JHCPB Joint Venture

Groundwater Management Plan

RIC-JHC-MPL-00-PL-300-001

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Glossary / Abbreviations

Abbreviations	Expanded text
ASSMP	Acid Sulfate Soils Management Plan
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
Bi-monthly	Every two months
CEMP	Construction Environmental Management Plan
CoA	Conditions of Approval
CFU	Colony Forming Unit
CSSI	The Critical State Significant Infrastructure, as described in Schedule 1, the carrying out of which is approved under the terms of the SSI 7485 approval
DPIE	NSW Department of Planning, Industry and Environment
DoI Water	NSW Department of Industry Water (formerly DPI Water)
DPI Water	NSW Department of Primary Industries - Water
DPIE Water	NSW Department of Planning, Industry and Environment – Water (formerly DoI Water)
EC	Electrical Conductivity
EIS	M4-M5 Link Environmental Impact Statement
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
ER	Environmental Representative
EWMS	Environmental Work Method Statement
GDEs	Groundwater Dependent Ecosystems
GMP	Groundwater Management Plan (this document)
GWMP	Groundwater Monitoring Program
GMR	Groundwater Modelling Report
GWQ	Groundwater quality
JHCPB	John Holland CPB Contractors Joint Venture
mAHD	elevation in metres with respect to the Australian Height Datum
mBGL	metres below ground level
mTOC	metres below top of casing
m/day	metres per day
NRAR	Natural Resources Access Regulator
µS/cm	micro-Siemens per centimetre
REMM	Revised Environmental Management Measures

Abbreviations	Expanded text
Roads and Maritime	Roads and Maritime Services (now Transport for NSW)
SPIR	M4-M5 Link Submissions and Preferred Infrastructure Report
SSTV	Site Specific Trigger Value
TWG	The Water Group
TfNSW	Transport for NSW
SSWMP	Soil and Surface Water Management Sub-plan
WTP	Water Treatment Plant

1. Introduction

1.1. Context

This Groundwater Management Sub-plan (GMP or Plan) and accompanying Groundwater Monitoring Program (GWMP, Annexure B) forms part of the Construction Environmental Management Plan (CEMP) for the Design and Construction of Rozelle Interchange (the Project).

This GMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), Project Approvals and all applicable guidance and legislation..

This document acknowledges the authors of the GMP for the M4-M5 Link Mainline Tunnels (Stage One of the M4-M5 Link project) and groundwater report for the Environmental Impact Statement (EIS) (AECOM 2017). Words have been appropriated from these documents within certain sections of this GMP and GWMP to provide continuity across the relevant requirements of the Project.

1.2. Project background

The M4-M5 Link EIS (AECOM 2017) assessed the impacts of construction and operation of the Project on groundwater, within Chapter 19 and Appendix T (Technical working paper: Groundwater). For a detailed understanding and background of the main project, please refer to these documents. The information provided within this report relates only to the Project area.

The EIS identified the potential for minor impacts on groundwater during construction typically associated with drawdown and contamination. However, it concluded any potential impacts could be managed by the standard mitigation and management measures that are described in this GMP. The potential minor impacts on groundwater during construction are discussed in Section 5.

Please refer to Section 1.3 of CEMP for a Project Description.

1.3. Scope of the Sub-plan

The scope of this plan is to describe how John Holland CPB Contractors Joint Venture (JHCPB) proposes to manage and protect groundwater during construction of the project. This document does not address groundwater management within the operational stage of the project.

1.4. Environmental management system overview

The environmental management system overview is described in Section 1.5 of the CEMP.

2. Purpose and Objectives

2.1. Purpose

The purpose of this plan is to describe how JHCPB proposes to manage and protect groundwater during construction of the Project. This Plan should be read in conjunction with the CEMP.

2.2. Objectives

The key objectives of the GMP are to ensure all CoA, REMMs and licence / permit requirements relevant to groundwater are described, scheduled and assigned responsibility as outlined in:

- All documents listed in CoA A1
- Conditions of Approval: SSI-7485,
- The Roads and Maritime Services (Roads and Maritime) Specifications G36, G38 and G40,
- The Project's Environment Protection Licence (EPL), and
- All relevant legislation and other requirements described in Section 3.1 of this Plan.

2.3. Environmental performance outcomes and targets

The key objective of the GMP is to ensure that groundwater impacts during construction are minimised and are within the scope permitted by the SSI Approval. This includes ensuring long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are consistent with the Approved Project.

To achieve these objectives, JHCPB will undertake the following:

Table 1: Performance outcomes

No.	Performance Outcome	How addressed	Records	Source
1	Groundwater management during the construction phase of the project will be in accordance with this GMP	This plan outlines how groundwater will be managed during the construction phase of the project.	Audit report	CoA C4 (f)
2	Groundwater monitoring will be undertaken in accordance with the GWMP	Groundwater monitoring is outlined within Section 3 of the GWMP.	Water monitoring report EPL monitoring report Audit reports	CoA C9 (b) CoA C10
3	Water discharged from a Water Treatment Plant (WTP) will be discharged within the defined water quality discharge criteria	The discharge criteria and performance criteria for the water treatment plant are outlined in Section 3.3 of the GWMP.	Water monitoring report EPL monitoring report	EPL
4	Design and construct tunnels to minimise groundwater inflow	The interception of groundwater in regard to design and construction to minimise groundwater inflow is outlined in Section 6.2.4.2.	Detailed design Water monitoring report	EIS, Appendix A
5	Establish water quality discharge criteria with consideration of NSW Water Quality Objectives	The discharge criteria and performance criteria are outlined in Section 3.3 of the GWMP.	This GMP	EIS, Appendix A
6	Effectively treat water to meet water quality discharge criteria	Water will be treated to meet water discharge quality criteria in	Water monitoring report	EIS, Appendix A

No.	Performance Outcome	How addressed	Records	Source
		accordance with Section 7.1 of this plan and Section 3.3 of the GWMP.		
7	Maximise reuse of treated water during construction	Section 7.1 outlines water treatment processes during construction. The water reuse strategy will include details of the preferred reuse options to maximise reuse of treated water.	Water monitoring report	EIS, Appendix A

3. Environmental requirements

3.1. Relevant legislation and guidelines

3.1.1. Legislation

All legislation relevant to this GMP is described in Annexure A of the CEMP.

3.1.2. Guidelines and standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC): National Water Quality Management Strategy, Paper No.4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines (ANZECC 2000),
- Environment Protection Authority (EPA): Approved methods for Sampling and Analysis of Water Pollutants in NSW (EPA 2004),
- Department of Planning, Industry and Environment (DPIE): Guideline for riparian corridors on waterfront land (DPE 2012),
- Department of Land and Water Conservation (DLWC):
  - NSW Groundwater Dependent Ecosystem Policy (DLWC 2002),
  - NSW Groundwater Policy Framework Document (DLWC 2002),
  - NSW Groundwater Quality Protection Policy (DLWC 1998),
  - NSW Groundwater Quality Management Policy (DLWC 2007),
- Department of Water and Energy (DWE): NSW Water Extraction Monitoring Policy (DWE 2007),
- NSW Office of Water (NoW):
  - NSW Aquifer Interface Policy (NoW 2012),
  - Water Sharing Plan, Greater Metropolitan Reginal Groundwater Sources Background Document, Sydney (NoW 2011), and
- Road and Maritime: Dewatering Guideline (Roads and Maritime 2011).

3.2. Minister's Conditions of Approval

The CoA relevant to this plan are listed in Table 2 below. A cross reference is also included to indicate where the condition is addressed in this Plan or other project management documents. Specific CoA relevant to groundwater management for the Project are included within Annexure A.

Table 2: Summary of the Conditions of Approvals relevant to and addressed in this Plan.

CoA No.	Condition requirements	Document reference	How addressed
C4(f)	The following CEMP Sub-plans must be prepared in consultation with the relevant authorities identified for each CEMP Sub-plan and be consistent with the CEMP referred to in the EIS	Section 3.4	This GMP has been prepared in accordance with this condition and describes how JHCPB propose to manage groundwater during construction of the project. This Plan has been provided to The Water Group (formerly DPIE Water)/Natural Resources Access Regulator (NRAR) for consultation.
C5	The CEMP Sub-plans must state how:		
	(a) the environmental performance outcomes identified in the documents listed in Condition A1 as modified by these conditions will be achieved;	Section 2.3 Table 6	This plan was prepared in accordance with the environmental performance outcomes identified in the documents listed in Condition A1 and is evidenced primarily in Section 2.3 and Table 6.
	(b) the mitigation measures identified in the documents listed in Condition A1 as modified by these conditions will be implemented	Section 7	The implementation of groundwater management and mitigation measures identified in the documents listed in Condition A1 are listed in Table 6.
	(c) the relevant terms of this approval will be complied with and	Section 3.2, Table 2, Annexure A	Details regarding how JHCPB propose to comply with the relevant terms of approval are listed in this table and in Annexure A.
	(d) issues requiring management during construction (including cumulative impacts), as identified through ongoing environmental risk analysis, will be managed.	Section 6.2 and Section 7 Table 6 Initial Environmental Risk Assessment (Annexure B of CEMP) Section 6.1 of the GWMP (Annexure B)	Groundwater management issues requiring management during construction of the Project have been identified through EIS, SPIR and Environmental Risk Assessment Workshop. These issues including cumulative impacts have been detailed in Section 6 of this plan and Annexure B of the CEMP. Environmental risk analysis will be ongoing and regularly reviewed in accordance with section 3.2.1 of the CEMP to ensure effective management of groundwater mitigation and management measures listed in Table 6.

CoA No.	Condition requirements	Document reference	How addressed
C6	The CEMP Sub-plans must be endorsed by the ER and then submitted to the Secretary for approval no later than one (1) month prior to the commencement of the construction activities to which they apply	Refer to Section 2.2 of the CEMP	This GMP has been endorsed by the ER on 25 June 2019. The GMP has been submitted to DPIE for approval no later than one month prior to the commencement of construction activities.
C7	Any of the CEMP Sub-plans may be submitted to the secretary along with, or subsequent to, the submissions of the CEMP	Refer to Section 2.2 of the CEMP	This Sub-plan has been submitted for approval to DPIE following submission of the CEMP for DPIE approval.
C8	Construction must not commence until the CEMP and all CEMP Sub-plans have been approved by the Secretary. The CEMP and CEMP Sub-plans, as approved by the Secretary, including any minor amendments approved by the ER, must be implemented for the duration of construction. Where the CSSI is being staged, construction of that stage is not to commence until the relevant CEMP and CEMP Sub-plans have been endorsed by the ER and approved by the Secretary.	Refer to Section 2.2 of the CEMP	Construction will not commence until the CEMP and all CEMP Sub-plans have been approved by DPIE. The CEMP and CEMP Sub-plans will be implemented for the duration of construction.
C9 (b)	The following Construction Monitoring Programs must be prepared in consultation with the relevant authorities identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance. (b) Groundwater Monitoring Program: DPI Water, Sydney Water and relevant council(s)	Section 3.4 Section 2.3 of the GWMP (Annexure B)	The GWMP has been prepared in accordance with this condition and describes how JHCPB propose to conduct groundwater monitoring during construction of the Project. The GWMP has been provided to The Water Group (formerly DPIE Water) / NRAR, Sydney Water, City of Sydney Council and Inner West Council for consultation.
C10	Each Construction Monitoring Program must provide: (a) details of baseline data available;	Annexure A and Annexure B of the GWMP	The baseline data is available in Annexure A and Annexure B of the GWMP.

CoA No.	Condition requirements	Document reference	How addressed
	(b) details of baseline data to be obtained and when;	Section 3.1 of the GWMP	The details of baseline data obtained and when are contained in this section.
	(c) details of all monitoring of the project to be undertaken	Section 3.2 of the GWMP	This section details the monitoring to be undertaken with Table 4 outlining the locations of the groundwater monitoring bores
	(d) the parameters of the project to be monitored	Section 3.1.3 of the GWMP	This section outlines the parameters of the project to be monitored with Table 4 outlining the parameters
	(e) the frequency of the monitoring to be taken	Section 3.2 and Section 4 of the GWMP	Outlines the frequency in which monitoring will be undertaken
	(f) the location of monitoring	Section 3.2 of the GWMP	This section details of all monitoring to be undertaken with Table 4 outlining the locations of the groundwater monitoring bores
C12	Each Construction Monitoring Program must include: (a) Daily measurement of the amount of water discharged from the water treatment plants	Section 4.4 and 3.3.1 of the GWMP	Outlines how the water treatment plant discharge sampling will be undertaken and the frequency.
	(b) water quality testing of the water discharged from the water treatment plants	Section 3.3.2 of the GWMP	Outlines the water quality testing of the water discharged from water treatment plants.
	(c) monitoring of groundwater pore pressures in the Hawkesbury Sandstone aquifers adjacent to the tunnel alignment, in consultation with The Water Group	Section 3.2 of the GWMP	Details pore pressure monitoring to be undertaken in consultation with The Water Group

CoA No.	Condition requirements	Document reference	How addressed
	(d) monitoring of groundwater electrical conductivity in key locations between saline water bodies and the tunnel as identified by the project groundwater model including: • (ii) in the Rozelle area to the north of Rozelle Bay • (iii) in the Annandale area to the west of Rozelle Bay • (iv) in the Rozelle area to the south east of Iron Cove with a minimum of two (2) groundwater monitoring wells to be provided in each key location in consultation with DoI Water.	Section 4.3 and Table 4 of the GWMP	Details electrical conductivity to be undertaken.
	(e) measures to record or otherwise estimate and report groundwater inflows into the tunnels during their construction	Section 3.2.4 and 3.3.1 of the GWMP	Outlines how groundwater inflows are calculated and monitored.
	(f) a method for providing the data collected in (a) and (b) to Sydney Water every three (3) months to demonstrate the project's compliance with the discharge criteria and, if applicable, the Proponent's trade waste licence	Table 9 of the GWMP Table 6	Outlines reporting requirements. Data collection and reporting requirements are outlined in Table 6.
	(g) a method for providing the groundwater monitoring data to The Water Group every three (3) months during construction, and	Table 9 of the GWMP	Outlines reporting requirements.
	(h) the installation of a minimum of two (2) groundwater open hole monitoring wells in the north Rozelle/ Lilyfield area to the west of the ventilation tunnel at Iron Cove to monitor groundwater quality and groundwater levels, in consultation with DPI Water.	Section 3.2.2 and Section 3.2.3 of GWMP	Details monitoring wells and locations.

3.3. Revised Environmental Management Measures

Refer to Table 8 in Annexure A for all REMMs relevant to the development of this plan.

3.4. Consultation

This plan and the GWMP were provided to The Water Group (formerly DPIE Water) in accordance with CoA C4(f) and Sydney Water, Inner West Council and City of Sydney Council in accordance with CoA C9(a). Further to this, the GWMP was provided to DPI Fisheries and EPA in accordance with REMM OGW9. Refer to Section 2 of the CEMP for consultation requirements relating to CEMP and all sub-plans.

Table 3 provides a summary of the consultation undertaken for this GMP and GWMP and the key issues identified by the relevant stakeholders.

Consultation with relevant councils and stakeholders, including any unique local receivers, may be undertaken for issues pertaining to the Project's impact on groundwater. Community feedback and complaints relating to groundwater will be dealt with in accordance with the Communication Strategy and Complaints Management System.

Table 3: Summary of consultation for development of the Groundwater Management Plan and Groundwater Monitoring Program

Agency	Contact with agency	Response received	Key issues	Where addressed
Sydney Water	Via email from the Project: ▪ 27/03/19 ▪ 02/04/19 ▪ 17/04/19 ▪ 23/04/19 ▪ 06/05/19	Meeting on 4/4/19. Via email to the Project: ▪ 11/04/19 ▪ 17/04/19 Sydney Water provided a single comment. ▪ 06/05/19 Sydney Water confirmed they had no further comments on the management documents provided to Sydney Water.	No groundwater discharges would be accepted to a Sydney Water stormwater drain without accompaniment with a licence to pollute issued by the EPA and approval by Sydney Water to do so.	Section 8.3 of the GMP notes that JHCPB will obtain an EPL for licenced discharges. JHCPB will obtain all other required licences and approvals.
The Water Group (formerly DPIE Water)	Via email from the Project: ▪ 27/03/19 ▪ 02/04/19 ▪ 10/04/19 ▪ 17/04/19 ▪ 06/05/19 Via phone from the Project: ▪ 20/06/19 Meeting on 10/7 with JHCPB, RMS and DPIE Water. Meeting on 10/7 with JHCPB and DPIE Water	Via email to the Project: ▪ 15/04/19 – requesting extension of time. ▪ 05/07/19 – DPIE Water provided comments on the GMP/GWMP. Meeting on 10/07/19 with JHCPB, RMS and DPIE Water. JHCPB facilitated inspection of Sydney Metro Tunnels Martin Place for DPIE Water to view methods and mitigation measures, similar to those planned for this Project. Meeting on 10/7 with JHCPB and DPIE Water to discuss how DPIE Water comments have been addressed.	▪ Additional groundwater monitoring wells ▪ Performance criteria for groundwater quality in bores and discharge from the excavation. ▪ Figure showing tunnel design and construction monitoring bores. ▪ Cross-section drawings showing monitoring bores, tunnels and geology. ▪ Additional monitoring reporting requirements.	▪ Additional monitoring wells provided in Section 3.2.1 of the GWMP. ▪ Section 3.2.3.1, Section 3.3.2.3 of the GWMP. ▪ Revised Figures 1 and 2 provided in the GWMP. ▪ Cross-section drawings provided in Annexure C of the GWMP. ▪ Table 9 of the GWMP.

Agency	Contact with agency	Response received	Key issues	Where addressed
Port Authority of New South Wales	Via email from the Project: ▪ 02/04/19 ▪ 04/04/19 ▪ 10/04/19	Via email to the Project: ▪ 16/04/19 Port Authority provided comments on the GMP	Justification to the groundwater monitoring program extent, and why bores currently located within the Port Facility are not included in the monitoring program Request to be included in the distribution list of groundwater monitoring reports	The three bores shown within the Port Facility were erroneously included in Figure 1 of the GWMP. These bores are not part of the Project's EIS and were not therefore included in the baseline monitoring in the GWMP (see Section 3.1 in the GWMP). These bores have been removed from Figure 1 of the GWMP. Section 5.1.4 of the GWMP outlines reporting requirements.
Inner West Council (IWC)	Via email from the Project: ▪ 27/03/19 ▪ 02/04/19 ▪ 10/04/19 ▪ 17/04/19	Attendance at the Rozelle Interchange Regulator Briefing Session: ▪ 06/03/2019 Via email to the Project: ▪ 02/04/19 – IWC confirmed receipt of GWMP ▪ 18/04/19 – IWC provided comments on the GWMP.	A range of aspects that related to the EIS submission, and this Groundwater Management Plan. Key items included: ▪ Contaminants polluting groundwater ▪ Ground movement / Settlement ▪ The water objectives and guidelines used ▪ Groundwater drawdown ▪ Saline water intrusion	Contamination related to groundwater is addressed within Section 6.2.4.2 of this GMP Settlement is addressed within Section 6.2.3.4 of this GMP The main guidelines, specifications and policy documents relevant to this Plan are outlined in Section 3.1.2 Groundwater drawdown is outlined in Section 6.2.3.1. Saltwater intrusion is outlined in Section 6.2.4.6.
City of Sydney	Via email from the Project: ▪ 27/03/19 ▪ 02/04/19 ▪ 10/04/19 ▪ 17/04/19 Via phone from the Project: ▪ 12/06/19	Via email to the Project: ▪ 12/06/19 – City of Sydney confirmed they had no comments on the GWMP.	City of Sydney confirmed they had no comments on this document.	N/A

Agency	Contact with agency	Response received	Key issues	Where addressed
DPI Fisheries	Via email from the Project: ▪ 11/04/19	Via email to the Project: ▪ 12/06/19 – DPI Fisheries confirmed they had reviewed the document and had no comments or objections to the GWMP.	No comments or objections to this document.	N/A
Environment Protection Authority (EPA)	Via email from the Project: ▪ 11/04/19	Via email to the Project: ▪ 15/04/19 – EPA advised they would not review the GWMP.	It is not EPA policy to review management plans.	N/A

4. Existing Environment

4.1. Overview

The following sections summarise the factors influencing groundwater within the Project area. The Project transects a highly urbanised environment, where rainfall recharge to groundwater has been reduced by hardstand and roof captured runoff being directed to stormwater. The existing developments consist of established industrial, commercial, recreational, and residential areas. Groundwater recharge within the GMP primarily occurs in parks, gardens, bushland, and creeks, where it is ultimately discharged to Sydney Harbour. The Project alignment, which this GMP addresses, encompasses the Rozelle interchange network that is situated within Rozelle and Easton Park and extends from the proposed Iron Cove Link joining Victoria Road at Parramatta River to the north, the intersection of Victoria Road and The Crescent at Rozelle Bay to the east, and through to Lilyfield in the south, before linking with the Mainline Tunnel at Annandale and Leichardt.

The following chapter has been summarised to pertinent detail relating to the Project from Chapter 19, Groundwater of the EIS (AECOM 2017).

4.2. Topography and drainage

The topography of the Project area is relatively flat and low lying, ranging from sea level (adjacent to Sydney Harbour at Iron Cove and Rozelle Bay) up to approximately 30 m Australian Height Datum (AHD) around Rozelle and Lilyfield.

Most of the Project alignment is located in a heavily urbanised area and is drained by the stormwater network. The primary surface water features in the area are creeks, infilled creeks, and concrete lined canals that discharge into Sydney Harbour via Rozelle Bay and Iron Cove.

The following primary watercourses within the GMP boundary are summarised below:

- Whites Creek: A brick and concrete-lined channel that flows through the suburbs of Leichhardt and Marrickville, discharging to Rozelle Bay,
- Johnston's Creek: A lined channel that drains Annandale and Glebe, discharging into Rozelle Bay,
- Dobroyd Canal (Iron Cove Creek): Dobroyd Canal is the lower tidal section of Iron Cove Creek, a concrete lined channel that drains Haberfield, discharging into Iron Cove on the Parramatta River, and
- Easton Park Drain: Water within Easton Park is drained through a conduit located south of Easton Park. The Easton Park drain drains through Rozelle Rail Yards, discharging into Rozelle Bay.

Most the creeks and canals in the Project area are concrete lined, thereby have limited hydraulic connection with the local groundwater resource. However, Sydney Water has proposed to undertake naturalisation (i.e. removal of the concrete lining) of sections of Dobroyd Canal and Whites Creek (Sydney Water 2017). The naturalisation of creeks will allow for hydraulic connection to the underlying alluvium, particularly during high flows.

4.3. Geological setting

The Project area is located within the Permo-Triassic Sydney Basin, which is characterised by sub-horizontal sedimentary sequences, mainly sandstone and shale. The footprint of the Project is primarily underlain by Hawkesbury Sandstone and Quaternary alluvium. Ashfield Shale does not occur within the geological setting of construction works.

The main stratigraphic units encountered within the Project area of this GMP, from youngest to oldest, are:

- Anthropogenic fill,
- Quaternary alluvium (recent beneath creeks, palaeochannels) (minor occurrence), and
- Triassic Hawkesbury Sandstone.

The stratigraphy in the Project area has been intersected by multiple geological structural features including dykes and faults that may impact groundwater flow. Identified features include:

- Dykes identified within the sandstone cutting north of the Rozelle Rail Yards and 150 m east of the Rozelle Rail Yards, and
- Geological faults (a fracture or resulting joints within a rock where displacement may have occurred), which are typically found within the Hawkesbury Sandstone. The presence of faults can be associated with increased groundwater inflows.

Further detail on the stratigraphic units, including weathering profiles and implications for hydraulic conductivity is provided in Appendix T of the EIS (Technical working paper: Groundwater, AECOM 2017).

5. Hydrogeological setting

5.1. Regional groundwater flow, recharge and discharge

The Sydney Basin comprises sub-horizontal layered clastic sedimentary successions with localised igneous volcanic rocks and dykes, and geological faults. Dykes such as those identified beneath the Hawthorne Canal palaeochannel typically impede groundwater flows. Geological faults, typically found within the Hawkesbury Sandstone, are typically associated with increased groundwater flow.

Groundwater resources are recharged via direct rainfall and the infiltration of surface runoff derived from rainfall. Due to the level of urbanisation within the Project area, this will primarily occur where formations outcrop. Regional groundwater systems discharge via leakage, throughflow, and to local springs, watercourses, and the ocean. The regional groundwater table typically reflects a subdued version of topography.

Groundwater in the Sydney Basin is described at a regional scale in the Water Sharing Plan for the Greater Metropolitan Region (NoW 2011). Within the porous rock aquifer the level of connection between groundwater and surface water is stated as low to moderate. The travel time between shallow groundwater and unregulated rivers is estimated to be years to decades.

5.2. Hydrogeological units

Groundwater is present within the following hydrogeological units within the GMP area, described below:

- Quaternary alluvium, and
- Hawkesbury Sandstone.

5.2.1. Alluvium

Quaternary alluvium outcrops proximal to the harbour at Rozelle Bay and is present beneath fill, together with slightly older alluvium infilling palaeochannels. These older palaeochannels are ancient river systems that have eroded into the underlying bedrock creating a deeper sequence of variably permeable and saturated sediments that form part of the unconfined aquifer of the Project. The alluvium surrounding creeks is generally of high permeability and the groundwater within the alluvium can be a source of either recharge or discharge, depending on whether an upward or downward hydraulic gradient is present.

The palaeochannels that occur beneath some of the major watercourses or valleys within the Project alignment are saturated, highly transmissive, and extend to depths of up to 25 m.

Groundwater within the palaeochannels is typically saline, due to leakage from tidal tributaries.

Typically, the creeks along the Project alignment are concrete lined, thereby limiting hydraulic connection with the local groundwater resource.

5.2.2. Hawkesbury Sandstone

The Hawkesbury Sandstone is a heterogeneous layered unit characterised as a dual porosity aquifer dominated by secondary fracture groundwater flow. Interbedded shale lenses can provide local or extensive confining layers, creating separate aquifers with different hydraulic properties. Generally, the bulk hydraulic conductivity of the Hawkesbury Sandstone is low, although high groundwater yields can be encountered when saturated fractures are intersected. Increased groundwater flow to tunnels is typically associated with the intersection of such major faults, joints or fractures.

Regionally, groundwater flow is eastward, discharging into Sydney Harbour. Recharge is via rainfall infiltration on fractured outcrops, and through the soil profile and alluvium. Discharge within the Project area is via creeks and evapotranspiration.

Groundwater quality within the Hawkesbury Sandstone is generally mildly acidic and of low salinity in the Project area. The salinity of the upper part of the aquifer, however, can be elevated due saltwater ingress from Rozelle Bay and the alluvium palaeochannels. Elevated concentrations of dissolved iron and manganese naturally occur within the Hawkesbury Sandstone, which can cause staining when discharged and oxidised. In tunnels, groundwater ingress becomes oxidised, causing dissolved iron and manganese to precipitate and form sludge in drainage lines.

5.3. Groundwater levels and flow

5.3.1. Baseline monitoring

Baseline groundwater level and groundwater quality monitoring data has been collected from the Project's groundwater monitoring network since June 2016. This baseline dataset is augmented by baseline data and construction data collected since October 2015 for the adjacent M4 East and New M5 projects.

The Project baseline monitoring network was installed between May 2016 and May 2017 and consists of 34 monitoring bores, located within the Project area, intersecting groundwater within the alluvium and Hawkesbury Sandstone. Monitoring bores were designed and constructed to target the expected tunnel zone and allow assessment of potential impacts to groundwater. At one location where alluvium was present, nested monitoring bores were constructed.

Monitoring bores have been designed to target the following hydrogeological formations:

- Alluvium:
  - Five at The Crescent,
  - Four at Rozelle,

- Hawkesbury Sandstone:
  - 18 at Rozelle,
  - Three at The Crescent,
  - Two at Iron Cove, and
  - Two at Easton Park.

5.3.2. Alluvium

At Rozelle, groundwater level fluctuations are generally between 1.0 mAHD to 2.2 mAHD and respond directly to significant rainfall events.

At The Crescent the groundwater table is shallow (0.2 mAHD to 1.7 mAHD) and groundwater levels also respond directly to significant rainfall events. Tidal influences superimpose the general groundwater trend caused by rainfall recharge and are typically between 1 to 6 m.

5.3.3. Hawkesbury Sandstone

Baseline groundwater levels within the Hawkesbury Sandstone are currently monitored at 25 monitoring bores within the Project area and varies based on geological setting.

At Rozelle Rail Yards, measured groundwater levels range between 0.8 and 12 mAHD, with the majority being shallow and less than 1.8 mAHD. Groundwater level fluctuations ranged from approximately 0.5 m to 0.8 m and responded closely to rainfall recharge.

At The Crescent, measured groundwater levels within the Hawkesbury Sandstone ranged between 1.4 and 1.6 mAHD. Groundwater levels showed a response to significant rainfall events of more than 30 mm. Superimposed over the fluctuations were daily oscillations with an amplitude between 0.1 m and 0.25 m which correspond to tidal fluctuations from Rozelle Bay.

Groundwater levels measured in nested monitoring wells demonstrated that groundwater is likely discharging from the Hawkesbury Sandstone into the overlying alluvium (except at RZ_BH01, where the trend is reversed).

5.4. Hydraulic properties

Hydraulic conductivity testing (packer tests and laboratory core testing) was conducted during the field investigation program to inform the EIS (AECOM 2017) and to provide hydraulic parameters to support the groundwater modelling. Packer test results are summarised in Table 4. The majority (86%) of packer tests were conducted within the Hawkesbury Sandstone, where most the tunnels are located. Most estimated hydraulic conductivity values are low, suggesting that inflows into the tunnels will be low. No site-specific data was collected during the groundwater investigations (AECOM 2017) for the hydraulic conductivity of the alluvium. Typical hydraulic conductivity values for similar lithology across the Sydney Basin would be expected to range from 0.001 metres per day (m/day) for clayey alluvium up to 1 m/day for sandy alluvium (AECOM 2017).

Table 4: Estimated hydraulic conductivity values form packer testing for the Hawkesbury Sandstone

Hydraulic conductivity (m/day)	
Mean	0.10
Minimum	0.01
Maximum	1.17
Number of tests	181

5.5. Groundwater quality

The baseline water quality data is discussed in Section 5.5 of Annexure B and summarised in Table 5. Interpretation of baseline groundwater monitoring data is also included in the EIS (AECOM 2017) and the final baseline interpretive report (AECOM 2018).

Table 5: Summary of baseline groundwater quality within the Project area

Parameter	Alluvium	Hawkesbury Sandstone
EC	Variable: marginal to slightly saline Range: 1,561 to 9,068 μS/cm	Fresh to moderately saline Range: 558 to 16,300 μS/cm
pH	Weakly acidic to weakly basic Range: 5.96 to 8.06	Slightly acidic to strongly basic Range: 5.77 to 12.69
Major ions	Dominated by sodium, magnesium, chloride and bicarbonate. The dominance of sodium and chloride is attributed to tidal influences.	Dominated by sodium and chloride, which may be in part due to the influence of saline water intrusion.
Metals	Maximum levels exceeded guideline[1] concentration values for all but cadmium and nickel. In most cases the exceedance is marginal, indicating that background levels are already elevated.	Maximum levels exceeded guideline[1] concentration values for chromium, copper, iron, lead, manganese, nickel, and zinc. Consistently elevated iron and manganese, which is typical for Hawkesbury Sandstone (McKibbon and Smith 2000).
Nutrients	Nitrite and nitrate concentrations indicate that background nutrient levels are low. Reactive phosphorous levels are also low. Ammonia values exceeded guideline[1] concentration values.	Nitrite and nitrate concentrations indicate that background nutrient levels are low. Reactive phosphorous levels are very low. Ammonia values marginally exceeded guideline[1] concentration value.
Sulfate reducing bacteria[2]	Not assessed	No pattern was assessed for sulfate reducing bacteria because many samples were above the measurement limit (500,000 CFU/mL). Groundwater from the Hawkesbury Sandstone has high sulfate concentrations. When reducing conditions are present, SRB flourish in the absence of oxygen.
Groundwater aggressivity	Not assessed	Mildly aggressive towards concrete piles for average concentrations of chloride, pH, and sulfate. Mildly aggressive towards steel piles for average concentrations of chloride and pH. Severely aggressive towards steel piles for groundwater with low conductivity.

EC = electrical conductivity; μS/cm = micro-Siemens per centimetre
[1] Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
[2] measured as a colony forming unit (CFU) per 100 mL

5.6. Sensitivity receptors

5.6.1. Priority groundwater dependent ecosystems

There are no priority Groundwater Dependent Ecosystems (GDEs) identified in the Water Sharing Plan (NoW 2011) within 5 km of the Project alignment.

5.6.2. Non-priority groundwater dependent ecosystems

A manmade wetland has been constructed at Whites Creek Valley Park at Annandale, immediately west of Whites Creek. This wetland is unlikely to have any groundwater dependence as it continually receives low flows from Whites Creek.

Vegetation within low lying areas (typically containing alluvium soils) may utilise some portion of shallow groundwater for support. These areas are subject to periodic flooding, which recharges the groundwater in the underlying alluvium.

The above assessments will be confirmed in the Groundwater Modelling Report (GMR), developed in accordance with condition of approval E193, which will assess the impacts of groundwater drawdown on groundwater dependant ecosystems. The GMR will be developed in consultation with DPIE Water and provided to The Secretary prior to the finalisation of the tunnel design. The GMR will identify if additional mitigations measures are required to prevent adverse impacts on groundwater dependant ecosystems.

5.6.3. Registered groundwater bores

A review of bores registered with DPIE Water (AECOM 2017) indicates that of the registered bores within 2 km of the Project alignment (153 bores), the majority are registered as monitoring bores. Within the Rozelle Interchange, limited registered bores, including monitoring wells, exist at the Rozelle Rail Yards.

Only one of the identified bores is registered for domestic use, a 210 m deep bore (GW110247) at the University of Sydney at Camperdown extracts groundwater from the Hawkesbury Sandstone. The M4-M5 Link Mainline Tunnels Groundwater Management Sub-plan states that owner of GW110247 will be contacted to facilitate ongoing monitoring and to assess drawdown during the construction phase. (LSBJV 2018).

5.6.4. Potential groundwater contamination

An assessment of contaminated land risk is provided in the EIS, Appendix R (Technical working paper: Contamination) (AECOM 2017). Areas within the overarching Project footprint that may contain contaminated soil and/or groundwater due to past or present land use practices have been investigated. During routine monthly baseline groundwater monitoring to inform the EIS, a suite of contaminants was assessed for laboratory analyses including cations and anions, heavy metals, and nutrients.

Site management works for contamination within the Rozelle Rail Yard, located north and northwest of Rozelle Bay, were undertaken in 2017 (AECOM 2018) and were subject to a separate environmental assessment. The review of environmental factors (REF) was approved by Roads and Maritime in April 2017. Contamination investigations undertaken as part of the REF and for the M4-M5 WestConnex Link project confirmed contamination within the Rozelle Rail Yard is likely from historic land use and importation of fill materials of unknown origin. This has resulted in the presence of variable concentrations of heavy metals, PAHs, TRHs, and bonded and friable asbestos in the soils, fill, ballast and existing stockpiles. In addition, contamination of groundwater was also identified with limited exceedances of zinc and copper (one location), zinc (one location) and TRHs, naphthalene and Bis(2-ethylhexyl) phthalate (one location).

The primary risk to groundwater at the Rozelle Rail Yards is the migration of contaminated groundwater due to altered groundwater flow paths from tunnel construction. The remediation of the soils within the Rozelle Rail Yards was completed in 2018 (AECOM 2018b) and therefore has reduced the potential for leachate to contaminate the groundwater.

6. Environmental aspects and impacts

6.1. Construction activities

Key aspects of the construction phase of the Project that could result in adverse impacts to groundwater include:

- Tunnelling and cut and cover construction
- Dewatering of groundwater inflows into tunnels, and
- Operation of Water Treatment Plants (WTP).

Refer also to the Aspects and Impacts Register included in Appendix A2 of the CEMP.

6.2. Impacts

6.2.1. Overview

The potential for impacts on groundwater will be dependent on the nature, extent, and magnitude of construction activities and their interaction with the natural environment. Potential impacts to groundwater attributable to construction, discussed in detail below, include:

- Reduced groundwater recharge,
- Groundwater level decrease (drawdown due to tunnel inflows) including potential impacts on:
  - GDEs,
  - Surface water baseflow,
  - Ground movement (settlement),
- Changes in groundwater quality, as a result of:
  - Spills and incidents,
  - Intercepting contaminated groundwater,
  - Groundwater treatment - Surface water impacts as a result of discharges the groundwater collection & discharge system,
  - Saline intrusion.
- Impacts to utilities, and
- Cumulative impacts.

Some impacts on groundwater attributable to the Project are anticipated and predicted in the groundwater model (AECOM 2017). Relevant aspects and the potential for related impacts have been considered in a risk assessment in Annexure B of the CEMP. Section 7 of this GMP provides a suite of mitigation measures that will be implemented to avoid or minimise those impacts.

6.2.2. Reduced groundwater recharge

The majority of the Project is below ground and will not directly impact groundwater recharge from rainfall.

The majority of the above ground footprint at Rozelle Rail Yards will be turned over as open space. The above ground built infrastructure footprint represents a small increase including the motorway operations complexes, ventilation infrastructure, substations, and WTP. Given the scale of the above ground footprint a reduction in rainfall recharge is considered negligible (AECOM 2017).

6.2.3. Groundwater level decrease

6.2.3.1. Groundwater drawdown

Construction of drained tunnels beneath the water table is expected to cause ongoing groundwater inflow to the tunnels, inducing groundwater drawdown along the tunnel alignment. Actual groundwater level drawdown would be dependent on a number of factors, including proximity to the tunnel alignment and the specific geological conditions present (AECOM 2017).

In accordance with REMM GW9 investigations (e.g. groundwater monitoring, pump tests, advanced probing) will occur to identify areas where groundwater inflows to the tunnels are likely to be elevated, to guide the development of the detailed design and construction methodology. Groundwater monitoring (i.e. standpipes, piezometers) is currently being undertaken in accordance with the GWMP. The need for additional investigations (e.g. advanced probing, pump tests), including the frequency and location of those investigations, will be identified in the detailed design, and the results will inform construction methodology.

High groundwater inflow during excavation is possible in faulted or fractured zones such as beneath the Rozelle Rail Yard (Whites Creek paleochannel) and in the alluvium (AECOM 2017). Targeted grouting will be undertaken as required through the construction program reducing tunnel inflow.

Potential groundwater drawdown due to the Project construction (to proposed opening in 2023) has been predicted in the groundwater model (see Section 9.2) and the regional extent of the drawdown impacts due to tunnel construction would be minimal considering the generally low hydraulic conductivity of the Hawkesbury Sandstone restricting the extent of drawdown during the relatively short construction time frame (AECOM 2017). Groundwater inflows at the Rozelle interchange are expected to be further restricted, due to the proximity and number of tunnels, ultimately distributing available groundwater across multiple drained systems. Expected total groundwater drawdown is summarised below:

- At the end of construction, the maximum drawdown is predicted to be 42 metres centred on the Rozelle interchange,
- Predicted drawdown centres are discontinuous along the alignment and are a reflection of tunnel depth and timing of excavation, as well as geological boundaries,
- Drawdown is predicted to be up to 10 m within the alluvium. Tunnels have been designed along relevant sections of the Project alignment to ensure that there will be minimal inflow from the alluvium into the tunnels. This would be achieved by providing potential additional measures, such as targeted grouting as required where the portals and cut-and-cover sections intersect alluvium, such as at Rozelle Rail Yards, and
- While the impacts are localised, with two metres or more drawdown extending no further than around 600 metres from the tunnels, the groundwater sink predicted to develop would create a hydraulic barrier along the length of the tunnel alignment, reversing groundwater gradients

6.2.3.2. Potential impacts to Groundwater Dependent Ecosystems

6.2.3.2.1. Priority Groundwater Dependent Ecosystems

No priority GDEs are likely to be impacted by groundwater level decrease associated with either the construction or the long-term operation of the Project.

6.2.3.2.2. Non-priority Groundwater Dependent Ecosystems

The manmade wetland constructed at Whites Creek Valley Park at Annandale, immediately west of Whites Creek is unlikely to be impacted during construction because the tunnels are below the alluvium unit.

Areas where the water table is shallow, such as at the Rozelle Rail Yards, are typically subjected to periodic flood inundation, which would provide water for shallow rooted plants that may have some groundwater dependence. Continued flood inundation would recharge to the alluvium, although flows would be reduced due to the installation of flood mitigation measures as part of the project.

In low-lying areas, such as the Rozelle Rail Yards or close to Rozelle Bay the availability of water for plants is not expected to change, given the high permeability of the sandy soils in combination with frequent rainfall events and higher recharge than elevated sites. The above assessments will be confirmed in the GMR, developed in accordance with condition of approval E193, which will assess the impacts of groundwater drawdown on groundwater dependant ecosystems. The GMR will be developed in consultation with DPIE Water and provided to The Secretary prior to the finalisation of the tunnel design. The GMR will identify if additional mitigations measures are required to prevent adverse impacts on groundwater dependant ecosystems.

6.2.3.3. Potential impacts on surface water baseflow

Groundwater modelling (AECOM 2017) indicated that the overall contribution to flow to surface watercourses from groundwater is relatively small, since the watercourses are mostly concrete lined channels. It is expected that the majority of stream flow would be derived from rainfall runoff and tidal inflow. Groundwater inflows to the tunnels that would have the potential to impact surface water levels are unlikely for the section of the tunnels that would be constructed through the Whites Creek alluvium beneath the Rozelle Rail Yards. Permanent works tunnels excavated through the alluvium in the Rozelle Railyards will have engineering measures such as i targeted grouting of the alluvium to mitigate groundwater inflow where required. Interaction between the tunnel and surface water baseflow is also minimised as Whites Creek and Eastern Channel (the principal surface water creeks near proposed tunnel in alluvium) are concrete lined culverts / stormwater pipes and have negligible interaction with groundwater.

Sydney Water is proposing in the future to naturalise parts of Whites Creek. The Project will naturalise the short section between The Crescent and Rozelle Bay. Removal of sections of the concrete-lined base would allow more groundwater and surface water interaction, leading to a higher contribution of baseflow to surface water flow in the creeks, and additional surface water recharge via bed leakage when the water table is below the creek bed (AECOM 2017).

6.2.3.4. Ground movement (settlement)

Ground movement (settlement) or subsidence can be caused by the compression of the soil structure due to groundwater drawdown. Within the footprint of the Rozelle Interchange, natural soils are classified as part of the Gymea residual soil profiles that developed on the weathered Hawkesbury Sandstone bedrock. These soils are typically thin, stiff or medium dense to dense, and of limited compressibility, and as such would be less susceptible to ground settlement. Settlement within the alluvium would be dependent on the amount of groundwater drawdown and is expected to be negligible due to design measures for the shafts, including constructing tanked shafts through the alluvium to minimise groundwater ingress if required. Cut and cover structures through Rozelle Rail Yards are designed to include a lining between the road and soil which mitigates groundwater ingress, which would reduce potential settlement.

During tunnel construction, the bulk hydraulic conductivity of the Hawkesbury Sandstone would decrease due to local and in places global ground support of the tunnel crown and shoulders, decreasing groundwater inflow and thereby reducing potential settlement.

Small scale dewatering of the alluvium and Hawkesbury Sandstone may be required during construction. This could result in an increase in effective stress, leading to ground settlement. Movement in clay soils between hydrogeological units would cause both consolidation settlement and creep settlement, which may result in settlement continuing over an extended period.

6.2.4. Groundwater quality

6.2.4.1. Spills and incidents

There is potential to contaminate groundwater through incidents associated with the storage of hazardous materials or refuelling operations at the surface, particularly if a leak or incident occurs over the alluvium, a palaeochannel, or fractured sandstone. Stockpiling of construction materials may also introduce contaminants that could potentially leach into and contaminate local groundwater (AECOM 2017).

The risks to groundwater as a result of such incidents would be managed through construction management procedures in accordance with the CEMP. Runoff from high rainfall events during construction would be managed in accordance with the measures outlined in the Soil and Surface Water Management Sub-plan (SSWMP). Following high rainfall events, groundwater quality impacts would be minor, as the majority of runoff would discharge to receiving waters. Environmental control measures are listed in Section 7.2 and management and mitigation measures in Table 8.

6.2.4.2. Intercepting contaminated groundwater

There are pockets of soil contamination present across the Project, including within the Rozelle Rail Yards that could contaminate groundwater through the migration of contaminated groundwater plumes towards the tunnels. In general, the risk of intersecting contaminated groundwater decreases with tunnel design depth.

Historic information and limited site investigations indicate the presence of light non-aqueous phase liquid within a relatively small area in the centre of the Rozelle civil and tunnel compound. Tunnelling and portal structures are not expected to intersect this area. A Phase 2 Environmental Site Assessment, in accordance with the Soil and Surface Water Sub Plan, will identify the need for controls or remediation.

In areas where tunnels are to be constructed within the alluvium and palaeochannels, including at the Rozelle Rail Yards, additional mitigation measures including targeted grouting to limit permeability in hydraulic conductive ground and engineered structures such as soldier pile walls and diaphragm walls will be implemented to restrict groundwater ingress from the alluvium entering the tunnels where required.

Where groundwater does enter the tunnels, it is to be pumped and treated at designated water treatment plants before discharge back into the receiving environment. Discharge criteria are outlined in Chapter 17 (AECOM 2017) and Section 3.3 of the GWMP (Annexure B).

Shallow groundwater is likely to be encountered during ground excavation works for the tunnels at the Rozelle Rail Yards. Shallow groundwater requiring treatment will be minimised as excavations will be designed with engineering controls such as shotcrete supplemented concrete soldier pile walls at the edge of excavation mitigating inflow. Shallow groundwater requiring off-site disposal will be treated and tested to ensure compliance with either; a Sydney Water Trade Waste Agreement if in place, or if discharged to the environment in accordance with CoA E186 which requires water discharged from the construction water treatment plant must comply with the ANZECC (2000) 90 per cent species protection level unless the EPL is in force.

6.2.4.3. Groundwater treatment and surface water impacts

The existing groundwater quality within the Project area is described in Section 5.5. In order to prevent adverse impacts on downstream surface water quality, WTPs will be installed at three locations at Rozelle civil and tunnel site. WTPs will be designed so that the quality of the discharge will be in compliance with the ANZECC derived discharge criteria or the Project EPL. The GWMP provides further detail on the design and discharge criteria for the WTPs (refer Section 7.1 of this GMP and Section 3.3 in Annexure B).

6.2.4.4. Groundwater associated with Potential Acid Sulfate Soils

Potential acid sulfate soils (PASS) have been identified within natural alluvium sediments beneath the Rozelle Rail Yards. Construction activities in areas of identified PASS may cause the generation of acidic leachate, increasing the acidity of the local groundwater. Any excavation of PASS material would be managed under an Acid Sulfate Soils Management Plan (ASSMP) as discussed in Chapter 15 (AECOM 2017) and provided in SSWMP.

6.2.4.5. Soil salinity impacting groundwater

Salts are naturally present in soil and rock and can be mobilised in the subsurface by the movement of groundwater. Salt concentrations within the Hawkesbury Sandstone and alluvium are typically variable, with concentrations within the alluvium impacted by tidal influences (seawater).

During the construction of the Rozelle Interchange, there is potential for salts within the Whites Creek alluvium to be mobilised by local dewatering, particularly at the Rozelle Rail Yards and proximal to Whites Creek. Inflow mitigations installed by the Project may cause an impediment to groundwater flow, resulting in localised mounding of the groundwater, which may lead to the dissolution of soil salts. Saline groundwater resulting from the dissolution of soil salts within the Whites Creek alluvium is to be directed towards the modified drainage system. This will remove the mobilised salts from the system (AECOM 2017).

6.2.4.6. Saltwater intrusion

Over time, saline intrusion is predicted to result in saline water reaching the tunnels. The proportion of saline water flowing into the tunnels, however, would be low during the relatively short construction phase. In addition, the groundwater along the tidal fringe is naturally saline, and the additional slow increase in salinity is unlikely to impact the environment.

A capture zone analysis has been undertaken as part of the groundwater modelling (AECOM 2017) to investigate salt water intrusion within the tunnel catchment areas. From this analysis it was not possible to quantify volumes or concentrations of saline water entering the tunnels and therefore the following discussion is based on a qualitative analysis.

6.2.4.6.1. Tidal zones

The groundwater model (AECOM 2017) predicts that saline groundwater from the Parramatta River will enter the tunnels at the Rozelle Interchange. Groundwater levels are predicted to decrease below sea level therefore saline waters from tidal zones would flow towards the tunnels and would ultimately enter the tunnels via a hydraulic connection with the alluvium. Initially, the saline water would represent a small fraction of total groundwater entering the tunnels during construction that will continue to increase over time.

Average times for saline water to enter the tunnels are predicted to be more than 100 years with an upper limit expectancy in the order of thousands of years. As a result, groundwater in the tunnel catchment zones would gradually become saline over thousands of years. Since the operational lifetime for major infrastructure is in the order of 100 years, the slow salinity increase should have minimal impacts on the tunnels and infrastructure in the Project’s operational lifetime, and negligible impacts during construction.

Groundwater quality (salinity as Electrical Conductivity (EC)) during construction will be routinely monitored at key locations between saline water bodies and the tunnel as identified by the Project groundwater model (AECOM 2017).

Details of the construction groundwater quality monitoring program are presented in the GWMP (refer Section 3 in Annexure B of this GMP).

6.2.5. Utilities

The Project would involve works that would include the protection of existing utilities, construction of new utilities, and relocation of existing utilities. The majority of the utility works for the Project are very shallow in existing roads and footpaths above the groundwater table. The impacts associated with the Project are likely to be negligible.

6.2.6. Cumulative impacts

A cumulative impact assessment was undertaken for the EIS (AECOM 2017). The assessment:

- Used the groundwater model to predict the cumulative impacts on groundwater due to the Project in combination with other WestConnex tunnel projects (M4 East and New M5)
- Qualitatively assessed the cumulative impacts of the Project, other WestConnex projects, and other proposed infrastructure projects (Sydney Metro City and Southwest).

6.2.6.1. WestConnex projects

During construction, cumulative impacts on groundwater would be greatest at either end of the Project alignment where the Project tunnels would overlap with the tunnels for the M4-M5 Link. Once all three of these WestConnex tunnel projects are operational, cumulative groundwater drawdown impacts due to the three tunnel projects are not predicted to be greater than in any one section of the overall Project footprint (AECOM 2017).

The tunnels and associated lining for each project would be designed and constructed to comply with the groundwater inflow criterion of one litre per second per kilometre for any kilometre length of tunnel. Consequently, the groundwater inflows along the tunnels would vary within a known range. A comprehensive GWMP would be required for each project to confirm that the actual inflows do not exceed the criterion and drawdown does not exceed predictions. The GWMP for the project is provided as Annexure B of this GMP.

Long-term cumulative groundwater tunnel inflows due to the WestConnex tunnel projects may cause groundwater salinity to increase due to surface water from tidal reaches being drawn into or towards the tunnels. Initially, as discussed in Section 6.2.4.6. the saline water would be a small fraction of total tunnel ingress, but this is expected to increase over time as water is drawn from further afield, although it is expected to always be a minor component of total inflow volume and negligible during construction.

6.2.6.2. Other relevant projects

The Sydney Metro tunnels are to be constructed as tanked tunnels resulting in negligible impacts on groundwater drawdown. The station boxes are to be constructed and operated as drained shafts and will extract groundwater over time. The closest drained structure is proposed at Rozelle which is close to the boundary of the Project, and it is considered unlikely to have significant cumulative impacts on groundwater drawdown in the Project area. There is potential for the concrete lined tunnels of the Sydney Metro project to create a partial hydraulic barrier to groundwater flow, however the risk is considered low since the tunnels are constructed below the water table.

The Western Harbour Tunnel is currently preparing an EIS for a new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting WestConnex at Rozelle and the existing Warringah Freeway at North Sydney. Sydney Metro is investigating options for new intermediate stations at Camellia/Rydalmere, North Burwood/Five Dock/Kings Bay and Pyrmont, known as the Sydney Metro West Project.

This plan will be updated when more information of the Western Harbour Tunnel and the Sydney Metro West Project become readily available.

6.2.7. Construction monitoring

A GWMP has been developed to describe how JHCPB propose to monitor potential impacts to groundwater during construction of the Project (refer Section 3.2 of Annexure B).

7. Environmental control measures

7.1. Water treatment

Water treatment forms a key environmental control measure. Groundwater captured during construction of the Project will be treated at three WTPs at the Rozelle civil and tunnel site (C5). The WTPs will be of a modular design so that they can be modified if required to meet design requirements. WTPs will be designed so that the water will be of suitable quality for discharge to the receiving environment in compliance with the relevant discharge criteria. In accordance with CoA E186 water to be discharged from the water treatment plant must comply with the ANZECC (2000) 90 per cent species protection level unless the EPL is in force.

Refer to Section 3.3 of the GWMP for more details regarding monitoring of discharge volume and discharge water quality and relevant discharge criteria.

The WTPs will undergo commissioning and testing to determine the treatment efficacy of the WTP. During commissioning of each of the WTPs, a minimum of two rounds of commissioning sampling will be undertaken to confirm their efficacy. The WTPs will not be deemed commissioned until the two rounds of commissioning sampling demonstrate compliance with the criteria.

Monthly sampling will be undertaken to ensure that each of the WTPs continues to meet design specifications. The results will be reviewed by trained personnel to ensure that the discharged water meets discharge criteria. Where in-line sensors (typically pH and turbidity) or monitoring identify WTPs performance drift outside of the required criteria measures will be implemented to return the WTPs performance back into the required range. In these instances, water will be retreated to meet appropriate discharge criteria, discharged to trade waste (where permitted), re-used on site (e.g. dust suppression) or disposed offsite at an appropriate licenced liquid waste facility.

Water quality results and an overview of corrective actions will be reported in the six-monthly water monitoring report.

Procedures relating to the management of the WTPs will also be prepared and implemented in an Environmental Work Method Statement (EWMS).

7.2. Other environmental control measures

Specific measures and requirements to meet the objectives of this GMP (refer Section 2.2) and to address impacts on groundwater are outlined in Table 6. Based on the mitigation and management measures it is considered that potential groundwater impacts that may arise as a result of the construction of the Project can be effectively managed.

Table 6: Groundwater management and mitigation measures

ID	Measurement/ requirement	When to implement	Responsibility	Reference	Evidence
GWMM1	The tunnels will be designed so there will minimal groundwater inflow from the alluvium (and palaeochannels) into the tunnels.	Design Construction	Design Manager	EIS section 19.5 REMM GW1	Tunnel design
GWMM2	Further assessment of the risk posed by the presence of sulfate reducing bacteria and groundwater aggressivity will be undertaken prior to construction. A corrosion assessment will be undertaken to assess the impact on building materials that may be used in the tunnel infrastructure such as concrete, steel, aluminium, stainless steel, galvanised steel, and polyester resin anchors. The outcomes of the corrosion assessment will be considered when selecting building materials likely to encounter groundwater.	Pre-construction	Design Manager	EIS Section 19.5 REMM GW4	Corrosion assessment / durability report
GWMM3	Potential impacts associated with subsurface components of the Project intercepting and altering groundwater flows and levels will be considered during detailed design. Measures to reduce potential impacts will be identified and included in the detailed construction methodology and the detailed design as relevant.	Design	Design Manager	EIS Section 19.5 REMM GW6	Tunnel design
GWMM4	A detailed groundwater model will be developed by JHCPB. The model will be used to predict groundwater inflow rates and volumes within the tunnels and groundwater levels (including drawdown) in adjacent areas during construction and operation of the Project.	Pre-construction	Design Manager	CoA E192 REMM GW7	Groundwater modelling report
GWMM5	Groundwater inflow and groundwater levels in the vicinity of the tunnels will be monitored during construction and compared to model predictions and groundwater performance criteria applied to the Project. The groundwater model will be updated based on the results of the monitoring as required and proposed management measures to minimise potential groundwater impacts adjusted accordingly to ensure that groundwater inflow performance criteria are met.	During construction	Environment & Sustainability Manager Design Manager	REMM GW8	Groundwater model updates
GWMM6	Further investigations (e.g. groundwater monitoring, advance probing, pump tests) will be carried out to identify areas where groundwater inflows to the tunnels are likely to be higher, to guide the development of the detailed design and construction methodology. The investigations will be carried out prior to the commencement of excavations with the potential to result in groundwater inflow at each identified location.	Pre-construction Construction	Design Manager	REMM GW9	Tunnel design

ID	Measurement/ requirement	When to implement	Responsibility	Reference	Evidence
GWMM7	In order to prevent adverse impacts on downstream surface water quality, water treatment plants will be designed so that the effluent will be of suitable quality for discharge to the receiving environment in compliance with the discharge criteria (Section 3.3 of the Annexure B),), the Project EPL, and if applicable, JHCPB's trade waste licence.	Pre-construction and during construction	Construction Manager	CoA E186 REMM SW10	Water monitoring reports
GWMM8	Site-specific trigger values (SSTV) for electrical conductivity (EC) have been developed for each water quality monitoring bore using the baseline data from the EIS (AECOM 2017). The SSTV's were derived by calculating the 80th percentile values of the baseline EC data (refer Section 4.2 of Annexure B). The SSTV's provide an easily identifiable indication of a change in salinity. A management response would be initiated if any of the following occurs: • The EC data continuously exceeds the SSTV over the period of three months and depicts a rising trend • The EC data exceeds the SSTV at any time by more than 100% In the event that one or both of the above EC trigger exceedances are recorded, a review will be initiated to determine the significance of the exceedance(s) and possible causes. The review will assess the historical and surrounding monitoring bore data, and modelling predictions. If the exceedance is determined to be attributable to Project works and outside of modelling predictions for saline intrusion, additional management measures (including review of the groundwater model) may be implemented in consultation with the relevant authorities.	During construction	Environment & Sustainability Manager	CoA C5 CoA C10	Groundwater monitoring reports
GWMM9	Groundwater level decreases outside of the seasonal fluctuation will be assessed and compared against predicted drawdown as simulated in the groundwater model (refer Section 4.2.2 of Annexure B). The assessment will determine whether the observed decrease is attributable to the Project and, if so, whether it aligns with approved predictions. If drawdown is identified outside of model predictions, management actions will be initiated including (but not limited to) a review of baseline groundwater level data in the relevant and surrounding monitoring bores as well as an assessment of groundwater inflow rates into the tunnel.	During construction	Environment & Sustainability Manager Design Manager	CoA E192 REMM GW7 REMM GW8	Groundwater monitoring reports
GWMM10	Identification of a groundwater decrease (beyond seasonal fluctuations in nearby monitoring bores) will be monitored to determine whether the decrease is attributable to dewatering from the Project. The assessment will include a review of groundwater levels in the surrounding monitoring bore network. Where an impact is confirmed, in accordance with the Aquifer Interference Policy (NoW 2012), measures will be taken to 'make good' the impact on an impacted water supply bore. The measures taken could include, for example,	During construction	Environment & Sustainability Manager	CoA E192 REMM GW5	Groundwater monitoring reports

ID	Measurement/ requirement	When to implement	Responsibility	Reference	Evidence
	deepening the bore, providing a new bore or providing an alternative water supply. 'Make good' will only apply to registered bore users.				
GWMM11	In zones where the inflow rates are anticipated to exceed one litre per second per kilometre for any kilometre length of tunnel, detailed design and / or construction methodology techniques will be implemented to limit permeability as required to reduce ongoing groundwater inflow.	During construction	Construction Manager	CoA E190 REMM GW2	Construction reports
GWMM12	Groundwater quality (salinity as Electrical Conductivity (EC)) during construction will be routinely monitored at a minimum of two key locations in consultation with The Water Group between saline water bodies and the tunnel as identified by the groundwater model (AECOM 2017).	During construction	Environment & Sustainability Manager	CoA C12 (d)	Groundwater monitoring results
GWMM13	Groundwater intercepted during construction will be managed by either capturing the water that enters the tunnels, caverns and portals, or by other suitable measures. All captured inflow will be treated prior to discharge (refer Section 7.1 and Section 3.3 in Annexure B).	During construction	Construction Manager	EIS Section 19.5	Site inspection report
GWMM14	The groundwater model will be used to predict influences on the Project as well as the cumulative impacts from the other WestConnex projects and local infrastructure projects.	Pre-construction and during construction	Design Manager	CoA C5(d)	Groundwater modelling report
GWMM15	A geotechnical model of representative geological and groundwater conditions will be prepared prior to excavation and tunnelling to identify geological structures and groundwater features to assess the cumulative predicted settlement, ground movement, stress redistribution and horizontal strain profiles caused by excavation and tunnelling, including groundwater drawdown and associated impacts, on adjacent surface and sub-surface structures.	Pre-construction and during construction	Design Manager	CoA E101	Geotechnica l modelling report

8. Compliance management

8.1. Roles and responsibilities

The JHCPB Project Team's organisational structure and overall roles and responsibilities are outlined in Section 3.3 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Table 6 of this Plan.

8.2. Training

All employees, contractors and utility staff working on site will undergo site induction training relating to relevant aspects of this Plan, particularly construction risks which have the potential to impact on groundwater resources.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in groundwater management. Groundwater specific training will include:

- Groundwater monitoring methodology and protocols (refer Section 5 of Annexure B), and
- Project obligations including requirements to assess and classify contamination on site.

Further details regarding staff induction and training are outlined in Section 3.5 of the CEMP.

8.3. Monitoring and inspection

Section 3 of the GWMP (Annexure B) provides detailed inspection criteria including:

- Groundwater monitoring locations,
- Parameters/analytes to be monitored,
- Type of monitoring,
- Frequency of monitoring, and
- Monitoring methodology.

Additional requirements and responsibilities in relation to inspections are documented in Section 3.3.1 of the CEMP.

8.4. Licenses and permits

The Project construction activities will be regulated by an EPL issued by the EPA. The EPL typically prescribes water quality parameters to be measured and associated discharge criteria from licensed discharge points. They also detail the monitoring and analytical requirements by reference to authority publications (e.g. Methods for Sampling and Analysis of Water Pollutants in NSW (EPA 2004)).

Other relevant licences or permits will be obtained in the lead up to and during construction as required.

8.5. Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this Plan, CoA and other relevant approvals, licenses, and guidelines.

Audit requirements are detailed in Section 3.9.3 of the CEMP.

8.6. Reporting

Reporting requirements relevant to this GMP are outlined in Table 7 as well as data provision requirements.

Additional reporting requirements for the Project are outlined in Section 3.9 of the CEMP.

Table 7: Reporting requirements

Schedule (during construction)	Requirements	Recipient (relevant authority)
Reporting		
Water monitoring reports (every six months)	Data summary reports presenting tabulated groundwater monitoring data collected during the reporting period. Groundwater level hydrographs (including rainfall) and water quality (EC) results will be presented and SSTV exceedances will be highlighted. Metres of ground excavated and flow rates during construction will be presented. Applicable management responses will be documented. Compliance against discharge criteria will also be presented. Report will present validation of groundwater modelling and determine the need for any necessary adjustments to the GWMP (Annexure B).	DPIE, DPIE Water, Sydney Water, Port Authority of NSW
EPL Monitoring Reports and Annual Returns	EPL monitoring data reports will be prepared in accordance with the requirements of the EPL. An EPL Annual Return will be prepared in respect of each EPL reporting period (typically 12 months).	EPA
Data provision		
Quarterly (every 3 months)	WTP discharge water quality and flow data (raw data collated and tabulated in Excel) To demonstrate compliance with the CoA (C12(f)), project discharge criteria (defined in Section 7.1 this Plan and Section 3.3 of the GWMP), EPL, and if applicable JHCPB's trade waste licence.	Sydney Water
Quarterly (every 3 months)	Groundwater level and groundwater quality (EC) monitoring data (raw data collated and tabulated in Excel) To demonstrate compliance with the CoA (C12(g)).	DPIE Water (formerly DoI Water)

9. Review and improvement

9.1. Continuous improvement

Continuous improvement of this Plan will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance
- Determine the cause or causes of non-conformances and deficiencies
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies
- Verify the effectiveness of the corrective and preventative actions
- Document any changes in procedures resulting from process improvement
- Make comparisons with objectives and targets.

9.2. Groundwater model update

The results of the groundwater modelling will be documented in a GMR. The GMR will be finalised in accordance with the Australian Groundwater Modelling Guidelines (National Water Commission, 2012) and prepared in consultation with DPIE Water.

The groundwater model will be updated once 24 months of construction groundwater monitoring data are available and the results of the updated modelling provided to the Secretary and DPIE Water in an updated GMR.

9.3. GWMP update and amendment

The processes described in Section 3.13 of the CEMP may result in the need to update or revise this Plan. The groundwater model update (Section 9.2) may result in the need to update or revise this Plan. Plan updates will occur on an as needed basis.

Only the Environment and Sustainability Manager, or delegate, has the authority to change any of the environmental management documentation. All amendments to environmental management documentation require endorsement from the Environmental Representative. Minor updates may be approved by the Environmental Representative.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 3.11.2 of the CEMP.

9.4. WTP performance

Performance criteria for water to be discharged from the WTP during the construction stage were developed in accordance with CoA E186. The discharge criteria for turbidity, and oil and grease reflect standard EPL requirements for discharges from sedimentation basins. The pH criteria are the default trigger values for chemical and physical stressors for estuaries in South east Australia (refer Table 3.3.2 of ANZECC 2000). Estuarine triggers values are used as the salinity in the receiving environment is typical of the salinity found in estuaries.

The performance criteria for monthly WTP discharge samples are the default trigger values for the protection of 90% of marine species (cadmium, chromium, copper, lead, mercury, nickel and zinc); and for the protection of recreational water quality (iron) as listed in Tables 3.4.1 and 5.2.3 of ANZECC 2000 respectively.

10. References

AECOM, 2017. M4-M5 Link: Groundwater Monitoring Interpretative Report, August 2017

AECOM, 2018. M4-M5 Link Rozelle Rail Yards - Tranche 5: Groundwater Contamination Sampling, April 2018

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC), 2000.Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Bureau of Meteorology (BoM) 2012. National Atlas of Groundwater Dependent Ecosystems

Department of Land and Water Conservation (DLWC), 2002. NSW Groundwater Dependent Ecosystems Policy.

DLWC, 1998. NSW Groundwater Policy Framework Document. DLWC, 1998. NSW Groundwater Quality Protection Policy.

DLWC, 1997. NSW Groundwater Quantity Management Policy.

Department of Planning, Industry and Environment (DPIE), 2012. Guideline for riparian corridors on waterfront land.

Department of Water and Energy (DWE), 2007. NSW Water Extraction Monitoring Policy.

Environment Protection Authority (EPA), 2004. Approved Methods for the Sampling and Analysis of Water Pollutants in NSW.

Lendlease, Samsung C&T and Bouygues Construction Australia Joint Venture (LSBJV), 2018. Appendix B6 Groundwater Management Sub-plan, M4-M5 Link Mainline Tunnels, November 2018.

McKibbin D & Smith PC 2000, ‘Sandstone Hydrogeology of the Sydney Region’, proceedings of the 15th Australian Geological Convention, Sandstone City – Sydney’s Dimension Stone and other Sandstone Geomaterials, in EEHSG Geological Society of Australia. Monograph No. 5, GH McNally & BJ Franklin (eds).

NSW Office of Water (NoW), 2011. Water Sharing Plan, Greater Metropolitan Regional Groundwater Sources Background Document, Sydney.

NSW Roads and Maritime Services, 2017. M4-M5 Link Environmental Impact Statement, August 2017.

NoW, 2012. NSW Aquifer Interference Policy.

Roads and Maritime Services (Roads and Maritime), 2011. Road and Maritime Dewatering Guideline.

Annexure A Conditions of Approval

Table 8: Other Conditions of Approval relevant to the development of this Sub-plan

CoA No.	Condition Requirements	Document Reference
C4	The following CEMP Sub-plans must be prepared in consultation with the relevant authorities identified for each CEMP Sub-plan and be consistent with the CEMP referred to in the EIS. **Required CEMP Sub-plan** / **Relevant authority(s) and council(s) to be consulted for each CEMP Sub-plan** f) Groundwater — DPI Water *Port Authority of NSW to be consulted when considering impacts on port land.	This plan
C9	The following Construction Monitoring Programs must be prepared in consultation with the relevant authorities identified for each Construction Monitoring Program to compare actual performance of construction of the CSSI against predicted performance. **Required Construction Monitoring Programs** / **Relevant authority(s) and council(s) to be consulted for each Construction Monitoring Program** b) Groundwater Monitoring Program — DPI Water, Sydney Water and relevant council(s)	Annexure B
C10	Each **Construction Monitoring Program** must provide: (a) details of baseline data available; (b) details of baseline data to be obtained and when; (c) details of all monitoring of the project to be undertaken; (d) the parameters of the project to be monitored; (e) the frequency of monitoring to be undertaken; (f) the location of monitoring; (g) the reporting of monitoring and analysis results against relevant criteria; (h) details of the methods that will be used to analyse the monitoring data; (i) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and (j) any consultation to be undertaken in relation to the monitoring programs.	a) Annexure B of the GWMP b) Section 3.1 of the GWMP c) Section 3.2 of the GWMP d) Section 3.3.1 of the GWMP e) Section 3.2 and Section 4 of the GWMP f) Section 3.2 of the GWMP g) Section 5.1.4 of the GWMP h) Section 5.1.2 of the GWMP i) Section 6 of the GWMP j) Section 2.3 of the GWMP
C12	The **Groundwater Monitoring Program** must include: (a) daily measurement of the amount of water discharged from the water treatment plants; (b) water quality testing of the water discharged from the water treatment plants; (c) monitoring of groundwater pore pressures in the Hawkesbury Sandstone aquifers adjacent to the tunnel alignment, in consultation with DPI Water;	a) Section 4.4 and Section 3.3.2 of the GWMP b) Section 3.3.2 of the GWMP c) Section 3.2 of the GWMP

CoA No.	Condition Requirements	Document Reference
	(d) monitoring of groundwater electrical conductivity in key locations between saline water bodies and the tunnel as identified by the project groundwater model including: (i) in the Haberfield / Lilyfield area to the south of Iron Cove, (ii) in the Rozelle area to the north of Rozelle Bay, (iii) in the Annandale area to the west of Rozelle Bay, (iv) in the Rozelle area to the south east of Iron Cove, and (v) in the St Peters area to the north west of Alexandra Canal, with a minimum of two (2) groundwater monitoring wells to be provided in each key location in consultation with DPI Water; (e) measures to record or otherwise estimate and report groundwater inflows into the tunnels during their construction; (f) a method for providing the data collected in (a) and (b) to Sydney Water every three (3) months to demonstrate the project's compliance with the discharge criteria and, if applicable, the Proponent's trade waste licence, (g) a method for providing the groundwater monitoring data to DPI Water every three (3) months during construction, and (h) the installation of a minimum of two (2) groundwater open hole monitoring wells in the north Rozelle / Lilyfield area to the west of the ventilation tunnel at Iron Cove to monitor groundwater quality and groundwater levels, in consultation with DPI Water.	d) Section 4.3 of the GWMP e) Section 3.2.4 and Section 3.3.1 of the GWMP f) Table 9 of the GWMP and Table 6 of this plan g) Table 9 of the GWMP h) Section 3.2.2 and Section 3.2.3 of the GWMP
E101	A geotechnical model of representative geological and groundwater conditions must be prepared prior to excavation and tunnelling to identify geological structures and groundwater features. The model must include details of proposed excavations and tunnels, construction staging, and identify surface and sub-surface structures, including any specific attributes, which may be impacted by the CSSI. The Proponent must use this model to assess the cumulative predicted settlement, ground movement, stress redistribution and horizontal strain profiles caused by excavation and tunnelling, including groundwater drawdown and associated impacts, on adjacent surface and sub-surface structures.	Table 5 GWMM15
E186	The CSSI construction water treatment plant discharge criteria must comply with the ANZECC (2000) 90 per cent species protection level unless an EPL is in force in respect to the CSSI. Discharge criteria for iron during construction must comply with the ANZECC (2000) recreational water quality criteria.	Table 6 GWMM7 Section 9.4
E190	The Proponent must take all practicable measures to limit operational groundwater inflows into each tunnel to no greater than one litre per second across any given kilometre (1L/s/km). Compliance with this condition cannot be determined by averaging groundwater inflows across the length of the tunnel.	Table 6 GWMM11
E191	The Proponent must identify and commit to the implementation of 'make good' provisions for groundwater users in the event of a decline in water supply levels, quality and quantity from registered existing bores associated with groundwater changes from either construction and/or ongoing operational dewatering caused by the CSSI.	Table 6 GWMM10
E192	The Proponent must undertake further modelling of groundwater drawdown, tunnel inflows and saline water migration (using particle tracking) prior to finalising the design of the tunnels and undertaking any works that would impact on groundwater flows or levels. The modelling must be undertaken in consultation with DPI Water and include the results and hydrogeological analyses of at least 12 continuous months of current baseline groundwater monitoring data from bores identified in the EIS and SPIR. The modelling must also include data from any other existing monitoring bores identified in consultation with DPI Water, as required to supplement baseline data.	Table 6 GWMM4 Section 9.2

CoA No.	Condition Requirements	Document Reference
E193	The results of the groundwater modelling must be documented in a Groundwater Modelling Report. The Groundwater Modelling Report must be finalised in accordance with the Australian Groundwater Modelling Guidelines (National Water Commission, 2012) and prepared in consultation with DPI Water. The Groundwater Modelling Report must include, but not be limited to: (a) justification for layer choice; (b) specification and justification of the grid based hydraulic conductivity and storage parameters (specific yield and specific storage) assigned to each layer and/or zone with reference to those values determined from data analyses and the literature; (c) an explanation of how groundwater flow was simulated within each model layer with reference to confined, unconfined or variably saturated flow solutions; (d) an explanation and justification of the drain-cell conductance term(s) applied to the tunnel boundaries to limit tunnel inflows; (e) an explanation and justification of the groundwater recharge values applied across the model domain, including around the modelled specific yield values and the water table fluctuations observed within the monitoring data in response to rainfall-fed groundwater recharge; (f) details (including figures) of the expected changes in groundwater flow directions in the vicinity of landfills, groundwater wells and surface water receptors; (g) cross-section diagrams of geology showing baseline groundwater levels in the monitoring piezometres, and for the predicted baseline condition groundwater levels in 2030 and 2100; (h) statistical evaluation of the model's calibration; (i) details of the groundwater monitoring data inputs (levels and quality); (j) details of the proposed groundwater model update and validation as additional data is collected; (k) assessment of impacts of groundwater drawdown, taking into consideration the NSW Aquifer Interference Policy (DPI, 2012), including potential impacts on licensed bores and groundwater dependent ecosystems; (l) a comparison of the results with the modelling results detailed in the documents referred to in Condition A1; and (m) documentation of any additional measures that would be implemented to manage and/or mitigate groundwater impacts not previously identified. A copy of the Groundwater Modelling Report must be submitted to the Secretary prior to finalising the tunnel design. The Groundwater Modelling Report must include details of consultation with DPI Water.	Table 6 GWMM4 Section 9.2
E194	The groundwater model must be updated once 24 months of construction groundwater monitoring data are available and the results of the updated modelling provided to the Secretary and DPI Water in an updated Groundwater Modelling Report.	Section 9.2

Table 9: Revised Environmental Mitigation Measures relevant to the development of this Sub-plan

Outcome	Ref#	Commitment	Timing	Reference
Impacts on water quality from the discharge of	SW10	Temporary construction water treatment plants will be designed and managed so that treated water will be of suitable quality for discharge to the receiving environment.	Construction	Table 6 GWMM7

Outcome	Ref#	Commitment	Timing	Reference
treated wastewater during construction		An ANZECC (2000) species protection level of 90 per cent is considered appropriate for adoption as discharge criteria for toxicants where practical and feasible. The discharge criteria for the treatment facilities will be included in the CSWMP.		
High groundwater inflows in excess of the one litre per second per kilometre design criterion, which will cause significant groundwater inflows and groundwater drawdown	GW1	Groundwater inflows within the tunnels will be minimised by designing the final tunnel alignment to minimise intersections with known palaeochannels and alluvium present in the project footprint.	Construction	Table 6 GWMM1
	GW2	Appropriate waterproofing measures will be identified and included in the detailed design to permanently, where reasonable and feasible, reduce the inflow into the tunnels to below one litre per second per kilometre for any kilometre length of the tunnel.	Construction	Section 6.2.3.1, 6.2.6.1 Table 5 GWMM11
	GW3	Appropriate measures will be investigated and implemented at dive structures and shafts and for cut-and-cover sections of the tunnel to minimise groundwater inflow.	Construction	Section 6.2.3.1, 6.2.6.1
	GW9	Further investigations will be carried out to identify areas where groundwater inflows to the tunnels are likely to be elevated, to guide the development of the detailed design and construction methodology. The investigations will be carried out prior to the commencement of excavations with the potential to result in groundwater inflow at each identified location.	Construction	Section 6.2.4.2
Corrosion of building materials by sulfate reducing bacteria	GW4	Further assessment of the risk posed by the presence of sulfate reducing bacteria and groundwater aggressivity will be undertaken prior to construction. A corrosion assessment will be undertaken by the construction contractor to assess the impact on building materials that may be used in the tunnel infrastructure such as concrete, steel, aluminium, stainless steel, galvanised steel and polyester resin anchors. The outcomes of the corrosion assessment will be considered when selecting building materials likely to encounter groundwater.	Construction	Table 6 GWMM2
Groundwater drawdown impacting a water supply well water level by more than two metres	GW5	In accordance with the Aquifer Interference Policy (DPI-Water 2012), measures will be taken to ‘make good’ the impact on an impacted water supply bore by restoring the water supply to pre-development levels. The measures taken will be dependent upon the location of the impacted bore but could include, for example, deepening the bore, providing a new bore or providing an alternative water supply.	Construction	Table 5 GWMM10
Alteration of groundwater flows and levels due to the installation	GW6	Potential impacts associated with subsurface components of the project intercepting and altering groundwater flows and levels will be considered during detailed design. Measures to reduce potential impacts will be identified and included in the detailed construction methodology and the detailed design as relevant.	Construction	Table 6 GWMM4, GWMM3

Outcome	Ref#	Commitment	Timing	Reference
of subsurface project components				
Actual groundwater inflows and drawdown in adjacent areas exceed expectations	GW7	A detailed groundwater model will be developed by the construction contractor during detailed design. The model will be used to predict groundwater inflow rates and volumes within the tunnels and groundwater levels (including drawdown) in adjacent areas during construction and operation of the project.	Construction	Table 6 GWMM4, GWMM9
	GW8	Groundwater inflow within and groundwater levels in the vicinity of the tunnels will be monitored during construction and compared to model predictions and groundwater performance criteria applied to the project. The groundwater model will be updated based on the results of the monitoring as required and proposed management measures to minimise potential groundwater impacts adjusted accordingly to ensure that groundwater inflow performance criteria are met.	Construction	Table 6 GWMM5, GWMM9

Annexure B Groundwater Monitoring Program

JHCPB Joint Venture

Groundwater Monitoring Program

RIC-JHC-MPL-00-PL-300-002

Project	Design and Construction of Rozelle Interchange Enabling Works Project
Design Lot No.	00-PL-300
Document No.	RIC-JHC-MPL-00-PL-300-002
Revision Date	05 May 2021

Document Approval

Developed By:		
Name: Ciara Moriarty	Position: Senior Environmental Advisor	
Reviewed By:		
Name	Position	Date Reviewed
Adrian Broger	Approvals Advisor	05/05/2021

Revision Record				
Rev	Rev Date	Reason for issue	Developed by	Approved by
A	07/03/2019	For RMS review	Natalie Jongebloed	N/A
B	02/04/2019	Issued for consultation	Natalie Jongebloed	N/A
00	01/05/2019	For submission to DPIE	Natalie Jongebloed	N/A

01	21/06/2019	Updated in response to DPIE comments	Natalie Jongebloed	N/A
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03	31/10/2019	Updated in response to DPIE Water comments	Ivan Juricic	N/A
04	02/09/2020	Updated in response to modifications to the Planning Approval	Ciara Moriarty	N/A
05	16/12/2020	For DPIE approval	Adrian Broger	DPIE
06	05/05/2021	For DPIE Approval	Ciara Moriarty	DPIE

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Glossary / Abbreviations

Abbreviations	Definition
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
Bi-monthly	Every two months
CEMP	Construction Environmental Management Plan
CoA	Conditions of Approval
CFU	Colony Forming Unit
DPIE	NSW Department of Planning, Industry and Environment
DoI Water	NSW Department of Industry Water (formerly DPI Water)
DPI Water	NSW Department of Primary Industries - Water
DPIE Water	NSW Department of Planning, Industry and Environment – Water (formerly DoI Water)
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
ER	Environmental Representative
GMP	Groundwater Management Sub-Plan
GMR	Groundwater Modelling Report
GWMP	Groundwater Monitoring Program
GWL	Groundwater level
GWQ	Groundwater quality
HSS	Hawkesbury Sandstone
JHCPB	John Holland CPB Contractors Joint Venture
mAHD	elevation in metres with respect to the Australian Height Datum
mBGL	metres below ground level
mTOC	metres below top of casing
m/day	metres per day
NRAR	Natural Resources Access Regulator
POEO Act	*Protection of the Environment Operations Act 1997*
µS/cm	micro-Siemens per centimetre

Abbreviations	Definition
REMM	Revised Environmental Management Measures
Roads and Maritime	Roads and Maritime Services (now Transport for NSW)
SP	Standpipe piezometer
SPIR	Submissions and Preferred Infrastructure Report
SSTV	Site Specific Trigger Value
TfNSW	Transport for NSW
VWP	Vibrating Wire Piezometer
WTP	Water Treatment Plant

1. Introduction

1.1. Context

This Groundwater Monitoring Program (GWMP or Program) has been prepared for the construction of the Design and Construction of Rozelle Interchange Project (the Project). This document acknowledges the authors of the Stage One Groundwater Management Sub-plan for the M4-M5 Link Mainline Tunnels and the Project's groundwater report for the Environmental Impact Statement (EIS) (AECOM 2017), in which words have been appropriated within certain sections of this document to provide continuity across the relevant requirements of the Project, which this document address.

This GWMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), Project Approvals and all applicable guidance and legislation.

1.2. Scope of the groundwater monitoring program

The scope of this GWMP is to describe how JHCPB propose to monitor the extent and nature of potential impacts to groundwater quality during construction of the Project. Operational monitoring and operation measures do not fall within the scope of the construction phase and therefore are not included in the processes contained within the GWMP.

1.3. Implementation of the groundwater monitoring program

The Construction Monitoring Programs must be endorsed by the Environmental Representative (ER) and then submitted to the Secretary for approval at least one (1) month prior to commencement of construction.

Construction will not commence until the Secretary has approved all required Construction Monitoring Programs relevant to that activity and all the necessary baseline data for the required monitoring programs has been collected, to which the CEMP relates.

The Construction Monitoring Programs, as approved by the Secretary, including any minor amendments approved by the ER, must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Secretary, whichever is the greater.

2. Purpose and Objectives

2.1. Purpose

The purpose of the GWMP is to describe how JHCPB propose to monitor the extent and nature of potential impacts to the groundwater level and quality during construction of the Project.

The GWMP will be implemented to monitor the effectiveness of mitigation measures applied during the construction phase of the Project. Monitoring of groundwater will be undertaken to identify potential impacts and ensure a comprehensive management regime can be implemented to address those impacts and manage local groundwater quality.

This Program provides details of the groundwater monitoring network, frequency of monitoring, and test parameters. This GWMP supplements the Groundwater Management Sub-plan (GMP), which itself is an appendix of the CEMP.

This GWMP is based on baseline studies developed for the Project EIS (AECOM 2017) and continued baseline monitoring reports (AECOM 2018).

2.2. Objectives

This GWMP has been prepared to ensure all CoA, REMM, and licence/permit requirements relevant to groundwater monitoring are described, scheduled, and assigned responsibility as outlined in:

- All documents listed in CoA A1,
- Conditions of Approval: SSI-7485,
- Roads and Maritime specifications G36, G38 and G40
- The Project’s Environment Protection Licence (EPL)
- All relevant legislation and other requirements

2.3. Consultation

This program was provided to The Water Group (DPIE Water), Sydney Water, City of Sydney Council, Inner West Council in accordance with CoA C9(b). In addition, the document was also offered to the EPA and NSW Fisheries for review and comment in accordance with REMM OGW9. Refer to Section 2 of the CEMP for consultation requirements relating to the CEMP and all sub-plans.

The Project is proposing to utilise bores from the existing baseline monitoring network established by RMS for construction monitoring. RMS developed this network in consultation with DPIE Water with the objective of providing good coverage along the alignment and to be located near sensitive environmental features or potentially contaminated areas.

A summary of consultation undertaken during the development of the GMP and GWMP is included in Section 3.4 of the GMP.

Consultation with DPIE has been be undertaken to determine monitoring well locations and when monitoring groundwater pore pressures in the Hawkesbury Sandstone aquifers adjacent to the tunnel alignment in accordance with CoA C12 (c).

Community feedback and complaints relating to groundwater will be managed in accordance with the Communication Strategy and Complaints Management System.

3. Groundwater monitoring

3.1. Baseline monitoring

3.1.1. Monitoring network

Baseline groundwater level and groundwater quality monitoring data has been collected from the Project groundwater monitoring network since June 2016. This baseline dataset is augmented by baseline data and construction data collected since October 2015 for the adjacent M4 East and New M5 projects.

The Project baseline monitoring network was installed between May 2016 and May 2017 and consists of 34 monitoring bores, located within the confines of the Project construction works, intersecting groundwater within the alluvium and Hawkesbury Sandstone. Monitoring bores were designed and constructed to target the expected tunnel zone and allow the assessment of potential impacts to groundwater. At one location where alluvium was present, nested monitoring bores were constructed.

Monitoring bores have been designed to target the following hydrogeological formations:

- Alluvium
  - 5 at the Crescent
  - 4 at Rozelle
- Hawkesbury Sandstone
  - 18 at Rozelle
  - 3 at the Crescent
  - 2 at Iron Cove
  - 2 at Easton Park

In addition to the collection of groundwater quality and groundwater level data, baseline studies to inform the Project EIS (AECOM 2017) included the collection of hydraulic data for the local aquifer systems (including packer tests). This data is not discussed further in this document as it has no relevance to the ongoing monitoring program.

The baseline monitoring bore network is shown in Table 1 and Figure 1.

The following sections summarise the factors influencing groundwater within the Project. The Project transects a highly urbanised environment that consists of established industrial, commercial, recreational, and residential areas. The alignment encompasses the Rozelle interchange network that is situated within Rozelle and Easton Park and extends from the proposed Iron Cove Link joining Victoria Road at Parramatta River to the north, the intersection of Victoria Road and the Crescent at Rozelle Bay to the east, and through to Lilyfield in the south, before linking with the Mainline Tunnel at Leichardt.

The key reference document is Chapter 19, Groundwater, of the EIS (AECOM 2017).

Table 1: Baseline groundwater monitoring network

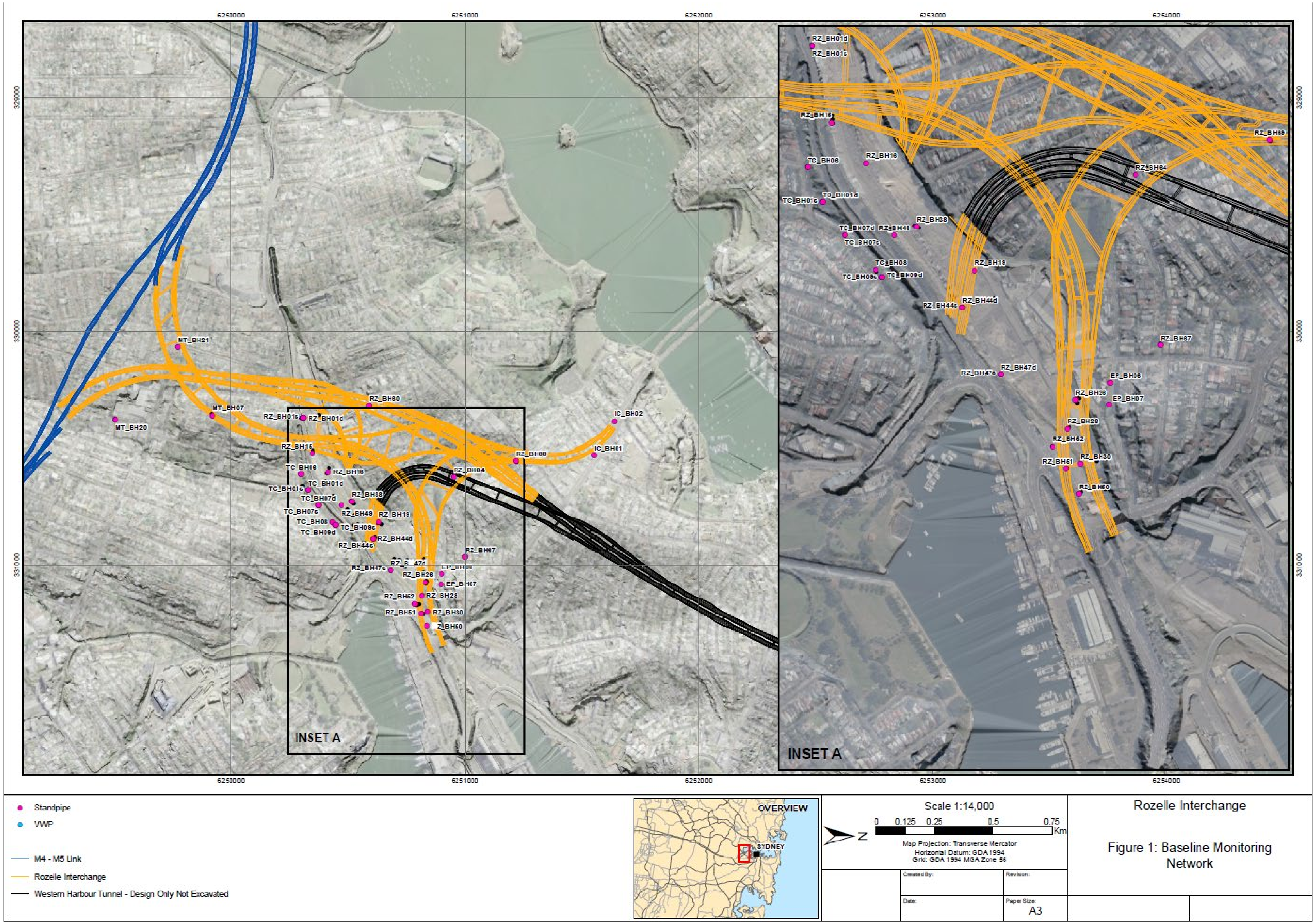
Bore ID	Location	Easting	Northing	Screened interval (mBGL)	Lithology	Used in EIS for baseline groundwater level monitoring	Number of water quality samples analysed during baseline monitoring
Rozelle							
RZ_BH01d	Rozelle Rail Yard	330608.87	6250381.26	22-25	HSS	Yes	22
RZ_BH01s	Rozelle Rail Yard	330611.47	6250381.61	7-10	Alluvium	Yes	22

Bore ID	Location	Easting	Northing	Screened interval (mBGL)	Lithology	Used in EIS for baseline groundwater level monitoring	Number of water quality samples analysed during baseline monitoring
RZ_BH15	Rozelle Rail Yard	330522.59	6250349.91	18-21	HSS	Yes	22
RZ_BH16	Rozelle Rail Yard	330609.43	6250409.41	17-20	HSS	Yes	22
RZ_BH19	Rozelle Rail Yard	330822.45	6250626.95	19-22	HSS	Yes	20
RZ_BH26	East of RRY	331066.28	6250835.05	20-23	HSS	Yes	22
RZ_BH28d	Rozelle Rail Yard	331126.56	6250818.78	27-30	HSS	Yes	19
RZ_BH30	Rozelle Rail Yard	331192.90	6250834.96	16-19	HSS	Yes	18
RZ_BH38	Rozelle Rail Yard	330726.61	6250812.07	28-31	HSS	Yes	21
RZ_BH44d	Rozelle Rail Yard	330885.77	6250613.96	25-28	HSS	Yes	20
RZ_BH44s	Rozelle Rail Yard	330884.43	6250613.29	12-15	Alluvium	Yes	21
RZ_BH47d	Rozelle Rail Yard - RZ Bay	331025.23	6250701.67	27-30	HSS	No	21
RZ_BH47s	Rozelle Rail Yard - RZ Bay	331027.87	6250703.96	15-18	Alluvium	Yes	21
RZ_BH49s	Rozelle Rail Yard	330730.38	6250461.58	13-16	Alluvium	No	20
RZ_BH50	Rozelle Rail Yard	331255.63	6250841.07	22-25	HSS	Yes	19
RZ_BH51	Rozelle Rail Yard	331206.58	6250813.32	19-22	HSS	Yes	18
RZ_BH52	Rozelle Rail Yard	331163.77	6250784.58	32-35	HSS	Yes	20
RZ_BH53	SHFA	331100.88	6250738.06	18-21	HSS	No	0
RZ_BH60	Opposite 46 Justin St, Lilyfield	330317.83	6250589.57	56-59	HSS	Yes	13
RZ_BH64	Brockley Street, Rozelle	330623.50	6250949.00	46-49	HSS	Yes	13
RZ_BH67	Alfred St, Rozelle	330961.48	6250999.73	46-49	HSS	No	10
RZ_BH69	Albion St, Rozelle	330558.20	6251218	38-41	HSS	No	4
The Crescent							
TC_BH01d	RailCorp, Lilyfield	330661.99	6250305.25	25-28	HSS	No	23
TC_BH01s	RailCorp, Lilyfield	330660.57	6250304.92	3-6	Alluvium	Yes	22
TC_BH06s	Railway Pde, Annandale	330610.16	6250298.14	4.5-7.5	Alluvium	Yes	19

Bore ID	Location	Easting	Northing	Screened interval (mBGL)	Lithology	Used in EIS for baseline groundwater level monitoring	Number of water quality samples analysed during baseline monitoring
TC_BH07d	Railway Pde, Annandale	330746.03	6250373.53	19-22	HSS	Yes	16
TC_BH07s	Railway Pde, Annandale	330747.41	6250374.95	3-6	Alluvium	Yes	22
TC_BH08s	Railway Pde, Annandale	330818.34	6250435.89	5-8	Alluvium	Yes	22
TC_BH09d	Railway Pde, Annandale	330830.31	6250444.46	21-24	HSS	Yes	22
TC_BH09s	Railway Pde, Annandale	330830.70	6250445.81	2-5	Alluvium	No	11
Iron Cove							
IC_BH01	Waterloo St, Rozelle	330514.22	6251504.54	23-26	HSS	Yes	15
IC_BH02	Toelle St, Rozelle	330334.97	6251646.37	8-11	HSS	No	9
Easton Park							
EP_BH06	Lilyfield Rd, Rozelle	331025.39	6250903.92	10-13	HSS	Yes	18
EP_BH07	Starling St, Lilyfield	331082.28	6250898.80	10-13	HSS	Yes	18
Main Tunnel							
MT_BH07	White Creek Reserve, Lilyfield	330355.81	6249914.91	43-46	HSS	Yes	16
MT_BH20	John Street, Leichhardt	330379.4	6246735.87	41-44	HSS	No	6
MT_BH21	Ainsworth St, Lilyfield	330066.72	6249771	47-50	HSS	Yes	7
Rozelle Rail Yard once off contamination sampling							
RZ_BH081	Rozelle Rail Yard	330831.19	6250767.25	2.5-3.2	Alluvium	N/A	N/A
RZ_BH101	Rozelle Rail Yard	330871.54	6250706.63	1.0-4.0	Alluvium	N/A	N/A
RZ_BH103	Rozelle Rail Yard	330943.03	6250752.15	0.7-2.7	Alluvium	N/A	N/A
RZ_BH105	Rozelle Rail Yard	331013.16	6250752.15	1.5-4.5	Alluvium	N/A	N/A
RZ_BH107	Rozelle Rail Yard	330888.30	6250817.43	2.5-4.5	Alluvium	N/A	N/A
RZ_BH109	Rozelle Rail Yard	330898.71	6250716.34	0.9-3.1	Alluvium	N/A	N/A

Bore ID	Location	Easting	Northing	Screened interval (mBGL)	Lithology	Used in EIS for baseline groundwater level monitoring	Number of water quality samples analysed during baseline monitoring
RZ_BH111	Rozelle Rail Yard	330946.47	6250745.17	1.1-3.4	Alluvium	N/A	N/A
BH57	Rozelle Rail Yard	330945.60	6250740.73	2.0-5.0	Alluvium	N/A	N/A
BH60	Rozelle Rail Yard	330995.16	6250763.70	1.0-4.0	Alluvium	N/A	N/A

Figure 1: Baseline Monitoring Network



3.1.2. Groundwater level

Baseline groundwater level data has included monthly manual dips and continuous data from dedicated pressure logging transducers (dataloggers). Dataloggers were installed in key groundwater monitoring bores and programmed to record baseline data on an hourly basis. The data has since been corrected for barometric pressure effects, converted to a groundwater level measurement and compared to local rainfall.

The purpose of the baseline groundwater level monitoring was to establish pre-construction groundwater level and flow conditions across the Project area to inform groundwater modelling and the EIS (AECOM 2017). The EIS presents interpretation of the baseline groundwater level conditions, summarised in Section 3 of this GWMP.

Identified potential Project impacts will be routinely monitored during construction and include:

- Groundwater level decrease (see Section 3.2 and 3.2.2)
- Saline intrusion (see Section 3.2.3).

Manual baseline groundwater level monitoring results are included in Appendix A.

3.1.3. Groundwater quality

Baseline monthly groundwater quality monitoring commenced in June 2016 or later as each monitoring location became operational. The objectives for the baseline groundwater quality monitoring program included:

- Characterise the existing hydrogeochemistry in the three main hydrogeological units (alluvium, Ashfield Shale (note: this unit is absent in the current Project area), and Hawkesbury Sandstone)
- Establish the environmental value and beneficial use of groundwater under existing (pre-construction) conditions
- Develop a groundwater quality baseline dataset to inform the EIS
- Characterise the potential aggressiveness of the native groundwater to the building material used to construct the Project infrastructure
- Obtain a preliminary understanding of the groundwater treatment requirements prior to discharge during the construction and operation phases.

A summary of the groundwater quality samples collected from June 2016 for each hydrogeological unit within the confines of the Project is shown in Table 2.

Table 2: Baseline groundwater quality sampling program

	Alluvium	Hawkesbury Sandstone	Total
# of samples	180	406	586

The baseline groundwater quality sampling program included the following analytes:

- Physico-chemical field parameters (temperature, dissolved oxygen, electrical conductivity (EC), pH, and redox potential)
- Major ions (calcium, magnesium, sodium, potassium, chloride, sulphate, carbonate and bicarbonate)
- Dissolved metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc)
- Nutrients (nitrite as N, nitrate as N, reactive phosphorus and ammonia)
- Benzene, toluene, ethylbenzene, xylene, and naphthalene (BTEXN)
- Total recoverable hydrocarbons (TRHs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Organochlorine pesticides (OCPs)
- Organophosphate pesticides (OPPs)
- Semi-volatile organic hydrocarbons (SVOCs)
- Volatile organic compounds (VOCs)

- Sulphate reducing bacteria.

Interpretation of the baseline groundwater monitoring data is included in the EIS (AECOM 2017) and is summarised in Table 3.

Table 3: Summary of baseline groundwater quality within the Project area

Parameter	Alluvium	Hawkesbury Sandstone
EC	Variable fresh to brackish Range: 328 to 74,800 µS/cm	Fresh to moderately saline Range: 149 to 9,910 µS/cm
pH	Weakly acidic to weakly basic Range: 5.96 to 8.06	Slightly acidic to strongly basic Range: 5.77 to 12.69
Major ions	Dominated by sodium, magnesium, chloride and bicarbonate. The dominance of sodium and chloride is attributed to tidal influences.	Dominated by sodium and chloride, which may be in part due to the influence of saline water intrusion.
Metals	Maximum levels exceeded guideline concentration values for all but cadmium and nickel. In most cases the exceedance is marginal, indicating that background levels are already elevated.	Maximum levels exceeded guideline concentration values for chromium, copper, iron, lead, manganese, nickel, and zinc. Consistently elevated iron and manganese, which is typical for Hawkesbury Sandstone (McKibbon and Smith 2000).
Nutrients	Nitrite and nitrate concentrations indicate that background nutrient levels are low. Reactive phosphorous levels are also low. Ammonia values exceeded guideline[1] concentration values.	Nitrite and nitrate concentrations indicate that background nutrient levels are low. Reactive phosphorous levels are very low. Ammonia values marginally exceeded guideline[1] concentration value.
Sulfate reducing bacteria[2]	Not assessed	No pattern was assessed for sulfate reducing bacteria because many samples were above the measurement limit (500,000 CFU/mL). Groundwater from the Hawkesbury Sandstone has high sulfate concentrations. When reducing conditions are present, SRB flourish in the absence of oxygen.
Groundwater aggressivity	Not assessed	Mildly aggressive towards concrete piles for average concentrations of chloride, pH, and sulfate. Mildly aggressive towards steel piles for average concentrations of chloride and pH. Severely aggressive towards steel piles for groundwater with low conductivity.

EC = electrical conductivity; µS/cm = micro-Siemens per centimetre
[1] Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
[2] measured as a colony forming unit (CFU) per 100 mL

3.2. Construction monitoring

3.2.1. Overview

As discussed in Section 3, potential impacts on groundwater during construction are identified as:

- Groundwater level decrease in the vicinity of the Project tunnels (groundwater drawdown)
- Intrusion of saline water in tidal zones.

Groundwater level and groundwater quality (salinity) monitoring will be carried out during construction at the monitoring network listed in Table 4 and shown in Figure 2 utilising background monitoring wells where functional for consistency. The data will be assessed (Section 5.1.2) and reported in the six-monthly water monitoring report as identified in Table 9. Where a well becomes inoperable, damaged or within the works footprint the Environment and Sustainability Manager will identify a suitable replacement in consultation with a suitably qualified hydrogeologist. Groundwater inflows intercepted during tunnelling, and subsequent discharge via the Project WTP, will also be monitored. Construction phase groundwater level and quality (EC) data will be fed into the groundwater model.

The construction groundwater monitoring program will monitor:

- Groundwater level
- Groundwater quality (EC) at key bores
- Groundwater inflow to the tunnels.

Monitoring bores target the two main hydrogeological formations within the confines of the Project area (alluvium and Hawkesbury Sandstone) with a minimum of two groundwater monitoring wells located in the following key project locations (in accordance with CoA C12 d)):

- Rozelle area to the north of Rozelle Bay,
- Annandale area to the west of Rozelle Bay, and
- Rozelle area to the south east of Iron Cove

The locations of these wells have been determined in consultation with DPIE Water.

For those wells that are to be installed prior to the commencement of adjacent tunnelling works, their locations are indicated in Table 4 and . The position of each future well has a 100 metre buffer to facilitate re-positioning, where necessary, to avoid potential utility clashes, minimise vegetation clearance, avoid heritage impacts and reduce impacts to traffic and pedestrians where possible.

It may be necessary to construct additional monitoring bores if some of the existing bores are inaccessible or damaged during tunnel construction or as a possible management action as part of an investigation into discrepancies in monitoring data, if required.

Two monitoring wells are installed in the north Rozelle/Lilyfield area to the west of the ventilation tunnel at Iron Cove to monitor salinity as per CoA12 (h) in consultation with The Water Group (DPIE Water)These are identified as IC_BH03 and IC_BH04 and locations shown in Figure 2 below

Vibrating wire piezometers (VWPs) will be used to validate drawdown predictions from the groundwater model. More than three VWPs will be installed in accordance with REMM OGW10 as close as possible to the tunnel centrelines to allow for the comparison of pore pressure (recorded by the VWPs) and standing water level (recorded by standpipe groundwater monitoring bore). As stated in REMM OGW10, the wells could be constructed about five to ten meters above the top of the tunnel crown to allow for groundwater drawdown during monitoring within the Hawkesbury sandstone. The location of these VWPs has been undertaken in consultation with DPIE Water. The details of the VWPs are included in this Monitoring Program accordingly.

Table 4: Construction phase groundwater monitoring bores

Bore ID	Location	Easting	Northing	Elevation (mAHD)	Lithology	Type	Parameters
RZ_BH60 Log	Justin St, Lilyfield	330994	6250766	24.96	Hawkesbury Sandstone	SP	GWL, GWQ (EC)
RIC_PSM_BH 008_VMP_01[1]	Street between Justin St and Lamb St, Lilyfield	330338.3	6250772	-5.54	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_PSM_BH 008_VMP_02[1]	Street between Justin St and Lamb St, Lilyfield	330338.3	6250772	-26.54	Hawkesbury Sandstone	VWP	Pore pressure/ GWL

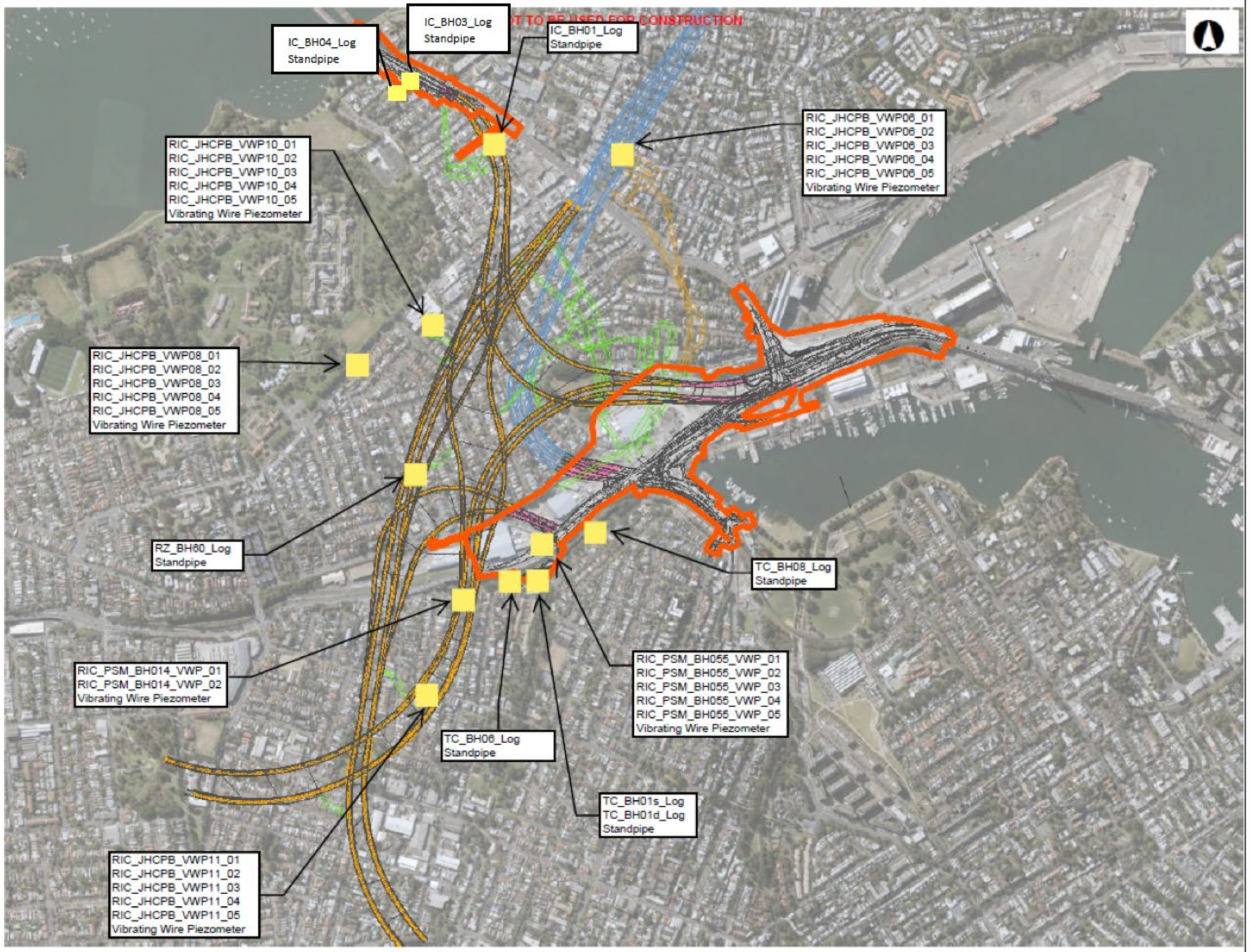
RIC_PSM_BH 008_VMP_03[1]	Street between Justin St and Lamb St, Lilyfield	330338.3	6250772	-47.54	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
TC_BH01d Log	RailCorp, Lilyfield	330660.6	6250304.9	2.54	Hawkesbury Sandstone	SP	GWL, GWQ (EC)
TC_BH01s Log	RailCorp, Lilyfield	330660.6	6250304.9	2.55	Alluvium	SP	GWL, GWQ (EC)
TC_BH06_Log	Railway Pde, Annandale	330611.4	6250298.3	2.65	Alluvium	SP	GWL, GWQ (EC)
TC_BH08_Log	Railway Pde, Annandale	330818.3	6250435.9	2.24	Alluvium	SP	GWL, GWQ (EC)
IC_BH01 Log	Waterloo St, Rozelle	330514.2	6251505	26.77	Hawkesbury Sandstone	SP	GWL, GWQ (EC)
RIC_JHCPB_VWP06_01	National St, Rozelle	330875.4	6251485	10.03	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP06_02	National St, Rozelle	330875.4	6251485	0.03	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP06_03	National St, Rozelle	330875.4	6251485	-9.97	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP06_04	National St, Rozelle	330875.4	6251485	-39.97	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP06_05	National St, Rozelle	330875.4	6251485	-79.97	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP8_01	Balmain Rd, Lilyfield	330150.8	6250888	10.04	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP8_02	Balmain Rd, Lilyfield	330150.8	6250888	-9.9593	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP8_03	Balmain Rd, Lilyfield	330150.8	6250888	-29.9593	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP8_04	Balmain Rd, Lilyfield	330150.8	6250888	-49.9593	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP8_05	Balmain Rd, Lilyfield	330150.8	6250888	-79.9593	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP10_01	Fred St, Lilyfield	330357.2	6250996	10	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP10_02	Fred St, Lilyfield	330357.2	6250996	-10	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP10_03	Fred St, Lilyfield	330357.2	6250996	-30	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP10_04	Fred St, Lilyfield	330357.2	6250996	-50	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP10_05	Fred St, Lilyfield	330357.2	6250996	-80	Hawkesbury Sandstone	VWP	Pore pressure/ GWL

RIC_JHCPB_VWP11_01	Paling St, Lilyfield	330360.6	6249979	-0.0473	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP11_02	Paling St, Lilyfield	330360.6	6249979	-10.0473	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP11_03	Paling St, Lilyfield	330360.6	6249979	-20.0473	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP11_04	Paling St, Lilyfield	330360.6	6249979	-40.0473	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_JHCPB_VWP11_05	Paling St, Lilyfield	330360.6	6249979	-60.0473	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_PSM_BH014_VMP_01[1]	Starling St, Lilyfield	330456.4	6250242	-0.17	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_PSM_BH014_VMP_02[1]	Starling St, Lilyfield	330456.4	6250242	-14.17	Hawkesbury Sandstone	VWP	Pore pressure/ GWL
RIC_PSM_BH055_VWP01[1]	Rozelle Rail Yard	330665.9	6250403	-2.7	Alluvium	VWP	Pore pressure/ GWL
RIC_PSM_BH055_VWP02[1]	Rozelle Rail Yard	330665.9	6250403	-4.3	Alluvium	VWP	Pore pressure/ GWL
RIC_PSM_BH055_VWP03[1]	Rozelle Rail Yard	330665.9	6250403	-5.3	Alluvium	VWP	Pore pressure/ GWL
RIC_PSM_BH055_VWP04[1]	Rozelle Rail Yard	330665.9	6250403	-9.7	Alluvium	VWP	Pore pressure/ GWL
RIC_PSM_BH055_VWP05[1]	Rozelle Rail Yard	330665.9	6250403	-11.9	Alluvium	VWP	Pore pressure/ GWL
IC_BH03 Log	Clubb St, Rozelle	330215.2	6251636.7	-10	Hawkesbury Sandstone	SP	GWL, GWQ (EC)
IC_BH04 Log	Onsite, between Toelle St and Clubb St	330273.0	6251661.6	-20	Hawkesbury Sandstone	SP	GWL, GWQ (EC)

HSS = Hawkesbury Sandstone; GWL = Groundwater level; GWQ = Groundwater quality; SP = Standpipe piezometer; VWP = Vibrating Wire Piezometer

[1] Bore to be relocated due to construction activities (excavations and installation of pavements). Relocated bore to be as local to the original position as site/construction constraints allow, as well as having an equivalent screened interval.
[2] Future VWPs to be installed prior to the commencement of adjacent tunnelling works (see).

Figure 2: Construction phase groundwater monitoring network – standpipe and vibrating wire piezometers



Legend

Site Access Schedule Boundai

917.2 0 458.62 917.2 Meters

1: 18,056 @A4

DISCLAIMER:This map is a user generated as uncontrolled output from the Westconnex 3B Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate or current. Neither John Hollland, CPB or the Westconnex project team accept liability or responsibility for the inappropriate use of this information.

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3.2.2. Groundwater level

Dataloggers will be installed (or maintained from the baseline monitoring phase) in each construction monitoring bore (Table 4) to provide continuous data collection. Dataloggers will be programmed to record at hourly intervals. The VWPs will be equipped with dataloggers set to record pore pressures at six-hourly intervals.

To supplement the above continuous monitoring, manual measurements will be collected every two months (bi-monthly), pending access, at each bore in the construction monitoring network in Table 4. Measurements will be recorded in metres below top of casing (mbTOC) and converted to metres below ground level (mBGL) and metres Australian Height Datum (mAHD).

Two monitoring wells are installed in the north Rozelle/Lilyfield area to the west of the ventilation tunnel at Iron Cove to monitor groundwater levels as per CoA C12 (h).

Recorded data will be compensated for barometric pressure and converted to a groundwater level measurement. Manual monitoring data will be used to verify continuous data.

Groundwater level data will be compared to local rainfall records to assess trends.

Table 5: Groundwater level monitoring

Monitoring target (hydrogeological unit/number of bores)	Processed data outputs	Frequency
Alluvium (4)	mBGL; mBTOC; mAHD	hourly (via datalogger) Bi-monthly (manual dips)
Hawkesbury Sandstone (8)	mBGL; mBTOC; mAHD	hourly (via datalogger) Bi-monthly (manual dips)

3.2.2.1. Performance criteria

Seasonal fluctuation considered within the EIS groundwater model (AECOM 2017) will facilitate the assessment and comparison between groundwater level decrease and the predicted drawdown from the Project. The assessment will determine whether the observed decrease is attributable to the Project and, if so, whether it aligns with approved predictions. Data analysis is described in Section 5.1.2 and water monitoring reports will be produced every six months to assess this which will include data summary reports presenting tabulated groundwater monitoring data collected during the reporting period in accordance with Table 9.

If drawdown is identified outside of model predictions, management actions outlined in the GMP will be initiated including (but not limited to) a review of baseline groundwater level and quality data in the relevant and surrounding monitoring bores as well as an assessment of groundwater inflow rates into the tunnel.

3.2.3. Groundwater salinity

Dedicated dataloggers with specification allowing the measurement of electrical conductivity (EC) and groundwater level will be installed at the key monitoring bores between the tunnel alignment and saline water bodies (Table 4). The dataloggers will be programmed to record data on an hourly basis.

Dataloggers will be downloaded bi-monthly (every two months). Electrical conductivity (EC) results will be assessed to detect changes in water quality that may indicate the intrusion of saline water towards the tunnel in accordance with CoA C12 (d). Data analysis is described in Section 5.1.2 and water monitoring reports produced every six months in accordance with Table 9. A review after the first 12 months of construction of the monitoring program will be completed to determine the efficiency of the monitoring program and any required changes.

3.2.3.1. Performance criteria

Baseline monitoring shows that some groundwater quality parameters exceed the default ANZECC (2000) water quality trigger values for slightly to moderately disturbed ecosystems. This is not unexpected given the highly disturbed and urbanised Project area.

Site-specific trigger values (SSTV) (Table 6) for EC have been developed for each water quality monitoring bore using the baseline data used to inform the EIS (AECOM 2017). The SSTV's were derived by calculating the 80th percentile values of the baseline EC data (using ANZECC 2000 and 2018 methodology). A percentile is the value below which a given percentage of observations fall. The 80th percentile is therefore the value below which 80% of observations are found. Using these percentiles removes anomalous data that is outside of the normal range (defined here as 0 – 80 % of values).

The SSTV's provide an easily identifiable indication of a potential change in salinity. A management response would be initiated if any of the following occurs:

- The EC data continuously exceeds the SSTV over a period of three months and depicts a rising trend
- The EC data exceeds the SSTV at any time by more than 100%

In the event that one or both of the above EC triggers are observed a review will be initiated to determine the significance of the exceedance(s) and possible causes. The review will assess the historical and surrounding monitoring bore data, and modelling predictions.

If the exceedance is determined to be attributable to Project works and outside of approved model predictions for saline intrusion the groundwater model will be reviewed and updated. The updated model will be used to assess potential impacts and inform potential mitigation measures.

Table 6: Salinity (EC) trigger values

Region	Monitoring bore[1]	Lithology	Sample count	EC min (μS/cm)	EC max (μS/cm)	SSTV[2] (μS/cm)	Relocation bore
Rozelle	RZ_BH01s	Alluvium	22	397	2,174	600	RZ_GW24
	RZ_BH01d[3]	Hawkesbury Sandstone	23	307	3,650	2,000	N/A
	RZ_BH015[3]		22	368	1,470	1,100	RZ_GW22
	RZ_BH44d[3]		22	161	1,925	1,400	SB_BH01
	RZ_BH51[3]		19	239	4,100	1,800	RZ_GW01
	RZ_BH52[3]		21	526	1,317	1,000	RZ_GW05b
	RZ_BH60		13	172	4,910	3,900	N/A
	RZ_BH67[3]		9	507	773	600	GC01_GW01b
The Crescent	TC_BH01s	Alluvium	22	6,899	74,800	30,100	N/A
	TC_BH06s		23	1,175	4,723	2,400	N/A
	TC_BH08s		22	3,170	42,730	13,500	N/A
	TC_BH01d	Hawkesbury Sandstone	22	1,126	9,910	3,900	N/A
Iron Cove	IC_BH01	Hawkesbury Sandstone	14	516	7,980	2,100	N/A

EC = electrical conductivity; μS/cm = micro-Siemens per centimetre
[1] Key monitoring locations.
[2] SSTV = site specific trigger value (80th percentile of baseline data, rounded to nearest 100).
[3] Bore to be relocated due to construction activities (excavations and installation of pavements). Relocated bore to be as local to the original position as site/construction constraints allow, as well as having an equivalent screened interval. This is to allow future EC values to be compared against those in this table.

All relocated bores are identified by the Environment and Sustainability Manager in consultation with a suitably qualified hydrogeologist.

Locations of all salinity loggers are in Figure 3 and Figure 4.

Two monitoring wells are installed in the north Rozelle/Lilyfield area to the west of the ventilation tunnel at Iron Cove to monitor salinity as per CoA12 (h) in consultation with The Water Group (DPIE Water)These are identified as IC_BH03 and IC_BH04 and locations shown in Figure 4 below. In the absence of background monitoring data for these bores and based on the groundwater model and HIR, no significant fluctuations in the levels recorded is expected and any changes that occur from the initial time of installation will be monitored.

At the time of installation, the value will be recorded and is used as the salinity quality trigger value

Figure 3 Construction phase groundwater monitoring network – salinity logger locations (Rozelle)

Figure 4 Construction phase groundwater monitoring network – salinity logger locations (Iron Cove)

3.2.4. Tunnel inflow

During construction, groundwater will be intersected and managed by either capturing the water that enters the tunnels, caverns, and portals or by restricting inflow through targeted grouting where required in cut-and- cover sections.

Groundwater inflow into the tunnels will be monitored during construction and compared to model predictions. Data analysis is addressed in Section 5.1.2, and will be documented in the water monitoring reports produced every six months in accordance with Table 9. The groundwater model will be updated as required based on the results of monitoring, and proposed management measures to minimise potential groundwater impacts adjusted accordingly.

A simple water balance approach will be used to estimate groundwater inflows to the tunnel during construction:

Groundwater inflow = WTP discharge – Project water inputs

This simplistic approach doesn't consider the water that will be extracted in the spoil. This water is accounted for in groundwater modelling for the Project and is predicted to not contribute to ongoing drawdown and associated impacts.

In areas where tunnels are to be constructed within the alluvium and paleochannels, including at the Rozelle Rail Yards, additional mitigation measures including targeted grouting in hydraulic conductive ground and engineered structures such as soldier pile walls and diaphragm walls will be implemented to restrict groundwater ingress from the alluvium entering the tunnels where required.

High groundwater inflow during excavation is possible in faulted or fractured zones such as beneath the Rozelle Rail Yard (Whites Creek paleochannel) and in the alluvium (AECOM 2017). Grouting will be undertaken as required through the construction program reducing tunnel inflow.

3.3. Water treatment plant monitoring

Groundwater captured during construction of the Project will be treated at three water treatment plants at the Rozelle civil and tunnel site (C5). The water from the treatment plants will be tested and either reused or discharged in accordance with this document or the Project EPL or JHCPB's trade waste licence requirements (if requested by JHCPB and granted by Sydney Water). This data will be reviewed and assessed in the water monitoring reports produced every six months in accordance with Table 9.

3.3.1. Tunnel discharge volume

Discharge volumes will be continuously monitored at the WTPs via calibrated flow meters, which will enable the daily measurement of the amount of water discharged from the WTPs.

3.3.2. Discharge water quality

3.3.2.1. Water treatment plant commissioning

During commissioning of each of the WTPs, a minimum of two rounds of commissioning sampling will be undertaken to confirm their efficacy. All of the parameters listed in Table 7 and Table 8 will be tested during this commissioning phase. The main objectives of the commissioning testing will be to determine:

- If the WTPs perform to meet the proposed discharge criteria in
- Table 7: WTP construction discharge criteria
- and the design performance in Table 8 and what (if any) design or operational modifications may be required to the WTP in order for it to meet the required specifications, and
- The relationship between TSS and turbidity to allow turbidity to be measured as a proxy for TSS — this will require more samples than for the other parameters and may continue into the post-commissioning phase.

The WTPs will not be deemed commissioned until two rounds of testing confirm compliance with the criteria. If monitoring results in an exceedance, the commissioning process will be continued, and adjustments made if necessary, until two subsequent rounds of testing are compliant.

3.3.2.2. Water treatment plant post-commissioning

In addition to the commissioning sampling, the WTPs discharge will be sampled for water quality analysis, via grab samples, for the parameters listed in Table 7 and Table 8. Sampling will be undertaken in accordance with the EPL requirements. The results will be reviewed by trained personnel to ensure that the discharged water meets discharge criteria.

Monthly sampling of the design performance criteria listed in Table 8 will be undertaken to ensure that each of the WTPs continues to meet design specifications. Where in-line sensors (typically pH and turbidity) or monitoring identify WTPs performance drift outside of the required criteria measures will be implemented to return the WTPs performance back into the required range. In these instances, water will be discharged to trade waste (where permitted), re-used on site or disposed offsite at an appropriate licenced liquid waste facility. Water quality will be monitored via in-line sensors calibrated pH and turbidity sensors with appropriate alerts set to inform management of any drift in WTP performance.

Water quality results will be analysed monthly, and along with an overview of corrective actions will be reported in the six-monthly water monitoring report.

3.3.2.3. Performance criteria

In accordance with CoA E186 water to be discharged from the water treatment plant must comply with project's EPL and ~~the ANZECC (2000) 90 per cent species~~ the protection level listed in Table 8 ~~unless the EPL is in force in which the guidelines in Table 8 can~~ will be adhered to when discharging water into the environment. If required, when discharging into existing sewer drains, Sydney Water trade waste agreement criteria will be adhered to.

The WTPs will undergo commissioning and testing to determine the treatment efficacy in accordance with Section 3.3.2.1 and Section 3.3.2.2.

Table 7: WTP construction discharge criteria

Parameter	Discharge criteria	Reference
pH	6.5 - 8.5	EPL
Oil and grease	None visible	EPL
Turbidity	An NTU value calibrated to achieve <50 mg/L equivalent Total Suspended Solids	EPL

~~Note: EPL is yet to be finalised and approved by the EPA~~

Table 8: Water treatment plant monthly design performance criteria

Parameter	Unit	WTP performance criteria
Cadmium	mg/L	0.014
Chromium (hexavalent)	mg/L	~~0.0486~~ 0.07
Chromium (trivalent)	mg/L	~~0.02~~ 0.15
Copper	mg/L	~~0.003~~ 0.04
Iron~~[1]~~	mg/L	~~0.3~~ 1.5
Lead	mg/L	~~0.0066~~ 0.03
Mercury	mg/L	0.0007
Nickel	mg/L	0.2
Zinc	mg/L	~~0.023~~ 0.15
Arsenic	mg/L	0.05

Source: Project EPL ~~ANZECC (2000a) – Trigger values for 90% species protection level except where:~~

~~[1] Guideline for recreational water quality~~

WTPs will be of a modular design so that they can be modified if required to ensure discharge can be conducted in accordance with the discharge criteria.

4. Monitoring methodology

4.1. Overview

The methodology for monitoring groundwater for the Project includes:

- Assessment of groundwater level (measurement and datalogger download (including VWPs))
- Assessment of groundwater salinity as EC (datalogger download)
- Assessment of WTP discharge water quality (grab samples and analysis)
- Implementation of quality control plan including appropriate chain-of-custody for laboratory analysis and provision of appropriate documentation.

Groundwater monitoring is to be undertaken by suitably qualified personnel at all times.

4.2. Manual groundwater level measurements

Groundwater monitoring will be overseen by personnel with appropriate qualifications and experience. Trained field personnel will complete monitoring rounds using appropriate personal protective equipment (PPE) and monitoring equipment.

The static groundwater level will be measured and recorded at each standpipe groundwater monitoring bore using an electronic groundwater level dip meter (dipper) to verify the continuous data recorded by dataloggers (Section 4.3). The level (to the nearest millimetre) will be referenced to a known (and consistent) surveyed point at the top of the bore casing (mTOC). This measurement will be corrected to mAHD using survey data. Recorded groundwater level will be tabulated in both metres below top of bore casing (mBTOC) and mAHD. This monitoring will occur bi-monthly.

4.3. Continuous groundwater level and quality (EC) measurements

Groundwater level (as pressure) and EC will be measured automatically by calibrated dataloggers at key monitoring locations and VWPs (pore pressure only). Continuous data (recorded every hour) will be periodically validated by manual measurements.

Groundwater level/pressure measurement will be converted to mAHD using calibration coefficients, installation data, and survey data. Spreadsheets will be maintained detailing the conversion and converted groundwater level measurement.

The dataloggers will be downloaded bi-monthly. Dataloggers will be checked and maintained as necessary before being re-calibrated and then returned to the monitoring bore at a known depth below the top of casing.

4.4. Water Treatment Plant discharge samples

4.4.1. Sample collection

Grab samples will be collected manually from the WTP locations and sent to a NATA accredited laboratory for analysis. Further information about WTP monitoring is detailed in Section 3.3 of this GWMP.

4.4.2. Field measurements

Field physico-chemical parameters including temperature, EC, pH, DO, TDS, ORP, and turbidity will be measured at each WTP location before water is discharged using a fully calibrated inline water quality meters. Other observations including odour and colour will also be recorded.

The water quality meters will be calibrated against known standards, as supplied by the manufacturer, at the start and completion of each day of water quality sampling. Calibration records will be maintained in accordance with the appropriate standard.

4.4.3. Decontamination

Equipment will need to be cleaned periodically to prevent a build-up of dirt. The following method will be followed:

- Rinse the equipment in tap water
- Clean with De-Con 90 (a phosphate free detergent), or equivalent
- Rinse again with tap water
- Rinse three times with de-ionised water, and finally
- Allow to dry.

De-ionised and tap water will be available for washing equipment in the field, if required.

4.4.4. Quality Assurance and documentation

Quality assurance and control protocols during sampling and recording of physico-chemical (field) parameters will be undertaken in accordance with ANZECC/ARMCANZ (2000b) to ensure the integrity of the dataset.

As part of sampling, quality assurance and control samples during sampling will be undertaken to ensure the integrity of the dataset. These are to include:

- Rinsate blanks (one per sampling event only)
- Blind duplicates (at a rate not less than 20% of total samples)
- Split duplicates (at a rate not less than 20% of total samples)

Samples are to be transported to a NATA-accredited laboratory under documented chain-of- custody protocols.

Field results will be checked for accuracy before leaving the site and errors or discrepancies will be cross-checked, and further investigation initiated if required.

4.4.5. Recording and documentation of results

All monitoring and sampling will be documented and transferred to a central electronic database under the responsibility of the Environment and Sustainability Manager. This data will be reviewed and assessed as detailed in Section 5.1.2

Results for each monitoring location will be recorded on appropriate field sheets (hard copy or digital) using unique sampling identification nomenclature consisting of the sample date, location, and sampler details.

The field sheet will detail:

- Prevailing weather conditions
- Prevailing tidal movement (where applicable)
- Name of sampler
- Time and date of sampling.

5. Compliance management

5.1. Roles, responsibility and training

The JHCPB Project Team's organisational structure, and overall roles and responsibilities, are outlined in Section 3.3 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in the GMP.

All employees, contractors and utility staff working on site will undergo site induction and targeted training relating to groundwater management issues detailed in the GMP.

Further details regarding staff induction and training are outlined in Section 3.5 of the CEMP.

5.1.1. Monitoring and inspection

Section 4.2 and Section 5 of this GWMP provide detailed inspection criteria including:

- Groundwater monitoring locations
- Parameters/analytes to be monitored
- Type of monitoring
- Frequency of monitoring
- Monitoring methodology.

Additional requirements and responsibilities in relation to inspections are documented in Section 3.3.1 of the CEMP.

5.1.2. Data analysis

Results from the construction monitoring program will be compared with the SSTVs and groundwater modelling predictions following each bi-monthly sampling event for ground water salinity, monthly for water quality, and in-line continuous monitoring.

Monitoring results of groundwater level will involve recorded data being compensated for barometric pressure and converted to a groundwater level measurement. Manual monitoring data will be used to verify continuous groundwater level data. Groundwater level data will be compared to local rainfall records to assess trends.

Water quality results from the WTPs will be analysed monthly, and along with an overview of corrective actions will be reported in the six-monthly water monitoring report. The monitoring results will be compared against the requirements for discharge (Table 7) and Project EPL ~~ANZECC (2000) 90 per cent species protection level~~ (see Table 8).

Monitoring results for EC will be compared against SSTVs (see Table 6) bi-monthly and reported in the water monitoring reports (Table 9). If results trigger a response (see Section 3.2.2.1), management actions will be implemented, as required, should an initial review determine a potential impact outside of approved predictions.

The monitoring results for groundwater level will be used to inform the groundwater model updates increasing the confidence level in model predictions with respect to groundwater inflow and drawdown. Where required (see Section 4.2) the groundwater model will be calibrated to monitoring results and predictions updated.

5.1.3. Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this Program, CoA, and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 3.9.3 of the CEMP.

5.1.4. Reporting

During construction, groundwater level and EC will be collected, tabulated and assessed against baseline conditions and performance criteria. Monitoring reports will be submitted to DPIE, DPIE Water, Sydney Water and Port Authority of NSW within 60 days of the reporting period unless otherwise agreed with DPIE.

Data provision and reporting requirements associated with the Program for the construction phase of the Project are presented in Table 9.

Table 9: Reporting requirements

Schedule (during construction)	Requirements	Recipient (relevant authority)
Reporting		
Water monitoring reports (every six months)	Data summary reports presenting tabulated groundwater monitoring data collected during the reporting period. Groundwater level hydrographs (including rainfall) and water quality (EC) results will be presented and SSTV exceedances will be highlighted. Metres of ground excavated and flow rates during construction will be presented. Applicable management responses will be documented. Compliance against discharge criteria will also be presented. Report will present validation of groundwater modelling and determine the need for any necessary adjustments to the GWMP (this document).	DPIE, DPIE Water Water, Sydney Water, Port Authority of NSW
EPL Monitoring Reports and Annual Returns	EPL monitoring reports will be prepared in accordance with the requirements of the EPL. An EPL Annual Return will be prepared in respect of each EPL reporting period (typically 12 months).	EPA
Construction Compliance Reports (every six months)	A results summary an analysis of environmental monitoring	DPIE, TfNSW, ER
Monthly Environmental Report (every month)	Commentary on monitoring program performance will be documented in the Monthly Environmental Report. Any incidents and key environmental issues will be documented.	TfNSW
Data provision		
Quarterly (every 3 months)	WTP discharge water quality and flow data (raw data collated and tabulated in Excel) To demonstrate compliance with the CoA (C12(f)), Project discharge criteria (defined in Section 3.3 of this GWMP, EPL, and if applicable JHCPB's trade waste licence.	Sydney Water
Quarterly (every 3 months)	Groundwater level and groundwater quality (EC) monitoring data (raw data collated and tabulated in Excel) To demonstrate compliance with the CoA (C12(g)).	DPIE Water

6. Review and improvement

6.1. Continuous improvement

Monitoring data will be reviewed throughout the construction period to provide validation of the groundwater model and potential requirements to increase, or decrease, the number of sampling locations and/or the analytical suites. SSTV will be reviewed for appropriateness following 12 months of construction monitoring. Alterations to monitoring locations, analytical suites, or frequencies will be reported in the construction compliance monitoring reports.

Continuous improvement of this Program will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance
- Determine the cause or causes of non-conformances and deficiencies
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies
- Verify the effectiveness of the corrective and preventative actions
- Document any changes in procedures resulting from process improvement
- Make comparisons with objectives and targets.

6.2. GWMP update and amendment

The processes described in Section 3.1.3 of the CEMP may result in the need to update or revise this Program. This will occur as needed.

Only the Environment and Sustainability Manager, or delegate, has the authority to change any of the environmental management documentation. All amendments to environmental management documentation require endorsement from the Environmental Representative.

A copy of the updated Program and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure, refer to Section 3.11.2 of the CEMP.

7. References

AECOM, 2017. M4-M5 Link: Groundwater Monitoring Interpretative Report, August 2017.

AECOM, 2018. M4-M5 Link Rozelle Rail Yards - Tranche 5: Groundwater Contamination Sampling, April 2018

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC), 2000, updated in 2018.Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Bureau of Meteorology (BoM) 2012. National Atlas of Groundwater Dependent Ecosystems

Department of Land and Water Conservation (DLWC), 2002. NSW Groundwater Dependent Ecosystems Policy.

DLWC, 1998. NSW Groundwater Policy Framework Document. DLWC, 1998. NSW Groundwater Quality Protection Policy.

DLWC, 1997. NSW Groundwater Quantity Management Policy.

Department of Planning, Industry and Environment (DPIE), 2012. Guideline for riparian corridors on waterfront land.

Department of Water and Energy (DWE), 2007. NSW Water Extraction Monitoring Policy.

Environment Protection Authority (EPA), 2004. Approved Methods for the Sampling and Analysis of Water Pollutants in NSW.

Lendlease, Samsung C&T and Bouygues Construction Australia Joint Venture (LSBJV), 2018. Appendix B6 Groundwater Management Sub-plan, M4-M5 Link Mainline Tunnels, November 2018.

NSW Office of Water (NoW), 2011. Water Sharing Plan, Greater Metropolitan Regional Groundwater Sources Background Document, Sydney.

NSW Roads and Maritime Services, 2017. M4-M5 Link Environmental Impact Statement, August 2017.

NoW, 2012. NSW Aquifer Interference Policy.

Roads and Maritime Services (Roads and Maritime), 2011. Road and Maritime Dewatering Guideline.

Annexure A Baseline Groundwater Quality Sampling Program Summary

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH01D	27/07/2016	19.4	1.17	1373	7.04	-117.3
	30/08/2016	20.4	1.79	1491	6.63	-116.1
	29/09/2016	18.6	1.43	1261	9.88	-167.6
	24/10/2016	20.7	1.21	1979	6.01	-6.1
	25/10/2016	21.1	0.38	2146	6.0	-14.5
	28/11/2016	22.4	1.25	1987	6.78	-81.9
	12/12/2016	22.7	2.75	1408	6.65	-72.0
	12/01/2017	23.1	2.85	1817	6.74	-22.0
	14/02/2017	20.4	0.60	1869	6.43	-68.0
	13/03/2017	22.1	1.24	1646	6.92	-114.6
	26/04/2017	22.7	2.54	1876	6.79	-69.2
	24/05/2017	20.3	3.35	1489	6.37	19.3
	15/06/2017	19.4	0.93	1246	6.92	19.4
	18/07/2017	18.9	3.65	892	7.12	-126.0
	11/08/2017	20.7	1.56	1339	8.52	-123.4
	19/10/2017	25.4	2.95	1932	7.75	-73.3
	21/11/2017	21.8	4.13	452	8.65	119.7
	11/01/2018	22.5	2.93	742	7.3	-129.5
	15/02/2008	24.0	2.66	1644	7.25	-125.0
	15/03/2018	24.3	6.25	307	11.3	-95.0
	16/04/2018	22.7	2.03	3650	9.74	162.0
	16/05/2018	17.6	9.05	2186	10.8	-93.0
	13/06/2018	20.5	7.58	930	7.6	-38.1
RZ_BH01S	27/07/2016	20.0	1.72	456	6.96	-95.5
	30/08/2016	19.9	1.61	397	6.95	-109.0
	27/09/2016	19.8	0.09	528	7.02	-163.6
	25/10/2016	25.0	1.44	627	6.69	-65.0
	28/11/2016	22.6	2.75	426	7.29	-53.9
	12/12/2016	21.3	3.37	540	7.12	-66.0
	12/01/2017	22.8	3.82	517	7.07	-25.0
	14/02/2017	21.3	1.78	560	6.66	-90.0
	13/03/2017	21.9	0.87	527	6.77	-88.9
	26/04/2017	21.7	3.78	523	6.85	-109.4
	24/05/2017	21.0	3.25	448	6.75	-4.6
	15/06/2017	20.0	0.69	419	7.06	-76.9
	18/07/2017	20.1	6.02	399	7.18	-120.0
	11/08/2017	23.0	2.11	417	9.69	-149.5
	19/10/2017	22.6	4.67	507	8.08	506.6
	21/11/2017	20.5	3.44	445	8.79	-47.5
	12/01/2018	23.8	3.34	450	7.46	-85.5
	16/02/2018	23.9	2.89	584	7.1	-112.8
	16/03/2018	21.0	1.71	493	7.13	-118.0
	17/04/2018	21.6	1.92	1250	7.18	-117.0
	17/05/2018	17.9	6.16	787	7.15	-55.7

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	14/06/2018	20.2	7.12	2174	10.34	-93.6
RZ_BH15	27/07/2016	18.7	1.56	611	9.35	-132.3
	30/08/2016	20.7	1.47	368	7.7	-76.0
	29/09/2016	19.1	0.58	1248	7.14	-141.0
	25/10/2016	20.8	0.09	1048	6.55	-58.1
	28/11/2016	22.7	1.94	698	7.48	-93.2
	12/12/2016	22.7	1.87	995	6.65	18.0
	12/01/2017	23.8	0.66	694	6.86	-55.0
	14/02/2017	21.2	1.76	984	6.65	-90.1
	13/03/2017	21.9	1.23	880	6.99	-93.4
	26/04/2017	21.6	1.99	1067	7.04	-82.8
	24/05/2017	22.4	2.19	890	6.2	17.9
	15/06/2017	19.7	0.90	921	6.8	-40.3
	18/07/2017	19.7	2.87	877	6.95	-140.0
	11/08/2017	20.3	1.55	977	11.39	-238.8
	19/10/2017	21.7	4.61	1010	7.63	-41.5
	21/11/2017	20.8	3.85	955	7.79	-14.3
	11/01/2018	23.8	4.65	954	7.72	-118.0
	15/02/2008	24.4	3.51	1080	7.03	-107.1
	15/03/2018	21.0	0.81	499	6.85	-73.0
	16/04/2018	20.7	2.20	754	7.13	-99.0
	16/05/2018	15.6	6.67	1086	6.86	-10.5
	13/06/2018	22.5	6.54	1470	7.37	-66.0
RZ_BH16	14/07/2016	20.5	1.17	1310	7.24	27.1
	27/07/2016	19.0	1.24	690	10.3	-158.8
	30/08/2016	19.4	1.87	672	10.02	-54.1
	29/09/2016	18.9	0.11	782	8.93	-170.4
	24/10/2016	20.2	1.69	1225	6.09	-17.2
	25/10/2016	23.8	1.75	768	7.32	-41.2
	28/11/2016	22.3	1.46	969	7.51	-75.3
	12/12/2016	20.2	1.53	993	8.96	9.0
	12/01/2017	22.2	2.06	925	8.38	-9.0
	14/02/2017	19.9	2.26	969	7.35	-45.3
	13/03/2017	21.9	0.31	1065	7.51	-134.3
	26/04/2017	21.3	4.34	945	7.11	-118.9
	24/05/2017	19.7	0.55	830	9.22	10.5
	15/06/2017	18.4	4.75	202	7.48	22.0
	18/07/2017	19.1	2.14	466	8.62	-125.0
	11/08/2017	20.6	2.01	563	9.72	-129.4
	15/09/2017	20.6	4.16	339	7.7	23.9
	19/10/2017	24.9	1.03	946	7.99	-6.2
	21/11/2017	23.9	2.35	551	8.52	-43.5
	12/01/2018	23.6	6.72	839	7.64	-43.3
	16/02/2018	24.9	3.85	639	7.17	-114.4
	16/03/2018	23.6	3.42	496	7.31	-93.0
	17/04/2018	22.0	1.00	344	7.74	-174.0
	17/05/2018	17.3	6.45	1460	9.22	-182.0
	14/06/2018	21.9	4.74	1874	8.44	-141.3

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH19	10/08/2016	20.0	0.36	1112	7.34	155.9
	29/09/2016	18.6	0.10	1199	8.11	-132.1
	24/10/2016	21.0	1.44	1245	6.07	-20.4
	27/10/2016	19.8	0.06	1270	7.04	-135.8
	28/11/2016	21.1	1.50	1227	8.34	-158.7
	12/12/2016	21.8	1.15	1245	9.82	-154.0
	13/01/2017	21.4	0.66	1190	6.7	124.0
	14/02/2017	20.4	0.10	1240	8.5	-203.0
	13/03/2017	23.0	0.14	1340	6.69	-230.0
	26/04/2017	21.4	4.50	918	7.68	-152.9
	24/05/2017	20.1	2.57	1052	7.83	13.5
	15/06/2017	21.4	3.14	963	7.5	-112.9
	18/07/2017	19.1	3.38	919	8.47	-123.0
	11/08/2017	19.9	0.53	957	8.11	-117.4
	15/09/2017	20.8	3.38	1190	8.03	-88.0
	19/10/2017	25.5	1.85	1242	7.86	-89.7
	21/11/2017	20.5	0.20	955	8.11	-141.8
	12/01/2018	26.8	2.46	1149	8.18	-78.5
	16/02/2018	22.1	2.43	1090	7.19	-64.7
	16/03/2018	22.9	2.90	1175	7.52	-124.0
	17/04/2018	22.1	2.32	431	7.71	-173.0
	17/05/2018	17.8	6.65	2269	7.44	-74.3
	14/06/2018	20.0	4.97	2386	7.45	-72.2
RZ_BH26	14/07/2016	18.7	1.24	445	6.65	60.0
	27/07/2016	17.4	1.82	449	10.29	-107.2
	30/08/2016	19.8	1.60	4547	9.16	54.3
	29/09/2016	18.9	0.30	560	7.35	-149.5
	24/10/2016	20.6	0.64	547	5.73	-7.0
	25/10/2016	20.3	3.98	488	9.29	-112.6
	28/11/2016	21.2	0.80	611	7.02	-115.0
	12/12/2016	21.3	1.56	469	6.97	-133.0
	13/01/2017	23.7	1.44	604	6.83	-29.0
	14/02/2017	19.8	2.51	617	6.79	-126.9
	13/03/2017	21.3	0.55	712	6.4	-113.2
	26/04/2017	22.6	4.03	601	7.09	-66.7
	24/05/2017	18.7	0.24	549	6.68	-39.7
	15/06/2017	19.2	0.51	577	6.73	-86.1
	18/07/2017	18.8	2.88	459	6.81	-114.0
	11/08/2017	20.5	3.02	472	7.65	-20.6
	15/09/2017	19.3	2.99	501	6.97	-47.9
	19/10/2017	23.4	3.11	545	7.43	-16.9
	21/11/2017	22.7	8.57	123	10.45	-30.6
	12/01/2018	25.2	2.24	587	8.66	-110.8
	16/02/2018	26.1	1.95	672	6.95	-97.8
	16/03/2018	23.7	3.52	644	6.77	-88.0
	17/04/2018	22.8	2.43	223	6.71	-111.0
	17/05/2018	19.5	4.34	1226	6.72	-36.4
	14/06/2018	18.8	7.06	1508	6.54	-7.6

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH28	10/08/2016	18.9	1.08	833	6.09	-7.9
	29/09/2016	18.8	0.95	835	6.79	-88.8
	25/10/2016	20.7	0.17	849	5.96	-97.2
	28/11/2016	21.4	1.57	887	6.64	-35.4
	12/12/2016	21.2	2.85	935	6.8	-72.0
	13/01/2017	23.3	2.27	868	6.42	-17.0
	14/02/2017	19.7	2.43	862	6.4	-61.3
	13/03/2017	21.1	0.85	963	6.19	-51.0
	26/04/2017	23.6	3.10	814	6.89	-43.2
	24/05/2017	19.6	3.03	725	6.34	52.9
	15/06/2017	20.0	1.98	753	6.15	21.5
	18/07/2017	18.4	3.62	612	6.52	-83.0
	11/08/2017	21.0	3.60	695	7.34	110.3
	12/01/2018	24.6	3.03	778	7.61	-42.9
	16/02/2018	22.3	3.10	885	6.69	-31.8
	16/03/2018	21.6	2.84	441	6.11	-6.0
	17/04/2018	25.5	4.46	3041	6.88	-60.0
	17/05/2018	19.7	7.31	1489	6.32	33.6
	14/06/2018	18.1	7.52	363	6.88	39.6
RZ_BH30	27/07/2016	20.0	0.60	1452	6.75	-67.5
	31/08/2016	20.3	2.54	1347	6.7	-87.7
	28/09/2016	21.7	1.20	1598	6.84	-109.8
	16/01/2017	21.1	5.26	951	6.13	95.0
	26/04/2017	20.1	3.69	1422	6.75	-39.2
	24/05/2017	19.6	2.91	1094	6.74	52.8
	15/06/2017	20.2	3.59	415	7.06	-31.0
	18/07/2017	18.2	2.50	#	6.69	-76.0
	11/08/2017	19.9	1.68	1098	7.23	-11.9
	15/09/2017	21.1	3.68	1248	7.33	237.7
	19/10/2017	24.5	1.29	1535	7.46	-49.8
	12/01/2018	25.7	2.18	1424	7.28	-35.2
	16/02/2018	25.1	1.78	1680	6.82	-42.1
	16/03/2018	21.2	3.59	206	3.9	142.0
	17/04/2018	22.1	2.58	259	7.18	-70.0
	17/05/2018	19.4	6.84	1957	6.78	15.1
	14/06/2018	17.6	6.87	2758	7.6	-55.6
RZ_BH38	10/08/2016	20.1	1.18	1136	9.72	-281.1
	29/09/2016	18.4	0.64	1350	8.57	-178.3
	26/10/2016	20.4	0.81	1682	7.86	-94.9
	27/10/2016	21.1	0.89	1276	10.45	-139.2
	28/11/2016	22.1	1.29	1946	8.24	-148.2
	12/12/2016	-	3.02	1971	7.99	-96.0
	12/01/2017	24.2	2.50	1933	8.0	-56.0
	14/02/2017	20.6	1.29	2056	7.3	-164.0
	13/03/2017	22.1	0.28	2193	7.51	22.1
	26/04/2017	20.6	6.22	1467	7.35	-94.6
	24/05/2017	20.0	1.54	1543	7.43	28.3
	15/06/2017	19.4	2.11	1484	7.22	-57.9

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	18/07/2017	18.8	2.88	1400	8.28	-117.0
	11/08/2017	19.5	2.71	1211	9.14	-97.9
	15/09/2017	21.3	2.85	1300	7.95	-24.5
	19/10/2017	25.8	4.45	1565	7.54	-29.5
	21/11/2017	21.9	1.39	1344	8.04	-97.6
	12/01/2018	23.4	1.97	1476	8.06	-75.4
	16/02/2018	27.7	0.52	1509	7.26	-78.2
	16/03/2018	18.2	3.48	1175	6.87	-51.0
	17/04/2018	21.7	2.60	534	8.09	-190.0
	17/05/2018	18.1	7.34	1934	7.97	-79.2
	14/06/2018	19.9	6.23	2315	7.52	-11.3
RZ_BH44S	10/08/2016	21.8	0.99	6681	6.49	-62.5
	29/09/2016	18.3	0.26	3713	5.79	-28.9
	27/10/2016	19.1	0.21	2706	6.28	-70.8
	28/11/2016	22.3	1.06	2844	6.67	-18.8
	12/12/2016	21.3	3.57	2610	5.84	-6.0
	13/01/2017	21.5	4.20	2390	6.78	-38.0
	14/02/2017	20.4	2.38	2685	6.17	-19.8
	13/03/2017	21.4	1.66	2934	6.7	-91.0
	26/04/2017	22.5	3.68	2430	7.2	-44.9
	24/05/2017	21.0	3.22	2248	6.3	50.2
	15/06/2017	21.3	4.84	1880	6.22	37.0
	18/07/2017	19.5	3.65	1425	6.77	-123.0
	11/08/2017	21.0	2.56	2000	7.59	-96.8
	15/09/2017	19.6	4.93	702	7.46	59.2
	19/10/2017	23.1	-	2264	7.3	10.9
	21/11/2017	23.0	2.15	2095	8.1	-77.1
	12/01/2018	23.6	0.58	1559	6.91	-20.9
	16/02/2018	22.8	2.26	1918	6.22	48.7
	16/03/2018	26.2	5.38	242	6.9	-22.0
	17/04/2018	22.5	3.24	566	6.69	-87.0
	17/05/2018	18.3	5.62	4540	6.67	39.9
	14/06/2018	20.0	8.82	3071	6.91	44.3
RZ_BH44D	10/08/2016	20.9	0.53	715	6.95	-84.5
	29/09/2016	18.7	0.94	1168	7.04	-124.3
	27/10/2016	20.6	2.65	1304	7.04	-106.1
	28/11/2016	22.0	2.56	1401	7.89	-117.0
	12/12/2016	22.6	0.93	1199	6.77	-117.0
	13/01/2017	22.3	3.08	1344	7.42	11.0
	14/02/2017	20.9	0.43	1470	7.01	-133.8
	13/03/2017	21.4	1.82	1332	6.89	-123.0
	26/04/2017	24.0	2.85	1403	7.62	-128.1
	24/05/2017	20.6	2.32	1071	7.02	2.4
	15/06/2017	21.4	3.07	481	7.0	-1.9
	18/07/2017	19.1	4.66	347	7.81	-108.0
	11/08/2017	20.0	1.11	590	7.79	-83.1
	15/09/2017	20.3	3.65	571	8.07	-71.1
	19/10/2017	21.4	3.32	820	7.4	-45.6

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	21/11/2017	21.4	2.93	1007	8.2	-75.8
	12/01/2018	22.7	1.22	795	7.07	-59.0
	16/02/2018	24.1	1.61	565	7.2	-77.8
	16/03/2018	23.6	3.91	161	7.41	-133.0
	17/04/2018	22.1	2.32	1925	7.06	-126.0
	17/05/2018	19.1	8.76	910	6.94	-14.4
	14/06/2018	19.4	8.29	1201	7.16	-12.1
RZ_BH47S	31/08/2016	23.0	1.75	1216	6.27	-57.2
	29/09/2016	18.7	0.22	1393	5.56	10.8
	25/10/2016	19.9	5.22	328	9.64	-129.4
	28/11/2016	23.1	0.69	1271	6.65	4.2
	12/12/2016	23.4	4.22	932	6.39	-14.0
	13/01/2017	24.8	2.36	1203	6.41	-24.0
	14/02/2017	21.1	0.88	1120	6.25	-22.5
	13/03/2017	22.3	0.99	1202	6.14	-27.0
	26/04/2017	22.6	3.16	1193	7.26	-21.8
	24/05/2017	20.5	3.03	1003	6.06	64.3
	15/06/2017	20.5	1.77	1085	5.95	41.5
	18/07/2017	19.9	1.83	857	6.53	-101.0
	11/08/2017	23.3	1.67	993	7.46	-56.5
	15/09/2017	19.7	5.30	904	7.22	142.1
	19/10/2017	24.4	1.74	1271	8.18	-8.5
	21/11/2017	22.4	4.51	845	9.08	-59.0
	12/01/2018	23.1	0.12	1255	7.83	-40.5
	16/02/2018	26.3	1.05	1307	6.23	-29.2
	16/03/2018	27.3	3.38	1234	5.91	39.0
	17/04/2018	19.3	1.68	6780	7.13	-124.0
	17/05/2018	20.1	6.26	2319	6.16	56.7
	14/06/2018	21.1	6.23	3508	6.41	34.8
RZ_BH47D	31/08/2016	22.5	2.26	829	6.51	-62.3
	29/09/2016	19.1	0.13	1031	6.34	-63.0
	25/10/2016	21.7	4.30	338	8.72	-132.9
	28/11/2016	21.9	1.20	900	6.7	-60.5
	12/12/2016	23.3	2.08	921	6.58	-73.0
	13/01/2017	25.4	3.35	931	6.49	-16.0
	14/02/2017	20.8	1.00	946	6.58	-104.3
	13/03/2017	21.9	0.60	1007	6.65	-104.0
	26/04/2017	21.4	4.82	926	6.98	-70.8
	24/05/2017	19.9	1.20	845	6.4	29.7
	15/06/2017	20.3	2.75	894	6.5	6.6
	18/07/2017	19.6	1.39	753	6.72	-87.0
	11/08/2017	21.3	3.14	858	7.27	-35.0
	15/09/2017	20.1	2.35	881	7	-6.0
	19/10/2017	23.2	2.03	1068	7.52	-51.7
	21/11/2017	21.9	4.43	957	8.75	-83.4
	12/01/2018	23.1	3.01	881	7.65	-33.8
	16/02/2018	25.1	3.36	1001	6.71	-60.2
	16/03/2018	29.0	2.78	967	6.55	-41.0

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	17/04/2018	25.1	2.30	5280	7.04	-85.0
	17/05/2018	19.2	5.97	2585	6.06	56.8
	14/06/2018	18.0	7.56	2546	6.51	66.6
RZ_BH49	14/07/2016	19.1	0.67	9258	7.57	33.7
	27/07/2016	18.0	3.46	3017	9.95	-168.8
	30/08/2016	20.0	1.96	7900	6.69	-55.6
	29/09/2016	18.1	0.41	10778	6.49	-64.2
	26/10/2016	20.8	2.28	5419	7.56	-87.1
	28/11/2016	22.2	2.82	4416	8.46	-49.7
	12/12/2016	20.0	4.25	3580	7.82	-3.0
	12/01/2017	22.6	4.16	646	7.35	38.0
	14/02/2017	19.9	0.80	9348	6.45	-53.2
	13/03/2017	21.4	1.05	9869	6.82	-75.7
	26/04/2017	21.1	5.36	1995	7	-19.4
	24/05/2017	19.7	3.69	6453	7.31	53.5
	15/06/2017	18.9	5.03	4483	6.89	13.2
	18/07/2017	18.7	4.07	3840	7.34	-42.0
	11/08/2017	19.5	7.29	655	9.62	6.8
	15/09/2017	20.0	7.73	1174	7.73	207.9
	19/10/2017	26.3	2.26	9693	6.84	1.5
	12/01/2018	24.9	2.61	9329	7.23	-75.5
	16/02/2018	24.1	1.32	8263	6.75	-62.7
	16/03/2018	24.3	2.04	3040	7.31	-65.0
	17/04/2018	25.9	2.20	1427	7.06	-48.0
	17/05/2018	19.5	7.39	9784	6.61	29.9
	14/06/2018	20.7	6.81	21550	6.89	19.3
RZ_BH50	31/08/2016	20.9	1.44	338	7.47	-120.3
	28/09/2016	22.0	0.82	678	6.05	-37.9
	25/10/2016	22.4	0.20	594	5.76	-111.6
	28/11/2016	21.4	0.79	598	6.79	-37.2
	12/12/2016	23.0	2.41	422	6.2	-33.0
	16/01/2017	20.9	5.78	423	6.5	-10.0
	14/02/2017	20.5	6.10	6600	6.74	-54.7
	15/03/2017	22.8	2.58	531	6.56	-20.6
	26/04/2017	23.1	4.07	550	7.26	-1.4
	24/05/2017	20.1	2.75	550	6.22	34.9
	15/06/2017	20.3	1.27	541	6.17	-26.3
	18/07/2017	19.6	4.06	505	6.55	-87.0
	11/08/2017	19.8	3.27	520	7.47	-46.2
	15/09/2017	21.5	3.42	499	7.07	44.1
	19/10/2017	23.1	1.96	686	7.64	-34.6
	16/02/2018	23.0	2.44	646	6.35	-49.8
	16/03/2018	21.1	3.00	224	4.12	-4.0
	17/04/2018	21.3	2.81	211	6.65	-76.0
	17/05/2018	20.3	3.86	1064	6.35	26.7
	14/06/2018	15.8	8.13	1692	7.16	-35.1
RZ_BH51	10/08/2016	24.9	1.52	4100	11.92	-190.6
	28/09/2016	20.0	0.23	1770	6.62	-84.8

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	25/10/2016	26.5	2.26	1801	6.37	-107.1
	28/11/2016	21.8	0.90	1580	7.16	-123.5
	12/12/2016	22.0	3.04	1645	6.71	-30.0
	16/01/2017	21.5	1.30	1440	6.57	63.0
	14/02/2017	21.0	1.46	1533	6.74	-77.0
	26/04/2017	20.9	5.40	1161	6.88	-18.4
	24/05/2017	20.6	3.55	1467	6.48	43.9
	15/06/2017	21.0	2.53	824	6.98	-48.3
	18/07/2017	19.8	5.51	1101	6.67	-69.0
	11/08/2017	21.1	3.25	1265	6.81	-11.7
	15/09/2017	22.5	5.30	996	6.98	68.3
	12/01/2018	26.1	2.36	1375	8.42	-130.4
	16/02/2018	26.5	1.63	1155	7.93	-148.1
	16/03/2018	24.8	1.87	1422	6.91	-91.0
	17/04/2018	21.3	2.65	239	7.03	-137.0
	17/05/2018	20.1	6.33	1081	6.81	-16.1
	14/06/2018	17.3	3.41	1766	7.82	-102.6
RZ_BH52	10/08/2016	22.0	1.23	526	10.15	154.3
	28/09/2016	21.0	1.08	1256	6.59	-74.1
	25/10/2016	21.3	0.17	1004	5.6	-106.2
	28/11/2016	22.2	2.50	1033	7.44	-48.5
	12/12/2016	22.2	2.42	775	6.44	-77.0
	14/02/2017	21.2	0.27	1087	6.66	-72.8
	15/03/2017	25.3	0.32	920	6.68	16.0
	26/04/2017	20.5	3.78	818	7.05	-64.6
	24/05/2017	20.7	1.38	873	6.45	20.6
	15/06/2017	20.7	2.13	980	6.41	-37.4
	18/07/2017	18.9	6.32	724	6.73	-85.0
	11/08/2017	20.5	0.87	853	7.03	-8.2
	15/09/2017	22.2	2.73	831	6.67	44.9
	19/10/2017	25.7	2.62	986	6.82	9.4
	21/11/2017	23.4	4.64	659	9.63	23.4
	12/01/2018	24.6	2.15	873	9.05	-89.4
	16/02/2018	26.1	4.01	937	7.02	-92.9
	16/03/2018	21.2	3.01	854	11.56	-22.0
	17/04/2018	23.8	4.72	923	6.82	-78.0
	15/05/2018	21.4	5.60	1317	6.63	34.5
	14/06/2018	16.9	6.89	926	7.62	33.8
RZ_BH60	16/01/2017	22.5	9.63	4910	11.76	-95.0
	17/02/2017	20.9	0.79	4291	11.43	-294.1
	15/03/2017	21.2	0.93	3393	12.37	-93.2
	27/04/2017	18.5	2.76	3764	11.86	-184.9
	26/05/2017	19.0	2.88	3303	12.19	64.4
	16/06/2017	17.6	1.12	3081	12.45	-144.6
	17/07/2017	19.0	9.29	172	11.81	-248.0
	10/08/2017	22.0	2.46	3262	12.95	-89.7
	14/09/2017	17.9	2.94	3542	11.22	-51.8
	20/10/2017	17.9	3.03	3284	11.83	-66.9

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	20/11/2017	24.1	2.00	2615	10.63	-76.4
	15/02/2018	21.4	2.92	3422	12.11	-46.6
	15/03/2018	25.9	2.74	2570	11.86	25.0
RZ_BH64	26/05/2017	19.3	1.59	572	9.16	562.0
	15/06/2017	17.8	2.10	605	8.56	-122.3
	18/07/2017	18.6	1.54	545	8.63	-149.0
	10/08/2017	19.8	1.34	602	7.6	-135.6
	14/09/2017	17.3	3.03	675	7.52	-44.8
	20/10/2017	17.8	3.54	672	10.52	-160.5
	20/11/2017	22.8	2.76	581	8.29	-65.9
	12/01/2018	24.5	2.46	745	7.83	-112.6
	16/02/2018	24.0	2.46	762	7.62	-96.1
	15/03/2018	27.4	2.46	259	7.03	-92.0
	16/04/2018	20.9	2.21	256	6.63	-193.0
	16/05/2018	17.3	2.43	1358	7.73	-124.6
	13/06/2018	16.0	8.76	1806	7.45	-141.6
RZ_BH67	17/02/2017	21.4	0.03	773	8.96	-316.8
	15/03/2017	22.2	0.78	602	7.06	-61.7
	27/04/2017	17.5	5.20	507	6.73	-20.9
	26/05/2017	20.2	3.11	523	6.42	19.2
	16/06/2017	18.3	1.01	518	6.88	-90.6
	14/09/2017	17.9	4.83	573	8.3	-104.7
	20/10/2017	19.9	1.23	588	7.43	-32.6
	20/11/2017	21.7	1.94	532	8.86	-98.9
	16/03/2018	20.3	3.71	642	11.65	-4.0
RZ_BH69	16/02/2017	20.4	1.13	424	5.79	-168.1
	15/03/2017	20.1	2.98	2469	12.28	-80.8
	18/07/2017	17.6	2.11	974	11.82	-19.5
	14/09/2017	19.0	1.54	453	8.35	103.9
	20/10/2017	19.9	1.72	1349	9.37	-157.8
	16/04/2018	21.3	2.91	138	7.12	173.0
TC_BH01D	8/07/2016	18.2	1.85	1126	8.66	30.7
	27/07/2016	17.4	2.20	3883	12.06	-183.4
	30/08/2016	18.5	0.84	3267	11.86	-293.2
	27/09/2016	21.9	1.34	3817	11.53	-242.5
	26/10/2016	20.7	0.48	3855	10.3	-118.5
	29/11/2016	21.6	2.61	1696	7.61	-99.6
	13/12/2016	25.0	2.06	3230	11.59	-289.0
	16/01/2017	23.6	4.94	2450	10.88	-117.0
	16/02/2017	23.1	0.04	4004	10.52	-297.1
	14/03/2017	22.0	1.95	2962	9.42	-112.7
	27/04/2017	19.7	4.06	3077	9.26	-184.7
	25/05/2017	18.9	2.07	2724	7.35	20.5
	15/06/2017	20.2	0.37	2789	11.28	-115.0
	17/07/2017	17.6	3.10	#	11.05	-123.0
	10/08/2017	17.7	9.29	2857	11.7	-127.9
	20/10/2017	19.0	4.41	3054	8.94	-82.8
	20/11/2017	21.3	1.82	2912	7.39	82.0

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	12/01/2018	21.7	1.79	2763	8.17	78.1
	15/02/2018	22.0	2.08	3515	10.66	-127.0
	15/03/2018	24.8	2.01	3910	9.97	-136.0
	16/04/2018	29.6	2.02	1127	9.21	-222.0
	16/05/2018	19.8	6.97	8040	7.52	26.8
	13/06/2018	16.8	6.61	9910	7.57	122.0
TC_BH01S	8/07/2016	19.5	3.59	11084	6.97	-219.8
	21/07/2016	17.1	3.70	17511	6.87	-64.7
	30/08/2016	17.4	4.25	6899	7.05	-52.0
	27/09/2016	19.3	0.16	34922	6.63	-81.4
	26/10/2016	21.6	1.77	24313	6.68	-110.6
	29/11/2016	21.7	2.67	9665	7.03	-14.6
	13/12/2016	21.9	3.93	19850	7.37	-109.0
	16/01/2017	23.2	5.50	14240	8.25	-71.0
	16/02/2017	23.8	0.89	29747	6.82	-168.0
	14/03/2017	23.2	2.04	27564	7.03	130.6
	27/04/2017	20.6	2.85	29460	8.3	-100.4
	25/05/2017	19.2	6.36	11554	6.87	46.7
	15/06/2017	20.2	3.11	18544	6.96	-48.7
	17/07/2017	17.6	1.01	#	6.84	-44.0
	10/08/2017	17.8	1.36	25188	7.93	-83.1
	20/10/2017	18.7	6.02	24371	7.83	-75.6
	20/11/2017	20.8	4.52	22954	6.7	-55.2
	12/01/2018	21.7	3.98	22885	7.1	-92.2
	15/02/2018	22.7	2.81	30912	6.81	-37.5
	15/03/2018	23.9	3.54	30600	6.77	-67.0
	16/04/2018	29.1	1.51	8860	6.9	-69.0
	16/05/2018	20.4	7.10	17430	6.82	31.5
	13/06/2018	19.8	5.99	74800	6.83	15.3
TC_BH06	8/07/2016	17.4	3.55	1966	6.54	-40.7
	27/07/2016	18.9	1.02	1993	7.14	-113.0
	30/08/2016	17.3	3.06	1424	6.84	-83.0
	27/09/2016	18.9	0.22	1677	6.33	-55.7
	26/10/2016	19.9	1.01	1672	7.5	-112.7
	29/11/2016	20.2	2.39	3530	7.88	-45.4
	13/12/2016	22.5	7.65	1628	6.84	-65.0
	16/01/2017	22.8	5.47	1935	7.76	-135.0
	17/02/2017	21.9	1.98	2236	7.31	-216.1
	14/03/2017	21.9	2.03	1464	6.71	3.9
	27/04/2017	20.5	3.41	1504	10.25	-188.8
	25/05/2017	19.7	3.15	1500	6.57	18.4
	15/06/2017	19.5	1.57	1959	6.64	-65.8
	17/07/2017	16.0	1.04	#	6.88	-69.0
	10/08/2017	16.0	4.45	1492	8.36	-73.2
	15/09/2017	20.3	3.17	1175	6.51	-2.6
	20/10/2017	18.1	4.23	1485	8.89	-69.3
	20/11/2017	20.8	3.81	1839	7.73	-56.5
	12/01/2018	21.9	3.21	1861	8.42	-117.2

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	15/02/2018	22.9	3.90	2241	6.66	-73.0
	15/03/2018	24.9	7.53	2480	6.73	-86.0
	16/04/2018	27.2	2.69	2321	6.8	-98.0
	16/05/2018	19.5	3.47	3473	6.57	21.5
	13/06/2018	15.7	6.74	4723	6.68	13.9
TC_BH07D	8/07/2016	18.7	5.41	4202	11.84	-132.7
	27/07/2016	17.3	1.56	1762	7.63	-91.2
	31/08/2016	19.5	1.07	1713	8.55	-18.9
	26/10/2016	24.2	0.66	2640	6.84	-101.7
	16/01/2017	22.8	9.48	1547	7.4	-79.0
	16/02/2017	23.4	1.90	3123	6.49	-183.0
	14/03/2017	23.9	3.72	2416	7.18	-40.2
	27/04/2017	19.7	3.91	2045	9.01	-96.7
	16/06/2017	17.8	2.77	1846	6.8	-67.0
	17/07/2017	15.6	1.06	940	6.71	-57.0
	10/08/2017	18.2	0.91	1862	7.56	-70.4
	21/11/2017	20.2	6.20	1606	8.6	-61.6
	15/03/2018	26.3	2.54	845	6.78	-69.0
	17/04/2018	20.3	2.49	774	7.76	-151.0
	13/06/2018	16.9	5.51	4316	6.53	61.6
TC_BH07S	8/07/2016	18.1	3.33	30018	7.78	-117.9
	27/07/2016	17.6	1.24	23684	6.98	-160.2
	30/08/2016	18.2	1.68	24493	6.81	-71.2
	27/09/2016	18.6	0.06	31947	6.82	-260.0
	26/10/2016	21.9	1.70	28266	6.71	-107.4
	13/12/2016	22.7	3.51	373	6.93	-62.0
	16/01/2017	22.6	8.20	16700	6.9	-44.0
	16/02/2017	23.7	2.04	26816	6.2	-179.0
	14/03/2017	24.3	2.52	30388	6.89	-66.2
	28/04/2017	17.2	4.63	29619	6.91	-113.6
	25/05/2017	20.1	2.35	28938	6.72	27.5
	15/06/2017	19.8	3.49	27338	6.86	-46.2
	17/07/2017	15.9	1.08	#	6.87	-170.0
	10/08/2017	17.9	6.37	26990	6.73	-56.3
	15/09/2017	20.1	3.04	27541	6.12	22.6
	20/10/2017	18.8	2.08	29311	7.58	-38.5
	20/11/2017	23.5	4.29	16383	6.47	-35.8
	12/01/2018	22.0	1.39	29029	6.74	-130.9
	15/02/2018	23.6	3.41	26914	6.94	-93.3
	15/03/2018	29.0	1.45	3180	6.95	-81.0
	17/04/2018	20.2	3.25	6770	7.14	-148.0
	16/05/2018	18.8	4.73	128000	6.71	-2.1
	13/06/2018	17.5	8.49	40480	7.03	-113.4
TC_BH08	27/07/2016	19.0	1.23	7575	9.71	14.8
	30/08/2016	17.6	5.45	7104	8.1	20.7
	27/09/2016	19.2	0.06	13379	6.85	-121.0
	26/10/2016	21.0	2.36	10250	6.97	-88.6
	29/11/2016	20.2	2.01	12491	7.25	-95.0

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	13/12/2016	24.0	3.24	10940	7.08	-102.0
	16/01/2017	22.3	6.06	10250	7.23	-46.0
	16/02/2017	22.5	5.39	11702	7.19	-182.3
	14/03/2017	22.6	2.28	13552	7.21	40.3
	27/04/2017	20.5	3.76	7203	8.46	-128.6
	25/05/2017	20.4	1.49	9735	6.95	10.5
	15/06/2017	20.0	3.62	3170	7.52	-67.6
	17/07/2017	15.6	1.07	#	7.06	-119.0
	10/08/2017	18.5	6.51	4050	6.93	-14.2
	15/09/2017	19.6	6.43	5599	7.76	32.8
	20/10/2017	19.0	3.65	10212	8.11	-71.4
	20/11/2017	21.4	3.37	11368	6.66	-61.9
	12/01/2018	21.7	4.61	13051	6.84	-82.3
	15/02/2018	24.8	3.42	14898	7.32	-96.8
	15/03/2018	29.6	3.78	12810	7.18	-9.7
	17/04/2018	20.0	2.35	16520	7.01	-97.0
	16/05/2018	18.9	3.33	8467	6.92	-20.1
	13/06/2018	17.7	7.23	42730	7.05	-15.9
TC_BH09D	27/07/2016	18.8	1.00	1761	6.25	2.3
	30/08/2016	17.3	1.32	1385	6.62	-41.5
	28/09/2016	17.5	4.94	1917	6.5	-67.5
	26/10/2016	22.5	1.44	2012	6.95	-86.3
	29/11/2016	-	2.84	1794	8.13	84.7
	13/12/2016	24.4	1.01	2020	7.96	-129.0
	16/01/2017	23.6	8.01	2050	7.92	-110.0
	16/02/2017	23.6	1.57	1995	7.51	-232.0
	14/03/2017	23.1	0.37	1870	7.46	-56.2
	27/04/2017	20.2	4.40	1910	9.59	-102.2
	25/05/2017	19.7	1.52	1907	7.53	-9.0
	15/06/2017	19.9	2.19	2336	7.02	-65.4
	17/07/2017	15.5	7.10	#	7.07	-71.0
	10/08/2017	18.6	3.85	1836	7.99	-41.5
	20/10/2017	19.3	0.77	1752	9.27	-101.5
	20/11/2017	22.8	1.14	1555	8.13	-77.1
	12/01/2018	22.7	2.52	1724	8.02	-84.2
	15/02/2018	24.0	2.94	2153	6.78	-57.2
	15/03/2018	28.5	2.22	2311	6.73	-67.0
	17/04/2018	20.7	2.37	1205	6.91	-99.0
	16/05/2018	19.8	3.53	4898	7.11	-6.9
	13/06/2018	18.1	7.14	6103	6.54	61.9
TC_BH09S	27/07/2016	18.4	0.35	2601	6.73	17.4
	30/08/2016	16.1	2.05	1255	6.59	143.7
	26/10/2016	21.4	1.95	4699	6.48	-73.8
	29/11/2016	20.4	2.04	5114	7.54	-43.6
	13/12/2016	23.0	3.83	2830	7.16	-111.0
	17/01/2017	23.0	2.38	2780	6.25	21.0
	17/02/2017	23.4	1.55	3955	6.93	-204.5
	28/04/2017	18.2	3.57	2997	8.63	-107.4

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	26/05/2017	18.4	0.78	3195	7.1	24.8
	16/06/2017	18.1	4.37	1673	6.86	-18.7
	21/11/2017	20.6	4.30	2974	8.76	-87.9
EP_BH07	27/10/2016	20.4	7.29	429	7.97	-81.2
	30/11/2016	19.8	2.96	416	7.28	160.3
	13/12/2016	20.9	8.10	245	5.25	169.0
	12/01/2017	21.5	3.22	261	5.89	136.0
	16/02/2017	20.5	1.92	330	6.54	-137.1
	14/03/2017	21.2	3.51	336	4.48	127.5
	27/04/2017	16.8	4.99	314	7.64	130.7
	26/05/2017	19.8	5.63	287	8.68	77.6
	16/06/2017	20.0	2.57	326	5.19	176.2
	18/07/2017	15.6	3.70	390	6.92	-59.0
	11/08/2017	19.8	1.26	299	8.35	-14.1
	15/09/2017	18.5	2.22	333	7.05	199.5
	20/10/2017	20.3	4.66	616	8.35	61.3
	21/11/2017	19.9	6.33	302	8.98	61.5
	12/01/2018	21.3	2.70	300	9.74	-26.8
	16/02/2018	20.6	7.37	334	6.74	112.3
	16/03/2018	21.1	2.41	257	10.81	172.0
	17/04/2018	21.1	1.57	149	6.96	-98.0
	17/05/2018	15.3	7.81	403	7.25	72.6
	14/06/2018	14.7	6.34	490	6.45	127.8
EP_BH06	27/10/2016	21.5	5.08	547	7.59	-102.6
	30/11/2016	20.7	2.41	1274	8.08	-10.4
	13/12/2016	22.2	1.88	851	5.53	129.0
	12/01/2017	21.2	1.29	659	5.63	72.0
	16/02/2017	21.1	0.95	509	5.91	-165.0
	14/03/2017	21.8	1.48	469	5.7	85.9
	27/04/2017	18.1	2.72	421	6.99	42.3
	26/05/2017	20.9	2.73	398	7.21	68.3
	16/06/2017	19.3	3.64	425	5.59	109.7
	18/07/2017	16.2	3.41	358	6.15	-74.0
	11/08/2017	18.9	2.42	355	7.75	-21.3
	15/09/2017	18.3	3.54	431	6.81	174.3
	20/10/2017	20.1	3.01	401	7.7	117.0
	21/11/2017	19.3	5.53	382	8.51	43.6
	12/01/2018	21.6	4.59	394	9.16	-59.4
	16/02/2018	22.4	5.76	487	6.61	110.0
	16/03/2018	20.5	5.01	541	11.79	184.0
	17/04/2018	20.7	2.41	174	6.09	-17.0
	17/05/2018	14.6	8.79	713	7.22	91.0
	14/06/2018	17.5	6.73	1302	5.73	155.1
IC_BH01	27/10/2016	20.8	0.42	2852	11.65	-98.4
	30/11/2016	21.0	0.19	1300	8.65	-95.6
	13/12/2016	23.2	4.33	873	6.54	63.0
	17/01/2017	22.7	1.05	723	6.02	32.0
	14/03/2017	22.0	0.75	7980	6.11	81.5

Monitoring Well	Date	Temperature (º C)	Dissolved Oxygen (ppm)	Electrical Conductivity (µS/cm)	pH	Redox Potential (mV)
	28/08/2017	20.8	1.12	784	11.2	-244.0
	15/06/2017	20.0	0.11	766	6.51	-64.4
	17/07/2017	18.8	1.07	#	6.36	-135.0
	11/08/2017	19.9	1.31	545	7.82	-40.8
	20/10/2017	20.4	1.20	622	6.79	32.2
	20/11/2017	22.3	1.76	516	9.45	-179.0
	11/01/2018	22.7	3.09	553	10.69	16.3
	16/04/2018	25.9	1.24	689	5.94	25.0
	16/05/2018	17.9	6.18	1518	8.41	162.8
	13/06/2018	14.6	7.82	2122	5.96	180.2
IC_BH02	14/03/2017	22.1	2.72	160	5.31	84.3
	28/04/2017	16.7	3.75	191	9.26	34.5
	26/05/2017	18.5	6.06	259	7.44	51.2
	15/06/2017	19.8	4.20	255	8.58	5.5
	17/07/2017	18.8	4.10	#	7.91	-18.0
	20/10/2017	20.4	3.88	158	7.16	122.5
	15/02/2018	21.5	1.89	644	5.74	71.5
MT_BH07	17/02/2017	20.4	1.13	2880	10.8	-295.1
	14/03/2017	22.0	1.93	2362	12.13	42.3
	27/04/2017	17.0	6.12	2140	11.73	-40.7
	26/05/2017	20.2	3.48	1738	11.22	51.3
	15/06/2017	19.1	2.68	1633	11.49	-72.4
	17/07/2017	19.9	7.37	#	10.82	-77.0
	11/08/2017	18.5	6.45	1423	11.02	-87.0
	14/09/2017	17.6	9.36	1690	11.09	70.1
	20/10/2017	18.2	4.33	1718	11.38	-38.2
	20/11/2017	21.7	2.71	1467	9.28	-164.7
	15/02/2018	23.3	4.51	1702	11.13	119.5
	16/03/2018	25.0	3.93	1409	10.92	64.0
	16/04/2018	29.3	2.13	451	10.91	-78.0
	16/05/2018	16.6	8.33	2825	9.86	-49.5
	13/06/2018	19.7	7.16	4598	11.58	-138.1
	13/06/2018	19.2	5.98	10920	11.48	-115.4
MT_BH21	17/02/2017	20.6	1.76	2797	11.18	-246.3
	14/03/2017	22.3	3.69	1985	8.22	194.9
	15/06/2017	21.3	2.90	2065	6.69	2.8
	11/08/2017	18.4	0.80	1828	9.17	-177.5
	14/09/2017	18.2	3.43	2073	9.31	-109.0
	21/11/2017	20.5	5.06	1762	7.77	10.9
	16/04/2018	23.8	3.19	730	10.64	-31.0
BH60	29/09/2016	18.1	0.05	3912	7.35	-200.2

Annexure B Baseline Groundwater Level Monitoring Program Summary

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Jun-16		Jul-16		Aug-16		Sep-16		Oct-16	
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30	3.91	2.39	4.31	1.99	4.74	1.56	4.71	1.59	5.11	1.20
RZ_BH01s	alluvium	7-10	6.39	4.39	2.00	4.36	2.03	4.35	2.04	4.422	1.97	4.56	1.83
RZ_BH15	Hawkesbury Sandstone	18-21	6.02	3.55	2.47	4	2.02	4.45	1.57	4.38	1.64	4.57	1.45
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82			4.11	1.71	4.26	1.56	4.257	1.56	4.37	1.45
RZ_BH19	Hawkesbury Sandstone	19-22	2.46					1.00	1.46	0.956	1.50	1.02	1.44
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84			1.1	1.74	1.32	1.52	1.335	1.51	1.60	1.24
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83					0.93	1.90	1.06	1.77	1.64	1.19
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04			0.02	2.02	0.54	1.50	0.473	1.57		
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27					0.55	1.72	0.69	1.58	0.71	1.57
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29					0.42	1.87	0.67	1.62	0.76	1.53
RZ_BH44s	Alluvium	12-15	2.25					1.14	1.11	1.298	0.95	1.36	0.89
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30					0.75	1.55	0.783	1.52	1.67	0.63
RZ_BH47s	Alluvium	15 - 18	2.50					1.34	1.16	1.393	1.11	1.38	1.12
RZ_BH49s	alluvium	13-16	5.99			4.64	1.35	4.65	1.34	4.694	1.30	4.81	1.19
RZ_BH50	Hawkesbury Sandstone	22-25	1.92					0.05	1.87	0.455	1.47	0.60	1.32
RZ_BH51	Hawkesbury Sandstone	19-22	2.15					0.01	2.14	0.704	1.45	0.60	1.55
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53					1.01	1.52	1.304	1.23	1.12	1.41
RZ_BH60	Hawkesbury Sandstone	56-59	24.96										
RZ_BH64	Hawkesbury Sandstone	46-49	10.38										
RZ_BH67	Hawkesbury Sandstone	46-49	12.84										
RZ_BH69	Hawkesbury Sandstone	38-41	30.29										
TC_BH01d	Hawkesbury Sandstone	25-28	2.54			0.77	1.77	0.89	1.65	0.994	1.55	1.06	1.48
TC_BH01s	alluvium	3-6	2.55			1.53	1.02	1.55	1.00	1.637	0.91	1.78	0.77
TC_BH06s	alluvium	4.5-7.5	2.65					1.29	1.36	1.57	1.08	1.50	1.15
TC_BH07d	Hawkesbury Sandstone	19-22	2.03			1.06	0.97	0.40	1.63				
TC_BH07s	Alluvium	3-6	2.06			1.06	1.00	1.59	0.47	1.655	0.41	1.72	0.34
TC_BH08s	Alluvium	5-8	2.24			1.58	0.66	1.59	0.65	1.655	0.59	1.76	0.48

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Jun-16		Jul-16		Aug-16		Sep-16		Oct-16	
TC_BH09d	Hawkesbury Sandstone	21-24	2.25			0.61	1.64	0.64	1.61	0.675	1.58	0.80	1.45
TC_BH09s	alluvium	2-5	2.29			1.61	0.68	1.60	0.69			1.75	0.54
IC_BH01	Hawkesbury Sandstone	23-26	26.77									7.51	19.26
IC_BH02	Hawkesbury Sandstone	8-11	20.77										
EP_BH06	Hawkesbury Sandstone	10-13	7.60									3.48	4.12
EP_BH07	Hawkesbury Sandstone	10-13	10.48									7.02	3.46
MT_BH07	Hawkesbury Sandstone	43-46	24.41										
MT_BH20	Hawkesbury Sandstone	41-44	12.27										
MT_BH21	Hawkesbury Sandstone	47-50	25.05										

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Nov-16		Dec-16		Jan-17		Feb-17		Mar-17	
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30	4.745	1.56	4.91	1.39	4.86	1.44	4.71	1.59	4.573	1.73
RZ_BH01s	alluvium	7-10	6.39	4.669	1.72	4.72	1.67	4.76	1.64	4.50	1.89	4.421	1.97
RZ_BH15	Hawkesbury Sandstone	18-21	6.02	4.439	1.58	4.46	1.56	4.55	1.47	4.45	1.57	4.243	1.78
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82	4.223	1.60	3.29	2.53	4.39	1.43	4.22	1.60	4.102	1.72
RZ_BH19	Hawkesbury Sandstone	19-22	2.46	1.083	1.38	1.01	1.45	0.84	1.62	0.81	1.65	0.853	1.61
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84	1.443	1.40	1.42	1.42	1.20	1.64	1.52	1.32	1.314	1.53
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83	1.194	1.64	1.20	1.63	1.08	1.75	1.07	1.76	1.059	1.77
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04					0.57	1.47	#			
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27	1.49	0.78	0.79	1.48	0.92	1.35	0.65	1.62	0.638	1.63
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29	0.78	1.51	0.90	1.39	0.56	1.73	0.56	1.73	0.602	1.69
RZ_BH44s	Alluvium	12-15	2.25	1.431	0.82	1.49	0.76	1.44	0.81	1.35	0.90	1.214	1.04
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30	0.891	1.41	0.99	1.31	0.62	1.69	0.61	1.69	0.751	1.55
RZ_BH47s	Alluvium	15 - 18	2.50	1.434	1.07	1.49	1.01	1.36	1.14	1.32	1.19	1.294	1.21
RZ_BH49s	alluvium	13-16	5.99	4.73	1.26	4.95	1.04	4.91	1.08	4.79	1.20	4.534	1.46
RZ_BH50	Hawkesbury Sandstone	22-25	1.92	0.914	1.01	0.53	1.39	0.47	1.45	0.62	1.30	0.662	1.26
RZ_BH51	Hawkesbury Sandstone	19-22	2.15	0.766	1.38	0.80	1.35	0.69	1.46	0.49	1.66	0.504	1.65
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53	1.523	1.01	1.11	1.42			0.97	1.56	0.989	1.54
RZ_BH60	Hawkesbury Sandstone	56-59	24.96							12.50	12.46	12.391	12.57
RZ_BH64	Hawkesbury Sandstone	46-49	10.38							15.24	-4.86		
RZ_BH67	Hawkesbury Sandstone	46-49	12.84							4.03	8.81	5.049	7.79

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Nov-16		Dec-16		Jan-17		Feb-17		Mar-17	
RZ_BH69	Hawkesbury Sandstone	38-41	30.29							15.236	15.05	15.023	15.27
TC_BH01d	Hawkesbury Sandstone	25-28	2.54	0.73	1.81	1.02	1.52	1.05	1.49	0.97	1.57	1.821	0.72
TC_BH01s	alluvium	3-6	2.55	1.915	0.64	1.93	0.62	1.94	0.61	1.83	0.72	1.727	0.823
TC_BH06s	alluvium	4.5-7.5	2.65	1.62	1.03	1.63	1.02	1.69	0.96	1.50	1.15	1.421	1.229
TC_BH07d	Hawkesbury Sandstone	19-22	2.03					0.68	1.35	0.40	1.63	0.304	1.726
TC_BH07s	Alluvium	3-6	2.06	0.744	1.32	1.75	0.31	1.70	0.36	1.57	0.49	1.634	0.426
TC_BH08s	Alluvium	5-8	2.24	0.785	1.46	1.80	0.44	1.74	0.51	1.66	0.58	1.639	0.601
TC_BH09d	Hawkesbury Sandstone	21-24	2.25	0.69	1.56	0.84	1.41	0.74	1.51	0.67	1.58	0.559	1.691
TC_BH09s	alluvium	2-5	2.29	0.85	1.44	1.78	0.51	1.75	0.54	1.71	0.58		2.29
IC_BH01	Hawkesbury Sandstone	23-26	26.77	7.54	19.23	7.86	18.91	7.80	18.97			8.029	18.74
IC_BH02	Hawkesbury Sandstone	8-11	20.77			4.03	16.74					3.342	17.43
EP_BH06	Hawkesbury Sandstone	10-13	7.60	3.77	3.83	3.80	3.80	3.78	3.82	3.754	3.85	3.555	4.046
EP_BH07	Hawkesbury Sandstone	10-13	10.48	7.46	3.02	7.08	3.40	7.57	2.91	7.726	2.75	7.704	2.774
MT_BH07	Hawkesbury Sandstone	43-46	24.41							19.01	5.40	18.837	5.573
MT_BH20	Hawkesbury Sandstone	41-44	12.27									1.956	10.31
MT_BH21	Hawkesbury Sandstone	47-50	25.05							10.51	14.54	10.26	14.79

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Apr-17		May-17		Jun-17		Jul-17		Aug-17	
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30	4.56	1.75	4.771	1.53	4.555	1.75	4.674	1.63	4.878	1.42
RZ_BH01s	alluvium	7-10	6.39	4.39	2.00	4.537	1.85	4.353	2.04	4.502	1.89	4.622	1.77
RZ_BH15	Hawkesbury Sandstone	18-21	6.02	4.27	1.75	4.483	1.54	4.264	1.76	4.392	1.63	4.384	1.64
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82	4.05	1.77	4.335	1.49	4.506	1.31	4.175	1.65	4.191	1.63
RZ_BH19	Hawkesbury Sandstone	19-22	2.46	0.76	1.70	1.021	1.44	0.709	1.75	0.804	1.66	0.879	1.58
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84	0.22	2.62	1.328	1.51	0.989	1.85	1.123	1.72	1.285	1.56
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83	0.95	1.88	1.15	1.68	1.069	1.76	1.038	1.79	1.114	1.72
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04	0.46	1.59	0.555	1.49	0.265	1.78	0.307	1.73	0.501	1.54
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27	0.54	1.73	0.793	1.48	0.581	1.69	0.827	1.44	0.665	1.61
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29	0.53	1.76	1.267	1.02	0.444	1.85	0.545	1.75	0.651	1.64
RZ_BH44s	Alluvium	12-15	2.25	1.18	1.07	1.331	0.92	1.197	1.05	1.345	0.91	1.371	0.88
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30	0.64	1.66	0.831	1.47	0.509	1.79	0.600	1.70	0.734	1.57
RZ_BH47s	Alluvium	15 - 18	2.50	1.23	1.27	1.382	1.12	1.271	1.23	1.354	1.15	1.365	1.14
RZ_BH49s	alluvium	13-16	5.99	4.57	1.42	4.763	1.23	4.585	1.41	4.751	1.24	4.814	1.18
RZ_BH50	Hawkesbury Sandstone	22-25	1.92	0.68	1.24	0.969	0.95	1.109	0.81	1.212	0.71	1.228	0.69
RZ_BH51	Hawkesbury Sandstone	19-22	2.15	0.59	1.57	0.671	1.48	0.409	1.74	0.429	1.72	0.775	1.38
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53	0.87	1.66	1.057	1.47	0.806	1.72	0.967	1.56	0.987	1.54
RZ_BH60	Hawkesbury Sandstone	56-59	24.96	12.22	12.74	12.395	12.57	12.424	12.54	12.430	12.53	12.466	12.49
RZ_BH64	Hawkesbury Sandstone	46-49	10.38			1.318	9.06	1.194	9.19	1.204	9.18	1.317	9.06
RZ_BH67	Hawkesbury Sandstone	46-49	12.84	4.20	8.64	4.392	8.45	4.486	8.35				
RZ_BH69	Hawkesbury Sandstone	38-41	30.29							14.311	15.98		
TC_BH01d	Hawkesbury Sandstone	25-28	2.54	0.55	1.99	1.026	1.51	0.765	1.78	0.992	1.55	0.955	1.59
TC_BH01s	alluvium	3-6	2.55	1.61	0.94	1.745	0.81	1.527	1.02	1.691	0.86	1.761	0.79
TC_BH06s	alluvium	4.5-7.5	2.65	1.46	1.19	1.476	1.17	1.298	1.35	1.820	0.83	1.805	0.85
TC_BH07d	Hawkesbury Sandstone	19-22	2.03	0.38	1.65	0.529	1.50	0.321	1.71	0.498	1.53	0.422	1.608
TC_BH07s	Alluvium	3-6	2.06	1.60	0.46	1.724	0.34	1.589	0.47	1.892	0.17	1.670	0.390
TC_BH08s	Alluvium	5-8	2.24	1.65	0.59	1.738	0.50	1.424	0.82	1.623	0.62	1.711	0.53
TC_BH09d	Hawkesbury Sandstone	21-24	2.25	0.65	1.60	0.836	1.41	0.571	1.68	0.756	1.49	0.697	1.553
TC_BH09s	alluvium	2-5	2.29	1.66	0.63	1.724	0.57	1.579	0.71			1.725	0.565

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Apr-17		May-17		Jun-17		Jul-17		Aug-17	
IC_BH01	Hawkesbury Sandstone	23-26	26.77	7.91	18.86			7.934	18.83	8.002	18.77	7.845	18.92
IC_BH02	Hawkesbury Sandstone	8-11	20.77	2.91	17.86	3.32	17.45	3.791	16.98	3.504	17.27		
EP_BH06	Hawkesbury Sandstone	10-13	7.60	3.56	4.04	3.763	3.84	3.535	4.07	3.771	3.83	3.869	3.73
EP_BH07	Hawkesbury Sandstone	10-13	10.48	7.44	3.03	7.613	2.87	7.416	3.06	7.587	2.89	7.773	2.71
MT_BH07	Hawkesbury Sandstone	43-46	24.41	18.78	5.63	17.918	6.49	16.279	8.13	14.136	10.27	17.306	7.10
MT_BH20	Hawkesbury Sandstone	41-44	12.27										
MT_BH21	Hawkesbury Sandstone	47-50	25.05					8.556	16.494			11.788	13.26

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Sep-17		Oct-17		Nov-17		Dec-17		Jan-18	
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30			4.858	1.442	4.832	1.468			4.803	1.497
RZ_BH01s	alluvium	7-10	6.39			4.558	1.832	4.581	1.809			5.704	0.686
RZ_BH15	Hawkesbury Sandstone	18-21	6.02			4.868	1.152	4.568	1.452			4.520	1.500
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82	4.382	1.44	4.366	1.454	4.354	1.466			4.316	1.504
RZ_BH19	Hawkesbury Sandstone	19-22	2.46	1.059	1.40	1.112	1.348	1.012	1.448			1.072	1.388
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84	1.372	1.47	1.567	1.273	1.267	1.573			1.443	1.397
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83									1.250	1.580
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04	0.601	1.44	0.741	1.299					0.574	1.466
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27	0.854	1.42	0.856	1.414	0.821	1.449			0.841	1.429
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29	0.804	1.49	0.867	1.423	0.743	1.547			0.745	1.545
RZ_BH44s	Alluvium	12-15	2.25	1.432	0.82	1.565	0.685	1.474	0.776			1.454	0.796
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30	0.869	1.43	0.917	1.383	0.809	1.491			0.851	1.449
RZ_BH47s	Alluvium	15 - 18	2.50	1.447	1.05	1.509	0.991	1.442	1.058			1.405	1.095
RZ_BH49s	alluvium	13-16	5.99	4.935	1.06	5.074	0.916					4.956	1.034
RZ_BH50	Hawkesbury Sandstone	22-25	1.92	1.216	0.70	1.316	0.604						
RZ_BH51	Hawkesbury Sandstone	19-22	2.15	0.693	1.46							0.761	1.389
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53	1.06	1.47	1.134	1.396	0.999	1.531			0.988	1.542
RZ_BH60	Hawkesbury Sandstone	56-59	24.96	12.54	12.42	12.461	12.499	13.78	11.178				
RZ_BH64	Hawkesbury Sandstone	46-49	10.38	1.853	8.53	1.604	8.776	1.7	8.680			3.746	6.634
RZ_BH67	Hawkesbury Sandstone	46-49	12.84	4.819	8.02	5.179	7.661	5.112	7.728				
RZ_BH69	Hawkesbury Sandstone	38-41	30.29	14.37	15.92	14.526	15.764						
TC_BH01d	Hawkesbury Sandstone	25-28	2.54			1.112	1.428	1.006	1.534			1.037	1.503
TC_BH01s	alluvium	3-6	2.55			1.998	0.552	2.929	-0.379			1.903	0.647
TC_BH06s	alluvium	4.5-7.5	2.65	1.653	1.00	1.741	0.909	1.587	1.063			1.614	1.036
TC_BH07d	Hawkesbury Sandstone	19-22	2.03					0.548	1.482				
TC_BH07s	Alluvium	3-6	2.06	1.751	0.31	1.801	0.259	1.724	0.336			1.683	0.377
TC_BH08s	Alluvium	5-8	2.24	1.799	0.44	1.789	0.451	1.817	0.423			1.724	0.516
TC_BH09d	Hawkesbury Sandstone	21-24	2.25			0.837	1.413	0.746	1.504			0.825	1.425
TC_BH09s	alluvium	2-5	2.29					1.819	0.471				

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Sep-17		Oct-17		Nov-17		Dec-17		Jan-18	
IC_BH01	Hawkesbury Sandstone	23-26	26.77			8.313	18.455	8.507	18.261			8.484	18.284
IC_BH02	Hawkesbury Sandstone	8-11	20.77			4.287	16.486						
EP_BH06	Hawkesbury Sandstone	10-13	7.60	4.041	3.56	4.072	3.529	3.854	3.747			3.943	3.658
EP_BH07	Hawkesbury Sandstone	10-13	10.48	7.988	2.49	8.109	2.369	7.983	2.495			8.078	2.400
MT_BH07	Hawkesbury Sandstone	43-46	24.41	18.07	6.34	19.152	5.258	19.19	5.218			19.17	5.241
MT_BH20	Hawkesbury Sandstone	41-44	12.27									2.331	9.94
MT_BH21	Hawkesbury Sandstone	47-50	25.05	11.29	13.756			12.07	12.978				

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Feb-18		Mar-18		Apr-18		May-18		Jun-18	
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30	4.775	1.525	4.494	1.806	4.752	1.548	4.847	1.453	4.824	1.476
RZ_BH01s	alluvium	7-10	6.39	4.721	1.669	4.417	1.973	4.653	1.737	4.756	1.634	4.533	1.857
RZ_BH15	Hawkesbury Sandstone	18-21	6.02	4.475	1.545	4.19	1.830	4.463	1.557	4.56	1.460	4.545	1.475
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82	4.283	1.537	4.066	1.754	4.272	1.548	4.366	1.454	4.352	1.468
RZ_BH19	Hawkesbury Sandstone	19-22	2.46	1.123	1.337	0.734	1.726	0.94	1.520	1.037	1.423	0.970	1.490
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84	1.351	1.489	1.19	1.650	1.352	1.488	1.431	1.409	1.327	1.513
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83	1.262	1.568	0.925	1.905	1.219	1.611	1.316	1.514	1.154	1.676
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04	0.572	1.468	0.209	1.831	0.567	1.473	0.647	1.393	0.459	1.581
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27	0.746	1.524	0.52	1.750	0.728	1.542	0.824	1.446	0.773	1.497
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29	0.837	1.453	0.521	1.769			0.797	1.493	0.698	1.592
RZ_BH44s	Alluvium	12-15	2.25	1.483	0.767	1.342	0.908	1.375	0.875	1.473	0.777	1.336	0.914
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30	0.884	1.416	0.715	1.585	0.815	1.485	1.071	1.229	0.861	1.439
RZ_BH47s	Alluvium	15 - 18	2.50	1.430	1.070	1.232	1.268	1.445	1.055	1.464	1.036	1.337	1.163
RZ_BH49s	alluvium	13-16	5.99	5.044	0.946	4.709	1.281	4.887	1.103	4.901	1.089	4.779	1.211
RZ_BH50	Hawkesbury Sandstone	22-25	1.92	1.154	0.766	1.203	0.717	1.13	0.790	1.150	0.770	1.119	0.801
RZ_BH51	Hawkesbury Sandstone	19-22	2.15	0.705	1.445	0.525	1.625	0.715	1.435	0.777	1.373	0.600	1.550
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53	0.937	1.593	0.67	1.860	0.905	1.625	1.006	1.524	0.878	1.652
RZ_BH60	Hawkesbury Sandstone	56-59	24.96	12.74	12.224	12.77	12.193	12.81	12.153			12.94	12.017
RZ_BH64	Hawkesbury Sandstone	46-49	10.38		1.816	8.564	1.782	8.598	1.883	8.497	1.893	8.487	
RZ_BH67	Hawkesbury Sandstone	46-49	12.84		5.145	7.695			5.162	7.678			
RZ_BH69	Hawkesbury Sandstone	38-41	30.29				14.43	15.864					
TC_BH01d	Hawkesbury Sandstone	25-28	2.54	1.032	1.508	0.501	2.039	1.033	1.507	1.162	1.378	0.954	1.586
TC_BH01s	alluvium	3-6	2.55	1.971	0.579	1.821	0.729	1.973	0.577	1.957	0.593	1.830	0.720
TC_BH06s	alluvium	4.5-7.5	2.65	1.442	1.208	1.37	1.280	1.62	1.030	1.819	0.831	1.531	1.119
TC_BH07d	Hawkesbury Sandstone	19-22	2.03		0.08	1.950	0.642	1.388			0.456	1.574	
TC_BH07s	Alluvium	3-6	2.06	1.636	0.424	1.816	0.244	1.749	0.311	1.772	0.288	1.669	0.391
TC_BH08s	Alluvium	5-8	2.24	1.734	0.506	1.709	0.531	1.802	0.438	1.793	0.447	1.721	0.519
TC_BH09d	Hawkesbury Sandstone	21-24	2.25	0.808	1.442	0.348	1.902	0.934	1.316	0.963	1.287	0.765	1.485
TC_BH09s	alluvium	2-5	2.29										

Monitoring Well	Lithology Screened	screen interval (m)	RL toc mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
				Feb-18		Mar-18		Apr-18		May-18		Jun-18	
IC_BH01	Hawkesbury Sandstone	23-26	26.77				8.513	18.255	8.537	18.231	8.463	18.305	
IC_BH02	Hawkesbury Sandstone	8-11	20.77	8.287	12.486								
EP_BH06	Hawkesbury Sandstone	10-13	7.60	4.01	3.591	4.022	3.579	4.014	3.587	4.136	3.465	4.001	3.600
EP_BH07	Hawkesbury Sandstone	10-13	10.48	8.204	2.274	8.094	2.384	8.326	2.152	8.390	2.088	8.373	2.105
MT_BH07	Hawkesbury Sandstone	43-46	24.41	19.27	5.139	19.24	5.170	19.31	5.102	19.35	5.057	#####	4.982
MT_BH20	Hawkesbury Sandstone	41-44	12.27	2.369	9.90	2.403	9.87	2.404	9.87			2.477	9.79
MT_BH21	Hawkesbury Sandstone	47-50	25.05				12.89	12.159					

Annexure C Cross-Section Drawings