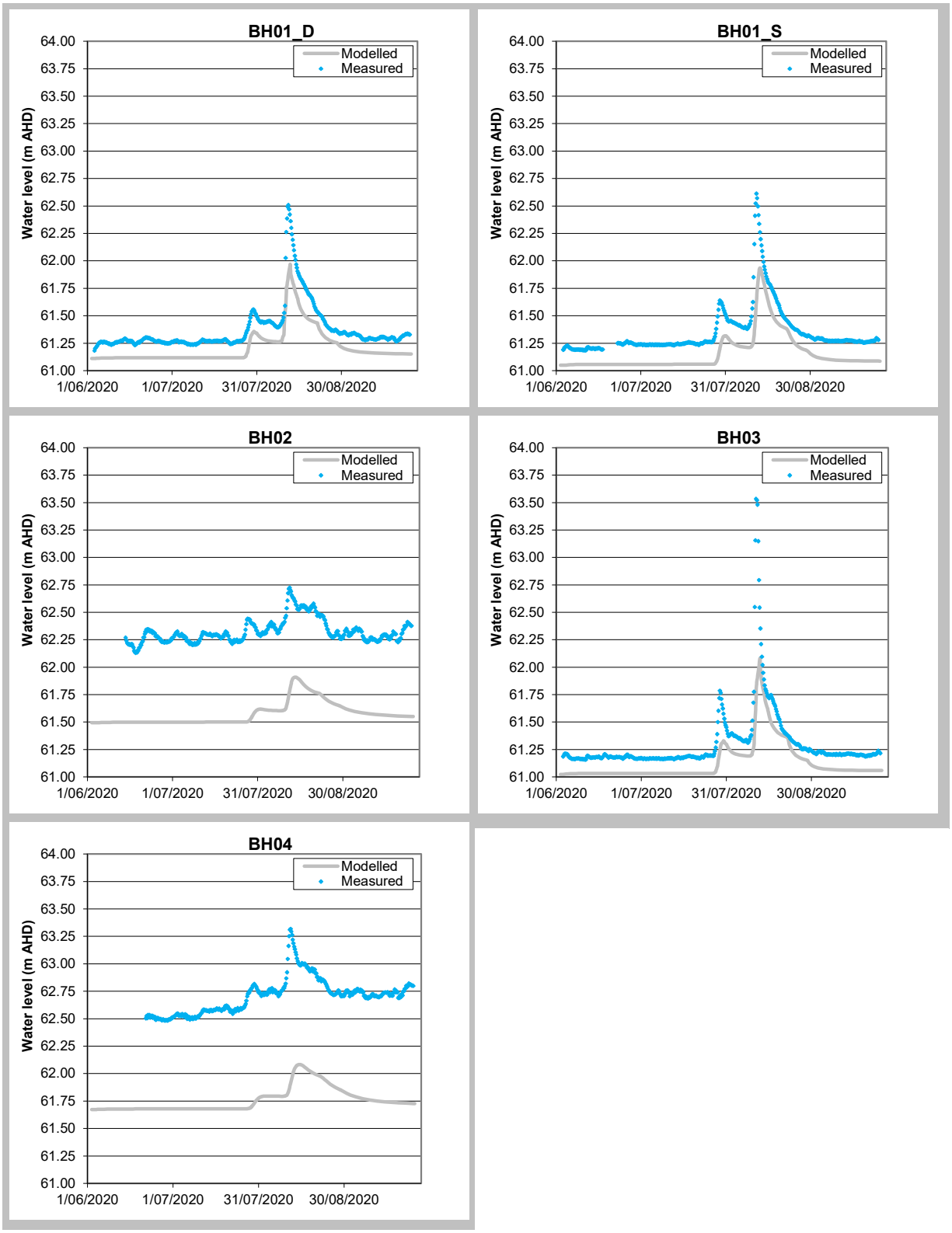

Figure 4.1 - Modelled and measured hydrographs (History Matching)

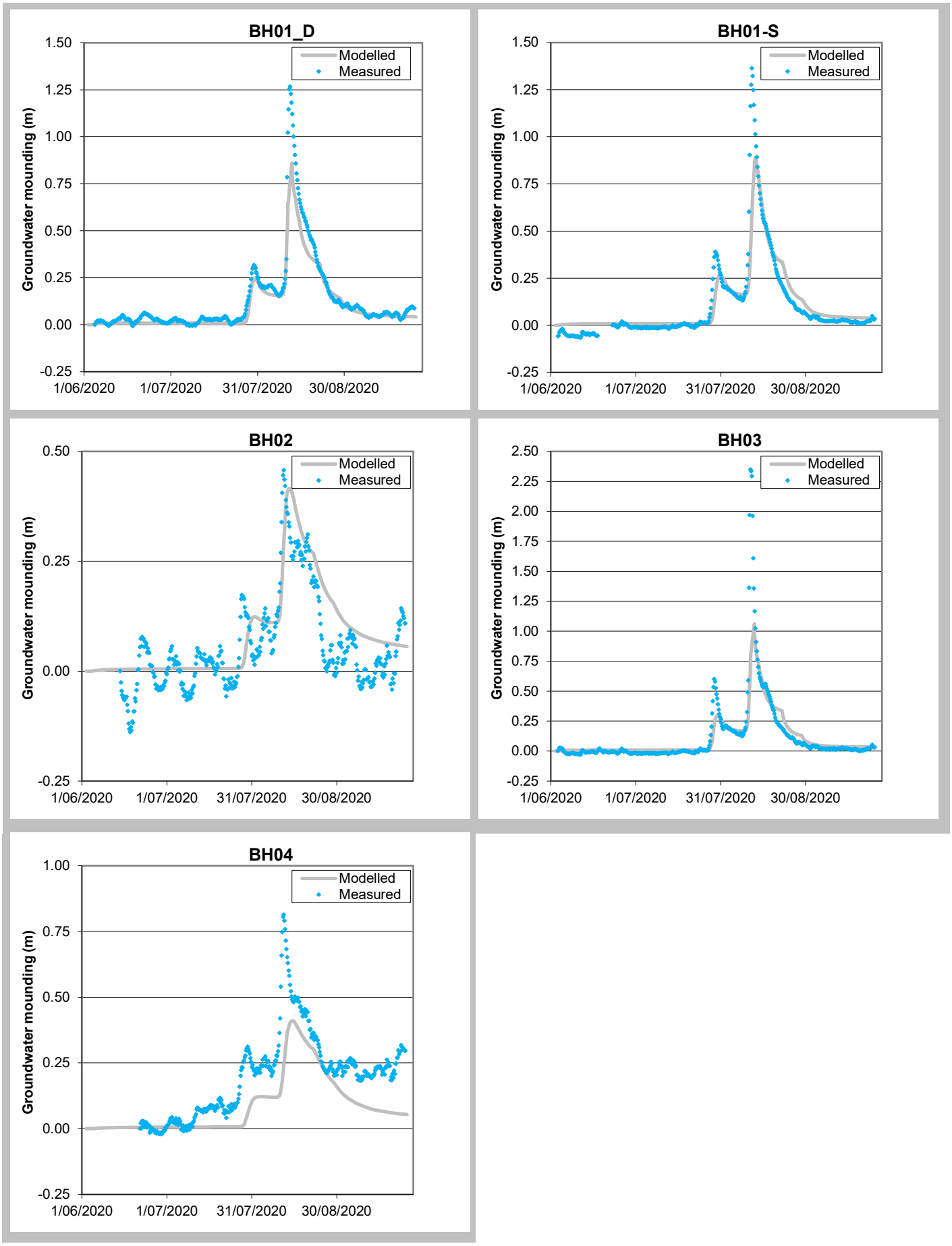

Figure 4.2 - Modelled and measured mounding hydrographs (History Matching)

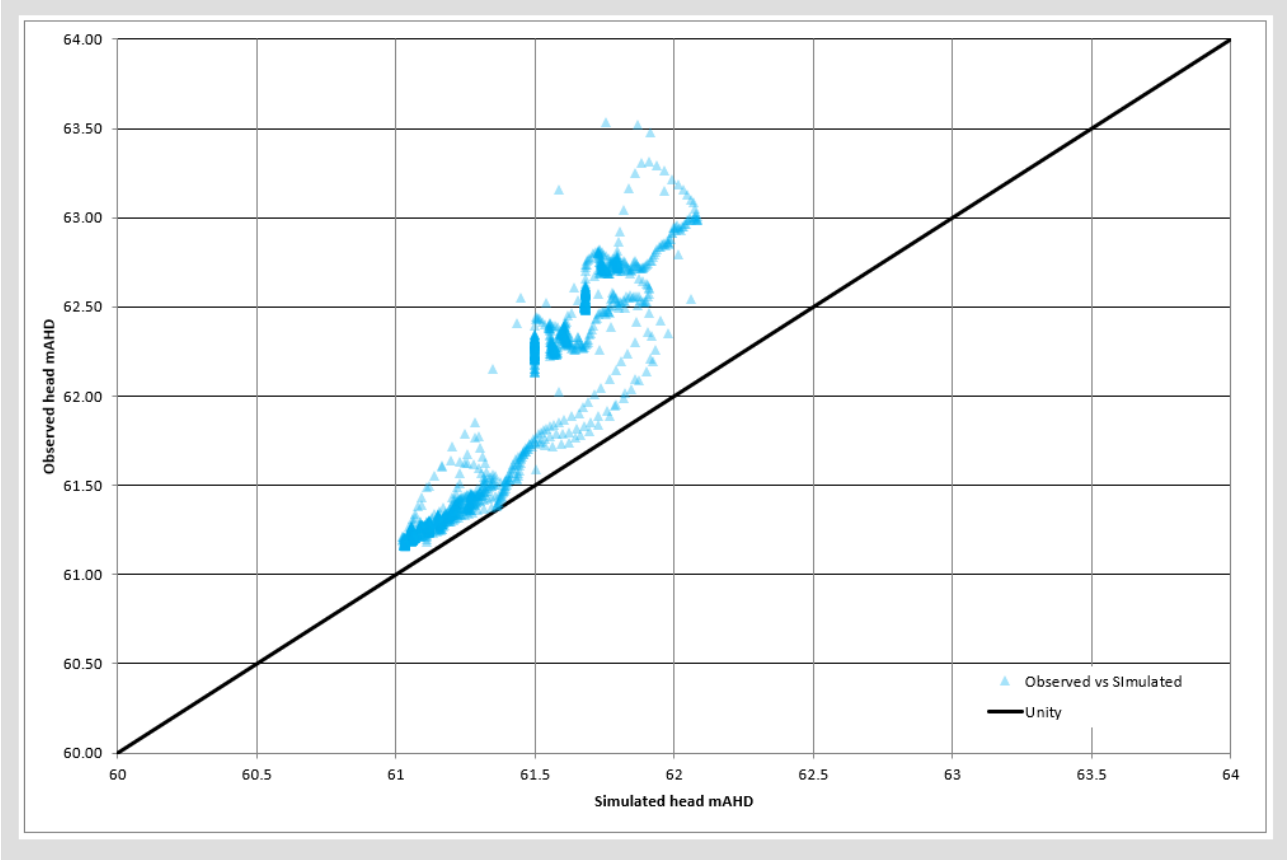

Figure 4.3 Scatter plot of modelled versus measured hydraulic head

4.4 Sensitivity analysis

A relative composite sensitivity analysis was performed on the calibrated model and the results show that the model is most sensitive to horizontal hydraulic conductivity (model layers 2, 4 and 5) and specific yield of layer 2 (alluvium). Figure 4.4 shows the relative values of the composite sensitivity. The sensitivity of the history-matched model is based on the hydraulic head targets at the site monitoring bores.

As there are no measurements in model layer 1, the sensitivity shows a low relative sensitivity to the parameters of layer 1.

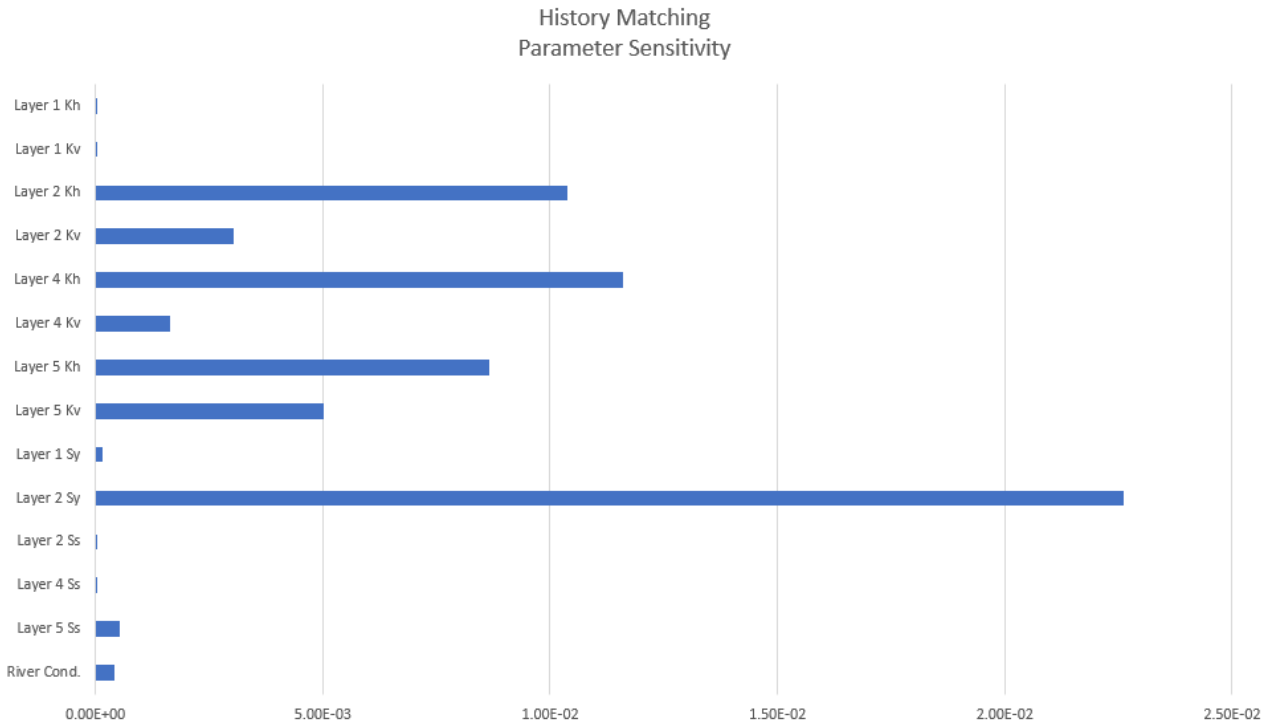

Figure 4.4 Relative composite sensitivity of the history-matched model

5 Predictive scenarios

5.1 Predictive modelling

a Quarry void material properties used in predictive modelling

For the predictive modelling of the proposed project, the following material properties were implemented:

- Hydraulic conductivity: a significant increase in the horizontal and vertical hydraulic conductivity was used to represent void space. A value of 1,000 m/d was assigned to layer 1 in the quarry void areas.
- Specific yield: specific yield was increased to 100% in quarry void areas of model layer 1.

b Boundary conditions

The Nepean River boundary condition simulated a synthetic high flow event, designed to represent the maximum driving head that can cause groundwater interception by the quarry. River level was raised over time to just below the overtopping level of the river banks, at an elevation of 64 mAHD. The base of the proposed quarry was set at an elevation of 62 mAHD, which is 1 m above the long-term average watertable. When river levels are above 64 mAHD, the river overtops the banks and any water captured by the quarry is considered surface water. Therefore, simulation of a river stage higher than modelled would not represent an event requiring licensing of groundwater.

A synthetic river flood event was constructed from a review of measured Nepean River historic high flow events. River level measurements since 1990 indicate that 13 high flow events occurred where the maximum river level was below 64 mAHD. A synthetic flood event was created where the rise and fall of the Nepean River was designed to be consistent with typical historical events, particularly the duration of river level above the base of the quarry floor (62 mAHD). Figure 5.1 shows measured river levels during high flow events, and the synthetic event assigned to the Nepean River boundary condition in the predictive modelling. It was observed that since the end of the Millennium drought (2010), 12 high flow events (with river levels above 62 mAHD but not greater than 64 mAHD) have occurred. Therefore, a high flow event occurred on average 1.2 times per year. As the predictive scenario only simulates one high flow event, rather than an annual duration, the model results have been multiplied by 1.2 to annualise them.

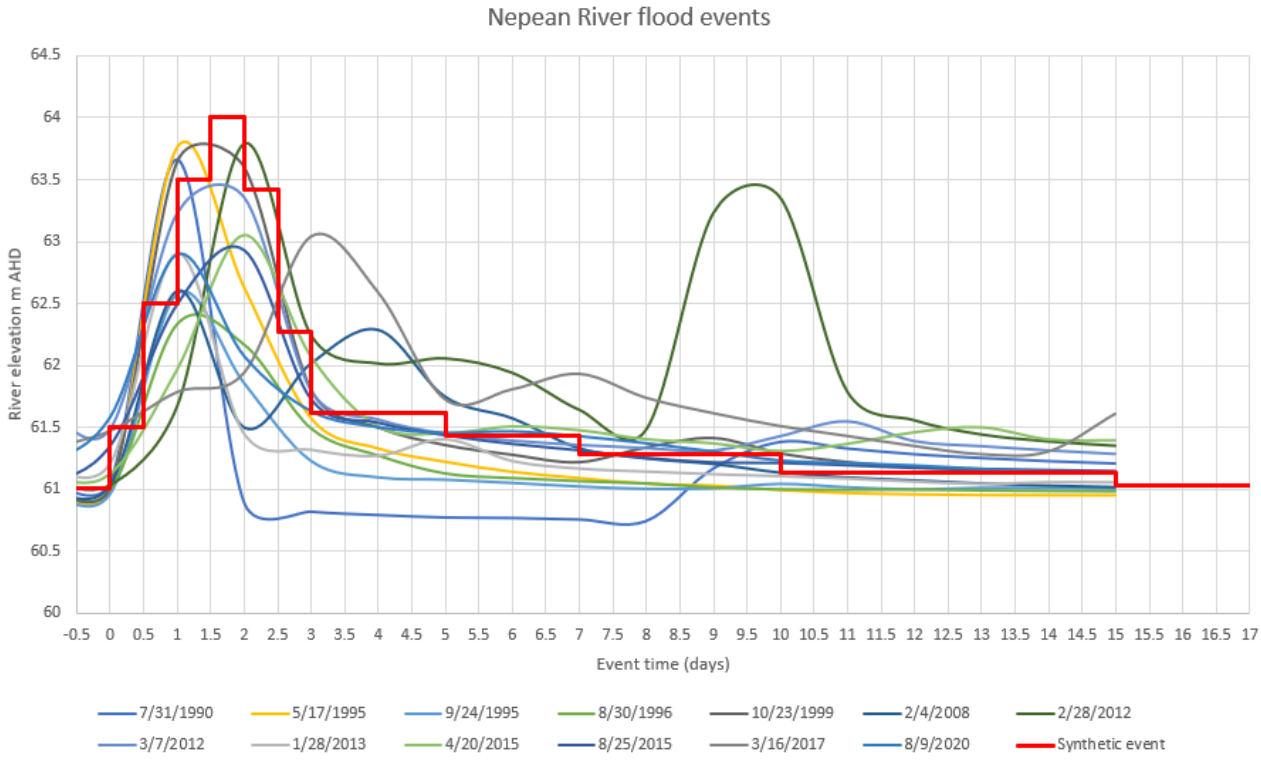

Figure 5.1 Nepean River high flow events since 1990 and the modelled synthetic scenario

c Predictive scenarios

The quarry plan will minimise the open quarry area and active face that is exposed at any one time with progressive backfill of the quarried areas. The project quarry areas (substages 8A to 8M) were subdivided into four sections (1, 2, 3 and 4) that represent areas of quarry that are active at any time and to represent the open area of the quarry consistent with the progressive backfilling approach. For example, area 8A is subdivided into A-1, A-2, A-3 and A-4. All simulated quarry areas have the same pit floor elevation (62 mAHD).

EMM initially selected four predictive scenarios to allow estimates of a range of inflows to the quarry based on active quarry area:

- Scenario 1: quarrying from the subdivision area longest parallel to the Nepean River (Area 8B-4, refer Figure 5.2);
- Scenario 2: quarrying from the largest of the subdivided areas (Area 8F-4, refer Figure 5.2);
- Scenario 3: quarrying from the smallest of the subdivided areas (Area 8C-4, refer Figure 5.2); and
- Scenario 4: quarrying from the subdivided area shortest parallel to the Nepean River (Area 8G-3, refer Figure 5.2).

Figure 5.2 shows the locations of the simulated quarry area for the various predictive modelling scenarios. While reviewing the total inflow data, it was observed that location 8C-4 (Scenario 3), the smallest of the subdivided area, showed the highest inflow volumes. The reason for this may relate to the location of the quarry area relative to the river, where the quarry allows a longer interaction length (eastern and southern faces of the quarry) between the quarry and river. As such, four additional scenarios were simulated as part of the predictive modelling:

- Scenario 5: the northern cell in the north section of the quarry (Area 8A-1, refer Figure 5.2);
- Scenario 6: the northern cell in the southern section of the quarry (Area 8D-1, refer Figure 5.2);
- Scenario 7: the southern cell in the southern section of the quarry (Area 8M-4, refer Figure 5.2); and
- Scenario 8: a quarry cell that is closest to the mean size of all subdivided areas (Area 8K-2, refer Figure 5.2).

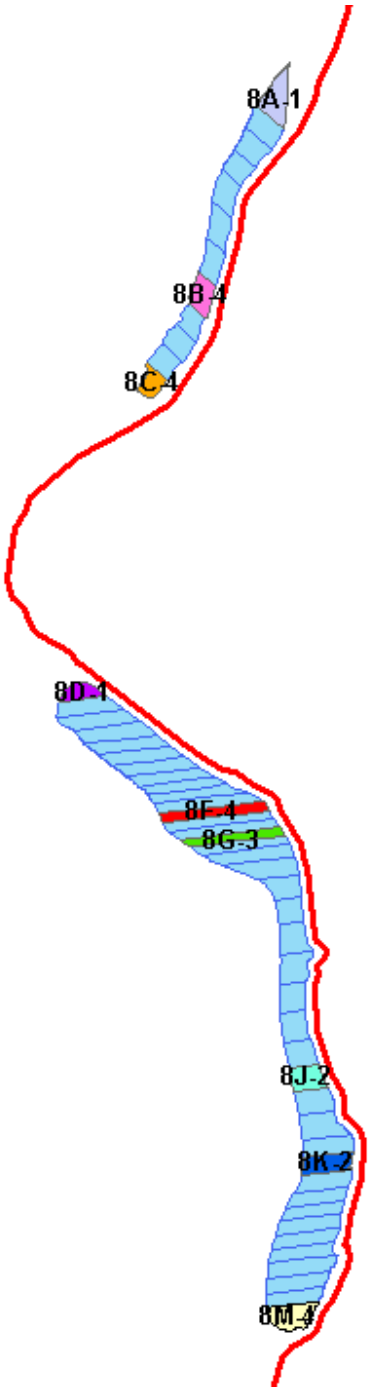

Figure 5.2 Quarry pit locations simulated in predictive modelling

5.2 Predictive uncertainty analysis

A single 'true' model cannot be constructed due to the inherent uncertainty that exists within hydrogeological systems, which is introduced by effects of error in field measurements, conceptual, spatial and temporal simplifications (Barnett et al 2012). To better understand how the prediction results may vary due to uncertainty within the system, a simple uncertainty analysis has been carried out. This is in the form of 'scenario analysis with subjective probability' as defined by the IESC explanatory note on Uncertainty Analysis (Middlemis and Peeters 2018). The main advantage of this kind of 'what-if' analysis is that it is straight forward to implement and communicate to stakeholders, and it is less computationally demanding compared to some other approaches. This approach is viewed as appropriate for this low-risk project.

The following uncertainty analysis was performed, which was guided by the relative composite sensitivity analysis that was performed on the history matching model (Section 4.4). The predictive uncertainty analysis was performed on the quarry cell that showed the highest predicted inflow during the simulated flood event.

Five predictive uncertainty models were generated based on the following changes to hydraulic parameters:

- Uncertainty 1 – increase the hydraulic conductivity in the alluvium by 25%;
- Uncertainty 2 – reduce the hydraulic conductivity in the alluvium by 25%;
- Uncertainty 3 – increase the specific yield to 10% (twice the history-matched value);
- Uncertainty 4 – reduce the specific yield to 2.5% (half the history-matched value); and
- Uncertainty 5 – a combination of #1 and #4 above.

6 Results

The model predicted inflow volumes are presented in Table 6.1. The modelled inflow volumes are calculated from the change in storage of Layer 1 (quarry layer) over the quarry area for each simulation. As the predictive model duration only covers one flood event, rather than an annual period, the model results have been multiplied by 1.2 to represent an indicative annual inflow amount, consistent with the requirement for licensing.

The scaled modelled inflow volumes range from 4 kL/yr to 408 kL/yr (up to 0.4 ML/yr).

Table 6.1 Model predicted inflow volumes

Scenario	Quarry area	Modelled inflow volumes (kL)	Scaled inflow volumes (kL/yr)
1	8B-4 – longest along Nepean River	97	116
2	8F-4 – largest area	55	66
3	8C-4 – smallest area and southern end of southern area	214	257
4	8G-3 – shortest along Nepean River	26	31
5	8A-1 – Northern end of northern area	38	46
6	8D-1 – Northern end of southern area	28	34
7	8M-4 – Southern end of southern area	340	408
8	8K-2 – average area	3	4

The predictive uncertainty analysis was conducted on Scenario 7 (Area 8M-4), as it has the highest predicted inflow during the simulated high flow event. Table 6.2 shows the results of the predictive uncertainty analysis.

Table 6.2 Predictive uncertainty analysis – Area 8M-4 predicted inflow volumes

Uncertainty run #	Model changes	Modelled results (kL)	Scaled volumes (kL/yr)
1	Increase alluvium hydraulic conductivity by 25%	460	552
2	Decrease alluvium hydraulic conductivity by 25%	220	264
3	Increase specific yield to 10%	191	229
4	Decrease specific yield to 2.5%	463	556
5	Alluvium K values up by 25% and Sy down to 2.5%	592	710

The model results show a large range in the predicted inflow volumes, with the predicted inflow volumes for Area 8M-4 ranging from 229 kL/yr to 710 kL/yr, compared to the base case (ie using history-matched parameter values) of 408 kL/yr. For example, a 25% increase in alluvium hydraulic conductivity results in a 35% increase in predicted inflows.

7 Summary

The groundwater model was constructed based on limited regional data, and was history matched on the 3 months of available hydraulic site data. The model will be updated following the collection of 12 months of monitoring data, in June 2021.

Based on preliminary Stage 1 modelling, the project will require an annual licence allocation to cover the peak predicted inflow volume of 410 kL/yr (0.4 ML/yr) for a high flow event (river level up to 64 mAHD). However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model (see below), the inflow volumes may reach 710 kL/yr (0.7 ML/yr).

8 Limitations

Numerical simulation of the hydrogeological regime at the Menangle Sand and Soil Quarry area has limitations that reflect the complexity of the groundwater systems, the influence of the adjacent Nepean River, the scope and timing of the project, data availability and the restrictions imposed by the software. The main limitations are as follows:

- Any faults, bedding planes and fracture/joint planes have not been represented as discrete features due to limitations of available detailed structural and/or hydraulic information related to these potential features. This simplification means that the influence of these heterogeneities (preferential pathways or secondary porosities) is not be captured, which may be locally important in controlling flux distribution.

- Any local mining operations (BHP, South32 and others) are not explicitly simulated. In reality, mine planning and associated dewatering and depressurisation may have changed, which could influence predictions for the Menangle Quarry area.

- The model layers represent the hydrostratigraphy in the area of the Menangle Quarry. These data were collected from the WaterNSW and MinView databases for water drill points and for mine drill data, respectively.

- Model history-matching included site-specific hydraulic head data at Menangle and publicly available data from WaterNSW for the Nepean River weir at Menangle. However, there are information gaps related to bore construction and screened lithological unit for some publicly available data, as such these data are not vetted in terms of accuracy of groundwater elevations.

- The model does not consider backfill operations, however it is planned that the pits will be backfilled to an elevation of 64 mAHD such that they will no longer intercept groundwater during times of high river levels.

- The groundwater model does not simulate the removal of water from the excavation of alluvium material.

- The groundwater model did not simulate all quarry areas, a representative sampling of quarry areas was used to generate a range of potential inflow volumes.

- Potential density-dependent flow is assumed to be negligible in the model. The salinity levels at the site do not warrant that their effects to be simulated.

- Contaminant fate and transport modelling are not part of the modelling scope.

- Simulation of quarry water management is limited to reporting of the amount of the groundwater intercepted from the rise of the Nepean River in active quarrying areas.

- Waste stockpiles and other stockpiles were not simulated.

- Quantification of baseflow or river leakage will not be included as part of history-matching or the modelling of the proposed project.

- Impacts of local climatic or weather variations were not modelled.

- Topography used in the groundwater model is based on a 1 second (~30 m) digital elevation model (DEM) dataset from Geoscience Australia based on Shuttle Radar Topography Mission (SRTM).

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2020c, Hume Coal Project and Berrima Rail Project – Response to Submissions Volume 2D Appendix F Revised groundwater modelling, June 2018.

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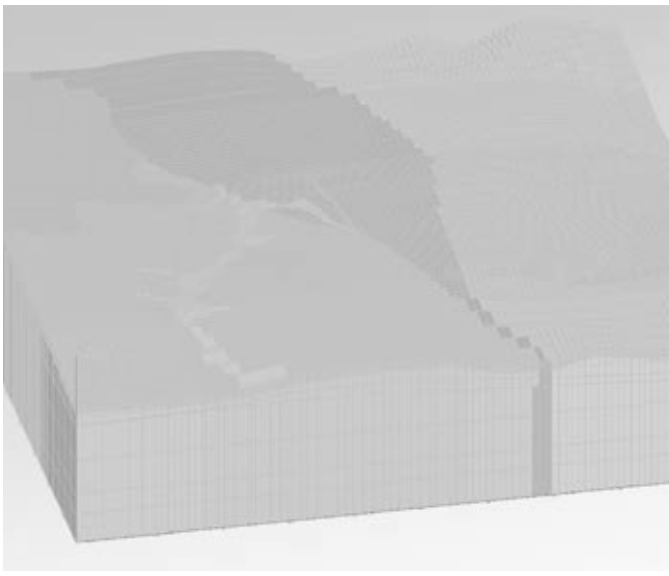
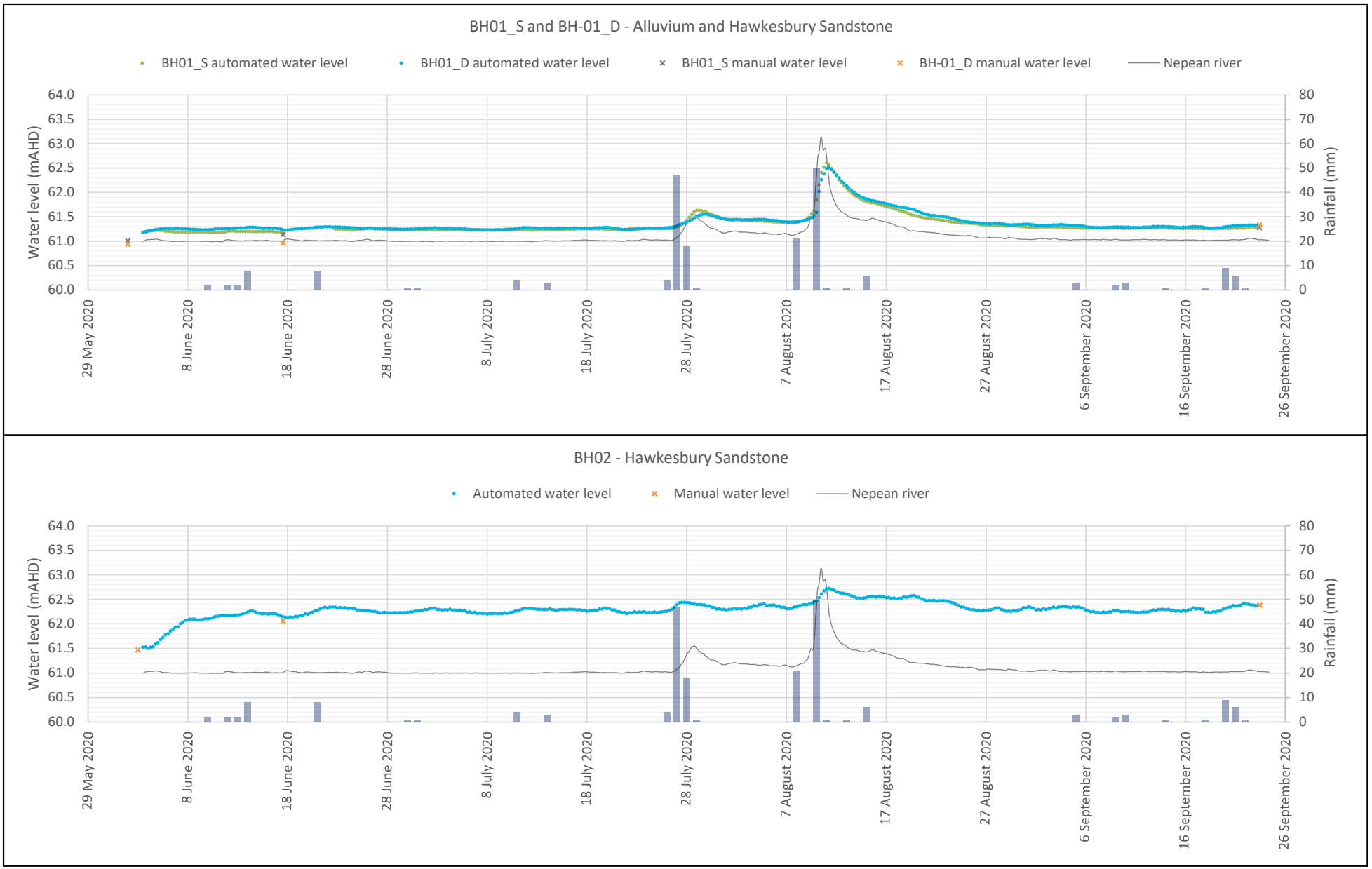
Rau GC, Arcworth RI, Halloran LJS, Timms WA, Cuthbert MO, 2018 Quantifying compressible groundwater storage by combining cross-hole seismic surveys and head response to atmospheric tides. Journal of Geophysical Research: Earth Surface, 123, 1910-1930. Https://doi.org/10.1029/2018JF004660.

Appendix A

Hydrographs





Notes

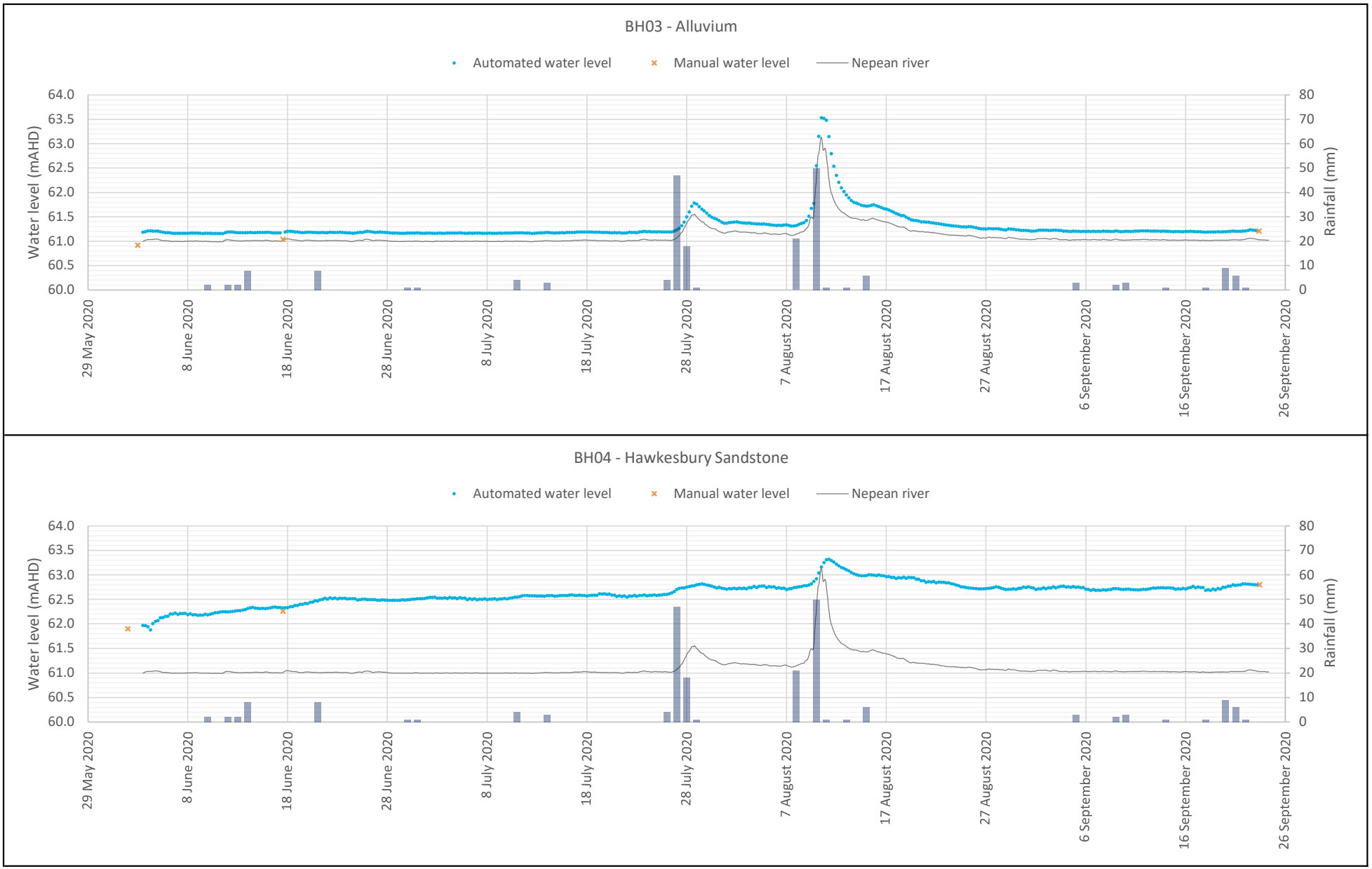
Average hourly river height data accessed from Menangle Weir gauging station, WaterNSW station reference 212238 (https://realtimedata.waternsw.com.au/)

Daily rainfall data accessed from Menangle Bridge monitoring station, BoM reference 68216. (http://www.bom.gov.au/climate/data/)

Water level hydrographs - BH01_S, BH01_D and BH02

Menangle Sand and Soil Pty Ltd

Figure A.1



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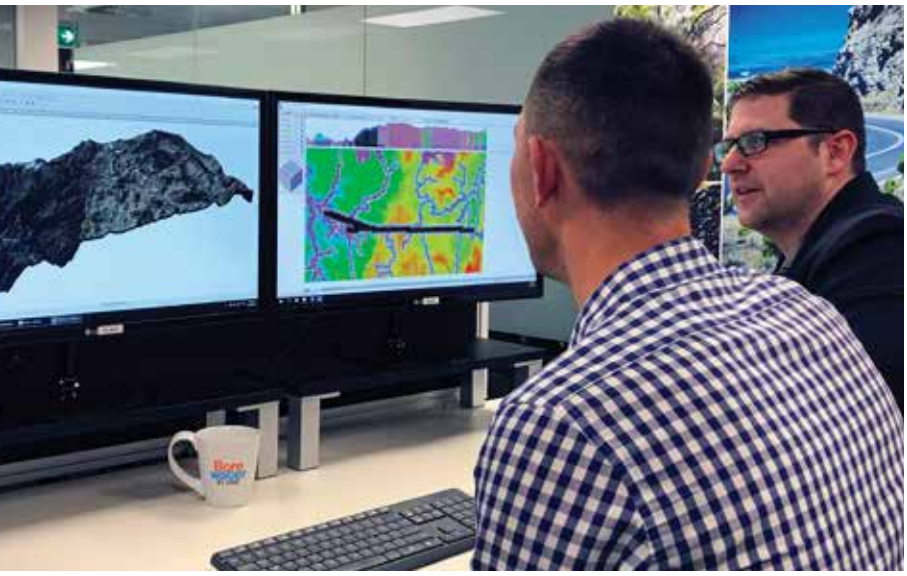
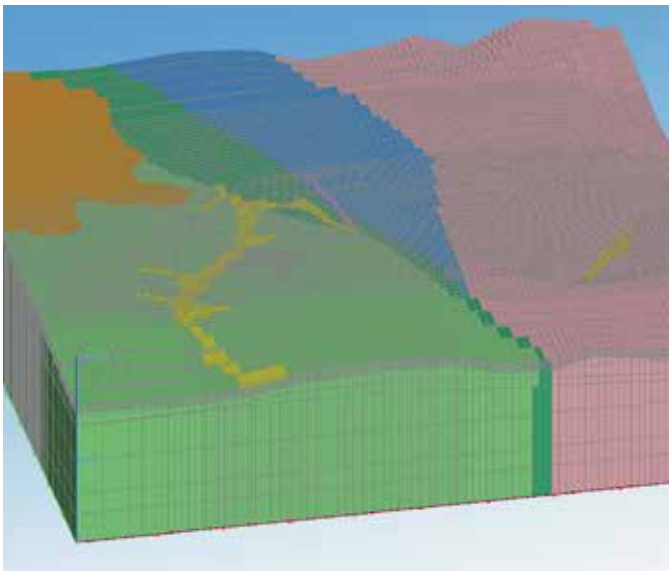
Water level hydrographs - BH03 and BH04

Menangle Sand and Soil Pty Ltd

Figure A.2





Appendix D

Groundwater Monitoring and Modelling Update - July 2021

Memorandum

23 September 2021

To: Ernest Dupere
Director
Benedict Industries Pty Ltd
From: Henry Noakes
Subject: Groundwater monitoring and modelling update - July 2021

Dear Ernest,

1 Introduction

Menangle Sand and Soil Quarry (the quarry) is located at 15 Menangle Road, Menangle NSW (refer Figure 2.1). The quarry extracts sand and soil along the Nepean River as approved by Development Consent 85/2865 (the Consent), granted by the Minister for Planning on 15 November 1989, and as modified (Modification 1) by the NSW Land and Environment Court in September 2020.

This memorandum presents the June 2021 groundwater monitoring results and subsequent groundwater model/site water balance update. It has been prepared for Menangle Sand and Soil Pty Ltd by EMM Consulting Pty Limited (EMM). It addresses monitoring requirements of the *Menangle Sand and Soil Quarry Soil and Water Management Plan* (SWMP) (EMM 2021a) and conditions B25(b) and B25(c) of the Consent that require Menangle Sand and Soil to:

- update the groundwater model following collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021; and
- incorporate the outputs of the groundwater model into the Site Water Balance as required under condition B36(c)(i) of Schedule 2 [within the conditions].

2 Monitoring

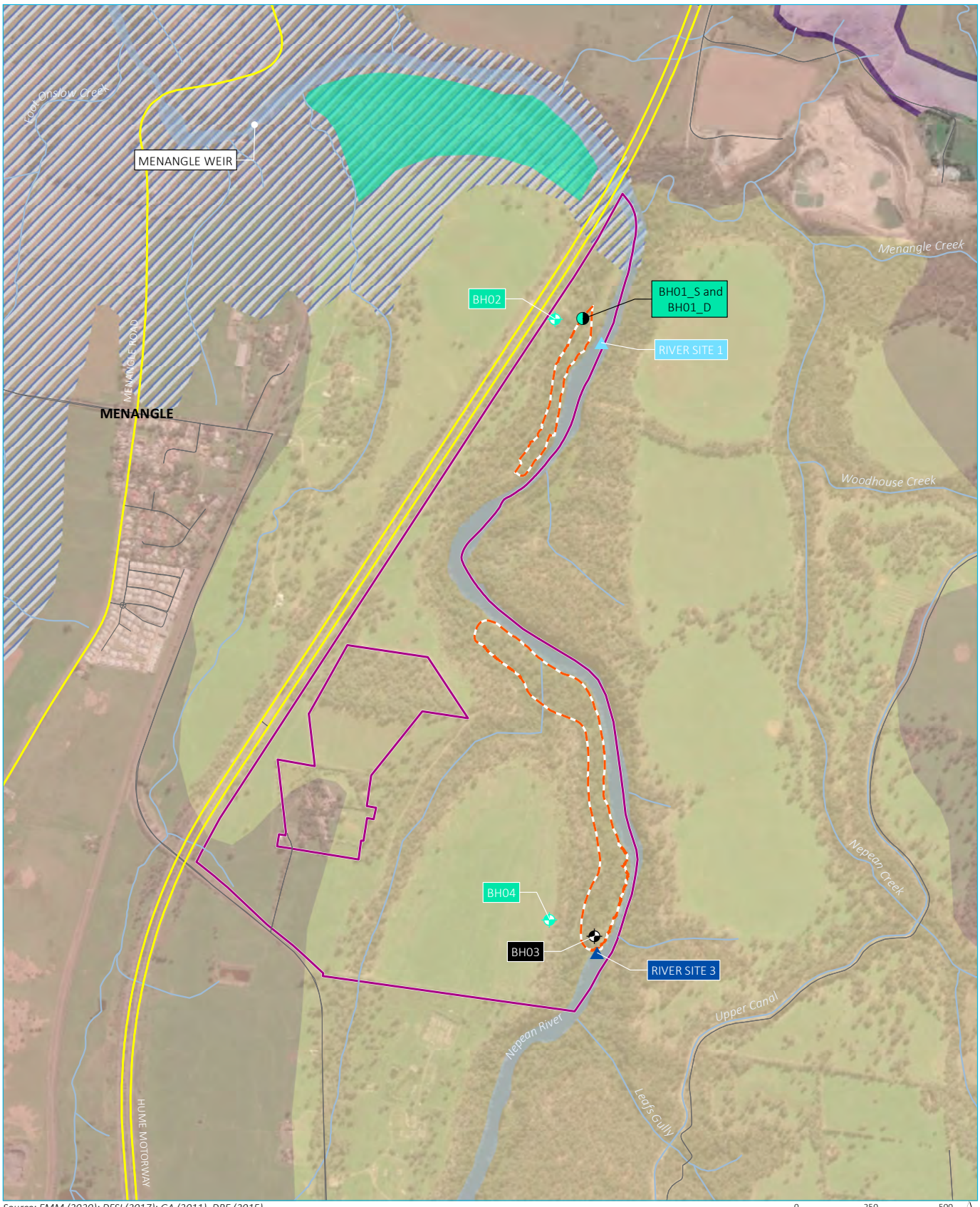
2.1 Fieldwork

The following fieldwork was undertaken on 18 June 2021 in accordance with the SWMP, Section 6: Groundwater management (refer Figure 2.1):

- manual groundwater level measurement (dip) and download of automated groundwater level loggers (loggers) at five groundwater monitoring bores (BH01_S, BH01_D, BH02, BH03 and BH04);
- collection of water samples in five bores (BH01_S, BH01_D, BH02, BH03 and BH04) and two surface water sites, within the adjacent Nepean River (River site 1 and River site 3) to:
    - assess physico-chemical parameters (temperature, pH, electrical conductivity, total dissolved solids, reduction potential and dissolved oxygen) using a calibrated YSI water quality meter; and
    - submit to a NATA accredited laboratory for analytical testing suites, comprising:

- general water quality (pH, electrical conductivity[EC], total dissolved solids, hardness and alkalinity); and
- major ions (calcium, chloride, fluoride, sodium, magnesium, potassium, sulfate and an ionic balance).

At the time of the fieldworks (18 June 2021), quarrying activities had not begun within the Stage 8 extraction area (refer Figure 2.1).



Source: EMM (2020); DFSI (2017); GA (2011), DPE (2015)

0 250 500 m

GDA 1994 MGA Zone 56

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KEY

- Study area
- Menangle Quarry - Stage 7
- Proposed extraction area
- Main road
- Local road
- Watercourse/drainage line
- Named waterbody

Location Type

- Borehole - alluvium
- Borehole - sandstone
- Borehole - alluvium & sandstone
- Surface water quality
- Surface water quality and level

Surface geology

- Alluvium
- Ashfield shale
- Bringelly shale
- Hawkesbury sandstone
- Minchinbury sandstone

Monitoring bore locations

Menangle Quarry Extension
Groundwater monitoring and modelling update - July 2021
Figure 2.1

EMM creating opportunities

2.2 Groundwater level

A summary of groundwater dips and groundwater level trigger values (EMM 2021a) is provided in Table 2.1. Time series data of the groundwater level in each bore is provided in Figure 2.2–Figure 2.3.

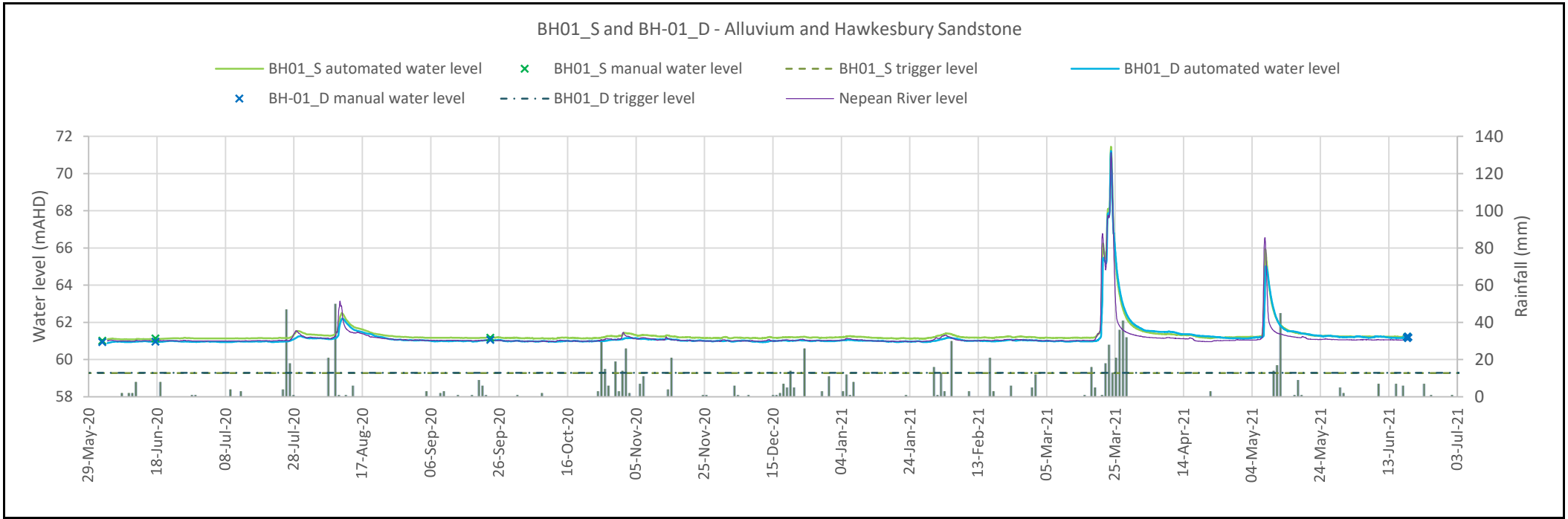
Table 2.1 Groundwater levels

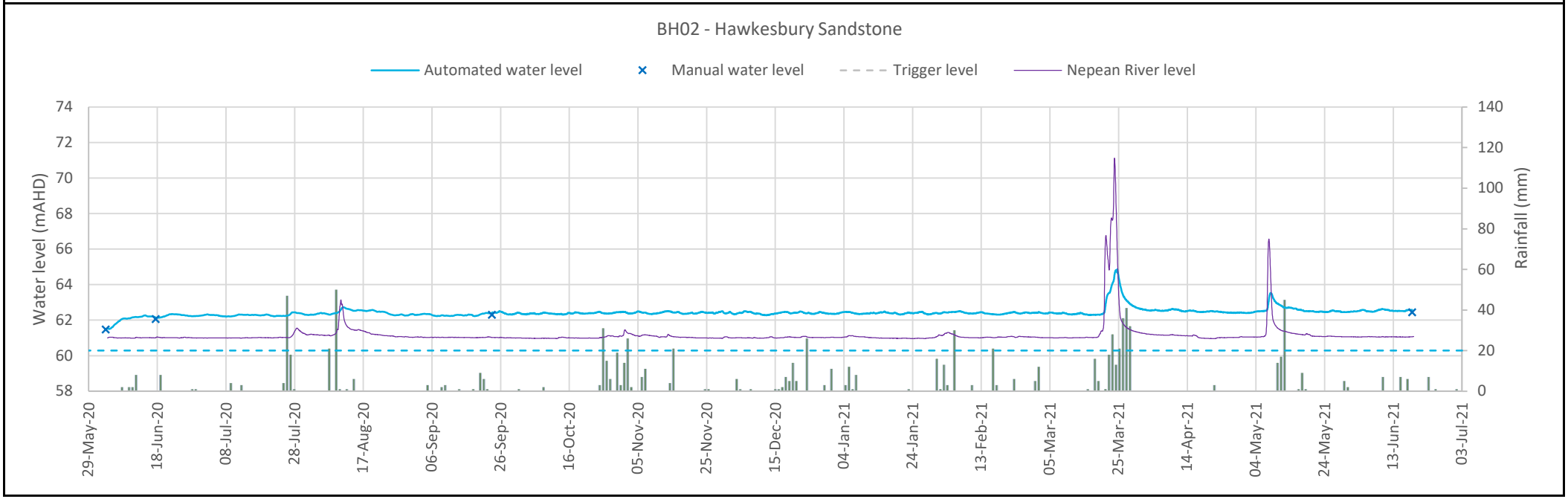
Bore ID	Screened lithology	Groundwater level (18 June 2021)		[3]Groundwater low level trigger value	Exceedance
		[1]mbtoc	[2]mAHD	[2]mAHD	
BH01_S	Alluvium	5.52	61.22	59.27	No
BH01_D	Hawkesbury Sandstone	5.84	61.20	59.29	No
BH02	Hawkesbury Sandstone	25.18	62.44	60.29	No
BH03	Alluvium	4.56	61.15	59.2	No
BH04	Hawkesbury Sandstone	42.70	63.22	60.7	No

1. metres below top of casing (mbtoc);
2. metres above Australian Height Datum;
3. (EMM 2021b)

There was a flood event on 23 March 2021 (to a maximum level of 71.122 m at Menangle Weir). It appears that the barometric data logger (barologger) was inundated from 22 to 24 March 2021. Evidence of flooding above the barologger was noted by field staff (flood debris, fallen timber, rubbish, sediment build-up and broken foliage). Barometric data during this period is considered unreliable and has been inferred from historical data. The barologger appears to be fully functioning following 24 March 2021.

No groundwater level exceedances were observed over the monitoring period (3 June 2020–18 June 2021).





Notes

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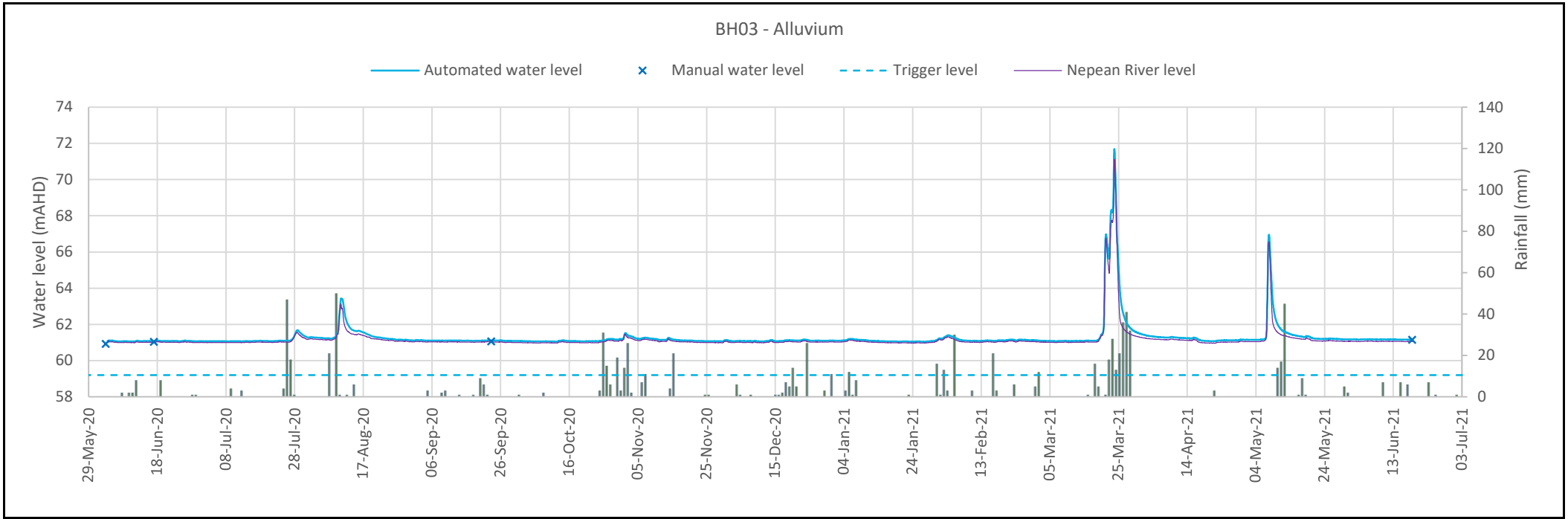
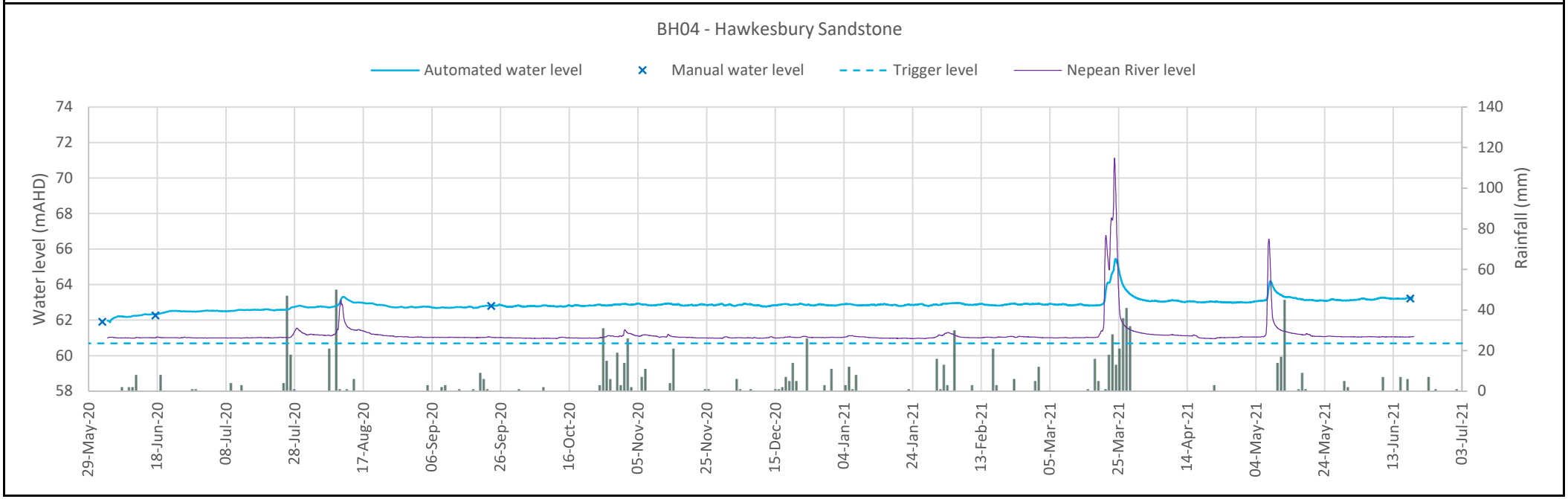
Daily rainfall data accessed from Menangle Bridge monitoring station, BoM reference 68216. (http://www.bom.gov.au/climate/data/)

Time series data - BH01_S, BH01_D and BH02

Menangle Sand and Soil Pty Ltd

Figure 2.2





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Daily rainfall data accessed from Menangle Bridge monitoring station, BoM reference 68216. (http://www.bom.gov.au/climate/data/)

Time series data - BH03 and BH04

Menangle Sand and Soil Pty Ltd

Figure 2.3

2.3 Groundwater sampling

Groundwater sampling was undertaken by a suitably qualified and experienced EMM hydrogeologist, using either a 'Micro-purge' low flow bladder pump (BH01_S and BH01_D) or stainless-steel bailer (BH02, BH03 and BH04). Sampling was undertaken in general accordance with:

- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC 2004); and
- Australia/New Zealand Standard AS/NZS 5667.11:1998 Water Quality – Sampling, Part 11: Guidance on Sampling of Groundwaters (Standards Australia 1998).

A summary of groundwater pH and EC is provided in Table 2.2 with associated trigger values (EMM 2021a), exceedances have been highlighted. Laboratory certificates of analysis are attached as Appendix B. Field sampling records are attached as Appendix C.

Table 2.2 Groundwater pH and EC summary (including trigger values)

Site ID	Screened lithology	EC trigger value[1] (µS/cm)		EC June 2021 (µS/cm)		pH trigger value		pH June 2021	
		Lower limit	Upper limit	Field	Laboratory	Lower limit	Upper limit	Field	Laboratory
BH01_S	Alluvium	125	2,500	227.2	218.0	6.5	8.0	**5.23**	**6.03**
BH01_D	Hawkesbury Sandstone	125	3,000	1,217.0	1,310.0	6.5	8.0	6.62	7.35
BH02	Hawkesbury Sandstone	125	10,000	7,091.0	8,230.0	6.5	8.5	**5.80**	6.61
BH03	Alluvium	125	2,500	314.1	141.0	6.5	8.0	**5.73**	**5.90**
BH04	Hawkesbury Sandstone	125	12,000	6,864.0	8,460.0	6.5	8.5	6.52	7.42

Notes: 1. (EMM 2021a)

Results indicate groundwater is typically acidic (with the exception of laboratory pH results at BH01_D [pH 7.35] and BH04 [pH 7.42]). Field pH results in BH01_S, BH02 and BH03 were below the lower limit trigger level. Laboratory pH results exceeded lower trigger values in BH01_S and BH03 however, did not exceed in BH02. In accordance with Table 6.6 of the SWMP (EMM 2021a), groundwater quality data will continue to be monitored and assessed.

Higher EC is noted in the Hawkesbury Sandstone (marginal salinity in BH01_D to slightly saline in BH04) compared to the alluvium (fresh in both BH01_S and BH03). No EC trigger value exceedances were recorded in the June 2021 monitoring event.

An obstruction was encountered in BH03, approximately 7 metres below top of casing (mbTOC). A groundwater sample could not be obtained from within the screen interval at BH03 (20–23 mbTOC), in accordance with recommendations provided by *Water quality - Sampling, Part 11: Guidance on Sampling of Groundwaters* Standards Australia (1998). A grab sample was recovered from approximately 6–7 mbTOC and is considered representative; however, BH03 will be assessed during the next site visit using smaller diameter sample equipment.

A summary of groundwater major ion results is provided in Table 2.2. Additional water sampling results are attached as Appendix A. Laboratory certificates of analysis are attached as Appendix B.

Table 2.3 Groundwater major ion summary

Site ID	Screened lithology	Hardness (mg/L)	Alkalinity (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sodium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sulfate (mg/L)	Cations (meq/L)	Anions (meq/L)	Ionic balance (%)
BH01_S	Alluvium	38	30	7	29	<0.1	28	5	<1	30	1.98	2.04	-
BH01_D	Hawkesbury Sandstone	130	322	34	172	0.4	210	11	6	120	11.9	13.8	7.38
BH02	Hawkesbury Sandstone	1,140	392	151	2,700	0.6	1,200	185	12	389	75.3	92.1	10.0
BH03	Alluvium	40	8	11	24	<0.1	16	3	2	17	1.54	1.19	-
BH04	Hawkesbury Sandstone	1,180	454	110	2,700	0.4	1,160	219	32	300	74.8	91.5	10.0

3 Groundwater model update

3.1 Groundwater model and site water balance update

A preliminary groundwater model was constructed in March 2021 (EMM 2021b) in accordance with conditions B24 and B25(a) of the Consent:

- using a variant of MODFLOW standard software, or equivalent software, to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 area (Figure 2.1); and
- using the first three months of groundwater monitoring data.

The initial modelling, employing a subjective uncertainty analysis approach, predicted annual groundwater interception to range up to 0.7 ML/year from within the Sydney Basin Nepean Groundwater Source (Management Zone 2).

In order to perform a validation of the existing numerical groundwater model, built using MODFLOW-USG (Panday et al 2013) and Groundwater Vistas 7 (ESI 2017), an extension to the history-matching period was made. The extended model stress period setup and stages assigned to the River (RIV) package boundary conditions used to simulate the Nepean River (based on Menangle Weir station 212238) are presented in Table 3.1 and Figure 3.1.

Table 3.1 Stress periods and river representation

Stress period/s	Date range	Duration (d)	River stage (mAHD)	Description
1	n/a	Steady state	61.009	Initialisation
2	3 Jun 2020 (12:00) to 26 Jul 2020 (12:00)	53	61.009	Steady river
3–5	26 Jul 2020 (12:00) to 28 Jul 2020 (12:00)	0.6667 (each)	61.053, 61.194, 61.428	Rising river
6	28 Jul 2020 (12:00) to 28 Jul 2020 (24:00)	0.5	61.538	Steady river (peak)
7-9	28 Jul 2020 (24:00) to 31 Jul 2020 (24:00)	1 (each)	61.405, 61.271, 61.185	Falling river
10	31 Jul 2020 (24:00) to 8 Aug 2020 (06:00)	7.25	61.165	Steady river
11–13	8 Aug 2020 (06:00) to 10 Aug 2020 (12:00)	0.708 (each)	61.203, 61.4, 62.359	Rising river
14	10 Aug 2020 (12:00) to 10 Aug 2020 (14:00)	0.1667	63.118	Steady river (peak)
15–17	10 Aug 2020 (14:00) to 14 Aug 2020 (14:00)	1.333 (each)	62.373, 61.614, 61.465	Rapidly falling river
18–19	14 Aug 2020 (14:00) to 28 Aug 2020 (14:00)	7 (each)	61.318, 61.109	Slowly falling river
20	28 Aug 2020 (14:00) to 23 Sep 2020 (14:00)	26.25	61.034	Steady river
21	23 Sep 2020 (19:00) to 23 Oct 2020 (19:00)	30	60.996	Steady river
22	23 Oct 2020 (19:00) to 28 Oct 2020 (19:00)	5	61.059	Rising river
23	28 Oct 2020 (19:00) to 31 Oct 2020 (19:00)	3	61.092	Rising river
24-25	31 Oct 2020 (19:00) to 2 Nov 2020 (19:00)	1 (each)	61.370, 61.261	Steady river (peak)
26	2 Nov 2020 (19:00) to 4 Nov 2020 (19:00)	2	61.170	Falling river
27	4 Nov 2020 (19:00) to 7 Nov 2020 (19:00)	3	61.142	Falling river
28	7 Nov 2020 (19:00) to 11 Nov 2020 (19:00)	4	61.100	Falling river
29	11 Nov 2020 (19:00) to 16 Nov 2020 (19:00)	5	61.083	Steady river
30	16 Nov 2020 (19:00) to 26 Nov 2020 (19:00)	10	61.014	Steady river
31	26 Nov 2020 (19:00) to 26 Dec 2020 (19:00)	30	61.018	Steady river
32	26 Dec 2020 (19:00) to 15 Jan 2021 (19:00)	20	61.040	Steady river

Table 3.1 Stress periods and river representation

Stress period/s	Date range	Duration (d)	River stage (mAHD)	Description
33	15 Jan 2021 (19:00) to 30 Jan 2021 (19:00)	15	60.984	Steady river
34-35	30 Jan 2021 (19:00) to 3 Feb 2021 (19:00)	2 (each)	61.128, 61.258	Rising river
36	3 Feb 2021 (19:00) to 4 Feb 2021 (19:00)	1	61.236	Steady river (peak)
37-38	4 Feb 2021 (19:00) to 8 Feb 2021 (19:00)	2 (each)	61.119, 61.035	Falling river
39	8 Feb 2021 (19:00) to 13 Feb 2021 (19:00)	5	61.015	Steady river
40	13 Feb 2021 (19:00) to 28 Feb 2021 (19:00)	15	61.051	Steady river
41	28 Feb 2021 (19:00) to 17 Mar 2021 (19:00)	17	61.015	Steady river
42	17 Mar 2021 (19:00) to 19 Mar 2021 (19:00)	2	61.089	Steady river
43	19 Mar 2021 (19:00) to 20 Mar 2021 (19:00)	1	61.542	Rising river
44–46	20 Mar 2021 (19:00) to 21 Mar 2021 (13:00)	0.25 (each)	64.441, 66.491, 66.560	Rising river
47–54	21 Mar 2021 (13:00) to 25 Mar 2021 (13:00)	0.5 (each)	65.639, 65.206, 67.475, 67.866, 70.559, 68.148,64.671, 62.582	Rising river, falling river
55	25 Mar 2021 (13:00) to 26 Mar 2021 (13:00)	1	61.896	Falling river
56	26 Mar 2021 (13:00) to 28 Mar 2021 (13:00)	2	61.564	Falling river
57	28 Mar 2021 (13:00) to 2 Apr 2021 (13:00)	5	61.309	Falling river
58	2 Apr 2021 (13:00) to 12 Apr 2021 (13:00)	10	61.167	Steady river
59	12 Apr 2021 (13:00) to 6 May 2021 (13:00)	24	61.041	Steady river
60	6 May 2021 (13:00) to 7 May 2021 (01:00)	0.5	61.202	Rising river
61–69	7 May 2021 (01:00) to 9 May 2021 (07:00)	0.25 (each)	62.281, 64.731, 66.435, 66.217, 65.023, 63.652, 62.577, 62.067, 61.892	Rising river, falling river
70	9 May 2021 (07:00) to 9 May 2021 (19:00)	0.5	61.742	Falling river
71	9 May 2021 (19:00) to 10 May 2021 (19:00)	1	61.564	Falling river
72	10 May 2021 (19:00) to 12 May 2021 (19:00)	2	61.404	Falling river
73	12 May 2021 (19:00) to 17 May 2021 (19:00)	5	61.248	Falling river
74	17 May 2021 (19:00) to 27 May 2021 (19:00)	10	61.113	Steady river
75	27 May 2021 (19:00) to 16 Jun 2021 (19:00)	20	61.061	Steady river

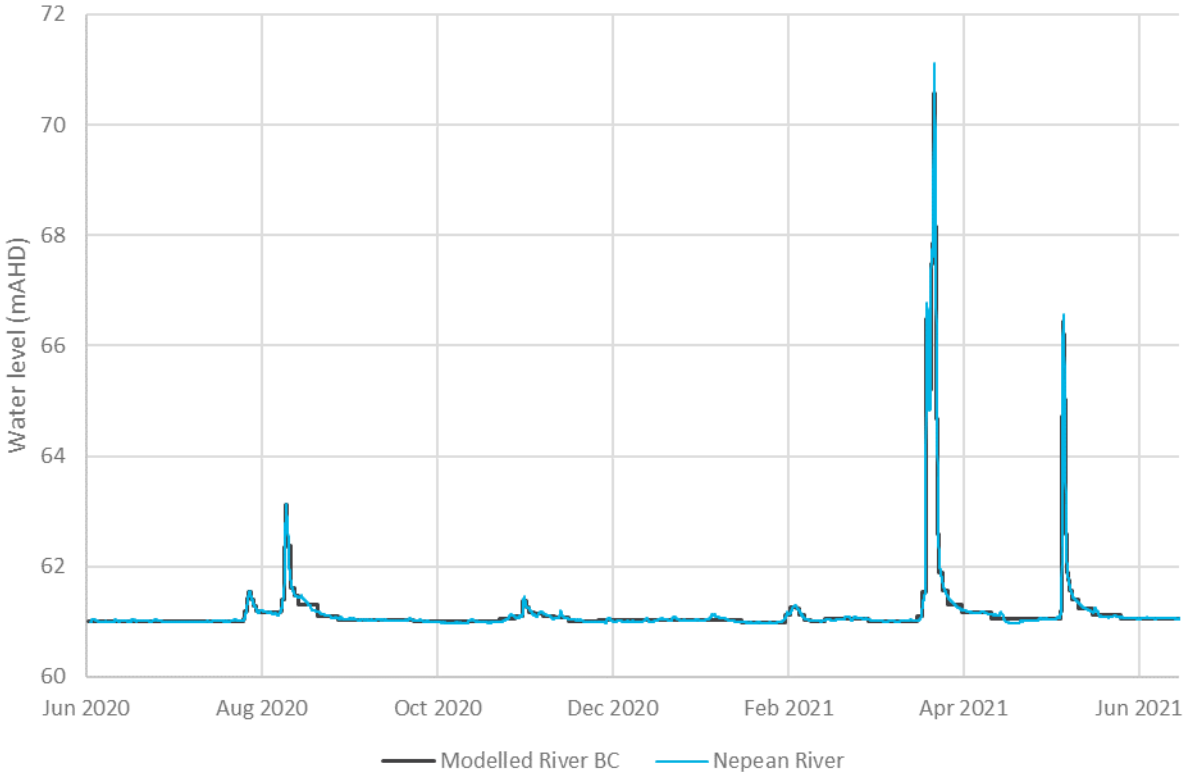

Figure 3.1 Modelled and measured Nepean River stage

3.2 Validation Performance

The history-matching performance of the groundwater model over the extended historical validation period was evaluated statistically and by comparing dynamic trends of modelled and measured groundwater responses.

Statistical measures of the match between modelled and measured groundwater responses over the initial calibration periods (~3.5 months of groundwater monitoring) and the extended validation period (~12 months of groundwater monitoring) are provided in Table 3.2.

Figure 3.2 presents modelled and measured hydraulic head at the site groundwater monitoring bores (BH01–BH04). Figure 3.3 illustrates these same data when converted to drawdown relative to the pseudo steady state period, inferred from the first ~1.5 months of groundwater monitoring, during which there were no significant rises in Nepean River level.

Overall, history-matching to the extended 12-month historical dataset is similar to the performance of the initial calibration over 3.5 months. The very high river level events of early 2021 did lead to an increase in the largest residuals between modelled and measured values, but these events likely involved overtopping of the river-bank which is not represented by the model. Normalised statistical measures of performance for both head and drawdown are improved with the 12-month dataset relative to the first 3.5 months. The trends in modelled responses to high river level events, presented in the hydrographs in Figure 3.2 and Figure 3.3, closely match those measured.

Table 3.2 History-matching statistics

Measure	~3.5 months of monitoring	~12 months of monitoring
SRMS (head)	22.7%	7.5%
SRMS (drawdown)	4.6%	3.0%
Average residual (head)	0.42 m	0.51 m
Average absolute residual (head)	0.42 m	0.55 m
Average residual (drawdown)	0.017 m	0.006 m
Average absolute residual (drawdown)	0.058 m	0.134 m

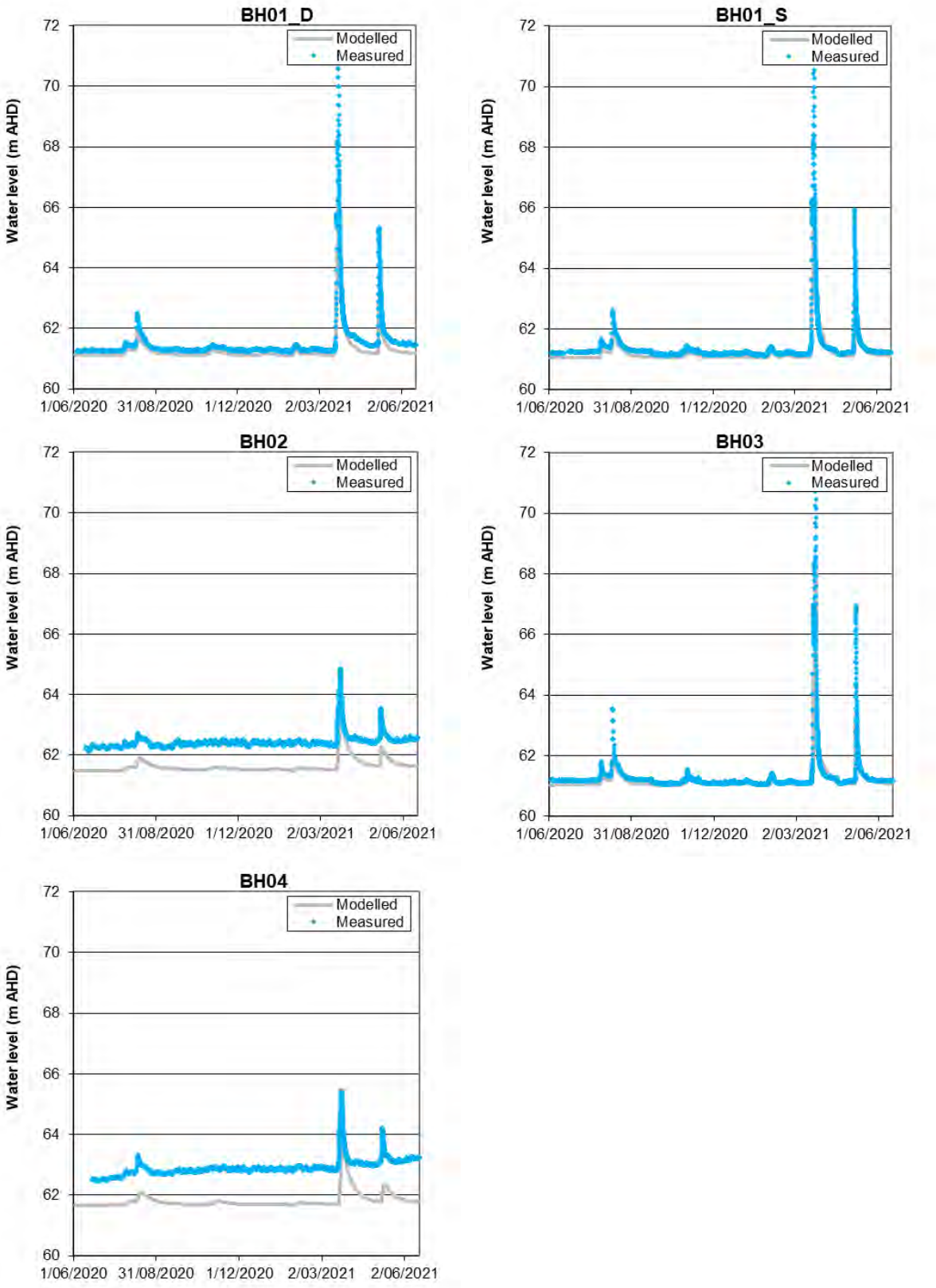

Figure 3.2 **Modelled and measured hydraulic head over the history-matching period**

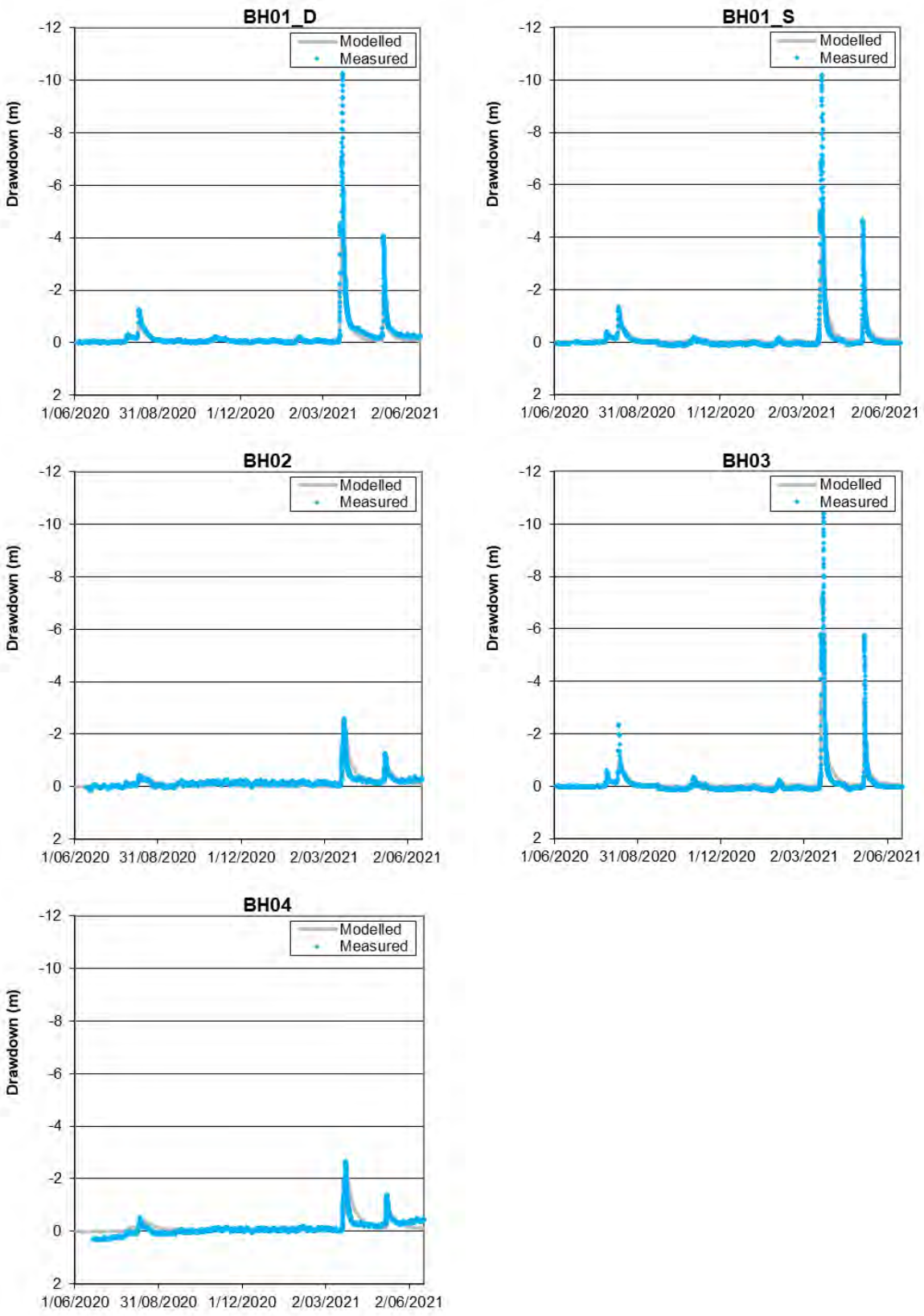

Figure 3.3 **Modelled and measured groundwater drawdown over the history-matching period**

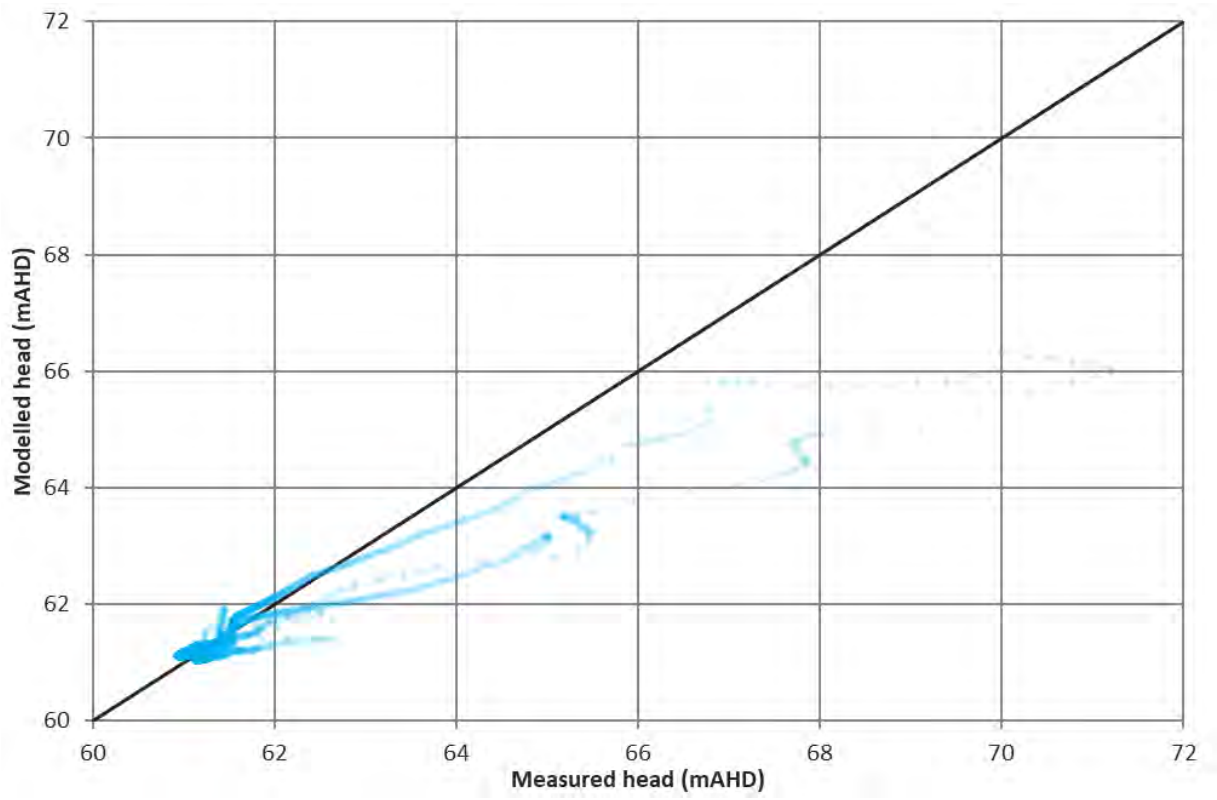

Figure 3.4 Scatter plot of modelled versus measured hydraulic head

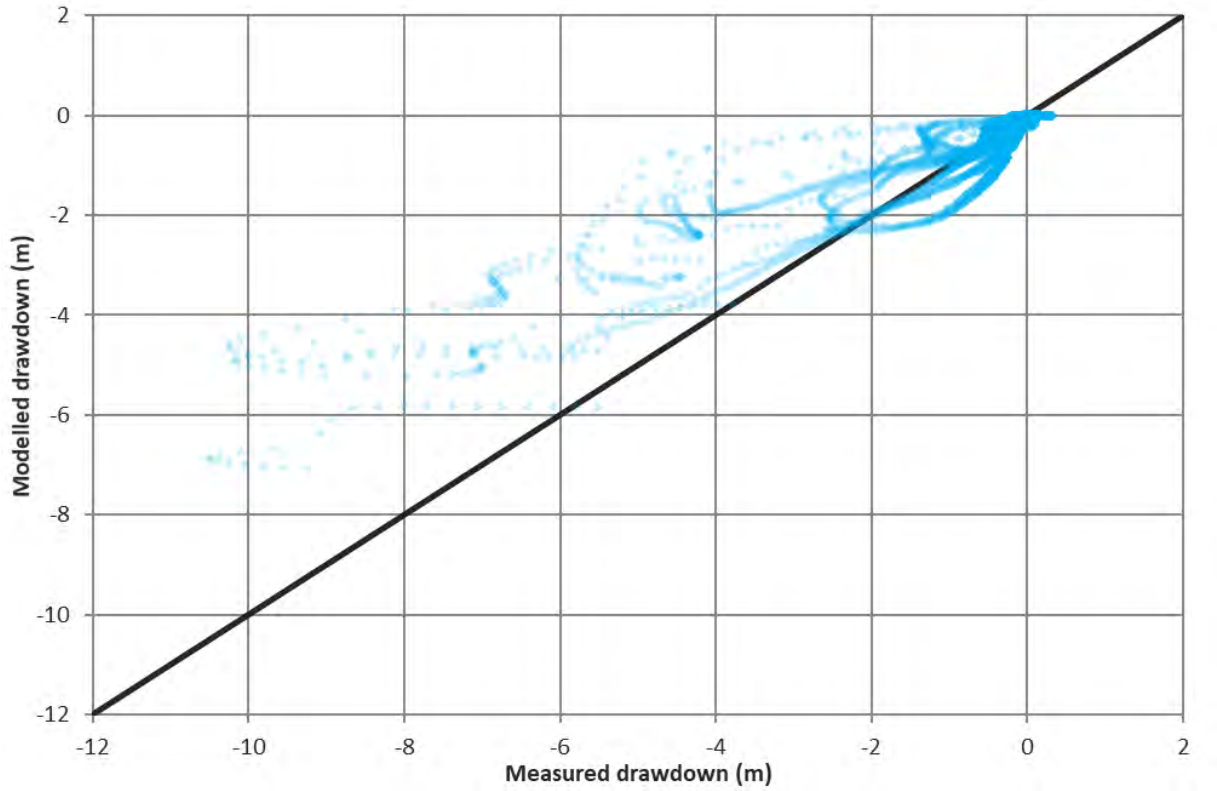

Figure 3.5 Scatter plot of modelled versus measured drawdown

3.3 Summary

The initial 3.5-month groundwater monitoring dataset from five monitoring locations used to calibrate the numerical groundwater model has been extended to 12 months. Extension of the numerical model simulation period and comparison of model results against measured groundwater responses over the 12 months of groundwater monitoring have validated the model. Therefore, the modelling presented in EMM (2021), including maximum predicted groundwater interception of 0.4 ML/yr for the base case and 0.7 ML/yr from the uncertainty analysis, are deemed to be valid. Given the performance of the model over the extended monitoring period, and its inclusion of high river levels relevant to the objective of licensing groundwater interception by pit voids, no further update to the modelling is recommended.

4 Site water balance model update

As summarised in Section 3.3, the modelled groundwater inflows presented in Section 5.3 of the SWMP are considered applicable and no update to the 'Groundwater inflow to Stage 8 area' component of site water balance model is required. The relevant site water balance model is re-produced from the SWMP in Table 4.1.

Table 4.1 Summary of site water balance results

Water management component	Typical dry year (ML/year)	Median rainfall year (ML/year)	Typical wet year (ML/year)
Annual rainfall (mm/year)	443	730	916
Inputs			
Direct rainfall onto storages and catchment runoff	27	49	73
Nepean River water supply	116	90	82
Groundwater inflow to Stage 8 area	0.7	0.7	0.7
Total inputs	**144**	**140**	**156**
Outputs			
Evaporation	16	13	14
Infiltration (infiltration area, seepage from Stage 8 area)	10	19	28
Process water (dust suppression, timber plant, truck washdown)	86	76[1]	77
Water lost in product (wash water)	33	33[2]	33
Overflows from processing area	0	0	2
Total outputs	**145**	**141**	**154**
Change is storage	-1	-1	2
Balance (inputs – outputs – change in storage)	**0**	**0**	**0**

1. See Table 5.3 (EMM 2021a): dust suppression + timber plant + truck washdown = 77 ML/year, with rounding difference
2. See Table 5.3 (EMM 2021a): washing = 33 ML/year

5 Closing

This letter describes updates to the groundwater model following collection of the first 12 months of data collected and the site water balance, thereby addressing the requirements of Conditions B25(b) and B25(c) of the Consent. The predicted groundwater interception is unchanged and no changes to the site water balance are required.

Yours sincerely

Henry Noakes
Senior Hydrogeologist
hnoakes@emmconsulting.com.au

6 References

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Appendix A

Groundwater quality results

				Location Code	BH01_D		BH01_S		BH02		BH03		BH04		River Site 1		River Site 3	
				Date	2/06/2020	18/06/2021	29/05/2020	18/06/2021	29/05/2020	18/06/2021	2/06/2020	18/06/2021	29/05/2020	18/06/2021	29/05/2020	18/06/2021	29/05/2020	18/06/2021
				Lab Report Number	ES2019091	ES2123005	ES2018927	ES2123005	ES2018927	ES2123005	ES2019091	ES2123005	ES2018927	ES2123005	ES2018927	-	ES2018927	-
		Units	LOR	Water type (GW / SW)	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	SW	SW	SW	SW
Analytical results – general	Temperature (Field)	(°C)	1		17.0	18.2	18.5	18.3	15.2	18.7	15.0	17.8	14.3	17.1	15.5	11.6	14.8	11.9
	Hardness as $CaCO_3$ (filtered)	mg/L	1		260	130	278	38	1,180	1,140	383	40	1,970	1,180	26	-	33	-
	Electrical Conductivity (Field)	(µs/cm)	-		2150.0	1217.0	1137.0	227.2	8732.0	7091.0	2101.0	314.1	10355.0	6864.0	195.2	165.8	264.9	160.5
	Electrical Conductivity (Lab)	µS/cm	1		2,730	1,310	1,370	218	9,840	8,230	2,640	141	12,000	8,460	228	-	308	-
	pH (Field)	-	-		6.90	6.62	6.72	5.23	8.38	5.80	7.32	5.73	8.43	6.52	7.25	8.01	7.22	6.36
	pH (Lab)	-	0.01		6.85	7.35	6.45	6.03	8.04	6.61	7.65	5.90	8.11	7.42	7.79	-	7.88	-
	Dissolved oxygen (% saturation - Field)	mg/L	-		51.1	6.9	92.4	4.5	165.9	15.8	126.7	55.1	143.2	32.6	112.0	93.4	127.6	99.0
	Oxidation reduction potential (Field)	mg/L	-		153.1	-84.4	39.9	30.0	50.2	-78.0	135.7	30.4	94.5	-64.7	25.6	-37.7	74.8	23.6
	Total Dissolved Solids (Field)	mg/L	-		-	793.00	-	147.55	-	4608.50	-	204.10	-	4465.50	-	107.90	-	104.00
	Total Dissolved Solids (Calc.)	mg/L	1		1,770	852	890	142	6,400	5,350	1,720	92	7,800	5,500	148	-	200	-
Analytical results – alkalinity	Alkalinity (Bicarbonate as $CaCO_3$)	mg/L	1		228	322	8	30	318	392	32	8	567	454	52	-	82	-
	Alkalinity (Carbonate as $CaCO_3$)	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	-
	Alkalinity (Hydroxide) as $CaCO_3$	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	<1	-
	Alkalinity (total) as $CaCO_3$	mg/L	1		228	322	8	30	318	392	32	8	567	454	52	-	82	-
Inorganics	Calcium (filtered)	mg/L	1		43	34	42	7	142	151	20	11	172	110	4	-	5	-
	Chloride	mg/L	1		732	172	462	29	2,880	2,700	893	24	4,050	2,700	35	-	43	-
	Fluoride	mg/L	0.1		<0.1	0.4	<0.1	<0.1	0.8	0.6	0.1	<0.1	0.6	0.4	<0.1	-	<0.1	-
	Sodium (filtered)	mg/L	1		450	210	138	28	1,650	1,200	348	16	1,840	1,160	34	-	47	-
	Magnesium (filtered)	mg/L	1		37	11	42	5	201	185	81	3	374	219	4	-	5	-
	Potassium (filtered)	mg/L	1		5	6	2	<1	15	12	3	2	31	32	3	-	4	-
	Anions Total	meq/L	0.01		29.7	13.8	13.4	2.04	104	92.1	26.8	1.19	138	91.5	2.15	-	3.08	-
	Ionic Balance	%	0.01		8.77	7.38	7.33	-	3.93	10.0	7.99	-	6.82	10.0	-	-	-	-
	Cations Total	meq/L	0.01		24.9	11.9	11.6	1.98	95.8	75.3	22.9	1.54	120	74.8	2.08	-	2.81	-
	Sulfate as SO_4 - Turbidimetric (filtered)	mg/L	1		215	120	12	30	770	389	49	17	587	300	6	-	11	-
Metals	Arsenic (filtered)	mg/L	0.001		<0.001	-	<0.001	-	0.001	-	<0.001	-	0.003	-	<0.001	-	<0.001	-
	Cadmium (filtered)	mg/L	0.0001		<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-	<0.0001	-
	Chromium (III+VI) (filtered)	mg/L	0.001		<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-
	Copper (filtered)	mg/L	0.001		<0.001	-	<0.001	-	0.004	-	<0.001	-	0.006	-	0.017	-	<0.001	-
	Iron (filtered)	mg/L	0.05		<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	0.38	-	0.25	-
	Lead (filtered)	mg/L	0.001		<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-
	Nickel (filtered)	mg/L	0.001		0.006	-	0.003	-	0.020	-	0.013	-	0.023	-	0.006	-	0.003	-
	Zinc (filtered)	mg/L	0.005		0.116	-	0.074	-	0.041	-	0.017	-	0.109	-	0.033	-	<0.005	-

Appendix B

Laboratory certificates of analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2018927**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 01-Jun-2020 19:00
Order number	: J190166	Date Analysis Commenced	: 01-Jun-2020
C-O-C number	: ----	Issue Date	: 03-Jun-2020 20:31
Sampler	: KAITLYN BRODIE		
Site	: ----		
Quote number	: ----		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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.

- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site_1_S	Site 2	Site 4	River_Site 1	River_Site 3
			Client sampling date / time	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2018927-001	ES2018927-002	ES2018927-003	ES2018927-004	ES2018927-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.45	8.04	8.11	7.79	7.88
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1370	9840	12000	228	308
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	890	6400	7800	148	200
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	278	1180	1970	26	33
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	8	318	567	52	82
Total Alkalinity as CaCO3	----	1	mg/L	8	318	567	52	82
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	12	770	587	6	11
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	462	2880	4050	35	43
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	42	142	172	4	5
Magnesium	7439-95-4	1	mg/L	42	201	374	4	5
Sodium	7440-23-5	1	mg/L	138	1650	1840	34	47
Potassium	7440-09-7	1	mg/L	2	15	31	3	4
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	0.003	<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	0.004	0.006	0.017	<0.001
Nickel	7440-02-0	0.001	mg/L	0.003	0.020	0.023	0.006	0.003
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	0.074	0.041	0.109	0.033	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	0.38	0.25
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	0.8	0.6	<0.1	<0.1
EN055: Ionic Balance								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Site_1_S	Site 2	Site 4	River_Site 1	River_Site 3
				Client sampling date / time	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00	29-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2018927-001	ES2018927-002	ES2018927-003	ES2018927-004	ES2018927-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**13.4**	**104**	**138**	**2.15**	**3.08**
ø **Total Cations**	----	0.01	meq/L		**11.6**	**95.8**	**120**	**2.08**	**2.81**
ø **Ionic Balance**	----	0.01	%		**7.33**	**3.93**	**6.82**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2018927**	Page	: 1 of 5
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 01-Jun-2020
Order number	: J190166	Date Analysis Commenced	: 01-Jun-2020
C-O-C number	: ----	Issue Date	: 03-Jun-2020
Sampler	: KAITLYN BRODIE		
Site	: ----		
Quote number	: ----		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Quality Control Report contains the following information:

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 (%)*
EA005P: pH by PC Titrator (QC Lot: 3053496)									
ES2018890-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.14	5.79	5.87	0% - 20%
ES2018927-004	River_Site 1	EA005-P: pH Value	----	0.01	pH Unit	7.79	7.66	1.68	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 3053497)									
EW2002521-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	194	194	0.00	0% - 20%
ES2018890-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	272	280	3.14	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 3053493)									
ES2018843-002	Anonymous	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	64	58	9.32	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	64	58	9.32	0% - 20%
ES2018883-001	Anonymous	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	87	84	3.36	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	87	84	3.36	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 3053498)									
EW2002533-001	Anonymous	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
ES2018927-004	River_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	52	53	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	52	53	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3053456)									

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 (%)*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3053456) - continued									
ES2018927-001	Site_1_S	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	12	12	0.00	0% - 50%
ED045G: Chloride by Discrete Analyser (QC Lot: 3053457)									
ES2018927-001	Site_1_S	ED045G: Chloride	16887-00-6	1	mg/L	462	460	0.355	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 3053790)									
ES2018856-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	14	14	0.00	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	22	22	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	138	141	1.92	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	36	36	0.00	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 3053788)									
ES2018927-005	River_Site 3	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	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: 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: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.25	0.25	0.00	No Limit
ES2018856-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	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: 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: Nickel	7440-02-0	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.016	0.016	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.08	0.07	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 3053490)									
ES2018620-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	0.00	No Limit
ES2018927-004	River_Site 1	EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	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 Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 3053496)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	99.7	98.0	102
EA010P: Conductivity by PC Titrator (QCLot: 3053497)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2100 µS/cm	108	95.0	113
ED037P: Alkalinity by PC Titrator (QCLot: 3053493)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	99.5	81.0	111
				----	50 mg/L	113	70.0	130
ED037P: Alkalinity by PC Titrator (QCLot: 3053498)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	101	81.0	111
				----	50 mg/L	108	70.0	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3053456)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	115	82.0	122
				<1	500 mg/L	92.2	82.0	122
ED045G: Chloride by Discrete Analyser (QCLot: 3053457)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	108	80.9	127
				<1	1000 mg/L	115	80.9	127
ED093F: Dissolved Major Cations (QCLot: 3053790)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.1	80.0	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.8	90.0	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	95.1	82.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	95.6	85.0	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 3053788)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	92.8	85.0	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	92.6	84.0	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	91.5	85.0	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	90.8	81.0	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.4	83.0	111
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	89.8	82.0	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	93.7	81.0	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82.0	112
EK040P: Fluoride by PC Titrator (QCLot: 3053490)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	105	82.0	116

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**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	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: 3053456)							
ES2018927-001	Site_1_S	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	109	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 3053457)							
ES2018927-001	Site_1_S	ED045G: Chloride	16887-00-6	250 mg/L	108	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 3053788)							
ES2018856-003	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	96.4	70.0	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	94.0	70.0	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	81.0	70.0	130
		EG020A-F: Copper	7440-50-8	1 mg/L	91.5	70.0	130
		EG020A-F: Lead	7439-92-1	1 mg/L	101	70.0	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	93.8	70.0	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	97.0	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 3053490)							
ES2018620-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	105	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2018927**	Page	: 1 of 5
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 01-Jun-2020
Site	: ----	Issue Date	: 03-Jun-2020
Sampler	: KAITLYN BRODIE	No. of samples received	: 5
Order number	: J190166	No. of samples analysed	: 5

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
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	----	----	----	01-Jun-2020	29-May-2020	**3**

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
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	29-May-2020	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	26-Jun-2020	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural (ED093F)							
Site_1_S	**29-May-2020**	**----**	----	----	**02-Jun-2020**	05-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**02-Jun-2020**	26-Jun-2020	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	12-Jun-2020	✓

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
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	26-Jun-2020	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	26-Jun-2020	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
Site_1_S	**29-May-2020**	**----**	----	----	**02-Jun-2020**	05-Jun-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**02-Jun-2020**	26-Jun-2020	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020A-F)							
Site_1_S	**29-May-2020**	**----**	----	----	**02-Jun-2020**	25-Nov-2020	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**02-Jun-2020**	25-Nov-2020	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
Site_1_S, Site 2, Site 4, River_Site 1, River_Site 3	**29-May-2020**	**----**	----	----	**01-Jun-2020**	26-Jun-2020	✓

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		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	24	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	4	24	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	5	**40.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	5	**40.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	5	**20.00**	**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
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. 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.
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)
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)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES2018927**

Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: hnoakes@emmconsulting.com.au	E-mail	: ALSEnviro.Sydney@ALSGlobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: J190166 - Menangle Quarry	Page	: 1 of 2
Order number	: J190166	Quote number	: ----
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KAITLYN BRODIE		

Dates

Date Samples Received	: 01-Jun-2020 19:00	Issue Date	: 01-Jun-2020
Client Requested Due Date	: 04-Jun-2020	Scheduled Reporting Date	: **04-Jun-2020**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 6.6' C - Ice Bricks present
Receipt Detail	:	No. of samples received / analysed	: 5 / 5

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Sample "Site 1_D" not received**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

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

Method / Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Dissolved Metals by ICP-MS - Suite A : EG020A-F		
Site_1_S	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered

Summary of Sample(s) and Requested Analysis

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

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EG020F Dissolved Metals by ICP/MS	WATER - NT-12 General Water Suite	WATER - W-01 7 Metals
ES2018927-001	29-May-2020 00:00	Site_1_S	✓	✓	✓
ES2018927-002	29-May-2020 00:00	Site 2	✓	✓	✓
ES2018927-003	29-May-2020 00:00	Site 4	✓	✓	✓
ES2018927-004	29-May-2020 00:00	River_Site 1	✓	✓	✓
ES2018927-005	29-May-2020 00:00	River_Site 3	✓	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

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

Method / Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received Date	Samples Received Evaluation	Instructions Received Date	Instructions Received Evaluation
EA005-P: pH by PC Titrator							
River_Site 1	Clear Plastic Bottle - Natural	----	29-May-2020	01-Jun-2020	×	----	----
River_Site 3	Clear Plastic Bottle - Natural	----	29-May-2020	01-Jun-2020	×	----	----
Site 2	Clear Plastic Bottle - Natural	----	29-May-2020	01-Jun-2020	×	----	----
Site 4	Clear Plastic Bottle - Natural	----	29-May-2020	01-Jun-2020	×	----	----
Site_1_S	Clear Plastic Bottle - Natural	----	29-May-2020	01-Jun-2020	×	----	----

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	finance@emmconsulting.com.au

HENRY NOAKES

- *AU Certificate of Analysis - NATA (COA)	Email	hnoakes@emmconsulting.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	hnoakes@emmconsulting.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	hnoakes@emmconsulting.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	hnoakes@emmconsulting.com.au
- Chain of Custody (CoC) (COC)	Email	hnoakes@emmconsulting.com.au
- EDI Format - ESDAT (ESDAT)	Email	hnoakes@emmconsulting.com.au
- EDI Format - XTab (XTAB)	Email	hnoakes@emmconsulting.com.au

Katharine Bond

- A4 - AU Tax Invoice (INV)	Email	kbond@emmconsulting.com.au

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

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

☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

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

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

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

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

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

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

CLIENT: EMM Consulting Pty Ltd	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Sydney		☒ Non Standard or urgent TAT **(List due date): 2 day turnaroud**	Custody Seal Intact? Yes No N/A
PROJECT: J190166 - Menangle Quarry	**ALS QUOTE NO.:**	**COC SEQUENCE NUMBER (Circle)**	Preserved / Received on Ice? Yes No N/A
ORDER NUMBER: J190166		COC: 1 2 3 4 5 6 7	Cooling Method: Ice Gel Ice Pack None
PROJECT MANAGER: Katharine Bond / Henry Noakes	**CONTACT PH: 0439 604 035 / 0448 772 835**	OF: 1 2 3 4 5 6 7	Sample Temperature on Receipt: °C
SAMPLER: Kailtyn Brodie	**SAMPLER MOBILE: 0401 881 447**		Other comments:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE/TIME:	DATE/TIME: 1/6/20 1900	DATE/TIME:	DATE/TIME:

COC emailed to ALS? (YES / NO) **EDD FORMAT (or default):**

Email Reports to (will default to PM if no other addresses are listed): **hnoakes@emmconsulting.com.au**

Email Invoice to (will default to PM if no other addresses are listed): **kbond@emmconsulting.com.au**

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	General water suite NT-12	Dissolved Metals Suite W-1 PLUS IRON (Fe)						
1	Site 1_S	29/05/2020	W	2 x P	2	x	x						Please lab filter from unpreserved bottle for metals.
SM12	Site 1_D	29/05/2020	W	1 x P & 1 x N	2	x	x						
2	Site 2	29/05/2020	W	1 x P & 1 x N	2	x	x						
3	Site 4	29/05/2020	W	1 x P & 1 x N	2	x	x						
4	River_Site 1	29/05/2020	W	1 x P & 1 x N	2	x	x						
5	River_Site 3	29/05/2020	W	1 x P & 1 x N	2	x	x						
				TOTAL	12	6	6						

Environmental Division Sydney
Work Order Reference
ES2018927

Telephone : +61-2-8784 8555

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

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2019091**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 02-Jun-2020 19:00
Order number	: J190166	Date Analysis Commenced	: 02-Jun-2020
C-O-C number	: ----	Issue Date	: 04-Jun-2020 11:47
Sampler	: KAITLYN BRODIE		
Site	: ----		
Quote number	: EN/112/18 - Primary work only		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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.

- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Site 3	Site 1_D	----	----	----
			Client sampling date / time	02-Jun-2020 00:00	02-Jun-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2019091-001	ES2019091-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.65**	**6.85**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2640**	**2730**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**1720**	**1770**	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**383**	**260**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**32**	**228**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**32**	**228**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**49**	**215**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**893**	**732**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**20**	**43**	----	----	----
Magnesium	7439-95-4	1	mg/L	**81**	**37**	----	----	----
Sodium	7440-23-5	1	mg/L	**348**	**450**	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	**5**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.013**	**0.006**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.017**	**0.116**	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	<0.1	----	----	----
EN055: Ionic Balance								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**Site 3**	**Site 1_D**	**----**	**----**	**----**
				Client sampling date / time	02-Jun-2020 00:00	02-Jun-2020 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**ES2019091-001**	**ES2019091-002**	--------	--------	--------
					Result	Result	----	----	----
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**26.8**	**29.7**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**22.9**	**24.9**	**----**	**----**	**----**
ø **Ionic Balance**	----	0.01	%		**7.99**	**8.77**	**----**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2019091**	Page	: 1 of 5
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 02-Jun-2020
Order number	: J190166	Date Analysis Commenced	: 02-Jun-2020
C-O-C number	: ----	Issue Date	: 04-Jun-2020
Sampler	: KAITLYN BRODIE		
Site	: ----		
Quote number	: EN/112/18 - Primary work only		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Quality Control Report contains the following information:

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 (%)
EA005P: pH by PC Titrator (QC Lot: 3056122)									
ES2019014-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.49	7.49	0.00	0% - 20%
ES2019017-004	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	11.4	11.4	0.0875	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 3056119)									
ES2018934-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	3.36 mS/cm	3340	0.664	0% - 20%
ES2019017-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2230	2230	0.00	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 3056121)									
ES2018934-001	Anonymous	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	848	931	9.24	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	848	931	9.24	0% - 20%
ES2019017-004	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	265	257	3.02	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	186	169	9.64	0% - 20%
		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	452	426	5.70	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3056140)									
ES2019075-008	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	7	7	0.00	No Limit
ES2018934-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	202	201	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 3056137)									
ES2019072-003	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	14	14	0.00	0% - 50%
ES2018934-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	548	549	0.233	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 3056143)									
ES2019091-002	Site 1_D	ED045G: Chloride	16887-00-6	1	mg/L	732	736	0.524	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 3055986)									
ES2019091-001	Site 3	ED093F: Calcium	7440-70-2	1	mg/L	20	20	0.00	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 (%)*
ED093F: Dissolved Major Cations (QC Lot: 3055986) - continued									
ES2019091-001	Site 3	ED093F: Magnesium	7439-95-4	1	mg/L	81	82	1.50	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	348	355	1.89	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 3055987)									
ES2019091-001	Site 3	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	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: 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: Nickel	7440-02-0	0.001	mg/L	0.013	0.013	0.00	0% - 50%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.017	0.016	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 3056120)									
ES2018934-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.6	0.6	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 Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 3056122)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	99.7	98.0	102
EA010P: Conductivity by PC Titrator (QCLot: 3056119)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2100 µS/cm	106	95.0	113
ED037P: Alkalinity by PC Titrator (QCLot: 3056121)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	93.0	81.0	111
				----	50 mg/L	105	70.0	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3056140)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	106	82.0	122
				<1	500 mg/L	103	82.0	122
ED045G: Chloride by Discrete Analyser (QCLot: 3056137)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	106	80.9	127
				<1	1000 mg/L	112	80.9	127
ED045G: Chloride by Discrete Analyser (QCLot: 3056143)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	107	80.9	127
				<1	1000 mg/L	117	80.9	127
ED093F: Dissolved Major Cations (QCLot: 3055986)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	102	80.0	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.2	90.0	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	98.0	82.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.9	85.0	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 3055987)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	94.9	85.0	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.1	84.0	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	96.7	85.0	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	93.8	81.0	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	93.2	83.0	111
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	90.8	82.0	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	93.4	81.0	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	82.0	112
EK040P: Fluoride by PC Titrator (QCLot: 3056120)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	98.4	82.0	116

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**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	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: 3056140)							
ES2018934-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 3056137)							
ES2018934-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	102	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 3056143)							
ES2019091-002	Site 1_D	ED045G: Chloride	16887-00-6	250 mg/L	95.9	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 3055987)							
ES2019091-002	Site 1_D	EG020A-F: Arsenic	7440-38-2	1 mg/L	95.1	70.0	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	98.3	70.0	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	97.2	70.0	130
		EG020A-F: Copper	7440-50-8	1 mg/L	93.5	70.0	130
		EG020A-F: Lead	7439-92-1	1 mg/L	105	70.0	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	93.6	70.0	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	102	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 3056120)							
ES2018934-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	120	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2019091**	Page	: 1 of 5
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Telephone	: +61-2-8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 02-Jun-2020
Site	: ----	Issue Date	: 04-Jun-2020
Sampler	: KAITLYN BRODIE	No. of samples received	: 2
Order number	: J190166	No. of samples analysed	: 2

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

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES2018934--001	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

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
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	02-Jun-2020	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	30-Jun-2020	✓
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural (ED093F)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	09-Jun-2020	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	16-Jun-2020	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	30-Jun-2020	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	30-Jun-2020	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	09-Jun-2020	✓

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 Plastic Bottle - Natural (EG020A-F)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	29-Nov-2020	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
Site 3, Site 1_D	**02-Jun-2020**	**----**	----	----	**02-Jun-2020**	30-Jun-2020	✓

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		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	21	**19.05**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	19	**5.26**	**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
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. 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.
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)
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)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES2019091**

Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: hnoakes@emmconsulting.com.au	E-mail	: ALSEnviro.Sydney@ALSGlobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: J190166 - Menangle Quarry	Page	: 1 of 2
Order number	: J190166	Quote number	: ----
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KAITLYN BRODIE		

Dates

Date Samples Received	: 02-Jun-2020 19:00	Issue Date	: 02-Jun-2020
Client Requested Due Date	: 03-Jun-2020	Scheduled Reporting Date	: **04-Jun-2020**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 10.1' C - Ice Bricks present
Receipt Detail	:	No. of samples received / analysed	: 2 / 2

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

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

Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Dissolved Metals by ICP-MS - Suite A : EG020A-F		
Site 3	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered
Site 1_D	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered

Summary of Sample(s) and Requested Analysis

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

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EG020F Dissolved Metals by ICP/MS	WATER - NT-12 General Water Suite	WATER - W-01 7 Metals
ES2019091-001	02-Jun-2020 00:00	Site 3	✓	✓	✓
ES2019091-002	02-Jun-2020 00:00	Site 1_D	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	finance@emmconsulting.com.au

HENRY NOAKES

- *AU Certificate of Analysis - NATA (COA)	Email	hnoakes@emmconsulting.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	hnoakes@emmconsulting.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	hnoakes@emmconsulting.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	hnoakes@emmconsulting.com.au
- Chain of Custody (CoC) (COC)	Email	hnoakes@emmconsulting.com.au
- EDI Format - ESDAT (ESDAT)	Email	hnoakes@emmconsulting.com.au
- EDI Format - XTab (XTAB)	Email	hnoakes@emmconsulting.com.au

Katharine Bond

- A4 - AU Tax Invoice (INV)	Email	kbond@emmconsulting.com.au

4/6/20

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

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

☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

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

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

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

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

☐TOWNSVILLE 14-16 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

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

CLIENT: EMM Consulting Pty Ltd	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☐ Standard TAT (List due date):
OFFICE: Sydney		☒ Non Standard or urgent TAT (List due date): Due by COB 3/6/2020
PROJECT: J190166 - Menangle Quarry	**ALS QUOTE NO.:**	
ORDER NUMBER: J190166		
PROJECT MANAGER: Katharine Bond / Henry Noakes	**CONTACT PH:** 0439 604 035 / 0448 772 835	
SAMPLER: Kailtyn Brodie	**SAMPLER MOBILE:** 0401 881 447	
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	
Email Reports to (will default to PM if no other addresses are listed): **hnoakes@emmconsulting.com.au**		
Email Invoice to (will default to PM if no other addresses are listed): **kbond@emmconsulting.com.au**		

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: 10.1 °C

Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE/TIME:	James D. DATE/TIME: 2/6/20 1900	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	General water suite NT-12	Dissolved Metals Suite W-1 PLUS IRON (Fe)							
1	Site 3	2/06/2020	W	1 x P & 1 x N	2	x	x							
2	Site 1_D	2/06/2020	W	1 x P & 1 x N	2	x	x							This site appeared on COC sent on 01/06/2020 accidentally.
				TOTAL	4	2	2							

TAT

TAT

Environmental Division Sydney

Work Order Reference

ES2019091

Telephone : +61-2-8784 8555

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

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2123005**	Page	: 1 of 3
Amendment	: **1**		
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 21-Jun-2021 18:45
Order number	: J190166	Date Analysis Commenced	: 21-Jun-2021
C-O-C number	: ----	Issue Date	: 01-Jul-2021 18:24
Sampler	: STEVE ROCKS		
Site	: ----		
Quote number	: EN/112/20 Primary work		
No. of samples received	: 5		
No. of samples analysed	: 5		

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, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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.

- Amendment (01/07/2021): This report has been amended and re-released to allow a change in sampling date to 18/06/2021 for samples 001-005. All analysis results are as per the previous report.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH01_D	BH01_S	BH02	BH03	BH04
			Sampling date / time	18-Jun-2021 11:30	18-Jun-2021 12:15	18-Jun-2021 13:30	18-Jun-2021 15:00	18-Jun-2021 15:30
Compound	CAS Number	LOR	Unit	ES2123005-001	ES2123005-002	ES2123005-003	ES2123005-004	ES2123005-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.35	6.03	6.61	5.90	7.42
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1310	218	8230	141	8460
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	852	142	5350	92	5500
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	130	38	1140	40	1180
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	322	30	392	8	454
Total Alkalinity as CaCO3	----	1	mg/L	322	30	392	8	454
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	120	30	389	17	300
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	172	29	2700	24	2700
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	34	7	151	11	110
Magnesium	7439-95-4	1	mg/L	11	5	185	3	219
Sodium	7440-23-5	1	mg/L	210	28	1200	16	1160
Potassium	7440-09-7	1	mg/L	6	<1	12	2	32
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.4	<0.1	0.6	<0.1	0.4
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	13.8	2.04	92.1	1.19	91.5
ø Total Cations	----	0.01	meq/L	11.9	1.98	75.3	1.54	74.8
ø Ionic Balance	----	0.01	%	7.38	----	10.0	----	10.0

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2123005**	Page	: 1 of 5
Amendment	: **1**		
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 21-Jun-2021
Order number	: J190166	Date Analysis Commenced	: 21-Jun-2021
C-O-C number	: ----	Issue Date	: 01-Jul-2021
Sampler	: STEVE ROCKS		
Site	: ----		
Quote number	: EN/112/20 Primary work		
No. of samples received	: 5		
No. of samples analysed	: 5		

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, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA005P: pH by PC Titrator (QC Lot: 3748449)									
ES2122916-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.71	6.67	0.6	0% - 20%
ES2122988-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.84	7.85	0.1	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 3748448)									
ES2123005-003	BH02	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	8230	8310	0.9	0% - 20%
ES2122916-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1250	1250	0.0	0% - 20%
ES2123022-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1020	1020	0.2	0% - 20%
ES2122988-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	46500	46800	0.7	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 3748450)									
ES2122916-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	25	24	4.3	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	25	24	4.3	0% - 20%
ES2122988-002	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	115	118	1.8	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	115	118	1.8	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 3749782)									
ES2123005-001	BH01_D	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	120	119	1.5	0% - 20%
EW2102711-004	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8	8	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 3749783)									
ES2123005-001	BH01_D	ED045G: Chloride	16887-00-6	1	mg/L	172	173	0.6	0% - 20%
EW2102711-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	39	39	0.0	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 3754213)									
ES2122543-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	79	75	5.6	0% - 20%

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
ED093F: Dissolved Major Cations (QC Lot: 3754213) - continued									
ES2122543-001	Anonymous	ED093F: Magnesium	7439-95-4	1	mg/L	29	31	6.5	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	5	5	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit
ES2122976-007	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	4	4	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	3	2	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	18	18	0.0	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	5	2	81.9	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 3748451)									
ES2123005-003	BH02	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.6	0.5	0.0	No Limit
ES2122988-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	1.1	1.1	0.0	0% - 50%

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

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

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 3748449)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.0	98.8	101
				----	7 pH Unit	100	99.2	101
EA010P: Conductivity by PC Titrator (QCLot: 3748448)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	220 µS/cm	99.6	91.1	107
				<1	2100 µS/cm	98.7	93.2	108
ED037P: Alkalinity by PC Titrator (QCLot: 3748450)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	99.2	81.0	111
				----	50 mg/L	103	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3749782)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	103	82.0	122
				<1	500 mg/L	103	82.0	122
ED045G: Chloride by Discrete Analyser (QCLot: 3749783)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	50 mg/L	106	80.9	127
				<1	1000 mg/L	103	80.9	127
ED093F: Dissolved Major Cations (QCLot: 3754213)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	106	80.0	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.1	90.0	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	106	82.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	93.9	85.0	113
EK040P: Fluoride by PC Titrator (QCLot: 3748451)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	88.4	82.0	116

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**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 3749782)							
ES2123005-001	BH01_D	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 3749783)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
ED045G: Chloride by Discrete Analyser (QCLot: 3749783) - continued							
ES2123005-001	BH01_D	ED045G: Chloride	16887-00-6	50 mg/L	109	70.0	130
EK040P: Fluoride by PC Titrator (QCLot: 3748451)							
ES2122972-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	90.6	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES2123005**	Page	: 1 of 5
Amendment	: **1**		
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Telephone	: +61 2 8784 8555
Project	: J190166 - Menangle Quarry	Date Samples Received	: 21-Jun-2021
Site	: ----	Issue Date	: 01-Jul-2021
Sampler	: STEVE ROCKS	No. of samples received	: 5
Order number	: J190166	No. of samples analysed	: 5

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

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES2123005--001	BH01_D	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
BH01_D, BH01_S, BH02, BH03, BH04	----	----	----	21-Jun-2021	18-Jun-2021	**3**

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: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**21-Jun-2021**	18-Jun-2021	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**21-Jun-2021**	16-Jul-2021	✓

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
EA065: Total Hardness as CaCO3							
Clear Plastic Bottle - Natural (ED093F)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**24-Jun-2021**	25-Jun-2021	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**21-Jun-2021**	02-Jul-2021	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**22-Jun-2021**	16-Jul-2021	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**22-Jun-2021**	16-Jul-2021	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**24-Jun-2021**	25-Jun-2021	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
BH01_D, BH01_S, BH02, BH03, BH04	**18-Jun-2021**	**----**	----	----	**21-Jun-2021**	16-Jul-2021	✓

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		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	3	36	**8.33**	**8.33**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	36	**2.78**	**1.67**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	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
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM 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) on a settled supernatant aliquot of the sample using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM 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 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 seal method 2 017-1-L
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 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 Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM 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 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 Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **ES2123005**		
Amendment	: **1**		
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HENRY NOAKES	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: hnoakes@emmconsulting.com.au	E-mail	: Sepan.Mahamad@ALSGlobal.com
Telephone	: ----	Telephone	: +61 2 8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: J190166 - Menangle Quarry	Page	: 1 of 2
Order number	: J190166	Quote number	: ES2020EMGAMM0004 (EN/112/20 Primary work)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: STEVE ROCKS		

Dates

Date Samples Received	: 21-Jun-2021 18:45	Issue Date	: 01-Jul-2021
Client Requested Due Date	: 29-Jun-2021	Scheduled Reporting Date	: **29-Jun-2021**

Delivery Details

Mode of Delivery	: Client Drop Off	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 6.2'C - Ice Bricks present
Receipt Detail	: large esky	No. of samples received / analysed	: 5 / 5

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **(01/07/2021) This is an updated SRN which reflects a change in sampling date to 18/06/2021 for samples 001-005.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

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

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

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

Matrix: **WATER**

Laboratory sample ID	Sampling date / time	Sample ID	WATER - NT-12 General Water Suite
ES2123005-001	18-Jun-2021 11:30	BH01_D	✓
ES2123005-002	18-Jun-2021 12:15	BH01_S	✓
ES2123005-003	18-Jun-2021 13:30	BH02	✓
ES2123005-004	18-Jun-2021 15:00	BH03	✓
ES2123005-005	18-Jun-2021 15:30	BH04	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

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

Method / Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received		Instructions Received	
				Date	Evaluation	Date	Evaluation
EA005-P: pH by PC Titrator							
BH01_D	Clear Plastic Bottle - Natural	----	18-Jun-2021	21-Jun-2021	✘	----	----
BH01_S	Clear Plastic Bottle - Natural	----	18-Jun-2021	21-Jun-2021	✘	----	----
BH02	Clear Plastic Bottle - Natural	----	18-Jun-2021	21-Jun-2021	✘	----	----
BH03	Clear Plastic Bottle - Natural	----	18-Jun-2021	21-Jun-2021	✘	----	----
BH04	Clear Plastic Bottle - Natural	----	18-Jun-2021	21-Jun-2021	✘	----	----

Requested Deliverables

ALL ESDAT REPORTS

- EDI Format - ESDAT (ESDAT)	Email	emmconsulting@esdat.net

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	finance@emmconsulting.com.au

HENRY NOAKES

- *AU Certificate of Analysis - NATA (COA)	Email	hnoakes@emmconsulting.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	hnoakes@emmconsulting.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	hnoakes@emmconsulting.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	hnoakes@emmconsulting.com.au
- Chain of Custody (CoC) (COC)	Email	hnoakes@emmconsulting.com.au
- EDI Format - ENMRG (ENMRG)	Email	hnoakes@emmconsulting.com.au
- EDI Format - ESDAT (ESDAT)	Email	hnoakes@emmconsulting.com.au

Katharine Bond

- A4 - AU Tax Invoice (INV)	Email	kbond@emmconsulting.com.au

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: EMM Consulting Pty Ltd	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☑ Standard TAT (List due date):
OFFICE: Sydney		☒ Non Standard or urgent TAT (List due date): 2 day turnaround
PROJECT: J190166 - Menangle Quarry	ALS QUOTE NO.:	
ORDER NUMBER: J190166		COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7
PROJECT MANAGER: Katharine Bond / Henry Noakes	CONTACT PH: 0439 604 035 / 0448 772 835	
SAMPLER: Steve Rocks	SAMPLER MOBILE: 0414 776 988	
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	
Email Reports to (will default to PM if no other addresses are listed): hnoakes@emmconsulting.com.au		
Email Invoice to (will default to PM if no other addresses are listed): kbond@emmconsutling.com.au		

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:	6.2 °C		
Other comment:			

RELINQUISHED BY:	RECEIVED BY: James	RELINQUISHED BY:	RECEIVED BY: SGS/Alex SGS
DATE/TIME:	DATE/TIME: 21/6 2.10pm	DATE/TIME:	DATE/TIME: 21/6/21 1845

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	General water suite NT-12							
1	BH01_D	21/06/2021 11:30	W		1	x							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
2	BH01_S	21/06/2021 12:15	W		1	x							Please lab filter from unpreserved bottle for metals.
3	BH02	21/06/2021 13:30:00 PM	W		1	x							
4	BH03	21/06/2021 15:00:00 PM	W		1	x							
5	BH04	21/06/2021 15:30:00 PM	W		1	x							
				TOTAL	5	5							

TAT

Environmental Division
Sydney
Work Order Reference
ES2123005

Telephone : + 61-2-8784 8555

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

...maldehyde Preserved Glass;

Appendix C

Groundwater sampling forms

EMM
creating opportunities

Low Flow Sampling Record

I.D: BH01_D (SANDSTONE)

Date start / finish	18/6/2021	Well diameter (mm)	50	Sample method	BLADDER PUMP
Project	J190166 - MENANGLE QUARRY	Stickup (magl)	#	Water quality meter	YSI PRO
Project number	~~J190166~~ J190166	Intial time	11:00	Calibration date	18/06/21
Client	MENANGLE SAND/SOIL (BENEDICT INDUSTRIES)	Initial SWL (mbtoc)	6.332 mbTOC	Final SWL (mbtoc)	10.25
Field staff	SR	Intial TD (mbtoc)		Sample time	11:35
Weather	CLEAR.	Well volume (L)		Logger installed ?	Y

Time	Volume	Yield	Temp	pH	EC	TDS	DO		Redox	Observations / olfactory
	L	L/s	°C ~±0.1	~±0.05	µs/cm ~±5%	mg/L ~±5%	%	mg/L	mV ~±5%	(Colour, turbidity, odour)
17:12	1		18.6	6.43	1375	890.50	8.6	0.81	-81.8	YELLOW BROWN, SLIGHT METALLIC ODOUR
11:20	2		18.6	6.60	1278	832.0	7.7	0.72	-90.2	" " "
11:23	3		18.6	6.59	1241	806.0	8.7	0.81	-84.2	" " "
11:29	4		18.3	6.62	1216	793.0	7.5	0.70	-84.1	" " "
11:31	5		18.3	6.62	1219	793.0	7.1	0.66	-84.4	"
11:35	6		18.2	6.62	1217	793.0	6.9	0.65	-84.4	" " "
SAMPLED ↑										

Additional notes # SLOW RECOVERY - DRAW DOWN UNAVOIDABLE.

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Low Flow Sampling Record

I.D: BH01_S (ALLUVIUM)

Date start / finish	18/06/21	Well diameter (mm)	50	Sample method	LOW FLOW BLADDER
Project	MENANGLE PARK SAND & SOIL	Stickup (magl)		Water quality meter	YSI PRO
Project number	J190166	Intial time		Calibration date	18/6/21
Client	BENEDICT INDUSTRIES	Initial SWL (mbtoc)	6.165	Final SWL (mbtoc)	
Field staff	SR	Intial TD (mbtoc)		Sample time	
Weather	CLEAR	Well volume (L)		Logger installed ?	YES

Time	Volume	Yield	Temp	pH	EC	TDS	DO		Redox	Observations / olfactory
	L	L/s	°C ~±0.1	~±0.05	µs/cm ~±5%	mg/L ~±5%	%	mg/L	mV ~±5%	(Colour, turbidity, odour)
12:06	2		18.1	4.91	~~2265~~	~~146.30~~	9.3	0.87	60.6	DIRTY BROWN/ORANGE
12:08	4		18.2	5.05	222.8	144.30	7.4	0.69	48.6	" "
12:10	5		18.3	5.17	219.4	142.35	5.4	0.5	330	" "
12:12	6		18.3	5.20	222	144.30	4.4	0.41	27.6	" "
12:14	7		18.3	5.22	224	145.6	4.3	0.41	28.1	GETING CLEARER / NO ODOUR
12:16	8		18.3	5.23	227.2	147.55	4.5	0.43	30.0	" "
SAMPLED ↑										

Additional notes * CLEARER THAN FIRST PURGE, STILL SLIGHT GREY.

Low Flow Sampling Record

I.D: BH02

Date start / finish	18/06/21	Well diameter (mm)	50	Sample method	BLADDER
Project	J190166 MENANGLE PARK	Stickup (magl)		Water quality meter	YSI PRO
Project number	J190166	Intial time	13:00	Calibration date	18/06/21
Client	BENEDICT INDUSTRIES MENANGLE PARK SAND & SOIL.	Initial SWL (mbtoc)	25.862	Final SWL (mbtoc)	
Field staff	SR	Intial TD (mbtoc)		Sample time	14:10
Weather	CLEAR	Well volume (L)		Logger installed ?	✓

SCREEN = 33.0 – 39.0 mbGL

Time	Volume	Yield	Temp	pH	EC	TDS	DO		Redox	Observations / olfactory
	L	L/s	°C ~±0.1	~±0.05	µs/cm ~±5%	mg/L ~±5%	%	mg/L	mV ~±5%	(Colour, turbidity, odour)
13:00 *	—	—								
	18.7	1	18.7	5.86	7091	4608.5	15.8	1.44	-78.0	GREY, CLOUDY, SULPHUROUS ODOUR
										SAND/SILT PARTICLES
** SAMPLED @ 13:00 WITH SS BAILER										

Additional notes * ISSUES WITH BLADDER PUMP, SANDY BOREHOLE CLOGGING PUMP. USED BAILER INSTEAD.

** SAMPLE RECOVERED FROM SCREENED INTERVAL @ APPROX. 36-37 mbTOC

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Low Flow Sampling Record

I.D: BH03

Date start / finish	18/06/21	Well diameter (mm)	50	Sample method	BAILER (STAINLESS STEEL)
Project	MENANGLE PARK SAND & SOIL	Stickup (magl)		Water quality meter	YSI PRO
Project number	J190166	Intial time		Calibration date	18/6/21
Client	BENEDICT INDUSTRIES	Initial SWL (mbtoc)	5.170	Final SWL (mbtoc)	
Field staff	SR	Intial TD (mbtoc)		Sample time	15:00
Weather	CLEAR	Well volume (L)		Logger installed ?	Y

Time	Volume	Yield	Temp	pH	EC	TDS	DO		Redox	Observations / olfactory
	L	L/s	°C ~±0.1	~±0.05	µs/cm ~±5%	mg/L ~±5%	%	mg/L	mV ~±5%	(Colour, turbidity, odour)
15:00	2		17.8	5.73	314.1	204.10	55.1	5.23	30.4	GREY - CLEAR, NO ODOUR
* SAMPLED USING SS BAILER @ 15:00										

Additional notes * BAILED DUE TO ISSUES WITH BLADDER PUMP. * 6-7 mbgl THE BAILER STOPPED DUE TO POSSIBLE OBSTRUCTION OF BORE, POSSIBLY AFTER FLOODS. ** SAMPLE RECOVERED FROM APPROX. 6-7m bTOC

Low Flow Sampling Record

I.D: BH04

Date start / finish	18/06/21	Well diameter (mm)	50	Sample method	BAILER (STAINLESS)
Project	MENANGLE PARK	Stickup (magl)		Water quality meter	YSI PRO
Project number	J190166	Intial time		Calibration date	18/6/21
Client	BENEDICT INDUSTRIES	Initial SWL (mbtoc)	43.462	Final SWL (mbtoc)	
Field staff	SR	Intial TD (mbtoc)		Sample time	15:30
Weather	CLEAR	Well volume (L)		Logger installed ?	Y

SCREENED @ 54.0 - 60.0 mbgl

Time	Volume	Yield	Temp	pH	EC	TDS	DO		Redox	Observations / olfactory
	L	L/s	°C ~±0.1	~±0.05	µs/cm ~±5%	mg/L ~±5%	%	mg/L	mV ~±5%	(Colour, turbidity, odour)
*15:30	1		17.1	6.52	6864	4465.5	32.6	3.07	-64.7	GREY/YELLOW SLIGHTLY CLOUDY, SLIGHT
**SAMPLED										SULPHUROUS ODOUR
WITH SS BAILER										

Additional notes: SAMPLED USING BAILER. BAILED FROM WITHIN SCREENED INTERVAL APPROX. 57 mbTOC

Appendix E

Flood scour risk and remedial response TARP

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
Prior to extraction within substage				
Sand and soil extraction in the Stage 8 area.	Flood modelling to predict the peak flow velocities in potential extraction areas. Survey the extent of the exclusion zones – defined in the Consent as areas where predicted the peak flow velocity is >4 m/s during a 1% AEP flood.	Prior to extraction in each substage. Modelling for Substages 8A–8C has been completed. Exclusion zones associated with substages 8A–8C have been surveyed by a registered surveyor in accordance with Development Consent 85/2865 (the Consent) Condition A22.	Should scour occur that results in the loss of trees in the lower riverbank or Nepean River Buffer Zone: • review, and if required, update flood modelling; and • prepare Incident Report.	Incident Report: findings of flood/scour model review/update. Annual report: progress of actions arising from incident report.
Ongoing during extraction				
Sand and soil extraction within an area that may be inundated by flooding of the Nepean River with a predicted peak flow velocity of ≤4 m/s during a 1% AEP flood.	Quarry design to meet the requirements specified in: • the Consent (including Conditions A10, B32, B71 and B72); • the *Applicant's Description of Amended Project* (EMM 2019); and • the environmental management plans. Inspections to review compliance against the quarry design. The base of the active extraction area is to remain 1 m above the water table in accordance with Consent Condition B22.	Ongoing implementation of quarry design. Weekly inspections.	If the quarry does not meet the design requirements (eg batter angles are too steep), undertake earthmoving operations to ensure that quarry design conforms with the approved design. If any extraction is identified outside of the surveyed extraction area or within the exclusion zone: • cease work in this area immediately; • report as an incident/non-compliance as described in Section 8 of the *Menangle Sand and Soil Quarry Environmental*	Incident Report: providing details of non-compliance and corrective/remedial actions. Annual report: • progress of actions arising from incident report; and • summary of compliance with the Consent, design and environmental management plans relevant this TARP.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
	The maximum length of the riverside batter that has a slope between 1:1 and 1:5 will be restricted to 30-m long so that it can be returned to a 1:5 batter within 12 hours if flooding is predicted. The riverside batter will have a slope of no more than 1:5 in the final landform.		*Management Strategy* (EMS) and prepare Incident Report; and • rehabilitate the area in accordance with the *Menangle Sand and Soil Quarry Biodiversity and Rehabilitation Management Plan* (BRMP).	
	Commence rehabilitation of completed extraction area as soon as practicable, always ensuring that the active extraction area is no more than 0.33 ha, in accordance with Consent Condition B72.	Ongoing implementation of quarry design. Weekly inspections of active quarry area, including installation of pegs/flagging to mark the exclusion zone. Monthly review of active quarry area using most recent NearMap (or equivalent) images.	If any extraction is identified outside of the surveyed extraction area or within the exclusion zone: • cordon off part of the extraction area such that the active extraction area is ≤0.33 ha; • commence rehabilitation as described in the BRMP in the cordoned off area; and • report as an incident/non-compliance as described in Section 8 of the EMS and prepare Incident Report.	Incident Report: providing details of non-compliance and corrective/remedial actions. Annual Report: • progress of actions arising from incident report; and • summary of weekly inspections and monthly reviews.
	Install woody debris in rehabilitation area (as required by Consent Condition B78) and in restoration area as described in BRMP Section 7.5. Woody debris should be used to pin brush or mesh surface cover.	Ongoing.	Annual monitoring to confirm that woody debris meets the requirements of Consent Condition B78 (see BRMP Section 8.4).	Report woody debris installation over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
Sand and soil extraction within an area that may be inundated by flooding of the Nepean River with a predicted peak flow velocity of >4 m/s during a 1% AEP flood.	Do not extract sand and soil within the exclusion zone, where predicted the peak flow velocity is >4 m/s during a 1% AEP flood as provided in Appendix 2 of the Consent. As described in Section 2.3.3 of the *Applicant's Description of Amended Project*, a qualified surveyor has undertaken the following: • mark the boundary of the extraction area closest to the river as defined by the 64 m AHD contour; • mark the extent of the 10-m wide horizontal setback area; • mark all living native trees with their trunk within the 10-m wide horizontal setback area; • place a peg 7.5 m horizontally landward of each tree within the 10-m wide horizontal setback area – marking the extent to which the existing bank will be retained, ie forming the 10-m to 17.5-m wide horizontal setback area; • mark all other boundaries of the extraction area; and • mark the boundaries of the adjacent restoration (no resource extraction) area. Sand and soil is not to be extracted from outside of the marked extraction area.	Each extraction area (8A–8C) is to be marked prior to extraction within the substage.	If any extraction is identified outside of the surveyed extraction area or within the exclusion zone: • cordon off part of the extraction area such that the active extraction area is ≤0.33 ha; • commence rehabilitation as described in the BRMP in the cordoned off area; and • report as an incident/non-compliance as described in Section 8 of the EMS and prepare Incident Report.	Incident Report: providing details of non-compliance and corrective/remedial actions. Annual report: • progress of actions arising from incident report; and • summary of compliance with quarry design.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
Prior to flooding (Flood Management TARP actions relevant to substages 8A–8C)				
Stand-by: Bureau of Meteorology (BoM) issues 'flood watch' for Nepean River catchment. 'Flood watch' generally issued up to four days in advance of the expected onset of flooding but maybe as short as 12 hours.	Inform quarry personnel that flooding may impact the quarry in the coming days. Continue to monitor rainfall and flood watch advice.	Immediately following the 'flood watch' notification being received by the quarry.	Inform quarry personnel if BoM updates 'flood watch' so that flooding is no longer expected.	-
Risk level to be advised: BoM issues 'flood warning' for Nepean River catchment in vicinity of the quarry.	Inform quarry personnel that flooding within the Nepean River may inundate quarrying areas. Monitor rainfall and flood warning advice hourly.	Immediately following the 'flood warning' notification being received by the quarry	Continue to monitor BoM flood severity for updates. Proceed to next level of TARP if flood severity classed as 'minor'.	-
Minor: Nepean River flooding adjacent to the quarry is predicted to exceed 64 mAHD (ie a predicted Menangle Weir level of 63.5 mAHD).	Prepare the Stage 8 extraction area for potential flood inundation as described in the FMP, including: • Backfill the active Stage 8 extraction area to achieve a maximum batter slope of 1:5 adjacent to the riverside batter. • Flatten exposed batters and the base of the active extraction area to remove isolated highpoints that may be susceptible to scour. • Smooth all exposed sand and soil in the extraction area so that there are no rapid	Immediately (if safe to do so) following the prediction that flood levels will exceed 64 mAHD.	Continue to monitor BoM flood severity for updates. Proceed to next level of TARP if flood severity classed as 'moderate'. Proceed to 'event over' when flood warning removed.	-

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
	changes in slopes, particularly at the intersections of different batters. • Move all plant and infrastructure from the active extraction area to higher ground (above predicted maximum flood level). Sand face stabilisation and installation of pinning mesh or brush on potential erosion areas with particular focus in low areas where concentrated flood flows may enter or leave the extraction area.			
Moderate: Nepean River flooding adjacent to the quarry is predicted to exceed 66 mAHD – access road between site entry and operations area becomes inundated.	Move all plant to higher ground (above predicted maximum predicted flood level).	Immediately (if safe to do so) following the prediction that flood levels will exceed 66 mAHD.	Continue to monitor BoM flood severity for updates. Proceed to next level of TARP if flood severity classed as 'major'. Proceed to 'event over' when flood warning removed.	-
Major: Nepean River flooding adjacent to the quarry is predicted to exceed 74 mAHD – entire site inundated	Evacuate personnel from the site.	Immediately (if safe to do so) following the prediction that flood levels will exceed 74 m AHD.	Continue to monitor BoM flood severity for updates. Proceed to 'event over' when flood warning removed.	-
Event over: The SES issue safe to return or flood levels have receded below 64 m AHD.	Assess and report any damage to the active extraction area and operations area. Remediate areas of damage, including clearing of debris and areas undergoing rehabilitation at the time of the flood event. Recommence quarrying activities.	Within 5 days or as soon as practical following the 'event over' trigger is actioned.	Debrief all key personnel and update/modify the FMP as necessary.	-

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
Post-flood event				
Following a minor, moderate or major flood event.	Inspect the following areas that have been inundated: • lower riverbank and NRBZ adjacent to substages 8A–8C; • rehabilitation area; and • active extraction area.	Within 24 hours of floodwater receding.	Implement corrective actions for other triggers as required (see below).	Annual Report: summary of floods in preceding 12 months.
Any tree, major roots have been exposed, the roots have tilted or the tree appears to be unstable.	Inspect tree health and vulnerability.	Within 24 hours of floodwater receding.	If, for any tree, major roots have been exposed, the roots have tilted or the tree appears to be unstable: • the tree is to be inspected by an arborist and remedial actions implemented; and • report as an incident/non-compliance as described in Section 8 of the EMS and prepare Incident Report.	Incident Report: arborist findings and proposed remedial actions. Annual Report: progress of actions arising from incident report.
Rehabilitation areas have been scoured such that they are below the final landform level (approximately 64 m AHD).	Infill the scoured area with sand and soil to restore the final landform level.	Within 1 week of the flood event.	Monitor rehabilitation in accordance with the BRMP. Review revegetation performance and evaluate for flood hazard reduction and scour protection for the rehabilitated landform. Revegetate (see below).	Annual Report: • report any occurrences; • if scouring occurs, summarise revegetation performance for flood hazard reduction; and • present remedial actions.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
Vegetation in post-extraction rehabilitation areas has been swept away.	Rehabilitate the area in accordance with the BRMP including: • addition of soil ameliorants if required; • placement of woody debris if density no longer meets the requirements of Consent Condition B78; and • infill seeding or planting.	Within 1 month of re-establishing the final landform.	Monitor rehabilitation in accordance with the BRMP.	Annual Report: report any occurrences and remedial actions.
Woody debris placed in post-extraction rehabilitation areas has been washed away.	Felled habitat trees and woody debris will be preserved for rehabilitation and restoration purposes. Woody debris will be placed over the ground in rehabilitation areas and pressed in or tracked-rolled to ensure intimate contact with soil to minimise the potential for erosion under the woody debris. Woody debris should be used to pin brush or mesh surface cover.	Within 1 week of the flood event.	Monitor woody debris placement in accordance with the BRMP Section 8.4.	Report woody debris installation over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Batters in extraction area have been scoured such that they are too steep and no longer meet the maximum batter angle requirements.	Infill scoured batters with sand and soil to ensure that they meet the maximum batter angle requirements.	Within 1 week of the flood event.	Review batter angles as part of weekly site inspections to ensure that quarry design conforms with the approved design. Undertake further rectification earthworks if required.	Annual Report: report any occurrences and remedial actions.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
The base of the active extraction area has been scoured such that it is with 1 m of the normal water table.	Infill the base of the active extraction with sand and soil to ensure that it is not below the maximum depth (within 1 m of the normal water table). Reinstall bores in the base of the extraction area in accordance with the *Menangle Sand and Soil Quarry Soil and Water Management Plan* (SWMP).	Within 1 week of the flood event.	Measure the depth to groundwater using the bores in the active extraction area. Undertake further rectification earthworks if required.	Annual Report: report any occurrences and remedial actions.
Trees in the lower riverbank or NRBZ adjacent to the active extraction area or rehabilitation area have been uprooted. And/or Remnant native vegetation in floodplain strips immediately upstream or downstream of the active extraction area has been swept away.	If roots of the tree are no longer providing bank stability, install measures, eg coir matting, large rocks or rip rap, around the previous root area to prevent erosion. If part of the roots remain in the soil, leave in situ to allow the roots to continue to provide bank stability. Remove the upper part of the tree (chainsaw) to reduce the risk of the tree being washed away in subsequent flooding. If required, install measures to prevent erosion. Bank stabilisation and installation of pinning mesh or brush on potential erosion areas.	Within 2 weeks of the flood event.	Inspect area as part of the drainage, erosion and sediment control inspections (see SWMP Section 8): • weekly during normal operations; • daily during periods of rainfall; and • within 12 hours of the cessation of a rainfall event (greater than 10 mm) causing runoff to occur on, or from, the quarry. Undertake further stabilisation works if required. Should scour occur that results in the loss of trees: • review, and if required, update scour flood model; and • prepare Incident Report.	Incident Report: description of tree loss and proposed remedial actions. Annual Report: progress of actions arising from incident report.

Flood scour risk and remedial response TARP

Trigger	Action required	Timing	Follow up actions	Reporting*
The lower riverbank and NRBZ adjacent to the active extraction area or rehabilitation area is scoured such that the top of the lower riverbank is reduced to less than 64 mAHD or the bank becomes unstable.	Install measures, eg coir matting, large rocks or rip rap, in and around the scour area to prevent erosion. Rehabilitate and revegetate area.	Within 1 week of the flood event.	Inspect area as part of the drainage, erosion and sediment control inspections: • weekly during normal operations; • daily during periods of rainfall; and • within 12 hours of the cessation of a rainfall event (greater than 10 mm) causing runoff to occur on, or from, the quarry. Undertake further stabilisation works if required. Report as an incident/non-compliance as described in Section 8 of the EMS.	Incident Report: report on extent of bank loss and proposed remedial actions. Annual Report: progress of actions arising from incident report.
Sediment from the Stage 8 area deposits in the Nepean River such that river flow is impeded.	Inspection by an appropriately qualified geomorphologist to assess the potential impacts of the deposited sediment on river flow, bank stability and flooding and to determine the rate at which the deposited sediment is likely to be removed by river flow. Inspection by an appropriately qualified aquatic ecologist to determine if the changed flow conditions are likely to cause impacts to aquatic biodiversity. If significant impacts are predicted, prepare and implement a plan to remove the sediment. The sediment will be returned to the Stage 8 area.	Inspections within 1 month of the flood event. Plan preparation within 2 months of the inspection. Required works within 2 months of plan finalisation.	To be determined as part of the sediment removal plan. Report as an incident/non-compliance as described in Section 8 of the EMS.	Incident Report: • report on extent of incident; • geomorphologist report on impacts and proposed remedial actions; and • aquatic ecologist report on impacts and proposed remedial actions. Annual Report: progress of actions arising from incident report.

* See Menangle Sand and Soil Flood Management Plan.

Appendix F

Vegetation management and site stabilisation TARP

Vegetation management and site stabilisation TARP

Trigger	Action required	Timing	Follow-up actions	Reporting*
Controlling threats				
Livestock incursions, or evidence thereof (trampling, grazing, scats) Undesirable access to the property by people, or evidence thereof (litter, vandalism).	Ongoing incidental observations.	Ongoing	Repair damage; inspect and repair fence-lines. Reseed, replant tube stock as required.	Annual Report: report any occurrences and remedial actions.
Increased feral pest sightings within Stage 8 area.	Ongoing incidental observations.	Ongoing	Baiting and trapping programs, if there is an increasing trend in feral animal sightings.	Annual Report: report any occurrences and remedial actions.
Bushfire within Stage 8 area.	Bushfire hazards are managed. Control uncontrolled burns on site as soon as possible.	Incident based	In a fire occurs: • investigate cause of burn and if any preventative measures can be taken; • review erosion and sediment control measures in the burn area; • observe recovery of vegetation; and • undertake additional seeding/in-fill planting as required.	Annual Report: report any bushfires and investigation outcomes.
Active rill, gully or tunnel erosion.	Drainage, erosion and sediment control inspections (see *Menangle Sand and Soil Quarry Soil and Water Management Plan* (SWMP) Section 8).	Weekly inspections (see SWMP Section 8.2)	Ameliorate to stop erosion as per methods in the SWMP.	Annual Report: summary of weekly inspections and remedial actions required.
Physical conditions				
Growth medium development unsuitable	Collect and analyse soil samples at selected floristic monitoring plots (see BRMP Table 8.6).	Annual	Ameliorate soil if outside desired range and is impacting plant growth and condition.	Report landform establishment and stability assessment (including growth medium development) over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in the *Menangle Sand and Soil Quarry Biodiversity and Rehabilitation Management Plan* (BRMP) Section 8.8.

Vegetation management and site stabilisation TARP

Trigger	Action required	Timing	Follow-up actions	Reporting*
Species composition				
Native trees: total foliage cover of species allocated to Tree (TG) growth form is not trending towards the benchmark range of 27.5–32.5.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Progressive revegetation Annual monitoring	If foliage cover is not trending towards target value (ie by 5 years post-establishment), increase species cover and abundance via infill seeding and/or planting.	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Native shrubs: total foliage cover of species allocated to Shrub (SG) growth form is not trending towards the benchmark range of 21–31.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Progressive revegetation Annual monitoring	If foliage cover is not trending towards target value (ie by 5 years post-establishment), increase species cover and abundance via infill seeding and/or planting.	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Native grasses (or grasslike): total foliage cover of species allocated to Grass and Grasslike (GG) growth form is not trending towards the benchmark range of 24.45–30.45.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Progressive revegetation Annual monitoring	If target value is not being met, increase species cover and abundance as early as possible (ie 2 years post-establishment). This should be achieved by planting, hydro-mulching, etc., depending upon conditions.	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Native forbs: total foliage cover of species allocated to Forb (FG) growth form is not trending towards the benchmark range of 24.45–30.45.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Progressive revegetation Annual monitoring	If target value is not being met, increase species cover and abundance as early as possible (ie 2 years post-establishment). This should be achieved by planting, soil amelioration, hydro-mulching, etc. depending upon conditions.	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Species diversity: after 5 years of management in a given area, at least 24 species characteristic of River-flat Eucalypt Forest are not present.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Progressive revegetation Annual monitoring	Undertake in-fill planting of additional species from BRMP Table 5.1 that are not growing adequately or that have died. This should be done as soon as possible (ie 2 years post-establishment).	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.

Vegetation management and site stabilisation TARP

Trigger	Action required	Timing	Follow-up actions	Reporting*
Weed cover in the rehabilitation and restoration areas is not decreasing based on annual monitoring.	Weed control as described in BRMP Section 5.5. Given the very high weed current loads, it is expected that it will take some time for weed growth to be brought under control and will require ongoing maintenance with the objective to eventually achieve a sum foliage cover of species identified as 'high threat exotic' under the Biodiversity Assessment Method (BAM) and 'priority weeds' as identified by the Local Land Services (LLS) in the relevant strategic weed management plan for the region is no more than 2%. Biodiversity monitoring (see BRMP Section 8.4).	Ongoing weed control. Annual monitoring.	Evaluate weed management methods. Consider trialling different weed management techniques. Increase intensity of weed control.	Report the results of weed mapping in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Ecosystem function				
Plant species not regenerating after disturbance event.	Implement revegetation of rehabilitation area as described in BRMP Chapters 4–6. Biodiversity monitoring (see BRMP Section 8.4).	Incident based, including inundation.	Infill seeding/planting as required.	Report floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Litter is not increasing towards the target value of 40% cover.	Biodiversity monitoring (see BRMP Section 8.4).	Annual monitoring.	If litter cover is not increasing after 5–10 years post-establishment, additional canopy species will need to be planted.	Report litter as part of floristic monitoring over the last 12 months in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.
Nest boxes are missing or are not suitable for use by the target species (see BRMP Table 7.2).	Install 106 nest boxes will be (see BRMP Section 7.5.1).	Install nest boxes prior to extraction in the Stage 8 area. Annual monitoring (see BRMP Section 8.4).	Repair damaged nest boxes. Install the deficit number of nest boxes.	Report results of nest box survey in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.

Vegetation management and site stabilisation TARP

Trigger	Action required	Timing	Follow-up actions	Reporting*
Woody debris is not installed in accordance with Consent Condition B78: • at least 400 m/ha of woody debris (ie. logs > 10 cm diam, >0.5 m long); and • at least 100 m/ha of large woody debris (ie. logs >50cm diam, >0.5 m long).	Woody debris will be placed over the ground in rehabilitation areas and pressed in or tracked-rolled to ensure intimate contact with soil to minimise the potential for erosion under the woody debris (see BRMP Section 7.5.2). Woody debris should be used to pin brush or mesh surface cover.	Once within 18 months of commencing extraction of each substage. Annual monitoring (see BRMP Section 8.4).	Install the deficit amount of woody debris. Report as an incident/non-compliance as described in Section 8 of the EMS.	Report results of woody debris survey in the Rehabilitation and Restoration Site Annual Progress Report as described in BRMP Section 8.8.

* Annual report: summarising any triggers that have been exceeded in the last 12 months and the actions taken in response; and providing a list of any incident reports in the last 12 months and reporting on the progress of follow up actions arising from each incident report.

Significant incidents in relation to this TARP are to be reported to NRAR immediately in accordance with Consent Condition D7.


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