Groundwater Monitoring Program

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

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Document approval

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Signature:				

Details of Revision Amendments

Document Control

The Project Director is responsible for ensuring that this plan is reviewed and approved. The Design Director is responsible for updating this plan to reflect changes to construction, legal and other requirements, as required.

Amendments

Each revision of the CEMP and Sub-Plans, where amendments are not considered minor, will be issued to stakeholders for review, comment, approval and/or information in accordance with Planning Approval Conditions (SSI 10051) or Staging Report requirements.

Any minor amendments must be approved by the ER pursuant CoA A32 (e) (j) prior to implementation.

Revision Details

Revision	
A	Initial draft issue
B	Second draft issue
C	Third draft issue
D	Nil
0	Revised in response to stakeholder consultation
1	Revised in response to ER comments
2	Revised following completion of baseline groundwater assessment
3	Revised in response to additional monitoring data and ER comments
4	Revised in response to consultation and SM and ER comments

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Definitions

Term	Definition
AIP	Aquifer Interference Policy
ANZG (2018)	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)
ASS	Acid Sulfate Soil
BTEXN	Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene
CEMP	Construction Environmental Management Plan
CPBG	CPB Contractors Ghella Joint Venture
CoA	Conditions of Approval
COC	Chain of Custody
CoPC	Contaminants of Potential Concern
CSSI	The Critical State Infrastructure, as described in Schedule 1, the carrying out of which is approved under the terms of the SSI 10051 approval
DCCEEW	Department of Climate Change, Energy, the Environment and Water (formerly DPE (Water))
DNAPL	Dense non-aqueous phase liquid
DPE	NSW Department of Planning and Environment (former name of DPHI)
DPHI	NSW Department of Planning, Housing and Infrastructure (formerly DPE)
DQO	Data Quality Objective
EC	Electrical Conductivity
EIS	Sydney Metro Western Sydney Airport – Environmental Impact Statement
EMM	Environmental Management Measures
EMS	Environmental Management System
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	Environment Protection Licence
EWMS	Environmental Work Method Statements
GDEs	Groundwater Dependent Ecosystems
GIR	Geological Interpretative Report
GWMP	Groundwater Monitoring Program
GWQ	Groundwater Quality
HIR	Hydrogeological Interpretive Report
LOR	Limit of Reporting

Term	Definition
m AHD	Elevation in metres with respect to the Australian Height Datum
mbgl	Metres below ground level
mbtoc	Metres below top of casing
m/day	Metres per day
m/s	Metres per second
NATA	National Association of Testing Authorities
NRAR	Natural Resources Access Regulator
PCE	Perchloroethene
PFAS	Per- and Polyfluoroalkyl Substances
PIRMP	Pollution Incident Response Management Plan
POEO Act	Protection of the Environment Operations Act 1997
PRB	Permeable reactive barrier
ROL	Road Occupancy Licence
RPD	Relative Percent Difference
SMART	Specific, Measurable, Achievable, Realistic, and Time-based goals
SSTOM	Stations, Systems, Trains, Operations and Maintenance
SSTV	Site-Specific Trigger Value
TBM	Tunnel boring machine
TDS	Total Dissolved Solids
TfNSW	Transport for NSW
TOC	Top of Casing
TRH	Total Recoverable Hydrocarbons
µS/cm	Micro-Siemens per centimetre
VOC	Volatile Organic Compounds
WSI	Western Sydney International
WTP	Water Treatment Plant

1 Introduction

1.1 Project overview

This NSW (Off-airport) Groundwater Monitoring Program (GWMP) is applicable to the Station Boxes and Tunnelling Works (SBT Works) Package of the Sydney Metro Western Sydney Airport (the Project) and is an Appendix of the Soil and Water Management Sub-Plan (SWMP). This GWMP describes how the CPB Contractors Ghella Joint Venture (CPBG) will monitor the groundwater impacts of the SBT Works in NSW.

The Project forms part of the broader Sydney Metro network. It involves the construction and operation of a new 23km metro rail line from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The alignment includes tunnels and civil structures, including a viaduct, bridges, and surface and open-cut troughs between the two tunnel sections (Figure 1).

The Project will be delivered through several works packages including the SBT Works, which includes the design and construction of:

- Two sections of twin tunnels with a combined length of approximately 9.8km, plus associated portal structures, one from Orchard Hills to St Marys and the other under Western Sydney International (WSI) airport to the new Aerotropolis Station
- Excavations at either end to enable trains to turn back, and stub tunnels to enable future extensions
- Station box excavations with temporary ground support for four stations at St Marys, Orchard Hills, Airport Terminal and Aerotropolis
- Excavations for two intermediate services facilities, one in each of the tunnel sections at Claremont and Bringelly.

1.2 SBT Works scope

The construction methodology for the SBT Works entails:

- Utility works including removal, diversion, protection and connection to SBT worksites
- Local area works including provision of site accesses and some road upgrades
- Site establishment works including:
  - Fencing
  - Installation of environmental mitigation measures including erosion and sediment controls, noise barriers and acoustic enclosures
  - Clearing and grubbing of existing vegetation
  - Demolition of existing buildings and structures
  - Site levelling and drainage works
  - Establishment of internal access roads, hardstand areas and onsite parking
  - Erection of demountable buildings including offices and amenities
  - Other ancillary facilities including the erection of sheds, establishment of materials laydown and stockpiling areas and Tunnel Boring Machine (TBM) support works including spoil conveyors.
- Construction of station, shaft and dive excavations predominantly completed by piling and excavators with rippers and hammers. Roadheaders will also be used at St Marys and Aerotropolis to complete the stub tunnels
- Construction of mainline tunnels using four TBMs, as follows:
  - Two earth pressure balance TBMs will be launched from Orchard Hills and tunnel north to St Marys a distance of approximately 4.3km, including traversing the Claremont Shaft. The TBMs will be retrieved from the St Mary's station box.

- Two double shield TBMs will be launched from the Airport Dive and tunnel south, traverse the Airport Terminal station box and shaft, where tunnelling will stop and the conveyor and backend equipment will be demobilised from the Airport Dive and re-established at the Airport Terminal Shaft. The TBMs will then recommence tunnelling, including traversing the Bringelly Shaft, and will be retrieved from the Aerotropolis station box (5.5km from the Airport Dive, with 2.5km of the southern tunnels located within NSW).
- Cross passages will be constructed using concrete saws and excavators with hammers.

It is anticipated that the shaft and station excavations will be completed in advance of TBM tunnel construction. The TBMs will be delivered via oversize heavy vehicles to Orchard Hills and the Airport Dive site and retrieved from St Marys and Aerotropolis, subject to relevant approvals.

The SBT Works do not include any surface works between the northern and southern tunnel sections, which are to be undertaken by another contractor.

Tunnelling, including station box, shaft and dive excavation and associated support activities will occur 24 hours a day, seven days a week. Utility and local area works that cannot be completed during standard daytime hours due to Road Occupancy Licence (ROL) or utility authority requirements will also be undertaken out of hours.

Completed sections of the SBT Works, including established construction worksites, will be progressively handed over to Sydney Metro to enable follow-on contractors to commence works. The exception is the temporary precast facility, where the site will be decommissioned following the completion of segment manufacture and storage, and hydroseeded.

An overview of works at each SBT worksite is provided in Table 1-1.

Table 1-1: SBT Worksite overview

Jurisdiction	Worksite	Indicative scope of works
NSW	St Marys	• Demolition of existing industrial premises • Offices, amenities, car parking and access roads • Piling and station box excavation using rippers and rock hammers • Stub tunnel excavation using road headers • TBM retrieval • Operation of water treatment plant and discharge of water.
NSW	Claremont Meadows	• Offices, amenities, car parking and access roads • Piling and services facility shaft excavation using ripper and rock hammers • Construction of part of the cast-in-situ permanent shaft • Cross passage construction support • Invert construction support (pouring of an invert concrete slab in the tunnel) (subject to Sydney Metro approval) • Operation and discharge of tunnel ventilation system • Operation of water treatment plant and discharge of water
NSW	Orchard Hills	• Demolition of existing buildings and removal of septic tanks • Offices, amenities, car parking and access roads • Lansdowne Road temporary diversion and construction of the permanent road bridge • Piling and portal, station box and dive excavation using rippers and rock hammers • Construction of cast-in-situ permanent portal structure • TBM assembly, launch and tunnelling support works • Cross passage construction support • Precast segment storage • Operation and discharge of tunnel and acoustic enclosure ventilation system • Operation of water treatment plant and discharge of water

Jurisdiction	Worksite	Indicative scope of works
On-Airport	Airport Portal Dive Structure	• Offices, amenities, car parking and access roads • Piling and portal excavation using rippers and rock hammers • Open cut dive excavation using rippers and rock hammers • Construction of cast-in-situ permanent dive structure • TBM assembly, launch and tunnelling support works • Cross passage construction support • Materials laydown • Segment storage • General storage
On-Airport	Airport Terminal and TBM shaft	• Offices, amenities car parking and access roads • Piling and station box and shaft excavation using rippers and rock hammers • TBM re-launch and tunnelling support works • Cross passage construction support • Operation of water treatment plant and discharge of water
On-Airport	Primary Spoil Receival	• Access road • TBM spoil conveyor set up • Earthworks in accordance with Sydney Metro Specifications.
NSW	Bringelly	• Offices, amenities, car parking and access roads • Piling and services facility shaft using rippers and rock hammers • Construction of part of the cast-in-situ permanent shaft • Cross passage construction support • Invert construction support (subject to Sydney Metro approval) • Operation and discharge of tunnel ventilation system • Operation of water treatment plant and discharge of water
NSW	Aerotropolis	• Offices, amenities, car parking and access roads • Piling and station box excavation using rippers and rock hammers • Stub tunnel excavation using roadheaders • TBM retrieval • Operation and discharge of tunnel ventilation system • Operation of water treatment plant and discharge of water

Note: Worksites in grey are within the boundary of the Western Sydney International (On-Airport) and regulated under the *Commonwealth Airports Act 1996*.

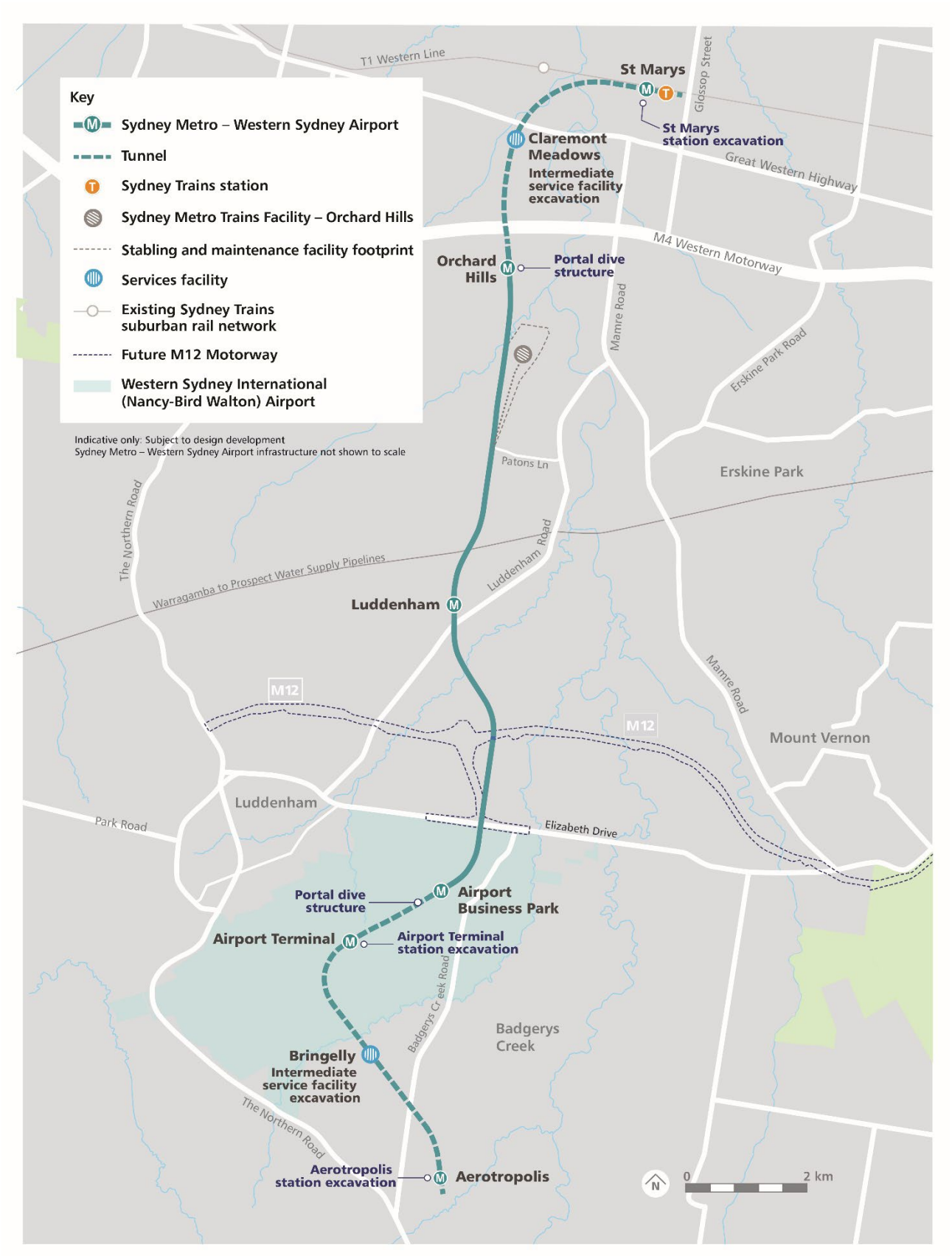

Figure 1-1: Overview of SBT works

1.3 Purpose and objectives of this GWMP

The purpose of this GWMP is to describe how CPBG propose to monitor the extent and nature of potential impacts to the groundwater level and quality during SBT Works.

The GWMP will be implemented to monitor the effectiveness of mitigation measures applied during the construction phase of the SBT Works. 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.

Reflecting the requirements of Condition C13(b), this GWMP supports the SWMP by detailing the groundwater monitoring network, frequency of monitoring, and test parameters.

This GWMP is based on baseline studies developed for the Western Sydney Airport (WSA) Environmental Impact Statement (EIS) (WSP and AECOM 2020), baseline monitoring reports completed by Cardno (2021), the project-wide baseline groundwater assessment (Tetra Tech Major Projects 2023), and additional information sources as listed in Section 2 of the Hydrogeological Interpretative Report (HIR) (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403).

This GWMP details specific steps that are required to monitor groundwater in accordance with the SSI 10051 Planning Approval and management and mitigation measures outlined in the Soil and Water Sub-Plan.

Specifically, the purpose of this GWMP is to:

- Assist CPBG to manage the impacts of the SBT Works to ensure there are no outcomes which are detrimental to the pre-existing hydrogeological regime.
- Demonstrate mitigation and management measures are achieving the stated objectives.
- Identify if adaptive management responses are required to further manage groundwater impacts.

The objectives of the GWMP are to:

- Comply with:
  - State Significant Infrastructure (SSI) 10051 Planning Approval (dated 23 July 2021)
  - Sydney Metro Western Sydney Airport – CSSI Staging Report (Revision 6.0) (Staging Report)
  - Sydney Metro Construction Environmental Management Framework (CEMF)
  - EIS and the Submissions Report, including the Revised Environmental Mitigation Measures (REMMs)
  - Environment Protection Licence (EPL)
  - Contractual requirements, including the SBT Design and Construction Deed and General and Particular Specifications
  - Applicable legislation
- Reduce the potential for drawdown of surrounding groundwater resources.
- Prevent the pollution of groundwater through appropriate controls.
- Reduce the potential impacts on groundwater dependent ecosystems.
- Confirm no adverse impacts on the receiver during construction, or to effectively manage any impacts with the implementation of appropriate mitigation measures.

The objectives will be achieved by:

- Establishing monitoring parameters that enable comparison of the actual construction performance against the predicted performance of mitigation measures.
- Identifying thresholds for monitoring parameters that if exceeded will trigger the need for management responses.
- Scheduling and assignment of responsibilities of monitoring requirements.

1.4 Scope of groundwater monitoring program

The scope of this GWMP is to describe how CPBG will monitor the extent and nature of potential impacts to groundwater levels and quality during the SBT Works which will allow for implementation of appropriate management measures to address construction impacts.

Operational monitoring measures do not fall within the scope of the construction phase and therefore are not included in this GWMP.

1.4.1 Technical requirements

This GWMP includes the following:

- Groundwater monitoring to be undertaken, including:
  - the location and frequency of monitoring and
  - parameters to be monitored
- Detail of water treatment plant monitoring to be undertaken
- Detail regarding analysis and reporting of monitoring data.

1.4.2 Conditions of Approval, REMMs and CEMF

The Conditions of Approval, REMMs and CEMF requirements of relevance to the GWMP are presented in Table 1-2 together with a cross-reference to where the requirement is addressed in this document.

Table 1-2: Conditions requirement relevant to groundwater

Condition	Requirement	Reference
Conditions of Approval		
C14	Each Construction Monitoring Program must provide:	This monitoring program
C14 (a)	details of baseline data available including the period of baseline monitoring;	Section 5.1 (Pre-award baseline data) Section 5.3 (Groundwater dependent ecosystems)
C14 (b)	details of baseline data to be obtained and when;	Section 5.2 (Baseline groundwater assessment) Section 5.3 (Groundwater dependent ecosystems)
C14 (c)	details of all monitoring of the project to be undertaken;	Section 5.2 (Baseline groundwater assessment) Section 5.3 (Groundwater dependent ecosystems) Section 6 (Construction monitoring)
C14 (d)	the parameters of the project to be monitored;	Section 5.2 (Baseline groundwater assessment) Section 6 (Construction monitoring) Section 7 (Monitoring methodology)
C14 (e)	the frequency of monitoring to be undertaken;	Section 5.2 (Baseline groundwater assessment) Section 6 (Construction monitoring)

Condition	Requirement	Reference
		Section 7 (Monitoring methodology)
C14 (f)	the location of monitoring;	Sections 5 and 6 (Baseline and Construction monitoring)
C14 (g)	the reporting of monitoring results and analysis results against relevant criteria;	Section 6 (Construction monitoring) Section 7 (Monitoring methodology) Section 8 (Compliance management)
C14 (h)	details of the methods that will be used to analyse the monitoring data;	Section 5.2 (Baseline groundwater assessment) Section 6 (Construction monitoring) Section 7 (Monitoring methodology) Section 8.3 (Data analysis)
C14 (i)	procedures to identify and implement additional mitigation measures where the results of the monitoring indicated unacceptable project impacts;	Section 6 (Construction monitoring) Section 8.3 (Data analysis)
C14 (j)	a consideration of SMART principles;	Sections 5 and 6 (Baseline and construction Groundwater monitoring) and Table A1, Annexure E
C14 (k)	any consultation to be undertaken in relation to the monitoring programs; and	Section 1.5 (Stakeholder consultation and approvals)
C14 (l)	any specific requirements as required by Conditions C15 to C16	Table 1-2
C16	Groundwater Construction Monitoring Program must include:	This monitoring program
C16 (a)	Groundwater monitoring networks at each construction excavation site predicted to intercept groundwater in the documents listed in Condition A1;	Sections 5 and 6 (Baseline and construction Groundwater monitoring)
C16 (b)	Detail of the location of all monitoring bores with nested sites to monitor both shallow and deep groundwater levels and quality;	Sections 5 and 6 (Baseline and construction Groundwater monitoring)
C16 (c)	Define the location of saltwater interception monitoring where sentinel groundwater monitoring bores will be installed between the saline sources and that of each construction excavation site predicted to intercept groundwater in the documents listed in Condition A1;	Section 2.4 (Groundwater quality) Section 5.3 (GDE monitoring) Section 6 (Construction monitoring)
C16 (d)	Results from existing monitoring bores;	Section 2.3 and 2.4 (Groundwater levels and quality) Section 5 (Baseline monitoring) Annexure D (Water Quality Analytical Data) Annexure E (Baseline Groundwater Quality Summary)

Condition	Requirement	Reference
C16 (e)	Monitoring and gauging of groundwater inflow to the excavations predicted to intercept groundwater in the documents listed in Condition A1, appropriate trigger action response plan for all predicted groundwater impacts upon each noted neighbouring groundwater	Section 6 (Construction monitoring) Section 7 (Monitoring methodology) Section 8.3 (Data analysis)
C16 (f)	Trigger levels for groundwater quality, salinity and groundwater drawdown in monitoring bores and / or other groundwater users;	Section 6 (Construction monitoring)
C16 (g)	Daily measurement of the amount of water discharged from the water treatment plants;	Section 7 (Monitoring methodology)
C16 (h)	Water quality testing of the water discharged from treatment plants;	Section 4.3 (Water Treatment) Section 6 (Construction monitoring)
C16 (i)	Management and mitigation measures and criteria, including measures to address impacts	Section 4 (Environmental control measures) Section 6 (Construction monitoring) Section 8.3 (Data analysis)
C16 (j)	Groundwater inflow to the excavations to enable a full accounting of the groundwater take from the Sydney Basin Central Groundwater Source;	Section 4.1 (Inflow controls)
C16 (k)	Reporting of groundwater gauging at excavations, groundwater monitoring, groundwater trigger events and action responses; and	Section 6 (Construction monitoring)
C16 (l)	Methods for providing the data collected to Sydney Water where discharges are directed to their assets	Section 1.5 (Stakeholder engagement) Section 8.5 (Reporting)
E133	Make good provisions for groundwater users must be provided in the event of a material decline in water supply levels, quality or quantity from registered existing bores associated with groundwater changes from either construction and/or ongoing operational dewatering by the CSSI	Section 2.5 (Groundwater Users) Section 3.2 (Environmental Impacts)
REMMs		
GW5	Detailed hydrogeological and geotechnical models for the project would be developed and progressively updated during design and construction. These models would: • Be informed by the results of groundwater monitoring undertaken before and during construction • Identify predicted changes to groundwater levels, including at nearby water supply works and at groundwater dependent • ecosystems or other sensitive groundwater receptors.	Hydrogeological and geotechnical models are detailed in the Project-Wide Groundwater Modelling Report (SMWSASBT-CPG-SWD-SW000-GE-RPT-040402)
GW5	Where changes to groundwater levels are predicted at nearby water supply works, groundwater	Section 3.2.3 (Groundwater Dependent Ecosystems)

Condition	Requirement	Reference
	dependent ecosystems or other sensitive groundwater receivers, an appropriate groundwater monitoring program would be developed and implemented.	Section 6.4 (GDE and Salinity Monitoring) The SBT Works are not located in the vicinity of water supply works
GW5	Where changes to groundwater level are close to the ground surface, dryland salinity monitoring would be implemented to allow for management of any identified impacts.	Section 3.2.3 (Groundwater Dependent Ecosystems) Section 6.4 (GDE and Salinity Monitoring) The SBT Works will not result in changes to groundwater level close to the surface and as such, the requirements of this REMM are not triggered.
GW5	The groundwater monitoring program would aim to confirm no adverse impacts on the receiver during construction or to effectively manage any impacts with the implementation of appropriate mitigation measures. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	Section 1.6 (Groundwater regulatory framework and legislation) Section 6 (Construction monitoring)
GW6	A Groundwater Management Plan would be prepared and implemented. The plan must include the following trigger-action response measures in relation to groundwater levels in areas identified as subject to potential drawdown (at groundwater dependent ecosystems or other sensitive receivers) but outside the construction footprint and Western Sydney International Stage 1 Construction Impact Zone: a. target criteria, set with reference to relevant standards and site specific parameters b. trigger values and corresponding corrective actions to prevent recurring or long-term exceedance of the target criteria described in (a) c. corrective actions to compensate for any recurring or long-term exceedance of the target criteria described in (a) Response measures may include: • Targeted ground improvement and grouting to limit groundwater inflows into station excavations, tunnels and cross-passage to reduce groundwater drawdown • Design of undrained temporary retention systems to minimise groundwater inflow into station excavations and reduce groundwater drawdown • Supplementing groundwater supply at affected groundwater dependent ecosystems or watercourses • Make good provisions for groundwater supply wells impacted by changes in groundwater level or quality.	Section 6.2.1 (Groundwater level – performance criteria) Sections 6.3.1 and 6.3.3 (Groundwater Quality Performance Criteria) Section 6.4.1 (GDE Monitoring Performance Criteria) Section 8.3 (Data Analysis and Response)

Condition	Requirement	Reference
SC9	Targeted groundwater investigations would be undertaken prior to construction to identify high salinity areas at risk from rising groundwater. Where high saline areas (>1000 µS/cm) are identified, measures such as planting, regenerating and maintaining native vegetation and good ground cover in recharge, transmission and discharge zones would be implemented where possible.	Section 5.2 (Baseline groundwater assessment) Section 6.4 (GDE and salinity monitoring)
CEMF		
7.2 (b) viii	Details of groundwater monitoring if required.	Section 6 (Construction monitoring)

1.5 Stakeholder consultation and approvals

Reflecting the requirements of Conditions A6 and C13(c), this GWMP was prepared in consultation with Department of Climate Change, Energy, the Environment and Water (DCCEEW) (formerly DPE (Water)). A detailed consultation report, including matters raised by stakeholders and CPBG responses is provided in Annexure G.

This GWMP was updated to address relevant comments prior to submission to the Environmental Representative (ER) for endorsement. In accordance with the Staging Report, this GWMP was also submitted to the Planning Secretary of the DPHI for approval.

Endorsement of this GWMP by the ER is provided in Annexure H.

Consistent with the requirements of Condition A32(j), amendments to this GWMP that are not minor in nature are subject to additional stakeholder consultation and DPHI approval. Reflecting the outcomes of groundwater monitoring undertaken to date, material changes of the GWMP were warranted. As such, Revision 3 of this GWMP will be prepared in consultation with nominated stakeholders, endorsed by the ER and submitted to DPHI for approval.

Consultation with Sydney Water, including engagement on monitoring and reporting requirements, will also be undertaken where Sydney Water assets are used to receive discharged water from the SBT Works, as part of a trade waste agreement or similar. The monitoring and reporting requirements for trade waste discharges will be covered under the SWMP for the project.

Consistent with Condition E130 and section 45 of the POEO Act, a Discharge Impact Assessment has been prepared to inform licensing (refer Section 6.1 of the SWMP). An Environment Protection Licence (EPL) was subsequently obtained by the Project (EPL 21672) in May 2022.

1.6 Groundwater Regulatory framework and legislation

Groundwater in NSW is regulated by the Department of Primary Industry Water (DPI Water) under the *Water Act 1912* (NSW) and the *Water Management Act 2000* (NSW). If an activity results in the removal of water from a water source, movement of water from one part of an aquifer to another, or movement of water from one water source to another water source, then approval and/or license is required.

The *Water Management Act 2000* requires:

- A Water Access Licence (WAL) with adequate water allocation (or shares) within a specified water management area
- A Water Supply Works Approval authorises the holder to construct and use specified water supply work (dewatering pumps, sump pumps etc.)
- A Water Use Approval to use the water for a particular purpose.

The processes and requirements that DPI Water apply to assess aquifer interference of a project under the *Water Management Act 2000* are outlined in the Aquifer Interference Policy (AIP) (NSW Office of Water (2012)). This assessment process has been considered in the Hydrogeological Interpretative report (refer to Section 2.2). Key components of the AIP are:

- Where an activity results in the loss of water from the environment, a WAL is required under the *Water Management Act 2000* to account for this water take.
- An activity must address minimal impact considerations in relation to the water table, groundwater pressure and groundwater quality.
- Where the actual impacts of an activity are greater than predicted, planning measures must be put in place ensuring there is sufficient monitoring.

For the SBT project, which is a Critical State Significant Infrastructure (SSI) project, the following exemptions are relevant:

- The *Environmental Planning and Assessment Act 1979* (EPA Act 1979) Clause 5.23 Part 1 (g) states that water use approval, water management work approval, or activity approval (other than an aquifer interference approval) under the *Water Management Act 2000* is not required for SSI.
- The *Water Management (General) Regulation 2018* Division 2 Clause 21(1) and Clause 3 of Schedule 4 exempts transport authorities from the requirement for WAL under the *Water Management Act 2000* if the transport authority, after considering the environmental impact of the activity, in accordance with section 5.5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (as if the transport authority were the determining authority under that section) is satisfied that the activity is not likely to significantly affect the environment.

The project footprint is also subject to the rules of the Sydney Basin Central Groundwater Source which is covered by the Greater Metropolitan Region Groundwater Source Water Sharing Plan.

The water-sharing plan outlines the recommended management approaches of surface and groundwater connectivity, minimisation of interference between neighbouring water supply works, protection of water quality and sensitive environmental areas and limitations to the availability of water.

The Sydney Basin Central Groundwater Source is a porous hard rock aquifer and is considered to be a “less productive” groundwater source as defined in the AIP.

Key considerations for the Sydney Basin Central Groundwater Source with respect to the level 1 minimal harm considerations for a less productive porous rock aquifer and highly productive coastal aquifer (as defined in the AIP) are:

1. Water table impacts:
   - Less than or equal to 10 per cent cumulative variation in the water table allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any high priority groundwater-dependent ecosystem or high priority culturally significant site listed in the Schedule of the water sharing plan.
   - A maximum of two metres cumulative groundwater level decline at any water supply works.
2. Water pressure impacts:
   - A cumulative pressure head decline of not more than two metres at any supply work.
3. Water quality impacts:
   - Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.

Developments conducted on waterfront land and along waterways are regulated by the *Water Management Act 2000* in accordance with the *Guidelines for riparian corridors on waterfront land* (DPI-Water 2012). These guidelines state that waterfront land includes the bed and bank of any

waterway and all land within 40 metres of the highest bank of the waterbody. The SBT Works footprint does not include waterfront land as defined by the guidelines.

Controlled activities on waterfront land are administered by DPI Water and include removal of vegetation, earthworks and construction of temporary detention basins. A controlled activity approval must be obtained from DPI Water before commencing the controlled activity, however as noted above, a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000* is not required for SSI projects.

An overview of the relevant legislation and policy and their project implications is provided in Table 1-3.

Table 1-3: Key legislative and policy documents

Policy	Relevance
Water Management Act 2000 (NSW)	SSI projects are exempt from requiring some water supply works approvals and controlled activity approvals. Transport authorities (including Sydney Metro) are exempt from requirement for water access licence if the transport authority, after considering the environmental impact of the activity, is satisfied that the activity is not likely to significantly affect the environment. Aquifer interference activity approval provisions have not yet commenced but are administered under the Act. Water Sharing Plans are administered under this Act.
Water Act NSW (1912)	Administration of water access licences and trade of water licences and allocations.
NSW Aquifer Interference Policy (2012)	Manages the impacts of aquifer interference activities in accordance with the Water Management Act and Water Sharing Plans. Aquifer interference activities must address minimal impact considerations as outlined in the policy. In the event that actual impacts are greater than predicted there should be sufficient monitoring in place.
Water Sharing Plan, Greater Metropolitan Region Groundwater Sources (2011)	Manages the long-term surface and groundwater resources of a defined area. The plan outlines rules for the sharing and sustainability of water between various uses such as town water supply, stock and domestic, industry and irrigation.
NSW Water Extraction Monitoring Policy (2007)	Sets out monitoring requirements with regards to evaluating aquifer interference.
NSW Groundwater Quality Protection Policy (1998)	Sets out monitoring requirements with regards to degradation of groundwater quality.
NSW Groundwater Quantity Management Policy (2001)	Complements the aquifer interference policy.
NSW Groundwater Dependent Ecosystem Policy (2002)	Sets out guidelines to evaluate potential impacts on groundwater dependent ecosystems.
Australian Groundwater Modelling Guidelines (2012)	Sets out guidelines for developing models appropriate to evaluate potential impacts.

1.7 Related documents

The primary documents supporting this plan include:

- M2A Joint Venture (WSP and AECOM) (2020). Sydney Metro Western Sydney Airport – EIS Chapter 14: Flooding, hydrology and water quality
- M2A Joint Venture (WSP and AECOM) (2020). Sydney Metro Western Sydney Airport – EIS Chapter 15: Groundwater and geology
- M2A Joint Venture (WSP and AECOM) (2020). Sydney Metro Western Sydney Airport – EIS Technical Paper 6: Flooding, hydrology and water quality
- ARUP (2020). Sydney Metro Western Sydney Airport – EIS Technical Paper 7: Groundwater. Ref. SMGW-ARP-AEC-GE-REP-002447. October 2020
- Golder and Douglas Partners (2021). Sydney Metro Western Sydney Airport – Groundwater Monitoring Report – Phase 1 – 4 Locations Ref. 19122621-018-R-GWMR12 Rev 0. 24 March 2021
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- Tetra Tech Major Projects (2022) Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works Orchard Hills Station Detailed Site Investigation Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040514_RevA05
- Tetra Tech Major Projects (2022) Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works St Marys Station Detailed Site Investigation Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040513_A03
- Tetra Tech Major Projects (2023) Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works Hydrogeological Report (Project-wide) Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040403
- Tetra Tech Major Projects (2023) Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works Project-wide Groundwater Modelling Report Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040402
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1.8 Limitations

In addition to data obtained by CPBG during detailed site investigations (DSI) and the assessment of baseline groundwater conditions, this monitoring program relies on information obtained directly from Sydney Metro, supplied digital databases and the EIS, which includes but is not limited to: groundwater level/pressure, water quality and aquifer parameter data, survey data, laboratory analytical data and engineering borehole logs.

Testing has been carried out across the alignment, however, data gaps and uncertainty regarding site-specific conditions remain. Where site-specific information is not available, reported ranges for the area have been made based upon published information, local experience and correlations.

Detailed site investigations will be carried out during detailed design to verify the parameter recommendations made in this report and inform the development of further detailed predictive groundwater models and refine the monitoring program. Such investigations are yet to be complete and will be incorporated in future revisions of this report.

The following key groundwater related data gaps and limitations are noted:

- The influence of structural geology (i.e. faults, folds and dykes) on groundwater flow behaviour and the mobilisation of existing groundwater contamination.
- The influence of permanent water bodies, open drains and similar on groundwater flow behaviour and interaction with groundwater dependant ecosystems (GDEs).
- Geology and groundwater elevation is characterised along the alignment, however, less information exists off-alignment and extrapolation of ground conditions beyond the alignment for the assessment of groundwater levels and drawdown is required which creates uncertainty in the assessments and predictions.
- Changes to groundwater conditions are expected to have occurred as a result of filling on the airport site. Groundwater monitoring data post filling is extremely limited. This affects the reliability of the assessment of groundwater levels and quality.
- Unidentified sources of existing groundwater contamination may be present.
- Limited long-term groundwater level data is available to characterise historical groundwater conditions including temporal variability. This introduces uncertainty around the nomination of representative stable groundwater levels which are used to derive aquifer boundary conditions for numerical modelling as well as design groundwater levels.
- Due to limitations in the testing and water level monitoring records, there is uncertainty in the outcomes of the assessments completed on behalf of CPBG. This uncertainty extends to the assessment of inflow rates to excavations and the extent and magnitude of drawdown associated with the construction and operation of the WSA SBT. Additional monitoring and assessment to be carried out during construction is expected to reduce the extent of this uncertainty.

Monitoring results during construction will need to be compared with predictions to provide early warning of deviation from anticipated responses. Ongoing comparison against observed conditions and refinement of operation of any mitigation systems (if required) may be needed throughout the construction phase to address the uncertainties in aquifer behaviour and response to construction activities.

2 Physical Setting

2.1 Geology

This section provides an overview of the key geological units across the Project based on the available data. For further detail, refer to the relevant Geotechnical Interpretative Report (GIR, SMWSASBT-CPG-SWD-SW000-GE-RPT-040302).

The geological map for Penrith indicates that the Project alignment is located within the Cumberland Basin and Penrith Basin which forms part of the Permian-Triassic Sydney Basin. The Sydney Basin is a structural trough which is the southern continuation of a much longer structural trough including the Sydney, Gunnedah, and Bowen Basins.

The region is dominated by the mid-Triassic Wianamatta Group of sedimentary rocks while the underlying Hawkesbury Sandstone (also of mid-Triassic age) dominates the Blue Mountains to the west. The late Permian-Early to Middle Triassic Narrabeen Group which lies below the Hawkesbury Sandstone can be observed in the gorges of the Blue Mountains. The underlying Permian Illawarra Coal Measures are exposed along the western margin of the Sydney Basin.

Geological long sections for the Project alignment are presented in Annexure B. Anticipated geological units encountered within the SBT Works sites are described in more detail below, and in the Hydrogeological Interpretative Report (HIR, Document reference: SMWSASBT-CPG-SWD-SW000-GE-RPT-040403) and GIR (Document reference: SMWSASBT-CPG-SWD-SW000-GE-RPT-040302).

The three geological units relevant to hydrogeology and groundwater monitoring and management along the alignment are:

Alluvial deposits

Quaternary alluvial deposits are mapped where the Project alignment crosses local waterways such as the lower-lying area of South Creek and its tributaries. The areas of Quaternary Alluvium typically comprise laterally discontinuous layered sequences of silts, clays, and sandy clays with trace carbonaceous inclusions. Localised sandy/gravelly deposits can be found within the alluvial floodplains and in proximity to the existing watercourses and may represent major historical flood events, or creek paleochannels.

Weathered bedrock

Weathered bedrock is characterised by residual soil, extremely weathered rock, and highly weathered rock. Residual soil comprising silty clay produced by surface weathering of the underlying bedrock is expected along the alignment with varying thickness but is generally thicker at the north end of the project. Extremely weathered rock is characterised by very stiff to hard, silty clay, sandy clay, clayey sand. Highly weathered rock however is characterised by frequent fractures and iron-staining which can extend for several metres above the more competent rock. It is frequently friable and generally very low to low strength.

Bedrock

The Bringelly Shale Formation forms the underlying bedrock for the Project alignment and is believed to be about 150m thick below the Project area. It is largely comprised of claystone, siltstone, and laminate, with localised layers of higher strength sandstone. These sandstone beds typically range in thickness from about 0.5 m to 7 m, and often cap the higher hills. Further detail on the geology of the Bringelly Shale Formation is provided in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403).

2.2 Hydrogeology

2.2.1 Aquifers

The aquifers present across the Project alignment can be broadly characterised as either the bedrock aquifer of the Wianamatta Group fracture bedrock and Hawkesbury Sandstone formation (bedrock aquifer) or Quaternary alluvium deposit aquifers along drainage lines of tributaries associated with the South Creek. Localised perching of groundwater on the extremely weathered bedrock (which due to its clayey nature is likely to be very low permeability) can also be expected.

Fill

Fill in the form of a mixture of sand, gravel and clay is present in places over the SBT Works sites. Fill is typically thin (less than 2 m thick) and is almost invariably above the groundwater table. Fill may be saturated in places where infiltrated water is perched on the underlying residual clay soil.

Quaternary alluvial aquifer

The Quaternary alluvial aquifer overlies bedrock along the main drainage channels and creek lines including South Creek and its tributaries. Quaternary alluvial deposits typically comprise a mixture of gravels, sands, silts and clays. The alluvial deposits within the channels associated with watercourses typically act as zones of discharge of groundwater from the underlying residual soil and rock. Therefore, while the shallow aquifer can be relatively fresh, during droughts the discharge of groundwater from the bedrock aquifer can resulting an increase in salinity in the shallow aquifer and streams such as South Creek (McNally 2009).

Residual soil

Residual soil derived from the in-situ weathering of Bringelly Shale units typically comprise clay and have low hydraulic conductivity. Outside the alluvial channels, the residual soil has shallow topsoil or fill cover.

Recharge to the aquifer is from rainfall and flow along the soil horizon interface, and therefore closer to perched water than true groundwater (McNally 2009). Rainfall is expected to percolate through the residual soil, potentially leaching salt stored in the residual soils into local waterways, rather than recharging to the underlying Bringelly Shale.

Bedrock aquifers

The bedrock units of the Wianamatta Group (Bringelly Shale, Minchinbury Sandstone and Ashfield Shale) and underlying Mittagong Formation and Hawkesbury Sandstone form heterogeneous fractured rock aquifers where groundwater flows occur within defects within the rock mass. The bedrock aquifers in the Wianamatta Group are typically semi-confined to confined in low lying areas where the residual soils are rich in clay and can act as a confining layer.

The origin of the saline water in the shales and residual soils is thought to be due to windblown aerosols, rather than historically trapped sea water. The salt accumulates by evapotranspiration, and infiltrates into the residual soils, and the underlying shales of the bedrock aquifer (McNally 2009).

Bringelly Shale is the upper rock unit beneath the tunnel alignment. It comprises shale with sandstone bands. Defects including faults, dykes and shear zones are present. Permeability of the intact shale is low with flow occurring through defects associated with bedding, joints, shear zones and fractures. On exposure, the shale swells, and its exposed surface deteriorates with time. The permeability of the sandstone beds may be significantly greater than the intact shale.

As a result of the interbeds of sandstone within the shale, vertical permeability of the rock mass is expected to typically be lower than the horizontal permeability.

2.2.2 Groundwater recharge and discharge

Recharge to the alluvial deposit aquifer is primarily via rainfall recharge. Some recharge from watercourses may occur during periods of high flow and from small farm dams within the area. The watercourses are however expected to act predominantly as the line of groundwater discharge.

Groundwater levels are expected to mound between watercourses with vertical infiltration downward through the residual clay cover and lateral migration from the elevated areas towards the watercourses via the Bringelly Shale.

Due to the low permeability of the residual soil cover, groundwater recharge to the underlying shale aquifers is expected to be low perhaps between 1 and 2 % of the average annual rainfall.

An increase in development around the area is likely to reduce the direct recharge from rainfall.

2.3 Groundwater levels and flow

Groundwater flow is interpreted to be controlled by rainfall infiltration and discharge along the watercourses. As a result, the groundwater flow direction is expected to generally follow topography towards the main drainage channels in a northerly and easterly direction towards Cosgroves Creek, a southerly and easterly direction towards Badgerys Creek and South Creek and westwards towards Duncans Creek. Groundwater levels are typically within 5 m of the ground surface though groundwater is deeper than 5 m depth in the higher ground away from the watercourses.

Groundwater level contours have been interpreted based on average baseline groundwater levels, watercourses and topographic contours (Figures 2-1 to 2-5). Groundwater levels used to develop the groundwater contours are provided in Table 8-1 of the Baseline Groundwater Assessment (ref. SMWSASBT-CPG-SWD-SW000-GE-RPT-040405). Groundwater flow is complex, and the interpretation is considered to provide a general indication of the broad pattern of existing groundwater flow. Local-scale influences may not captured.

Downward head gradients are interpreted to be present away from the watercourses linked to infiltration of rainfall through the residual soil to the deeper rock aquifer. Upward gradient may be present at the water courses where the potentiometric pressures in the deep bedrock are above the base of the creek/watercourse level. This has been reported near the west bank of Claremont Creek (refer Section 13.4.1 of the HIR) and is noted to cause of periodic increases in salinity in South Creek due to the discharge of saline water from the Bringelly shale aquifer (McNally 2009).

More detailed discussion on groundwater level and flow direction along the SBT Works alignment are provided in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403).

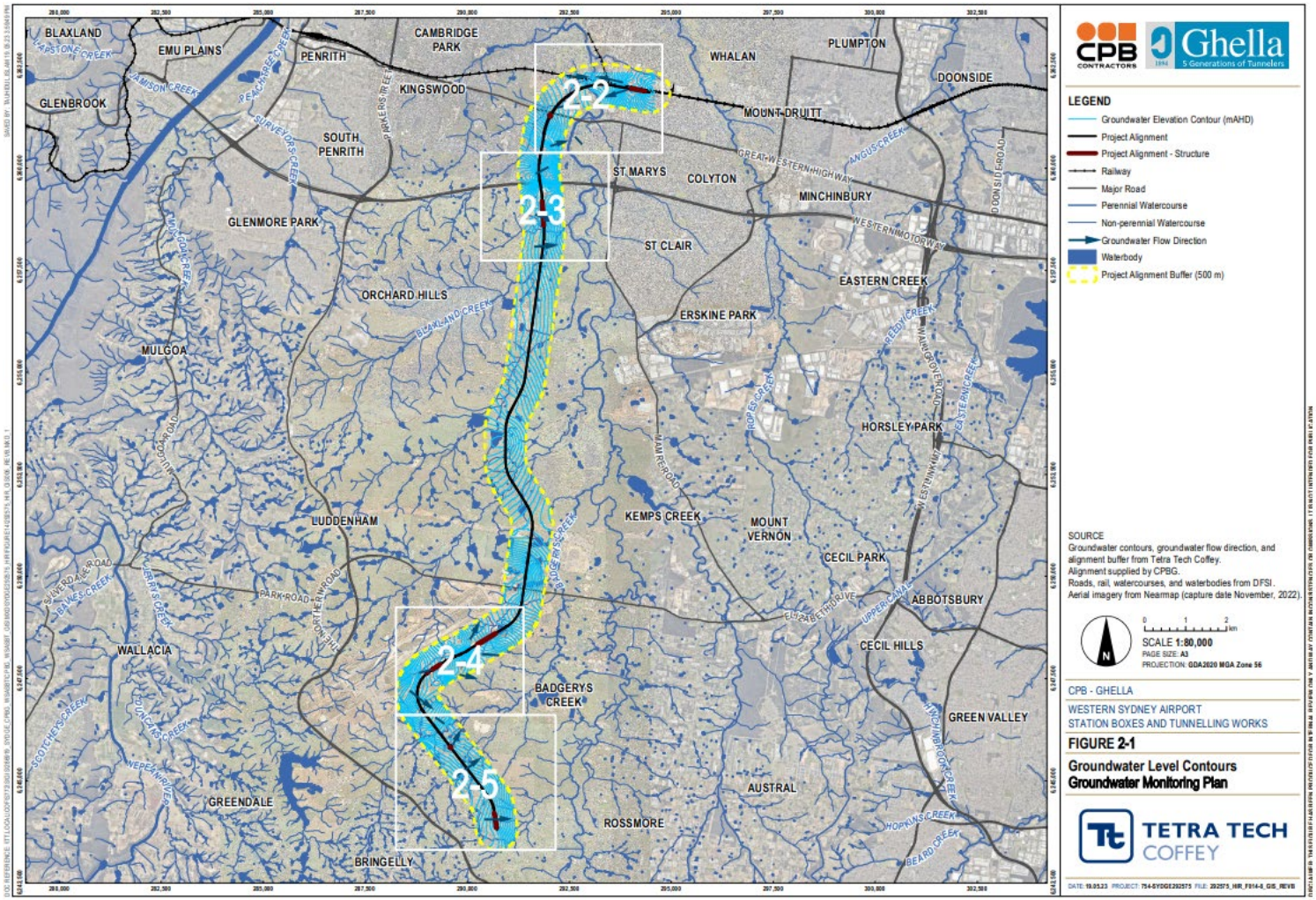


Figure 2-1: Groundwater level contours and flow direction – Alignment Overview

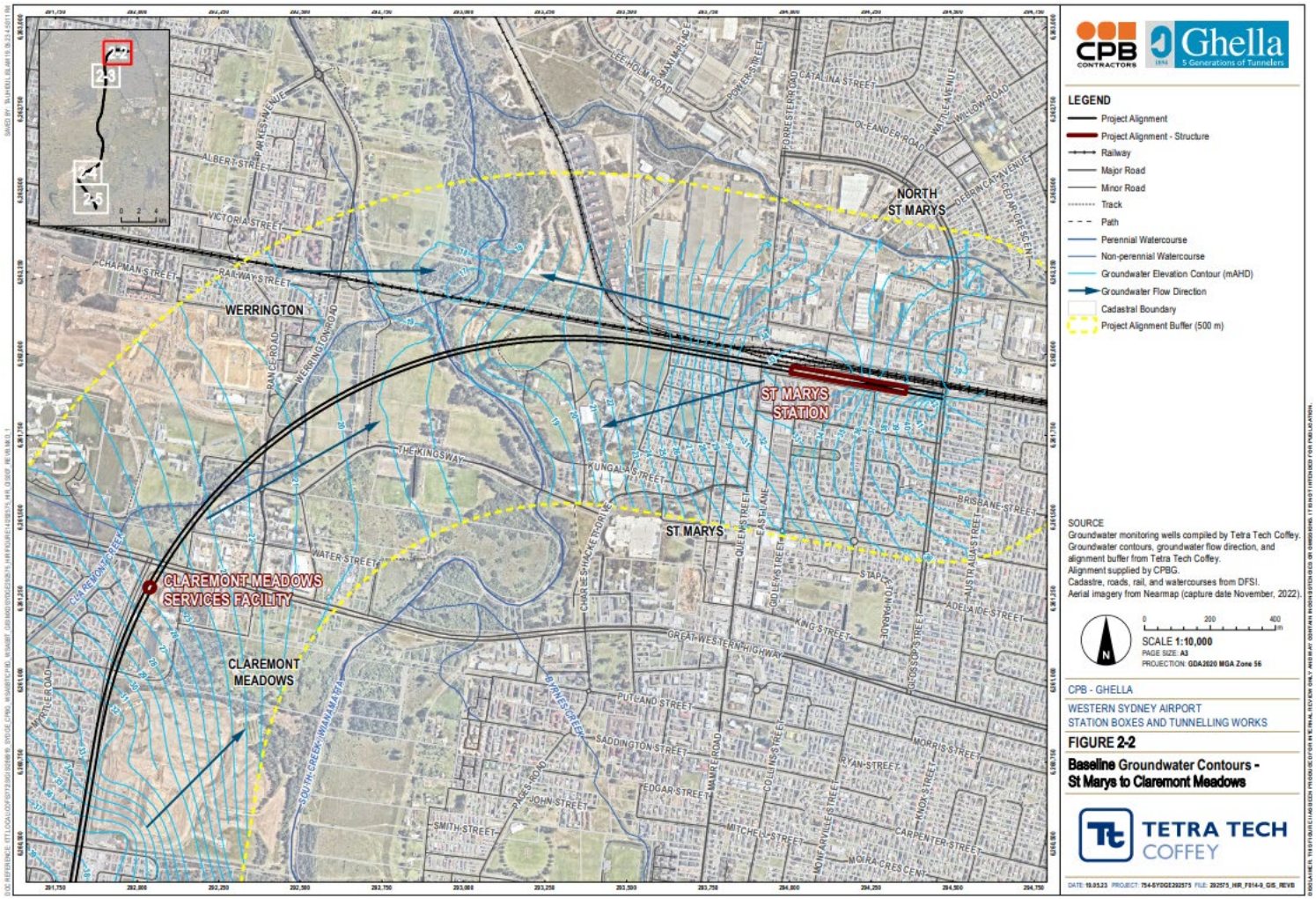


Figure 2-2: Groundwater level contours and flow direction – St Marys Station and Claremont Meadows

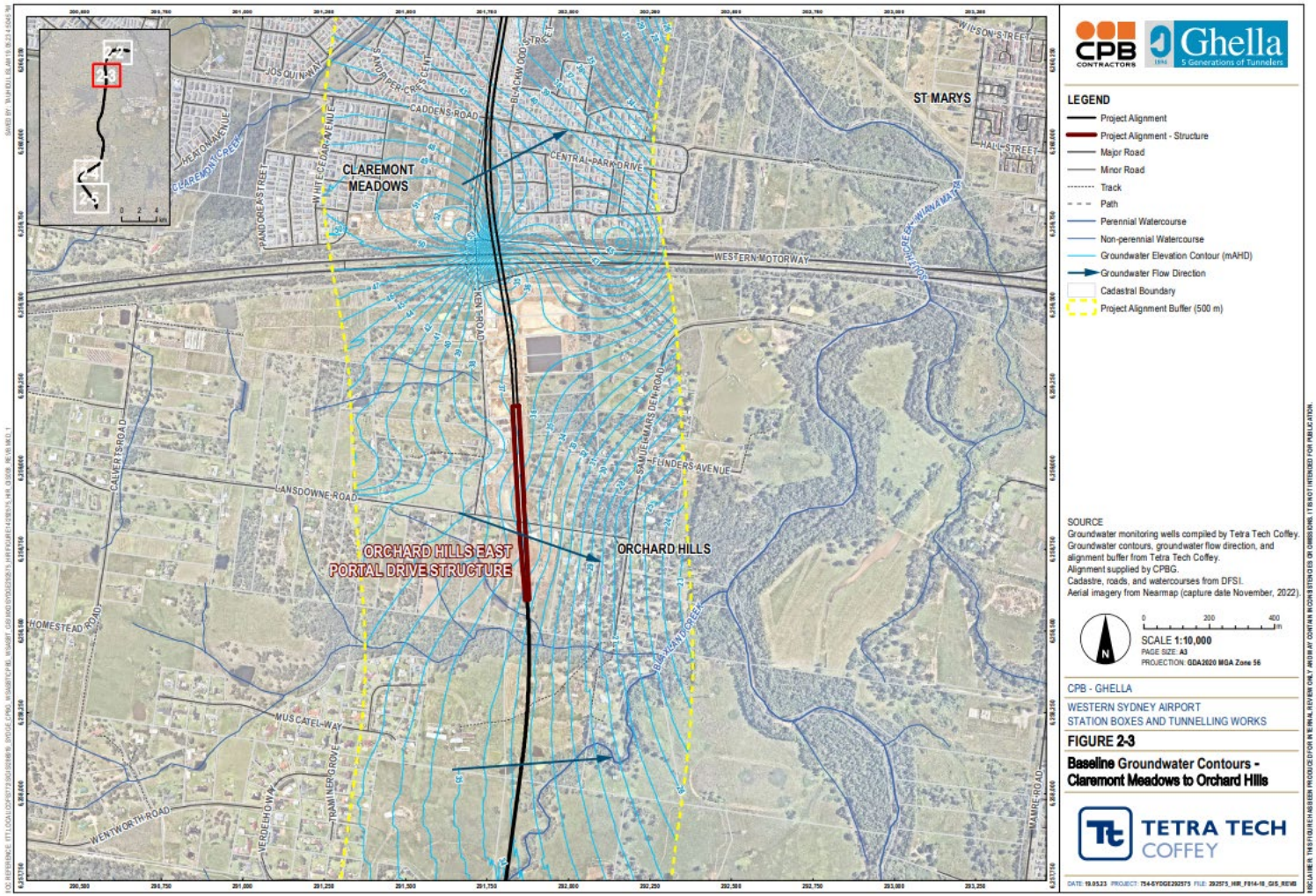


Figure 2-3: Groundwater level contours and flow direction – Claremont Meadows and Orchard Hills Station

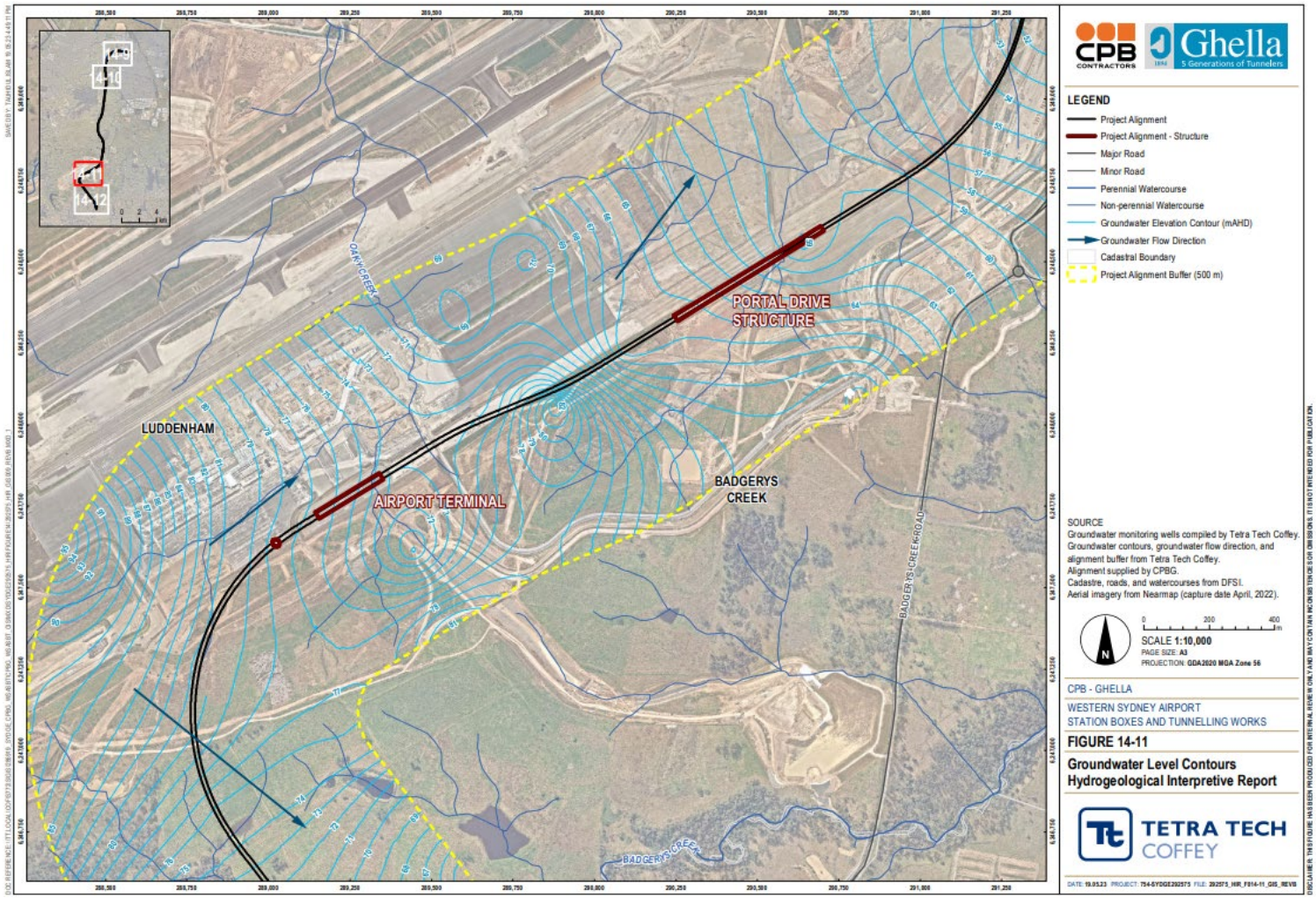


Figure 2-4: Groundwater level contours and flow direction – Airport Terminal and Portal Dive Structure

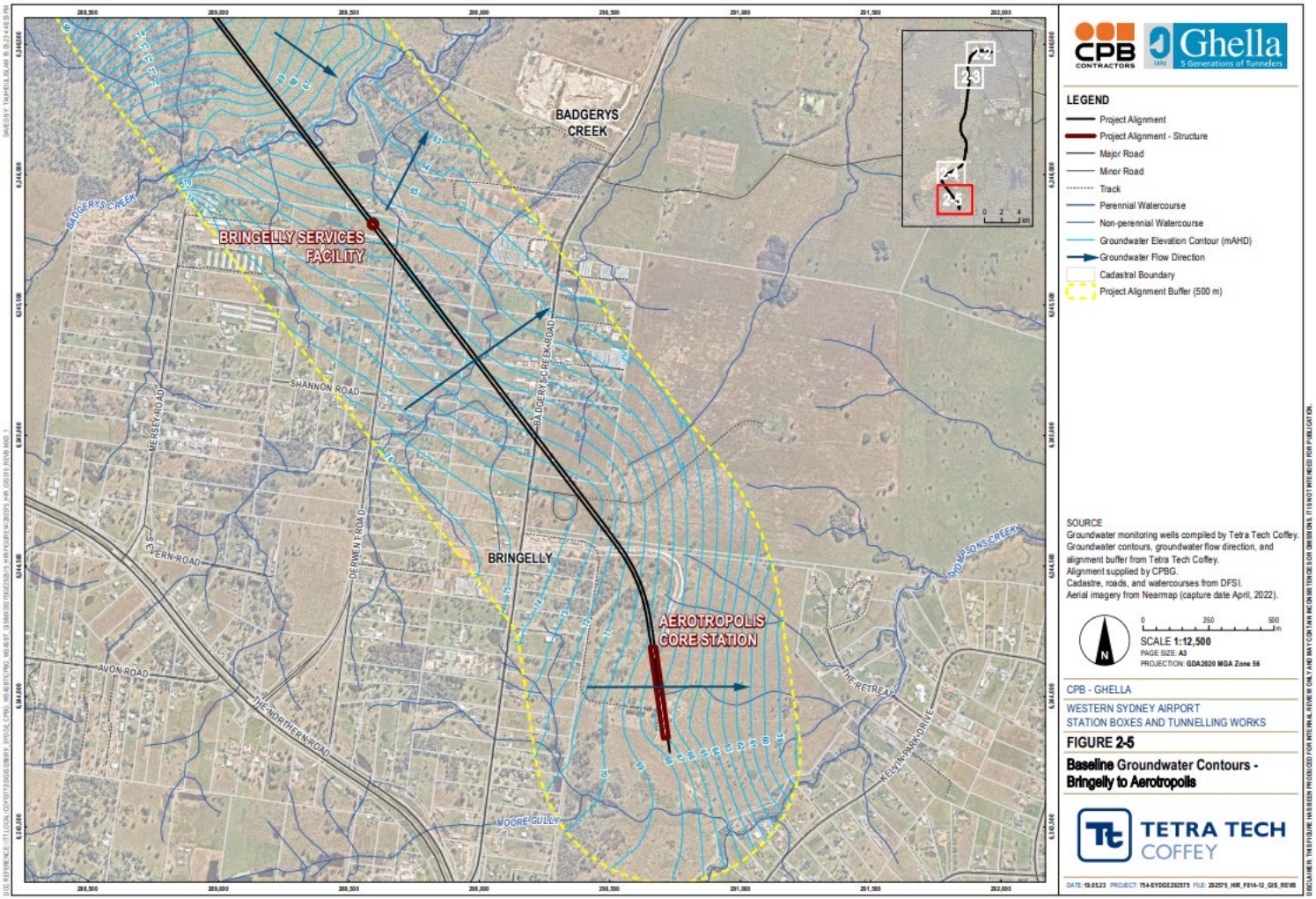


Figure 2-5: Groundwater level contours and flow direction – Bringelly Service Facility and Aerotropolis Core

2.4 Groundwater quality

Groundwater quality along the SBT Works alignment is presented in detail in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403) and Baseline Groundwater Report (SMWSASBT-CPG-SWD-SW000-GE-RPT-040405), with a focus on areas where there is the potential for significant interaction with groundwater and where potential groundwater quality issues have been identified. All currently available groundwater quality data is provided in Annexure D, with a summary of baseline groundwater quality by monitoring zone provided in Annexure E (as reported in the Baseline Groundwater Report).

General groundwater quality along the SBT Works alignment is summarised in Table 2-1, with the summary statistics provided separately for the alluvial, residual and bedrock aquifers. Further discussion is provided below and in the baseline groundwater quality summary in Annexure E.

The general characteristics of groundwater across the SBT Works area are:

- Groundwater along the alignment ranges from fresh to saline, generally exceeding 10,000µS/cm. The groundwater EC is typically higher in wells screened in the bedrock and residual soils. The lowest salinity (<1,000uS/cm) were reported near South Creek and Claremont Creek between St Marys and Claremont Meadows, indicating that fresh surface water bodies discharge to shallow groundwater in some areas.
- Groundwater along the alignment is generally neutral to acidic, ranging from 3.87 to 11.74 pH units (average pH of 6.54). Generally, pH readings were below 8 pH units. Low pH groundwater (pH <6) along the alignment is commonly associated with elevated metals in the groundwater. Strongly alkaline groundwater (pH>10) has consistently been reported in one location (SMGW-BH-A122) at tunnel depth to the south of Claremont Meadows and the Gipps St Landfill, and in SBT-GW-1806 to the west of Orchard Hills Station.
- Sulfate concentrations in groundwater along the alignment groundwater varied widely. Concentrations do not always correlate with groundwater EC, which is attributed to the presence of organic compounds, including hydrocarbon contamination at several locations along the alignment. The lowest relative sulfate concentrations were reported in groundwater bores at the northern end of the alignment at St Marys, Claremont Meadows, Orchard Hills and to a lesser extent at WSI.
- Groundwater is typically of sodium-chloride water type. An increased sulfate and bicarbonate to chloride ratio is present at some locations in St Marys, along the northern tunnel alignment to the Claremont Meadows Service Facility, and at Bringelly, which is attributed to the hydrocarbon or other organic impact in groundwater in these areas.

Table 2-1: General groundwater quality summary

Parameter	Units	Alluvial	Residual	Bedrock	Alluvial	Residual	Bedrock	Alluvial	Residual	Bedrock	Alluvial	Residual	Bedrock
		No. samples			Minimum			Maximum			Average/ Comment		
TDS	mg/L	43	106	128	468	638	283	26,700	29,500	44,000	10,680	12,422	14,107
EC (Lab)	µS/cm	46	133	144	826	876	390	37,000	35,600	37,200	15,515	18,360	19,173
pH (Field)	pH units	156	134	149	4.32	3.87	3.62	8.38	8.26	11.74	6.49	5.89	7.01
pH (Lab)	pH units	46	134	143	4.20	3.65	3.83	9.31	8.51	12.20	6.82	6.62	7.61
Redox Potential (Field)	mV	95	133	114	-271.7	-392.7	-337.1	301.2	297.4	193.4	-22.5	36.0	-47.4
Chloride[1]	mg/L	81	165	172	3	<1	2	454	510	1,290	160	127	299
Calcium	mg/L	84	167	178	86	65	64	13,700	12,600	19,000	5,704	6,487	6,648
Sulfate as SO4[1]	mg/L	84	167	178	12	<0.273	3	3,110	2,220	2,200	620	650	597
Alkalinity (Total)	mg/L	83	165	175	1	<1	<1	1,400	5,100	11,000	466	370	730
Bicarbonate Alkalinity (as CaCO3)	mg/L	83	165	175	1	<1	<1	1,400	5,100	11,000	464	369	712

1. The summary includes total sulfate and total chloride concentrations as filtered concentrations were similar when analysed for in the same samples

Several suspected or known contamination source areas have been identified on or adjacent to the SBT Works alignment within the areas where groundwater drawdown during construction is predicted to be >1 metre. Sites that were identified as having the potential to result in contamination of groundwater, or where there was no baseline data, are discussed in detail in Section 15 of the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403), and informed the DSIs and baseline groundwater assessment.

Key sites include:

- Former Dry Cleaner – 1-7 Queen St, St Marys
- Harris Street construction laydown area, St Marys
- Industrial area Queen and Phillip Streets, St Marys
- St Marys Plaza
- Current and suspected historical Service Stations to the west of Claremont Meadows Facility
- Gipps Street Landfill
- 34-38 Lansdowne Road, Orchard Hills
- 106-112 Kent Road, Orchard Hills
- 94-98 Kent Road, Orchard Hills
- Former OTC site, Aerotropolis Core Station.

Further discussion on potential sources of groundwater contamination is provided in Section 3.2.2. The data gaps identified and discussed in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403) were addressed through DSI and the baseline groundwater monitoring report to provide an assessment of existing groundwater conditions.

2.5 Groundwater users

A search of the Bureau of Meteorology's Groundwater Explorer database (BOM, 2021) identified 42 registered groundwater bores within 1 km of the SBT Works alignment. Of the 42 registered bores within 1 km of the SBT Works alignment, only two are registered with an extractive use (Table 2-2). All other registered wells are registered for groundwater monitoring purposes and are not considered further.

The two extractive use wells are registered for industrial use and are reported to be over 200 m deep. These wells are expected to access groundwater from the bedrock aquifer which is consistent with the understanding that shallow groundwater typically has a higher salinity that would not be desirable for most extractive uses. Details of the two extractive use wells are summarised in Table 2-2, with the locations shown on Figure C-1, Annexure C.

Table 2-2: Registered groundwater wells with extractive use

Bore ID	Easting	Northing	Drilled Date	Depth	Distance to alignment	Registered Use
GW105382	291651	6255672	19/04/2004	252 m	120 m east	Commercial Industrial
GW105054	291424	6256068	2/10/2002	210 m	152 m west	Commercial Industrial

In addition to registered groundwater users, consideration has also been given to constructed farm dams in areas where groundwater levels approach the ground surface. It is possible that in these areas farm dams may be partly supported by shallow groundwater and construction induced drawdown beneath these dams could potentially result in reduced dam water levels. These conditions may particularly exist around Orchard Hills East portal drive structure and the Bringelly services facility (refer Figures C-3 and C-5, Annexure C). Groundwater bores installed for construction monitoring of groundwater levels in the vicinity of these features are discussed in Section 6.

2.6 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are receptors that rely wholly or partially on groundwater to provide all or some of their water needs. GDEs relevant to the SBT Works can broadly be categorised as:

- Terrestrial GDEs: Ecosystems reliant on the subsurface presence of groundwater (i.e., vegetation that is accessing the water table and/or capillary fringe)
- Aquatic GDEs: Ecosystems reliant on the surface expression of groundwater (i.e., wetlands and baseflow fed watercourses).

Terrestrial GDEs are ecosystems with vegetation that rely on the availability of shallow groundwater, which is within reach of the root zone. Mature, large trees are likely to have the deepest root systems and are the most likely vegetation type in a given ecosystem to access groundwater. Two classifications of terrestrial GDEs are recognised:

- Obligate groundwater dependency – where vegetation (or some vegetation in a wider ecosystem) sources most, or all its water requirements from groundwater or the capillary fringe.
- Facultative groundwater dependency – where groundwater may be used periodically either only when it is available, or only when it is required.

Subterranean GDEs have not been mapped in the vicinity of the SBT Works and as such are not considered further. There are also no Ramsar or nationally important wetlands within the study area.

A desktop search of groundwater dependent ecosystems within a 1 km buffer of the SBT Works identified several aquatic and terrestrial ecosystems listed as having moderate or high potential for groundwater dependence (BoM, 2021). Data sources and the assessment process used to identify potential GDEs are detailed in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403).

A detailed description of the suspected aquatic and terrestrial GDEs in the vicinity of the SBT Works is provided in Annexure C, along with figures presenting an overview of the mapped locations.

3 Environmental Impacts

3.1 Construction groundwater inflow and drawdown assessment

The assumed station and facility construction details are outlined in the HIR (Document reference: SMWSASBT-CPG-SWD-SW000-GE-RPT-040403). The design of various excavations has been amended since tender, with secant pile walls to be used instead of diaphragm walls at both the Claremont Meadows and Bringelly Service Facilities. The effect of this design modification has been assessed in recent versions of the HIR, and the assumed drawdown extents updated for this GWMP.

3.1.1 St Marys Station

The existing groundwater level at the station in the main aquifer is assessed to be 32.5 to 33 mAHD, with some higher levels toward the east end of the station. This level was adopted for the assessment of drawdown impacts associated with construction. A higher level of 34 mAHD was adopted for the assessment of potential sustained groundwater inflow due to periods of sustained high rainfall.

For construction groundwater assessment, it is assumed that groundwater level will be controlled to 18.5 mAHD within the excavation allowing for excavation to facilitate foundation preparation and casting of the base slab.

South Creek is present 800 m to the southwest and a minor tributary of South Creek is present 420 m to the north. The estimated sustained inflow is 0.8L/s if untreated. Higher inflow may occur initially depending upon the rate of excavation. Drawdown of 1m associated with the excavation is assessed to occur for a distance of up to 550 m from the excavation. As a result, the excavation is considered unlikely to influence the nearby watercourses.

Based on the borehole logs Bringelly Shale is interpreted to be present at the bulk excavation level over the lower 16 m of the excavation. Perched groundwater (at the shallow level than the recorded groundwater level within shale) is anticipated in the shallow soil profile at higher elevations than the main aquifer. The groundwater inflow assessment assumed that such shallow groundwater would be address separately by surface drainage or cutoff trenching.

The operational state is not known, but if the station is to be drained during operation, the extent of impact is expected to be similar as described above.

3.1.2 Claremont Meadows Facility

The depth to groundwater at the Claremont Meadows facility has been measured within 2.5 m of the ground surface in places and some dewatering during construction is expected.

Secant walls will be used during construction, which will likely result in a higher magnitude of groundwater drawdown propagating from the construction site when compared with the original diaphragm wall design option.

Claremont Creek is approximately 140 m to the northwest of the facility. Based on the parameters adopted and approach as outlined in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403), and making allowance for the presence of Claremont Creek, sustained inflow to the excavation if untreated is estimated to be 0.44L/s, with greater initial inflow in the short term. Minor inflows are expected provided adequate waterproofing is installed. During construction, influence is estimated to extend 350 m to the east, and 1 m drawdown of the water table up to 250 m from the excavation. The magnitude of groundwater level drawdown towards the north, where higher hydraulic conductivity alluvial sediments exist, is expected to be limited.

3.1.3 Orchard Hills Station

The Orchard Hills Station excavation is anticipated to extend to about 27 mAHD allowing some over-excavation for the preparation of the floor for the casing of the base slab. A ramp to the ground surface will be constructed to the south and will provide construction access and will form part of the metro rail system.

An ephemeral watercourse is present to the north of the station. This is treated as having little influence on groundwater levels. It is interpreted to act as a zone of groundwater discharge under pre-development conditions.

Based on the parameters outlined in the HIR, the sustained estimated seepage to the station excavation and dive structure is assessed as 0.43 L/s and the extent of the impact is assessed to be within 350 m of the station. This zone of influence does not extend as far as South Creek to the west so no adverse impacts on South Creek are predicted. No existing groundwater bores have been identified within the assessed zone of influence.

Drawdown related settlement is assessed to be less than 5 mm (allowing a drained modulus of 35 MPa and a Poisson's Ratio of 0.3 for depressurisation of up to 5 m of residual soil).

3.1.4 Bringelly Services Facility

Secant walls will be used during construction of the Bringelly Service Facility, which will likely result in a higher magnitude of groundwater drawdown propagating from the construction site than initially predicted based on previous assumed use of solider piles or a diaphragm wall.

A pre-development groundwater level of 69 mAHD was adopted for assessment of drawdown impact and construction groundwater seepage inflow based on the records from monitoring location SMGW-BH-D303S.

A sustained construction groundwater seepage inflow of 0.44 L/s is assessed during construction, with minor inflows expected provided adequate water proofing is installed. Drawdown response is expected to be limited to 400 m from the shaft, with greater than 1 m assessed to occur within 200m (north) to 330m (southwest) of the excavation.

3.1.5 Aerotropolis Core Station

The Aerotropolis Cores Station is approximately 200 m to the northwest of Thompsons Creek. Groundwater levels recorded at location SMGW-BH-D326 showed a 1.1 m rise in response to a heavy rainfall event in March 2021 with subsequent recovery to a level of 66.8 mAHD. Based on these measurements a pre-development groundwater level of 67 mAHD was adopted for assessment of construction groundwater inflow and drawdown response.

Borehole logs for the area show thin residual soil cover over Bringelly Shale.

A sustained construction groundwater seepage inflow of 0.49 L/s is assessed if untreated, with a drawdown response limited to 450 m from the shaft. Drawdown greater than 1 m is assessed to occur within 300 m of the excavation.

3.2 Environmental impacts

Potential impacts resulting from the SBT Works before the implementation of mitigation measures were identified and assessed as part of the preliminary groundwater impact assessment as detailed in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403).

The SBT Works will interact with the groundwater environment during the construction. The construction methods and permanent design adopted for the underground structures directly influences how the SBT Works will impact groundwater systems and sensitive receptors.

Table 3-1 summarises key risks posed by the SBT Works to the groundwater environment during construction.

Table 3-1: Key potential construction stage groundwater risks

Issue	Risk
Change in groundwater level	Reduced availability for groundwater-dependent ecosystems (aquatic and terrestrial)
	Reduced availability for existing extractive groundwater users
	Impact on third party structures (property, utilities, and the environment) due to consolidation settlement
	Mounding and barrier effects upstream of buried structures (stations, dive structures) and the tunnel.
Change in groundwater quality	Mobilisation of existing groundwater contamination into previously unaffected areas resulting in unacceptable risk to sensitive receptors/third parties
	Mobilisation or generation of groundwater having quality that is adverse to underground structures
	Degradation of groundwater quality by drawing saline water from the deep bedrock aquifer into possibly fresh to brackish shallow (alluvial) aquifers
	Contamination of groundwater due to surface spills and leaks
	Acidification of groundwater due to oxidation of acid sulphate soil and rock
Disposal of groundwater	Management of groundwater seepage, including potentially contaminated groundwater, into construction excavations or permanent structures resulting in unacceptable impacts at the point of discharge

3.2.1 Registered groundwater users

Extractive use groundwater bores

Extractive groundwater users require consideration of both potential level and quality impacts associated with the SBT Works.

The SBT Works is required to comply with Table 1 – *Minimal Impact Considerations for Aquifer Interference Activities* of the NSW *Aquifer Interference Policy* which specifies that the SBT Works must not result in a cumulative water level decline of more than 2 m at any water supply work (groundwater bore).

Two extractive use bores reported to be over 200 m deep are registered for commercial or industrial use in close proximity (between 120 m and 150 m) to the project alignment. These wells are expected to access groundwater from the bedrock aquifer which is consistent with the understanding that shallow groundwater typically has a higher salinity that would not be desirable for most extractive uses. The project design includes only above-ground infrastructure in this area and no groundwater level or quality impacts are expected as a result of project activities.

Farm dams

It is possible that if dams are constructed in low-lying areas, or where groundwater levels are shallow (i.e., within 2 mbgl), they may have a level of connectivity with the underlying aquifer. Where this occurs, temporary groundwater drawdown could result in temporarily reduced surface water levels in some farm dams.

Make good arrangements could be considered as a contingency mitigation measure during construction if impacts were observed.

3.2.2 Mobilisation of groundwater contamination

Potential sources of groundwater contamination that may be mobilised by construction activities, and data gaps as identified in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403), are summarised in Table 3-2.

These data gaps were addressed through a series of DSI completed by Tetra Tech in 2022 and 2023 and the baseline groundwater assessment (discussed in Section 5).

Table 3-2: Potential sources of groundwater contamination and identified data gaps

Area	Site	Current understanding	Identified data gap
St Marys Station	Former dry cleaner	Investigations have confirmed the presence of chlorinated hydrocarbons in groundwater and vapour at site. The composition (predominantly perchloroethene (PCE)) and increasing concentrations at depth is consistent with an onsite dense non-aqueous phase liquid (DNAPL) source.	The vertical and lateral extent of chlorinated hydrocarbon impact is unknown.
St Marys Station	Harris St construction laydown area	Former wreckers, workshop, bus depot and plastic manufacturer. There is limited groundwater quality data in area, including a suspected source areas adjacent to the station excavation. Underground storage tank fill points and pumps were also identified in 2019 at the north-east corner of Harris Street and Forrester Street within drawdown area.	No groundwater data within or downgradient of suspected source areas.
St Marys Station	Former industrial sites to south of station on Queen and Philip Streets	Former site uses within the predicted 5m draw down area include a water proofer, former service stations and a dry cleaner.	No groundwater data within or downgradient of suspected source areas.
St Marys Station	St Marys Plaza	Former service station and potential chemical storage for backup generators.	No groundwater data within or downgradient of the suspected source area, or between the area and station construction area.
Claremont Meadows Facility	Possible historic service station	Suspected source within 60m of excavation based on site layout on historic aerial imagery.	No groundwater data within the suspected source area, and shallow well downgradient not analysed for petroleum hydrocarbons.
Claremont Meadows Facility	Gipps Street Landfill	Previous investigation of the Gipps Street Landfill described in the EIS reported contamination in groundwater derived from landfill leachate including but not limited to ammonia, metals, pesticides, and other organic compounds.	Vertical and lateral extent of impact is not known.

Area	Site	Current understanding	Identified data gap
Orchard Hills Station	34-38 Lansdowne Road	Suspected use of herbicides and pesticides on cultivated land. Site within predicted drawdown area.	Groundwater data indicates metals contamination is present. Vertical and lateral extent of impact is not known.
Orchard Hills Station	64 Kent Road	Unlicensed waste disposal suspected adjacent to and downgradient of construction area and within predicted drawdown area.	No groundwater data within or downgradient of suspected source area, or between the area and station construction area.
Orchard Hills Station	94-98 Kent Road	Suspected former cattle or sheep dip, and area of stressed vegetation. Directly on station construction area, and within predicted drawdown area.	Elevated metals concentrations in groundwater, and detectable concentrations of hydrocarbons. The vertical and lateral extent of groundwater impact is not known.
Airport Dive Portal	Draw down area	No indications of gross contamination, however limited groundwater quality data. Metals, PAH and TRH detected in soil data in vicinity of drawdown area, and PFAS detected in soil on alignment in construction area (SMGW-TP-C343).	Limited groundwater data available within predicted groundwater drawdown area.
Airport Terminal	Draw down area	No indications of gross contamination, however limited groundwater quality data. Elevated zinc identified in soil in area.	Limited groundwater data available within predicted groundwater drawdown area.
Bringelly Service Facility	Draw down area	Elevated strontium detected in groundwater (source unknown). PFAS detected in groundwater, and low-level volatile hydrocarbons detected at depth in soil.	Insufficient groundwater data to assess whether contaminant concentrations reported represent maximum in construction/drawdown area.
Aerotropolis Core Station	Former OTC site compound	Site inspection in 2019 identified UST, transformer and substation, fire hydrants and pumphouse. PFAS, volatile hydrocarbons and low concentrations of methane and DDD detected in groundwater.	Extent of groundwater impact is unknown.

Significant chlorinated hydrocarbon contamination in groundwater has been identified beneath the former dry cleaner at 1-7 Queen St. Existing groundwater quality and associated environmental impacts, are detailed in the following reports:

- *Former Dry Cleaner, 1-7 Queen St – Assessment of Human Health Risk and Mitigation Options* report (Tetra Tech Major Projects, 2023 Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040540);
- *St Marys Station Detailed Site Investigation* (Tetra Tech Major Projects, 2023, Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040513).

Except for the former dry cleaner at 1-7 Queen Street, St Marys, the results of the DSIs and baseline groundwater assessment indicate that no active mitigation is required to manage groundwater contamination along the remainder of the alignment. However, the requirement for groundwater

management may need to be reviewed, and revised (if necessary), should groundwater conditions change.

3.2.3 Groundwater dependent ecosystems

Where excavation is planned below the water table along the alignment, the SBT Works are expected to interact with the groundwater environment.

Key potential impacts posed by the SBT Works to GDEs during construction and operation are summarised in Table 3-3.

Table 3-3: Key groundwater potential impacts

Issue	Potential impact
Change in groundwater level	Reduced availability for GDEs (aquatic and terrestrial).
	Acidification of groundwater due to oxidation of acid sulfate soil and rock.
Change in groundwater quality	Mobilisation of existing groundwater contamination or saline groundwater into previously unaffected areas resulting in unacceptable risk to sensitive receptors.

A risk-based assessment approach has been adopted to assess the potential impacts to identified GDEs along the SBT Works alignment. The assessment approach adopts a GDE risk ranking matrix that was established for the project (refer to Section 18.4.2 of the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403)). The risk ranking matrix considers both groundwater level and quality changes, their magnitudes and duration.

This approach is intended to identify potential impacts that would be considered unacceptable or undesirable and allows for alternative engineering design options to be developed, or suitable mitigation measures to be implemented prior to construction commencing.

GDEs and predicted drawdown along the alignment are shown on Figures C-1 to C-5, Annexure C.

Aquatic GDE impact assessment

A preliminary assessment of impacts to aquatic GDEs was undertaken in Section 18.4.3 of the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403). The assessment considered the potential influence of the SBT Works on the following aquatic GDEs:

- South Creek
- Badgerys Creek
- Thompsons Creek.

The groundwater inflow and drawdown assessment (Section 17 of the HIR) has concluded that the predicted zone of 1 m groundwater drawdown is unlikely to extend to within 50 m of either South Creek, Badgerys Creek or Thompson Creek. Based on this assessment, there is a negligible risk of impact to aquatic GDEs during construction based on the current engineering design and inflow assessment. A lower magnitude drawdown of between 0.1 and 1 m was also assessed. Modelling results indicate the 0.1 m drawdown contour does not extend below South Creek or Badgerys Creek.

Mitigation measures are not currently proposed for aquatic GDEs but this may be revised in future versions of this document.

Terrestrial GDE impact assessment

The design phase groundwater drawdown estimates adopted for the GDE impact assessment are based on construction phase modelling and drawdown estimates which are presented and discussed in detail in Section 19 of the HIR.

The magnitude of groundwater level drawdown around the rail tunnels and the cross passages during construction is expected to be relatively minor due to the relatively short construction duration and the low hydraulic conductivity of the Bringelly Shale. Therefore, the assessment has been limited to the areas of predicted groundwater level drawdown around dewatered excavations, such as station boxes, portals and other major infrastructure (refer to Section 19.4 of the HIR).

A summary of the terrestrial GDE impact assessment presented in the HIR (SMWSASBT-CPG-SWD-SW000-GE-RPT-040403) is provided in Table 3-4.

Table 3-4: Terrestrial GDE impact assessment summary

SBT Works site	Terrestrial GDE	Assumed GDE type	Potential impact	Risk ranking
Claremont Meadows Facility	Cumberland Shale Plains Woodland east of Gipps Street	Facultative	Unquantified groundwater drawdown (potentially up to 2m) through secant piled walls, estimated for more than 6 months	Moderate
	Claremont Creek riparian zone	Unknown (potentially obligate)	Unquantified groundwater drawdown unlikely to significantly alter levels in alluvial sediments	Minor
Orchard Hills Station	Cumberland Shale Plains Woodland north and east of the station	Facultative	Temporary drawdown in excess of 2 m across large area, persisting for at least 6 months.	Moderate
	Cumberland River Flat Forest south of Lansdowne Road	Facultative	Temporary drawdown in excess of 1 m across large area, persisting for at least 6 months.	Minor
	Cumberland River Flat Forest in South Creek riparian zone	Facultative	Temporary drawdown in excess of 1 m across large area, persisting for at least 6 months.	Minor
Bringelly Services facility	Cumberland Shale Plains Woodland 30 m south of the construction zone	Facultative	Temporary drawdown of approximately 5 m predicted across 1.3 ha stand on private property, persisting for at least 6 months.	Moderate
	Cumberland Shale Plains Woodland 300 m north of the construction zone	Facultative	Temporary drawdown of up to 2 m is predicted to extend beneath the southern edge of the woodland, persisting for at least 6 months.	Moderate
Aerotropolis core	Cumberland River Flat Forest along Thompson Creek riparian zone	Facultative	There are no mapped terrestrial GDEs that fall within the predicted 1 m drawdown contour extending around the station box.	Negligible

4 Environmental control measures

The need for active control measures is based on the identification of where SBT Works may result in an unacceptable risk to a sensitive and relevant groundwater receptor. Mitigation and management measures are then implemented to control impacts to within acceptable levels.

The results of the DSIs and baseline assessment have been reviewed to refine the need for and approach to groundwater mitigation and management. The effectiveness of any measures implemented will be validated through the groundwater construction monitoring program (Section 6).

4.1 Inflow control

Estimate inflows, and the general approach for assessment, are detailed in the Groundwater Modelling Report (SMWSASBT-CPG-SWD-SW000-GE-RPT-040402). The results are replicated in Table 4-1.

The assessments indicate that inflows will be quite low, with local defects potentially resulting in short term higher flows. Localised grouting may be implemented as a control measure where required.

Table 4-1: Estimated long-term inflows at structure locations.

Tunnel or Station Box	Estimated long-term inflows	
	L/s, untreated	L/s, treated (Note 3)
Tunnel – North	0.09	(Note 1)
Tunnel – South	0.12	(Note 1)
Cross Passages – North	0.60	(Note 1)
Cross Passages – South	0.30	(Note 1)
St Marys Station	0.80	0.80 (Note 2)
Claremont Meadows	0.44	(Note 1)
Orchard Hills Station	0.37	0.37 (Note 2)
Orchards Hills Dive	0.06	0.06
Airport Dive	0.68	(Note 1)
Airport Terminal Station	0.78	0.78 (Note 2)
Airport TBM Shaft	0.18	(Note 1)
Bringelly Facility	0.44	(Note 1)
Aerotropolis Station	0.49	0.47 (Note 2)

Notes: (1) Minor inflows are expected subject to adequate waterproofing being installed. Refer to Particular Specs, Cl. 4.1.8 (f) to inflow restriction/waterproofing requirements. Installation of the waterproofing requirements to meet the limits stated as required by the Particular Specs is the responsibility of CPBG.

(2) The operational state of St Marys, Orchard Hills Station, Airport Terminal and Aerotropolis is not known and not included in the scope of the SBT Works. Should these stations be drained during operation, the extent of the impact is as described above.

(3) Waterproofing applied per the Particular Specifications.

4.2 Groundwater contamination

The results of the DSIs and baseline assessment have informed the approach to groundwater mitigation and management. Active control measures are required where Project activities may result in an unacceptable risk to a sensitive and relevant groundwater receptor.

Contamination requiring active mitigation has been confirmed at the former dry cleaner at 1-7 Queen Street, St Marys, with measures implemented to control impacts to within acceptable levels. Mitigation, management and construction monitoring measures are detailed in:

- *St Marys Station - Remedial Action Plan* (Tetra Tech Major Projects, 2023, SMWSASBT-CPG-SWD-SW000-GE-RPT-040521)
- *St Marys Station – Implementation of Permeable Reactive Barrier* (Tetra Tech Major Projects, 2023, SMWSASBT-CPG-SWD-SW000-GE-RPT-040561.

Except for the former dry cleaner at 1-7 Queen Street, the risk of adverse groundwater related impacts due to mobilisation of contamination during construction is considered to be low and no active groundwater mitigation is proposed. Control measures for groundwater contamination elsewhere along the alignment therefore consist of management via monitoring to assess whether existing conditions change such that there is an adverse change in risk profile.

The effectiveness of any measures implemented will be validated through the groundwater construction monitoring program (Section 6).

4.3 Water Treatment

Groundwater inflows, TBM process water, and washdown water from construction activities will be treated using the dedicated water treatment plants (WTPs) located at St Mary's, Claremont Meadows, Orchard Hills, Bringelly, and Aerotropolis. Following treatment, the WTPs will discharge effluent either to receiving waterways or to trade waste (sewer) depending whether environmental criteria for discharge to waterways are achieved. On-site beneficial reuse of treated effluent is also considered a viable option to support dust suppression measures.

All WTPs will include a minimum seven-step treatment process that has been designed to significantly improve water quality, prior to the discharge of treated effluent into receiving waterways.

Each site will include an approximately 20,000 litre storage tank that will be used to store treated water prior to discharge. The treated water storage tanks will include a "high water" level trigger that will activate pumped discharge from the storage tank to receiving waterways via existing stormwater connections or proposed conveyance structures. Discharge will cease once the "low water" trigger level is reached.

Details of the proposed water treatment processes and the resulting effects on water quality are summarised in Table 4-2, noting that treatment to reduce salinity is not proposed, and saline water will need to be discharged as trade waste if not acceptable for release to waterways.

Table 4-2: Minimum Water Treatment Plant Processes

Site Location	WTP Process
Primary Solids Removal	First order reduction of suspended solids and suspended contaminants.
Flocculation / Coagulation	Second order reduction of turbidity suspended solids, and suspended contaminants. Coagulant aids may be used to improve softening of water and enhance reduction in concentrations of dissolved solids / contaminants.
Clarification	Third order reduction of turbidity suspended solids, and suspended contaminants. Combination softening-clarification units may improve and enhance reduction in concentrations of dissolved solids / contaminants.

Site Location	WTP Process
Media Filtration	Fourth order reduction of turbidity and suspended solids, and suspended contaminants. May be used with softening process to reduce concentrations of dissolved solids / contaminants.
Breakpoint Chlorination	Reduce concentrations of ammonia.
Activated Carbon Filtration	Remove organic contaminants, hydrocarbons, chlorine, PFAS, chloramines, nitrate, and improve colour and odour.
pH Correction	Adjustment of pH to appropriate discharge limits.

4.4 GDE Mitigation Measures

Moderate potential for adverse effects has been identified at several locations along the project alignment (Claremont Meadows facility, Orchard Hills station, and Bringelly services facility) where dewatering is likely to cause groundwater levels to be temporarily drawn down below the root zone of facultative terrestrial GDEs for a period of greater than six months.

In many cases these facultative GDEs may be unaffected by short term dewatering where there are sufficient alternative sources such as rainfall and soil moisture. However, given the high ecological value of the Cumberland Shale Plain Woodland and Cumberland River Flat Forest, and in the absence of site-specific assessment of groundwater dependence, a conservative assessment has been adopted assuming that any temporary decline in tree health would be considered unacceptable.

Table 4-3 summarises the recommended monitoring and mitigation measures to minimise potential impacts (such as declining tree health or dieback) to terrestrial GDEs assessed as having moderate risk rankings. Monitoring requirements are detailed further in Section 6.

Table 4-3: Groundwater assessment, monitoring and mitigation measures – terrestrial GDEs

Measure	Proposed action	Description
Assessment	Groundwater drawdown assessment	Refinement of the potential zone of native vegetation impact based on numerical groundwater modelling, groundwater level and quality monitoring, and confirmation of the period of dewatering.
	Construction groundwater level monitoring	Additional groundwater monitoring wells have been installed in the vicinity of suspected GDEs to assess the zone of drawdown during construction (Section 6).
Monitoring	Groundwater level and quality monitoring	A program of groundwater level and quality monitoring will be implemented during construction (Section 6). As the SBT Works are progressively completed, each site and the associated groundwater monitoring network will be transferred to the Stations, Systems, Trains, Operations and Maintenance (SSTOM) contractor. The requirements for groundwater monitoring post-SBT works is included in the SSTOM Soil and Water Management Plan (Appendix G – Groundwater Monitoring Program). Periodic review of monitoring results will consider whether drawdown is progressing in line with modelled estimates or if additional areas of terrestrial GDE may require management.
	Tree health monitoring	In areas of non-certified GDEs where modelling predicts drawdown of greater than 2 metres, tree health monitoring will be conducted twice a year during the

Measure	Proposed action	Description
	(predicted drawdown >2m)	SBT Works and by ecological specialists. Monitoring will guide the need for further mitigation (such as manual tree watering) or longer-term mitigations.
	Tree health monitoring (predicted drawdown >1m)	Where groundwater levels at GDE monitoring locations exceed the trigger levels detailed in Table 6-4 and Table 6-11 for 6 consecutive months as a result of the SBT Works, site specific tests will be conducted by ecologists and hydrogeologists to determine vegetation reliance on groundwater to identify any additional monitoring and/or mitigations to be implemented.
Mitigation system	Manual tree watering	Where the tree health monitoring program identifies signs of declining tree health during construction, and groundwater monitoring confirms a reduced water table, manual tree watering events should commence until tree health recovers, or until groundwater levels recover post-construction (where permanent drawdown is not expected). Manual watering events will continue during low rainfall periods until tree health recovers, or groundwater levels recover to levels that return supply to the root zone.

The monitoring and mitigation measures presented in Table 4-3 are considered appropriate and effective to manage the potential impacts of temporary groundwater level drawdown. Should unforeseen permanent drawdown, or vegetation dieback occur despite the proposed mitigation as provided in Table 4-3, the contingency measures detailed in Table 4-4 would be implemented.

Table 4-4: Proposed contingency mitigation and offsets for terrestrial GDEs

Measure	Description	Proposed design
Contingency measure	Replanting	Where long term drawdown occurred and tree health monitoring indicated the likely declining health in the absence of manual watering, the affected area would be replanted with juvenile trees. As these juvenile trees mature in the absence of groundwater, they will adapt to the new groundwater conditions and replace affected trees over the long term.
Contingency measure	Native vegetation offset	In the case where tree health monitoring identifies dieback or expects dieback to occur in the future as a result of project activities and the ecosystem cannot be appropriately maintained by replanting in the time available, native vegetation offsets will be secured.

5 Groundwater monitoring – baseline conditions

The following section summarises the baseline groundwater assessment completed to inform existing conditions and refine the construction monitoring program.

All groundwater monitoring locations along the alignment, including pre-award bores and project bores installed by CPBG, are shown on figures in Annexure C.

5.1 Pre-award Data

The pre-award project monitoring network was installed between 2019 and 2023, and consists of 78 existing groundwater monitoring bores, and 52 vibrating wire piezometers (VWPs) installed at 30 locations along the alignment. Monitoring bores were designed to target the following three hydrogeological units:

- Quaternary alluvial aquifer
- Residual soils, including perched water
- Bedrock aquifer, predominantly in the Bringelly Shale.

Groundwater quality data was also available from nine (9) groundwater wells installed at Western Sydney International (WSI), with these wells sampled up to eight times between March 2017 and April 2019.

Data from these monitoring locations is included in Annexure D and was included in the Baseline Groundwater Assessment (SMWSASBT-CPG-SWD-SW000-GE-RPT-040405).

5.2 Baseline groundwater assessment

To inform existing conditions, support the DSIs and provide the construction monitoring network, 55 groundwater bores and 55 vibrating wire piezometers (VWPs) were installed by CPBG at 88 locations along the alignment.

In addition to informing baseline conditions, where required, data from these locations was included in the DSIs to address identified contamination data gaps. A number of bores were also installed to monitor where the potential for environmental impacts during construction was identified, or where existing wells will either be destroyed or become dry during construction, and no existing monitoring locations were available as an alternative.

The details of depth, co-ordinates and target stratigraphic unit for all monitoring bores and VWPs sampled or monitored for the baseline assessment, including pre-award bores, are listed in Table 5-1 and Table 5-2, respectively. Table 5-2 also indicates locations where data loggers have been installed. The location of all bores and VWPs included in the baseline assessment are shown on Figure 5-1 and Figure 5-2.

All newly installed monitoring bores were sampled for water quality at least once for the full analytical suite as detailed in Table 6-6, and levels gauged to supplement the existing baseline dataset. Most bores were sampled three times, with a limited analytical suite adopted for the second and third rounds where no PFAS or hydrocarbon contamination was identified when analysed for the full analytical suite.

A number of existing groundwater monitoring bores had not previously been sampled and/ or had not been analysed for a full analytical suite, including some nearby suspected contamination sources. Where these bores still existed, and could be accessed, they were also sampled as part of the baseline assessment program to provide as complete a baseline assessment as possible. In total, 23 pre-award groundwater monitoring bores were sampled as part of the baseline assessment at least once for the full analytical suite.

The initial screening criteria used to assess baseline groundwater quality included:

- ANZECC/ARMCANZ 2000 relevant physical and chemical stressors
- ANZG (2018) 95% species protection criteria for freshwater water, with criteria for toxicants known to bioaccumulate assessed based on the 99% species protection criteria
- PFAS National Environmental Management Plan (NEMP 2.0) 99% species protection values
- Australian Standard AS2159 – 2009 Piling design and installation have also been considered to assess potential groundwater aggressivity risks posed by groundwater to underground concrete and steel structures (discussed in Section 20.2 of the HIR).
- Discharge concentration limits negotiated with EPA as detailed in L2.4 of Environmental Licence (EPL 21672, amended 10 March 2023)
- *Airports (Environment Protection) Regulations* (AEPR) 1997 guidelines (on-airport locations only).

A summary of the baseline groundwater quality is provided in Annexure E. Summary tables are provided for each monitoring area with the minimums, maximums and average concentrations for key parameters for each aquifer, and comparison to the screening criteria.

Detailed presentation and discussion of the baseline groundwater data is provided in the baseline groundwater assessment (SMWSASBT-CPG-SWD-SW000-GE-RPT-040405).

Baseline groundwater quality associated with the chlorinated hydrocarbon contamination from the former dry cleaner at 1- 7 Queen Street, St Marys is detailed in the following reports:

- *Former Dry Cleaner, 1-7 Queen St – Assessment of Human Health Risk and Mitigation Options* report (Tetra Tech Major Projects, 2023 Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040540)
- *St Marys Station Detailed Site Investigation* (Tetra Tech Major Projects, 2023, Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040513).

Table 5-1: Construction details of groundwater monitoring bores able to be sampled for baseline assessment

Well ID	Alternate ID	Monitoring Zone	Date Installed	Aquifer	Easting	Northing	TOC Elevation (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)	Comment
SBT-CM-1022	SBT-GW-1022	St Marys	14-Jul-22	Bedrock	293832.3	6261980.6	34.287	9 - 12	22.3 - 25.3	
SBT-CM-1030	SBT-GW-1030	XPN13 / Tunnel	17-Aug-22	Residual/Bedrock	291923.5	6260911.5	36.807	2 - 6	30.8 - 34.8	
SBT-GW-0001	-	St Marys	NK	Unknown	293910.9	6261970.2	35.21	NK	NK	
SBT-GW-0001B	-	St Marys	4-May-23	Bedrock	293910.9	6261970.2	35.211	8.5 – 14.5	20.7 - 26.7	
SBT-GW-1001	SBT-GW-1001_S	St Marys	6-May-22	Residual/ Bedrock	294435.2	6261848.3	48.827	2 - 8	40.8 - 46.8	
SBT-GW-1002	-	St Marys	15-Aug-22	Residual/ Bedrock	294464.6	6261979.9	42.605	2 - 8	34.6 - 40.6	
SBT-GW-1005	SBT-GW1005_S	St Marys	28-Jul-22	Residual/ Bedrock	294262.4	6261825.2	44.195	2 - 8	36.2 - 42.2	
SBT-GW-1012	-	St Marys	12-Dec-22	Residual/ Bedrock	293930.5	6261971.2	35.361	2.5 - 7.5	27.9 - 32.9	
SBT-GW-1013	-	St Marys	8-Dec-22	Residual/ Bedrock	293931.4	6261964.9	35.398	2.5 - 7.5	27.9 - 32.9	
SBT-GW-1014	-	St Marys	8-Dec-22	Residual/ Bedrock	293931.8	6261959.4	35.471	2.5 - 7.5	27.9 - 32.9	
SBT-GW-1016	-	St Marys	7-Oct-22	Residual/ Bedrock	293905.8	6261847.7	36.122	5 - 10	26.1 - 31.1	
SBT-GW-1017	-	St Marys	27-Sep-22	Residual/ Bedrock	293646.1	6262114.9	32.475	2 - 8	22.5 - 30.5	
SBT-GW-1019R	SBT-GW-1019_r	St Marys	1-Sep-22	Bedrock	293888.3	6261978.7	35.196	13.9 - 18	17.2 - 21.3	
SBT-GW-1020	SBT-CM-1020	St Marys	9-Jun-22	Alluvium	293862.0	6261980.1	34.943	2 - 7	27.9 - 34.9	
SBT-GW-1021	-	St Marys	21-Aug-22	Residual/ Bedrock	293847.8	6262056.4	33.906	2 - 8	25.6 - 31.6	
SBT-GW-1024	-	Claremont Meadows SF	20-May-22	Alluvium/ Bedrock	292108.9	6261303.0	28.506	3 - 12	NK	
SBT-GW-1031	-	XPN14/ Tunnel	4-Aug-22	Bedrock	291872.1	6260654.0	40.808	15 - 20	20.8 - 25.8	

Well ID	Alternate ID	Monitoring Zone	Date Installed	Aquifer	Easting	Northing	TOC Elevation (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)	Comment
SBT-GW-1037	SBT-GW-1037_S	Orchard Hills Station	4-Aug-22	Residual/ Bedrock	291757.7	6259320.6	40.544	2 - 8	32.5 - 38.5	
SBT-GW-1042	-	Orchard Hills Station	17-Jun-22	Alluvium	291874.7	6259123.7	40.069	2 - 8	32.1 - 38.1	
SBT-GW-1043	SBT-GW-1043_S	Orchard Hills Station	8-Aug-22	Alluvium/ Bedrock	291876.5	6259087.8	39.631	2 - 8	31.6 - 37.6	
SBT-GW-1048	-	Orchard Hills Station	12-Aug-22	Alluvium/ Bedrock	291955.6	6259007.4	39.642	2 - 8	31.6 - 37.6	
SBT-GW-1063	-	Orchard Hills Station	30-Sep-22	Alluvium/ Bedrock	292193.5	6258861.3	31.558	2 - 11	20.6 - 29.6	
SBT-GW-1347a	-	St Marys	10-May-23	Alluvial	293953.9	6261962.4	35.734	6 - 9	26.7 - 29.7	
SBT-GW-1347b	-	St Marys	10-May-23	Residual/ Bedrock	293954.9	6261962.8	35.712	12 - 15	20.7 - 23.7	
SBT-GW-1347c	-	St Marys	9-May-23	Bedrock	293954.6	6261962.2	35.74	17 - 20	15.7 - 18.7	
SBT-GW-1348a	-	St Marys	15-May-23	Alluvial	293952.9	6261956.1	35.796	5.5 – 8.5	27.3 - 30.3	
SBT-GW-1348b	-	St Marys	12-May-23	Residual/ Bedrock	293954.0	6261955.9	35.831	11 - 14	21.8 - 24.8	
SBT-GW-1348c	-	St Marys	11-May-23	Bedrock	293953.4	6261957.0	35.848	17 -20	15.8 - 18.8	
SBT-GW-1803		St Marys	27-Mar-23	Bedrock	294375.8	6261850.4	47.649	16.5 - 25.5	22.2 - 31.2	Installed to replace SMGW-BH-A103
SBT-GW-1804		South Creek	26-Aug-23	Residual	292194.9	6261580.1	21.021	3 - 5	16.0 - 19.0	Installed to replace SMGW-BH-A107S
SBT-GW-1805		Claremont Meadows SF	4-Apr-23	Residual	292046.7	6261326.1	27.296	3 - 9	18.3 - 24.3	Installed to replace SMGW-BH-A109S
SBT-GW-1806		Orchard Hills	3-Apr-23	Bedrock	291755.3	6258999.8	42.957	15 - 24	19 - 28	Installed to replace SMGW-BH-A017
SBT-GW-1807		Orchard Hills	3-Mar-23	Bedrock	291901.4	6258843.1	37.479	10 - 16	21.5 - 27.5	Installed to replace SMGW-BH-A117
SBT-GW-1808		Orchard Hills	3-Mar-23	Residual	291902.3	6258845.2	37.455	2 - 5	32.5 - 35.5	Installed to replace SMGW-BH-A117S
SBT-GW-3003-A	SBT-GW-3003	Portal / XPS01	11-Aug-22	Bedrock	290425.6	6248380.7	67.706	2 - 5	62.7 - 65.7	

Well ID	Alternate ID	Monitoring Zone	Date Installed	Aquifer	Easting	Northing	TOC Elevation (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)	Comment
SBT-GW-3003-B	SBT-GW-3004	Portal / XPS01	11-Aug-22	Bedrock	290424.6	6248382.2	67.378	10 - 13	54.4 - 57.4	
SBT-GW-3003-C	SBT-GW-3005	Portal / XPS01	10-Aug-22	Bedrock	290423.4	6248384.0	67.328	19 - 22	45.3 - 48.3	
SBT-GW-3006	SBT-BH-3006, SBT-GW-3006_w	Airport Terminal	29-Jun-22	Bedrock	289368.0	6247844.4	84.305	29 - 35	49.3 - 55.3	
SBT-GW-3012-A	-	Airport Terminal	28-Aug-22	Bedrock	289133.2	6247685.6	83.958	2 - 8	76 - 82	
SBT-GW-3012-B	-	Airport Terminal	28-Aug-22	Bedrock	289134.8	6247682.9	83.9	10 - 16	67.9 - 73.9	
SBT-GW-3012-C	-	Airport Terminal	28-Aug-22	Bedrock	289136.4	6247680.3	83.777	20 - 26	57.8 - 63.8	
SBT-GW-3022	-	Airport Terminal	1-Aug-22	Bedrock	289446.1	6247614.1	77.776	3 - 15	62.8 - 74.8	
SBT-GW-4000	-	Western Sydney Airport	1-Dec-22	Bedrock	289140.5	6246360.3	72.235	2.5 - 13	59.2 - 69.7	Replaced SMGW-BH-C209 for XP monitoring
SBT-GW-4003	-	Bringelly SF	23-Jun-22	Residual/ Bedrock	289518.7	6245851.2	71.932	2 - 7	64.9 - 69.9	
SBT-GW-4005	SBT-BH-4005	Bringelly SF	26-May-22	Bedrock	289666.8	6245749.6	73.613	10 - 20	53.6 - 53.6	
SBT-GW-4008	SBT-BH-4008	Cross passage / Tunnel	2-Nov-22	Bedrock	290230.0	6244991.9	78.269	22 - 28	50.27 - 56.27	
SBT-GW-4010	-	Aerotropolis - Bringelly	3-Jun-22	Bedrock	290427.4	6244758.3	78.779	22 - 28	50.78 - 56.78	Replacement for SMGW-BH-D205
SBT-GW-4014	SBT-GW-4014_S	Aerotropolis Station	1-Aug-22	Residual/ Bedrock	290632.2	6243966.3	73.902	5 - 14	59.9 - 68.9	
SBT-GW-4017	-	Aerotropolis Station	26-May-22	Residual	290805.8	6243870.8	71.334	2 - 12	59.3 - 61.3	Well destroyed. Replacement to be installed
SBT-GW-4019	SBT-BH-4019	Aerotropolis Station	28-Jul-22	Bedrock	290669.6	6243885.0	75.875	20 - 30	45.9 - 55.9	
SBT-GW-4021	-	Aerotropolis Station	26-Aug-22	Alluvium/ Bedrock	291112.5	6243748.0	62.847	2 - 11	51.9 - 60.9	
SBT-GW-4800	-	Bringelly SF	29-Mar-23	Residual/ Bedrock	289626.6	6245830.0	71.432	2 - 7	64.4 - 69.4	Installed to replace SBT-GW-4002

Well ID	Alternate ID	Monitoring Zone	Date Installed	Aquifer	Easting	Northing	TOC Elevation (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)	Comment
SBT-GW-4801	-	Bringelly SF	30-Mar-23	Residual/ Bedrock	289580.1	6245835.6	71.372	4 - 16	55.4- 67.4	Installed to replace SBT-GW-4020
SBT-GW-4802	-	Bringelly SF	30-Mar-23	Bedrock	289583.3	6245761.2	74.348	4 - 16	58.4 - 70.4	Installed to replace SBT-GW-4022
SBT-GW-4803	-	Aerotropolis	28-Mar-23	Bedrock	290647.1	6244147.5	72.657	5 - 11	61.7 - 67.7	Installed to replace SMGW-BH-D310
SMGW-BH-A107	-	TBM Tunnel - South Creek	5-Dec-19	Bedrock	292413.0	6261713.0	22.5	19 - 26	-3.5 - 3.5	
SMGW-BH-A122	-	Claremont Meadows SF	11-Dec-19	Bedrock	291893.0	6260308.0	41.4	25 - 35	6.4 - 16.4	
SMGW-BH-A315	-	Orchard Hills	11-Feb-21	Residual/ Bedrock	291726.6	6258863.8	42.28	4 - 10	32.3 - 38.3	
SMGW-BH-A361	-	St Marys	28-Jun-21	Bedrock	293852.4	6261984.6	34.871	11 - 17	17.9 - 23.9	
SMGW-BH-A401	-	St Marys	6-Oct-21	Residual/ Bedrock	294106.3	6261997.8	36.51	3 - 9	27.5 - 33.5	Replacement for SBT-GW-1008
SMGW-BH-B120	-	Luddenham Road	17-Jan-20	Bedrock	290964.0	6253779.0	52.6	5 - 14	38.6 - 47.6	
SMGW-BH-B123	-	Luddenham Road	22-Jan-20	Bedrock	290939.0	6253035.0	57.2	5 - 14	43.2 - 52.2	
SMGW-BH-B317	-	Orchard Hills	30-Mar-21	Residual/ Bedrock	291440.3	6254935.2	44.23	1.5 - 4.5	39.7 - 42.7	Department of Defence access required
SMGW-BH-B319	-	Orchard Hills	NK	Residual/ Bedrock	291172.9	6254263.9	50.02	1.8 - 4.8	45.2 - 48.2	
SMGW-BH-C320	-	Western Sydney Airport	8-Mar-21	Residual/ Bedrock	289629.3	6246534.9	66.47	3 - 9	57.5 - 63.5	
SMGW-BH-C321	-	Western Sydney Airport	10-Mar-21	Residual/ Bedrock	289808.6	6246630.0	63.45	1.5 - 6	57.4 - 61.9	
SMGW-BH-C324	-	Western Sydney Airport	12-Mar-21	Residual/ Bedrock	289732.8	6246812.8	67.78	4 - 10	57.8 - 63.8	
SMGW-BH-C330	-	Western Sydney Airport	8-Mar-21	Bedrock	289535.1	6246506.5	69.35	3 - 9	60.3 - 66.3	
SMGW-BH-C332	-	Western Sydney Airport	8-Mar-21	Bedrock	289459.4	6247135.2	81.83	4 - 9	72.8 - 77.8	
SMGW-BH-D109S	-	Aerotropolis	2-Apr-20	Bedrock	290715.8	6243821.2	72.4	5.95 - 8.95	63.4 - 66.4	

Well ID	Alternate ID	Monitoring Zone	Date Installed	Aquifer	Easting	Northing	TOC Elevation (mAHD)	Screen Interval (mBGL)	Screen Interval (mAHD)	Comment
SMGW-GW01	GW01, GW-01	St Marys	1-May-19	Residual	293863.6	6261984.7	35.12	4.5 - 7.5	27.6 - 30.6	
SMGW-GW02	GW02, GW-02	St Marys	1-May-19	Residual	293887.3	6261984.0	35.39	5 - 8	27.4 - 30.4	
WSA GW0S	WSA GW05	WSI	NK	Unknown	288574.0	6246161.0	74	5 - 10	64 - 67	
BH207	-	M12	NK	Unknown	292342.0	6251217.0	40	5.9 - 17.9	22.1 - 34.1	
BH209	-	M12	NK	Unknown	292587.0	6251246.0	39.4	0.5 - 18.2	21.2 - 38.9	
MW02	-	Aerotropolis	NK	Unknown	291241.0	6243734.0	61.5	3 - 6	55.5 - 58.5	
MW1	BH1, MW-1	St Marys	NK	Residual	293889.0	6261976.0	NK	4.3 - 7.3	NK	
MWO1	-	Aerotropolis	NK	Unknown	290928.0	6244381.0	68.1	3 - 6	62.1 - 65.1	

Table 5-2: VWPs installed to inform baseline conditions and monitor levels during construction

Location	Well ID	VWP Sensor ID	VWP Installation Date	As-built Easting	As-built Northing	Ground Surface Elevation (mAHD)	VWP Installation Depth (m)	VWP Instrument Elevations (mAHD)	Logger Installed
Aerotropolis	SBT-GW-4014	SWD-TU400-39565-VWP04-A	08/01/2022	290629.58	6243965.78	73.749	26	47.749	Yes
Aerotropolis	SBT-GW-4014	SWD-TU400-39565-VWP04-B	08/01/2022	290629.58	6243965.78	73.749	23	50.749	Yes
Aerotropolis	SBT-VWP-4403	SWD-TU400-39287-VWP01	08/12/2022	290678.80	6244221.52	72.636	15.13	57.506	Yes
Aerotropolis	SBT-VWP-4404	SWD-TU400-39340-VWP02	08/12/2022	290713.24	6244100.06	71.031	15.20	55.831	Yes
Aerotropolis	SBT-VWP-4405	SWD-TU400-39532-VWP03	08/10/2022	290633.34	6244057.27	73.797	18.63	55.167	Yes
Aerotropolis	SBT-VWP-4406	SWD-TU400-39606-VWP05	28/07/2022	290746.98	6243921.43	72.535	28	44.535	Yes
Airport Portal	SBT-VWP-3400	SWD-TU300-33586-VWP01	08/02/2022	290421.72	6248468.38	65.723	15	50.723	Yes
Airport Portal	SBT-VWP-3401	SWD-TU300-33565-VWP02	08/08/2022	290542.13	6248450.48	67.466	15	52.466	Yes
Airport Terminal	ABP-TD300	ABP-TD300-VWP01	29/11/2022	290453.70	6248468.38	62.94	7.84	55.1	Yes
Airport Terminal	ABP-TD300	ABP-TD300-VWP02	29/11/2022	290453.70	6248468.38	62.94	7.84	55.1	Yes
Airport Terminal	ABP-TD300	ABP-TD300-VWP03	29/11/2022	290453.70	6248468.38	62.94	7.84	55.1	Yes
Airport Terminal	ABP-TD300	ABP-TD300-VWP04	29/11/2022	290453.70	6248468.38	62.94	7.84	55.1	Yes
Airport Terminal	ATL-SN350-VWP01	SWD-TU300-34874-VWP03-01	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	ATL-SN350-VWP01	SWD-TU300-34874-VWP03-02	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	ATL-SN350-VWP01	SWD-TU300-34874-VWP03-03	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes

Location	Well ID	VWP Sensor ID	VWP Installation Date	As-built Easting	As-built Northing	Ground Surface Elevation (mAHD)	VWP Installation Depth (m)	VWP Instrument Elevations (mAHD)	Logger Installed
Airport Terminal	ATL-SN350-VWP01	SWD-TU300-34874-VWP03-04	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	ATL-SN350-VWP02	SWD-TU300-34893-VWP04-01	24/11/2022	289287.18	6247775.06	82.5	23.95	60	Yes
Airport Terminal	ATL-SN350-VWP02	SWD-TU300-34893-VWP04-02	24/11/2022	289287.18	6247775.06	82.5	23.95	60	Yes
Airport Terminal	ATL-SN350-VWP02	SWD-TU300-34893-VWP04-03	24/11/2022	289287.18	6247775.06	82.5	23.95	60	Yes
Airport Terminal	ATL-SN350-VWP02	SWD-TU300-34893-VWP04-04	24/11/2022	289287.18	6247775.06	82.5	23.95	60	Yes
Airport Terminal	SBT-VWP-3402	ATL-SN350-VWP01-01	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	SBT-VWP-3402	ATL-SN350-VWP01-02	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	SBT-VWP-3402	ATL-SN350-VWP01-03	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	SBT-VWP-3402	ATL-SN350-VWP01-04	25/11/2022	289293.55	6247837.34	84.6	25.59	60	Yes
Airport Terminal	SBT-VWP-3403	ATL-SN350-VWP02-01	24/11/2022	289287.18	624777.06	82.504	23.95	60	*No*
Airport Terminal	SBT-VWP-3403	ATL-SN350-VWP02-02	24/11/2022	289287.18	624777.06	82.504	23.95	60	*No*
Airport Terminal	SBT-VWP-3403	ATL-SN350-VWP02-03	24/11/2022	289287.18	624777.06	82.504	23.95	60	*No*
Bringelly SF	SBT-VWP-4400	SWD-TU351-37371-VWP04	21/06/2022	289609.96	6245825.35	71.313	21	50.313	Yes
Bringelly SF	SBT-VWP-4401	SWD-TU351-37377-VWP05	16/06/2022	289570.22	6245793.49	73.530	21	52.530	Yes
Bringelly SF	SBT-VWP-4402	SWD-TU351-37471-VWP06	20/06/2022	289666.84	6245755.19	73.516	21	52.516	Yes
Claremont Meadows	SBT-GW-1028	SWD-TU100-20071-VWP07-A	26/05/2022	292050.01	6261167.99	30.813	28	2.813	Yes

Location	Well ID	VWP Sensor ID	VWP Installation Date	As-built Easting	As-built Northing	Ground Surface Elevation (mAHD)	VWP Installation Depth (m)	VWP Instrument Elevations (mAHD)	Logger Installed
Claremont Meadows	SBT-GW-1028	SWD-TU100-20071-VWP07-B	26/05/2022	292050.01	6261167.99	30.813	28	2.813	Yes
Claremont Meadows	SBT-VWP-1402	SWD-TU100-19957-VWP05-01	18/11/2022	292049.66	6261277.91	26.872	20.87	6	Yes
Claremont Meadows	SBT-VWP-1402	SWD-TU100-19957-VWP05-02	18/11/2022	292049.66	6261277.91	26.872	20.87	6	Yes
Claremont Meadows	SBT-VWP-1402	SWD-TU100-19957-VWP05-03	18/11/2022	292049.66	6261277.91	26.872	20.87	6	Yes
Claremont Meadows	SBT-VWP-1403	SWD-TU100-19992-VWP06-01	21/11/2022	292018.33	6261280.67	26.948	20.95	6	Yes
Claremont Meadows	SBT-VWP-1403	SWD-TU100-19992-VWP06-02	21/11/2022	292018.33	6261280.67	26.948	20.95	6	Yes
Claremont Meadows	SBT-VWP-1403	SWD-TU100-19992-VWP06-03	21/11/2022	292018.33	6261280.67	26.948	20.95	6	Yes
Orchard Hills	SBT-GW-1037	SWD-TU150-21965-VWP01-A	08/04/2022	291758.78	6259323.57	39.597	23	16.597	Yes
Orchard Hills	SBT-GW-1037	SWD-TU150-21965-VWP01-B	08/04/2022	291758.78	6259323.57	39.597	23	16.597	Yes
Orchard Hills	SBT-GW-1043	SWD-TU150-22193-VWP05-A	08/09/2022	291875.98	6259094.91	39.499	19	20.499	Yes
Orchard Hills	SBT-GW-1043	SWD-TU150-22193-VWP05-B	08/09/2022	291875.98	6259094.91	39.499	19	20.499	Yes
Orchard Hills	SBT-VWP-1404	SWD-TU150-22010-VWP02	08/05/2022	291860.78	6259289.87	38.810	16	22.810	Yes
Orchard Hills	SBT-VWP-1405	SWD-TU150-22115-VWP03	16/06/2022	291809.07	6259171.24	39.582	16	23.582	Yes
Orchard Hills	SBT-VWP-1406	SWD-TU150-22120-VWP04	19/08/2022	291856.09	6259233.73	36.429	14.5	21.929	Yes
Orchard Hills	SBT-VWP-1407	SWD-TU150-22205-VWP06	08/10/2022	291885.11	6259049.02	40.280	16	24.280	Yes
Orchard Hills	SBT-VWP-1408	SWD-TU150-22333-VWP07	08/11/2022	291819.18	6258954.04	40.795	16	24.795	Yes
St Marys	SBT-GW-1001	SWD-TU100-17275-VWP01-B	05/06/2022	294435.35	6261848.20	49.155	29	20.155	Yes
St Marys	SBT-GW-1001	SWD-TU100-17275-VWP01-A	05/06/2022	294435.35	6261848.20	49.155	29	20.155	Yes

Location	Well ID	VWP Sensor ID	VWP Installation Date	As-built Easting	As-built Northing	Ground Surface Elevation (mAHD)	VWP Installation Depth (m)	VWP Instrument Elevations (mAHD)	Logger Installed
St Marys	SBT-GW-1005	SWD-TU100-17443-VWP03-A	28/07/2022	294262.15	6261823.15	44.557	31	13.557	Yes
St Marys	SBT-GW-1005	SWD-TU100-17443-VWP03-B	28/07/2022	294262.15	6261823.15	44.557	31	13.557	Yes
St Marys	SBT-VWP-1400	SWD-TU100-17351-VWP02	11/04/2022	294366.53	6261901.00	37.671	22.95	14.721	Yes
St Marys	SBT-VWP-1401	SWD-TU100-17720-VWP04	08/05/2022	294001.37	6261933.76	36.407	23	13.407	Yes
XP-S07/ Airport Terminal Temp Shaft	SBT-VWP-3404	SWD-TU351-35209-VWP01	25/01/2023	289022.34	6247666.51	84.630	26.92	58.1	Yes
XP-S07/ Airport Terminal Temp Shaft	SBT-VWP-3405	SWD-TU351-35240-VWP02	25/01/2023	288984.85	6247640.40	84.580	26.78	57.8	Yes

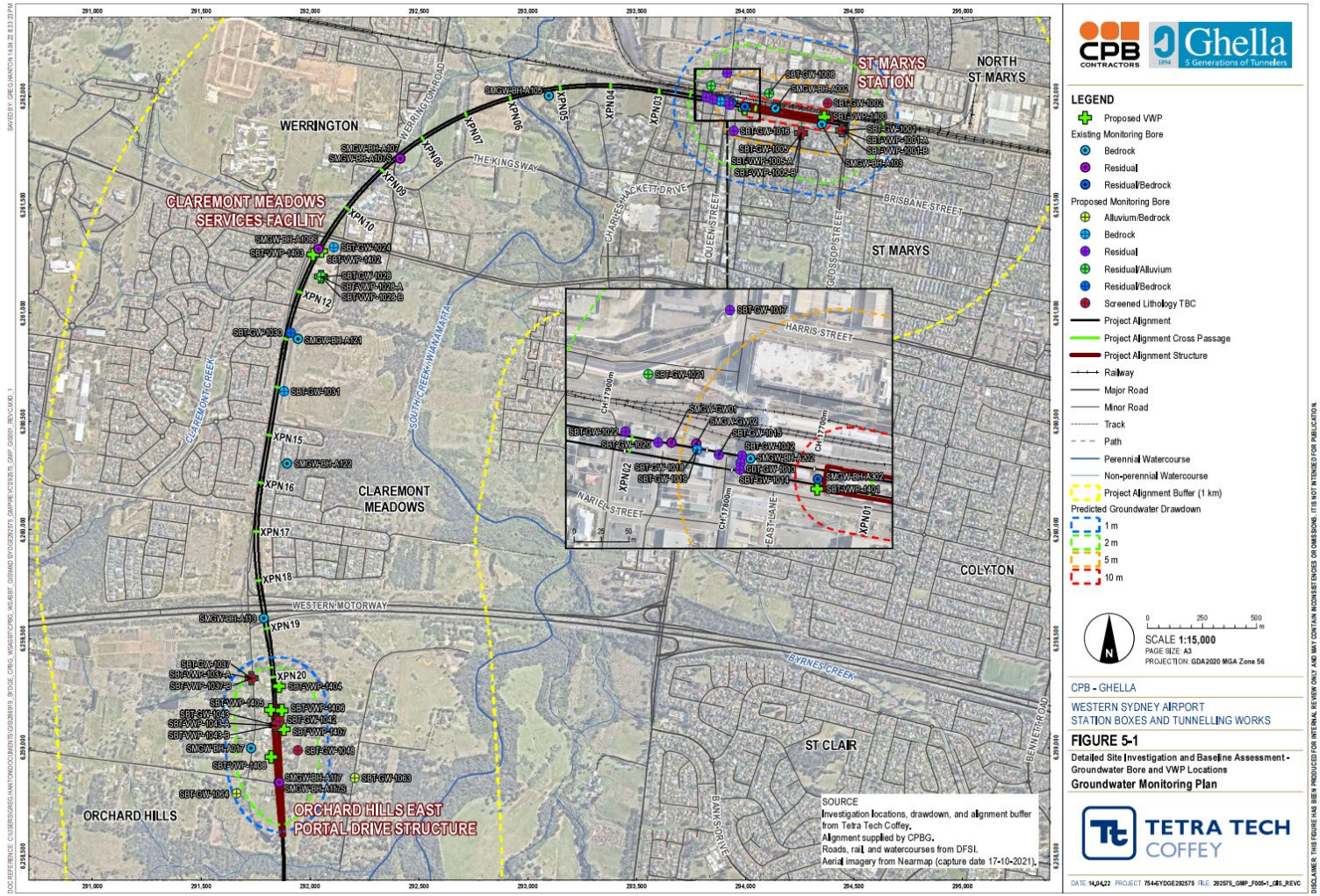


Figure 5-1: Detailed Site Investigation and Baseline Assessment Works – Northern Groundwater Bore and VWP Locations

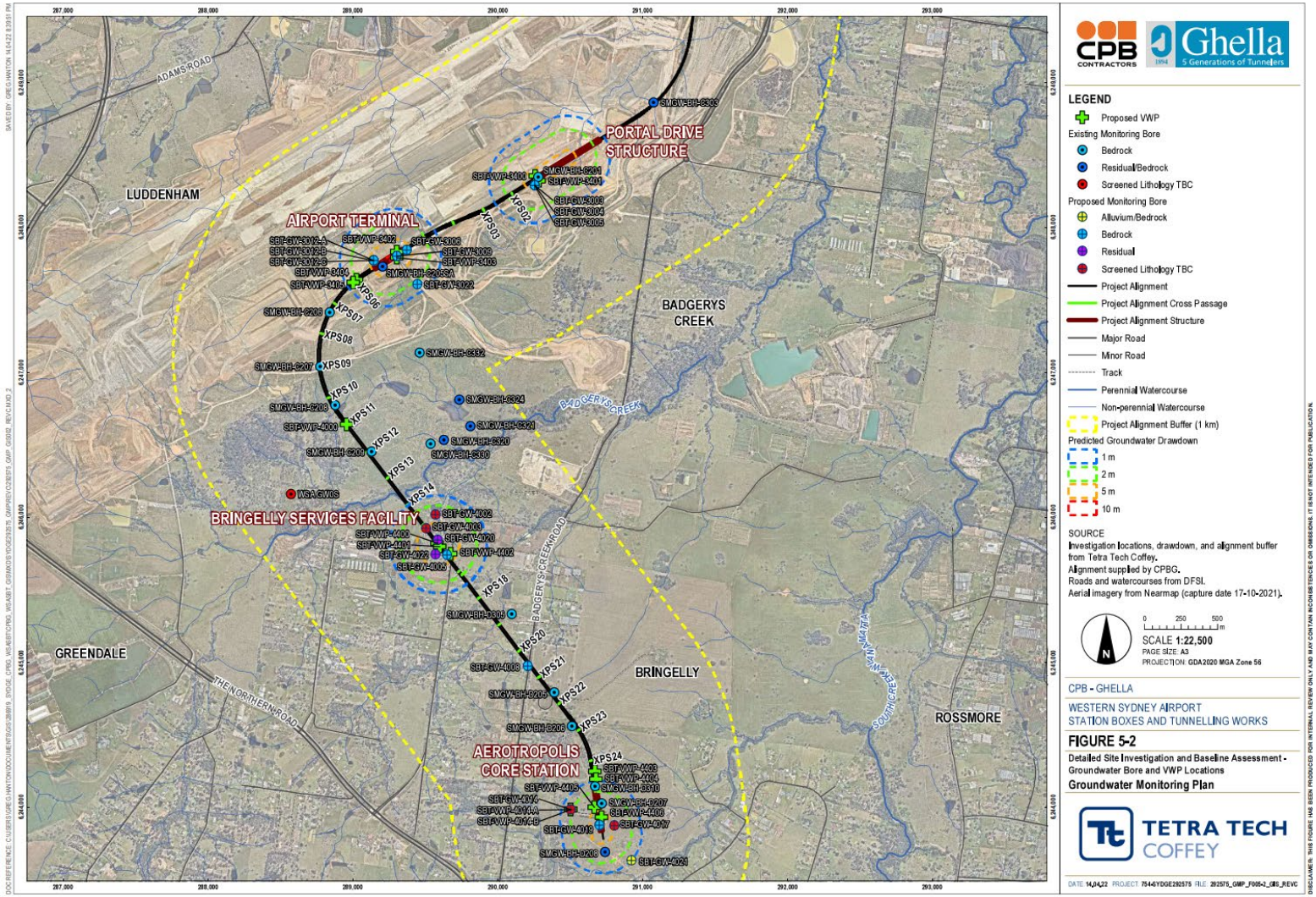


Figure 5-2: Detailed Site Investigation and Baseline Assessment Works – Southern Groundwater Bore and VWP Locations

5.3 GDE monitoring

To address the requirement of Condition C16 (c) for sentinel groundwater monitoring bores, electrical conductivity (EC) and groundwater level data loggers have been installed at 16 locations to continuously monitor conditions during the construction phase.

Levels and EC have been recording hourly since installation, with all data downloaded in August 2023. Level and EC ranges and averages for baseline period for all locations where loggers have been deployed are summarised in Table 5-3. For locations where logger data was not yet available, data ranges based on pre-award and baseline sampling events is instead provided.

Baseline level and EC data indicate that hourly recording of EC and levels during construction is appropriate as it allows diurnal patterns of vegetation water-use to be captured.

Six of the locations are to be monitored to specifically assess potential risks to groundwater dependent ecosystems (GDEs). The baseline data has been used to develop site specific trigger values (SSTVs) to assess conditions during construction. SSTVs, developed by an Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) (CEnvP (SC)), are provided in Table 6-10.

The data review process (Section 8.3) will include comparison of data with groundwater level loggers installed in nearby control locations away from mapped GDEs to identify where changes in levels are due to seasonal variation rather than related to the SBT Works.

Table 5-3: Baseline groundwater EC and levels in GDE monitoring wells

Location	Area	Assumed End of Baseline Conditions	Data date range	Average EC (uS/cm)	Min EC (uS/cm)	Max EC (uS/cm)	Ave Ground water Level mAHD	Min Ground water Level mAHD	Max Ground water Level mAHD	Comment
SMGW-BH-A105S	Cross passages	Pre-TBM	*26/05/2020 - 16/02/2021*	*2,310*	*2,140*	*2,550*	-	-	-	
SMGW-BH-A107	Cross passages	Pre-TBM	1/08/2023 - 4/08/2023	3,749	3,736	3,753	21.2	20.9	21.6	
SBT-GW-1804	Cross passages	Pre-TBM	26/07/2023 - 4/08/2023	3,730	3,727	3,732	18.8	18.7	19.0	Installed to replace SMGW-BH-A107S
SBT-GW-1805	Claremont Meadows	17-03-23	*23/05/2023 – 23/06/2023*	*2,750*	*2,480*	*3,100*	25.1	24.7	25.6	Installed to replace SMGW-BH-A109S
SBT-GW-1028	Claremont Meadows	17-03-23	Unable to access – asbestos exclusion zone							
SBT-GW-1042	Orchard Hills	16-12-22	*23/11/2022 - 13/12/2022*	*12,150*	*11,900*	*12,400*	*37.8*	*37.7*	*37.8*	
SBT-GW-1063	Orchard Hills	16-12-22	21/04/2023 - 4/08/2023	12,502	11,650	13,293	25.6	25.4	25.7	
SMGW-BH-A315	Orchard Hills	16-12-22	14/07/2023 - 4/08/2023	2,157	1,842	2,878	39.4	38.8	40	
SBT-GW-3006	Airport Terminal	01-03-23	*30/11/2022 - 19/01/2023*	*2,420*	*2,340*	*2,510*	*74.3*	*72.9*	*74.6*	
SBT-GW-3003-A	Airport Terminal	01-03-23	9/06/2023 - 4/08/2023	24,846	24,485	25,052	63.5	63.7	63.9	
SBT-GW-3003-B	Airport Terminal	01-03-23	9/06/2023 - 4/08/2023	17,389	1,024	20,281	59	55	63	
SBT-GW-4000	Cross passages	Pre-TBM	14/06/2023 - 4/08/2023	13,148	13,023	13,317	70.7	70.5	70.9	Replacement for SMGW-BH-C209 (change in XP location)
SBT-GW-4010	Aerotropolis	02-03-23	15/05/2023 - 4/08/2023	21,739	20,451	21,868	73.6	73.3	73.8	Installed to replace SMGW-BH-D205

Location	Area	Assumed End of Baseline Conditions	Data date range	Average EC (uS/cm)	Min EC (uS/cm)	Max EC (uS/cm)	Ave Ground water Level mAHD	Min Ground water Level mAHD	Max Ground water Level mAHD	Comment
SBT-GW-4008	Aerotropolis	02-03-23	15/05/2023 - 4/08/2023	17,847	17,416	18,622	72	72	72.2	Replaced SMGW-BH-D305 due to access denied by landowner
SBT-GW-4021	Aerotropolis	02-03-23	*01/12/2022 - 18/01/2023*	*21,700*	*21,400*	*22,000*	*59.9*	*59.8*	*59.9*	

Italics denotes manual data presented.
Purple shading indicates data collected outside baseline conditions but considered to be valid for development of SSTVs.

6 Construction monitoring

Groundwater level and quality monitoring will be carried out at a combination of pre-award and CPBG installed monitoring bores and VWPs. Following the completion of the baseline groundwater assessment (SMWSASBT-CPG-SWD-SW000-GE-RPT-040405), the construction monitoring program detailed in this Section was reviewed and refined in accordance with Section 9.

6.1 Construction Timing

The timing of construction commencement below the water table within each monitoring area is summarised in Table 6-1 and within each cross passage in Table 6-2. As relevant to cross passages, the construction start is based on drilling of weep holes, and completion is based on date when weep holes are grouted.

As the SBT Works are progressively completed, each site and the associated groundwater monitoring network will be transferred to the Stations, Systems, Trains, Operations and Maintenance (SSTOM) contractor. An indicative program for the SBT Works program and the transfer for the groundwater monitoring network is provided in Annexure F. Following formal transfer of each monitoring well, the requirements of this GWMP will no longer be applicable to the respective well.

Table 6-1: Construction phase timing

Monitoring area	Construction below water table
St Marys Station	17 March 2023 (Eastern end of Station box, Zone 1) 22 July 2023 (Western end of Station box, Zone 4)
Claremont Meadows Facility	17 March 2023
Orchard Hills Station	16 December 2022
Airport Portal Dive	14 February 2023
Airport Terminal Station	1 March 2023
Bringelly Services Facility	17 January 2023
Aerotropolis Core Station	2 March 2023
Airport Terminal TBM Shaft	1 May 2023

Table 6-2: Indicative cross passage construction timing

Cross Passage ID	Proposed Date	
	Commenced	Completed
Northern Tunnel		
XP N2	29/03/2024	02/08/2024
XP N3	19/03/2024	13/08/2024
XP N4	08/03/2024	14/07/2024
XP N5	26/02/2024	15/06/2024
XP N6	15/02/2024	08/08/2024
XP N7	22/01/2024	20/05/2024
XP N8	20/01/2024	30/05/2024
XP N9	16/01/2024	11/05/2024
XP N10	04/01/2024	17/04/2024
XP N11	09/12/2023	11/04/2024

Cross Passage ID	Proposed Date	
	Commenced	Completed
XP N12	*Claremont Meadows Service Facility*	
XP N13	18/11/2023	09/03/2024
XP N14	12/11/2023	28/02/2024
XP N15	05/11/2023	15/03/2024
XP N16	29/10/2023	29/02/2024
XP N17	24/10/2023	19/02/2024
XP N18	16/10/2023	24/02/2024
XP N19	08/10/2023	10/02/2024
XP N20	30/09/2023	17/01/2024
XP N21	22/09/2023	26/01/2024
Southern Tunnel		
XP S2	17/06/2023	27/11/2023
XP S3	04/07/2023	15/01/2024
XP S4	17/08/2023	14/12/2023
XP S5	26/09/2023	13/02/2024
XP S6	20/09/2023	13/02/2024
XP S7	*Airport Terminal Shaft*	
XP S8	02/11/2023	19/03/2024
XP S9	10/11/2023	19/03/2024
XP S10	29/11/2023	16/04/2024
XP S11	07/12/2023	16/04/2024
XP S12	08/01/2024	10/05/2024
XP S13	15/01/2024	10/05/2024
XP S14	09/02/2024	04/06/2024
XP S15	12/02/2024	04/06/2024
XP S16	*Bringelly Service Facility*	
XP S17	07/03/2024	03/07/2024
XP S18	08/03/2024	09/08/2024
XP S19	08/04/2024	30/07/2024
XP S20	11/04/2024	04/09/2024
XP S21	07/05/2024	26/08/2024
XP S22	27/05/2024	01/10/2024
XP S23	31/05/2024	20/09/2024

6.2 Groundwater level monitoring

Groundwater levels during construction will be monitored predominantly through VWPs as listed in Table 5-2, with the methodology and data reporting detailed in Section 7.2. VWP locations included in the construction monitoring program are shown on Figures A1 – A7, Annexure A.

Levels in groundwater monitoring bores will also be measured prior to water quality sampling (six monthly, refer Section 6.2) or monthly gauging and downloading of loggers to assess GDEs and salinity (Section 6.4).

Note that due to access issues, groundwater levels during construction of XPS18 to XPS22 will be monitored using a combination of existing monitoring wells within 250m of cross passages and monitoring well SBT-GW-4008 on Badgerys Creek Road. Monitoring will be supported by modelling to assess the likely influence of construction drawdown, and comparison to similar lithologies elsewhere along the alignment where the effects of cross passage construction can be measured close to the construction area.

The adequacy of the monitoring network will also be reviewed and revised (as required) if the modelled extent of drawdown is significantly changed due to the design changes.

6.2.1 Groundwater level – performance criteria

To manage potential impacts associated with drawdown propagation during construction, trigger levels have been developed based on the modelled response (Table 6-4).

The project groundwater model has been used to define the trigger levels during construction, with actual groundwater level responses to be assessed against the predicted water levels, and trigger values assessed / revised where required.

Early observation of groundwater level response to construction is important in understanding and predicting the longer-term response, and these trigger levels may be refined as construction progresses and the groundwater response to excavation is better understood.

A traffic light system will be adopted based on baseline groundwater conditions and anticipated groundwater level drawdown from the works, with Table 6-3 summarising proposed actions when the specific trigger level is activated.

Table 6-3: Traffic light trigger level system

Trigger level	Action
Green	• Groundwater levels observed are within the target / green trigger level range and require no additional action
Amber	• Investigate the possible reason for the drawdown or drawdown trend • Consider an increase in monitoring frequency to confirm trend • Check instrumentation and monitoring equipment • Consider the need for mitigation (i.e. targeted recharge) where drawdown is not found to be a seasonal variation, and is identified to be due to Project activities
Red	• Investigate the possible reason for the drawdown or drawdown trend • Increase monitoring frequency to confirm trend • Change groundwater level management where trend is deemed to be a function of the Project activities; may include implementation of localised recharge or other hydraulic control

Table 6-4: Groundwater trigger levels and limits

Area	Location ID	Monitoring bore screen or VWP sensor elevation (m AHD)	Pre-development groundwater level range (mAHD)	Trigger levels based on anticipated groundwater level at completion of excavation and tunnelling		
				Green Trigger Level (m AHD)	Amber Trigger Level (m AHD)	Red Trigger Level (m AHD)
St Marys	SWD-TU100-17275-VWP01-A	15.15	42 to 43.3	35.0	34.5	34.0
St Marys	SWD-TU100-17275-VWP01-B	20.15	42 to 43.3	35.0	34.5	34.0
St Marys	SWD-TU100-17443-VWP03-A	13.56	26.6 to 32.8	19.9	19.4	18.9
St Marys	SWD-TU100-17443-VWP03-B	18.56	28 to 34	21.3	20.8	20.3
St Marys	SWD-TU100-17720-VWP04	13.41	31.7 to 32	(Note 1)		
TBM Tunnel - South Creek	SMGW-BH-A105S	14.6 to 20.6	19 to 19.8	18.9	18.4	17.9
TBM Tunnel - South Creek	SMGW-BH-A107	-4.44 to 3.46	20.9 to 21.6	20.8	20.3	19.8
TBM Tunnel - South Creek	SBT-GW-1804	16.0 to 19.0	18.7 to 19	18.5	18.0	17.5
Claremont Meadows SF	SBT-GW-1805	18.3 to 24.3	24.7 to 25.6	21.5	21.0	20.5
Claremont Meadows	SWD-TU100-19992-VWP06-01	5.998	20.2 to 25	(Note 1)		
Claremont Meadows	SWD-TU100-19992-VWP06-02	11	20.2 to 25	(Note 1)		
Claremont Meadows	SWD-TU100-19992-VWP06-03	17.5	20.6 to 25	(Note 1)		
Claremont Meadows	SWD-TU100-20071-VWP07-A	2.813	26.9 to 27	25.4	24.9	24.4
Claremont Meadows	SWD-TU100-20071-VWP07-B	7.813	27.1 to 27.3	25.6	25.1	24.6
Claremont Meadows	SBT-GW-1028	22.5 to 27.5	26.7 to 26.5	25.2	24.7	24.2
Orchard Hills	SWD-TU150-21965-VWP01-A	16.6	37.8 to 38.5	36.0	35.5	35.0
Orchard Hills	SWD-TU150-21965-VWP01-B	21.6	36.8 to 37.5	35.0	34.5	34.0
Orchard Hills	SWD-TU150-22010-VWP02	22.81	33.8 to 35.3	30.5	30.0	29.5
Orchard Hills	SWD-TU150-22115-VWP03	23.58	35.2 to 37.6	(Note 1)		
Orchard Hills	SBT-GW-1042	32.1 to 38.1	37.7 to 37.8	33.5	33.0	32.5
Orchard Hills	SWD-TU150-22193-VWP05-A	20.499	33.7 to 34.9	(Note 1)		
Orchard Hills	SWD-TU150-22193-VWP05-B	25.499	34.5 to 35.7	(Note 1)		

Area	Location ID	Monitoring bore screen or VWP sensor elevation (m AHD)	Pre-development groundwater level range (mAHD)	Trigger levels based on anticipated groundwater level at completion of excavation and tunnelling		
				Green Trigger Level (m AHD)	Amber Trigger Level (m AHD)	Red Trigger Level (m AHD)
Orchard Hills	SWD-TU150-22205-VWP06	24.28	32.5 to 35	(Note 1)		
Orchard Hills	SWD-TU150-22333-VWP07	24.795	35.5 to 37.3	(Note 1)		
Orchard Hills	SMGW-BH-A315	32.3 to 38.3	38.8 to 40	37.4	36.9	36.4
Orchard Hills	SBT-GW-1063	20.6 to 29.6	25.4 to 25.7	24.8	24.3	23.8
Airport Portal	SWD-TU300-33565-VWP02	52.466	55.2 to 64	50.3	49.8	49.3
Airport Terminal	ABP-TD300-VWP03	56.296	60 to 62.2	(Note 1)		
Airport Terminal	ABP-TD300-VWP02	56.277	59.8 to 61.7	(Note 1)		
Airport Terminal	ABP-TD300-VWP01	55.1	59.3 to 62.9	(Note 1)		
Airport Terminal	ABP-TD300-VWP04	55.123	60.5 to 62.7	(Note 1)		
Portal / Cross passage XPS01	SBT-GW-3003-A	62.7 to 65.7	63.7 to 63.9	60.0	59.5	59.0
Portal / Cross passage XPS01	SBT-GW-3003-B	54.4 to 57.4	55 to 63	51.3	50.8	50.3
Portal / Cross passage XPS01	SBT-GW-3003-C	45.3 to 48.3	59.4 to 59.6	55.7	55.2	54.7
Airport Terminal	SBT-GW-3006	49.3 to 55.3	72.9 to 74.6	65.0	64.5	64.0
Airport Terminal	ATL-SN350-VWP01-01	60	69.2 to 75	56.9	56.4	55.9
Airport Terminal	ATL-SN350-VWP01-02	64	69.1 to 75.1	56.8	56.3	55.8
Airport Terminal	ATL-SN350-VWP01-03	67.999	69.1 to 75.1	56.8	56.3	55.8
Airport Terminal	ATL-SN350-VWP01-04	72.998	73 to 74.1	60.7	60.2	59.7
Airport Terminal	SWD-TU300-34874-VWP03-01	60	74.2 to 74.6	(Note 1)		
Airport Terminal	SWD-TU300-34874-VWP03-02	64	74.2 to 74.6	(Note 1)		
Airport Terminal	SWD-TU300-34874-VWP03-03	68	74.4 to 74.6	(Note 1)		
Airport Terminal	SWD-TU300-34874-VWP03-04	73	74.8 to 75.2	(Note 1)		
Airport Terminal	SWD-TU300-34893-VWP04-04	73	74 to 74.7	62.6	62.1	61.6
Airport Terminal	SWD-TU300-34893-VWP04-01	60	72.7 to 73.7	61.3	60.8	60.3

Area	Location ID	Monitoring bore screen or VWP sensor elevation (m AHD)	Pre-development groundwater level range (mAHD)	Trigger levels based on anticipated groundwater level at completion of excavation and tunnelling		
				Green Trigger Level (m AHD)	Amber Trigger Level (m AHD)	Red Trigger Level (m AHD)
Airport Terminal	SWD-TU300-34893-VWP04-02	64	72.7 to 73.7	61.3	60.8	60.3
Airport Terminal	SWD-TU300-34893-VWP04-03	68	73 to 73.8	61.6	61.1	60.6
Airport Terminal Temp Shaft	SWD-TU351-35209-VWP01	58.1	77 to 78.1	(Note 1)		
Airport Terminal Temp Shaft	SWD-TU351-35240-VWP02	57.8	77.1 to 77.8	(Note 1)		
Western Sydney Airport	SBT-GW-4000	59.2 to 69.7	70.5 to 70.9	70.5	70.0	69.5
Bringelly SF	SWD-TU351-37371-VWP04	50.313	62.5 to 67.1	50.6	50.1	49.6
Bringelly SF	SWD-TU351-37377-VWP05	52.53	64.5 to 67.2	56.0	55.5	55.0
Bringelly SF	SWD-TU351-37471-VWP06	52.516	67.6 to 68	62.5	62.0	61.5
Aerotropolis	SBT-GW-4008	50.3 to 56.3	72 to 72.2	71.8	71.3	70.8
Aerotropolis	SBT-GW-4010	62 to 68	73.3 to 73.8	73.0	72.5	72.0
Aerotropolis	SWD-TU400-39287-VWP01	57.506	67 to 67.6	60.3	59.8	59.3
Aerotropolis	SWD-TU400-39340-VWP02	55.831	65.6 to 66.8	55.6	55.1	54.6
Aerotropolis	AEC-SN450-EW-VWP07	51.75	66 to 66.1	55	54.5	54
Aerotropolis	SBT-GW-4021	51.9 to 60.9	59.8 to 59.9	58.6	58.1	57.6

Notes: (1) Purpose of monitoring asset is wall design where drawdown is not the critical design case.

6.3 Groundwater quality monitoring

6.3.1 St Marys – Mitigation system monitoring

Significant chlorinated hydrocarbon contamination in groundwater has been identified beneath the former dry cleaner at 1-7 Queen Street, St Marys. This contamination has been investigated and measures have been implemented to mitigate potential construction related risks and adverse changes in risk profile due to station excavation related drawdown.

Mitigation, management and construction monitoring measures are detailed in:

- *St Marys Station - Remedial Action Plan* (Tetra Tech Major Projects, 2023, SMWSASBT-CPG-SWD-SW000-GE-RPT-040521)
- *St Marys Station – Implementation of Permeable Reactive Barrier* (Tetra Tech Major Projects, 2023, SMWSASBT-CPG-SWD-SW000-GE-RPT-040561.
- *St Marys Station Remedial Action Plan - Proposed revision to mitigation groundwater sampling frequency* (Tetra Tech Major Projects, 2024, SMWSASBT-CPG-SWD-SW000-GE-MEM-040402)
- *St Marys Station Remedial Action Plan - Proposed revision to mitigation groundwater monitoring network* (Tetra Tech Major Projects, 2024, SMWSASBT-CPG-SWD-SW000-GE-MEM-040403)
- Off-Airport Sydney Metro Western Sydney Airport Construction Soil and Water Management Plan.

In summary, a permeable reactive barrier (PRB) has been installed to mitigate the potential risk of construction related drawdown mobilising chlorinated hydrocarbon impact in groundwater to the west of St Marys Station.

Given the potential for unacceptable inhalation or direct contact risk, a targeted groundwater monitoring and mitigation approach has been applied, to allow for contingency mitigation to be implemented if required before an unacceptable exposure occurs.

A PRB mitigation monitoring program as detailed in the RAP was implemented by CPB Ghella Joint Venture (CPBG) with weekly monitoring from 30 June 2023. In December 2023, after six months of weekly monitoring, the frequency of monitoring was reviewed and amended to fortnightly, as the groundwater gradient in the vicinity of the former dry cleaner had not changed, and chlorinated hydrocarbon concentrations in all monitoring wells were below the level of reporting (LOR). The change in sampling frequency, was agreed to by the auditor on 21 December 2023, and Sydney Metro on 22 December 2023.

In addition to monitoring for potential contaminant mobilisation, a weekly monitoring program has been implemented on behalf of Sydney Metro to assess conditions in the vicinity of the source area when the TBMs pass through the area.

The TBM monitoring includes weekly sampling of groundwater in the vicinity of the former dry cleaner at 1-7 Queen Street. The monitoring is to start four weeks before TBM-1 passes through the suspected source area (starting 12 April 2024), and continue until four weeks after TBM-2 passes through in mid to late June 2024. The program nominally consists of 16 weekly monitoring events.

The TBMs are pressurised, therefore PRB mitigation monitoring wells within 3m of the tunnels required decommissioning prior to the TBMs passing through the area, as the wells potentially provided a pathway to the surface which would result in depressurisation.

With the decommissioning of monitoring wells prior to the TBM passing through the area, a revised mitigation monitoring program will be implemented (Table 6-5). In addition to sampling and analysing for chlorinated hydrocarbons, groundwater levels in key wells will be used to assess hydraulic gradients between the source area and the Station excavation:

- MW1 to SBT-GW-0001 – hydraulic gradient across the source area
- SBT-GW-0001 to SBT-GW-1347a – hydraulic gradient from the PRB to station box excavation (shallow)
- SBT-GW-0001 to SBT-GW-1347c – hydraulic gradient from the PRB to station box excavation (deep)

Table 6-5: Mitigation groundwater monitoring – St Marys

Monitoring Well	Monitoring frequency	Analytes	Comment
SBT-GW-1347a	Fortnightly	Volatile chlorinated hydrocarbons	Shallow well downgradient of PRB
SBT-GW-1347c			Deep well downgradient of PRB
SBT-GW-0001			Shallow well upgradient of PRB and downgradient of suspected source area
SBT-GW-0001b			Mid-level well upgradient of PRB and downgradient of suspected source area
MW1	Weekly until end of July 2024		Shallow well in vicinity of source
MW2			Shallow (impacted) well to north of source area
SMGW-GW02			Shallow (impacted) well to south of source area

The first nine months of monitoring indicate that the extent of drawdown may be less than conservatively predicted, and construction activities have not yet influenced the groundwater flow direction in the source area. conditions indicate that any change in groundwater flow direction, and mobilisation of contamination, will be slow (in the order of months or years).

If detectable concentrations of chlorinated hydrocarbons are reported in SBT-GW-0001, the risk profile will be assessed, and additional measures will be put in place if required.

6.3.2 Alignment wide groundwater quality monitoring

Groundwater quality monitoring during construction will be undertaken using a combination of pre- and post-award groundwater monitoring bores. The construction monitoring program has been reviewed and refined following completion of the baseline assessment.

The frequency of water quality monitoring along the alignment is six monthly, and monthly during cross passage construction. Monthly monitoring during cross passage construction will commence one month prior to cross passage construction and continue until one month after cross passage construction.

The analytical suites for construction monitoring for groundwater quality are provided in Table 6-6.

Table 6-6: Construction Monitoring – Analytical Suites

Program	Analysis suites
Construction Monitoring – Base Analytical Suite	General indicators (pH, EC, TDS)
	Total organic carbon
	Major cations (calcium, magnesium, sodium, potassium)

Program	Analysis suites
	Major anions (chloride, sulphate) and speciated alkalinity (bicarbonate, carbonate, hydroxide)
	Dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc) and total metals (aluminium, cobalt, iron, manganese)
	Nutrients (ammonia, nitrate, nitrite, total kjeldahl nitrogen, total nitrogen, total phosphorous, reactive phosphorous)
Additional analytes – included for select wells where compounds were detected and/or exceeded adopted criteria in the Baseline Assessment	Total Recoverable Hydrocarbons (TRH)
	Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene (BTEXN)
	Volatile Organic Compounds (VOCs)
	Phenols
	Per- and Polyfluoroalkyl Substances (PFAS) (short suite)

The revised construction groundwater monitoring program is provided in Table 6-7, with well details; co-ordinates, screen intervals and rationale for inclusion, provided in Table A1, Annexure D. Bore locations for construction water quality monitoring are shown on Figure 6-1 to Figure 6-4.

Table 6-7: Construction water quality monitoring wells – frequency, water quality analysis and level/EC monitoring

Location ID [1]	Monitoring Zone	Aquifer	TOC mAHD	Water quality sampling frequency	Base analytical Suite	Additional analytes
SBT-GW-1001	St Marys	Residual/ Bedrock	48.8	Six Monthly	✓	
SBT-GW-1002	St Marys	Residual/ Bedrock	42.6	Six Monthly	✓	
SBT-GW-1005	St Marys	Residual/ Bedrock	44.2	Six Monthly	✓	
SBT-GW-1016	St Marys	Residual/ Bedrock	36.1	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-1017	St Marys	Residual/ Bedrock	32.5	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-1019R[3]	St Marys	Bedrock	35.2	Six Monthly	✓	VOCs, PFAS
SBT-GW-1021	St Marys	Residual/ Bedrock	33.9	Six Monthly	✓	Phenols
SMGW-BH-A360	St Marys	Bedrock	33.3	As required [2]	✓	TBD[4]
SBT-GW-1803	St Marys	Bedrock	47.6	Six Monthly	✓	
SMGW-BH-A401	St Marys	Residual/Bedrock	36.5	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-1804	TBM Tunnel - South Creek	Residual	21	As required [2]	✓	
SMGW-BH-A107	TBM Tunnel - South Creek	Bedrock	22.5	As required [2]	✓	
SBT-GW-1030	Cross passage / Tunnel (XPN13)	Residual/Bedrock	36.8	As required [2]	✓	PFAS
SBT-GW-1031	Cross passage / Tunnel (XPN14)	Bedrock	40.8	As required [2]	✓	
SBT-GW-1024	Claremont Meadows SF	Alluvium/Bedrock	28.5	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-1805	Claremont Meadows SF	Residual	27.3	Six Monthly	✓	
SBT-GW-1806	Orchard Hills	Bedrock	43	Six Monthly	✓	TRH/BTEXN
SBT-GW-1807	Orchard Hills	Bedrock	37.5	Six Monthly	✓	
SBT-GW-1808	Orchard Hills	Residual	37.5	Six Monthly	✓	
SMGW-BH-A315	Orchard Hills	Residual/Bedrock	42.3	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-1042	Orchard Hills	Alluvium	40.1	Six Monthly	✓	
SBT-GW-1048	Orchard Hills	Alluvium/Bedrock	39.6	Six Monthly	✓	

Location ID [1]	Monitoring Zone	Aquifer	TOC mAHD	Water quality sampling frequency	Base analytical Suite	Additional analytes
SBT-GW-3003-A	Portal / Cross passage XPS01	Bedrock	67.7	Six Monthly	✓	
SBT-GW-3003-B	Portal / Cross passage XPS01	Bedrock	67.4	Six Monthly	✓	
SBT-GW-3003-C	Portal / Cross passage XPS01	Bedrock	67.3	Six Monthly	✓	
SBT-GW-3006	Airport Terminal	Bedrock	84.3	Six monthly	✓	
SBT-GW-3012-A	Airport Terminal	Bedrock	84	Six Monthly	✓	
SBT-GW-3012-B	Airport Terminal	Bedrock	83.9	Six Monthly	✓	TRH
SBT-GW-3012-C	Airport Terminal	Bedrock	83.8	Six Monthly	✓	
SBT-GW-3022	Airport Terminal	Bedrock	77.8	Six Monthly	✓	TRH
SBT-GW-4000	Western Sydney Airport	Bedrock	72.2	As required [2]	✓	TRH/BTEXN
SMGW-BH-C320	Western Sydney Airport	Residual/Bedrock	66.5	Six Monthly	✓	TRH/BTEXN, PFAS
SMGW-BH-C321	Western Sydney Airport	Residual/Bedrock	63.5	Six Monthly	✓	
SMGW-BH-C330	Western Sydney Airport	Bedrock	69.4	Six Monthly	✓	
SBT-GW-4003	Bringelly SF	Residual/Bedrock	71.9	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-4005	Bringelly SF	Bedrock	73.6	Six Monthly	✓	
SBT-GW-4800	Bringelly SF	Residual/ Bedrock	71.432	Six Monthly	✓	
SBT-GW-4801	Bringelly SF	Residual/ Bedrock	71.372	Six Monthly	✓	
SBT-GW-4802	Bringelly SF	Bedrock	74.348	Six Monthly	✓	
SBT-GW-4008	Aerotropolis	Bedrock	78.3	As required [2]	✓	
SBT-GW-4010	Aerotropolis	Bedrock	78.8	As required [2]	✓	
SBT-GW-4014	Aerotropolis	Residual/Bedrock	73.9	Six Monthly	✓	PFAS
SBT-GW-4017	Aerotropolis	Residual	71.3	Six Monthly	✓	TRH/BTEXN, PFAS
SBT-GW-4021	Aerotropolis	Alluvium/Bedrock	62.8	Six Monthly	✓	
SBT-GW-4803	Aerotropolis	Bedrock	72.7	Six Monthly	✓	

Note: *Italic* denotes bore detail unknown as not installed by CPBG

1. Alternate well IDs listed in Table 5-1
2. Monthly sampling during cross passage construction – refer Table 6.2 for monitoring period
3. Well decommissioned April 2024 due to being located within 3m of the northern tunnel alignment. No replacement warranted.
4. Existing well SMGW-BH-A360 to replace SBT-GW-1022 for monitoring during cross-passage construction. As there is no baseline water quality data, first sample undertaken will be analysed for full analytical suite. Analytical suite for subsequent monitoring will be determined by a suitably qualified person based on previous sampling results.

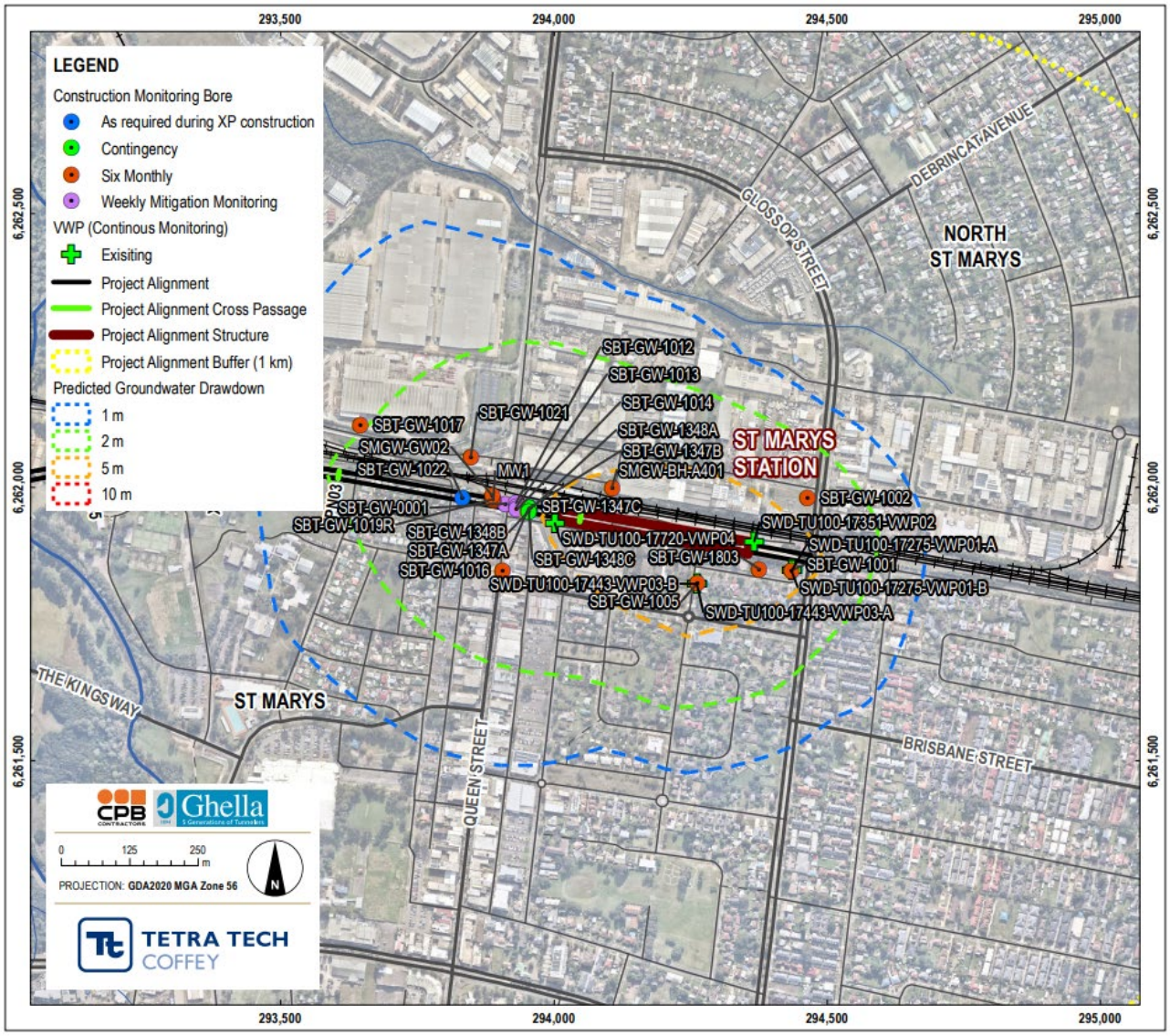


Figure 6-1: Construction groundwater monitoring program – St Marys Station

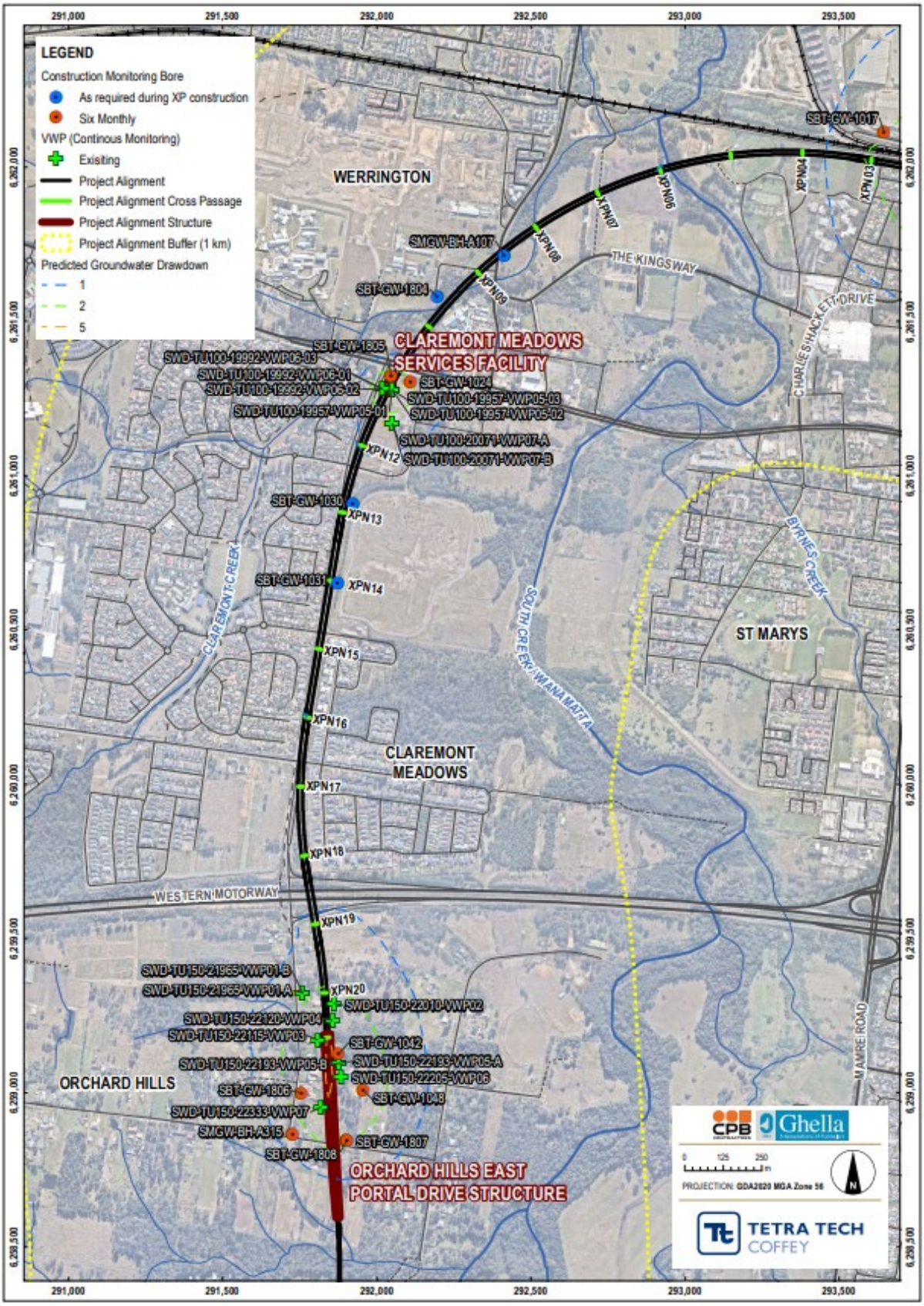


Figure 6-2: Construction groundwater monitoring program – South Creek to Orchard Hills Station

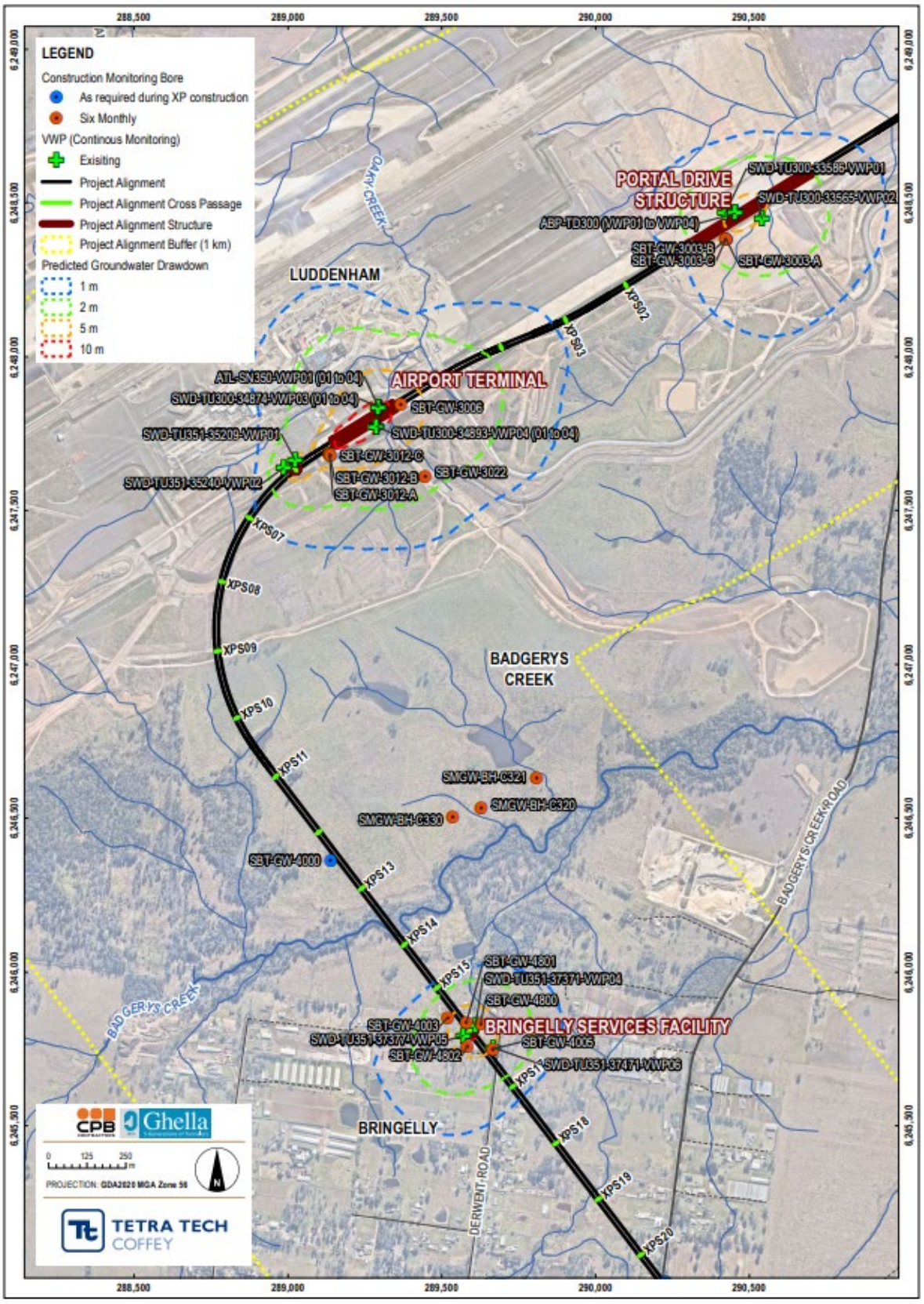

LEGEND
Construction Monitoring Bore
As required during XP construction
Six Monthly
VWP (Continous Monitoring)
Exisiting
Project Alignment
Project Alignment Cross Passage
Project Alignment Structure
Project Alignment Buffer (1 km)
Predicted Groundwater Drawdown
1 m
2 m
5 m
10 m
PORTAL DRIVE STRUCTURE
AIRPORT TERMINAL
LUDDENHAM
BADGERYS CREEK
BRINGELLY
BRINGELLY SERVICES FACILITY
SWD-TU300-33586-VWP01
SWD-TU300-33565-VWP02
ABP-TD300 (VWP01 to VWP04)
SBT-GW-3003-B
SBT-GW-3003-C
SBT-GW-3003-A
ATL-SW350-VWP01 (01 to 04)
SWD-TU300-34374-VWP03 (01 to 04)
SBT-GW-3006
SWD-TU300-34393-VWP04 (01 to 04)
SWD-TU351-35209-VWP01
SBT-GW-3012-C
SBT-GW-3012-B
SBT-GW-3022
SBT-GW-3012-A
SWD-TU351-35240-VWP02
SMGW-BH-C321
SMGW-BH-C320
SMGW-BH-C330
SBT-GW-4000
SBT-GW-4001
SWD-TU351-37371-VWP04
SBT-GW-4000
SBT-GW-4003
SWD-TU351-37372-VWP05
SBT-GW-4002
SBT-GW-4005
SWD-TU351-37471-VWP06
XPS02
XPS03
XPS07
XPS08
XPS09
XPS10
XPS11
XPS13
XPS14
XPS15
XPS17
XPS18
XPS19
XPS20
BADGERYS CREEK ROAD
DERWENT ROAD
PROJECTION: GDA2020 MGA Zone 56
TETRA TECH COFFEY

Figure 6-3: Construction groundwater monitoring program – WSI and Bringelly Services Facility

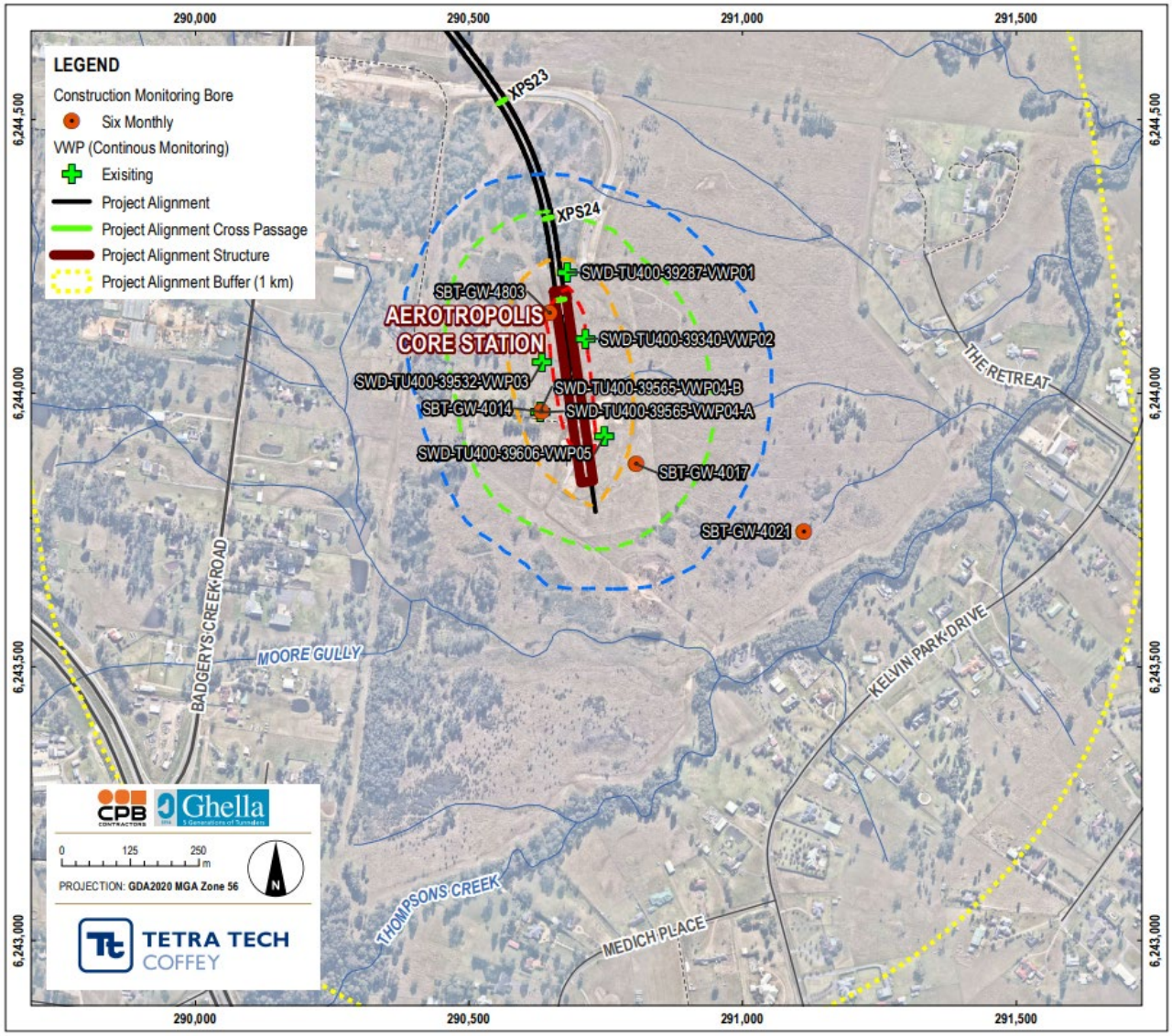


Figure 6-4: Construction groundwater monitoring program – Aerotropolis Core Station

The frequency of sampling and analysis required has been reviewed based on data from the baseline assessment. Six monthly groundwater sampling events for the construction monitoring bore network is considered sufficient as the timing for changes in water quality is expected to be greater than six months, and no contamination requiring active management has been identified with the exception of the former dry cleaner at 1-7 Queen St.

The groundwater monitoring network and program will be refined during construction based on the observed groundwater responses to construction activities and ongoing development and recalibration of the groundwater model.

The construction groundwater monitoring program is considered to be suitable for identification of potential groundwater quality issues as bores have been targeted along the alignment where model predicted drawdown has been identified.

6.3.3 Groundwater quality performance criteria

The baseline data indicates that some groundwater quality parameters exceed initial screening criteria based on:

- ANZECC/ARMCANZ 2000 relevant physical and chemical stressors
- ANZG (2018) 95% species protection criteria for freshwater water, with criteria for toxicants known to bioaccumulate assessed based on the 99% species protection criteria
- PFAS National Environmental Management Plan (NEMP 2.0) 99% species protection values
- Australian Standard AS2159 – 2009 Piling design and installation have also been considered to assess potential groundwater aggressivity risks posed by groundwater to underground concrete and steel structures (discussed in Section 21.2 of the HIR).
- Discharge concentration limits negotiated with EPA as detailed in L2.4 of Environmental Licence (EPL 21672, amended 9 February 2023)
- *Airports (Environment Protection) Regulations 1997* (AEPR) guidelines (on-airport locations only).

Site-specific groundwater quality action triggers have been developed for select locations where baseline assessment identified groundwater contamination may be within the area predicted to be influenced by construction related drawdown, and either:

- Above detect for TPH or PFAS, or
- 10 x EPL for contaminants of potential concern (CoPC) which typically exceed the EPL along the alignment (i.e aluminium, cadmium, copper, zinc, total nitrogen and total phosphorus).

Site specific triggers are based on detection of CoPC concentration above the baseline maximum, with metal action triggers relating to filtered metal concentrations.

This approach acknowledges that existing groundwater conditions exceed the EPL limits for a number of parameters along the alignment. Any adverse change in risk will therefore likely to be due to where high concentrations already exist, and have been reported in the baseline assessment, with the intent of the triggers to identify where conditions have changed.

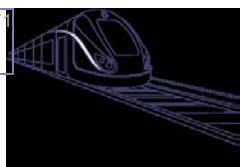
For sentinel wells, and for CoPCs where baseline concentrations are less than 10 x the EPL limits, but exceed the initial screening criteria, a potential adverse change in conditions will be identified by statistical trend assessment (Mann Kendall Statistic), rather than via well and analyte specific action triggers. As trend analysis requires a minimum of four values, and many construction sampling locations have three or less baseline values, the trend analysis will be undertaken using the two most recent values from the baseline assessment, and construction monitoring phase data.

Where a statistically increasing trend is reported, the baseline data range will be reviewed, and a trigger reported if the construction monitoring concentration is greater than 250% of the maximum historical concentration.

Where a trigger is exceeded, or a statistically increasing trend is identified for a CoPC and concentrations exceed the initial screening criteria, then an investigation will be carried out which may include:

- Further monitoring to confirm groundwater conditions (increased frequency)
- Assessment to identify if the exceedance represents an adverse change in risk profile and a remedial response is required (refer to Section 7.9.1 of the SWMP), or if the Action Trigger should be revised or implemented in a sentinel well for the CoPC triggered.

Where trigger exceedances are identified, and concentrations are outside the background range for groundwater along the alignment, the monitoring program will also be reviewed as outlined in Section 9.



This approach to site specific groundwater quality action triggers has been developed by consultants certified under the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)).

The action triggers are not intended for use as discharge criteria, or to assess potential risk to ecological receptors.

With the exception of groundwater associated with the former dry cleaner at St Marys, no existing potential vapour intrusion risks have been identified based on baseline data collected, and therefore no SSTVs for VOCs have been developed.

Site specific trigger levels for water quality are provided in Table 6-8.

Table 6-8: Groundwater quality action triggers

Location ID [1]	Monitoring Zone	Aluminium	Cadmium	Copper	Zinc	pH	Total N	Total P	Total PFAS	TRH/BTEXN	Other	Trends only
MW1	St Marys								PFOS >1.07ug/L		cis 1,2 DCE >4.7mg/L PCE >0.98mg/L VC > 0.32mg/L	
SBT-GW-0001 *	St Marys											✓
SBT-GW-1001	St Marys	>24.4mg/L		>81ug/L	>2,600ug/L	<4.5						
SBT-GW-1002	St Marys	>2.1mg/L		>29ug/L	>172ug/L	<4.0						
SBT-GW-1005	St Marys											✓
SBT-GW-1012*	St Marys											✓
SBT-GW-1013*	St Marys											✓
SBT-GW-1014*	St Marys											✓
SBT-GW-1016	St Marys				>236ug/L		>29.8mg/L	>10.1mg/L	>0.032ug/L	BTEXN >9ug/L		
SBT-GW-1017	St Marys						>47.4mg/L	>33.2mg/L	>0.0102ug/L	TPH >C10 >500ug/L		
SBT-GW-1019R	St Marys						>13mg/L	>5.6mg/L	>0.0066ug/L		PCE >203ug/L	
SBT-GW-1021	St Marys										Phenol >31ug/L	
SBT-GW-1022	St Marys											✓
SBT-GW-1803	St Marys											✓
SBT-GW-1347C*	St Marys											✓
SBT-GW-1348C*	St Marys											✓
SMGW-BH-A401	St Marys	>3mg/L		>3,240ug/L	>235ug/L	pH <4.6		>3.75mg/L	>0.021ug/L			
SMGW-GW02	St Marys								>0.2ug/L		PCE >1,900ug/L cis1,2 DCE >17ug/L	
SBT-GW-1804	TBM Tunnel - South Creek											✓
SMGW-BH-A107	TBM Tunnel - South Creek											✓

Location ID [1]	Monitoring Zone	Aluminium	Cadmium	Copper	Zinc	pH	Total N	Total P	Total PFAS	TRH/BTEXN	Other	Trends only
SBT-GW-1030	Cross passage / Tunnel (XPN13)	>7.5mg/L		>26ug/L	>542ug/L	pH <4.4			>0.13ug/L			
SBT-GW-1031	Cross passage / Tunnel (XPN14)											✓
SBT-GW-1024	Claremont Meadows SF								>0.09ug/L	TPH C6-C9 > 2,100ug/L		
SBT-GW-1805	Claremont Meadows SF							>6.6mg/L	>19.9mg/L			
SBT-GW-1806	Orchard Hills		>8.1ug/L	47ug/L		pH (11-11.2)				BTEXN >4ug/L		
SBT-GW-1807	Orchard Hills											✓
SBT-GW-1808	Orchard Hills	>2,260ug/L		>79ug/L	>478ug/L	pH <3.65						
SMGW-BH-A315	Orchard Hills				>240ug/L				>0.034ug/L	TPH >C10 > 260ug/L		
SBT-GW-1042	Orchard Hills	>1,900ug/L			>2,182ug/L	pH < 4.5	183mg/L					
SBT-GW-1048	Orchard Hills		>2.7ug/L		>833ug/L							
SBT-GW-3003-A	Portal / Cross passage XPS01											✓
SBT-GW-3003-B	Portal / Cross passage XPS01											✓
SBT-GW-3006	Airport Terminal											✓
SBT-GW-3012-A	Airport Terminal											✓
SBT-GW-3012-B	Airport Terminal											✓
SBT-GW-3012-C	Airport Terminal											✓
SBT-GW-3022	Airport Terminal									TPH >C10 >3,300ug/L		
SBT-GW-4000	Western Sydney Airport							>5.4mg/L		TPH >C10 >1,620ug/L Toluene > 46ug/L		
SMGW-BH-C320	Western Sydney Airport								> 0.5ug/L	Toluene > 34ug/L		

Location ID [1]	Monitoring Zone	Aluminium	Cadmium	Copper	Zinc	pH	Total N	Total P	Total PFAS	TRH/BTEXN	Other	Trends only
SMGW-BH-C321	Western Sydney Airport								> 0.046ug/L			
SMGW-BH-C330	Western Sydney Airport	>5,310ug/L			>1,090ug/L	pH <4.9						
SBT-GW-4003	Bringelly SF									TPH C6-C9 > 20ug/L		
SBT-GW-4005	Bringelly SF								>0.01ug/L			
SBT-GW-4800	Bringelly SF							2.2mg/L				
SBT-GW-4801	Bringelly SF											✓
SBT-GW-4802	Bringelly SF											✓
SBT-GW-4008	Aerotropolis											✓
SBT-GW-4010	Aerotropolis											✓
SBT-GW-4014	Aerotropolis								>0.002ug/L			
SBT-GW-4017 [1]	Aerotropolis								>0.0145ug/L	TPH >C10 >880ug/L TPH C6-C9 > 40ug/L		
SBT-GW-4021	Aerotropolis						28.3mg/L	>16.2mg/L				
SBT-GW-4803	Aerotropolis											✓

1. Well destroyed. Replacement to be installed at same location. Triggers may require review if higher concentrations reported when initially sampled.

6.4 GDE and Salinity monitoring

Risk posed to GDE health by altered groundwater quality is currently considered negligible, and the implementation of the construction groundwater quality monitoring program is considered sufficient for GDE monitoring for the SBT Works.

Level monitoring is the primary, leading indicator of potential impact to GDEs. Groundwater level and EC monitoring will be conducted in monitoring wells identified in Table 6-9, which includes proposed wells in the vicinity of GDEs to specifically monitor GDE conditions.

Groundwater level and quality monitoring will be conducted using data loggers that can record EC, and groundwater level. The loggers have been installed at key monitoring bores between the alignment and GDEs (Table 6-9) and programmed to record data hourly.

Data loggers will be downloaded and locations manually gauged on a monthly basis, which is considered sufficient as the timing for changes in water level and quality with respect to GDEs is expected to be greater than one month. The monthly download and review of data will be supported by laboratory testing of water quality as outlined in Section 6.3.

All level / EC loggers will record on hourly intervals, which may be adjusted over consecutive monitoring events according to observed fluctuations or trends in groundwater conditions.

Table 6-9: Groundwater bores to be monitored for EC and level during construction

Location	Area	Easting MGA2020	Northing MGA2020	Target stratigraphic unit	Screen Interval (mBTOC)	Monitoring	Status
SMGW-BH-A105S	Cross passage XP-N05	293100	6261999	Alluvium/Residual	2 - 8	Level / EC	Installed
SMGW-BH-A107	Cross passage XP-N09	292413	6261713	Bedrock	19 - 26	Level / EC	Installed
SBT-GW-1804	Cross passage XP-N10	292194.9	6261580.1	Residual	3 - 5	Level / EC	Location optimised to monitor effects of cross passage construction
SBT-GW-1805	Claremont Meadows	292046.7	6261326.1	Residual	3 - 9	Level / EC	Installed
SBT-GW-1028	Claremont Meadows	292050	6261168	Residual/Alluvium	3 - 6	Level / EC	Unable to access – asbestos exclusion zone
SBT-GW-1042	Orchard hills	291874.7	6259123.7	Alluvium	2 - 8	Level / EC	Installed
SBT-GW-1063	Orchard hills	292193.5	6258861.3	Alluvium/Bedrock	2 - 11	Level / EC	Installed
SMGW-BH-A315	Orchard hills	291726.6	6258863.8	Residual/Bedrock	4 - 10	Level / EC	Installed
SBT-GW-3006	Airport Terminal	289368	6247844.4	Bedrock	29 - 35	Level / EC	Installed
SBT-GW-3003-A	Airport Terminal	290425.6	6248380.7	Bedrock	2 - 5	Level / EC	Installed
SBT-GW-3003-B	Airport Terminal	290424.6	6248382.2	Bedrock	1 - 10	Level / EC	Installed
SBT-GW-4000	Cross passage XP-S13	289140.5	6046360.3	Bedrock	2.5 - 13	Level / EC	Installed
SBT-GW-4010	Aerotropolis	290427.4	6244758.3	Bedrock	10.8 - 16.8	Level / EC	Installed
SBT-GW-4008	Aerotropolis	290230	6244991.9	Bedrock	22 - 28	Level / EC	Installed
SBT-GW-4021	Aerotropolis	291112.5	6243748	Alluvium/Bedrock	2 - 11	Level / EC	Installed

6.4.1 GDE monitoring performance criteria

Preliminary SSTVs have been developed following completion of baseline groundwater level and quality monitoring (Table 6-10). The SSTVs may require future revision as limited EC data is available for some locations.

Table 6-10: Preliminary EC SSTVs for continuous EC monitoring of GDEs

Area	Bore ID	Screened unit	Installed screen depth (mbgl)	Baseline EC range (µS/cm)	Preliminary EC SSTV (µS/cm)
Claremont Meadows	SBT-GW-1805	Residual	3 - 9	2,480 – 3,100	3,650
Claremont Meadows	SBT-GW-1028	Residual	3 - 6	No sampling as in asbestos exclusion zone	
Orchard Hills	SBT-GW-1042	Alluvium	2 - 8	11,900 – 12,400	18,600
Orchard Hills	SBT-GW-1063	Alluvium/Bedrock	2 -11	11,650 – 13,293	19,940
Orchard Hills	SMGW-BH-A315	Alluvium/Bedrock	4 -10	1,842 – 2,878	4,317
Aerotropolis	SBT-GW-4021	Alluvium/Bedrock	2 - 11	21,400 – 22,000	33,000

The SSTVs for EC may be refined over time as additional data is available, and existing variability including seasonal trends and vertical stratification are further assessed.

The SSTVs will provide an identifiable indication of a potential change in salinity. A management response will be initiated if any of the following occurs:

- EC data continuously exceeds the SSTV over a period of three months and displays a rising trend
- EC data exceeds the SSTV at any time by more than 150%.

If 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, including a review to assess the historical and surrounding monitoring bore data, and modelling predictions (refer to Section 7.2 of the SWMP). If applicable, where high saline areas are identified, measures such as planting, regenerating and maintaining native vegetation and good ground cover in recharge, transmission and discharge zones would be implemented where possible.

SSTVs were also developed for level decline at each GDE based on their obligate or facultative dependence. Groundwater level related SSTVs are provided in Table 6-11.

Table 6-11: Preliminary Level SSTVs for continuous level monitoring of GDEs

Area	Bore ID	Screened unit	Installed screen/sensor depth (mbgl)	Baseline level range (mAHD)	Preliminary Level SSTV (mAHD) *
Claremont Meadows	SBT-GW-1805	Residual	3 - 9	24.7 to 25.6	21.5
Claremont Meadows	SBT-GW-1028	Residual	3 - 6	26.5 – 26.7	24.7
Orchard Hills	SBT-GW-1042	Alluvium	2 - 8	37.7 – 37.8	33.0
Orchard Hills	SWD-TU150-22010-VWP02	Bedrock	16 (VWP)	33.8 – 35.3	31.0
Orchard Hills	SBT-GW-1063	Alluvium/Bedrock	2 -11	25.4 - 25.7	24.3

Area	Bore ID	Screened unit	Installed screen/sensor depth (mbgl)	Baseline level range (mAHD)	Preliminary Level SSTV (mAHD) *
Orchard Hills	SMGW-BH-A315	Alluvium/Bedrock	4 -10	38.8 - 40	36.9
Aerotropolis	SBT-GW-4021	Alluvium/Bedrock	2 - 11	59.8 - 59.9	59.1

* Based on Amber Trigger Level as presented in Table 6-4

Where groundwater levels fall below the SSTVs listed in Table 6-11 as a result of the SBT Works, the GDE mitigation measures detailed in Section 4.4 will be implemented.

Data from the monthly downloads will continue to be assessed against the SSTVs to identify where conditions are not as expected or predicted (discussed further below). Data analysis and groundwater monitoring reports will be produced every 6 months (consistent with Section 8.5 of this document).

6.5 Tunnel inflows and water treatment plant monitoring

Inflows to the WTPs at St Marys, Claremont Meadows, Bringelly Services Facility and Aerotropolis Core are derived primarily through groundwater inflows to excavations that extend below the water table, with additional inflows from rainfall events that result in incidental rainfall over the excavation footprints, and any washdown activities within the catchment of the WTPs.

Inflows to the WTP at Orchard Hills includes a combination of groundwater inflows to the station excavations and tunnels during construction, process water from tunnelling activities and surface works, incidental rainfall over the excavation footprints, and any washdown activities within the catchment of the WTPs.

Daily inflow volumes for groundwater, process water, washdown water and incidental rainfall will be highly variable over the course of the construction activities in response to both progression of the project and natural variability. Variability in flow will be managed through the influent balance tanks of each WTP.

Incidental rainfall into excavations is unlikely to generate significant volumes of additional inflow to WTPs and will be managed through the onsite WTPs, remaining site stormwater falling outside of WTP capture zones will be stored and treated through stormwater management systems (including sediment ponds).

Process water volumes contributing to inflows at Orchard Hills are anticipated to increase from <1 L/s to a peak 5 L/s over the course of construction activities.

Additional inflows from rainfall will be highly variable in response to variable intensity-duration and antecedent soil conditions. However, additional inflows from rainfall are considered unlikely to exceed the treatment capacity of the WTPs.

A summary of the range and average inflow rates for groundwater and process water are summarised in Table 6-12.

Table 6-12: WTP Groundwater Inflow and Process Water Summary

Site Location	Groundwater Inflow Range (L/s)	Average Groundwater Inflow (L/s)	Process Water Inflow Range (L/s)
St Marys	0.0 – 0.21	0.19	0.0

Site Location	Groundwater Inflow Range (L/s)	Average Groundwater Inflow (L/s)	Process Water Inflow Range (L/s)
Claremont Meadows	0.0 – 0.26	0.24	0.0
Orchard Hills	0.0 – 1.78	0.40	0.1 – 5.0
Bringelly	0.0 – 0.31	0.29	0.0
Aerotropolis	0.0 – 0.21	0.18	0.0

A program of ongoing water quality monitoring at each WTP provides an ongoing assessment of effluent water quality and potential risks to the Water Quality Objectives in receiving waterways.

The monitoring program provides monitoring data for effluent water quality retained within the storage tank prior to discharge, including:

1. Live continuous monitoring of pH and turbidity
2. Field monitoring of electrical conductivity
3. Monthly and quarterly sampling and laboratory testing for the parameters listed in Table 7-2 (Section 7.8.2) against the relevant ANZECC / ANZG (2018) 95% and 99% species protection criteria.

All laboratory testing will be undertaken to quantify contaminants at levels commensurate with comparison against the adopted discharge criteria and ANZECC (2000) and ANZG (2018) default guideline values. Contaminants for which practical quantification limits (PQL) are greater than default guideline values will be noted within each monitoring report.

7 Monitoring methodology

7.1 Overview

This section details the groundwater monitoring methodology to be implemented during the SBT Works. Procedures for the collection of continuous and discrete groundwater monitoring data are provided, including all quality assurance / quality control requirements. Specifically, this methodology provides an approach for collection and assessment of the following environmental datasets:

- Groundwater level as mBTOC groundwater and mAHD (measurement and datalogger download)
- Groundwater salinity as electrical conductivity (measurement and datalogger download)
- Groundwater quality at key locations (field measurement and sample collection)
- WTP discharge water quality (field measurement and sample collection)
- Groundwater inflows (collection of pump flow meter data).

The methodology also provides quality assurance / quality control procedures for collecting and managing environmental datasets.

The groundwater sampling methodology has been developed for compliance with the following Australian and International Standards and Guidance:

- AS/NZS 5667.11:1998: Water Quality – Sampling Part 11: Guidance on Sampling of Groundwaters (Reconfirmed 2016)
- AS/NZS 5667.1:1998: Water Quality – Sampling Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples (Reconfirmed 2016)
- Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T., 2009. Groundwater Sampling and Analysis – A Field Guide. Geoscience Australia, Record 2009/27 95 pp.

7.2 Continuous Groundwater Monitoring

Continuous groundwater monitoring will be undertaken to monitor for changes to groundwater conditions during the SBT Works. The continuous monitoring infrastructure includes a combination of VWPs and standard monitoring bores fitted with dataloggers. The monitoring and data collection methodology for each are discussed in further detail below.

7.2.1 Vibrating Wire Piezometers

The VWPs that form a part of the groundwater monitoring network for the project are identified in Table 6-4 and shown on Figures A-1 to A-7, Annexure A.

VWPs are used to monitor porewater pressure and can also be used to monitor water levels. The VW piezometer converts water pressure to a frequency signal via a diaphragm, a tensioned steel wire, and an electromagnetic coil.

The piezometer is designed so that a change in pressure on the diaphragm causes a change in tension of the wire. An electro-magnetic coil is used to excite the wire, which then vibrates at its natural frequency. The vibration of the wire in the proximity of the coil generates a frequency signal that is transmitted to the readout device.

The readout or data logger stores the reading in Hz. Modern data logger readouts may also automatically convert the reading in Hz to a pressure or level reading when a suitable pre-calibration is used. For non-vented piezometers, barometric pressure corrections are required because the space inside the piezometer isolated and disconnected from the atmosphere. Vented piezometers designed to eliminate barometric effects, and as such barometric pressure corrections are not required.

VWPs are set to record data at a maximum interval of once every six hours and are telemetered with real time data available via the project portal SensGrid. VWP monitoring data will be reviewed on a weekly basis to assess changes in groundwater levels during the initial construction stages of the project for all excavations, including cross-passages, and as TBM operations progress along the alignment.

Results will be presented on continuous data graphs to show any trends in groundwater levels over time, compared to trigger levels, and plotted with rainfall, to assist in identification of trends that may be attributable to construction activities.

7.2.2 Groundwater monitoring bores

The groundwater monitoring bores that form a part of the groundwater monitoring network for the project are identified in Section 6.3 and Figure 6-1 to Figure 6-4.

Select standpipe piezometers have been fitted with level and EC data-loggers for the continuous measurement of groundwater levels and electrical conductivity of groundwater for GDE monitoring, and level monitoring (detailed in Table 6-9).

Data-loggers are set at a depth lower than the predicted minimum water table elevation, accounting for natural variations and artificially induced drawdown, with sensors set within the screened interval for accurate assessment of groundwater salinity.

The data-loggers are set to record data at a maximum interval of every six (6) hours, or hourly for GDE monitoring locations. Monitoring data will be downloaded and reviewed monthly for GDE monitoring, and six monthly for other locations to assess changes in groundwater levels and EC during the construction stages of the project. All data will be downloaded directly from the readouts by manual collection.

The static groundwater level will be measured and recorded at each standpipe piezometer using an oil/water interface probe to verify the continuous data recorded by dataloggers and identify any non-aqueous phase liquid (NAPL) contamination. The methodology for the manual measurement of groundwater levels is summarised in Section 7.3.

7.3 Manual groundwater level measurements

Discrete interval groundwater level monitoring will be undertaken on a regular basis where groundwater is sampled for the construction groundwater monitoring (identified in Section 6 and Figure 6-1 to Figure 6-4) to collect information on groundwater conditions during construction stages of the project.

Groundwater levels will be measured and recorded at all relevant standpipe piezometers using an oil-water interface probe. Measurements collected using the interface probe will be used to verify / calibrate any continuous data collected by data-loggers and check for the presence of any hydrocarbon Light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL).

The level (to the nearest millimetre) of groundwater and LNAPL / DNAPL (if present) 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. The base of the bore will be measured and recorded on each manual groundwater monitoring event by lowering the dipper to the base of the bore until it touches the bottom, where possible

LNAPL product layers will be present as an oil-product layer on top of the groundwater level. DNAPL is determined by lowering the probe to the base of the well.

All groundwater level monitoring will be carried out prior to any purging and sampling activities (where applicable).

7.4 Groundwater Sampling

The purpose of groundwater sampling is to retrieve a water sample that represents the characteristics of water below the ground surface. There are a number of methods that can be adopted to collect representative groundwater samples, including but not limited to:

- Borehole purging
- Low-flow sampling
- Passive sampling
- Hydrasleeve™ sampling.

The sampling methodology selected for the groundwater monitoring program is discussed in the following sections.

7.4.1 Sampling Methodology

The groundwater monitoring program will adopt the Hydrasleeve™ sampling methodology for the collection of all groundwater samples at all sites identified in Section 6.

The Hydrasleeve™ methodology has been adopted as it allows for multi-level sampling in a single well and are well suited to relatively low permeability aquifers where drawdown can be an issue with low-flow. A Hydrasleeve™ captures a core of water, typically 1 litre, from the screened interval of the well. The Hydrasleeve™ is deployed to a target depth based on screened interval. Where a single depth is sampled, the Hydrasleeve™ is installed at 1.5 m below the top of the screen interval (i.e. within the screen). Where the groundwater table is within the screen interval, the Hydrasleeve™ is installed at 1.5m below the standing groundwater level.

Prior to installation of the Hydrasleeve™ and/ or sample collection, groundwater levels are to manually gauged.

After installation, the Hydrasleeve™ is left undisturbed until conditions are considered to have stabilised. The time to stabilise depends on the transmissivity of the aquifer, with more transmissive aquifer stabilising more rapidly. Typically, a minimum of five (5) days should allowed for stabilisation, which is considered appropriate given many bores are screened within the bedrock aquifer.

The Hydrasleeve™ is sealed except during sample collection when it is pulled up through the sampling interval, and re-seals once full. Therefore, only groundwater from the target depth interval is sampled and recovered.

For analysis of volatile organic compounds (VOCs), to reduce volatile losses, samples should be collected as rapidly as practicable with minimal agitation and zero headspace in sample bottles.

Sample containers should be placed directly into ice filled coolers and transported to the NATA-accredited laboratories under Chain of Custody (COC) processes. Samples are required to be documented as received by the laboratory chilled and intact. Samples should be submitted as soon as practicable to the laboratories to prevent loss while in storage or transit and analysed within recommended holding times.

7.4.2 Field Measurements

Some water quality parameters cannot be reliably measured in the laboratory as their characteristics change over a very short time scale. Parameters to be measured in the field include pH, electrical conductivity (EC), temperature, dissolved oxygen (DO) and redox potential.

Water quality parameters will be measured using a calibrated field water quality meter following sample collection and recorded in the field.

Other visual and olfactory observations such as odour, colour and indications of gross contamination (i.e. LNAPL/ DNAPL) should also be recorded in the field on appropriate field sheets/tablets.

A Standard Operating Procedure (SOP) compliant with AS/NZS 5667.11:1998 should be developed and adhered to for all Hydrasleeve™ sampling operations, including the collection of field parameters.

7.5 Effluent Water Quality – Water Treatment Plant

7.5.1 In-Line Monitoring

The construction WTPs will be designed to include in-line monitoring sensors to monitor pH and turbidity prior to effluent discharge. If either parameter is out of range an alert will be sent to the WTP operator to recirculate water through the WTP until parameters are within the required range. Once parameters are within the required range, effluent will be discharged to either trade waste or the relevant receiving waterway (depending on whether the effluent is suitable for discharge to receiving waterways under the EPL conditions).

7.5.2 Sampling Methodology

Grab samples will be collected manually from the WTP locations as per the frequencies specified in the EPL to verify that water from the WTPs remain below the limits identified in the EPL. The volume of sample collected will be sufficient for the required physico-chemical (field) parameter analysis using a multi-probe water quality meter(s).

An SOP will be developed to provide a consistent methodology in collection of samples from each WTP.

7.5.3 Field Measurements

Field physico-chemical parameters including temperature, EC, pH, DO, and turbidity will be measured at each sampling location using a calibrated multi-probe hand-held water quality meter immediately prior to collection of water quality samples. The collection of field measurements should follow a similar approach to that of field parameters collected from groundwater monitoring bores (Section 7.4.2).

Other observations including odour, colour and indications of gross contamination will also be recorded on field logging sheets.

7.6 Field Notes

Field notes for each monitoring location will be recorded on appropriate field sheets (hard copy or digital). Details to be recorded on field notes include:

- Unique sampling identification nomenclature consisting of the sample date, location, and sampler details.
- Stable readings from field parameter testing
- Observations of contamination including odour, colour and indications of gross contamination
- Weather conditions at the time of sampling or field investigation
- Any other relevant observations which may affect field or laboratory testing results.

7.7 Field Quality Assurance / Quality Control

7.7.1 Sampling Records

The following information will be included with the results from water quality monitoring:

a. The date(s) on which the sample was taken

b. The time(s) at which the sample was collected

c. The point at which the sample was taken (location ID)

d. The name of the person who collected the sample.

7.7.2 Decontamination Procedures

All non-disposable sampling equipment will be decontaminated before and between sampling locations to reduce the potential for cross contamination to occur between samples. Decontamination will include the following procedure:

- Washing non-disposable sampling equipment in a solution of phosphate free detergent (e.g. Liquinox) and potable water
- Rinsing with distilled water
- Rinsing with water from sample location prior to sample collection.

7.7.3 Field Method Blanks

One field method blank will be collected for each sampling round. The field method blank will be used to assess potential for cross contamination from the use of any non-disposable equipment that may be used in the sampling process. The field method blank will be collected by rinsing non-disposable sampling equipment with distilled water (following decontamination procedures) and collecting rinse water in the required laboratory testing containers. Field method blanks will not be required where sampling is conducted without the use of non-disposable equipment.

7.7.4 Intra-Laboratory Duplicates

Intra-laboratory field duplicates will be collected on an average frequency of one sample per twenty samples collected (5%), with an increased frequency for PFAS of one per ten (10%) according to NEMP 2.0. The analytical results of the two spilt samples will be compared to assess the precision of the sampling protocol and provide an indication of variability in the sample source. The relative percentage difference (RPD) acceptance limits will be:

- No limit analytical results <10 times Level of reporting (LOR)
- 50% analytical results 10-20 times LOR
- 30% analytical results >20 times LOR.

The RPD exceedances (if any) will be assessed to determine whether the project DQO's can still be addressed. If not, then further sampling and/or analysis may be required.

7.7.5 Inter-laboratory Duplicates (Triplicates)

Inter-laboratory field duplicates will be collected on an average frequency of one sample per twenty samples collected (5%) with an increased frequency for PFAS of one per ten (10%) according to NEMP 2.0. The analytical results of the two spilt samples will be compared to assess the precision of the sampling protocol and provide an indication of variability in the sample source. The relative percentage difference (RPD) acceptance limits will be:

- No limit analytical results <10 times LOR
- 50% analytical results 10-20 times LOR
- 30% analytical results >20 times LOR.

RPD exceedances (if any) will be assessed and whether the project data quality objectives (DQO) can still be addressed. If not, then further sampling and/or analysis may be required.

7.7.6 Trip Blanks

Trip blanks will be used and analysed for a batch of samples provided to the laboratory. Trip blanks will be analysed for BTEX and assess whether sample storage and transport procedures minimise the introduction of contamination to a sample during storage and transport.

The acceptance limit for analytical results is to be below the laboratory reporting limits. The significance of acceptance limit exceedances will be assessed and whether the project DQO's can still be addressed. If not, then further sampling and/or analysis may be required.

7.8 Laboratory Selection and Water Quality Testing Parameters

7.8.1 Laboratory Selection

The primary and secondary laboratories used for this project will be NATA-accredited for the analyses being undertaken.

7.8.2 Laboratory Testing Parameters

All water quality samples will be scheduled for analysis of the parameters identified in Table 6-6 at the nominated NATA accredited testing laboratory, with the testing frequency listed in Table 6-7.

Sampling frequencies will be increased to quarterly sampling where action triggers are exceeded as detailed in Table 6-8 and discussed in Section 6.3.3.

Quality control samples will be analysed for the basic suite (Table 6-6), with additional QC analysis sufficient to meet the duplicate requirements as detailed in Section 7.7.4 and 7.7.5.

7.8.3 Sample Filtration and Preservative Requirements

The proposed sample filtration and preservative requirements for the laboratory testing parameters are presented in Table 7-1. Filtration should be carried out in the field for all samples unless otherwise specified so that results are representative of dissolved concentrations.

Table 7-1: Sample Filtration and Preservative Requirements

Analyte Suite	Field Filtration	Preservative	Comments
General Water Quality	Not Required	Not required	-
Nutrients	0.45µm	Sulfuric acid (H2SO4)	-
Dissolved Metals	0.45µm	Not required	-
Total Metals	Not Required	Hydrochloric acid (HCl)	-
Petroleum Hydrocarbons	Not Required	Not required	Sample bottles required to be filled with zero headspace
BTEXN or Volatile organic compounds	Not Required	Sulfuric acid	Sample bottles required to be filled with zero headspace
Semi-volatile organic compounds	Not Required	Not required	Sample bottles required to be filled with zero headspace
Perfluorinated alkyl substances	Not Required	Not required	-

7.9 Laboratory Quality Assurance / Quality Control

7.9.1 Laboratory Data Quality Indicators

The laboratory data quality will be assessed by checking the following:

- Laboratory methods used are NATA accredited.

- Laboratory limits of reporting are less than adopted assessment criteria.
- Samples are extracted and analysed within holding times.
- Results of method blanks, surrogate, lab control sample, spike recoveries, RPDs between primary and duplicate laboratory samples.

Data Quality Indicators (DQI) adopted for quality control samples are presented in Table 7-2.

Table 7-2: Sample Filtration and Preservative Requirements

Type of Quality Control Sample	Control Limit
Method blank	Analytical result < LOR
Surrogate % recovery	50% to 150%
Lab control sample % recovery	70% to 130%
Spike % recovery	70% - 130% for inorganics 60% - 140% for organics
RPD	No limit Analytical results <10 times LOR 50% Analytical results 10-20 times LOR 30% Analytical results >20 times LOR

If the results of a laboratory quality control sample exceed the relevant adopted control limit, the laboratory will be requested assess the significance of the exceedance on the quality of the laboratory analytical data for the relevant batch.

The significance of the control limit exceedance will be assessed and whether the project DQO's can still be addressed. If not, then further sampling and/or analysis may be required.

7.10 Suitability of Sampling Results

If the results of the laboratory analytical data and field data quality assessment are acceptable (i.e., comply with the procedures, requirements and limits set out in Table 7-3, then the sampling data will be considered suitable for the purposes of the project. Data will be assessed for completeness, comparability, representativeness, precision, and accuracy.

Table 7-3: Sampling Data Quality Indicators

Field Considerations	Laboratory Considerations
Completeness	
All critical locations sampled All samples collected (from grid and at depth) SOPs appropriate and complied with Experienced sampler Correct documentation	All critical samples analysed in accordance with the data quality objectives All analytes analysed in accordance with the data quality objectives Appropriate methods and LORs Sample documentation complete Sample holding times compliant
Comparability	
Same SOPs used on each occasion	Sample analytical methods used (including clean-up)

Field Considerations	Laboratory Considerations
Experienced sampler Climatic conditions (temperature, rainfall, wind) Same types of samples collected (filtered, size fractions)	Sample LORs (justify/quantify if different) Same laboratories (justify/quantify if different) Same units (justify/quantify if different)
Representativeness	
Appropriate media sampled in accordance with the data quality objectives All media identified in data quality objectives sampled	All samples analysed in accordance with the data quality objectives
Precision	
SOPs appropriate and complied with	Analysis of: • Laboratory and inter-laboratory duplicates • Field duplicates • Laboratory-prepared volatile trip spikes
Accuracy	
SOPs appropriate and complied with	Analysis of: • Field blanks • Rinsate blanks • Reagent blanks • Method blanks • Matrix spikes • Matrix spike duplicates • Surrogate spikes • Reference materials • Laboratory control samples • Laboratory-prepared spikes

Two types of error should be considered when assessing the results from monitoring, including:

Type I error (false positive): Deciding that water quality samples exceed the environmental trigger values when they do not; and

Type II error (false negative): Deciding that water quality samples do not exceed the environmental trigger values when they do.

The potential for decision errors will be managed through confidence in the reliability of assessment methods (e.g., field observations, laboratory analysis and data review) and appropriate levels of qualification and/or experience in the personnel undertaking the relevant task.

7.11 Suitably Qualified Staff

Any staff or contractors undertaking water quality sampling for the monitoring program should be suitably qualified and experienced to undertake the required activities to ensure a suitable level quality assurance / quality control in sampling results.

At a minimum staff or contractors undertaking water quality sampling must have qualifications and experience relevant to the work being undertaken.

8 Compliance management

8.1 Roles and responsibilities and training

The CPBG organisational structure and overall roles and responsibilities are outlined in Section 4 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Part B of the SWMP.

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

Further details regarding staff training are outlined in Section 7.8 of the CEMP.

8.2 Groundwater monitoring

Groundwater monitoring requirements are detailed in Section 6 and include the location, parameters to be monitored, analysis suite and frequency of monitoring. Groundwater monitoring methodology is summarised in Section 7.

Additional requirements and responsibilities in relation to inspections are documented in Part B of the SWMP.

8.3 Data analysis and response

Groundwater level records from data loggers will be manually compensated for barometric pressure and converted to the Project datum (m AHD). Manual groundwater level measurements will be corrected for salinity and used to validate the accuracy of continuous groundwater level records.

Groundwater level monitoring results from VWPs, data loggers and manual groundwater measurements will be compared to groundwater model predicted drawdown and GDE SSTVs established in Section 6.4, where relevant. If potential adverse impacts arise as a result of this comparison, the implementation of additional mitigation measures will be considered including:

- Targeted ground improvement and grouting to limit groundwater inflows into station excavations, tunnels and cross-passage to reduce groundwater drawdown.
- Design of undrained temporary retention systems to minimise groundwater inflow into station excavations and reduce groundwater drawdown.
- Supplementing groundwater supply at affected groundwater dependent ecosystems or watercourses
- Make good provisions for groundwater supply wells impacted by changes in groundwater level or quality.

Local rainfall trends will be considered to assess the impacts of seasonal variability in groundwater levels during construction. Groundwater level observations will be used to inform future revision of this GWMP and groundwater model.

Groundwater quality results from monitoring bores will be compared to baseline data following each monitoring event. Trends will be reviewed to assess potential mobilisation of existing contamination due to construction. EC results from data loggers will be compared to SSTVs following data collection and if required, inform the implementation of any mitigation measures.

Water treatment plant sample results will be compared with discharge criteria monthly and reported in the six-monthly groundwater report as detailed in SWMP.

8.4 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, and compliance with this GWMP, the SSI 10051 Planning Approval, and other relevant approvals, licences and guidelines.

Audit requirements are detailed in Section 9.4 of the SWMP.

8.5 Reporting and records

8.5.1 Reporting

The SWMP details the reporting and record keeping requirements and processes, and complaints management and reporting. Reporting requirements specific to the groundwater monitoring program are presented in Table 8-1.

Detailed periodic review and reporting of groundwater level and quality will be conducted during construction, with particular focus during early excavation below the groundwater level. Groundwater level and quality results will be compared to baseline results and adopted performance criteria. Monitoring reports will be submitted to DCCEEW, Sydney Water (where required) and Sydney Metro within 60 days of the reporting period unless otherwise agreed with DCCEEW.

Table 8-1: Groundwater monitoring reporting schedule

Reporting timing / frequency	Reporting requirement	Report recipient
Baseline Groundwater Report (Project-wide) (Initial)	A review report will be prepared to document results of the first three months of monitoring new bores. This report will recommend monitoring frequency and analytical suites for construction monitoring, and updates to the GWMP. Selected bores will continue with six monthly monitoring for construction as outlined in Section 6, with the monitoring frequency of the remaining bores and the analytical suite to be reviewed based on the results of baseline assessment monitoring.	DCCEEW, Planning Secretary, ER, Sydney Water, NSW EPA (if requested)
Groundwater Monitoring Report (six-monthly)	Construction groundwater level and quality monitoring reports will include data collected during the reporting period. The report will include comparison of observed levels to model predictions (and GDE SSTVs established in Section 6.4, where relevant) and groundwater quality to SSTV and baseline data. A summary of construction status and inflow during the reporting period will be presented. A summary of WTP discharge compliance will be presented. The implementation of groundwater management measures during the reporting period will be summarised and the requirement for any additional management measures will be documented. If connection to a Sydney Water asset is required, then the reporting of the data collected under C16(L) would be provided as required by Sydney Water.	DCCEEW, Planning Secretary, ER, Sydney Water, NSW EPA (if requested)

Monitoring, reporting and engagement requirements will be agreed with Sydney Water where Sydney Water assets are used to receive discharged water from the SBT Works, as part of a trade waste agreement or similar. The monitoring and reporting requirements for trade waste discharges will be included in the SWMP.

8.5.2 Records

In addition to the record keeping detailed in the SWMP, the following compliance records will be retained by CPBG:

- Records of groundwater monitoring bores and wells in the immediate vicinity of SBT Works sites (If monitoring locations change due to damage to a bore, or a bore need to be added because of the revised modelling predictions, the GWMP will be revised as noted in Section 9)
- Records of groundwater levels and water quality testing
- EPL Annual Reports
- Groundwater monitoring field sheets
- WTP operational performance data
- Laboratory records.

9 Review and Improvement

9.1 Review

Where trigger levels as set out in Section 6 are exceeded, the GWMP will be reviewed, and if necessary, revised to account for the observed conditions. This may include assessment of the appropriateness of existing trigger levels based on the observed response and inferred risk to sensitive groundwater receptors, and revision of trigger levels.

9.2 Continual improvement

Monitoring data will be reviewed throughout construction for continual improvement. Section 9.4 of the SWMP describes the process for the continual improvement of project documents.

Continual improvement of this GWMP will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets and Project performance outcomes of the EIS for the purpose of identifying opportunities for improvement.

The continual improvement process is intended 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 corrective and preventative action to address any non-conformances and deficiencies (refer to Part B of the SWMP and the CEMP)
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement.
- Make comparisons with objectives and targets.

9.3 Updates to GWMP

There are several mechanisms which may trigger additional review and revision of the document:

- Receipt of new data that materially affects the interpretations that underpin the requirement for groundwater monitoring and/or management.
- Completion of further modelling, where the model predictions differ significantly from those used to form the basis for the assessment of groundwater-related impacts and specification of mitigation measures (if required)
- The identification of previously unknown contaminant sources / plume(s) of contaminated groundwater that may be influenced by SBT Works.

10 References

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SYDNEY METRO - WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

Consultation Report

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

Project number	WSA-200-SBT
Document number	SMWSASBT-CPG-SWD-SW000-EN-RPT-295409
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Revision	A

Document approval

Rev	Date	Prepared by	Reviewed by	Approved by	Signature
A	10/07/2024	[redacted]	[redacted]	Nil	

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Annexures

1. Introduction

1.1. Background

The Sydney Metro Western Sydney Airport (the Project) forms part of the broader Sydney Metro network. It involves the construction and operation of a 23km new metro rail line that extends from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The alignment includes a combination of tunnels and civil structures, including viaduct, bridges, surface and open-cut troughs between the two tunnel sections

The Sydney Metro Western Sydney Airport EIS was prepared in October 2020 to assess the impacts of construction and operation of the Project and was placed on public exhibition between 21 October 2020 and 2 December 2020. The Project was declared a Critical State Significant Infrastructure (CSSI) Project and is listed in Schedule 5 of State Environmental Planning Policy (State and Regional Development).

The Project was approved by the Minister for Planning and Public Spaces on 23 July 2021 (SSI 10051) under section 5.19 of the *Environmental Planning and Assessment Act 1997* (EP&A Act).

1.2. Scope of the report

Reflecting the requirements of the SSI 10051 Planning Approval, this report has been prepared to provide the evidence of consultation with the identified parties during the development of the following documents:

- Groundwater Monitoring Program, SMWSASBT-CPG-SWD-SW000-GE-RPT-040404, Rev 4 (Subject Document).

2. Consultation Requirements

2.1. SSI 10051 Planning Approval

The Conditions of Approval relevant to stakeholder consultation on the Subject Document are listed in Table 1.

Table 1: Conditions of Approval

Ref	Condition
A6	Where the terms of this approval require a document or monitoring program to be prepared, or a review to be undertaken, in consultation with identified parties, evidence of the consultation undertaken must be submitted to the Planning Secretary with the document. The evidence must include: (a) documentation of the engagement with the party identified in the condition of approval that has occurred before submitting the document for approval; (b) a log of the dates of engagement or attempted engagement with the identified party and a summary of the issues raised by them; (c) documentation of the follow-up with the identified party(s) where feedback has not been provided to confirm that the party(s) has none or has failed to provide feedback after repeated requests; (d) outline of the issues raised by the identified party(s) and how they have been addressed; and (e) a description of the outstanding issues raised by the identified party(s) and the reasons why they have not been addressed.
C13	The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies (as required by Condition A6) identified for each to compare actual performance of construction of the CSSI against the performance predicted in the documents listed in Condition A1 or in the CEMP. Where a government agency(ies) request(s) is not included, the Proponent must provide the Planning Secretary / ER (whichever is applicable) justification as to why.

	Required Construction Monitoring Programs	Relevant government agencies to be consulted for each Construction Monitoring Program
(a)	Noise and vibration	Relevant Councils and WaterNSW (in relation to its assets)
(b)	Surface water quality	DPIE Water, DPI Fisheries, and Relevant Councils
(c)	Groundwater	DPIE Water
(d)	Air Quality	Relevant Councils

2.2. Revised Environmental Mitigation Measures

There are no Revised Environmental Mitigation Measures (REMMs) relevant to stakeholder consultation on the Subject Document.

3. Consultation summary

In accordance with the SSI 10051 Planning Approval and the REMMs, the Subject Documents have been prepared in consultation with the identified parties. A summary of the consultation is provided in Table 3.

Table 2: Stakeholder consultation summary

Stakeholder	Consultation Summary	Status	Reference
DCCEEW Water	Recommendations received relating to aquifer interference requirements	GWP (Section 1.5) updated to clarify	Annexure A

Annexure A DCCEEW Water (formerly DPIE Water) Consultation Evidence

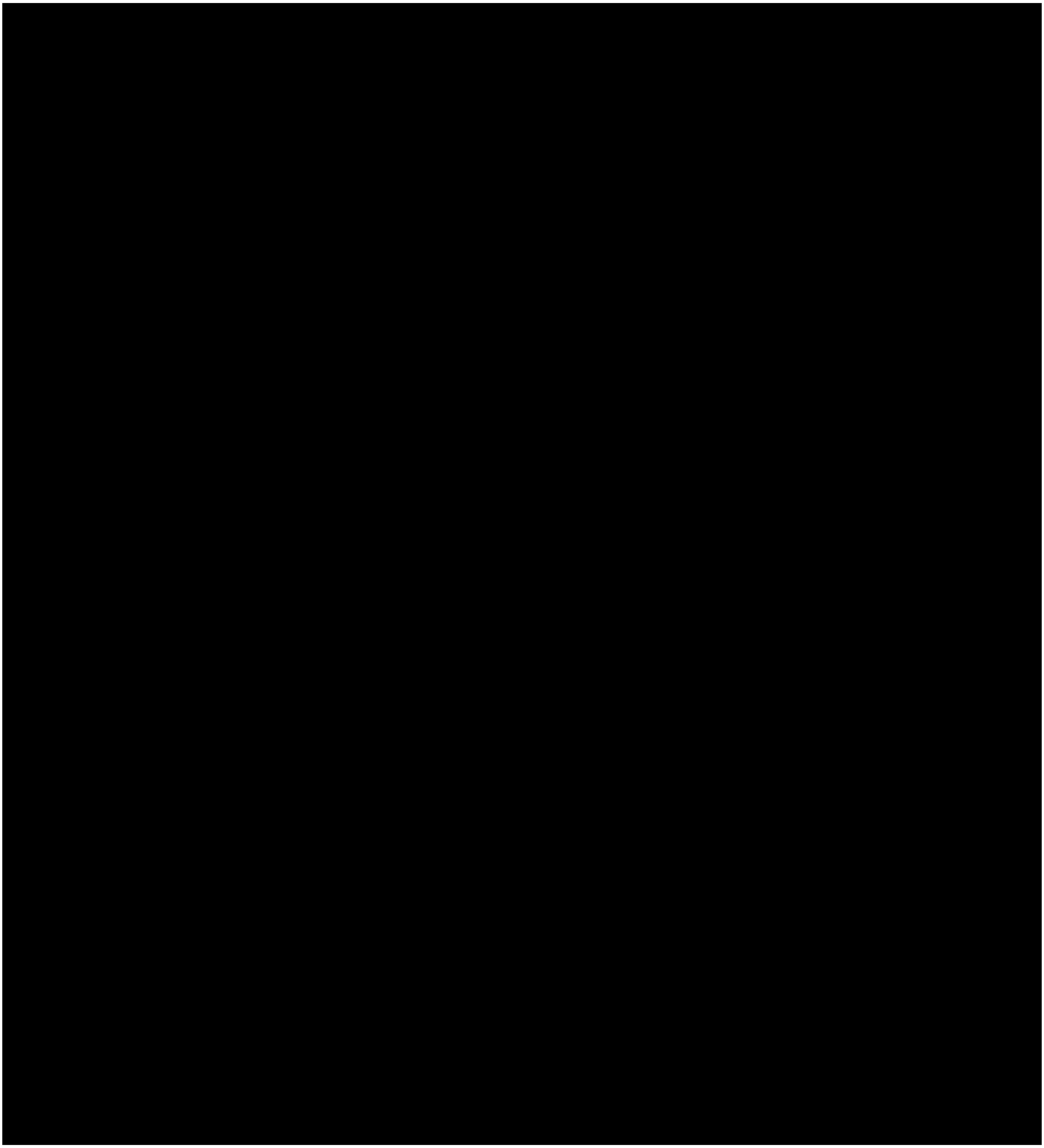
Table 3: Consultation Log

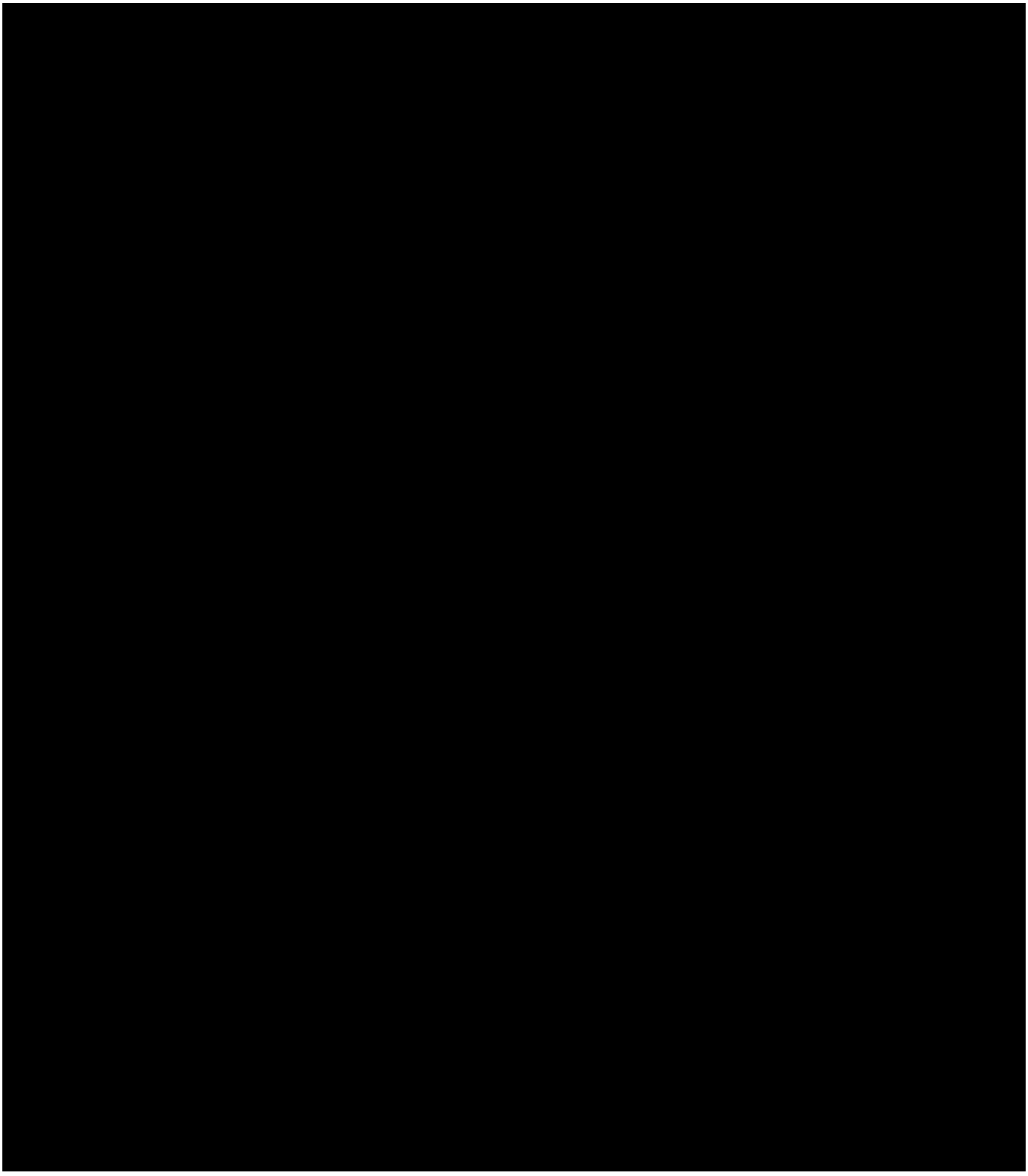
In/out	Date and time	Method of contact	Details of contact
Out	5 June 2024	DPHI Post Approvals Portal	Sydney Metro submitted a copy of the SBT Groundwater Monitoring Program – Revision 3 to DCCEEW Water (shown as DPE Water in the DPHI Post Approvals Portal) on behalf of CPBG.
Out	20 June 2024 1:53pm	Email	Sydney Metro followed-up with DCCEEW (on behalf of CPBG) to confirm when comments would be provided.
In	21 June 2024 1:45pm	Email	DCCEEW Water confirmed receipt and advised that they were awaiting technical advice to finalise and submit the report.
Out	1 July 2024 3:15pm	Email	Sydney Metro follow with DCCEEW Water (on behalf of CPBG) to confirm when comments would be provided as CPBG were looking to finalise the program by the end of the week.
In	2 July 2024 4:10pm	Email	DCCEEW Water advised SM that they could expect a response by the end of the week.
Out	8 July 2024 10:53am	Email	Sydney Metro followed-up with DCCEEW Water (on behalf of CPBG) to confirm when comments would be provided as no response had yet been received.
In	9 July 2024	DPHI Post Approvals Portal	DCCEEW Water provided a letter (ref OUT24/10360) dated 9 July 2024, including recommendations on the SBT Groundwater Monitoring Program.

Table 4: Issues raised by Stakeholder on Subject Documents

Ref	Issues raised	How addressed	Subject Document ref
Groundwater Monitoring Program			
01	DCCEEW recommendations include: Prior to approval: • Quantify the maximum annual volume of water take due to aquifer interference activities • Demonstrate sufficient entitlement can be acquired in the relevant water source	Table 4-1 of the GWMP provides estimates of the long-term inflows at various locations to quantify the annual volume of water take. It is noted the DCCEEW recommendation(s) refer to Aquifer Interference Licence requirements. To clarify this Section 1.6 has been updated to reflect the exemption(s) applicable to SBT regarding approval for aquifer interference, specifically that transport authorities (Sydney Metro) are exempt from the requirements of a Water Access Licence after considering the environmental impact of the activity	Section 1.6 & Table 4-1

Ref	Issues raised	How addressed	Subject Document ref
		as if the transport authority were the determining authority.	
02	Post approval: • Ensure sufficient entitlement is held in a water access licence/s to account for the maximum predicted water take for each water source prior to take occurring	It is noted the DCCEEW recommendation(s) refer to Aquifer Interference Licence requirements. To clarify this Section 1.6 has been updated to reflect the exemption(s) applicable to SBT regarding approval for aquifer interference, specifically that transport authorities (Sydney Metro) are exempt from the requirements of a Water Access Licence after considering the environmental impact of the activity as if the transport authority were the determining authority.	Section 1.6





SYDNEY METRO - WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

Consultation Report

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

Project number	WSA-200-SBT
Document number	SMWSASBT-CPG-SWD-SW000-EN-RPT-295409
Revision date	10 July 2024
Revision	A

Document approval

Rev	Date	Prepared by	Reviewed by	Approved by	Signature
A	10/07/2024	[redacted]	[redacted]	Nil	

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1. Introduction

1.1. Background

The Sydney Metro Western Sydney Airport (the Project) forms part of the broader Sydney Metro network. It involves the construction and operation of a 23km new metro rail line that extends from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The alignment includes a combination of tunnels and civil structures, including viaduct, bridges, surface and open-cut troughs between the two tunnel sections

The Sydney Metro Western Sydney Airport EIS was prepared in October 2020 to assess the impacts of construction and operation of the Project and was placed on public exhibition between 21 October 2020 and 2 December 2020. The Project was declared a Critical State Significant Infrastructure (CSSI) Project and is listed in Schedule 5 of State Environmental Planning Policy (State and Regional Development).

The Project was approved by the Minister for Planning and Public Spaces on 23 July 2021 (SSI 10051) under section 5.19 of the *Environmental Planning and Assessment Act 1997* (EP&A Act).

1.2. Scope of the report

Reflecting the requirements of the SSI 10051 Planning Approval, this report has been prepared to provide the evidence of consultation with the identified parties during the development of the following documents:

- Groundwater Monitoring Program, SMWSASBT-CPG-SWD-SW000-GE-RPT-040404, Rev 4 (Subject Document).