 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 (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 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 (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)



Analytical Methods	Method	Matrix	Method Descriptions
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 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 (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	SOIL	In house: Referenced to APHA 4500 Norg- D; APHA 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	In house: Referenced to USEPA 200.2. 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 (2013) Schedule B(3) (Method 202)
1M HCl Extraction for Metals in Sediments (1 hour)	EN71	SOIL	In house: Referenced to In house, Allen (1993). 1g of sample is leached at room temperature for 1 hour in 10% hydrochloric acid. The resultant extract is filtered and bulked for analysis of extracted metals.
Sieving (fine to -2mm)	GEO26	SOIL	In house: The dried sample is sieved to 2mm and the fines are then analysed per the client's request.
Sieving (fine to -63µm)	GEO26C	SOIL	In house: The sample is sieved to -63µm and the fines are then analysed per the client's request.
Dry and Pulverise (up to 100g)	GEO30	SOIL	#
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to 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 (2013) Schedule B(3)



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	FBX1	----	----	----	----
Client sampling date / time				05-Mar-2017 09:50	----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1704569-011	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.09	----	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	----	----	----	----	----



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	FBX1	----	----	----	----
Client sampling date / time				05-Mar-2017 09:50	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1704569-011	-----	-----	-----	-----	
				Result	----	----	----	----	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.03	----	----	----	----	
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	0.04	----	----	----	----	
Total Cations	----	0.01	meq/L	<0.01	----	----	----	----	

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EB1711949	Page	: 1 of 11
Amendment	: 1		
Client	: WAFI GOLPU SERVICES LIMITED	Laboratory	: Environmental Division Brisbane
Contact	: TRAVIS WOOD	Telephone	: +61-7-3243 7222
Project	: 520 Wafi-Golpu Project	Date Samples Received	: 12-Jun-2017
Site	: ----	Issue Date	: 23-Jun-2017
Sampler	: A.T.	No. of samples received	: 11
Order number	: 712184	No. of samples analysed	: 11

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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



Outliers : Analysis Holding Time Compliance

Matrix: WATER

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	----	----	13-Jun-2017	08-Jun-2017	5
Clear Plastic Bottle - Natural S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	----	----	13-Jun-2017	09-Jun-2017	4
EK071G: Reactive Phosphorus as P by discrete analyser						
Clear Plastic Bottle - Natural S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	----	----	13-Jun-2017	08-Jun-2017	5
Clear Plastic Bottle - Natural S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	----	----	13-Jun-2017	09-Jun-2017	4

Analysis Holding Time Compliance

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

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

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

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

Matrix: WATER

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	13-Jun-2017	13-Jun-2017	✓
Clear Plastic Bottle - Natural (EA025H) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	13-Jun-2017	14-Jun-2017	✓



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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	15-Jun-2017	20-Jun-2017	✓
Clear Plastic Bottle - Natural (ED037-P) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	15-Jun-2017	21-Jun-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	13-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Natural (ED041G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	13-Jun-2017	05-Jul-2017	✓
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	13-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Natural (ED045G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	13-Jun-2017	05-Jul-2017	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	14-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	14-Jun-2017	05-Jul-2017	✓



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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: SAR and Hardness Calculations							
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) S/ Site 3, S/ Site 7, S/ Site 8_DUP S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	14-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F) S/ Site 1, S/ Site 5, S/ Site 9, S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	14-Jun-2017	05-Jul-2017	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG020B-F) S/ Site 3, S/ Site 7, S/ Site 8_DUP S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	14-Jun-2017	03-Dec-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (EG020B-F) S/ Site 1, S/ Site 5, S/ Site 9, S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	14-Jun-2017	04-Dec-2017	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T) S/ Site 3, S/ Site 7, S/ Site 8_DUP S/ Site 4, S/ Site 8,	06-Jun-2017	15-Jun-2017	03-Dec-2017	✓	15-Jun-2017	03-Dec-2017	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020B-T) S/ Site 1, S/ Site 5, S/ Site 9, S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	15-Jun-2017	04-Dec-2017	✓	15-Jun-2017	04-Dec-2017	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F) S/ Site 3, S/ Site 7, S/ Site 8_DUP S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	15-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F) S/ Site 1, S/ Site 5, S/ Site 9, S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	15-Jun-2017	05-Jul-2017	✓



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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	16-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	16-Jun-2017	05-Jul-2017	✓
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	15-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Natural (EK040P) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	15-Jun-2017	05-Jul-2017	✓
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	15-Jun-2017	04-Jul-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	15-Jun-2017	05-Jul-2017	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	13-Jun-2017	08-Jun-2017	*
Clear Plastic Bottle - Natural (EK057G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	13-Jun-2017	09-Jun-2017	*



Matrix: WATER

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

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis			
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	15-Jun-2017	04-Jul-2017	✔
Clear Plastic Bottle - Sulfuric Acid (EK059G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	15-Jun-2017	05-Jul-2017	✔
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	16-Jun-2017	04-Jul-2017	✔	16-Jun-2017	04-Jul-2017	✔
Clear Plastic Bottle - Sulfuric Acid (EK061G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	16-Jun-2017	05-Jul-2017	✔	16-Jun-2017	05-Jul-2017	✔
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	16-Jun-2017	04-Jul-2017	✔	16-Jun-2017	04-Jul-2017	✔
Clear Plastic Bottle - Sulfuric Acid (EK067G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	16-Jun-2017	05-Jul-2017	✔	16-Jun-2017	05-Jul-2017	✔
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G) S/ Site 3, S/ Site 7, S/ Site 8_DUP	S/ Site 4, S/ Site 8,	06-Jun-2017	----	----	----	13-Jun-2017	08-Jun-2017	✘
Clear Plastic Bottle - Natural (EK071G) S/ Site 1, S/ Site 5, S/ Site 9,	S/ Site 2, S/ Site 6, FBx 1	07-Jun-2017	----	----	----	13-Jun-2017	09-Jun-2017	✘



Quality Control Parameter Frequency Compliance

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

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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	24	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	27	11.11	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	4	40	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	24	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	11	18.18	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Matrix: **WATER**

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

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Regular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	24	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	27	7.41	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	24	8.33	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	9.09	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of 'non-filterable' residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. 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 Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 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.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. 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.



Analytical Methods	Method	Matrix	Method Descriptions
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 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.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered 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 (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 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 (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH ₃ G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO ₂ - B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined separately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NO _x) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO ₃ - F. Combined oxidised Nitrogen (NO ₂ +NO ₃) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO ₃ -. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)



<i>Analytical Methods</i>			
<i>Method</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 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 (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
<i>Preparation Methods</i>			
<i>Method</i>	<i>Method</i>	<i>Matrix</i>	<i>Method Descriptions</i>
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to 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 (2013) Schedule B(3)

QUALITY CONTROL REPORT

Work Order	: EB1704569	Page	: 1 of 16
Client	: COFFEY ENVIRONMENTS PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: TRAVIS WOOD	Contact	: Jenny Bevan
Address	: LEVEL 1, 436 JOHNSTON STREET ABBOTSFORD VIC, AUSTRALIA 3067	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: +61-7-3243 7222
Project	: 520 - WAFI	Date Samples Received	: 08-Mar-2017
Order number	: ----	Date Analysis Commenced	: 09-Mar-2017
C-O-C number	: ----	Issue Date	: 12-Apr-2017
Sampler	: TRAVIS WOOD		
Site	: ----		
Quote number	: BN/288/16 V6		
No. of samples received	: 41		
No. of samples analysed	: 31		



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

This Quality Control Report contains the following information:

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Epps	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

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

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

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

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

Laboratory Duplicate (DUP) Report

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

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005-SDH: 1M HCl-Extractable Metals by ICPAES (QC Lot: 784876)									
EB1704569-032	YALU1 <2000µm Fraction	EG005-SDH: Cadmium	7440-43-9	0.1	mg/kg	0.1	0.1	0.00	No Limit
		EG005-SDH: Cobalt	7440-48-4	0.5	mg/kg	6.2	6.2	0.00	0% - 50%
		EG005-SDH: Arsenic	7440-38-2	1	mg/kg	1.2	1.5	17.3	No Limit
		EG005-SDH: Barium	7440-39-3	1	mg/kg	32.9	33.1	0.682	0% - 20%
		EG005-SDH: Chromium	7440-47-3	1	mg/kg	3.5	3.5	0.00	No Limit
		EG005-SDH: Copper	7440-50-8	1	mg/kg	22.1	22.3	0.654	0% - 20%
		EG005-SDH: Lead	7439-92-1	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG005-SDH: Nickel	7440-02-0	1	mg/kg	8.4	8.4	0.00	No Limit
		EG005-SDH: Silver	7440-22-4	1	mg/kg	<1.0	<1.0	0.00	No Limit
		EG005-SDH: Zinc	7440-66-6	1	mg/kg	19.3	19.6	1.42	0% - 50%
		EG005-SDH: Manganese	7439-96-5	10	mg/kg	264	267	1.03	0% - 20%
		EG005-SDH: Vanadium	7440-62-2	2	mg/kg	20.2	20.4	0.983	0% - 50%
		EG005-SDH: Aluminium	7429-90-5	50	mg/kg	21700	21900	1.06	0% - 20%
EG005-SDH: Iron	7439-89-6	50	mg/kg	9510	9600	0.895	0% - 20%		
EG005T: Total Metals by ICP-AES (QC Lot: 790514)									
EB1704569-022	YALU1 <63µm Fraction	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	120	110	0.00	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	46	46	0.00	0% - 20%
		EG005T: Cobalt	7440-48-4	2	mg/kg	21	20	0.00	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	45	44	0.00	0% - 20%
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	78	76	2.72	0% - 50%
		EG005T: Lead	7439-92-1	5	mg/kg	5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	727	721	0.824	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	69	69	0.00	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 (%)
EG005T: Total Metals by ICP-AES (QC Lot: 790514) - continued									
EB1704569-022	YALU1 <63µm Fraction	EG005T: Aluminium	7429-90-5	50	mg/kg	38600	39100	1.24	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	45300	46100	1.72	0% - 20%
EB1704569-032	YALU1 <2000µm Fraction	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	110	110	0.00	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	31	28	10.4	0% - 50%
		EG005T: Cobalt	7440-48-4	2	mg/kg	17	16	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	33	32	4.44	0% - 50%
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	57	56	0.00	0% - 50%
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	629	607	3.64	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	55	58	5.75	0% - 50%
		EG005T: Aluminium	7429-90-5	50	mg/kg	41100	41500	1.09	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	38400	36900	4.09	0% - 20%
EG020-SDH: 1M HCl Extractable metals by ICPMS (QC Lot: 784877)									
EB1704569-032	YALU1 <2000µm Fraction	EG020-SDH: Selenium	7782-49-2	0.5	mg/kg	<0.5	<0.5	0.00	No Limit
		EG020-SDH: Tin	7440-31-5	2	mg/kg	<2.0	<2.0	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 790515)									
EB1704569-022	YALU1 <63µm Fraction	EG020X-T: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EB1704569-032	YALU1 <2000µm Fraction	EG020X-T: Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EB1704569-022	YALU1 <63µm Fraction	EG020X-T: Tin	7440-31-5	0.1	mg/kg	0.4	0.6	28.6	No Limit
EB1704569-032	YALU1 <2000µm Fraction	EG020X-T: Tin	7440-31-5	0.1	mg/kg	0.4	0.3	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 790516)									
EB1704569-022	YALU1 <63µm Fraction	EG020Z-T: Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EB1704569-032	YALU1 <2000µm Fraction	EG020Z-T: Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 790518)									
EB1704569-022	YALU1 <63µm Fraction	EG020Y-T: Selenium	7782-49-2	1	mg/kg	<1	<1	0.00	No Limit
EB1704569-032	YALU1 <2000µm Fraction	EG020Y-T: Selenium	7782-49-2	1	mg/kg	<1	<1	0.00	No Limit
EG035-SDH: 1M HCl extractable Mercury by FIMS (QC Lot: 784878)									
EB1704569-032	YALU1 <2000µm Fraction	EG035-SDH: Mercury	7439-97-6	0.1	mg/kg	<0.10	<0.10	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 790517)									
EB1704569-022	YALU1 <63µm Fraction	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	0.02	0.02	0.00	0% - 20%
EB1704569-032	YALU1 <2000µm Fraction	EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	<0.01	0.00	0% - 20%
EK055: Ammonia as N (QC Lot: 794071)									
EB1704569-033	YALU2 <2000µm Fraction	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.00	No Limit
EB1704569-041	MARA1D <2000µm Fraction	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 790521)									



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 (%)
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 790521) - continued									
EB1704569-037	BUMB1 <2000µm Fraction	EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 790519)									
EB1704569-037	BUMB1 <2000µm Fraction	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	0.1	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 790523)									
EB1704569-032	YALU1 <2000µm Fraction	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	60	60	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 790522)									
EB1704569-032	YALU1 <2000µm Fraction	EK067G: Total Phosphorus as P	----	2	mg/kg	329	385	15.8	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 790520)									
EB1704569-037	BUMB1 <2000µm Fraction	EK071G: Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	1.1	1.1	0.00	0% - 50%
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 820416)									
EB1704569-032	YALU1 <2000µm Fraction	EP003: Total Organic Carbon	----	0.02	%	0.96	0.95	1.87	0% - 20%
EP003TC: Total Carbon (TC) in Soil (QC Lot: 820417)									
EB1704569-032	YALU1 <2000µm Fraction	EP003TC: Total Carbon	TC	0.02	%	1.60	1.62	1.02	0% - 20%
Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 783752)									
EB1704478-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	26	26	0.00	No Limit
EB1704478-011	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	164	170	3.59	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 783753)									
EB1704569-009	WAMI1	EA025H: Suspended Solids (SS)	----	5	mg/L	20	32	48.8	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 787924)									
EB1704569-001	YALU1	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	160	162	1.44	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	160	162	1.44	0% - 20%
EB1704569-009	WAMI1	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	15	18	16.8	0% - 50%
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	233	227	2.59	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	249	246	1.28	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 784015)									
EB1704569-001	YALU1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	6	6	0.00	No Limit
EB1704569-011	FBX1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 784018)									
EB1704569-001	YALU1	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.00	No Limit
EB1704569-011	FBX1	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 783816)									
EB1704569-001	YALU1	ED093F: Calcium	7440-70-2	1	mg/L	30	30	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	6	6	0.00	No Limit



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 783816) - continued									
EB1704569-001	YALU1	ED093F: Sodium	7440-23-5	1	mg/L	24	24	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.00	No Limit
EB1704569-009	WAMI1	ED093F: Calcium	7440-70-2	1	mg/L	55	55	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	14	14	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	26	27	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 783814)									
EB1704478-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.04	0.04	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EB1704569-001	YALU1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.03	0.03	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 783814) - continued									
EB1704569-001	YALU1	EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 783817)									
EB1704569-001	YALU1	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1704569-009	WAMI1	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 783818)									
EB1704569-009	WAMI1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 783896)									
EB1704569-004	BUMB3	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.018	0.017	9.81	0% - 50%
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.031	0.029	6.68	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.401	0.386	3.82	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.015	0.014	0.00	0% - 50%
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.022	0.022	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	13.4	12.6	6.38	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	15.0	13.9	7.81	0% - 20%		
EB1704569-010	MARA1	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.003	0.003	0.00	No Limit



Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report					
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: 783896) - continued									
EB1704569-010	MARA1	EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.002	0.003	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.082	0.088	6.12	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.006	0.007	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.006	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	4.38	4.73	7.56	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	3.92	4.30	9.44	0% - 20%		
EG020T: Total Metals by ICP-MS (QC Lot: 783897)									
EB1704569-004	BUMB3	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1704569-010	MARA1	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 783815)									
EB1704478-011	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1704478-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 783819)									
EB1704569-009	WAMI1	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 783904)									
EB1704291-007	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1704478-008	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 783905)									
EB1704569-002	YALU2	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 784256)									
EB1704569-001	YALU1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1704569-011	FBX1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.09	0.06	42.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 784016)									
EB1704569-001	YALU1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1704569-011	FBX1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 784257)									
EB1704569-001	YALU1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.15	0.14	0.00	0% - 50%
EB1704569-011	FBX1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 786746)									
EB1704569-001	YALU1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.3	0.3	0.00	No Limit
EB1704569-011	FBX1	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 786747)									
EB1704569-001	YALU1	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.83	0.80	4.39	0% - 20%

Page : 8 of 16
 Work Order : EB1704569
 Client : COFFEY ENVIRONMENTS PTY LTD
 Project : 520 - WAFI



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 786747) - continued									
EB1704569-011	FBX1	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.03	0.02	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 784017)									
EB1704569-001	YALU1	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.08	0.07	0.00	No Limit
EB1704569-011	FBX1	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	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 Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG005-SDH: 1M HCl-Extractable Metals by ICPAES (QCLot: 784876)									
EG005-SDH: Aluminium	7429-90-5	50	mg/kg	<50	4579.7 mg/kg	95.2	86	130	
EG005-SDH: Arsenic	7440-38-2	1	mg/kg	<1.0	9.2 mg/kg	94.2	73	116	
EG005-SDH: Barium	7440-39-3	1	mg/kg	<1.0	71.9 mg/kg	89.2	70	130	
EG005-SDH: Cadmium	7440-43-9	0.1	mg/kg	<0.1	0.51234 mg/kg	96.0	70	130	
EG005-SDH: Cobalt	7440-48-4	0.5	mg/kg	<0.5	2.6 mg/kg	106	70	130	
EG005-SDH: Chromium	7440-47-3	1	mg/kg	<1.0	5 mg/kg	110	70	124	
EG005-SDH: Copper	7440-50-8	1	mg/kg	<1.0	9.2 mg/kg	111	75	113	
EG005-SDH: Iron	7439-89-6	50	mg/kg	<50	6700.5 mg/kg	99.8	71	123	
EG005-SDH: Lead	7439-92-1	1	mg/kg	<1.0	28 mg/kg	103	87	130	
EG005-SDH: Manganese	7439-96-5	10	mg/kg	<10	246.9 mg/kg	100	70	130	
EG005-SDH: Nickel	7440-02-0	1	mg/kg	<1.0	3.8 mg/kg	113	70	128	
EG005-SDH: Silver	7440-22-4	1	mg/kg	<1.0	1.03852 mg/kg	90.0	89	117	
EG005-SDH: Vanadium	7440-62-2	2	mg/kg	<2.0	11.1 mg/kg	98.9	70	130	
EG005-SDH: Zinc	7440-66-6	1	mg/kg	<1.0	49.2 mg/kg	105	70	117	
EG005T: Total Metals by ICP-AES (QCLot: 790514)									
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	----	----	----	----	
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	118.9 mg/kg	87.1	84	123	
EG005T: Barium	7440-39-3	10	mg/kg	<10	105.1967 mg/kg	94.2	89	129	
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----	
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	1.87125 mg/kg	90.9	88	117	
EG005T: Chromium	7440-47-3	2	mg/kg	<2	22.7 mg/kg	92.0	83	125	
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	11.5 mg/kg	92.6	89	125	
EG005T: Copper	7440-50-8	5	mg/kg	<5	55 mg/kg	94.6	86	122	
EG005T: Iron	7439-89-6	50	mg/kg	<50	34900 mg/kg	91.6	70	120	
EG005T: Lead	7439-92-1	5	mg/kg	<5	72.1 mg/kg	90.2	84	119	
EG005T: Manganese	7439-96-5	5	mg/kg	<5	604.6 mg/kg	88.2	84	113	
EG005T: Nickel	7440-02-0	2	mg/kg	<2	16.6 mg/kg	91.8	89	126	
EG005T: Zinc	7440-66-6	5	mg/kg	<5	182.3 mg/kg	92.2	87	127	
EG020-SDH: 1M HCl Extractable metals by ICPMS (QCLot: 784877)									
EG020-SDH: Selenium	7782-49-2	0.5	mg/kg	<0.5	0.061 mg/kg	76.1	70	130	
EG020-SDH: Tin	7440-31-5	2	mg/kg	<2.0	0.521 mg/kg	88.9	70	130	
EG020T: Total Metals by ICP-MS (QCLot: 790515)									
EG020X-T: Antimony	7440-36-0	0.1	mg/kg	<0.1	----	----	----	----	
EG020X-T: Tin	7440-31-5	0.1	mg/kg	<0.1	4.48 mg/kg	106	79	130	



Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG020T: Total Metals by ICP-MS (QCLot: 790516)									
EG020Z-T: Silver	7440-22-4	0.1	mg/kg	<0.1	3.16 mg/kg	89.3	72	120	
EG020T: Total Metals by ICP-MS (QCLot: 790518)									
EG020Y-T: Selenium	7782-49-2	1	mg/kg	<1	----	----	----	----	
EG035-SDH: 1M HCl extractable Mercury by FIMS (QCLot: 784878)									
EG035-SDH: Mercury	7439-97-6	0.1	mg/kg	<0.10	1.863 mg/kg	121	70	130	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 790517)									
EG035T-LL: Mercury	7439-97-6	0.01	mg/kg	<0.01	0.111 mg/kg	94.0	70	130	
EK055: Ammonia as N (QCLot: 794071)									
EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	25 mg/kg	98.6	80	110	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 790521)									
EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	2.5 mg/kg	103	83	111	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 790519)									
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	98.5	86	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 790523)									
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20 <20	877 mg/kg 3644 mg/kg	98.1 85.2	70 70	110 110	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 790522)									
EK067G: Total Phosphorus as P	----	2	mg/kg	<2 <2	766 mg/kg 1200 mg/kg	78.8 87.7	70 70	110 110	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 790520)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.1	mg/kg	<0.1	2.5 mg/kg	104	89	115	
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 820416)									
EP003: Total Organic Carbon	----	0.02	%	<0.02	100 %	109	70	130	
EP003TC: Total Carbon (TC) in Soil (QCLot: 820417)									
EP003TC: Total Carbon	TC	0.02	%	<0.02	100 %	108	70	130	

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 783752)									
EA025H: Suspended Solids (SS)	----	5	mg/L	<5 <5	150 mg/L 1000 mg/L	101 94.0	88 88	112 112	
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 783753)									
EA025H: Suspended Solids (SS)	----	5	mg/L	<5 <5	150 mg/L 1000 mg/L	103 96.6	88 88	112 112	
ED037P: Alkalinity by PC Titrator (QCLot: 787924)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	105	80	120	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
				Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 784015)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	109	85	118
				<1	100 mg/L	97.9	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 784018)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	92.2	90	115
				<1	1000 mg/L	98.5	90	115
ED093F: Dissolved Major Cations (QCLot: 783816)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 783814)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	98.2	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	108	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.7	88	116
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	97.5	70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.6	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	87	113
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	86	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	104	88	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	98.1	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.6	89	120
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	103	89	112
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	103	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	110	83	112
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	101	86	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	100	87	113
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	96.0	81	125
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	82	114
EG020F: Dissolved Metals by ICP-MS (QCLot: 783817)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	96.9	85	114
EG020F: Dissolved Metals by ICP-MS (QCLot: 783818)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	99.5	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	106	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	100	88	116
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	95.1	70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.1	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	87	113
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	102	86	112



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 783818) - continued									
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	104	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.8	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.8	89	120	
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	103	89	112	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	105	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	112	83	112	
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	98.7	86	112	
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	99.2	87	113	
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	92.5	81	125	
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	114	
EG020T: Total Metals by ICP-MS (QCLot: 783896)									
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	80	114	
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	105	88	112	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	98.6	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	103	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	102	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	101	88	114	
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	104	90	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	107	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	79	111	
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	110	86	116	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	99.4	84	114	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	104	82	118	
EG020T: Total Metals by ICP-MS (QCLot: 783897)									
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	102	84	117	
EG035F: Dissolved Mercury by FIMS (QCLot: 783815)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	98.8	84	118	
EG035F: Dissolved Mercury by FIMS (QCLot: 783819)									
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	84	118	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 783904)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	97.1	80	100	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 783905)									
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	97.8	80	100	
EK055G: Ammonia as N by Discrete Analyser (QCLot: 784256)									
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	92.8	86	112	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 784016)									



Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 784016) - continued									
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	102	90	110	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 784257)									
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.9	89	115	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 786746)									
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	86.8	70	111	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 786747)									
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	88.2	77	109	
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 784017)									
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	105	88	115	

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**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery (%) MS	Recovery Limits (%)	
						Low	High
EG005-SDH: 1M HCl-Extractable Metals by ICPAES (QCLot: 784876)							
EB1704569-033	YALU2 <2000µm Fraction	EG005-SDH: Arsenic	7440-38-2	25 mg/kg	84.1	70	130
		EG005-SDH: Barium	7440-39-3	25 mg/kg	105	70	130
		EG005-SDH: Cadmium	7440-43-9	12.5 mg/kg	93.3	70	130
		EG005-SDH: Cobalt	7440-48-4	25 mg/kg	94.7	70	130
		EG005-SDH: Chromium	7440-47-3	25 mg/kg	95.2	70	130
		EG005-SDH: Copper	7440-50-8	25 mg/kg	96.2	70	130
		EG005-SDH: Lead	7439-92-1	25 mg/kg	95.0	70	130
		EG005-SDH: Manganese	7439-96-5	25 mg/kg	# Not Determined	70	130
		EG005-SDH: Nickel	7440-02-0	25 mg/kg	93.9	70	130
		EG005-SDH: Vanadium	7440-62-2	25 mg/kg	91.8	70	130
EG005-SDH: Zinc	7440-66-6	25 mg/kg	97.5	70	130		
EG005T: Total Metals by ICP-AES (QCLot: 790514)							
EB1704569-023	YALU2 <63µm Fraction	EG005T: Arsenic	7440-38-2	50 mg/kg	83.6	70	130
		EG005T: Barium	7440-39-3	50 mg/kg	112	70	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	94.0	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	89.9	70	130
		EG005T: Cobalt	7440-48-4	50 mg/kg	90.4	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	95.1	70	130
		EG005T: Lead	7439-92-1	50 mg/kg	91.3	70	130



Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 790514) - continued							
EB1704569-023	YALU2 <63µm Fraction	EG005T: Manganese	7439-96-5	50 mg/kg	# Not Determined	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	96.0	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	83.8	70	130
EG035-SDH: 1M HCl extractable Mercury by FIMS (QCLot: 784878)							
EB1704569-033	YALU2 <2000µm Fraction	EG035-SDH: Mercury	7439-97-6	1.25 mg/kg	84.6	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 790517)							
EB1704569-023	YALU2 <63µm Fraction	EG035T-LL: Mercury	7439-97-6	0.5 mg/kg	83.9	70	130
EK055: Ammonia as N (QCLot: 794071)							
EB1704569-032	YALU1 <2000µm Fraction	EK055: Ammonia as N	7664-41-7	100 mg/kg	99.4	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 790521)							
EB1704569-039	WAMI1 <2000µm Fraction	EK057G: Nitrite as N (Sol.)	14797-65-0	2 mg/kg	103	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 790519)							
EB1704569-039	WAMI1 <2000µm Fraction	EK059G: Nitrite + Nitrate as N (Sol.)	----	2 mg/kg	123	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 790523)							
EB1704569-033	YALU2 <2000µm Fraction	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	99.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 790522)							
EB1704569-033	YALU2 <2000µm Fraction	EK067G: Total Phosphorus as P	----	100 mg/kg	# Not Determined	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 790520)							
EB1704569-039	WAMI1 <2000µm Fraction	EK071G: Reactive Phosphorus as P	14265-44-2	2 mg/kg	99.6	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 784015)							
EB1704569-002	YALU2	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	106	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 784018)							
EB1704569-002	YALU2	ED045G: Chloride	16887-00-6	400 mg/L	107	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 783814)							
EB1704478-002	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	107	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	70.2	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	101	70	130
		EG020A-F: Barium	7440-39-3	0.5 mg/L	99.6	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	100	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	93.1	70	130



Sub-Matrix: WATER

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
				Low	High		
EG020F: Dissolved Metals by ICP-MS (QCLot: 783814) - continued							
EB1704478-002	Anonymous	EG020A-F: Cobalt	7440-48-4	0.1 mg/L	102	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	# Not Determined	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	98.5	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	# Not Determined	70	130
		EG020A-F: Molybdenum	7439-98-7	0.1 mg/L	92.6	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	101	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	106	70	130
		EG020A-F: Tin	7440-31-5	0.1 mg/L	91.8	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	102	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	96.0	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 783818)							
EB1704569-010	MARA1	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	101	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	79.6	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	103	70	130
		EG020A-F: Barium	7440-39-3	0.5 mg/L	98.7	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	100	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	102	70	130
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	102	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	104	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	99.0	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	98.4	70	130
		EG020A-F: Molybdenum	7439-98-7	0.1 mg/L	100	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	101	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	109	70	130
		EG020A-F: Tin	7440-31-5	0.1 mg/L	97.3	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	105	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	94.2	70	130
		EG020T: Total Metals by ICP-MS (QCLot: 783896)					
EB1704478-012	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	100	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	102	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	102	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	104	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	106	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	103	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	104	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	104	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	99.8	70	130



Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035F: Dissolved Mercury by FIMS (QCLot: 783815)							
EB1704478-002	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	81.0	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 783819)							
EB1704569-010	MARA1	EG035F: Mercury	7439-97-6	0.01 mg/L	88.6	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 783904)							
EB1704294-001	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	83.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 783905)							
EB1704569-003	BUMB2	EG035T: Mercury	7439-97-6	0.01 mg/L	85.6	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 784256)							
EB1704569-002	YALU2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	74.0	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 784016)							
EB1704569-002	YALU2	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	98.6	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 784257)							
EB1704569-002	YALU2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	70.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 786746)							
EB1704569-002	YALU2	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	94.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 786747)							
EB1704569-002	YALU2	EK067G: Total Phosphorus as P	----	1 mg/L	98.5	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 784017)							
EB1704569-002	YALU2	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	100	70	130

QUALITY CONTROL REPORT

Work Order	: EB1711949	Page	: 1 of 11
Amendment	: 1		
Client	: WAFI GOLPU SERVICES LIMITED	Laboratory	: Environmental Division Brisbane
Contact	: TRAVIS WOOD	Contact	: Customer Services EB
Address	: WAFI GOLPU JV PO BOX 4015 LAE 411 MOROBE PROVINCE PAPUA NEW GUINEA	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: +61-7-3243 7222
Project	: 520 Wafi-Golpu Project	Date Samples Received	: 12-Jun-2017
Order number	: 712184	Date Analysis Commenced	: 13-Jun-2017
C-O-C number	: ----	Issue Date	: 23-Jun-2017
Sampler	: A.T.		
Site	: ----		
Quote number	: BN/288/16		
No. of samples received	: 11		
No. of samples analysed	: 11		



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

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

This Quality Control Report contains the following information:

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

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

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

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

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

Laboratory Duplicate (DUP) Report

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

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 940977)									
EB1711949-001	S/ Site 1	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	6	18.2	No Limit
EB1711949-011	FBx 1	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.00	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 942832)									
EB1711949-001	S/ Site 1	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	310	303	2.28	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	310	303	2.28	0% - 20%
EB1711949-011	FBx 1	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	0.00	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 941038)									
EB1711949-001	S/ Site 1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	5	5	0.00	No Limit
EB1711949-011	FBx 1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 941035)									
EB1711949-001	S/ Site 1	ED045G: Chloride	16887-00-6	1	mg/L	36	36	0.00	0% - 20%
EB1711949-011	FBx 1	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 942537)									
EB1711949-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	270	274	1.42	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	407	408	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	3200	3190	0.430	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	29	29	0.00	0% - 20%
EB1711949-001	S/ Site 1	ED093F: Calcium	7440-70-2	1	mg/L	80	79	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	14	14	0.00	0% - 50%



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED093F: Dissolved Major Cations (QC Lot: 942537) - continued									
EB1711949-001	S/ Site 1	ED093F: Sodium	7440-23-5	1	mg/L	46	46	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 942541)									
EB1711949-010	S/ Site 8_DUP	ED093F: Calcium	7440-70-2	1	mg/L	31	31	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	6	6	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	20	20	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 942539)									
EB1711949-001	S/ Site 1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.065	0.066	0.00	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1711949-010	S/ Site 8_DUP	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.009	0.008	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.04	0.04	0.00	No Limit
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit		



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 942539) - continued									
EB1711949-010	S/ Site 8_DUP	EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 942540)									
EB1711949-001	S/ Site 1	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1711949-010	S/ Site 8_DUP	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 942609)									
EB1711879-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.024	0.024	0.00	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.023	0.023	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EB1711949-001	S/ Site 1	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.094	0.094	0.00	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.12	0.12	0.00	0% - 50%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	0.17	0.18	5.98	No Limit		
EG020T: Total Metals by ICP-MS (QC Lot: 942610)									
EB1711949-001	S/ Site 1	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EB1711949-011	FBx 1	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 942611)									
EB1711949-011	FBx 1	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
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: 942611) - continued									
EB1711949-011	FBx 1	EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.008	36.5	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit		
EB1711965-018	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0064	0.0065	1.64	0% - 20%
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.017	0.016	0.00	0% - 50%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	0.358	0.363	1.24	0% - 20%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.105	0.107	1.62	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	44.9	45.6	1.69	0% - 20%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.259	0.261	0.501	0% - 20%
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	3.07	3.13	1.77	0% - 20%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	8.69	8.49	2.37	0% - 20%
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020A-T: Iron	7439-89-6	0.05	mg/L	46.5	47.5	2.25	0% - 20%		
EG035F: Dissolved Mercury by FIMS (QC Lot: 942538)									
EB1711919-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1711949-001	S/ Site 1	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 942542)									
EB1711949-010	S/ Site 8_DUP	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 942613)									
EB1711879-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1711949-001	S/ Site 1	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 942614)									
EB1711949-011	FBx 1	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1711965-018	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 942833)									



Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK040P: Fluoride by PC Titrator (QC Lot: 942833) - continued									
EB1711949-001	S/ Site 1	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.1	0.1	0.00	No Limit
EB1711949-011	FBx 1	EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 943248)									
EB1711949-001	S/ Site 1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1711949-011	FBx 1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 941036)									
EB1711949-001	S/ Site 1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1711949-011	FBx 1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 943249)									
EB1711949-001	S/ Site 1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EB1711949-011	FBx 1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 946876)									
EB1711948-010	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.0	1.9	0.00	0% - 20%
EB1711949-005	S/ Site 5	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.3	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 946875)									
EB1711948-010	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.42	0.41	3.41	0% - 20%
EB1711949-005	S/ Site 5	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.15	0.14	0.00	0% - 50%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 941037)									
EB1711949-001	S/ Site 1	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.07	0.07	0.00	No Limit
EB1711949-011	FBx 1	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	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 Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 940977)									
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	103	88	112	
				<5	1000 mg/L	100	88	112	
ED037P: Alkalinity by PC Titrator (QCLot: 942832)									
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	93.2	80	120	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 941038)									
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	107	85	118	
				<1	100 mg/L	97.2	85	118	
ED045G: Chloride by Discrete Analyser (QCLot: 941035)									
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	96.7	90	115	
				<1	1000 mg/L	101	90	115	
ED093F: Dissolved Major Cations (QCLot: 942537)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
ED093F: Dissolved Major Cations (QCLot: 942541)									
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----	
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----	
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----	
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS (QCLot: 942539)									
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	97.9	79	118	
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	112	87	113	
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.8	88	116	
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.5 mg/L	94.0	70	130	
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	95.3	88	108	
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	97.9	87	113	
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	96.5	86	112	
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	98.0	88	114	
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	89	110	
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.5	89	120	
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	103	89	112	
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.2	89	113	
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	97.1	83	112	



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike	Spike Recovery (%)		Recovery Limits (%)	
					Concentration	LCS	Low	High	
EG020F: Dissolved Metals by ICP-MS (QCLot: 942539) - continued									
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	102	86	112	
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	97.4	87	113	
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	96.6	81	125	
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	114	
EG020F: Dissolved Metals by ICP-MS (QCLot: 942540)									
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	111	85	114	
EG020T: Total Metals by ICP-MS (QCLot: 942609)									
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	106	80	114	
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	103	88	112	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	107	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	106	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	104	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	108	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	108	88	114	
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	111	90	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	104	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	109	79	111	
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	110	86	116	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	102	84	114	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	110	82	118	
EG020T: Total Metals by ICP-MS (QCLot: 942610)									
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	106	84	117	
EG020T: Total Metals by ICP-MS (QCLot: 942611)									
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	106	80	114	
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	103	88	112	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	109	88	111	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	89	115	
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	108	89	115	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	106	88	116	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	109	89	112	
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	107	88	114	
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	110	90	114	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	105	88	116	
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	106	79	111	
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	109	86	116	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	101	84	114	
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	115	82	118	



Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
				Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
					LCS	Low	High	
EG035F: Dissolved Mercury by FIMS (QCLot: 942538)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	113	84	118
EG035F: Dissolved Mercury by FIMS (QCLot: 942542)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	98.5	84	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 942613)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	80	100
EG035T: Total Recoverable Mercury by FIMS (QCLot: 942614)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	100	80	100
EK040P: Fluoride by PC Titrator (QCLot: 942833)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	10 mg/L	98.6	80	117
EK055G: Ammonia as N by Discrete Analyser (QCLot: 943248)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	99.0	86	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 941036)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	98.2	90	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 943249)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.4	89	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 946876)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	82.6	70	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 946875)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	82.5	77	109
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 941037)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	99.7	88	115

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: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
				MS	Low	High	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 941038)							
EB1711949-002	S/ Site 2	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	99.4	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 941035)							
EB1711949-002	S/ Site 2	ED045G: Chloride	16887-00-6	400 mg/L	104	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 942539)							
EB1711919-009	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	96.6	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	117	70	130



Sub-Matrix: WATER

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%)	
						Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 942539) - continued							
EB1711919-009	Anonymous	EG020A-F: Arsenic	7440-38-2	0.1 mg/L	102	70	130
		EG020A-F: Barium	7440-39-3	0.5 mg/L	102	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	101	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	96.8	70	130
		EG020A-F: Cobalt	7440-48-4	0.1 mg/L	95.6	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	95.9	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	93.0	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	95.0	70	130
		EG020A-F: Molybdenum	7439-98-7	0.1 mg/L	85.9	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	93.8	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	95.7	70	130
		EG020A-F: Tin	7440-31-5	0.1 mg/L	79.7	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	91.4	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	94.9	70	130
EG020T: Total Metals by ICP-MS (QCLot: 942609)							
EB1711879-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	99.5	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	104	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	93.4	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	92.5	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	85.5	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	93.3	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	94.8	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	88.2	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	87.6	70	130
EG020T: Total Metals by ICP-MS (QCLot: 942611)							
EB1711965-002	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	98.0	70	130
		EG020A-T: Cadmium	7440-43-9	0.5 mg/L	106	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	98.4	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	101	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	97.7	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	99.9	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	101	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	97.4	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	96.8	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 942538)							
EB1711919-002	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	87.2	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 942542)							
EB1711949-009	S/ Site 9	EG035F: Mercury	7439-97-6	0.01 mg/L	90.8	70	130



Sub-Matrix: WATER

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 942613)							
EB1711879-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	94.5	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 942614)							
EB1711965-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	103	70	130
EK040P: Fluoride by PC Titrator (QCLot: 942833)							
EB1711949-002	S/ Site 2	EK040P: Fluoride	16984-48-8	5 mg/L	97.8	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 943248)							
EB1711949-002	S/ Site 2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	94.4	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 941036)							
EB1711949-002	S/ Site 2	EK057G: Nitrite as N	14797-65-0	0.4 mg/L	92.4	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 943249)							
EB1711949-002	S/ Site 2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	94.0	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 946876)							
EB1711948-012	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	94.8	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 946875)							
EB1711948-012	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	118	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 941037)							
EB1711949-002	S/ Site 2	EK071G: Reactive Phosphorus as P	14265-44-2	0.4 mg/L	100	70	130