ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

25 June 2019

Boral Land & Property Group
PO Box 6041
North Ryde NSW 2113

Attention: **Mr Adnan Voloder**
Planning & Development Manager (NSW & ACT)

Dear Adnan

Dunmore Lakes Sand Extraction Project Modification 2 (DA 195-8-2004): Response to Submissions (Perceived Environmental Risk relating to Hydrogeology and Acid Sulfate Soils)

1 Introduction

1.1 General

Environmental Earth Sciences was commissioned by Element Environment on behalf of the client, Dunmore Sand and Soil Pty Ltd to respond to submissions received from Shellharbour City Council, Kiama Municipal Council, NSW Department of Industry and NPI Fisheries for the proposed Dunmore Lakes Sand Extraction Project Modification 2 (DA 195-8-2004).

1.2 Background

Dunmore Sand and Soil (DSS) is seeking to modify the current Project Approval (DA 195-8-2004) under Section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act), to provide for an additional extraction area (Stage 5) on adjoining private land, encompassing two separate extraction areas, Stage 5A located at 471 Riverside Drive, and Stage 5B located at 69 Fig Hill Lane, Dunmore (hereafter referred to as the 'Site') (Figures 1 and 2, appended to this report).

It is understood that following approval of the proposed modification, up to 800,000 tonnes per annum (tpa) of sand will continue to be extracted across the existing DSS operations, via dredging for commercial sale. The proposal consists of an area to be disturbed of approximately 12 hectares. The excavation formed would be rehabilitated on completion of the sand extraction activities. This would see the proposed Stage 5A excavation rehabilitated with appropriately characterised material, and the Stage 5B area remaining as a pond and rehabilitated for wetland purposes.

An Environmental Assessment (EA) was submitted to NSW Department of Planning and Environment in support of the modification proposal, for review and public exhibition in February 2019.

During the public exhibition period (which concluded in May 2019) responses were received from key stakeholders including Shellharbour City Council (SCC), Kiama Municipal Council (KMC), NSW Department of Industries (DoI) and NPI Fisheries, who raised several concerns in relation to perceived environmental risks posed by the expanded sand extraction activities on identified sensitive receptors.

Specifically, concerns were raised in relation to environmental risks relating to a potentially altered hydrogeological regime and chemical impacts associated with the oxidation *in-situ* of potential acid sulfate soil (PASS), based on the findings of three assessment reports[1] prepared in support of the DA modification by Environmental Earth Sciences between 2018 and 2019.

The response provided herein specifically addresses the components of the submissions received, pertaining to perceived environmental risk.

2 Objective

The objective of this report is to provide a direct, structured response to those comments received to date from key stakeholders in relation to the perceived environmental risks (hydrogeological and/ or *in-situ* oxidation of PASS) associated with the establishment, operation and decommissioning of the Dunmore Lakes Sand Extraction Project Modification 2 (DA 195-8-2004).

3 Additional data acquisition and interpretation

Since the completion of the PASS and hydrogeological impact assessment reports in February and April 2019 respectively, further data has been acquired in the form of pressure transducer logger data, manual dips for static water levels (SWLs) and groundwater sampling from existing bores for chemical analysis. This data has been presented and summarised below, in order to assist the response to agency comments provided in Section 4 (and Tables 1 to 4).

Chart 1 provides pressure transducer data for bore MW5A1 from October 2018 to May 2019, showing the response of water-table levels to rainfall over this period with a fluctuation in SWL of between 0.4-1.0m AHD. The response to rainfall is also rapid, confirming that recharge to the aquifer is primarily via direct infiltration from the surface, with potential local run-on from outcropping bedrock.

Chart 2 provides manual dip SWL data for all bores for the same period and confirms the relative consistency of groundwater elevations over time, with bore MW5B1 being

[1] Environmental Earth Sciences (2019a) Hydrogeological Impact Assessment (HIA), Dunmore Lakes Sand Extraction Project; Environmental Earth Sciences (2019b) Acid Sulfate Soils Impact Assessment (ASSIA) at Boral Dunmore Sand & Soil-Stage 5, NSW;
Environmental Earth Sciences (2019c) DRAFT Acid Sulfate Soil Management Plan, Modification 2 (Stage 5) Dunmore, NSW (June 2019)

hydraulically up-gradient of Stage 5B and bore MW5A2 up-hydraulic gradient of Stage 5A. Groundwater flow directions are to the north-east in Stage 5A and east to south-east in Stage 5B.

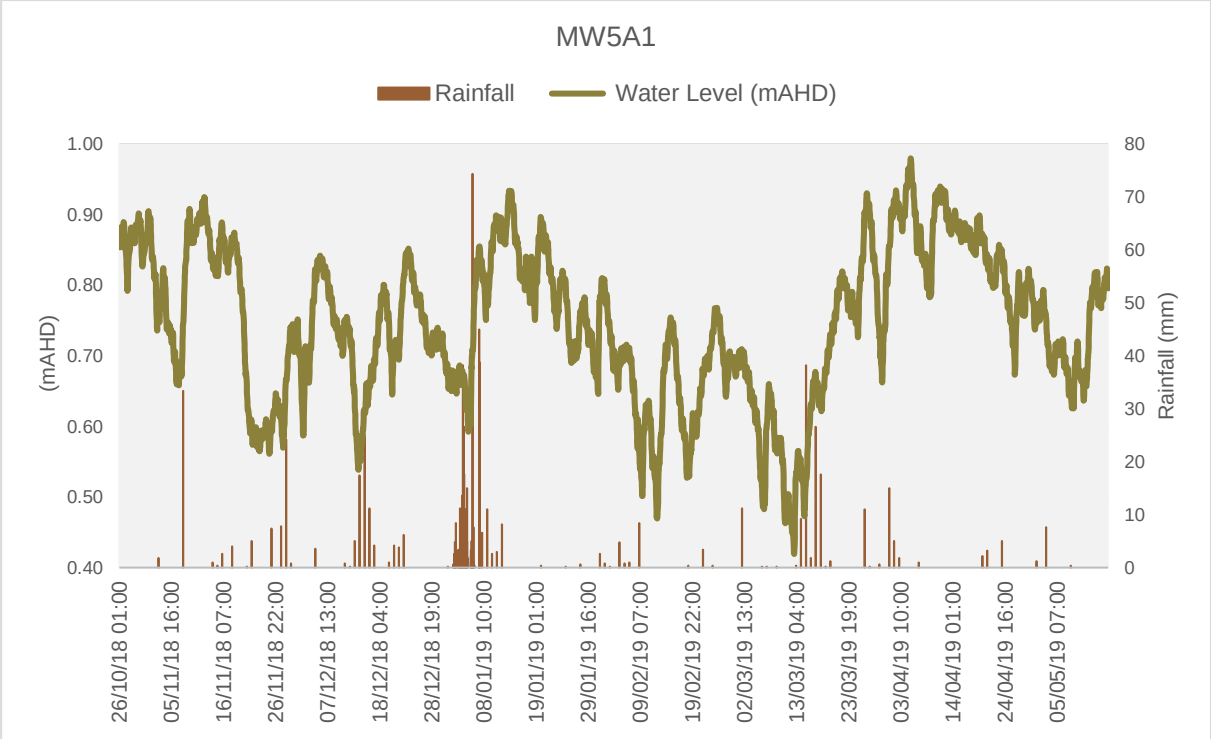


Chart 1 – Hydrograph for bore MW5A1, October 2018 – May 2019

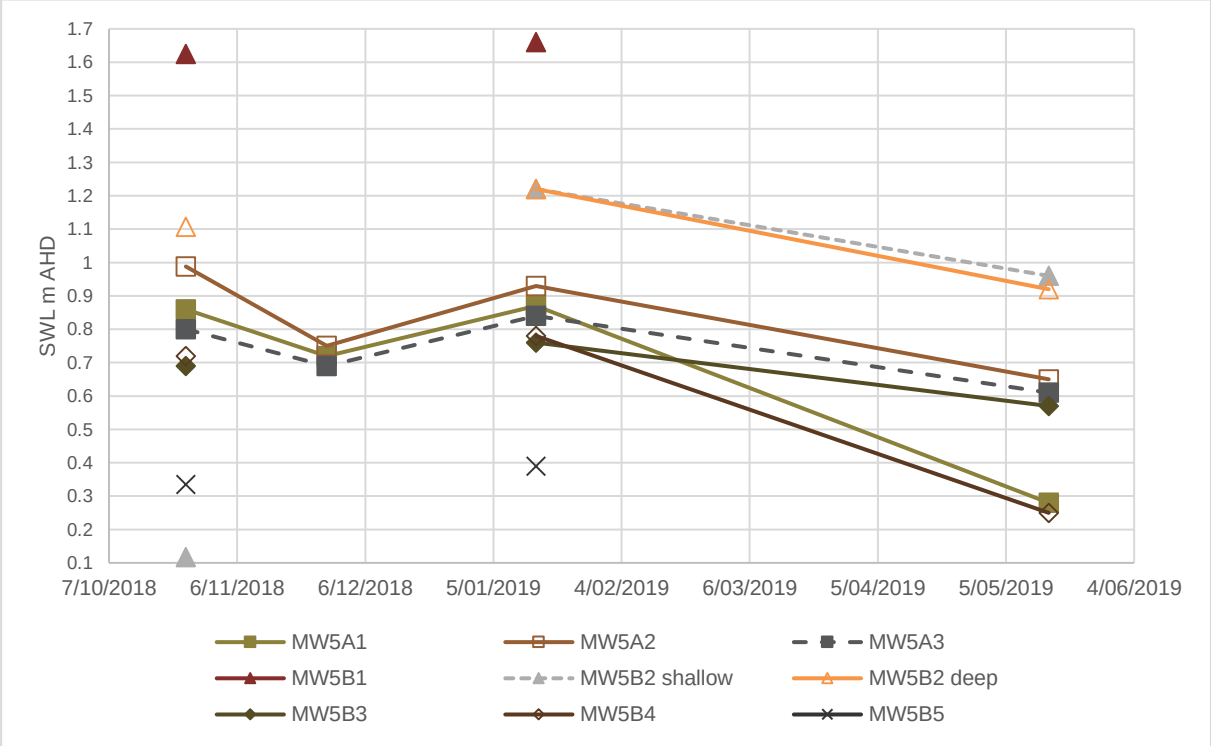


Chart 2 – Hydrograph for all bores, October 2018 – May 2019

Charts 3 and 4 show that Stage 5A bores have a wider range of salinity, with bore MW5A1 being very fresh (TDS <250 mg/L) and bore MW5A3 having the highest salinity on the site.

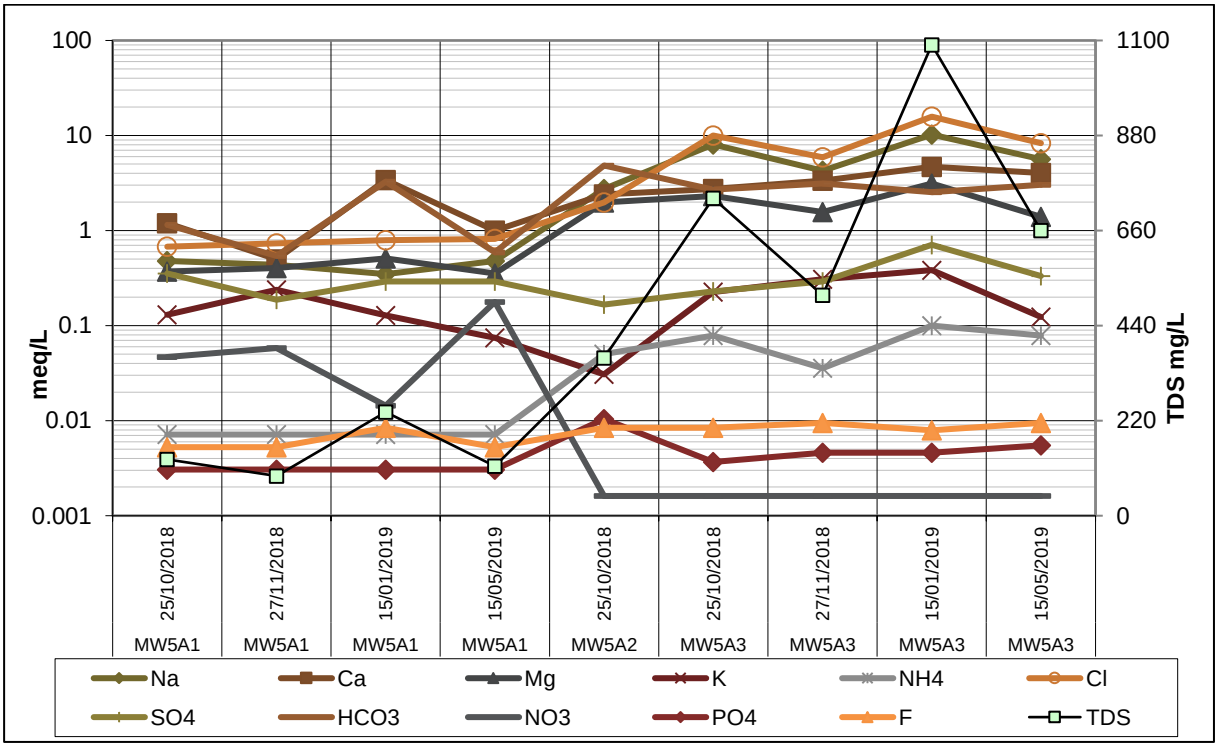


Chart 3 – Schoeller Plot for Stage 5A bores, October 2018 – May 2019

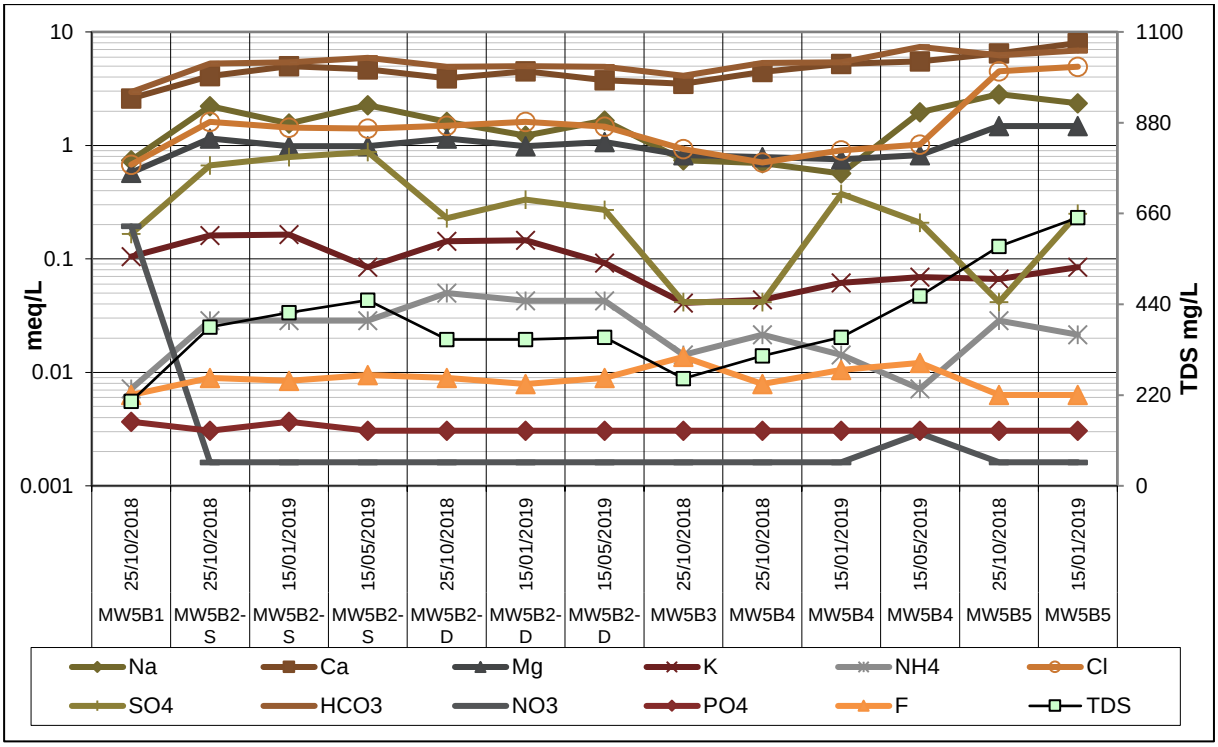


Chart 4 – Schoeller Plot for Stage 5B bores, October 2018 – May 2019

The chemistry of groundwater within Stage 5B is consistent spatially and temporally, with all bores having a salinity between 200 and 650 mg/L, pH 7 and above, and $CaHCO_3$ dominant chemistry (consistent with the frequent occurrence of shell fragments in the lithology).

4 Response to Comments

Environmental Earth Sciences has prepared directed responses to each submission received from KMC, SCC and NPI Fisheries. These responses are presented in tabulated format in relation to individual submission comments/ requests for clarification in Tables 1 to 4 below.

In addition, Environmental Earth Sciences determination is that based on the data obtained, and methodology of extraction proposed, it can be concluded that the Minnamurra River and estuary will be protected from any impacts associated with the Stage 5 dredging proposal.

Whilst groundwater from Stage 5B migrates to the river (see Figures 3 and 4 of this report), the creation of a lake at Stage 5B is not predicted to alter the hydrogeological regime, being natural movements of groundwater, or groundwater chemistry from current conditions. As such, it is concluded that the proposal has a low overall level of risk of impact on the river ecosystem and other potential receptors (e.g. recreation, fishing, stock-watering, water quality).

5 Conclusions and Recommendations

In summary, in relation to the tabulated responses provided in Tables 1 – 4 below, although the consequences associated with the identified environmental risks range from moderate (chemical impacts associated with PASS oxidation) to low (physical impacts associated with negligible anticipated changes to the local hydrogeological regime) these consequences, based on the extraction methodologies proposed and the findings of both the HIA and ASSIA are unlikely to be realised.

Environmental Earth Sciences considers that any residual environmental risk can be further mitigated and/ or managed provided appropriate monitoring and management regimes are established at the site prior to the commencement of extraction activities, and that these are continued during extraction and for a specified period following remediation, post closure.

Specifically, to minimise the residual risk it is recommended that:

- PASS management options to ensure sediments below the site surface remain saturated, and related management measures to ensure that acid leachate is not produced, be implemented through an ASS management plan, requiring that:
    - excavation works commence by mining the shallow sand material (above the water-table) and work to depth;
    - once the excavation extends in depth greater than 1-2m below the ground surface some groundwater ingress may commence;

Table 1: Responses to Comments (Shellharbour Council)

#No	Shellharbour City Council	
	Council Review Comment/ Request for Clarification	**Environmental Earth Sciences Response**
ASS/ PASS		
1	The PASS finds the greatest risk to groundwater resources and downstream receptors is the potential chemical impact as a result of oxidisation and subsequent acidification of in situ potential acid sulfate soil (PASS) within the Stage 5A area.	This is correct. During the field investigation, undertaken as part of the Acid Sulfate Soils Impact Assessment (ASSIA)[2] for the proposed expansion project, the full extent of the proposed dredging profile was examined. Of the eight locations assessed across the site, PASS, material was confirmed underlying the Stage 5A area *only*, in the vicinity of two boreholes (MW5A2 and MW5A3) from a depth of up to 4 metres below ground surface (m bgs), representing an estimated 136,800 m^3 of sand material. Given PASS has been confirmed underlying Stage 5A and the nature of the development is such that the disturbance of PASS is unavoidable, the risk of *in-situ* oxidation of PASS and subsequent acidification and release has been deemed moderate. However, it should be noted that the likelihood of this risk being realised is deemed low, given appropriate management and mitigation measures are proposed to be deployed at the site during and post sand extraction, and will be detailed in an acid sulfate soil management plan (ASSMP[3]). The preferred management strategy is detailed in section 5 of this letter.
2	The borehole log for test sites within Stage 5B in the PASSA show consistent pH readings including up to 9.6pH at 17m (MW5B2) and commonly above 9 pH. Note: borehole results for 5B area generally indicates an increase in pH at 3-3.5m depth. This poses a risk of leachate from soils well below natural groundwater levels (measured at 0.9-3.31m) contaminating groundwater, as under the proposal, groundwater would interface with soil strata well below this depth. The PASS assessment finds all soils sampled in 5B are not ASS or are non-reactive, stating "it is reasonable to extrapolate that a natural buffering capacity does exist across Stage 5B due to the presence of shell grit within sand deposits". Environmental Earth Scientists state Boral has requested an Acid Sulfate Soil Management Plan (ASSMP) be prepared in accordance with the Acid Sulfate Management Plan Guidelines (Acid Sulfate Advisory Committee 1998). This management plan must also include pH monitoring for Stage 5B and any management actions required to mitigate against the potential impacts from potential acidic leachate contaminating groundwater. This risk is not identified in any reporting as reviewed and needs to be quantified and the potential consequences considered in order to determine management actions and assess the acceptable level of risk.	The results of the field assessment within the Stage 5B area confirmed that samples collected throughout the vertical soil profile could be classified according to pH screening and/or laboratory confirmatory testing as: • NASS – Not acid sulfate soils; or • NRNR – No risk non-reactive i.e. these soils are completely self-buffering & do not require management through neutralisation if oxidised. Those soils designated NASS can be discounted from further consideration in relation to a potential acid sulfate soil risk. Those soils designated as NRNR retain a very low risk as, although acid could be generated following exposure and oxidation, these acids would be neutralised by the inherent buffering capacity of the soil. In the case of soils in Area 5B, this buffering capacity is attributable to shell grit ($CaCO_3$) which naturally occurs within the sand deposits. Accordingly, while Environmental Earth Sciences concurs that ongoing monitoring of water levels, field parameters and laboratory assessment should occur for Area 5B at regular intervals to monitor changes in static water level (SWL) and chemistry (as per the recommendations of the ASSMP) as part of a proactive monitoring regime, the likelihood of acidic leachate generation and release, resulting in environmental impacts from soils classified NRNR on exposure to air, is deemed low. Furthermore, as per the findings of the Hydrogeological Impact Assessment (HIA)[4] the likelihood of significant acid generation and release, even from the exposure and subsequent oxidation of known PASS materials is deemed low given: • No dewatering is required during the proposed sand extraction activities. Sand will be extracted via dredging activities which will see the majority of water drain back into the dredge pond thus preventing a lowering of the groundwater table; and • The aquifer underlying the site is likely to be subject to rapid recharge (dune lithology) with an anticipated 70% infiltration rate, further preventing impacts (i.e. lowering) of the groundwater table across the site. Accordingly, there is deemed to be a low risk of the exposure and subsequent oxidation of localised instances of PASS. It is noted that excavated (*ex-situ*) PASS will also be managed appropriately to minimise the likelihood of oxidation and acidification of disturbed materials with any fine fractions (typically containing the reactive sulfides) removed and returned to the base of the dredge pond (i.e. reburied) during the necessary processing of dredged materials for preparation as a commercially viable sand product, for sale. Based on the available information, Environmental Earth Sciences considers that the management and monitoring actions specified within the ASSMP, primarily designed to mitigate the risks of acid generation from the PASS located in Area 5A are also suited to ongoing, proactive and conservative management of NRNR soils in Area 5B. i.e. • During sand extraction, sands should be sieved, and fines reburied below the water-table to prevent oxidation; • On completion of extraction activities in the Stage 5B area, the area should be converted to a wetland to further facilitate water-table recharge and a return to natural conditions; and • All bores within both the Stage 5A and 5B areas should be monitored at regular intervals during sand extraction and post closure in accordance with the recommendations of the ASSMP to monitor changes in SWL and chemistry (field and laboratory analysis). This monitoring should continue until such time that it can be demonstrated that SWLs are at steady state, in equilibrium with the surrounding environment and not facilitating oxidation of *in-situ* PASS (where present) and/ or soils designated NRNR. ○ Should bores be destroyed during the extraction activities, replacement bores will be installed to facilitate ongoing monitoring, to a minimum depth of 6 m bgs.

[2] Environmental Earth Sciences (2019b) Acid Sulfate Soils Impact Assessment at Boral Dunmore Sand & Soil-Stage 5, NSW
[3] Environmental Earth Sciences (2019c) DRAFT Acid Sulfate Soil Management Plan, Modification 2 (Stage 5) Dunmore, NSW (June 2019) – consultation with agencies is yet to occur for the formulation of this document.
[4] Environmental Earth Sciences (2019a) Hydrogeological Impact Assessment, Dunmore Lakes Sand Extraction Project

#No	Shellharbour City Council	
3	Given the risk of impact posed by Acid Sulfate Soil and Potential Acid Sulfate Soil and sensitivity of the receiving ecological communities and aquatic habitat, Council recommends that an ASSMP be prepared and submitted prior to approval. The ASSMP must be prepared in accordance with the Acid Sulfate Management Plan Guidelines (Acid Sulfate Advisory Committee 1998). This management plan must also include pH monitoring for Stage 5B as well as any management actions required to mitigate against the potential impacts from potential acidic leachate contaminating groundwater.	An ASSMP will be prepared for the proposed Dunmore Stage 5 Extraction Project by Environmental Earth Sciences in consultation with relevant agencies. A draft document has been prepared, however it is considered that finalisation of this management strategy cannot occur until the statutory implications associated with the approval are rationalised, and any implications which may arise in the course of the assessment are considered. It is noted that the ASSMP will be assessed by NSW EPA, in line with any additional requirements contained within an amended EPL, to take into account the new extraction areas. Councils request is noted. The draft ASSMP includes information on the proposed monitoring and management actions to be implemented at the site, prior to, during and on completion of the proposed extraction activities. Refer to Response 2 above in relation to anticipated risk and response actions for Stage 5B.
Surface Water/Groundwater		
4	**Groundwater:** i) While there is expected to be a net deficit in water levels due to evaporation and localised changes to groundwater movement at the 5A area, these impacts are minimal in the context of the wider Minnamurra River catchment area of 120 km^2. Significant change in groundwater levels and/or impacts to the adjacent and downstream environments has not been considered nor anticipated. ii) With regard to chemical changes or contamination to groundwater, the Hydrogeological Impact Assessment Report (HIA) determines a low risk of impact from vegetation removal, dredging and site remediation. The risk of impacts from acid sulfate and soil oxidisation of potentially acid sulfate soil to groundwater is determined to be moderate and is considered under 'Acid Sulfate Soil" above. An ASSMP is required prior to approval and must include monitoring and control measures as required for both stages 5A and 5B.	i) Significant change in groundwater levels and/or impacts to adjacent and downstream environments is not anticipated given the proposed excavation methodology will not cause significant changes to either the hydrogeological flow regime (flow direction) or SWLs. ii) Please refer to Response 3, above.
5	**Water Quality** i) Potential impact on water quality to Rocklow Creek and Minnamurra River are from sedimentation resulting from soil disturbance as well as groundwater contamination as discussed above. ii) With regard to sedimentation management, adequate measures must be implemented to ensure material cannot move from the site and contaminate downstream environments. The summary report states that this will be addressed in updates to the current Environmental Management Plan.	Appropriate sedimentation controls to minimise any potential impact on the water quality of Rocklow Creek and the Minnamurra River should be deployed prior to the commencement of extraction activities within the Stage 5A and 5B areas and be maintained until such time as extraction has been completed. Details pertaining to these controls will be provided by way of an updated Environmental Management Plan and clarifications provided in a draft ASSMP, which can be circulated to agencies for comment subsequent to modification approval, for implementation prior the commencement of extraction activities.

Table 2: Responses to Comments (Kiama Council)

#No	Kiama Municipal Council	
	Council Review Comment/Request for Clarification	**Environmental Earth Sciences Response**
Surface Water/Groundwater		
1	**Groundwater Hydrology and Acid Sulfate Soils** The potential change in the groundwater hydrology and its impact upon the groundwater movement in the vicinity of the Minnamurra Waste and Recycling Depot and its likely effect on the water quality in Rocklow Creek and Minamurra River Estuary is an issue that needs further investigation. If this issue is not further investigated and managed properly there may be the potential that the groundwater under the landfill could move towards the dredging site or the adjoining Minnamurra River estuary ecosystem.	Interaction with the Minnamurra Waste and Recycling Depot is unlikely to occur. The existing groundwater bores at the site were surveyed in January 2019 and an updated groundwater contour figure for October 2018 and January 2019 (Figures 3 and 4 respectively) generated to facilitate an updated assessment of the groundwater flow regime. In addition, refer to the discussion and additional information on groundwater flows spatially and temporally in Section 3.0 above. The assessment confirmed: • The overall groundwater flow direction in the vicinity of Area 5A is toward the north east and the Minnamurra Waste and Recycling Facility. Thus, groundwater underlying the landfill is not currently moving towards the proposed extraction site nor toward the adjoining Minnamurra River Estuary Ecosystem. It is noted that this groundwater flow regime has remained consistent, with minimal variation throughout the four groundwater monitoring events completed in October 2018, November 2018, January 2019 and May 2019 and the associated continual groundwater level measurement performed over this period (which is on-going). See Charts 1 and 2 above. • In order for groundwater from beneath the landfill to move toward the proposed Stage 5A expansion site, Environmental Earth Sciences considers a significant alteration in the current groundwater flow regime would be required, triggered by significant drawdown at the project site creating a cone of depression extensive enough to draw in groundwater underlying the landfill site over 50 m away. Based on the information provided to date, the generation of such a cone of depression associated with the proposed Stage 5 extraction activities is deemed unlikely as: • Minimal dewatering is required during the proposed sand extraction activities. Sand will be extracted via suction dredge that will operate

#No	Kiama Municipal Council	
		from a barge on the lake that is to be created by the extraction excavation extending below the water-table; and • The majority of <u>water removed during dredging will drain back into the dredge pond</u> thus preventing a lowering of the water-table. ○ It is also noted that recharge from rainfall is rapid (see Chart 1 in Section 3 above), further preventing impacts to the groundwater table across the site. Given the above, active management is not deemed necessary. However, it is recommended that all bores within both the Stage 5A and 5B areas are monitored at regular intervals during sand extraction and post closure to monitor changes in SWL and chemistry (field and laboratory analysis). This monitoring should continue until it can be demonstrated that SWLs are at steady state, in equilibrium with the surrounding environment.
2	**Groundwater and Surface Hydrology Assessment and Testing** **Kiama council recommends that:** a) Prior to an operational approval being granted by NSW Department of Planning & industry for the proposed Stage 5A sand extraction site an additional comprehensive hydrological assessment is to be undertaken to assess any potential changes in the groundwater movement in the vicinity of the Minnamurra Waste and Recycling Depot and towards the Stage 5A sand extraction site. The report is to identify all issues of concern including liability considerations of the groundwater hydrology does change in future and any recommended environmental control works and ongoing groundwater hydrology and water quality testing required. b) Kiama Principality Council and NSW EPA is to be consulted prior to conducting and upon completion of the outcomes and any recommendations contained in the additional comprehensive hydrological assessment report. c) Any groundwater and surface water hydrological and water quality testing is to be undertaken to coincide with the dates and times of quarterly monitoring and surface testing as required to be undertaken by Kiama Municipal Council & NSW EPA as part of the Minnamurra Landfill Depot Closure Plan. d) Kiama Municipal Council is to be provided with copies of all groundwater and surface water testing results on a quarterly basis and in any environmental monitoring reports.	a) Please refer to Response 1 above. Environmental Earth Sciences do not consider that additional, detailed hydrogeological assessment in this area is warranted, given the current and anticipated groundwater flow regime in this area, taking into account the minimal drawdown and negligible impacts on the local hydrogeological regime associated with the proposed site activities. It is our view that the HIA report does consider all issues and recommends a monitoring program that will identify changes to the groundwater hydrology and chemistry. b) Please see Response 2a above. c) Environmental Earth Sciences agree that the proposed groundwater and surface water hydrogeological and water testing could be undertaken to coincide with the existing quarterly monitoring regime required in accordance with the Minnamurra Landfill Depot Closure Plan, provided such times align with timings/ frequencies required by DPE/ EPA. d) Groundwater data and analytical results are already published by the site on an annual basis, and are available for download from the Boral Dunmore website. In the interests of transparency, we submit that Kiama Council should also publish their results online.
3	**Porosity, Permeability and Testing of VENM** The porosity and permeability of the imported soil that will be used to backfill the proposed dredged pond in the Stage 5A can also result in significant changes to the hydrology of the catchment area and impacts associated with increased acid sulfate soils generation. The environmental assessment report does not contain details of requirements relating to the porosity and permeability by standards to be achieved by the imported soil to be used to backfill the proposed dredged pond at Stage 5A. To prevent any significant changes in the groundwater hydrology in the catchment area, including in the vicinity of the Minnamurra Waste and Recycling Facility, it is important that the soil used for backfilling be of a similar porosity and permeability currently located on the Stage 5A site. The backfill soil to be used must also be tested and certified that it meets this requirement.	Environmental Earth Sciences disagrees with Council's interpretation provided herein. Environmental Earth Sciences considers that materials used to backfill the proposed dredge pond at Stage 5A will have a negligible impact on local hydrogeology and potential acid sulfate soil oxidation. While the reinstatement of the excavation with VENM will likely have the physical impact of decreasing bulk porosity of the aquifer matrix within the proposal site footprint due to the expected finer texture, the consequence of this is deemed to be minor. Accordingly, the provision of detailed porosity and permeability specifications are unwarranted. Environmental Earth Sciences do not concur that the backfilled soil must be of a similar porosity and permeability to that located on the Stage 5A site, as this material is proposed to be extracted as a commercial resource. It would make no commercial sense to backfill with the same material that was extracted. Furthermore, it is noted that the natural soil landscape both at Stage 5A and in the broader area are described as "Mangrove Creek Soils" which are highly variable, with a wide porosity and permeability range. Accordingly, we consider that any certified non-PASS VENM imported under appropriate receival protocols, accompanied by appropriate certification/ test certificates to validate will be suitable to backfill the excavation.

Table 3: Responses to Comments (NSW Department of Industries)

#No	NSW Department of Industries	
	Council Review Comment/Request for Clarification	**Environmental Earth Sciences Response**
Surface Water/Groundwater		
1	The location of the excavations cannot be within 200m of a high priority groundwater dependent ecosystem (GDE) as listed in the *Greater Metropolitan Region Groundwater Sources Groundwater Sharing Plan 2011 (Metropolitan Coastal Sands Water Source).* The boundaries of the two excavations (5a and 5b) must be amended to comply with the GDE rules of the Water Sharing Plan to allow the proposal to be considered for approval.	It is understood that the Minnamurra River and wetlands are listed as a high priority GDE (Figure 4) in Clause 1 of Schedule 4 of the Water Sharing Plan, which states: ***41 Rules for water supply works located near sensitive environmental areas*** *(1) A water supply work approval must not be granted or amended to authorise the construction of a water supply work which, in the Minister's opinion, is located:* *(a) within 100 metres of a high priority groundwater dependent ecosystem listed in clause 1 of Schedule 4 in the case of a water supply work solely for basic landholder rights,* *(b) within 200 metres of a high priority groundwater dependent ecosystem listed in clause 1 of Schedule 4 in the case of a water supply*

<table>
<tr><th>#No</th><th>NSW Department of Industries</th><th></th></tr>
<tr><td></td><td></td><td>work not solely for basic landholder rights.
However, it is noted, in accordance with Clause 2:
(2) The distance restrictions specified in subclause (1) (a) and (b) do not apply to the grant or amendment of a water supply work approval if the Minister is satisfied that no more than minimal drawdown of water will occur at the perimeter of any groundwater dependent ecosystem listed in Clause 1 of Schedule 4 of this Plan as a result of the grant or amendment of the water supply work approval.
Based on the findings of the HIA, alongside the proposed dredging methodologies to be employed at the site and their minimum anticipated impact to the local groundwater regime, Environmental Earth Sciences considers that there is sufficient justification for Clause 2 to take effect should approval from the Minister be received, negating the requirement for excavation boundaries to be adjusted.
Specifically, in relation to the applicability of Clause 2 to the proposed development scenario, based on the assessment completed to date it is noted:
• Minimal to no dewatering is required during the proposed sand extraction activities. Sand will be extracted via suction dredge that will operate from a barge on the lake that is to be created by the extraction excavation extending below the water-table;
• The majority of water removed during dredging will drain back into the dredge pond thus preventing a lowering of the water-table; and
• Recharge is rapid in this lithology (infiltration anticipated at around 70%) therefore, rainfall will rapidly recharge the aquifer, further preventing impacts to the groundwater table across the site (see Chart 1 in Section 3 above).
The above notwithstanding, it should also be noted, given the proposed modification is a transitional Part 3A project, by virtue of section 75U(1) of the EP&A Act, the provisions of the WM Act in regard to water use approvals under Section 89, a water management work approval under Section 90 or an activity approval under Section 91 may not be applicable to the development.</td></tr>
<tr><td>2</td><td>Provide historic (during and post mining) data on water quality (EC and pH) within the adjacent Stage 1 pond</td><td>Environmental Earth Sciences understands that historic water quality data for Stage 1 will be released to DoI by the proponent.</td></tr>
<tr><td>3</td><td>Estimate the volume of aquifer material to be removed from the excavations, and the effect of this on groundwater inflow during sand extraction. The aquifer material volume/ removal rate must to be accounted for, and water balances updated and presented for both extraction and non-extraction scenarios.</td><td>A site water balance for the sand extraction scenario, based on the findings of a detailed hydrogeological desktop review and field assessment was completed for the site as part of the HIA and pertinent details, reproduced in italic type, below.
• Groundwater flux (Q) beneath the Stage 5A extraction area, assuming a maximum path area of 3,600 m^2 (300 m length by 12 m thickness of aquifer), K of 20m/day and hydraulic gradient of 0.002 m/m, is estimated at 144 m^3/day (53 ML/a); and
• Groundwater flux (Q) beneath the Stage 5B area, assuming a maximum cross-section flow path area of 5,680 m^2 (355 m length by 16 m thickness of aquifer), K of 15 m/day and hydraulic gradient of 0.007 m/m, is estimated at 600 m^3/day (220 ML/a).
As the entire aquifer has an estimated cross-sectional area of discharge from the south-west to the north-east of 6,750 m^2 (450 metre wide corridor of the northern boundary between the Latite elevations to the north of the Stage 5B extraction area and a similar length directly north of the north eastern boundary of the Stage 5A extraction area with an average thickness of 15 m), discharge volumes are estimated (under a hydraulic gradient of 0.005m/m and K of 20 m/day) at 675 m^3/day (250 ML/a).
Based on the total Site area of close to 12 hectares (120,000 m^2), it can be estimated that an average of close to 125,000 m^3 (125 ML, or 340 m^3/day) of rainfall falls on the Site per annum, 30% of which (37 ML/a or 100 m^3/day) is expected to recharge the aquifer and the remainder (88 ML/a or 240 m^3/day) is expected to discharge as surface flow.
It has been assumed that evapotranspiration is approximately 70% of recharge, and that the extracted sand will contain approximately 8% moisture and be removed at a rate of 450,000 tonnes per annum. Accordingly, a site water balance for the sand extraction scenario, based on these calculations is provided, below (‘Pre-lake’ scenario).
<table>
<tr><th>Parameter</th><th colspan="2">Inflow (m^3/day)</th><th colspan="2">Outflow (m^3/day)</th></tr>
<tr><th>Scenario</th><th>Pre-lake</th><th>Lake</th><th>Pre-lake</th><th>Lake (post-closure)</th></tr>
<tr><td>Recharge</td><td>100</td><td>340</td><td></td><td></td></tr>
<tr><td>Groundwater inflow</td><td>675</td><td>675</td><td></td><td></td></tr>
<tr><td>Evapotranspiration/ Evaporation</td><td></td><td></td><td>70</td><td>366</td></tr>
<tr><td>Sand extraction + Dust suppression</td><td></td><td></td><td>0</td><td>49+70 (0+0)</td></tr>
<tr><td>Groundwater Outflow</td><td></td><td></td><td>675</td><td>675</td></tr>
<tr><td>TOTAL</td><td>775</td><td>1015</td><td>745</td><td>1160 (1041)</td></tr>
</table>
As the entire 120 km^2 Minnamurra River catchment including the site is calculated to accumulate and discharge close to 120,000,000 m^3 (120,000 ML) in an average rainfall year, the site groundwater component of catchment discharge can be seen as being minimal (<0.21% of total catchment discharge).
A water balance has also been completed for the extraction and post-extraction scenarios (Southeast Engineering and Environmental, 2019) and is also summarised in the table above. Based on the above, the extraction scenario is anticipated to have a negligible effect on the existing hydrogeological regime, particularly following closure. It is anticipated that the excavation of aquifer sediments will temporarily increase the area</td></tr>
</table>

#No	NSW Department of Industries	
		available for water storage on site, with this process reversed and the temporary increased storage volume returned back to near pre-excavation levels following rehabilitation/ reinstatement of Stage 5A.
4	The necessary licences and approvals under the Water Management Act must be obtained for extraction of groundwater from the *Metropolitan Coastal Sands Groundwater Source* of the *Greater Metropolitan Region Groundwater Sources 2011.*	Environmental Earth Sciences understands that all necessary licences under the Water Management Act will be obtained prior to the commencement of the proposed site activities.
ASS/PASS		
5	(i) Describe the process that will be used to determine if Potential Acid Sulfate Soils (PASS) may be disturbed by altered hydrogeological conditions from dredging. (ii) Provide an estimate of the volume of acid sulfate soil that will be removed from the excavation(s) and deposited back in the pond(s), including the minimum deposition depth below the water table. (iii) Specify a timeframe for developing an acid sulfate soils management plan, should it be determined that potential acid sulfate soils (PASS) may be disturbed by altered hydrogeological conditions from dredging.	It is proposed that an ASSMP be finalised prior to the commencement of works associated with the proposal. A draft ASSMP was prepared for the proposed Dunmore Stage 5 Extraction Project by Environmental Earth Sciences, and will seek to include information on the proposed monitoring and management actions to be implemented at the site, prior to, during and on completion of the proposed extraction activities. The ASSMP includes commentary for both Stage 5A and Stage 5B. This ASSMP will be reviewed and revised (as necessary) to ensure each of these comments are adequately addressed prior to final submission, and subject to further consultation with relevant agencies.

Table 4: Responses to Comments (NPI Fisheries)

#No	NPI Fisheries	
	NPI Fisheries Review Comment/Request for Clarification	**Environmental Earth Sciences Response**
ASS/PASS		

1	Clarification on how impacts from the potential oxidation of 600 m^3 of Potential Acid Sulfate Soil around the perimeter of the excavation site will be monitored and mitigated. DPI Fisheries requests the opportunity to provide comment on the Acid Sulfate Soil Management Plan prior to its implementation.	A number of monitoring recommendations were made in the ASSMP which are to be formalised in an update to the existing GMMP[5], prepared for DSS, on determination of the Stage 5 expansion proposal.
		• The GMMP forms a subplan to the Water Management Plan (WPM) prepared in accordance with Schedule 3 (34) for the existing Development Consent DA 195-8-2004 (2004) for Stages 2, 3 and 4. The GMMP describes the objectives of the groundwater management and monitoring and details the proposed types and locations of monitoring. It also describes the monitoring observations which would trigger actions and the proposed action and/or mitigation measures to be deployed should triggers be exceeded.
		The recommendations include:
		• Maintenance of the existing monitoring well network. Acknowledging up to five monitoring bores (MW5A, MW5A2, MW5A3, MW5B1 and MW5B2) are likely to be destroyed during dredging and thus will need to be replaced, and the replacements surveyed for relative height to Australian Height Datum (m AHD) with at least 0.001 m accuracy to facilitate comparison of relative groundwater levels;
		• Monthly measurement of SWL and pond water level AHD heights during excavation, reinstatement and rehabilitation works (bores only). With all seven (existing and proposed) bores incorporated into the existing quarterly monitoring program for the wider quarrying site following rehabilitation;
		• Monthly measurement of pH in all seven bores and the pond during excavation and rehabilitation works; and
		• Quarterly sampling of all monitoring bores for
		  ○ field parameters (pH, EC, ORP, SWL, DO and temperature) and
		  ○ laboratory analysis (full ionic balance suite – pH, TDS, cations, anions, nutrients and dissolved iron.
		The ASSMP will be reviewed and revised (as necessary) to ensure this comment is adequately addressed prior to final submission, subsequent to approval of this modification.

[5] Environmental Earth Sciences NSW (2018). Groundwater monitoring and management plan, Boral Dunmore Sand and Soil. Report number 118076_v2 to Boral Dunmore Sand and Soil Pty Ltd.

    - manage the on-going excavation of sand materials (containing PASS) by sieving the fines out of the excavated material and returning fines to the excavation (under the water-table) immediately;

- all ongoing environmental monitoring recommendations made with respect to surface water and groundwater are formalised in an update to the existing GMMP to encompass the proposed Stage 5 area.

This will allow a proactive monitoring regime to be established so that in the event of unforeseen circumstances (i.e. early indications of acid generation) appropriate management actions will be triggered before environmental impacts are realised.

6 Limitations

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific scope of works requested by E Mail as a variation to PO117066_VAR5 (Project 118044) requested by Luke Farrell for and on behalf of Element Environment;

2. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);

3. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;

4. The report only relates to the site referred to in the scope of works being located at the proposed Dunmore Stage 5 Expansion Project (Lot 501 DP1174897 and Lot 51 DP1012246) (“the site”);

5. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;

6. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;

7. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill, excavated natural material (ENM) or virgin excavated natural material (VENM) if deposited off site;

8. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and

9. Our General Limitations set out at the back of the body of this report.

Should you have any queries, please do not hesitate to contact us on (02) 9922 1777 or (07) 3852 6666.

For and on behalf of
Environmental Earth Sciences NSW

Author
Kat Spruth
Senior Environmental Scientist

Project Director / Internal Reviewer
Mark Stuckey
Senior Principal, Hydrogeologist and Soil Scientist

118044 Ltr1 v2

7 References

Environmental Earth Sciences (2019a). Hydrogeological impact assessment (HIA), Dunmore Lakes Sand Extraction Project Modification 2 (Stage 5), Dunmore, NSW. Report reference 118044_v4, 26 February 2019.

Environmental Earth Sciences (2019b). Potential acid sulfate soils assessment, Dunmore Lakes Sand Extraction Project Modification 2 (Stage 5), Dunmore, NSW. Report reference 118044_PASS_v3, 25 February 2019.

Environmental Earth Sciences (2019c). DRAFT Acid Sulfate Soil Management Plan at Boral Dunmore Sand & Soil – Stage 5, Dunmore, NSW.

Environmental Earth Sciences NSW (2018). Groundwater monitoring and management plan, Boral Dunmore sand and soil. Report number 118076_v2 to Boral Dunmore Sand and Soil Pty Ltd.

Southeast Engineering and Environmental (2019). Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand Project. Report Prepared for Element Environment, on behalf of Dunmore Sand & Soil Pty Limited, February 2019.

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

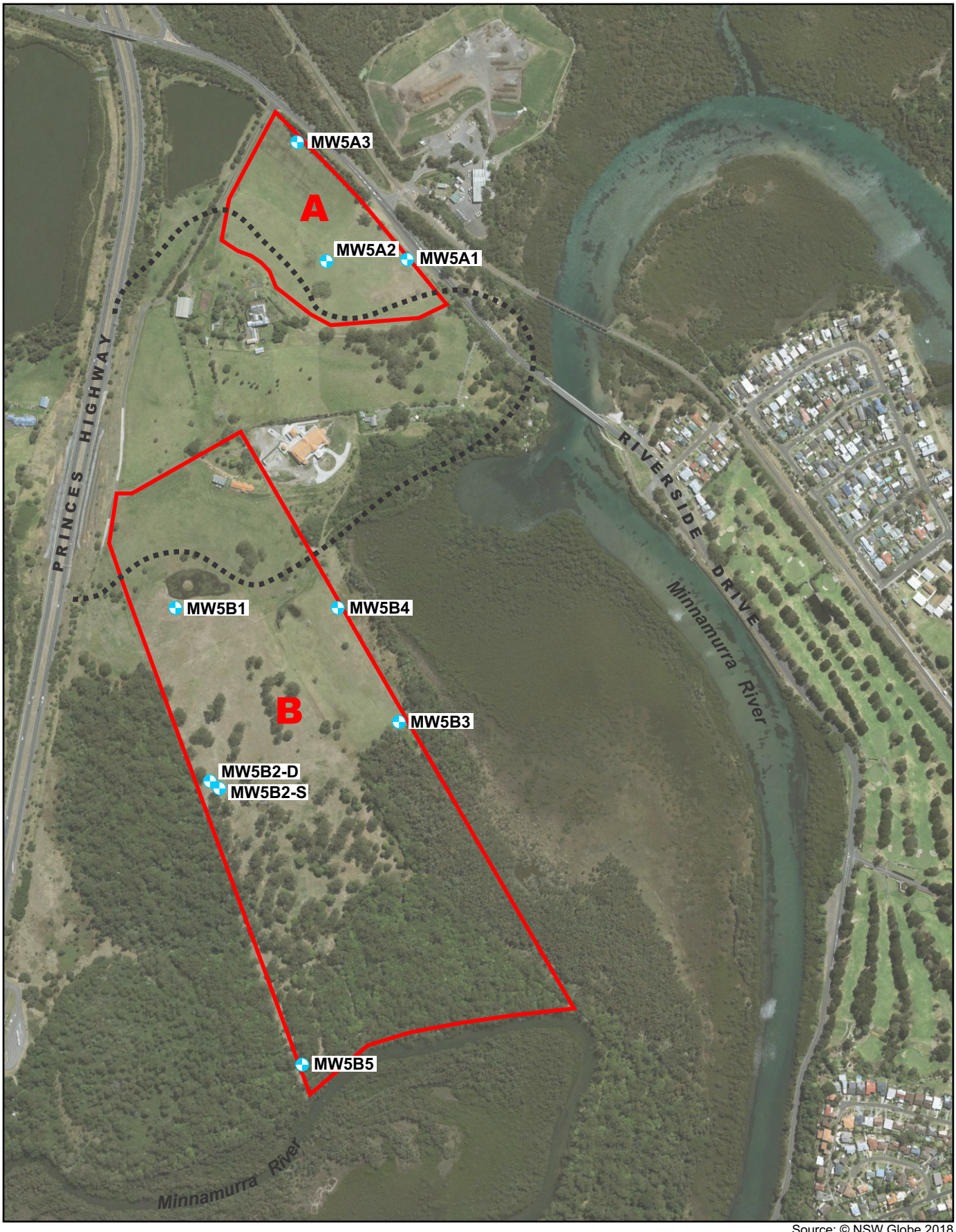
0 1000

Scale in Metres

Source: © Google Maps

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Locality Map**
Location:	**Boral Dunmore Sand and Soil - Stage 5**
Client:	**Element Environmental**
Job No:	**118044**
Project Man:	**EG**
Scale:	**As Shown**
Drawn By:	**LB**
Date:	**January 2019**
	Figure 1



Source: © NSW Globe 2018

LEGEND:

- Lot boundary
- Monitoring well location
- Latite

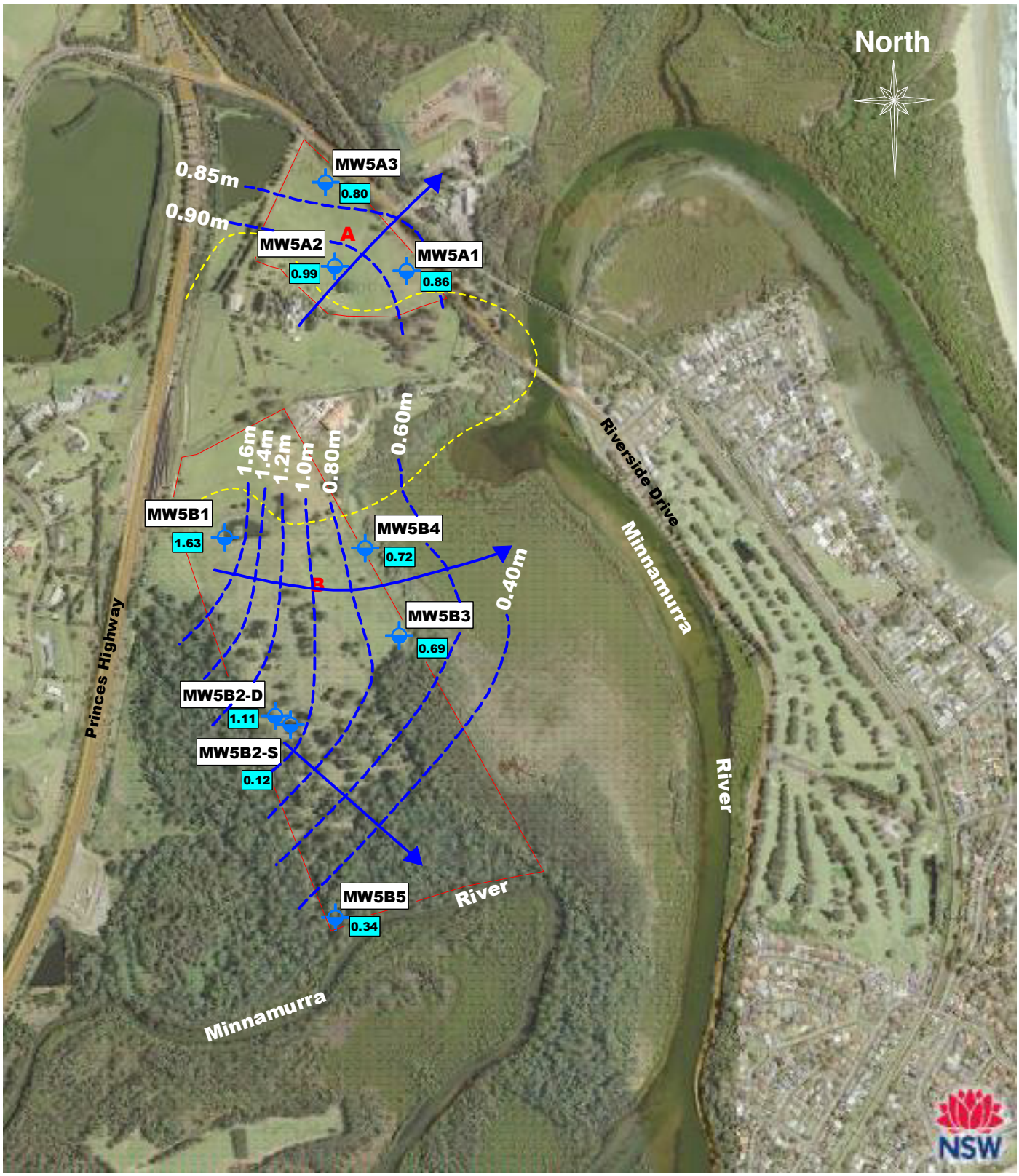
0 250

Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Layout and Borehole Locations**
Location:	**Boral Dunmore Sand and Soil - Stage 5**
Client: **Element Environmental**	Job No: **118044**
Project Man: **EG**	Scale: **As Shown**
Drawn By: **LB**	Date: **January 2019**

Figure 2



Reference: NSW Spatial Information Exchange digital image 2019.

Legend:

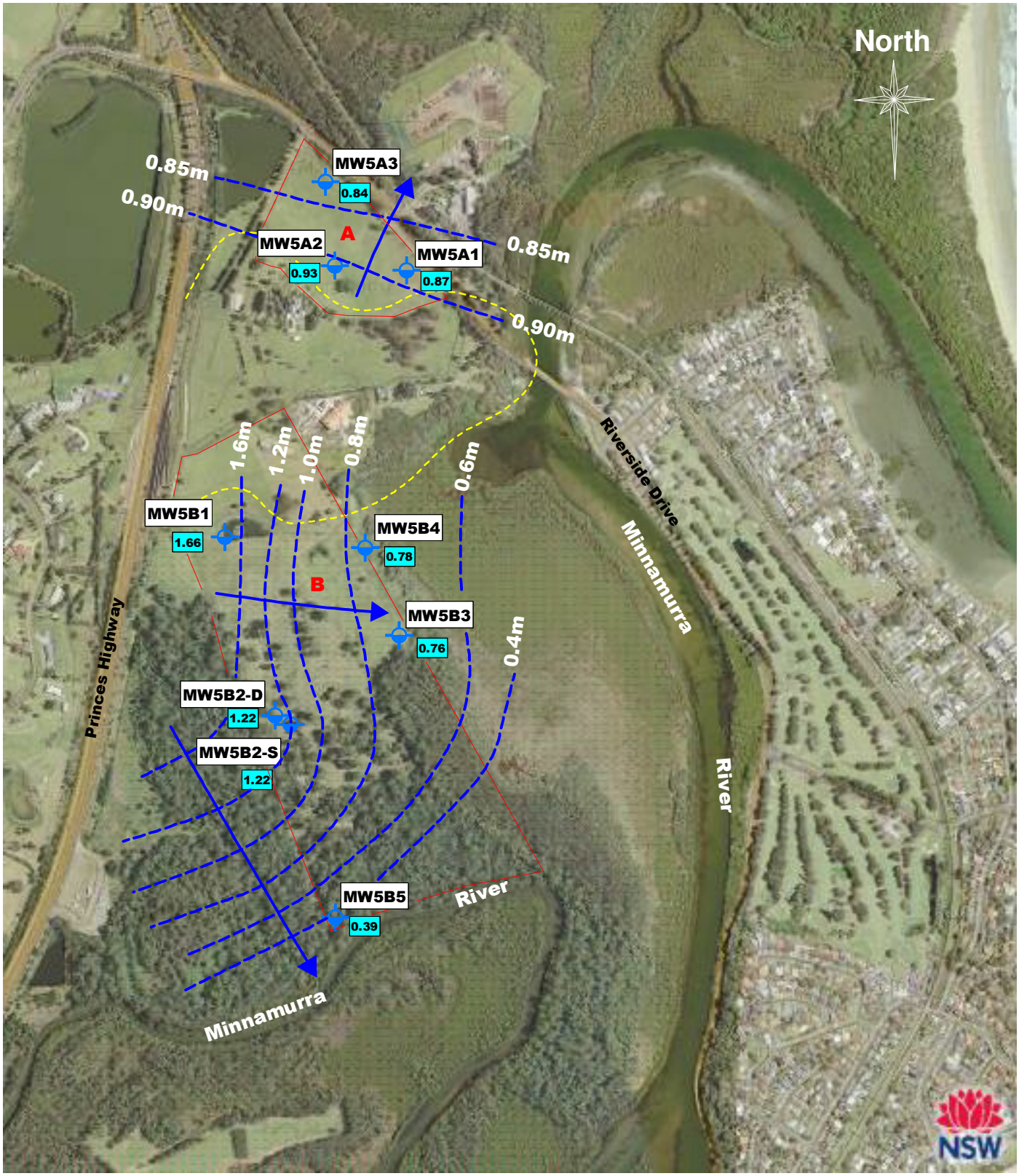
- Lot boundary
- Monitoring well location
- Latite
- Inferred groundwater contours (mAHD)
- Inferred groundwater flow direction
- 0.76 — Standing water level (mAHD)

0 — 0.4km

Scale (approx.)

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Inferred Groundwater Contours - 25 October 2018**
Location:	**Dunmore Sand & Soil - Stage 5**
Client:	**Element Environmental**
Job No. 118044	**Date: 20 June 2019**
Drawn by: TRJ	**Proj. Man. EG** — **Scale: As shown**
Figure 3	



Reference: NSW Spatial Information Exchange digital image 2019.

Legend:

- Lot boundary
- Monitoring well location
- Latite
- Inferred groundwater contours (mAHD)
- Inferred groundwater flow direction
- 0.76 — Standing water level (mAHD)

0 — 0.4km

Scale (approx.)

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Inferred Groundwater Contours - 15 January 2019**
Location:	**Dunmore Sand & Soil - Stage 5**
Client:	**Element Environmental**
Job No. 118044	**Date: 20 June 2019**
Drawn by: TRJ	**Proj. Man. EG**
Scale: As shown	**Figure 4**

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

20 September 2018

Dunmore Sand & Soil Pty Ltd
c/- Boral Quarries
38 Tabbitta Road
Dunmore NSW 2529

Attention: **Ben Williams**
Environmental Coordinator

Dear Ben,

Annual report on groundwater level monitoring at 38 Tabbitta Road, Dunmore NSW – May 2017 to May 2018

1 Introduction

Environmental Earth Sciences NSW was engaged by Dunmore Sand & Soil Pty Ltd (DS&S) to monitor groundwater levels at the Dunmore Lakes Sand Project (Stages 2 – 4) at 38 Tabbitta Road, Dunmore, NSW (the 'site') between May 2017 and May 2018. Refer to Figure 1 for the site's locality.

The Dunmore Lakes Sand Project (Stages 2 – 4) has been approved for the extraction and processing of approximately eight million tonnes of sand and soil under Development Consent 195-8-2004 (2004), issued on 29 June 2005 under the Environmental Planning and Assessment Act 1979. It is recognised that the operation of the Dunmore Lakes Sand Project has the potential to influence the groundwater beneath the site.

To manage the potential impact on groundwater, DS&S has implemented a groundwater monitoring and management program in line with the Development Consents for Stage 2 – 4 as well as the site's:

- Environmental Management Plan (EMP) (DS&S, 2006);
- Water Management Plan (WMP) (Arcadis, 2016); and,
- Groundwater Monitoring and Management Plan (GMMP) (Environmental Earth Sciences, 2018).

The objective of this report is to assess whether former and on-going sand extraction activities are impacting groundwater levels and quality in accordance with the aforementioned Development Consents and management plans pertaining to the site.

The scope of works undertaken to achieve this objective as outlined in proposal number PO717052 included:

- downloading data from the water level loggers;
- manual water level measurement to calibrate water levels (i.e. convert head to mAHD);
- review water level data from the data loggers located in the vicinity of Swamp Road Quarry and the Stage 3 sand dredging area; and
- review the groundwater quality data generally collected by Boral Staff across the monitoring period.

2 Fieldwork and data downloading

The groundwater monitoring network established for the site is illustrated in Figure 2 with details summarized in Table 1 overleaf.

Water level data from each active monitoring location (bores DG5, DG6, BHA, BHD, BHF, DG31 and DG59) was downloaded from pressure transducer data loggers ('divers') at quarterly intervals by Environmental Earth Sciences personnel in August 2017, November 2017, February 2018 and May 2018 unless decommissioned earlier. Note that divers were removed from BHA, BHD and BHF during the monitoring period due to Stage 3 dredge pond expansion.

Water level data from May 2017 to May 2018 for bores DG5, DG6, BHA, BHD, BHF, DG31 and DG59 has been compared to rainfall totals in Appendix A, Chart 1 and to tidal data in Appendix A, Chart 2. Water level data from bores DG1, DG5 and DG6 have been compared to rainfall and tidal data separately in Appendix A, Chart 3.

Water quality monitoring of the active groundwater monitoring network was generally undertaken at quarterly intervals by Boral DS&S personnel in July 2017, October 2017 and March 2018, and in May 2018 by Environmental Earth Sciences. The results of Boral's groundwater quality monitoring were provided to Environmental Earth Sciences for review and comparison to trigger levels outlined in the GMMP (Environmental Earth Sciences, 2018) for the purposes of this Annual Report.

Table 1: Monitoring bore network

Bore ID	Easting	Northing	Elevation (mAHD)	Depth (m)	Screen interval (mBGL)	Status[1]	Diver installed[1]	Comments
BHA	301383	6167892	2.225	5.2	2.2-5.2	To decommission	-	Considered no longer reliable: within ~10 m of dredge pond.
BHB	301450	6167890	-	5.1	2.1-5.1	Destroyed	-	Decommissioned in November 2016 due to Stage 3 dredge pond expansion.
BHC	301531	6167902	-	5.2	2.2-5.2	Destroyed	-	Decommissioned in November 2016 due to Stage 3 dredge pond expansion.
BHD	301620	6167901	1.760	5.1	2.1-5.1	Destroyed	-	Diver removed between February 2018 due to Stage 3 dredge pond expansion. Decommissioned in May 2018.
BHE	301595	6167932	-	5.1	2.1-5.1	Destroyed	-	Decommissioned in November 2016 due to Stage 3 dredge pond expansion.
BHF	301505	6167931	2.225	5.2	2.2-5.2	Destroyed	-	Diver removed in August 2017 due to Stage 3 dredge pond expansion. Decommissioned in February 2018.
DG1	301753	6167355	2.225	-	-	Proposed for monitoring water levels	-	Recommend to monitor standing water levels monthly to measure background groundwater levels.
DG2	301665	6167434	2.598	-	-	Inactive	-	2015-16 Annual review recommended that monitoring cease due to completion of Stage 1 (Environmental Earth Sciences, 2016)

Bore ID	Easting	Northing	Elevation (mAHD)	Depth (m)	Screen interval (mBGL)	Status[1]	Diver installed[1]	Comments
DG3	302005	6167259	1.866	-	-	Inactive	-	2015-16 Annual review recommended that monitoring cease due to completion of Stage 1 (Environmental Earth Sciences, 2016)
DG4	301966	6167408	2.083	-	-	Inaccessible	-	No longer accessible. Removed from monitoring network.
DG5	301883	6167521	1.717	-	-	Active	Yes	Nested well; deep well contains diver.
DG6	301844	6167628	1.647	-	-	Active	Yes	Nested well; shallow well contains diver.
DG7	-	-	-	-	-	Pending installation	-	Scheduled to install pending Council / RMS approval.
DG17	301279	6167877	-	-	-	Pending re-installation	-	Proposed to re-install in similar location with a diver to continue to monitor water levels.
DG21	301699	6168236	1.616	11.3	-	Pending re-installation	-	Proposed to re-install at similar location with a diver to monitor water levels as bore had been damaged (June 2017).
DG31	301363	6168137	3.087	11.0	-	Pending re-installation	-	Proposed to re-install at similar location with a diver to monitor water level as bore had been damaged (2017).
DG35	-	-	-	8.0	4.0 – 8.0	Active	-	Bore installed August 2018, no diver
DG36	-	-	-	8.0	5.0 – 8.0	Active	-	Bore installed August 2018, no diver
DG54	301403	6167969	2.311	11.5	-	Decommissioned	-	Decommissioned in 2017 / 2018 due to Stage 3 dredge pond expansion.
DG56	301639	6168017	1.369	10.5	-	Decommissioned	-	Decommissioned in 2017 /2018 due to Stage 3 dredge pond expansion.

Bore ID	Easting	Northing	Elevation (mAHD)	Depth (m)	Screen interval (mBGL)	Status[1]	Diver installed[1]	Comments
DG59	301125	6167718	1.763	8.69	-	Active	Yes	-
DG60	301275	6167683	1.501	1.9	-	Active	-	-

Notes:
1. Correct as of August 2018
2. – no information available
3. mAHD – metres above Australian Height Datum
4. mBGL – metres Below Ground Level

2.1 Water level calibration

Standing water levels (SWL) are manually measured from the top of casing (TOC) of each monitoring bore with the TOCs surveyed to the Australian Height Datum (mAHD). To assess groundwater levels these measurements from TOC are converted into relative levels to calibrate datalogger measurements. Subtracting the bore dip from the surveyed TOC level provides a water level in mAHD that can be used to calibrate the datalogger pressure reading. Table 2 below summarizes the SWL for bores generally obtained during the May 2017 – May 2018 monitoring period.

Table 2: Standing water levels across the monitoring network May 2017 – May 2018.

Location	Trigger Value[1]		May 2017	Aug 2017	Nov 2017	Feb 2018	May 2018
	Upper Limit	Lower Limit					
BHD	-	-	1.40	1.77	1.715	2.02	Removed
DG31	-	-	2.12	2.48	2.476	2.785	2.90
DG59	-	-	0.92	1.15	0.905	1.480	1.675
BHA	-	-	1.37	1.41	-	1.825	2.25
DG60	-	-	Dry (1.75)	Dry (1.75)	Dry (1.75)	1.626	Dry (1.75)
BHF	-	-	1.86	-	-	2.22	Removed
DG1 (shallow)	0.085	1.905	1.21	1.28	-	-	1.50
DG5 (shallow)	-	-	-	-	-	-	1.18
DG5 (deep)	0.19	1.55	0.96	1.03	-	1.10	1.23
DG6 (shallow)	-	-	-	0.89	-	1.025	1.13
DG6 (deep)	-	-	-	0.89	-	1.025	1.19

Notes:

1. Trigger values taken from Table 5: Physical Triggers – Groundwater Levels of the GMMP (Environmental Earth Sciences, 2018) have been converted from mAHD to mBTOC for comparison to SWL.
2. – no information available or not applicable
3. All measurements in mBTOC – metres Below Top Of Casing

The data logging of the piezometric pressure (water pressure) in the monitoring bores containing divers was undertaken at 60 minute intervals, with readings compensated for barometric changes. The data from the loggers is downloaded quarterly at each location and used to compare the piezometric head with tidal influence and rainfall. No measurements

obtained from the diver data or SWL readings exceeded the trigger values outlined in the GMMP (Environmental Earth Sciences, 2018).

2.2 Rainfall data

Local daily rainfall data was obtained from the Bureau of Meteorology (BOM) weather station 068242 located at Kiama (Bombo Headland) approximately 4.6 km away from site. The majority of rainfall during both 2017 and 2018 occurred in spring and later summer. One significant spring rainfall event totalling 79 mm (November 2017) and one high summer rainfall event of 52 mm (February 2018) was recorded.

Rainfall during the monitoring period was lower compared to previous years. Rainfall totals compared to water level data at DS&S are presented Appendix A, Chart 1.

2.3 Tidal data

Tidal data from the Minnamurra River tidal monitoring station (214442) was purchased from Manly Hydraulics Laboratory for the period between 1 May 2017 and 1 June 2018 for the purpose of comparing the water level data to tidal movements (Appendix A, Chart 2).

2.4 Water quality data

Bores west of the Princes Highway (ID: BHA, BHD, BHF, DG31 and DG59) and bores east of the Princes Highway (ID: DG5 and DG6) are presented separately due the strong tidal influence on easterly bores.

Table 3 of the Tables Appendix summarizes quarterly data for the western bores (ID: BHA, BHD, BHF, DG31 and DG59). All monitoring events were reported as below trigger values with the following exceptions:

- bores BHA and BHD/F reported slightly acidic pH ranges (5.8 – 6.2) in August and November 2017, and again in May 2018 for bore BHA. This is considered due to the proximity of the dredge pond causing interference and not representative of local groundwater conditions;
- bore DG31 reported elevated ammonia (NH_3N) in November 2017 and May 2018;
- bore DG31 and DG59 (upgradient bores) reported electrical conductivity (EC) and bicarbonate (HCO_3) in excess of trigger values for at least three consecutive monitoring events (November 2017, February 2018 and May 2018);
- a spike in EC as well as sodium (Na), potassium (K), magnesium (Mg), chloride (Cl) and sulfate (SO_4) was reported in BHF / BHD in May 2018; and,
- these results are discussed in more detail in Section 3.4.

Table 4 of the Tables Appendix summarizes quarterly data for the eastern bores (ID: DG5-S, DG5-D, DG6-S and DG6-D). All monitoring events were reported as below trigger values with the following exceptions:

- bores DG5-D, DG6-S and DG6-D all reported elevated Mg concentrations in May 2018. Bore DG6-D was consistently elevated across the monitoring period;
- bore DG5-D reported elevated ammonia (NH_3N) in May 2018;
- bore DG6-S and DG6-D reported elevated dissolved iron (Fe) concentrations in February 2018 and May 2018 respectively;
- the following analytes: K, Mg, Cl, SO_4, HCO_3 and Fe were reported as elevated to the trigger values in bore DG6-D in May 2018; and,
- these results are discussed in more detail in Section 3.4.

Refer to Appendix B – Laboratory Transcripts.

3 Data interpretation and discussion

A review of the water level data collected during the 2017 / 2018 monitoring period indicates no observable impact on local groundwater from dewatering or extraction activities undertaken at DS&S. Water levels up gradient (bore BH31 and DG59) report a downward trend that Chart 2 illustrates is more associated with lower rainfall in the region than site activities. Bores down gradient (DG1, DG5 and DG6) have generally remained consistent as these are more influenced by tidal fluctuations (Appendix A, Chart 1).

3.1 Groundwater level response and rainfall analysis

The aquifer beneath site has historically responded rapidly to local rainfall events (Environmental Earth Sciences 2009-2016), a trend which was repeated during 2017 / 2018 monitoring period at all locations (Appendix A, Chart 1).

No rainfall during the May 2017 – May 2018 monitoring period exceeded 80 mm in a single event. Historically, several rainfall events >150 mm were generally recorded across the monitoring period. The reduced recharge of the aquifer via rainfall was evidenced in the downward trend in groundwater levels across the site.

Bores BHA – BHF, BH54 and BH56 were decommissioned due to dredge pond expansion in Stage 3 during the May 2017 – May 2018 monitoring period. Bore BHD displayed a particularly variable SWL and these fluctuations are attributed to the encroachment of the dredge pond to within 5 m of the bore and other disturbances associated with sand dredging activities. Data collected from BHD is not considered representative of the local groundwater levels due to its location adjacent to the dredge pond and should be disregarded (see Appendix A, Chart 1).

The groundwater in bore BH31 although affected by rainfall (late 2017), had a dampened response (lower overall fluctuations) during 2017 -18 when compared to the other bores on site. This is likely as result of a reduced sensitivity to rainfall totals <20mm, reduced tidal influences and being located further up the catchment and closer to the edge of the aquifer / unconsolidated sediments (Appendix A, Chart 1). Data gaps result from diver malfunction.

Bore DG59 exhibited a rapid rainfall response pattern and appeared to be more easily influenced by rainfall events (Appendix A, Chart 1). Fluctuations in the water-table level up to one metre AHD can be seen during rainfall events up to 79 mm. This observation fits the conceptual site model (CSM) of the aquifer's effective porosity being close to 30% and recharge from rainfall being close to 100% of total recharge at the water-table level (Environmental Earth Sciences, 2013b).

Response to decreased recharge was dampened in bores DG1, DG5 and DG6 as these bores were more susceptible to tidal influence (Appendix A, Chart 3).

3.2 Groundwater level response and tide analysis

The unconfined aquifer which is intercepted by all bore locations is susceptible to tidal influences, however at relatively low amplitudes. Tidal characteristics of the aquifer are shown in Appendix A, Chart 2 and 3.

Groundwater fluctuations in response to tidal influxes in bore DG5 and DG6 have historically been larger (approximately double) compared to bore DG1 (Appendix A, Chart 3) while the tidal amplitudes at bores DG59, BH31 show dampened responses. This indicates a reduced tidal impact on groundwater levels further up the Rocklow Creek catchment.

Groundwater level responsiveness to tidal fluctuations (high and low tides) is as follows for each bore and graphically displayed in Appendix A, Chart 2:

- bore DG5 and DG6: ±0.03-0.05 m; and,
- bore DG59: ±0.01-0.02 m.

3.3 Hydraulic gradient and groundwater flow direction

The groundwater hydraulic gradient at each location is determined by comparing the average standing water level (SWL, converted to mAHD) in the unconfined aquifer at each location to down-gradient bore DG5. The inferred groundwater contours (Figure 3 and 4) indicate that groundwater flow is influenced by both tidal movements and localised dredging activities in Stage 3, but showed a consistent south easterly pressure gradient towards Rocklow Creek, the Minnamurra River and the coast.

3.4 Groundwater quality

In general, groundwater did not exceed the site-specific trigger levels outlined in the GMMP (Environmental Earth Sciences, 2018) across the monitoring period.

Due to tidal influences, bores east of the Princes Highway consistently reported greater EC and cation / anion concentrations than those west of the Princes Highway. The bores screened in the deeper aquifer (DG5-D and DG6-D) exhibited greater EC and cation / anion concentrations than those screened in the shallow aquifer (DG5-S and DG5-D).

It was noted that in May 2018 BHF / BHD reported elevated electrical conductivity as well as sodium, potassium, magnesium, chloride, sulfate and bicarbonate concentrations. This is considered a result of the proximity of the bore to the dredge pond causing interference. In May 2018 the dredge pond was approximately 15 m deep and intersecting the deeper

aquifer. The groundwater results suggest this influence. Likewise, the encroachment of the dredge pond to BHA was considered to cause interference with the chemical data such as pH.

Ammonia concentrations in both the west and the east of the site were reported as elevated to the trigger levels at various times. As the natural environment surrounding the site contains numerous wetlands and swamps, the presence of elevated concentrations of ammonia and other nitrogenous compounds is not unexpected and considered to be due to the breakdown of organic material.

Electrical conductivity above trigger values in the bores west of the Princes Highway will continue to be monitored. Analytes reported above the trigger values will continue to be monitoring as per the contingency plan in the GMMP (Environmental Earth Sciences, 2018) and with consideration to current site operations and climate.

3.5 Recommendations for future monitoring

Quarterly groundwater level and quality monitoring should continue in line with the Development Consents for Stage 2 – 4 as well as the EMP (DS&S, 2006), WMP (Arcadis, 2016) and GMMP (Environmental Earth Sciences, 2018). It is understood that DS&S ceased Stage 1 dredging activities at the Swamp Road site in March 2009, and the site is currently a rehabilitated pond. Sand dredging of Stage 2 is complete and dredging operations within Stage 3 are approaching capacity.

Substitutes for the bores decommissioned due to Stage 3 dredge pond expansion have been proposed as bore DG7 in the east and a replacement bore DG17 in the west (refer to Figure 2) in the GMMP (Environmental Earth Sciences, 2018). An additional two bores (ID: DG35 and DG36) were installed up gradient of Stage 2 in August 2018. Bores BH31 and BH21 were damaged and are also proposed for replacement at the same or similar locations.

Based on a review of the 2017 / 2018 monitoring data the following adjustments are recommended to the program:

- monitoring of representative onsite diver locations should continue at quarterly intervals as indicated on Figure 2 by the Active and Proposed monitoring network;
- install replacement bores to the network (ID: DG7, DG17, BH21 and BH31) as proposed on Figure 2 and in the GMMP (Environmental Earth Sciences, 2018);
- install divers in the proposed bores in the network (ID: DG7, DG17, BH21 and BH31) as indicated on Figure 2;
- monitoring of onsite historical locations within Stage 3 (bore DG59) along the southern edge of Stage 3 should continue at quarterly intervals as the dredge area advances to the south west;
- all new bores should be surveyed to provide exact relative levels data for each location. This would enable a review of the site's current groundwater flow direction and contour maps; and,

- should divers be reported as malfunctioning, replacements divers should be installed to maintain consistent groundwater level monitoring at the site.

3.6 Conclusions

The data obtained from the data loggers installed in bores DG59, DG31, DG5 and DG6 indicates that over the past monitoring year natural fluctuations in water levels were occurring in response to rainfall and tide as illustrated in Appendix A, Charts 1 and 2. This is consistent with previous findings dating back to 2003 (Environmental Earth Sciences 2009, 2010, 2011, 2012, 2013a, 2014, 2015, 2016, 2017).

All data obtained from the bores monitored strongly indicate the following:

- that influences on groundwater levels are related to recharge from rainfall and more minor tidal influx (this finding is supported by chemical monitoring of tidal seawater intrusion from Rocklow Creek);
- reductions in groundwater levels are related to periods of low rainfall (i.e. not to minor recharge) where the aquifer is slowly draining from Rocklow Creek and the south-east aquifer boundary; and
- water-table fluctuations are therefore naturally occurring and cannot be seen to be impacted by dredging activities in the area (except immediately around bore BHD and BHF in immediate proximity to the dredge pond).

4 Limitations

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Dunmore Sand and Soil Pty Ltd;
2. The specific scope of works set out in PO717052;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at 38 Tabbita Road, Dunmore, NSW, 2529 (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;

7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;

8. Our General Limitations set out in the back of this report.

Should you have any queries, please do not hesitate to contact us on (02) 9922 1777.

For and on behalf of
Environmental Earth Sciences NSW

Project Manager
Loretta Visintin
Environmental Scientist

Project Director / Internal Reviewer
Mark Stuckey
Senior Principal Soil Scientist, Hydrogeologist & Risk Assessor
Contaminated Land/ Site Auditor (NSW, QLD & VIC)

117053_Annual Review_v1

5 References

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Environmental Earth Sciences (2016b) *Annual Monitoring Report at 38 Tabbitta Road, Dunmore, NSW*. Report No. 116083

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6 Glossary of terms

The following descriptions are of terms used in the text of this report.

Acid Sulfate Soil (ASS). A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell.

Alluvial. Describes material deposited by, or in transit in, flowing water.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined. An aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched. A region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Background. The natural level of a property.

Baseline. An initial value of a measure.

Biodegradation. A biochemical process of microbial oxidation of complex organic compounds, to simpler chemical products. Micro-organisms derive the energy and cell carbon for growth from oxidation of organic compounds.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Borehole. An uncased well drill hole.

Contaminant. Generally, any chemical species introduced into the soil or water. More particularly relates to those species that render soil or water unfit for beneficial use.

Contamination. Is considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration.

Diffusion. A process by which species in solution move, driven by concentration gradients (from high to low).

Dilution. The mixing of a small volume of contaminated leachate with a large volume of uncontaminated water. The concentration of contaminants is reduced by the volume of the lower concentrated water. However the physical process of dilution often causes chemical disequilibria resulting in the destruction of ligand bonds, the alteration of solubility products and the alteration of water pH. This usually causes precipitation by different chemical means of various species.

Discrete sample. Samples collected from different locations and depths that will not be composited but analysed individually.

Dispersion. A process by which species in solution mix with a second solution, thus reducing in concentration. In particular, relates to the reduction in concentration resulting from the movement of flowing groundwater.

Dissolved Oxygen (DO). Oxygen in the gaseous phase dissolved in water. Measured either as a concentration in mg/L or as a percentage of the theoretical saturation point, which is inversely related to temperature. At 19, 20 and 21 degrees Celsius, the oxygen concentrations in mg/L corresponding to 100% saturation are 9.4, 9.2 and 9.0 respectively.

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Flow path. The direction in which groundwater is moving.

Fluvial. A material deposited by, or in transit, in streams or watercourses.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater. The water held in the pores in the ground below the water table.

Groundwater Elevation. The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (mAHD) or an arbitrary survey datum onsite, or “reduced level” (mRL).

Head space. The air space at the top of a soil or water sample.

Heavy Metals. All metallic elements whose atomic mass exceeds that of calcium (20) and includes lead (Pb), copper (Cu), Zinc (Zn), cadmium (Cd), and tin (Sn).

Heterogeneous. A condition of having different characteristics in proximate locations. Non-uniform. (Opposite of homogeneous).

Hydraulic Conductivity (K). A coefficient describing the rate at which water can move through a permeable medium. It has units of length per time. The units for hydraulic conductivity are typically m3/day/m2 or m/day.

Hydraulic Gradient (i). The rate of change in total head per unit of distance of flow in a given direction – the direction is that which yields a maximum rate of decrease in head. Hydraulic Gradient is unit less.

Hydraulic Head (h). The sum of the elevation head and the pressure head at a point in an aquifer. This is typically reported as an elevation above a fixed datum, such as sea level.

Ionic Exchange. Adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxy-hydroxides represent examples of the former type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions. An ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include: Cl^-, SO_4^{2-}, HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, K^+, NH_4^+, NO_3^-, NO_2^-, F^-, PO_4^{3-} and the heavy metals.

Perched Groundwater. Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone. Perched groundwater typically occurs in discontinuous, often ephemeral, lenses, with unsaturated conditions both above and below.

Permeability (k). Property of porous medium relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Where water is the fluid, this is effectively the hydraulic conductivity. A function of the connectivity of pore spaces.

Piezometric or Potentiometric Surface. A surface that represents the level to which water will rise in cased bores. The water table is the potentiometric surface in an unconfined aquifer.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Potential Acid Sulfate Soil (PASS). A soil that has the potential to become acidic if it is exposed to the atmosphere.

Porosity (n). The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. Typically given as a percentage.

Porosity, effective (ne). The volume of the void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

Precipitation (chemical). There are two types of precipitation, pH dependent precipitation and solubility controlled precipitation. As the pH is raised beyond a threshold level the precipitation of metal cations such as oxy-hydroxides and hydroxides occur. As the pH is raised further precipitation continues until there are very few metal cations remaining in solution. This reaction is entirely reversible. Solubility controlled precipitation occurs between two ions when, at a given temperature and pressure, the concentration of one of the ions exceeds a certain level.

Purge (wells). The pumping out of well water to remove drilling debris or impurities; also conducted to bring fresh groundwater into the casing for sample collection. The later ensures that a more representative sample of an aquifer is taken.

Remediation. The restoration of land or groundwater contaminated by pollutants, to a state suitable for other, beneficial uses.

Representative Sample. Assumed not to be significantly different than the population of samples available. In many investigations samples are often collected to represent the worst case situation.

Saturated Zone. A zone in which the rock or soil pores are filled (saturated) with water.

Standing Water Level (SWL). The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface.

Stratigraphy. A vertical sequence of geological units.

Total Dissolved Salts (TDS). The total dissolved salts comprise dissociated compounds and undissociated compounds, but not suspended material, colloids or dissolved gases.

Toxicity. The inherent potential or capacity of a material to cause adverse effects in a living organism.

Unsaturated Zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water (water in the unsaturated zone is present at less than atmospheric pressure). It includes the root zone, intermediate zone and capillary fringe. Saturated bodies such as perched groundwater may exist in the unsaturated zone. Also referred to as the Vadose Zone.

Volatile. Having a low boiling or subliming pressure (a high vapour pressure).

Water table. Interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

Well. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a Bore.

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

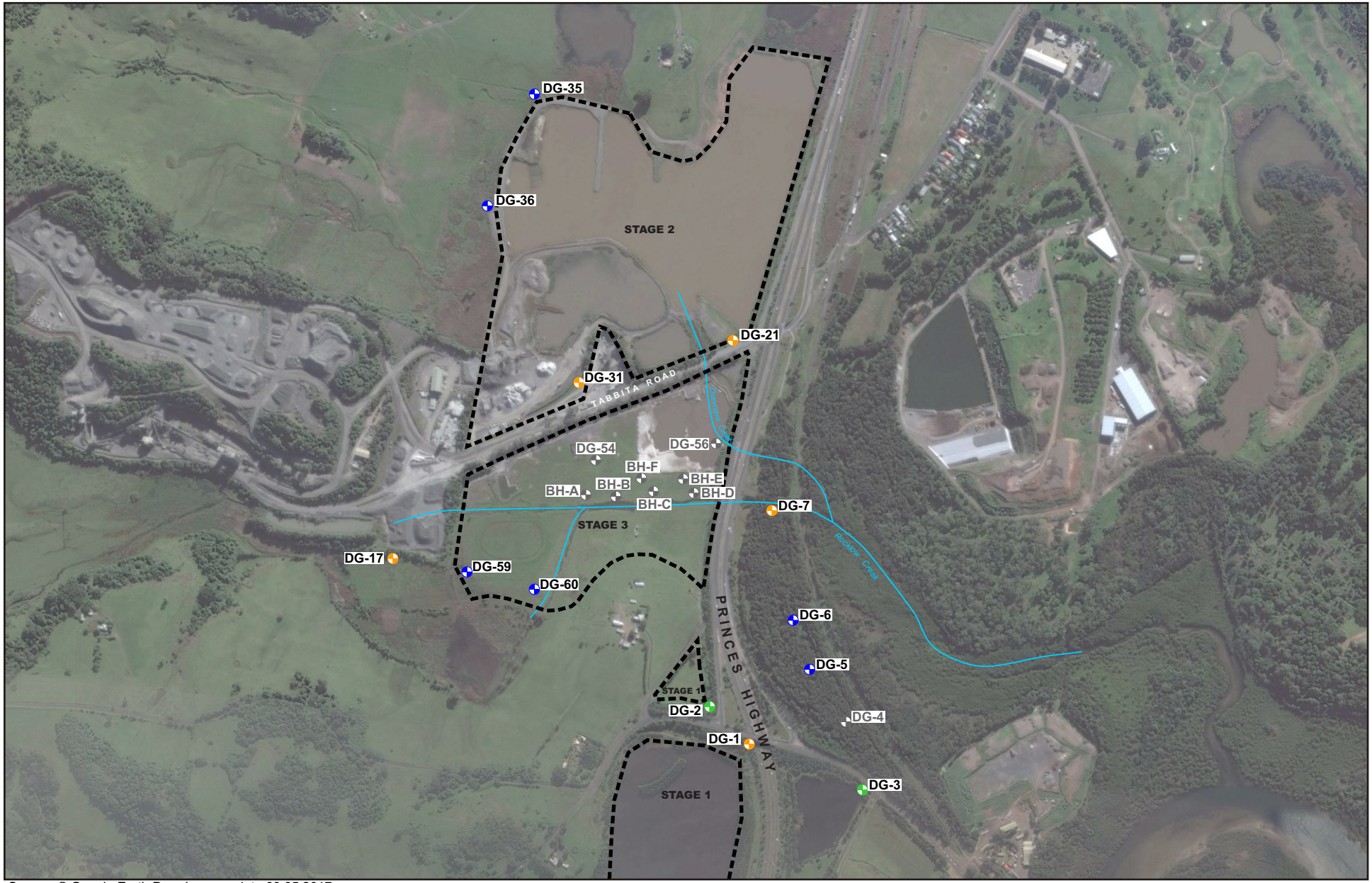
To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

Source: Google Maps

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Locality Map**		
Location:	**Dunmore, NSW**		
Client:	**Dunmore Sand and Soil Pty Ltd**		Job No: **117053**
Project Man:	**LV**	Scale:	**As Shown**
Drawn By:	**LB**	Date:	**September 2018**
			Figure 1



Source: © Google Earth Pro - Imagery date 09.05.2017

LEGEND:

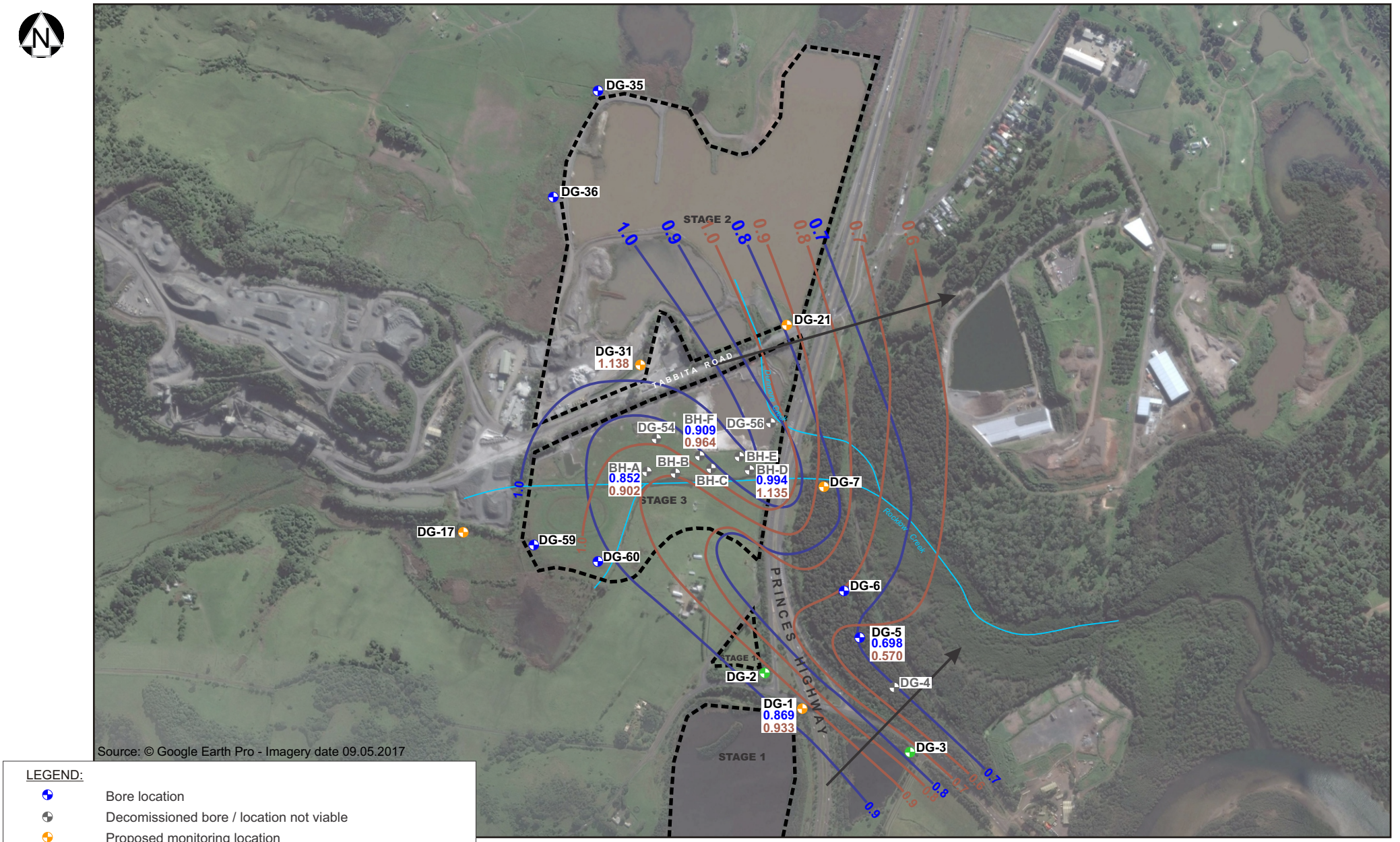
- Monitoring bore location
- Decomissioned bore / location not viable
- Proposed monitoring location
- Inactive monitoring bore location

0 100 200 300 400 500

Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Layout and Borehole Locations**
Location:	**Dunmore, NSW**
Client: **Dunmore Sand and Soil Pty Ltd**	Job No: **117053**
Project Man: **LV**	Scale: **As Shown**
Drawn By: **LB**	Date: **September 2018**
	Figure 2



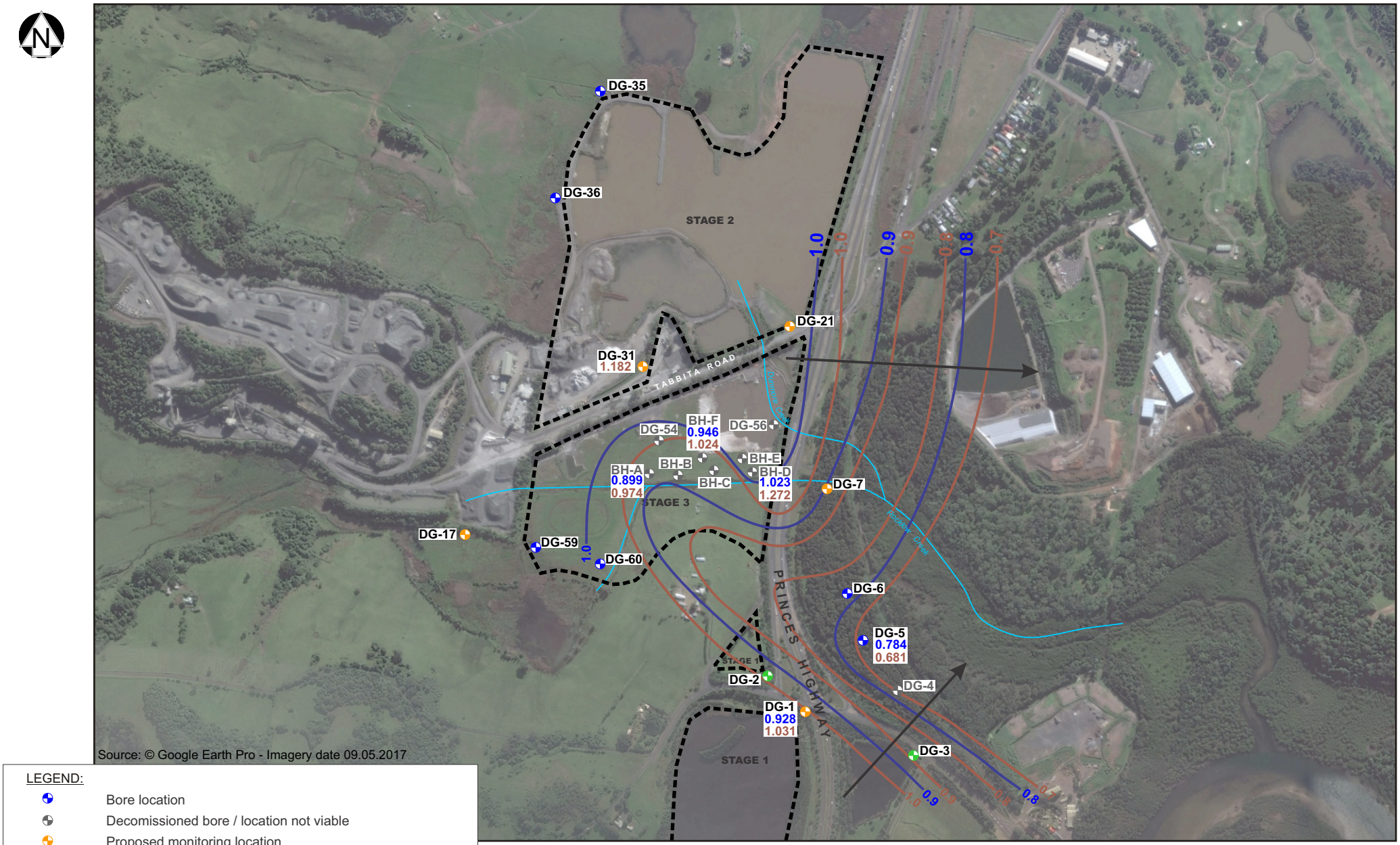
LEGEND:

- Bore location
- Decomissioned bore / location not viable
- Proposed monitoring location
- Inactive monitoring bore location
- Inferred groundwater contour - Low tide 10/11 Oct 2013
- 0.869 SWL (mAHD)
- Inferred groundwater contour - Low tide 10/11 Oct 2016
- Inferred groundwater flow direction - Low tide 10/11 Oct 2013 & 10/11 Oct 2016
- 0.933 SWL (mAHD)

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	Inferred Groundwater Contours - Low Tide
Location:	Dunmore, NSW
Client:	Dunmore Sand and Soil Pty Ltd
Job No:	117053
Project Man:	LV
Scale:	As Shown
Drawn By:	LB
Date:	September 2018
Figure	3



LEGEND:

- Bore location
- Decomissioned bore / location not viable
- Proposed monitoring location
- Inactive monitoring bore location
- Inferred groundwater contour - Low tide 10/11 Oct 2013
- 0.869 SWL (mAHD)
- Inferred groundwater contour - Low tide 10/11 Oct 2016
- Inferred groundwater flow direction - Low tide 10/11 Oct 2013 & 10/11 Oct 2016
- 0.933 SWL (mAHD)

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	Inferred Groundwater Contours - High Tide
Location:	Dunmore, NSW
Client:	Dunmore Sand and Soil Pty Ltd
Job No:	117053
Project Man:	LV
Scale:	As Shown
Drawn By:	LB
Date:	September 2018
Figure	4

TABLES

Table 3: Results for bores west of the Princes Highway (ID: BHA, BHF/BHD, DG31s and DG59) between May 2017 - May 2018

Analyte[1]	Units	Trigger Value		BHA				BHF / BHD				DG31s				DG59			
		DA[2]	GMMP[3]	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May
pH	-	6.5 – 8.5	**6.5 – 8.5**	**6.2**	**5.8**	6.5	**6.0**	**6.0**	**5.9**	-	6.9	6.9	6.7	8.1	6.9	-	7.4	7.4	7.2
EC	µS/cm	<1,500	**1,500**	243	493	700	**2,060**	282	189	-	**13,500**	1,400	**2,250**	**1,730**	**2,840**	-	**2,210**	**6,010**	**3,000**
TDS	mg/L	-	**-**	-	-	-	1,220	-	-	-	8,360	-	-	-	1,740	-	-	-	1,920
Total N	mg/L	100 – 500	**-**	-	-	1.3	0.4	0.2	0.2	-	1.1		-	-	<0.1	-	-	5.0	<0.1
Na	mg/L	400	**560**	34	52	113	280	38	24	-	**2,050**	134	266	190	330	-	412	855	425
K	mg/L	50	**50**	1	3	3	17	1	1	-	**220**	8	11	7	24	-	26	16	35
Mg	mg/L	50	**90**	4	13	7	47	6	4	-	**435**	34	50	35	78	-	51	**115**	80
Cl	mg/L	300	**1,400**	31	57	79	590	49	19	-	**4,520**	126	335	272	620	-	259	1,330	585
Ca	mg/L	-	**-**	-	-	-	86	-	-	-	165	-	-	-	180	-	-	-	140
F	mg/L	-	**-**	-	-	-	<0.1	-	-	-	**0**	-	-	-	<0.1	-	-	-	0.11
Fe	mg/L	6	**3**	0.2	0.1	1.0	2.7	0.2	0.2	-	0.2	0.1	0.1	0.2	2.1	-	0.1	1.2	0.0
NO_3	mg/L	-	**-**	-	-	-	<0.1	-	-	-	<0.1	-	-	-	<0.1	-	-	-	<0.1
SO_4	mg/L	250	**300**	43	93	118	150	12	32	-	**710**	135	301	11	260	-	26	522	170
PO_4[6]	mg/L	5 – 50	**4**	-	-	-	<0.1	-	-	-	0.2	-	-	-	<0.1	-	-	-	<0.1
HCO_3[7]	mg/L	750	**400**	30	57	108	100	39	28	-	110	**520**	**592**	**663**	**430**	-	**1,009**	**629**	**825**
NH_3N	mg/L	20	**1**	0.03	0.08	-	0.16	0.2	0.2	-	0.33	**1.64**	**2.08**	-	**2.0**	-	**1.56**	-	**1.08**

Notes:

1. EC = Electrical Conductivity; TDS = Total Dissolved Solids; PO4 = Phosphorous; Total N = Total Nitrogen; Na = Sodium; K = Potassium; Mg = Magnesium; Cl = Chloride; SO4 = Sulfate; HCO3 = Bicarbonate; Fe = Dissolved Iron; NH3 = Ammonia.
2. DA Criteria is not site specific and outlined under Development Consent 195-8-2004 (2004), issued on 29 June 2005 for The Dunmore Lakes Sand Project (Stages 2 – 4).
3. GMMP Criteria are site-specific criteria for groundwater quality and a sub-plan to the WMP (Arcadis, 2016).
4. Elevated concentrations to site-specific GMMP criteria are **shaded and bold.**
5. Potential sampler confusion between bore BHD and BHF as they are in close proximity. Aug '17 - Feb '18 reported as BHF, May '18 data reported as BHD.
6. Reported as Total Phosphorous in Aug '17, Nov '17 and Feb '18 hence not included
7. Reported as mg/$CaCO_3$/L in Aug '17, Nov '17 and Feb '18. These results were converted to HCO_3 by multiplying mg/$CaCO_3$/L by 1.219
8. Divided by 1.2 when reported as Ammonia Total to get NH_3N

Table 4: Results for bores east of the Princes Highway (ID: DG5-S, DG5-D, DG6-S, DG6-D) between May 2017 - May 2018

Analyte[1]	Units	Trigger Value		DG5-S				DG5-D				DG6-S				DG6-D			
		DA[2]	GMMP[3]	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May
pH	-	6.5 – 8.5	**6.5 – 8.5**	7.0	7.3	7.8	7.4	6.6	7.4	7.8	7.4	6.8	6.5	7.3	6.7	7.0	6.8	7.7	6.9
EC	µS/cm	<1,500	**33,000**	1,010	1,000	1,040	980	505	12,000	12,200	18,300	15,800	15,800	17,000	16,800	19,800	19,700	20,900	25,900
TDS	mg/L	-	**-**	-	-	-	620	-	-	-	11,600	-	-	-	10,300	-	-	-	16,100
Total N	mg/L	100 – 500	**-**	-	-	-	<0.1	-	-	1.7	<0.1	-	-	2.4	<0.1	-	-	1.2	<0.1
Na	mg/L	400	**5,500**	64	62	79	75	64	2,130	1,930	2,950	2,650	2,800	2,850	2,500	3,360	3,750	3,600	3,950
K	mg/L	50	**170**	5	5	5	11	7	83	80	240	97	98	94	210	127	128	118	**350**
Mg	mg/L	50	**420**	19	19	21	17	10	257	213	**610**	330	369	327	**530**	**421**	**487**	**422**	**960**
Cl	mg/L	300	**6,900**	129	116	133	145	116	3,630	3,710	6,550	5,210	4,820	5,280	5,550	6,510	6,100	6,510	**9,180**
Ca	mg/L	-	**-**	-	-	-	110	-	-	-	365	-	-	-	290	-	-	-	**495**
F	mg/L	-	**-**	-	-	-	<0.1	-	-	-	<0.1	-	-	-	0.1	-	-	-	<0.1
Fe	mg/L	6	**4**	0.05	0.11	2	0.02	0.30	0.10	1.92	0.02	0.32	0.12	**4.05**	1.20	0.06	0.05	0.10	**16**
NO_3	mg/L	-	**-**	-	-	-	<0.1	-	-	-	<0.1	-	-	-	<0.1	-	-	-	<0.1
SO_4	mg/L	250	**1,170**	100	122	120	96	12	460	438	870	675	662	588	650	842	832	864	**1,320**
PO_4[5]	mg/L	5 – 50	**0.7**	-	-	-	<0.1	-	-	-	0.2	-	-	-	0.2	-	-	-	<0.1
HCO_3[6]	mg/L	750	**420**	257	286	294	280	51	244	236	295	345	299	407	420	**447**	**425**	**468**	**440**
NH_3N[7]	mg/L	20	**3**	0.01	0.17	-	0.33	0.01	1.06	-	**3.25**	0.01	0.71	-	1.0	0.02	0.04	-	1.25

Notes:

1. EC = Electrical Conductivity; TDS = Total Dissolved Solids; PO4 = Phosphorous; Total N = Total Nitrogen; Na = Sodium; K = Potassium; Mg = Magnesium; Cl = Chloride; SO4 = Sulfate; HCO3 = Bicarbonate; Fe = Dissolved Iron; NH3 = Ammonia.
2. DA Criteria is not site specific and outlined under Development Consent 195-8-2004 (2004), issued on 29 June 2005 for The Dunmore Lakes Sand Project (Stages 2 – 4).
3. GMMP Criteria are site-specific criteria for groundwater quality and a sub-plan to the WMP (Arcadis, 2016).
4. Elevated concentrations to site-specific criteria are **shaded and bold.**
5. Reported as Total Phosphorous in Aug '17, Nov '17 and Feb '18 hence not included
6. Reported as mg/$CaCO_3$/L in Aug '17, Nov '17 and Feb '18. These results were converted to HCO_3 by multiplying mg/$CaCO_3$/L by 1.219
7. Divided by 1.2 when reported as Ammonia Total to get NH_3N

APPENDIX A: CHARTS

Chart 1 - Rainfall data compared to groundwater water levels: May 2017 to May 2018

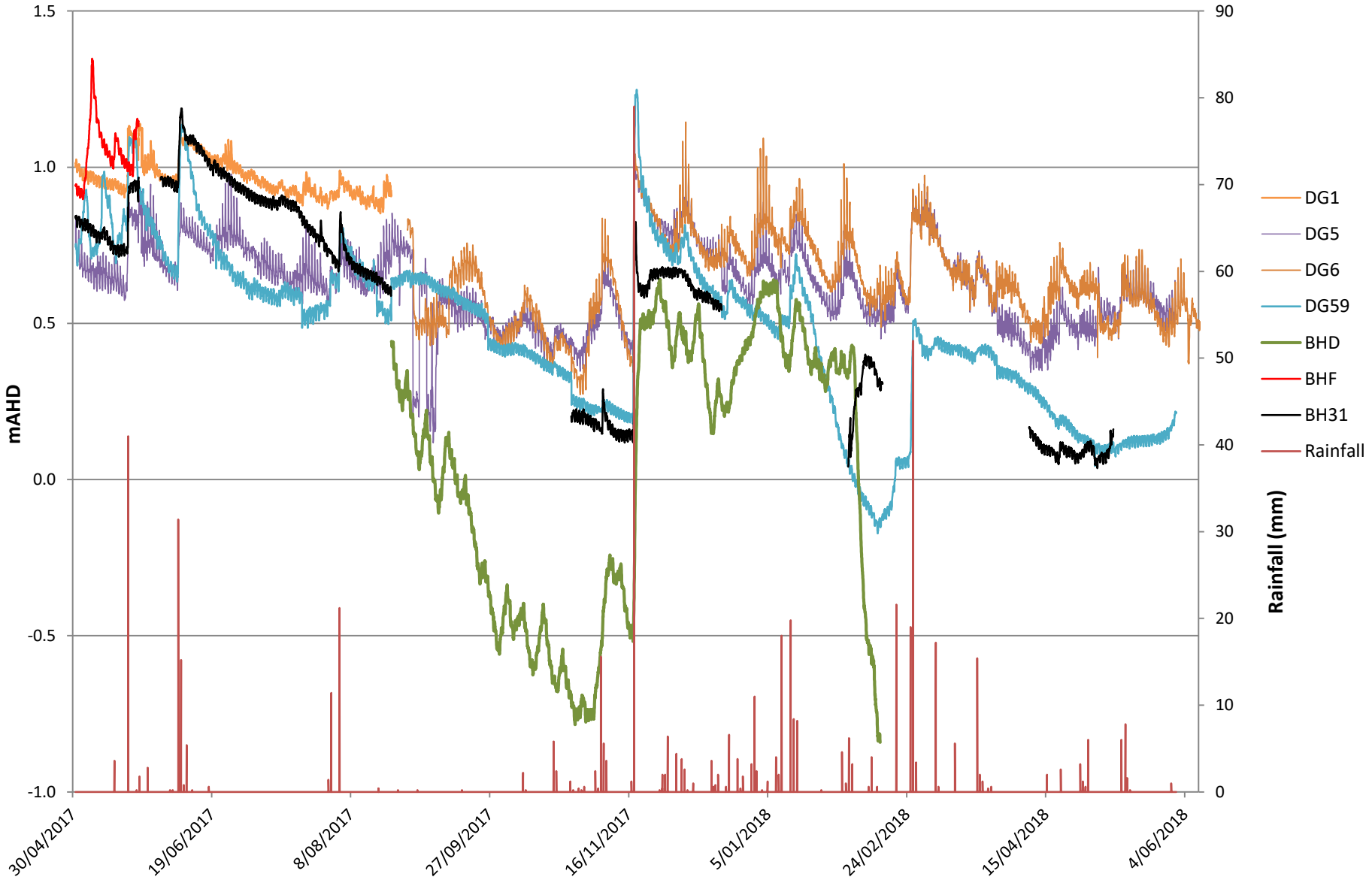


Chart 2 - Tidal data compared to groundwater water levels: May 2017 to May 2018

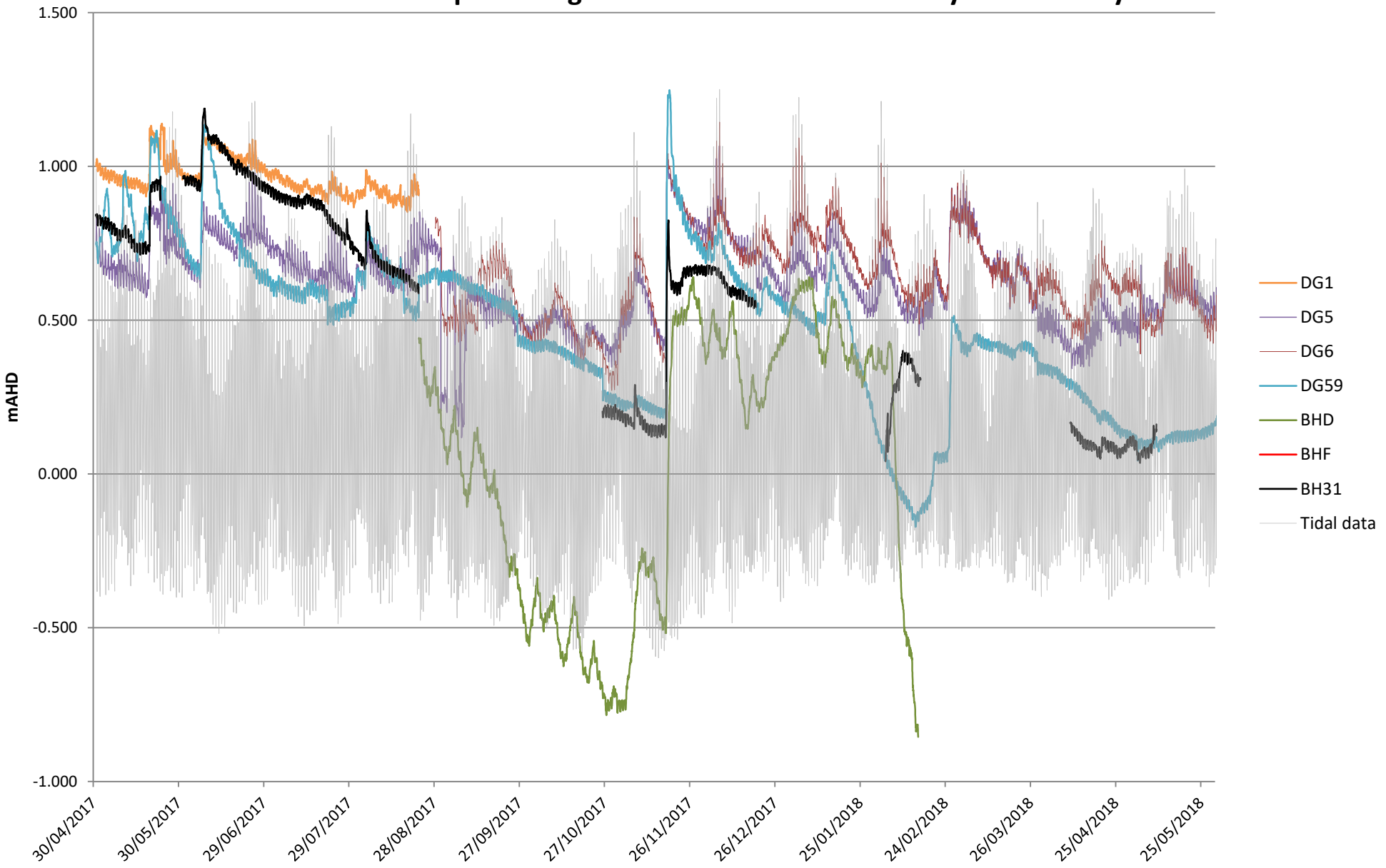
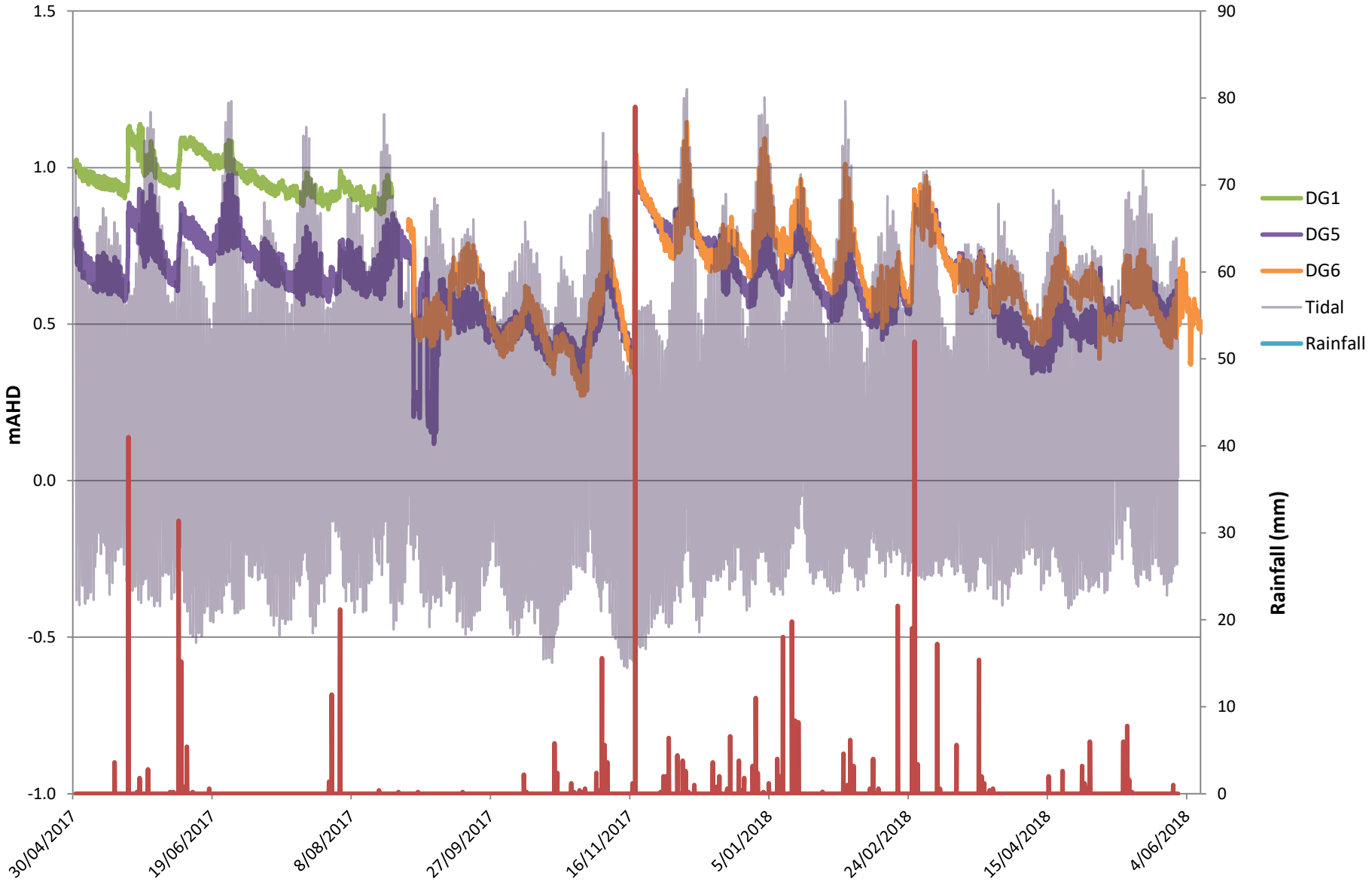


Chart 3 - DG1, DG5 and DG6 compared to rain and tidal data: May 2017 to May 2018



APPENDIX B: LABORATORY TRANSCRIPTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW1703171**	Page	: 1 of 6
Client	: **BORAL LIMITED**	Laboratory	: Environmental Division NSW South Coast
Contact	: ELLIE RANDALL	Contact	: Aneta Prosaroski
Address	:	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW
Telephone	: ----	Telephone	: 02 4225 3125
Project	: Groundwaters	Date Samples Received	: 21-Jul-2017 15:20
Order number	: 5769787	Date Analysis Commenced	: 21-Jul-2017
C-O-C number	: ----	Issue Date	: 31-Jul-2017 15:51
Sampler	: ELLIE RANDALL		
Site	: ----		
Quote number	: WO/017/17		
No. of samples received	: 7		
No. of samples analysed	: 7		

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
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

- EK067G: LOR raised for Total P on sample No 3 due to sample matrix.
- TDS by method EA-015 may bias high for sample 6 due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- pH and Conductivity data supplied by ALS Wollongong.
- pH and Conductivity tests completed on day of receipt.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DG5D	DG5S	DG6D	DG6S	DG31
			Client sampling date / time	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00
Compound	CAS Number	LOR	Unit	EW1703171-001	EW1703171-002	EW1703171-003	EW1703171-004	EW1703171-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	6.6	7.0	7.0	6.8	6.9
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	505	1010	19800	15800	1400
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	274	603	13200	10200	889
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	42	211	367	283	427
Total Alkalinity as CaCO3	----	1	mg/L	42	211	367	283	427
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	12	100	842	675	135
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	116	129	6510	5210	126
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	14	113	214	150	114
Magnesium	7439-95-4	1	mg/L	10	19	421	330	34
Sodium	7440-23-5	1	mg/L	64	64	3360	2650	134
Potassium	7440-09-7	1	mg/L	7	5	127	97	8
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.02	0.01	0.01
Manganese	7439-96-5	0.001	mg/L	0.005	0.104	0.200	0.102	0.038
Iron	7439-89-6	0.05	mg/L	0.30	<0.05	0.06	0.32	0.12
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.1	0.3	0.7	0.7	0.2
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	<0.01	<0.01	0.02	<0.01	1.64
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as NO3	14797-55-8	0.01	mg/L	1.90	0.40	0.71	3.10	0.04
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.43	0.09	0.16	0.70	0.02
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DG5D	DG5S	DG6D	DG6S	DG31
				Client sampling date / time	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00	21-Jul-2017 00:00
Compound	CAS Number	LOR	Unit		EW1703171-001	EW1703171-002	EW1703171-003	EW1703171-004	EW1703171-005
					Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.9**	**0.6**	**0.8**	**1.1**	**2.7**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.3**	**0.7**	**1.0**	**1.8**	**2.7**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.24**	**0.20**	<0.02	**0.11**	**0.11**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**4.36**	**9.94**	**208**	**167**	**14.9**
Total Cations	----	0.01	meq/L		**4.48**	**10.1**	**195**	**152**	**14.5**
Ionic Balance	----	0.01	%		**1.39**	**0.88**	**3.42**	**4.48**	**1.28**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BHA	BHF	----	----	----
			Client sampling date / time	21-Jul-2017 00:00	21-Jul-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EW1703171-006	EW1703171-007	--------	--------	--------
				Result	Result	----	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	**6.2**	**6.0**	----	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	**243**	**282**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**238**	**206**	----	----	----
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	**25**	**32**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**25**	**32**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**43**	**12**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**31**	**49**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**8**	**9**	----	----	----
Magnesium	7439-95-4	1	mg/L	**4**	**6**	----	----	----
Sodium	7440-23-5	1	mg/L	**34**	**38**	----	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	**0.08**	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.011**	**0.054**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.16**	**0.24**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	----	----	----
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	**0.03**	**0.20**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as NO3	14797-55-8	0.01	mg/L	**0.04**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BHA	BHF	----	----	----
				Client sampling date / time	21-Jul-2017 00:00	21-Jul-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EW1703171-006	EW1703171-007	--------	--------	--------
					Result	Result	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.1**	**1.9**	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.1**	**1.9**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**2.01**	**2.62**	**----**	**----**	**----**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.27**	**2.27**	**----**	**----**	**----**
Total Cations	----	0.01	meq/L		**2.21**	**2.60**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW1704404**	Page	: 1 of 6
Client	: **BORAL LIMITED**	Laboratory	: Environmental Division NSW South Coast
Contact	: ELLIE RANDALL	Contact	: Aneta Prosaroski
Address	:	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW
Telephone	: ----	Telephone	: 02 4225 3125
Project	: Groundwaters	Date Samples Received	: 26-Oct-2017 14:46
Order number	: 5811300	Date Analysis Commenced	: 26-Oct-2017
C-O-C number	: ----	Issue Date	: 02-Nov-2017 16:29
Sampler	: ELLIE RANDALL		
Site	: ----		
Quote number	: WO/017/17		
No. of samples received	: 8		
No. of samples analysed	: 8		

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

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

This 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
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW

General Comments

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

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

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

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

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

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

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

- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- pH and Conductiviy data supplied by ALS Wollongong.
- pH and Conductiviy tests completed on day of receipt.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DG5D	DG5S	DG6D	DG6S	DG59
			Client sampling date / time	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00
Compound	CAS Number	LOR	Unit	EW1704404-001	EW1704404-002	EW1704404-003	EW1704404-004	EW1704404-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	----	0.1	pH Unit	**7.4**	**7.3**	**6.8**	**6.5**	**7.4**
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	**12000**	**1000**	**19700**	**15800**	**2210**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**7800**	**628**	**14400**	**10100**	**1240**
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	**200**	**235**	**349**	**298**	**828**
Total Alkalinity as CaCO3	----	1	mg/L	**200**	**235**	**349**	**298**	**828**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**460**	**122**	**832**	**662**	**26**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**3630**	**116**	**6100**	**4820**	**259**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**142**	**112**	**231**	**162**	**45**
Magnesium	7439-95-4	1	mg/L	**257**	**19**	**487**	**369**	**51**
Sodium	7440-23-5	1	mg/L	**2130**	**62**	**3750**	**2800**	**412**
Potassium	7440-09-7	1	mg/L	**83**	**5**	**128**	**98**	**26**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01
Manganese	7439-96-5	0.001	mg/L	**0.094**	**0.231**	**0.023**	**0.525**	**0.279**
Iron	7439-89-6	0.05	mg/L	**0.10**	**0.11**	<0.05	**0.12**	<0.05
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.7**	**0.3**	**0.6**	**0.6**	**0.8**
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	**1.06**	**0.17**	**0.04**	**0.71**	**1.56**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as NO3	14797-55-8	0.01	mg/L	<0.01	<0.01	**1.86**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	**0.42**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DG5D	DG5S	DG6D	DG6S	DG59
				Client sampling date / time	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00
Compound	CAS Number	LOR	Unit		EW1704404-001	EW1704404-002	EW1704404-003	EW1704404-004	EW1704404-005
					Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		1.6	1.2	0.9	2.1	2.3
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		1.6	1.2	1.3	2.1	2.3
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.64	0.68	0.32	0.67	0.50

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DG31	BHA	BHF	----	----
			Client sampling date / time	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit	EW1704404-006	EW1704404-007	EW1704404-008	--------	--------
				Result	Result	Result	----	----
EA005FD: Field pH								
pH	----	0.1	pH Unit	**6.7**	**5.8**	**5.9**	----	----
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	**2250**	**493**	**189**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**1290**	**324**	**196**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**486**	**47**	**23**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**486**	**47**	**23**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**301**	**93**	**32**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**335**	**57**	**19**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**187**	**21**	**7**	----	----
Magnesium	7439-95-4	1	mg/L	**50**	**13**	**4**	----	----
Sodium	7440-23-5	1	mg/L	**266**	**52**	**24**	----	----
Potassium	7440-09-7	1	mg/L	**11**	**3**	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.05**	**0.30**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.400**	**0.019**	**0.045**	----	----
Iron	7439-89-6	0.05	mg/L	**0.07**	**0.06**	**0.17**	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	<0.1	<0.1	----	----
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	**2.08**	**0.08**	**0.21**	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as NO3	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	<0.01	<0.01	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DG31	BHA	BHF	----	----
				Client sampling date / time	26-Oct-2017 00:00	26-Oct-2017 00:00	26-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EW1704404-006	EW1704404-007	EW1704404-008	--------	--------
					Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**4.0**	**1.6**	**2.1**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**4.0**	**1.6**	**2.1**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.64**	**1.41**	**1.19**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EW1800864**	Page	: 1 of 6
Client	: **BORAL LIMITED**	Laboratory	: Environmental Division NSW South Coast
Contact	: ELLIE RANDALL	Contact	: Aneta Prosaroski
Address	: Boral Dunmore Sand and Soil 38 Tabbita Road Dunmore NSW 2529	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW
Telephone	: ----	Telephone	: 02 4225 3125
Project	: DSS Quality Groundwater	Date Samples Received	: 01-Mar-2018 16:22
Order number	: 5875258	Date Analysis Commenced	: 01-Mar-2018
C-O-C number	: ----	Issue Date	: 09-Mar-2018 09:12
Sampler	: ----		
Site	: ----		
Quote number	: WO/017/17		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

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

General Comments

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

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

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

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

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

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

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

- Microbiological Comment: EW1704364 – 01 & 02 results for MW006 are reported as estimate (~) due to the presence of many non-target organism colonies that may have inhibited the growth of the target organisms on the filter membrane. It may be informative to record this fact.

  Microbiological Comment: EW1704364 – 03 results for MW006 are reported as estimate (~) due to the growth of bacteria on the filter membrane being counted <10 cfu and/or >100 cfu and due to the presence of many non-target organism colonies that may have inhibited the growth of the target organisms on the filter membrane. It may be informative to record this fact.
- pH, Conductivity and Dissolved Oxygen data supplied by ALS Wollongong.
- pH, Conductivity and Dissolved Oxygen tests completed on day of receipt.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DG31s	BH-A	DG5D	DG5S	DG59
			Client sampling date / time	01-Mar-2018 11:30	01-Mar-2018 11:50	01-Mar-2018 13:45	01-Mar-2018 13:30	01-Mar-2018 14:00
Compound	CAS Number	LOR	Unit	EW1800864-001	EW1800864-002	EW1800864-003	EW1800864-004	EW1800864-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.18	6.58	7.77	7.87	7.47
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1730	700	12200	1040	6010
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	1060	488	7210	658	3690
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	544	89	194	241	516
Total Alkalinity as CaCO3	----	1	mg/L	544	89	194	241	516
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	11	118	438	120	522
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	272	79	3710	133	1330
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	131	11	132	111	212
Magnesium	7439-95-4	1	mg/L	35	7	213	21	115
Sodium	7440-23-5	1	mg/L	190	113	1930	79	855
Potassium	7440-09-7	1	mg/L	7	3	80	5	16
EG020F: Dissolved Metals by ICP-MS								
Iron	7439-89-6	0.05	mg/L	0.16	1.01	1.92	2.03	1.17
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	0.56	0.09	1.01	0.18	1.12
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	0.17	0.23	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.8	1.3	1.5	0.8	5.0
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	1.8	1.3	1.7	1.0	5.0
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.24	0.99	0.60	0.29	0.49
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	18.8	6.46	118	11.1	58.7

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DG31s	BH-A	DG5D	DG5S	DG59
				Client sampling date / time	01-Mar-2018 11:30	01-Mar-2018 11:50	01-Mar-2018 13:45	01-Mar-2018 13:30	01-Mar-2018 14:00
Compound	CAS Number	LOR	Unit		EW1800864-001	EW1800864-002	EW1800864-003	EW1800864-004	EW1800864-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
Total Cations	----	0.01	meq/L		**17.9**	**6.12**	**110**	**10.8**	**57.6**
Ionic Balance	----	0.01	%		**2.48**	**2.75**	**3.31**	**1.07**	**0.90**
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**1.1**	**4.8**	**4.6**	**5.8**	**1.5**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DG6S	DG6D	----	----	----
			Client sampling date / time	01-Mar-2018 13:08	01-Mar-2018 13:15	----	----	----
Compound	CAS Number	LOR	Unit	EW1800864-006	EW1800864-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.37	7.70	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	17000	20900	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	10300	13100	----	----	----
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	334	384	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	334	384	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	588	864	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	5280	6510	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	188	219	----	----	----
Magnesium	7439-95-4	1	mg/L	327	422	----	----	----
Sodium	7440-23-5	1	mg/L	2850	3600	----	----	----
Potassium	7440-09-7	1	mg/L	94	118	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Iron	7439-89-6	0.05	mg/L	4.05	0.10	----	----	----
EK055G-NH4: Ammonium as N by DA								
Ammonium as N	14798-03-9_N	0.01	mg/L	1.05	0.05	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.14	0.20	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.3	1.0	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	2.4	1.2	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.48	0.10	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	168	209	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DG6S	DG6D	----	----	----
				Client sampling date / time	01-Mar-2018 13:08	01-Mar-2018 13:15	----	----	----
Compound	CAS Number	LOR	Unit		EW1800864-006	EW1800864-007	--------	--------	--------
					Result	Result	----	----	----
EN055: Ionic Balance - Continued									
Total Cations	----	0.01	meq/L		**163**	**205**	**----**	**----**	**----**
Ionic Balance	----	0.01	%		**1.57**	**0.97**	**----**	**----**	**----**
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**5.5**	**6.0**	**----**	**----**	**----**

SYDNEY
ANALYTICAL
LABORATORIES

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A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: L.VISINTIN

JOB NO: SAL26772

CLIENT ORDER: 117053

DATE RECEIVED: 09/05/18

DATE COMPLETED: 25/05/18

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 8

.....
Issued on 25/05/18
Lance Smith
(Chief Chemist)

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG5-S	DG5-D
pH		7.4	7.4
Total Dissolved Solids	mg/L	620	11600
Total Nitrogen	mg/L	2.7	4.0
Conductivity	uS/cm	980	18300
Iron (Dissolved)	mg/L	0.02	0.02

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	75	3.263	2950	128.325
Calcium Ca++	110	5.489	365	18.214
Potassium K+	11	0.282	240	6.144
Magnesium Mg++	17	1.399	610	50.203
Ammonia (Total)	0.4	0.029	3.9	0.278
TOTAL CATIONS		10.462		203.164
Chloride Cl-	145	4.089	6550	184.710
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	96	1.997	870	18.096
Bicarbonate HCO3-	280	4.592	295	4.838
Phosphate PO4---	<0.1		0.15	0.005
TOTAL ANIONS		10.678		207.649

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG6-S	DG6-D
pH		6.7	6.9
Total Dissolved Solids	mg/L	10300	16100
Total Nitrogen	mg/L	2.3	7.4
Conductivity	uS/cm	16800	25900
Iron (Dissolved)	mg/L	1.2	16

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	2500	108.750	3950	171.825
Calcium Ca++	290	14.471	495	24.701
Potassium K+	210	5.376	350	8.960
Magnesium Mg++	530	43.619	960	79.008
Ammonia (Total)	1.2	0.086	1.5	0.107
TOTAL CATIONS		172.302		284.601
Chloride Cl-	5550	156.510	9180	258.876
Fluoride F-	0.10	0.005	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	650	13.520	1320	27.456
Bicarbonate HCO3-	420	6.888	440	7.216
Phosphate PO4---	0.18	0.006	<0.1	
TOTAL ANIONS		176.929		293.548

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		BHA	DG55/BHD
pH		6.0	6.9
Total Dissolved Solids	mg/L	1220	8360
Total Nitrogen	mg/L	0.4	1.1
Conductivity	uS/cm	2060	13500
Iron (Dissolved)	mg/L	2.7	0.15

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	280	12.180	2050	89.175
Calcium Ca++	86	4.291	165	8.233
Potassium K+	17	0.435	220	5.632
Magnesium Mg++	47	3.868	435	35.801
Ammonia (Total)	0.2	0.014	0.4	0.029
TOTAL CATIONS		20.788		138.870
Chloride Cl-	590	16.638	4520	127.464
Fluoride F-	<0.1		0.13	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	150	3.120	710	14.768
Bicarbonate HCO3-	100	1.640	110	1.804
Phosphate PO4---	<0.1		0.18	0.006
TOTAL ANIONS		21.398		144.049

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG31-S	DG59
pH		6.9	7.2
Total Dissolved Solids	mg/L	1740	1920
Total Nitrogen	mg/L	4.0	2.9
Conductivity	uS/cm	2840	3000
Iron (Dissolved)	mg/L	2.1	0.04

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	330	14.355	425	18.488
Calcium Ca++	180	8.982	140	6.986
Potassium K+	24	0.614	35	0.896
Magnesium Mg++	78	6.419	80	6.584
Ammonia (Total)	2.4	0.171	1.3	0.093
TOTAL CATIONS		30.541		33.047
Chloride Cl-	620	17.484	585	16.497
Fluoride F-	<0.1		0.11	0.006
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	260	5.408	170	3.536
Bicarbonate HCO3-	430	7.052	825	13.530
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		29.944		33.569

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18
SAMPLES		BLANK
pH		7.1
Total Dissolved Solids	mg/L	<1
Total Nitrogen	mg/L	<0.1
Conductivity	uS/cm	0.9
Iron (Dissolved)	mg/L	<0.01

	mg/L	meq/L
Sodium Na+	<0.1	
Calcium Ca++	<0.1	
Potassium K+	<0.1	
Magnesium Mg++	<0.1	
Ammonia (Total)	<0.1	
TOTAL CATIONS		
Chloride Cl-	<1	
Fluoride F-	<0.1	
Nitrate NO3-	<0.1	
Sulphate SO4--	<2	
Bicarbonate HCO3-	<1	
Phosphate PO4---	<0.1	
TOTAL ANIONS		

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
4500B	Total Nitrogen
2510B	Conductivity
3111B	Iron (Dissolved)