ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **ES1623649** | Page | : 1 of 7 |
| Client | : **ORIGIN ENERGY RESOURCES LTD** | Laboratory | : Environmental Division Sydney |
| Contact | : [redacted] | Contact | : [redacted] |
| Address | : ORIGIN ENERGY RESOURCES LIMITED GPO BOX 148 BRISBANE QLD, AUSTRALIA 4001 | Address | : 277-289 Woodpark Road Smithfield NSW Australia 2164 |
| Telephone | : [redacted] | Telephone | : [redacted] |
| Project | : Beetaloo Groundwater Monitoring | Date Samples Received | : 20-Oct-2016 13:45 |
| Order number | : 16231417 | Date Analysis Commenced | : 21-Oct-2016 |
| C-O-C number | : COC_AMNW1H_SU_TT_20161019 | Issue Date | : 27-Oct-2016 14:43 |
| Sampler | : ---- | | |
| Site | : Betaloo | | |
| Quote number | : ---- | | |
| No. of samples received | : 3 | | |
| No. of samples analysed | : 3 | | |

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

## *Signatories*

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

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| [redacted] | Inorganic Chemist | Sydney Inorganics, Smithfield, NSW |
| | Senior Spectroscopist | Sydney Inorganics, Smithfield, NSW |
| | Organic Coordinator | Sydney Organics, Smithfield, NSW |
| | Inorganics Coordinator | Sydney Inorganics, Smithfield, NSW |

## General Comments

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

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

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

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

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

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

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

- EG020/ED093: LOR's have been raised for sample ID ES1623649 - #001 & #003 due to matrix interference. (High Total Dissolved Solids)
- ED041G: LOR raised for Sulfate for sample 1 due to sample matrix.
- ED041G: LOR raised for (Sulfate analysis) on sample no:3, due to sample matrix.
- EN055: Ionic Balance out of acceptable limits for sample 1 due to analytes not quantified in this report.
- EP050: The MBAS reported is calculated as LAS, mol wt ____342___.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentra ion of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | Client sample ID | BET-PW001_Fe_7x5 | BET-PW001_Fe_8x5 | BET-PW001_Fe_11x5 | ---- | ---- |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | ES1623649-001 | ES1623649-002 | ES1623649-003 | -------- | -------- |
| | | | | Result | Result | Result | --- | --- |
| **EA005P: pH by PC Titrator** | | | | | | | | |
| pH Value | ---- | 0.01 | pH Unit | 6.51 | 7.56 | 7.47 | ---- | ---- |
| **EA010P: Conductivity by PC Titrator** | | | | | | | | |
| Electrical Conductivity @ 25°C | ---- | 1 | µS/cm | 41400 | 21100 | 26800 | ---- | ---- |
| **EA015: Total Dissolved Solids dried at 180 ± 5 °C** | | | | | | | | |
| Total Dissolved Solids @180°C | ---- | 10 | mg/L | 29900 | 14400 | 18100 | ---- | ---- |
| **EA016: Calculated TDS (from Electrical Conductivity)** | | | | | | | | |
| Total Dissolved Solids (Calc.) | ---- | 1 | mg/L | 26900 | 13700 | 17400 | ---- | ---- |
| **EA065: Total Hardness as CaCO3** | | | | | | | | |
| Total Hardness as CaCO3 | ---- | 1 | mg/L | 3340 | 1280 | 2080 | ---- | ---- |
| **ED037P: Alkalinity by PC Titrator** | | | | | | | | |
| Hydroxide Alkalinity as CaCO3 | DMO-210-001 | 1 | mg/L | <1 | <1 | <1 | ---- | ---- |
| Carbonate Alkalinity as CaCO3 | 3812-32-6 | 1 | mg/L | <1 | <1 | <1 | ---- | ---- |
| Bicarbonate Alkalinity as CaCO3 | 71-52-3 | 1 | mg/L | 586 | 714 | 1020 | ---- | ---- |
| Total Alkalinity as CaCO3 | ---- | 1 | mg/L | 586 | 714 | 1020 | ---- | ---- |
| **ED041G: Sulfate (Turbidimetric) as SO4 2- by DA** | | | | | | | | |
| Sulfate as SO4 - Turbidimetric | 14808-79-8 | 1 | mg/L | <10 | 46 | <10 | ---- | ---- |
| **ED045G: Chloride by Discrete Analyser** | | | | | | | | |
| Chloride | 16887-00-6 | 1 | mg/L | 13300 | 6520 | 8010 | ---- | ---- |
| **ED093F: Dissolved Major Cations** | | | | | | | | |
| Calcium | 7440-70-2 | 1 | mg/L | 1020 | 358 | 611 | ---- | ---- |
| Magnesium | 7439-95-4 | 1 | mg/L | 192 | 95 | 135 | ---- | ---- |
| Sodium | 7440-23-5 | 1 | mg/L | 9940 | 3950 | 5590 | ---- | ---- |
| Potassium | 7440-09-7 | 1 | mg/L | 70 | 273 | 63 | ---- | ---- |
| **EG020F: Dissolved Metals by ICP-MS** | | | | | | | | |
| Arsenic | 7440-38-2 | 0.001 | mg/L | 0.016 | 0.032 | 0.061 | ---- | ---- |
| Boron | 7440-42-8 | 0.05 | mg/L | 62.9 | 38.2 | 66.0 | ---- | ---- |
| Barium | 7440-39-3 | 0.001 | mg/L | 36.4 | 7.97 | 12.9 | ---- | ---- |
| Beryllium | 7440-41-7 | 0.001 | mg/L | <0.010 | <0.001 | <0.010 | ---- | ---- |
| Cadmium | 7440-43-9 | 0.0001 | mg/L | <0.0010 | <0.0001 | <0.0010 | ---- | ---- |
| Cobalt | 7440-48-4 | 0.001 | mg/L | <0.010 | <0.001 | <0.010 | ---- | ---- |
| Chromium | 7440-47-3 | 0.001 | mg/L | 0.031 | 0.044 | 0.055 | ---- | ---- |
| Copper | 7440-50-8 | 0.001 | mg/L | <0.010 | <0.001 | <0.010 | ---- | ---- |
| Manganese | 7439-96-5 | 0.001 | mg/L | 2.24 | 0.906 | 1.39 | ---- | ---- |
| Nickel | 7440-02-0 | 0.001 | mg/L | 0.016 | 0.016 | 0.028 | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | BET-PW001_Fe_7x5 | BET-PW001_Fe_8x5 | BET-PW001_Fe_11x5 | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | ES1623649-001 | ES1623649-002 | ES1623649-003 | -------- | -------- |
| | | | | | Result | Result | Result | --- | --- |
| **EG020F: Dissolved Metals by ICP-MS - Continued** | | | | | | | | | |
| Lead | 7439-92-1 | 0.001 | mg/L | | <0.010 | <0.001 | <0.010 | ---- | ---- |
| Selenium | 7782-49-2 | 0.01 | mg/L | | <0.10 | <0.01 | <0.10 | ---- | ---- |
| Vanadium | 7440-62-2 | 0.01 | mg/L | | <0.10 | <0.01 | <0.10 | ---- | ---- |
| Zinc | 7440-66-6 | 0.005 | mg/L | | <0.050 | <0.005 | <0.050 | ---- | ---- |
| **EG035F: Dissolved Mercury by FIMS** | | | | | | | | | |
| Mercury | 7439-97-6 | 0.0001 | mg/L | | <0.0001 | <0.0001 | <0.0001 | ---- | ---- |
| **EK040P: Fluoride by PC Titrator** | | | | | | | | | |
| Fluoride | 16984-48-8 | 0.1 | mg/L | | 1.6 | 1.6 | 2.6 | ---- | ---- |
| **EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser** | | | | | | | | | |
| Nitrite + Nitrate as N | ---- | 0.01 | mg/L | | 0.02 | 0.03 | 0.02 | ---- | ---- |
| **EK061G: Total Kjeldahl Nitrogen By Discrete Analyser** | | | | | | | | | |
| Total Kjeldahl Nitrogen as N | ---- | 0.1 | mg/L | | 88.0 | 69.6 | 72.8 | ---- | ---- |
| **EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser** | | | | | | | | | |
| ^ Total Nitrogen as N | ---- | 0.1 | mg/L | | 88.0 | 69.6 | 72.8 | ---- | ---- |
| **EK067G: Total Phosphorus as P by Discrete Analyser** | | | | | | | | | |
| Total Phosphorus as P | ---- | 0.01 | mg/L | | 1.20 | 0.52 | 0.75 | ---- | ---- |
| **EN055: Ionic Balance** | | | | | | | | | |
| Total Anions | ---- | 0.01 | meq/L | | 387 | 199 | 246 | ---- | ---- |
| Total Cations | ---- | 0.01 | meq/L | | 501 | 204 | 286 | ---- | ---- |
| Ionic Balance | ---- | 0.01 | % | | 12.8 | 1.32 | 7.51 | ---- | ---- |
| **EP033: C1 - C4 Hydrocarbon Gases** | | | | | | | | | |
| Methane | 74-82-8 | 1 | µg/L | | 2000 | 669 | 2080 | ---- | ---- |
| Ethene | 74-85-1 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Ethane | 74-84-0 | 1 | µg/L | | 2 | <1 | <1 | ---- | ---- |
| Propene | 115-07-1 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Propane | 74-98-6 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Butene | 25167-67-3 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Butane | 106-97-8 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| **EP041A: Nonionic Surfactants** | | | | | | | | | |
| Nonionic Surfactants as CTAS | ---- | 5 | mg/L | | <5 | <5 | <5 | ---- | ---- |
| **EP050: Anionic Surfactants as MBAS** | | | | | | | | | |
| Anionic Surfactants as MBAS | ---- | 0.1 | mg/L | | <0.1 | <0.1 | 0.2 | ---- | ---- |
| **EP075(SIM)A: Phenolic Compounds** | | | | | | | | | |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | BET-PW001_Fe_7x5 | BET-PW001_Fe_8x5 | BET-PW001_Fe_11x5 | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | ES1623649-001 | ES1623649-002 | ES1623649-003 | -------- | -------- |
| | | | | | Result | Result | Result | --- | --- |
| **EP075(SIM)A: Phenolic Compounds - Continued** | | | | | | | | | |
| Phenol | 108-95-2 | 1 | µg/L | | **18.5** | **5.2** | **13.2** | ---- | ---- |
| 2-Chlorophenol | 95-57-8 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2-Methylphenol | 95-48-7 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 3- & 4-Methylphenol | 1319-77-3 | 2 | µg/L | | **91.2** | **31.5** | **762** | ---- | ---- |
| 2-Nitrophenol | 88-75-5 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2.4-Dimethylphenol | 105-67-9 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2.4-Dichlorophenol | 120-83-2 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2.6-Dichlorophenol | 87-65-0 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 4-Chloro-3-methylphenol | 59-50-7 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2.4.6-Trichlorophenol | 88-06-2 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| 2.4.5-Trichlorophenol | 95-95-4 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Pentachlorophenol | 87-86-5 | 2 | µg/L | | <2.0 | <2.0 | <2.0 | ---- | ---- |
| **EP075(SIM)B: Polynuclear Aromatic Hydrocarbons** | | | | | | | | | |
| Naphthalene | 91-20-3 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Acenaphthylene | 208-96-8 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Acenaphthene | 83-32-9 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Fluorene | 86-73-7 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Phenanthrene | 85-01-8 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Anthracene | 120-12-7 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Fluoranthene | 206-44-0 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Pyrene | 129-00-0 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Benz(a)anthracene | 56-55-3 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Chrysene | 218-01-9 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Benzo(b+j)fluoranthene | 205-99-2 205-82-3 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Benzo(k)fluoranthene | 207-08-9 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Benzo(a)pyrene | 50-32-8 | 0.5 | µg/L | | <0.5 | <0.5 | <0.5 | ---- | ---- |
| Indeno(1.2.3.cd)pyrene | 193-39-5 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Dibenz(a.h)anthracene | 53-70-3 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| Benzo(g.h.i)perylene | 191-24-2 | 1 | µg/L | | <1.0 | <1.0 | <1.0 | ---- | ---- |
| ^ Sum of polycyclic aromatic hydrocarbons | ---- | 0.5 | µg/L | | <0.5 | <0.5 | <0.5 | ---- | ---- |
| ^ Benzo(a)pyrene TEQ (zero) | ---- | 0.5 | µg/L | | <0.5 | <0.5 | <0.5 | ---- | ---- |
| **EP080/071: Total Petroleum Hydrocarbons** | | | | | | | | | |
| C6 - C9 Fraction | ---- | 20 | µg/L | | **50** | <20 | <20 | ---- | ---- |
| C10 - C14 Fraction | ---- | 50 | µg/L | | **330** | **120** | **360** | ---- | ---- |

## Analytical Results

| Sub-Matrix: WATER (Matrix: WATER) | | | | Client sample ID | BET-PW001_Fe_7x5 | BET-PW001_Fe_8x5 | BET-PW001_Fe_11x5 | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | 19-Oct-2016 12:00 | ---- | ---- |
| Compound | CAS Number | LOR | Unit | | ES1623649-001 | ES1623649-002 | ES1623649-003 | -------- | -------- |
| | | | | | Result | Result | Result | --- | --- |
| **EP080/071: Total Petroleum Hydrocarbons - Continued** | | | | | | | | | |
| C15 - C28 Fraction | ---- | 100 | µg/L | | 250 | 370 | 370 | ---- | ---- |
| C29 - C36 Fraction | ---- | 50 | µg/L | | <50 | <50 | <50 | ---- | ---- |
| ^ C10 - C36 Fraction (sum) | ---- | 50 | µg/L | | 580 | 490 | 730 | ---- | ---- |
| **EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions** | | | | | | | | | |
| C6 - C10 Fraction | C6_C10 | 20 | µg/L | | 40 | <20 | <20 | ---- | ---- |
| ^ C6 - C10 Fraction minus BTEX (F1) | C6_C10-BTEX | 20 | µg/L | | 40 | <20 | <20 | ---- | ---- |
| >C10 - C16 Fraction | ---- | 100 | µg/L | | 370 | 200 | 490 | ---- | ---- |
| >C16 - C34 Fraction | ---- | 100 | µg/L | | 210 | 350 | 290 | ---- | ---- |
| >C34 - C40 Fraction | ---- | 100 | µg/L | | <100 | <100 | <100 | ---- | ---- |
| ^ >C10 - C40 Fraction (sum) | ---- | 100 | µg/L | | 580 | 550 | 780 | ---- | ---- |
| ^ >C10 - C16 Fraction minus Naphthalene (F2) | ---- | 100 | µg/L | | 370 | 200 | 490 | ---- | ---- |
| **EP080: BTEXN** | | | | | | | | | |
| Benzene | 71-43-2 | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Toluene | 108-88-3 | 2 | µg/L | | <2 | <2 | <2 | ---- | ---- |
| Ethylbenzene | 100-41-4 | 2 | µg/L | | <2 | <2 | <2 | ---- | ---- |
| meta- & para-Xylene | 108-38-3 106-42-3 | 2 | µg/L | | <2 | <2 | <2 | ---- | ---- |
| ortho-Xylene | 95-47-6 | 2 | µg/L | | <2 | <2 | <2 | ---- | ---- |
| ^ Total Xylenes | 1330-20-7 | 2 | µg/L | | <2 | <2 | <2 | ---- | ---- |
| ^ Sum of BTEX | ---- | 1 | µg/L | | <1 | <1 | <1 | ---- | ---- |
| Naphthalene | 91-20-3 | 5 | µg/L | | <5 | <5 | <5 | ---- | ---- |
| **EP075(SIM)S: Phenolic Compound Surrogates** | | | | | | | | | |
| Phenol-d6 | 13127-88-3 | 1 | % | | 23.8 | 23.2 | 24.2 | ---- | ---- |
| 2-Chlorophenol-D4 | 93951-73-6 | 1 | % | | 49.2 | 51.7 | 54.7 | ---- | ---- |
| 2.4.6-Tribromophenol | 118-79-6 | 1 | % | | 81.3 | 83.6 | 80.1 | ---- | ---- |
| **EP075(SIM)T: PAH Surrogates** | | | | | | | | | |
| 2-Fluorobiphenyl | 321-60-8 | 1 | % | | 67.5 | 68.9 | 56.6 | ---- | ---- |
| Anthracene-d10 | 1719-06-8 | 1 | % | | 66.5 | 67.6 | 68.0 | ---- | ---- |
| 4-Terphenyl-d14 | 1718-51-0 | 1 | % | | 86.6 | 94.0 | 85.1 | ---- | ---- |
| **EP080S: TPH(V)/BTEX Surrogates** | | | | | | | | | |
| 1.2-Dichloroethane-D4 | 17060-07-0 | 2 | % | | 94.1 | 96.5 | 95.3 | ---- | ---- |
| Toluene-D8 | 2037-26-5 | 2 | % | | 123 | 115 | 112 | ---- | ---- |
| 4-Bromofluorobenzene | 460-00-4 | 2 | % | | 123 | 115 | 110 | ---- | ---- |

## Surrogate Control Limits

Sub-Matrix: **WATER**

| Compound | CAS Number | Recovery Limits (%) Low | High |
|---|---|---|---|
| **EP075(SIM)S: Phenolic Compound Surrogates** | | | |
| **Phenol-d6** | 13127-88-3 | 10 | 44 |
| **2-Chlorophenol-D4** | 93951-73-6 | 14 | 94 |
| **2.4.6-Tribromophenol** | 118-79-6 | 17 | 125 |
| **EP075(SIM)T: PAH Surrogates** | | | |
| **2-Fluorobiphenyl** | 321-60-8 | 20 | 104 |
| **Anthracene-d10** | 1719-06-8 | 27 | 113 |
| **4-Terphenyl-d14** | 1718-51-0 | 32 | 112 |
| **EP080S: TPH(V)/BTEX Surrogates** | | | |
| **1.2-Dichloroethane-D4** | 17060-07-0 | 71 | 137 |
| **Toluene-D8** | 2037-26-5 | 79 | 131 |
| **4-Bromofluorobenzene** | 460-00-4 | 70 | 128 |