Appendix B4

SGWPW-JHSW-NWW-PM-PLN-00519 Groundwater Management Sub Plan – SSI 9737

Sydney Gateway Road Project

June 2021

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Contents

Figures

Tables

Document control

Approval and authorisation

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Dated	
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1	Transport for New South Wales	
2	Independent Verifier	
3	Environmental Representative	
4	Project Director	
5	Environment and Sustainability Manager	
6	Quality Manager	

Glossary/ Abbreviations

Abbreviations	Expanded text
AQMP	Air Quality Management Sub-Plan
BoM	Australian Government Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CoA	Conditions of Approval
CSSI	Critical State Significant Infrastructure
DMS	Dewatering Management Strategy
DPIE	NSW Department of Planning, Industry and Environment
DPIE-Water	NSW Department of Planning, Industry and Environment - Water
EIS	Environmental Impact Statement
EPL	Environmental Protection License
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
ER	Environmental Representative
EWMS	Environmental Work Method Statements
GMP	Groundwater Management Sub Plan
GWMM	Groundwater Mitigation Measure
GWMP	Groundwater Monitoring Program
JHSWJV	John Holland Seymour Whyte Joint Venture
LLGOMP	Landfill Leachate, Gas and Odour Management Sub Plan
MDP	Major Development Plan
POEO Act	*Protection of the Environment Operations Act 1997*
SWMP	Soil and Water Management Sub Plan
TWP	Technical Working Paper
TfNSW	Transport for NSW (formerly Roads and Maritime Services)
UMM	Updated Management Measures

1 Introduction

1.1 Context

This Groundwater Management Sub Plan (Plan) forms part of the Construction Environmental Management Plan (CEMP) for Design and Construction of Sydney Gateway Project.

This Plan has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the environmental management measures listed in the Projects combined Environmental Impact Statement (EIS) / Major Development Plan (MDP), Updated Management Measures (UMM's) from the Response to Submissions Report and all applicable legislation and TfNSW requirements.

Note – this Plan has been developed specifically for works occurring within NSW State owned land under approval SSI 9737, which is administered by the NSW Department of Planning, Industry and Environment (DPIE).

1.2 Environmental management systems overview

The environmental management system overview is described in Section 1.5 of the CEMP. Used together, the CEMP, issue specific environmental management plans, strategies, procedures and environmental work method statements (EWMS) form management guides that clearly identify required environmental management actions for reference by JHSWJV personnel and contractors.

1.3 Background

1.3.1 Background

Transport for NSW (TfNSW) have gained approval to deliver a high capacity road connection linking the Sydney motorway network at St Peters interchange with Sydney Airport's domestic and international terminals and the Port Botany Precinct. The Project is located on both State and Commonwealth land.

For areas on State land, the Project was declared to be critical State significant infrastructure (CSSI) under the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) and was approved by the NSW Minister for Planning and Public Spaces on 27 August 2020.

Commonwealth approval under the *Airports Act 1996* (the *Airports Act*) was granted by the Australian Minister for Infrastructure, Transport and Regional Development on 23 September 2020.

John Holland Seymour White Joint Venture (JHSWJV) have been contracted by Transport for New South Wales (TfNSW) for the Design and Construction of Sydney Gateway Stage 1 & Stage 3 (the Project).

1.3.2 Project Objectives

The objectives of the Project are to connect Sydney Airport Terminal 1 (the International Terminal) and Terminals 2/3 (the Domestic Terminals) with each other and with the Sydney motorway network via St Peters interchange. The Project aims to facilitate the movement of traffic towards Port Botany via General Holmes Drive, and will provide three main routes for traffic:

- Between the Sydney motorway network and Terminal 1, and towards the M5 motorway and the Princes Highway
- Between the Sydney motorway network and Terminals 2/3, and towards General Holmes Drive, Port Botany and Southern Cross Drive
- Between Terminal 1 and Terminals 2/3

The Project also aims to provide improved access to Sydney Airport land located on both sides of Alexandra Canal and across the Botany Rail Line.

1.3.3 Detailed Description

The Project is located about eight kilometres south of the Sydney Central Business District, in the suburbs of Tempe, St Peters and Mascot. It sits within the boundaries of the Inner West, City of Sydney and Bayside local government areas.

The key features of the Project are illustrated in Figure 1-1, which include:

- Road links to provide access between the Sydney motorway network and Sydney Airport's terminals, consisting of the following components:
    - St Peters interchange connection – a new elevated section of road extending from St Peters interchange to the Botany Rail Line, including an overpass over Canal Road
    - Terminal 1 connection – a new section of road connecting Terminal 1 with the St Peters interchange connection, including a bridge over Alexandra Canal and an overpass over the Botany Rail Line
    - Qantas Drive upgrade and extension – widening and upgrading Qantas Drive to connect Terminals 2/3 with the St Peters interchange connection, including a high-level bridge over Alexandra Canal
- Terminal links – two new sections of road connecting Terminal 1 and Terminals 2/3, including a bridge over Alexandra Canal
- Terminals 2/3 access – a new elevated viaduct and overpass connecting Terminals 2/3 with the upgraded Qantas Drive
- Road links to provide access to Sydney Airport land:
    - A new section of road and an overpass connecting Sydney Airport's northern lands on either side of the Botany Rail line (the northern lands access)
    - A new section of road, including a signalised intersection with the Terminal 1 connection and a bridge, connecting Sydney Airport's existing and proposed freight facilities on either side of Alexandra Canal (the freight terminal access)
- An active transport link, about 3 kilometres long and located along the western side of Alexandra Canal, to maintain connections between Sydney Airport, Mascot and the Sydney central business district
- Intersection upgrades and/or modifications
- Construction of operational ancillary infrastructure including maintenance bays, new and upgraded drainage infrastructure, signage and lighting, retaining walls, noise barriers, flood mitigation basin, emplacement mounds, utility works and landscaping

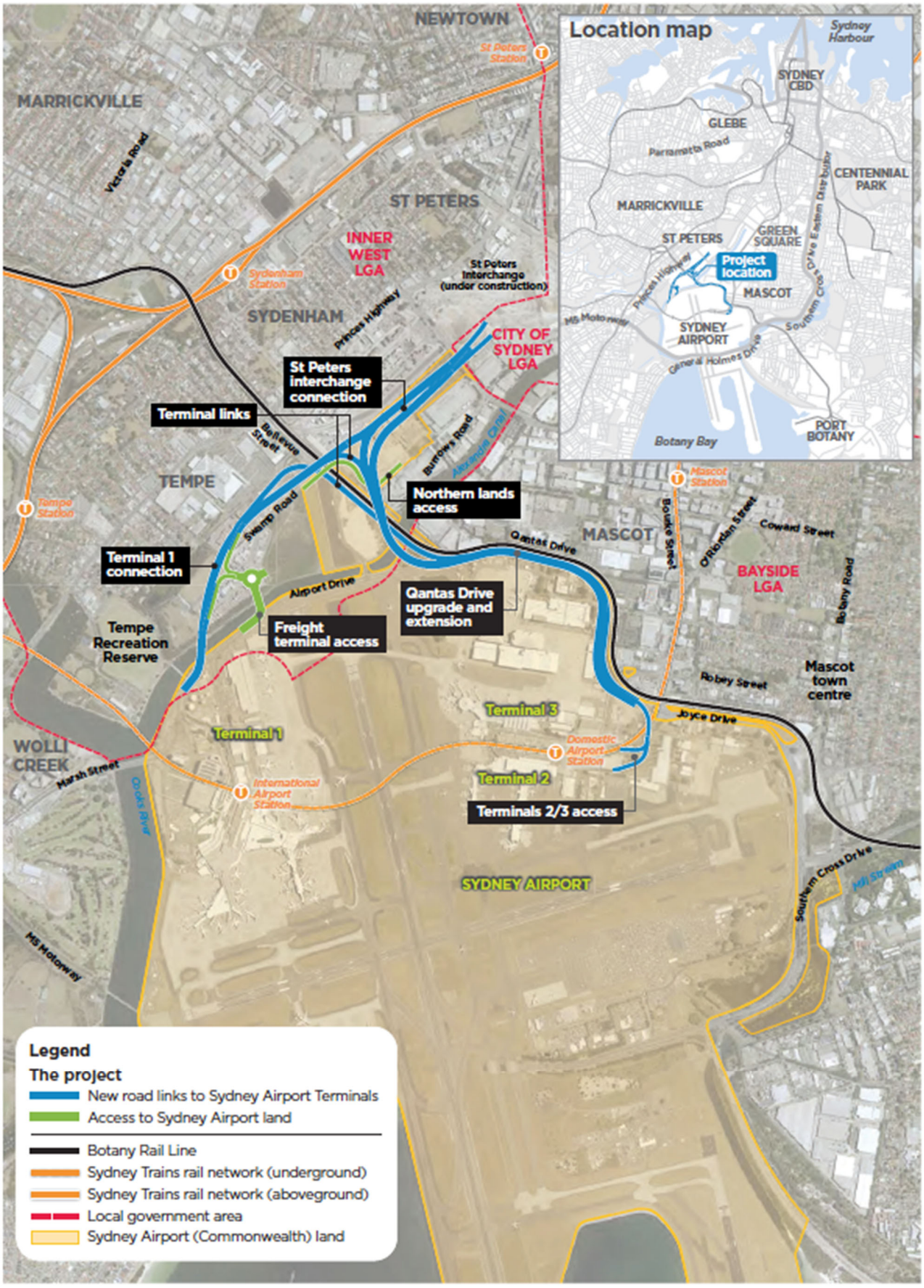

Figure 1-1 – Project overview

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how the JHSWJV will manage potential groundwater impacts during construction.

The potential groundwater impacts, as identified in the EIS/MDP, include:

- groundwater drawdown resulting from excavation and/or dewatering
- water table changes at groundwater dependant ecosystems

2.2 Scope

The scope of this Plan is limited to the management of groundwater and mitigation required for construction of the Project. This Plan does not include measures to manage surface water quality impacts associated with contaminated land. Those impacts are managed through the Soil and Water Management Sub Plan (SWMP).

In addition:

- any waste removal associated with the works (including liquid waste) will be managed in accordance with the Waste & Resources Management Sub Plan (WRMP).
- if Acid Sulphate Soils (ASS) are encountered these will be managed in accordance with the ASS Management Plan included in the SWMP.

This Plan does not include measures to manage the works within the former Tempe Landfill (including management of leachate, gas and odour). These works are managed through the Landfill Leachate, Gas and Odour Management Sub Plan (LLGOMP).

This Plan does not include measures to manage contaminated land management during the works. This will be managed in accordance with the Contaminated Land Management Plan, noting that any contaminated groundwater requirements may also form part of the remedial actions required under the Remedial Action Plans.

2.3 Objectives

The key objective of this Plan is to ensure all requirements relevant to groundwater management are captured, scheduled and assigned responsibility as outlined in:

- The combined Environmental Impact Statement (EIS) / Major Development Plan (MDP) prepared for the Sydney Gateway Project – Stages 1 & 3
- Conditions of Approval (CoA) for SSI 9737 issued by the Minister for Planning and Public Spaces (NSW), on 27 August 2020
- Updated Management Measures (UMM) detailed in the Response to Submissions Report.
- Roads and Maritime specifications G36 and G38
- The Project's Environmental Protection Licence (EPL)
- Relevant legislation and other requirements described in Section 3.1 of this Plan

2.4 Targets and performance outcomes

The following targets have been established for the management of groundwater impacts during the delivery of the Project. JHSWJV will:

- Ensure compliance with the relevant legislation, policy, CoA and UMMs
- Meet EPL requirements
- Ensure training is provided in the form of inductions to relevant Project personnel relating to groundwater issues before they begin work on site
- Implement reasonably practicable measures to manage groundwater during construction
- Monitor groundwater quality to ensure compliance with discharge requirements
- Implement a dewatering strategy that considers expected volume of inflow
- Monitor any changes to groundwater levels and quality due to the Project to ensure no impacts to the local area

The performance outcomes relevant to groundwater management (as identified in Chapter 27.4 Compilation of performance outcomes of the EIS/MDP) are detailed in Table 2-1.

Table 2-1 – Environmental performance targets and outcomes

No.	Performance Outcomes	Where addressed
1	The project avoids long term impacts on surface water and groundwater hydrology.	Section 5.3 Section 6 Appendix B – Groundwater Monitoring Program
2	Impacts to water quality during construction and operation are minimised.	Section 5.4 Section 6 Appendix B - Groundwater Monitoring Program

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

All legislation relevant to this Plan is included in Table 3.1 below as detailed in Section 3.2.3 of the CEMP.

Table 3-1 – Legislation relevant to this Plan

Act	Activity / aspect	Requirement	Reference	Applicability
Water Management Act 2000 With the exception of controlled activity approvals, the Water Management Act 2000 (WM Act) only applies in relation to those water sources covered by operational water sharing plans – these areas cover most of the State's major regulated river systems.	Groundwater	An aquifer interference approval/licence may be required under Section 91(3) of the WM Act if construction groundwater is intercepted by the Project.	S91	No - Under the EP&A Act the Project is exempt from this requirement. .
Water Act 1912 Note that this Act is being progressively repealed by the WM Act. With the exception of controlled activity approvals, the WM Act only applies in relation to those water sources covered by operational water sharing plans – these areas cover most of the State's major regulated river systems.	Groundwater	Obtain a licence where interference with groundwater is likely to occur.	S112 S121A	S112 does not apply to the Crown. TfNSW is therefore not required to obtain a licence under this provision.
Protection of the Environment Operations Act 1997	Harming the environment	Do not risk harming the environment by wilfully or negligently: • disposing of waste unlawfully.	S115 S116 S117 S120	Yes

		• causing any substance to leak, spill or otherwise escape (whether or not from a container); or emitting an ozone depleting substance		
	Control equipment	Properly and efficiently maintain and operate any installed pollution control equipment (including monitoring devices).	S167 S120	Yes
	Notification of pollution incidents	Notify the EPA immediately of pollution incidents where material harm to the environment is caused or threatened.	S148	Yes
Contaminated Land Management Act 1997	Contamination investigations	Site investigations must be undertaken in accordance with guidelines made or approved under this legislation	S105	Yes
	Reporting contamination	Notify the EPA if: • Contaminants exceed thresholds contained in guidelines or the regulations where contamination has entered or will foreseeably enter neighbouring land, the atmosphere, groundwater or surface water • Contaminants in soil are equal to or exceed guideline levels with respect to the current or approved use of the land.Contamination meets other criteria that may be prescribed by the regulations.	S60	Yes

3.1.2 Guidelines and standards

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

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC): National Water

Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines (ANZECC 2000)

- Department of Land and Water Conservation (DLWC)
  - NSW Groundwater Dependent Ecosystems Policy (DLWC 2002)
  - NSW Groundwater Policy Framework Document (DLWC 1998)
  - NSW Groundwater Quality Protection Policy (DLWC 1998)
  - NSW Groundwater Quantity Management Policy (DLWC 2007)
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (2004).
- Australian Drinking Water Guidelines (NHMRC 2013)
- NSW Water Quality and River Flow Objectives (DECCW 2006)
- NHMRC 2018
- Botany Bay and Catchment Water Quality Improvement Plan (SMCMA 2011)
- Department of Water and Energy (DWE): NSW Water Extraction Monitoring Policy (DWE 2007)
- NSW Department of Planning, Industry and Environment (DPIE) – Water
  - NSW Aquifer Interference Policy (NoW 2012)
  - Water Sharing Plan, Greater Metropolitan Regional Groundwater Sources
- PFAS National Environmental Management Plan (HEPA 2020)
- Australian Groundwater Modelling Guidelines (National Water Commission 2012)
- Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004) and Volume 2 (DECC 2008) (the “Blue Book”)
- Roads and Maritime:
  - Dewatering guideline (Road and Maritime 2011)
  - QA Specification G36 – Environmental Protection (Management System)
  - QA Specification G38 – Soil and Water Management (Soil and Water Management Sub Plan)

3.2 Water Quality Discharge Criteria

CoA E93 requires that, unless an EPL is in force that specifies alternative criteria, discharges from water treatment plans must not exceed the criteria set out in Table 6-1 in Section 6 below. These criteria were developed and approved as part of Appendix E in the Response to Submissions Report.

3.3 Conditions of Approval – SSI 9737

The Conditions of Approval (CoA) relevant to this Plan are listed in Table 3-3 below. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

3.4 Other Requirements Relevant to the Development of this Plan

Other requirements detailed in the Updated Mitigation Measures (UMMs) and relevant TfNSW Specifications (G36, 38 and 40) are detailed in Table 3-4 below.

Table 3-2 – Conditions of Approval relevant to the Groundwater Management Sub Plan

Source	Requirement	Document Reference	How addressed
CoA C5(g)	The following **CEMP Sub-plans** must be prepared in consultation with the relevant agencies identified for each **CEMP Sub-plan.** Details of all information requested by an agency during consultation must be included in the relevant **CEMP Sub-plan,** including copies of all correspondence from those agencies. (g) Groundwater-- (DPIE Water, Sydney Water (if it is proposed to discharge to or impact on its assets)	Section 3.5	The Groundwater Management Sub Plan has been prepared in accordance with this condition and describes how JHSWJV will manage groundwater during construction of the Project. This Plan was provided to DPIE-Water and Sydney Water for consultation.
CoA C6	The CEMP Sub-plans must state how:		
	(a) the environmental performance outcomes identified in the documents listed in Condition A1 will be achieved;	Section 2.3	This plan was prepared in accordance with the environmental performance outcomes detailed in the EIS / MDP and Response to submissions report and is evidenced in Section 2.3.
	(b) the mitigation measures identified in the documents listed in Condition A1 will be implemented;	Section 6	Mitigations measures and how they will be implemented are detailed in Section 6.
	(c) the relevant terms of this approval will be complied with; and	Section 3.3, Table 3.2	Details of how JHSWJV will comply with relevant terms of approval are detailed in this Table.
	(d) issues requiring management during construction, as identified through ongoing environmental risk analysis, will be managed.	Section 5 Section 6 Section 8	Groundwater management issues during construction have been identified through the EIS, MDP and response to submissions report. Issues requiring management have been detailed in Section 5. Assessment of potential groundwater risks and impacts will be regularly reviewed in accordance with Section 8 of this Plan to ensure effective management of groundwater. Mitigation measures to reduce groundwater impacts are detailed in Section 6.3, Table 6.3.
CoA C15 (c)	The following **Construction Monitoring Programs** must be prepared in consultation with the relevant agencies identified for each program to compare actual performance of construction of the	Appendix B	A groundwater monitoring program has been completed that addresses this condition- refer Appendix B. Consultaiton with

Source	Requirement	Document Reference	How addressed
	CSSI against the predicted performance and to inform management measures		DPIE Water on this Program has been undertaken as part of this overall Plan.
CoA E92	Groundwater generated from the dewatering of excavations and leachate from Tempe Landfill cannot be directly discharged to surface waters unless an EPL is in force in regard to the discharge which permits the discharge.	Section 6.1.6 Table 6.3, GWMM5	Management of leachate encountered in the former Tempe Landfill area will be managed in accordance with the Landfill Leachate, Odour and Gas Management Sub Plan (LLGOMP). A leachate treatment plant will be installed to treat leachate to the requirements outlined in the Sydney Water Trade Waste Agreement (TWA35548). Groundwater from excavations outside of the former landfill area will be sent to the WTP for treatment and discharge. Discharge from the water treatment plants (WTPs) will be in accordance with the requirements of the EPL (once received). No discharge from WTPs will occur until the EPL is in place and discharge criteria agreed. A preliminary Dewatering Management Strategy is included in Appendix A of this Plan which will be updated (if required) once the EPL is finalised and prior to the commencement of bulk excavation
CoA E93	Unless an EPL is in force in respect to the CSSI and that licence specifies alternative criteria, discharges from construction water treatment plants to surface waters must not exceed: (a) the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (AWQG) default guideline values for toxicants at the 90 per cent species protection level; (b) for physical and chemical stressors, the guideline values set out in Tables 3,3.2 and 3.3,3 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000); and (c) for bioaccumulative and persistent toxicants, the AQWG guidelines values at a minimum of 95 per cent species protection level. Where the AWQG (2018) does not provide a default guideline value for a particular pollutant, the approaches set out in the AWQG (2018)	UMM-SW8 Section 6.1.3, Table 6.2	Discharge from the water treatment plants (WTPs) will be in accordance with the requirements of the EPL (once received). No discharge from WTPs will occur until the EPL is in place and discharge criteria agreed.

Source	Requirement	Document Reference	How addressed
	for deriving guideline values, using interim guideline values and/or using other lines of evidence such as international scientific literature or water quality guidelines from other countries, must be used.		

Table 3-3 – Other environmental requirements relevant to this Sub Plan

Source	Requirement	Document Reference	How addressed
TfNSW G38 C2.1.2c(iv), (v)	The Soil and Water Management Plan (SWMP) must identify all risks relating to soil erosion, and pollution caused by sediments and other materials, and describes how these risks will be addressed during construction. Site investigation and assessment of the following: • Groundwater • possibilities of, and limitations on, water extraction.	CEMP Appendix B9 Section 5 Section 6, Table 6.3	Risks to groundwater have been included and addressed in this Groundwater Management Sub Plan. Risks to soil erosion and pollution are addressed in the Soil and Water Management Sub Plan.
UMM – CS1	Additional soil and groundwater investigations will be undertaken to inform detailed design, construction planning, and preparation of remediation action plan(s) (RAP(s)). The investigations will include: • Groundwater investigations for all assessment areas and any indirectly affected areas • Soil and groundwater testing to address data gaps for land north of the rail corridor and Sydney Airport land.	Section 6 Table 6.3 GWMM9	Additional investigations are currently being completed to inform detailed design and construction planning. This will be detailed in the Hydrogeological Report (Design Report). In addition, a Contaminated Sites Investigation Report (CSIR) will be prepared in accordance with CoA E44. Any remediation required or testing requirements will be documented in the relevant RAP.
UMM – GW1	Detailed design and construction planning will seek to minimise impacts on groundwater by: • Avoiding the need to extract groundwater • Minimising groundwater inflows and volumes into excavations.	Section 6 Table 6.3	Appropriate measures to reduce intercepting and/or reducing groundwater inflows have been selected in the design phase and will be implemented during construction. A preliminary Dewatering Management Strategy is included in Appendix A of this Plan which will be updated (if required) once the EPL is finalised and prior to the commencement of bulk excavation.

Source	Requirement	Document Reference	How addressed
UMM – GW3	A survey of GW024036 will be undertaken to confirm the use of this bore. If this bore is in use, alternative water sources will be considered to ensure ongoing water supply as required.	Section 4.10 Section 6 Table 6.3	Site survey of GW024036 has been completed and confirmed to be not operational(under formal RFI system through TfNSW).
UMM – CS10	Acid Sulfate Soils Management Plan will be prepared as part of the Construction Soil and Water Management Plan in accordance with the Acid Sulfate Soils Assessment Guidelines (ASSMAC, 1998). The plan will define the process and measures to manage actual and potential acid sulfate soil and sediment disturbed during construction. The plan will include a summary of available acid sulfate soil information relevant to the project site and identify any further soil/water analysis required as a precursor to implementing the management plan. Acid sulfate soils will be disposed off site (where required) in accordance with the Waste Classification Guidelines – Part 4: Acid sulfate soils (NSW EPA, 2014).	Section 6, Table 6.3 GWMM12	An Acid Sulfate Soils Management Plan has been developed as part of the Soil and Water Management Sub Plan.
UMM – GW4	A dewatering management strategy will be developed to confirm the approach to managing dewatering of excavations during construction. The strategy will: • Outline measures to minimise groundwater inflow • Describe likely groundwater quality based on sampling data • Estimate potential groundwater inflow rates and volumes for proposed excavations • Identify proposed methods for managing extracted water, which could include reuse, infiltration, reinjection, discharge to stormwater, disposal to the wastewater system, and collection for off-site disposal • Include a feasibility assessment of each proposed management option for extracted groundwater • Identify any groundwater treatment requirements and methods for any of the proposed management options • Describe any applicable monitoring requirements.	Section 6.3 Table 6.3 GWMM4	A preliminary Dewatering Management Strategy is included in Appendix A of this Plan which will be updated (if required) once the EPL is finalised and prior to the commencement of bulk excavation

Source	Requirement	Document Reference	How addressed
UMM – GW5	A leachate management strategy will be developed to manage leachate at the former Tempe landfill during construction and ensure that the objectives of the site's voluntary remediation agreement continue to be met. The strategy will: • Identify predicted changes in leachate volumes due to the project, based on the detailed construction methodology • Identify any required changes to the existing leachate management system due to predicted changes in leachate volume and concentration and any other changes due to the project • Describe a framework for monitoring leachate levels and water quality to ensure that no leachate migrates into Alexandra Canal as a result of the project. • The strategy will be developed in consultation with Inner West Council, Sydney Water and the NSW EPA.	Section 6.1.6, Table 6.3 GWMM5	A Landfill Leachate, Gas and Odour Management Sub Plan (LLGOMP) has been completed. Monitoring associated with the former Tempe Tip has have been included in the LLGOMP.
UMM – GW7	The existing groundwater monitoring program will continue during construction, and will be supplemented as required, to: • Confirm groundwater quality to inform the selection management options for extracted groundwater, including treatment requirements for discharge • Monitor potential migration of contaminants due to groundwater extraction (if it is a credible risk) • Confirm if acidification of groundwater is occurring due to exposure of acid sulphate soils • Confirm local groundwater levels to inform estimation of potential inflows and dewatering rates • Monitor drawdown levels and radii of influence as well as extraction rates to allow comparison against predictions.	Appendix B of this Plan	A groundwater monitoring program has been completed that addresses this condition- refer Appendix B.
UMM – SW7	The performance of treatment systems required to treat construction water before discharge will be verified in relation to the established discharge criteria.	Section 6.1.4 Section 6.1.5 GWMM10	Water treatment plants (WTP) will be appropriately commissioned to validate treatment efficacy against discharge criteria. WTP discharge will be monitored to ensure discharge criteria are being met. This is detailed in the Soil and Water Management Sub Plan.

Source	Requirement	Document Reference	How addressed
UMM – SW8	The discharge criteria specified in Appendix E would be met for any extracted groundwater or surface water that has come into contact with excavated waste materials prior to discharge into Alexandra Canal and connected stormwater systems.	Section 6.3, Table 6.3	Criteria detailed in Table 3-2, Table 6.2 and the appendices of this document.
UMM – SW9	Options to reuse construction water, such as for dust suppression and irrigation of rehabilitated and landscaped areas, would be investigated and adopted where practicable to minimise the volumes requiring discharge or disposal.	Section 6.1 GWMM4	This is detailed in the Soil and Water Management Sub Plan.

3.5 Consultation

This Plan and the Groundwater Monitoring Program were provided to DPIE-Water and Sydney Water in accordance with CoA C5(g) and C15(c).

4 Existing environment

4.1 Climate

Climate data has been obtained from the closest BOM weather station (066037) at Sydney Airport. Sydney Airport has data from 1939 to present (81 years).

Most rainfall occurs between during autumn and the highest average rainfall occurs in June. The lowest rainfall occurs in Spring. The average annual rainfall is 1,079.1 mm. Statistics are provided in Table 4-1.

Table 4-1 – Climate statistics for Sydney Airport (066037)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall average (mm)	93.8	114.2	118.1	106.0	95.3	124.8	69.2	75.6	59.7	70.1	79.5	72.8
Temp mean minimum (°C)	23.1	24.2	23.3	20.5	18.2	15.3	15.3	15.3	17.7	19.9	250.7	22.6
Temp mean maximum (°C)	30.6	29.4	28.4	26.2	23.4	20.4	20.4	21.5	25.2	27.0	27.2	29.5
Average ET (mm)	146.5	120.5	110.7	82.2	62.4	47.7	55.0	74.0	96.9	122.2	134.9	150.0

Notes: 1. ET – evapotranspiration
2. Data sourced from Bureau of Meteorology (data range 1939 to 2020)

4.2 Hydrogeology and aquifers

The following details the hydrostratigraphic units in the project area:

- **Fill** – Two main types of fill materials are in the study area – landfill material at the former Tempe landfill, and fill associated with reclaimed land in the vicinity of and including Sydney Airport land. The reclaimed material is generally reworked local estuarine deposits and is similar in composition to the underlying natural materials. There are also intermittent areas of fill across the project site associated with development/infrastructure.
- **The Botany Sands** – Groundwater is contained in the pore spaces in the unconsolidated sand sediments. The aquifer is unconfined and high yielding with a significant connection with surface water.
- **Ashfield Shale** – A low-yielding aquifer. Like the Hawkesbury Sandstone, its permeability is controlled by fracture intensity and connectivity. Groundwater within this unit is highly saline.
- **Hawkesbury Sandstone** – A semi-confined dual porosity regional aquifer extending across the Sydney Basin. Groundwater flow is predominantly through the open and connected fractures and bedding plane of the rock mass. Reduced water quality within the upper portion of the sandstone unit may be due to the natural leakage of saline groundwater from the Wianamatta Group (Ashfield Shale).

The project site is likely to intersect the shallow, unconsolidated Botany Sands aquifer across most excavations outside of the Tempe Tip landfill area.

4.3 Groundwater recharge

Groundwater recharge is primarily by rainfall infiltration. The main area of recharge for the Botany Sands is located to the north-east of the project site at Centennial Park. Other areas of significant recharge are the Botany Wetlands to the east of the project site, golf courses and parklands. Recharge ranges from 6% of rainfall over estuarine sediments and 37% of rainfall over sands. Around the project site, recharge is limited by impervious surfaces.

4.4 Groundwater flow and depth

Flow directions within the Botany Sands aquifer are controlled by topography. From the recharge areas located at higher elevations east and north-east of the Botany Basin (ie Centennial Park), groundwater flows south and south-west towards discharge points in Botany Bay, Cooks River and Alexandra Canal. The groundwater level near Cent

ennial Park is approximately 35 metres above sea level with elevations gently declining south to Botany Bay. Estimated travel time within the aquifer is days to months and is highly connected to surface water features.

Depth to groundwater for the Project ranges from 0.20 to 14.42 m below ground level and -7.74 to 2.38 m above sea level.

4.5 Hydraulic conductivity

Hydraulic conductivity is a measure of how easily groundwater moves through the aquifer. The Botany Sands is known to be a highly permeable and productive aquifer with high connectivity to surface water features. A summary of hydraulic conductivity data, from previous investigations documented in the EIS/MDP and those completed for the project, for the Botany Sands aquifer and unconsolidated fill is provided in Table 4-2.

Table 4-2 – Hydraulic conductivity within the Botany Sands and alluvial sediments aquifer

Value	Hydraulic conductivity (m/day)
Average	10.03
Minimum	0.09
Maximum	52
Median	1.86
Number of tests	31

Note: 1. m/day – metres per day

4.6 Groundwater quality

The groundwater quality in the Project area is poor due to historical contamination from surrounding industry. Baseline monitoring, from December 2018 to December 2020, completed for the project identified exceedances for the following criteria:

- Human health (recreational) criteria for arsenic, chromium, total phosphorus, manganese, naphthalene, total recoverable hydrocarbon (TRH), iron, ammonia, chloride, sodium, total dissolved solids, pH, lead and PFAS.
- Ecological criteria for the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018):

- Freshwater criteria for aluminium, nickel, zinc, copper, boron, cadmium and manganese.
- Marine criteria for cobalt, lead and zinc.
- Freshwater and marine criteria for naphthalene, ammonia and PFOS.

4.7 Ecology

The Alexandra Canal and Cooks Rivers is characterised as a highly disturbed estuarine systems. The goal is to return these ecosystems to a less disturbed condition. For this purpose, the adoption of the ANZG (2018) guideline values for the protection of 80 per cent of species in marine ecosystems, and 95 per cent of species for toxicants that bioaccumulate, have been adopted.

Technical Working Paper 8 has also developed site specific water quality objectives in accordance with the referential approach in ANZG (2018). This has included the adoption of the 80th percentile observed water quality values in the Cooks River and Alexandra Canal for analytes with concentrations above the adopted ANZG (2018) criteria. These values are presented in Table 3-2

The NEMP provides ecological marine criteria for PFAS, which has also been adopted for aquatic ecosystems in the Alexandra Canal. These two features are expected to be the primary surface water features that would be potentially affected by groundwater discharged from the Project. The NEPM provides criteria for highly disturbed systems such as the Alexandra Canal. Due to the sensitivity of issues related to PFAS and the potential for bioaccumulation, guideline values for a higher level of protection (95 per cent of marine species) have been adopted.

4.8 Acid sulphate soils:

Information from the EIS/MDP identifies that ASS is present in several areas and that drawdown intersects class 2 and class 3 ASS. Further details are provided in the Soil and Water Quality Management Sub Plan.

4.9 Potential sources of groundwater contamination

Data from existing groundwater monitoring across the Project area and general vicinity of the Project have identified a range of pollutants present in the groundwater. Many of these pollutants are at levels which exceed screening levels and/or human health levels (EIS/MDP TWP 7). Potential contaminants of concern are:

- Heavy metals
- Nutrients (ammonia, nitrogen)
- PFAS
- Pesticides
- Total Recoverable Hydrocarbons (TRH)
- Total xylenes (BTEX)
- Petroleum hydrocarbons – volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs)
- Phthalates and polychlorinated biphenyls
- Chlorinated hydrocarbons, dioxins and phenols
- LNAPL

Properties within and near the Project site that have been listed on the NSW EPAs Contaminated land record are as follows:

- Former Tempe landfill
- Alexandra Canal bed sediments
- Former Mascot Galvanising
- Cooks River rail terminal
- Ing Industrial Fund
- Heritage Business Centre
- Sokol Corporation

Other contaminated sites that are near the Project site but are not listed on the NSW EPAs contaminated land record are as follows:

- Sydney Airport northern lands staff car park
- Sydney Airport Joint User Hydrant Installation (JUHI)
- Hydrocarbon plumes within the Sydney Airport Qantas lease areas
- Sydney Airport taxi parking area between Ninth and Seventh streets
- Boral St Peters recycling facility

4.10 Leachate

The former Tempe landfill is capped and dammed with a bentonite wall. A leachate management system is in place to capture excess leachate, preventing it from entering Alexandra Canal. In this regard, there is a clear separation of leachate management (inside the bentonite wall) and groundwater management (outside the bentonite wall). The management of leachate is further detailed in the Landfill, Leachate Gas and Odour Management Plan.

4.11 Groundwater dependent ecosystems

There are no GDEs near the Project site. The closest high priority GDE to the Project site is the Botany Wetlands and Lachlan Swamps, located about two kilometres east of the southern end of the Project.

4.12 Groundwater users

A total of 23 registered groundwater bores were identified within a 1 km radius of the project site (EIS/MDP Chapter 15). Nine of those bores are registered as water supply bores. Most of the bores are less than 20 metres deep and are expected to be within the Botany Sands aquifer and alluvial sediments.

5 Environmental aspects and impacts

5.1 Construction activities

Key aspects of the Project that could result in groundwater impacts include:

- Drilling, piling, excavation and benching;
- Dewatering activities including from utility installations and drainage works;
- Installation of retaining walls; and
- Dynamic compaction.

5.2 Impacts

The impacts of Project construction on groundwater include:

- Groundwater drawdown at sensitive groundwater receptors;
- Environmental and health risks due to dewatering/disposal of contaminated groundwater; and
- Dewatering / groundwater drawdown induced settlement

Impacts on groundwater are described in the EIS/MDP and subsequently in this Plan. The sections below provide further details.

5.2.1 Groundwater Drawdown and Settlement

There are 23 items of Project infrastructure estimated to intercept the groundwater table. Highest inflows are generally associated with the stormwater channel installations. Modelled groundwater inflow rates during construction are detailed in Table 6-3 of this Plan (refer TWP7).

The temporary nature of groundwater interference activities (excavations and dewatering) limits the drawdown extent. Drawdown impacts are not anticipated with no groundwater receptors (ie GDEs or users) within the modelled drawdown. The area of drawdown influence predicted in the EIS/MDP (TWP 7) intersects a number of built-up areas primarily around Qantas Drive, Airport Drive and north-west of the Northern Lands, which may therefore be subject to settlement.

The modelled drawdown intersects the Alexandra Canal. The Alexandra Canal is a highly modified surface water drainage system, it is tidally influenced and has a large catchment. It is considered unlikely to be noticeably impacted by drawdown from construction activities. There are no other surface water sources or ecosystem within the modelled drawdown.

Temporary dewatering for construction activities may result in settlement (ie the compression of the soil structure). Factors influencing potential for settlement include:

- Duration of groundwater drawdown
- Depth and thickness of the soil profiles in which settlement occurs
- Spatial extent, distribution and variability of the soil profiles
- Geotechnical properties of the materials (ie stiffness and consolidation properties)
- Changes in groundwater pressure and/or extent of recharge

Predictions of groundwater drawdown were used to estimate potential ground settlement on structures adjacent excavations (refer TWP7). The groundwater drawdown is not expected to

induce significant settlement with the desktop assessment completed for the project estimating settlement risk ranging from very slight to slight (ie less than 35 mm maximum settlement).

Drawdown impacts will be monitored as per the Groundwater Monitoring Program (and Dewatering Management Strategy). Monitoring bores will be equipped with automated pressure transducers which will record continuous groundwater level data to validate the modelled drawdown.

5.2.2 Impacts on existing groundwater users

Two third-party water supply wells are within the modelled drawdown influence:

- Groundwater Works (GW)024036, on Keith Smith Avenue. This bore will be destroyed by project construction. Survey information has confirmed that this bore is not in use..
- GW024655 in a former Caltex property. This bore is on the edge of the modelled drawdown. It is unlikely the well is used for water supply because of the Botany Sands embargo and the lands former use as a fuel station.

5.2.3 Acid sulphate soil materials

Dewatering for construction will lower the groundwater table, potentially in areas with ASS environments. The disturbance and/or dewatering of ASS can lead to oxidation and generation of sulfuric acid, lowering the pH of the soil and groundwater.

Modelled drawdown intersects areas mapped as class 2 and class 3 acid sulphate soils (ASS).

While groundwater would be captured during dewatering, any oxidised sediments could potentially continue to generate low pH groundwater and alter groundwater quality which could discharge to surface water environments.

ASS could corrode subsurface infrastructure and deteriorate surface water quality and riparian ecosystems. However, riparian ecosystems near the project (ie Alexandra Canal) are tidal and sediments are predisposed to regular oxidation meaning acidification of the soil has likely already occurred and the current riparian ecosystem represents this occurrence, or sediments do not contain ASS generating properties.

5.2.4 Contaminated sites

Soils and groundwater within and in the vicinity of the Project site feature a range of pollutants depending on the location and historical land uses. There is potential to intersect contaminated soil and groundwater during excavation which could contaminate receiving environments if not managed correctly.

It is possible dewatering could draw groundwater contamination plumes toward excavations. The following known contaminated sites are within worst case scenario modelled drawdown radius:

- Former Tempe landfill –leachate migration is likely to be limited by the bentonite wall and leachate capture system.
- Boral facility – modelled drawdown estimates the stormwater channel installations that flank the facility and Alexandra Canal could capture contaminated groundwater.
- Sydney Airport staff taxi parking area – the site has known LNAPL of unknown extent. Modelled drawdown estimates indicate the proposed stormwater line may intersect the LNAPL plume under worse case conditions.
- The joint user hydrant installation (JUHI) – proposed stormwater lines and retaining walls are close to the JUHI and there is a high possibly contaminated groundwater would be captured by excavations.

- Qantas Jet Base – stormwater lines are closely located and have a high potential to capture contaminated groundwater if present.

5.2.5 Excavation dewatering

Discharges from dewatering have the potential to impact receiving environments and put construction workers at risk of exposure to contaminated groundwater.

Discharge criteria for abstracted groundwater is detailed in Section 3.2

5.2.6 Surface Water

Contaminated surface water runoff from construction areas could flow to surface water systems and infiltrate the groundwater system. However, the infiltration process is generally effective in filtering polluting particles and sediment, the risk of contaminating groundwater from particulate bound contaminants, such as heavy metals, is considered low.

5.2.7 Fuel and chemical storage

Inadequate storage or spills of fuels and chemicals during construction could further contaminate surface and groundwater systems. Soluble pollutants (ie pH altering solutes, salts and nitrates) and soluble hydrocarbons can infiltrate soils and contaminate groundwater.

6 Environmental control measures

6.1 Management of Excavation Areas

Management of water entering excavation areas will ultimately determine the extent of groundwater management during construction. The following steps have been considered for excavation areas across the Project:

- Installation of surface water diversions (clean water diversions, drains/swales etc) where possible around excavation areas to minimise the extent of surface water runoff that has the potential to enter excavations (to minimise the extent of water interacting with the groundwater in excavations);
- The design of the project has actively been completed (being completed) to minimise the extent of excavation required across the alignment. A significant number of fill areas exist across the alignment. The groundwater table is high in the Project area and some project works will be unable to avoid groundwater interactions.
- Where excavations are required, the dewatering strategy (refer Appendix A) will be utilised. The primary strategy is use of the Water Treatment Plant for managing and treating groundwater encountered within excavations. As noted in Section 6.2 of the Plan, two WTPs are proposed for the Project- one fixed location at the C1 Compound and one mobile plant to assist in management of excavations and dewatering where pipework cannot be feasibly located to transfer water to the fixed WTP.
- JHSW has undertaken detailed construction planning of the planned excavations across the Project alignment, timing of excavations (in relation to other activities that require dewatering) and the volumes of water reasonably expected in the excavations- both during dry weather and wet weather. This has formed the basis of the sizing of the WTPs.

6.2 Water treatment

6.2.1 Overview

Extracted groundwater, once collected through localised storage in the form of tanks at work fronts and bunded areas, will be transferred to discrete water treatment plants (WTPs) via high-density polyethylene (HDPE) pipelines for treatment and subsequent discharge into Alexandra Canal. In the event transfer to WTP is not available, captured groundwater will be taken off site as liquid waste.

The potential for appropriately sized storage tanks at various work fronts will be considered as part of the detailed construction planning for the water management within the work sites.

There are two WTPs proposed for the project as follows:

- A fixed WTP will be located in the C1 Visy Compound as indicated below in Figure 6.1. This WTP will be designed to an approximate capacity of approximately 25-30L/s. The exact capacity will be determined as part of the detailed design process.
- A mobile WTP will be located in areas of the Project where pipework to the main/fixed WTP is not feasible. This WTP will be designed to an approximate capacity of 5L/s.

Both WTPs will discharge into Alexandra Canal in accordance with the Project discharge criteria (refer to Table 6-1, noting that this criteria is to be finalised in the EPL) and at authorised discharge points (also to be finalised in the EPL), noting that the discharge point for the mobile WTP will need to be varied under the EPL from time to time.

Opportunities to reuse treated construction and groundwater to reduce discharge volumes will be implemented where appropriate.

The treatment process are likely to include:

- Pre-treatment: physical separation using baffle bins to remove heavier particulates and air strippers which will target ammonia, volatile organics, iron and manganese;
- Primary Treatment: settlement, including chemical injection (coagulation, flocculation and pH adjustment) if necessary. This stage targets organics and heavy metals;
- Secondary Treatment: media filtration using zeolite which will be utilised for physical filtration for further removal of particulates and ion exchange for metals and ammonia; and,
- Tertiary Treatment: media filtration of coal based granular activated carbon (GAC) and/or acid washed coconut catalytic GAC, which will incorporate physical adsorption targeting PFAS removal and provide a fail-safe for any remaining contaminants.

Figure 6-1 Indicative location of Water Treatment Plant (C1-Visy Compound)

6.2.2 Discharge volume

Discharge volumes will be monitored and recorded using calibrated flow metres on the WTPs. Volumes will be reported in routine (3 monthly) monitoring reports.

6.2.3 Discharge water quality

The discharge criteria for Alexandra Canal is detailed in Table 6-1 below. The criteria were developed in compliance with CoA E93.

Table 6-1 – Discharge criteria for Alexandra Canal

Parameter	Unit	Alexandra Canal
pH	pH units	7.0 to 8.5
Turbidity	NTU	10
Aluminium	µg/L	0.5
Arsenic	µg/L	2.3
Barium	mg/L	2
Boron	µg/L	5,100
Cadmium	µg/L	5.5
Chromium (VI)	µg/L	20
Chromium (III)	µg/L	49
Copper	µg/L	3
Cobalt	µg/L	14
Iron	µg/L	300
Lead	µg/L	6.6
Manganese	µg/L	80
Mercury	µg/L	0.40
Nickel	µg/L	70
Zinc	µg/L	23
Bicarbonate alkalinity as $CaCO_3$	mg/L	124
Ammonia	ug/L	1200
Nitrate	ug/L	15
Nitrite	ug/L	15
Total Phosphorus	ug/L	30
Total Nitrogen	ug/L	300
PFOA	µg/L	220
PFOS	µg/L	0.13
TPH – C6-C9 fractions	µg/L	150
TPH – mineral oil (>C9 fractions)	µg/L	600
F2-Napthalene	mg/L	70
Ethylbenzene	µg/L	110
Total xylenes	µg/L	830
p-xylene	µg/L	200
m-xylene	µg/L	100
o-xylene	µg/L	350
Naphthalene	µg/L	70
Anthracene	µg/L	0.4
Phenanthrene	µg/L	2
Fluoranthene	µg/L	1.4

Parameter	Unit	Alexandra Canal
Benzo(a)pyrene	µg/L	0.2

Note: Criteria based on draft EPL proposed by the EPA

6.2.4 WTP commissioning

The WTPs performance will be assessed and modified as required to meet the relevant discharge criteria within the EPL or as listed above. A minimum of two samples, testing the analytes detailed in Table 6-1, will be completed to confirm the WTPs efficacy. This will be completed once all the WTP infrastructure is in place.

A relationship between TSS and turbidity can also be developed which can serve as a proxy for the TSS threshold.

6.2.5 WTP post-commissioning

WTP discharge will be sampled fortnightly during the first 3 months of operation (the commissioning period). After the commissioning period, JHSWJV will continue to sample WTP discharge monthly throughout construction. Table 6-1 details the analytes and parameters to be sampled to ensure discharge criteria are being met.

In-line sensors, monitoring pH and turbidity (as NTU), will be installed to allow operators to observe any drift in water quality which may require investigation. If the WTP is shut down for maintenance, raw water will be recycled where appropriate, discharged as trade waste and/or disposed to a licensed waste facility. It should be noted that routine maintenance will likely be undertaken on weekend and night periods when inflows are minimal and can be temporarily placed in storage tanks until the WTP is back online. In the event of emergency maintenance, a review will be undertaken to determine if construction works need to temporarily cease to manage inflows to the WTP.

Water quality results and any WTP maintenance will be detailed in routine (3 monthly) monitoring reports.

6.2.6 Leachate treatment plant

JHSW will establish and operate an upgraded new Leachate Treatment Plant (LTP) for the duration of activities interact with the former Tempe Landfill. Any groundwater or construction water within the former Tempe Landfill area will be directed to the LTP for treatment and disposal.

The proposed LTP is a Sequencing Batch Reactor (SBR). This biological process involves utilising a maintained inventory of nitrifying bacteria to oxidise Ammonia within the raw leachate into Nitrate and Nitrite prior to discharge to sewer.

The LTP will use the existing leachate collection system, avoiding impacts to the bentonite wall, and will have sufficient capacity for current and future flows to ensure that the water quality of Alexandra Canal is not adversely affected by leachate originating from site. The capacity of the system will be in the order of 200m3/day unblended with a hydraulic blending capacity of 250m3/day.

Leachate will be treated to the requirements outlined in the Sydney Water Trade Waste Agreement (TWA35548).

6.3 Groundwater drawdown and plume migration

The modelled drawdown during construction is presented in Table 6-3 below (EIS, TWP 7). Reference to modelled excavation time relates to the number of days an excavation is expected to be opened.

Table 6-2 – Modelled inflow rates during Project construction

Project feature	Modelled excavation time (days)	Likely case inflow rates (ML/day)	Worst-case inflow rates (ML/day)	Likely case drawdown extent (m)	Worse case drawdown extent (m)
Retaining walls	3	0.090 - 0.224	0.151 - 0.740	80	100
Stormwater outlets/lines	2	0.03 - 0.41	0.400 - 1.620	70	90
Stormwater channels	2	0.184 - 0.550	1.262 - 2.135	70	90
Utilities	2	0.058 - 0.170	0.050 - 1.025	60	85
Eastbound terminal link	90	-	0.510	-	500

Additional groundwater monitoring data received since the EIS/MDP indicates that the extent of the groundwater contamination plumes are contained within Commonwealth land. The fact that each excavation area will be open for a limited number of days, and that these excavations are only temporary indicates that the potential for plume migration is limited.

JHSW has commissioned further plume modelling to inform detailed construction planning. The modelled groundwater drawdown and potential for contaminated plume migration will be validated by monitoring across the groundwater monitoring network (refer to the Monitoring Program in Appendix B). If drawdown observations exceed modelled predictions, mitigation measures will be implemented as per the Trigger Action Response Plan (TARP).

The inflow rate (and dewatering requirements) can be reduced by staging excavations and reducing the timeframes during which excavations are open. Additional controls include grout injection, sheet piling and/or sealed caissons. The most appropriate method to reduce inflows will be selected during detailed construction planning pending the outcomes of the plume modelling.

6.4 Settlement

At the time of preparing this Plan, the Hydrogeological Interpretative Report (HIR) is still under development and further details around settlement from drawdown are required. This report covers both areas directly impacted by the construction of the Project as well as areas that may be indirectly affected by groundwater induced settlement (ie there is a radius covering the potential zone of impact from the construction works). It is important to note that significant areas of fill are required across the alignment and whilst excavations will occur, the extent and duration has been limited to the greatest extent possible. Where mitigation of drawdown induced settlement is required, alternate construction methods can be considered (this includes the use of concrete module column construction in areas around the Alexandra Canal to displace soil from the excavation area and minimise potential settlement load). At this stage, reinjection of groundwater may not be feasible.

In addition, survey monitoring points will be used along the alignment to monitor for settlement as a result of construction of the Project. This will be in accordance with the relevant design packages along the alignment.

6.5 Other environmental mitigation measures

Specific measures and requirements to meet the objectives of this Groundwater Management Sub Plan and to address the CoA and UMMs are outlined in Table 6-3.

Table 6-3 – Groundwater management and mitigation measures

ID	Measure/Requirement	When to implement	Responsibility	Reference	Evidence
GWMM1	Detailed design and construction planning will avoid intersecting the groundwater table where possible by: • Optimising the design of the road formation and drainage to reduce excavation depths below groundwater levels. • Staging works to reduce the extent of open excavation areas that intersect with groundwater levels. • Specific areas with localised deep excavations well below the water table will be reviewed as part of construction staging to , reduce the extent of dewatering infrastructure required during these works (where possible).	Pre-construction	Design manager	UMM-GW1	Detailed design. Given the level of groundwater in the project area, some project works will be unable to avoid groundwater interactions.. A preliminary Dewatering Management Strategy has been developed to look at options for managing groundwater during excavations- refer Appendix A Monitoring of groundwater levels throughout construction as detailed in Appendix B
GMMW2	Modelling of settlement induced by construction dewatering will be completed, in accordance with the relevant guidelines, to predict potential settlement issues during construction. Should modelling identify any settlement issues, measures to reduce settlement will be confirmed during the design phase and implemented during construction to reduce impacts.	Pre-construction	Design manager	UMM-GW2	Design settlement assessment to be completed as part of the predicted effects reporting. The design will detail trigger levels and monitoring will validate levels in accordance with the design. No settlement impacts to surrounding infrastructure. Settlement remains less than 35 mm.
GWMM4	A Dewatering Management Strategy will be prepared, approved and implemented to minimise adverse impacts to the environment and ensure compliance with project	Prior to bulk excavation	Environment and sustainability manager	UMM-GW4 UMM-SW9	A preliminary Dewatering Management Strategy has been developed to look at options for managing

ID	Measure/Requirement	When to implement	Responsibility	Reference	Evidence
	planning and approval requirements. The Strategy will outline the following: • Describes groundwater quality based on the sampling data. • Estimates potential groundwater inflow rates and volumes for proposed excavations. • Details the methods to manage extracted water (ie treatment and/or reuse) and provides feasibility for selected methods. • Details treatment for discharge to receiving environments. • Describes monitoring requirements during dewatering.			UMM-CS19	groundwater during excavations- refer Appendix ADetails relating to monitoring and discharge are included in Appendix B Groundwater Monitoring Program.
GWMM5	A groundwater monitoring program will be completed to provide the necessary framework to monitor and assess potential construction impacts on groundwater by taking into consideration: • Groundwater quality to inform the selection management options for extracted groundwater, including treatment requirements for discharge. • Monitor potential migration of contaminations due to groundwater extraction (if it is a credible risk). • Confirm if acidification of groundwater is occurring due to exposure of acid sulphate soils. • Confirm local groundwater levels to inform estimation of potential inflow and dewatering rates. • Monitoring drawdown levels and radii of influence as well as extraction rates to allow comparison against predictions.	Construction Post-construction	Environment and sustainability manager	UMM-GW7	Groundwater Monitoring Program (Appendix B) Routine 3 monthly monitoring reports
GWMM6	Implement any remediation required or testing requirements documented in the relevant RAP.	Pre-construction	Design manager Construction manager	UMM-CS1	Remediation Action Plans may include requirements around groundwater. Once developed, the required measures will be

ID	Measure/Requirement	When to implement	Responsibility	Reference	Evidence
			Environment and sustainability manager		implemented in accordance with the RAP(s).
GWMM7	The WTP will be commissioned and post commissioned to verify to efficacy of the WTP in treating construction water to the criteria detailed in 3 and Section 6 in accordance with CoA E93. Regular monitoring will be completed to ensure WTP are meeting discharge criteria.	Pre-construction Construction	Design manager Construction manager Environment and sustainability manager	UMM-SW7 CoA E93	Discharge to Alexandra canal meeting discharge criteria detailed in Section 3 and 6. Ongoing monitoring verifying the WTP is meeting discharge criteria. Results of WTP discharge monitoring provided in 3 monthly monitoring reports.
GWMM8	As per condition UMM-SW8, the discharge criteria specified in Appendix E, Table 4.8 of the EIS submissions report will be used to discharge treated groundwater to Alexandra Canal and connected water systems.	Construction	Environment and sustainability manager	CoA E93 UMM-SW8	Section 3 and Section 6, of this Plan. Results of WTP discharge monitoring provided in 3 monthly monitoring reports.
GWMM9	The groundwater monitoring program will include monitoring of Acid Sulfate Soils	Pre-construction Construction Post-construction	Environment and sustainability manager	UMM-CS10	Monitoring of Acid Sulfate Soils has been included in the Monitoring Program in Appendix B (ie groundwater monitoring points).
GWMM10	Excavation and dewatering activities in areas of known acid sulphate soils will be managed in accordance with the Acid Sulphate Soils Management Plan.	Construction	Construction Manager	UMM-CS10	The Acid Sulphate Soils Management Plan is included in the Soil and Water Management Sub Plan.

7 Compliance management

7.1 Roles and responsibilities

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

7.2 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to overall environmental management. The induction training will address elements related to groundwater management including:

- Requirements of this Plan.
- Applicable and relevant legislative requirements.
- Roles and responsibilities for groundwater management.
- Typical construction activities that may impact groundwater and associated environmental mitigation and management measures.
- Procedures to be followed in the event of unexpected settlement, contamination or groundwater inflows.

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

- Potential project related groundwater impacts
- Potential project related groundwater impacts on the environment and surrounding community.
- Potential sources of groundwater contamination.
- Managing suspected contaminated water, sediments, soil or materials.
- Mitigation measures to minimise groundwater impacts.
- Managing and measuring dewatering operations.

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

7.3 Monitoring and inspection

7.3.1 Monitoring

The Groundwater Monitoring Program is provided in Appendix B. This Program will commence prior to bulk earthworks and will be reviewed at 6 monthly intervals for appropriateness.

This Program details inspection criteria, including:

- Groundwater level and quality monitoring locations
- The groundwater quality parameters and analytes
- Trigger level thresholds for groundwater level and quality
- The frequency of groundwater monitoring events
- Dewatering volumes

In addition, JHSW will undertake fortnightly surface water (ie Alexandra Canal) monitoring for the first three months of operation (the commissioning period). Following the commissioning period, JHSWJV will undertake monthly monitoring of the WTP discharge which will continue for the duration of the Project construction.

Groundwater level and quality monitoring and surface water quality monitoring will be completed in accordance with the following Australian Standards:

- AS/NZS 5667.6:1998 *Water Quality – Sampling – Guidance on sampling rivers and streams.*
- AS/NZS 5667.9:1998 *Water Quality – Sampling – Guidance on sampling from marine waters.*
- AS/NZS 5667.10:1998 *Water Quality – Sampling, Part 10: Guidance on sampling waste waters.*
- AS/NZS 5667.11:1998 *Water Quality – Sampling – Part 11, Guidance on Sampling of Groundwaters.*

7.3.2 Inspection

Regular monitoring and inspections will be completed by suitably trained JHSWJV personnel or qualified consultants. Relating to groundwater include:

- Inspections during construction dewatering to ensure dewatering volumes and quality are being measured and recorded.
- Inspections of HDPE pipe from dewatering sites to WTP to assess pipeline intergrity.
- Inspections of treated discharge water volumes to ensure discharge criteria are being met and volumes are being recorded.
- Inspections of treated discharge water sites to assess the efficacy of the dissipaters.
- Groundwater quality and level data will be reviewed and assessed following monitoring events for potential construction related impacts.

Results and notable observations from inspections will be included in 3-monthly reports to DPIE-Water.

Additional requirements and responsibilities in relation to inspections are documented in Section 3.9 of the CEMP.

7.4 Auditing

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

Audit requirements are detailed in Section 3.9 of the CEMP.

7.5 Reporting

Project reporting requirements specifically relevant to the management of groundwater impacts will be undertaken regularly using analysis of observed data against the groundwater impacts predicted in the EIS/MDP documents. This data will be reviewed as part of the quarterly monitoring report to DPIE Water as referenced below.

In accordance with CoA 19, groundwater monitoring data will be provided to DPIE-Water every three (3) months during the monitoring period and within one month of the last monitoring period. This data will be provided in excel format as requested by DPIE Water.

Other general reporting requirements are further detailed in Section 3.9 of the CEMP.

8 Review and improvement

8.1 Continuous improvement

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

The continuous improvement process will:

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

8.2 Plan update and amendment

The processes described in Section 3.9 to Section 3.13 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 3.11 of the CEMP.

Appendix A - Groundwater Dewatering Management Strategy (Preliminary)

Introduction

Dewatering, for the purposes of this Strategy, is any activity that involves the removal of ponded surface water or groundwater from on site excavations and the subsequent reuse or discharge of that water.

Surface water and groundwater will be encountered in construction formations and excavations. These areas must be dewatered to ensure work areas are not adversely affected by long periods of inundation.

Erosion and sediment controls will be used to control passive water movement off site and therefore are not considered dewatering for the purposes of this strategy. An approved Erosion and Sediment Control Plan (ESCP) will be in place.

The groundwater within the Project area is highly likely to be contaminated therefore it is important that surface water diversions are installed where possible to minimise the extent of potentially contaminated water being managed within excavations. These diversions will be managed through the implementation of Erosion and Sediment Control Plans (ESCPs) that will progressively be developed and updated as construction works progress.

Dewatering activities must be completed so as not to cause harm to the environment. A Dewatering Permit must be prepared and signed off for all dewatering activities. No dewatering is authorised until the Permit is signed off/approved.

Note: this Strategy is preliminary only on the basis that detailed design is not yet complete and detailed construction staging is being developed. In addition, the Project EPL is currently in draft form and therefore the criteria for water discharge and the discharge locations are preliminary only.

Areas of the Project that will require Dewatering / Potential Groundwater Inflows

The depth to groundwater for the Project ranges from 0.20 to 14.42 m below ground level. Details of existing groundwater levels within monitored borehole locations is provided in the Groundwater Monitoring Program. Due to the level of groundwater, majority of the excavation for the Project will encounter groundwater.

The modelled inflow rates estimated for the Project are as shown in the Table below:

Modelled inflow rates during Project construction

Project feature	Modelled excavation time (days)	Likely case inflow rates (ML/day)	Worst-case inflow rates (ML/day)	Likely case drawdown extent (m)	Worse case drawdown extent (m)
Retaining walls	3	0.090 - 0.224	0.151 - 0.740	80	100
Stormwater outlets/lines	2	0.03 - 0.41	0.400 - 1.620	70	90
Stormwater channels	2	0.184 - 0.550	1.262 - 2.135	70	90
Utilities	2	0.058 - 0.170	0.050 - 1.025	60	85
Eastbound terminal link	90	-	0.510	-	500

A summary of the groundwater quality is included in the table below:

Parameter	Botany Sands and alluvial sediments	Bedrock
Electrical conductivity (EC)	Brackish to saline • **Range:** 885 – 34,303 µS/cm • **Average:** 6,204 µS/cm	Brackish to saline • **Range:** 1,860 – 40,714 µS/cm • **Average:** 20,812 µS/cm
pH	Slightly acidic to mildly alkaline • **Range:** 6.41 – 9.42 • **Average:** 7.06	Slightly acidic ranging • **Range:** 5.76 – 6.32 • **Average:** 5.99
Major ions	Monitoring bores located near tidal areas are dominated by sodium chloride. Bores outside the tidal influence have a variable mix of cations (Na, Ca, Mg, K) dominated by bicarbonate ($CaCO_3$).	Monitoring bores located near tidal areas are dominated by sodium chloride. Bores outside the tidal influence have a variable mix of cations (Na, Ca, Mg, K) and anions (Cl, $CaCO_3$, SO_4).
Dissolved metals	Common exceedances of ANZG (2018) Fresh and marine water quality 80% DGVs[2] for B, Cd, Cu, Pb, Zn and Hg.	Common exceedances of ANZG (2018) Fresh and marine water quality 80% DGVs for Cd, Co, Cu, Mn, Ni, Pb and Zn.
Nutrients	Exceedances of the ANZG (2018) fresh and marine water quality 80% DGVs guidelines for Ammonia. Exceedances of the ANZECC (2000) DGVs for marine ecosystems for Total Nitrogen and Total Phosphorus.	
Groundwater aggressivity	Moderate risk to steel piles.	Aggressivity ranges from moderate risk to steel piles to high risk to concrete structures.

Notes: 1. µS/cm – Microsiemens per centimeter

2. DGVs – Default guideline value

Based on the above, the method of dewatering excavations is limited due to the highly contaminated nature of the water.

Dewatering Methods

Within the State land areas, there are three potential methods for dewatering of groundwater:

1. Water within the former Tempe landfill area will be managed through the Leachate Treatment Plant in accordance with the Landfill Leachate, Gas and Odour Management Plan. Testing regimes and discharge limits are in place for the Leachate Treatment Plant in accordance with the Trade Waste Agreement from Sydney Water.
2. Groundwater will be pumped from the site area/excavation via HDPE pipework to the WTP for appropriate treatment and disposal. Testing regimes and discharge limits are in place for the Water Treatment Plant (Note- discharge into State land is subject to an EPL being in place).
3. Groundwater will be removed from the site area/excavation via vacuum truck or sealed tanker and transported to the WTP for appropriate treatment and disposal. Testing regimes and discharge limits are in place for the Water Treatment Plant (subject to finalised EPL). Monitoring results will be provided to the EPA on a monthly basis.
4. Groundwater will be removed from the site area/excavation via vacuum truck or sealed tanker, tested and disposed offsite as liquid waste to a facility lawfully able to accept the waste. A waste classification report will be prepared prior to lawful disposal. Details will be maintained in the Waste Tracking register.

5. Groundwater infiltration. *Areas where groundwater infiltration may be possible are still being investigated by JHSW. Groundwater testing would need to confirm that the quality of the extracted groundwater is better than or the same as the receiving aquifer. These results along with a request for approval would need to be submitted to relevant authorities ahead of groundwater infiltration being undertaken.*
6. Groundwater reinjection. *Areas where groundwater reinjection may be possible are still being investigated by JHSW including the possible location of reinjection infrastructure. Groundwater testing would need to confirm that the quality of the extracted groundwater is better than or the same as the receiving aquifer. These results along with a request for approval would need to be submitted to relevant authorities ahead of groundwater reinjection being undertaken.*

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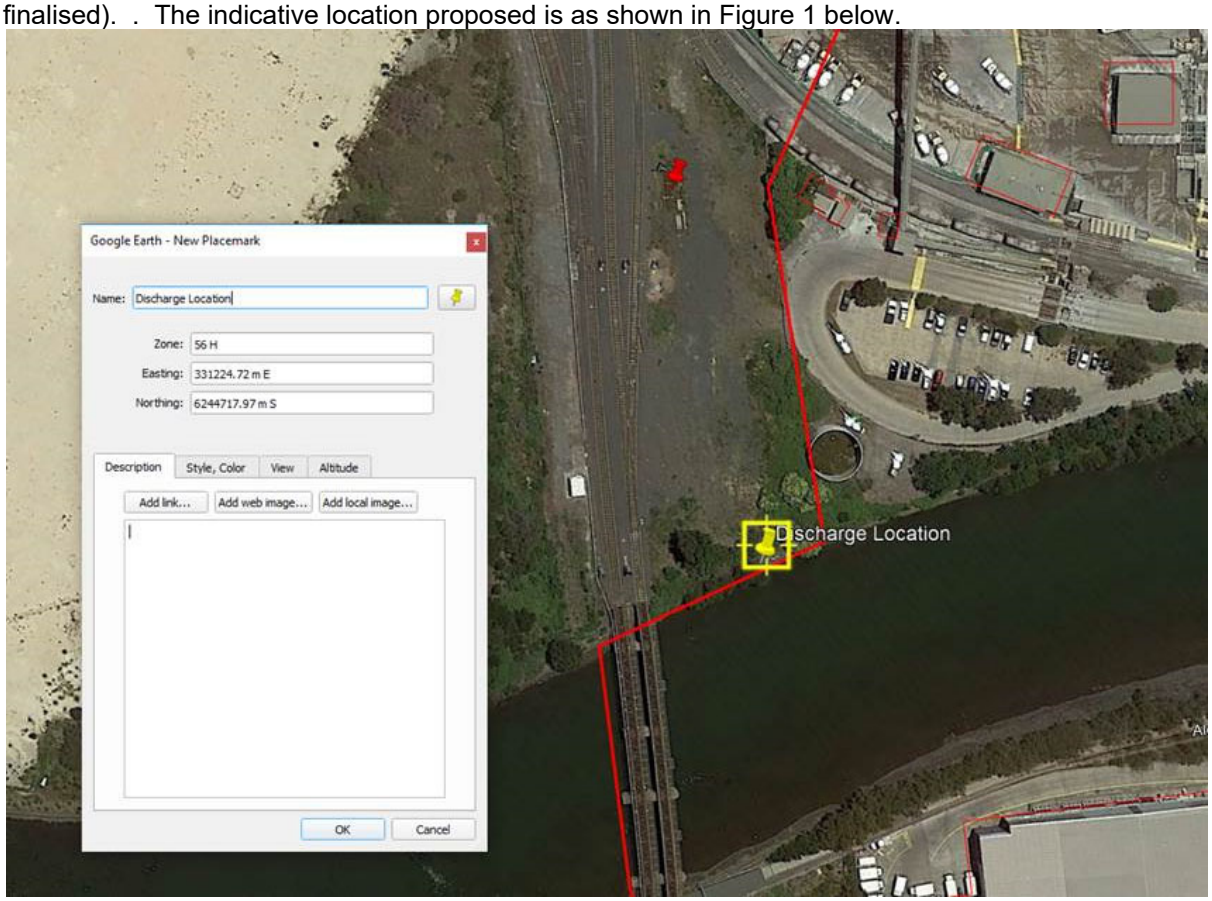
Opportunities for Reuse
It is highly unlikely that groundwater will be able to be reused (eg for dust suppression) on the Project due to the pre-existing contamination levels. Reuse of treated water from the WTP will be investigated.

Discharge location and water quality
The Water Treatment Plant discharge location is subject to detailed design (note- at this stage the location is based within State land and is therefore regulated under the Project EPL – still to be finalised). . The indicative location proposed is as shown in Figure 1 below.



Discharge criteria are also subject to the finalised EPL. The proposed discharge criteria are outlined in the table in **Appendix A** (to be updated if required once EPL is issued)

Monitoring requirements
Monitoring will be undertaken for both the discharge from the WTP as well as monthly groundwater monitoring (in accordance with the approved Groundwater Monitoring Program).

Approval for Dewatering
Prior to the commencement of dewatering activities, a Dewatering Permit must be signed off / approved by the relevant Environment Manager.

This will include a location map showing the area of the site that will require dewatering; a description and justification of all selected dewatering method; and confirmation of any testing that has been undertaken to confirm discharge criteria. Dewatering may not commence without a signed Permit. This Permit system also applies for transfer of water from one area of works within the project to another area of the project for final discharge (ie from excavation to WTP/LTP).

Responsibilities and Reporting
All dewatering activities must be supervised for the duration of dewatering. The responsibility for supervision will be the Project Engineer or Site Foreman. They are also responsible for ensuring they have an approved Dewatering Permit prior to comment.

In the event dewatering is undertaken without an approved Dewatering Permit, a non conformance will be raised (or an incident report in the event that the dewatering results in an incident) and notifications will be undertaken in accordance with the CEMP.

Appendix A- Discharge Criteria

Discharge criteria for Alexandra Canal

Parameter	Unit	Alexandra Canal
pH	pH units	7.0 to 8.5
Turbidity	NTU	10
Aluminium	µg/L	0.5
Arsenic	µg/L	2.3
Barium	mg/L	2
Boron	µg/L	5,100
Cadmium	µg/L	5.5
Chromium (VI)	µg/L	20
Chromium (III)	µg/L	49
Copper	µg/L	3
Cobalt	µg/L	14
Iron	µg/L	300
Lead	µg/L	6.6
Manganese	µg/L	80
Mercury	µg/L	0.40
Nickel	µg/L	70
Zinc	µg/L	23
Bicarbonate alkalinity as $CaCO_3$	mg/L	124
Ammonia	ug/L	1200
Nitrate	ug/L	15
Nitrite	ug/L	15
Total Phosphorus	ug/L	30
Total Nitrogen	ug/L	300
PFOA	µg/L	220
PFOS	µg/L	0.13
TPH – C6-C9 fractions	µg/L	150
TPH – mineral oil (>C9 fractions)	µg/L	600

Parameter	Unit	Alexandra Canal
F2-Napthalene	mg/L	70
Ethylbenzene	µg/L	110
Total xylenes	µg/L	830
p-xylene	µg/L	200
m-xylene	µg/L	100
o-xylene	µg/L	350
Naphthalene	µg/L	70
Anthracene	µg/L	0.4
Phenanthrene	µg/L	2
Fluoranthene	µg/L	1.4
Benzo(a)pyrene	µg/L	0.2

Note: Criteria based on draft EPL proposed by the EPA.

Appendix B- Groundwater Monitoring Program

Groundwater Monitoring Program – SSI 9737

Sydney Gateway Road Project

June 2021

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1 Introduction

1.1 Purpose

This Groundwater Monitoring Program (Program) sits within the Groundwater Management Sub Plan, which forms part of the Construction Environmental Management Plan (CEMP) for Design and Construction of Sydney Gateway Stage 1 & 3 (the Project).

The Program details the groundwater monitoring that will be completed to mitigate potential environmental impacts associated with the construction of the Sydney Gateway Road Project (SGWP). The Program addresses the Minister's Conditions of Approval (CoA), the environmental management measures listed in the Projects combined Environmental Impact Statement (EIS) / Major Development Plan (MDP), Updated Management Measures (UMMs) from the Response to Submissions Report and all applicable legislation and TfNSW requirements.

Note – this Program has been developed specifically for works occurring within NSW State owned land under approval SSI 9737, which is administered by the NSW Department of Planning, Industry and Environment (DPIE).

1.2 Objectives

The key objective of this Monitoring Program are to ensure all CoA, UMMs, and licence/permit requirements relevant to groundwater monitoring are described, scheduled, and assigned responsibility.

Operational monitoring and mitigation measures are outside of the scope of this Program.

1.3 Consultation

This Groundwater Monitoring Program has been submitted to DPIE Water and Sydney Water for review and comment along with the overarching Groundwater Management Sub Plan.

Refer to Section 3.5 for consultation requirements relating to the Groundwater Management Sub Plan.

Construction will not commence until such time as this Monitoring Programs has been endorsed by the ER and Approved by the Planning Secretary in accordance with the requirements of CoA C21 and C22.

1.4 Minister's Conditions of Approval

The CoA relevant to this Plan are listed in Table 1-1. A cross reference is also included to indicate where the condition is addressed in this Program or other documents.

1.5 Update Management Measures

The UMM relevant to this Plan are listed in Table 1-2. A cross reference is also included to indicate where the management measure is addressed in this Program or other documents.

Table 1.1 – Conditions of Approval

Source	Requirement	Document Reference
CoA C15(c)	The following Construction Monitoring Programs must be prepared in consultation with the relevant agencies identified for each program to compare actual performance of construction of the CSSI against the predicted performance and to inform management measures: (c) - Groundwater - (DPIE Water)	Section 1.3 of this Monitoring Program (and Section 3.5 of the Groundwater Management Sub Plan)
CoA C16	Each Construction Monitoring Program must provide:	
	(a) details of baseline data available;	Section 2 of this Monitoring Program
	(b) details of baseline data to be obtained and when;	The baseline monitoring has been completed for the Project and is detailed in Section 2 of this Monitoring Program.
	(c) details of all monitoring of the project to be undertaken;	Section 3 of this Monitoring Program
	(d) the parameters of the project to be monitored;	Section 3 of this Monitoring Program
	(e) the frequency of monitoring to be undertaken;	Section 3 of this Groundwater Monitoring Program
	(f) the location of monitoring;	Figure 2.1 shows the locations of baseline monitoring and Figure 3.1 shows the locations of the proposed groundwater monitoring points.
	(g) the timeframes and format for reporting of monitoring results and the agencies that will be provided with copies of the monitoring reports;	Section 5 of this Monitoring Program (and Section 7.5 of the Groundwater Management Sub Plan)
	(h) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and	Refer to Table 3.1 and Section 3.1 of this Monitoring Program
	(i) any consultation to be undertaken in relation to the monitoring programs.	Section 1.3 of this Monitoring Program (and Section 3.5 of the Groundwater Management Sub Plan)
CoA C19	The Groundwater Monitoring Program must include, but not be limited to:	
	(a) monitoring and recording of actual volumes of groundwater pumped from all excavations;	The details of recording volumes of groundwater is provided in Section 3.4 and Section 3.5.1.

Source	Requirement	Document Reference
	(b) monitoring and recording of groundwater levels and groundwater quality adjacent to areas where there is physical compaction in areas with shallow groundwater tables or adjacent to the former Tempe Landfill;	Section 5.1, Figure 5.1 and Table 5.2 of this plan
	(c) regular analysis of accumulated data against the groundwater impacts predicted in the documents listed in Condition A1; and	Section 5.1 of this Monitoring Program and Section 7.5 of the Groundwater Management Sub Plan
	(d) a method for providing the groundwater monitoring data to DPIE Water every three (3) months during the monitoring period within one month of the last monitoring period, including the format of the data.	Section 5 of this Monitoring Program (and Section 7.5 of the Groundwater Management Sub Plan)
CoA C20	The Construction Monitoring Programs must be developed in consultation with relevant agencies as identified in Condition C15 of this approval and must identify information, including monitoring parameters, requested by a relevant agency to be included in a Construction Monitoring Program.	Section 1.3 of this Monitoring Program (and Section 3.5 of the Groundwater Management Sub Plan)
CoA C21	The Construction Monitoring Programs must be endorsed by the ER and then submitted to the Planning Secretary for approval at least one month before the commencement of construction.	Section 1.3 of this Monitoring Program
CoA C22	Construction must not commence until the Planning Secretary has approved all of the required Construction Monitoring Programs, and all relevant baseline data for the specific construction activity has been collected.	Section 1.3 of this Monitoring Program
CoA C23	The Construction Monitoring Programs, as approved by the Planning Secretary, including any minor amendments approved by the ER, must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Planning Secretary, whichever is the greater.	Section 1.3 of this Monitoring Program
CoA C24	The results of the Construction Monitoring Programs must be submitted to the Planning Secretary, and relevant regulatory agencies, for information in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program.	Section 5 of this Monitoring Program 9and Section 7.5 of the Groundwater Management Sub Plan)

Note: 1. Only those conditions of approval (CoAs) relevant to this Groundwater Monitoring Program are listed in the table.

Table 1.2 – Updated Management Measures

UMM Ref.	Condition Requirements	Document Reference
UMM – GW2	Modelling of settlement induced by groundwater drawdown will be undertaken in accordance with relevant guidelines, based on detailed geotechnical information obtained from the site investigations and the proposed construction approach. Should modelling identify any settlement issues, measures to reduce settlement will be confirmed.	Design Report- Hydrogeological and Groundwater Interpretive Report (Doc No SGW13-JHSW-NWW-GE-RPT-000002)
UMM – GW4	A dewatering management strategy will be developed to confirm the approach to managing dewatering of excavations during construction. The strategy will: • Outline measures to minimise groundwater inflow • Describe likely groundwater quality based on sampling data • Estimate potential groundwater inflow rates and volumes for proposed excavations • Identify proposed methods for managing extracted water, which could include reuse, infiltration, reinjection, discharge to stormwater, disposal to the wastewater system, and collection foroff-site disposal • Include a feasibility assessment of each proposed management option for extracted groundwater • Identify any groundwater treatment requirements and methods for any of the proposed management options • Describe any applicable monitoring requirements.	A preliminary Dewatering Management Strategy is included in Appendix A of this Plan which will be updated (if required) once the EPL is finalised and prior to the commencement of bulk excavation. The monitoring requirements are detailed in this Monitoring Program.
UMM – GW6	The existing groundwater monitoring program will continue during construction, and will be supplemented as required, to: • Confirm groundwater quality to inform the selection management options for extracted groundwater, including treatment requirements for discharge • Monitor potential migration of contaminants due to groundwater extraction (if it is a credible risk) • Confirm if acidification of groundwater is occurring due to exposure of acid sulfate soils • Confirm local groundwater levels to inform estimation of potential inflows and dewatering rates • Monitor drawdown levels and radii of influence as well as extraction rates to allow comparison against predictions.	The existing groundwater monitoring program is detailed in Section 2 of this Monitoring Program and the proposed construction monitoring program is detailed in Section 3.
UMM – SW7	The performance of treatment systems required to treat construction water before discharge will be verified in relation to the established discharge criteria.	Refer to Section 3.5.2 of this Monitoring Program and Section 6.1.3 of the Groundwater Management Sub Plan

Note: 1. Only those updated management measures (UMMs) relevant to this Groundwater Monitoring Program are listed in the table.
2. UMMs that specifically relate to leachate management and works associated with the Tempe Landfill (ie GW5 and GW7) are dealt with in the Landfill Leachate, Gas and Odour Management Sub Plan and excluded from this Groundwater Management Sub Plan.

2 Baseline monitoring

2.1 Overview

A baseline groundwater monitoring program commenced in December 2018 with data available up to December 2020. The baseline groundwater monitoring network is presented in Figure 2-1 and Table 2.1.

The baseline monitoring program included:

- 52 monitoring bores
    - 26 monitoring bores within and around the former Tempe landfill area (prefixed MPI and MPE) to monitor groundwater quality, leachate levels and groundwater elevations inside and outside of the bentonite wall.
    - 4 monitoring bores screened in the underlying bedrock with reasonable distribution within the project site.
    - 24 wells around the construction footprint.
- Fifty monitoring bores were measured for baseline groundwater level.
- Automated data loggers installed in 16 monitoring bores.
- Forty-eight monitoring bores sampled for water quality, analytes included:
    - TRH, BTEX, VOCs, PAH, OCP, PCB, VHCs, Dioxins, Total Phenolics, heavy metals (Arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc).
    - Monitoring bores within and around the Tempe landfill were sampled for nutrients (ammonia, total nitrogen, nitrate/nitrite, total phosphorus), major ions (calcium, magnesium, sodium, potassium, chloride, sulphate, fluoride), ionic balance, alkalinity, hardness, total dissolved solids, total organic carbon, biochemical oxygen demand, dissolved heavy metals (aluminium, barium, cobalt, manganese.
    - Most wells were also screened for PFAS.
- Surface water sampling was completed in Alexandra Canal, Cooks River and Mill Stream. Water quality data collected from these sampling events were used to develop discharge criteria for the Projects water treatment plants (WTP).

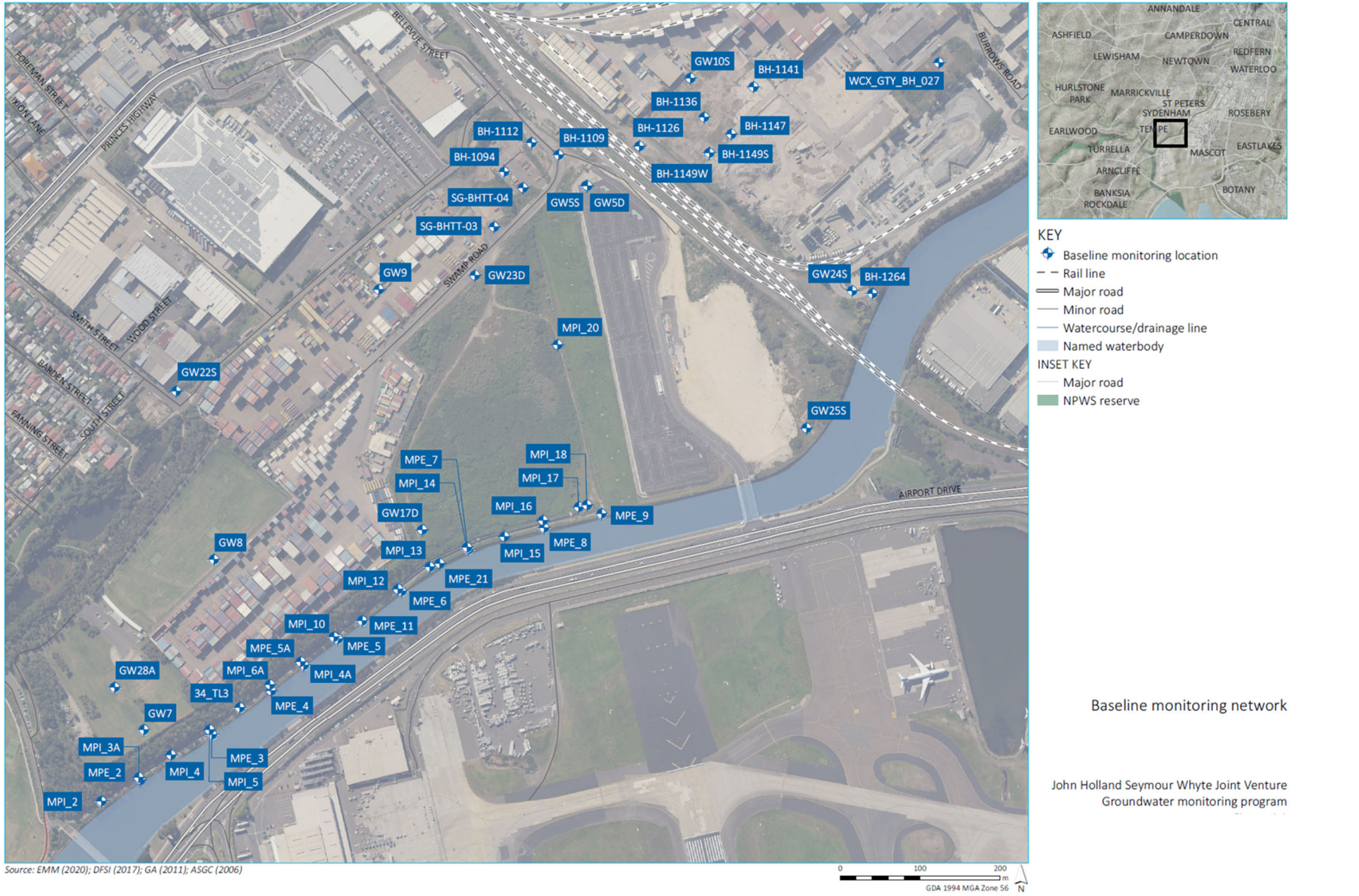
Table 2.1 – groundwater monitoring network summary

Bore ID	Easting	Northing	Depth (mBGL[1])	Screened interval (mBGL)	Lithology
34_TL3	330442.9	6244245	NA	NA	NA
BH-1094	330773.1	6244914	NA	NA	NA
BH-1109	330841.6	6244935	NA	NA	NA
BH-1112	330807.5	6244951	NA	NA	NA
BH-1126	330942.4	6244947	NA	NA	NA
BH-1136	331022.5	6244983	NA	NA	NA
BH-1141	331083.9	6245021	NA	NA	NA
BH-1147	331056	6244962	NA	NA	NA

Bore ID	Easting	Northing	Depth (mBGL[1])	Screened interval (mBGL)	Lithology
BH-1149s	331028	6244937	NA	NA	NA
BH-1149w	331029.1	6244938	NA	NA	NA
BH-1264	331232.6	6244762	NA	NA	NA
GW5d	330875.5	6244896	17	12.50-15.50	Shale, clay
GW5s	330877.6	6244897	6	1.0-3.0	Soil, cobbles, gravelly sandy clay
GW7	330323	6244217	18	2.5-15.0	Soil, cobbles, gravelly sandy clay, mixed landfill
GW8	330410.8	6244430	23.3	9.8-15.8	Gravelly sand, clay
GW9	330616.7	6244768	19.7	5.2-10.7	Mixed landfill, gravel
GW10s	331005	6245032	6.1	1.7-6.1	Clayey sand
GW11d	331246	6245246	16.45	13-16	Clay
GW13s	331783	6244531	6	3-5.9	Sand, clay
GW17d	330670.6	6244468	17.5	8.5-11.5	Mixed waste, decomposed waste
GW22s	330363.6	6244640	11.95	6.0-11.9	Shale
GW23d	330736.6	6244785	19.5	6.5-11.2	Landfill
GW24s	331207.1	6244766	6	2.50-5.0	Sand
GW25s	331150.4	6244594	6.5	3.5-6.5	Silty sand
GW28A	330286.5	6244270	18	10.0-16.0	Mixed landfill
GW100s	331989	6244626	6.1	2.2-6.1	Sand
MPE_2	330318.5	6244155	15	3.0-15.0	Silty sandy clay
MPE_3	330407.9	6244211	9	3.0-9.0	Sandy clay, weathered sandstone
MPE_4	330481.9	6244267	3.45	0.5-3.05	Sandy clay, gravel fill
MPE_5	330565.5	6244331	5.4	3.0-5.4	Sandy clay
MPE_5A	330522.9	6244298	NA	NA	NA
MPE_6	330645	6244391	9.5	3.0-9.5	Clay
MPE_7	330728.3	6244443	13.6	3.0-13.6	Sandy clay
MPE_8	330823.5	6244470	17	3.0-17.0	Siltstone, sandy clay
MPE_9	330895	6244488	20.1	3.0-20.1	Clayey sand

Bore ID	Easting	Northing	Depth (mBGL[1])	Screened interval (mBGL)	Lithology
MPE_11	330595.8	6244354	17	3.0-17.0	Silty sandy clay
MPE_21	330692.5	6244426	NA	NA	NA
MPI_2	330269.8	6244128	13.9	3.0-13.9	Sandy clay
MPI_3A	330316.5	6244158	NA	NA	NA
MPI_4	330357	6244186	NA	NA	NA
MPI_4A	330518.7	6244303	NA	NA	NA
MPI_5	330405.1	6244217	NA	NA	NA
MPI_6A	330480.7	6244275	NA	NA	NA
MPI_10	330560.2	6244333	NA	NA	NA
MPI_12	330640.4	6244394	NA	NA	NA
MPI_13	330680.5	6244421	NA	NA	NA
MPI_14	330726.9	6244445	NA	NA	NA
MPI_15	330773.4	6244459	NA	NA	NA
MPI_16	330821.8	6244479	NA	NA	NA
MPI_17	330866.3	6244496	NA	NA	NA
MPI_18	330876.7	6244499	NA	NA	NA
MPI_20	330839.7	6244698	NA	NA	NA
SG-BHTT-03	330760.4	3244846	26	NA	NA
SG-BHTT-04	330796.9	6244895	24.71	NA	NA
WCX_GTY_BH_027	331315.5	6245051	21	1.0-4.0	Sand

Note: NA = data not available; 1. mBGL – metres below ground level.



Baseline monitoring network

John Holland Seymour Whyte Joint Venture
Groundwater monitoring program

Figure 2-1 – Baseline groundwater monitoring network

2.2 Groundwater levels

Hydrographs are presented in Appendix A with manual water level data summarised in Table 2.2.

A total of 50 monitoring bores were measured for baseline groundwater level. Baseline groundwater levels range from 0.20 to 14.42 metres below ground level (mBGL) and reference levels (RL) range from -7.74 to 2.38 metres Australian Height Datum (mAHD).

Groundwater levels vary in response to intense or prolonged rainfall events. Some hydrographs show a subdued and delayed changes in groundwater levels while other hydrographs are short and sharp. The groundwater level responses are largely due to the aquifers connectivity with surface features, the ease in which rainfall infiltrates into the groundwater system and the aquifers anisotropic nature. Groundwater levels in monitoring bores located near the Alexandra Canal are tidally influenced.

Table 2.2 – Baseline groundwater level

Bore ID	Logger installed	Data count	Monitored period		Water Level (mBRL)			Water Level (mAHD)		
			From	To	Min	Max	Avg	Min	Max	Avg
34_TL3	Yes	8	Feb-19	Oct-19	1.02	1.51	1.11	0.54	1.03	0.93
BH-1002	No	8	Sep-19	Dec-20	1.02	1.60	1.32	NA	NA	NA
BH-1012	No	9	Sep-19	Dec-20	0.16	1.32	1.07	NA	NA	NA
BH-1038	No	9	Sep-19	Dec-20	4.10	5.25	4.94	NA	NA	NA
BH-1046	No	6	Sep-19	Feb-20	4.05	4.42	4.28	NA	NA	NA
BH-1052	No	9	Sep-19	Dec-20	1.11	1.44	1.30	NA	NA	NA
BH-1056	No	9	Sep-19	Dec-20	0.73	1.24	0.98	NA	NA	NA
BH-1094	No	2	Oct-19	Oct-19	4.76	4.96	4.86	NA	NA	NA
BH-1112	No	2	Oct-19	Oct-19	1.88	2.08	1.98	NA	NA	NA
BH-1126	No	2	Oct-19	Oct-19	0.86	0.87	0.87	NA	NA	NA
BH-1136	No	2	Oct-19	Oct-19	1.21	1.38	1.29	NA	NA	NA
BH-1141	No	2	Oct-19	Oct-19	0.67	0.83	0.75	NA	NA	NA
BH-1147	No	5	Oct-19	Dec-20	0.48	0.77	0.63	NA	NA	NA
BH-1149s	No	2	Oct-19	Oct-19	0.70	0.79	0.74	1.02	NA	NA
BH-1149w	No	2	Oct-19	Oct-19	1.42	1.44	1.43	0.37	NA	NA
BH-1178	No	5	Nov-19	Mar-20	1.26	1.68	1.54	NA	NA	NA
BH-1180	No	5	Dec-19	Jun-20	1.43	1.64	1.54	NA	NA	NA
BH-1184	No	7	Sep-19	Mar-20	2.18	2.45	2.37	NA	NA	NA
BH-1109	No	8	Sep-19	Jun-20	1.83	2.42	2.17	NA	NA	NA

Bore ID	Logger installed	Data count	Monitored period		Water Level (mBRL)			Water Level (mAHD)		
			From	To	Min	Max	Avg	Min	Max	Avg
BH-1192	No	8	Sep-19	Jun-20	1.56	2.13	1.92	NA	NA	NA
GW100s	No	17	Feb-19	Dec-20	1.77	2.45	2.18	-3.05	1.67	1.00
GW10s	Yes	6	Jan-19	Oct-19	0.36	0.66	0.53	1.24	1.54	1.37
GW11d	No	14	Mar-19	Dec-20	8.52	9.86	8.89	-3.35	-2.02	-2.38
GW13s	No	17	Dec-18	Jan-21	1.67	2.47	1.95	0.03	0.84	0.55
GW17d	Yes	5	Mar-19	Oct-19	8.69	8.85	8.78	1.50	1.66	1.57
GW22s	Yes	3	Apr-19	Oct-19	4.96	5.23	5.10	3.16	3.43	3.30
GW23d	Yes	4	Jan-19	Oct-19	10.23	10.32	10.28	1.27	1.37	1.31
GW24s	No	2	Mar-19	Apr-19	2.49	2.58	2.54	NA	NA	NA
GW25s	Yes	6	Jan-19	Oct-19	1.21	1.51	1.36	0.05	0.35	0.19
GW28A	Yes	3	Apr-19	Oct-19	14.37	14.42	14.40	1.70	1.75	1.73
GW5d	Yes	6	Feb-19	Oct-19	10.70	11.30	10.89	-7.74	-7.14	-7.32
GW5s	Yes	6	Jan-19	Oct-19	2.35	2.63	2.46	1.02	1.30	1.19
GW7	Yes	4	Apr-19	Oct-19	13.74	13.89	13.81	1.32	1.47	1.40
GW8	Yes	6	Feb-19	Oct-19	12.79	12.94	12.85	2.23	2.38	2.32
GW9	No	9	Feb-19	Sep-20	9.42	9.65	9.53	1.60	1.83	1.72
MPE_11	No	8	Dec-18	Oct-19	2.17	2.56	2.38	0.10	0.49	0.28
MPE_2	Yes	8	Dec-18	Oct-19	1.88	2.95	2.46	-0.27	0.80	0.22
MPE_21	No	9	Dec-18	Oct-19	2.01	2.85	2.42	-0.20	0.64	0.23
MPE_3	No	8	Dec-18	Oct-19	2.05	3.26	2.71	-0.29	0.92	0.26
MPE_4	No	7	Feb-19	Oct-19	2.01	3.91	2.87	-1.13	0.77	-0.09
MPE_5	Yes	8	Dec-18	Oct-19	2.00	3.00	2.56	-0.42	0.58	0.03
MPE_5A	No	8	Dec-18	Oct-19	1.94	3.01	2.66	-0.24	0.83	0.11
MPE_6	No	8	Dec-18	Oct-19	2.00	2.93	2.50	-0.32	0.61	0.11
MPE_7	No	7	Feb-19	Oct-19	3.64	5.15	4.28	-2.26	-0.75	-1.39
MPE_8	No	7	Feb-19	Oct-19	2.75	3.84	3.23	-1.22	-0.13	-0.61
MPE_9	No	8	Feb-19	Oct-19	1.53	2.40	2.11	-0.08	0.79	0.21
MPI_10	No	8	Dec-18	Oct-19	0.67	0.81	0.75	1.23	1.37	1.29

Bore ID	Logger installed	Data count	Monitored period		Water Level (mBRL)			Water Level (mAHD)		
			From	To	Min	Max	Avg	Min	Max	Avg
MPI_12	No	9	Dec-18	Oct-19	0.20	1.27	1.09	0.84	1.91	1.02
MPI_13	No	8	Dec-18	Oct-19	0.72	0.84	0.78	1.24	1.37	1.30
MPI_14	No	8	Dec-18	Oct-19	0.71	1.99	0.92	0.02	1.30	1.10
MPI_15	No	8	Dec-18	Oct-19	1.27	2.66	2.02	-0.05	1.33	0.58
MPI_16	No	8	Dec-18	Oct-19	3.88	4.17	4.03	-1.38	-1.09	-1.24
MPI_17	No	8	Jan-19	Oct-19	0.91	1.07	1.00	0.94	1.10	1.01
MPI_18	No	8	Dec-18	Oct-19	0.64	1.03	0.91	0.95	1.34	1.06
MPI_2	No	8	Dec-18	Oct-19	1.42	2.85	2.20	-0.54	0.90	0.11
MPI_20	No	9	Dec-18	Oct-19	2.38	2.55	2.47	1.51	1.68	1.59
MPI_3A	No	8	Dec-18	Oct-19	1.14	1.45	1.25	0.61	0.92	0.81
MPI_4	No	8	Dec-18	Oct-19	1.83	2.94	2.08	-0.69	0.42	0.18
MPI_4A	No	9	Dec-18	Oct-19	0.91	1.01	0.98	1.29	1.38	1.32
MPI_5	No	7	Dec-18	Oct-19	0.80	0.80	0.80	1.53	1.53	1.53
MPI_6A	No	7	Feb-19	Oct-19	1.20	1.41	1.30	0.80	1.01	0.91
SG-BHTT-03	Yes	3	Apr-19	Oct-19	9.13	9.29	9.20	1.22	1.38	1.31
SG-BHTT-04	Yes	3	Apr-19	Oct-19	3.53	3.67	3.58	1.46	1.60	1.55
SG-GW-5001	No	7	Sep-19	Mar-20	1.46	2.01	1.79	0.56	1.11	0.78
SG-GW-5010	No	9	Sep-19	Sep-20	1.42	2.11	1.70	0.51	1.20	0.92
WCX_GTY_BH_027	Yes	5	Jan-19	Oct-19	1.28	1.35	1.32	0.62	0.69	0.65

Notes: mBRL – metres below reference level; mAHD - metres Australian Height Datum.

2.3 Groundwater quality

Groundwater quality within and surrounding the project site is historically of poor quality due to contamination from surrounding industry. Table 2-3 provides a summary of groundwater quality in the Project area and Table 2-4 summarises baseline groundwater quality sampling events.

A total of 48 monitoring bores were measured for baseline groundwater quality. Notable groundwater quality exceedances from baseline groundwater quality monitoring are summarised below:

- Human Health (Recreational):
  - Common exceedances for arsenic, chromium, total phosphorus and manganese (GW5d)
  - Naphthalene (GW23d, MPI_15 and SG-BHTT-03)

  - TRH within the former Tempe landfill (MPI_12, MPI_13) and externally (GW23d and MPE_6).
    - Common exceedances of iron, ammonia (as NH3), chloride, sodium, total dissolved solids (TDS) and pH slightly acidic (aesthetic criteria only)
  - Lead (GW23d)
  - PFAS near the Qantas Jet base and the former Tempe landfill (GW7).

- Ecological criteria from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)*:
  - Common exceedances of the guideline values for protection of 95% and 80% of species in freshwater systems for aluminium, nickel, zinc and copper. Boron, cadmium and manganese also exceeded these criteria at a number of locations within and around the former Tempe landfill and in localised other areas (cadmium only).
  - Exceedances of the guideline values for protection of 95% of marine water species include cobalt, copper, lead and zinc, with exceedances of the guideline values for protection of 80% of marine species for copper, lead and zinc.
  - Values for the protection of 80 percent of marine and freshwater species for naphthalene at SG-BHTT-03.
  - Marine and freshwater exceedances of the guideline values for protection of 80% of species for ammonia (as NH3) occurred at nearly every sampling location.
  - Common PFOS exceedances of guideline values in freshwater and marine water (protection of 95% of species) occurred at 34_TL3, GW100s, GW104, GW10s, GW15s, GW24s, GW28A, GW7, GW8, MPE_4, MPI_2, MPI_3A, MPI_4A, MPI_5, MPI_6A, WCX_GTY_BH_004, WCX_GTY_BH_027.

There were no exceedances of the National Environmental Management Plan 2020 (NEMP 2020) PFAS guideline values for protection of 80% of species.

Table 2-3 – Summary of groundwater quality in the Project area

Parameter	Botany Sands and alluvial sediments	Bedrock
Electrical conductivity (EC)	Brackish to saline • **Range:** 885 – 34,303 µS/cm • **Average:** 6,204 µS/cm	Brackish to saline • **Range:** 1,860 – 40,714 µS/cm • **Average:** 20,812 µS/cm
pH	Slightly acidic to mildly alkaline • **Range:** 6.41 – 9.42 • **Average:** 7.06	Slightly acidic ranging • **Range:** 5.76 – 6.32 • **Average:** 5.99
Major ions	Monitoring bores located near tidal areas are dominated by sodium chloride. Bores outside the tidal influence have a variable mix of cations (Na, Ca, Mg, K) dominated by bicarbonate ($CaCO_3$).	Monitoring bores located near tidal areas are dominated by sodium chloride. Bores outside the tidal influence have a variable mix of cations (Na, Ca, Mg, K) and anions (Cl, $CaCO_3$, SO_4).
Dissolved metals	Common exceedances of ANZG (2018) Fresh and marine water quality 80% DGVs[2] for B, Cd, Cu, Pb, Zn and Hg.	Common exceedances of ANZG (2018) Fresh and marine water quality 80% DGVs for Cd, Co, Cu, Mn, Ni, Pb and Zn.

Parameter	Botany Sands and alluvial sediments	Bedrock
Nutrients	Exceedances of the ANZG (2018) fresh and marine water quality 80% DGVs guidelines for Ammonia. Exceedances of the ANZECC (2000) DGVs for marine ecosystems for Total Nitrogen and Total Phosphorus.	
Groundwater aggressivity	Moderate risk to steel piles.	Aggressivity ranges from moderate risk to steel piles to high risk to concrete structures.

Notes: 1. µS/cm – Microsiemens per centimeter

2. DGVs – Default guideline value

Table 2-4 – Summary of baseline sampling events

Bore ID	Number of samples	Recording period	
		From	To
34_TL3	5	Sep-19	Feb-20
BH-1094	8	Oct-19	Mar-20
BH-1109	1	Jul-19	-
BH-1112	8	Oct-19	Mar-20
BH-1126	3	Oct-19	Mar-20
BH-1136	4	Oct-19	Jan-20
BH-1141	6	Oct-19	Mar-20
BH-1147	6	Oct-19	Mar-20
BH-1149s	7	Oct-19	Mar-20
BH-1149w	6	Oct-19	Mar-20
BH-1264	3	Sep-20	Dec-20
GW5d	7	Oct-19	Mar-20
GW5s	7	Oct-19	Mar-20
GW7	6	Oct-19	Mar-20
GW8	7	Oct-19	Mar-20
GW9	-	-	-
GW10s	6	Oct-19	Mar-20
GW17d	5	Oct-19	Feb-20
GW22s	6	Oct-19	Feb-20
GW23d	1	Feb-20	-
GW24s	-	-	-
GW25s	6	Oct-19	Mar-20
GW28a	6	Oct-19	Mar-20
MPE_2	6	Sep-19	Feb-20
MPE_3	5	Sep-19	Feb-20
MPE_4	5	Sep-19	Feb-20
MPE_5	5	Sep-19	Feb-20
MPE_5A	5	Sep-19	Feb-20

Bore ID	Number of samples	Recording period	
		From	To
MPE_6	5	Sep-19	Feb-20
MPE_7	6	Sep-19	Feb-20
MPE_8	5	Sep-19	Feb-20
MPE_9	6	Oct-19	Feb-20
MPE_11	5	Sep-19	Feb-20
MPE_21	4	Sep-19	Feb-20
MPI_2	5	Sep-19	Feb-20
MPI_3A	5	Sep-19	Feb-20
MPI_4	5	Sep-19	Feb-20
MPI_4A	6	Sep-19	Feb-20
MPI_5	-	-	-
MPI_6A	5	Sep-19	Feb-20
MPI_10	5	Sep-19	Feb-20
MPI_12	5	Sep-19	Feb-20
MPI_13	5	Sep-19	Feb-20
MPI_14	5	Sep-19	Feb-20
MPI_15	5	Sep-19	Feb-20
MPI_16	5	Oct-19	Feb-20
MPI_17	5	Oct-19	Feb-20
MPI_18	5	Sep-19	Feb-20
MPI_20	6	Oct-19	Feb-20
SG-BHTT-03	6	Oct-19	Feb-20
SG-BHTT-04	7	Oct-19	Mar-20
WCX_BH_027	6	Oct-19	Feb-20

3 Construction monitoring program

3.1 Overview

The Project construction monitoring program employs a risk-based approach and is generally consistent with the baseline monitoring program detailed in the EIS/MDP and as required by UMM GW6. The approach was developed by adopting the data quality objective (DQO) approach recommended in the *National Environmental Protection Measure* (NEPM) 2013. This approach helps identify potential groundwater quality risks, identify what parameters should be monitored and how often, and sets a framework for how the monitoring results should be interpreted.

The program is designed to target the potential impacts to groundwater resources and their receptors during the construction stage of the Project. The three main (water quality) impacts identified in the EIS/MDP include ASS generation, leachate and the migration of existing contamination.

Table 3-1 summarises the risk-based approach to monitoring water quality impacts during the Project construction. Appendix B details the baseline groundwater quality maxima in which performance criteria will be assessed against. The construction monitoring bore network (44 monitoring bores) is presented in Figure 3-1 and summarised in Table 3-2. This monitoring program will commence prior to bulk earthworks for the Project and will be reviewed at a 6-monthly intervals or other intervals as deemed appropriate throughout the works. This review will include an assessment of any changes to the risk of ASS generation, leachate and the migration of existing contamination.

Table 3-1 – Risk-based groundwater monitoring program

Program	Acid sulphate soils (ASS)	Contamination
Risk	Generation of acid and mobilisation of heavy metals	Mobilisation of existing contamination
Risk area(s)	Class 2 & 3 soil north of Alexandra Canal (within modelled drawdown extent)	Tempe landfill Commercial land north of rail corridor Alexandra Canal
Key data	Groundwater level, alkalinity, pH & heavy metals (filtered)	Groundwater level, pH, major ions, heavy metals (filtered), nutrients, hydrocarbons & PFAS
Performance criteria[1]	**Alkalinity**: Decreasing trend over four or more monitoring events would indicate potential oxidation of ASS. **pH:** Decreasing trend over 4 or more monitoring events would indicate potential oxidation of ASS. **Heavy metals:** Increasing concentrations over four or more monitoring events may indicate groundwater impacts.	**Major ions:** Increasing ratio of sulphate to chloride concentrations over 4 consecutive monitoring events. **Heavy metals:** Monitoring results exceeding maximum concentrations reported in baseline monitoring for 4 or more monitoring events may indicate the migration of a contamination plume. **Hydrocarbons:** Monitoring results exceeding maximum concentrations reported in baseline monitoring for 4 or more monitoring events could indicate the migration of a contamination plume. **PFAS:** Monitoring results exceeding NEPM (2020) guideline values.
Bores	GW bores (18) – refer Table 3-2	GW bores (18) – refer Table 3-2
Frequency	Monthly field measurements (pH & level), monthly sampling & continuous level data (data loggers). Review of collected data following monitoring for early signs of construction impacts.	Monthly sampling & field measurements (pH & level) Review of collected data following monitoring for early signs of construction impacts.

Note: 1. Monitoring results will be assessed against listed performance criteria and baseline data ranges (Appendix A & B).

2. ASS – acid sulphate soils

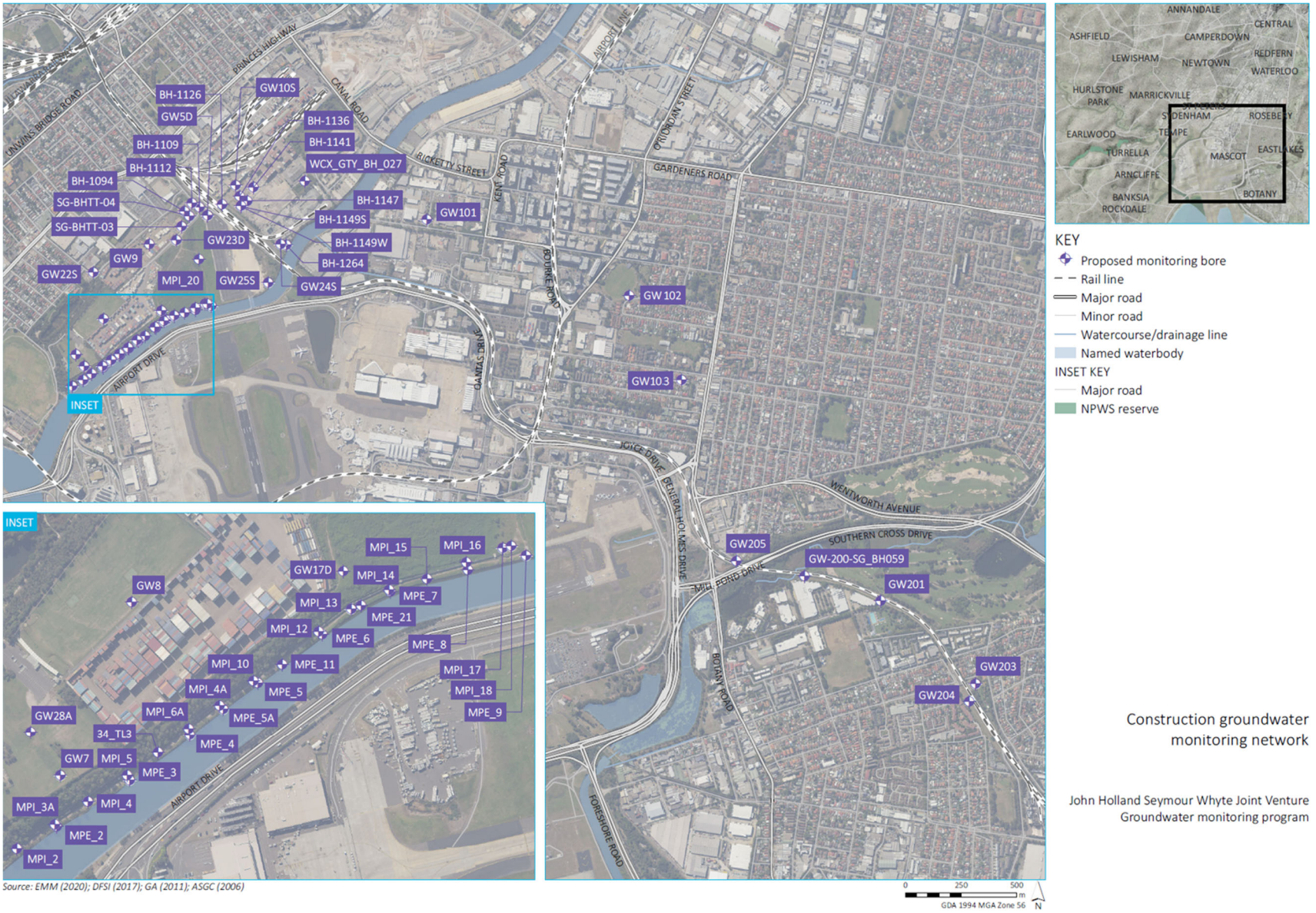


Figure 3-1 – Construction groundwater monitoring network

Table 3-2 – Groundwater monitoring network

Bore ID	Program	Easting	Northing	Screened interval (m)	Screened lithology
GW2d	ASS & Contamination	331132	6245002	10.50 – 13.50	Sandy clay
GW2s	ASS & Contamination	331132	6245001	2.0 – 6.0	Sandy clay
GW4d	ASS & Contamination	331447	6245409	11.50 – 14.50	Shale, clay
GW4i	ASS & Contamination	331445	6245413	3.5 – 6.0	Sandy clay
GW5d*	ASS & Contamination	330875	6244896	12.50 – 15.50	Shale, clay
GW5s*	ASS & Contamination	330878	6244897	1.0 – 3.0	Soil, cobbles, gravelly sandy clay
GW7*	ASS & Contamination	330323	6244217	2.5 – 15.0	Mixed landfill, sandy clay
GW8*	ASS & Contamination	330411	6244430	9.8 – 15.8	Gravelly sand, clay
GW9	ASS & Contamination	330617	6244768	5.2 – 10.7	Mixed landfill, gravel
GW10s*	ASS & Contamination	331005	6245032	1.7 – 6.1	Clayey sand
GW11d	ASS & Contamination	331246	6245246	13.0 – 16.0	Clay
GW11s	ASS & Contamination	331244	6245245	6.7 – 8.7	Sand and clay
GW17d*	ASS & Contamination	330671	6244468	8.5 – 11.5	Mixed waste, decomposed waste
GW22s*	ASS & Contamination	330364	6244640	6.0 – 11.9	Shale
GW23d*	ASS & Contamination	330737	6244785	6.5 – 11.2	Landfill
GW24s	ASS & Contamination	331207	6244766	2.50 – 5.0	Sand
GW25s	ASS & Contamination	331150	6244594	3.5 – 6.5	Silty sand
GW28a*	ASS & Contamination	330286	6244270	10.0 – 16.0	Mixed landfill
MPE_3	Leachate	330408	6244211	3.0 – 9.0	Sandy clay, weathered sandstone
MPE_8	Leachate	330823	6244470	3.0 – 17.0	Siltstone, sandy clay
MPE_11	Leachate	330596	6244354	3.0 – 17.0	Silty sandy clay
MPE_2*	Leachate	330318	6244155	3.0 – 15.0	Silty sandy clay
MPE_21	Leachate	330692	6244426	NA	NA
MPE_4	Leachate	330482	6244267	0.5 – 3.05	Sandy clay, gravel fill
MPE_5	Leachate	330565	6244331	3.0 – 5.4	Sandy clay
MPE_5A*	Leachate	330523	6244298	NA	NA
MPE_6	Leachate	330645	6244391	3.0 – 9.5	Clay
MPE_7	Leachate	330728	6244443	3.0 – 13.6	Sandy clay
MPE_9	Leachate	330895	6244488	3.0 – 20.1	Clayey sand
MPI_10	Leachate	330560.2	6244333	-	-

Bore ID	Program	Easting	Northing	Screened interval (m)	Screened lithology
MPI_12	Leachate	330640.4	6244394	-	-
MPI_13	Leachate	330680.5	6244421	-	-
MPI_14	Leachate	330726.9	6244445	-	-
MPI_15	Leachate	330773.4	6244459	-	-
MPI_17	Leachate	330866.3	6244496	-	-
MPI_18	Leachate	330876.7	6244499	-	-
MPI_2	Leachate	330269.8	6244128	13.9	3.0-13.9
MPI_20	Leachate	330839.7	6244698	-	-
MPI_3A	Leachate	330316.5	6244158	-	-
MPI_4	Leachate	330357	6244186	-	-
MPI_4A	Leachate	330518.7	6244303	-	-
MPI_5	Leachate	330405.1	6244217	-	-
MPI_6A	Leachate	330480.7	6244275	-	-

Note: *Bore equipped with automated (water level data) logger

3.2 Acid sulphate soils

Groundwater drawdown can expose saturated ASS material to oxygen potentially leading to the generation of sulfuric acid. The modelled drawdown during Project construction intersects areas mapped as Class 2 and Class 3 soils (refer EIS, chapter 13). The drawdown extent is greatest north of Alexandra Canal and Eastbound Terminal Link will be constructed.

Construction drawdown is temporary, the soils will therefore re-saturate as groundwater recharges. The Botany sands are marine deposited and have a natural buffering capacity provided by their bicarbonate content (shells).

Alkalinity and pH form the key monitoring parameters and impact assessment criteria for ASS. The first indicator of ASS generation is a decrease in alkalinity of the groundwater. A decrease in pH will follow (lagging indicator) with the potential mobilisation of metals.

Monitoring of groundwater level, pH, alkalinity and heavy metals will be completed across 18 monitoring bores (Table 5.2) at a monthly frequency.

3.3 Mobilisation of contamination

Soils in the vicinity of the project site feature a range of contaminants depending on the location and historical land uses in the study area (refer EIS, chapter 13). As a result, there is potential to intersect contaminated groundwater during excavation and/or mobilise contaminants towards excavations.

The monitoring network has been designed to identify the potential migration of contaminants as influenced by dewatering and resulting drawdown (Table 3-2). The contaminant monitoring program comprises monthly monitoring for groundwater levels, pH, major ions, heavy metals, nutrients, hydrocarbons & PFAS.

Should contaminant migration be identified, an assessment will be undertaken to determine if the cause of the contamination is attributable to JHSW Works. If associated with JHSW Works, a remediation plan will be developed in consultation with relevant stakeholders.

3.4 Dewatering

Extraction volumes will be monitored using calibrated flow metres. Volumes will be reported in routine (3 monthly) monitoring reports.

3.5 Water Treatment Plant

Groundwater captured during construction will be tested and treated at a WTP then reused (is possible), or discharged in accordance with the Project EPL and Project Trade Waste Agreement requirements (as applicable).

3.5.1 Discharge volume

Discharge volumes will be continuously monitored via calibrated flow metres. Volumes will be reported in routine (3 monthly) monitoring reports.

The maximum anticipated volume of daily discharge to Alexandra Canal is subject to detailed design. The volumes are expected to fluctuate depending on the construction works being undertaken.

3.5.2 Discharge water quality

Water discharged from the WTP will be treated to maintain water quality consistent with the criteria listed in Table 3-3. The criteria were developed and approved as part of the EIS/MDP and subsequently reviewed in the development of this Plan.

Discharge water quality will be monitored via in-line calibrated pH and turbidity dataloggers with appropriate alerts set to inform management of any exceedance of the criteria. JHSW will undertake fortnightly monitoring for the first three months of operation (the commissioning period). Following the commissioning period, JHSWJV will undertake monthly monitoring of the WTP discharge which will continue for the duration of construction. Results will be validated against discharge criteria detailed in Table 3-3.

Table 3-3 – Discharge criteria for Alexandra Canal

Parameter	Unit	Alexandra Canal
pH	pH units	7.0 to 8.5
Turbidity	NTU	10
Aluminium	µg/L	0.5
Arsenic	µg/L	2.3
Barium	mg/L	2
Boron	µg/L	5,100
Cadmium	µg/L	5.5
Chromium (VI)	µg/L	20
Chromium (III)	µg/L	49
Copper	µg/L	3
Cobalt	µg/L	14
Iron	µg/L	300
Lead	µg/L	6.6
Manganese	µg/L	80
Mercury	µg/L	0.40
Nickel	µg/L	70

Parameter	Unit	Alexandra Canal
Zinc	µg/L	23
Bicarbonate alkalinity as $CaCO_3$	mg/L	124
Ammonia	ug/L	1200
Nitrate	ug/L	15
Nitrite	ug/L	15
Total Phosphorus	ug/L	30
Total Nitrogen	ug/L	300
PFOA	µg/L	220
PFOS	µg/L	0.13
TPH – C6-C9 fractions	µg/L	150
TPH – mineral oil (>C9 fractions)	µg/L	600
F2-Napthalene	mg/L	70
Ethylbenzene	µg/L	110
Total xylenes	µg/L	830
p-xylene	µg/L	200
m-xylene	µg/L	100
o-xylene	µg/L	350
Naphthalene	µg/L	70
Anthracene	µg/L	0.4
Phenanthrene	µg/L	2
Fluoranthene	µg/L	1.4
Benzo(a)pyrene	µg/L	0.2

Note: Criteria based on draft EPL proposed by the EPA

3.6 Additional monitoring

3.6.1 Drawdown

The modelled drawdown influence is provided in the EIS/MDP and TWP7. Drawdown by itself is not considered an impact due to the established lack of receptors in the area. However, groundwater monitoring results will be used to validate modelled drawdown and inform assessments of potential settlement.

Drawdown monitoring will comprise measurements of groundwater level (manually and/or automated) at all monitored groundwater bores. Groundwater levels will be reported every 3 months (see Table 5-1) and plotted (hydrographs) to inform a comparison against baseline data and rainfall data.

3.6.2 Control bores

Control bores will be monitored to provide data on groundwater conditions outside of the predicted Project influence and assist with the assessment of cumulated impacts.

The control bores monitoring network is detailed in Table 3-4. Control bores will be manually measured for groundwater levels and physico-chemical parameters pH and EC every 3 months during project construction.

Table 3-4 – Control bore monitoring network

Bore ID	Easting	Northing	Depth	Screen interval	Lithology
GW101	331863.6	6244877	6.2	1.9-6.20	Clayey sand, sand
GW102	332774.6	6244535	7.5	3.0-7.5	Silty sand
GW103	333004.7	6244155	6	1.2-6.0	Silty sand
GW-200-SG_BH059	333557.3	6243277	-	-	NA
GW201	333899.7	6243165	7.01	2.5-7.0	Sand
GW203	334326.8	6242791	6.3	4.0-6.3	Sand
GW204	334297.1	6242712	5.4	2.3-5.3	Sand
GW205	333251.5	6243344	-	-	NA

Note: NA = not available; *Bore equipped with automated (water level data) logger.

3.7 Operational monitoring

Groundwater monitoring during the operational stage of the Project is not covered by this Program.

4 Monitoring methodology

4.1 Overview

Groundwater level and quality monitoring will be completed in accordance with Australian Standards:

- AS/NZS 5667.6:1998 *Water Quality – Sampling – Guidance on sampling rivers and streams.*
- AS/NZS 5667.9:1998 *Water Quality – Sampling – Guidance on sampling from marine waters.*
- AS/NZS 5667.10:1998 *Water Quality – Sampling, Part 10: Guidance on sampling waste waters.*
- AS/NZS 5667.11:1998 *Water Quality – Sampling – Part 11, Guidance on Sampling of Groundwaters.*

4.2 Groundwater levels

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

4.2.1 Attended readings

The standing groundwater level will be measured and recorded at each groundwater monitoring bore using an electronic groundwater level dip meter (dipper).

The level (to the nearest millimetre) will be referenced to a known (and consistent) surveyed point at the top of the bore reference point. This measurement will be corrected to metres above the Australian height datum (mAHD) using survey data. Recorded groundwater level will be tabulated in both metres below reference point (mBRP) and mAHD.

4.2.2 Automated loggers

Continuous water level data will be recorded by dataloggers programmed to record on a 12-hourly frequency. Barometers will be set to record at the same frequencies.

Bore equipped with data loggers are identified in Table 3-2, and Table 3-4. Faulty data loggers will be replaced on an as needs basis.

The recorded pressure will be converted to a standing water level and verified by the monthly manual measurements.

4.3 Water Quality

4.3.1 Physico-chemical parameters

Field physico-chemical parameters pH and electrical conductivity will be measured in monitoring bores detailed in Table 3-1 and Table 3-4 using a fully calibrated multi-probe water quality meter(s). Other observations including odour and water colour will also be recorded.

The multi-probe field water quality meter(s) will be calibrated against known standards, as supplied by the manufacturer, at the start of each day of water quality sampling. Calibration will be recorded for auditing purposes.

4.3.2 Laboratory analysis

Groundwater samples will be collected as per standards detailed in Section 6.1 and using laboratory supplied bottles. Samples will be preserved (ice/refrigeration) and delivered to a NATA

accredited laboratory within holding times under a formal chain of custody. Water quality analysis suites are detailed in Table 4.1.

Table 4.1 – Water quality analysis suites

Program	Analysis suites
Acid sulphate soils	Alkalinity – bicarbonate, carbonate, hydroxide & total alkalinity.
	pH – laboratory
	Filtered heavy metals – arsenic, barium, boron, cadmium, chromium, cobalt copper, lead, manganese, mercury, nickel & zinc.
Contamination	Major ions – calcium, magnesium, potassium, sodium, chloride, sulphate, carbonate, bicarbonate & hydroxide.
	Filtered heavy metals - arsenic, barium, boron, cadmium, chromium, cobalt copper, lead, manganese, mercury, nickel & zinc.
	Hydrocarbons – BTEX, TRH, TPH, PAH & VOCs
	PFAS – PFOS & PFOA
Leachate	Nutrients – ammonia, nitrate, nitrite, total nitrogen & total phosphorus.
	Filtered heavy metals - arsenic, barium, boron, cadmium, chromium, cobalt copper, lead, manganese, mercury, nickel & zinc.

4.4 Quality control

4.4.1 Recording of field results

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

4.4.2 Decontamination

Sampling equipment will be cleaned (decontaminated) between each sample. Where a sample site shows evidence of contamination (i.e. there is an algal bloom, or the site smells strongly of hydrocarbons, sewage or something else) equipment will need to be cleaned thoroughly. In addition, equipment will need to be cleaned periodically to prevent a build-up of dirt.

The following method will be followed:

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

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

4.4.3 Quality Assurance and documentation

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

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

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

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

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

Monitoring and calibration records will be maintained in accordance with the appropriate standard.

5 Reporting

5.1 Reporting

As per CoA19(d), 3 monthly reports summarising collected field data will be provided to DPIE-Water within 1 month of the previous monitoring period. A succinct report will include, but not limited to:

- Climate summary
- Dewatering volumes and water quality (laboratory and physico-chemical)
- WTP discharge volumes, water quality and a comparison of laboratory results against WTP discharge criteria
- analysis of accumulated data against the groundwater impacts identified in the EIS/MDP, specifically for:
    - ASS
    - Contamination
    - Climate
- Presentation of laboratory data
- Any approved changes to the Groundwater Monitoring Program or Groundwater Management Sub Plan.

Data provision and reporting requirements associated with the Program for the construction phase of the project are presented in Table 5-1 and Table 5-2 respectively.

Table 5-1 – Data provision requirements

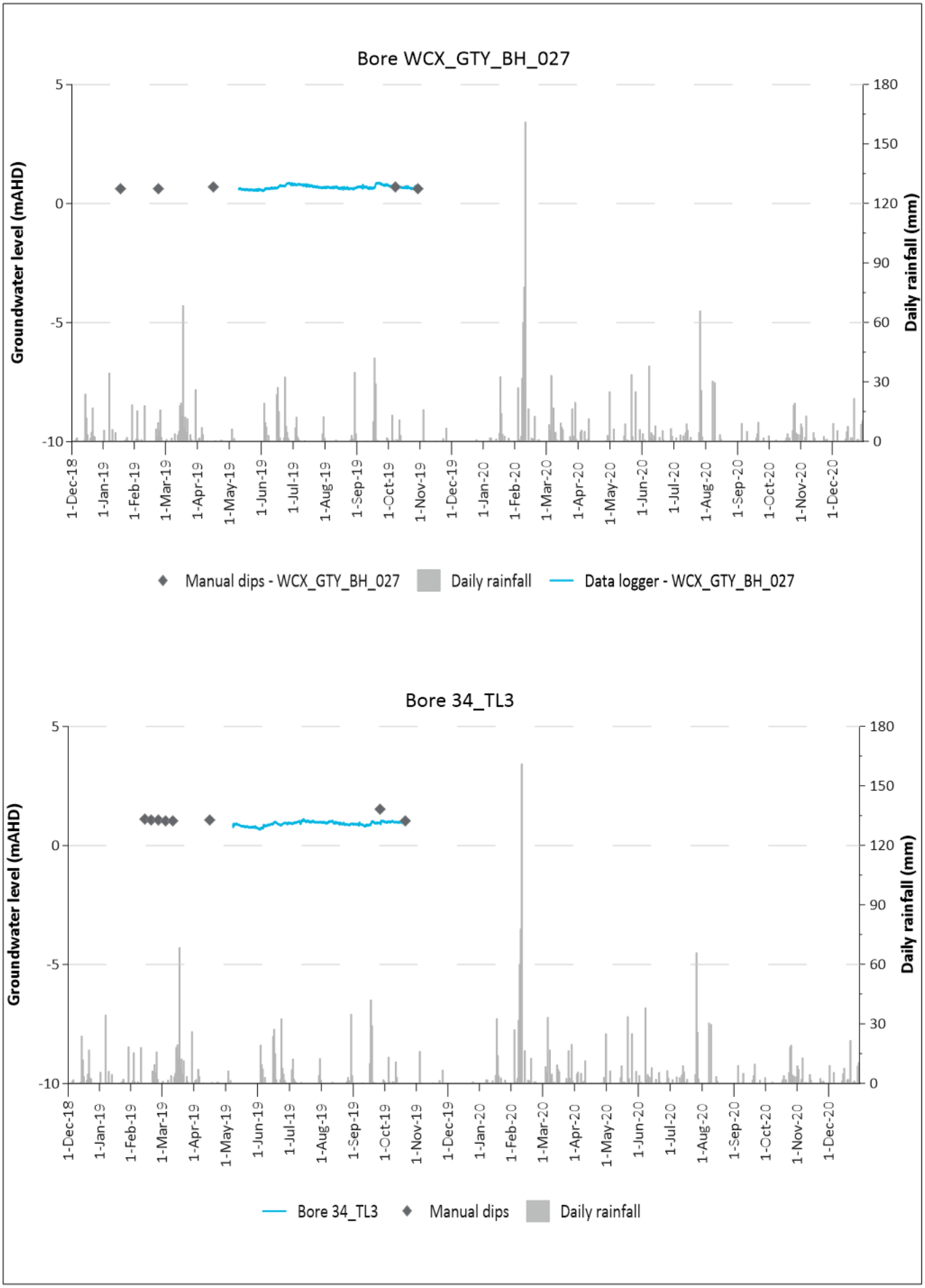
Schedule (during construction)	Requirements	Recipient (relevant authority)
Data provision		
Quarterly (every 3 months)	Groundwater level, groundwater quality and extraction volume monitoring data (raw data collated and tabulated in Excel)	DPIE-Water

Table 5-2 – Reporting requirements

Schedule (during construction)	Requirements	Recipient (relevant authority)
Reporting		

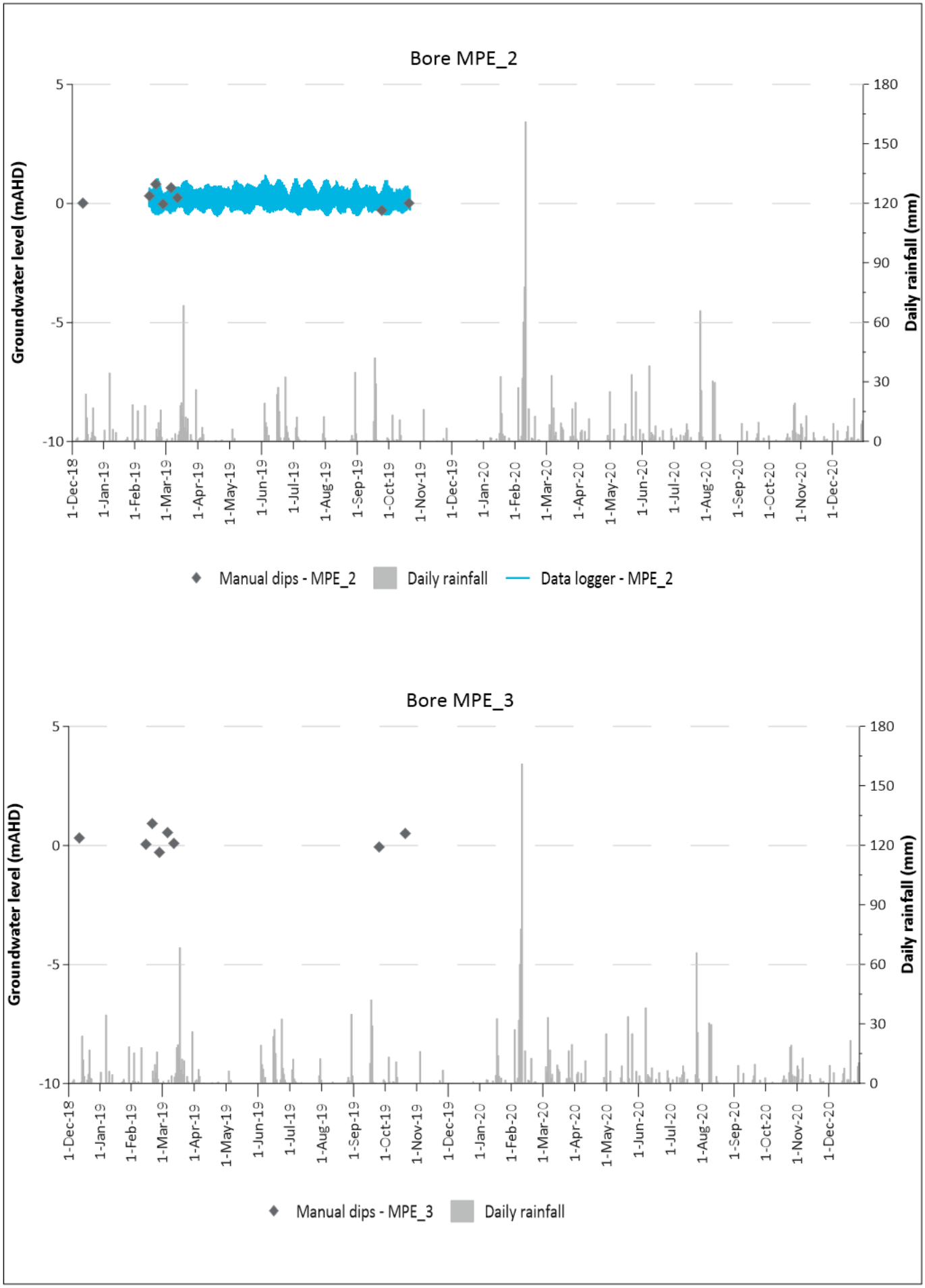
Schedule (during construction)	Requirements	Recipient (relevant authority)
Construction Compliance Monitoring Reports (every six months)	Data summary reports presenting tabulated groundwater monitoring data collected during the six-month period. Groundwater level hydrographs (including rainfall) and water quality results will be presented. Applicable management responses will be documented. Compliance against discharge criteria will also be presented. Report will also present validation of groundwater modelling and determine the need for adjustments to this Monitoring Program (monitoring location, parameters, and frequencies), if necessary.	DPIE-Water, Sydney Water, This report will also be provided to DPIE in accordance with CoA C24.

Appendix A Monitoring bore hydrographs



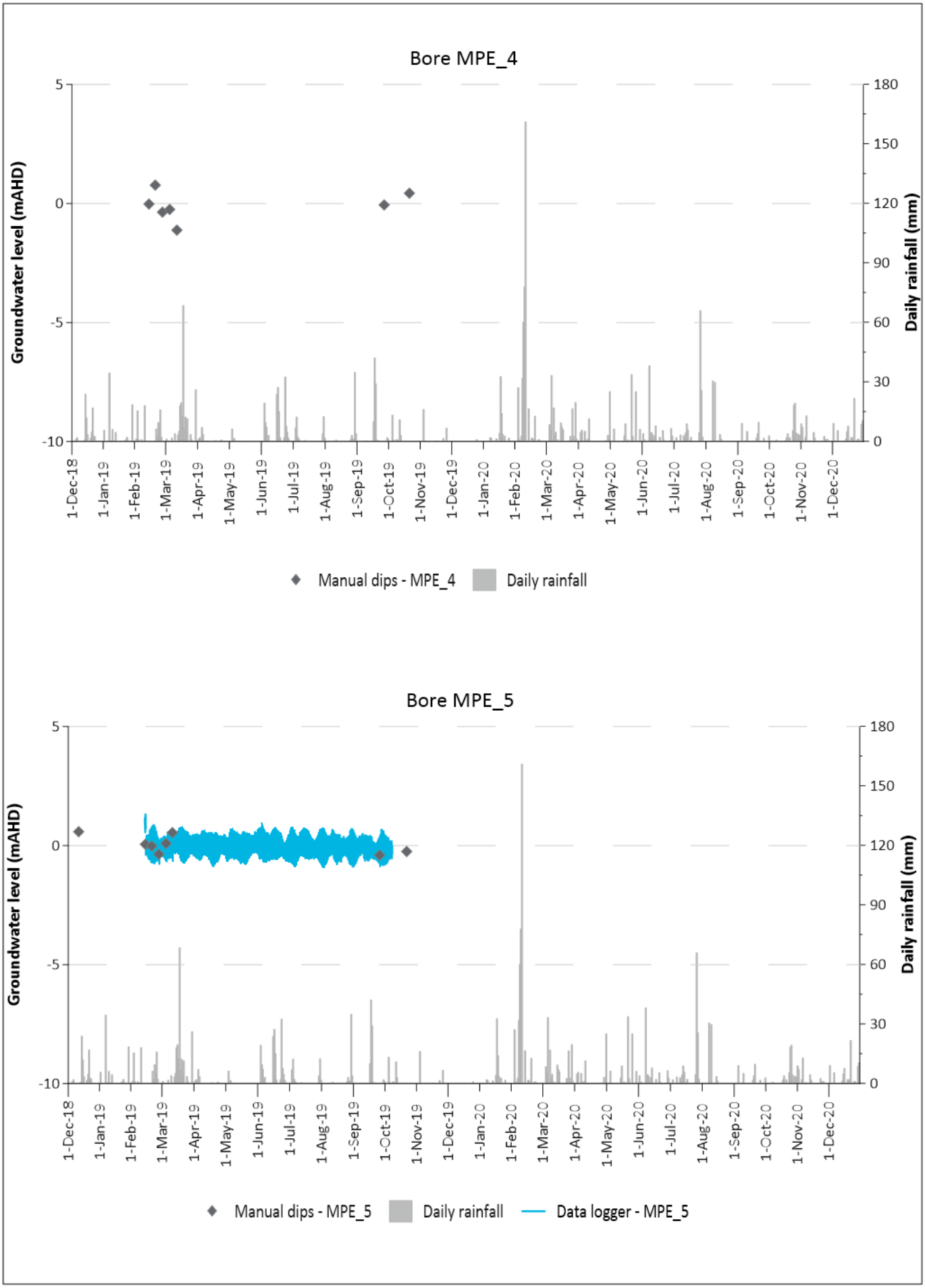
Hydrographs - WCX_GTY_BH_027 & 34_TL3

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.1



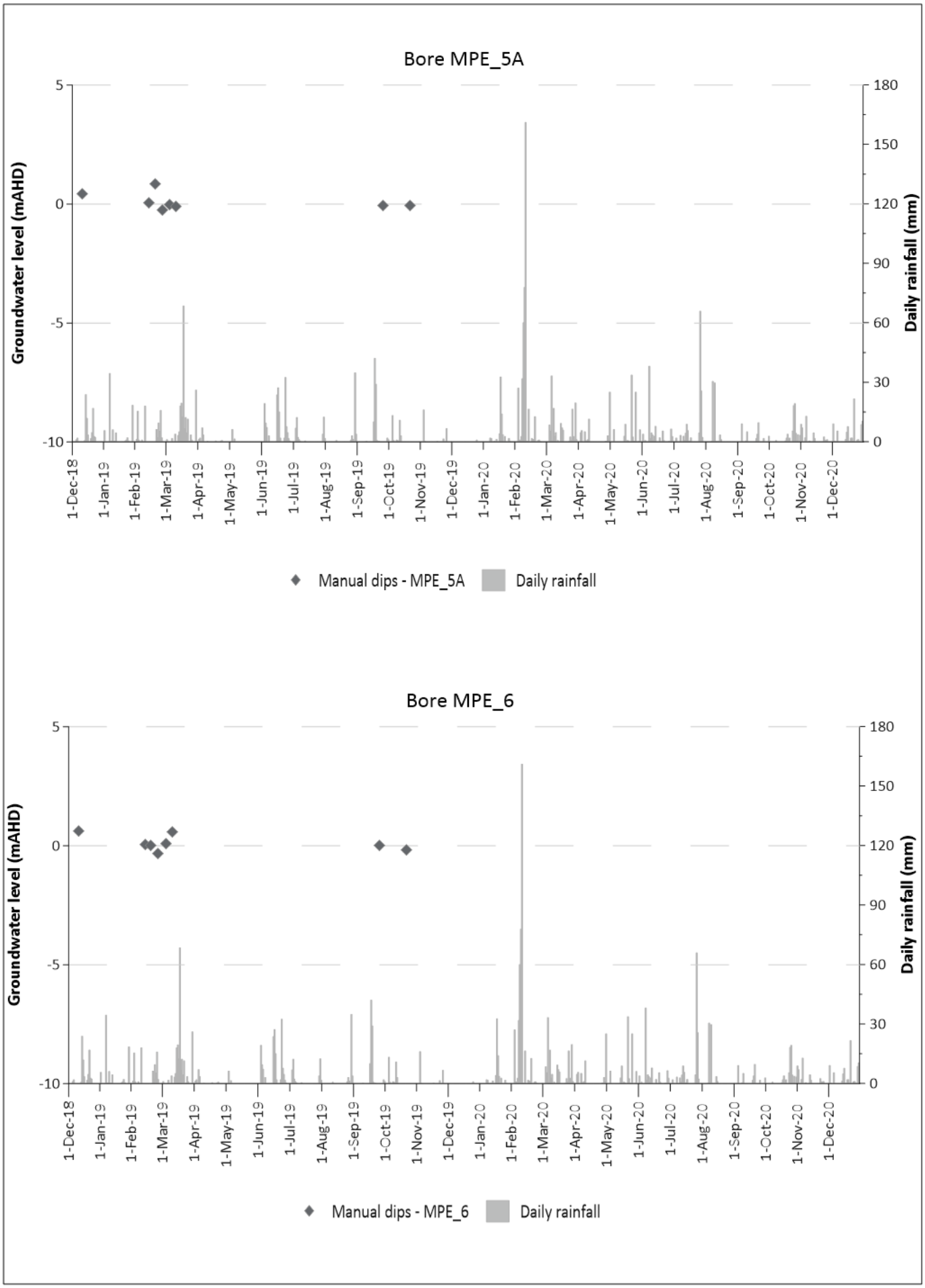
Hydrographs - MPE_2 & MPE_3

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.2



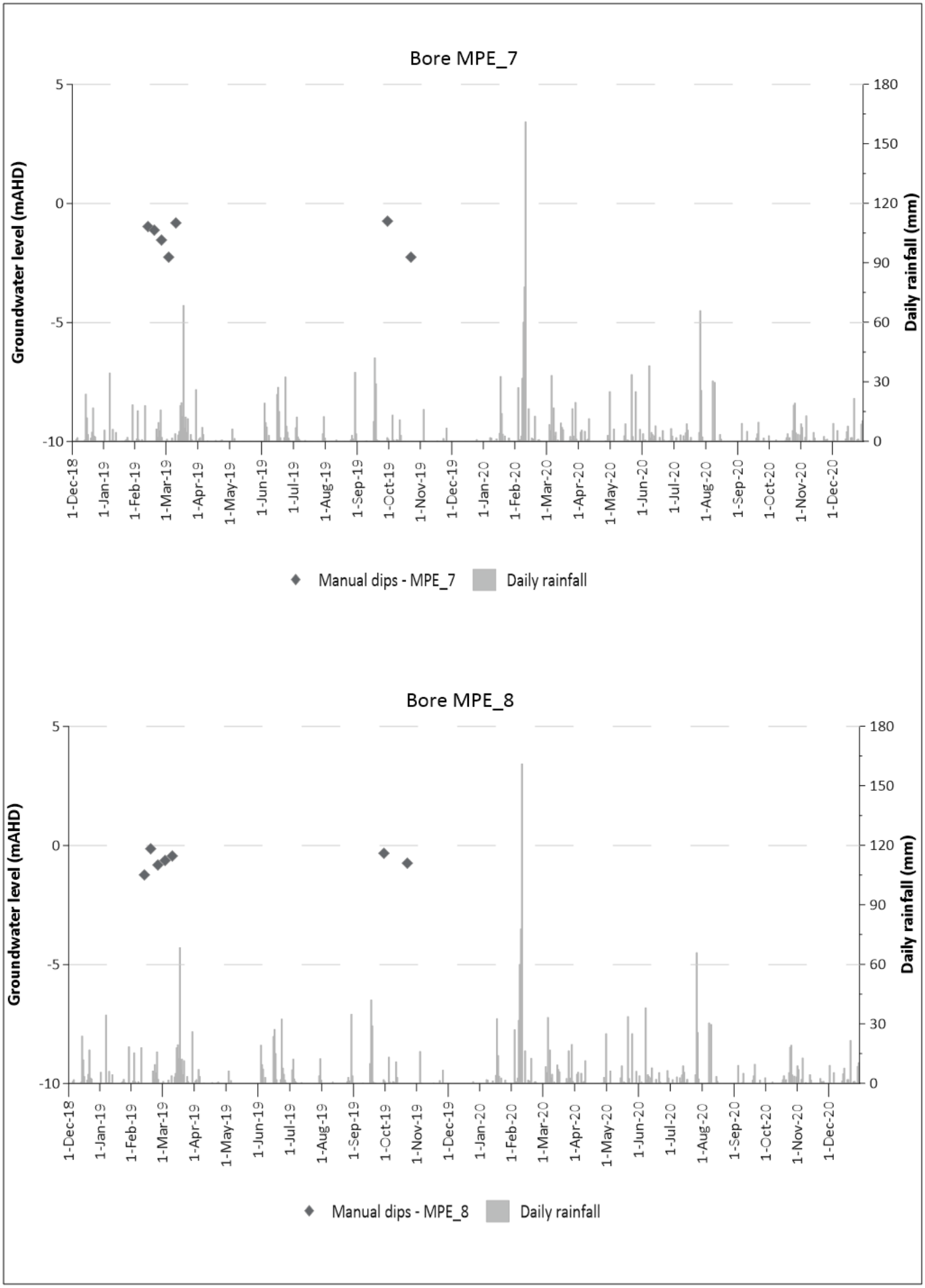
Hydrographs - MPE_4 & MPE_5

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.3



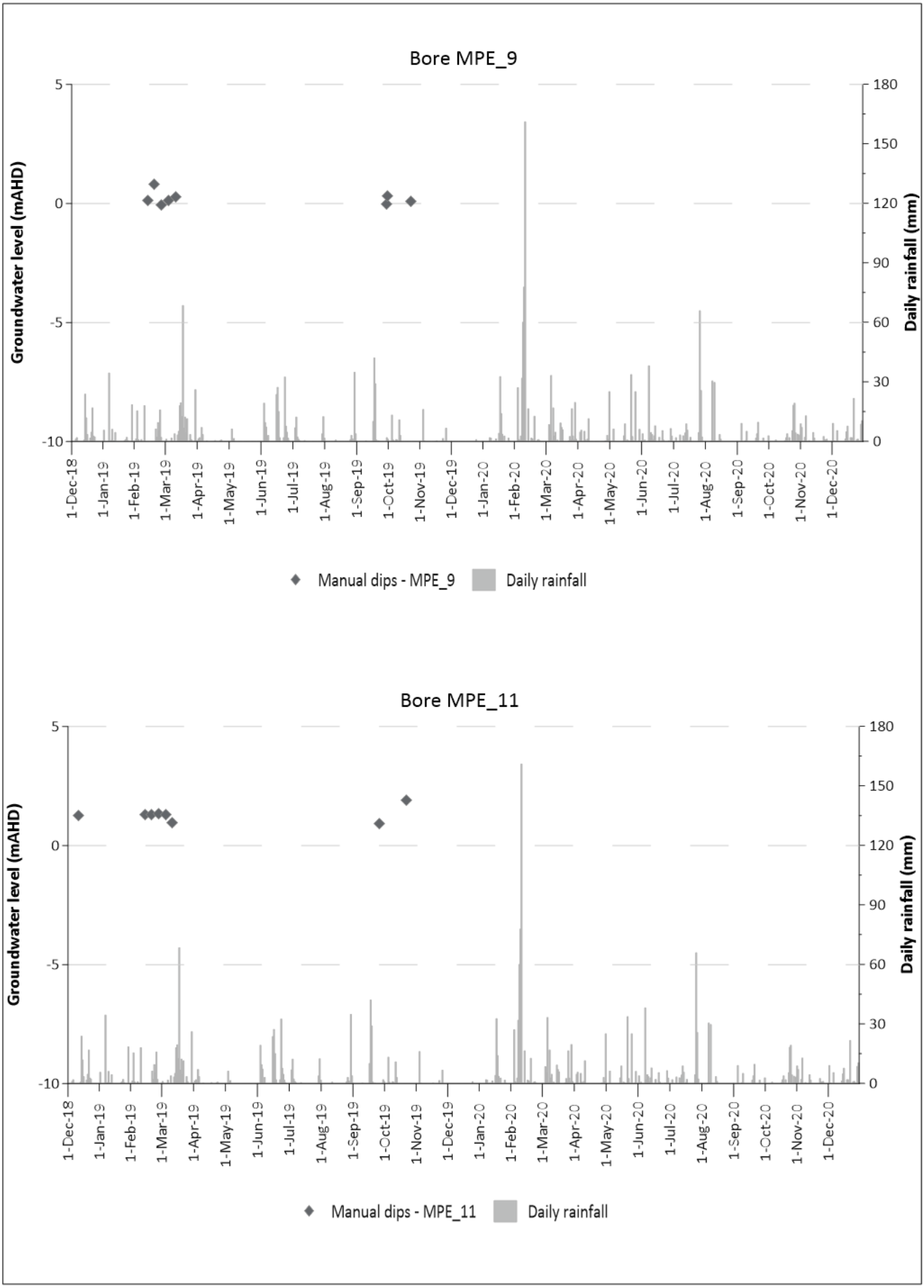
Hydrographs - MPE_5A & MPE_6

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.4



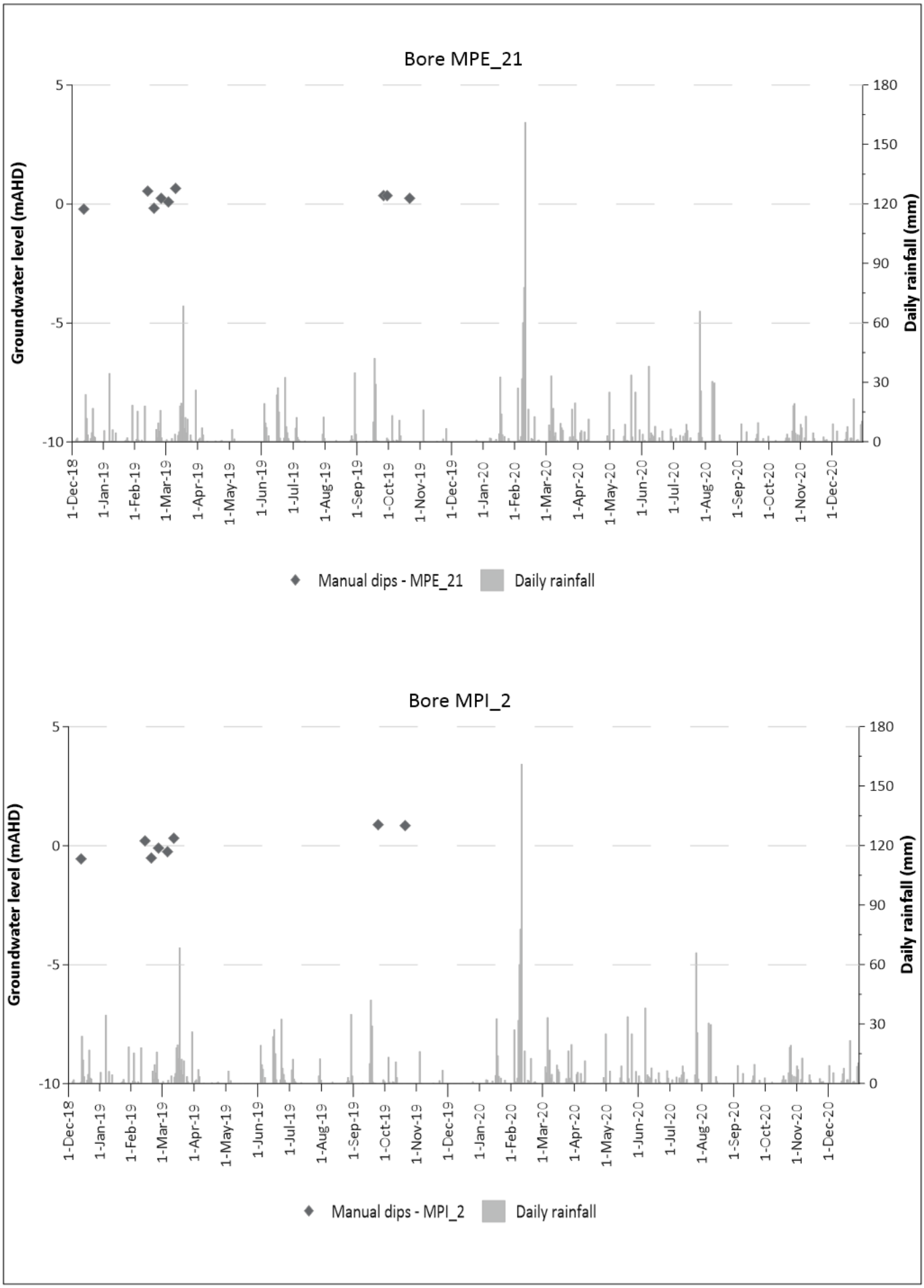
Hydrographs - MPE_7 & MPE_8

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.5



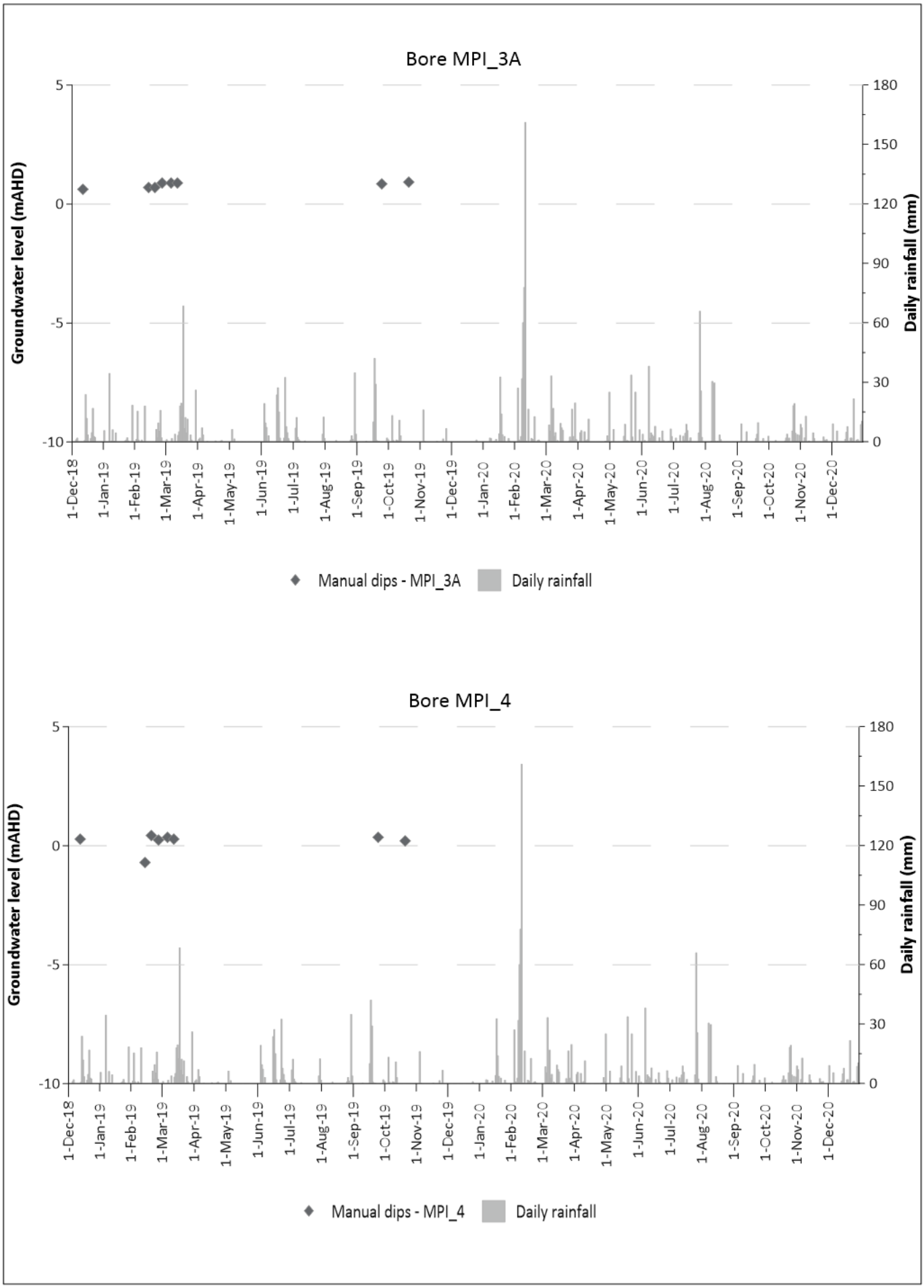
Hydrographs - MPE_9 & MPE_11

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.6



Hydrographs - MPE_21 & MPI_2

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.7



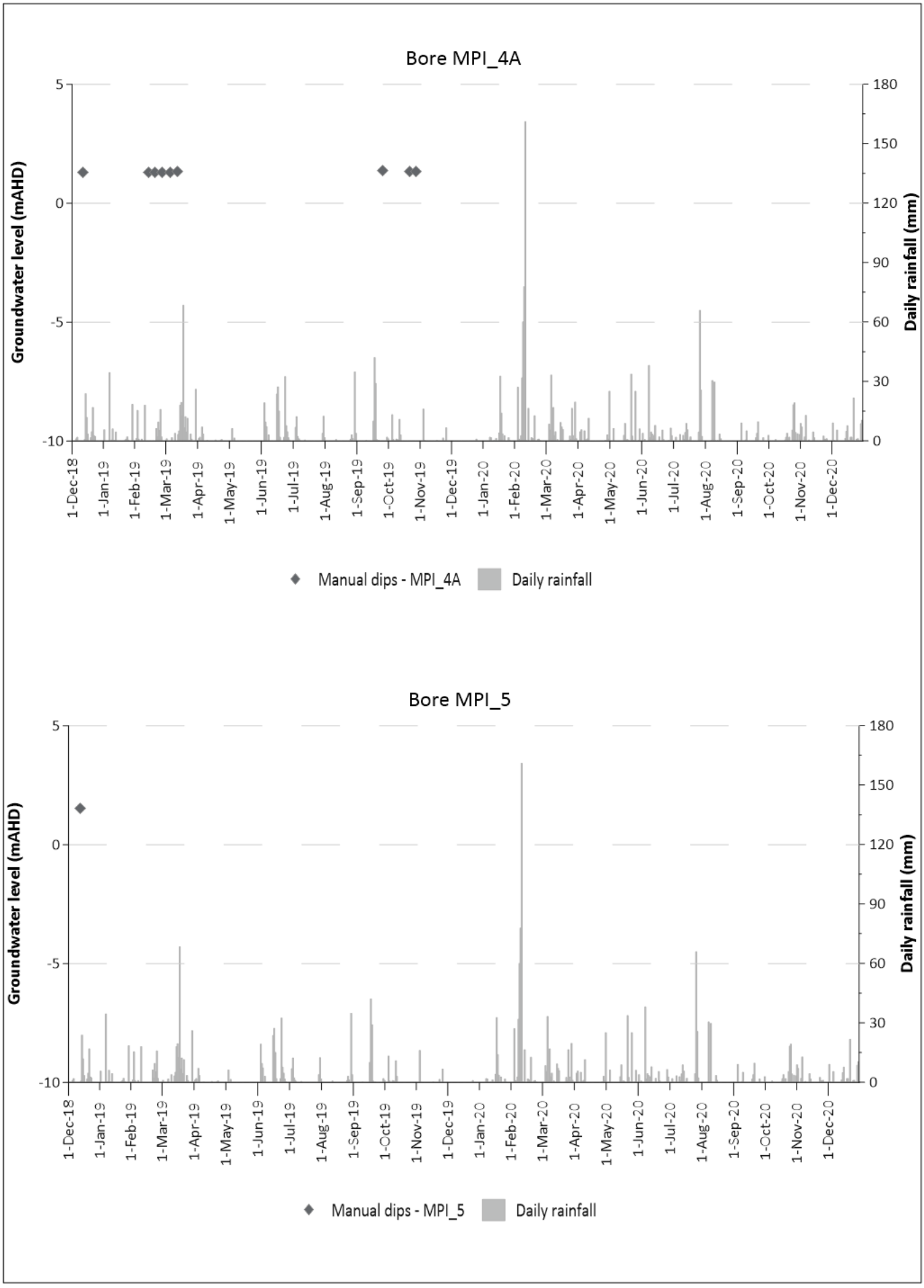
EMM

Hydrographs - MPI_3A & MPI_4

Groundwater Monitoring Program

Sydney Gateway Road Project

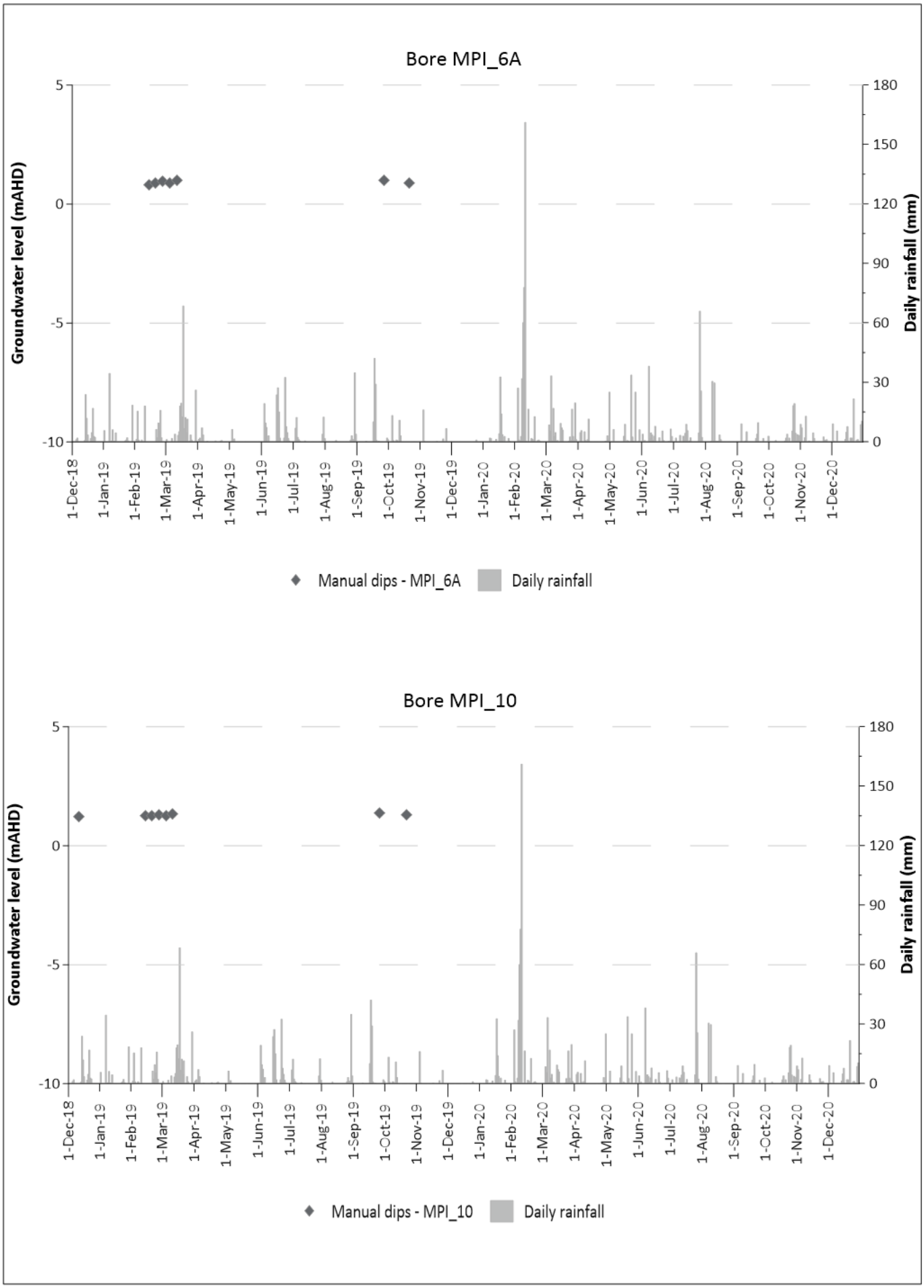
Figure A.8



EMM

Hydrographs - MPI_4A & MPI_5

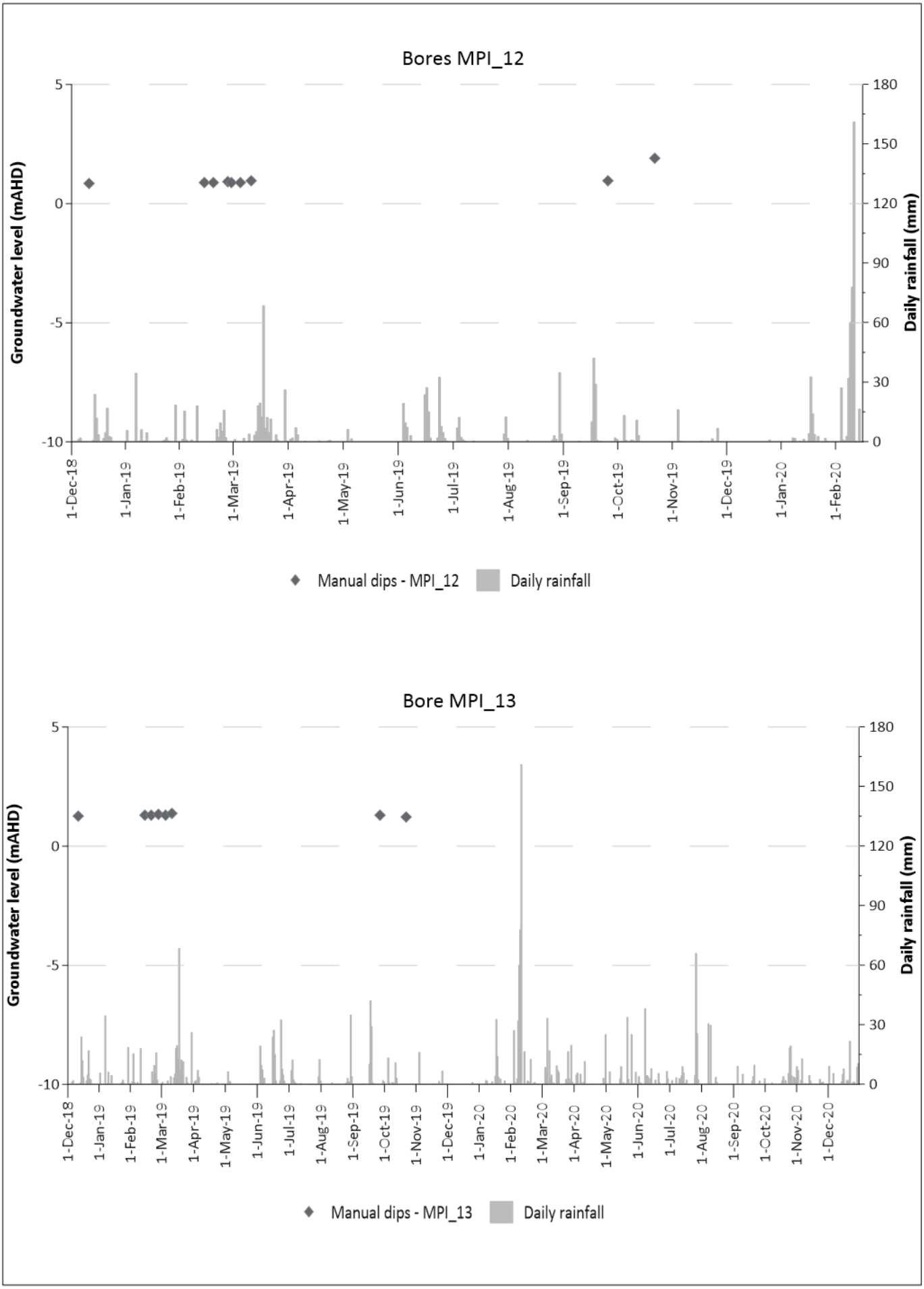
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.9



EMM

Hydrographs - MPI_6A & MPI_10

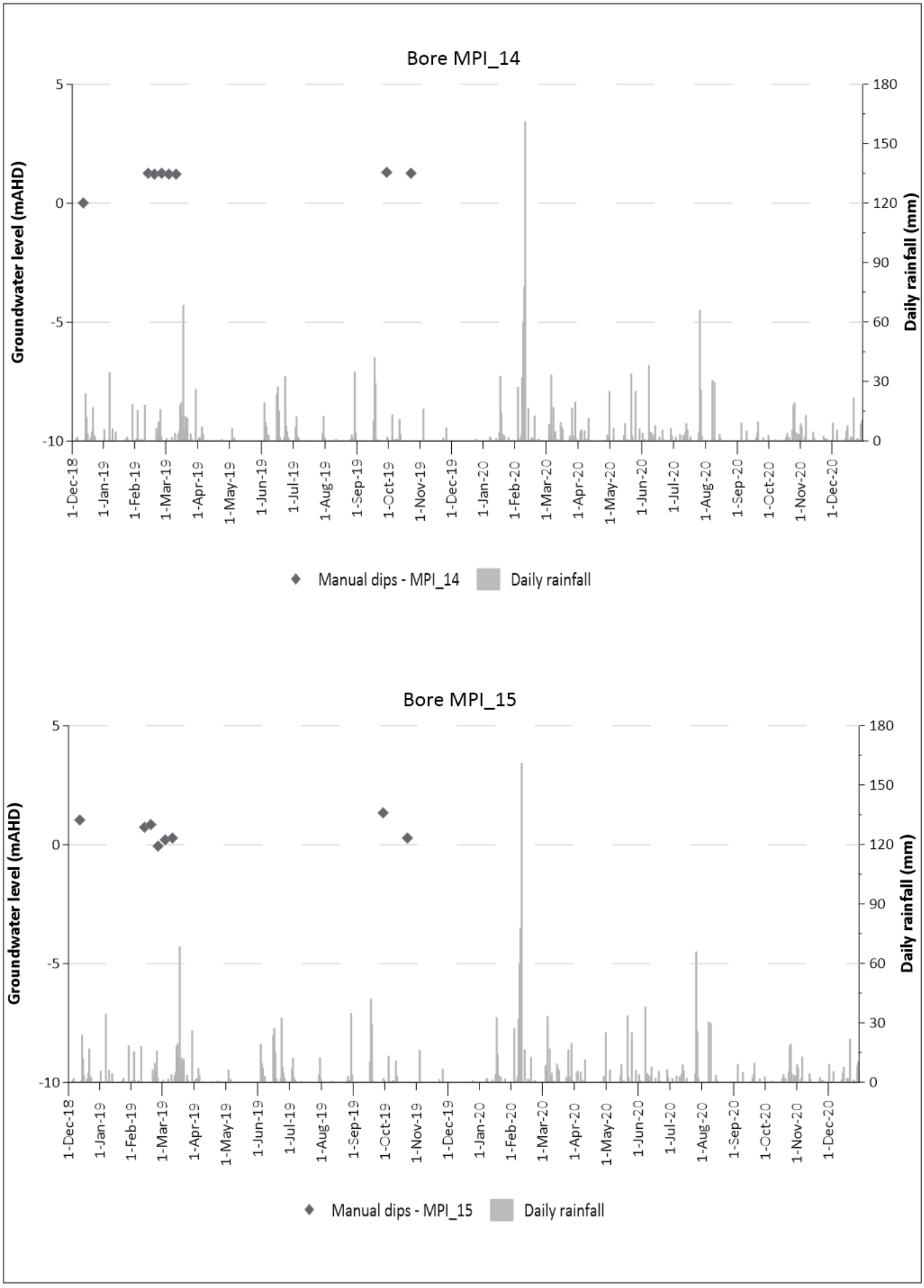
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.10



EMM

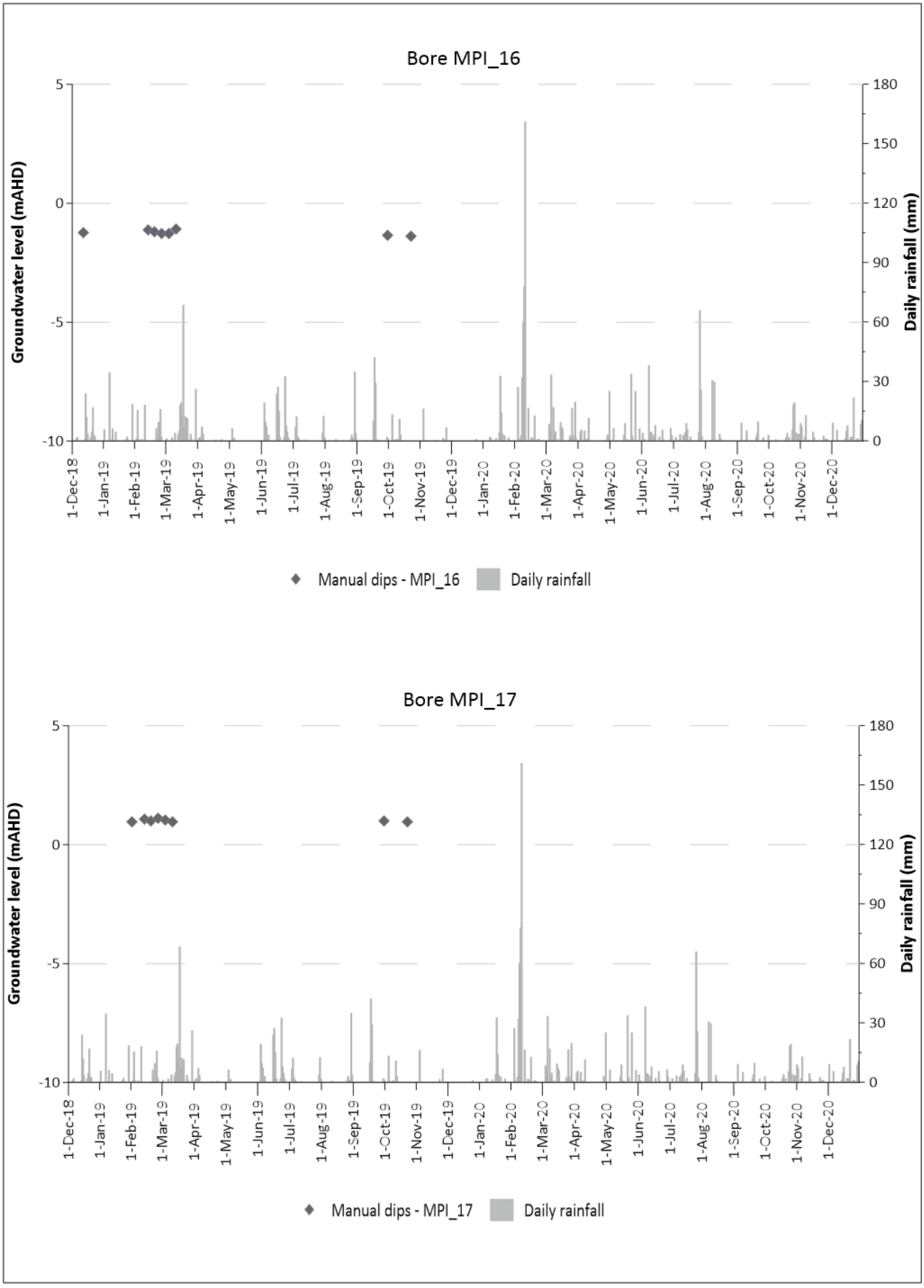
Hydrographs - MPI_12 & MPI_13

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.11



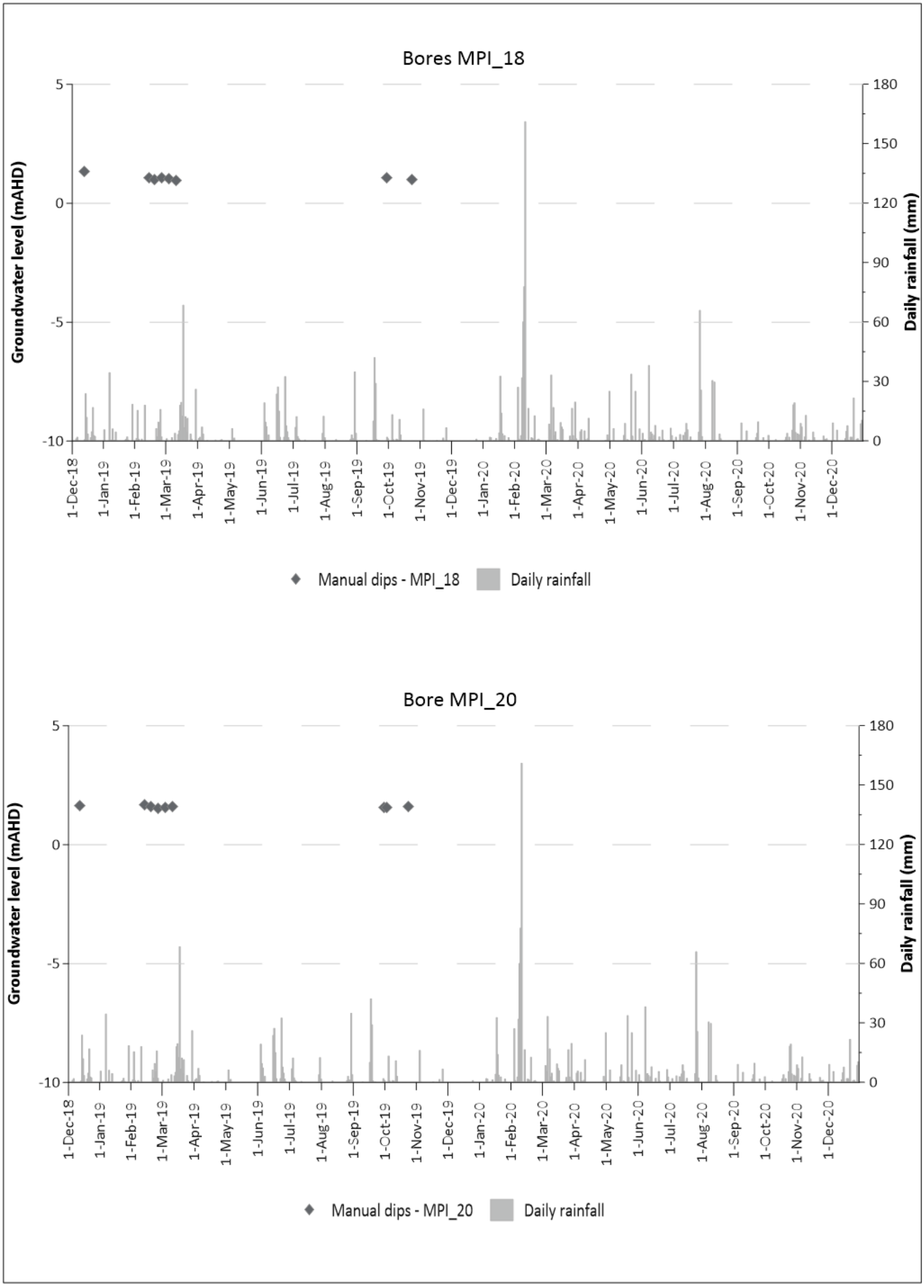
Hydrographs - MPI_14 & MPI_15

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.12



Hydrographs - MPI_16 & MPI_17

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.13



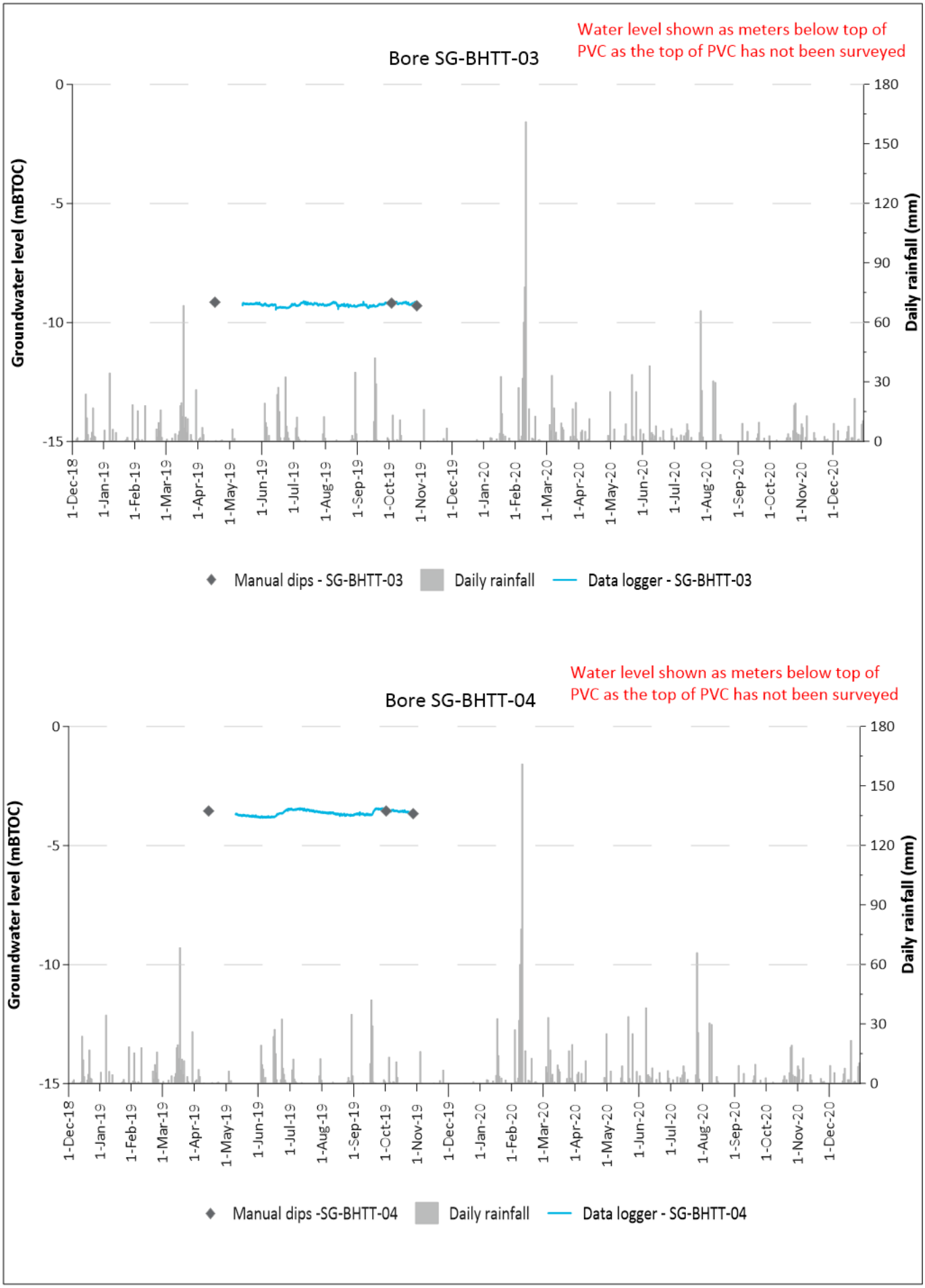
EMM

Hydrographs - MPI_18 & MPI_20

Groundwater Monitoring Program

Sydney Gateway Road Project

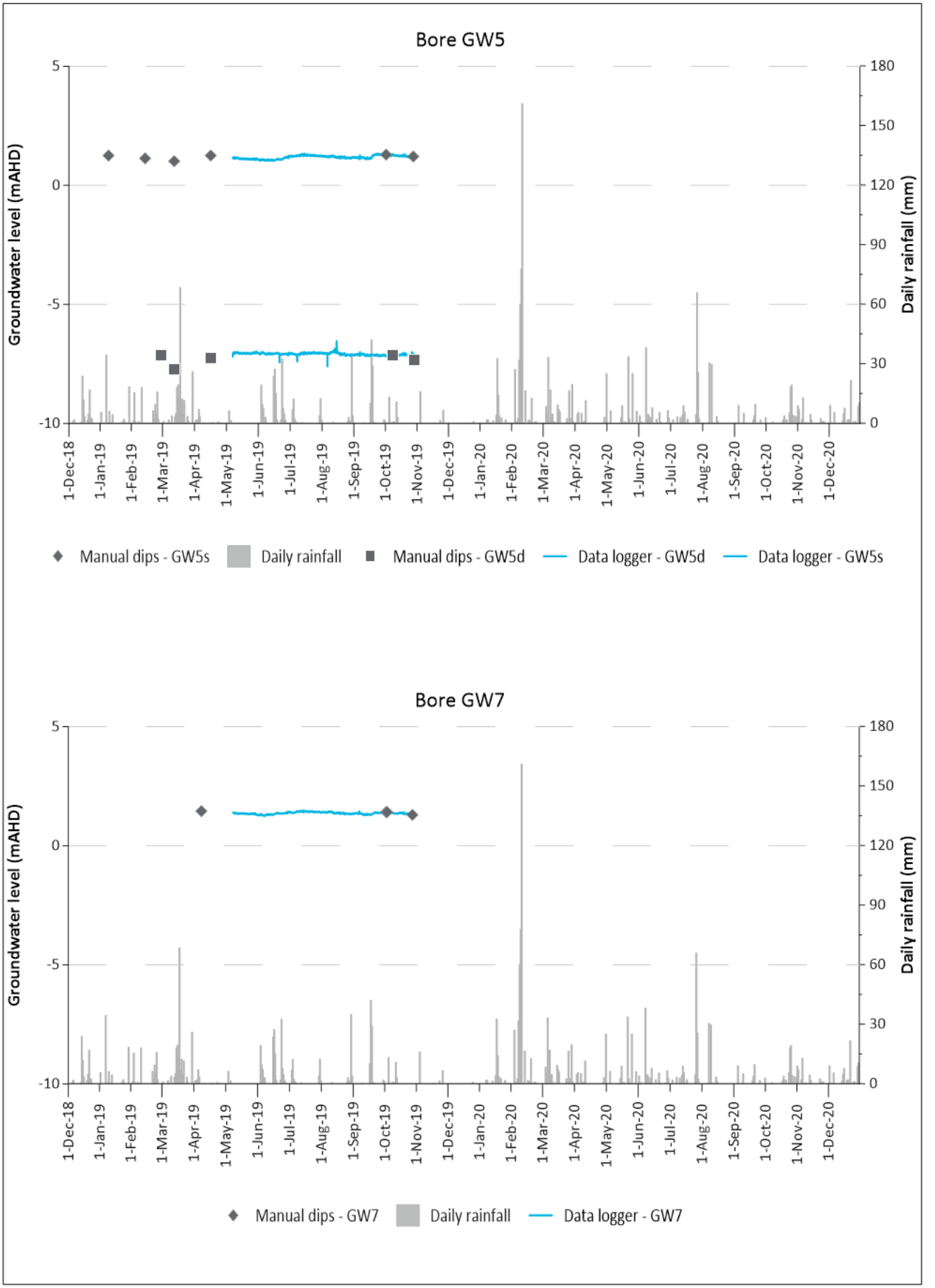
Figure A.14



EMM

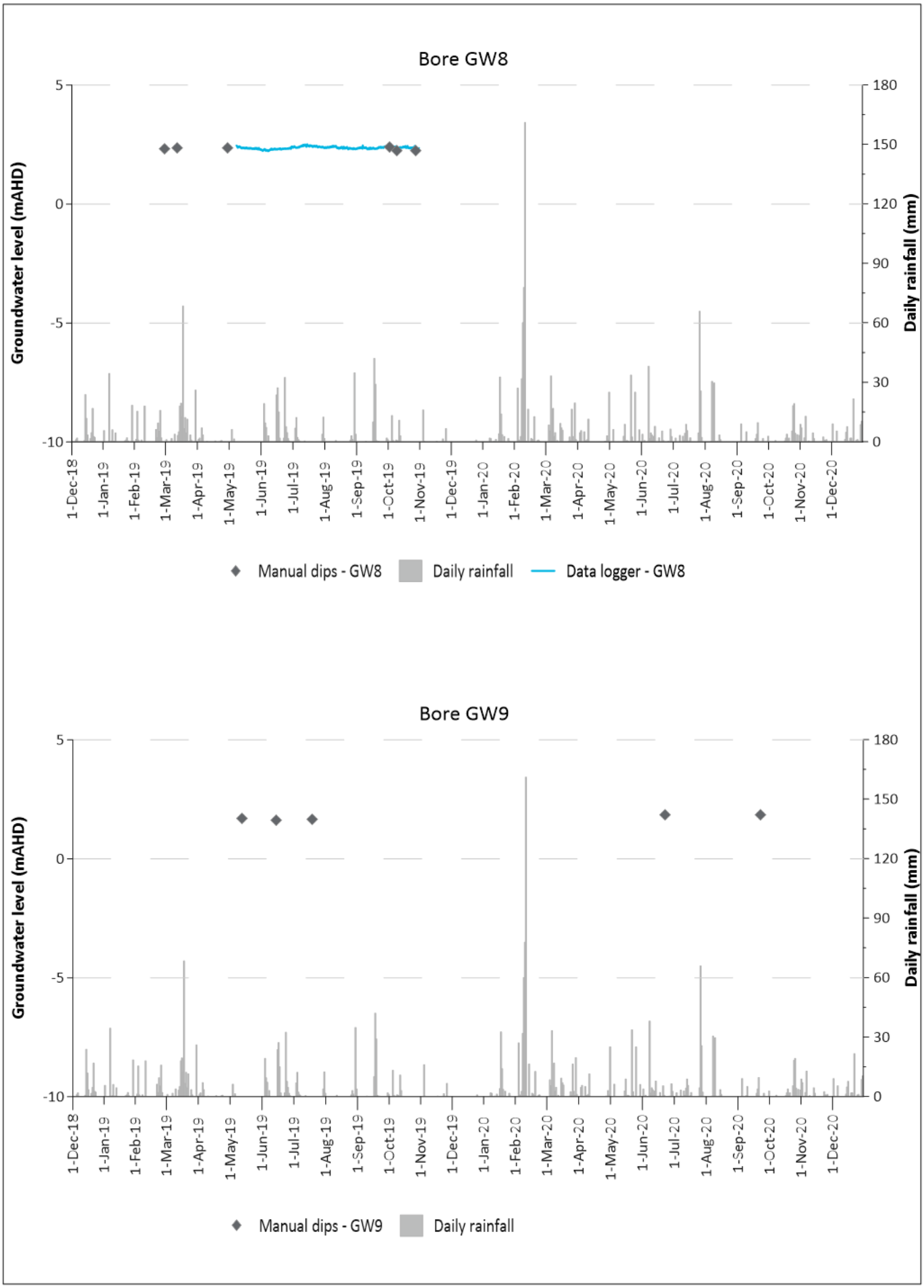
Hydrographs - SG-BHTT-03 & SG-BHTT-04

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.15

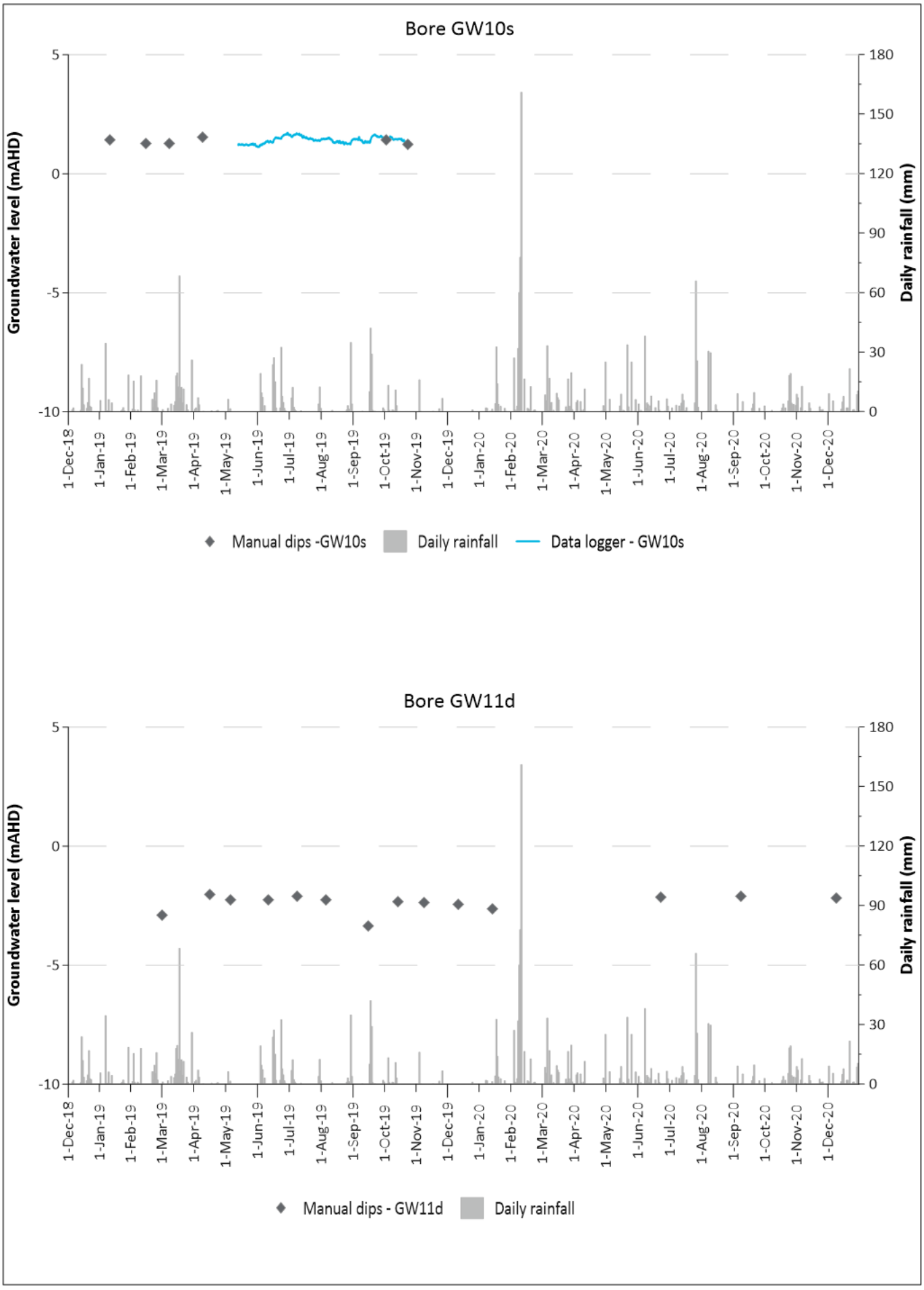


Hydrographs - GW5 & GW7

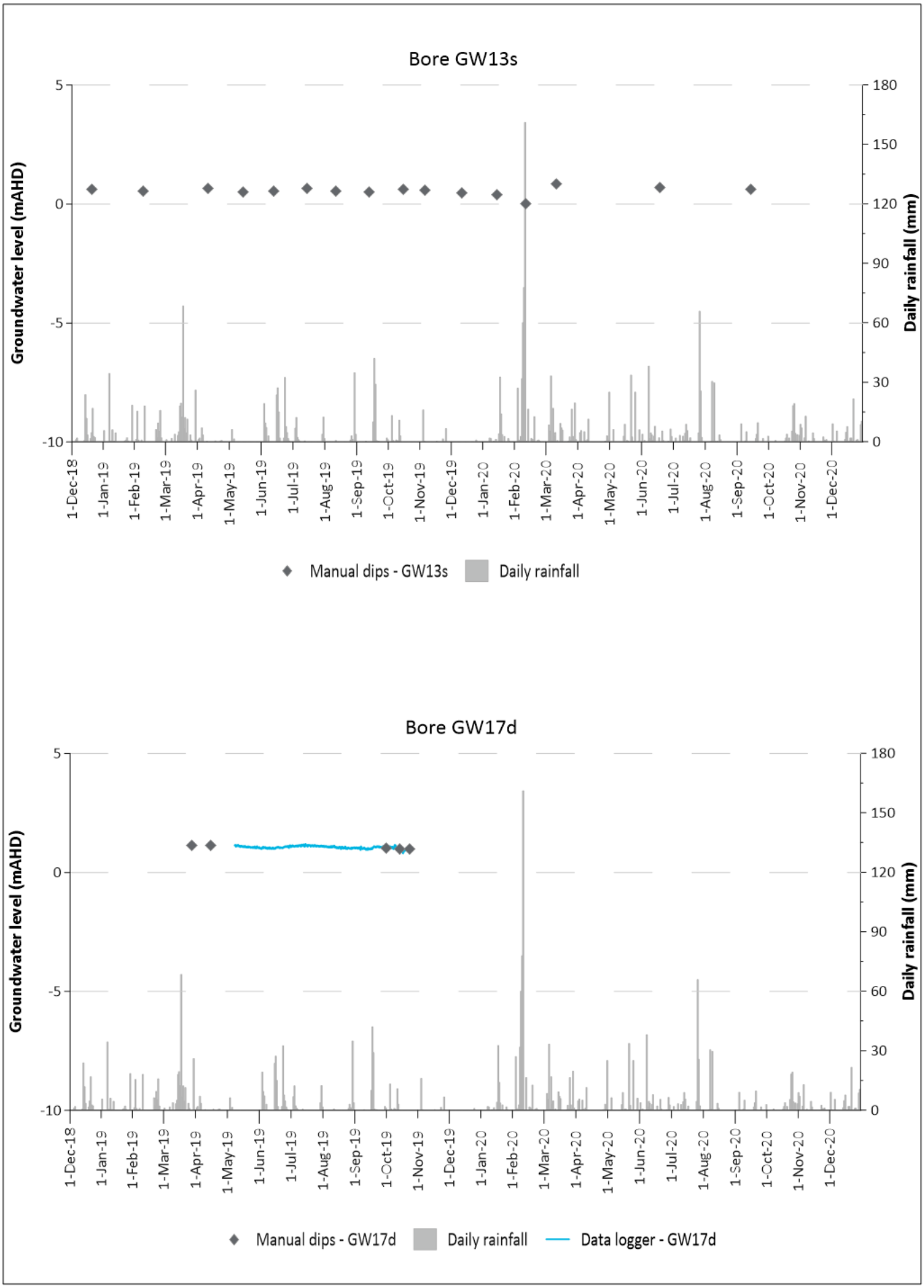
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.17



Hydrographs - GW8 & GW9
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.18

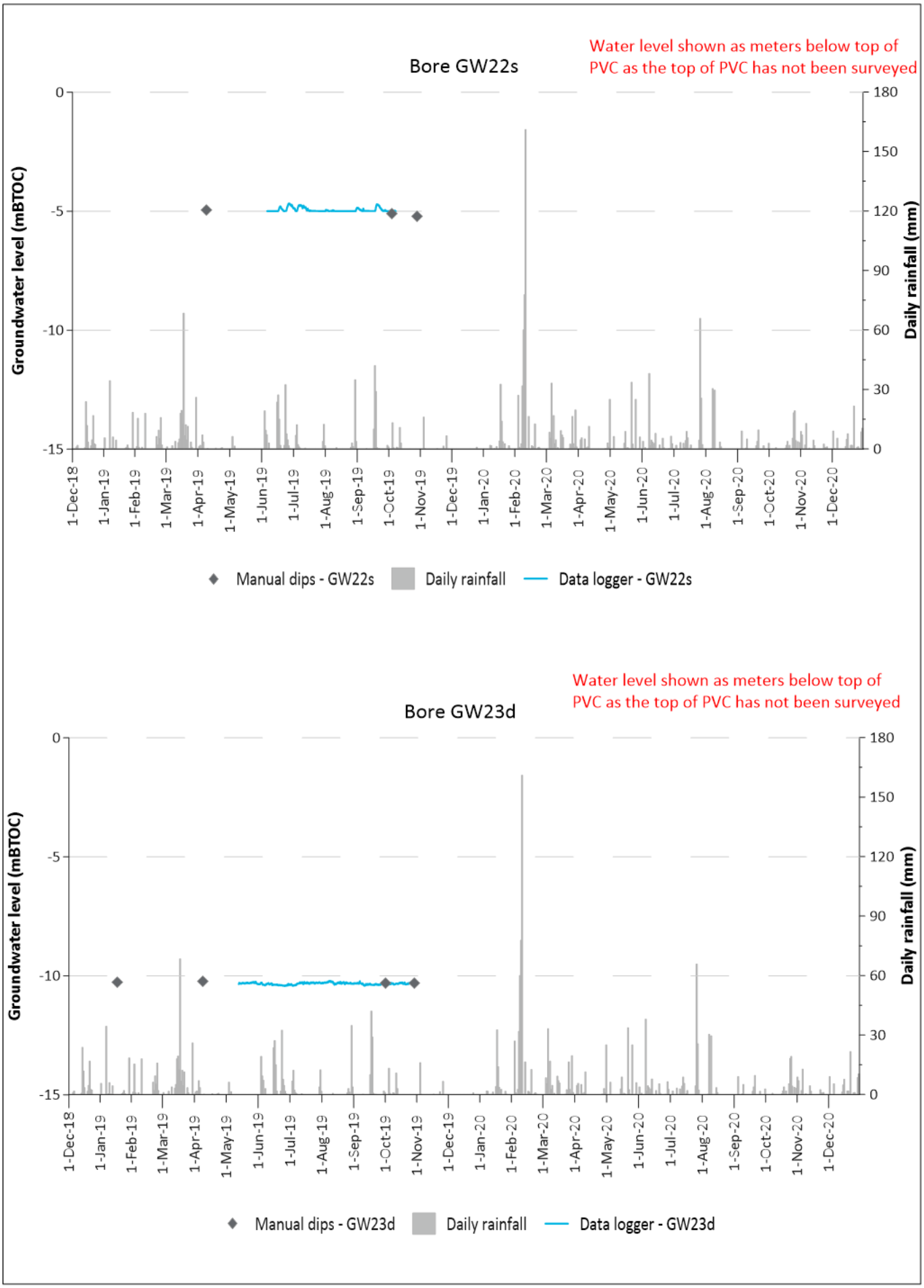


Hydrographs - GW10s & GW11d
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.19



Hydrographs - GW13s & GW17d

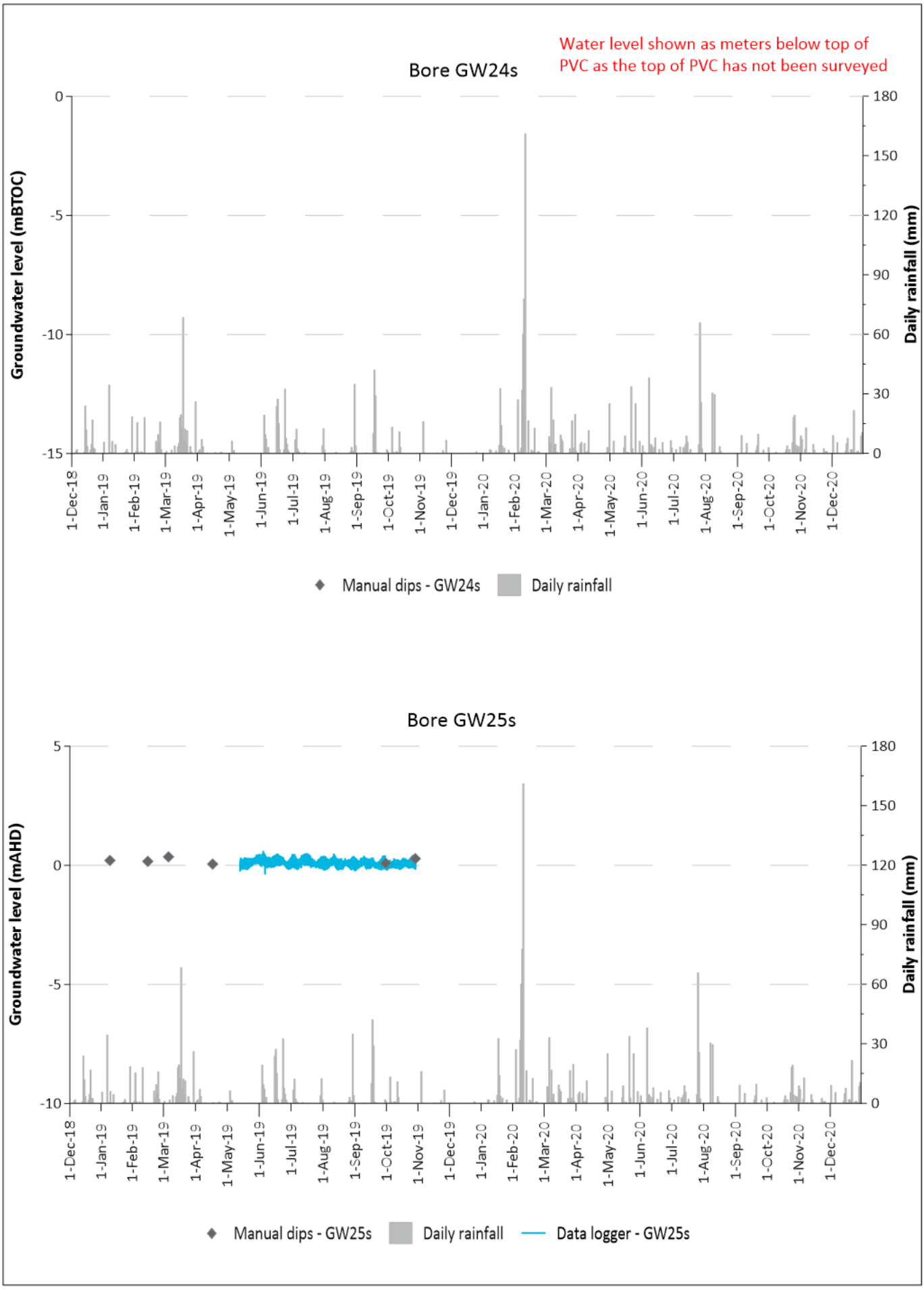
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.20



EMM

Hydrographs - GW22s & GW23d

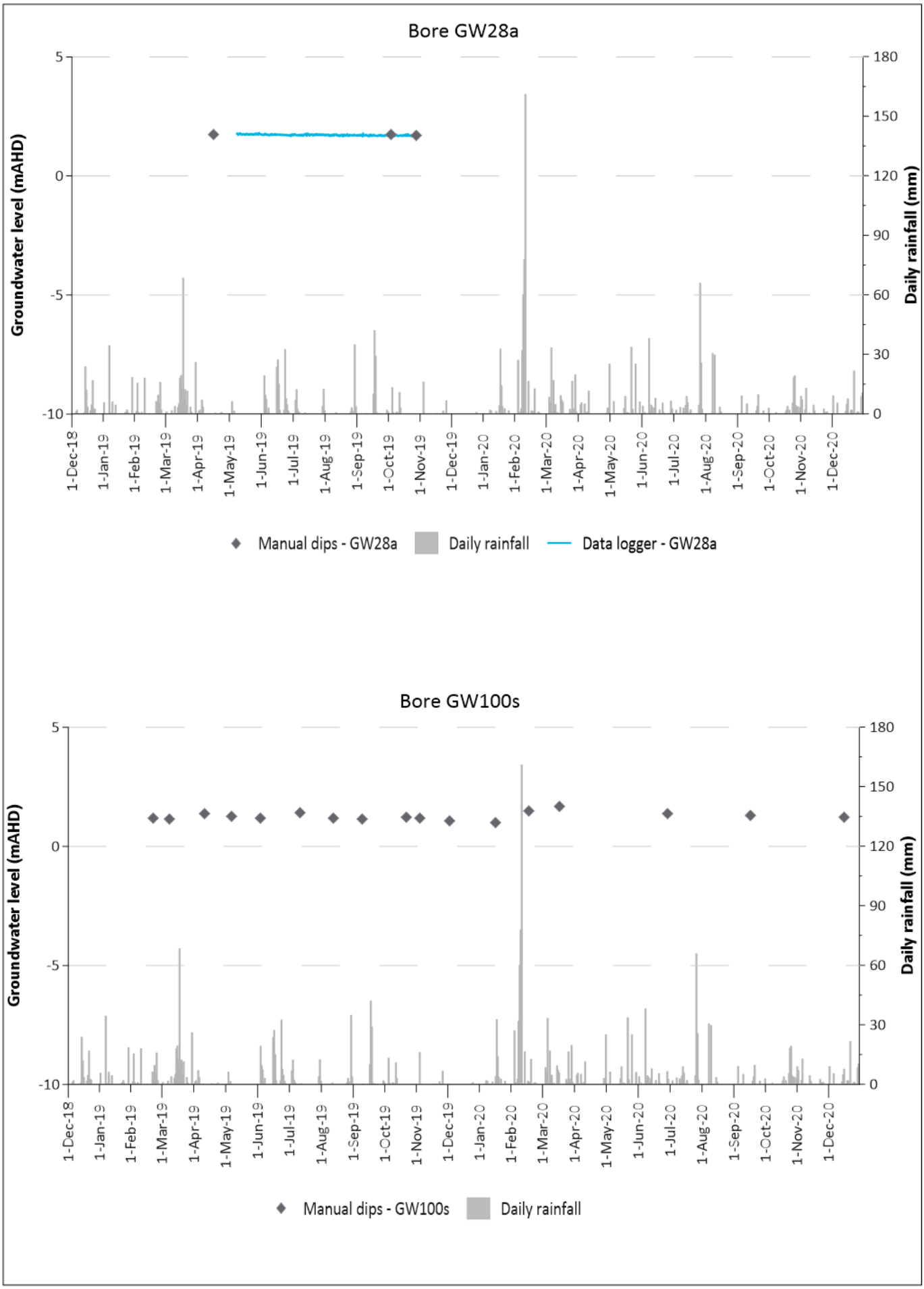
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.21



EMM

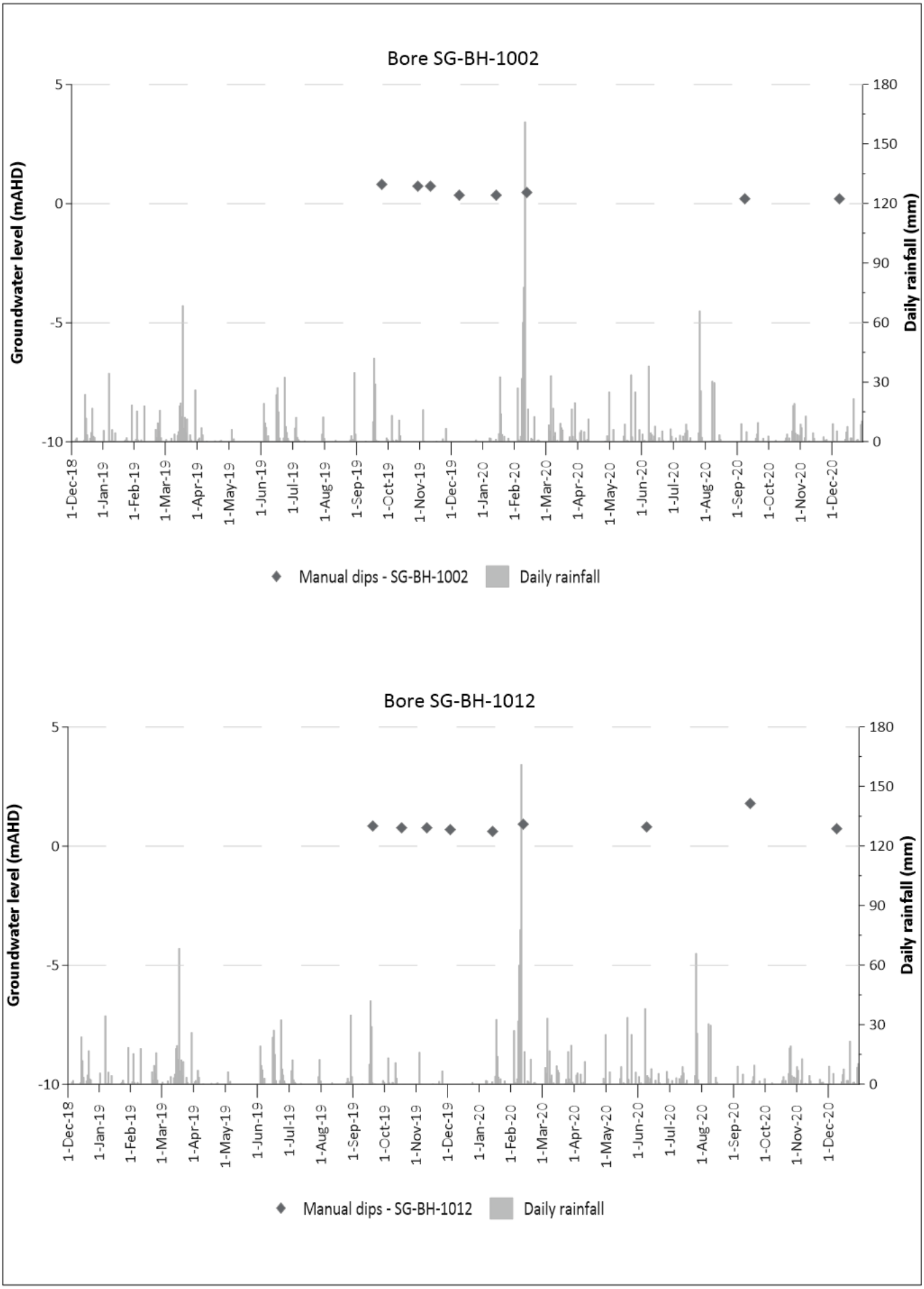
Hydrographs - GW24s & GW25s

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.22

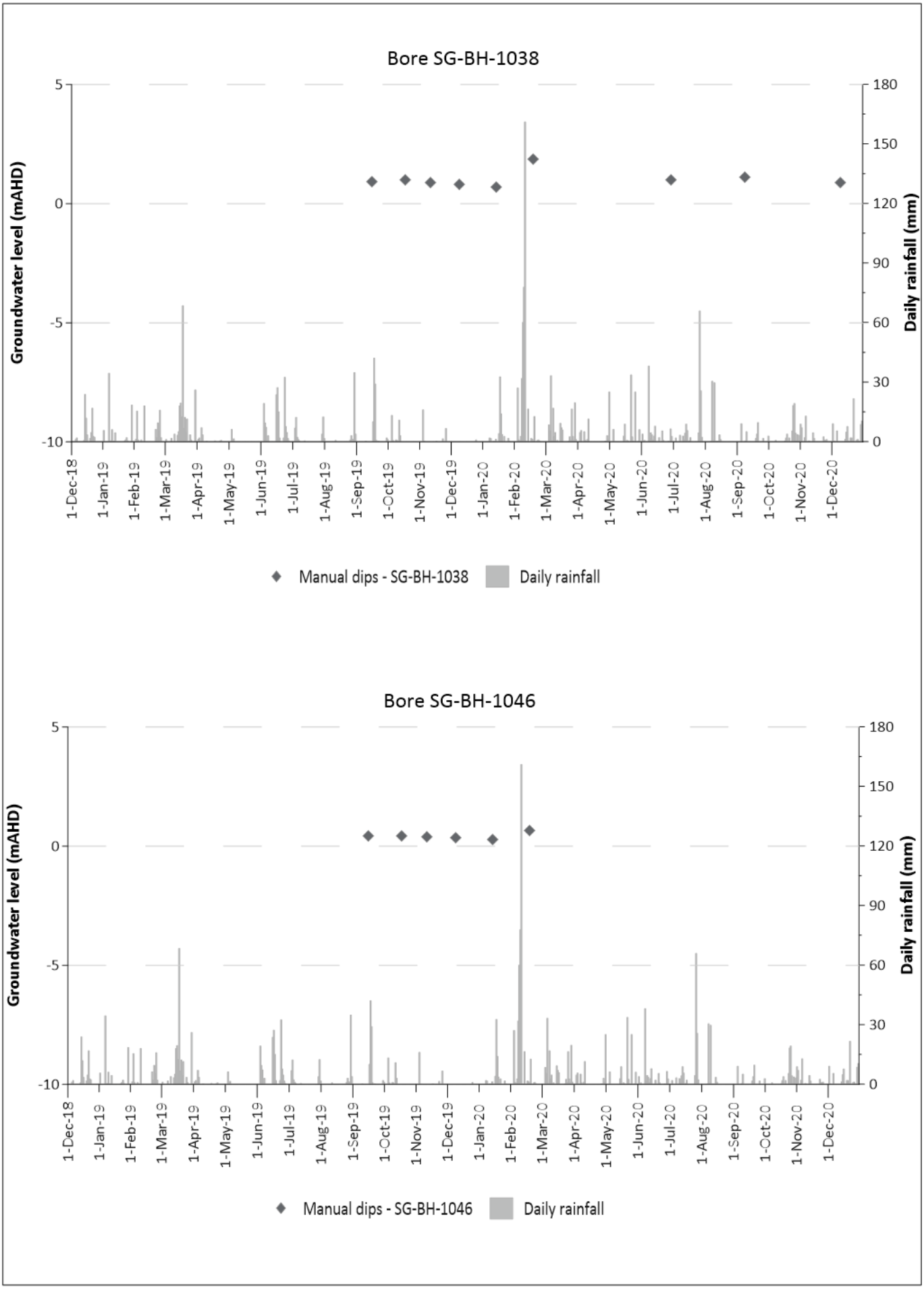


Hydrographs - GW28a & GW100s

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.23

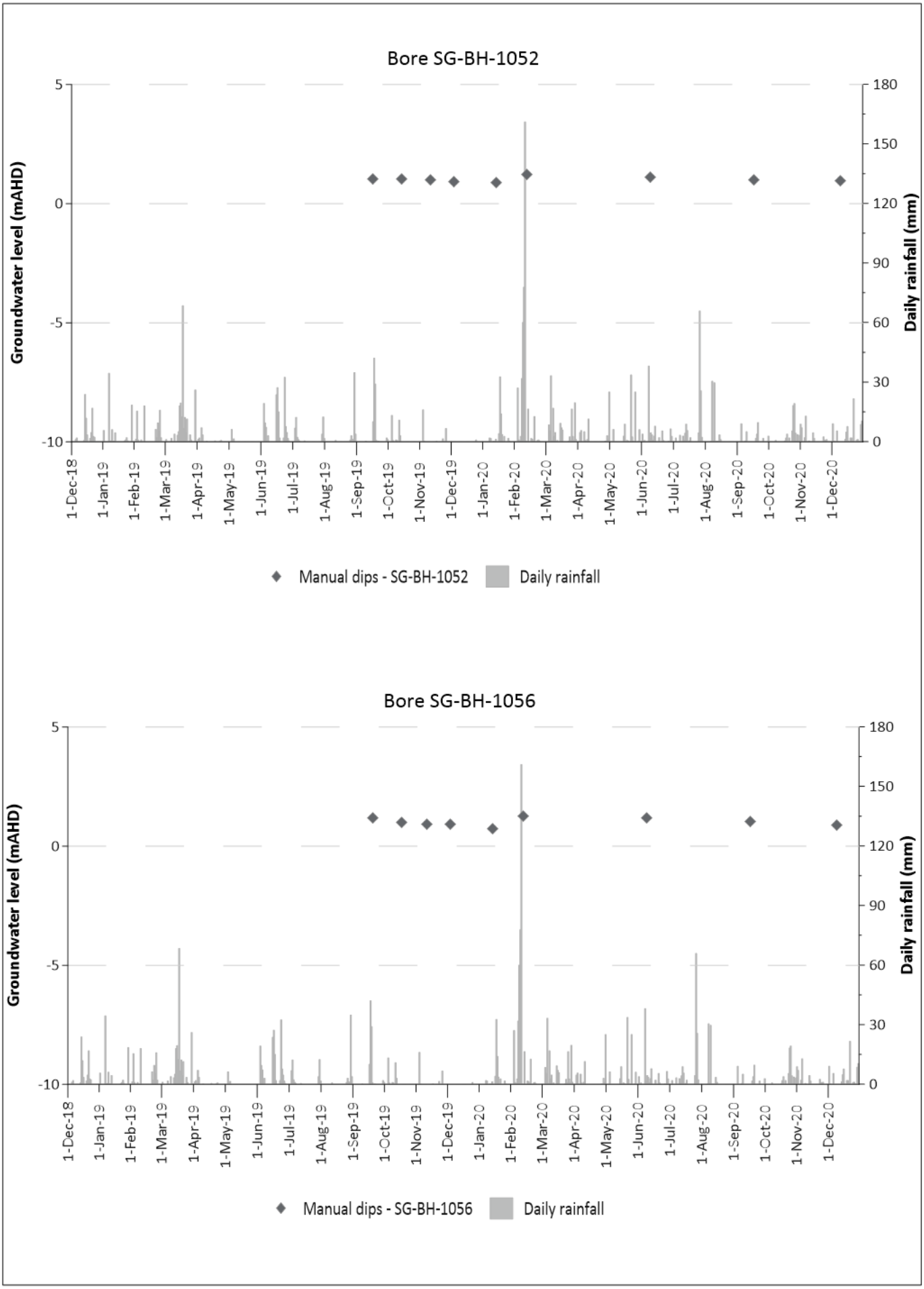


Hydrographs - SG-BH-1002 & SG-BH-1012
Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.24



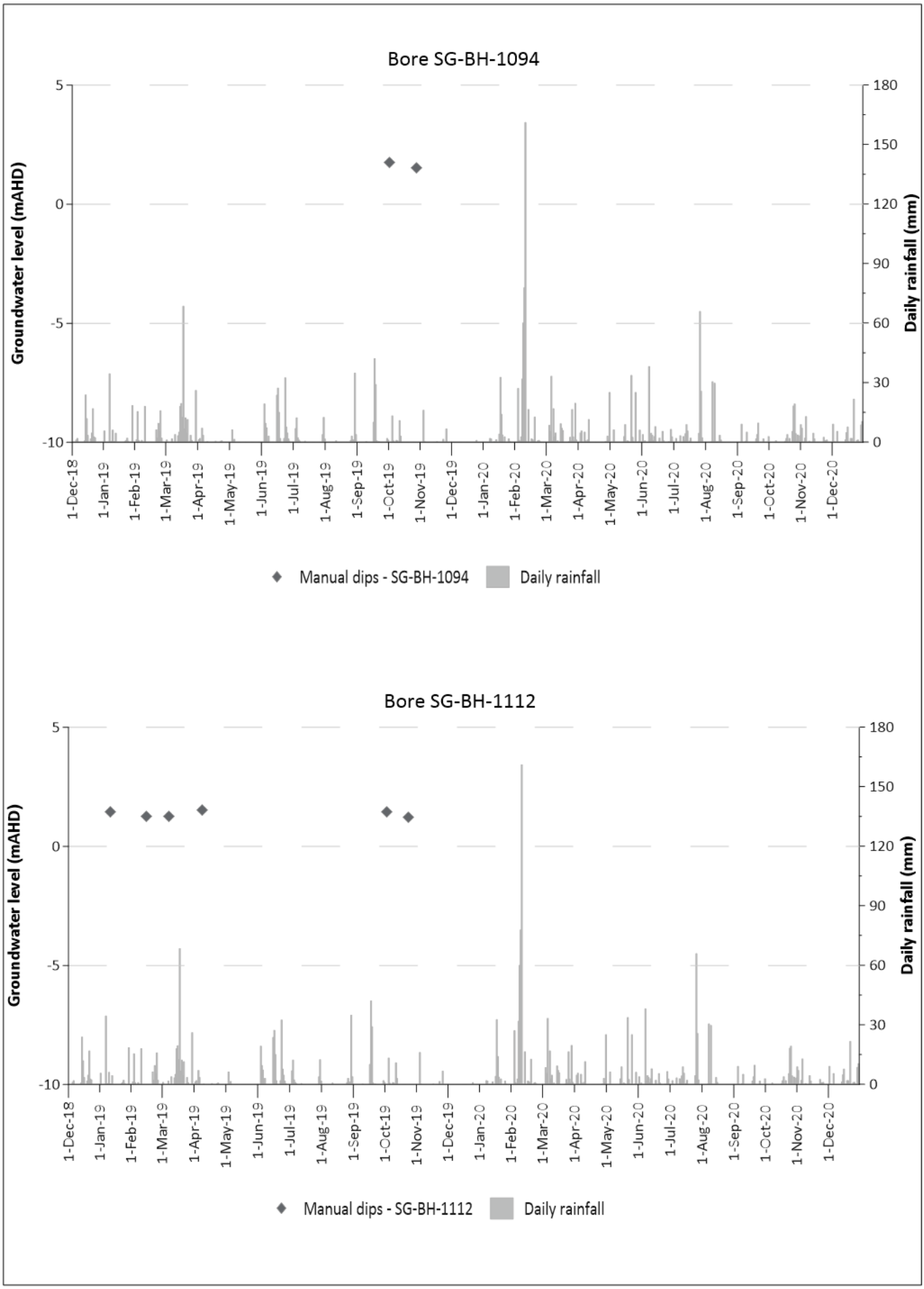
Hydrographs - SG-BH-1038 & SG-BH-1046

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.25



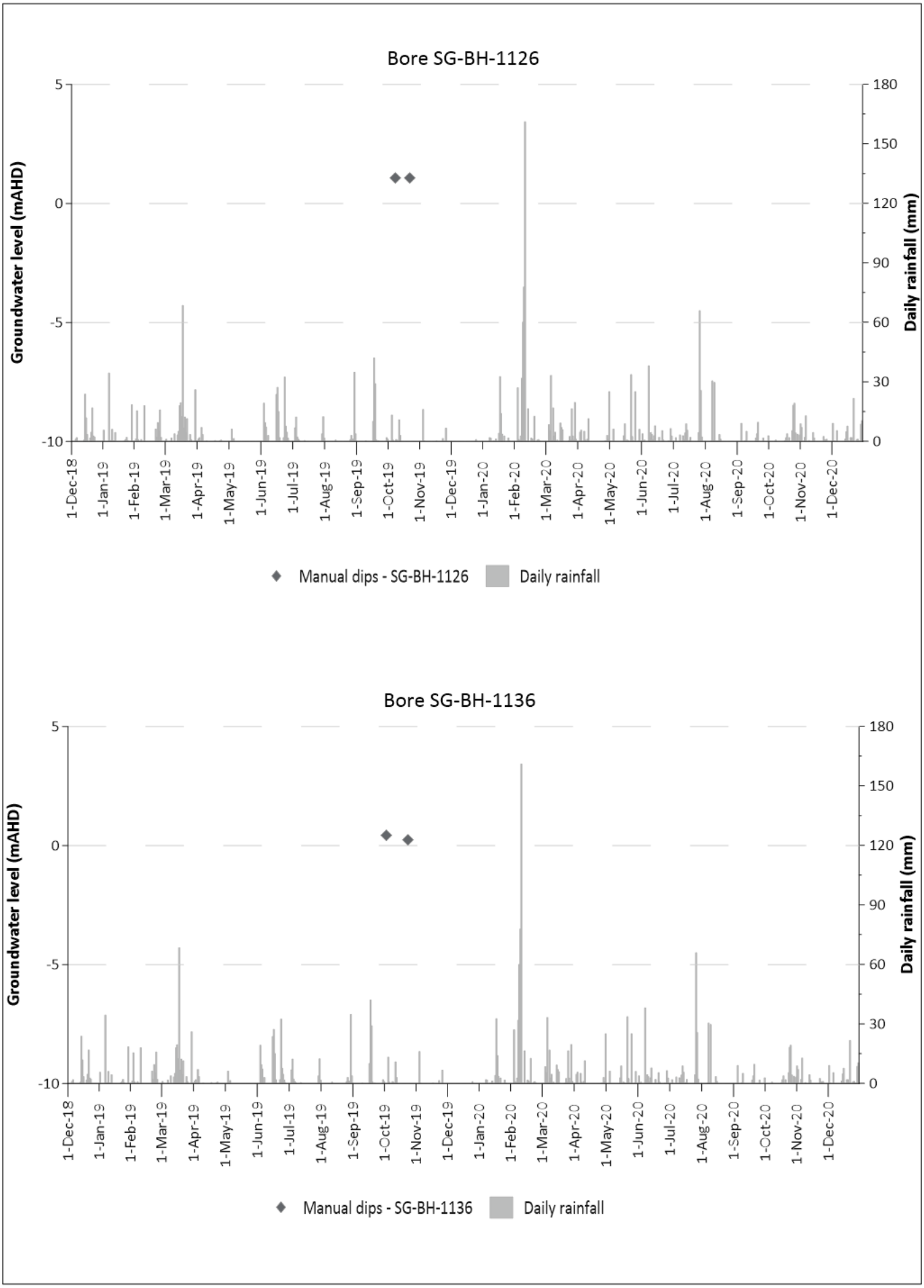
Hydrographs - SG-BH-1052 & SG-BH-1056

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.26



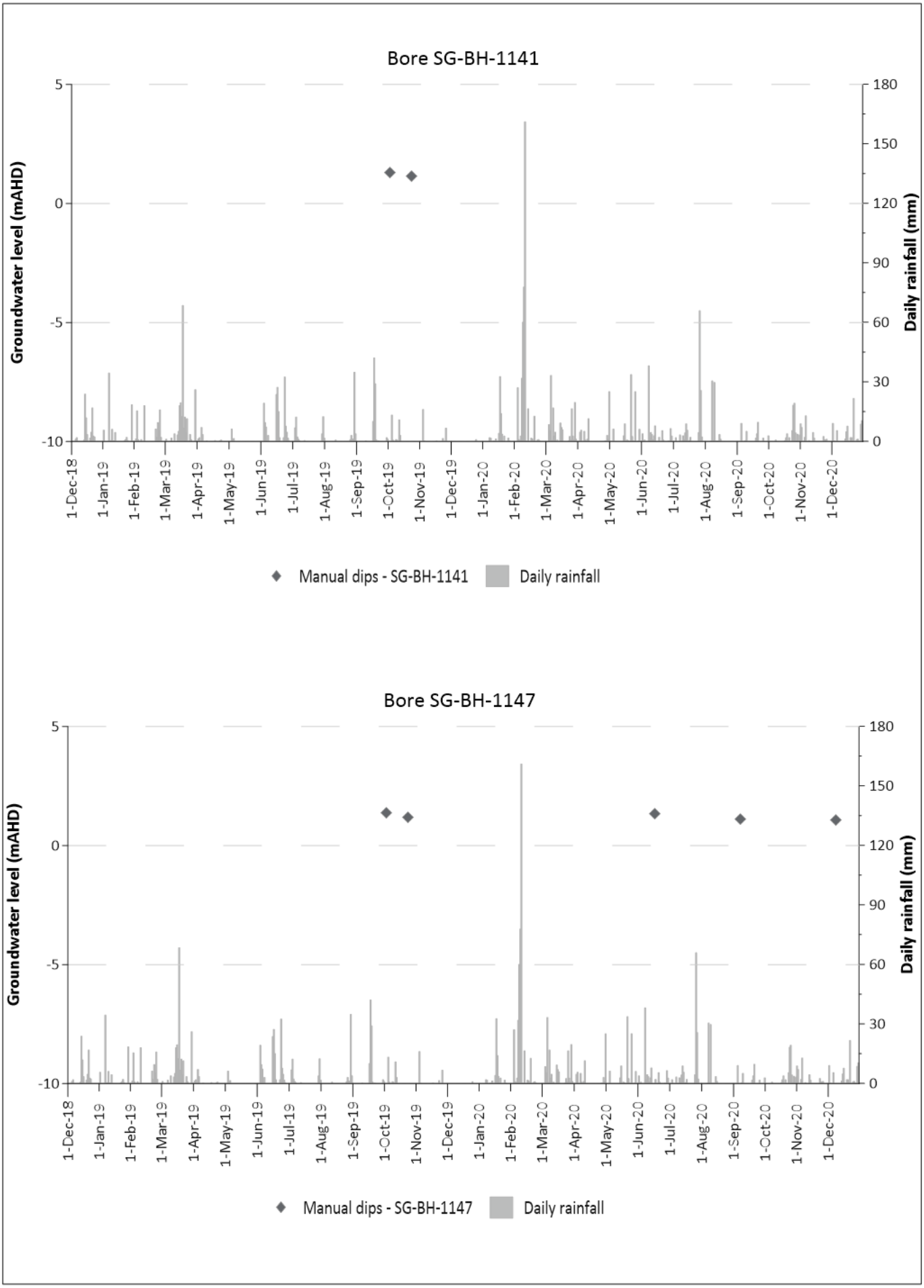
Hydrographs - SG-BH-1094 & SG-BH-1112

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.27



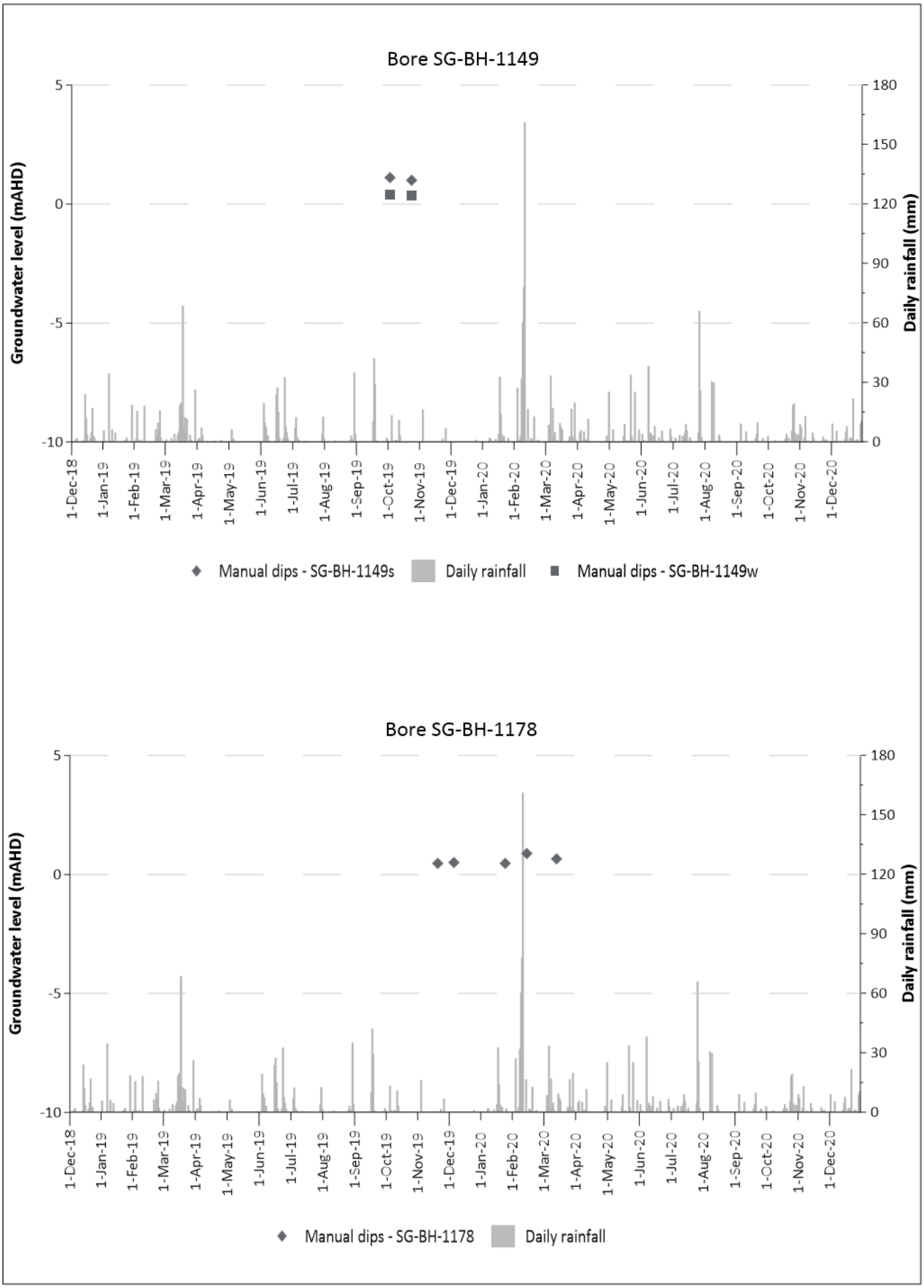
Hydrographs - SG-BH-1126 & SG-BH-1136

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.28



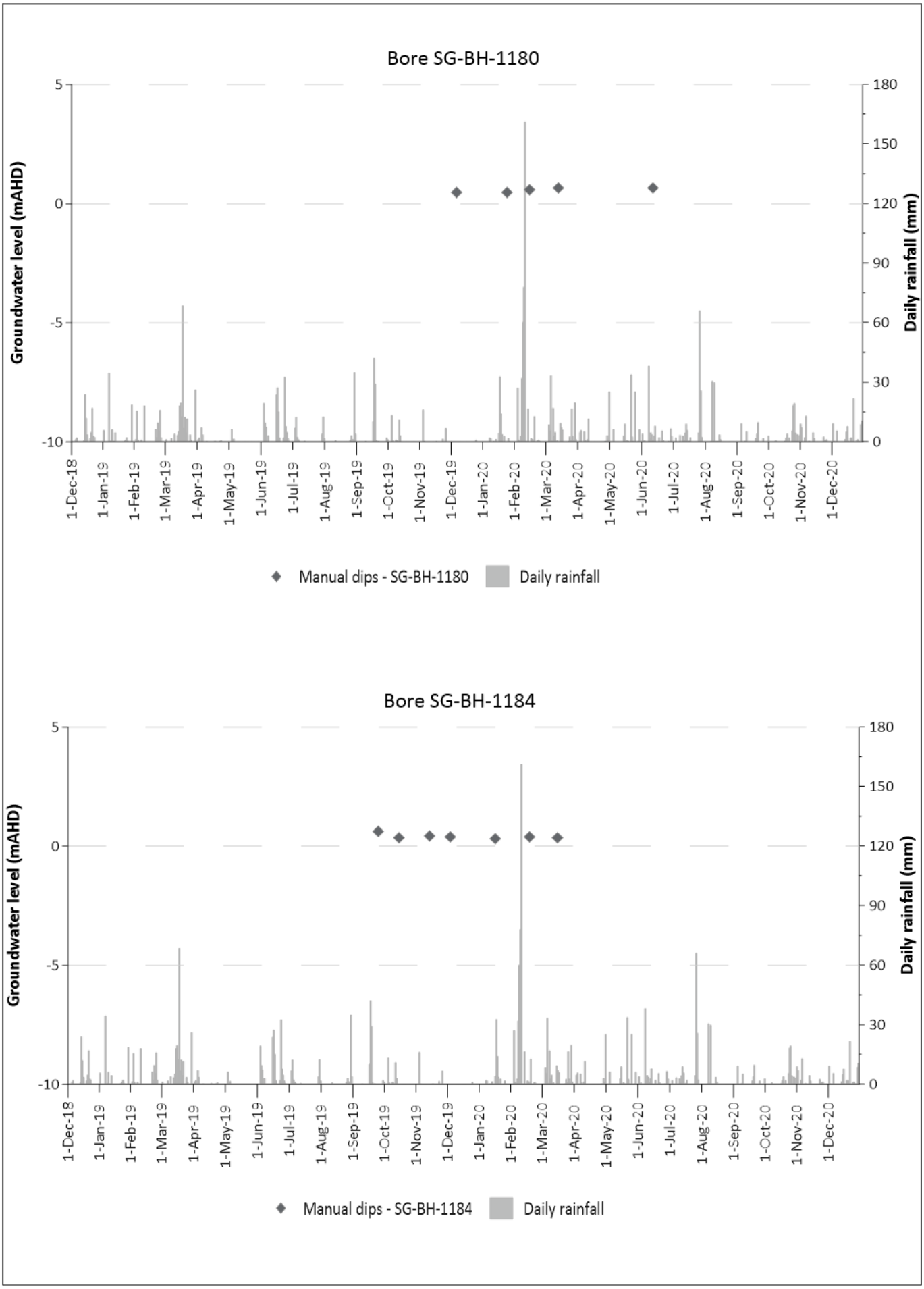
Hydrographs - SG-BH-1141 & SG-BH-1147

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.29



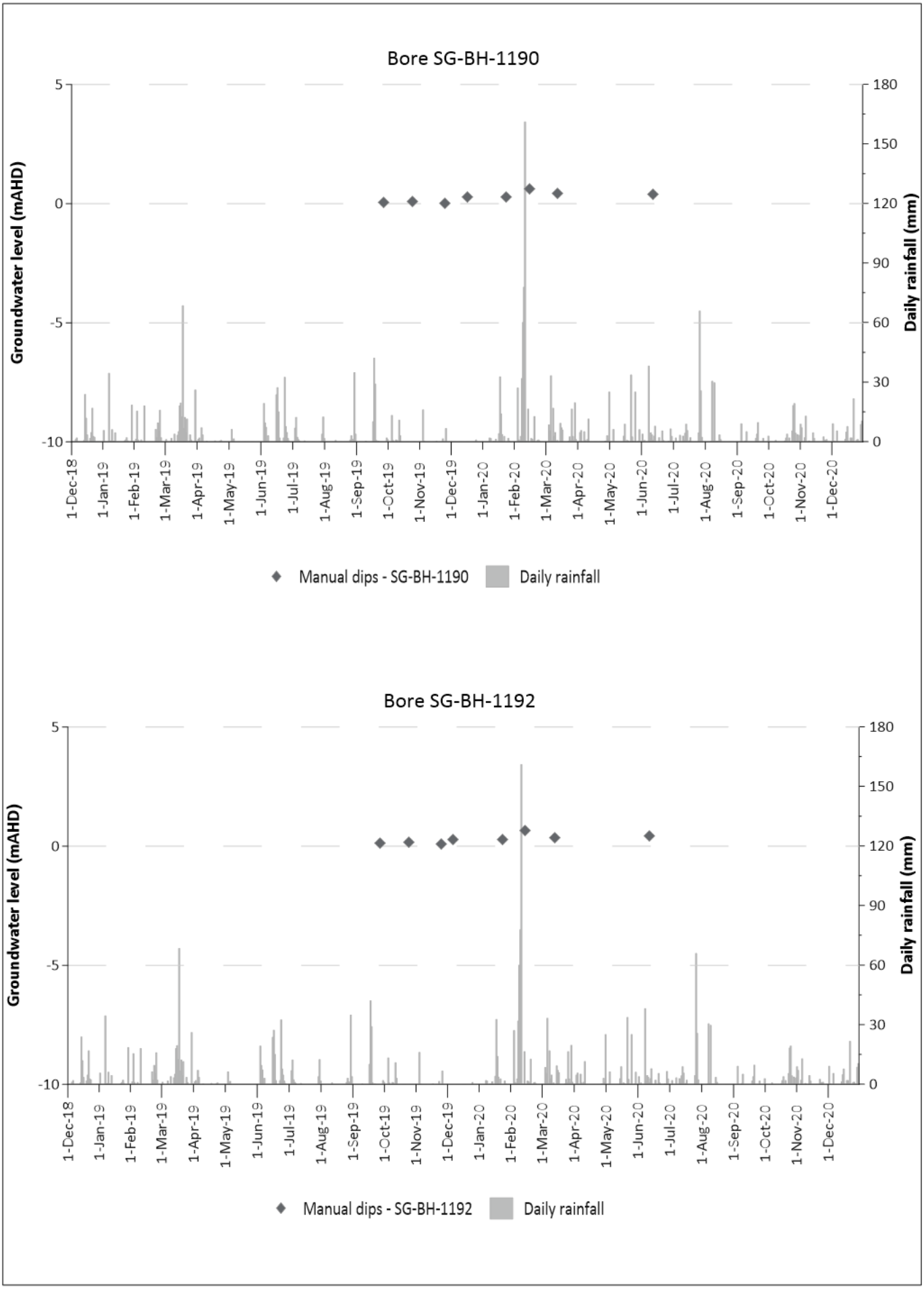
Hydrographs - SG-BH-1149 & SG-BH-1178

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.30



Hydrographs - SG-BH-1180 & SG-BH-1184

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.31



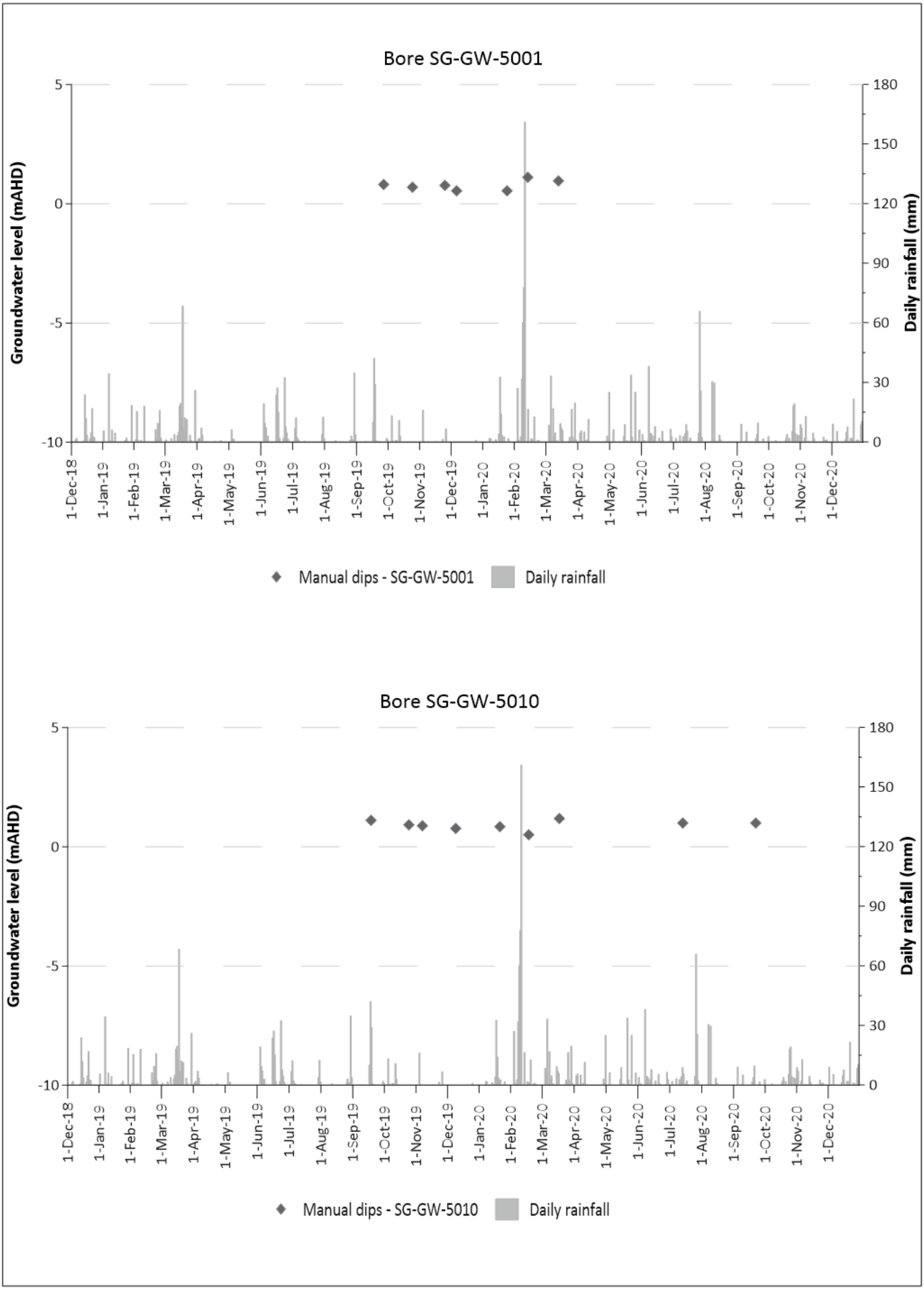
EMM

Hydrographs - SG-BH-1190 & SG-BH-1192

Groundwater Monitoring Program

Sydney Gateway Road Project

Figure A.32



Hydrographs - SG-GW-5001 & SG-GW-5010

Groundwater Monitoring Program
Sydney Gateway Road Project
Figure A.33

Appendix B Baseline groundwater quality data

Bore ID	Units	Minimum	Maximum
Physico-chemical			
pH	units	5.76	9.42
Major ions			
Chloride	mg/L	NA	22000
Sulphate	mg/L	NA	2700
Calcium	mg/L	NA	1000
Sodium	mg/L	NA	10000
Magnesium	mg/L	NA	1300
Potassium	mg/L	NA	480
Nutrients			
Alkalinity (Bicarbonate as $CaCO_3$)	mg/L	NA	6300
Alkalinity (Carbonate as $CaCO_3$)	mg/L	NA	300
Alkalinity (Hydroxide) as $CaCO_3$	mg/L	NA	<5
Alkalinity (total) as $CaCO_3$	mg/L	NA	6300
Alkalinity (Bicarbonate)	mg/L	NA	93
Alkalinity (Carbonate)	mg/L	NA	<5
Organic Nitrogen, as N	mg/L	NA	11
Ammonia as N	mg/L	NA	94
Ammonia as N (Filtered)	mg/L	NA	330
Kjeldahl Nitrogen Total	mg/L	NA	360
Nitrite (as N)	mg/L	NA	<0.005
Nitrite (as N) (Filtered)	mg/L	NA	0.27
Nitrate (as N)	mg/L	NA	<0.005
Nitrate (as N) (Filtered)	mg/L	NA	24
Nitrogen (Total)	mg/L	NA	360
Nitrogen (Total Oxidised) (Filtered)	mg/L	NA	0.008
Total Phosphorus	mg/L	NA	28
Heavy metals			
Arsenic (Filtered)	mg/L	NA	1.4
Barium (Filtered)	mg/L	NA	1.5

Bore ID	Units	Minimum	Maximum
Boron (Filtered)	mg/L	NA	10
Cadmium (Filtered)	mg/L	NA	0.013
Chromium (III+VI) (Filtered)	mg/L	NA	0.14
Cobalt (Filtered)	mg/L	NA	0.59
Copper (Filtered)	mg/L	NA	0.27
Lead (Filtered)	mg/L	NA	0.41
Manganese (Filtered)	mg/L	NA	10
Mercury (Filtered)	mg/L	NA	0.0066
Nickel (Filtered)	mg/L	NA	0.75
Zinc (Filtered)	mg/L	NA	2
BTEX			
Benzene	µg/L	NA	2.6
Ethylbenzene	µg/L	NA	1.6
Toluene	µg/L	NA	7.7
Total BTEX	µg/L	NA	8
Xylene (m & p)	µg/L	NA	2
Xylene (o)	µg/L	NA	1.2
Xylene Total	µg/L	NA	3.4
PFAS			
PFOA*	µg/L	NA	1824
PFOS*	µg/L	NA	31
TRH			
C10-C16	µg/L	NA	2400
C10-C16 (F2 minus Naphthalene)	µg/L	NA	2400
C10-C40 (Sum of total)	µg/L	NA	7200
C16-C34	µg/L	NA	4000
C34-C40	µg/L	NA	1200
C6-C10	µg/L	NA	440
C6-C10 (F1 minus BTEX)	µg/L	NA	440
PAH			

Bore ID	Units	Minimum	Maximum
Naphthalene	µg/L	NA	110
1-Methylnaphthalene	µg/L	NA	7.8
2-methylnaphthalene	µg/L	NA	9.4
Acenaphthene	µg/L	NA	5.2
Acenaphthylene	µg/L	NA	1
Anthracene	µg/L	NA	2.1
Benz(a)anthracene	µg/L	NA	2.4
Benzo(a) pyrene	µg/L	NA	2.3
Benzo(b+j+k)fluoranthene	µg/L	NA	ND
Benzo(b+j)fluoranthene	µg/L	NA	0.0028
Benzo(g,h,i)perylene	µg/L	NA	2.1
Benzo(k)fluoranthene	µg/L	NA	1
Chrysene	µg/L	NA	1.7
Dibenz(a,h)anthracene	µg/L	NA	0.4
Fluoranthene	µg/L	NA	6.4
Fluorene	µg/L	NA	4.4
Indeno(1,2,3-c,d)pyrene	µg/L	NA	2
Phenanthrene	µg/L	NA	11
Pyrene	µg/L	NA	6.3
Benzo(a)pyrene TEQ	µg/L	NA	ND
TPH			
C15-C28	µg/L	NA	3200
C10-C14	µg/L	NA	2100
C29-C36	µg/L	NA	1600
C6-C9	µg/L	NA	410
TRH C37-C40	µg/L	NA	820
VOCs			
cis-1,4-Dichloro-2-butene	µg/L	NA	ND
trans-1,4-Dichloro-2-butene	µg/L	NA	ND