AGL Upstream Infrastructure Investments Pty Ltd

Tiedman Irrigation Program - Water Compliance Report for the Period 5 July to 31 December 2014

Gloucester Gas Project

26 February 2015

PARSONS BRINCKERHOFF

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Glossary

Alluvium	Unconsolidated sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains, and alluvial fans.
Alluvial aquifer	Permeable zones that store and produce groundwater from unconsolidated alluvial sediments. Shallow alluvial aquifers are generally unconfined aquifers.
Aquifer	Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water.
Bore	A structure drilled below the surface to obtain water from an aquifer or series of aquifers.
Coal	A sedimentary rock derived from the compaction and consolidation of vegetation or swamp deposits to form a fossilised carbonaceous rock.
Coal seam	A layer of coal within a sedimentary rock sequence.
Coal seam gas (CSG)	Coal seam gas is a form of natural gas (predominantly methane) that can be extracted from coal seams.
Concentration	The amount or mass of a substance present in a given volume or mass of sample, usually expressed as microgram per litre (water sample) or micrograms per kilogram (sediment sample).
Datalogger	A digital recording instrument that is inserted in monitoring and pumping bores to record pressure measurements and water level variations.
Electrical conductivity (EC)	A measure of a fluid's ability to conduct an electrical current and is an estimation of the total ions dissolved. It is often used as a measure of water salinity.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.
MicroSiemens per centimetre (µS/cm)	A measure of water salinity commonly referred to as EC (see also electrical conductivity). Most commonly measured in the field with calibrated field meters.
Monitoring bore	A non-pumping bore, is generally of small diameter that is used to measure the water level/pressure head of an aquifer and/or water quality. Bores generally have a short well screen against a single aquifer through which water can enter.
pH	Potential of Hydrogen; the logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per litre; provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral, greater than 7 is alkaline and less than 7 is acidic).
Recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and by river water reaching the

	water table or exposed aquifers. The addition of water to an aquifer.
Redox potential (ORP)	The redox potential is a measure (in volts) of the affinity of a substance for electrons – its electronegativity – compared with hydrogen (which is set at 0). Substances more strongly electronegative than (i.e. capable of oxidising) hydrogen have positive redox potentials. Substances less electronegative than (i.e. capable of reducing) hydrogen have negative redox potentials. Also known as oxidation-reduction potential.
Salinity	The concentration of dissolved salts in water, usually expressed in EC units (µS/cm) or milligrams of total dissolved solids per litre (mg/L TDS).
Salinity classification	Fresh water quality – water with a salinity <800 µS/cm. Marginal water quality – water that is more saline than freshwater and generally waters between 800 and 1,600 µS/cm. Brackish quality – water that is more saline than freshwater and generally waters between 1,600 and 4,800 µS/cm. Slightly saline quality – water that is more saline than brackish water and generally waters with a salinity between 4,800 and 10,000 µS/cm. Moderately saline quality – water that is more saline than slightly saline water and generally waters between 10,000 and 20,000 µS/cm. Saline quality – water that is almost as saline as seawater and generally waters with a salinity greater than 20,000 µS/cm. Seawater quality – water that is generally around 55,000 µS/cm.
Screen	A type of bore lining or casing of special construction, with apertures designed to permit the flow of water into a bore while preventing the entry of aquifer or filter pack material.
Water quality	Term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water quality data	Chemical, biological, and physical measurements or observations of the characteristics of surface and ground waters, atmospheric deposition, potable water, treated effluents, and waste water and of the immediate environment in which the water exists.
Well	Pertaining to a gas exploration well or gas production well.

Abbreviations

AGL	AGL Upstream Infrastructure Investments Pty Ltd
CDFM	Cumulative deviation from mean
CSG	Coal seam gas
DRE	Division of Resources and Energy
EC	Electrical conductivity
EPA	Environment Protection Authority
EPL	Environment Protection Licence
GFDA	Gas Field Development Area
GGP	Gloucester Gas Project
LOR	Limit of reporting
NOW	NSW Office of Water
NSW T&I	NSW Department of Trade and Investment
OCSG	Office of Coal Seam Gas
REF	Review of Environmental Factors
SAR	Sodium adsorption ratio
TDS	Total dissolved solids
TIP	Tiedman Irrigation Program
TSS	Total suspended solids
WMP	Water management plan

Units

ºC	degrees Celsius
ha	hectare
m	metres
mAHD	metres Australian Height Datum
mbgl	metres below ground level
mg/L	milligrams per litre
mm	millimetres
mm/day	millimetres per day
ML	megalitres
mV	millivolt
µS/cm	microsiemens per centimetre
µm	micrometres

Executive summary

AGL Upstream Infrastructure Investments Pty Ltd (AGL) is proposing to develop the Gloucester Gas Project (GGP) which will comprise several stages of development; currently only one stage is approved, the Stage 1 Gas Field Development Area (GFDA). Surface water and groundwater investigations are ongoing pending the commencement of the GGP.

As part of its current exploration program, AGL proposed irrigating a maximum of 70 ML of produced water over a maximum area of 40 ha over a two to three year period. The original approval was for two years from 5 July 2012 to 4 July 2014, with the current approval extended to 30 April 2015. Irrigation includes water from exploration programs (from the 2013, 2014, and 2015 exploration activities) which is stored in the Tiedman dams, as well as any rainfall which falls in the dams. This water is blended with fresh water from sources including the Avon River to optimise the quality of the irrigated water.

Surface water and groundwater monitoring for the Tiedman Irrigation Program commenced in October 2011 and was established in accordance with the approved water management plan (AGL 2012). The monitoring aims to ensure that the quality of the water used for irrigation is appropriate and that the application of irrigated water does not result in impact on the local surface water or groundwater resources. Water level and water quality data are evaluated for each monitoring period.

This compliance report, the fourth in a series of five six-monthly reports during this approval period, is a requirement of the NSW Department of Trade and Investment (Office of Coal Seam Gas) and the Environment Protection Authority approvals and licences.

Monitoring during the six month period to 31 December 2014 showed there was no change in stream levels, alluvial, or shallow fractured rock groundwater levels that can be attributed to the irrigation program activities. Surface water and groundwater levels remained comparable to the results from the previous compliance period.

The quality of the blended water used for irrigation, which is stored in Tiedman south dam (TSD), was within the ANZECC (2000) irrigation guidelines with the exception of pH (all events), iron (August 2014) and total phosphorus (all events) which were slightly above the guidelines. Irrigation water pH was marginally over the irrigation guideline for the August 2014 event, variable iron concentrations are normal for groundwater. The iron and phosphorus exceedances relate to guidelines that are set to minimise clogging of irrigation equipment. On these grounds, the blended water in the TSD is considered suitable for irrigation, although the pH of the water should be slightly reduced.

Two catch dams were constructed to capture the first flush of runoff from the irrigation area during high rainfall events. After capturing the first flush, any further rainfall overflows the catch dams as overland flow. The runoff samples collected from the catch dams during the high rainfall events in late August and December 2014 exceeded EPL 20358 Condition L3.4 for total suspended solids (50 mg/L). The exceedances were notified to EPA and for the August exceedance no regulatory response was undertaken as the water quality in the Avon River upstream of the discharge area had higher levels of suspended solids than either of the catch dam discharges and the likelihood of environmental harm as a result of the discharge was considered minimal. Further to the December exceedance, AGL has met with the EPA and proposed improved sampling locations. There is no change in the downstream surface water quality (FSW01) that can be directly attributed to the high rainfall events in late August and December 2014.

A small number of surface water samples slightly exceeded the ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems during the monitoring period. However, such exceedances were noted during the baseline monitoring period (October 2011 to September 2012) and most analytes remain within

the ranges observed during the baseline period. It is concluded that there has been no detectable change in natural surface water or groundwater quality as a result of the irrigation program activities.

1. Introduction

This report presents the level and quality data from groundwater, surface water (streams), and irrigation associated with the Tiedman Irrigation Program (TIP). The report is a six-monthly compliance report covering the period from 5 July to 31 December 2014.

1.1 Gloucester Gas Project

AGL Upstream Infrastructure Investments Pty Ltd (AGL) is proposing to build the Gloucester Gas Project (GGP) which comprises several stages of development facilitating the extraction of coal seam gas (CSG) from the Gloucester Basin. Concept Plan and Project Approval (Part 3A Approval) for the Stage 1 Gas Field Development Area (GFDA) was granted on 22 February 2011 under Part 3A of the *Environmental Planning and Assessment Act (1979)* (EP&A Act). In addition, the project received approval under the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act) (EPBC Approval) on 11 February 2013.

AGL holds Petroleum Exploration Licence (PEL) 285, under the *Petroleum (Onshore) Act 1991*, covering the whole of the Gloucester Basin, approximately 100 km north of Newcastle, NSW.

The GGP will involve the depressurising of deep groundwater and the extraction of gas from multiple coal seams within the Gloucester Coal Measures. Target coal seam depths will vary from site to site and are expected to range between 200 and 1,000 m below ground level (bgl). The current GGP within the Stage 1 GFDA includes the construction, operation, and decommissioning of 110 CSG wells and associated infrastructure, including gas and water gathering lines. A comprehensive groundwater investigation (Phase 2 Groundwater Investigations) was completed in early 2012 to confirm the hydrogeological conceptual model across the Stage 1 GFDA (Parsons Brinckerhoff 2012). Surface water and groundwater investigations are ongoing pending the commencement of the GGP.

1.2 Irrigation program

Irrigation has been identified as the preferred water management and reuse method for produced water generated from the dewatering of deep coal seams during exploration programs at Gloucester. Consequently an irrigation program is underway to evaluate the sustainability of irrigating salt tolerant crops on improved soils on AGL's Tiedman property at Stratford. The current Tiedman Irrigation Program uses blended water for the irrigation of improved pasture, lucerne and summer/winter cereals. The produced water is derived from historical flow testing programs that were approved exploration activities. Blended water irrigation is only proposed for the reuse of produced water derived from exploration program activities. AGL has committed to desalination for the reuse of extracted water from the Stage 1 GFDA.

Part V approval under the *EP&A Act* for the current irrigation program was issued in July 2012 by the NSW Trade and Investment (T&I) – Division of Resources and Energy (DRE) for a period of two years (from 5 July 2012 to 4 July 2014) (DRE 2012). Approval was extended to 30 April 2015 by the NSW T&I – Office of Coal Seam Gas (OCSG) on 4 July 2014 (OCSG 2014). On 6 August 2014, the NSW Environment Protection Authority (EPA) issued Environment Protection Licence (EPL) 20358 that covers the approved CSG exploration, assessment and production activities in the GGP (EPA 2014). Soil and water monitoring and reporting associated with the TIP is captured under both these approvals.

AGL proposed irrigating a maximum of 70 ML of produced water over a maximum area of 40 ha over a two to three year period. Irrigation includes water from exploration programs which is stored in the Tiedman dams (and, prior to their rehabilitation, the Stratford dams), as well as any rainfall which falls in the dams and

any additional water produced from the 2013, 2014 and 2015 exploration activities. This water is blended with fresh water from sources including the Avon River to optimise the quality of the irrigated water.

The 40 ha irrigation area is divided into two areas, being Stage 1A and 1B (Figure 1.1):

- Stage 1A is an intensive irrigation area serviced by a lateral move irrigator in the north-west portion of the Tiedman property. The lateral move irrigator irrigates a maximum area of 18.2 ha, including 16 x 0.75 ha plots (12 ha) incorporating four different soil improvements. A small additional (adjacent) area for enhancements to the program was proposed for the Stage 1A area; however this is unlikely to proceed at this time.
- Stage 1B comprises the existing irrigation area of about 8.6 ha (of which about 4 ha has received irrigation) plus an expansion area to the west and south. It is highly unlikely that this expansion area of 21 ha will be required.

The irrigation water is a blended water mix with an electrical conductivity (EC) of around 1,500 µS/cm (although 2,000 µS/cm is the upper limit for the blended water in the Review of Environmental Factors (REF) for the irrigation program (Parsons Brinckerhoff 2011)). The target water salinity is expected to be mostly in the range 1,400 to 1,600 µS/cm. The blended water comprises an approximate ratio of three parts fresh water and one part produced water. Freshwater is sourced from local farm dams and the Avon River. The irrigation program allows salt tolerant crops to be grown, with continuous cropping over summer and winter.

The blended water irrigation program began on 29 April 2013 for the Stage 1A area and on 1 May 2013 for the Stage 1B area. Prior to this, lower salinity produced water was directly irrigated across the Stage 1B area from 16 October to 8 December 2012 to create some space in the Tiedman south dam (TSD) for blending the remaining produced water with fresh water sources.

Regional groundwater level monitoring commenced in January 2011 and surface water level monitoring commenced in March 2011. A baseline groundwater and surface water monitoring program was conducted between October 2011 and September 2012 to define pre-irrigation conditions (Parsons Brinckerhoff 2013a). This compliance report is the fourth in a series of five six-monthly reports required during the irrigation program period. The following compliance reports have been prepared:

- first compliance report covered the initial irrigation period to 30 June 2013 (Parsons Brinckerhoff 2013b)
- second compliance report covered the period 1 July to 31 December 2013 (Parsons Brinckerhoff 2014a)
- third compliance report covered the period 1 January to 4 July 2014 (Parsons Brinckerhoff 2014b)
- this fourth compliance report covers the period 5 July to 31 December 2014.

For the period from 5 July to 31 December 2014, 18.5 ML of blended irrigation water was applied to the 12 ha area within the Stage 1A area. No irrigation water was applied to the 4 ha Stage 1B area. During the same period, 417.0 mm of rainfall was recorded by AGL (2015), which equates to 66.72 ML of rainfall across the two irrigation areas.

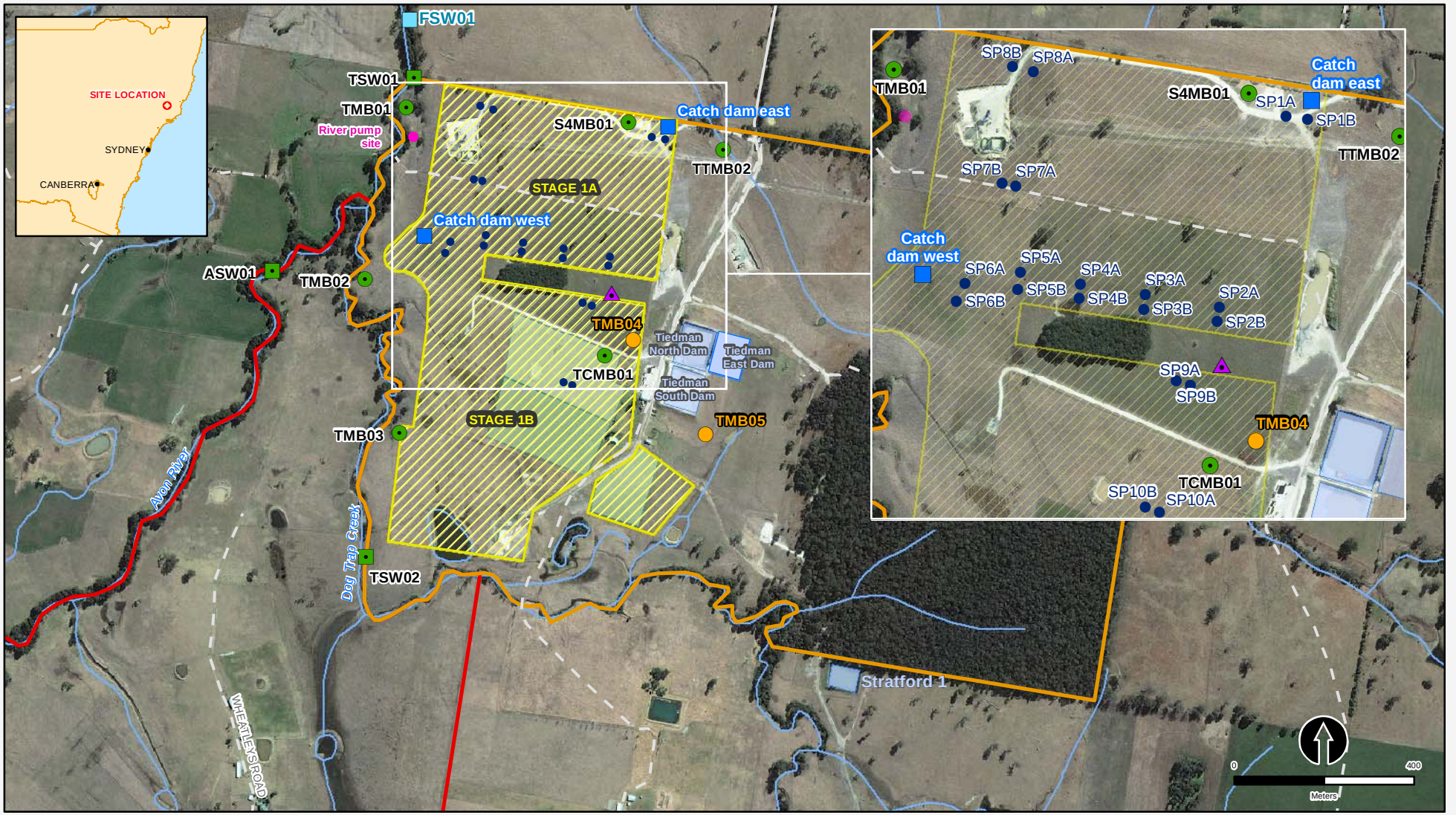
For the entire irrigation program to 31 December 2014, approximately 50 ML of produced water has been irrigated. There is approximately 8 ML of blended water remaining in TSD to be irrigated. On 5 January 2015 there was less than 5 ML of recycled stormwater/residual produced water in the Tiedman north dam (TND) and there was minimal water (just enough to settle the liner) in the Tiedman east dam (TED).

1.3 Objectives

The objectives of the irrigation program and the associated water monitoring program are to ensure that the quality of the water used for irrigation is appropriate and that the application of blended water does not result

in impacts to the local surface water or groundwater resources. This water monitoring program mostly focuses on the Stage 1A irrigation area, as it is the intensive irrigation area for which performance data is required on salt accumulation and water application rates.

The water monitoring program and compliance reporting must be in accordance with the REF approval (OCSG 2014), approved water management plan (AGL 2012) and EPL 20358 (EPA 2014). Details of the approved water management plan are provided in Section 2.3.



Groundwater monitoring bore
Stream gauge
Seepage monitoring bore
Surface water monitoring location
Perched shallow piezometer
River pump site
Catch dam
Produced water dam
Stage 1 irrigation area
Atkins Property
Tiedman Property
Roads
Tracks

Figure 1.1 Irrigation monitoring network

2. Monitoring network and methodology

2.1 Monitoring network and purpose

The water monitoring network for the irrigation program is summarised in Table 2.1 and shown on Figure 1.1.

Table 2.1 Summary of the water monitoring network

Category	Sub-category	Monitoring ID	Monitoring purpose	Monitoring commencement
Irrigation dams	Blended irrigation water	Tiedman south dam (TSD)	Monitor water quality of blended irrigation water	October 2011
	Produced water	Tiedman north dam (TND) Tiedman east dam (TED)	Monitor water quality of produced water	October 2011 May 2013
Groundwater	Shallow alluvial groundwater	TMB01 TMB02 TMB03	Monitor groundwater levels and quality in shallow alluvium adjacent to Dog Trap Creek and the Avon River for any potential impact from the project	February 2011
	Shallow rock groundwater	S4MB01 TCMB01 TTMB02	Monitor water levels and quality in fractured bedrock for any potential impact from the project	January 2011 August 2014 August 2014
	Perched groundwater (seepage monitoring bores)	TMB04 TMB05	Detect any potential leakage from the dams to form perched groundwater in the weathered rock profile adjacent to the dams	April 2011
	Perched water (soil piezometers)	SP1A/B to SP10A/B	Monitor perched water quality in the soil profile in and near the irrigation area for any potential impact from the project	November 2013
Surface water	Surface water	ASW01 TSW01 TSW02 FSW01	Monitor water levels and quality of the Avon River and Dog Trap Creek for any potential impact from the project	March 2011 March 2011 April 2012 February 2012
Catch dams	Irrigation plot runoff	Catch dam east (CDE) Catch dam west (CDW)	Monitor water quality of any Stage 1A irrigation plot runoff	May 2013

The groundwater and surface water monitoring locations for the Stage 1A and 1B irrigation areas provide monitoring for the possible receptors of blended irrigation water. Primary monitoring sites include:

- storage dams and catch dams
- surface water sources of the Avon River and Dog Trap Creek
- groundwater in the alluvium, adjacent and down gradient of the irrigation areas
- groundwater in the shallow rock below the irrigation areas.

The storage dams (TND, TSD, and TED) are of a 'turkey's nest' style construction, are located on high ground (beyond the floodplain), and are designed to prevent ingress from surface runoff. Storage dams TND and TSD are single lined dams while TED is a double lined dam. Storage dam TSD is the primary blended water irrigation dam and is monitored to ensure that the blended water complies with the ANZECC (2000) irrigation water quality guidelines.

The two catch dams (CDE and CDW) capture irrigation plot runoff (after heavy rainfall events) and are monitored for water quality.

The two seepage monitoring bores (TMB04 and TMB05) monitor soil/perched water in the weathered rock profile adjacent to the Tiedman north and south dams above the regional water table. The purpose of these bores is to detect leakage from the dams. Details of these bores are provided in Table 2.2.

Table 2.2 Seepage monitoring bore details

Monitoring bore	Total depth (mbgl)	Screened interval (mbgl)	Lithology
TMB04	15.0	8.0 – 14.0	Shallow rock (weathered sandstone and siltstone)
TMB05	10.0	6.0 – 9.0	

There are three stream gauges where surface water levels and quality are routinely monitored, being TSW01, TSW02 and ASW01 (Table 2.3). Until its inclusion in the routine quarterly sampling in August 2014, the FSW01 sampling location on the Avon River downstream of the Tiedman property was only monitored during high rainfall events. Stream gauge ASW01 is also monitored during high rainfall events and is considered a control site as it is located upstream of the irrigation areas and the confluence with Dog Trap Creek.

Table 2.3 Stream gauges

Gauge ID	Location
TSW01	Avon River downstream of the confluence with Dog Trap Creek and the irrigation areas, adjacent to monitoring bore TMB01.
TSW02	Dog Trap Creek upstream of the irrigation areas.
ASW01	Avon River upstream of the irrigation areas and the confluence with Dog Trap Creek.
FSW01	Avon River downstream of the Tiedman property and the confluence with Dog Trap Creek and the irrigation areas.

Three groundwater monitoring bores are screened within shallow alluvium associated with the Avon River and Dog Trap Creek (TMB01, TMB02 and TMB03). Three monitoring bores (S4MB01, TCMB01 and TTMB02) are screened within the fractured bedrock underlying the irrigation area. Details are presented in Table 2.4.

Table 2.4 Groundwater monitoring bore details

Monitoring bore	Total depth (mbgl)	Screened interval (mbgl)	Lithology	Formation
TMB01	12.0	7.0 – 10.0	Clay	Avon River alluvium
TMB02	15.5	9.0 – 12.0	Mixed gravels	Avon River alluvium
TMB03	12.5	5.0 – 11.0	Mixed gravels and sand	Avon River alluvium
S4MB01	66.0	58.0 – 64.0	Sandstone	Shallow rock: Leloma Formation
TCMB01	95.0	87.0 – 93.0	Sandstone	Shallow rock: Leloma Formation
TTMB02	90.0	76.0 – 88.0	Sandstone/siltstone	Shallow rock: Leloma Formation

There are 10 paired (soil water) piezometers (SP1A/B to SP10A/B; 0.3 - 1.2 m and 1.5 m deep) within and just outside the Stage 1A and 1B irrigation areas that are typically dry. These monitor soil water in the shallow soil profile and are not groundwater monitoring locations.

2.2 Monitoring program

Quarterly water monitoring is undertaken at most sites and is subject to six-monthly compliance reporting to both the OCSG and EPA. The water compliance reports are scheduled to align with soil compliance reports. The schedule of sampling events and reporting is provided in Table 2.5.

Table 2.5 Schedule of sampling/reporting events

Sampling event	Type	Sampling date	Compliance report
Baseline	Water	October 2011 – September 2012	January 2013
	Soil	January 2013	May 2013
Irrigation 1	Water	May 2013 (for period to 30 June 2013)	August 2013
	Soil	May 2013 (for period to 30 June 2013)	August 2013
Irrigation 2	Water	August 2013 and November 2013 (for period to 31 December 2013)	January 2014
	Soil	November 2013 (for period to 31 December 2013)	January 2014
Irrigation 3	Water	February 2014 and May 2014 (for period to 4 July 2014)	August 2014
	Soil	May 2014 (for period to 4 July 2014)	August 2014
Irrigation 4	Water	August 2014 and November 2014 (for period to 31 December 2014)	February 2015 (this report)
	Soil	November 2014 (for period to 31 December 2014)	February 2015

Water quality is the primary monitoring requirement at all water monitoring sites, although water levels are also measured continuously at the dedicated stream gauges (ASW01, TSW02 and TSW01), the two seepage monitoring bores near the Tiedman dams (TMB04 and TMB05), and the dedicated shallow alluvial monitoring bores (TMB01, TMB02 and TMB03) and fractured rock monitoring bores (S4MB01, TCMB01 and TTMB02).

Each of the three turkey nest dams (TSD, TND and TED) is monitored for water quality each quarter and salinity of the blended irrigation water is tracked continuously via a salinity (EC) logger in TSD. This logger has been operational since late 2011. Between 4 July and 2 September 2014, the logger was removed from TSD due to the lack of water in this dam. EC loggers were installed at catch dam west (CDW) and catch dam east (CDE) on 7 May 2013 and data until 26 November 2014 (when the loggers were downloaded) have been included in this compliance report.

Only one of the ten paired piezometers (SP1A/B to SP10A/B) had accumulated sufficient perched (soil) water to allow for a sample to be collected in August 2014. All ten paired piezometers were dry at the time of the November 2014 sampling.

Catch dams CDE and CDW are monitored for water quality each quarter and the salinity of the water is tracked continuously via a salinity (EC) logger in each dam.

FSW01 (Avon River – downstream), ASW01 (Avon River – upstream), CDW, and CDE are also monitored during high rainfall events. These locations were sampled by AGL during the high rainfall events in August and December 2014.

2.3 Approved water management plan

The approved water management plan (WMP) is titled '*Water Management Plan for the Tiedman Irrigation Program – Gloucester'* (AGL 2012). The WMP was based on the outline provided in the REF (Parsons Brinckerhoff 2011), the NSW Office of Water's (NOW) letter dated 12 August 2011, baseline monitoring initiated by AGL, discussions with NOW in December 2011, and additional information provided in February 2012.

Table 2.6 summarises the groundwater and surface water monitoring scope as outlined in the WMP. This is consistent with the monitoring requirements required under Conditions P1.3, M2.2 and M2.5 of EPL 20358 (EPA 2014).

Table 2.6 Groundwater and surface water monitoring locations and scope

Monitoring ID/(EPA ID)	Description	Water levels	Routine water quality and sampling frequency	Extra sampling
TND (27)	Tiedman north dam	Not required	Metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	Physical parameters[a] – Monthly
TSD (28)	Tiedman south dam	Not required	Salinity logger – Continuous Metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	Physical parameters – Monthly
TED (29)	Tiedman east dam	Not required	Metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	Physical parameters – Monthly
CDE (33)	Catch dam located north-east of Stage 1A irrigation area	Not required	Salinity logger – Continuous	Physical parameters, metals, nutrients, cations/anions – during high rainfall events[b]
CDW (34)	Catch dam located south-west of Stage 1A irrigation area	Not required	Salinity logger – Continuous	Physical parameters, metals, nutrients, cations/anions – during high rainfall events[b]

Monitoring ID/(EPA ID)	Description	Water levels	Routine water quality and sampling frequency	Extra sampling
TMB04 (30)	Seepage monitoring bore, located west of Tiedman north dam	Yes continuous	Physical parameters then purge dry and assess inflows – Quarterly If inflow within 12-hours then physical parameters again, metals, nutrients, cations/anions	Physical inspection of surrounding area – Monthly
TMB05 (31)	Seepage monitoring bore, located south of the Tiedman dams	Yes continuous	Physical parameters then purge dry and assess inflows – Quarterly If inflow within 12-hours then physical parameters again, metals, nutrients, cations/anions	Physical inspection of surrounding area – Monthly
ASW01 (36)	Avon River (upgradient), located on the Atkins property	Yes continuous	Salinity logger – Continuous Nominal physical parameters, metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	Physical parameters, metals, nutrients, cations/anions – during high rainfall events[b]
TSW02 (38)	Dog Trap Creek	Yes continuous	Salinity logger – Continuous Physical parameters, metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	None planned
TSW01 (37)	Avon River, located downgradient of the Tiedman boundary	Yes continuous	Salinity logger – Continuous Nominal physical parameters, metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	None planned
FSW01 (35)	Avon River, located downgradient, on the Farley property	Not required	Physical parameters, metals, nutrients, cations/anions – Quarterly Hydrocarbons – Annually	Physical parameters, metals, nutrients, cations/anions – during high rainfall events[b]
TMB01 (39)	Avon River alluvium, located downgradient, on the site boundary	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned
TMB02 (40)	Avon River/Dog Trap Creek alluvium (mid site)	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned
TMB03 (41)	Dog Trap Creek alluvium (southern site)	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned
S4MB01 (42)	Northern site boundary of Stage 1A area (shallow rock)	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned

Monitoring ID/(EPA ID)	Description	Water levels	Routine water quality and sampling frequency	Extra sampling
TCMB01[c] (43)	Located west of Tiedman dams (shallow rock)	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned
TTMB02[c] (44)	Located east of Stage 1A area (shallow rock)	Yes continuous	Nominal physical parameters, metals, cations/anions – Quarterly Hydrocarbons and nutrients – Annually	None planned

Note:

(a) Physical parameters defined in Table 2.7.

(b) High rainfall events samples are collected by AGL.

(c) Not included in WMP.

The WMP states that the water intended for irrigation will meet the ANZECC (2000) water quality criteria for irrigation purposes. There are no other commitments in the WMP regarding guidelines or thresholds. The assessment criteria proposed in these water compliance reports (see Section 2.5.2) is mostly for comparative purposes only.

2.4 Water level monitoring

2.4.1 Groundwater level monitoring

Groundwater levels are electronically and manually measured in all monitoring bores. Pressure transducers with dataloggers suspended in the monitoring bore water column are programmed to record a groundwater level measurement every six hours. Manual measurements using an electronic dip meter are recorded every monitoring round and used to calibrate the logger data.

A barometric datalogger installed above the water table at WKMB02 (part of the original Stage 1 groundwater monitoring network), located approximately 2 km to the north of the irrigation area, records changes in atmospheric pressure. Data from this logger are used to correct for the effects of changing barometric pressure on groundwater levels in the monitoring bores.

2.4.2 Surface water level monitoring

Surface water monitoring locations include dataloggers to continuously monitor water levels and salinity and gauge boards. Loggers installed at the stream gauges are set to take a reading every 15 minutes. Measurements are verified and calibrated by manual gauge readings and salinity (EC) measurements.

2.5 Water quality monitoring

Routine water quality sampling was completed at all of the sites listed in Table 2.6 as per EPL 20358 Condition P1.3.

2.5.1 Automated monitoring

Salinity (EC) loggers are installed at three surface water locations (ASW01, TSW02 and TSW01), the blended water irrigation dam (TSD) (October 2011 to March 2013 and from August 2013 onwards), TED (March to August 2013) and in the two catch dams (CDW and CDE).

EC measurements are recorded electronically, and manually verified during quarterly sampling events. Salinity dataloggers record EC measurements every 15 minutes at the surface water sites, and every six hours at the Tiedman and catch dam sites.

2.5.2 Sampling methodology

Five sampling methods were used to obtain surface water and groundwater samples:

- Submersible 12V pump:
  - At groundwater monitoring bores screened within relatively permeable geological materials, TMB01, TMB02, and TMB03. A minimum of three well volumes was purged prior to sampling.
  - At the seepage monitoring bores TMB04 and TMB05 which are screened within material of very low permeability. The physical parameters (as defined in Table 2.7) of the purged groundwater were initially tested, then the bores were purged dry and if any inflow was observed within 12 hours then physical parameters were tested again and a sample taken for analysis.
- Disposable bailer at the shallow perched soil water piezometers. Piezometers were purged dry and if any inflow was observed within 12 hours then physical parameters were tested again and a sample taken for analysis.
- In-situ snap sampler for groundwater monitoring bore S4MB01, screened within material of relatively low permeability.
- A micro-purge™ low flow sampling pump for monitoring bores TCMB01 and TTMB02, screened within material of relatively low permeability.
- Grab sample using a new Nalgene sub-sample bottle attached to telescopic sampling pole for surface water and dam water samples.

EC and pH were monitored during purging to ensure that they had stabilised prior to sample collection. Samples were sent to a NATA accredited laboratory for analysis, under the appropriate chain-of-custody protocols for chemical analysis. An intermediate water quality monitoring suite was adopted for the August and November 2014 sampling events (details are provided in Table 2.7).

Table 2.7 Analytical suite

Category			Parameters	
Physical parameters (field)	Intermediate suite	Comprehensive suite	EC	Redox potential
			Temperature	pH
			Dissolved oxygen	Total dissolved solids (TDS)
Physical parameters (lab)			EC	pH
			Total suspended solids (TSS)	TDS
Major ions			Calcium Magnesium Sodium Potassium Total alkalinity	Chloride[a] Bicarbonate Sulphate Fluoride Dissolved silica
Metals and minor/trace elements			Aluminium Arsenic Barium Beryllium Boron Bromine Cadmium Chromium Cobalt Copper Iron	Manganese Molybdenum Mercury Nickel Lead Selenium Strontium Uranium Vanadium Zinc
Nutrients			Total nitrogen Ammonia Phosphorus (total and reactive)	Nitrate Nitrite Total organic carbon (TOC)
Dissolved gases			Methane	
Hydrocarbons			Phenol compounds Polycyclic aromatic hydrocarbons	Total petroleum hydrocarbons Benzene, toluene, ethyl benzene and xylenes

Note:

(a) Chloride was analysed using two methods since August 2014: APHA 4500-Cl (standard) and APHA/USEPA 4110 (suitable for trace analysis of Cl).

Water quality samples were collected in the sample bottles provided by the laboratory, with the appropriate preservation when required. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

2.5.3 Assessment framework

The ANZECC (2000) guidelines and pre-irrigation baseline groundwater quality values are used for assessing water quality in this compliance report. The Avon River catchment is predominantly the northern Permian Gloucester Basin (which is a shallow marine, lacustrine and fluvial deposition basin), and as stated in the ANZECC (2000) guidelines, surface water quality will vary depending on the catchment geology and soils. Hence some natural surface water quality characteristics exceed these guidelines. Most of the groundwater within the catchment is brackish to slightly saline so the ANZECC (2000) guidelines are not appropriate for assessing groundwater quality.

The guidelines for fresh and marine water quality (ANZECC 2000) recommend developing site specific guideline values that are derived from local reference data. Section 7.4.4.1 of the ANZECC guidelines recommends a minimum of two years of continuous monthly data at the reference site to establish a valid threshold value taken at the 80th percentile. The guideline allows for the threshold value to be modified as new baseline data becomes available by applying a rolling 80th percentile value incorporating the latest 24 month monitoring period. Where data are insufficient to calculate a valid threshold value, the guideline recommends defaulting to the appropriate ANZECC (2000) guideline value.

In this study there is insufficient baseline data with which to develop site specific trigger values strictly as described in ANZECC (2000). Accordingly monitoring data are compared against the following:

- ANZECC (2000) default trigger values for the protection of freshwater aquatic ecosystems (toxicants)
- ANZECC (2000) default trigger values for aquatic ecosystems, south-east Australia, lowland river ecosystems (for physical and chemical stressors)
- ANZECC (2000) water quality for irrigation waters and general use, long-term threshold values
- natural ranges in water quality from observations during the baseline monitoring period.

The criteria used and rationale for the selection are provided in Table 2.9.

Guideline values are intended as a management tool for assessing water quality and protecting environmental values. The guideline values do not represent strict pass/fail criteria, rather the guideline value “triggers” management response to protect the environment or water resource. The response typically involves further assessment to determine if the water quality change is caused by the activity under assessment, and if it represents a significant threat to environmental values.

The EPA has defined total suspended solids (TSS) to be a concentration limit if overflow occurs at the catch dams CDE and CDW (Table 2.8) (EPA 2014).

Table 2.8 EPL 20358 concentration limit for overflow events at catch dams

Analyte	Units	100 percentile concentration limit
TSS	mg/L	50

Table 2.9 Water quality assessment criteria used and rationale for selection

Category	Monitoring ID	Assessment criteria	Rationale
Irrigation dams	Tiedman south dam (TSD)	ANZECC (2000) guidelines for Primary Industries (irrigation).	The blended water within this dam is used for irrigation.
	Tiedman north dam (TND) Tiedman east dam (TED)	None apply; however results have been compared to ANZECC (2000) guidelines for Primary Industries (irrigation).	The water in these dams is not directly used for irrigation. They are raw water sources for blended water.
Groundwater	TMB01 TMB02 TMB03	None apply. Reference is made to ranges in values over the baseline monitoring period[a].	There is insufficient baseline data with which to develop site specific trigger values strictly as described in ANZECC (2000) for these groundwater systems.
	S4MB01 TCMB01 TTMB02		
	TMB04 TMB05		
Surface water	ASW01 TSW01 TSW02 FSW01	ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems (95% protection levels (trigger values)).	These guidelines apply to natural surface water systems, with the 95% protection level most appropriate for moderately disturbed systems (see paragraph following this table for further details).
Catch dams	Catch dam east (CDE) Catch dam west (CDW)	If overflow occurs, the ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems (95% protection levels (trigger values)) together with EPL 20358 Condition L3.4 (water concentration limits).	The catch dams capture the initial runoff, which is returned to the Tiedman water storage dams (i.e. no guidelines apply). After capturing the first flush, further rainfall overflows the catch dams as overland flow to the Avon River, hence surface water guidelines apply.

Note:
(a) Baseline data was not collected for TCMB01 and TTMB02.

The ANZECC (2000) guidelines for the protection of fresh water ecosystems (80% and 95% protection levels) and irrigation water are provided in Table 2.10. Protection level signifies the percentage of species expected to be protected. In most cases the 95% protection level trigger values apply to ecosystems that could be classified as slightly-moderately disturbed, such as rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism. The 80% protection level relates to highly disturbed systems, such as rural streams receiving runoff from intensive horticulture and urban streams receiving road and stormwater runoff. Given these descriptions, the 95% protection level is deemed most appropriate for comparative purposes in this report for surface water and the catch dams. However for some analytes even these guideline values are exceeded because of the catchment geology and soils.

The ANZECC (2000) long term trigger values have been used as the irrigation guidelines because deficit irrigation is practiced. The long term trigger value is the maximum concentration of contaminant in the irrigation water which can be tolerated assuming 100 years of irrigation. This was adopted as a conservative approach and considers irrigation as a continuing management option.

Table 2.10 ANZECC (2000) guideline trigger values for aquatic ecosystems and irrigation water

Analyte[a]	Units	ANZECC - Aquatic ecosystems (freshwater) guideline value[b]		ANZECC – Irrigation guideline value[d]
		95% protection levels[h]	80% protection levels[h]	
pH (range)	pH units	6.5-8.0[c]		6.0-9.0
EC	µS/cm	125-2,200[c]		2,000[e]
Sodium	mg/L	-	-	460[f]
Chloride	mg/L	-	-	700[f,g]
Fluoride	mg/L	-	-	1
Total phosphorus	mg/L	0.025[c]		0.05[l]
Ammonia	mg/L	0.9	2.3	N/A
Aluminium	mg/L	0.055	0.150	5
Arsenic	mg/L	0.013[i]	0.140[i]	0.1
Boron	mg/L	0.37	1.30	0.5[j]
Cadmium	mg/L	**0.0005**	**0.0022**	0.01
Chromium (VI)	mg/L	**0.0025**	**0.1**	0.1
Cobalt	mg/L	ID	ID	0.05
Copper	mg/L	**0.0035**	**0.0063**	0.2
Iron	mg/L	ID	ID	0.2[k]
Lead	mg/L	**0.014**	**0.038**	2
Manganese	mg/L	1.9	3.6	0.2
Nickel	mg/L	**0.028**	**0.043**	0.2
Selenium (total)	mg/L	0.011	0.034	0.02
Uranium	mg/L	ID	ID	0.01
Zinc	mg/L	**0.020**	**0.078**	2

Notes:

(a) All metals are dissolved.

(b) ANZECC 2000 - Water Quality Guidelines: trigger values for the protection of freshwater aquatic ecosystems (for toxicants).

(c) ANZECC 2000 - Water Quality Guidelines: default trigger values for aquatic ecosystems, south-east Australia, lowland river ecosystems (for physical and chemical stressors). Note that the ANZECC (2000) guidelines for salinity state that NSW coastal rivers are typically in the range 200–300 µS/cm, however the Avon River (Manning River catchment) has high salinity levels given its geology (DIPNR 2004).

(d) ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values.

(e) Average root zone salinity threshold for Lucerne, Hunter River.

(f) Trigger value for the prevention of foliar injury due to chloride and sodium in irrigation water in moderately tolerant crops.

(g) Medium risk of increasing cadmium concentrations in crops due to chloride in irrigation waters.

(h) In most cases the 95% protection level trigger values apply to ecosystems that could be classified as slightly-moderately disturbed and the 80% protection level relates to highly disturbed systems.

(i) Arsenic species: As(V).

(j) This value is for very sensitive plant species (short-term use, up to 20 years). For sorghum and lucerne, values in soil pore water up to 6 mg/L are acceptable for short-term use.

(k) This value is not an environmental criterion but primarily relates to potential clogging of irrigation systems (trickle or drippers) (ANZECC 2000, Volume 3, Section 9.2.5.12).

(l) To minimise bioclogging of irrigation equipment (ANZECC 2000, Volume 3, Section 9.2.6).

Bold values have been corrected for moderate water hardness (based on ANZECC 2000 Table 3.4.4).

ID = insufficient data to derive a reliable trigger value.

- = no guideline value.

The range of results for groundwater from the pre-irrigation baseline sampling period at TMB01-02 and S4MB01 (Parsons Brinckerhoff 2013a) is provided in Table 2.11. Groundwater quality varies spatially and with depth across the Avon River catchment. There is insufficient baseline data with which to develop site specific trigger values strictly as described in ANZECC (2000). Water quality results are provided in Appendix A and are plotted against the appropriate criteria in Appendix B.

Table 2.11 Groundwater pre-irrigation baseline water quality

Analyte[a]	Units	Groundwater pre-irrigation baseline[b]	
		min	max
pH	pH units	6.32	7.77
EC	µS/cm	3,199	13,848
Sodium	mg/L	484	1,350
Chloride[d]	mg/L	841	2,940
Fluoride	mg/L	0.1	0.5
Total phosphorus	mg/L	0.02	0.1
Ammonia	mg/L	<0.01	2.45
Aluminium	mg/L	<0.01	0.06
Arsenic	mg/L	0.001	0.009
Boron	mg/L	<0.05	0.27
Cadmium	mg/L	<0.0001	0.0002
Cobalt	mg/L	<0.001	0.005
Copper	mg/L	<0.001	0.006
Iron	mg/L	0.36	6.53
Lead	mg/L	all <0.001	
Manganese	mg/L	0.223	1.73
Nickel	mg/L	<0.001	0.006
Selenium	mg/L	all <0.01	
Uranium	mg/L	<0.001	0.017
Zinc	mg/L	0.01	0.146

Notes:
(a) All metals are dissolved.
(b) Groundwater pre-irrigation baseline data from Parsons Brinckerhoff (2013a).
(c) Baseline ranges exclude the seepage bores TMB04 and TMB05.
(d) Chloride analysis method: APHA 4500-Cl.

3. Tiedman dams and seepage monitoring

3.1 Water quality results

The water quality analytes for the Tiedman dams (TSD, TND and TED) and seepage monitoring bores (TMB04 and TMB05) are presented in Table 3.1, Table 3.2 and Appendix A. Time-series plots are provided in Figures B-1 to B-23 in Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D. The analytical results for TSD are compared to the ANZECC (2000) guidelines for Primary Industries (irrigation) as the blended water within this dam is used for irrigation. The produced water in TND, fresh to marginal water in TED and seepage monitoring water is not directly used for irrigation and therefore a comparison with the ANZECC (2000) irrigation guidelines is not relevant for compliance purposes.

Table 3.1 Tiedman dams and seepage monitoring bores results for August 2014

Analyte[a]	Units	ANZECC (2000) irrigation[b]	TSD	TND	TED	TMB04	TMB05
pH (field)	pH units	6.0–9.0	**9.04**	9.67	9.54	5.91	4.96
EC (field)	µS/cm	2,000[c]	1,506	5,316	1,564	6,901	7,315
Chloride[d]	mg/L	700	240	832	234	2,030	2,100
Sodium	mg/L	460	318	1,180	367	1,140	1,330
Boron	mg/L	0.50	0.15	0.59	0.24	<0.05	<0.05
Iron	mg/L	0.20	**0.46**	0.23	1.13	1.83	5.00
Manganese	mg/L	0.20	0.003	0.077	0.009	8.840	17.40
Total phosphorus	mg/L	0.025	**1.44**	1.48	0.82	0.11	0.03
Ammonia	mg/L	N/A	0.05	0.02	0.04	0.04	0.24

Notes:

(a) All metals are dissolved.

(b) ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values (applied to TSD only).

(c) Average root zone salinity threshold for Lucerne, Hunter River.

(d) Method USEPA 4110B.

N/A – no guideline value.

Bold – above ANZECC 2000 guideline (applied to TSD only; TND, TED, TMB04 and TMB05 are not compared to the guideline).

Table 3.2 Tiedman dams and seepage monitoring bores results for November 2014

Analyte[a]	Units	ANZECC (2000) irrigation[b]	TSD	TND	TED	TMB04	TMB05
pH (field)	pH units	6.0–9.0	**10.30**	10.24	9.67	6.35	6.50
EC (field)	µS/cm	2,000[c]	1,593	5,798	1,202	7,420	7,334
Chloride[d]	mg/L	700	250.0	936.0	163.0	2,000	2,400
Sodium	mg/L	460	300	1,150	222	1,080	1,010
Boron	mg/L	0.50	0.20	0.72	0.22	0.05	<0.05
Iron	mg/L	0.20	0.09	1.22	0.13	12.60	11.40
Manganese	mg/L	0.20	0.020	0.024	0.014	8.560	18.90
Total phosphorus	mg/L	0.025	**0.48**	1.75	0.57	0.52	0.15
Ammonia	mg/L	N/A	<0.01	0.21	0.02	0.29	0.28

Notes:
(a) All metals are dissolved.
(b) ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values.
(c) Average root zone salinity threshold for Lucerne, Hunter River.
(d) Method USEPA 4110B.
N/A – no guideline value.
Bold – above ANZECC 2000 guideline (TSD only; TND, TED and TMB04 and TMB05 are not compared to the guideline).

3.2 Tiedman dams

TND stores produced water from the exploration programs while TED (at the present time) stores mostly fresh water captured and ready for preparing the next batch of blended irrigation water (blended and stored in TSD prior to irrigation). Fresh water is sourced from local farm dams and the Avon River to optimise its water quality to within irrigation guideline values and to minimise soil degradation.

3.2.1 Water quality

3.2.1.1 Field parameters and major ion chemistry

The salinity (EC) measurements in August and November 2014 for TSD were similar to the salinity of samples collected in the first half of 2014 and were below the adopted ANZECC (2000) guideline value of 2,000 µS/cm. The EC was marginal at TED and was slightly saline at TND, and was similar to the samples collected in the first half of 2014.

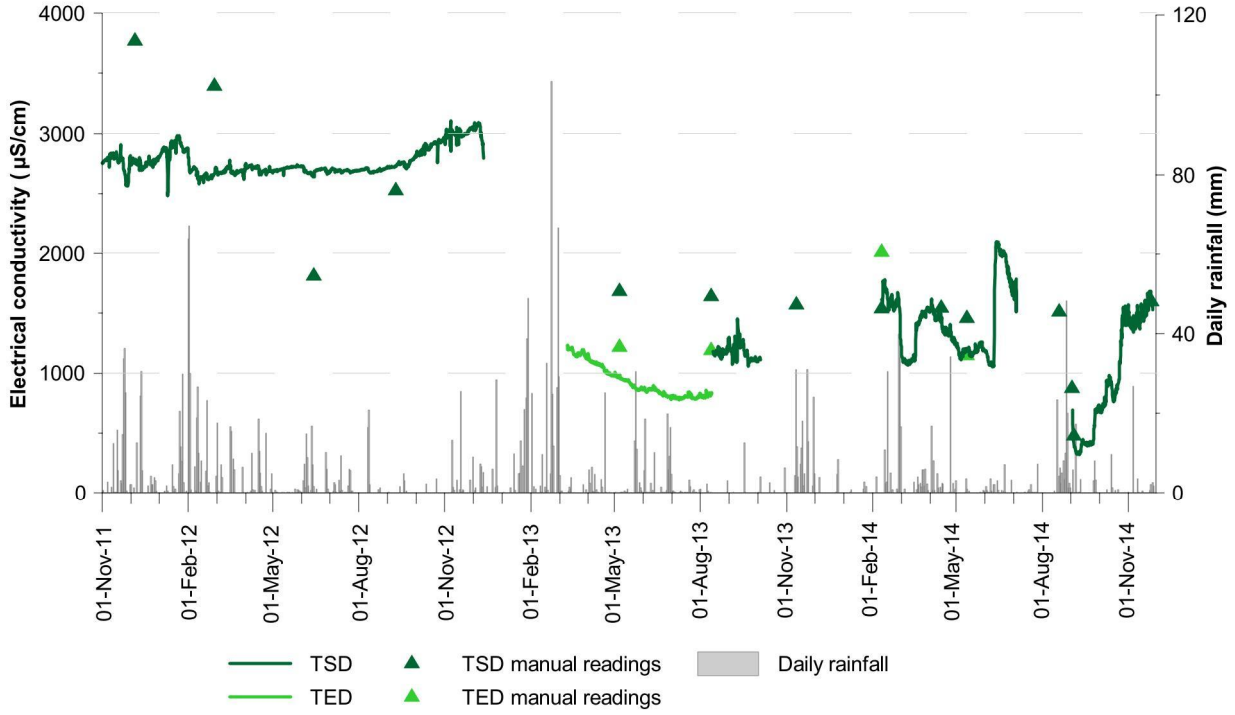
The pH measurements exceeded the ANZECC guideline range of 6.0-9.0 at all dams for both monitoring events. The alkaline blended water in TSD is compatible with the acidic soils within the Stage 1A and 1B irrigation areas.

The water type for the Tiedman dams was generally Na-Cl-HCO_3 as shown on the piper diagrams in Appendix C. TSD and TED had chloride and sodium concentrations below the ANZECC (2000) irrigation guidelines (700 mg/L and 460 mg/L, respectively) for both monitoring events. The sodium adsorption ratio (SAR) of the blended water in TSD (based on the August 2014 water quality results) is 25.2. This is high for irrigation waters but is ameliorated by the substantial lime and gypsum treatments applied to the soils within the Stage1A area plots.

The continuous EC logger data for the TSD from October 2011 to December 2012 are plotted in Figure 3.1. The logger was removed from this dam in December 2012 and redeployed in August 2013. Between March and August 2013 the logger was deployed in TED and a plot of the salinity trend for this period is also shown in Figure 3.1.

No logger data are provided from mid-September 2013 to mid-February 2014 because of logger inconsistencies and failure. No logger data are provided for TSD from mid-July 2014 to the beginning of September 2014 as no water was stored in the dam during that period.

The salinity in TSD changed from brackish (between October 2011 and December 2012) to marginal/brackish (from April 2013 to August 2014). Since redeployment of the logger in September 2014, the salinity in TSD changed from fresh to marginal. These changes in salinity are the result of water batching and ensuring that the blended irrigation water quality is around the required 1,500 µS/cm.



Note: logger failure between 11/09/13 and 11/02/14; logger removed from TSD between 4/7/14 and 2/9/14.

Figure 3.1 Continuous EC data at Tiedman south dam and Tiedman east dam

3.2.1.2 Dissolved metals

The Tiedman dams all had aluminium, arsenic, barium, boron, iron, manganese, molybdenum, strontium and zinc concentrations detected above the laboratory limit of reporting (LOR) for both monitoring events. Bromine was detected at all dams in November 2014. Copper and nickel concentrations were slightly above the LOR at all dams for both monitoring events except at TED in November 2014. Cadmium concentrations slightly above the laboratory LOR were detected at TSD in August 2014. Chromium, cobalt, lead and vanadium concentrations slightly above the laboratory LOR were detected at TND in November 2014. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR.

Dissolved metals in TSD were below the ANZECC (2000) guidelines for both monitoring events with the exception of iron. Iron concentrations at all dams exceeded the ANZECC (2000) guidelines for the August 2014 monitoring event (Appendix B). Elevated iron has been detected in previous monitoring events at the Tiedman dams. Elevated iron is not uncommon for natural groundwater (see Section 5), and the guideline value is predominantly set to guard against the potential clogging of irrigation systems (trickle or drippers).

The short term (irrigation) trigger value is 10 mg/L and the August 2014 exceedance for TSD (0.46 mg/L) is well below this trigger value.

3.2.1.3 Nutrients

Ammonia concentrations in the dams ranged from 0.02 mg/L to 0.05 mg/L in August 2014 and from below the laboratory LOR to 0.21 mg/L in November 2014. The ammonia concentration at TSD returned to within the historical range following an elevated concentration of 0.45 mg/L in May 2014. Ammonia concentrations increased from the early 2014 results at TND and TED.

The total phosphorus concentrations ranged from 0.82 mg/L to 1.48 mg/L in August 2014 and from 0.48 mg/L to 1.75 mg/L in November 2014. Total phosphorus concentrations at all dams remained above the ANZECC (2000) guideline value for irrigation (0.025 mg/L) and comparable to baseline concentrations. It should be noted that the guideline is only set at this low concentration to minimise bioclogging of irrigation equipment (ANZECC 2000) and that the short term irrigation criteria trigger value is 0.8-12 mg/L.

3.3 Seepage monitoring around the Tiedman dams

3.3.1 Water levels

The groundwater levels in the seepage bores are shown in Figure 3.2 along with daily rainfall and the monthly cumulative rainfall deviation from the mean (CDFM). (A positive slope in the CDFM indicates above average rainfall and a negative slope indicates below average rainfall.) Both seepage bores around the Tiedman dams have occasionally been dry following periods of low rainfall during the baseline monitoring period; however during the irrigation program the bores have consistently indicated perched water at shallow depth (Parsons Brinckerhoff 2013a). Groundwater levels increased at TMB05 in March 2013 after high rainfall in January and February 2013. To confirm the correlation with rainfall, dataloggers were installed in May 2013. Over the last 17 months of monitoring, no clear response to rainfall (or the lack of rainfall) is visible even though perched water was present throughout this period. Both seepage bores show a fast recovery after each sampling event and return to levels consistent with the baseline monitoring period (Figure 3.2).

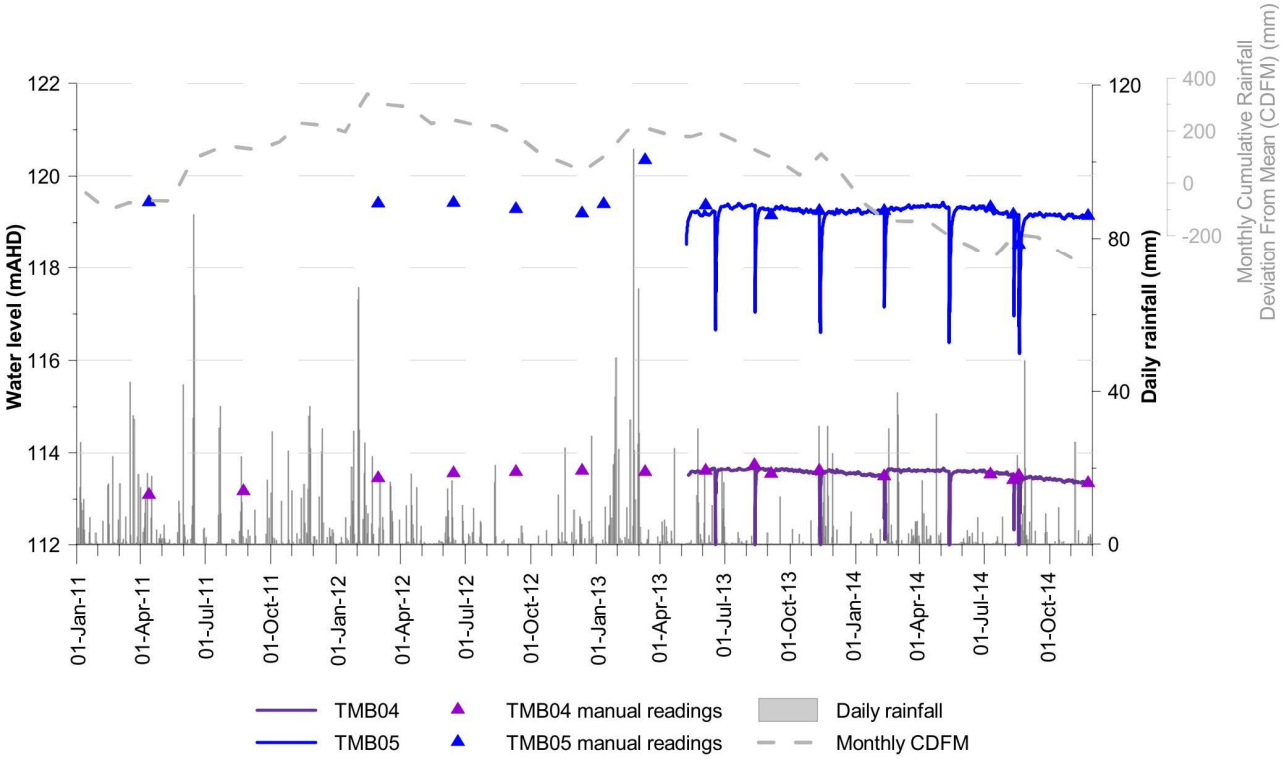


Figure 3.2 Groundwater levels for seepage monitoring bores (TMB04 and TMB05)

3.3.2 Water quality

Accumulated water in both seepage monitoring bores was sampled during the August and November 2014 sampling events.

3.3.2.1 Field parameters and major ions

The seepage water remained slightly saline over the monitoring period. The pH conditions remained acidic, which is characteristic of the shallow soils. In comparison to the results from the Tiedman dams, the pH is much lower and EC much higher.

Analysis of major ion components indicates that the water type for the seepage bores remained as Na–Mg–Cl dominant (Appendix C). The proportion of chloride in the seepage bores, in particular, is notably higher than the proportion of chloride in the water within the Tiedman dams.

3.3.2.2 Dissolved metals

Concentrations of dissolved metals were comparable to the early 2014 results. Aluminium, barium, beryllium, bromine, cadmium, cobalt, copper, iron, lead, manganese, nickel, strontium and zinc were detected above the laboratory LOR in at least one of the two seepage monitoring bores for the two monitoring events. In particular, iron and manganese concentrations were elevated at both seepage monitoring bores, consistent with baseline concentrations. All other dissolved metal analytes were either equivalent to, or below, the laboratory LOR.

There are distinct differences in the concentration of metals between the seepage bores and Tiedman dams, such as higher iron, manganese and zinc concentrations in the seepage bores. The water quality results are characteristic of the shallow soils. The monitoring results suggest there are no seepage losses from the

Tiedman dams and that there appears to be permanent perched water in the soil and weathered rock profile at these two locations.

3.3.2.3 Nutrients

Ammonia concentrations fluctuated from the early 2014 concentrations at TMB04 and TMB05. Total phosphorus concentrations increased from the early 2014 concentrations at both seepage bores.

4. Surface water monitoring

4.1 Surface water levels

Surface water levels from stream level gauges TSW01, TSW02, and ASW01 are shown in Figure 4.1. All three stream gauges on the Avon River and Dog Trap Creek show sharp increases in water level in response to rainfall events, and relatively steep recession curves. This is consistent with a rapid runoff response from a relatively small upstream catchment with limited riverbank storage. Stream levels decrease over several weeks following each rainfall event to a relatively consistent base level that represents a small groundwater baseflow component in the Avon River.

The Avon River and its major tributaries cease to flow during prolonged dry conditions. From early July 2014 to mid-August 2014, low rainfall was recorded leading to a reduction of stream flow along the Avon River and the formation of disconnected pools along Dog Trap Creek (Figure 4.1). Continuous stream flow returned following rainfall late August 2014 after which flows declined again resulting in minimal flow along the Avon River and the formation of disconnected pools along Dog Trap Creek.

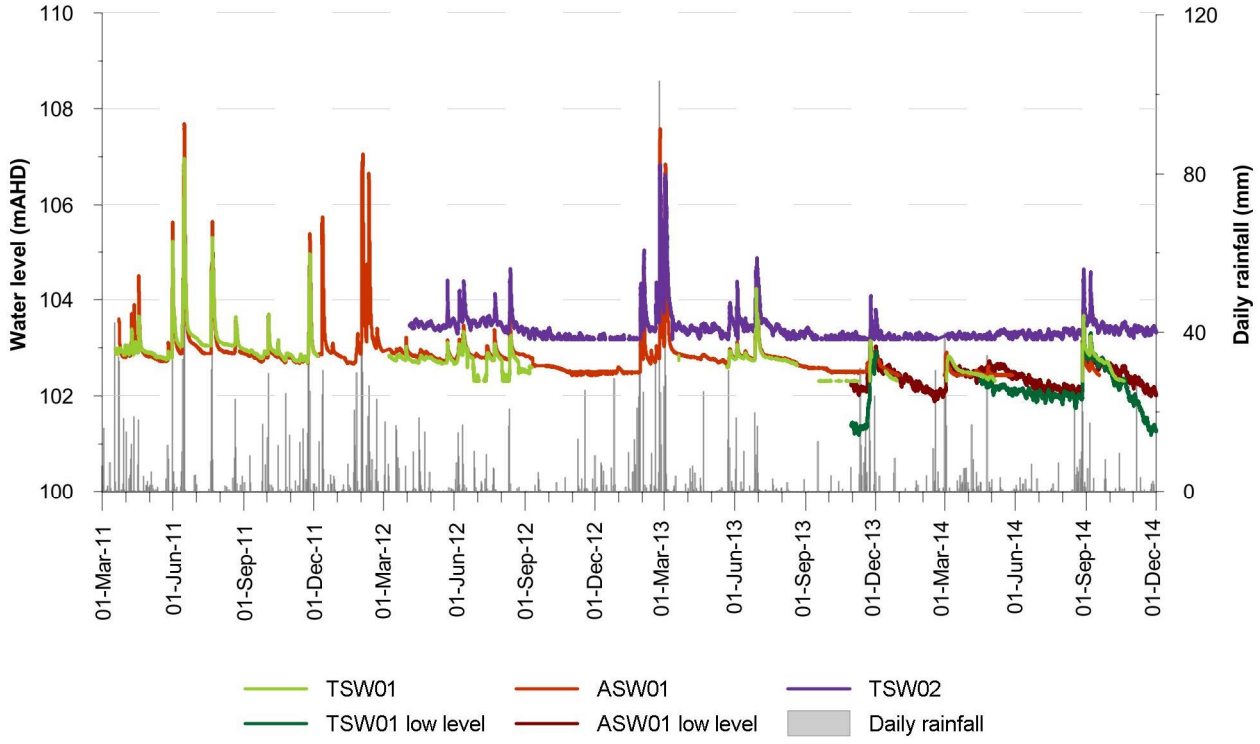


Figure 4.1 Surface water levels

4.2 Surface water quality

4.2.1 Surface water

In August and November 2014, surface water was sampled at ASW01, TSW01, TSW02 and FSW01, with FSW01 and ASW01 also sampled on 28 August and 11 December 2014, associated with the high rainfall events. No sample could be collected at TSW02 in November 2014 as Dog Trap Creek was dry. In August 2014, a sample was collected from a disconnected pool at TSW02; this is not considered to be representative of the salinity of flowing water in the creek.

The surface water quality results for the main analytes for TSW01 and TSW02 are presented in Table 4.1 for the quarterly sampling events. The surface water quality results for the main analytes for ASW01 and FSW01 are presented in Table 4.2 for the quarterly sampling events along with the high rainfall events water sample results from late August and December 2014.

Water quality time-series plots are provided in Figures B-1 to B-23 of Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

Table 4.1 August and November 2014 results for surface water monitoring locations TSW01 and TSW02

Analyte[a]	Units	ANZECC 2000 guidelines[b]		TSW01		TSW02
		95%[c]	80%[c]	Aug 2014	Nov 2014	Aug 2014[e]
pH (field)	pH units	6.5-8.0[d]		7.81	**8.05**	7.06
EC (field)	µS/cm	125-2,200[d]		568	517	**2,604**
Sodium	mg/L	-	-	77	60	322
Chloride[f]	mg/L	-	-	114	99.3	478
Boron	mg/L	0.37	1.30	0.14	<0.05	0.06
Iron	mg/L	ID	ID	0.17	2.93	0.38
Manganese	mg/L	1.9	3.6	0.057	0.892	6.850
Total phosphorus	mg/L	0.025[d]		**0.03**	**0.29**	**0.35**
Ammonia	mg/L	0.9	2.3	0.03	0.05	**1.84**

Notes:

(a) All metals are dissolved.

(b) ANZECC 2000 – Water Quality Guidelines: trigger values for the protection of freshwater aquatic ecosystems.

(c) Protection level signifies the percentage of species expected to be protected. In most cases the 95% protection level trigger values apply to ecosystems classified as slightly-moderately disturbed and the 80% protection level relates to highly disturbed systems.

(d) ANZECC 2000 – Water Quality Guidelines: default trigger values for aquatic ecosystems, south-east Australia, lowland river ecosystems.

(e) Sample collected from a disconnected pool and is not considered representative of the water quality of flowing water in the creek.

(f) Method USEPA 4110B.

Bold – above guideline value.

ID = insufficient data to derive a reliable trigger value.

- = no guideline value.

Table 4.2 August, November and December 2014 results for surface water monitoring locations ASW01 and FSW01

Analyte[a]	Units	ANZECC 2000 guidelines[b]		ASW01				FSW01			
		95%[c]	80%[c]	Aug 2014	Late Aug 2014[e]	Nov 2014	Dec 2014[e]	Aug 2014	Late Aug 2014[e]	Nov 2014	Dec 2014[e]
pH (field)	pH units	6.5-8.0[d]		7.45	**9.12**	7.85	7.93	**8.27**	**8.80**	**5.54**	**8.75**
EC (field)	µS/cm	125-2,200[d]		498	184	372	337	552	385	459	427
Sodium	mg/L	-	-	57	26	36	32	76	48	49	46
Chloride[f]	mg/L	-	-	97.2	37.5	61.1	61.0	109	81.3	85.2	84.0
Boron	mg/L	0.37	1.30	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	ID	ID	0.09	0.65	1.07	1.49	0.16	0.3	1.14	1.56
Manganese	mg/L	1.9	3.6	0.030	0.038	0.267	0.331	0.046	0.106	0.459	0.337
Total phosphorus	mg/L	0.025[d]		0.02	**0.16**	**0.14**	**0.12**	**0.03**	**0.17**	**0.22**	**0.23**
Ammonia	mg/L	0.9	2.3	<0.01	0.02	<0.01	0.05	0.06	0.04	<0.01	0.11

Notes:

(a) All metals are dissolved.

(b) ANZECC 2000 – Water Quality Guidelines: trigger values for the protection of freshwater aquatic ecosystems.

(c) Protection level signifies the percentage of species expected to be protected. In most cases the 95% protection level trigger values apply to ecosystems classified as slightly-moderately disturbed and the 80% protection level relates to highly disturbed systems.

(d) ANZECC 2000 – Water Quality Guidelines: default trigger values for aquatic ecosystems, south-east Australia, lowland river ecosystems.

(e) High rainfall event sampling late August and December 2014 (also shaded grey to highlight differences).

(f) Method USEPA 4110B.

Bold – above guideline value.

ID = insufficient data to derive a reliable trigger value.

- = no guideline value.

4.2.1.1 Field parameters and major ion chemistry

Surface water salinity (EC) inversely correlates with rainfall and surface water flow. Typically surface water EC initially spikes then sharply decreases after and during rainfall events, as relatively fresh runoff is routed into streams (Figure 4.2). This cyclical trend has been consistent since AGL commenced surface water monitoring in March 2011. The initial spike (sudden transient increase) in EC is often seen in the initial runoff phase as readily dissolvable salts are flushed from the ground surface and shallow soils across the whole catchment. After the initial salinity spike and sharp reduction in EC levels, the EC gradually increases as flow decreases during periods of recession. This gradual increase in EC is due to groundwater discharge becoming a more dominant component of flow, and evaporative concentration of salts taking place in residual and connected pools.

Additional low level loggers were installed at TSW01 and ASW01 in November 2013 to enable EC measurements below the initial datalogger level setting (Figure 4.2).

The surface water continued to be classified mostly as fresh. The salinity is highest in Dog Trap Creek (TSW02) and salinity increases along the Avon River, from upstream (ASW01) to downstream (TSW01 and FSW01). From continuous EC logging during the second half of 2014, the minimum EC was approximately 89 µS/cm (ASW01) and the maximum EC was 1,288 µS/cm (ASW01). The spike in EC at ASW01 in late August 2014 can be attributed to the rainfall events occurring during that period.

At the time of the high rainfall events in late August and December 2014, salinity was slightly more elevated at FSW01 compared to the upstream Avon River location at ASW01. At FSW01 and ASW01, salinity consistently decreased during the overflow events compared to the regular monitoring rounds.

The pH values were slightly acidic to alkaline across the four sampling locations for the routine August and November 2014 sampling events, with pH outside the ANZECC (2000) guideline range at TSW01 in November 2014 and at FSW01 during both routine sampling events. For the event monitoring samples in late August 2014, the pH at the downstream location FSW01 was comparable to that of the upstream location ASW01 and was slightly higher in the event sampling in December 2014. The pH values were outside the ANZECC (2000) guideline values range for the event monitoring samples, except for ASW01 in late August 2014.

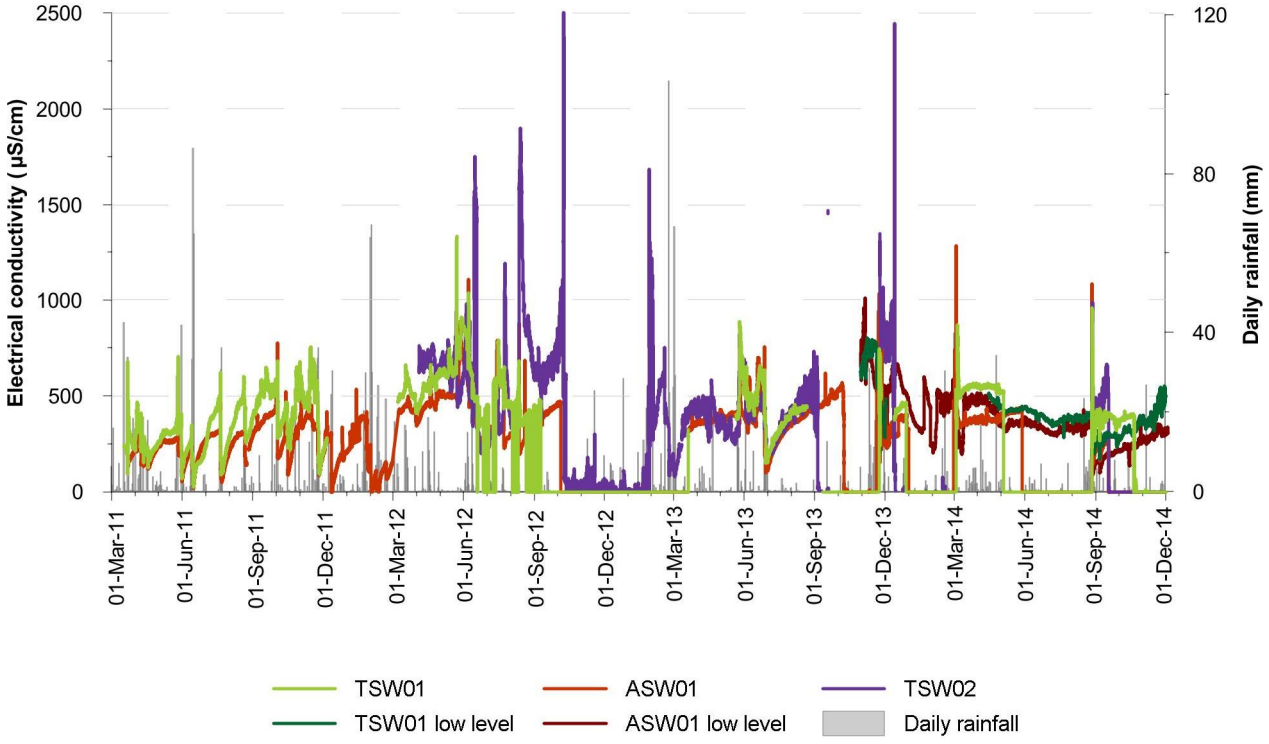


Figure 4.2 Continuous EC logging results at stream gauges

The water types for the surface water locations are presented in Table 4.3 and are displayed on the piper diagrams (Appendix C).

Table 4.3 Major ion chemistry in surface water

Location	Aug 2014	Late Aug 2014[a]	Nov 2014	Dec 2014[a]
FSW01	Na-Cl-HCO_3	Na-Cl-SO_4	Na-Mg-Cl-HCO_3	Na-Mg-Cl-HCO_3
TSW01	Na-Cl-HCO_3	ns	Na-Ca-Mg-HCO_3	ns
TSW02	Na-Mg-Cl-SO_4	ns	ns	ns
ASW01	Na-Cl-HCO_3	Na-Cl	Na-Ca-Mg-HCO_3	Na-Ca-Mg-HCO_3

Notes:

(a) High rainfall event sampling late August and December 2014 (also shaded grey to highlight differences).

ns = not sampled.

4.2.1.2 Dissolved metals

Concentration of dissolved aluminium, arsenic, barium, bromine, cadmium, chromium, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR in at least one of the four surface water sites. All these values were consistently below the ANZECC (2000) guidelines, except for aluminium at TSW02 in August 2014, at ASW01 and FSW01 in late August 2014 and at TSW01 in November 2014, chromium at TSW02 in August 2014 and zinc at FSW01 in late August 2014. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR.

4.2.1.3 Nutrients

Nutrient concentrations were consistently below the ANZECC (2000) guidelines for the routine August and November 2014 sampling events, except for ammonia at TSW02 in August 2014 and total phosphorus at the majority of surface water monitoring sites in August and November 2014. The total phosphorus concentration recorded at TSW02 in August 2014 was the highest recorded since monitoring began.

The total phosphorus concentrations at ASW01 and FSW01 increased during the event sampling in late August 2014 compared to the routine August 2014 sampling event, and are likely related to the high rainfall event in late August 2014 and the associated surface runoff from the upper Avon River catchment. Total phosphorus concentrations at ASW01 in November 2014 were comparable to the high rainfall event concentrations and slightly increased at the downstream location FSW01. The December 2014 concentrations at these locations were comparable to the concentrations measured during the routine sampling event in November 2014.

4.2.2 Irrigation plot runoff

Irrigation plot runoff is captured by CDE and CDW. These catch dams are designed to capture runoff from the Stage 1A area during larger rainfall events. They are now maintained at very low storage levels to minimise the storage of poor quality water. The irrigation plan is to maintain an irrigation deficit so there will always be capacity in the treated soil profile to accept rain events in a similar manner to the surrounding soils. Subject to the frequency, intensity, and duration of larger rain events, surface runoff may occur from the irrigation area. In such instances, the initial runoff from the area is captured in the catch dams and returned to the Tiedman water storage dams. After capturing the first flush, any further runoff overflows the catch dams as overland flow.

During the routine August and November 2014 sampling events there was minimal water stored in the catch dams; however there was sufficient water to enable sampling. Water collected in the catch dams was subsequently recycled back into the Tiedman dams and not released into the environment. As there was no overland flow to the Avon River, there is no comparison of the August and November 2014 data to the adopted ANZECC (2000) guidelines.

Following the large rainfall events in late August and December 2014 water samples were collected from the catch dams while they were overflowing.

The August, November and December 2014 results for key analytes are presented in Table 4.4, along with the ANZECC (2000) guideline for the protection of fresh water ecosystems and the EPL 20358 concentration limit for TSS for comparison with the late August and December 2014 events only.

Water quality time-series plots are provided in Figures B-1 to B-23 of Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

Table 4.4 August, November, December 2014 results for the catch dams

Analyte[a]	Units	ANZECC 2000 guidelines[b]		EPL condition	CDE				CDW			
		95%[c]	80%[c]		Aug 2014	Late Aug 2014[e]	Nov 2014	Dec 2014[e]	Aug 2014	Late Aug 2014[e]	Nov 2014	Dec 2014[e]
pH (field)	pH units	6.5-8.0[d]		-	8.37	**8.88**	8.50	**8.82**	8.10	**9.14**	8.80	**8.61**
EC (field)	µS/cm	125-2,200[d]		-	249	147	465	**101**	357	324	356	248
Total suspended solids	mg/L	-	-	50	27	**54**	81	**151**	21	**90**	60	**105**
Sodium	mg/L	-	-	-	35	18	45	14	44	44	52	33
Chloride[f]	mg/L	-	-	-	32.8	16.3	68.3	8.4	52.1	31.1	36.0	27.0
Boron	mg/L	0.37	1.30	-	<0.05	<0.05	0.06	<0.05	0.05	<0.05	<0.05	<0.05
Iron	mg/L	ID	ID	-	0.48	0.84	0.21	0.82	1.03	0.37	0.15	0.12
Manganese	mg/L	1.9	3.6	-	0.086	0.010	0.006	0.005	0.040	0.004	0.016	0.002
Total phosphorus	mg/L	0.025[d]		-	0.46	**0.75**	1.18	**1.10**	1.15	**1.53**	0.87	**1.72**
Ammonia	mg/L	0.9	2.3	-	0.01	0.04	<0.01	0.05	0.2	0.06	0.02	0.04

Notes:

(a) All metals are dissolved.

(b) ANZECC 2000 – Water Quality Guidelines: trigger values for the protection of freshwater aquatic ecosystems.

(c) Protection level signifies the percentage of species expected to be protected. In most cases the 95% protection level trigger values apply to ecosystems classified as slightly-moderately disturbed and the 80% protection level relates to highly disturbed systems.

(d) ANZECC 2000 – Water Quality Guidelines: default trigger values for aquatic ecosystems, south-east Australia, lowland river ecosystems.

(e) High rainfall event sampling late August and December 2014 (also shaded grey to highlight differences).

(f) Method USEPA 4110B.

Bold – above guideline value (for high rainfall event sampling only).

ID = insufficient data to derive a reliable trigger value.

- = no guideline value or EPL concentration limit.

4.2.2.1 Field parameters and major ion chemistry

The water in the catch dams can be classified as fresh and slightly alkaline to alkaline. The (slightly) alkaline pH is above the ANZECC (2000) guidelines and is typical for CDE and CDW (and Avon River catchment runoff). The EC values at CDW and CDE in the second half of 2014 were lower compared to the early 2014 results.

Analysis of major ion components indicate that the water in the catch dams is dominated by sodium, calcium, sulphate and bicarbonate, as illustrated on the piper diagrams (Appendix C). It is different in character to the blended irrigation water quality because the water is predominantly runoff across the amended soil profile.

The continuous EC logger data for CDW and CDE from 7 May 2013 to 26 November 2014 are plotted in Figure 4.3. The sharp increase in salinity on 15 May 2014 was not discussed in the previous compliance report (Parsons Brinckerhoff 2014b) as the continuous EC logger data for the two catch dams ended on 13 May 2014 (coinciding with the May 2014 sampling event). This sharp increase is attributable to runoff that occurred within those plots with freshly planted triticale.

Increases in salinity in the catch dams are mainly attributable to limited rainfall (and runoff) and evaporative concentration of stored water within each of the dams. Decreases in salinity are visible in both catch dams as a response to rainfall. Salinities sharply decreased at the end of August 2014 in response to the recycling of the stored water back to the Tiedman dams and rainfall events. Later data show an overall increasing trend from August 2014 onwards due to evaporative concentration of salts.

Analysis of TSS indicated exceedances of EPL 20358 Condition L3.4 for the high rainfall events in late August and December 2014. AGL reported these exceedances to the EPA as per EPL Condition R.2 and R.3. Investigations have identified that the sampling locations are not ideal as there is exposed sediment at each of the sampling points. Sampling locations have been moved slightly to obtain more representative samples, and improvement works are being investigated for each of the catch dams.

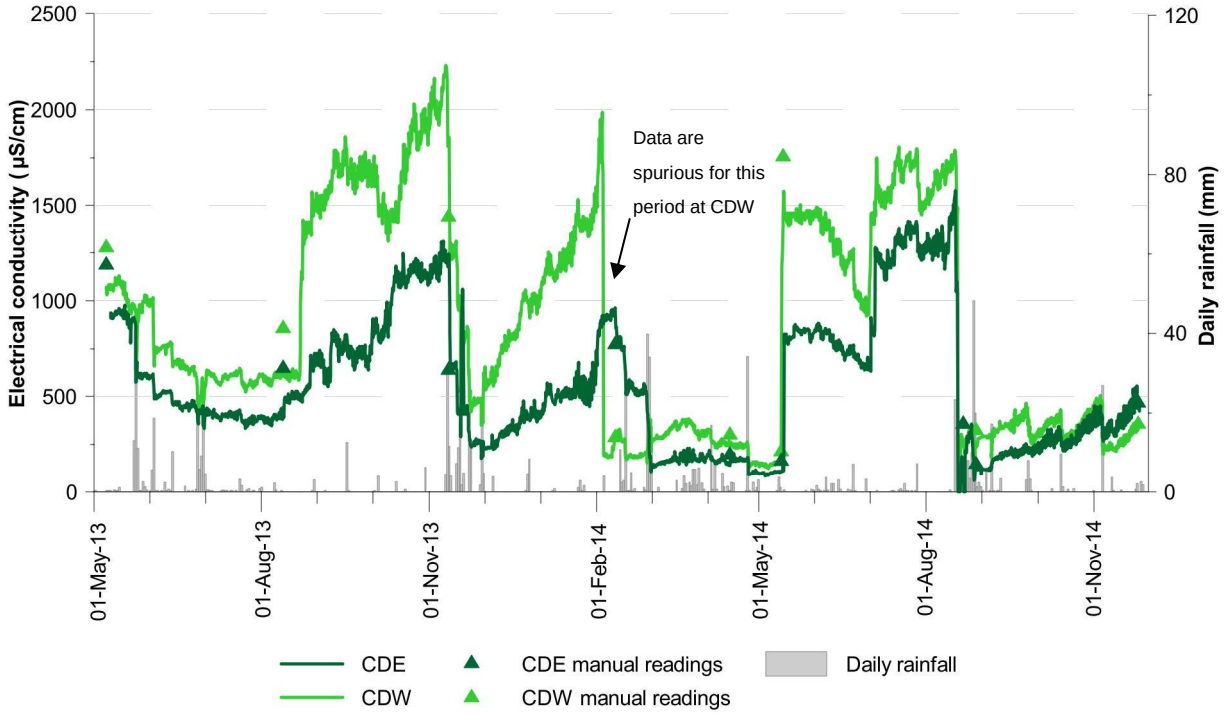


Figure 4.3 Continuous EC data at CDE and CDW

4.2.2.2 Dissolved metals

Concentrations of dissolved aluminium, arsenic, barium, boron, bromine, cobalt, copper, iron, manganese, molybdenum, nickel, strontium and zinc were detected above the laboratory LOR during at least one monitoring event. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR. Concentrations of dissolved metals were generally comparable to the May 2014 results, with the exception of cadmium, copper and lead at CDW in November 2014, where slightly higher concentrations were detected.

For the overflow events in late August and December 2014, aluminium, copper and zinc concentrations were above the ANZECC (2000) guidelines at CDW and CDE during at least one monitoring event. These exceedances may also relate to the location of the sampling points that are not ideal as there was exposed sediment at each of the points.

4.2.2.3 Nutrients

The total phosphorus concentrations generally increased from the May 2014 sampling event at both catch dams. Ammonia concentrations measured at the two catch dams were comparable to the early 2014 results.

In late August and December 2014, the (overflow) catch dam water quality was below the ANZECC (2000) guideline values except for total phosphorus at both catch dams. Phosphorus exceedance may also be related to the sampling locations and the exposed sediment.

5. Groundwater monitoring

5.1 Groundwater occurrence

This section is included to provide additional explanation of the different groundwater systems that occur in the immediate area of the Tiedman irrigation program areas. It has been included to specifically address Condition 6a) (5) in the REF approval extension that states:

"Provide a justification for the absence of monitoring of the water table beneath the area irrigated with blended produced water."

Groundwater in the vicinity of the Stage 1A and 1B areas occurs in two different geologies:

- groundwater in the alluvial sediments beneath the alluvial floodplain (located adjacent to the western end of the Stage 1A irrigation area)
- groundwater in shallow fractured rock (located beneath and adjacent to both irrigation areas on the valley sides off the floodplain).

The alluvial water table is shallow (generally less than 3 m from surface) and the hydraulic gradient is from south to north following the topography. In the vicinity of the Avon River, shallow groundwater from the alluvium discharges to the river during periods of low flow (i.e. the river is a gaining stream) while during flood events the river loses water to the alluvial groundwater system for a short time. Water table rises and falls are quite dynamic and respond quickly to rainfall and river stage events. AGL has three monitoring bores into the alluvium near the irrigation areas (TMB01, TMB02 and TMB03). The trends at these locations are described in Sections 5.2.1 and 5.3.1.

The shallow fractured rock water table is deeper than the alluvial water table however there is still a general hydraulic gradient down-valley and towards the river. There is diffuse discharge from the fractured rock aquifer to the alluvial aquifer along the floor of the valley. The influence of rainfall recharge on this groundwater system is low and is lagged by weeks and months. AGL has monitored this water table at S4MB01 (adjacent Stage 1A) since the beginning of the baseline monitoring.

Additional monitoring of this water table beneath the irrigation area is not warranted given that deficit irrigation is practiced and the only recharge to this aquifer system is via large rainfall events. There is no rise or fall at any of these adjacent sites that can be attributed to irrigation so there is no justification for monitoring beneath the irrigation area at multiple sites. To further confirm this, two additional shallow rock monitoring bores in the near vicinity of the irrigation area have been included in the monitoring network since the August 2014 sampling event: TCMB01 (adjacent Stage 1B) and TTMB02 (east of Stage 1A).

The only other sub-surface water is soil (pore) water in the unsaturated zone. This is monitored at the SP piezometer locations (see Section 5.3.3). This water is not groundwater, it is normally ephemeral, localised, and does not flow like the regional aquifer systems described above.

5.2 Groundwater levels

5.2.1 Shallow alluvium

In general, groundwater levels show a clear response to rainfall events and no response to irrigation events. The magnitude and rate of the response to rainfall varies between the shallow alluvial bores (Figure 5.1). The greatest groundwater level response continued to be recorded at TMB01, followed by TMB02 and TMB03.

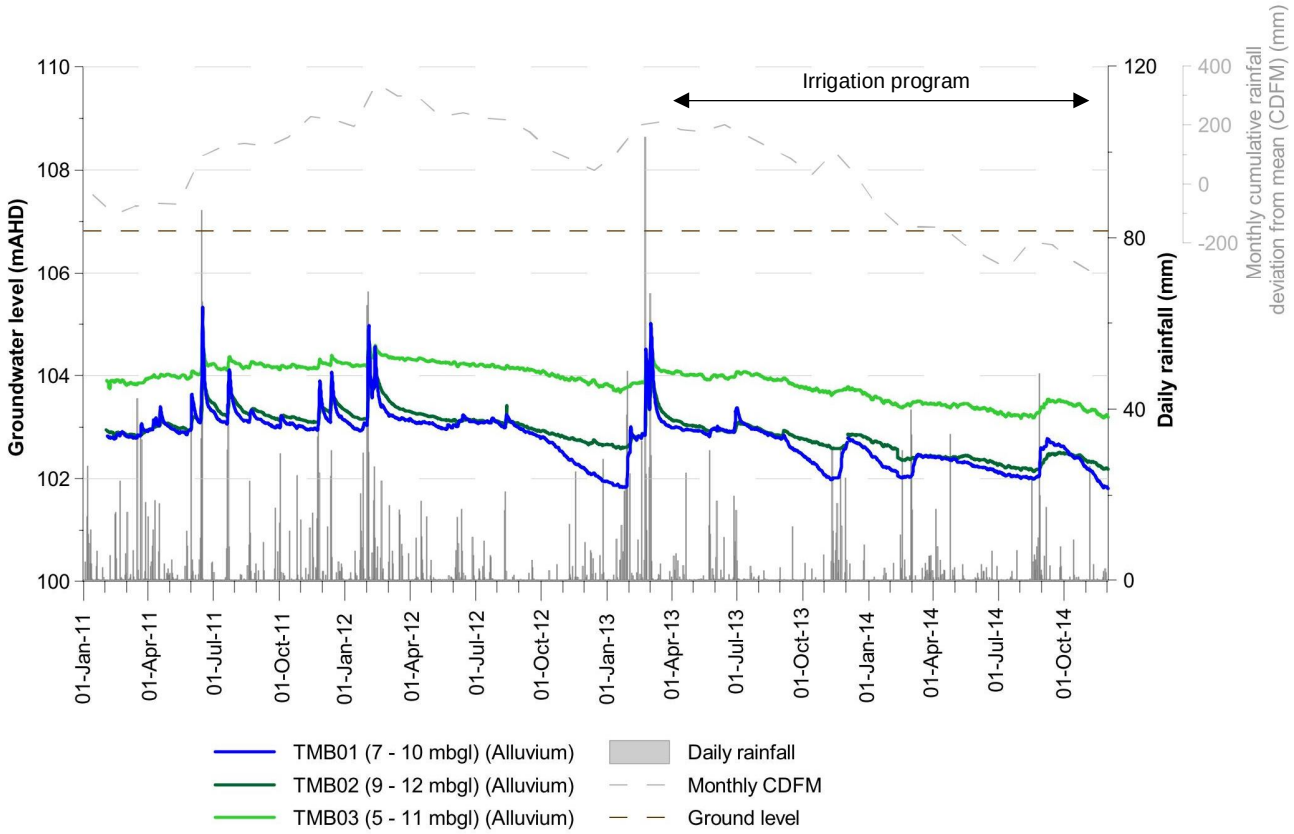


Figure 5.1 Groundwater levels for alluvial monitoring bores (TMB01, TMB02 and TMB03)

The groundwater level hydrographs can be divided into two main response types:

1. Monitoring bores TMB01 and TMB02 show a rapid response to rainfall recharge followed by a return to near-previous levels over a period of one to two months (i.e. a short term increase in storage). These responses imply direct recharge from rainfall and/or flooding and relatively high permeability of the alluvium. TMB01 also demonstrates that groundwater (near the river) quickly drains and contributes to stream baseflows during extended dry periods such as in Spring 2012 and Spring 2013.
2. Monitoring bore TMB03 shows a more subdued response to rainfall recharge. In addition, groundwater responses are more pronounced for larger rainfall events that exceed a certain threshold (> ~35 mm/day). However, smaller rainfall events show little or no obvious responses. Such responses imply rapid recharge during larger surface runoff and flooding events, although less significant recharge than by direct rainfall infiltration alone.

These observations are consistent with field observations during bore installation that show that there is a clay layer (approximately 1–2 m in thickness) above the alluvial mixed gravels at some locations. The clay layer would impede recharge to groundwater due to smaller rainfall events.

A decline in the groundwater levels is visible since irrigation began in April 2013. The decline is in line with the declining CDFM rainfall trend. No change in groundwater levels in the alluvial monitoring bores has been observed as a result of the irrigation program.

5.2.2 Shallow rock

The hydrographs for the shallow rock monitoring bores are presented in Figure 5.2. The groundwater levels show a general similar trend and show very minor responses to longer rainfall events and no response to irrigation. In general, groundwater levels in the shallow rock have declined slightly as a result of below average rainfall conditions since April 2013.

The effects of hydraulic testing ('slug' testing) and low flow sampling are visible in April 2011 and December 2011. The very slow recovery of groundwater levels after these events is consistent with low permeability in this unit (Parsons Brinckerhoff 2012).

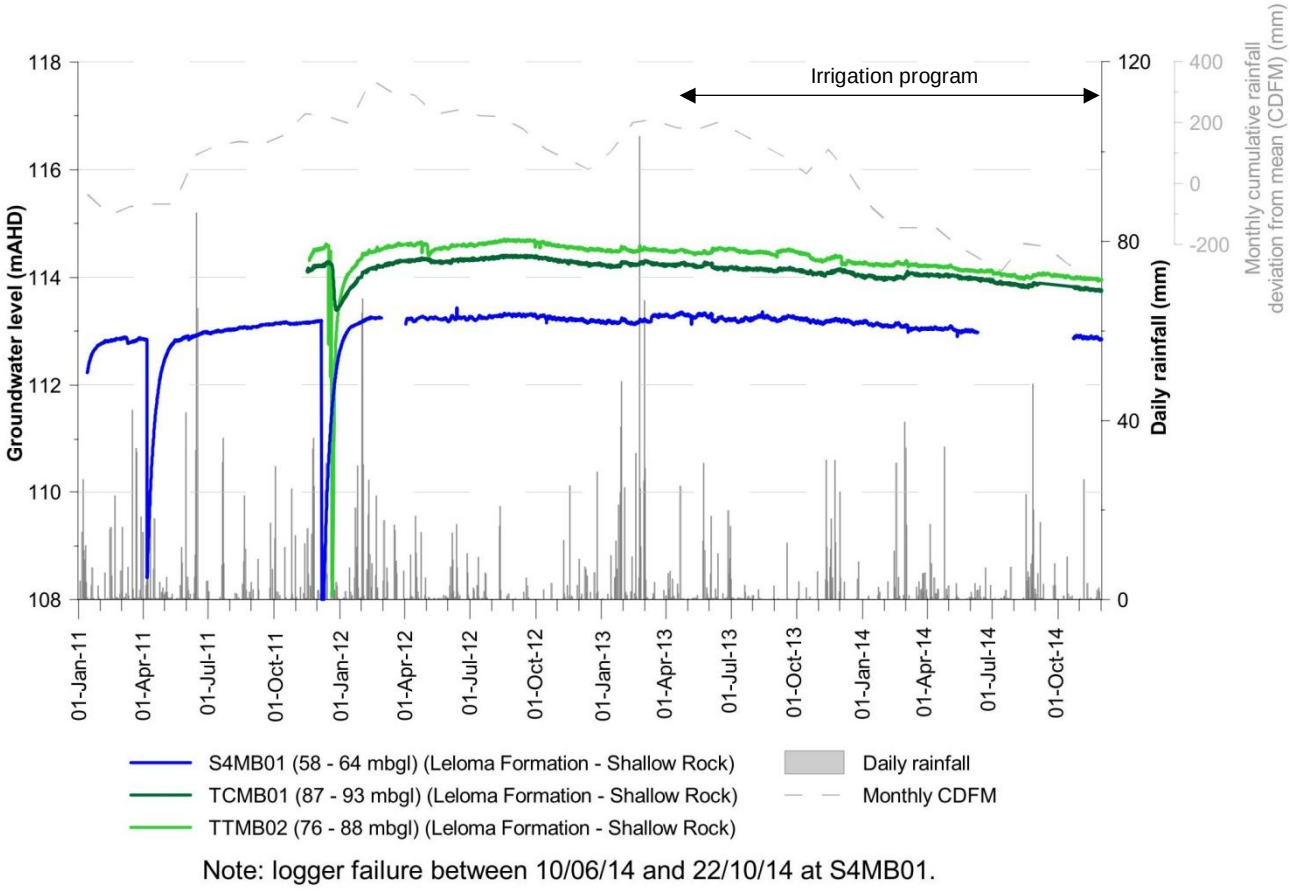


Figure 5.2 Groundwater levels for the shallow rock monitoring bores (S4MB01, TCMB01 and TTMB02).

5.3 Groundwater quality

The water quality for shallow alluvial groundwater and shallow rock groundwater sampled in August and November 2014 is assessed in this section and is compared to the groundwater pre-irrigation baseline values (Table 2.11). Water quality data are presented in Appendix A. Time-series plots are provided in Figures B-1 to B-23 in Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

5.3.1 Shallow alluvium

The groundwater quality results for the main analytes for the shallow alluvium bores (TMB01, TMB02 and TMB03) are presented in Table 5.1.

Table 5.1 August and November 2014 results for the shallow alluvium monitoring bores

Analyte[a]	Units	Groundwater baseline range[b]	TMB01		TMB02		TMB03	
			Aug 2014	Nov 2014	Aug 2014	Nov 2014	Aug 2014	Nov 2014
pH (field)	pH units	6.32 - 7.77	6.57	6.70	6.34	6.60	6.41	6.49
EC (field)	µS/cm	3,199 - 13,848	8,043	8,764	3,886	3,917	6,184	6,097
Sodium	mg/L	484 - 1,350	**1,380**	1,200	644	507	888	714
Chloride[c]	mg/L	841 - 2,940	2,320	2,690	1,120	1,160	1,680	1,720
Boron	mg/L	<0.05 - 0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	0.36 - 6.53	2.53	2.29	4.87	5.34	5.78	5.22
Manganese	mg/L	0.223 - 1.730	0.702	0.875	1.190	1.230	1.530	1.620
Total phosphorus	mg/L	0.02 - 0.10	**0.11**	0.08	0.06	0.07	0.04	0.04
Ammonia	mg/L	<0.10 - 2.45	0.16	0.13	0.26	0.29	0.24	0.23

Notes:
(a) All metals are dissolved.
(b) Groundwater pre-irrigation baseline data from Parsons Brinckerhoff (2013a).
(c) Method USEPA 4110B.
Bold – outside groundwater baseline range.

5.3.1.1 Field parameters and major ion chemistry

Groundwater in the shallow alluvium remained slightly saline at TMB01 and TMB03 in both monitoring rounds, while groundwater is brackish at TMB02. The EC is within the baseline range.

The pH levels are slightly acidic at all bores and are within the pre-irrigation baseline range. In early 2014, pH at TMB02 was below the pre-irrigation baseline range (Parsons Brinckerhoff 2014b), but returned to be within the baseline range in August and November 2014 (Figure B.1, Appendix B).

Analysis of major ion components indicate that the alluvial groundwater is generally a Na–Ca–Cl type or Na-Ca-Mg-Cl type as shown on the piper diagrams. In August 2014, the sodium concentration at TMB01 slightly exceeded the baseline range.

5.3.1.2 Dissolved metals

The dissolved metal concentrations in the August and December 2014 sampling events were generally low and within the baseline range, except for aluminium at TMB01 and TMB03 and copper at TMB03 in November 2014.

5.3.1.3 Nutrients

Nutrient concentrations remained within the baseline range for the August and November 2014 sampling events.

5.3.2 Shallow rock

The groundwater quality results for the main analytes for the shallow rock monitoring bores are presented in Table 5.2.

Table 5.2 August and November 2014 results for the shallow rock monitoring bores

Analyte[a]	Units	Groundwater baseline range[b]	S4MB01		TCMB01		TTMB02	
			Aug 2014	Nov 2014	Aug 2014	Nov 2014	Aug 2014	Nov 2014
pH (field)	pH units	6.32 - 7.77	7.30	6.99	7.19	6.93	6.68	6.50
EC (field)	µS/cm	3,199- 13,848	4,679	4,617	2,974	2,984	2,314	2,284
Sodium	mg/L	484 - 1,350	785	638	382	325	220	226
Chloride[c]	mg/L	841 - 2,940[d]	1,160	1,290	836	788.0	518	523.0
Boron	mg/L	<0.05 - 0.27	0.14	0.16	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	0.36 - 6.53	<0.05	1.50	1.19	1.98	2.13	2.05
Manganese	mg/L	0.223 - 1.730	0.245	**0.198**	0.030	0.064	0.108	0.105
Total phosphorus	mg/L	0.02 - 0.10	0.07	0.07	0.02	0.01	0.35	0.23
Ammonia	mg/L	<0.10 - 2.45	1.63	1.82	1.32	1.34	0.60	0.60

Notes:

(a) All metals are dissolved.

(b) Groundwater pre-irrigation baseline data for S4MB01 only from Parsons Brinckerhoff (2013a). Baseline data was not collected for TCMB01 and TTMB02.

(c) Method USEPA 4110B.

(d) Method APHA 4500-Cl.

Bold – outside groundwater baseline range – for S4MB01 only.

5.3.2.1 Field parameters and major ion chemistry

Groundwater at S4MB01 is slightly saline with neutral pH. All results are within groundwater pre-irrigation baseline range (Table 2.12). Groundwater salinity at the two additional shallow rock monitoring bores (TCMB01 and TTMB02) is brackish (fresher than S4MB01) with slightly acidic to neutral pH.

The water type at the shallow rock monitoring bores are presented in Table 5.3 and shown on the piper diagrams (Appendix C).

Table 5.3 Major ion chemistry at the shallow rock monitoring bores

Location	Aug 2014	Nov 2014
S4MB01	Na-Ca-Cl	Na-Ca-Cl
TCMB01	Na-Ca-Mg-Cl	Na-Ca-Cl-HCO_3
TTMB02	Na-Ca-Cl-HCO_3	Ca-Na-Cl-HCO_3

5.3.2.2 Dissolved metals

Most dissolved metals were below the laboratory LOR for the monitoring period, with the exception of the following metals, for which concentrations were above the laboratory LOR for at least one monitoring event in at least one of the shallow rock monitoring bores:

- Aluminium, arsenic, barium, boron, bromine, copper, iron, nickel, uranium and zinc; although concentrations at S4MB01 were in line with baseline ranges.
- The manganese concentration at S4MB01 was above the baseline range in November 2014.
- Chromium concentrations at S4MB01 returned to be below the laboratory LOR.

- Strontium concentrations at S4MB01 have consistently been the highest of the groundwater locations throughout the baseline period and they continue to be the highest for this monitoring period. High strontium concentrations were also detected at TCMB01 and TTMB02.

5.3.2.3 Nutrients

Nutrient concentrations were consistently below the baseline range for the August and November 2014 sampling events. Total phosphorus concentrations at TTMB02 are slightly more elevated than at other groundwater locations.

5.3.3 Soil water

Soil water was present in one of the dual piezometers associated with the Stage 1A irrigation area when inspected during the routine August and December 2014 sampling events. In the 6.5 weeks preceding the August 2014 sampling event, no irrigation took place, however piezometer SP6A had accumulated enough water to allow a water sample to be collected. In October and November 2014, irrigation was more dominant than precipitation in the Stage 1A area. No piezometer had accumulated enough water to allow for a water sample to be collected indicating that there was high evapotranspiration and “deficit irrigation” was effective.

“A” locations are located inside the irrigation area while “B” locations are located adjacent and outside the irrigated area. No soil water persisted outside of the irrigated areas suggesting that there was no or minimal lateral migration of perched water in the soil profile and that most irrigation water was being transpired by the crops within the main irrigation area.

The water quality results for the main analytes for piezometer SP6A in the irrigation area are presented in Table 5.4.

Table 5.4 August 2014 results for the perched water monitoring bore

Analyte[a]	Units	SP6A
		August 2014
pH (field)	pH units	7.44
EC (field)	µS/cm	6,954
Sodium	mg/L	1,380
Chloride[b]	mg/L	1,990
Boron	mg/L	<0.05
Iron	mg/L	0.53
Manganese	mg/L	0.213
Total phosphorus	mg/L	0.51
Ammonia	mg/L	0.04

Notes:
(a) All metals are dissolved.
(b) Method USEPA 4110B.

5.3.3.1 Field parameters and major ion chemistry

Water from the soil water piezometer was slightly saline. The pH conditions were neutral which is typical of the shallow soil profile.

Analysis of major ion components indicate that the water at SP6A is a Na–Cl type as shown on the piper diagrams (Appendix C).

5.3.3.2 Dissolved metals

Dissolved metal concentrations were detected at low levels in the monitoring piezometer. These levels are consistent with the shallow soil characteristics.

6. Discussion

6.1 Water levels

Continuous monitoring indicates that the alluvial groundwater levels and surface water levels respond to rainfall events. The rainfall response is immediate and pronounced, and sharp recession curves are often observed. Such a response suggests moderate to high permeability in the shallow alluvium; and for the surface water a rapid runoff response from a relatively small upstream catchment. There appears to be limited riverbank storage and groundwater baseflow contributions.

A minimal and lagged rainfall response is observed at the shallow rock monitoring bores suggesting groundwater levels respond to rainfall recharge via slow leakage over a broad area.

Water levels have not altered in the alluvium, shallow fractured rock, or the river in response to the irrigation program.

6.2 Water quality

6.2.1 Produced and blended irrigation water

6.2.1.1 Tiedman dams

Water quality monitoring in the Tiedman dams (TSD, TND and TED) indicates that the water is alkaline and marginal to slightly saline. The EC measurements in August and November 2014 for the blended water irrigation dam (TSD) remained below the ANZECC (2000) irrigation guideline value of 2,000 µS/cm. pH values were above the ANZECC guideline range (6.0-9.0) for the Tiedman dams. Dissolved metal concentrations were mostly above the laboratory LOR, below the ANZECC (2000) guidelines, and comparable between the three dams and the previous monitoring rounds.

Total phosphorus and ammonia concentrations typically remained elevated compared to the average over the whole monitoring period and overall nutrient concentrations were highest at TND (the dam storing the remaining produced water).

The water quality in the blended water irrigation dam (TSD) was within the ANZECC (2000) irrigation guidelines, with the exception of pH, iron and total phosphorus. The pH exceeded the guideline in August (pH 9.04) and November 2014 (pH 10.30). Iron concentrations exceeded the ANZECC (2000) guideline in August 2014 (0.46 mg/L). Elevated iron concentrations are not unusual for groundwaters. The total phosphorus level also exceeded the ANZECC irrigation guideline for both events. The irrigation guidelines are set at low concentrations to minimise the potential for clogging of irrigation equipment.

6.2.1.2 Seepage monitoring bores

The perched groundwater intersected by the seepage monitoring bores around the Tiedman dams remained slightly saline and acidic. The pH and salinity of this water differs from that within the Tiedman dams; salinity measurements are much higher and pH concentrations much lower in the perched water compared to the dam water.

Dissolved metals were slightly elevated, in particular iron and manganese concentrations. Overall dissolved metal concentrations were higher in the seepage bores because of the nature of the parent soils and the weathered rock. Ammonia and total phosphorus were detected at concentrations different than in the holding dams.

The differences in major/minor ions and dissolved metal chemistry, in addition to different nutrient concentrations, indicate that the perched water in TMB04 and TMB05 is not derived from leakage from the Tiedman dams.

6.2.2 Surface water

The salinity of the surface water inversely correlates with rainfall and surface water flow. Typically surface water salinity sharply decreases after rainfall events (after an initial salinity spike) as relatively fresh runoff is routed into streams. The surface water can be classified as fresh and pH values were near neutral.
The salinity in Dog Trap Creek as recorded during the August 2014 sampling event was brackish. The creek was not flowing at the time of sampling and therefore the measured salinity is not considered representative of normal flows in the creek.

Concentration of dissolved aluminium, arsenic, barium, bromine, cadmium, chromium, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR in at least one of the three surface water sites. All these values were consistently below the ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems (95% protection levels), except for aluminium at TSW02 in August 2014, at ASW01 and FSW01 in late August 2014 and at TSW01 in November 2014, chromium at TSW02 in August 2014 and zinc at FSW01 in late August 2014. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR.

Dissolved metal concentrations in surface water were typically lower than concentrations observed in the shallow alluvium and shallow rock groundwater samples, highlighting the dominance of surface water runoff over groundwater accessions. Surface water consistently has a different character to the blended irrigation water.

Total phosphorus concentrations typically (including during baseline sampling) at all locations exceeded the ANZECC (2000) guideline values for aquatic ecosystems (south-east Australia, lowland river ecosystems).

There is no evidence that overflow from the catch dams resulted in a change in water quality in the Avon River. For example:

- Table 4.2 shows that during each overflow event, the surface water EC decreased at both monitoring locations (ASW01 and FSW01). Furthermore, Table 4.4 shows that the EC of the water in the catch dams during the overflow events was lower than the receiving waters.
- Total phosphorus is higher in the surface runoff collected in the catch dams than in the Avon River. However, there is no consistent increase in total phosphorus at the downstream surface water sampling location (FSW01) during major rainfall and overflow events.
- The water quality is similar at FSW01 and ASW01 (control site during overflow events).

The Avon River receives runoff from a large catchment area during high rainfall events; the contribution from the catch dams is a negligible component of the river flow at FSW01.

6.2.3 Irrigation plot runoff

Samples taken during the routine sampling events in August and November 2014 from the two catch dams (CDW and CDE) were taken of the residual stored waters that were later recycled back to the Tiedman dams and not released into the environment.

The water quality at CDW and CDE during the overflow events in late August and December 2014 was fresh and pH values were alkaline. The total phosphorus concentrations at CDW and CDE exceeded the ANZECC (2000) trigger values for aquatic ecosystems (south-east Australia, lowland river ecosystems).

The runoff samples collected from the catch dams during the high rainfall events in late August and December 2014 exceeded EPL 20358 Condition L3.4 for total suspended solids (50 mg/L). The

exceedances were notified to EPA and for the August exceedance no regulatory response was undertaken as the water quality in the Avon River upstream of the discharge area had higher levels of suspended solids than either of the catch dam discharges and the likelihood of environmental harm as a result of the discharge was considered minimal. Further to the December exceedance, AGL has met with the EPA and proposed improved sampling locations.

6.2.4 Groundwater

Groundwater within the shallow alluvium showed no change in quality as a result of the irrigation program.

At TMB02 the pH returned to be within the pre-irrigation baseline range. Most dissolved metals were above the laboratory LOR and within the pre-irrigation baseline range for all analytes. Nutrient concentrations were all within the pre-irrigation baseline range.

Groundwater in the shallow rock remained slightly saline with neutral pH. Dissolved metal and nutrient concentrations were within the pre-irrigation baseline range, except for manganese at S4MB01 in November 2014. Shallow bedrock monitoring bores TCMB01 and TTMB02, which have been included in the monitoring network since August 2014, are lower in salinity although show similar dissolved metals and nutrient concentrations to S4MB01.

6.2.5 Soil water

Most paired soil water piezometers were dry during the period. The soil (pore) water in soil at one site in the irrigation area in August 2014 was slightly saline with near neutral pH. Dissolved metals concentrations were detected within the soil water and are indicative of the shallow soil characteristics.

This soil water is generally ephemeral and does not flow in the landscape like groundwater.

7. Conclusions and recommendations

Surface water and groundwater monitoring for the Tiedman irrigation program commenced in October 2011 and was established in accordance with the approved WMP (AGL 2012). The monitoring aims to ensure that the quality of the water used for irrigation is in accordance with this plan and adopted guidelines, and that the application of irrigated water does not result in impacts on the local surface water or groundwater resources.

The irrigation program for most of this six-monthly monitoring period has also been regulated under EPL20358 (since 6 August 2014). The water monitoring program and reporting is compliant with the relevant conditions in the EPL.

Monitoring during the six month period from 5 July to 31 December 2014 showed there was no change in stream levels, alluvial or shallow fractured rock groundwater levels attributable to the irrigation program activities. Surface water and groundwater levels remained comparable to the results from the previous compliance report (Parsons Brinckerhoff 2014b).

The blended water used for irrigation complied with the ANZECC (2000) irrigation guidelines, with the exception of pH (all events), iron (August 2014) and total phosphorus (all events). The pH exceedance was just over the guideline for the August 2014 events, and the iron and phosphorus exceedances relate to guidelines that are set to minimise clogging of irrigation equipment. The blended water in the TSD is considered to be suitable for irrigation. However it is recommended that the pH of the water is checked regularly to ensure that it is below the irrigation guideline of pH 9. It is noted that the exceedances of the above analytes do not pose an environmental risk. However, it is recommended that water in TSD should be treated or the blend adjusted to be within the ANZECC irrigation guideline.

There were a few minor exceedances of the ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems (95% protection levels) and the trigger values for aquatic ecosystems (south-east Australia, lowland river ecosystems) during the monitoring period for surface water, however there was no change in overall natural (baseline) surface water quality as a result of the irrigation program activities.

As specified in Section 2.5.3, guideline values are intended as a management tool for assessing water quality and protecting environmental values. The guideline values do not represent strict pass/fail criteria, rather they provide a “trigger” for further analysis and, if necessary, a management response. In the case of the exceedances noted in surface water during the current reporting period, the following observations are relevant:

- Transient, non-adverse trends in surface water quality are observed.
- The water quality is representative of the catchment geology and soils, and broad agricultural and grazing practices.
- No impact or clear link to the blended water irrigation activities is observed.

There is no change in the surface water quality (FSW01) that can be directly attributed to the high rainfall events in late August and December 2014.

It is recommended surface water and groundwater monitoring continues as outlined in the approved WMP (AGL 2012) given the extension of the irrigation program to 30 April 2015.

8. Statement of limitations

8.1 Scope of services

This water compliance report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

8.2 Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

8.3 Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the sites at the time of preparing the report. Also, it should be recognised that site conditions can change with time.

Within the limitations imposed by the scope of services, the monitoring and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

8.4 Report for the benefit of the client

The report has been prepared for the benefit of the client (and no other party), but may be relied upon by the administering authority. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Except as provided below, parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

8.5 Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

9. References

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- Parsons Brinckerhoff 2014b. Tiedman Irrigation Program – Water Compliance Report for the Period 1 January to 4 July 2014, Gloucester Gas Project. Report dated August 2014, 2162406F-WAT-RPT-001 RevD.

Appendix A

Summary tables

Summary table A1: August 2014 Water quality results

Water quality parameters	Units	TMB01	TMB02	TMB03	TMB04	TMB05	S4MB01	Tiedman south dam (TSD)	Tiedman north dam (TND)	Tiedman east dam (TED)	Catch dam west (CDW)	Catch dam east (CDE)	TSW01	TSW02	ASW01	FSW01	TCMB01	TTMB02
Sample date		19/08/2014	19/08/2014	19/08/2014	20/08/2014	19/08/2014	19/08/2014	19/08/2014	19/08/2014	19/08/2014	21/08/2014	21/08/2014	19/08/2014	19/08/2014	20/08/2014	19/08/2014	20/08/2014	21/08/2014
Formation		Alluvium	Alluvium	Alluvium	Seepage	Seepage	Shallow rock	Dam	Dam	Dam	Irrigation plot runoff	Irrigation plot runoff	Surface water	Surface water	Surface water	Surface water	Shallow rock	Shallow rock
Field parameters																		
Temperature	°C	18.41	18.05	17.91	16.14	18.23	16.88	15.06	13.59	15.09	15.17	23.36	11.34	13.21	11.93	12.77	18.11	20.08
EC	µS/cm	8,043	3,886	6,184	6,901	7,315	4,679	1,506	5,316	1,564	357	249	568	2,604	498	552	2,974	2,314
Dissolved Oxygen	% sat	16.2	18.1	18.2	12.2	56.5	23.3	72.1	43.3	96.5	65.6	115.5	65.5	81.6	83.8	77.1	15.6	9.4
Dissolved Oxygen	mg/L	1.43	1.68	1.71	1.18	5.22	2.23	7.27	4.38	9.61	6.56	9.83	7.13	8.42	8.98	8.10	1.45	0.83
pH	pH units	6.57	6.34	6.41	5.91	4.96	7.30	9.04	9.67	9.54	8.10	8.37	7.81	7.06	7.45	8.27	7.19	6.68
TDS	mg/L	5,228	2,526	4,020	4,486	4,757	3,041	979	3,455	1,017	232	162	369	1,731	324	359	1,933	1,504
Redox	mV	-60.1	-0.3	-18.3	86.1	234.5	-197.9	37.2	7.1	-67.8	50.5	19.0	49.6	120.6	120.2	-3.4	-124.5	-61.6
General parameters (lab)																		
pH	pH units	7.45	7.10	7.29	6.16	4.21	7.86	8.39	9.60	9.33	7.62	7.52	7.81	5.86	7.57	7.72	7.53	7.58
EC	µS/cm	8,400	4,040	6,440	7,030	7,690	4,880	1,570	5,550	1,630	354	216	569	2,440	498	566	3,020	2,350
TDS	mg/L	4,860	2,350	3,520	3,580	3,790	2,850	1,070	3,100	849	324	162	290	1,400	276	302	1,940	1,400
Suspended solids	mg/L	543	8	30	187	130	54	488	78	78	21	27	<5	51	<5	8	6	8
Laboratory analytes																		
Hydroxide alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	7	683	147	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate alkalinity as $CaCO_3$	mg/L	521	173	417	149	<1	451	233	660	246	65	34	65	3	79	64	319	329
Total alkalinity as $CaCO_3$	mg/L	521	173	417	149	<1	451	240	1,340	394	65	34	65	3	79	64	319	329
Sulfate as SO_4^{2-}	mg/L	79	46	158	634	245	27	128	16	18	17	12	11	440	11	11	<1	52
Chloride (APHA 4500-Cl^-)	mg/L	2,580	1,170	1,750	1,910	2,520	1,280	265	893	257	56	37	127	577	96	123	834	501
Chloride (trace) (USEPA 4110B)	mg/L	2,320	1,120	1,680	2,030	2,100	1,160	240	832	234	52.1	32.8	114	478	97.2	109	836	518
Calcium	mg/L	221	134	342	86	55	272	7	2	3	5	2	13	95	13	14	222	162
Magnesium	mg/L	248	94	184	222	288	63	3	1	2	3	1	11	77	10	12	80	47
Sodium	mg/L	1,380	644	888	1,140	1,330	785	318	1,180	367	44	35	77	322	57	76	382	220
Potassium	mg/L	3	3	4	22	18	7	88	309	58	12	8	7	32	6	7	5	4
Silicon as SiO_2	mg/L	39.2	38.2	34.5	61.9	85.0	30.6	1.8	28.2	12.1	15.3	4.7	4.5	15.6	2.6	7.9	26.2	32.9
Fluoride	mg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Dissolved metals																		
Aluminium	mg/L	0.12	<0.01	<0.01	0.05	1.6	<0.01	0.32	0.26	0.63	2.28	1.01	0.02	0.22	<0.01	<0.01	<0.01	0.02
Arsenic	mg/L	0.001	0.003	0.004	<0.001	<0.001	<0.001	0.005	0.008	0.002	0.002	0.002	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.223	0.696	0.213	0.061	0.071	1.890	0.146	0.411	0.056	0.036	0.032	0.051	0.080	0.043	0.058	6.66	0.775
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.0008	0.0036	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	0.002	0.002	0.077	0.329	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.079	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.003	<0.001	<0.001	0.006	0.030	<0.001	0.005	0.006	0.002	0.005	0.004	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.702	1.190	1.530	8.840	17.40	0.245	0.003	0.077	0.009	0.040	0.086	0.057	6.850	0.030	0.046	0.030	0.108
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.021	0.022	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	<0.001	<0.001	0.036	0.165	0.002	0.005	0.002	0.001	0.002	0.002	<0.001	0.010	<0.001	<0.001	<0.001	0.001
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	5.290	2.640	6.930	0.708	0.683	18.70	0.181	0.479	0.103	0.055	0.048	0.244	1.180	0.236	0.254	12.40	2.72
Uranium	mg/L	0.004	<0.001	0.003	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.037	0.010	0.007	0.288	1.310	0.005	0.021	0.036	0.016	0.084	0.037	0.008	0.188	<0.005	<0.005	0.030	0.051
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	0.15	0.59	0.24	0.05	<0.05	0.14	0.06	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	2.53	4.87	5.78	1.83	5.00	<0.05	0.46	0.23	1.13	1.03	0.48	0.17	0.38	0.09	0.16	1.19	2.13
Bromine	mg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Nutrients																		
Ammonia as N	mg/L	0.16	0.26	0.24	0.04	0.24	1.63	0.05	0.02	0.04	0.20	0.01	0.03	1.84	<0.01	0.06	1.32	0.60
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.13	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	<0.01	<0.01	<0.01	0.13	0.16	<0.01	0.02	<0.01	<0.01	0.07	<0.01	<0.01	0.87	<0.01	0.02	0.02	<0.01
Total nitrogen as N	mg/L	0.7	0.3	0.2	0.5	0.7	1.9	10.2	6.9	5.4	3.4	1.7	0.7	5.6	0.5	1.0	1.4	0.8
Total phosphorus	mg/L	0.11	0.06	0.04	0.11	0.03	0.07	1.44	1.48	0.82	1.15	0.46	0.03	0.35	0.02	0.03	0.02	0.35
Reactive phosphorus	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.74	0.18	<0.01	<0.01	<0.01	<0.01	0.04	<0.01
Total organic carbon	mg/L	3	<1	2	5	6	29	75	73	57	48	19	13	37	11	13	3	6
Total petroleum hydrocarbons																		
C_6-C_9 fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C_{10}-C_{14} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C_{15}-C_{28} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C_{29}-C_{36} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C_{10}-C_{36} fraction (sum)	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Total recoverable hydrocarbons																		
C_6-C_{10} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
C_6-C_{10} fraction minus BTEX	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
>C_{10}-C_{16} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
>C_{16}-C_{34} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
>C_{34}-C_{40} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
>C_{10}-C_{40} fraction (sum)	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Aromatic hydrocarbons																		
Benzene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Toluene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Ethyl Benzene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
m&p-Xylenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
o-Xylenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Total xlyenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Sum of BTEX	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Naphthalene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Dissolved gases																		
Methane	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Phenolic compounds																		
Phenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2-Chlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
3-&4-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2-Nitrophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2.4-Dimethylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2.4-Dichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2.6-Dichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
4-Chloro-3-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2.4.6-Trichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
2.4.5-Trichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Pentachlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Polycyclic aromatic hydrocarbons																		
Naphthalene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Acenaphthylene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Acenaphthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Fluorene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Phenanthrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Benz(a)anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Chrysene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Benzo(b)fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Benzo(k)fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Benzo(a)pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Indeno(1.2.3.cd)pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Dibenz(a.h)anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Benzo(g.h.i)perylene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Note:

na - not analysed

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Summary table A2: August 2014 Water quality results

Water quality parameters	Units	SP6A	Catch dam west (CDW)*	Catch dam east (CDE)*	ASW01*	FSW01*
Sample date		19/08/2014	28/08/2014	28/08/2014	28/08/2014	28/08/2014
Formation		Shallow rock	Irrigation plot runoff	Irrigation plot runoff	Surface water	Surface water
Field parameters						
Temperature	°C	13.76	13.39	13.59	14.68	14.08
EC	µS/cm	6,954	324	147	184	385
Dissolved Oxygen	% sat	17.1	174.3	147.3	163.0	176.1
Dissolved Oxygen	mg/L	1.71	na	na	na	na
pH	pH units	7.44	9.14	8.88	9.12	8.80
TDS	mg/L	4,520	na	na	na	na
Redox	mV	-111.5	2.8	3.8	-21.0	-0.1
General parameters (lab)						
pH	pH units	7.50	7.74	7.36	6.70	6.88
EC	µS/cm	7,750	356	158	194	420
TDS	mg/L	3,890	352	103	212	268
Suspended solids	mg/L	58	90	54	150	44
Laboratory analytes						
Hydroxide alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1
Carbonate alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1
Bicarbonate alkalinity as $CaCO_3$	mg/L	146	113	48	15	15
Total alkalinity as $CaCO_3$	mg/L	146	113	48	15	15
Sulfate as SO_4^{2-}	mg/L	282	19	<10	8	44
Chloride (APHA 4500-Cl^-)	mg/L	2,000	38	24	43	83
Chloride (trace) (USEPA 4110B)	mg/L	1,990	31.1	16.3	37.5	81.3
Calcium	mg/L	24	10	2	4	8
Magnesium	mg/L	133	5	2	3	8
Sodium	mg/L	1,380	44	18	26	48
Potassium	mg/L	2	15	9	4	7
Silicon as SiO_2	mg/L	25.0	17.4	13.5	12.7	12.4
Fluoride	mg/L	na	na	na	na	na
Dissolved metals						
Aluminium	mg/L	<0.01	0.26	2.03	0.56	0.13
Arsenic	mg/L	0.001	0.002	<0.001	0.001	<0.001
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.067	0.030	0.036	0.037	0.051
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.008	<0.001	<0.001	<0.001	0.001
Copper	mg/L	<0.001	0.006	0.004	0.002	0.003
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.213	0.004	0.010	0.038	0.106
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.009	0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.177	0.001	0.001	0.001	0.001
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	1.07	0.072	0.028	0.076	0.145
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.013	0.012	0.022	0.014	0.023
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	0.53	0.37	0.84	0.65	0.30
Bromine	mg/L	na	na	na	na	na
Nutrients						
Ammonia as N	mg/L	0.04	0.06	0.04	0.02	0.04
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	<0.01	0.21	0.05	0.12	0.48
Total nitrogen as N	mg/L	2.1	2.3	2.2	1.5	2.0
Total phosphorus	mg/L	0.51	1.53	0.75	0.16	0.17
Reactive phosphorus	mg/L	<0.01	0.97	0.54	0.04	0.07
Total organic carbon	mg/L	24	41	27	25	23
Total petroleum hydrocarbons						
C_6-C_9 fraction	µg/L	na	na	na	na	na
C_{10}-C_{14} fraction	µg/L	na	na	na	na	na
C_{15}-C_{28} fraction	µg/L	na	na	na	na	na
C_{29}-C_{36} fraction	µg/L	na	na	na	na	na
C_{10}-C_{36} fraction (sum)	µg/L	na	na	na	na	na
Total recoverable hydrocarbons						
C_6-C_{10} fraction	µg/L	na	na	na	na	na
C_6-C_{10} fraction minus BTEX	µg/L	na	na	na	na	na
>C_{10}-C_{16} fraction	µg/L	na	na	na	na	na
>C_{16}-C_{34} fraction	µg/L	na	na	na	na	na
>C_{34}-C_{40} fraction	µg/L	na	na	na	na	na
>C_{10}-C_{40} fraction (sum)	µg/L	na	na	na	na	na
Aromatic hydrocarbons						
Benzene	µg/L	na	na	na	na	na
Toluene	µg/L	na	na	na	na	na
Ethyl Benzene	µg/L	na	na	na	na	na
m&p-Xylenes	µg/L	na	na	na	na	na
o-Xylenes	µg/L	na	na	na	na	na
Total xlyenes	µg/L	na	na	na	na	na
Sum of BTEX	µg/L	na	na	na	na	na
Naphthalene	µg/L	na	na	na	na	na
Dissolved gases						
Methane	µg/L	na	na	na	na	na
Phenolic compounds						
Phenol	µg/L	na	na	na	na	na
2-Chlorophenol	µg/L	na	na	na	na	na
2-Methylphenol	µg/L	na	na	na	na	na
3-&4-Methylphenol	µg/L	na	na	na	na	na
2-Nitrophenol	µg/L	na	na	na	na	na
2.4-Dimethylphenol	µg/L	na	na	na	na	na
2.4-Dichlorophenol	µg/L	na	na	na	na	na
2.6-Dichlorophenol	µg/L	na	na	na	na	na
4-Chloro-3-Methylphenol	µg/L	na	na	na	na	na
2.4.6-Trichlorophenol	µg/L	na	na	na	na	na
2.4.5-Trichlorophenol	µg/L	na	na	na	na	na
Pentachlorophenol	µg/L	na	na	na	na	na
Polycyclic aromatic hydrocarbons						
Naphthalene	µg/L	na	na	na	na	na
Acenaphthylene	µg/L	na	na	na	na	na
Acenaphthene	µg/L	na	na	na	na	na
Fluorene	µg/L	na	na	na	na	na
Phenanthrene	µg/L	na	na	na	na	na
Anthracene	µg/L	na	na	na	na	na
Fluoranthene	µg/L	na	na	na	na	na
Pyrene	µg/L	na	na	na	na	na
Benz(a)anthracene	µg/L	na	na	na	na	na
Chrysene	µg/L	na	na	na	na	na
Benzo(b)fluoranthene	µg/L	na	na	na	na	na
Benzo(k)fluoranthene	µg/L	na	na	na	na	na
Benzo(a)pyrene	µg/L	na	na	na	na	na
Indeno(1.2.3.cd)pyrene	µg/L	na	na	na	na	na
Dibenz(a.h)anthracene	µg/L	na	na	na	na	na
Benzo(g.h.i)perylene	µg/L	na	na	na	na	na

Notes:

na - not analysed

* sample collected by AGL

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Summary table A3: November 2014 Water quality results

Water quality parameters	Units	TMB01	TMB02	TMB03	TMB04	TMB05	S4MB01	Tiedman south dam (TSD)	Tiedman north dam (TND)	Tiedman east dam (TED)	Catch dam west (CDW)	Catch dam east (CDE)	TSW01	TSW02	ASW01	FSW01	TCMB01	TTMB02
Sample date		25/11/2014	25/11/2014	25/11/2014	25/11/2014	26/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	25/11/2014	26/11/2014	25/11/2014	25/11/2014
Formation		Alluvium	Alluvium	Alluvium	Seepage	Seepage	Shallow rock	Dam	Dam	Dam	Irrigation plot runoff	Irrigation plot runoff	Surface water	Surface water	Surface water	Surface water	Shallow rock	Shallow rock
Field parameters																		
Temperature	°C	19.33	18.50	18.09	23.48	23.40	20.19	25.57	25.25	25.91	24.67	27.13	23.62	No sample (dry)	23.76	23.28	21.48	21.87
EC	µS/cm	8,764	3,917	6,097	7,420	7,334	4,617	1,593	5,798	1,202	356	465	517		372	459	2,984	2,284
Dissolved Oxygen	% sat	19.6	16.0	17.0	100.1	80.7	30.8	73.7	43.3	73.9	17.2	110.8	12.9		28.0	15.6	10.4	10.8
Dissolved Oxygen	mg/L	1.74	1.43	1.42	8.21	6.69	2.74	5.95	3.44	5.98	1.40	8.71	1.07		2.40	1.33	0.90	0.92
pH	pH units	6.70	6.60	6.49	6.35	6.50	6.99	10.30	10.24	9.67	8.80	8.50	8.05		7.85	5.54	6.93	6.50
TDS	mg/L	5,697	2,547	3,964	4,820	4,767	3,002	1,035	3,768	721	231	302	336		242	298	1,940	1,485
Redox	mV	-29.9	-26.6	-22.3	-21.5	-5.3	-130.2	-40.7	-54.3	-38.7	-137.2	-12.2	-58.4		-80.7	146.9	-27.5	-47.9
General parameters (lab)																		
pH	pH units	7.21	6.93	7.08	6.95	5.57	7.85	9.77	9.86	9.52	10.10	8.45	7.61		7.58	7.55	7.71	7.43
EC	µS/cm	9,010	4,010	6,190	7,520	7,490	4,810	1,610	5,870	1,220	355	454	516		354	440	3,060	2,350
TDS	mg/L	5,980	2,540	4,440	4,720	4,260	2,880	954	3,000	751	347	470	324		229	271	1,920	1,450
Suspended solids	mg/L	172	8	156	1,820	460	110	25	148	62	60	81	12		10	12	9	<5
Laboratory analytes																		
Hydroxide alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1
Carbonate alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1	<1	<1	265	1250	174	86	5	<1		<1	<1	<1	<1
Bicarbonate alkalinity as $CaCO_3$	mg/L	656	203	501	307	5	473	135	492	189	25	97	83		72	55	329	400
Total alkalinity as $CaCO_3$	mg/L	656	203	501	307	5	473	400	1740	363	111	102	83		72	55	329	400
Sulfate as SO_4^{2-}	mg/L	92	43	199	657	219	17	32	15	12	2	30	9		<10	13	<1	49
Chloride (APHA 4500-Cl^-)	mg/L	2,750	1,100	1,670	2,050	2,250	1,290	263	907	174	36	71	104		63	95	758	522
Chloride (trace) (USEPA 4110B)	mg/L	2,690	1,160	1,720	2,000	2,400	1,290	250	936	163	36.0	68.3	99.3		61.1	85.2	788	523
Calcium	mg/L	320	188	392	164	58	341	12	8	10	21	9	20		17	13	212	220
Magnesium	mg/L	239	85	151	194	236	58	7	3	6	5	8	12		9	11	70	48
Sodium	mg/L	1,200	507	714	1,080	1,010	638	300	1,150	222	52	45	60		36	49	325	226
Potassium	mg/L	2	3	3	17	15	6	73	303	39	12	12	6		5	6	6	4
Silicon as SiO_2	mg/L	35.4	35.0	32.8	53.7	66.3	29.3	19.0	26.1	14.4	5.9	19.2	16.8		8.3	14.0	20.7	33.6
Fluoride	mg/L	0.3	0.1	0.2	0.9	0.9	0.4	0.3	1.2	0.4	0.2	0.2	0.1		0.1	<0.1	0.1	<0.1
Dissolved metals																		
Aluminium	mg/L	0.13	<0.01	0.08	0.09	0.57	<0.01	0.17	2.94	0.32	0.02	1.30	0.08		<0.01	0.02	0.04	0.03
Arsenic	mg/L	0.001	0.003	0.006	0.001	0.001	0.002	0.003	0.013	0.004	0.003	0.002	0.004		0.002	0.003	<0.001	0.001
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.260	0.770	0.218	0.082	0.202	6.19	0.128	0.331	0.151	0.035	0.042	0.079		0.062	0.055	7.40	0.804
Cadmium	mg/L	<0.0001	<0.0001	0.0001	<0.0001	0.0025	<0.0001	<0.0001	<0.0001	<0.0001	0.0007	0.0001	<0.0001		<0.0001	<0.0001	<0.0001	0.0097
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	0.002	0.002	0.017	0.359	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001		<0.001	<0.001	<0.001	0.001
Copper	mg/L	<0.001	<0.001	0.007	0.005	0.202	<0.001	0.001	0.020	<0.001	0.015	0.003	<0.001		<0.001	0.001	0.002	0.013
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	0.010	<0.001	<0.001		<0.001	<0.001	<0.001	0.006
Manganese	mg/L	0.875	1.23	1.62	8.56	18.90	0.198	0.020	0.024	0.014	0.016	0.006	0.892		0.267	0.459	0.064	0.105
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	0.031	0.003	0.001	0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	<0.001	<0.001	0.001	0.01	0.175	<0.001	0.001	0.005	<0.001	0.001	0.002	<0.001		<0.001	<0.001	0.003	0.003
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	6.83	3.32	7.38	1.92	1.03	24.30	0.215	0.396	0.252	0.140	0.121	0.251		0.197	0.209	14.90	3.14
Uranium	mg/L	0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.020	0.013	0.026	0.066	1.200	<0.005	0.007	0.034	0.012	0.058	0.046	0.012		0.006	<0.005	0.025	0.327
Boron	mg/L	<0.05	<0.05	<0.05	0.05	<0.05	0.16	0.20	0.72	0.22	<0.05	0.06	<0.05		<0.05	<0.05	<0.05	<0.05
Iron	mg/L	2.29	5.34	5.22	12.60	11.40	1.50	0.09	1.22	0.13	0.15	0.21	2.93		1.07	1.14	1.98	2.05
Bromine	mg/L	4.2	2.1	2.9	3.0	1.8	2.6	0.5	2.2	0.4	0.1	0.1	0.1		<0.1	0.2	0.8	0.6
Nutrients																		
Ammonia as N	mg/L	0.13	0.29	0.23	0.29	0.28	1.82	<0.01	0.21	0.02	0.02	<0.01	0.05		<0.01	<0.01	1.34	0.6
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.04	0.04	0.03	0.03	0.02	<0.01	0.02	0.03	0.04	0.03	0.02	0.03		0.03	<0.01	0.03	0.04
Total nitrogen as N	mg/L	0.4	0.3	0.2	0.8	1.0	2.1	5.2	10.5	10.1	8.9	5.1	1.6		1.2	1.4	1.4	0.7
Total phosphorus	mg/L	0.08	0.07	0.04	0.52	0.15	0.07	0.48	1.75	0.57	0.87	1.18	0.29		0.14	0.22	0.01	0.23
Reactive phosphorus	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.08	0.15	0.14		0.05	0.08	0.03	0.02
Total organic carbon	mg/L	<1	<1	<1	6	10	30	31	124	36	32	33	17		16	17	<1	<1
Total petroleum hydrocarbons																		
C_6-C_9 fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
C_{10}-C_{14} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
C_{15}-C_{28} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
C_{29}-C_{36} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
C_{10}-C_{36} fraction (sum)	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Total recoverable hydrocarbons																		
C_6-C_{10} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
C_6-C_{10} fraction minus BTEX	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
>C_{10}-C_{16} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
>C_{16}-C_{34} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
>C_{34}-C_{40} fraction	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
>C_{10}-C_{40} fraction (sum)	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Aromatic hydrocarbons																		
Benzene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Toluene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Ethyl Benzene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
m&p-Xylenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
o-Xylenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Total xlyenes	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Sum of BTEX	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Naphthalene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Dissolved gases																		
Methane	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Phenolic compounds																		
Phenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2-Chlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
3-&4-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2-Nitrophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2.4-Dimethylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2.4-Dichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2.6-Dichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
4-Chloro-3-Methylphenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2.4.6-Trichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
2.4.5-Trichlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Pentachlorophenol	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Polycyclic aromatic hydrocarbons																		
Naphthalene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Acenaphthylene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Acenaphthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Fluorene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Phenanthrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Benz(a)anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Chrysene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Benzo(b)fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Benzo(k)fluoranthene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Benzo(a)pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Indeno(1.2.3.cd)pyrene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Dibenz(a.h)anthracene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na
Benzo(g.h.i)perylene	µg/L	na	na	na	na	na	na	na	na	na	na	na	na		na	na	na	na

Note:

na - not analysed

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Summary table A4: December 2014 Water quality results

Water quality parameters	Units	Catch dam west (CDW)*	Catch dam east (CDE)*	ASW01*	FSW01*
Sample date		11/12/2014	11/12/2014	11/12/2014	11/12/2014
Formation		Irrigation plot runoff	Irrigation plot runoff	Surface water	Surface water
Field parameters					
Temperature	°C	22.86	22.62	23.65	23.56
EC	µS/cm	248	101	337	427
Dissolved Oxygen	% sat	112.5	132.1	127.6	109.5
Dissolved Oxygen	mg/L	9.67	11.51	10.77	9.28
pH	pH units	8.61	8.82	7.93	8.75
TDS	mg/L	216	88	293	372
Redox	mV	-36.2	-30.3	-58.3	-51.3
General parameters (lab)					
pH	pH units	7.14	7.10	7.22	7.27
EC	µS/cm	241	107	328	418
TDS	mg/L	287	249	184	249
Suspended solids	mg/L	105	151	5	7
Laboratory analytes					
Hydroxide alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1
Carbonate alkalinity as $CaCO_3$	mg/L	<1	<1	<1	<1
Bicarbonate alkalinity as $CaCO_3$	mg/L	58	34	71	70
Total alkalinity as $CaCO_3$	mg/L	58	34	71	70
Sulfate as SO_4^{2-}	mg/L	29	14	<1	9
Chloride (APHA 4500-Cl^-)	mg/L	31	8	65	86
Chloride (trace) (USEPA 4110B)	mg/L	27.0	8.4	61.0	84.0
Calcium	mg/L	5	5	14	14
Magnesium	mg/L	2	1	8	10
Sodium	mg/L	33	14	32	46
Potassium	mg/L	9	6	4	6
Silicon as SiO_2	mg/L	33.1	11.9	8.2	13.4
Fluoride	mg/L	0.2	0.2	0.1	<0.1
Dissolved metals					
Aluminium	mg/L	0.03	1.77	0.02	0.04
Arsenic	mg/L	0.001	0.001	0.002	0.003
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.018	0.019	0.055	0.051
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.003	0.002	<0.001	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.002	0.005	0.331	0.337
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001
Nickel	mg/L	<0.001	<0.001	<0.001	<0.001
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.028	0.019	0.180	0.187
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.007	<0.005	<0.005	0.007
Boron	mg/L	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	0.12	0.82	1.49	1.56
Bromine	mg/L	<0.1	<0.1	0.1	0.1
Nutrients					
Ammonia as N	mg/L	0.04	0.05	0.05	0.11
Nitrite as N	mg/L	0.02	0.02	<0.01	<0.01
Nitrate as N	mg/L	0.20	0.26	<0.01	0.02
Total nitrogen as N	mg/L	1.6	2.6	0.9	1.2
Total phosphorus	mg/L	1.72	1.10	0.12	0.23
Reactive phosphorus	mg/L	1.60	0.73	0.04	0.12
Total organic carbon	mg/L	19	9	16	18
Total petroleum hydrocarbons					
C_6-C_9 fraction	µg/L	na	na	na	na
C_{10}-C_{14} fraction	µg/L	na	na	na	na
C_{15}-C_{28} fraction	µg/L	na	na	na	na
C_{29}-C_{36} fraction	µg/L	na	na	na	na
C_{10}-C_{36} fraction (sum)	µg/L	na	na	na	na
Total recoverable hydrocarbons					
C_6-C_{10} fraction	µg/L	na	na	na	na
C_6-C_{10} fraction minus BTEX	µg/L	na	na	na	na
>C_{10}-C_{16} fraction	µg/L	na	na	na	na
>C_{16}-C_{34} fraction	µg/L	na	na	na	na
>C_{34}-C_{40} fraction	µg/L	na	na	na	na
>C_{10}-C_{40} fraction (sum)	µg/L	na	na	na	na
Aromatic hydrocarbons					
Benzene	µg/L	na	na	na	na
Toluene	µg/L	na	na	na	na
Ethyl Benzene	µg/L	na	na	na	na
m&p-Xylenes	µg/L	na	na	na	na
o-Xylenes	µg/L	na	na	na	na
Total xlyenes	µg/L	na	na	na	na
Sum of BTEX	µg/L	na	na	na	na
Naphthalene	µg/L	na	na	na	na
Dissolved gases					
Methane	µg/L	na	na	na	na
Phenolic compounds					
Phenol	µg/L	na	na	na	na
2-Chlorophenol	µg/L	na	na	na	na
2-Methylphenol	µg/L	na	na	na	na
3-&4-Methylphenol	µg/L	na	na	na	na
2-Nitrophenol	µg/L	na	na	na	na
2.4-Dimethylphenol	µg/L	na	na	na	na
2.4-Dichlorophenol	µg/L	na	na	na	na
2.6-Dichlorophenol	µg/L	na	na	na	na
4-Chloro-3-Methylphenol	µg/L	na	na	na	na
2.4.6-Trichlorophenol	µg/L	na	na	na	na
2.4.5-Trichlorophenol	µg/L	na	na	na	na
Pentachlorophenol	µg/L	na	na	na	na
Polycyclic aromatic hydrocarbons					
Naphthalene	µg/L	na	na	na	na
Acenaphthylene	µg/L	na	na	na	na
Acenaphthene	µg/L	na	na	na	na
Fluorene	µg/L	na	na	na	na
Phenanthrene	µg/L	na	na	na	na
Anthracene	µg/L	na	na	na	na
Fluoranthene	µg/L	na	na	na	na
Pyrene	µg/L	na	na	na	na
Benz(a)anthracene	µg/L	na	na	na	na
Chrysene	µg/L	na	na	na	na
Benzo(b)fluoranthene	µg/L	na	na	na	na
Benzo(k)fluoranthene	µg/L	na	na	na	na
Benzo(a)pyrene	µg/L	na	na	na	na
Indeno(1.2.3.cd)pyrene	µg/L	na	na	na	na
Dibenz(a.h)anthracene	µg/L	na	na	na	na
Benzo(g.h.i)perylene	µg/L	na	na	na	na

Notes:
na - not analysed
* sample collected by AGL

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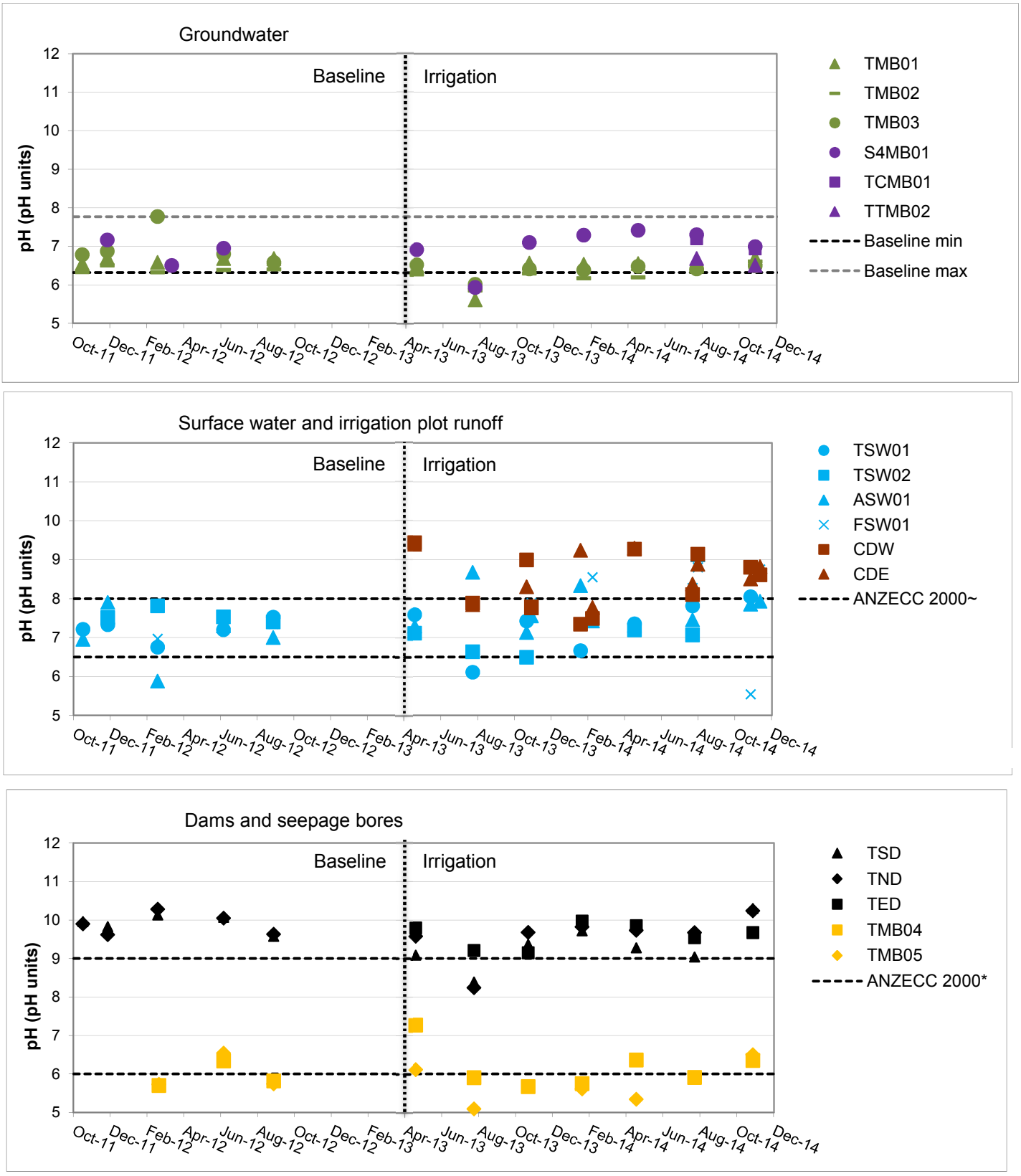
Appendix B

Water quality graphs

Figure B.1: Field measured pH



Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems,South-East Australia, low lying river ecosystems.

*ANZECC 2000. pH range of water for long-term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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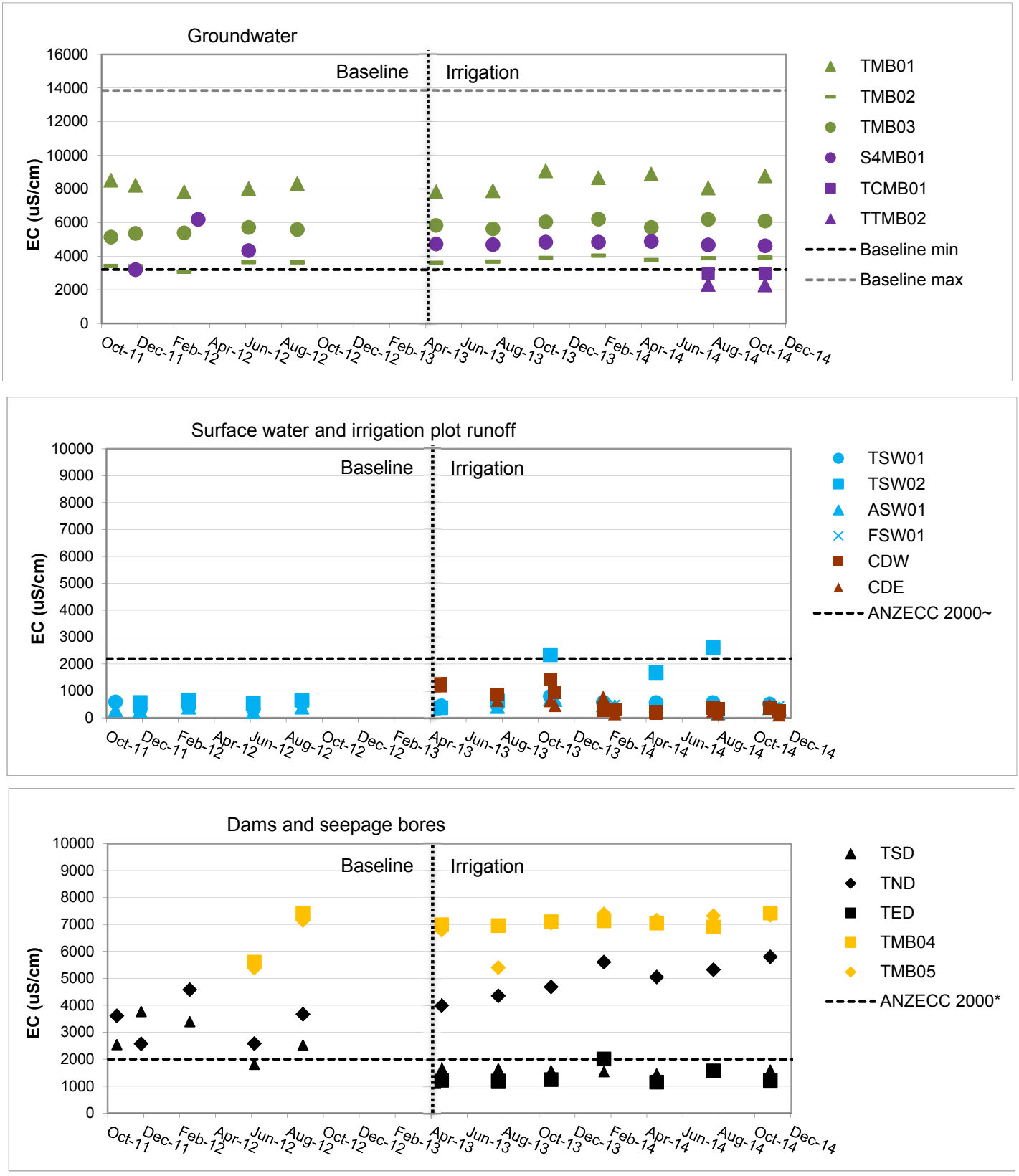
Figure B.2: Field measured EC



Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems,South-East Australia, low lying river ecosystems.

*ANZECC 2000. Water for long-term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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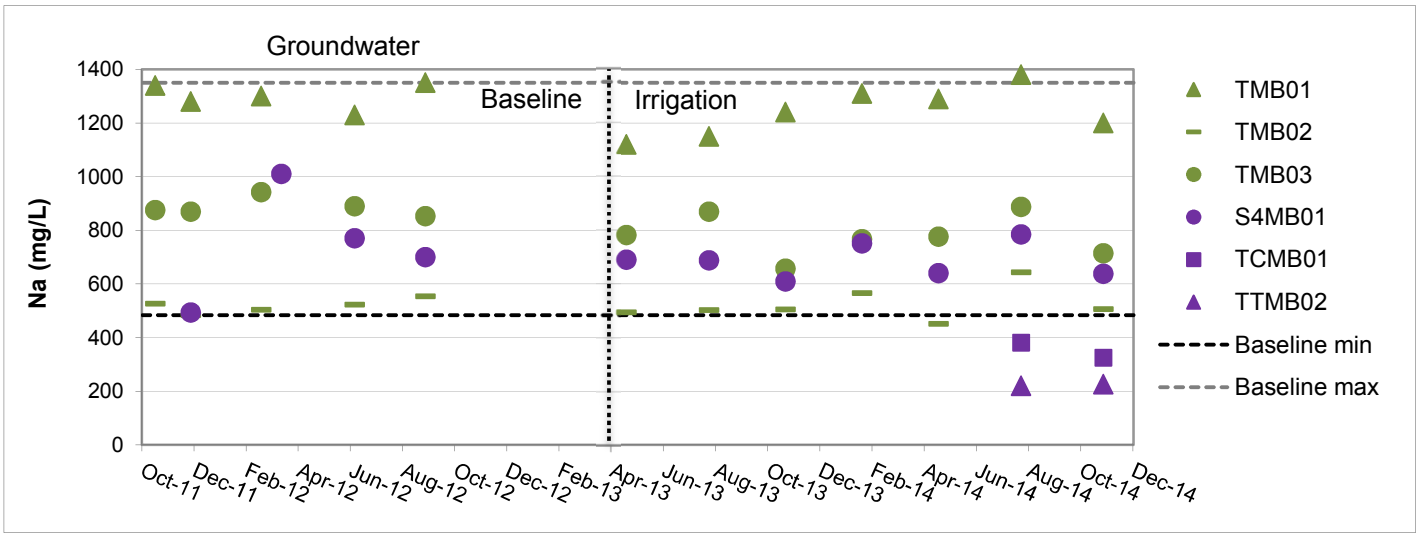
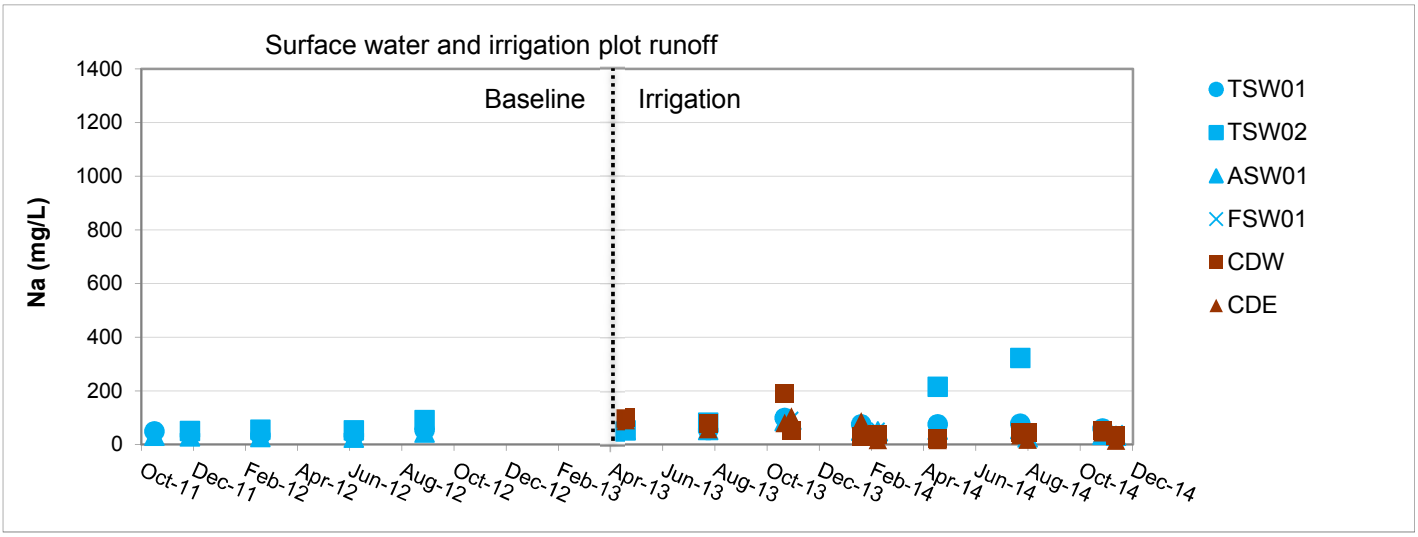
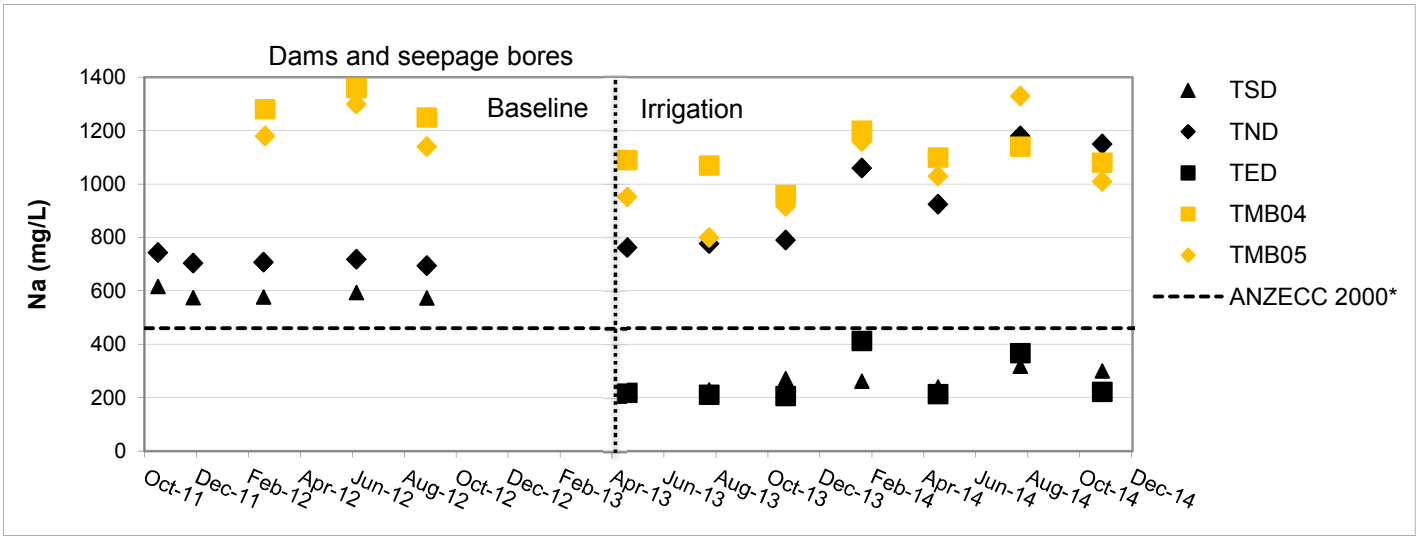
Figure B.3: Sodium concentrations







Note:

*ANZECC 2000. Water for irrigation and general water use. Moderately tolerant plants.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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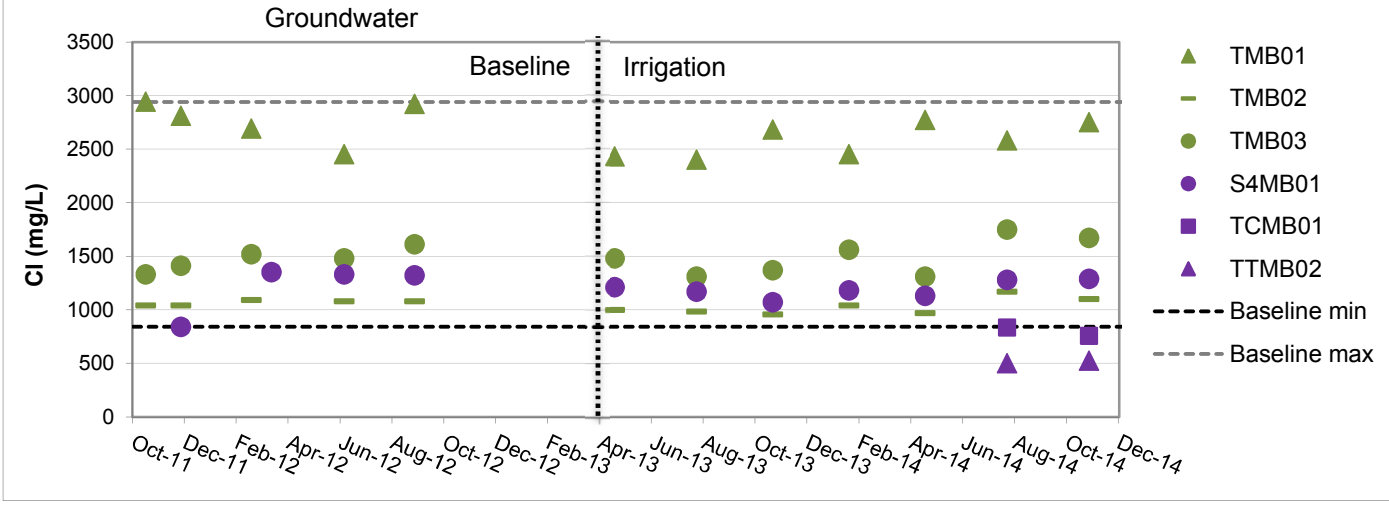
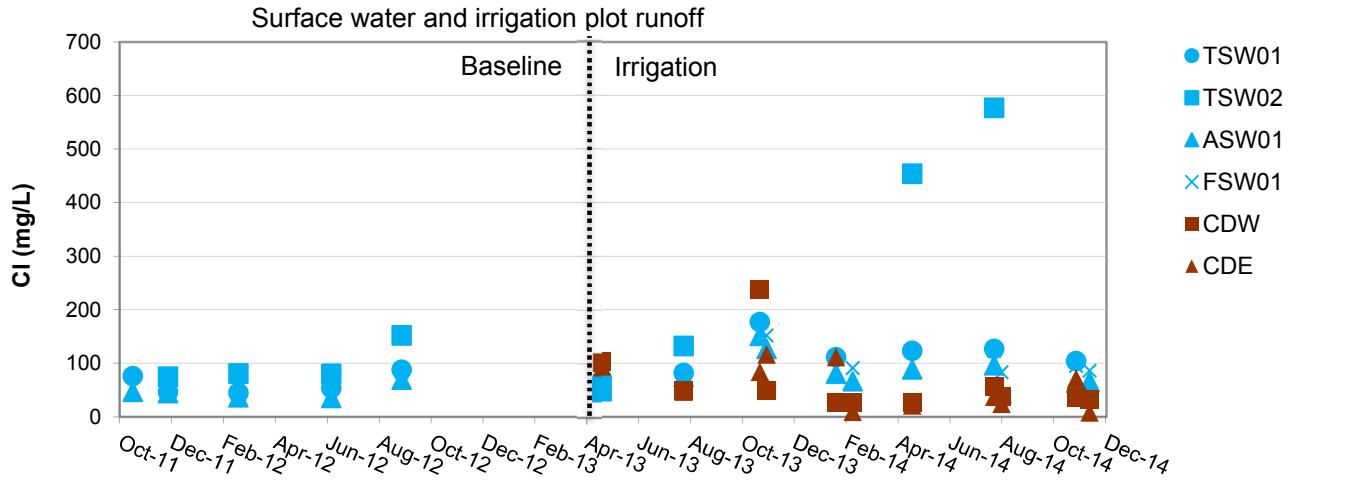
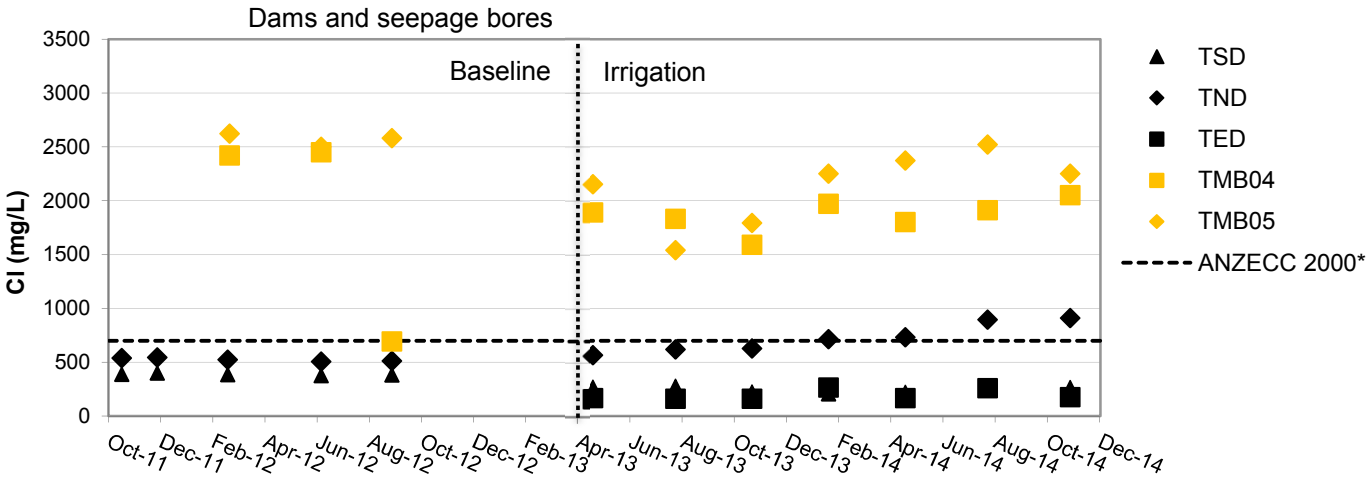
Figure B.4: Chloride concentrations







Note:

*ANZECC 2000. Water for irrigation and general water use. Moderately tolerant plants.

Chloride method used - APHA 4500-Cl^-

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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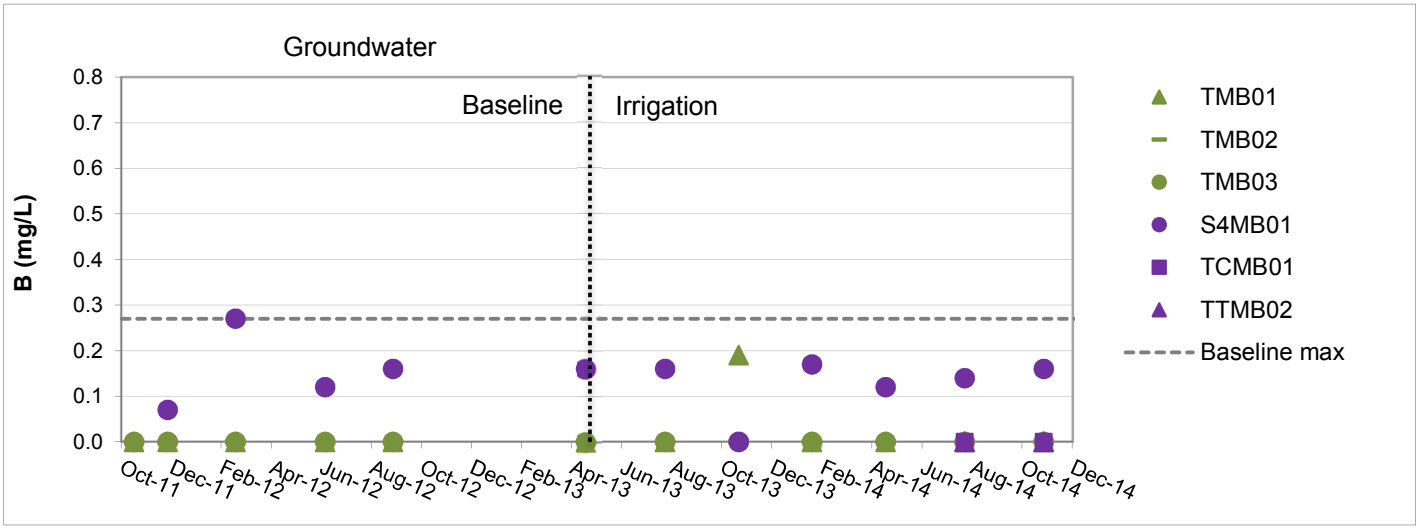
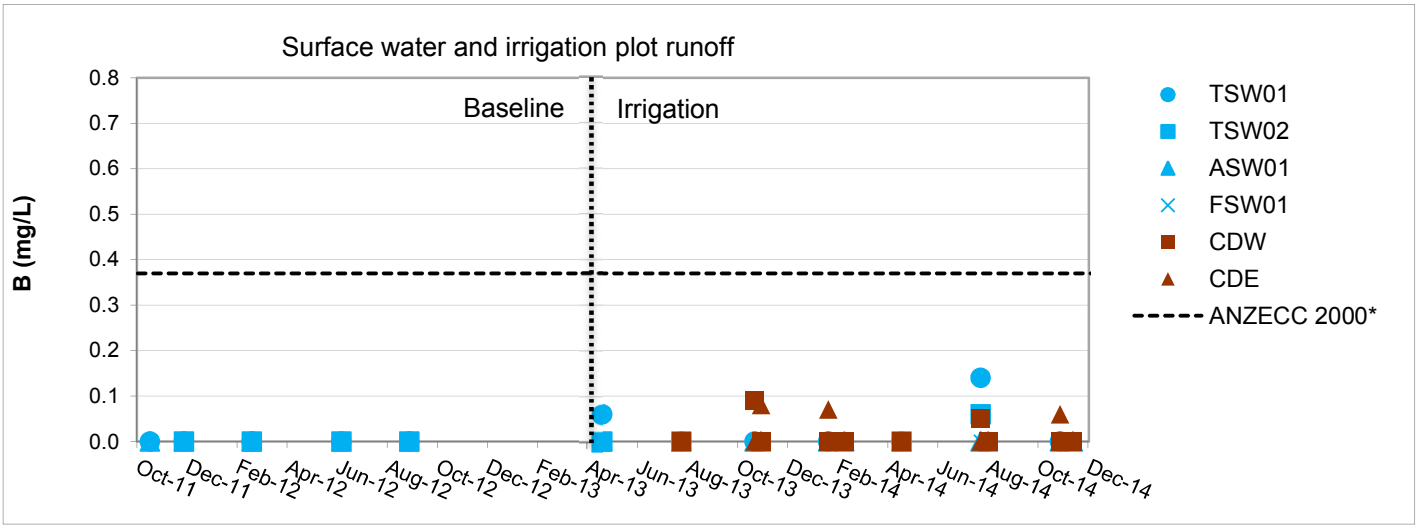
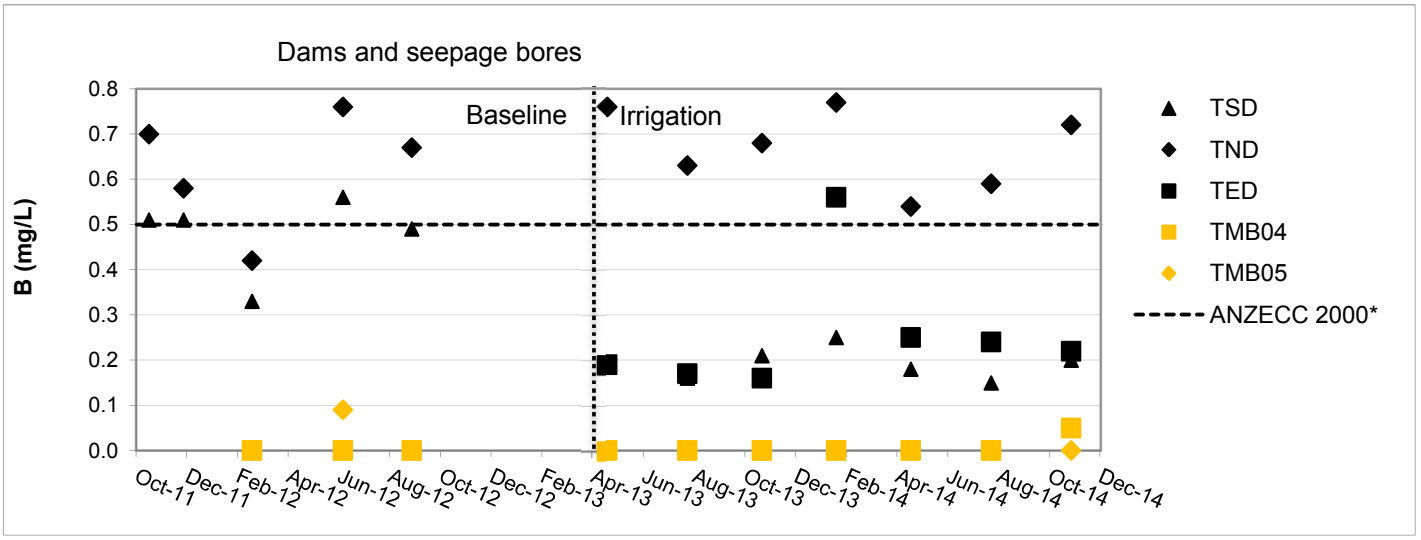
Figure B.5: Boron concentrations







Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long-term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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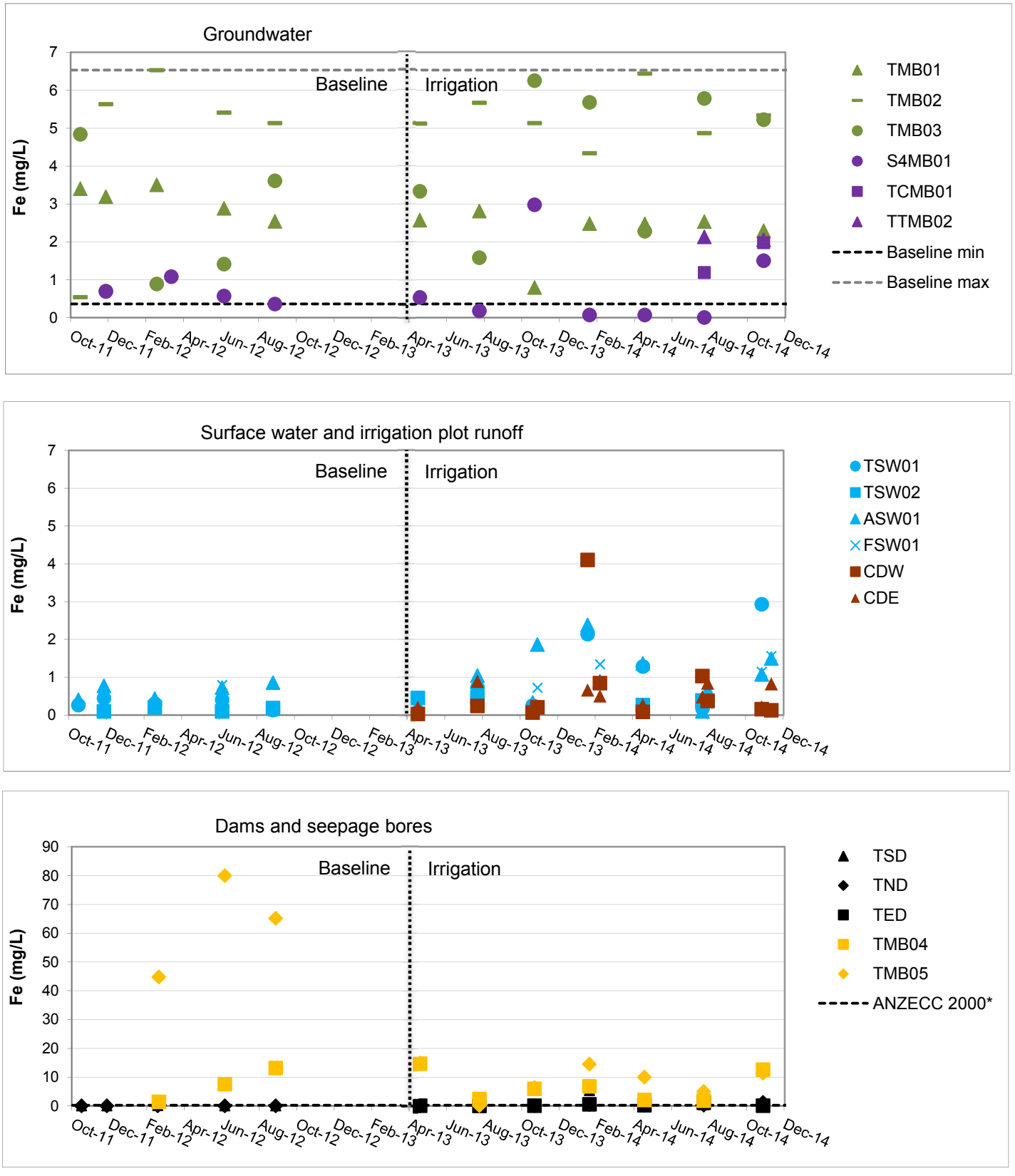
Figure B.6: Iron concentrations



Note:

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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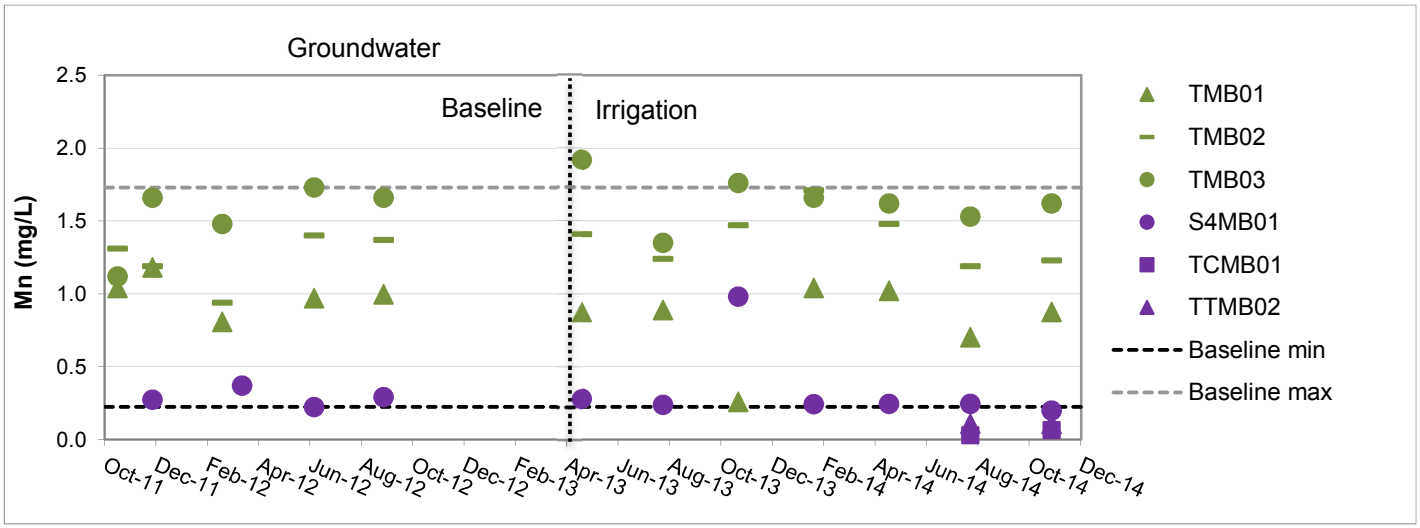
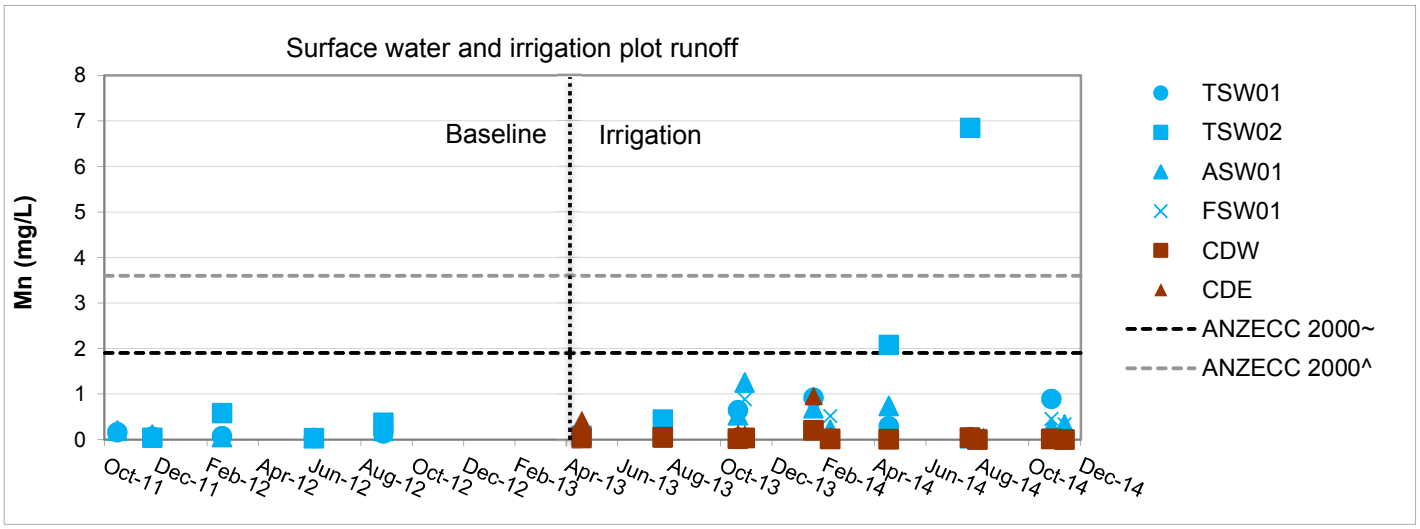
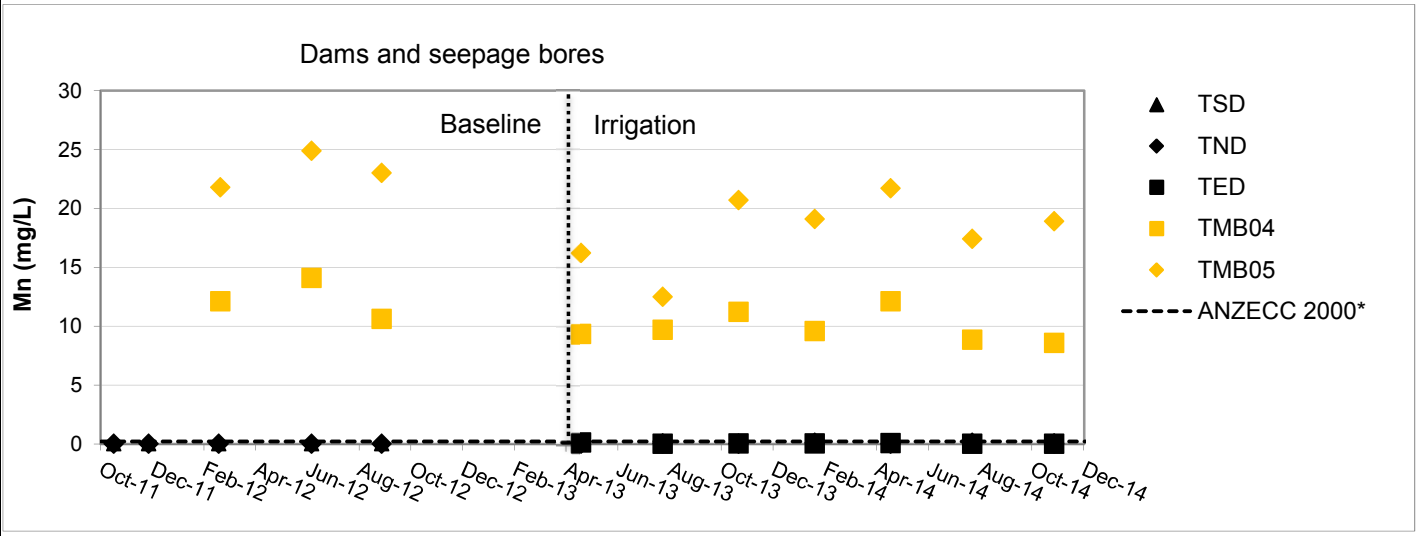
Figure B.7: Manganese concentrations







Notes:

~ANZECC 2000 - Water Quality Guidelines: 95 %protection levels for freshwater aquatic ecosystems.

^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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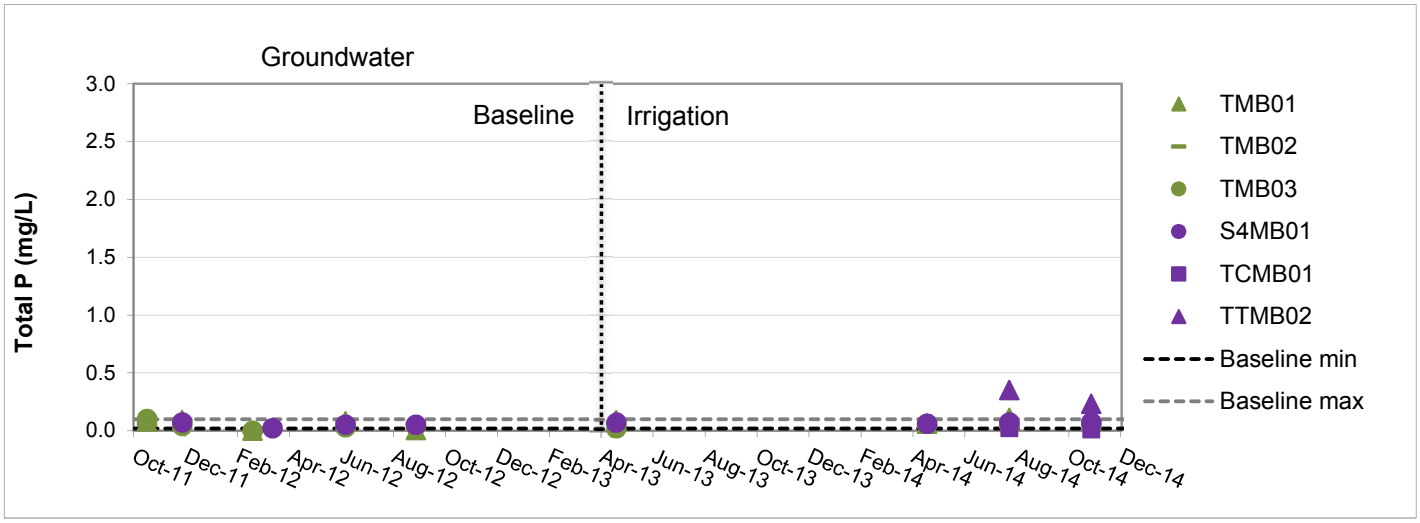
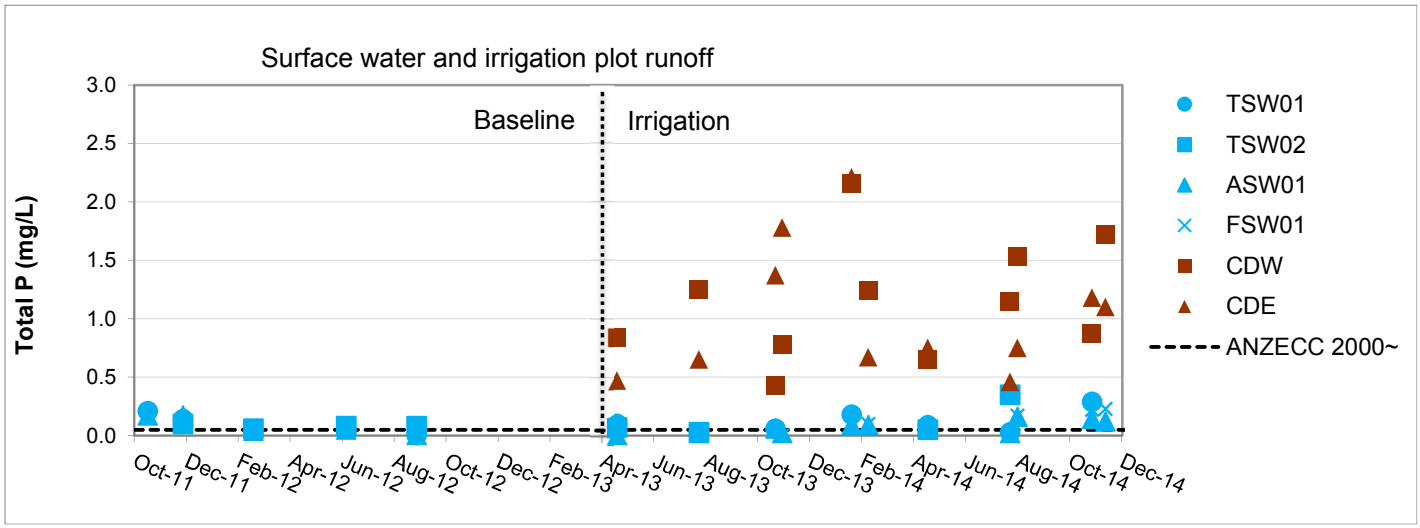
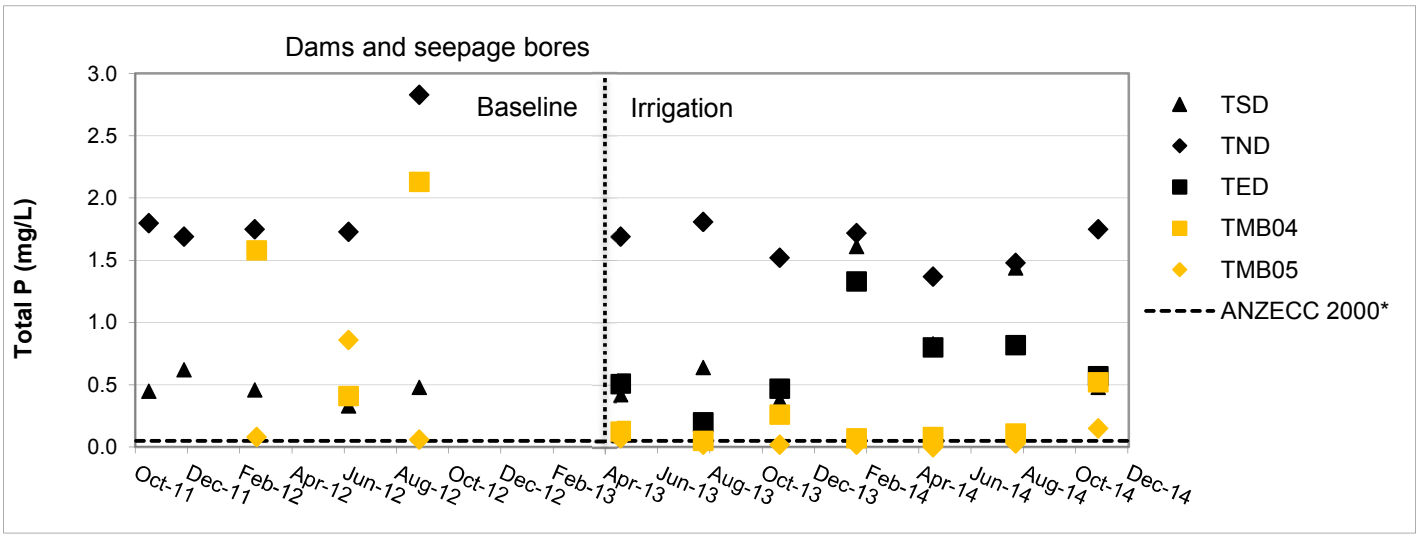
Figure B.8: Total Phosphorus concentrations







Note:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems,South-East Australia, low lying river ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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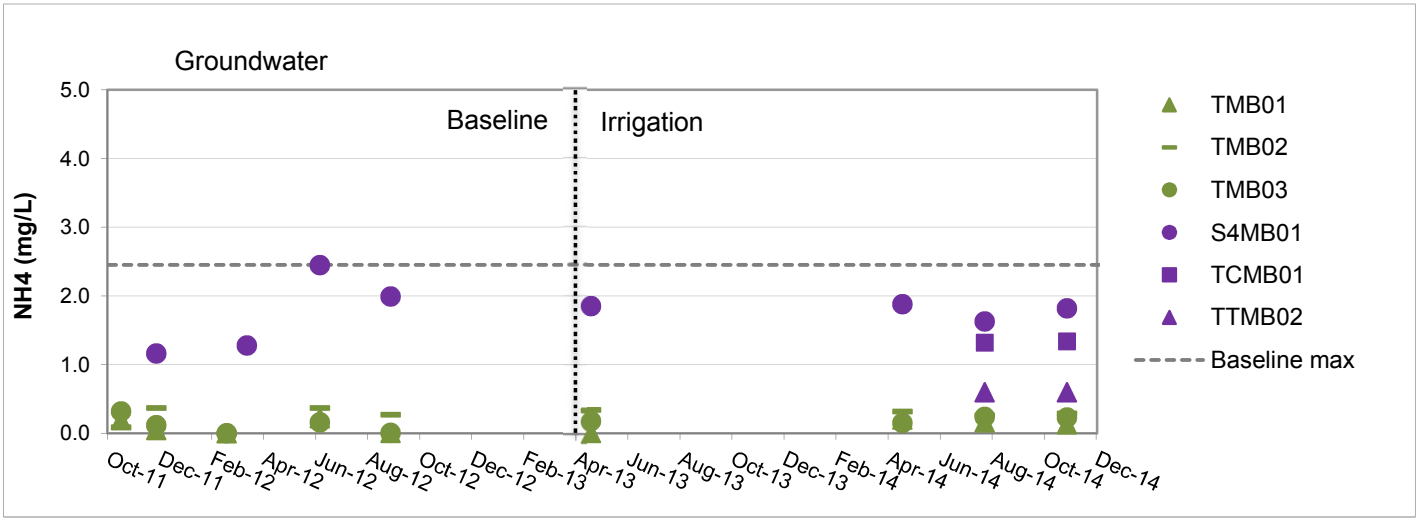
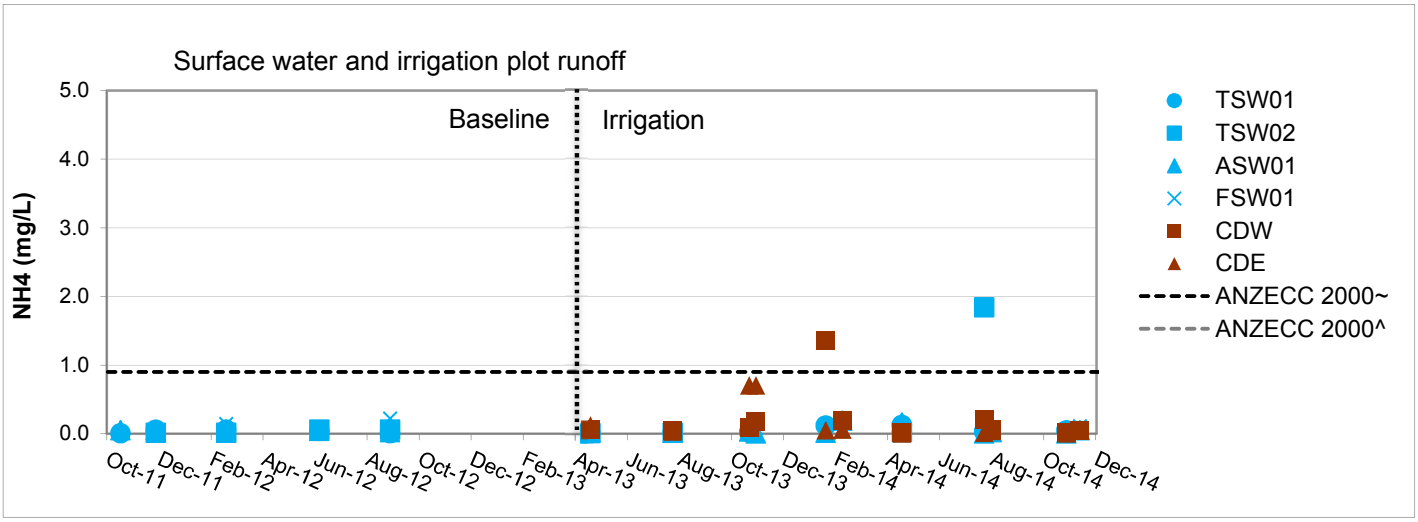
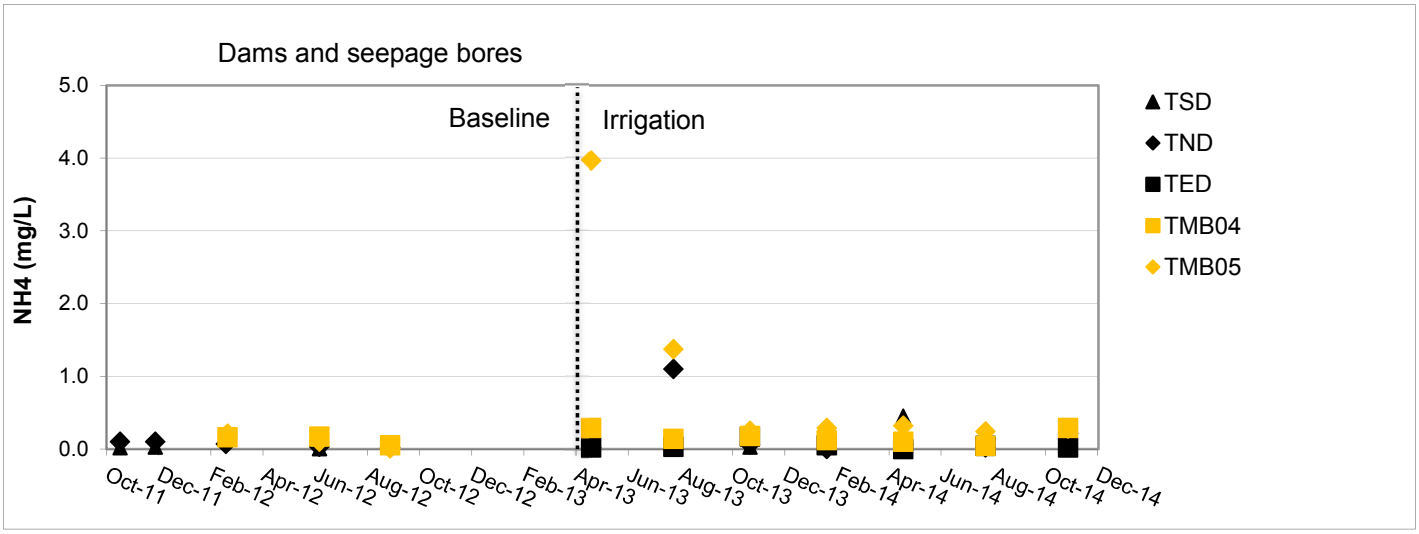
Figure B.9: Ammonia concentrations







Notes:
~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for the protection of freshwater aquatic ecosystems.
^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for the protection of freshwater aquatic ecosystems.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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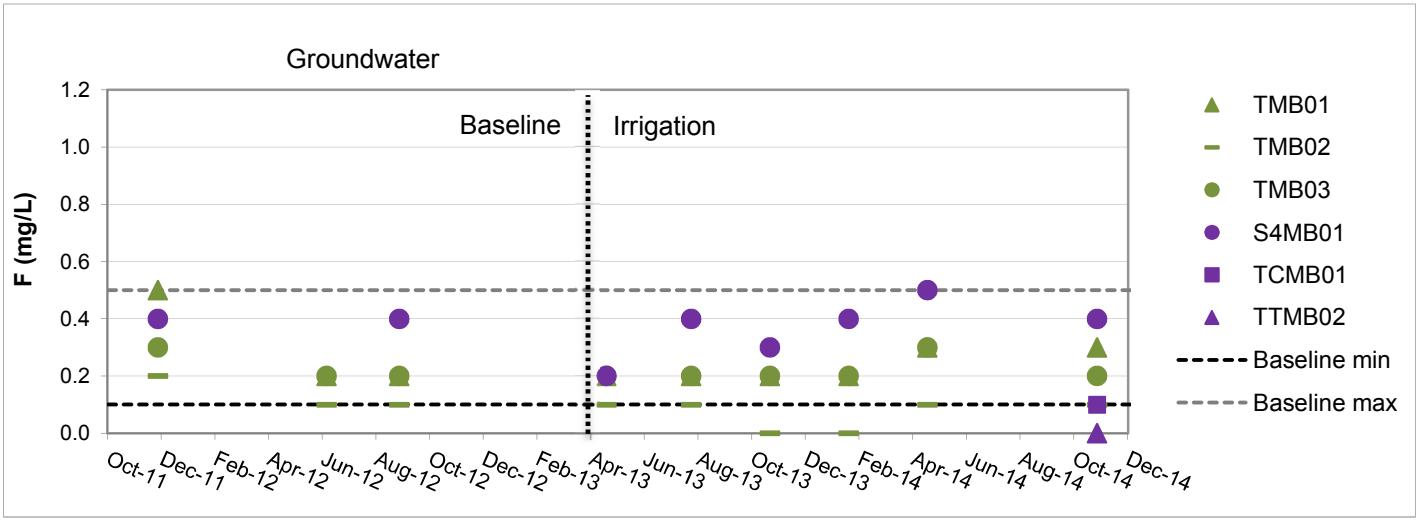
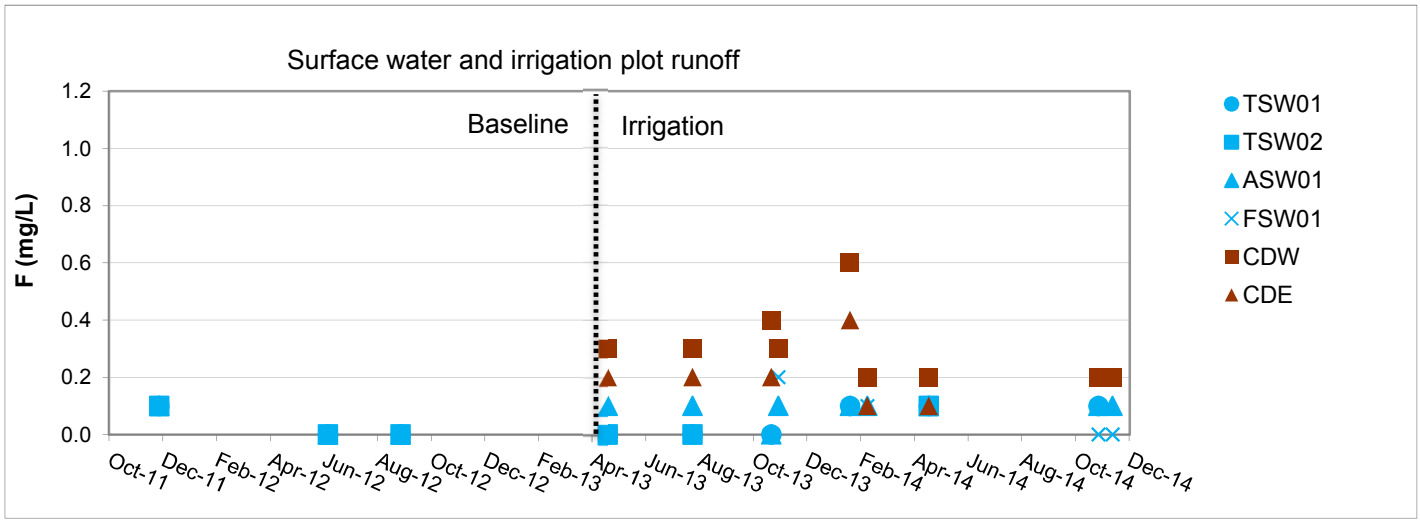
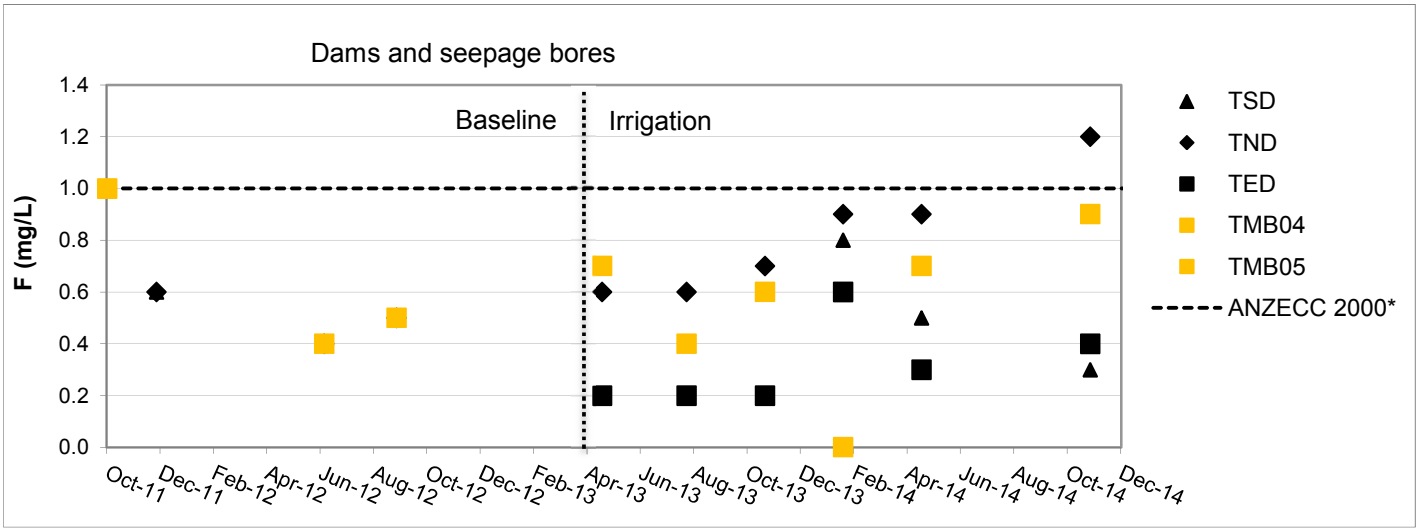
Figure B.10: Fluoride concentrations







Note:
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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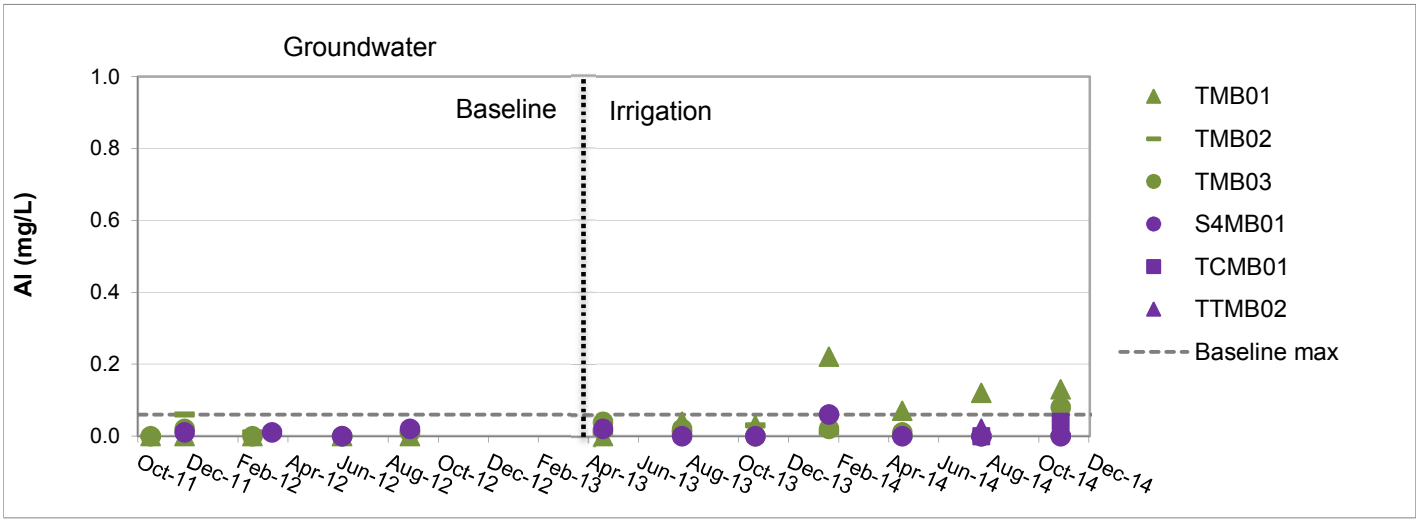
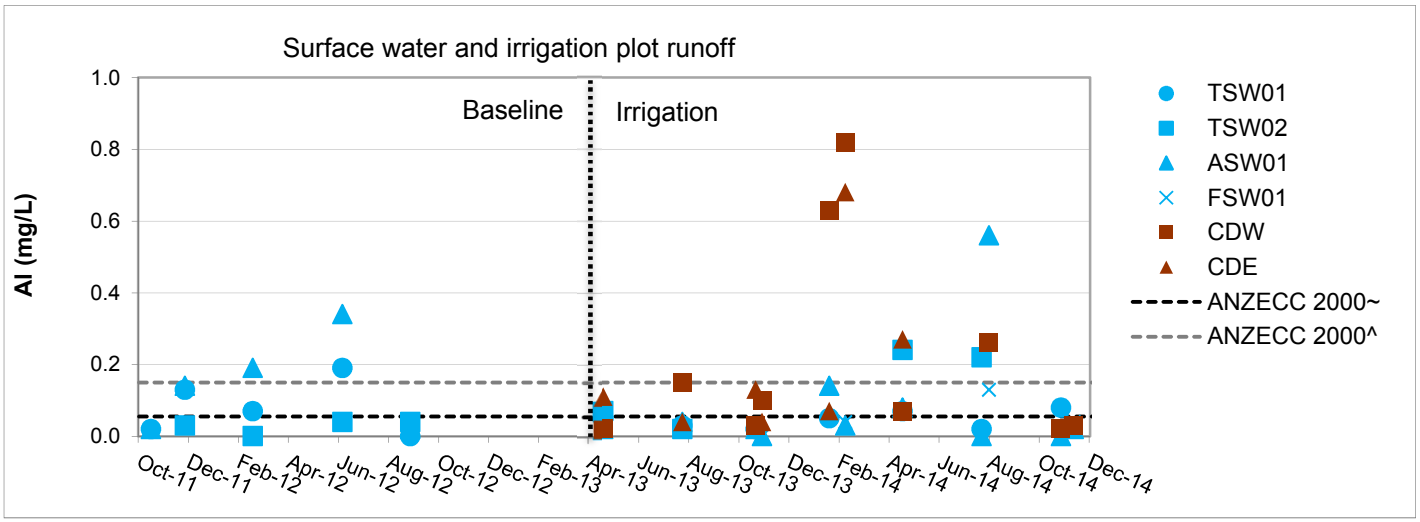
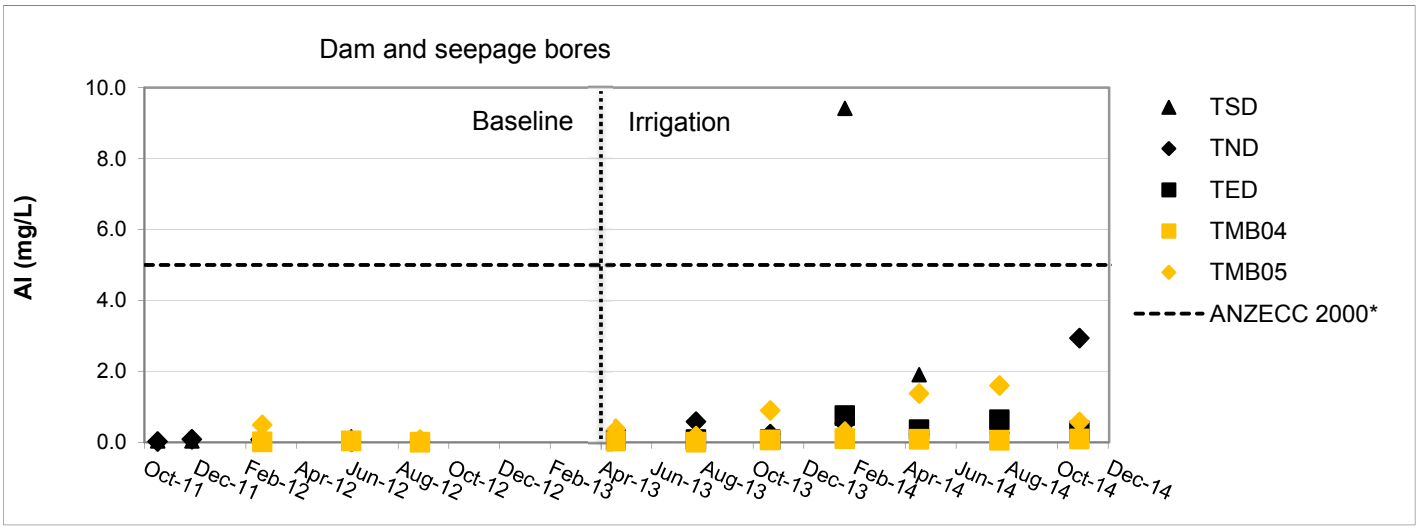
Figure B.11: Aluminium concentrations







Notes:

~ANZECC 2000 - Water Quality Guidelines: 95 %protection levels for freshwater aquatic ecosystems.

^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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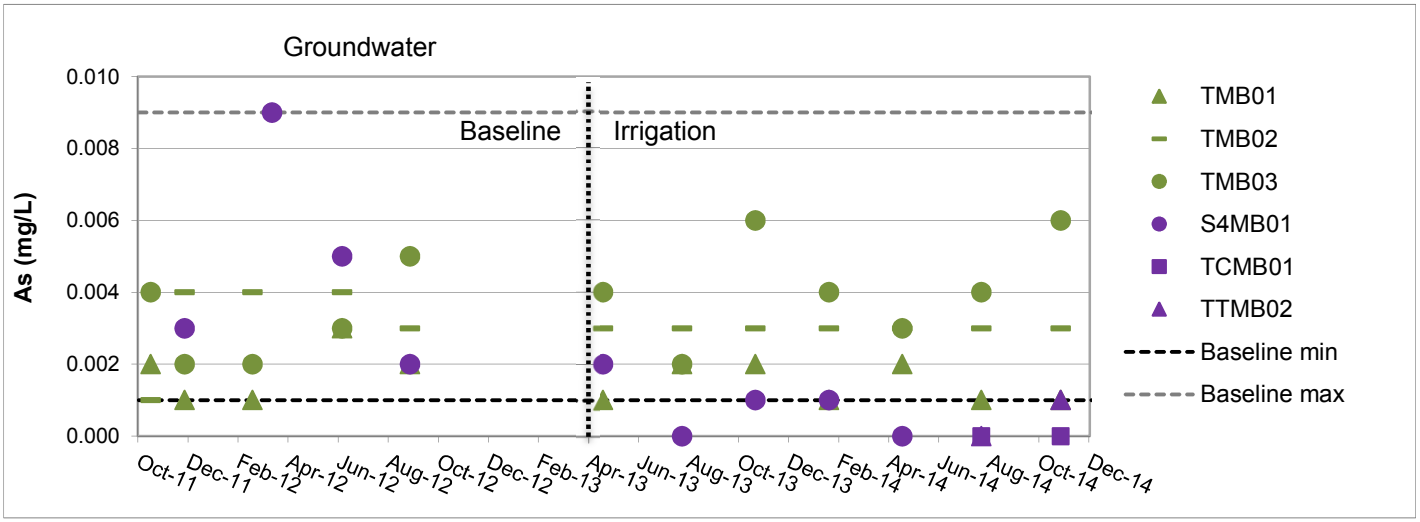
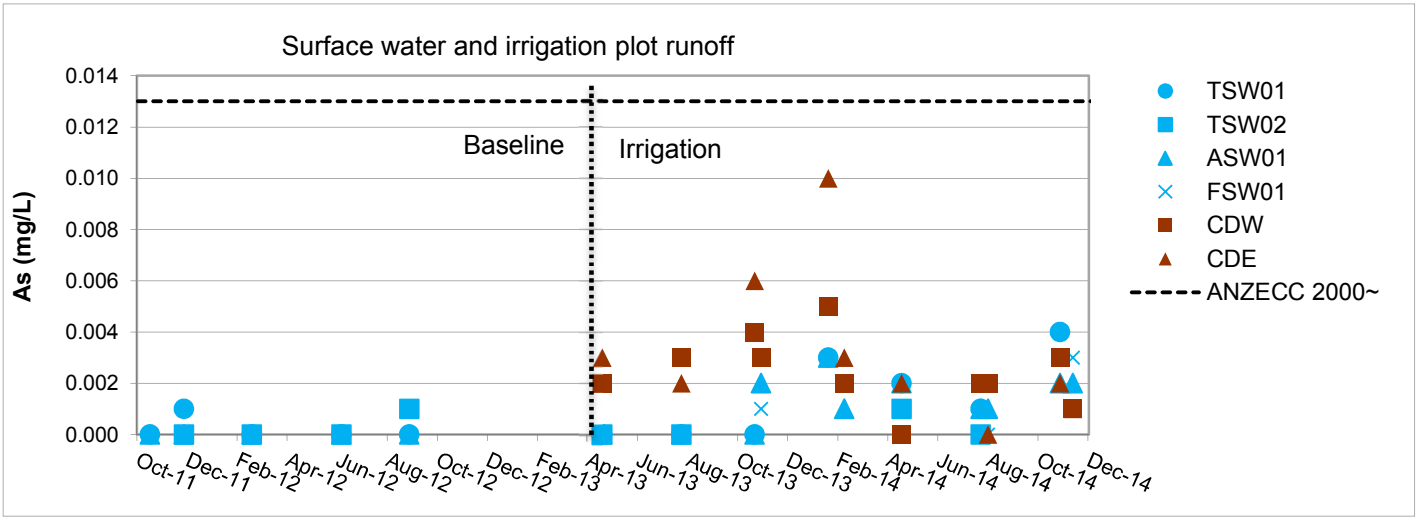
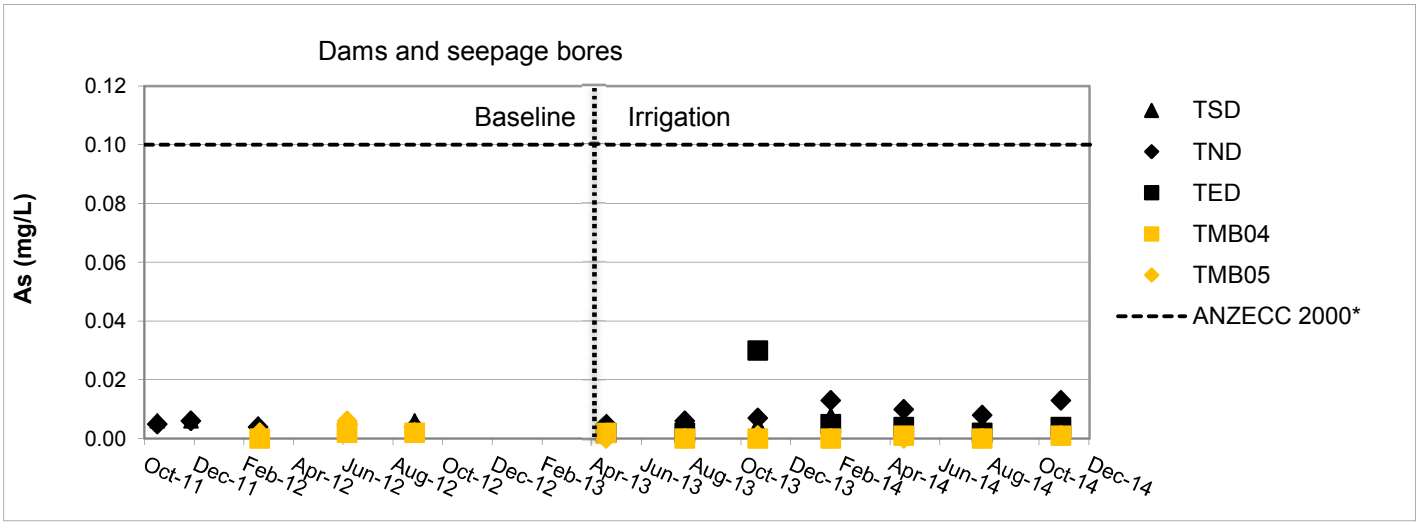
Figure B.12: Arsenic concentrations







Notes:
~ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems.
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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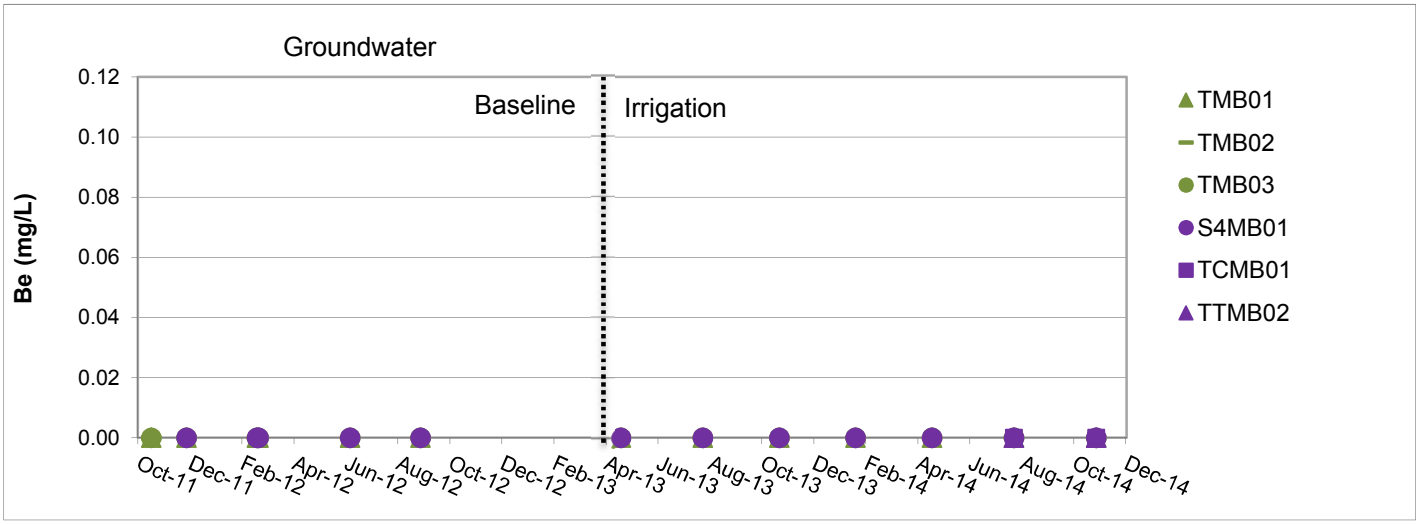
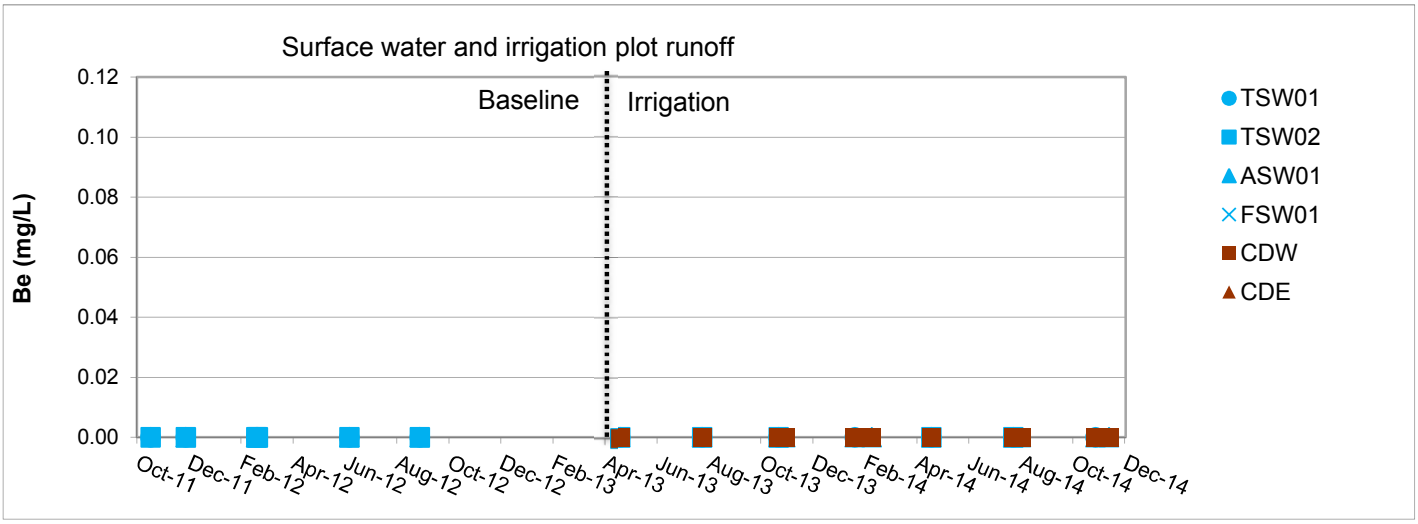
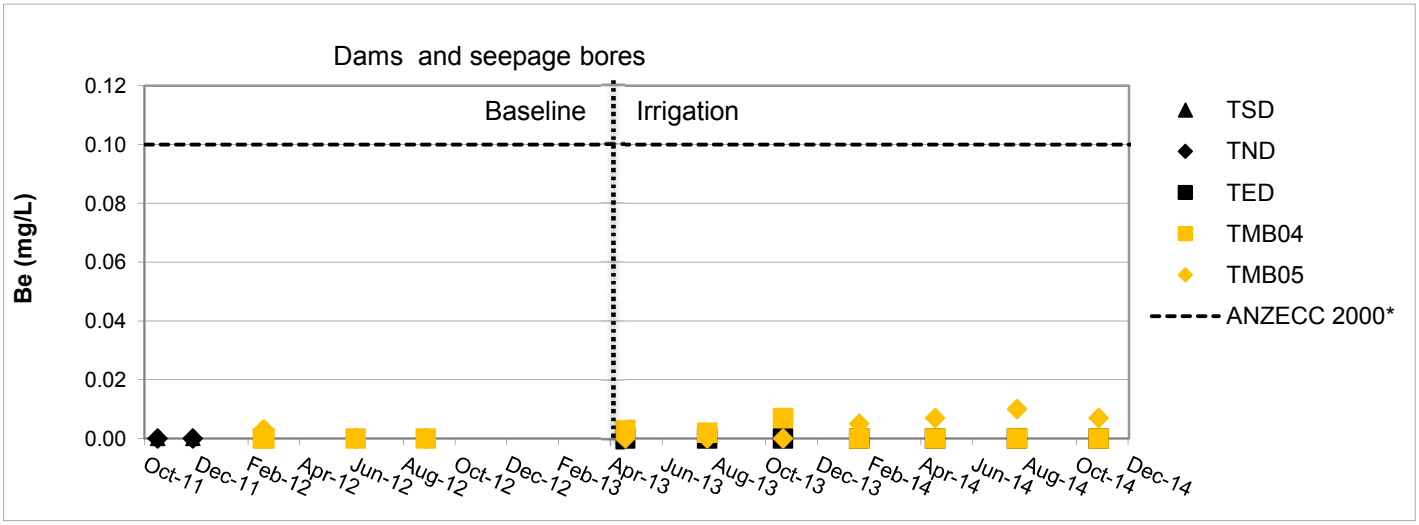
Figure B.13: Beryllium concentrations







Note:
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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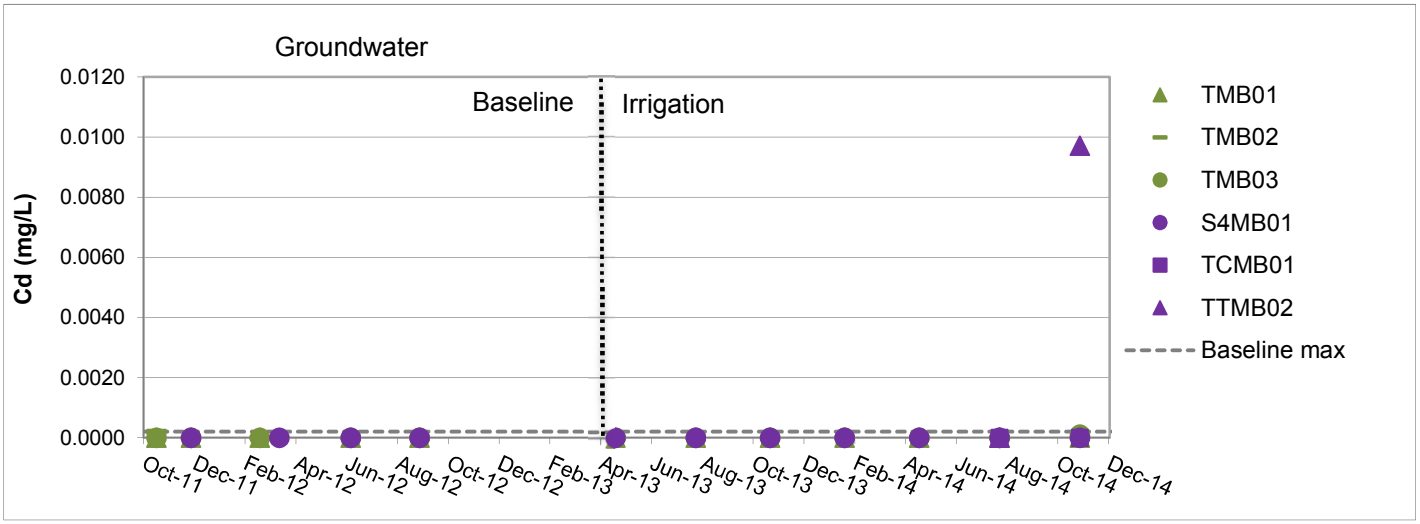
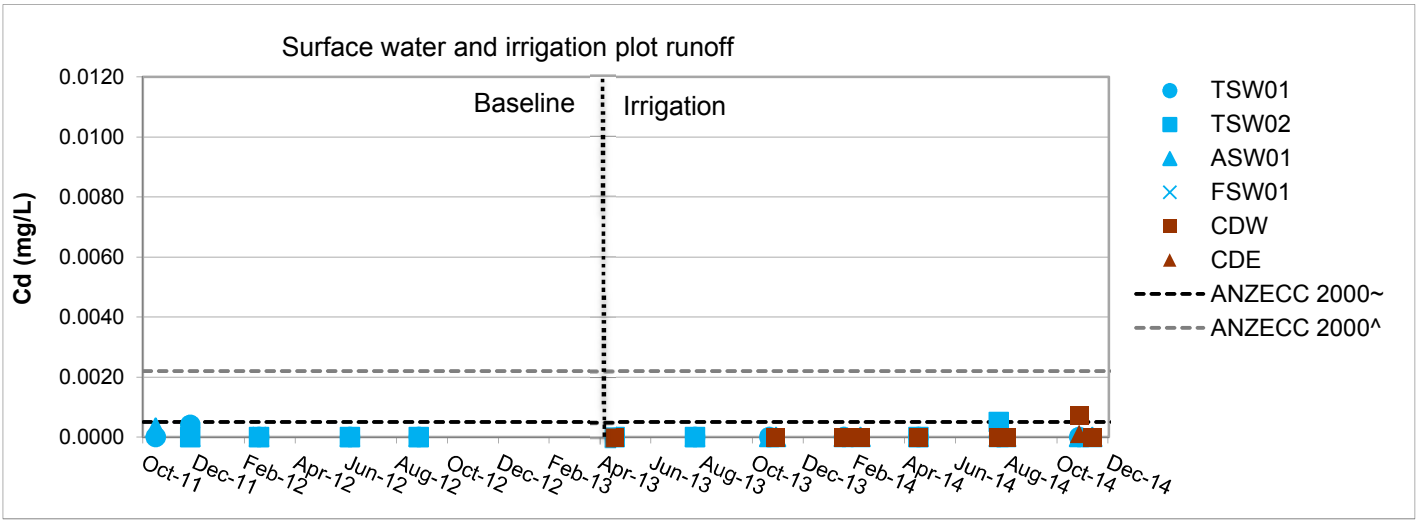
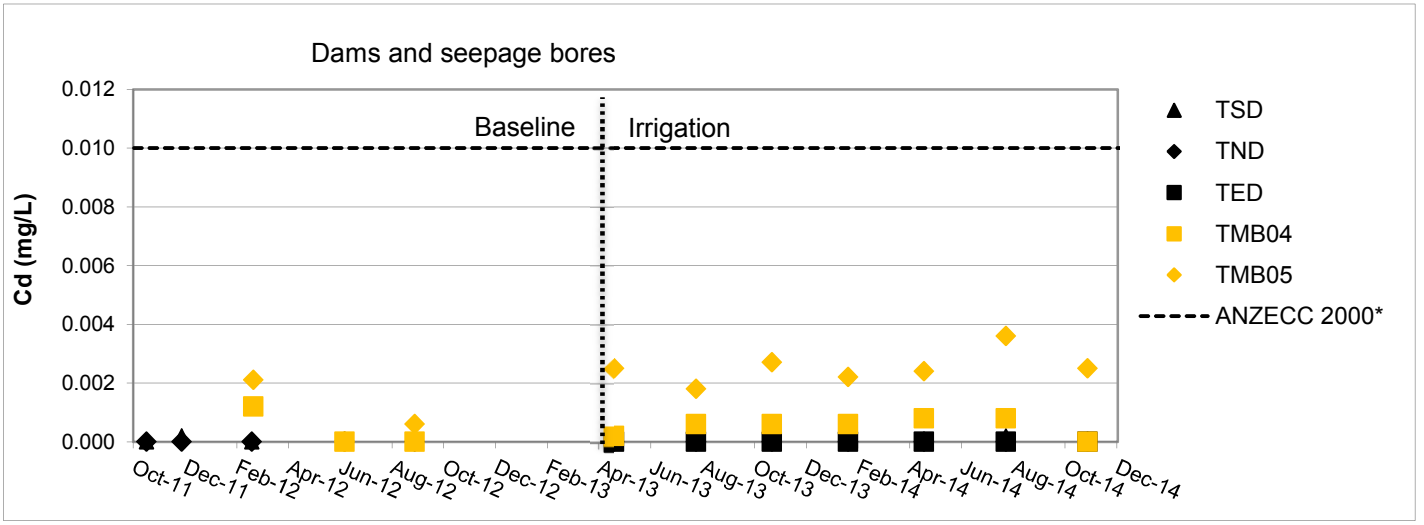
Figure B.14: Cadmium concentrations







Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems.

^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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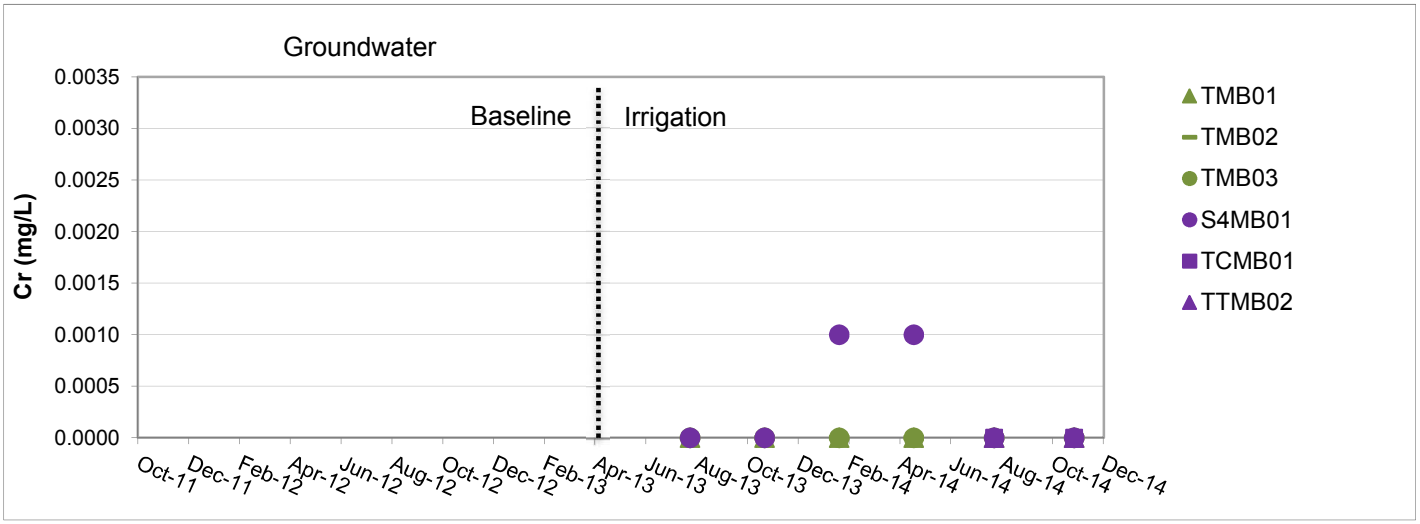
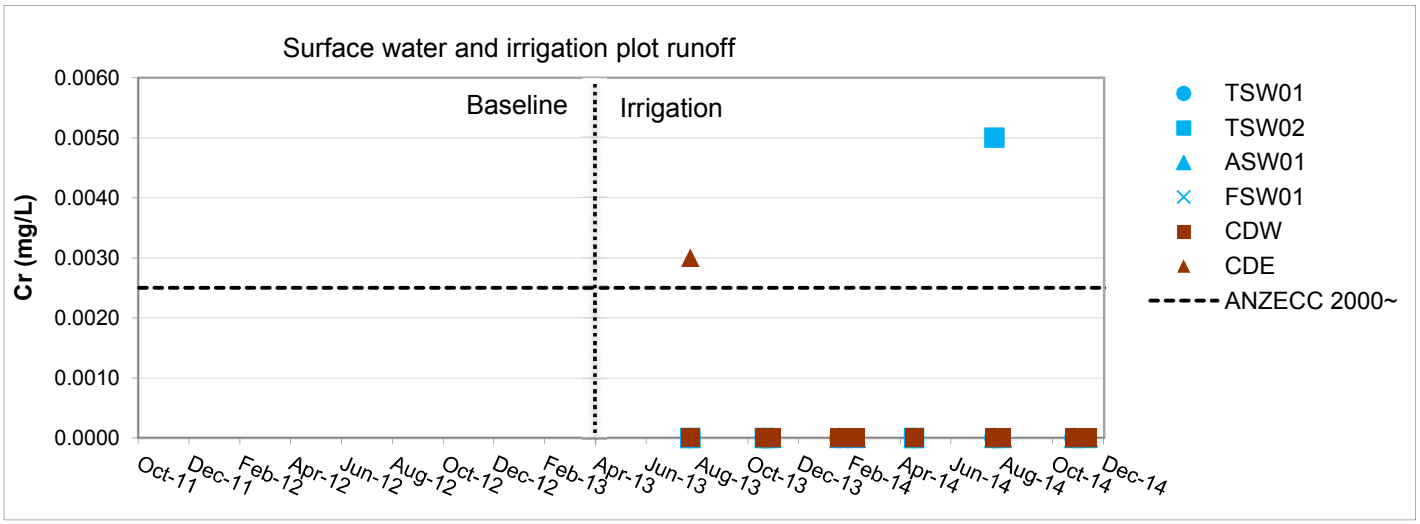
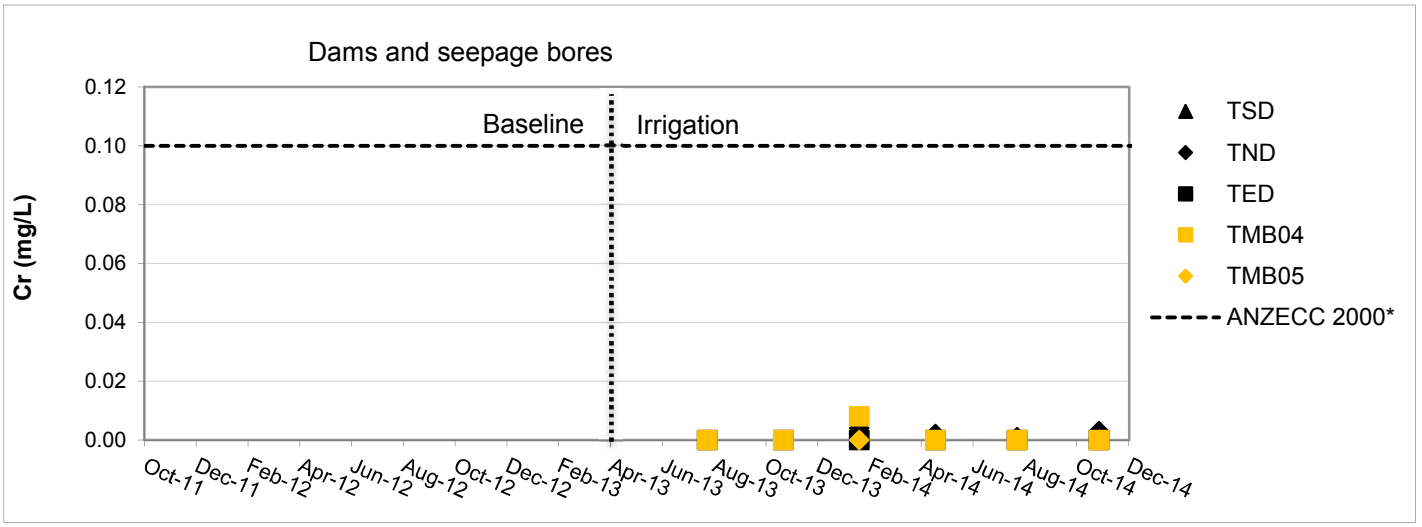
Figure B.15: Chromium concentrations







Notes:
~ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems.
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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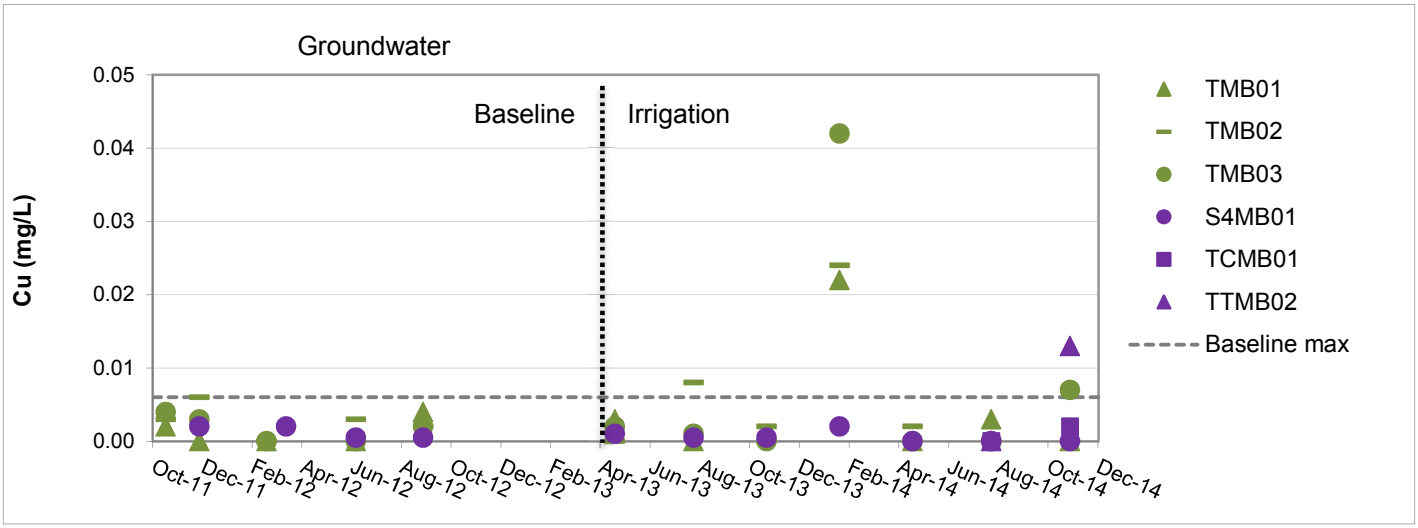
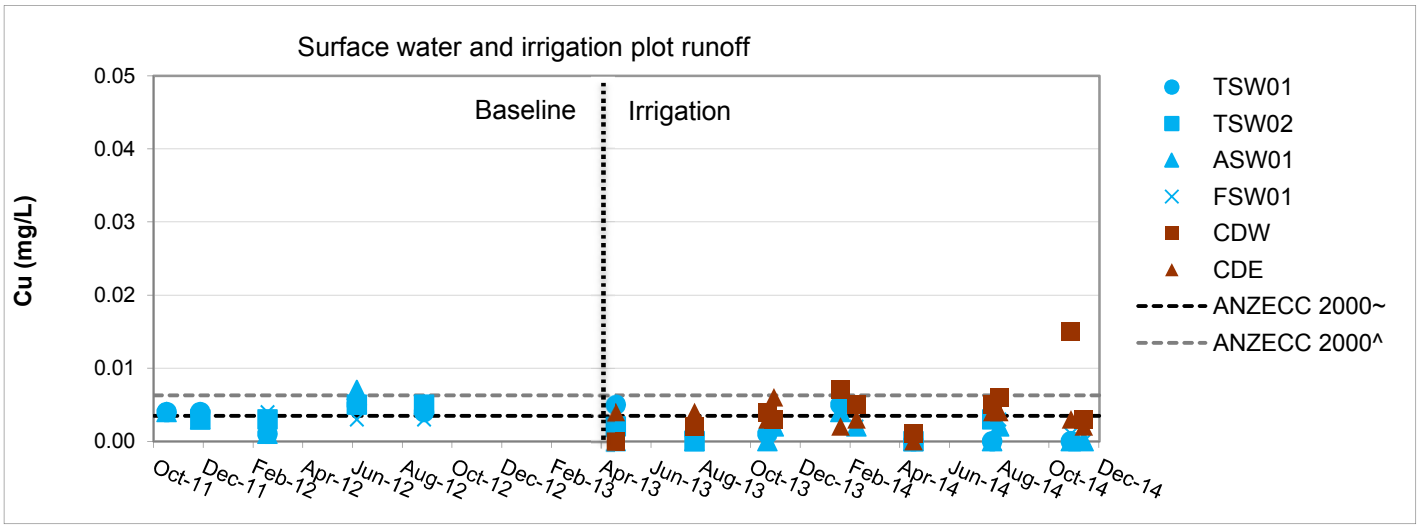
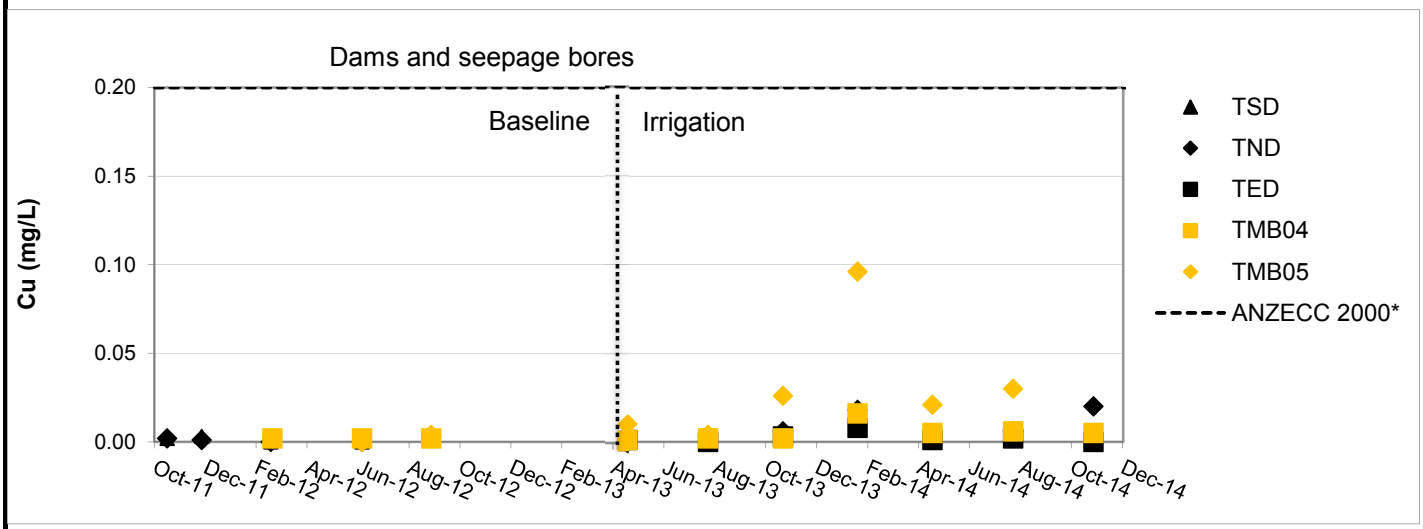
Figure B.16: Copper concentrations







Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems.

^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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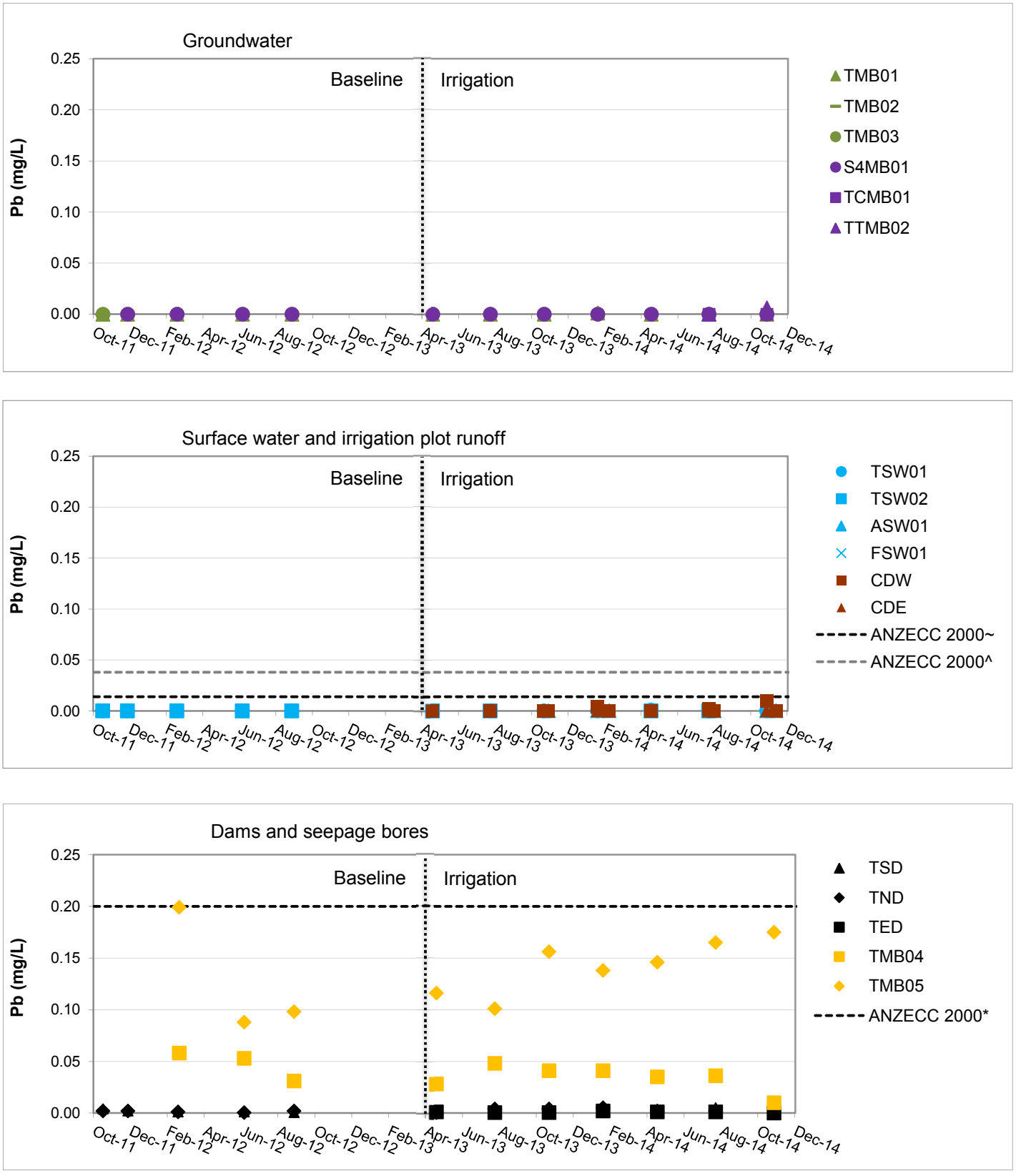
Figure B.17: Lead concentrations



Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems.

^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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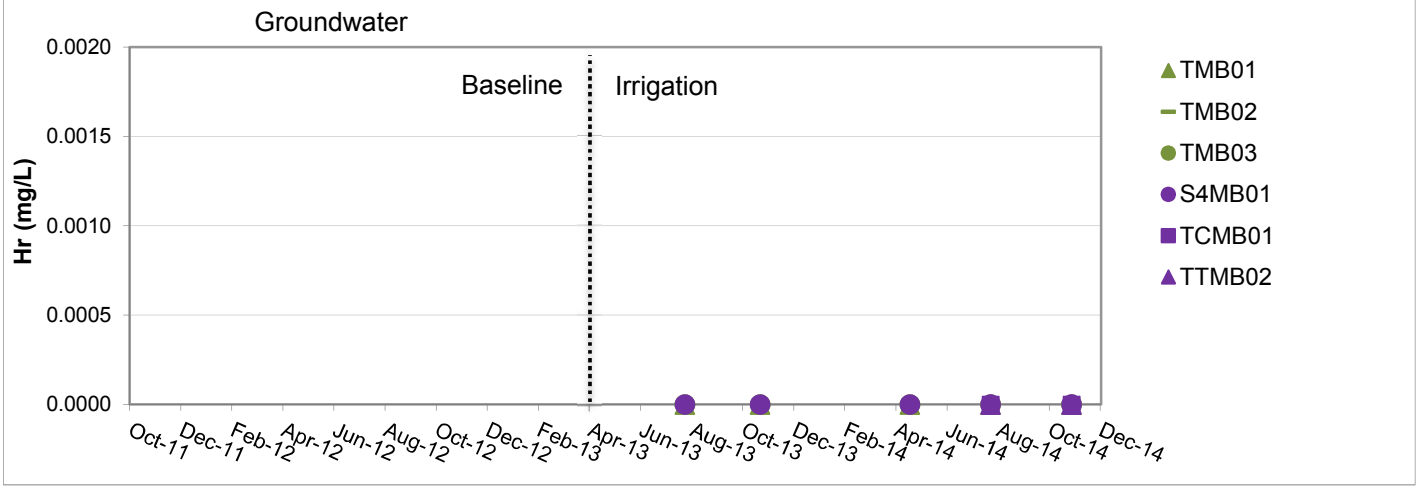
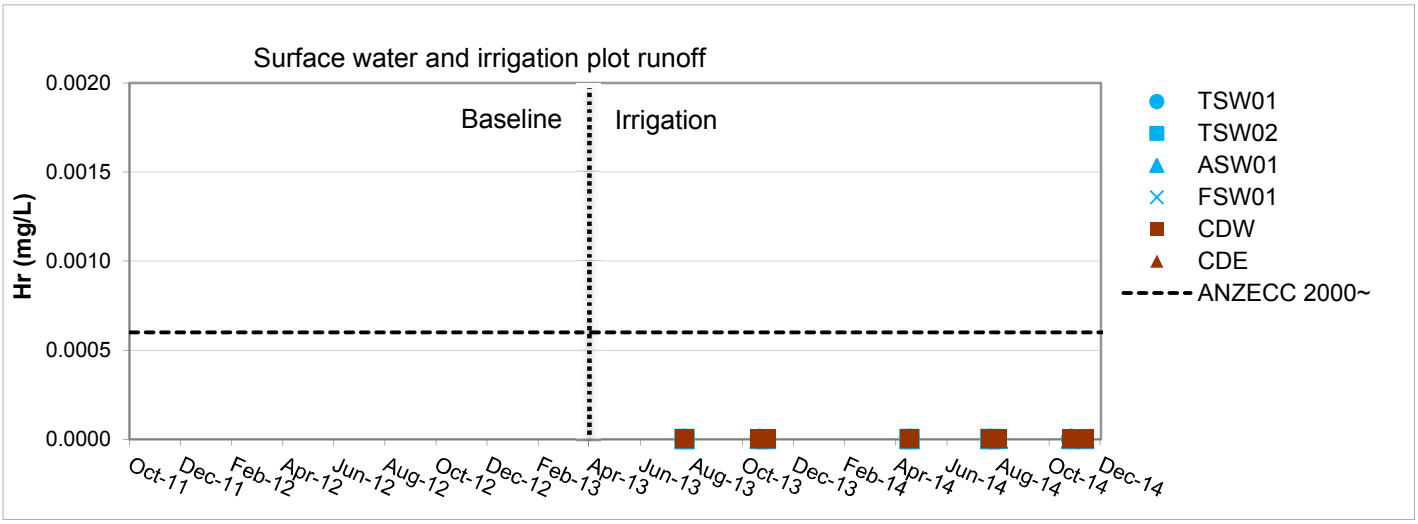
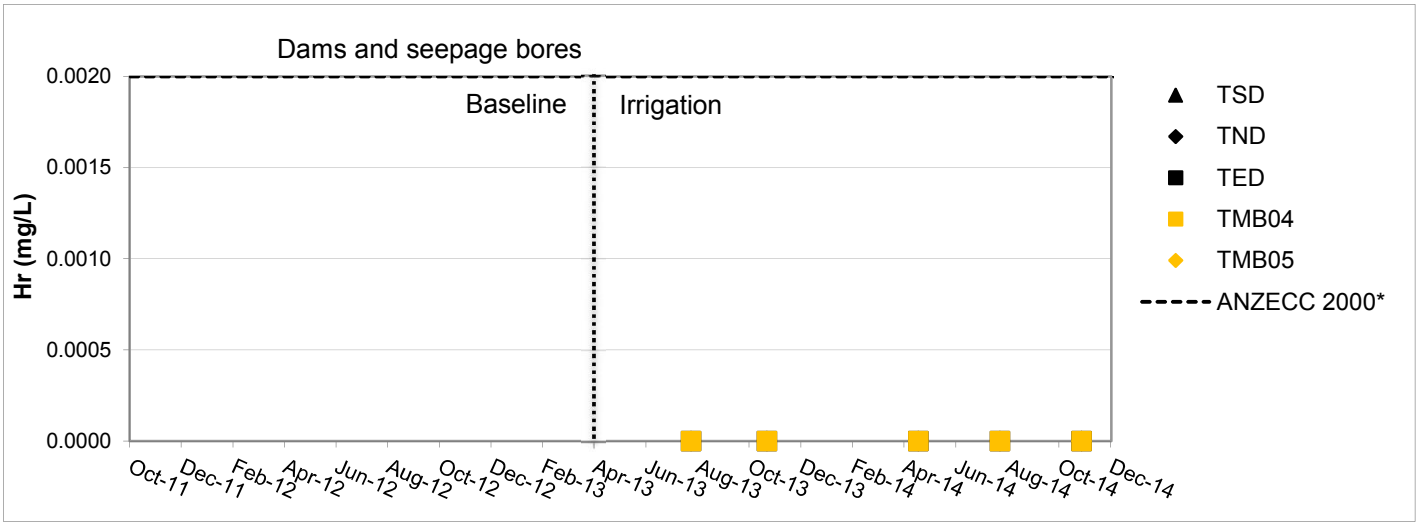
Figure B.18: Mercury concentrations







Notes:
~ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems.
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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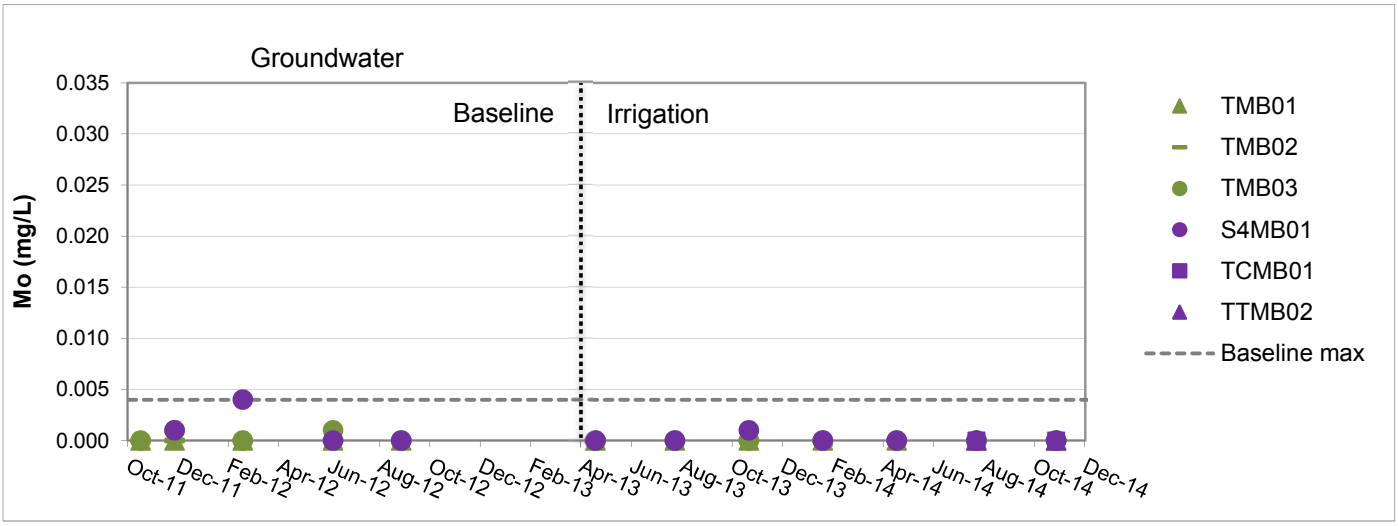
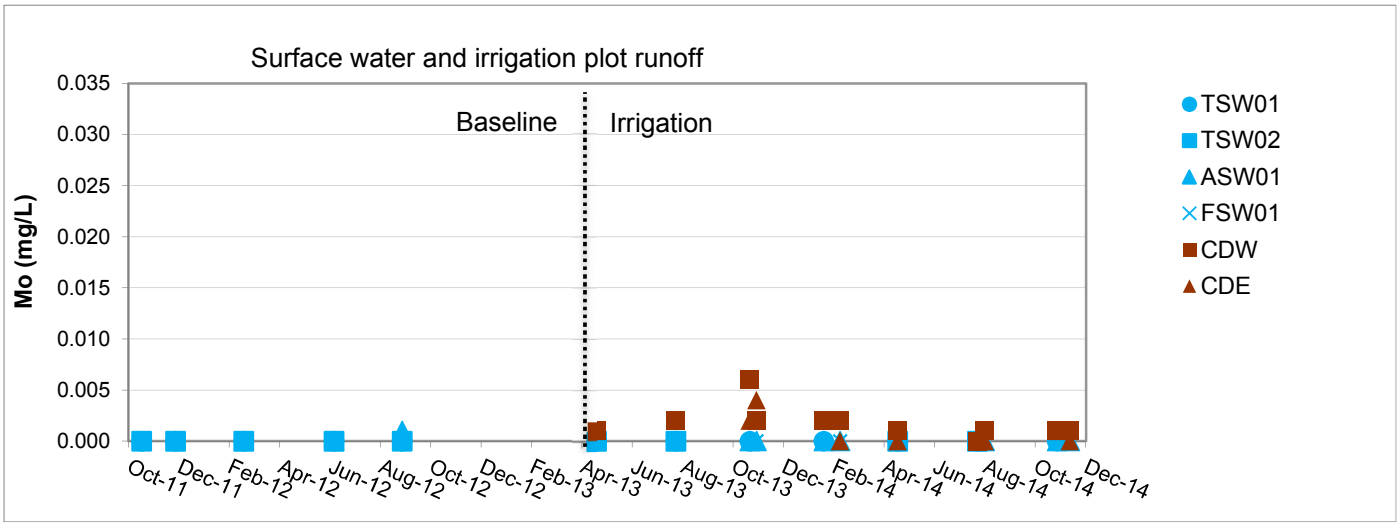
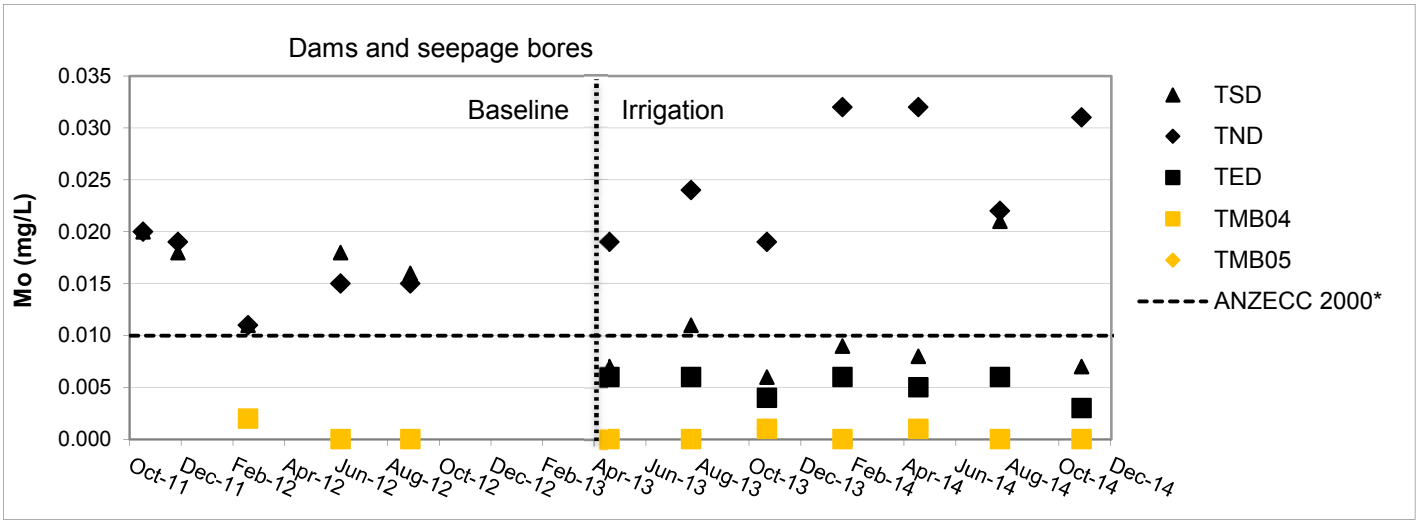
Figure B.19: Molybdenum concentrations







Note:
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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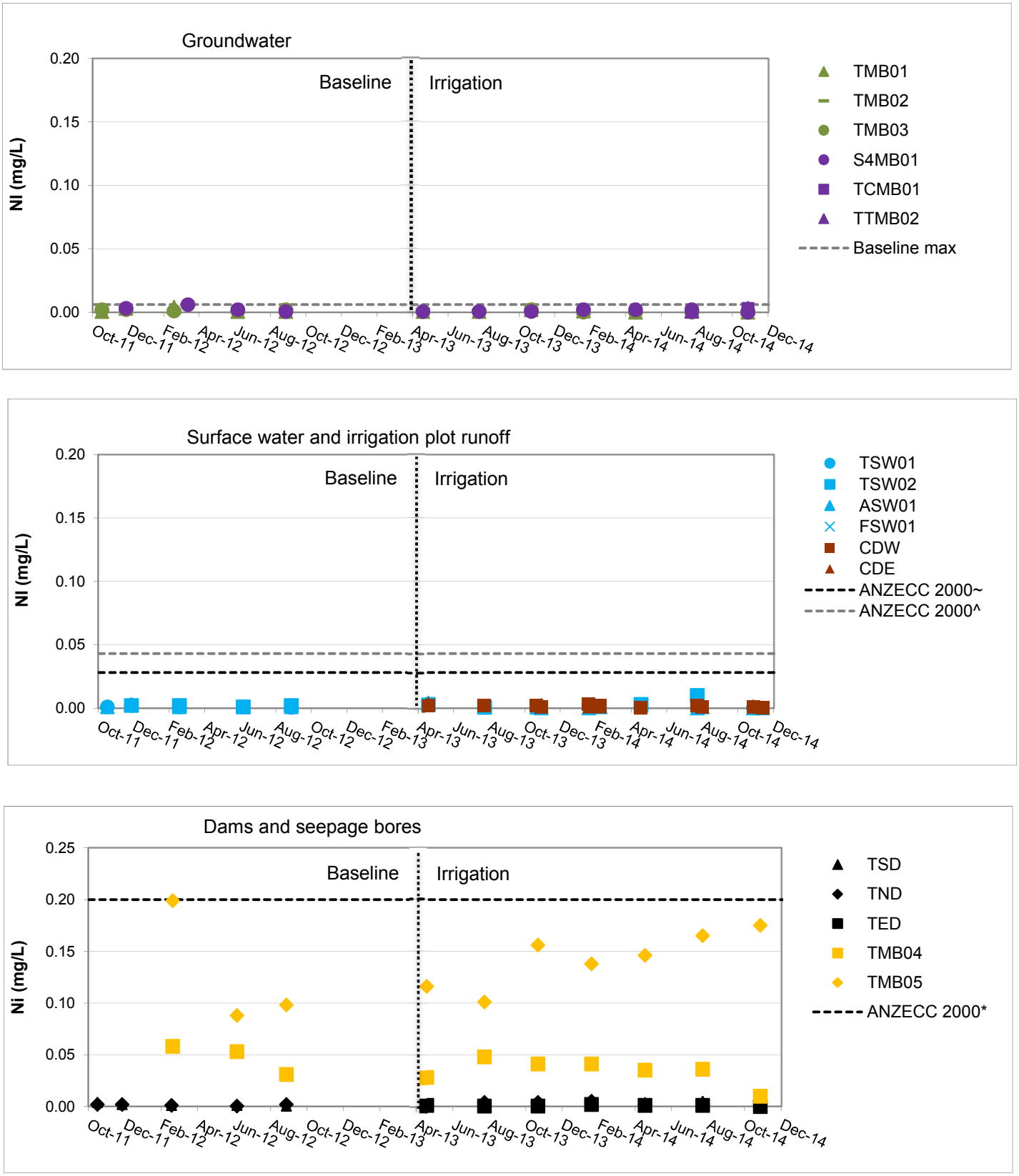
Figure B.20: Nickel concentrations



Notes:

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^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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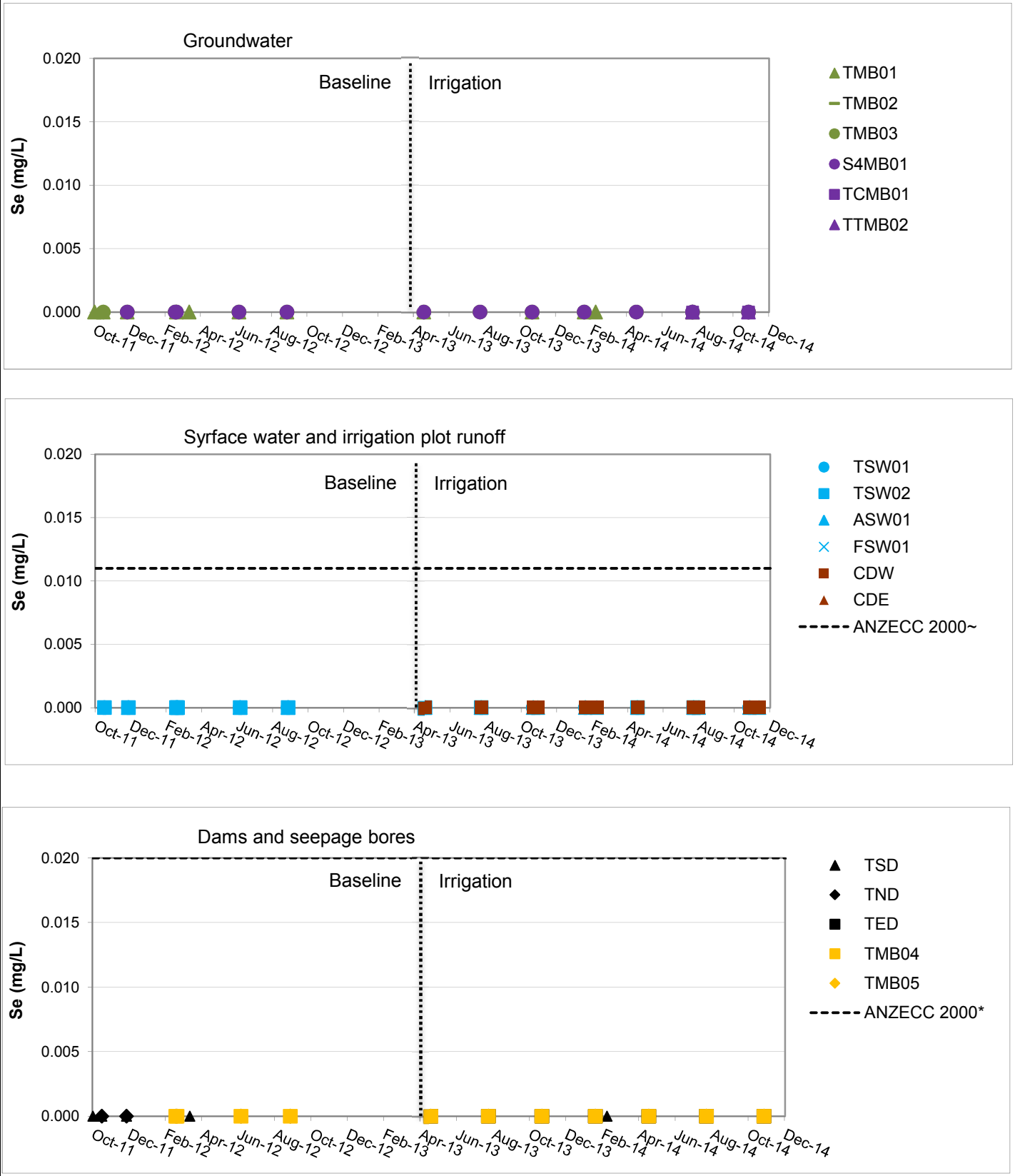
Figure B.21: Selenium concentrations



Notes:
~ANZECC 2000 - Water Quality Guidelines: 95% protection levels for freshwater aquatic ecosystems.
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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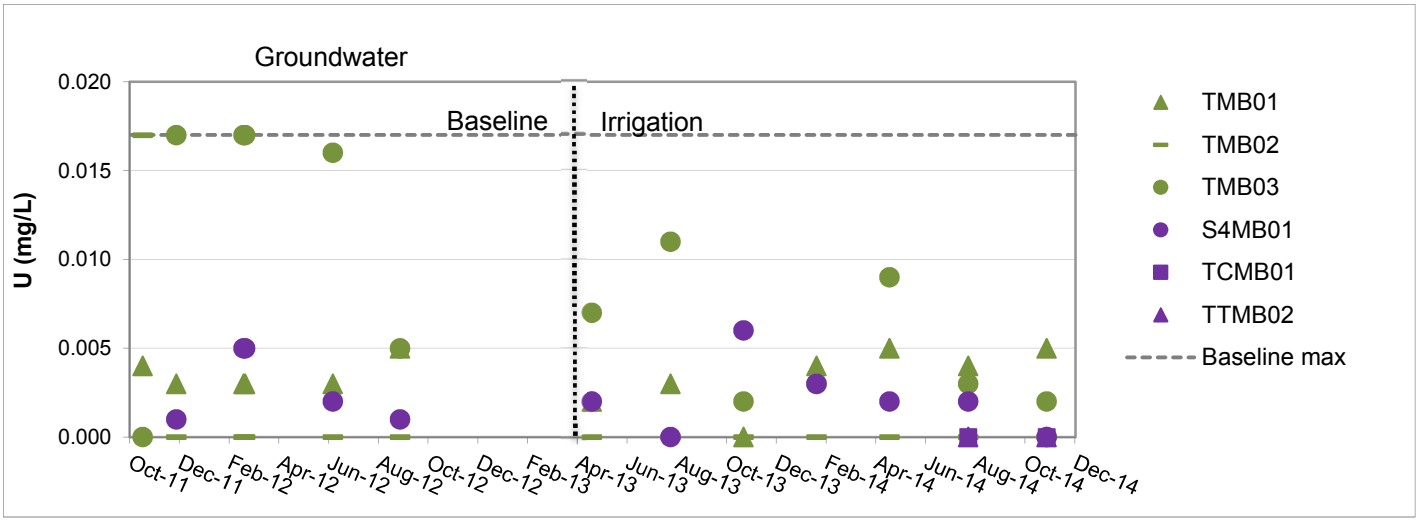
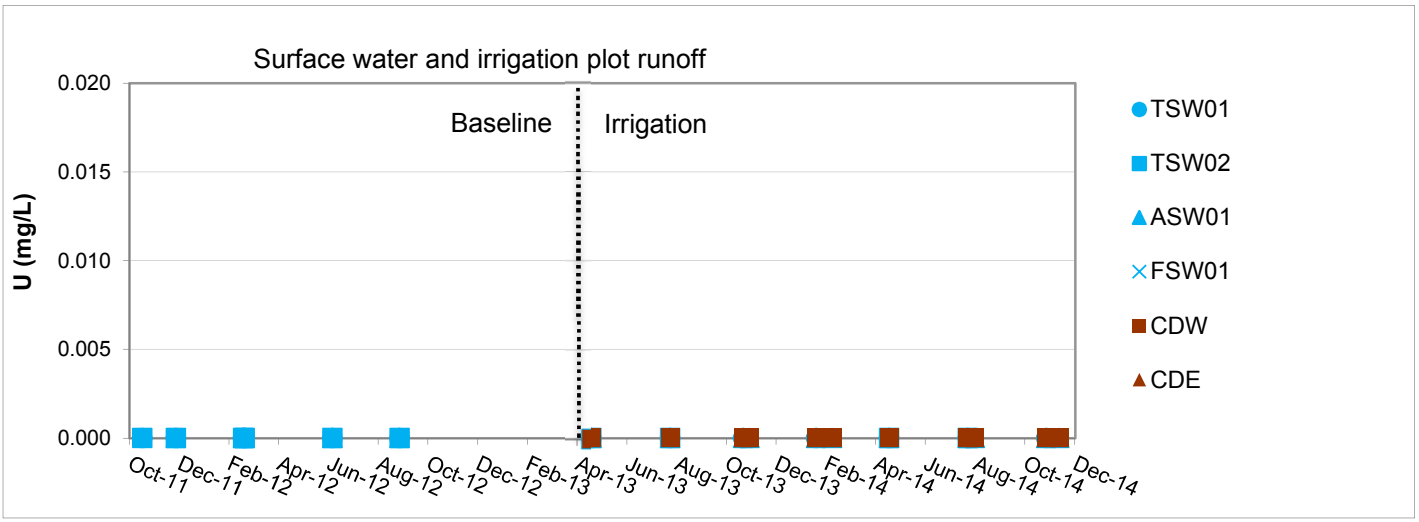
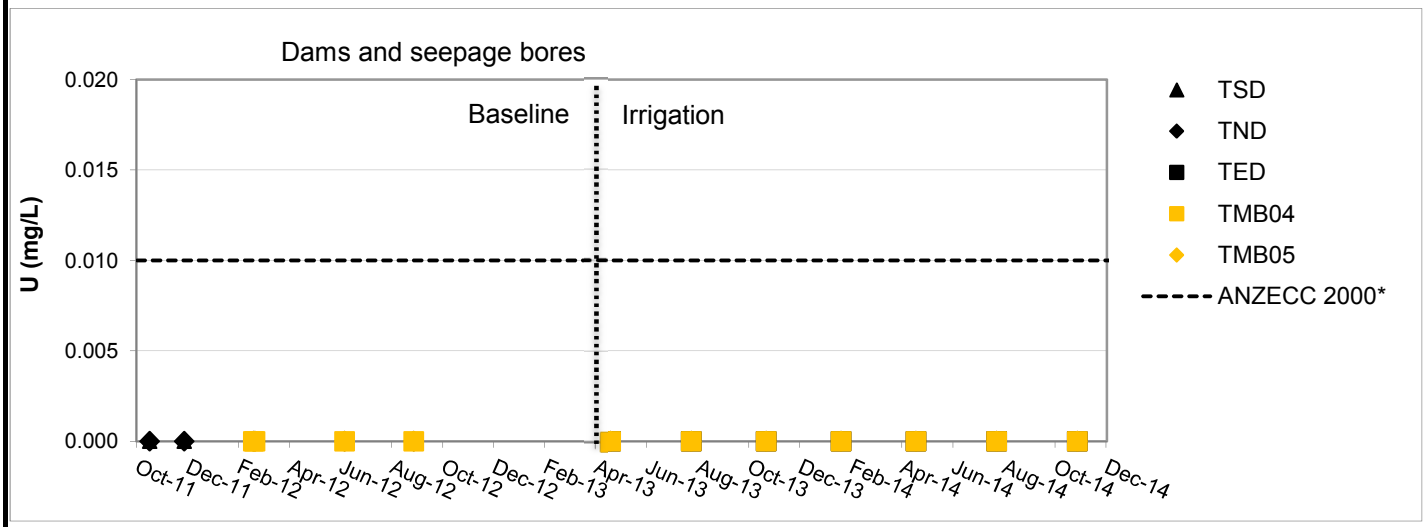
Figure B.22: Uranium concentrations







Note:
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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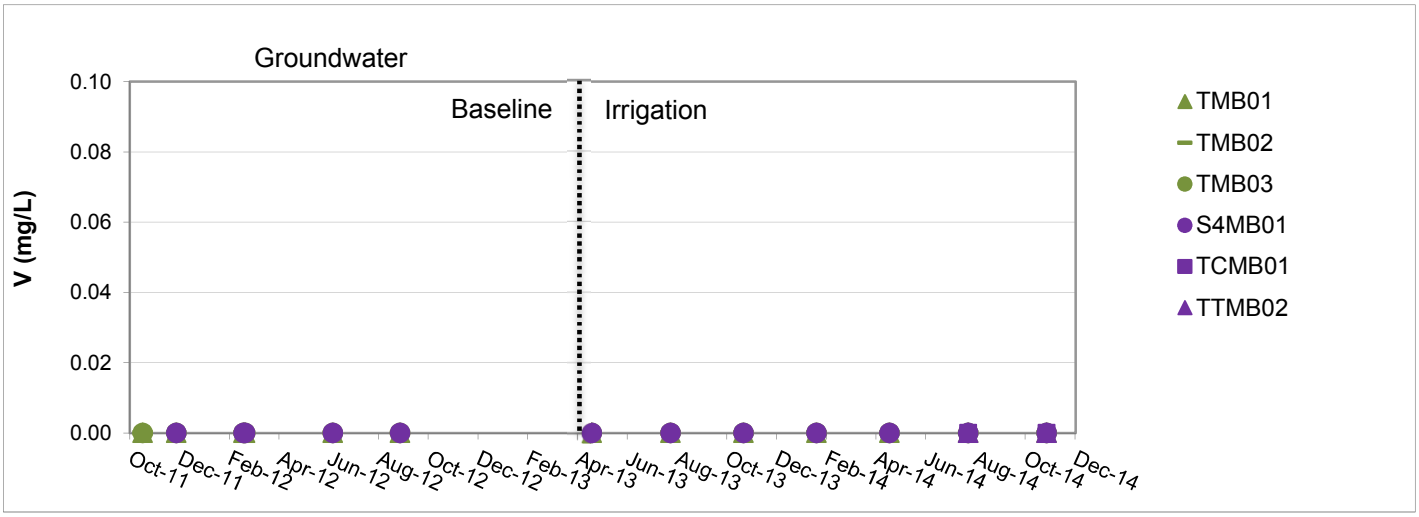
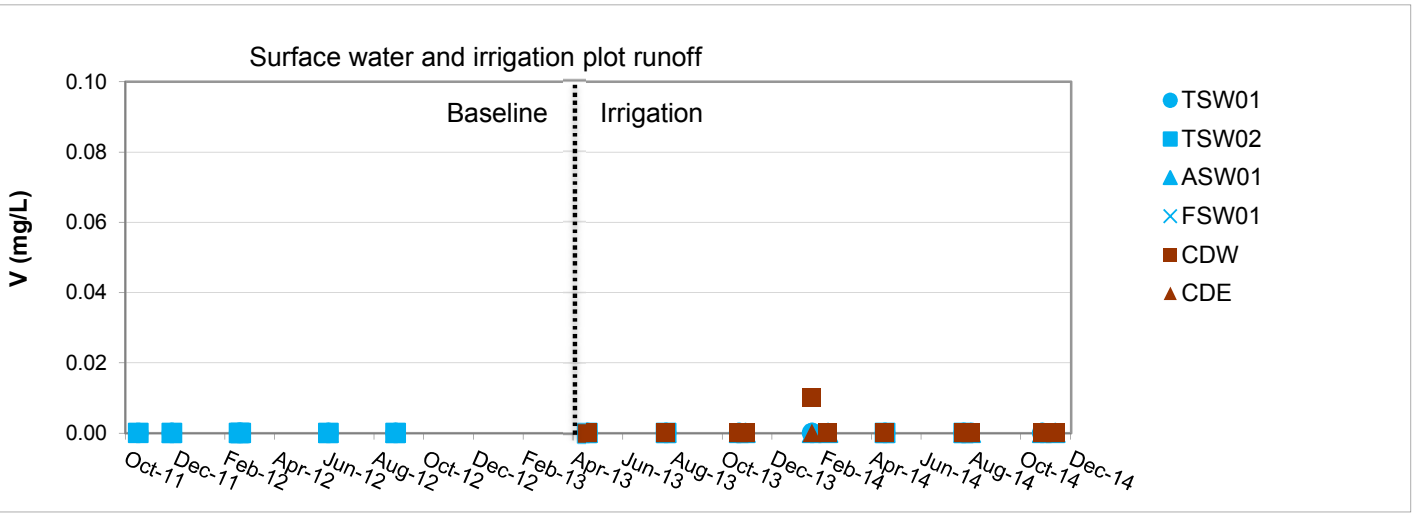
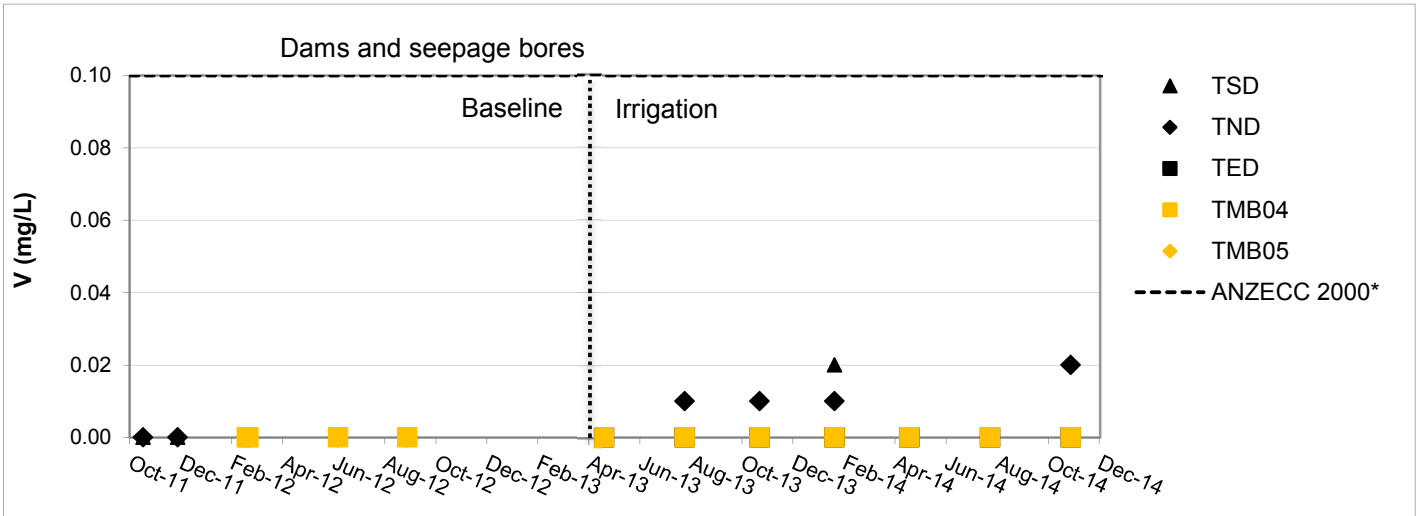
Figure B.23: Vanadium concentrations







Note:
*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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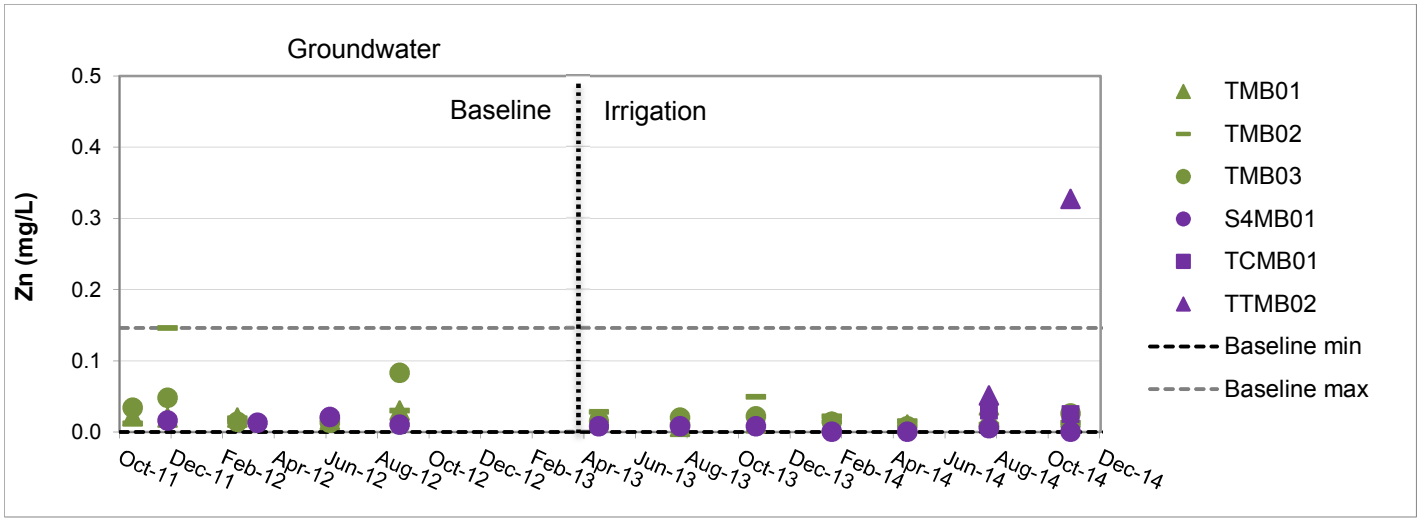
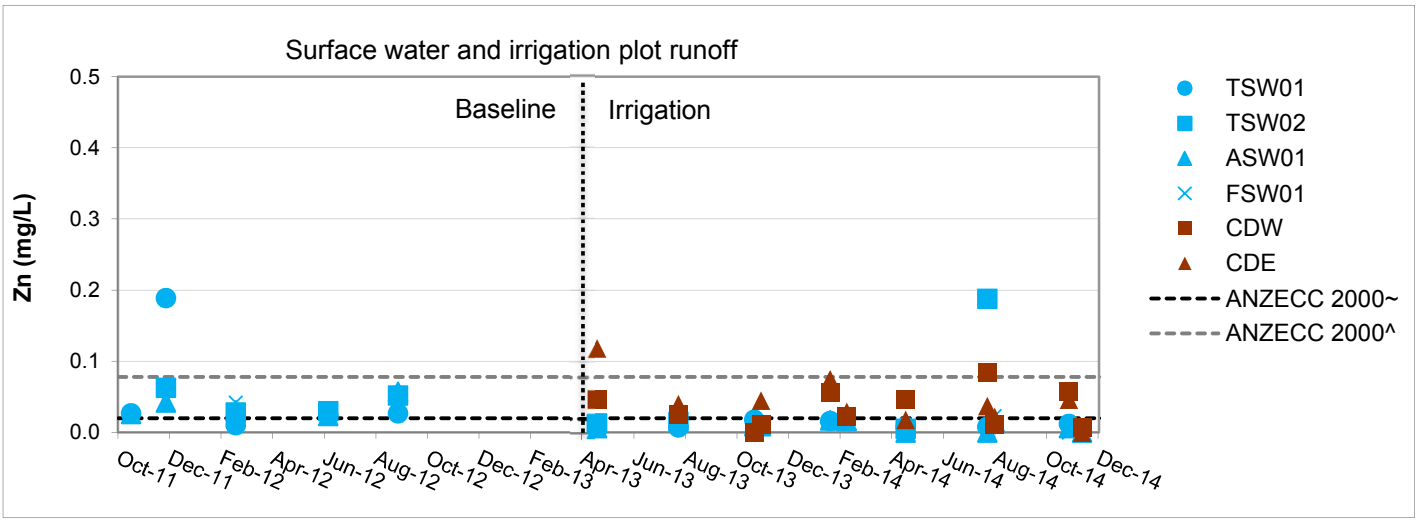
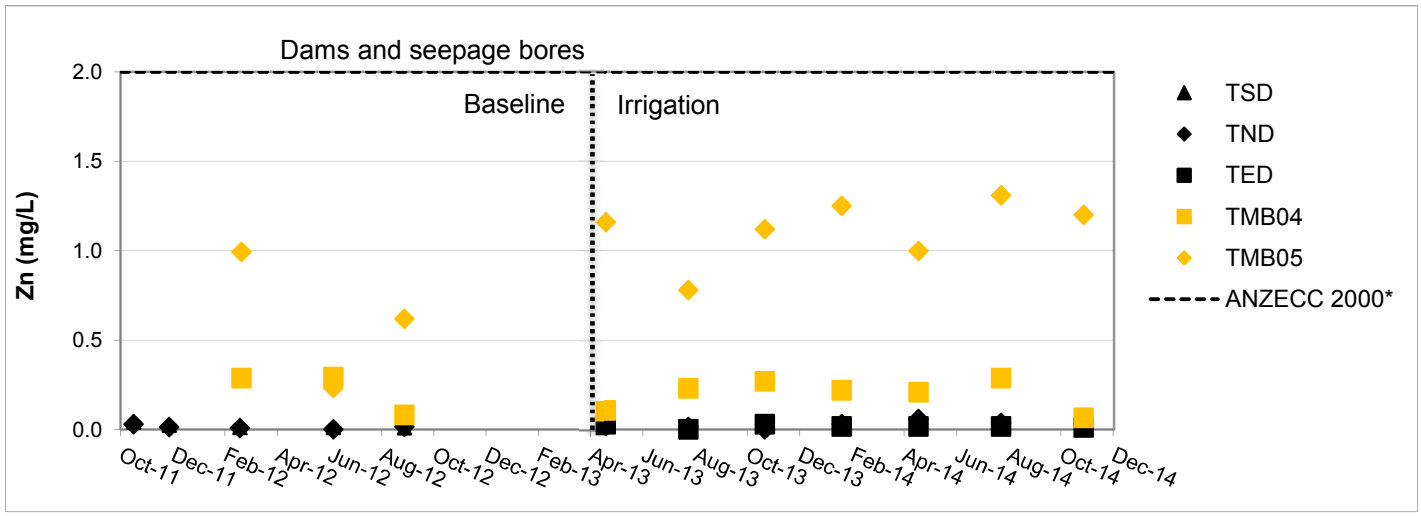
Figure B.24: Zinc concentrations







Notes:

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^ANZECC 2000 - Water Quality Guidelines: 80% protection levels for freshwater aquatic ecosystems.

*ANZECC 2000. Water for long term irrigation and general water use.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester Basin, NSW

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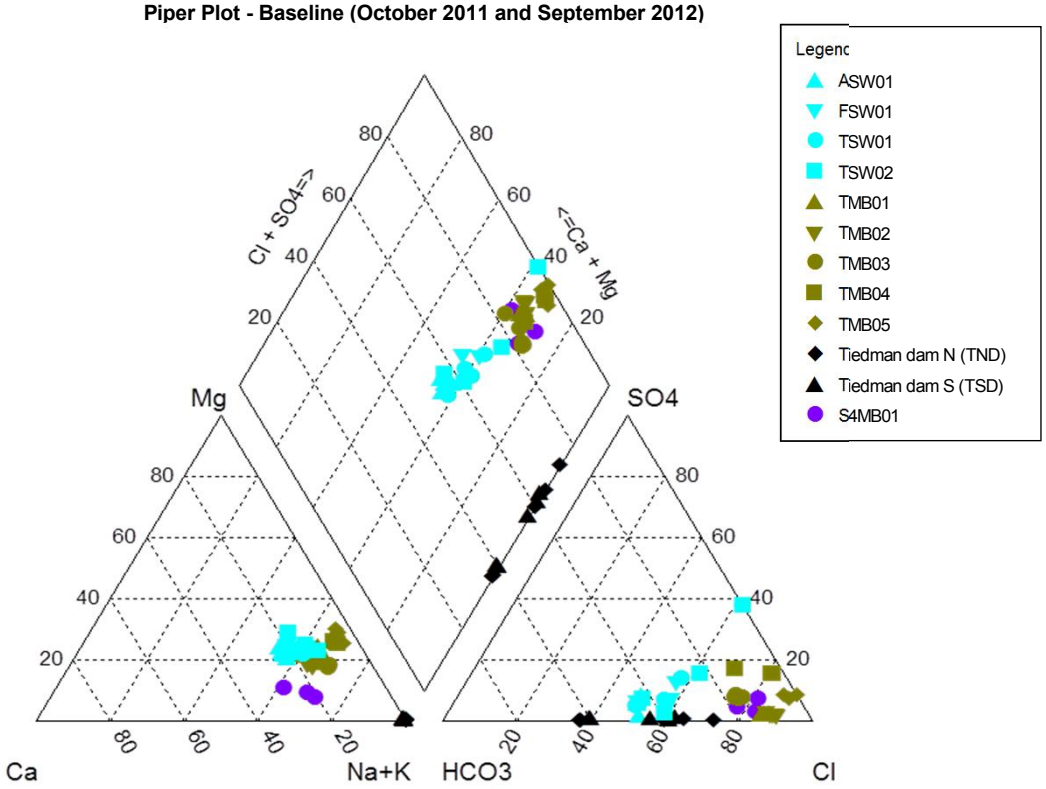
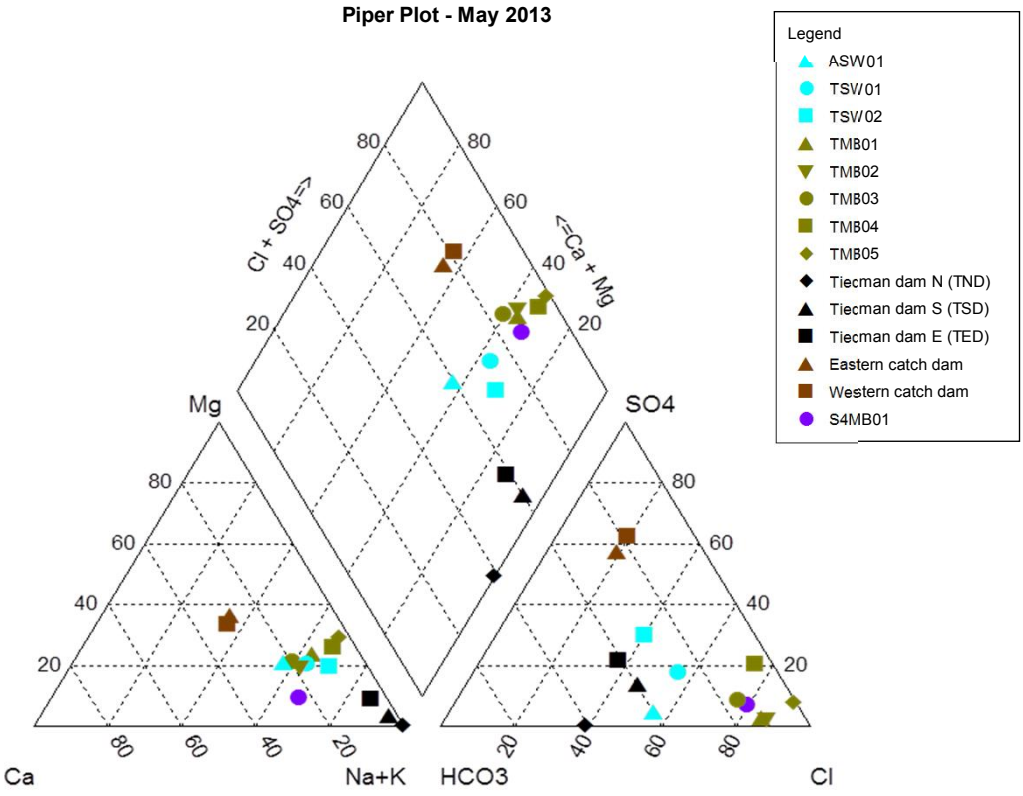
Appendix C

Piper diagrams

Piper Plot - Baseline (October 2011 and September 2012)



Piper Plot - May 2013

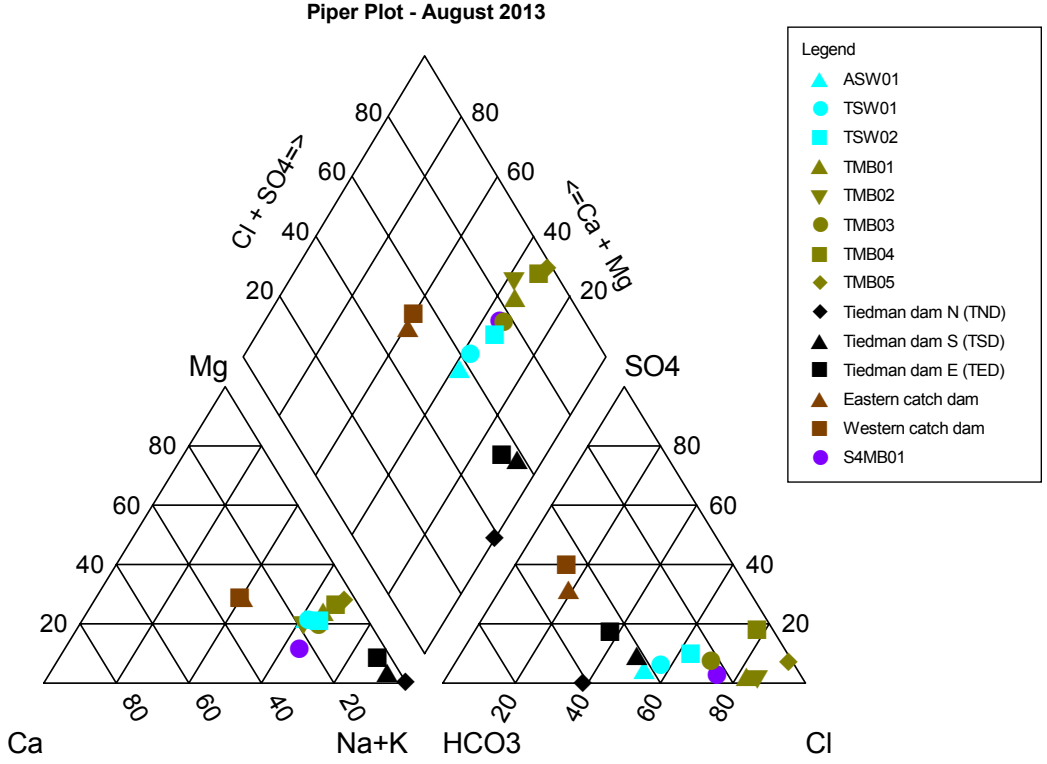


Note: blue - surface water; olive - shallow and perched groundwater; black - storage dams; brown - irrigation plot runoff; and purple - shallow rock.

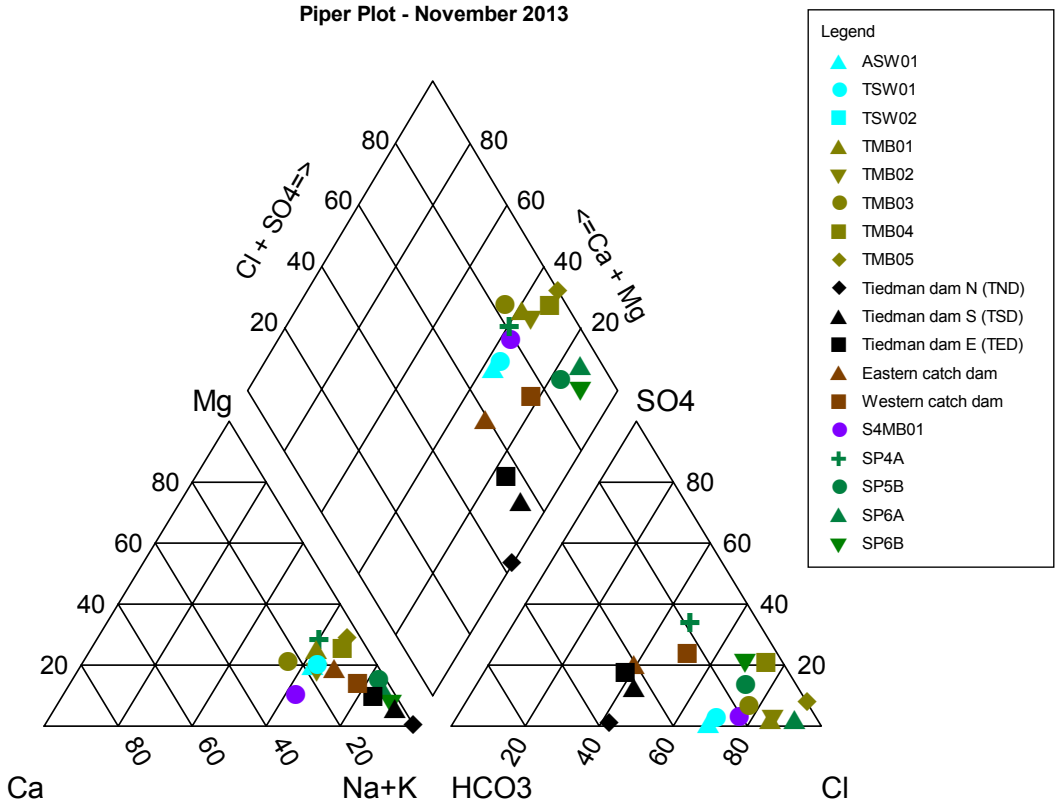
Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester, NSW

PARSONS BRINCKERHOFF

Piper Plot - August 2013



Piper Plot - November 2013

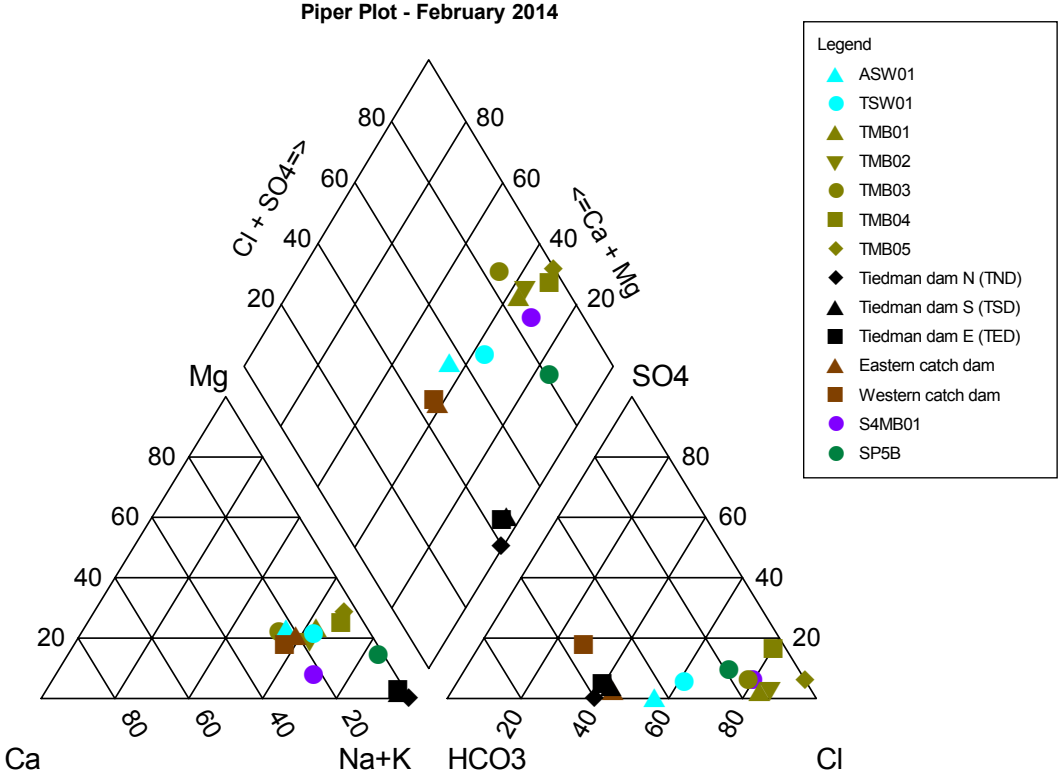


Note: blue - surface water; olive - shallow and perched groundwater; black - storage dams; brown - irrigation plot runoff; purple - shallow rock and green - perched groundwater on irrigation plot.

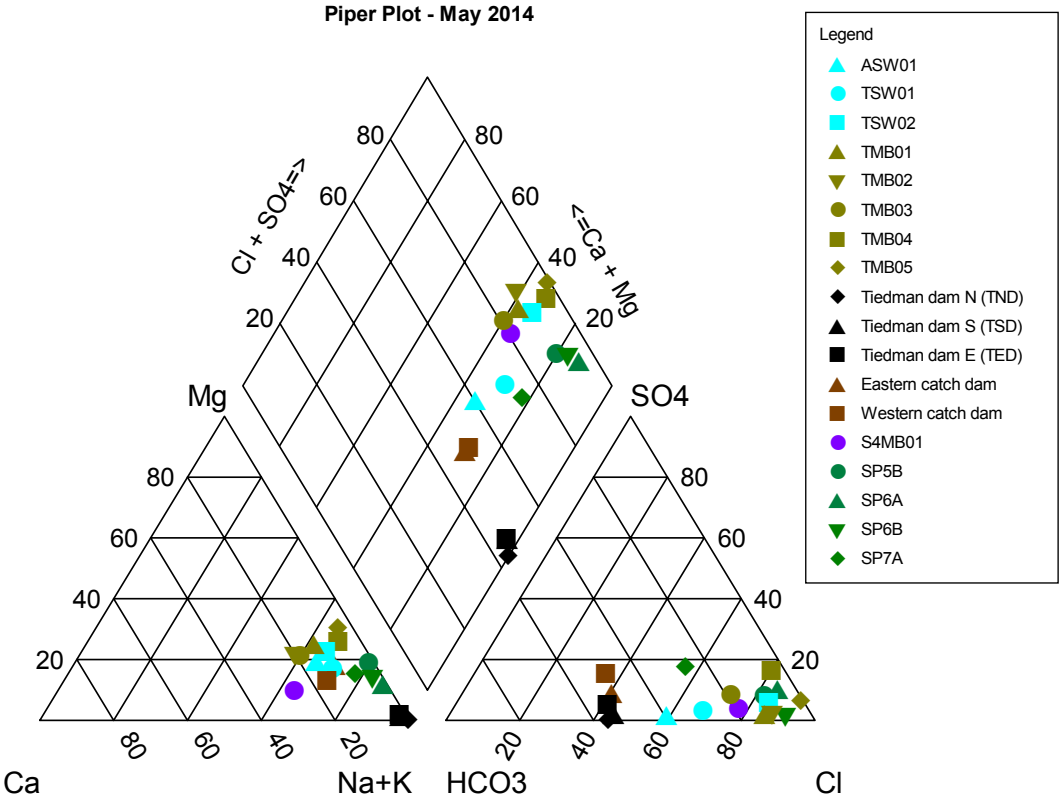
Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester, NSW

PARSONS BRINCKERHOFF

Piper Plot - February 2014



Piper Plot - May 2014

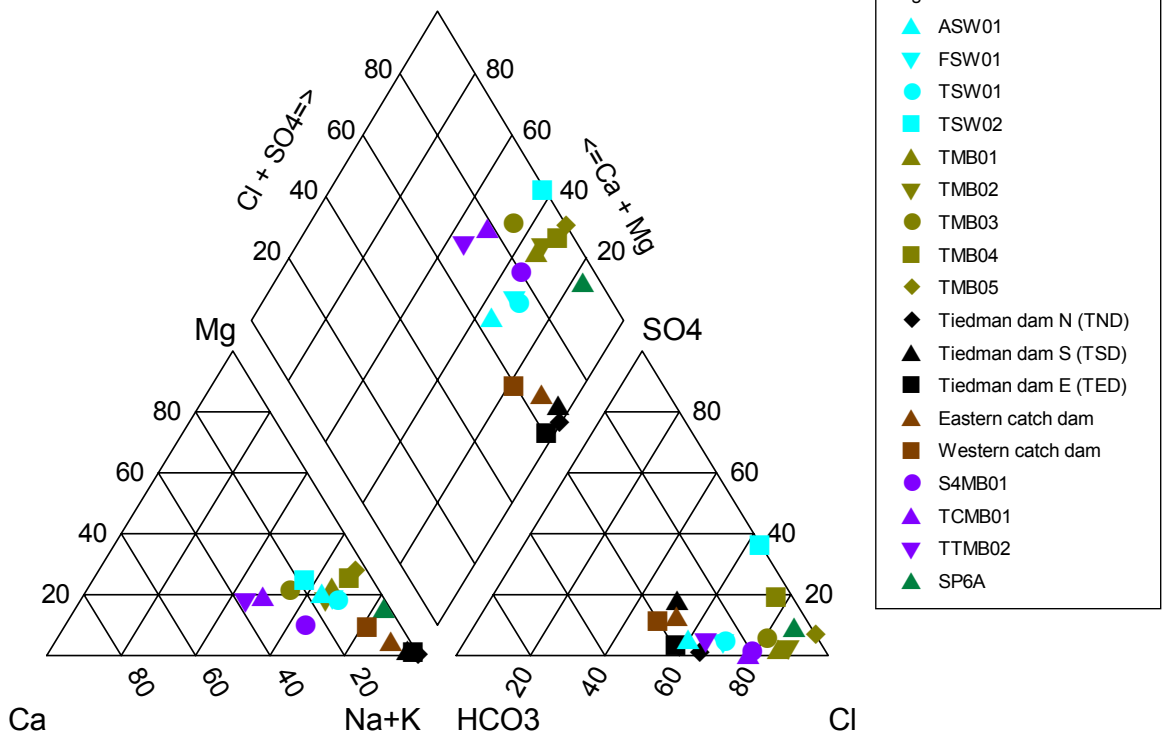


Note: blue - surface water; olive - shallow and perched groundwater; black - storage dams; brown - irrigation plot runoff; purple - shallow rock and green - perched groundwater on irrigation plot.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester, NSW

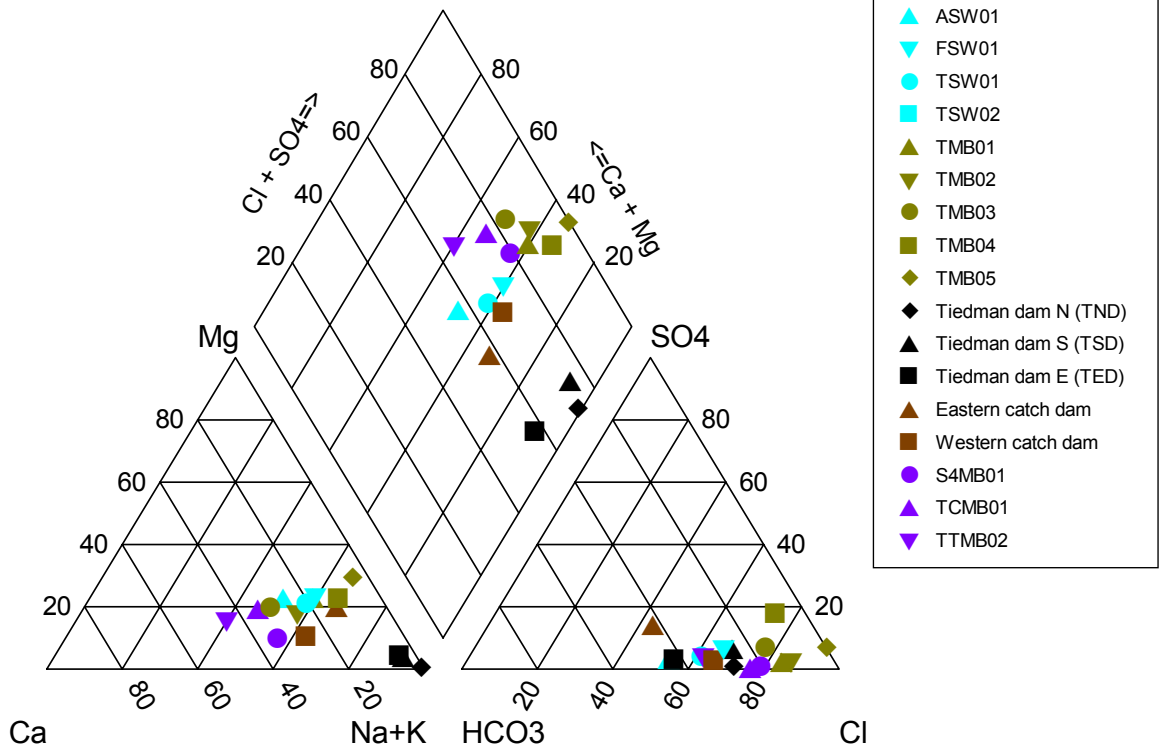
PARSONS BRINCKERHOFF

Piper Plot - August 2014



Legend
- ASW01
- FSW01
- TSW01
- TSW02
- TMB01
- TMB02
- TMB03
- TMB04
- TMB05
- Tiedman dam N (TND)
- Tiedman dam S (TSD)
- Tiedman dam E (TED)
- Eastern catch dam
- Western catch dam
- S4MB01
- TCMB01
- TTMB02
- SP6A

Piper Plot - November 2014



Legend
- ASW01
- FSW01
- TSW01
- TSW02
- TMB01
- TMB02
- TMB03
- TMB04
- TMB05
- Tiedman dam N (TND)
- Tiedman dam S (TSD)
- Tiedman dam E (TED)
- Eastern catch dam
- Western catch dam
- S4MB01
- TCMB01
- TTMB02

Note: blue - surface water; olive - shallow and perched groundwater; black - storage dams; brown - irrigation plot runoff; purple - shallow rock and green - perched groundwater on irrigation plot.

Client: AGL Upstream Infrastructure Investments Pty Ltd
Project: Tiedman Irrigation Program - Gloucester Gas Project
Location: Gloucester, NSW

PARSONS BRINCKERHOFF

Appendix D

Laboratory reports

CERTIFICATE OF ANALYSIS

Work Order	: **ES1418484**	Page	: 1 of 11
Amendment	: **1**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Client Services
Address	: PO BOX 1162 NEWCASTLE NSW, AUSTRALIA 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 4929 7299	Facsimile	: +61-2-8784 8500
Project	: 2162406F RFS14	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 20-AUG-2014
Sampler	: CR	Issue Date	: 07-JAN-2015
Site	: ----		
		No. of samples received	: 12
Quote number	: SY/746/14 V2	No. of samples analysed	: 12

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

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

- **EK055G: It has been noted that Ammonia is greater than TKN for sample ID(TMB03), however this difference is within the limits of experimental variation.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **This report has been amended and re-released to allow the reporting of additional analytical data.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TED	TSD	TND	TSW01	TSW02
				Client sampling date / time	19-AUG-2014 15:00	19-AUG-2014 11:00	19-AUG-2014 10:30	19-AUG-2014 15:00	19-AUG-2014 15:00
					ES1418484-001	ES1418484-002	ES1418484-003	ES1418484-004	ES1418484-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		9.33	8.39	9.60	7.81	5.86
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		----	----	170	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1630	1570	5550	569	2440
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		849	1070	3100	290	1400
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		78	488	78	<5	51
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		234	240	832	114	478
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		147	7	683	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		246	233	660	65	3
Total Alkalinity as CaCO3	----	1	mg/L		394	240	1340	65	3
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		12.1	1.8	28.2	4.5	15.6
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		18	128	16	11	440
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		257	265	893	127	577
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		3	7	2	13	95
Magnesium	7439-95-4	1	mg/L		2	3	1	11	77
Sodium	7440-23-5	1	mg/L		367	318	1180	77	322
Potassium	7440-09-7	1	mg/L		58	88	309	7	32
ED093F: SAR and Hardness Calculations									
Sodium Adsorption Ratio	----	0.01	-		----	25.3	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.63	0.32	0.26	0.02	0.22
Arsenic	7440-38-2	0.001	mg/L		0.002	0.005	0.008	0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TED	TSD	TND	TSW01	TSW02
				Client sampling date / time	19-AUG-2014 15:00	19-AUG-2014 11:00	19-AUG-2014 10:30	19-AUG-2014 15:00	19-AUG-2014 15:00
					ES1418484-001	ES1418484-002	ES1418484-003	ES1418484-004	ES1418484-005
EG020F: Dissolved Metals by ICP-MS - Continued									
Barium	7440-39-3	0.001	mg/L		**0.056**	**0.146**	**0.411**	**0.051**	**0.080**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0002**	<0.0001	<0.0001	**0.0005**
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	**0.005**
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	**0.079**
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.005**	**0.006**	<0.001	**0.003**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.591**	**0.452**	**1.93**	**0.002**	**0.011**
Manganese	7439-96-5	0.001	mg/L		**0.009**	**0.003**	**0.077**	**0.057**	**6.85**
Molybdenum	7439-98-7	0.001	mg/L		**0.006**	**0.021**	**0.022**	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.001**	**0.005**	**0.002**	<0.001	**0.010**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.103**	**0.181**	**0.479**	**0.244**	**1.18**
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.016**	**0.021**	**0.036**	**0.008**	**0.188**
Boron	7440-42-8	0.05	mg/L		**0.24**	**0.15**	**0.59**	**0.14**	**0.06**
Iron	7439-89-6	0.05	mg/L		**1.13**	**0.46**	**0.23**	**0.17**	**0.38**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.05**	**0.02**	**0.03**	**1.84**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.13**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	**0.87**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	**1.00**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**5.4**	**10.2**	**6.9**	**0.7**	**4.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**5.4**	**10.2**	**6.9**	**0.7**	**5.6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TED	TSD	TND	TSW01	TSW02
				Client sampling date / time	19-AUG-2014 15:00	19-AUG-2014 11:00	19-AUG-2014 10:30	19-AUG-2014 15:00	19-AUG-2014 15:00
Compound	CAS Number	LOR	Unit		ES1418484-001	ES1418484-002	ES1418484-003	ES1418484-004	ES1418484-005
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.82**	**1.44**	**1.48**	**0.03**	**0.35**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	**14.9**	----	**5.11**	**25.5**
Total Anions	----	0.01	meq/L		**16.2**	----	**53.6**	----	----
Total Cations	----	0.01	meq/L		**17.8**	**16.7**	**59.4**	**5.08**	**25.9**
Ionic Balance	----	0.01	%		----	**5.49**	----	**0.28**	**0.79**
Ionic Balance	----	0.01	%		**4.58**	----	**5.18**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**57**	**75**	**73**	**13**	**37**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	FSW01	S4MB01	TMB01	TMB02	TMB03
				Client sampling date / time	19-AUG-2014 16:00	19-AUG-2014 12:51	19-AUG-2014 15:00	19-AUG-2014 15:00	19-AUG-2014 15:00
Compound	CAS Number	LOR	Unit		ES1418484-006	ES1418484-007	ES1418484-008	ES1418484-009	ES1418484-010
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.72	7.86	7.45	7.10	7.29
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		566	4880	8400	4040	6440
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		302	2850	4860	2350	3520
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		<5	54	543	8	30
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		109	1160	2320	1120	1680
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		64	451	521	173	417
Total Alkalinity as CaCO3	----	1	mg/L		64	451	521	173	417
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		7.9	30.6	39.2	38.2	34.5
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		11	27	79	46	158
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		123	1280	2580	1170	1750
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		14	272	221	134	342
Magnesium	7439-95-4	1	mg/L		12	63	248	94	184
Sodium	7440-23-5	1	mg/L		76	785	1380	644	888
Potassium	7440-09-7	1	mg/L		7	7	3	3	4
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	0.12	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.001	0.003	0.004
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.058	1.89	0.223	0.696	0.213
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	0.002	0.002

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: FSW01	S4MB01	TMB01	TMB02	TMB03
				Client sampling date / time: 19-AUG-2014 16:00	19-AUG-2014 12:51	19-AUG-2014 15:00	19-AUG-2014 15:00	19-AUG-2014 15:00
				ES1418484-006	ES1418484-007	ES1418484-008	ES1418484-009	ES1418484-010
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.003**	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L	**0.002**	**0.424**	**0.062**	**0.056**	**0.132**
Manganese	7439-96-5	0.001	mg/L	**0.046**	**0.245**	**0.702**	**1.19**	**1.53**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	**0.001**	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.254**	**18.7**	**5.29**	**2.64**	**6.93**
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	**0.002**	**0.004**	<0.001	**0.003**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.005**	**0.037**	**0.010**	**0.007**
Boron	7440-42-8	0.05	mg/L	<0.05	**0.14**	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	**0.16**	<0.05	**2.53**	**4.87**	**5.78**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**1.63**	**0.16**	**0.26**	**0.24**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	<0.01	<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	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.0**	**1.9**	**0.7**	**0.3**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.0**	**1.9**	**0.7**	**0.3**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	**0.07**	**0.11**	**0.06**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: FSW01	S4MB01	TMB01	TMB02	TMB03
				Client sampling date / time: 19-AUG-2014 16:00	19-AUG-2014 12:51	19-AUG-2014 15:00	19-AUG-2014 15:00	19-AUG-2014 15:00
				ES1418484-006	ES1418484-007	ES1418484-008	ES1418484-009	ES1418484-010
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**4.98**	----	**84.8**	----	----
Total Anions	----	0.01	meq/L	----	**46.5**	----	**38.4**	**61.9**
Total Cations	----	0.01	meq/L	**5.17**	**53.1**	**91.5**	**42.5**	**70.9**
Ionic Balance	----	0.01	%	**1.90**	----	**3.80**	----	----
Ionic Balance	----	0.01	%	----	**6.60**	----	**5.05**	**6.79**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**13**	**29**	**3**	<1	**2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TMB05	SP6A	----	----	----
				Client sampling date / time	19-AUG-2014 15:00	19-AUG-2014 15:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1418484-011	ES1418484-012	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		4.21	7.50	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		7690	7750	----	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		3790	3890	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		130	58	----	----	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		2100	1990	----	----	----
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		<1	146	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		<1	146	----	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		85.0	25.0	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		245	282	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		2520	2000	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		55	24	----	----	----
Magnesium	7439-95-4	1	mg/L		288	133	----	----	----
Sodium	7440-23-5	1	mg/L		1330	1380	----	----	----
Potassium	7440-09-7	1	mg/L		18	2	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		1.60	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.001	----	----	----
Beryllium	7440-41-7	0.001	mg/L		0.010	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		0.071	0.067	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		0.0036	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		0.329	0.008	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: TMB05	SP6A	----	----	----
				Client sampling date / time: 19-AUG-2014 15:00	19-AUG-2014 15:00	----	----	----
				ES1418484-011	ES1418484-012	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	**0.030**	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.002**	<0.001	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.160**	**0.010**	----	----	----
Manganese	7439-96-5	0.001	mg/L	**17.4**	**0.213**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	**0.009**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.165**	**0.177**	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.683**	**1.07**	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	**1.31**	**0.013**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L	**5.00**	**0.53**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.24**	**0.04**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.16**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.16**	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	**2.1**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.7**	**2.1**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	**0.51**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TMB05	SP6A	----	----	----
			Client sampling date / time	19-AUG-2014 15:00	19-AUG-2014 15:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1418484-011	ES1418484-012	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	76.2	65.2	----	----	----
Total Cations	----	0.01	meq/L	84.8	72.2	----	----	----
Ionic Balance	----	0.01	%	5.31	5.08	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	6	24	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1418514**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Client Services
Address	: PO BOX 1162 NEWCASTLE NSW, AUSTRALIA 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 4929 7299	Facsimile	: +61-2-8784 8500
Project	: 2162406F	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 21-AUG-2014
Sampler	: CR	Issue Date	: 28-AUG-2014
Site	: ----		
		No. of samples received	: 3
Quote number	: SY/746/14 V2	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics

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

- **EK071G: It has been noted that Reactive P is greater than Total P for sample ID(TCMB01) however this difference is within the limits of experimental variation.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TCMB01	ASW01	TMB04	----	----
				Client sampling date / time	20-AUG-2014 14:00	20-AUG-2014 10:20	20-AUG-2014 08:00	----	----
					ES1418514-001	ES1418514-002	ES1418514-003	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.53**	**7.57**	**6.16**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**3020**	**498**	**7030**	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**1940**	**276**	**3580**	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		**6**	<5	**187**	----	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		**836**	**97.2**	**2030**	----	----
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		**319**	**79**	**149**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**319**	**79**	**149**	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**26.2**	**2.6**	**61.9**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	**11**	**634**	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**834**	**96**	**1910**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**222**	**13**	**86**	----	----
Magnesium	7439-95-4	1	mg/L		**80**	**10**	**222**	----	----
Sodium	7440-23-5	1	mg/L		**382**	**57**	**1140**	----	----
Potassium	7440-09-7	1	mg/L		**5**	**6**	**22**	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	**0.05**	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.001**	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Barium	7440-39-3	0.001	mg/L		**6.66**	**0.043**	**0.061**	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	**0.0008**	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	**0.077**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: TCMB01	ASW01	TMB04	----	----
				Client sampling date / time: 20-AUG-2014 14:00	20-AUG-2014 10:20	20-AUG-2014 08:00	----	----
				ES1418514-001	ES1418514-002	ES1418514-003	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.006**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.030**	**0.030**	**8.84**	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	**0.036**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.030**	<0.005	**0.288**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.071**	**0.002**	**0.398**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**12.4**	**0.236**	**0.708**	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Iron	7439-89-6	0.05	mg/L	**1.19**	**0.09**	**1.83**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**1.32**	<0.01	**0.04**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	<0.01	**0.13**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	<0.01	**0.13**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.4**	**0.5**	**0.4**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.4**	**0.5**	**0.5**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	**0.11**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.04**	<0.01	<0.01	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TCMB01	ASW01	TMB04	----	----
			Client sampling date / time	20-AUG-2014 14:00	20-AUG-2014 10:20	20-AUG-2014 08:00	----	----
Compound	CAS Number	LOR	Unit	ES1418514-001	ES1418514-002	ES1418514-003	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	----	**4.52**	**70.1**	----	----
Total Anions	----	0.01	meq/L	**30.7**	----	----	----	----
Total Cations	----	0.01	meq/L	**34.4**	**4.10**	**72.7**	----	----
Ionic Balance	----	0.01	%	----	**4.78**	**1.84**	----	----
Ionic Balance	----	0.01	%	**5.70**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**3**	**11**	**5**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1418533**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Client Services
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 9272 5101	Facsimile	: +61-2-8784 8500
Project	: 2162406F	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 22-AUG-2014
Sampler	: ----	Issue Date	: 29-AUG-2014
Site	: ----		
		No. of samples received	: 3
Quote number	: SY/746/14 V2	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dian Dao		Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

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

- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TTMB02	CDE	CDW	----	----
				Client sampling date / time	21-AUG-2014 12:05	21-AUG-2014 12:30	21-AUG-2014 13:05	----	----
					ES1418533-001	ES1418533-002	ES1418533-003	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.58**	**7.52**	**7.62**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**2350**	**216**	**354**	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**1400**	**162**	**324**	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		**8**	**27**	**21**	----	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		**518**	**32.8**	**52.1**	----	----
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		**329**	**34**	**65**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**329**	**34**	**65**	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**32.9**	**4.7**	**15.3**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**52**	**12**	**17**	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**501**	**37**	**56**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**162**	**2**	**5**	----	----
Magnesium	7439-95-4	1	mg/L		**47**	**1**	**3**	----	----
Sodium	7440-23-5	1	mg/L		**220**	**35**	**44**	----	----
Potassium	7440-09-7	1	mg/L		**4**	**8**	**12**	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	**1.01**	**2.28**	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.002**	**0.002**	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L		**0.775**	**0.032**	**0.036**	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: TTMB02	CDE	CDW	----	----
				Client sampling date / time: 21-AUG-2014 12:05	21-AUG-2014 12:30	21-AUG-2014 13:05	----	----
				ES1418533-001	**ES1418533-002**	**ES1418533-003**	**----**	**----**
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	**0.004**	**0.005**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.002**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.036**	**0.031**	**0.016**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.108**	**0.086**	**0.040**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	**0.002**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**2.72**	**0.048**	**0.055**	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.051**	**0.037**	**0.084**	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	**0.05**	----	----
Iron	7439-89-6	0.05	mg/L	**2.13**	**0.48**	**1.03**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.60**	**0.01**	**0.20**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	**0.07**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	**0.07**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.8**	**1.7**	**3.3**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.8**	**1.7**	**3.4**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.35**	**0.46**	**1.15**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.18**	**0.74**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TTMB02	CDE	CDW	----	----
			Client sampling date / time	21-AUG-2014 12:05	21-AUG-2014 12:30	21-AUG-2014 13:05	----	----
Compound	CAS Number	LOR	Unit	ES1418533-001	ES1418533-002	ES1418533-003	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	21.8	1.97	3.23	----	----
Total Cations	----	0.01	meq/L	21.6	1.91	2.72	----	----
Ionic Balance	----	0.01	%	0.37	----	8.67	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	6	19	48	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1419122**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS RICHARD	Contact	: Client Services
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: crichard@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 92725100	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 92725101	Facsimile	: +61-2-8784 8500
Project	: 2162406F	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 29-AUG-2014
Sampler	: AL,SG	Issue Date	: 05-SEP-2014
Site	: ----		
		No. of samples received	: 4
Quote number	: SY/746/14 V2	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

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

- **EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.**
- **ED041G: LOR raised for Sulfate analysis on sample ID: CDE due to matrix interferences.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **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.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	CDE	CDW	FSW01	ASW01	----
				Client sampling date / time	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	----
					ES1419122-001	ES1419122-002	ES1419122-003	ES1419122-004	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.36**	**7.74**	**6.88**	**6.70**	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**158**	**356**	**420**	**194**	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		----	**352**	**268**	**212**	----
EA016: Non Marine - Estimated TDS Salinity									
Total Dissolved Solids (Calc.)	----	1	mg/L		**103**	----	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		**54**	**90**	**44**	**150**	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		**16.3**	**31.1**	**81.3**	**37.5**	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**48**	**113**	**15**	**15**	----
Total Alkalinity as CaCO3	----	1	mg/L		**48**	**113**	**15**	**15**	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**13.5**	**17.4**	**12.4**	**12.7**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<10	**19**	**44**	**8**	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**24**	**38**	**83**	**43**	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**2**	**10**	**8**	**4**	----
Magnesium	7439-95-4	1	mg/L		**2**	**5**	**8**	**3**	----
Sodium	7440-23-5	1	mg/L		**18**	**44**	**48**	**26**	----
Potassium	7440-09-7	1	mg/L		**9**	**15**	**7**	**4**	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**2.03**	**0.26**	**0.13**	**0.56**	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.002**	<0.001	**0.001**	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
Barium	7440-39-3	0.001	mg/L		**0.036**	**0.030**	**0.051**	**0.037**	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	CDE	CDW	FSW01	ASW01	----
				Client sampling date / time	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	----
					ES1419122-001	ES1419122-002	ES1419122-003	ES1419122-004	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		**0.004**	**0.006**	**0.003**	**0.002**	----
Manganese	7439-96-5	0.001	mg/L		**0.010**	**0.004**	**0.106**	**0.038**	----
Nickel	7440-02-0	0.001	mg/L		**0.001**	**0.001**	**0.001**	**0.001**	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		**0.022**	**0.012**	**0.023**	**0.014**	----
Lithium	7439-93-2	0.001	mg/L		**0.008**	**0.014**	**0.002**	**0.002**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L		**0.028**	**0.072**	**0.145**	**0.076**	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Iron	7439-89-6	0.05	mg/L		**0.84**	**0.37**	**0.30**	**0.65**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.06**	**0.04**	**0.02**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.05**	**0.21**	**0.48**	**0.12**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.05**	**0.21**	**0.48**	**0.12**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.2**	**2.1**	**1.5**	**1.4**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**2.2**	**2.3**	**2.0**	**1.5**	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.75**	**1.53**	**0.17**	**0.16**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	CDE	CDW	FSW01	ASW01	----
			Client sampling date / time	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	28-AUG-2014 08:30	----
Compound	CAS Number	LOR	Unit	ES1419122-001	ES1419122-002	ES1419122-003	ES1419122-004	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.54**	**0.97**	**0.07**	**0.04**	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	----	----	----	**1.68**	----
Total Anions	----	0.01	meq/L	**1.64**	**3.73**	**3.56**	----	----
Total Cations	----	0.01	meq/L	----	----	----	**1.68**	----
Total Cations	----	0.01	meq/L	**1.54**	**3.26**	**3.39**	----	----
Ionic Balance	----	0.01	%	----	**6.65**	**2.31**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**27**	**41**	**23**	**25**	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1425982**	Page	: 1 of 11
Amendment	: **1**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61 2 8784 8500
Project	: 2268517A	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-NOV-2014
Sampler	: CS/CR	Issue Date	: 05-JAN-2015
Site	: ----		
		No. of samples received	: 14
Quote number	: SY/746/14 V2	No. of samples analysed	: 14

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

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

- **ED041G: LOR raised for Sulfate on sample 7 due to sample matrix.**
- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **EK055G: It has been noted that Ammonia is greater than TKN for sample 10 and 14, however this difference is within the limits of experimental variation.**
- **EK071G: It has been noted that Reactive P is greater than Total P on sample 12, however this difference is within the limits of experimental variation.**
- **Ionic Balance out of acceptable limits for sample 5 due to analytes not quantified in this report.**
- **TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**
- **This report has been amended and re-released to allow the reporting of additional analytical data.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TED	TSD	TND	CDW	CDE
				Client sampling date / time	25-NOV-2014 16:40	25-NOV-2014 17:00	25-NOV-2014 16:50	25-NOV-2014 15:30	25-NOV-2014 16:30
					ES1425982-001	ES1425982-002	ES1425982-003	ES1425982-004	ES1425982-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		9.52	9.77	9.86	10.1	8.45
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		----	----	88.0	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		1220	1610	5870	355	454
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		751	954	3000	347	470
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		62	25	148	60	81
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		163	250	936	36.0	68.3
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		174	265	1250	86	5
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		189	135	492	25	97
Total Alkalinity as CaCO3	----	1	mg/L		363	400	1740	111	102
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		14.4	19.0	26.1	5.9	19.2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		12	32	15	2	30
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		174	263	907	36	71
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		10	12	8	21	9
Magnesium	7439-95-4	1	mg/L		6	7	3	5	8
Sodium	7440-23-5	1	mg/L		222	300	1150	52	45
Potassium	7440-09-7	1	mg/L		39	73	303	12	12
ED093F: SAR and Hardness Calculations									
Sodium Adsorption Ratio	----	0.01	-		----	17.0	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.32	0.17	2.94	0.02	1.30
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	0.004	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		0.004	0.003	0.013	0.003	0.002

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TED	TSD	TND	CDW	CDE
				Client sampling date / time	25-NOV-2014 16:40	25-NOV-2014 17:00	25-NOV-2014 16:50	25-NOV-2014 15:30	25-NOV-2014 16:30
					ES1425982-001	ES1425982-002	ES1425982-003	ES1425982-004	ES1425982-005
EG020F: Dissolved Metals by ICP-MS - Continued									
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.151**	**0.128**	**0.331**	**0.035**	**0.042**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	**0.0007**	**0.0001**
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.003**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.001**	**0.020**	**0.015**	**0.003**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	**0.006**	**0.010**	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.435**	**0.578**	**2.22**	**0.010**	**0.017**
Manganese	7439-96-5	0.001	mg/L		**0.014**	**0.020**	**0.024**	**0.016**	**0.006**
Molybdenum	7439-98-7	0.001	mg/L		**0.003**	**0.007**	**0.031**	**0.001**	**0.001**
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.001**	**0.005**	**0.001**	**0.002**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.252**	**0.215**	**0.396**	**0.140**	**0.121**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	**0.02**	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.012**	**0.007**	**0.034**	**0.058**	**0.046**
Boron	7440-42-8	0.05	mg/L		**0.22**	**0.20**	**0.72**	<0.05	**0.06**
Iron	7439-89-6	0.05	mg/L		**0.13**	**0.09**	**1.22**	**0.15**	**0.21**
Bromine	7726-95-6	0.1	mg/L		**0.4**	**0.5**	**2.2**	**0.1**	**0.1**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.3**	**1.2**	**0.2**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	<0.01	**0.21**	**0.02**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	**0.02**	**0.03**	**0.03**	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.02**	**0.03**	**0.03**	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TED	TSD	TND	CDW	CDE
				Client sampling date / time	25-NOV-2014 16:40	25-NOV-2014 17:00	25-NOV-2014 16:50	25-NOV-2014 15:30	25-NOV-2014 16:30
					ES1425982-001	ES1425982-002	ES1425982-003	ES1425982-004	ES1425982-005
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**10.1**	**5.2**	**10.5**	**8.9**	**5.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**10.1**	**5.2**	**10.5**	**8.9**	**5.1**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.57**	**0.48**	**1.75**	**0.87**	**1.18**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.08**	**0.15**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**12.4**	**16.1**	**60.7**	----	**4.67**
Total Anions	----	0.01	meq/L		----	----	----	**3.92**	----
Total Cations	----	0.01	meq/L		**11.6**	**16.1**	**58.4**	**4.03**	**3.37**
Ionic Balance	----	0.01	%		**3.21**	**0.02**	**1.92**	----	**16.1**
Ionic Balance	----	0.01	%		----	----	----	**1.36**	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**36**	**31**	**124**	**32**	**33**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TSW01	ASW01	TMB01	TMB02	TMB03
				Client sampling date / time	25-NOV-2014 09:30	25-NOV-2014 16:30	25-NOV-2014 09:45	25-NOV-2014 10:30	25-NOV-2014 11:15
					ES1425982-006	ES1425982-007	ES1425982-008	ES1425982-009	ES1425982-010
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.61	7.58	7.21	6.93	7.08
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		516	354	9010	4010	6190
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		324	229	5980	2540	4440
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		12	10	172	8	----
Suspended Solids (SS)	----	5	mg/L		----	----	----	----	156
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		99.3	61.1	2690	1160	1720
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		83	72	656	203	501
Total Alkalinity as CaCO3	----	1	mg/L		83	72	656	203	501
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		16.8	8.3	35.4	35.0	32.8
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		9	<10	92	43	199
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		104	63	2750	1100	1670
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		20	17	320	188	392
Magnesium	7439-95-4	1	mg/L		12	9	239	85	151
Sodium	7440-23-5	1	mg/L		60	36	1200	507	714
Potassium	7440-09-7	1	mg/L		6	5	2	3	3
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.08	<0.01	0.13	<0.01	0.08
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		0.004	0.002	0.001	0.003	0.006
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.079	0.062	0.260	0.770	0.218
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	0.0001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TSW01	ASW01	TMB01	TMB02	TMB03
				Client sampling date / time	25-NOV-2014 09:30	25-NOV-2014 16:30	25-NOV-2014 09:45	25-NOV-2014 10:30	25-NOV-2014 11:15
					ES1425982-006	ES1425982-007	ES1425982-008	ES1425982-009	ES1425982-010
EG020F: Dissolved Metals by ICP-MS - Continued									
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		**0.001**	<0.001	<0.001	**0.002**	**0.002**
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.007**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.002**	**0.002**	**0.056**	**0.062**	**0.105**
Manganese	7439-96-5	0.001	mg/L		**0.892**	**0.267**	**0.875**	**1.23**	**1.62**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.001**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**0.251**	**0.197**	**6.83**	**3.32**	**7.38**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	**0.005**	<0.001	**0.002**
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.012**	**0.006**	**0.020**	**0.013**	**0.026**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**2.93**	**1.07**	**2.29**	**5.34**	**5.22**
Bromine	7726-95-6	0.1	mg/L		**0.1**	<0.1	**4.2**	**2.1**	**2.9**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	**0.3**	**0.1**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.05**	<0.01	**0.13**	**0.29**	**0.23**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.03**	**0.03**	**0.04**	**0.04**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.03**	**0.03**	**0.04**	**0.04**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.6**	**1.2**	**0.4**	**0.3**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.6**	**1.2**	**0.4**	**0.3**	**0.2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TSW01	ASW01	TMB01	TMB02	TMB03
				Client sampling date / time	25-NOV-2014 09:30	25-NOV-2014 16:30	25-NOV-2014 09:45	25-NOV-2014 10:30	25-NOV-2014 11:15
Compound	CAS Number	LOR	Unit		ES1425982-006	ES1425982-007	ES1425982-008	ES1425982-009	ES1425982-010
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.29**	**0.14**	**0.08**	**0.07**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.14**	**0.05**	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**4.78**	**3.22**	**92.6**	**36.0**	**61.3**
Total Cations	----	0.01	meq/L		**4.75**	**3.28**	**87.9**	**38.5**	**63.1**
Ionic Balance	----	0.01	%		**0.32**	**1.03**	**2.61**	**3.40**	**1.51**
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**17**	**16**	<1	<1	<1

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	TMB04	TCMB01	TTMB02	QA	----
				Client sampling date / time	25-NOV-2014 15:45	25-NOV-2014 10:00	25-NOV-2014 11:45	25-NOV-2014 00:00	----
					ES1425982-011	ES1425982-012	ES1425982-013	ES1425982-014	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.95**	**7.71**	**7.43**	**7.14**	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**7520**	**3060**	**2350**	**6240**	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**4720**	**1920**	**1450**	**4480**	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		**1820**	**9**	<5	----	----
Suspended Solids (SS)	----	5	mg/L		----	----	----	**32**	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		**2000**	**788**	**523**	**1730**	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**307**	**329**	**400**	**501**	----
Total Alkalinity as CaCO3	----	1	mg/L		**307**	**329**	**400**	**501**	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**53.7**	**20.7**	**33.6**	**31.9**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**657**	<1	**49**	**192**	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**2050**	**758**	**522**	**1680**	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**164**	**212**	**220**	**397**	----
Magnesium	7439-95-4	1	mg/L		**194**	**70**	**48**	**154**	----
Sodium	7440-23-5	1	mg/L		**1080**	**325**	**226**	**727**	----
Potassium	7440-09-7	1	mg/L		**17**	**6**	**4**	**3**	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.09**	**0.04**	**0.03**	**0.03**	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		**0.001**	<0.001	**0.001**	**0.005**	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L		**0.082**	**7.40**	**0.804**	**0.220**	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	**0.0097**	<0.0001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TMB04	TCMB01	TTMB02	QA	----
			Client sampling date / time	25-NOV-2014 15:45	25-NOV-2014 10:00	25-NOV-2014 11:45	25-NOV-2014 00:00	----
Compound	CAS Number	LOR	Unit	ES1425982-011	ES1425982-012	ES1425982-013	ES1425982-014	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	**0.017**	<0.001	**0.001**	**0.002**	----
Copper	7440-50-8	0.001	mg/L	**0.005**	**0.002**	**0.013**	**0.002**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.006**	<0.001	----
Lithium	7439-93-2	0.001	mg/L	**0.398**	**0.073**	**0.034**	**0.112**	----
Manganese	7439-96-5	0.001	mg/L	**8.56**	**0.064**	**0.105**	**1.60**	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	**0.010**	**0.003**	**0.003**	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L	**1.92**	**14.9**	**3.14**	**7.57**	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	**0.002**	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	**0.066**	**0.025**	**0.327**	**0.012**	----
Boron	7440-42-8	0.05	mg/L	**0.05**	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	**12.6**	**1.98**	**2.05**	**5.11**	----
Bromine	7726-95-6	0.1	mg/L	**3.0**	**0.8**	**0.6**	**2.9**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.9**	**0.1**	<0.1	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.29**	**1.34**	**0.60**	**0.22**	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	**0.03**	**0.04**	**0.05**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	**0.03**	**0.04**	**0.05**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.8**	**1.4**	**0.7**	**0.2**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.8**	**1.4**	**0.7**	**0.2**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TMB04	TCMB01	TTMB02	QA	----
			Client sampling date / time	25-NOV-2014 15:45	25-NOV-2014 10:00	25-NOV-2014 11:45	25-NOV-2014 00:00	----
Compound	CAS Number	LOR	Unit	ES1425982-011	ES1425982-012	ES1425982-013	ES1425982-014	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.52**	**0.01**	**0.23**	**0.05**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.03**	**0.02**	<0.01	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**77.6**	**28.0**	**23.7**	**61.4**	----
Total Cations	----	0.01	meq/L	**71.6**	**30.6**	**24.9**	**64.2**	----
Ionic Balance	----	0.01	%	**4.08**	**4.58**	**2.33**	**2.23**	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**6**	<1	<1	<1	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1426055**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Loren Schiavon
Address	: PO BOX 1162 NEWCASTLE NSW, AUSTRALIA 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 4929 7299	Facsimile	: +61 2 8784 8500
Project	: 2268517A	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 27-NOV-2014
Sampler	: CS/SR	Issue Date	: 04-DEC-2014
Site	: ----		
		No. of samples received	: 3
Quote number	: EN/008/14	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Merrin Avery	Supervisor - Inorganic	Newcastle - Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

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

- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: S4MB01	FSW01	TMB05	----	----
				Client sampling date / time: 27-NOV-2014 08:15	26-NOV-2014 09:40	26-NOV-2014 16:00	----	----
				ES1426055-001	**ES1426055-002**	**ES1426055-003**	**----**	**----**
EA005: pH								
pH Value	----	0.01	pH Unit	**7.85**	**7.55**	**5.57**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4810**	**440**	**7490**	----	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	----	10	mg/L	**2880**	**271**	**4260**	----	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	**110**	**12**	**460**	----	----
ED009: Anions								
Chloride	16887-00-6	0.100	mg/L	**1290**	**85.2**	**2400**	----	----
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	**473**	**55**	**5**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**473**	**55**	**5**	----	----
ED040F: Dissolved Major Anions								
Silicon as SiO2	14464-46-1	0.1	mg/L	**29.3**	**14.0**	**66.3**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**17**	**13**	**219**	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**1290**	**95**	**2250**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**341**	**13**	**58**	----	----
Magnesium	7439-95-4	1	mg/L	**58**	**11**	**236**	----	----
Sodium	7440-23-5	1	mg/L	**638**	**49**	**1010**	----	----
Potassium	7440-09-7	1	mg/L	**6**	**6**	**15**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.02**	**0.57**	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.003**	**0.001**	----	----
Boron	7440-42-8	0.05	mg/L	**0.16**	<0.05	<0.05	----	----
Barium	7440-39-3	0.001	mg/L	**6.19**	**0.055**	**0.202**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	**0.007**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	**0.0025**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: S4MB01	FSW01	TMB05	----	----
				Client sampling date / time: 27-NOV-2014 08:15	26-NOV-2014 09:40	26-NOV-2014 16:00	----	----
				ES1426055-001	ES1426055-002	ES1426055-003	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	**0.359**	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.001**	**0.202**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.198**	**0.459**	**18.9**	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	**0.175**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**1.20**	----	----
Lithium	7439-93-2	0.001	mg/L	**0.441**	**0.002**	**0.164**	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**24.3**	**0.209**	**1.03**	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Iron	7439-89-6	0.05	mg/L	**1.50**	**1.14**	**11.4**	----	----
Bromine	7726-95-6	0.1	mg/L	**2.6**	**0.2**	**1.8**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	<0.1	**0.9**	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**1.82**	<0.01	**0.28**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	**0.02**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	**0.02**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**2.1**	**1.4**	**1.0**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**2.1**	**1.4**	**1.0**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	S4MB01	FSW01	TMB05	----	----
			Client sampling date / time	27-NOV-2014 08:15	26-NOV-2014 09:40	26-NOV-2014 16:00	----	----
Compound	CAS Number	LOR	Unit	ES1426055-001	ES1426055-002	ES1426055-003	----	----
EK067G: Total Phosphorus as P by Discrete Analyser - Continued								
Total Phosphorus as P	----	0.01	mg/L	**0.07**	**0.22**	**0.15**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.02**	**0.08**	<0.01	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**46.2**	----	**68.1**	----	----
Total Anions	----	0.01	meq/L	----	**3.77**	----	----	----
Total Cations	----	0.01	meq/L	**49.7**	**3.84**	**66.6**	----	----
Ionic Balance	----	0.01	%	**3.66**	----	**1.12**	----	----
Ionic Balance	----	0.01	%	----	**0.92**	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**30**	**17**	**10**	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1427511**	Page	: 1 of 5
Amendment	: **1**		
Client	: **AGL ENERGY**	Laboratory	: Environmental Division Sydney
Contact	: MR SIMON GARNETT	Contact	: Client Services
Address	: GPO BOX 1048 BRISBANE QLD, AUSTRALIA 4001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: sgarnett@agl.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 07 3023 2437	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 3023 2496	Facsimile	: +61-2-8784 8500
Project	: TD	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 4510011197		
C-O-C number	: ----	Date Samples Received	: 12-DEC-2014
Sampler	: SG	Issue Date	: 27-JAN-2015
Site	: ----		
		No. of samples received	: 4
Quote number	: SY/479/14	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

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

- **EA015: TDS by method EA-015 may bias high for samples TED and TWD due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**
- **ED009x: Poor duplicate precision for Chloride on sample 4146538 due to sample matrix.**
- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **This report has been amended as a result of misinterpretation of sample identification numbers (IDs). All analysis results are as per the previous report**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CDE	CDW	FSW01	AWS01	----
				Client sampling date / time	11-DEC-2014 10:45	11-DEC-2014 11:15	11-DEC-2014 11:50	11-DEC-2014 12:45	----
Compound	CAS Number	LOR	Unit		ES1427511-001	ES1427511-002	ES1427511-003	ES1427511-004	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.10	7.14	7.27	7.22	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		107	241	418	328	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		249	287	249	184	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		151	105	7	5	----
ED009: Anions									
Chloride	16887-00-6	0.100	mg/L		8.38	27.0	84.0	61.0	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		34	58	70	71	----
Total Alkalinity as CaCO3	----	1	mg/L		34	58	70	71	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		11.9	33.1	13.4	8.2	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		14	29	9	<1	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		8	31	86	65	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		5	5	14	14	----
Magnesium	7439-95-4	1	mg/L		1	2	10	8	----
Sodium	7440-23-5	1	mg/L		14	33	46	32	----
Potassium	7440-09-7	1	mg/L		6	9	6	4	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		1.77	0.03	0.04	0.02	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		0.001	0.001	0.003	0.002	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
Barium	7440-39-3	0.001	mg/L		0.019	0.018	0.051	0.055	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	CDE	CDW	FSW01	AWS01	----
				Client sampling date / time	11-DEC-2014 10:45	11-DEC-2014 11:15	11-DEC-2014 11:50	11-DEC-2014 12:45	----
					ES1427511-001	ES1427511-002	ES1427511-003	ES1427511-004	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.003**	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L		**0.005**	**0.002**	**0.337**	**0.331**	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.007**	**0.007**	<0.005	----
Lithium	7439-93-2	0.001	mg/L		**0.006**	**0.010**	**0.002**	**0.001**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L		**0.019**	**0.028**	**0.187**	**0.180**	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Iron	7439-89-6	0.05	mg/L		**0.82**	**0.12**	**1.56**	**1.49**	----
Bromine	7726-95-6	0.1	mg/L		<0.1	<0.1	**0.1**	**0.1**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	<0.1	**0.1**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.05**	**0.04**	**0.11**	**0.05**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		**0.02**	**0.02**	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.26**	**0.20**	**0.02**	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.28**	**0.22**	**0.02**	<0.01	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.3**	**1.4**	**1.2**	**0.9**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**2.6**	**1.6**	**1.2**	**0.9**	----
EK067G: Total Phosphorus as P by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	CDE	CDW	FSW01	AWS01	----
			Client sampling date / time	11-DEC-2014 10:45	11-DEC-2014 11:15	11-DEC-2014 11:50	11-DEC-2014 12:45	----
Compound	CAS Number	LOR	Unit	ES1427511-001	ES1427511-002	ES1427511-003	ES1427511-004	----
EK067G: Total Phosphorus as P by Discrete Analyser - Continued								
Total Phosphorus as P	----	0.01	mg/L	1.10	1.72	0.23	0.12	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.73	1.60	0.12	0.04	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	1.20	2.64	4.01	3.25	----
Total Cations	----	0.01	meq/L	1.09	----	----	----	----
Total Cations	----	0.01	meq/L	----	2.08	3.76	2.93	----
Ionic Balance	----	0.01	%	----	----	3.26	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	9	19	18	16	----