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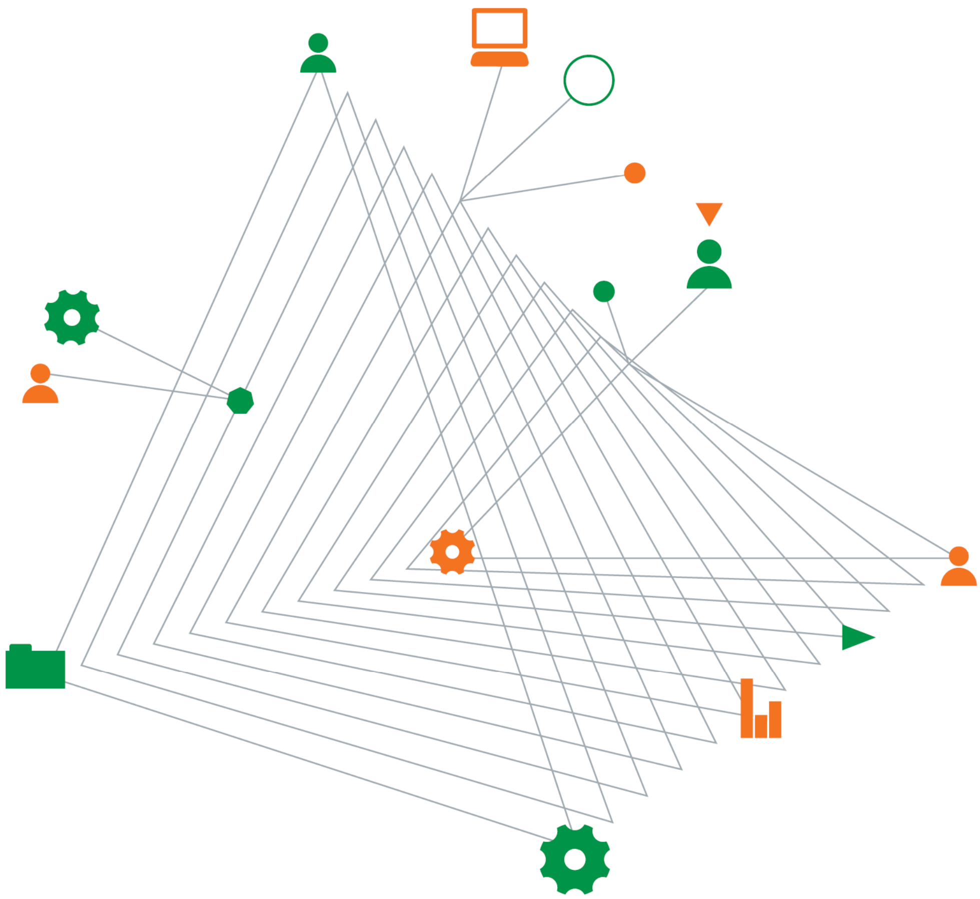
A TETRA TECH COMPANY

Art Gallery of New South Wales

Sydney Modern

Fuel Bunker Inflow Assessment

15 July 2016



Experience
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expertise

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Sydney Modern

Prepared for
Art Gallery of New South Wales
Art Gallery Road
The Domain
Sydney NSW 2000

Prepared by
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15 July 2016

Document authorisation

Our ref: GEOTLCOV25037AB-AE

For and on behalf of Coffey

Ben Rotter
Senior Groundwater Engineer

Quality information

Revision history

Revision	Description	Date	Author	Reviewer	Signatory
Final	Rev 0	15 Jul 2016	BR	AP	BR
Draft	Rev 0	20 May 2016	BR	RJB	BR

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Final	1	PDF	Nicholas Wolff, Art Gallery NSW Jane Fielding, Architectus Sydney Pty Ltd	15 Jul 2016
Draft	1	PDF	Nicholas Wolff, Art Gallery NSW	20 May 2016

Executive summary

Coffey Geotechnics Pty Ltd (Coffey) undertook an assessment of groundwater inflows to the existing underground fuel bunkers located on Royal Botanic Gardens property in The Domain, north of the land bridge over the Eastern Distributor, and bound by Art Gallery Road, Lincoln Crescent, the existing AusGrid substation, and the existing Art Gallery of NSW (AGNSW) building.

The assessment of groundwater inflows is in support of development approvals and design, and supports a State Significant Development (SSD) application for the proposed Sydney Modern building.

AGNSW intends to retain and re-purpose the southern fuel bunker as future art gallery space, and requires estimation of the groundwater inflow rate to the fuel bunkers in support of AGNSW's future treatment of the flows into the fuel bunkers.

Field investigation was undertaken to measure water levels within the fuel bunkers and groundwater levels immediately to the east of the bunkers. The quality of fuel bunker's water and surrounding groundwater was also assessed for the potential contribution of seawater to water seepage to the bunkers.

We consider that the majority of inflow to fuel the bunkers is sourced from groundwater.

Monitoring data suggest there is no significant tidal influence on water levels in the fuel bunkers or groundwater levels immediately east of the fuel bunkers, and groundwater quality indicates that seawater does not significantly contribute to water inflows to the fuel bunkers.

Monitoring of water levels in the southern fuel bunker indicate an approximate rate of inflow of 4.5 m^3/day (3.1 L/min or 1.6 ML/year) to both fuel bunkers during dry periods. Analytical assessment estimated groundwater inflow of approximately 7 m^3/day to both fuel bunkers. Rates may vary significantly in response to rainfall - rainfall recharge is expected to contribute to groundwater entering the fuel bunkers.

The estimate of inflow using monitoring data is based on a relatively short monitoring period where measured rises in response to rainfall (and potentially other phenomenon) were close to the measureable level of accuracy. Our analytical assessment is also based on numerous assumptions. In addition, monitoring results suggest the water level in the fuel bunkers respond to rainfall events, and the inflow rate may therefore change with time in response to rainfall or other mechanisms.

There is significant uncertainty in the accuracy of the reported rates of inflow and the mechanisms causing water levels to rise/fall in the fuel bunkers also remain inconclusive. The uncertainty in our assessment could be reduced by additional investigation, including longer term monitoring of water levels within the fuel bunkers than was possible for this assessment (i.e., monitoring for a duration of months rather than weeks).

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1. Introduction

This report provides an assessment of groundwater inflows to the existing underground fuel bunkers located in The Domain, north of the land bridge over the Eastern Distributor, and bounded by Art Gallery Road, Lincoln Crescent, the existing AusGrid substation, and the existing Art Gallery of NSW building.

The assessment of groundwater inflows is in support of development approvals and design, and supports a State Significant Development (SSD) application for the proposed Sydney Modern building.

The Secretary's Environmental Assessment Requirements (SEARs) do not address groundwater aspects related to the fuel bunkers. This report does not address the SEARs.

2. Project description

The Sydney Modern Project comprises a major expansion of the Art Gallery of New South Wales over the Eastern Distributor land bridge and adjacent disused Navy fuel bunkers in the Royal Botanic Gardens.

The new art gallery building will connect to the existing Art Gallery of NSW, providing new exhibition spaces, shops, food and beverage facilities, other amenities for visitors including art research, education and logistics spaces, and new publicly accessible plaza, terraces and landscaped areas.

3. Background

We understand that AGNSW requires estimation of the groundwater inflow rate to the fuel bunkers in support of AGNSW's future treatment of the flows into the fuel bunkers.

AGNSW intends to retain and re-purpose the southern fuel bunker as future art gallery space.

The fuel bunkers comprise two connected 'rooms' (two bunkers) each approximately 44 m by 51 m in footprint (as per the architectural drawing by Sanna Jimusho Ltd, drawing no. SMP-ARCH-D-10512 Rev 1. 9 May 2016). There is an adjacent pumping room to the north, from which water collecting in a sump can be pumped out. The sump footprint is approximately 2 m by 1.5 m.

We understand the fuel bunker lies entirely within bedrock.

The fuel bunker rooms are hydraulically connected by pipes running through the wall between rooms some 1 m above the base of the room floors. A similar pipe connection runs between the northern room and the pumping room.

We understand the fuel bunkers have a water overflow some 2 m above the floor level. Prior to the fuel bunker being pumped out in approximately April 2016, water continued to flow out of the overflow. AGNSW advised that the pumping contractor estimated the outflow rate from this point (prior to their pumping the water) was approximately 0.5 L/min to 1 L/min.

Some quantity of water which the pump inflow could not access remained in the fuel bunkers following pumping out. Since pumping out, water inflow to the rooms has been ongoing.

The fuel bunkers are roofed with concrete slabs, but the pumping room roof may be constructed of more permeable material. We therefore assume that rainfall recharge directly over the footprint of the fuel bunkers does not contribute to water inflows to the bunkers, but that rainfall recharge directly over the footprint of the pumping room may contribute to inflows to that room.

Since the footprint of the pumping room (some 8 m by 8 m) is significantly smaller than the footprint of the fuel bunker rooms, inflows to the fuel bunkers are expected to largely derive from lateral groundwater seepage (rather than groundwater seepage directly through the roof).

Two monitoring wells (MW1 and MW2) were installed on the eastern site boundary by GHD Pty Ltd in 1999. The construction details of these wells are unknown. However, given site topography and rock outcrops observed on Lincoln Cresent to the immediate east of the well locations, the monitoring wells are expected to be screened in sandstone bedrock.

4. Field testing

4.1. Water levels

On 29 April 2016, Coffey staff installed automatic water level loggers in the pumping room, the two fuel bunker rooms, and the two groundwater monitoring wells (MW1 and MW2) located to the immediate east of the fuel bunkers.

The locations of the rooms and monitoring wells are shown in Figure 1.

Coffey staff retrieved the loggers on 9 May 2016. Groundwater levels in the monitoring wells were still recovering to pre-test levels at that time.

Data recorded by the loggers located in the northern fuel bunker room and monitoring well MW1 were unable to be recovered due to equipment malfunction.

Groundwater levels in MW1 and MW2 were measured during the field testing (on 29 April 2016) and were also measured by Coffey during previous work in 2014. Interpreted groundwater levels are shown in Table 1.

Table 2 presents water levels manually measured in the fuel bunkers on 29 April 2016.

The groundwater level from the automatic logger installed in well MW2 is shown in Figure 2. Based on these results, the groundwater level does not show significant response to tides.

There was minimal rainfall over the continuous (automatic) monitoring period and it is not possible to assess the response in groundwater level due to rainfall based on these data. However, the range of values in historical measurements of groundwater (Table 1) suggests that groundwater levels may vary significantly with rainfall.

Table 1: Groundwater Levels in Monitoring Wells

Monitoring Well	Estimated Ground Surface Level* (m AHD)	Approximate Total Depth of Monitoring Well (m)	Depth to Groundwater from Ground Surface (m)			Interpreted Groundwater Level (m AHD)		
			18 Jun 2014	29 Apr 2016	9 May 2016	18 Jun 2014	29 Apr 2016	9 May 2016
MW1	2.91	5.26	2.37	1.96^	2.47&	0.54	0.95	0.44&
MW2	2.74	4.45	3.48	No accurate reading	1.61&	-0.74	N/A	1.13&

*Estimated from site survey by YSCO Geomatics, Plan of Lot 102 in DP854472, Reference 0714/1G, March 2014.
^Assuming 0.1 m between ground surface and top of well monitoring casing.
&The groundwater level in MW2 had fully recovered from hydraulic testing. It is unknown whether the groundwater level in MW1 had fully recovered from hydraulic testing.

Table 2: Water Levels in Fuel Bunkers

Bunker Room	Estimated Ground Surface Level* (m AHD)	Approximate Depth to Base of Room (m)	Approximate Floor of Room (m AHD)	Approximate Depth to Water from Ground Surface (m)	Interpreted Water Surface Level^ (m AHD)	Approximate Depth of Water in Room (m)
North	8.99	8.27	0.72	8.21	0.78	0.06
South	8.97	8.27	0.70	8.15	0.82	0.12

*Estimated from site survey by YSCO Geomatics, Plan of Lot 102 in DP854472, Reference 0714/1G, March 2014.

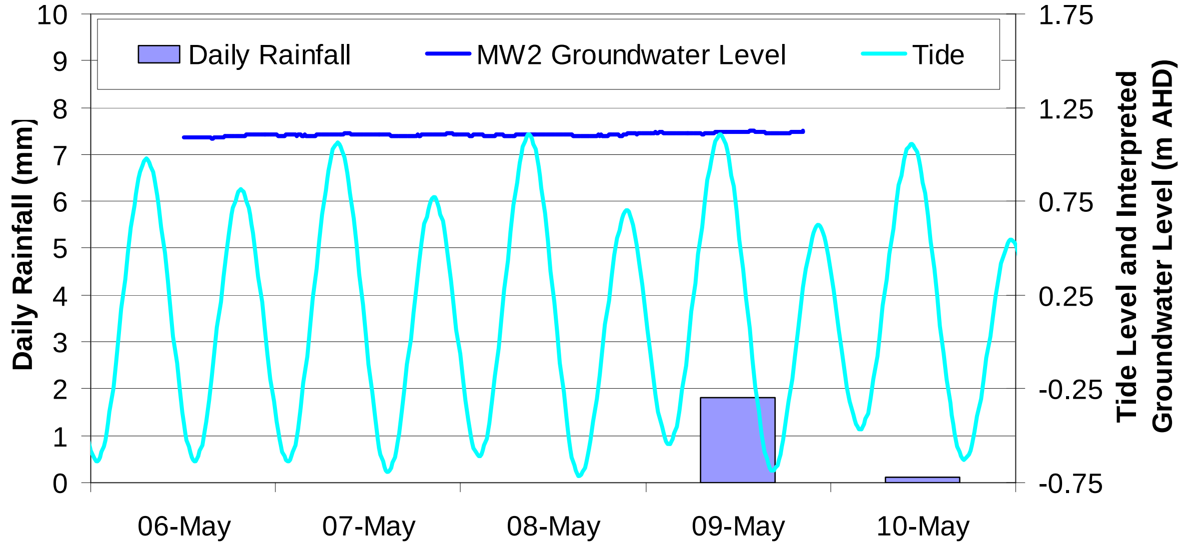

Figure 2: Interpreted Groundwater Level from Automatic Logger in MW2

4.2. Hydraulic conductivity

Coffey staff undertook hydraulic tests in both groundwater monitoring wells on 9 May 2016. However, the analysed hydraulic conductivity values are very low for sandstone that has experienced stress relief. It is quite possible that the hydraulic connection between the wells and the surrounding rock is influenced by well screen fouling (particularly given the age of the wells) or a well skin. These test results have therefore not been used in this assessment.

We consider it likely that sandstone in the vicinity of the fuel bunkers experienced stress relief due to being in a valley bottom and potentially due to past excavation. Based on experience on numerous Sydney projects, we assume the hydraulic conductivity of the sandstone in the vicinity of fuel bunkers could be as high as 0.1 m/day. However, there is significant uncertainty in this assumption.

4.3. Water quality

Coffey staff also sampled water from the fuel bunker pumping room sump and the two monitoring wells MW1 and MW2 on 29 April 2016. The laboratory certificate of analysis is provided in Appendix A.

Analyte concentrations are consistent between the monitoring wells and the sump. Table 3 lists concentrations of key analytes that differentiate seawater and freshwater for the sampled waters and typical seawater composition. The concentrations of these key analytes are significantly below the concentrations typical of seawater. Assuming water in the fuel bunker sump room is consistent with that in the fuel bunker rooms, these results indicate that the water sampled from the fuel bunker sump room and the monitoring wells is likely to be sourced from groundwater rather than seawater.

This is consistent with the groundwater level monitoring data, which indicates that the monitoring wells do not experience tidal influence and the groundwater elevation is above mean sea level.

Water seeping into the fuel bunkers is therefore expected to be sourced from (relatively) fresh groundwater rather than seawater. The groundwater contributing to inflows is likely to have emanated from within the bedrock aquifer to the west of the fuel bunkers. This aquifer is expected to be fed by rainfall recharge in the area.

Given that the floor of the bunkers lies at approximately 0.7 m AHD, the mean sea level is below this (at approximately 0.1 m AHD), and the bunkers lies some 90 m from the shoreline, this is not unexpected.

Table 3: Water Quality Results

Analyte	Concentration Range for Samples from Fuel Bunkers and Monitoring Wells (mg/L)	Typical Approximate Concentration in Seawater* (mg/L)
Chloride	57 to 70	19,000
Sulphate as S	7 to 31	2,600
Calcium	5 to 59	400
Magnesium	2 to 10	1,300
Sodium	46 to 90	10,600

*Source: World Health Organisation (http://www.who.int/water_sanitation_health/dwq/nutdesalination.pdf)

5. Inflow assessment

5.1. Based on measured water levels

Figures 3 and 4 show the interpreted depth of water in the southern fuel bunker room recorded by the automatic logger along with, respectively, tide levels and daily rainfall (recorded at the Bureau of Meteorology Station located in the Sydney Botanic Gardens). Note that daily rainfall records reported for a given day record the preceding 24 hours of rainfall from 9 am on that day.

The short-term variation (of up to 0.005 m) in logged water depth shown in Figure 3 is due to the instrument (and minor differences in atmospheric pressure correction for measured pressures). The accuracy of the instrument is approximately 0.005 m. Variations in water depth that are less than 0.005 m cannot be relied upon.

The results shown in Figure 3 suggest the water level in the southern fuel bunker room does not respond significantly to tide.

The results shown in Figure 4 suggest the water level in the southern fuel bunker room responds to rainfall events. The water level shows transient behaviour to rainfall, with a relatively rapid rise followed by a decline following the rainfall event.

We understand there was no pumping from the bunkers or pumping room sump during the monitoring period. It is possible that water seeps into the bunkers from the west, and potentially exits the bunkers on the eastern side. This may account for the transient behaviour in water levels within the bunkers.

There is therefore some uncertainty regarding the dynamics of inflow and outflow for the fuel bunkers. Nevertheless, there is a general trend of increasing water depth.

During the period between 2 May 2016 and 8 May 2016 there was no rainfall recorded (at the Bureau of Meteorology Station located in the Sydney Botanic Gardens).

Figure 5 shows the interpreted rise in water level in the southern fuel bunker room during this period, with a rise in water level of approximately 0.001 m/day occurring.

This rise equates to an inflow rate of approximately 4.5 m^3/day (3.1 L/min or 1.6 ML/year) to the fuel bunkers (including both rooms).

This is higher than the pumping contractor's estimate of pre-pump-out outflow rate (see Section 3) from the fuel bunkers of approximately 0.7 m^3/day to 1.4 m^3/day (0.5 L/min to 1 L/min). The rate of groundwater seepage to the bunkers is expected to reduce as the water level in the bunkers rises. The difference in the estimated rates of groundwater inflow may relate to the water level within the bunkers.

The monitoring of the water level in the room was conducted over a relatively short period and measured rises are close to the measureable level of accuracy. In addition, results suggest the water level in the fuel bunkers responds to rainfall events, and the inflow rate may therefore change with time in response to rainfall or other mechanisms. There is therefore uncertainty in the accuracy of the reported rates of inflow.

Figure 6 presents the interpreted water level in the sump room. During the monitoring period, the level in the sump rose in response to rainfall and subsequently declined. The inflow/discharge mechanisms in the sump are uncertain and, particularly given the relatively small size of the sump, large-scale inflow results for the fuel bunkers have not been extrapolated from these results.

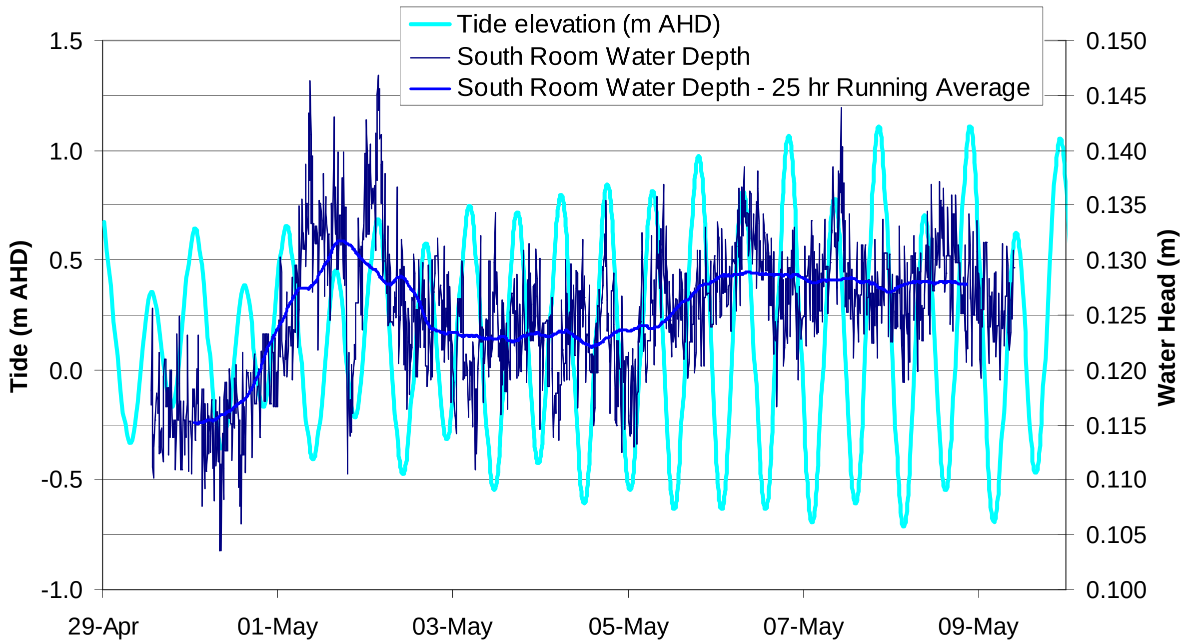

Figure 3: Interpreted Water Level in Southern Fuel Bunker Room and Tide

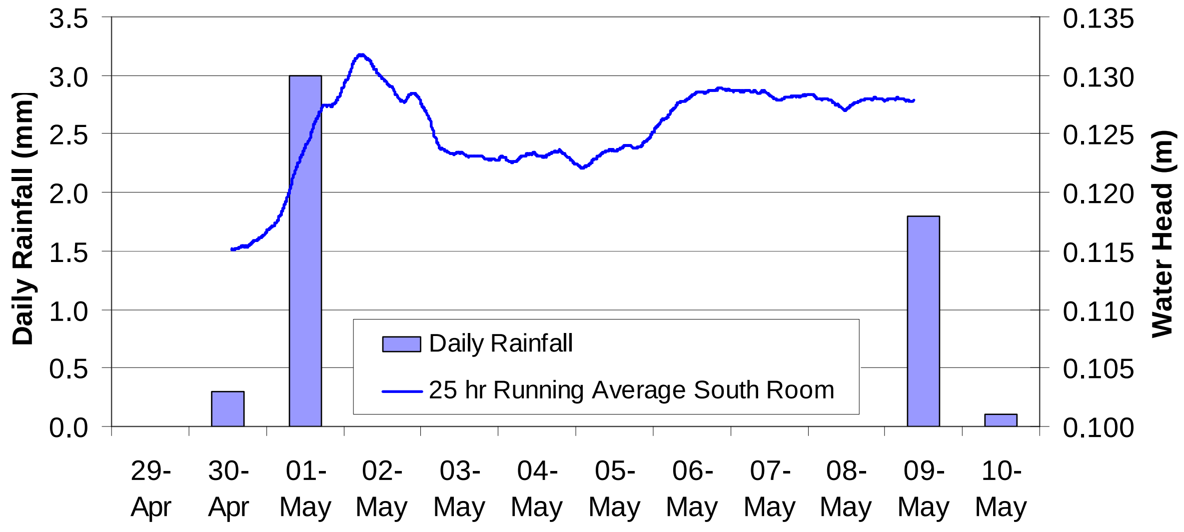

Figure 4: Interpreted Water Level in Southern Fuel Bunker Room and Daily Rainfall

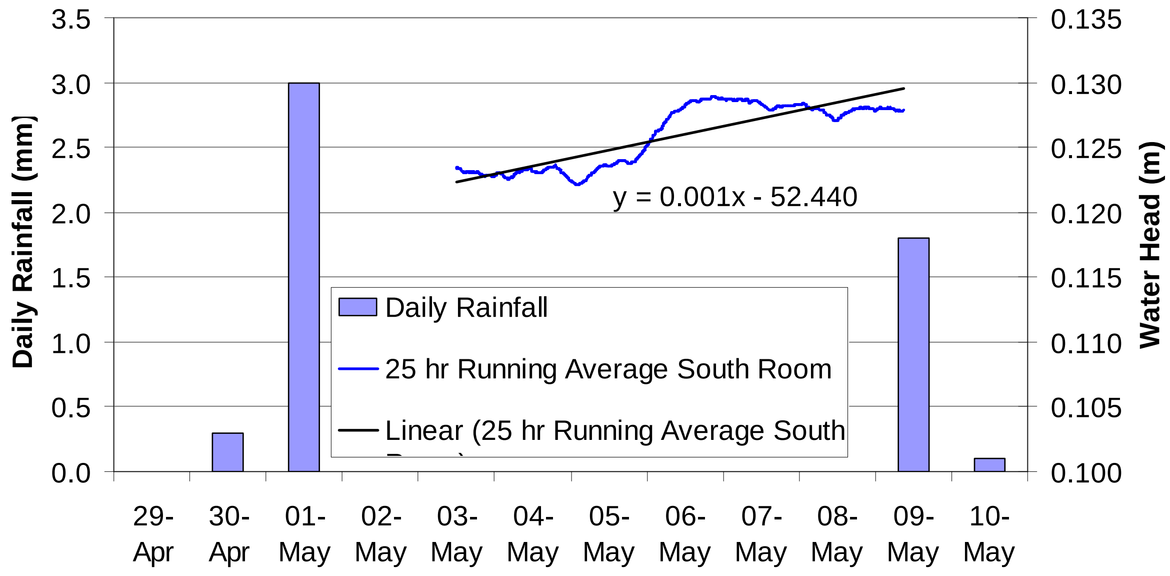

Figure 5: Interpreted Water Level in Southern Fuel Bunker Room During Period Without Rainfall

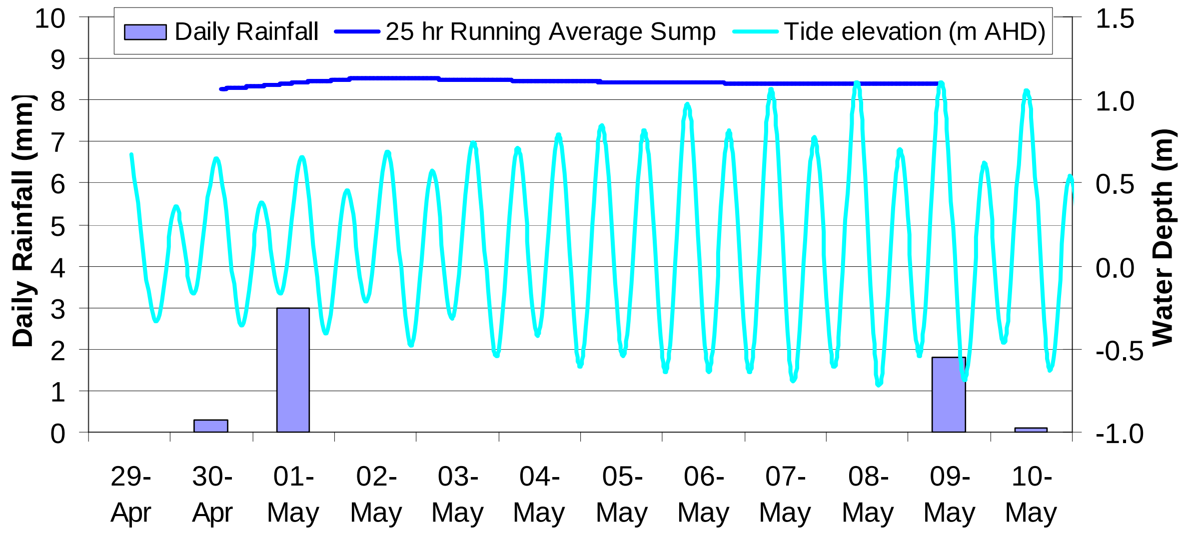

Figure 6: Interpreted Water Level in Pumping Room Sump

5.2. Based on analytical modelling

The fuel bunkers lies immediately east of a ridgeline. Art Gallery Road runs along the top of the ridge. Groundwater is expected to flow through the bedrock from the west into the bunkers.

At the time of monitoring, the groundwater level east of the bunkers (Figure 6) was above the water level within the bunkers. Groundwater may have entered the bunkers from the east during this time. However, when the bunkers are filled with water to the overflow level (approximately 2.7 m AHD), their water level would be higher than the surrounding groundwater level (assuming consistent conditions), and water within the bunkers may exit the bunkers to the west.

We have undertaken analytical assessment of the likely groundwater inflow to the fuel bunkers considering groundwater from the west enters the bunkers and does not exist to the east, and assuming the following:

- Groundwater level of 13 m AHD along the ridgeline, and some 35 m west of the bunker, as measured in borehole BH4 during previous geotechnical investigation by Coffey (Geotechnical Investigation for Sydney Modern Project, report reference GEOTLCOV25037AA-AF, 13 June 2014)
- Fuel bunker floor lies at 0.7 m AHD and there is minimal water within the bunker
- Mean sea level is 0.1 m AHD
- The groundwater table falls linearly between the ridge and the sea
- The hydraulic conductivity of the sandstone bedrock in the vicinity of the fuel bunker is 0.1 m/day (see Section 4.2).

Based on these assumptions, the estimated average rate of groundwater inflow to the fuel bunkers is approximately 7 m^3/day (4.9 L/min) to the fuel bunkers (including both rooms). This rate is likely to reduce as water level within the bunkers increases.

6. Conclusions

We conclude that:

- Considering the fuel bunkers are roofed with concrete slabs, and its footprint is significantly larger than the pumping room, the majority of inflow to the bunkers is expected to be sourced from groundwater

- Monitoring data shows no significant tidal influence on water levels in the fuel bunkers or groundwater levels immediately east of the fuel bunkers, and groundwater quality indicates that seawater does not significantly contribute to water inflows to the fuel bunkers

- Monitoring of water levels in the fuel bunkers indicates an approximate rate of inflow of 4.5 m^3/day (3.1 L/min or 1.6 ML/year) to the fuel bunkers (including both rooms) during dry periods. However, rates may vary significantly in response to rainfall - rainfall recharge is expected to contribute to groundwater entering the fuel bunkers

  This estimate is based on a relatively short monitoring period where measured rises were close to the measureable level of accuracy. The flows are small in magnitude, making measurements difficult. In addition, results suggest the water level in the fuel bunkers responds to rainfall events, and the inflow rate may therefore change with time in response to rainfall, water level within the bunkers, or other mechanisms. There is significant uncertainty in the accuracy of the reported rates of inflow. Further, the mechanisms underlying water levels rise/fall in the fuel bunkers also remain inconclusive

- Analytical assessment estimated groundwater inflow of approximately 7 m^3/day to the fuel bunkers (including both rooms). This assessment is based on numerous assumptions and there is significant uncertainty regarding its accuracy

- The uncertainty in our assessment could be reduced by additional investigation, including longer term monitoring of water levels within the fuel bunkers than was possible for this assessment (i.e., a duration of months rather than weeks).

7. Limitations

This report is based on limited data. Subsurface conditions can change over relatively short distances. Groundwater levels in the vicinity of the development were recorded at two locations and discrete points in time. Groundwater levels may vary across the site and in response to rainfall events. There is therefore uncertainty regarding groundwater levels at the site, and the likely inflows to the fuel bunkers.

Additional investigation and assessment is required to reduce the uncertainty associated with this assessment.

The attached document entitled “Important Information about Your Coffey Report” presents additional information on the uses and limitations of this report.

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Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

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Important information about your **Coffey** Report

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction,
speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Appendix A - Water Quality Laboratory Results

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Coffey Geotechnics Pty Ltd Chatswood
Level 18, Tower B, Citadel Tower 799 Pacific Highway
Chatswood
NSW 2067

Attention: **Lewis Fogerty**

Report **500929-W**
Project name ADDITIONAL: PORT GALLERY NSW
Project ID GEOTLCOV25037AC
Received Date May 17, 2016

Client Sample ID **Sample Matrix** **Eurofins | mgt Sample No.** **Date Sampled** Test/Reference	LOR	Unit	**MW1** **Water** **S16-My17480** **Apr 29, 2016**	**MW2** **Water** **S16-My17481** **Apr 29, 2016**	**SUMP** **Water** **S16-My17482** **Apr 29, 2016**
Ammonia (as N)	0.01	mg/L	0.14	< 0.01	< 0.01
Chloride	1	mg/L	57	70	62
Nitrate (as N)	0.02	mg/L	0.22	< 0.02	1.7
Sulphate (as S)	2	mg/L	31	6.7	16
Alkalinity (speciated)					
Bicarbonate Alkalinity (as CaCO3)	5	mg/L	65	40	170
Carbonate Alkalinity (as CaCO3)	5	mg/L	< 5	< 5	< 5
Alkali Metals					
Calcium	0.5	mg/L	8.8	4.7	59
Magnesium	0.5	mg/L	1.4	4.8	9.5
Potassium	0.5	mg/L	10	1.8	4.2
Sodium	0.5	mg/L	90	55	46

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite B11			
Ammonia (as N)	Sydney	May 17, 2016	28 Day
- Method: E036/E050 Ammonia as N			
Chloride	Sydney	May 18, 2016	28 Day
- Method: E033 /E045 /E047 Chloride			
Nitrate (as N)	Melbourne	May 19, 2016	7 Day
- Method: APHA 4500-NO3 Nitrate Nitrogen by FIA			
Sulphate (as S)	Sydney	May 18, 2016	28 Day
- Method: E045 Sulphate			
Alkalinity (speciated)	Sydney	May 19, 2016	14 Day
- Method: E035 Alkalinity			
Alkali Metals	Sydney	May 17, 2016	180 Day
- Method: E022/E030 Unfiltered Cations in Water			

Melbourne
2-5 Kingston Town Close
Oakleigh VIC 3166
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

ABN – 50 005 085 521 e.mail : EnviroSales@eurofins.com web : www.eurofins.com.au

Eurofins | mgt Unit F3, Building F, 16 Mars Road, Lane Cove West, NSW, Australia, 2066
ABN : 50 005 085 521 Telephone: +61 2 9900 8400 Facsimile: +61 2 9420 2977

Company Name:	Coffey Geotechnics Pty Ltd Chatswood	**Order No.:**		**Received:**	May 17, 2016 5:12 PM
Address:	Level 18, Tower B, Citadel Tower 799 Pacific Highway	**Report #:**	500929	**Due:**	May 19, 2016
	Chatswood	**Phone:**	+61 2 9406 1000	**Priority:**	2 Day
	NSW 2067	**Fax:**	+61 2 9406 1002	**Contact Name:**	Lewis Fogerty
Project Name:	ADDITIONAL: PORT GALLERY NSW				
Project ID:	GEOTLCOV25037AC				

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Eurofins | mgt Suite B11
Melbourne Laboratory - NATA Site # 1254 & 14271						X
Sydney Laboratory - NATA Site # 18217						X
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**	
	MW1	Apr 29, 2016		Water	S16-My17480	X
	MW2	Apr 29, 2016		Water	S16-My17481	X
	SUMP	Apr 29, 2016		Water	S16-My17482	X
Test Counts						3

Date Reported:May 19, 2016

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per Kilogram

mg/l: milligrams per litre

ug/l: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100ml: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

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Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Ammonia (as N)			mg/L	< 0.01			0.01	Pass	
Chloride			mg/L	< 1			1	Pass	
Nitrate (as N)			mg/L	< 0.02			0.02	Pass	
Sulphate (as S)			mg/L	< 2			2	Pass	
Method Blank									
Alkalinity (speciated)									
Bicarbonate Alkalinity (as CaCO3)			mg/L	< 5			5	Pass	
Carbonate Alkalinity (as CaCO3)			mg/L	< 5			5	Pass	
Method Blank									
Alkali Metals									
Calcium			mg/L	< 0.5			0.5	Pass	
Magnesium			mg/L	< 0.5			0.5	Pass	
Potassium			mg/L	< 0.5			0.5	Pass	
Sodium			mg/L	< 0.5			0.5	Pass	
LCS - % Recovery									
Ammonia (as N)			%	99			70-130	Pass	
Chloride			%	94			70-130	Pass	
Nitrate (as N)			%	99			70-130	Pass	
Sulphate (as S)			%	103			70-130	Pass	
LCS - % Recovery									
Alkalinity (speciated)									
Bicarbonate Alkalinity (as CaCO3)			%	80			70-130	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	114			70-130	Pass	
Magnesium			%	110			70-130	Pass	
Potassium			%	107			70-130	Pass	
Sodium			%	107			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Ammonia (as N)	S16-My17480	CP	%	106			70-130	Pass	
Nitrate (as N)	M16-My18488	NCP	%	91			70-130	Pass	
Sulphate (as S)	S16-My12664	NCP	%	107			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Bicarbonate Alkalinity (as CaCO3)	S16-My17480	CP	%	75			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	S16-My17482	CP	%	84			70-130	Pass	
Magnesium	S16-My17482	CP	%	109			70-130	Pass	
Potassium	S16-My17482	CP	%	106			70-130	Pass	
Sodium	S16-My17482	CP	%	108			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	S16-My17480	CP	mg/L	0.14	0.13	6.0	30%	Pass	
Chloride	S16-My15839	NCP	mg/L	29	28	6.0	30%	Pass	
Nitrate (as N)	M16-My18488	NCP	mg/L	2.2	2.3	2.0	30%	Pass	
Sulphate (as S)	S16-My12663	NCP	mg/L	4.3	4.3	1.0	30%	Pass	

Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	S16-My17480	CP	mg/L	65	70	7.0	30%	Pass	
Carbonate Alkalinity (as CaCO3)	S16-My17480	CP	mg/L	< 5	< 5	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	S16-My17481	CP	mg/L	4.7	4.8	1.0	30%	Pass	
Magnesium	S16-My17481	CP	mg/L	4.8	4.8	1.0	30%	Pass	
Potassium	S16-My17481	CP	mg/L	1.8	1.8	<1	30%	Pass	
Sodium	S16-My17481	CP	mg/L	55	53	3.0	30%	Pass	

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Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	No
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	No
Some samples have been subcontracted	No

Authorised By

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Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request