Great Eastern Highway Bypass Interchanges

M910 – Groundwater 85% Design Report

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Table of Contents

1. Project Overview

Roe Highway and Great Eastern Highway Bypass (GEHB) are strategic road corridors in Perth's north-east. They provide critical connections between Great Eastern Highway, Tonkin Highway and the Perth Metropolitan road network and support access to many key economic zones including Perth Airport precinct, the Kewdale, Hazelmere and Canning Vale industrial areas and freight distribution centres.

The intersections of Roe Highway/GEHB and GEHB/ Abernethy Road experience high congestion and a high number of accidents, directly associated with the volume and diverse mix of traffic.

In April 2019, the Federal and State Governments initiated a remedy by allocating funds for the planning, development and construction of two new grade-separated interchanges on Great Eastern Highway Bypass, at the intersections with Roe Highway and Abernethy Road.

The current planning and development for these interchanges considers the proposed realignment of the Midland Freight Rail, development around Airport North, the Kewdale-Hazelmere Regional Integrated Masterplan, reviews of local land use, updated traffic modelling and additional works planned on local government roads.

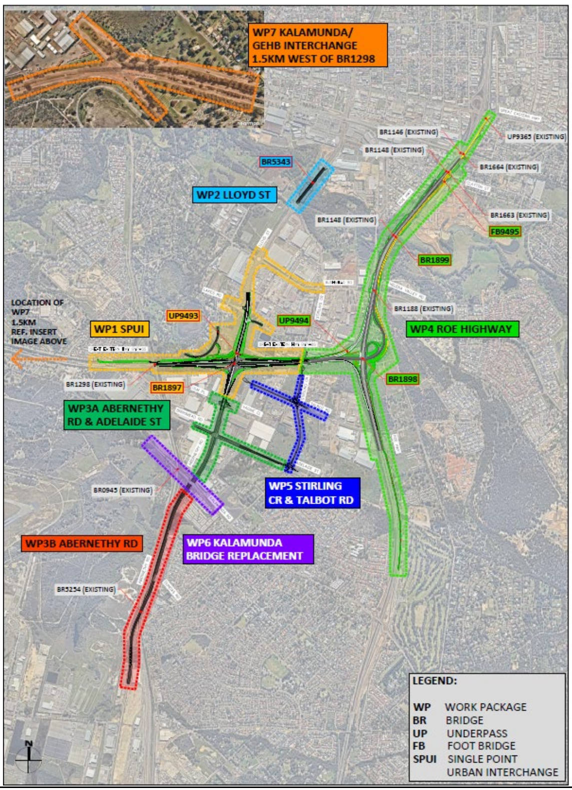

Figure 1 - Great Eastern site overview

In April 2020, the Western Australian Government announced the fast-tracking of the tendering process for a number of important projects, including the Great Eastern Highway Bypass Interchanges Project, with the intent to commence construction works in 2021.

1.1 Major Elements of the Project

- A new grade separated interchange at Roe Highway and GEHB
- Upgrade works to Roe Highway from GEHB to Clayton St
- Duplication of the Roe Highway Bridge over the Helena River
- New grade separated interchange at GEHB and Abernethy Rd
- Construction of a four-lane bridge over the Helena River providing connection between the northern and southern sections of Lloyd St
- Connection of Lloyd St to GEHB
- Connection of Adelaide St to Abernethy Rd
- Duplication of Abernethy Rd between Great Eastern Highway Bypass and Avonside Crescent.
- New PSP sections on Roe Highway and GEHB
- PSP under/overpasses at Roe Highway/Great Eastern Highway Bypass interchange (GEHBI)
- PSP under/overpasses at Abernethy Rd/Lloyd St interchange
- Rehabilitation, landscaping and revegetation over the disturbed and degraded areas of the site, including hard landscaping
- Production and integration of urban design elements, incorporating public art works and improved amenities.
- Upgrade of the intersection of Abernethy and Kalamunda Road including the bridge replacement over ARC rail on Kalamunda Road. The new Bridge must provide for a dual carriageway and shared path connections on both sides with the formation to tie into the existing Kalamunda road at grade west of the new structure.
- Planning and development for a new grade separated interchange of Great Eastern Highway Bypass and Kalamunda Rd for the Perth Airport Northern Precinct

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The primary objectives of the Project are to provide efficient and safe road access for all road users and to provide road infrastructure that supports economic development. In its delivery, the Project provides opportunity for innovative design and construction approaches to bring superior value for money and minimised risk to Main Roads, and to provide upskilling and employment opportunities for lower-tier contractors and Aboriginal people.

1.2 Scope of Project

Greater Connect Alliance will be responsible for completing all the outstanding project development activities, then commence design and construction. The main project development deliverables the Participants must undertake during the project development phase are as below:

- Complete detailed site surveys
- Complete geotechnical and hydrogeological investigations
- Undertake a pavement condition assessment
- Identify the location of potentially contaminated sites
- Prepare a materials sourcing strategy
- Prepare 3D design models to assess design options
- Update land dealing plans
- Identification of complex or costly accommodation works
- Undertake noise assessment and develop a mitigation strategy
- Recommend the extent and type of street lighting
- Prepare conceptual layout of guide signs
- Develop safety barrier strategy
- Identification of major service relocations
- Determination of the extent of visual screening
- Undertake traffic analysis
- Obtain Network Operations sign-off of traffic analysis
- Develop RAV and OSOM network requirements
- Review detailed design criteria
- Establish operational requirements of the intelligent transport systems
- Undertake design optioneering
- Develop an Urban and Landscape Design Strategy
- Develop a sustainability management plan
- Community and stakeholder engagement
- Prepare community and stakeholder engagement plan
- Obtain planning approvals
- Obtain environmental, Aboriginal heritage and other approvals
- Review and refine the Ultimate Concept Design
- Assess design options for the Project Case
- Prepare 15% Concept Design for the preferred Project Case.

The design and construction phases incorporate the detailed design of the scope of the project from 15% through to Issued for Construction (IFC) and delivery of the physical work. This includes:

- Highway incorporating grade separated interchanges and upgrades
- Other roads and bridge over Helena River connecting local government road network to Highway
- PSP and Paths
- Urban and Landscape Design and Public Art
- Design Verification
- Design Process
- Traffic Engineering & Management
- Testing, monitoring, independent quality certifier and Measure of Pavement condition performance
- Community and Stakeholder Engagement
- Road Maintenance
- Handover
- Defect correction

2. Introduction

2.1 Project Background

Greater Connect Alliance (GCA) is an Alliance between Laing O'Rourke (LOR), Arcadis and AECOM, who have entered into a contract with Main Roads WA for the design and construction of the works (Contract No. 197/19). The terms of engagement for the project are outlined in the Project Alliance Agreement (PAA) whilst the Basis for Development Design and Construction (BDDC) and the Scope of Works and Technical Criteria (SWTC) documents define the scope of works, technical standards and performance requirements.

2.2 Work Package Design Description

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This project comprises various sections, which have been allocated into Work Packages described in Table 1.

Table 1 – Work Package Design Descriptions

Design Section	Design Section Title	Description
Work Package 1	Abernethy Road - GEHB Interchange	Grade separated interchange at GEHB and Abernethy Rd, construction of SPUI Bridge 1897, new PSP sections including Underpass 9493
Work Package 2	Lloyd to GEHB	Connection of Lloyd Street to GEHB including construction of new Bridge 5343 over Helena River, providing connection between north and south sections of Lloyd Street
Work Package 3	Abernethy Road south of GEHB	Upgrade and duplication of Abernethy Road between Adelaide Street and south of Kalamunda Road, including connection of Adelaide St to Abernethy Rd
Work Package 4	GEHB – Roe Highway Interchange & Roe Highway Upgrade	A new grade separated interchange at Roe Highway – GEHB intersection, upgrade works to Roe Highway from GEHB to Clayton St (including construction of a pedestrian overpass at Clayton Street), duplication of the Roe Highway Bridge over the Helena River, new PSP sections at Roe Highway and GEHB, including Underpass 9494
Work Package 5	Stirling Crescent – Adelaide Street – Talbot Road	A roundabout at the intersection of Stirling Cr/Talbot Rd, upgrades to the main carriageway section of Stirling Crescent between the two roundabouts, a cul de sac at the most northern end of Stirling Crescent (immediately south of Great Eastern Highway Bypass) in response to the upgrade of the Great Eastern Highway Bypass, a cul de sac at the western end of Talbot Road, extension of Talbot Road (from Stirling Crescent to end of road in westerly direction)

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No Changes.

2.3 Scope of this Report

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This report documents the determination of maximum groundwater levels (MGL) for all work packages WP1 to WP5. The location and extent of these work packages is shown in **Figure 2**. The determination of MGLs is undertaken to inform design decisions for the 85% design phase of the project, and is based on assessment of literature and onsite groundwater investigations. The MGLs presented may be adjusted during the 100% design phase.

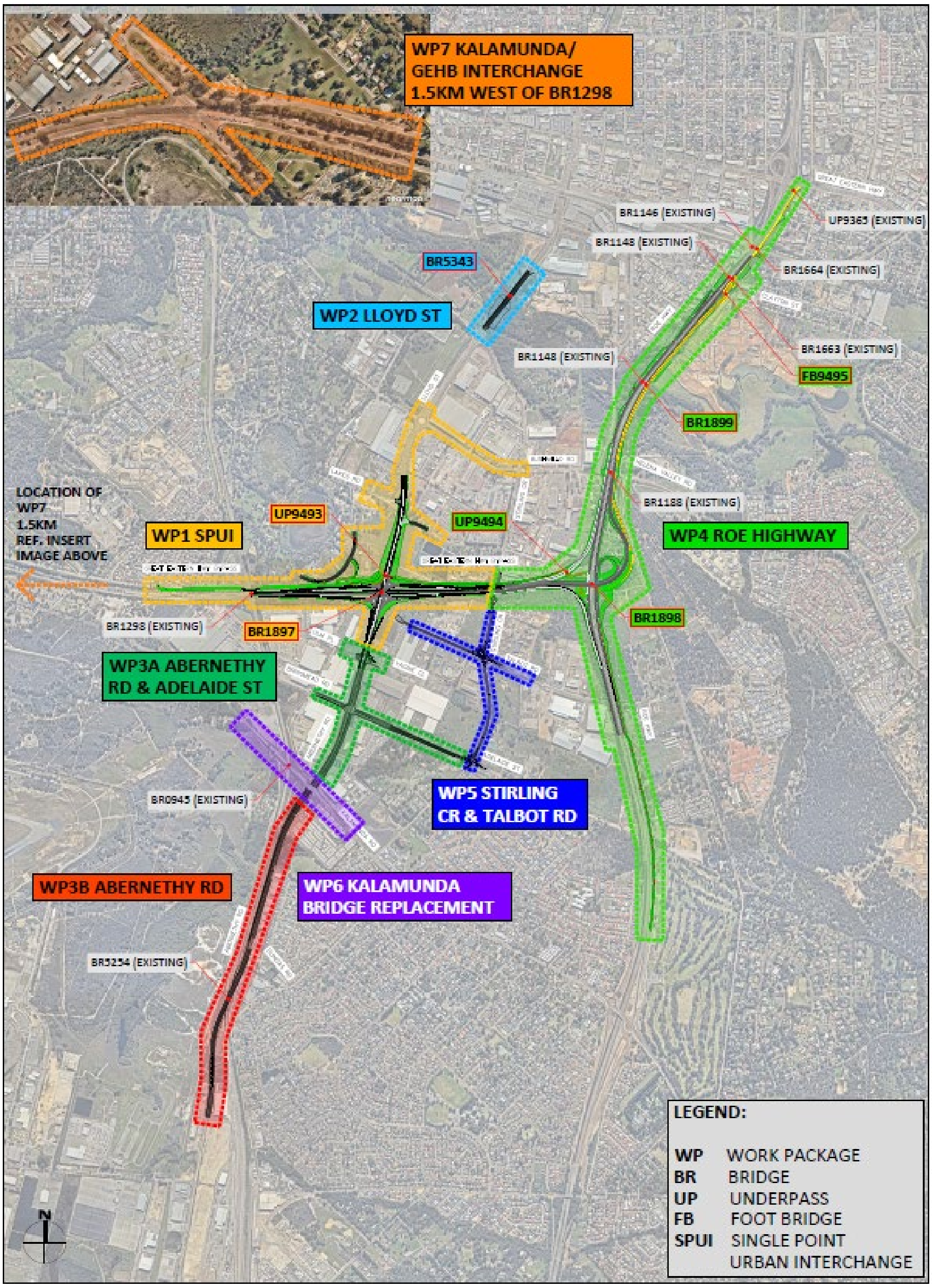

Figure 2 - Project Work Package Map

2.4 Related Design Reports & Documentation

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The Design Reports listed in Table 2 are related to this report and should be referred to as required.

Table 2 – Related Design Reports & Documentation

Document Number	Description
GEHBI-GCA-RPT-D300-DN-00001	Drainage - GEHBI/Abernethy
GEHBI-GCA-RPT-D310-DN-00001	Drainage – WP3
GEHBI-GCA-RPT-D320-DN-00001	Drainage - GEHBI/Roe
GEHBI-GCA-RPT-A000-EN-00008	Contamination Investigation Report
GEHBI-GCA-PLN-A000-EN-00010	Acid Sulphate Soils Management Plan
GEHBI-CMW-014-RPT-GE-00001	Geotechnical Factual Investigation Report

3. Design Criteria and Standards

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3.1 Codes, Reference Documents and Regulations

The SWTC for the project has been prepared by GCA using Main Roads template SWTC modified to suit the project scope and complying with the requirements of the BDDC. The development of the project SWTC has been undertaken separately with input and review from Main Roads WA.

The sitewide maximum groundwater levels (MGLs) have been prepared in accordance with the following documentations:

- GEHBI SWTC Report;
- BDDC for contract 197/19;

Key aspects of these documents related to the development of MGLs include:

- BDDC 2.1.4 '*The Participants must complete geotechnical and hydrogeological investigations over the Project area as needed to design the Project. Data, interpretation and recommendations associated with the Geotechnical and Hydrogeological investigations must be included in the WPR.*
  Hydrogeology investigations must be adequate to develop a design groundwater surface to assess groundwater risk to pavement and to determine infiltration rates for detailed drainage design.'
- BDDC 4.19 '*No part of the Pavement may be lower than the design groundwater surface. A concrete Pavement can be used where the design groundwater surface is close to subgrade level. Subsoil drains may be used locally to prevent groundwater from reaching the Pavement, but may not be placed lower than the design groundwater surface. [Refer clauses 4.5(j)(i)(I) and 4.5(g)]*
  The design groundwater surface must be developed by the Participants as needed to demonstrate compliance.
- SWTC 4.5(g)(i) '*The design must ensure that the Pavement does not wet up or become saturated through capillary rise, infiltration or any other means of moisture ingress to the extent that design assumptions or performance requirements are not met. Assumed groundwater levels (whether or not altered by subsoil drainage) and capillary rise must be the maximum expected during the life of the Pavement.*'
- SWTC 4.5(g)(iii) '*Unless it can be demonstrated to the satisfaction of Main Roads' Representative to be impractical, the Highway Pavement must be at or above the maximum groundwater levels and the expected capillary rise. Subsoil drains may be used locally to prevent groundwater from reaching the pavement, but may not be placed lower than the design groundwater level*'.
- SWTC 4.7(h)(i) '*Subsoil drainage systems must be provided where the Highway Pavement is below the expected maximum groundwater level and the expected capillary rise, and at any other locations necessary to comply with clause 4.5(g)*'.
- SWTC 4.7(h)(ii) '*The design of subsoil drainage must be approved by the Department of Water and Environmental Regulation. For the purposes of approval the Alliance must establish the profile of the maximum groundwater level (MGL) using bore records or other data if required by the Department of Water and Environmental Regulation.*'

3.2 MGL Development

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The MGLs developed for the 15% design phase are based on a desktop assessment of groundwater level and other hydrogeological data sourced from the DWER Water Information Reporting (WIR) database and other local reports. It is understood that this desktop data is limited in both spatial and temporal extent. It is also understood that hydrogeological site investigations are currently being undertaken, with a view to refining and adjusting the MGLs upon completion of this programme and processing of the collected data. This will be undertaken as part of the 85% design phase.

At this stage, due to the data limitations described above, the estimated MGLs described in Section 7 lie at or above the ground surface in some areas. In these areas, a risk based approach has been undertaken for road design, with the design based on an assumption that the MGL is at least 800mm below the existing pavement surface based. This assumption is based on the structural integrity of the pavement over the last 40 years, which indicates it has not been affected by groundwater.

85% Report

The MGLs developed for the 85% design phase expands upon the initial MGL development, capturing updated data from the DWER Water Information Reporting (WIR) database, recently acquired local reports and results from onsite groundwater investigations and data collection. The site investigations commenced late July 2021 with the drilling of groundwater monitoring bores and ongoing data collection.

With the accrual of specific onsite data to inform the MGLs during the 85% design phase, the risk-based approach informing road design described above is considered to be no longer required, due to improved confidence in MGLs developed.

4. Design Reference Information

4.1 Reference Information

15%/85% Report

A summary of the reference information relied upon for the preparation of this report is presented in **Table 3** below. The GCA has not conducted a verification of the accuracy of the information detailed in these reports, unless critical to the design aspects undertaken by the GCA.

Table 3 – Reference Information

Reference	Document Title	Revision/Date
SWTC	Scope of Works and Technical Criteria – Contract 197/19 – Great Eastern Highway Bypass Interchanges	Draft 01 (Final to be issued following Design Phase)
112.C197.19 20144397-002-M-Rev0	GEH Bypass – Phase 1 Groundwater well Installation – Technical Memorandum (Golder, 2020)	Rev 0 (27/08/2020)
20144397-008-M-Rev0	GEH Bypass - Groundwater Level Monitoring from 7th Aug 2020 to 17th May 2021 – Technical Memorandum (Golder, 2021)	Rev 0 (31/05/2021)
08.293 Report No: RP001	Proposed Hazelmere Enterprise Area – Surface and Groundwater Monitoring Report (ENV, 2009)	17/06/2009
DWER	Water Information Reporting (WIR) database for DWER bore records of historical groundwater level information	2021
76.C197.19 IW217847-0000-GT-RPT-0001/0	Abernethy Road Upgrade – Desktop Study Report (Jacobs, 2020)	21/08/2020
RPT-1552-001 V1	Local Water Management Strategy; Hatch court – Stirling Cres Scheme Amendment (Syrinx, 2016)	4/04/2016
GEOTPERT08167AG-AB	Geotechnical Report for Midland Health Campus (Coffey, 2011)	16/02/2011
379.C197.19 FAL-PTAWA-GE-RPT-00007	Forrestfield Airport Link Project – Stage 2 Geotechnical Investigation – Geological and Hydrogeological Model Report (Golder, 2015)	Rev 0 (6/05/2015)
436.C197.19 201100	Airport Estate Groundwater Modelling – Prepared for Perth Airport Pty Ltd	Nov 2020

5. Regional Setting

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5.1 Topography

The project is located at the base of the Darling Scarp, and has a general north western gradient. Surface topography ranges from approximately 50m AHD in the southeast at the base of the scarp, to 4m AHD in the northeast at the Helena River, and to approximately 10m AHD at the western extent of GEHB. Aside from the valley of the Helena River, the majority of the project area is relatively flat, as it was once part of the large former wetland network that characterised much of Perth's Swan Coastal Plain.

5.2 Climate

Perth has a Mediterranean climate with four seasons. The summer temperatures average >30°C during the day with February generally the hottest month. The winter temperatures average <20°C during the day with July and August generally the coolest months.

The majority of rainfall occurs between May and September, with July the wettest month receiving an average of 155mm of rainfall (BoM Station 009021) (BoM, 2021).

5.3 Site-Wide Geology

The project is located on the Swan Coastal Plain adjacent to the Darling Scrap and the majority of the project is situated on two main geological units of the Pinjarra Plain; the Bassendean Sand and the Guildford Formation. Site geology is shown on **Figure 3** with a general description of the major units as follows:

- Bassendean Sand (S8) - SAND - very light grey at surface SAND, White to pale grey at surface, yellow at depth. Fine to medium-grained, moderately sorted, sub-angular to sub-rounded, minor heavy minerals, of aeolian origin (Bassendean Sand).
- Bassendean Sand (S10) - SAND – thin Bassendean Sand overlying Guildford Formation
- Guildford Formation - SANDY SILT to CLAYEY SAND – mottled fine sand with variable clay content of alluvial origin and sand of fie to medium grained, sub angular to rounded quartz of alluvial origin.

The Helena River is within a channel of Alluvium shown on the Geological map to extend within an infilled channel running east to west. The Alluvium is shown to extend across the width of around 200 m at the Lloyd Street bridge and around 600 m at the Roe Highway Bridge. Immediately north and south of the Helena River lies Guildford Formation characterised by silts and clays with some quartz sand of alluvial origin.

Isolated zones of peaty clay are in low-lying areas, as shown on the geological maps. These are not expected to be intersected during the project works but remain a risk to the project where works are carried out in previously undeveloped areas.

Coffee rock is known to be present across the site, which is a layer of friable, limonite-cemented sand, deposited near the water table.

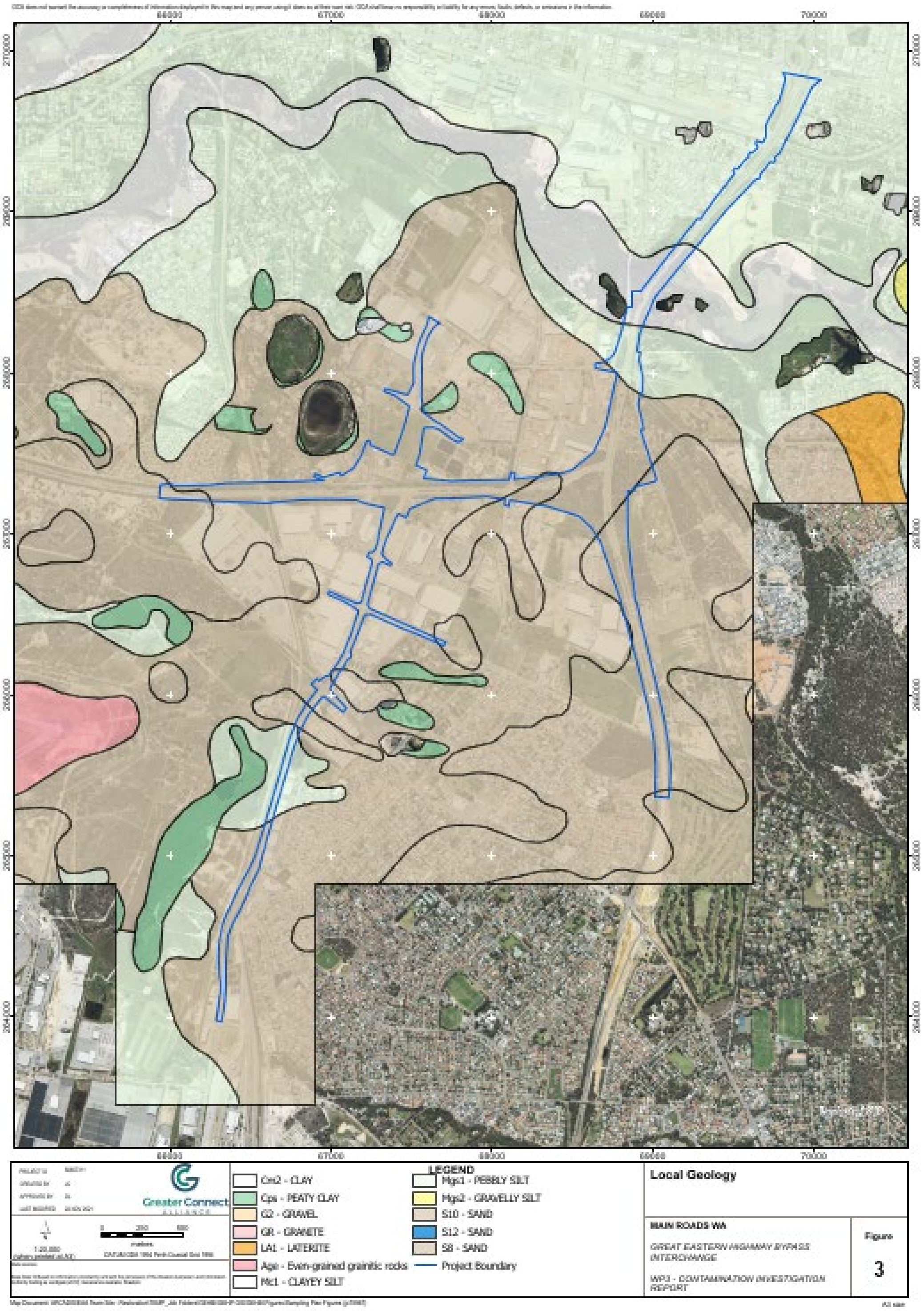

Figure 3 – Geology and Soils

5.4 Hydrology

The surface water bodies on the site are primarily the ephemeral Helena River, running generally east-west towards the northern portion of the site, its tributary Kadina Brook to the east of the site, and the two Hazelmere Lakes to the west of the site. There are several smaller wetlands, including Munday swamp to the south, that occur across the Project site and receive a combination of surface water flows, drainage and groundwater discharge, and occur as depressions in the local landscape. The Poison Gully creek also runs west across the Project site near the southern boundary.

These surface water bodies generally act as groundwater discharge zones in the Project area, particularly the Helena River which receives the majority of groundwater flow, discharging to the river from the southeast.

There is only one major catchment that contributes surface water flows to the Hazelmere Lakes, which originates within Perth Airport Precinct 3. There are two other major flow paths with anthropogenic modification, which skirt around the Lakes, either of which may have previously contributed to surface water recharge to the Lakes prior to development (AECOM, 2010). Pump testing undertaken by Fraser Consultants (1983) confirmed that there is a direct hydraulic connection between the Southern Hazelmere Lake and the superficial aquifer. Periods of time where the northern lake dried whilst the southern lake remained wet give further indication that groundwater is the primary control on lake levels (AECOM, 2010).

Poison Gully is an ephemeral creek which collects water from elevated areas to the east of the Site including parts of Kalamunda and flows in a westerly direction via the Perth Airport Northern Main Drain and Limestone Creek into the Swan River (Strategen, 2016).

Stormwater is collected where roads are unkerbed via table drains, and via pit and pipe network where kerbs are present. This water is generally discharged to the Helena River, the southern Hazelmere Lake and various depressions and basins across the landscape. Subsoil drainage is also present along GEHB beneath the Midland to Fremantle railway, discharging to the Helena River, and beneath Abernethy Road south of Kalamunda Road where discharge enters Munday swamp.

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No changes.

6. Site Investigations

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Not Commenced.

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6.1 Drilling and Installation of Groundwater Monitoring Bores

An onsite monitoring bore drilling programme was undertaken between 15th and 24th July 2021, for the purpose of characterising local hydrogeological conditions. A series of 13 monitoring bores were drilled and installed at 9 sites across the broader project area, proximal to the road alignments in each work package. The sites were spatially distributed to characterise groundwater levels and hydrogeological conditions across the entire project area, whilst locations also allowed continued access for regular monitoring.

Bores were drilled to characterise spatial and vertical hydrogeology. Bores at all sites intersect the water table, however four sites include dual 'shallow' and 'deep' monitoring bores, with the shallow bore targeting the water table and the deep bore the underlying aquifer or aquitard. Generally, shallow bores targeted the Bassendean Sand, with deeper bores targeting the underlying Guildford Formation. One bore site (MW06) targeted vertical intervals above and below the interpreted coffee rock unit.

Pilot holes were drilled using direct push or coring methods, the latter where formations were impenetrable with the direct push method. Hand auger was used for the top 1.5m of each hole. Bores were generally constructed with Class 9 or 12 uPVC casing with the bottom 3m slotted. Gravel pack was placed in the hole annulus around the slots to 1m above the top of the slotted section, with a 2m thick bentonite seal place above the gravel pack to isolate the target aquifer. Bores were then developed via airlift or submersible pump until the water column inside the bore was free of drill fluids, sediments and provided stable chemical parameters.

Core from pilot hole drilling was obtained for lithological logging. Survey of each bore was undertaken after bore completion to determine bore location coordinates (easting and northing) ground elevations (m AHD) at the bore collars.

Bore summary details, including construction details and drilling and airlift development results, are provided in **Table 4**. Bore logs are provided in **Appendix A**, whilst bore locations are shown on **Figure 4**.

Falling head permeability tests and laboratory analyses were conducted on these bores. Results of these tests and analyses are being conducted with results to be presented during the 100% design phase. These tests do not impact the interpretation of MGLs.

Table 4 – Monitoring Bore Summary Information

Site ID	Easting (PGA94)	Northing (PGA94)	Ground Level RL (mAHD)	Depth (m)	Slotted Interval (m)	Target Aquifer	Development
MW01	69,146	266,967	25.47	13.0	9.0-13.0	Guildford Formation	Pumped dry – 10L
MW02S	68,931	267,637	20.16	4.5	1.5-4.5	Bassendean Sand	Pumped dry – 2L
MW02D	68,933	267,632	20.25	12.0	9.0-12.0	Guildford Formation	80L purged; ~5L/min
MW03	69,158	267,940	19.47	9.0	6.0-9.0	Guildford Formation	Pumped dry – 10L
MW04S	68,429	265,997	28.77	4.5	1.5-4.5	Bassendean Sand	Pumped dry – 10L
MW04D	68,423	266,000	28.51	12.0	9.0-12.0	Guildford Formation	200L purged; ~20L/min

Site ID	Easting (PGA94)	Northing (PGA94)	Ground Level RL (mAHD)	Depth (m)	Slotted Interval (m)	Target Aquifer	Development
MW05	68,275	267,524	18.40	9.0	6.0-9.0	Bassendean Sand	Pumped dry – 20L
MW06S	68,891	268,494	10.95	3.5	0.5-3.5	Alluvial Clay (above Coffee rock)	Pumped dry – 10L
MW06D	68,891	268,494	10.95	9.0	7.0-9.0	Alluvial Clay (below Coffee Rock)	Pumped dry – 10L
MW07	67,044	266,602	16.75	4.5	1.5-4.5	Bassendean Sand	
MW08S	67,702	268,463	15.10	4.5	1.5-4.5	Bassendean Sand	70L purged; 7L/min
MW08D	67,698	268,457	15.05	12.0	9.0-12.0	Bassendean Sand	Pumped dry – 40L; 5L/min
MW09	66,783	267,422	11.48	5.0	2.0-5.0	Bassendean Sand	Pumped dry – 40L

6.2 Geotechnical and Contaminated Sites Programmes

Onsite investigations were also undertaken as part of the geotechnical and contaminated sites programmes. These programmes incorporated ground penetration through various means, including groundwater bores, open boreholes, hand augers and CPTs, with the sites focussed on the road alignments for each work package. Groundwater data was collected from each of these sites where possible, generally as 'one off' snapshots at the time of completion (programmes commenced July 2021).

The locations of these sites are shown on **Figure 4**. Further details are provided in the following documents:

- GEHBI-GCA-RPT-A000-EN-00008 Contamination Investigation Report
- GEHBI-CMW-014-RPT-GE-00001 Geotechnical Factual Investigation Report

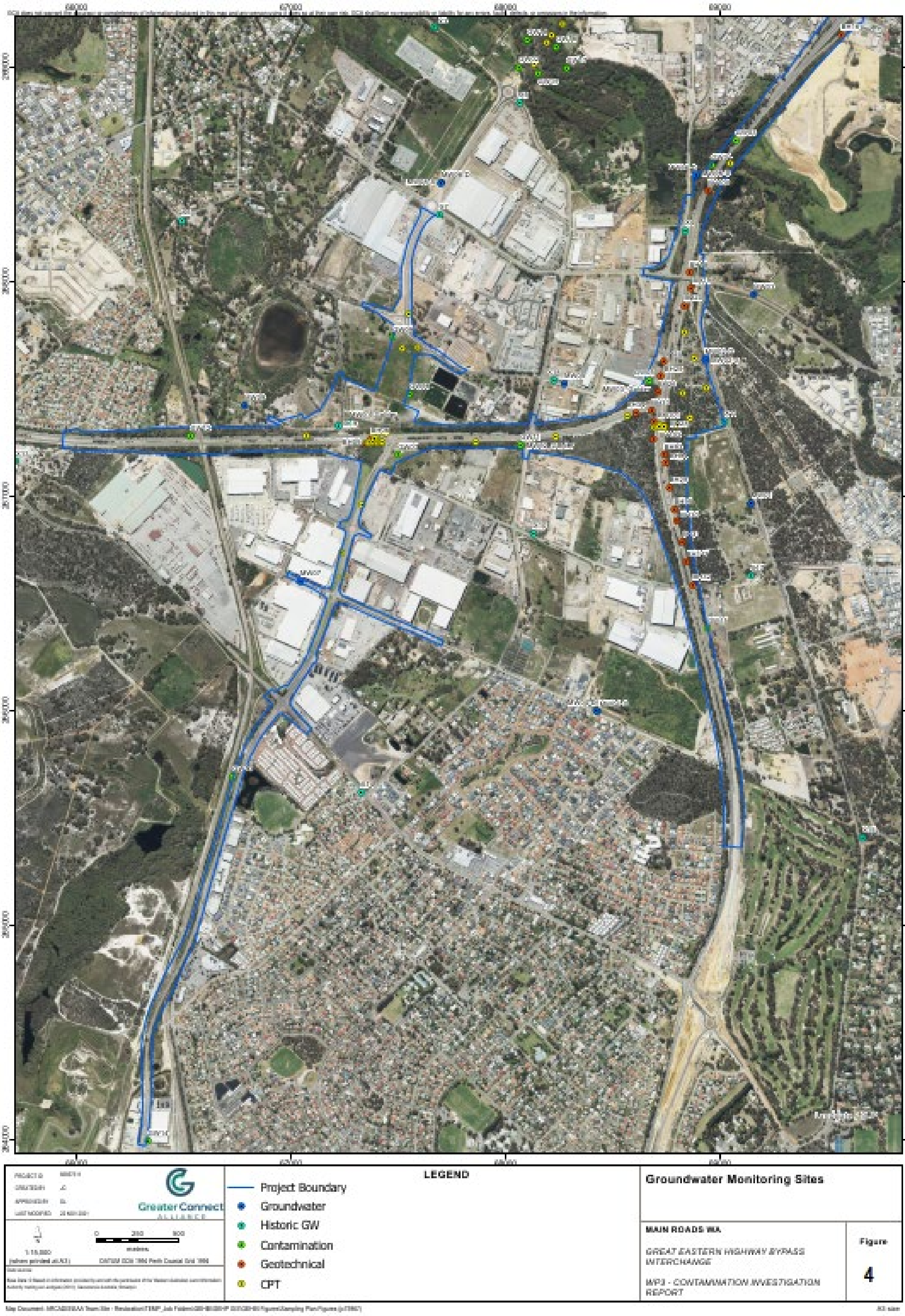

Figure 4 – Groundwater Investigation Locations

6.3 Groundwater Level Monitoring

Groundwater level monitoring was undertaken at all sites mentioned above and shown on Figure 4, either as single level snapshots or multiple readings in the case of the MW series monitoring bores. Monitoring commenced in July 2021 at the time of programme commencement, and is ongoing. This report presents the data captured between July 15th and October 31st 2021 which noting the prolonged wet season, is likely to capture the maximum groundwater levels for 2021.

In addition to the sites listed above, levels were also captured from accessible X series bores (X6 and X19) from the ENV (2009) assessment, allowing comparison of values between 2008 and present day.

A summary of maximum recorded levels from these sites are presented in **Table 5**, whilst full results including hydrographs are presented in **Appendix B** and **Appendix C** respectively. **Figure 5** presents a map of 2021 maximum recorded groundwater levels.

Table 5 – Maximum Recorded Groundwater Levels 2021

Site ID	Date	Depth to Water (mbgl)	Ground Level RL (mAHD)	Static Water Level (SWL) (mAHD)
BH06	17/08/2021	1.52	12.38	10.86
BH09	14/09/2021	2.19	8.31	6.12
BH101	10/08/2021	5.80	21.06	15.26
BH102	10/08/2021	3.80	22.09	18.29
BH105	14/09/2021	2.43	8.90	6.47
BH112	13/09/2021	7.00	31.33	24.33
BH18	2/09/2021	6.37	15.30	8.93
BH19	2/09/2021	3.32	17.95	14.63
BH20	2/09/2021	2.40	16.08	13.68
BH24	11/08/2021	1.20	18.21	17.01
BH25	12/08/2021	1.72	18.83	17.11
BH26	11/08/2021	2.20	20.08	17.88
BH28	9/08/2021	3.04	20.78	17.74
BH33	17/08/2021	3.50	22.10	18.60
BH34	17/08/2021	4.57	22.46	17.89
BH35	17/08/2021	2.80	21.89	19.09
BH93	9/08/2021	5.30	22.31	17.01
GW07	8/10/2021	0.80	14.48	13.68
GW08	10/07/2021	2.48	15.04	12.57

Site ID	Date	Depth to Water (mbgl)	Ground Level RL (mAHD)	Static Water Level (SWL) (mAHD)
GW11	8/10/2021	3.01	20.20	17.19
GW12	10/07/2021	1.06	7.71	6.64
GW13	10/07/2021	0.59	19.78	19.20
GW14	23/08/2021	1.42	26.25	24.83
MW01	8/10/2021	6.73	25.47	18.74
MW02-D	7/09/2021	3.10	20.16	17.06
MW02-S	23/08/2021	2.74	20.25	17.51
MW03	7/09/2021	3.39	19.47	16.09
MW04-D	15/10/2021		28.51	28.51
MW04-S	23/08/2021	3.57	28.77	25.21
MW05	22/07/2021	1.40	18.40	17.00
MW06-D	7/09/2021	3.94	10.95	7.01
MW06-S	7/09/2021	3.62	10.95	7.33
MW07	21/07/2021	1.87	16.75	14.88
MW08-D	7/09/2021	4.65	15.10	10.45
MW08-S	21/07/2021	0.50	15.05	14.55
MW09	8/10/2021	0.15	11.48	11.34
X19	8/10/2021	1.48	13.35	11.87
X6	8/10/2021	2.04	11.77	9.74

Figure 5 – 2021 Maximum Recorded Groundwater Levels

7. Project Area Hydrogeology

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7.1 Hydrostratigraphy

The projects site features two main hydrogeological units that makeup the superficial aquifer; the Bassendean Sand and the Guildford Formation. The Bassendean sand hosts the water table and overlies or interfingers with the Guildford Formation where they contact. The Bassendean Sand increases in saturated thickness to the west where up to10m saturated sands is common. The thickness of saturated Bassendean sand diminishes to the east, to the point where less than 2m is saturated near Roe Hwy. In the eastern region of the project site, the Guildford Formation sits at a higher elevation and is the primary unit forming the superficial aquifer.

Within the Bassendean Sand, and lying generally at the existing or previous water table, is a layer of weak to moderately well cemented sand known as ‘Coffee rock’. This unit is usually iron cemented, dark brown to black, fine to medium grained and variable in thickness and degree of cementing. Where present, the Coffee rock acts to provide vertical separation in the superficial aquifer, thus creating a ‘perched’ aquifer. The lateral and vertical extent of the Coffee Rock at the project site has not been well characterised to date.

Underlying the Guildford Formation lies the relatively impermeable Osborne Formation, providing hydraulic separation from the deeper sub artesian aquifers including the Leederville Aquifer. The base of the superficial aquifer resides between approximately 10m AHD and -15m AHD across the site, dipping towards the north-northwest.

Figure 6 prepared by Golder (2020) presents an east-west cross section along the GEHB road alignment showing the hydrostratigraphic units, water table elevation and saturated thickness of the two major units forming the superficial aquifer.

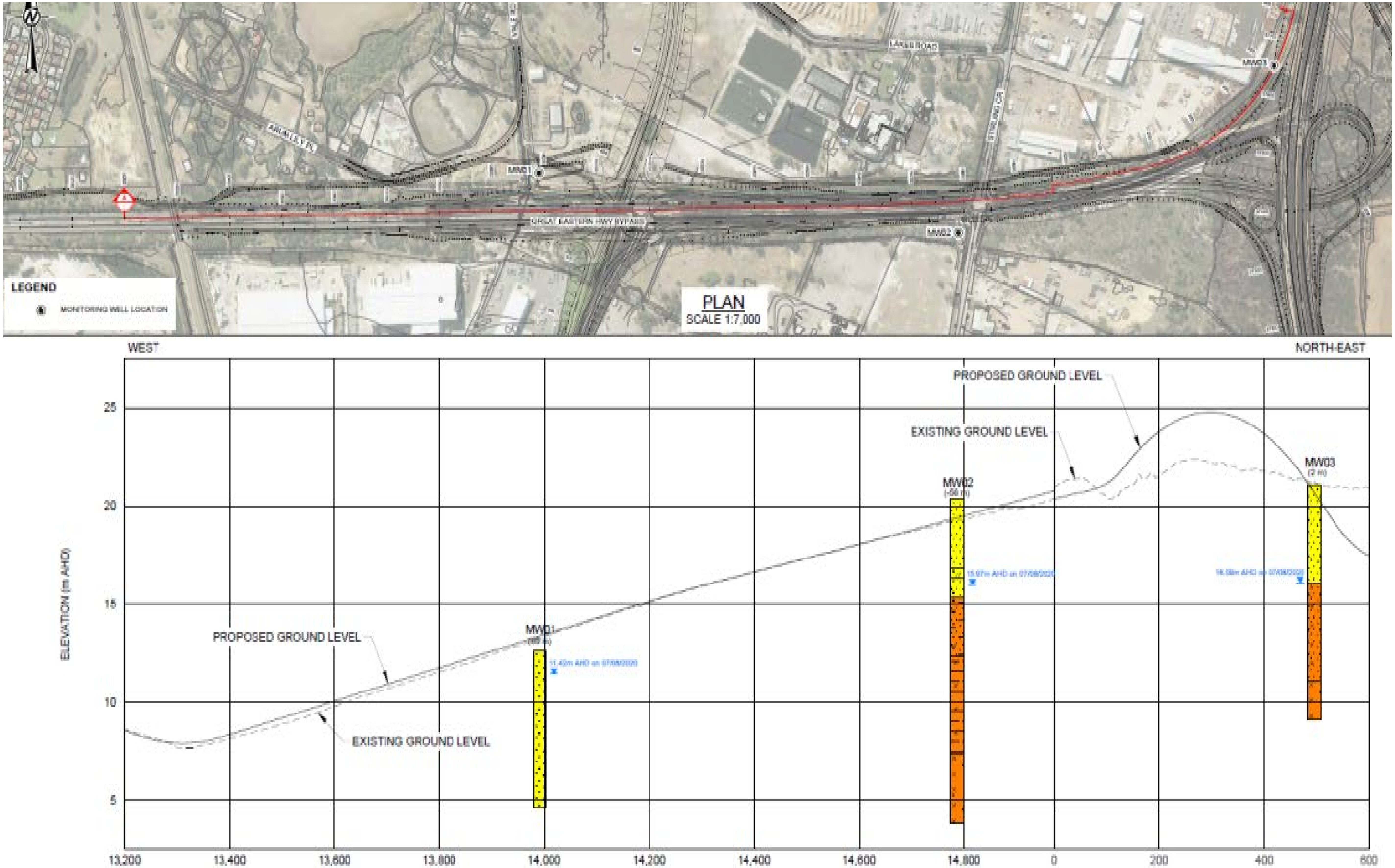

Figure 6 – Hydrostratigraphic Cross Section along GEHB (Golder, 2020)
- Bassendean Sand shown in yellow
- Guildford Formation shown in orange

Permeability of the two main units can be variable through the Perth region. According to the DoW's Perth Regional Aquifer Modelling System (PRAMS) (DoW, 2008), The Bassendean Sand represents highly permeable sandy materials, and over the entire area of the Bassendean Sand, the horizontal hydraulic conductivities range between 10 and 50 m/day, with an average of 15 m/day. In areas where the 'coffee rock' is generally thicker than elsewhere, the limonite cement may reduce the horizontal hydraulic conductivity to less than 10 m/day.

The Guildford Formation has a low hydraulic conductivity of less than 0.1 metres per day (m/day), although some basal sandy lenses have a horizontal hydraulic conductivity of up to 10 m/day (DoW, 2008).

The Guildford Formation is the dominant hydrostratigraphic unit to the north of the project site in the region of the Helena River (**Figure 3**). According to Coffee (2011), two groundwater systems within this unit have been identified and investigated; a complex shallow flow system perched within the Upper Clays, referred to as the Shallow Superficial Aquifer (SSA), and a deeper aquifer in the Lower Sands termed the Lower Superficial Aquifer (LSA), which is in direct hydraulic continuity with the Henley Sandstone.

The SSA largely comprises interbedded sands and sandy clays, separated by lower permeability clays and clayey sands. The SSA is absent beyond the foot of the Southern Embankment, where clay and silt sediments of the Helena River floodplain directly overlie the LSA. The LSA is confined or semi-confined by the Upper Clays. The fine-grained sand and silt of the Lower Sands is understood to form part of a relatively extensive aquifer beneath the site (Coffey, 2011)

7.2 Groundwater Levels and Flow

The DoW Perth Groundwater Atlas indicates groundwater levels reside between approximately 4m AHD and 16m AHD across the overall project area, decreasing towards the northwest. These levels however are likely not representative of the seasonal maximum level, as this data is based on recorded groundwater levels measured at the end of summer in May 2003. Golder (2020) provides a preliminary maximum groundwater level contour map which provides an indication of current maximum groundwater levels and flow direction, based on recent groundwater level recordings from onsite monitoring bores, and additional nearby data. These contours indicate groundwater levels range from approximately 26m AHD in the south east of the project area, to less than 8m AHD in the north and northwest of the project area near to the Helena River (**Figure 7**). These elevations correspond with groundwater levels ranging between >8m bgl to the southeast of the project area (ie at the southern extent of WP4) to <1m bgl towards the west (ie west of Abernethy Road) and north (ie banks of Helena River) of the project area.

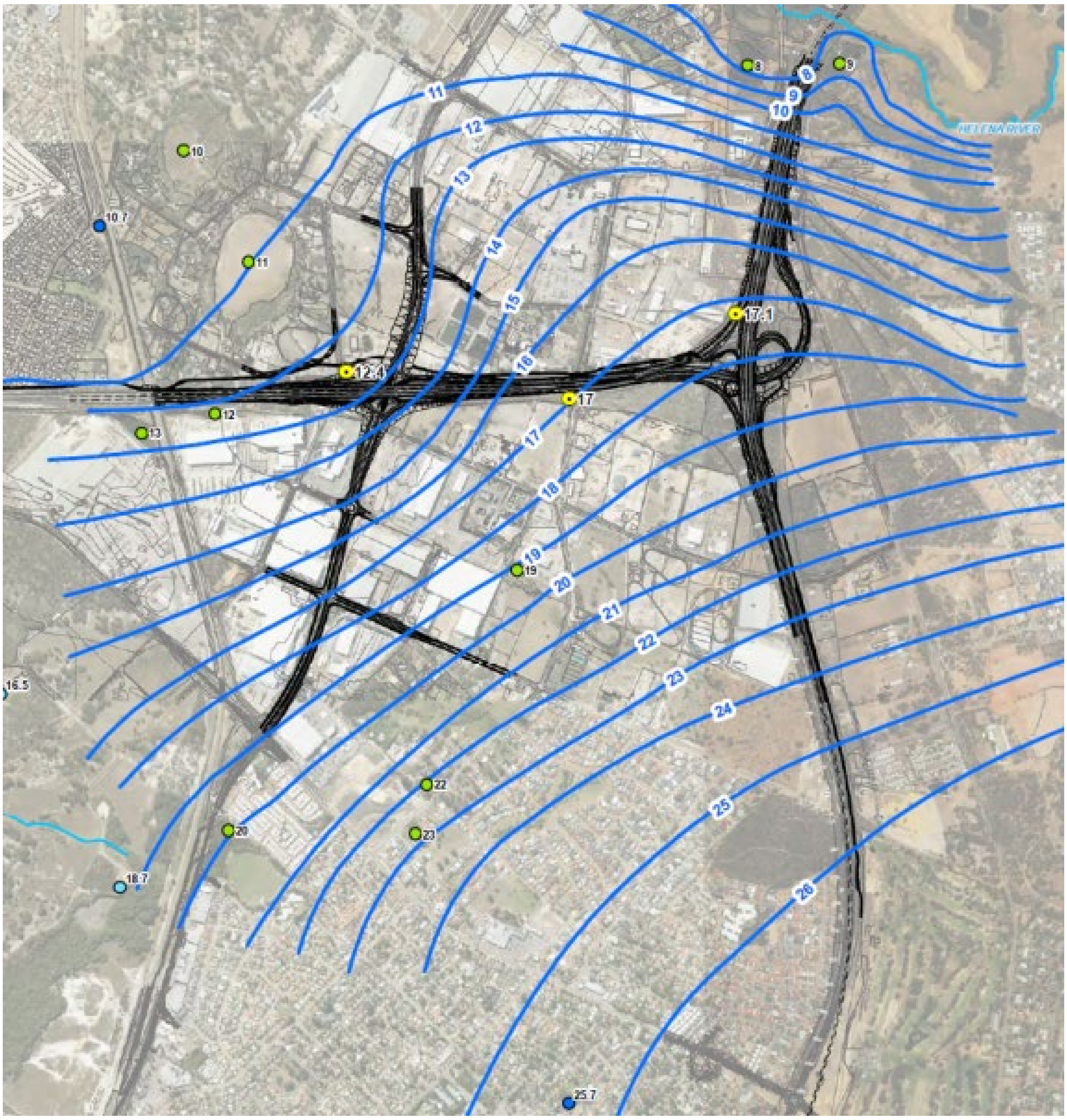

Figure 7 – Indicative Maximum Groundwater Level Contours (Golder, 2020)

Contours from both the DoW and Golder (2020) indicate a north to northwesterly groundwater flow direction under a relatively steep hydraulic gradient, with discharge into the Helena River. The gradient likely steepens towards the Helena River where the topography steepens and the higher permeability Bassendean Sands meet the lower permeability Guildford Formation. The Helena River appears to exert some control over groundwater flow direction, with contours indicating flow direction changes from northwest to north, according to the flow direction of the river and its main tributary in the area, Kadina Brook. On the northern side of the Helena River (to the northern end of WP4), groundwater flows southwest to discharge into the Helena River.

Groundwater levels vary seasonally by between 1 and 3 m, with lower seasonal fluctuations on the western side of the project area above more permeable Bassendean Sands, and higher fluctuations to the east and north on less permeable Guildford Formation. DWER monitoring bore 61619602, located north of the Helena River in the superficial aquifer shows a seasonal variation of generally between 2m and 4m (**Figure 8**).

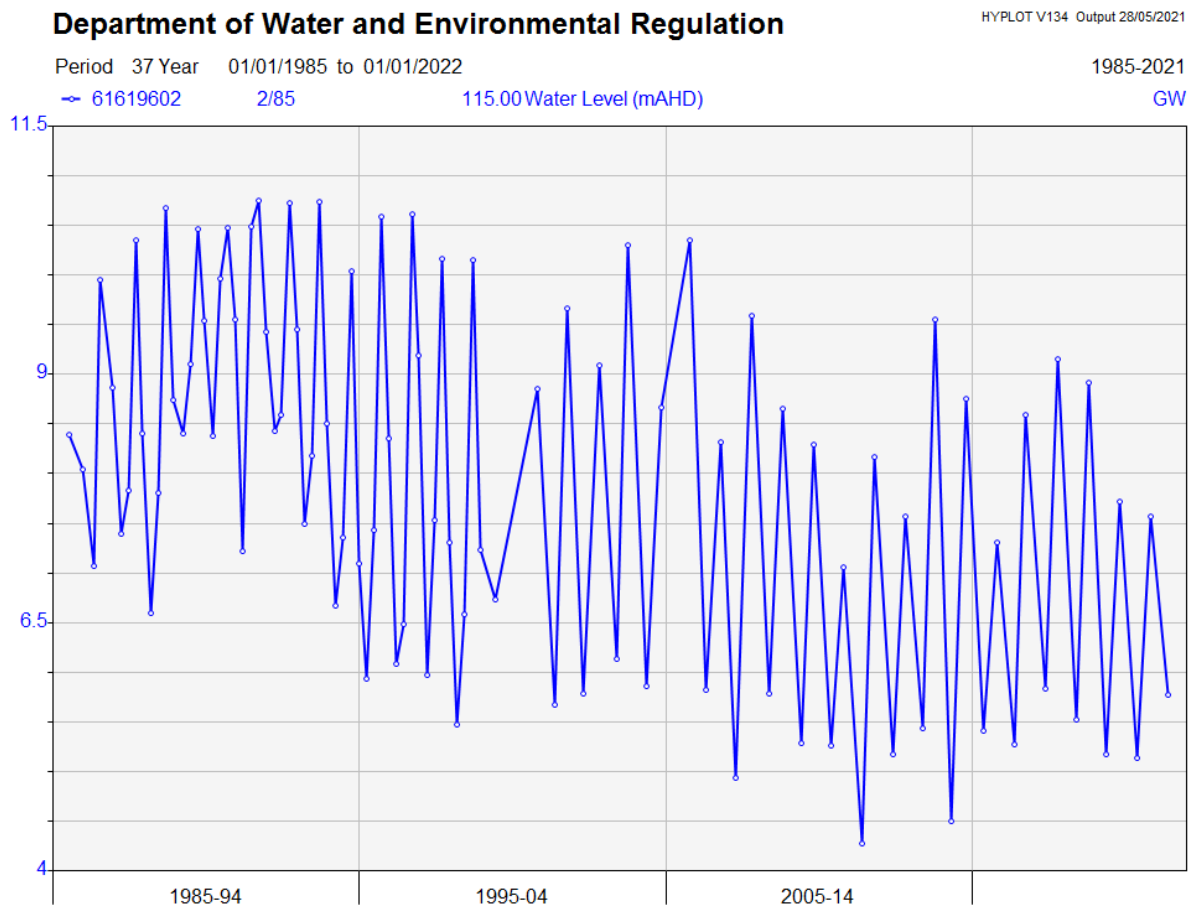

Figure 8 – Seasonal Fluctuation in DWER Bore 61619602

Although limited data is available, the expected impact of the clay beds between the SSA and the LSA north of Helena River is to hydraulically separate the aquifers and allow downward vertical flow gradients. In other words, the groundwater level in the SSA is above that of the LSA. This is supported by the findings of Coffee (2011) which indicate a groundwater level of between 7 and 12m AHD in the SSA, and between 3 and 4.5 m AHD in the underlying LSA. A similar separation with downward vertical flow is expected within the Bassendean sands at the project site where coffee rock is present.

7.3 Recharge and Discharge

The superficial aquifer is predominantly recharged via direct rainfall infiltration, however point source recharge through infiltration of stormwater at various local depressions and infiltration basins also contributes. The upper reaches of the Helena River and Kadina Brook to the east of the Project area, where these drainage channels are likely 'losing' streams, likely contribute recharge to the superficial aquifer which reaches the project area as throughflow.

Groundwater discharges primarily to the Helena River but also to the Hazelmere Lakes and other surface water bodies at the Project site.

7.4 Groundwater Quality

According to studies undertaken by ENV (2009) groundwater is generally fresh to slightly brackish, with recorded electrical conductivity (EC) values of between 0.24 and 3.64 mS/cm. Groundwater pH is generally slightly acidic, with values ranging from 4.85 to 7.38. Groundwater is generally high in phosphorous and nitrogen, and contained lead, copper and zinc in concentrations above NHMRC Drinking water Guidelines (lead) and ANZECC Freshwater Trigger values (copper and zinc) (ENV, 2009).

7.5 Groundwater Controls

Anthropogenic controls on groundwater levels in the project area occur in the form of drainage and groundwater abstraction.

Subsoil drains are located along GEHB west of Abernethy Road in WP1, as shown in **Figure 9** below. The inlets at the lowest elevation drains at this location is 6.25m AHD (Figure 7) which resides approximately 4 to 5m below the baseline water table. These drains likely permanently control groundwater levels in this area, as the inlet is interpreted to be below the seasonal low groundwater level.

Additional subsoil drains are located along Abernethy Road in WP3, opposite the Munday Swamp. The inlets at these two drains reside at 20.69 and 19.97m AHD, and potentially intersect seasonally high groundwater levels.

It is expected that any additional subsoil drains installed in new areas as part of the project will not permanently lower the water table, as these are expected to be located at or above the seasonal maximum groundwater level.

Figure 9 – Subsoil Drains at WP1

Groundwater abstraction also occurs at several sites with the project area. **Figure 10** below shows the locations of groundwater licenses and abstraction points within the project area and surrounds, as obtained from the online DWER Water Register. These licenses are primarily for industrial supply and reticulation for business, parks, sporting grounds and the Hillview golf course. The largest groundwater user is the City of Kalamunda, which abstracts up to 936,725 kL/yr across 18 parks and reserves for reticulation purposes. It should be noted that the licence allocations represent a maximum allowable groundwater abstraction volume. Actual abstraction volumes could be significantly less. Additionally, some of the licenses on Figure 8 relate to abstraction from deeper confined aquifers including the Leederville and Yarragadee aquifers.

Groundwater abstraction for domestic use also likely occurs in the area but as this is not licensed the locations are unknown.

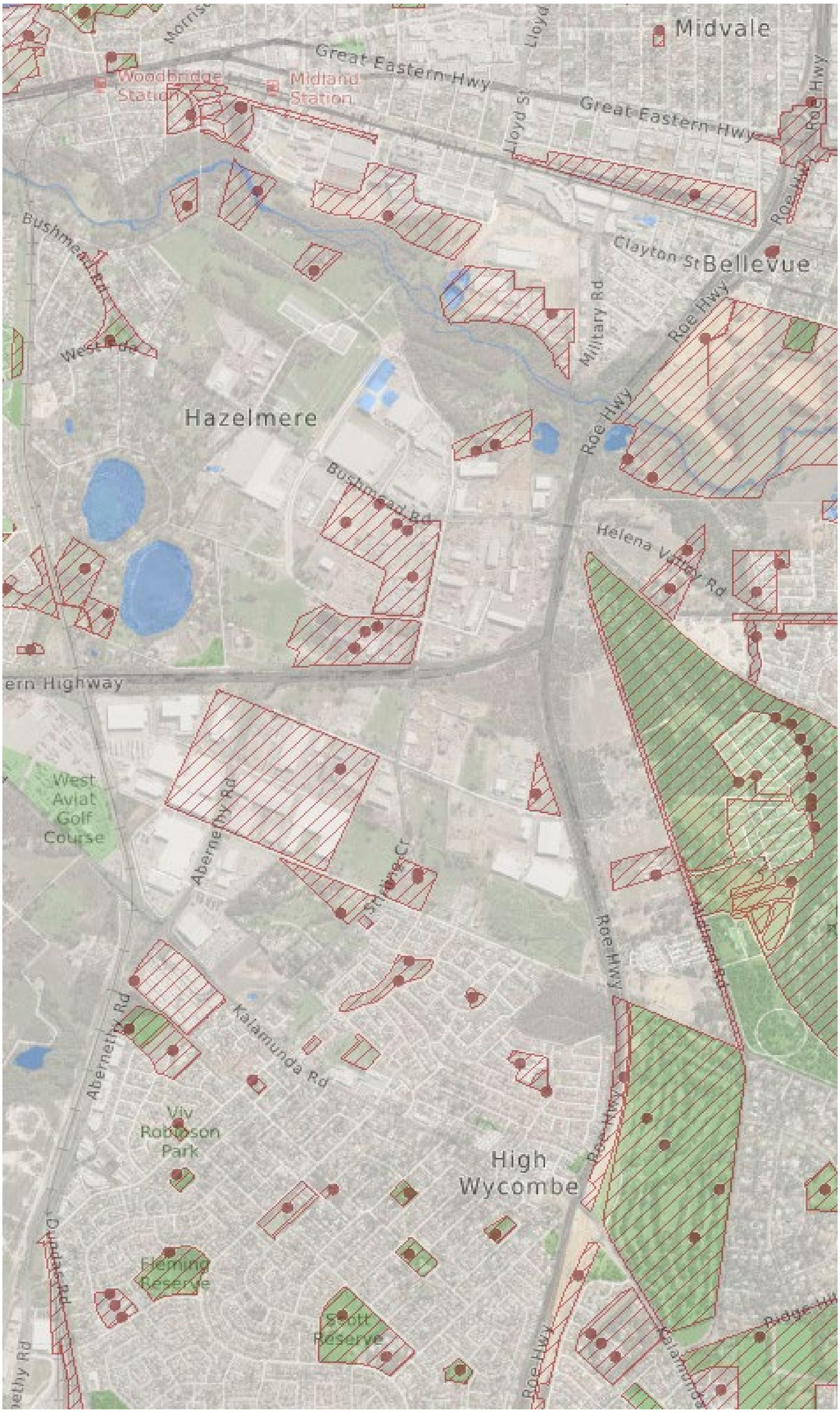

Figure 10 – Nearby Licenses to Abstract Groundwater (Source; DWER Online Water Register, 2021)

The impact of groundwater abstraction is shown in **Figure 11**. Bore MW02 resides within approximately 200m of a groundwater licence allowing abstraction of up to 66,000 kL/yr. The effects of the nearby abstraction indicate short term groundwater level changes on a daily or weekly basis aligned with pumping cycles. Levels are reducing slightly during abstraction and recovering once the bores are turned off. The seasonal cycle responding to rainfall appears to have a significantly greater impact on groundwater level changes.

85% Report

No Changes.

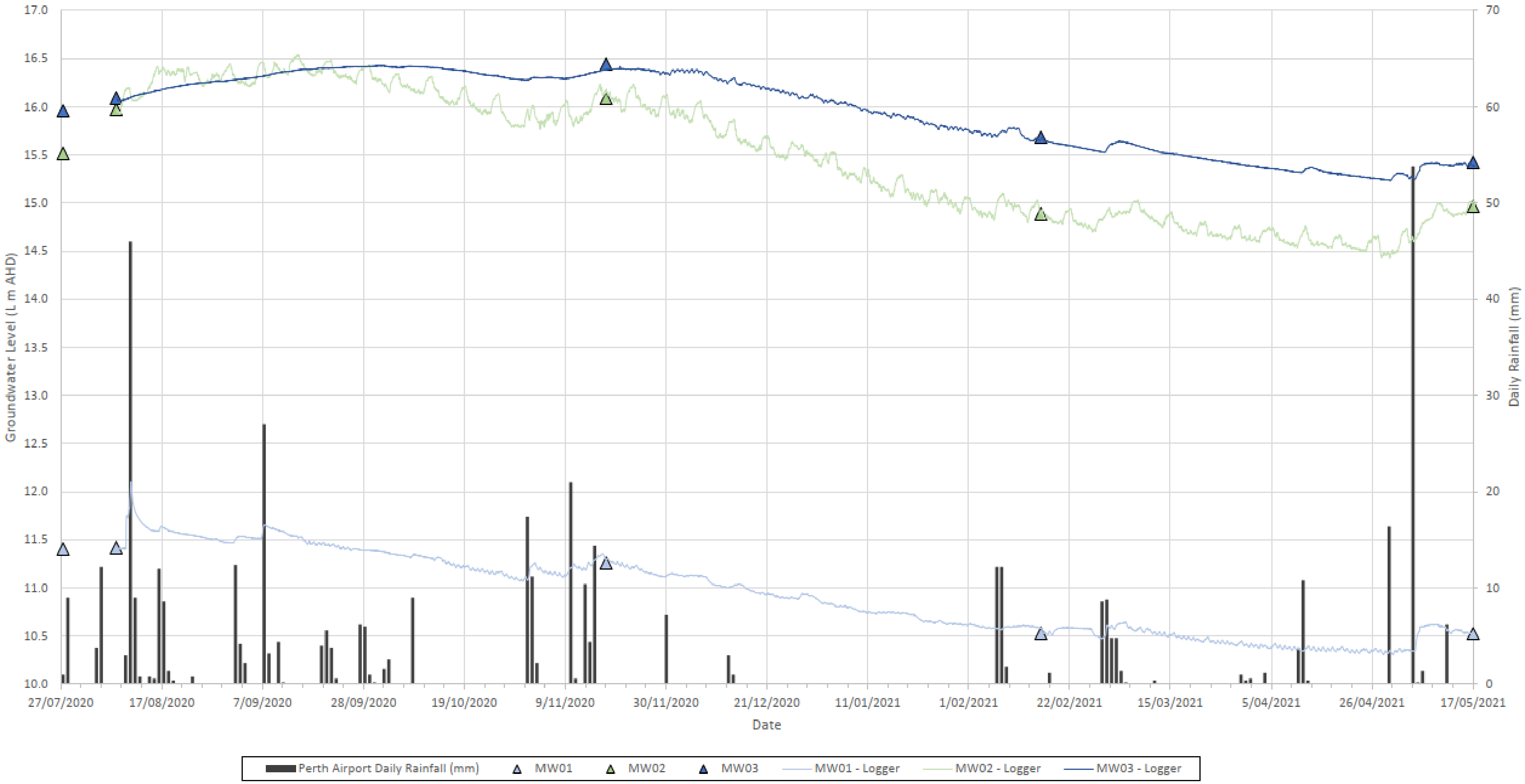

Figure 11 – Effects of Groundwater Abstraction (Source; Golder, 2021)

8. Determination of Maximum Groundwater Levels (MGLs)

8.1 Methodology and Data Sources

15% Report

The adopted approach for determining initial site wide MGLs was based primarily on historical data and used the following key inputs:

- Historical groundwater monitoring bore hydrographs available from DWER.
- Standalone groundwater level readings from DWER monitoring bores in locations where data gaps exist (and no historical hydrographs exist).
- Groundwater level information from the recently installed monitoring bores by Golder (2020).
- Groundwater levels from other nearby studies.
- Subsoil drain locations and inlet levels.
- Topographic contours of ground surface and wetlands from Landgate (1m interval).

The approach considered the historical groundwater level record from available monitoring bores and identified the maximum recorded groundwater over the bore history. The difference between the maximum level and current day level for this particular bore(s) was then added to the current day groundwater level at other bores at the site where no historical record exists. The data points were then manually contoured to produce an MGL groundwater elevation map.

This process assumed that site bores would follow a similar historical trend, and conservatively does not consider the effect of climate change on future groundwater levels.

The inital interpreted MGLs were considered preliminary and relied heavily on interpretations from DWER bore 61610508 and the assessment conducted at the general site location by ENV in 2009.

85% Report

The interpreted MGLs developed as part of the 85% design phase expand upon the initial MGLs, supplementing the desktop assessed data with data captured from onsite investigations described in **Section 6** of this report. Key information carried through to the 85% design phase MGL development is summarised in the sections below.

The approach for determining MGLs considers the historical groundwater level record from available monitoring bores and identifies the maximum recorded groundwater level over the bore history. The difference between the maximum level and current day level for this particular bore(s) is then added to the current day groundwater level at other bores at the site where no historical record exists. The data points are then contoured to produce an MGL groundwater elevation map.

This process assumes that site bores would follow a similar historical trend, and conservatively does not consider the effect of climate change on future groundwater levels.

8.2 Data Review

8.2.1 DWER Hydrographs and Groundwater Level Information

15% Report

A review of the DWER Water Information Reporting (WIR) database was conducted to identify local monitoring bores with historical groundwater level records. The review indicated that most superficial aquifer bores have only a single water level measurement, generally at the time of construction, thus give a temporally inconsistent range of water level information and do not give indications as to the maximum level over time.

Four bores were identified with longer term records, including bores 61611962, 61619601, 61619602 and 61619603. Bore 61611962 is located near Hazelmere Lake and provides a ten year hydrograph up to 2020. Bores 61619601 and 61619603 were drilled to depths beyond the superficial aquifer. Bore 61619602 was drilled to 11.7m depth and is located north of the Helena River in likely Guildford Formation. The bore has a 35 year groundwater level record. The bore shows a maximum recorded level of 10.8m AHD, which is approximately 3.3m above the 2020 groundwater level. This offset is expected to be too great to apply to the measured groundwater levels at the project site, and is largely not representative of the project site being on Guildford Formation.

15%/85% Report

No DWER bores screened in the Bassendean Sand and with adequate historical groundwater level records were identified in the Project area. The nearest DWER bore screened in the Bassendean Sand with adequate historical groundwater level records is located in Belmont approximately 10km to the southwest. The historical hydrograph for this bore is shown in **Figure 12**.

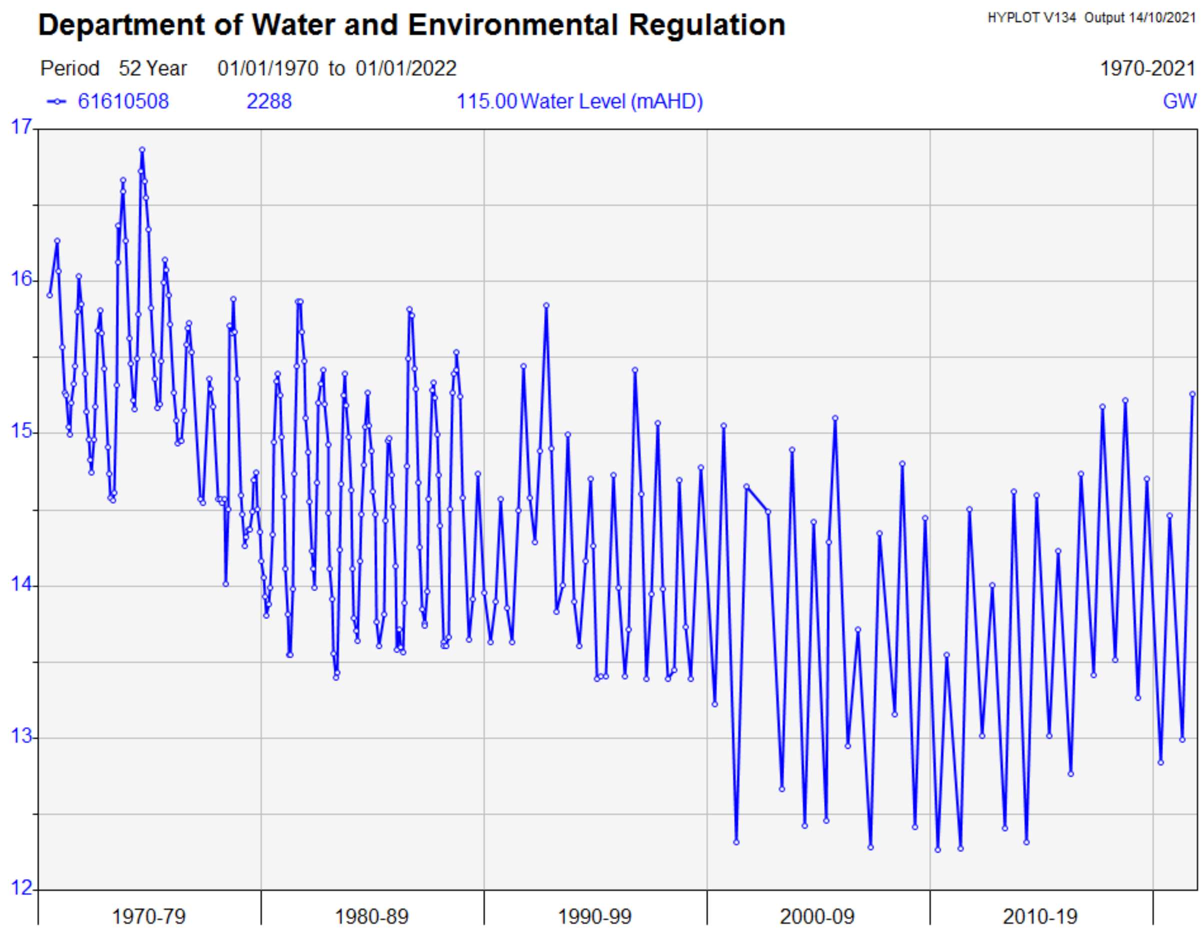

Figure 12 – DWER Bore 61610508 Hydrograph

The hydrograph shows a peak groundwater elevation of 16.8m AHD in 1974, which is 2.3m higher than the current day level. However, the hydrograph shows that the groundwater elevation of approximately 15.9m AHD is repeated on four occasions between 1978 and 1993 and may be more applicable as a maximum adopted groundwater level. This level is approximately 0.6m higher than the 2021 maximum level, recorded in October 2021.

8.2.2 ENV (2009) Assessment

15%/85% Report

ENV (2009) installed a series of 17 groundwater bores at the site area in 2008, and undertook an assessment of groundwater levels which included groundwater level measurements from October 2008 to March 2009. The ENV bores represent the best spatial coverage of groundwater monitoring bores across the Project site, however do not extend to the southern end of WP3 nor the northern end of WP4. The locations of these bores are shown as historical groundwater monitoring bores in **Figure 4**.

An attempt was made to locate, record the status and measure the ENV bores during site investigations. Five bores were located, however three of these were either dry or filled with silt and could not be relied upon for accurate measurements. Two bores, X6 and X19, were able to be measured and provided the following readings (**Table 6**).

Table 6 – Maximum Recorded Groundwater Levels 2021

Site ID	Max Recorded Level 2008 (mAHD)	Max Recorded Level 2021 (mAHD)	Difference
X6	9.08	9.74	0.66
X19	11.40	11.87	0.47

8.2.3 Golder Site Investigation 2020/2021

15% Report

Golder installed three groundwater monitoring bores in July 2020 along GEHB between Abernethy Rd and Roe Hwy (**Figure 13**). The bores were screened in;

- Sands of the Bassendean Sand between 5 and 8m bgl (MW01)
- Sandy Silt of the Guildford Formation between 13.5 and 16.5m bgl (MW02)
- Sandy Silt and Silty Sand of the Guildford Formation between 9 and 12m bgl (MW03).

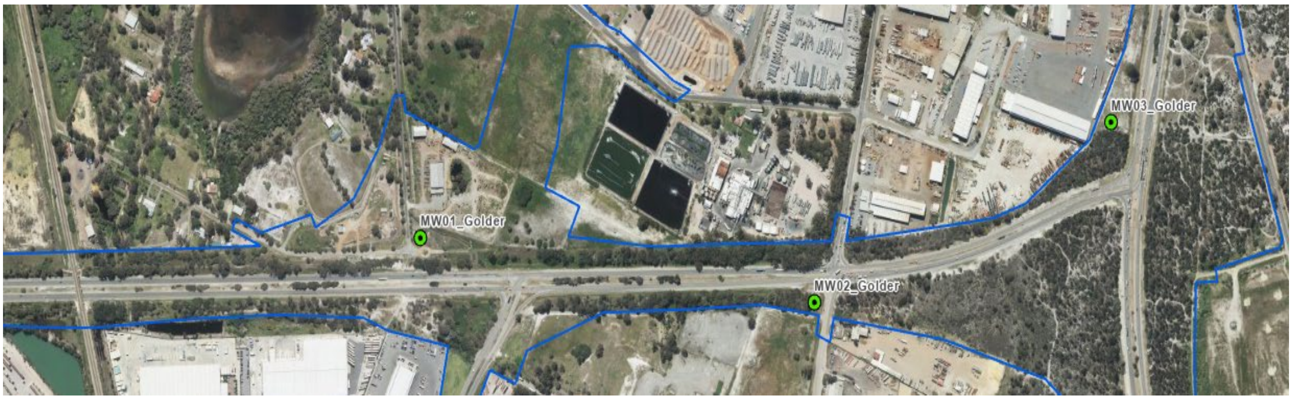

Figure 13 – Golder (2020) Bore locations

Depths to water at the time of installation were measured between 1.20 and 5.12m bgl. Groundwater level loggers were installed in each of the three bores on 7/8/20 and monitored through to August 2021. The hydrographs associated with these loggers are presented in **Figure 14**. The hydrographs indicate maximum groundwater elevations over the 12 month period range from 12.1m AHD (MW01) to 17.7m AHD (MW02) and generally increase to the east. As seen from Figure 15, MW03 generally shows a higher groundwater elevation than MW02, except during periods of seasonal high water levels. This may be attributable to the screen setting of MW02 in the deeper portion of the superficial aquifer, within the Guildford Formation.

Maximum groundwater levels during the 12 month logger period range from 0.5m bgl (MW01) to 3.78m bgl (MW03), also increasing to the east with rising topography. Groundwater levels at MW01 provide evidence for the interpreted high water table to western end of the project (WP1 and WP3), with levels coming within 1m of the ground surface during the wet seasons of both 2020 and 2021. Levels dropped to approximately 2.2m bgl in MW01 in May 2021 at the end of the dry season.

The 12 months of monitoring show seasonal fluctuations of between 1.8m (MW01) and 3.3m (MW02) with the lower permeability bores (MW02 and MW03) showing the largest seasonal fluctuations. Short term responses from rainfall events are evident in MW01, with rapid groundwater level rises and falls in response to heavy rainfall, as is expected in a permeable aquifer with shallow depth to water. Following significant rainfall through July 2021, groundwater levels in all bores responded, with MW02 and MW03 showing an August 2021 level which is 1.2m and 0.9m above the 2020 seasonal high respectively.

The findings of the Golder investigation confirm the conceptual hydrogeology of the site.

85% Report

No Changes.

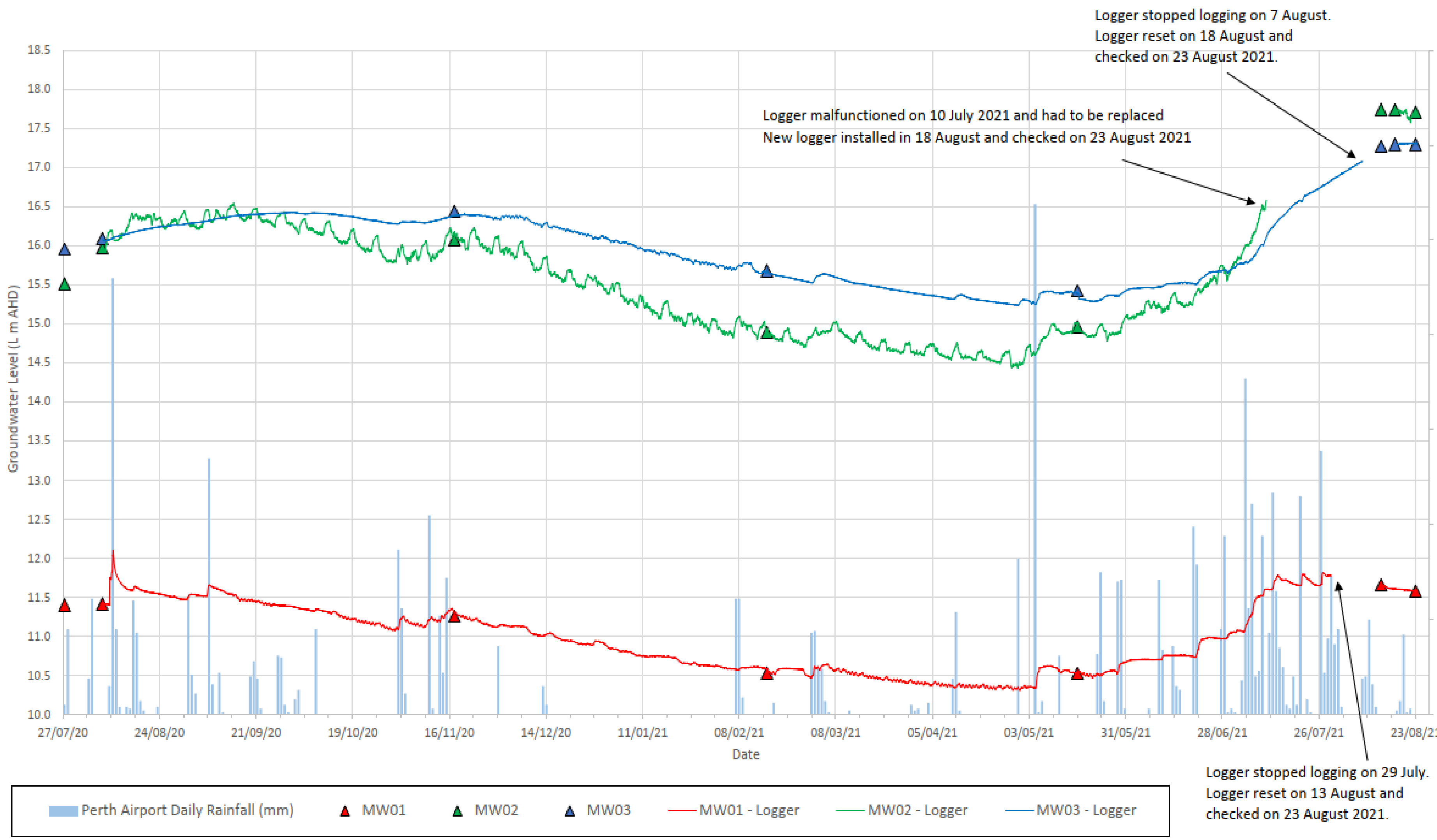

Figure 14 – MW01, MW02 and MW03 Hydrograph (Source: Golder 2021)

8.2.4 Perth Airport Pty Ltd (PAPL) 2020 Report

15% Report

Not available.

85% Report

PAPL undertook a study in 2020 to develop a groundwater model suitable to predict maximum and minimum groundwater levels across the Airport Estate for the existing development conditions and a future development scenario. AQ2 were engaged to complete the study. The scope of work included:

- Collation, review and assessment of all relevant data, and development of a conceptual hydrogeological model of the Airport Estate and surrounding areas.
- Development of a robust groundwater model.
- Prediction of maximum and minimum groundwater levels for current and future development scenarios under a range of realistic climate scenarios.

The PAPL assessment featured two monitoring bores that are located in the general project area for this project. One of these bores (MB2-s) was used to supplement data collected and assessed during this investigation, due to its location and relatively extensive historical groundwater level record (approximately 14 years from 2000 to 2014).

The historical record from this bore indicates the groundwater level at this site does not exceed 16mAHD. This value is consistent with the maximum levels recorded during the recent onsite investigation, in particular MW07 which is located close to this bore.

8.3 Results

15% Report

Using the above data sources, a preliminary MGL contour map was created. Creation of this map followed the methodology described in Section 7.1 and considered the the various constraints and shortcomings of the available dataset. As such the preliminary MGLs were specifically calculated using:

- All measured groundwater levels from the ENV (2009) investigation from October 2008.
- All measured groundwater levels from MW01 to MW03 (Golder, 2021).
- The revised maximum historical groundwater elevation in DWER monitoring bore 61610508 of 15.9m AHD, as described in Section 7.2.1.
- The October 2008 groundwater level measurement from DWER monitoring bore 61610508, of 14.8m AHD (thus an offset of 1.1m added to the ENV October 2008 groundwater level results).
- The October 2020 groundwater level measurement from DWER monitoring bore 61610508, of 14.5m AHD (thus an offset of 1.4m added to the 2020 maximum groundwater level results for the Golder bores).
- Interpretation and adjustment of new calculated MGLs where required through subsoil drains and topography.
- Groundwater spot elevations from DWER bores in the north of WP4, with interpreted offset of 1.1m added.
- Recorded groundwater levels from all reviewed studies in the project area (to ensure the calculated MGL equals or exceeds these groundwater level snapshots.

The calculated MGLs are provided in **Table 4.**

Table 4 – Estimated MGLs at bore locations

Bore	Maximum Recorded Groundwater Elevation (m AHD)	Calculated MGL (m AHD)
MW01	12.10	12.5
MW02	17.74	19.1
MW03	17.31	18.7
X1	2.09	3.2

Bore	Maximum Recorded Groundwater Elevation (m AHD)	Calculated MGL (m AHD)
X3	4.53	5.6
X4	13.00	14.1
X5	9.66	10.8
X6	9.08	10.2
X7	13.88	15.0
X8	9.22	10.3
X10	21.82	22.9
X11	19.00	20.1
X12	24.93	26.0
X13	11.63	12.7
X14	22.03	23.1
X15	35.06	36.2
X17	23.67	24.8
X18	16.89	18.0
X19	11.45	12.6

85% Report

Using the above data sources and the results from the site investigation, the initial MGL contour map was updated. This update used the following information:

- All measured groundwater levels from the ENV (2009) investigation from October 2008.
- All measured groundwater levels from MW01 to MW03 (Golder, 2021).
- The revised maximum historical groundwater elevation in DWER monitoring bore 61610508 of 15.9m AHD, as described in Section 8.2.1.
    - Offset of 0.6m between the revised historical maximum at this bore (15.9m AHD) and the 2021 maximum (15.3m AHD)
- All groundwater monitoring results from the onsite investigation detailed in Section 6.3.
- Recorded groundwater levels from all reviewed studies in the project area (to ensure the calculated MGL equals or exceeds these groundwater level snapshots.
- Subsoil drain locations and inlet levels.
- Topographic contours of ground surface and wetlands

To determine MGLs for the 85% design phase:

- An offset of 0.6m was added to the 2021 maximum recorded level for each site measured during the 2021 onsite investigation.
- An offset of 0.6m was added to the Golder series 2021 maximum levels.
- An offset of 0.6m was added to the ENV bores X6 and X19 2021 maximum levels.
- An offset of 1.1m was added to the remaining ENV bores. This offset was based on:
    - An average of 0.5m difference between 2008 maximum levels and 2021 maximum levels, calculated using the differences from X6 (0.66m), X19 (0.47m) and DWER bore 61610508 (0.45m).
    - 0.6m offset described above

- Interpretation and adjustment of new calculated MGLs was undertaken where required due to the influence of subsoil drains and topographic variations.

The MGLs are also shown as groundwater elevation contours in **Figure 15.**

Figure 15 – Calculated MGL Contours (m AHD)

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8.4 Gaps and Future Works

15% Report

The preliminary MGLs defined in this report are prepared in the knowledge that several data gaps and shortcomings exist, including:

- Limited existing bore data set, with reasonable spatial coverage but gaps in the network.
- Very limited time series records for existing bores (mostly one-off snapshots or short term monitoring records which are difficult to correlate temporally).
- Uncertainty over bore construction and lithology at existing bore locations.
- The need for groundwater level offsets to be determined based on one historical record located some distance from the project site.

A site investigation is currently in progress which is intended to address the data gaps as best as possible. The investigation locations are shown in **Figure 17**. The site investigations include:

- Drilling of groundwater monitoring bores at various vertical intervals across the site.
- Lithological logs from all monitoring bores, geotech and contaminated sites investigation holes.
- Recording of groundwater level snapshots from all drill holes and cased bores.
- Slug tests on all completed groundwater monitoring bores for estimation of hydraulic parameters.
- Groundwater sampling and quality analysis
- Installation of data loggers and collection of longer term groundwater level data.

The processing of this site data will help inform the determination of MGLs for the 85% design report, along with any additional seasonal data obtained from DWER monitoring bores or information from other nearby sources.

85% Report

The MGLs defined in this report are prepared in the knowledge that data gaps and shortcomings exist, including:

- Very limited time series records for existing bores (mostly one-off snapshots or short term monitoring records which are difficult to correlate temporally).
- The need for groundwater level offsets to be determined based on one historical record located some distance from the project site.

The onsite investigation is continuing, with the intention of continuing groundwater monitoring long term including continued use of data loggers employed in bores MW01, MW02 and MW03.

9. Design Reviews and Verification

15%/85% Report

9.1 Cross Discipline Review

This design report has been internally reviewed by members of the GCA design team prior to issuing. All comments have been addressed to enable the issue of the report.

9.2 Independent Review and Verification

The independent verifier for the design is Golder Associates and their review comments on this report and subsequent responses and agreed closeout actions will be recorded in the subsequent revision of this report.

9.3 Stakeholder Reviews

This 85% Design Report will be issued to the following stakeholders for review:

- Main Roads WA Material Engineering Branch
- Main Roads WA Metropolitan Region
- City of Swan
- PAPL

The responses raised and their closeout will be included in the next revision of the report. Responses from the 15% design report are attached in **Appendix E**.

10. Conclusions

The projects site features two main hydrogeological units that makeup the superficial aquifer; the Bassendean Sand and the Guildford Formation. The Bassendean sand hosts the water table and overlies or interfingers with the Guildford Formation where they contact. The Bassendean Sand increases in saturated thickness to the west. In the eastern region of the project site, the Guildford Formation sits at a higher elevation and is the primary unit forming the superficial aquifer. Underlying the Guildford Formation lies the relatively impermeable Osborne Formation, providing hydraulic separation from the deeper sub artesian aquifers including the Leederville Aquifer.

Within the Bassendean Sand, and lying generally at the existing or previous water table, is a layer of weak to moderately well cemented sand known as 'Coffee rock'. Where present, the Coffee rock acts to provide vertical separation in the superficial aquifer, thus creating a 'perched' aquifer. The lateral and vertical extent of the Coffee Rock at the project site has not been well characterised to date.

Groundwater flows in a north to northwesterly direction under a relatively steep hydraulic gradient, with discharge into the Helena River. The gradient likely steepens towards the Helena River where the topography steepens and the higher permeability Bassendean Sands meet the lower permeability Guildford Formation. On the northern side of the Helena River (to the northern end of WP4), groundwater flows southwest to discharge into the Helena River.

Groundwater levels vary seasonally by between 1 and 3 m, with lower seasonal fluctuations on the western side of the project area above more permeable Bassendean Sands, and higher fluctuations to the east and north on less permeable Guildford Formation.

This report documents the 85% maximum groundwater level determination (MGL) for all work packages WP1 to WP5.

The 85% MGL design is based on a desktop assessment of groundwater levels, hydrogeological data sourced from the DWER Water Information Reporting (WIR) database and other local reports and results form an onsite hydrogeological investigation, and the results of the onsite groundwater investigation.

The adopted approach for determining site wide MGLs uses the following key inputs:

- All measured groundwater levels from the ENV (2009) investigation from October 2008.
- All measured groundwater levels from MW01 to MW03 (Golder, 2021).
- The revised maximum historical groundwater elevation in DWER monitoring bore 61610508 of 15.9m AHD.
    - Offset of 0.6m between the revised historical maximum at this bore (15.9m AHD) and the 2021 maximum (15.3m AHD)
- All groundwater monitoring results from the onsite investigation.
- Recorded groundwater levels from all reviewed studies in the project area (to ensure the calculated MGL equals or exceeds these groundwater level snapshots).
- Subsoil drain locations and inlet levels.
- Topographic contours of ground surface and wetlands

To determine MGLs for the 85% design phase:

- An offset of 0.6m was added to the 2021 maximum recorded level for each site measured during the 2021 onsite investigation.
- An offset of 0.6m was added to the Golder series 2021 maximum levels.
- An offset of 0.6m was added to the ENV bores X6 and X19 2021 maximum levels.
- An offset of 1.1m was added to the remaining ENV bores. This offset was based on:
    - An average of 0.5m difference between 2008 maximum levels and 2021 maximum levels, calculated using the differences from X6 (0.66m), X19 (0.47m) and DWER bore 61610508 (0.45m).
    - 0.6m offset described above
- Interpretation and adjustment of new calculated MGLs was undertaken where required due to the influence of subsoil drains and topographic variations.

The MGLs are also shown as groundwater elevation contours in **Figure 15.**

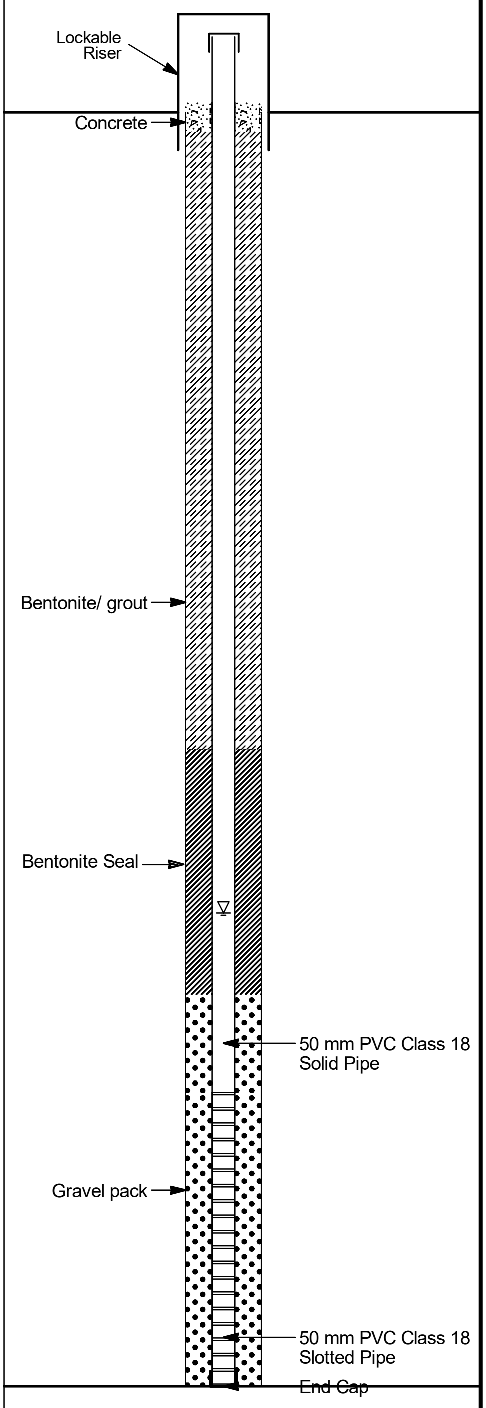
Appendix A – Bore Logs

MONITORING WELL MW01

Drilling Contractor:	National Geotech Drilling	Project Name:	GEHBI	Client:	Greater Connect Alliance
		Project No:	60657311	Location:	Hazelmere
Logged By:	S.B	Bore Size:	150 mm	Top of Casing:	mRL
Checked By:	D.L	Total Depth:	13.00 m	Coordinates:	mE
Date Started:	20/07/2021	Casing Size:	50 mm		mN
Date Finished:	20/07/2021	Permit No:			
Drill Type:	Push Tube	Drill Model:	Geoprobe7720DT	Drill Fluid:	N/A

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: Brown, sandy gravel, fine to coarse sand with sub-angular to sub-rounded gravel.	D	0
				FILL	Shades to dark grey.	D	1
				SP	SAND: light grey/cream, fine to coarse sand, poorly sorted and loosely packed.	D	
Push Tube				SP	Shades to light brown.	D	3
				SC	Clayey SAND: brown with light brown mottle, low plasticity clay with fine to coarse sand.	D	
				SC	Shades to grey/cream wihth some brown mottle.	D	5
				SW	SAND: light grey/cream, fine to coarse grained, well sorted.	M	6
				SM	Silty SAND: light grey, fined grained, well sorted.	M/W	8
				SM	Some coarse sand noted.	W	12
				CL	CLAY: grey, medium plasticity stiff clay.	W	
					End of hole at target depth 13.0 mbgl.		13

WELL CONSTRUCTION DETAILS



01. WELL DRAFT GEHBI LOGS -.GPJ WCC_AUS.GDT 8/10/21

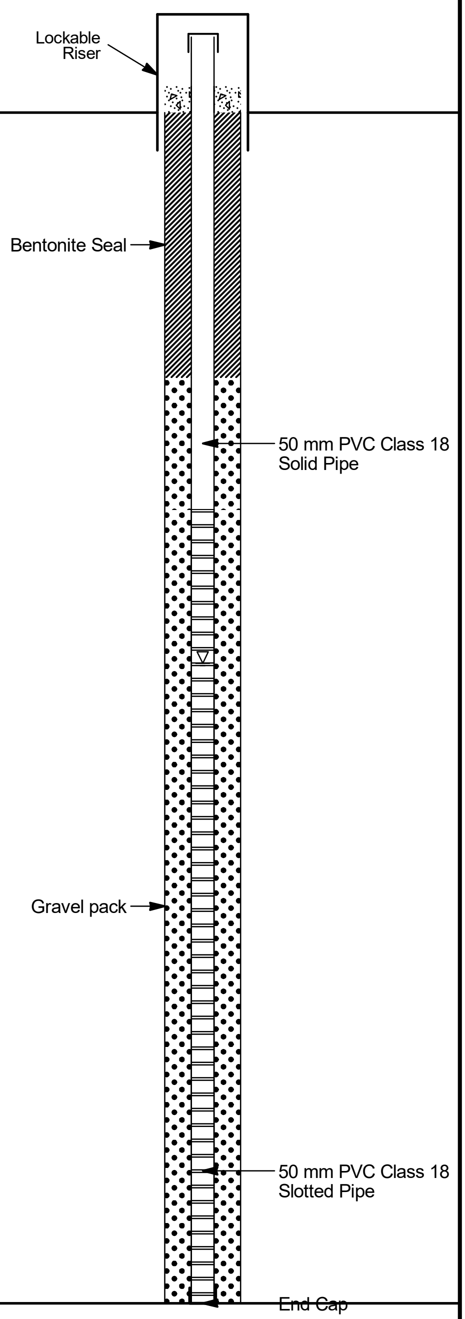
AECOM

MONITORING WELL MW02-S

Drilling Contractor:	**National Geotech Drilling**	Project Name:	**GEHBI**
Client:	**Greater Connect Alliance**	Location:	**Hazelmere**
Project No:	**60657311**		
Logged By:	**S.B**	Bore Size:	**150 mm**
Checked By:	**D.L**	Total Depth:	**4.50 m**
Date Started:	**21/07/2021**	Casing Size:	**50 mm**
Date Finished:	**21/07/2021**	Permit No:	
Top of Casing:	**mRL**	Drill Type:	**Push Tube**
Coordinates:	**mE** / **mN**	Drill Model:	**Geoprobe7720DT**
		Drill Fluid:	**N/A**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: brown, gravelly sand, fine to coarse grained sand with fine to coarse, sub-angular to sub-rounded gravel.	D	0
Hand Auger				SP	SAND: grey, fine to coarse grained, poorly sorted sand.	D	
Hand Auger				SP	Shades to light grey.	D/M	1
Push Tube				SANDST	Coffe Rock/SAND: dark brown, fine to coarse sand with some coarse gravel.	M	
Push Tube				SANDST	Shades to brown.	M	2
Push Tube				SP	SAND: light brown, fine to coarse sand, poorly sorted.	M	
Push Tube				SP	Shades to light grey with coarse sand.	W	3
Push Tube				SC	Clayey Sand: grey coarse sand with low plasticity clay.	W	4
					End of hole at target depth 4.5 mbgl.		

WELL CONSTRUCTION DETAILS

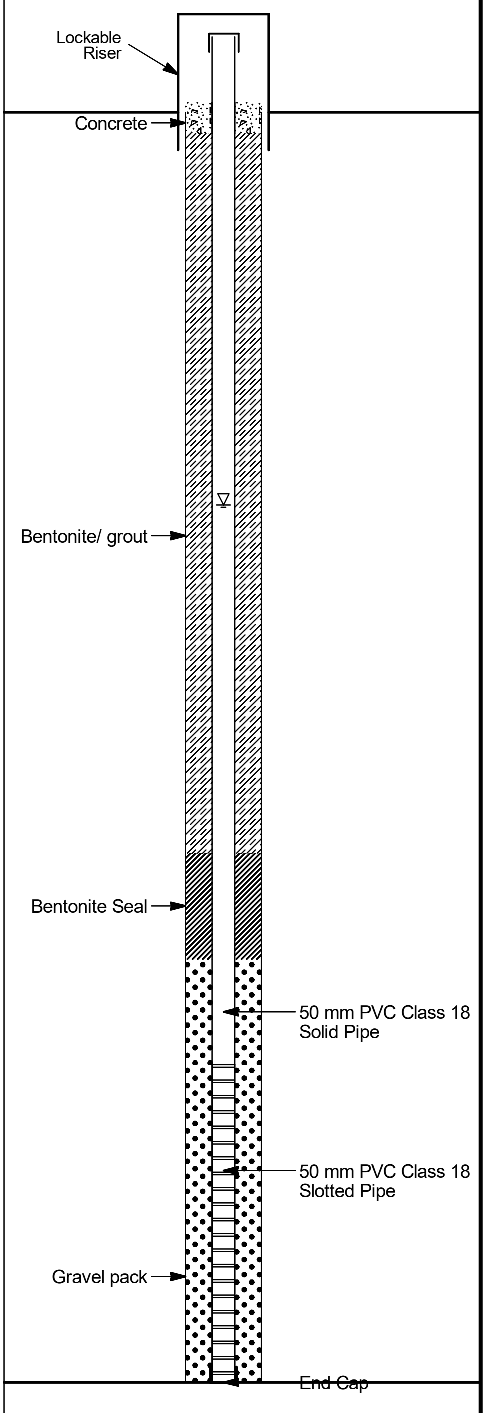


MONITORING WELL MW02-D

Drilling Contractor:	National Geotech Drilling			Project Name:	GEHBI	Client:	Greater Connect Alliance
				Project No:	60657311	Location:	Hazelmere
Logged By:	S.B	Bore Size:	150 mm	Top of Casing:	mRL	Drill Type:	Push Tube
Checked By:	D.L	Total Depth:	12.00 m	Coordinates:	mE	Drill Model:	Geoprobe7720DT
Date Started:	20/07/2021	Casing Size:	50 mm		mN	Drill Fluid:	N/A
Date Finished:	20/07/2021			Permit No:			

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: brown, gravelly sand, fine to coarse grained sand with fine to coarse, sub-angular to sub-rounded gravel.	D	0
				SP	SAND: light grey/cream, fine to coarse grained, poorly sorted sand.	D	1
Push Tube				SANDST	Coffe Rock/SAND: dark brown, fine to coarse sand with some coarse gravel.	D	2
				SANDST	Shades to brown.	D	
				SP	SAND: light grey, coarse sand, poorly sorted.	M	3
				SC	Clayey Sand: light grey fine to coarse sand with low plasticity clay.	M	4, 5
				CL-CH	CLAY: grey, low to medium plasticty stiff clay.	M	6
				CL-CH	Trace some sand.	M/W	
				SC	Silty Clayey SAND: light grey with fine sand and low plasticity clay.	W	7
				SM	Silty SAND: light grey, fine sand.	W	8
				SM	Shades to light grey/cream.	W	
				SP	SAND: light brown/cream, fine to coarse sand, poorly sorted.	W	9, 10
				SP	increased coarse sand content.	W	11
					End of hole at target depth 12.0 mbgl.		12

WELL CONSTRUCTION DETAILS



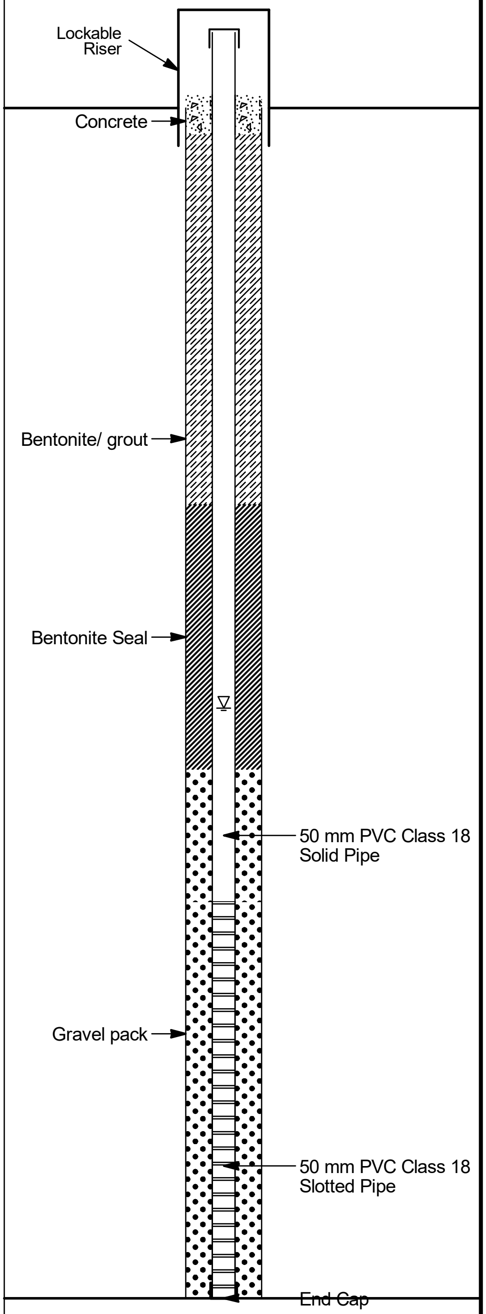
AECOM

MONITORING WELL MW03

Drilling Contractor:	National Geotech Drilling	Project Name:	GEHBI	Client:	Greater Connect Alliance
		Project No:	60657311	Location:	Hazelmere
Logged By: S.B	Bore Size: 150 mm	Top of Casing:	mRL	Drill Type:	Push Tube
Checked By: D.L	Total Depth: 9.00 m	Coordinates:	mE	Drill Model:	Geoprobe7720DT
Date Started: 21/07/2021	Casing Size: 50 mm		mN	Drill Fluid:	N/A
Date Finished: 21/07/2021		Permit No:			

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: brown, gravelly sand, fine to coarse grained sand with fine to coarse, sub-angular to sub-rounded gravel.	D	0
				SP	SAND: dark grey, fine to coarse grained, poorly sorted sand.	D	
					Shades to light grey.		1
Push Tube							2
				SANDST	Coffe Rock/SAND: dark brown with light brown mottle, fine to coarse sand with some coarse gravel.	D	3
				SANDST	Shades to brown.	D	
				SP	SAND: light grey/cream, fine to coarse sand, poorly sorted.	M	4
				SC	Clayey Sand: light grey fine to coarse sand with low plasticity clay.	M	5
							6
				SC	Clayey Silty SAND: light grey, fine to coarse grained sand, low plasticity sticky clay.	W	7
				SM	grades to well sorted coarse sands with reduced low plasticity clay content.	W	8
					End of hole at target depth 9.0 mbgl.		9

WELL CONSTRUCTION DETAILS



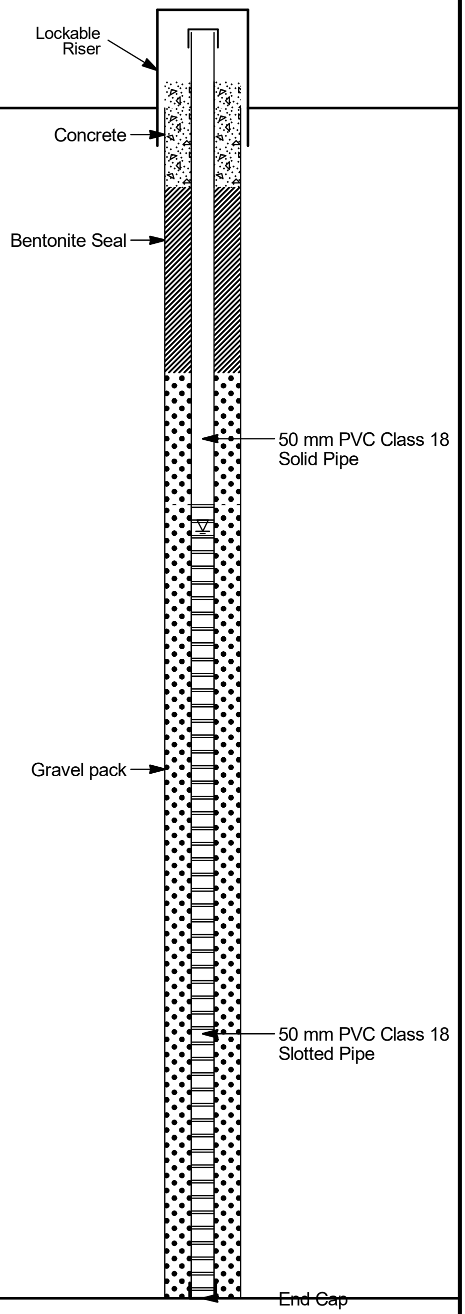
AECOM

MONITORING WELL MW04-S

Drilling Contractor:	**National Geotech Drilling**	Project Name:	**GEHBI**	Client:	**Greater Connect Alliance**
		Project No:	**60657311**	Location:	**Hazelmere**
Logged By:	**S.B**	Bore Size:	**150 mm**	Top of Casing:	**mRL**
Checked By:	**D.L**	Total Depth:	**4.50 m**	Coordinates:	**mE**
Date Started:	**19/07/2021**	Casing Size:	**50 mm**		**mN**
Date Finished:	**19/07/2021**			Permit No:	
Drill Type:	**Mud Core**	Drill Model:	**Geoprobe7720DT**	Drill Fluid:	**Mud**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: Dark brown sand with grass.	D	0
				SP	SAND: light grey/cream, fine to coarse grained sand, poorly sorted and loosely packed.	M	1
Mud Core				SP	Shades to light brown.	M/W	2, 3, 4
					End of hole at target depth 4.5 mbgl.		

WELL CONSTRUCTION DETAILS

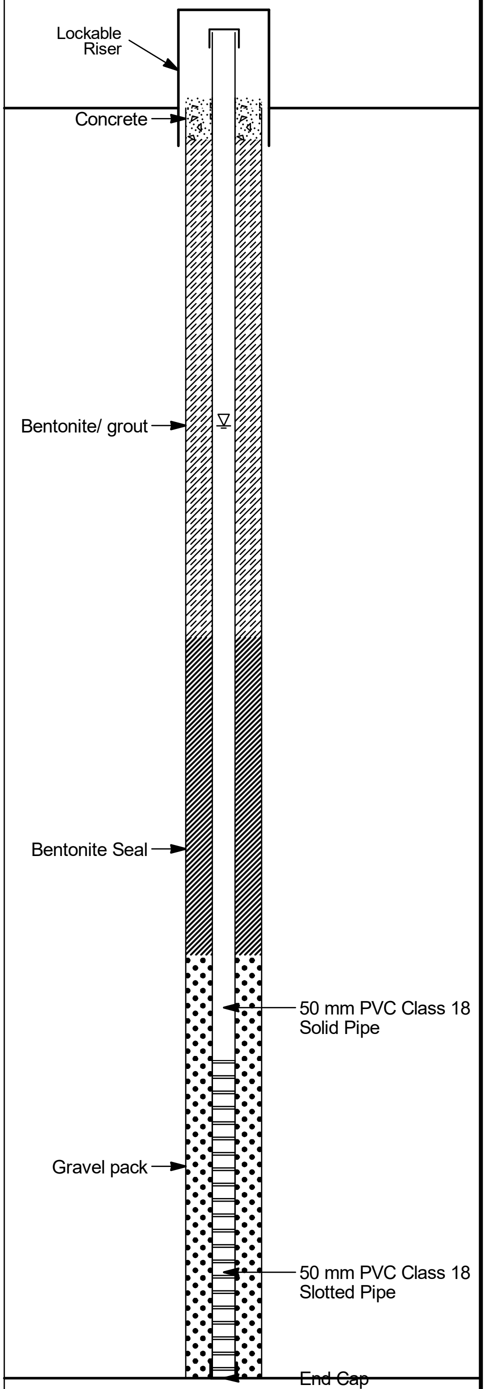


MONITORING WELL MW04-D

Drilling Contractor:	National Geotech Drilling			Project Name:	GEHBI	Client:	Greater Connect Alliance
				Project No:	60657311	Location:	Hazelmere
Logged By:	S.B	Bore Size:	150 mm	Top of Casing:	mRL	Drill Type:	Mud Core
Checked By:	D.L	Total Depth:	12.00 m	Coordinates:	mE	Drill Model:	Geoprobe7720DT
Date Started:	19/07/2021	Casing Size:	50 mm		mN	Drill Fluid:	Mud
Date Finished:	19/07/2021			Permit No:			

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: Dark brown sand with grass.	D	0
				SC	SAND: light grey, fine to coarse grained sand, loosely packed, poorly sorted.	D	1
Mud Core				SC	Shades to light brown.	D/M	2
				SC	Shades to light grey.	M	4
				SM	Silty SAND: grey, fine to coarse sand	M/W	6
				SC	SAND: light grey/cream, fine to coarse sand, poorly sorted.	W	9
				SC	increased coarse sand content.	W	11
					End of hole at target depth 12.0 mbgl.		12

WELL CONSTRUCTION DETAILS



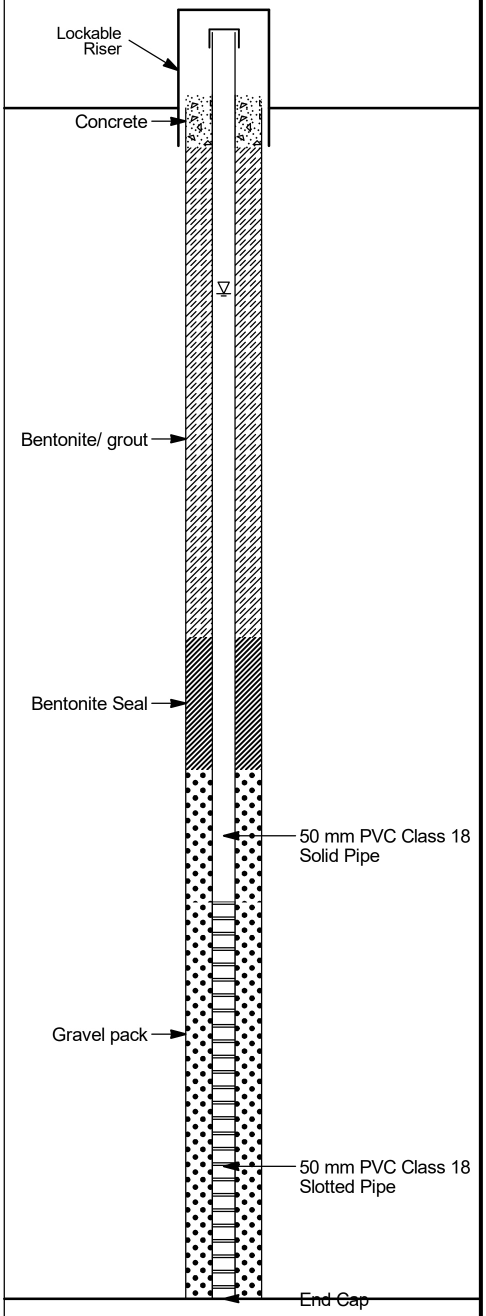
AECOM

MONITORING WELL MW05

Project Name:	GEHBI	Client:	Greater Connect Alliance		
Drilling Contractor:	National Geotech Drilling	Project No:	60657311	Location:	Hazelmere
Logged By:	S.B	Bore Size:	150 mm	Top of Casing:	mRL
Checked By:	D.L	Total Depth:	9.00 m	Coordinates:	mE
Date Started:	22/07/2021	Casing Size:	50 mm		mN
Date Finished:	22/07/2021			Permit No:	
Drill Type:	Push Tube	Drill Model:	Geoprobe7720DT	Drill Fluid:	N/A

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: dark brown sand with some grass.	D	0
				SP	SAND: grey, fine to coarse grained, poorly sorted.	D	1
Push Tube				SP	Shades to orange/brown.	M	2
				SANDST	Coffee Rock: red/brown with grey mottle.	M	
				SP	SAND: grey, fine to coarse, poorly sorted sand.	M	3
				SM	Silty SAND: grey, fine to coarse grained, well sorted sand with some light brown mottle noted.	W	4, 5
				SM	Grades to coarse sand.	W	6, 7, 8
					End of hole at target depth 9.0 mbgl.		9

WELL CONSTRUCTION DETAILS

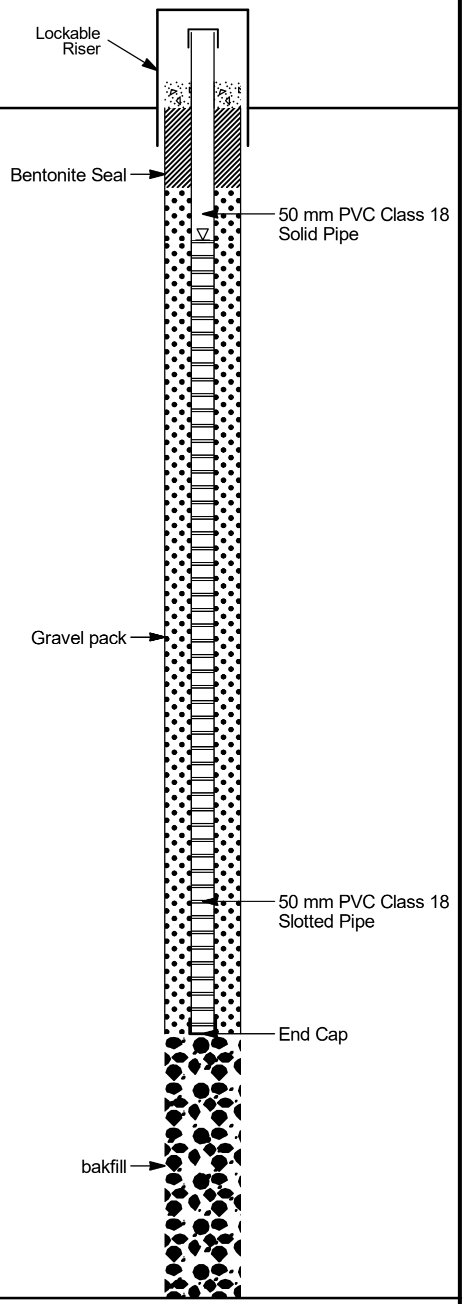


MONITORING WELL MW06-S

Drilling Contractor:	National Geotech Drilling	Project Name:	GEHBI
		Project No:	60657311
Client:	Greater Connect Alliance	Location:	Hazelmere
Logged By:	S.B	Bore Size:	150 mm
Checked By:	D.L	Total Depth:	3.50 m
Date Started:	22/07/2021	Casing Size:	50 mm
Date Finished:	22/07/2021		
Top of Casing:	mRL	Drill Type:	Mud Core
Coordinates:	mE mN	Drill Model:	Geoprobe7720DT
Permit No:		Drill Fluid:	Mud

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: grass, green.	D	0
Hand Auger				LIMEST	LIMESTONE: cream.	D/M	
Hand Auger				SC	Clayey SAND: red/brown, fine to coarse sand with low to medium plasticity sticky clay.	W	1
Mud Core				SC	Shades to grey, with brown mottle, grades to low plasticity clay.	W	
Mud Core				SANDST	Coffe Rock/SAND: yellow/brown with grey mottles and gravel.	W	2, 3
Mud Core				SC	Clayey SAND: grey, fine to coarse sand with low plasticity sticky clay.	W	4
					End of hole at target depth 4.5 mbgl.		

WELL CONSTRUCTION DETAILS

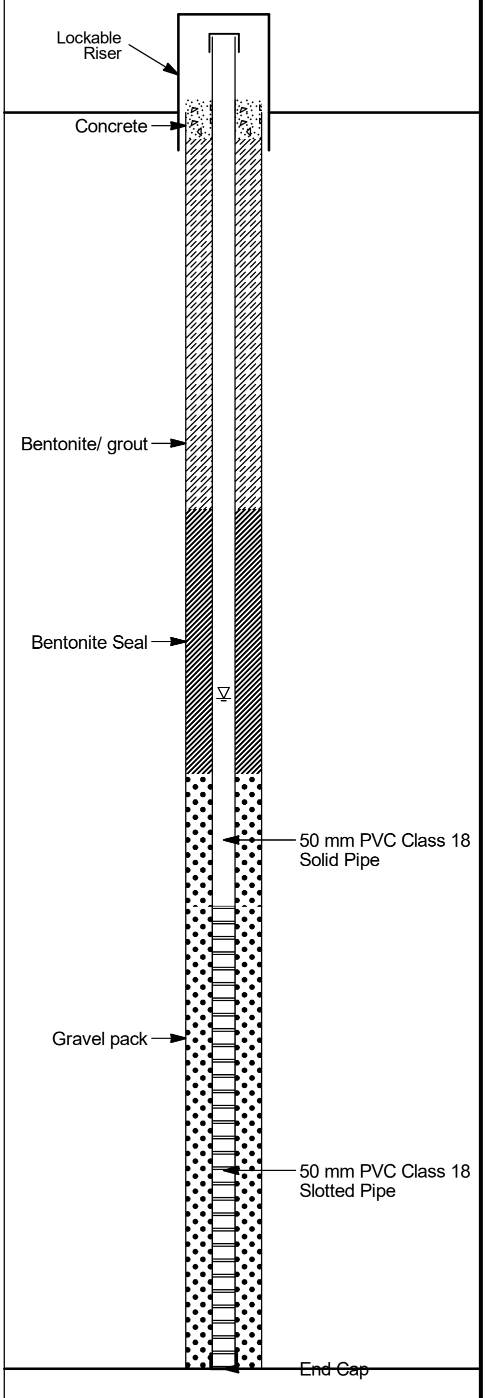


MONITORING WELL MW06-D

Project Name:	GEHBI	Client:	Greater Connect Alliance
Drilling Contractor:	National Geotech Drilling	Location:	Hazelmere
Project No:	60657311		
Logged By:	S.B	Bore Size:	150 mm
Checked By:	D.L	Total Depth:	9.50 m
Date Started:	22/07/2021	Casing Size:	50 mm
Date Finished:	22/07/2021		
Top of Casing:	mRL	Drill Type:	Push Tube
Coordinates:	mE	Drill Model:	Geoprobe7720DT
	mN	Drill Fluid:	Mud
Permit No:			

Drill Method	Sample Interval PID (ppm)	Sample ID	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger			FILL	FILL: grass, green.	D	0
Hand Auger			LIMEST	LIMESTONE: cream.	D/M	
Hand Auger			SC	Clayey SAND: red/brown, fine to coarse sand with low to medium plasticity sticky clay.	W	
Push Tube			SC	Shades to grey, with brown mottle, grades to low plasticity clay.	W	
Push Tube			SANDST	Coffe Rock/SAND: yellow/brown with grey mottles and gravel.	W	3
Push Tube			SANDST	grades to red with larger gravel.	W	4
Push Tube			SC	Clayey SAND: grey, fine to coarse sand with low plasticity sticky clay.	W	
Push Tube			SM	Silty SAND: grey, fine grained, well sorted.	W	
Push Tube			SP	SAND: grey, fine to coarse grained, poorly sorted.	W	9
				End of hole at target depth 9.5 mbgl.		

WELL CONSTRUCTION DETAILS

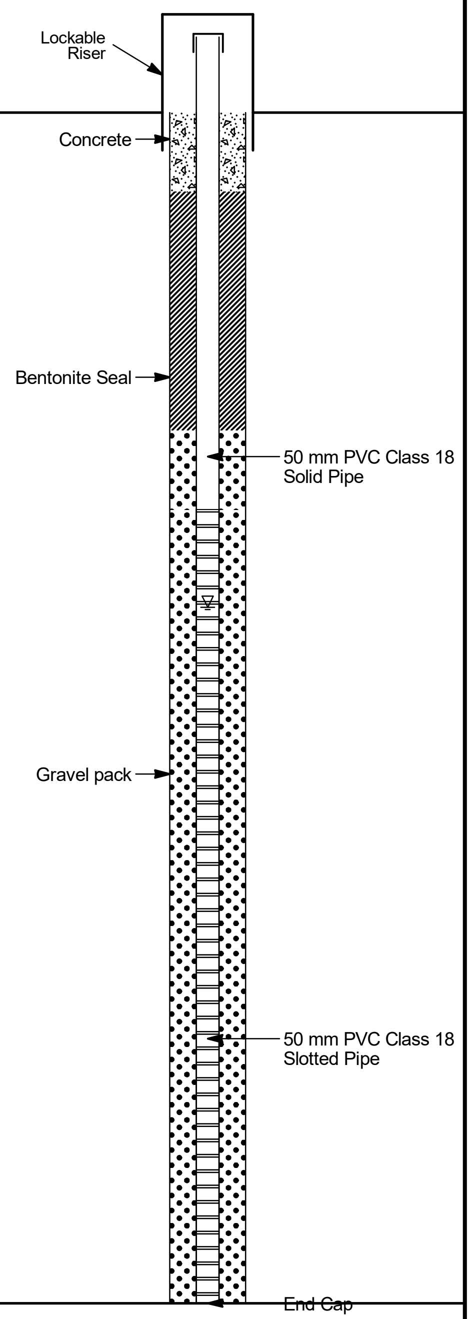


MONITORING WELL MW07

Drilling Contractor:	**National Geotech Drilling**	Project Name:	**GEHBI**	Client:	**Greater Connect Alliance**
		Project No:	**60657311**	Location:	**Hazelmere**
Logged By:	**S.B**	Bore Size:	**150 mm**	Top of Casing:	**mRL**
Checked By:	**D.L**	Total Depth:	**4.50 m**	Coordinates:	**mE**
Date Started:	**21/07/2021**	Casing Size:	**50 mm**		**mN**
Date Finished:	**21/07/2021**			Permit No:	
Drill Type:	**Mud Core**	Drill Model:	**Geoprobe7720DT**	Drill Fluid:	**N/A**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: bitumen, grey.	D	0
Hand Auger				SC	Gravelly Clayey SAND: brown, fine to coarse sand with low plasticity clay.	D/M	
Hand Auger				FILL	FILL: dark grey bitumen, gravelly sand.	M	1
Push Tube				SPG	Gravelly SAND: grey, fine to coarse grained, sub-angular to sub-rounded fine to coarse gravel.	M	
Push Tube				SP	SAND: grey fine to coarse sand, poorly sorted.	M	2
Push Tube				SP	Shades to dark brown.	M	3
Push Tube				SC	Clayey SAND: grey with light brown mottle, fine to coarse sand, low to medium plasticity clay.	M	4
					End of hole at target depth 4.5 mbgl.		

WELL CONSTRUCTION DETAILS

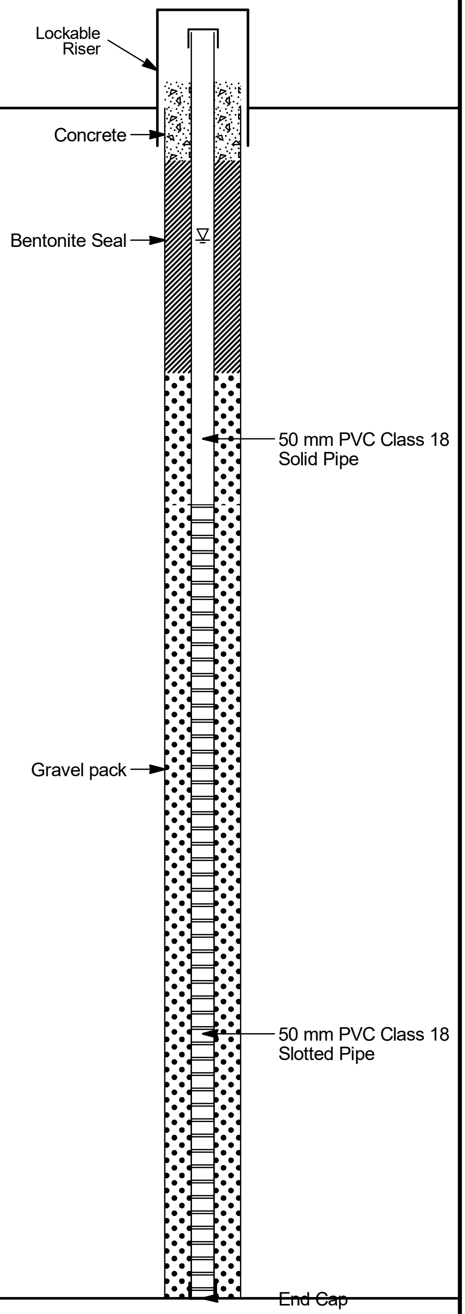


MONITORING WELL MW08-S

Drilling Contractor:	**National Geotech Drilling**	Project Name:	**GEHBI**	Client:	**Greater Connect Alliance**
		Project No:	**60657311**	Location:	**Hazelmere**
Logged By:	**S.B**	Bore Size:	**150 mm**	Top of Casing:	**mRL**
Checked By:	**D.L**	Total Depth:	**4.50 m**	Coordinates:	**mE**
Date Started:	**16/07/2021**	Casing Size:	**50 mm**		**mN**
Date Finished:	**16/07/2021**			Permit No:	
Drill Type:	**Push Tube**	Drill Model:	**Geoprobe7720DT**	Drill Fluid:	**Mud**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: sand, cream, fine to coarse grained with some fine to coarse limestone gravel.	D	0
Hand Auger				LIMEST	LIMESTONE: cream boulders.	D	
Hand Auger / Push Tube				SP	SAND: brown/light brown, fine to coarse grained sand, loosely packed and poorly sorted.	M/W	1 – 2
Push Tube				SP	Shades to dark brown.	W	3 – 4
					End of hole at target depth 4.5 mbgl.		

WELL CONSTRUCTION DETAILS

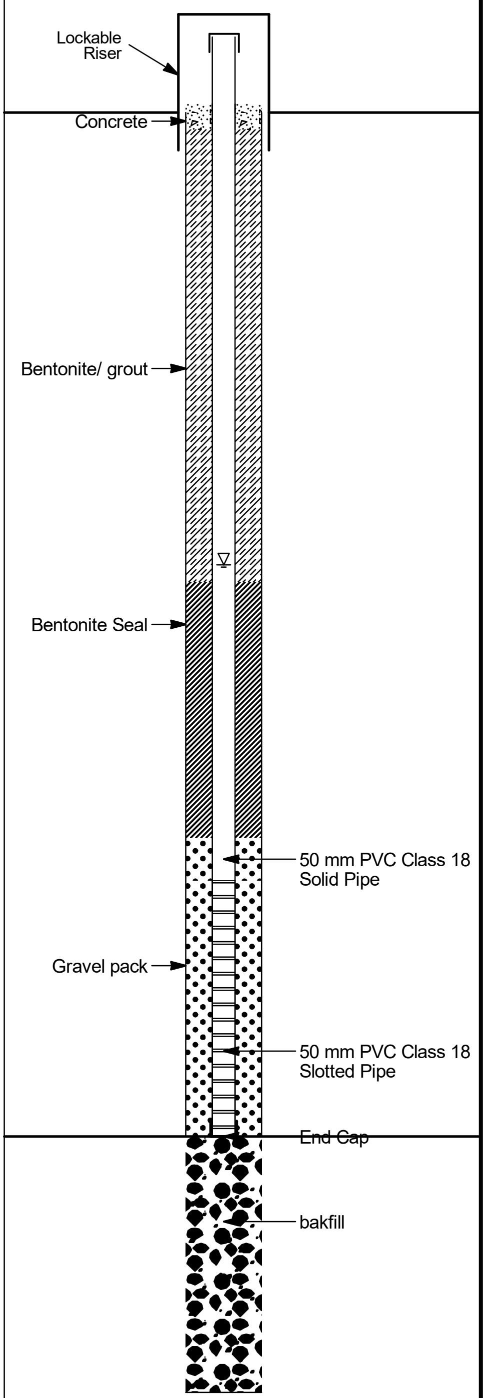


MONITORING WELL MW08-D

Drilling Contractor:	National Geotech Drilling	Project Name:	GEHBI
Logged By:	S.B	Project No:	60657311
Checked By:	D.L	Top of Casing:	mRL
Date Started:	15/07/2021	Coordinates:	mE
Date Finished:	16/07/2021		mN
Bore Size:	150 mm	Permit No:	
Total Depth:	12.00 m	Client:	Greater Connect Alliance
Casing Size:	50 mm	Location:	Hazelmere
		Drill Type:	Push Tube
		Drill Model:	Geoprobe7720DT
		Drill Fluid:	Mud

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				0.5	FILL: limestone, cream, fine to coarse gravel and fine to coarse sand.	D	0
Hand Auger				1	LIMESTONE: cream boulders.	D	
Hand Auger				2.5	SAND: brown/ light brown, fine to coarse sand, poorly sorted.	D/M	1
Push Tube				4.8		M/W	2.5
Push Tube				9	Shades to grey.	W	5
Push Tube				13	Increased coarse sands.	W	9
				15	grades to finer sand.	W	13
					End of hole at target depth 15.0 mbgl.		15

WELL CONSTRUCTION DETAILS

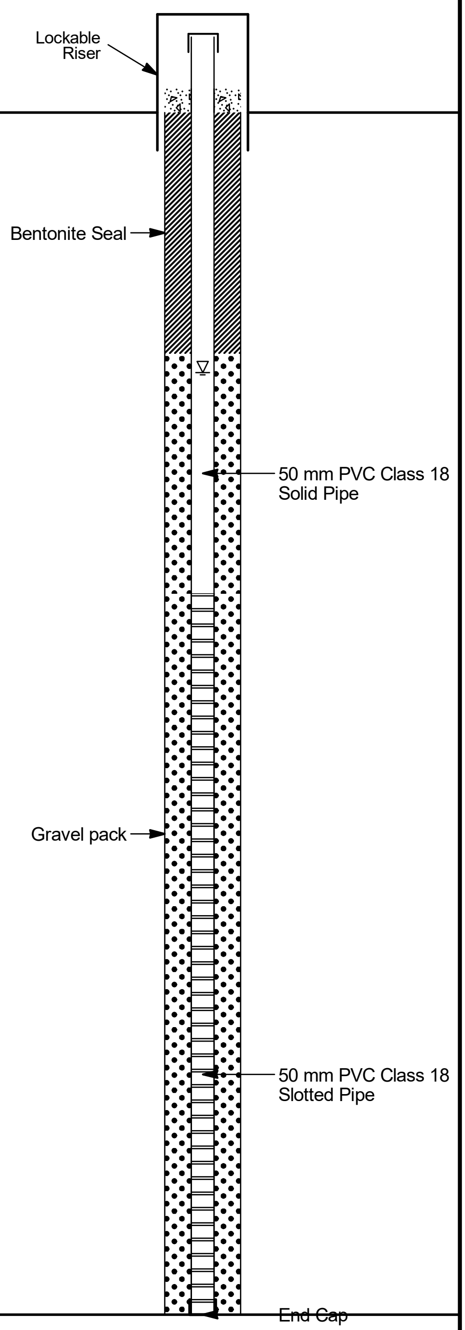


MONITORING WELL MW09

Drilling Contractor:	**National Geotech Drilling**			Project Name:	**GEHBI**	Client:	**Greater Connect Alliance**
				Project No:	**60657311**	Location:	**Hazelmere**
Logged By:	**S.B**	Bore Size:	**150 mm**	Top of Casing:	**mRL**	Drill Type:	**Push Tube**
Checked By:	**D.L**	Total Depth:	**5.00 m**	Coordinates:	**mE**	Drill Model:	**Geoprobe7720DT**
Date Started:	**22/07/2021**	Casing Size:	**50 mm**		**mN**		
Date Finished:	**22/07/2021**			Permit No:		Drill Fluid:	**N/A**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger				FILL	FILL: grass, natural drk brown brown sand.		0
				SP	SAND: grey, fine to coarse grained, poorly sorted.		
				SP	Shades to brown.		1
Push Tube				SP	Shades to cream.		
				SP	Shades to light brown.		2
				SP	Shades to dark brown.		
				SP	Shades to grey with coarse sand.		3
							4
					End of hole at target depth 5.0 mbgl.		5

WELL CONSTRUCTION DETAILS



Appendix B – Groundwater Level Database

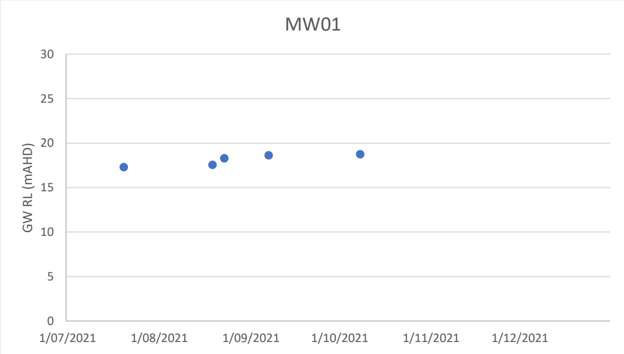
Date	MW01 RL mAHD	MW02-S RL mAHD	MW02-D RL mAHD	MW03 RL mAHD	MW04-S RL mAHD	MW04-D RL mAHD	MW05 RL mAHD	MW06-S RL mAHD	MW06-D RL mAHD	MW07 RL mAHD	MW08-S RL mAHD	MW08-D RL mAHD	MW09 RL mAHD	GW07 RL mAHD	GW08 RL mAHD	GW11 RL mAHD	GW12 RL mAHD	GW13 RL mAHD	GW14 RL mAHD	BH06 RL mAHD	BH09 RL mAHD	BH101 RL mAHD	BH102 RL mAHD	BH105 RL mAHD	BH112 RL mAHD	BH18 RL mAHD
20-Oct-08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Nov-08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Dec-08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Jan-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17-Feb-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17-Mar-09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.57	-	6.64	19.20	24.31	-	-	-	-	-	-	-
16-Jul-21	-	-	-	-	-	-	-	-	-	-	-	9.80	10.40	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-21	-	-	-	-	25.21	26.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-21	17.30	18.17	16.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-21	-	-	-	14.94	-	-	-	-	-	14.88	14.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-21	-	-	-	-	-	-	17.00	6.52	6.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.26	18.29		-	-
17-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.86	-	-	-	-	-	-
19-Aug-21	17.56	16.90	16.31	-	-	-	-	6.49	6.27	-	12.06	9.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-21	18.30	17.51	16.94	16.07	25.21	23.49	16.94	7.16	6.89	-	12.61	10.33	10.61	-	-	-	-	19.13	24.83	-	-	-	-	-	-	-
02-Sep-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.93
07-Sep-21	18.62	17.49	17.06	16.09	-	23.64	16.97	7.33	7.01	14.87	12.67	10.45	10.62	13.27	12.26	-	-	19.17	-	-	-	-	-	-	-	-
13-Sep-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24.33	-
14-Sep-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.12	-	-	6.47	-	-
08-Oct-21	18.74	17.29	16.95	15.91	25.05	23.47	16.87	7.14	6.90	-	12.57	10.43	11.34	13.68	-	17.19	-	19.11	24.71	-	-	-	-	-	-	-
15-Oct-21	-	-	-	15.91	-	28.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

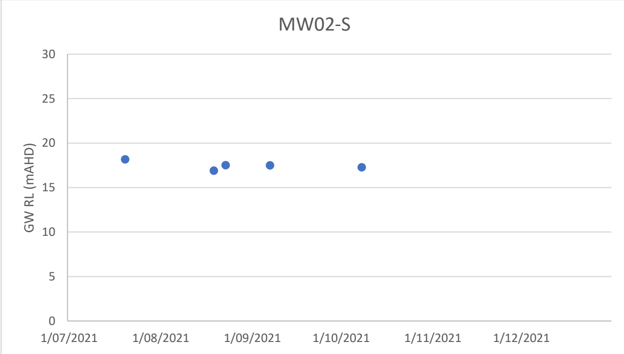
Statistics	MW01	MW02-S	MW02-D	MW03	MW04-S	MW04-D	MW05	MW06-S	MW06-D	MW07	MW08-S	MW08-D	MW09	GW07	GW08	GW11	GW12	GW13	GW14	BH06	BH09	BH101	BH102	BH105	BH112	BH18
Mean	18.10	17.47	16.74	15.78	25.15	25.21	16.94	6.93	6.70	14.87	12.89	10.15	10.74	13.47	12.41	17.19	6.64	19.15	24.62	10.86	6.12	15.26	18.29	6.47	24.33	8.93
Max	18.74	18.17	17.06	16.09	25.21	28.51	17.00	7.33	7.01	14.88	14.55	10.45	11.34	13.68	12.57	17.19	6.64	19.20	24.83	10.86	6.12	15.26	18.29	6.47	24.33	8.93
Min	17.30	16.90	16.31	14.94	25.05	23.47	16.87	6.49	6.27	14.87	12.06	9.76	10.40	13.27	12.26	17.19	6.64	19.11	24.31	10.86	6.12	15.26	18.29	6.47	24.33	8.93

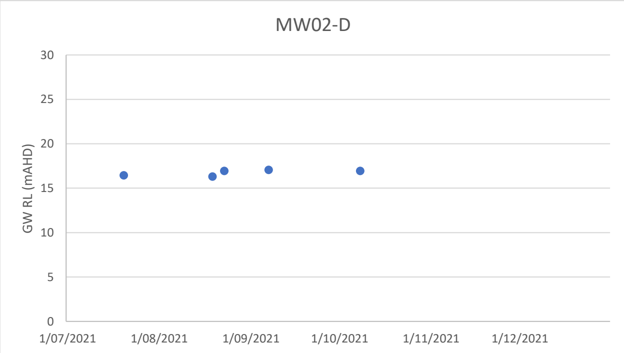
Date	X1 RL mAHD	X3 RL mAHD	X4 RL mAHD	X5 RL mAHD	X6 RL mAHD	X7 RL mAHD	X8 RL mAHD	X10 RL mAHD	X11 RL mAHD	X12 RL mAHD	X13 RL mAHD	X14 RL mAHD	X15 RL mAHD	X17 RL mAHD	X18 RL mAHD	X19 RL mAHD	BH19 RL mAHD	BH20 RL mAHD	BH24 RL mAHD	BH25 RL mAHD	BH26 RL mAHD	BH28 RL mAHD	BH33 RL mAHD	BH34 RL mAHD	BH35 RL mAHD	BH93 RL mAHD
20-Oct-08	1.49	3.81	12.40	12.40	8.48	13.28	8.62	21.22	18.40	24.33	11.03	21.43	34.46	23.07	16.29	10.85	-	-	-	-	-	-	-	-	-	-
19-Nov-08	1.35	3.92	12.32	12.32	7.88	13.04	8.44	20.98	18.19	23.10	10.85	21.31	-	22.72	16.14	10.80	-	-	-	-	-	-	-	-	-	-
22-Dec-08	1.14	3.93	12.24	12.24	7.10	12.92	8.17	20.81	17.97	21.55	10.72	21.20	-	22.40	15.97	10.75	-	-	-	-	-	-	-	-	-	-
21-Jan-09	-	3.75	12.04	12.04	5.86	12.67	7.97	20.52	17.55	-	10.50	21.03	34.44	21.89	15.66	10.59	-	-	-	-	-	-	-	-	-	-
17-Feb-09	-	3.55	11.92	11.92	5.71	12.49	7.76	19.90	17.56	-	10.34	20.94	-	21.66	15.41	10.46	-	-	-	-	-	-	-	-	-	-
17-Mar-09	-	3.30	11.80	11.80	5.39	12.32	7.58	19.79	17.51	-	10.20	20.87	34.45	21.66	15.11	10.34	-	-	-	-	-	-	-	-	-	-
10-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Jul-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
09-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.74	-	-	-	17.01
11-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.01	-	17.88	-	-	-	-	-
12-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.11	-	-	-	-	-	-
17-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18.6	17.89	19.09	-
19-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23-Aug-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
02-Sep-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.63	13.68	-	-	-	-	-	-	-	-
07-Sep-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
08-Oct-21	2.29	2.80	-	-	9.14	-	-	-	18.77	-	-	-	-	-	-	11.27	-	-	-	-	-	-	-	-	-	-
15-Oct-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

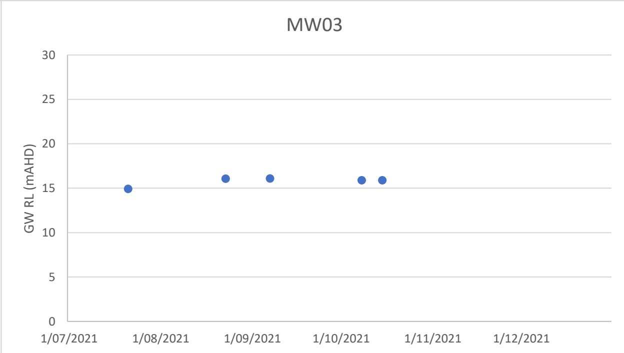
Statistics	X1	X3	X4	X5	X6	X7	X8	X10	X11	X12	X13	X14	X15	X17	X18	X19	BH19	BH20	BH24	BH25	BH26	BH28	BH33	BH34	BH35	BH93
Mean	1.57	3.58	12.12	12.12	7.08	12.78	8.09	20.54	17.99	22.99	10.61	21.13	34.45	22.23	15.76	10.72	14.63	13.68	17.01	17.11	17.88	17.74	18.60	17.89	19.09	17.01
Max	2.29	3.93	12.40	12.40	9.14	13.28	8.62	21.22	18.77	24.33	11.03	21.43	34.46	23.07	16.29	11.27	14.63	13.68	17.01	17.11	17.88	17.74	18.60	17.89	19.09	17.01
Min	1.14	2.80	11.80	11.80	5.39	12.32	7.58	19.79	17.51	21.55	10.20	20.87	34.44	21.66	15.11	10.34	14.63	13.68	17.01	17.11	17.88	17.74	18.60	17.89	19.09	17.01

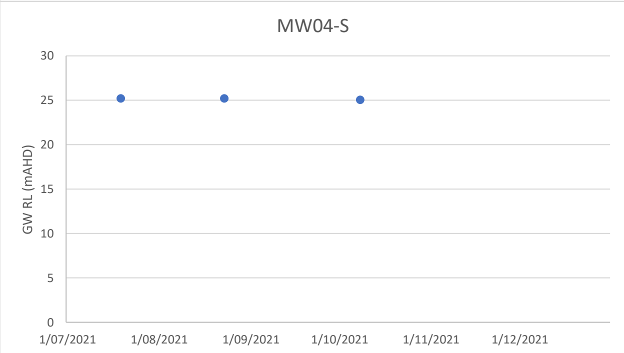
Appendix C – Groundwater Level Hydrographs

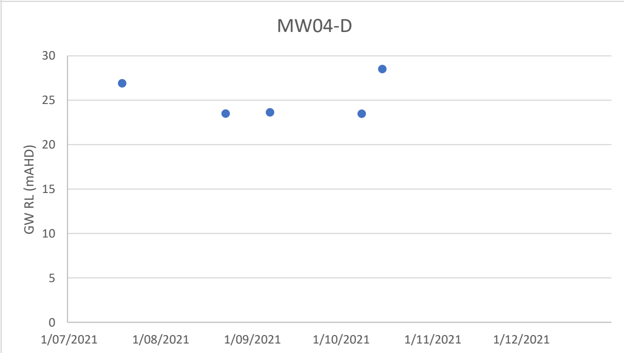

MW01
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

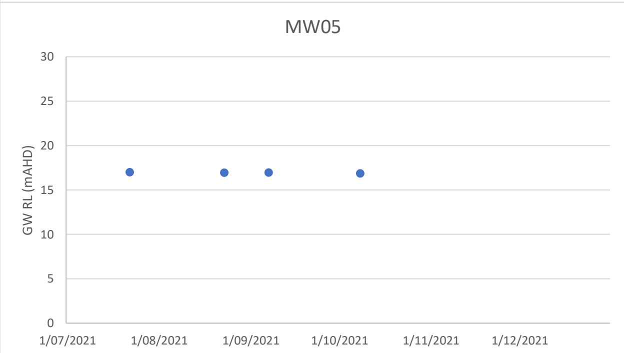

MW02-S
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

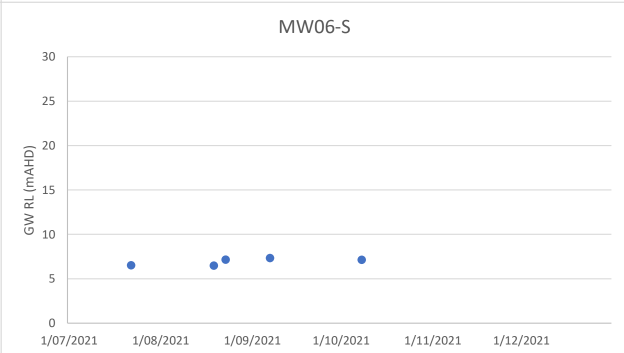

MW02-D
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

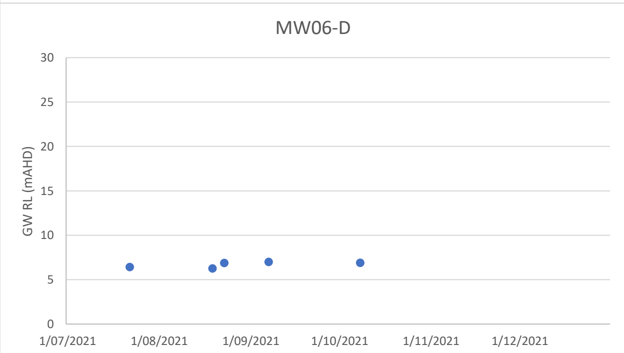

MW03
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

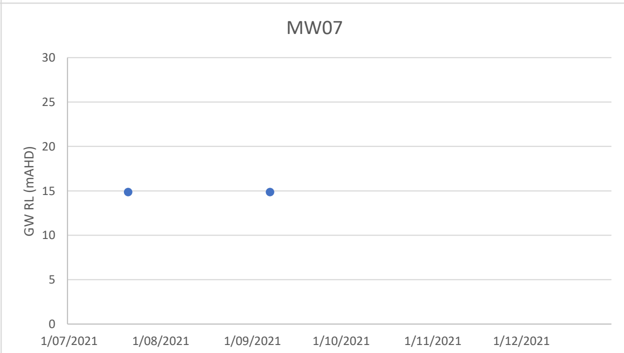

MW04-S
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

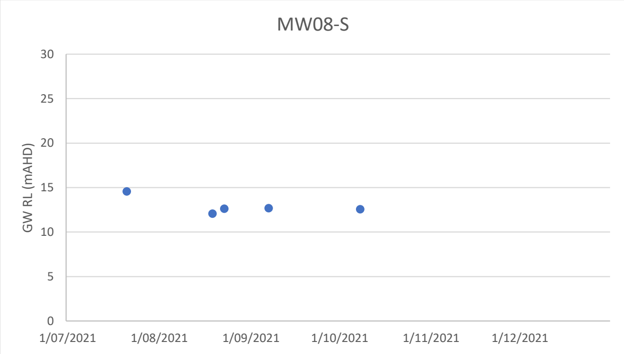

MW04-D
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

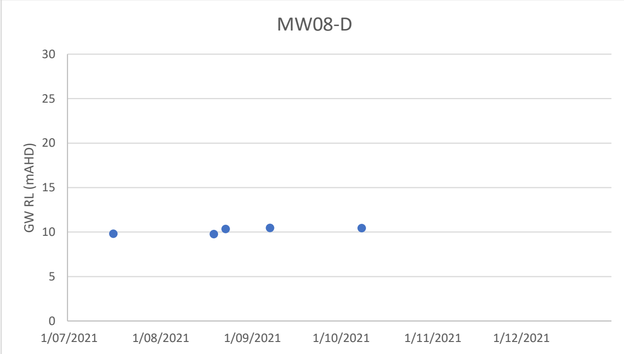

MW05
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

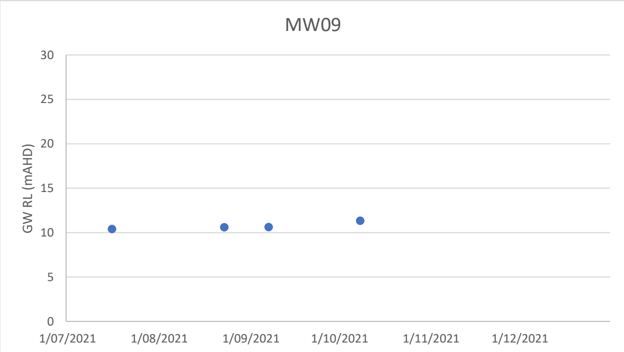

MW06-S
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

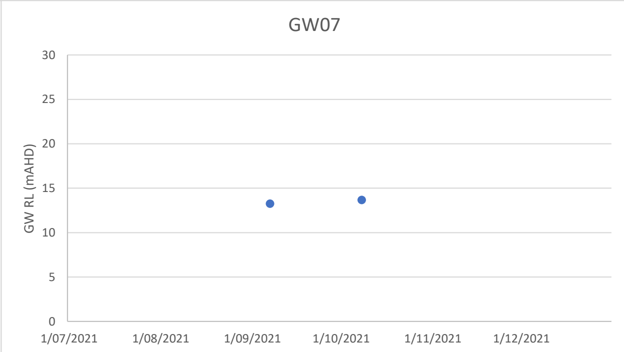

MW06-D
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

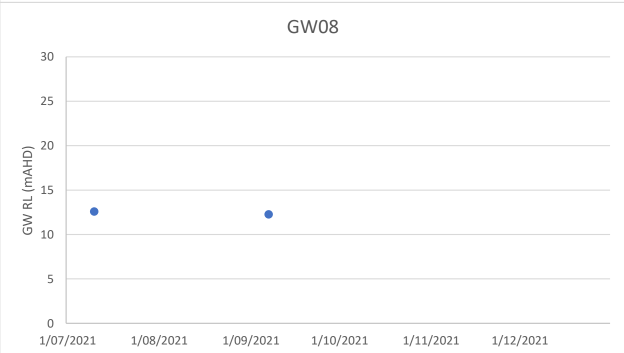

MW07
GW RL (mAHD)
0 5 10 15 20 25 30
1/07/2021 1/08/2021 1/09/2021 1/10/2021 1/11/2021 1/12/2021

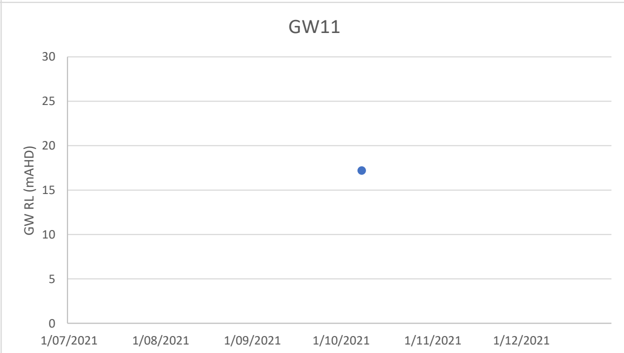

MW08-S
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021

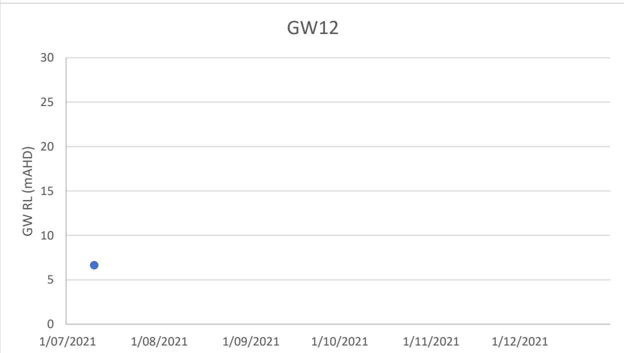

MW08-D
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


MW09
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW07
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW08
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW11
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW12
GW RL (mAHD)
30
25
20
15
10
5
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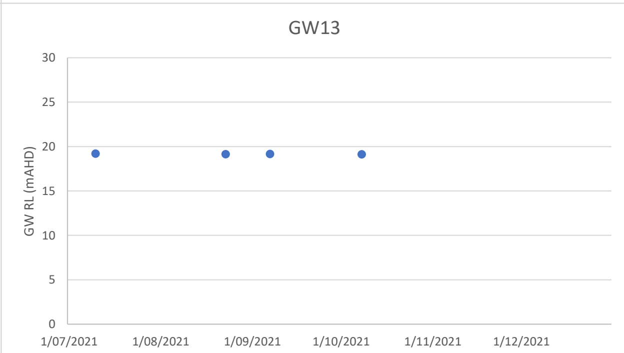
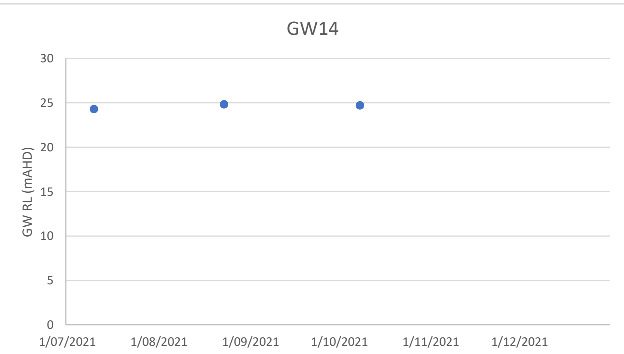
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW13
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


GW14
GW RL (mAHD)
30
25
20
15
10
5
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1/08/2021
1/09/2021
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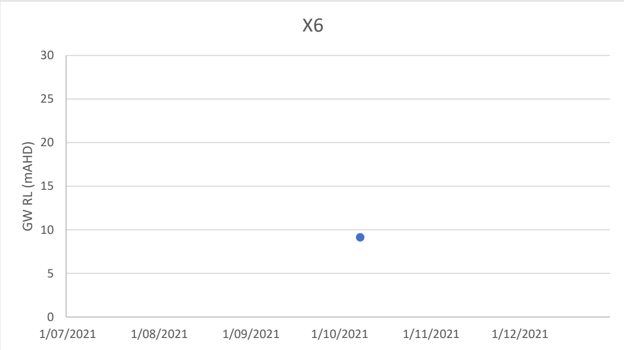
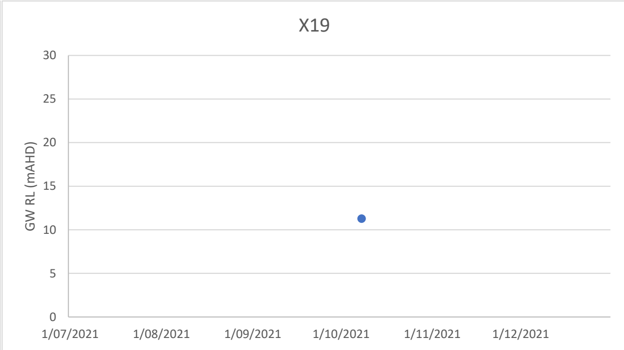
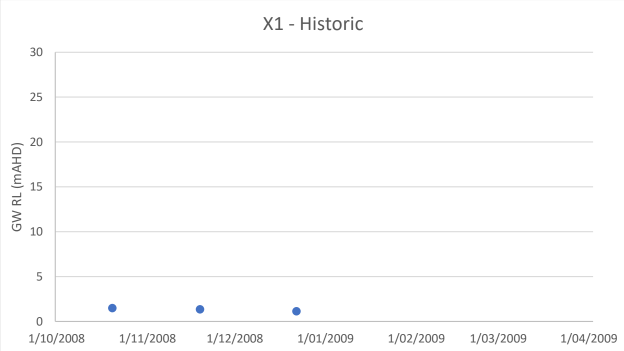
1/11/2021
1/12/2021


X6
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


X19
GW RL (mAHD)
30
25
20
15
10
5
0
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021


X1 - Historic
GW RL (mAHD)
30
25
20
15
10
5
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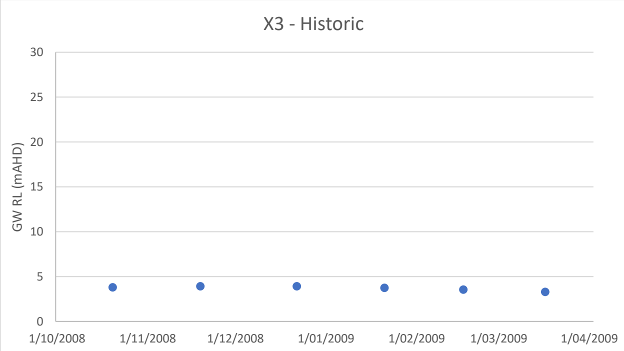
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009


X3 - Historic
GW RL (mAHD)
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25
20
15
10
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1/10/2008
1/11/2008
1/12/2008
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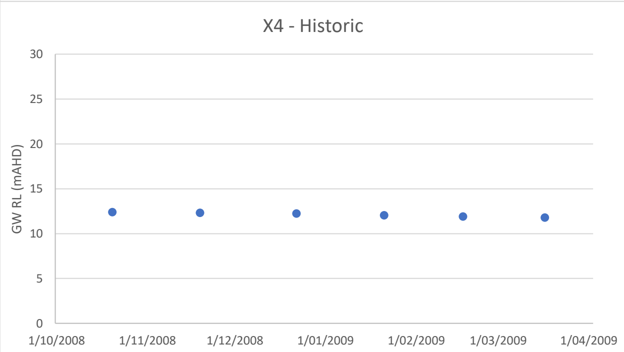
1/03/2009
1/04/2009


X4 - Historic
GW RL (mAHD)
30
25
20
15
10
5
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1/10/2008
1/11/2008
1/12/2008
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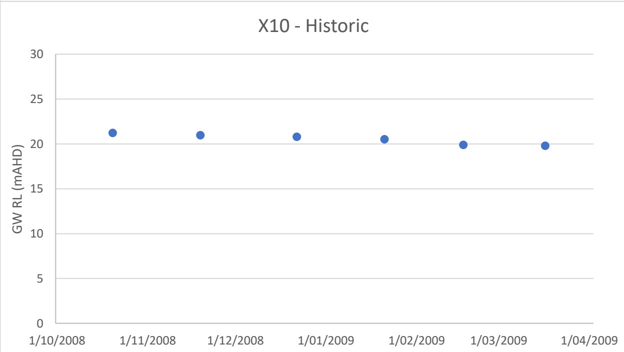
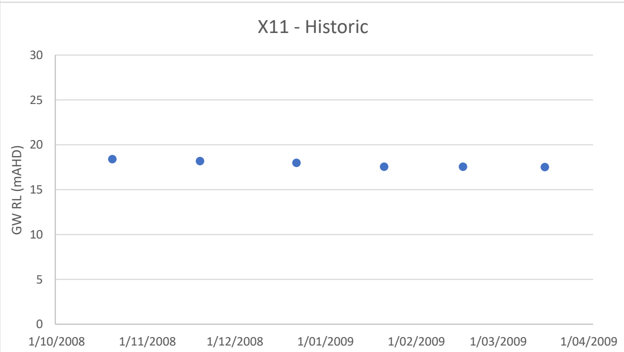
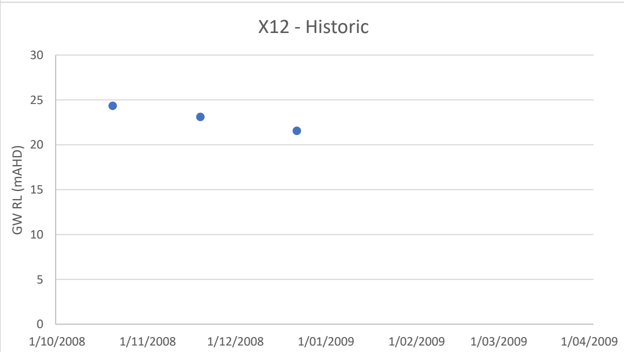
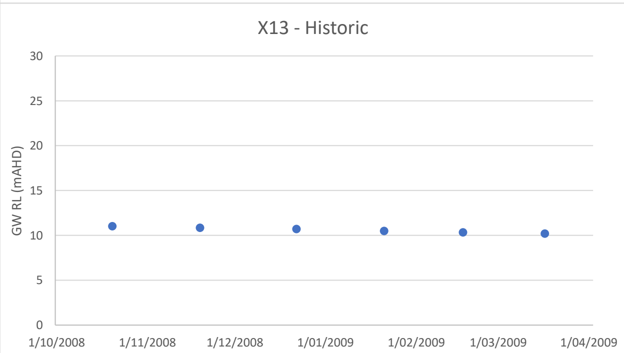
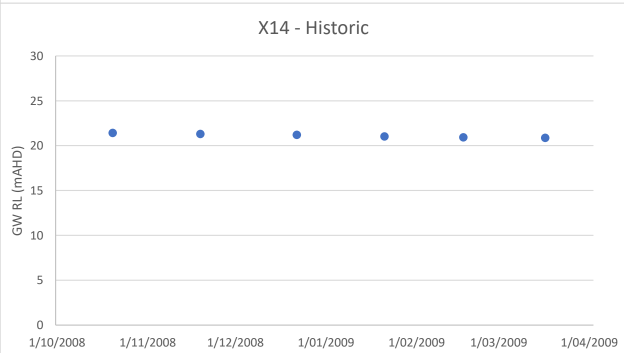
1/03/2009
1/04/2009

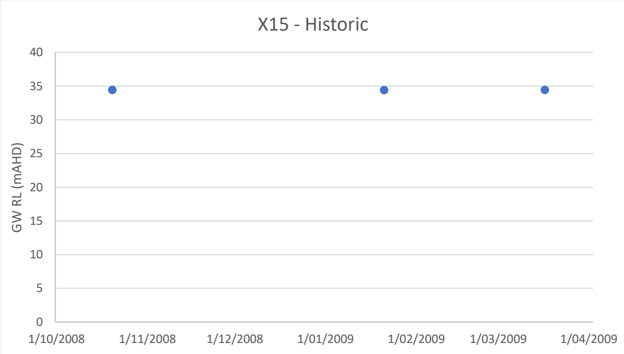

X10 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009


X11 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009

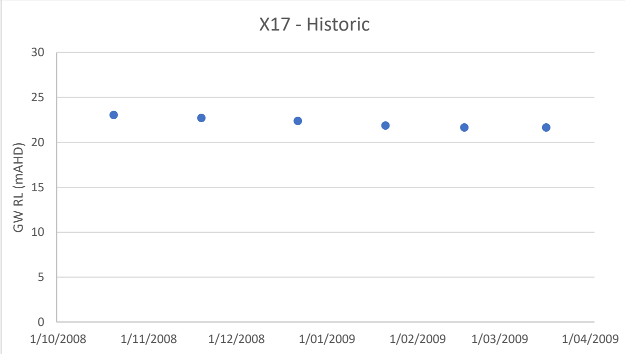

X12 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009


X13 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009

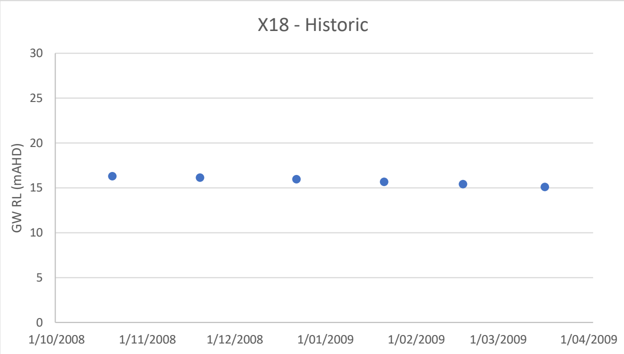

X14 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009



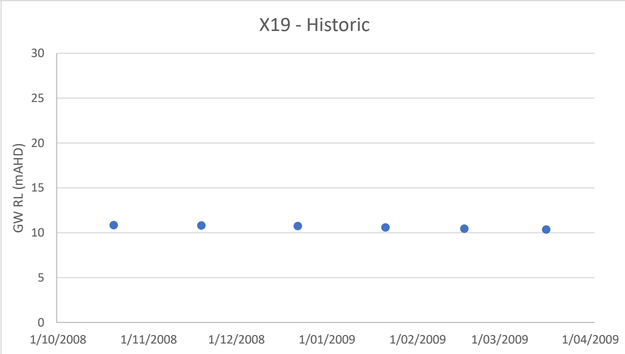
X15 - Historic
GW RL (mAHD)
40
35
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009



X17 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009

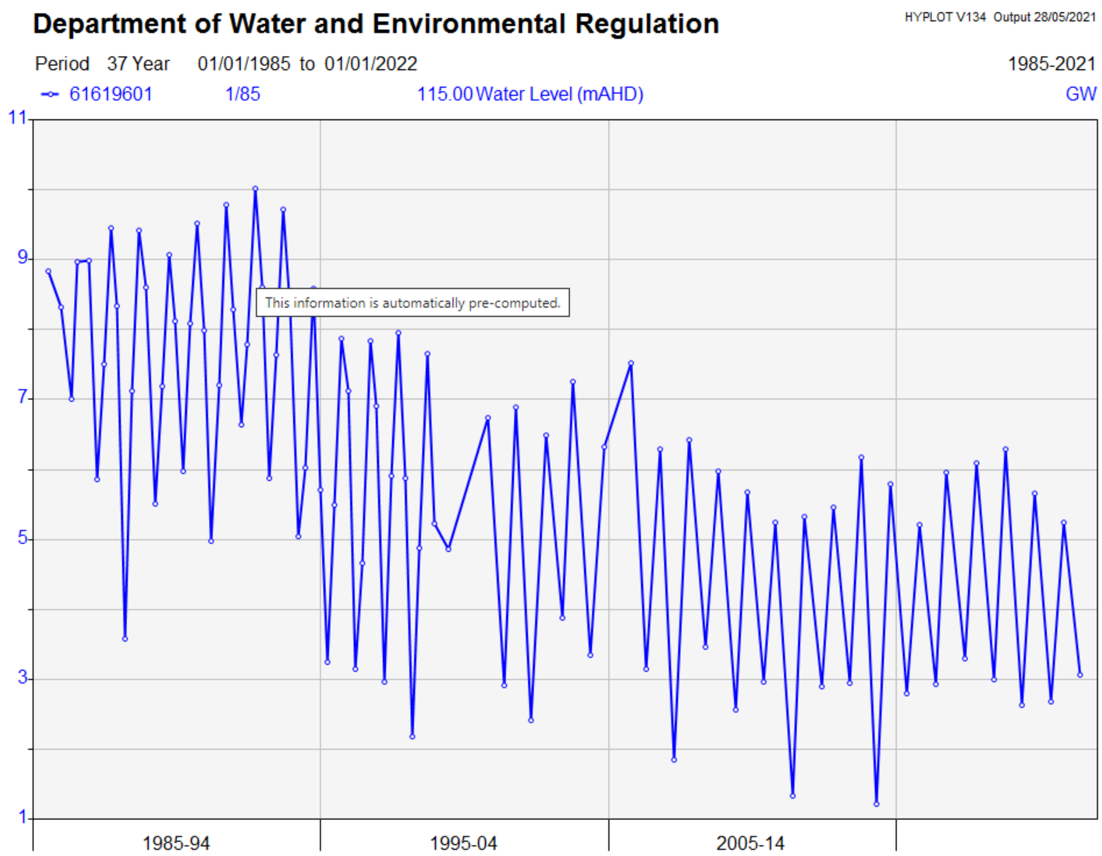


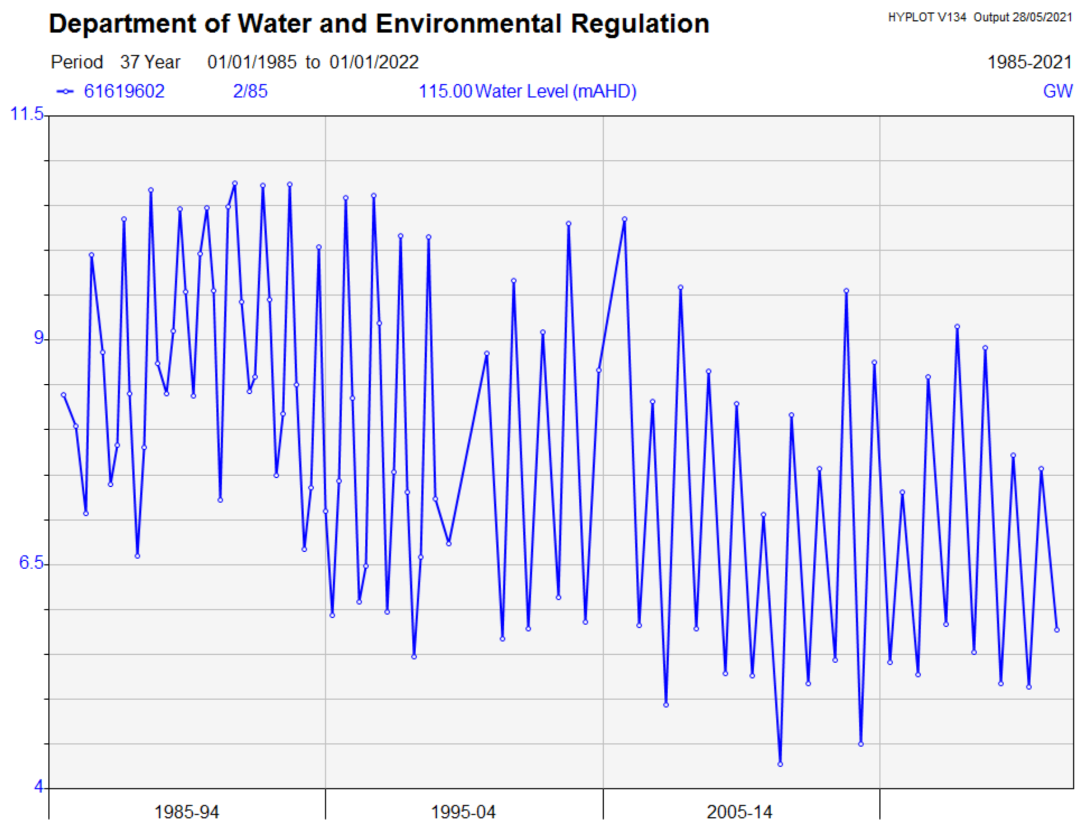
X18 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009

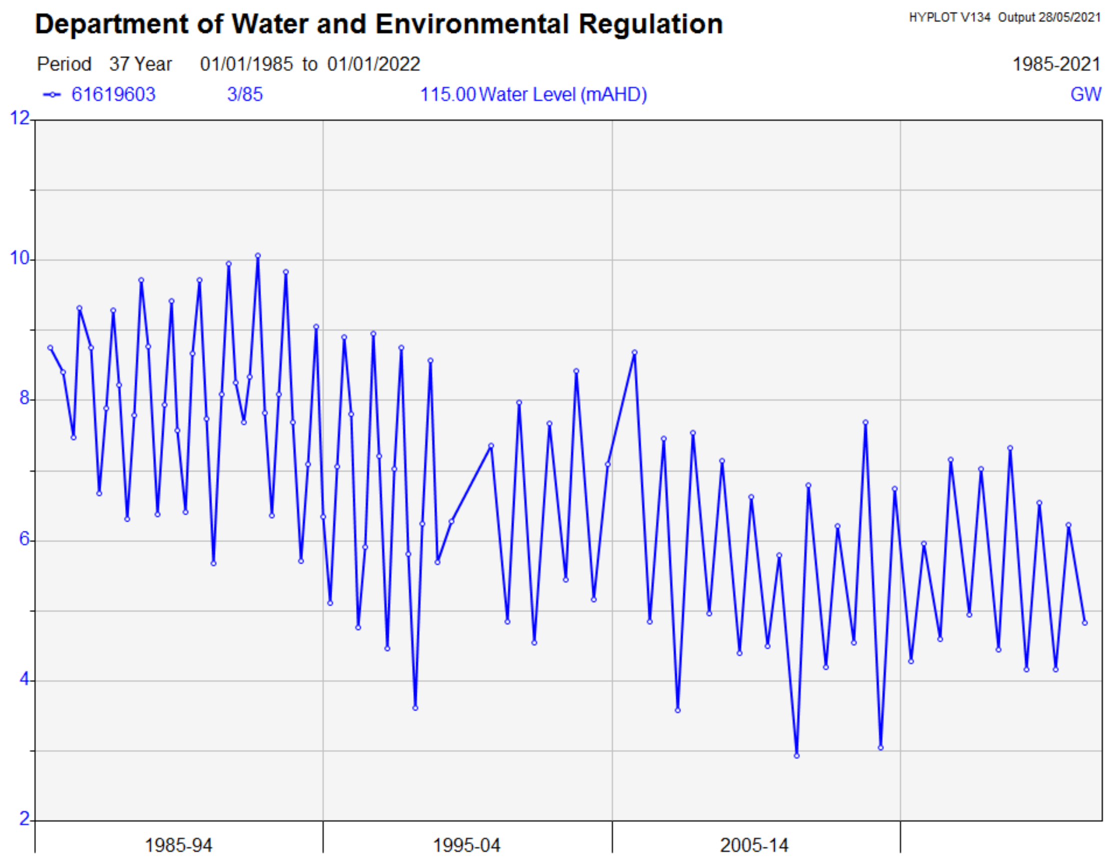


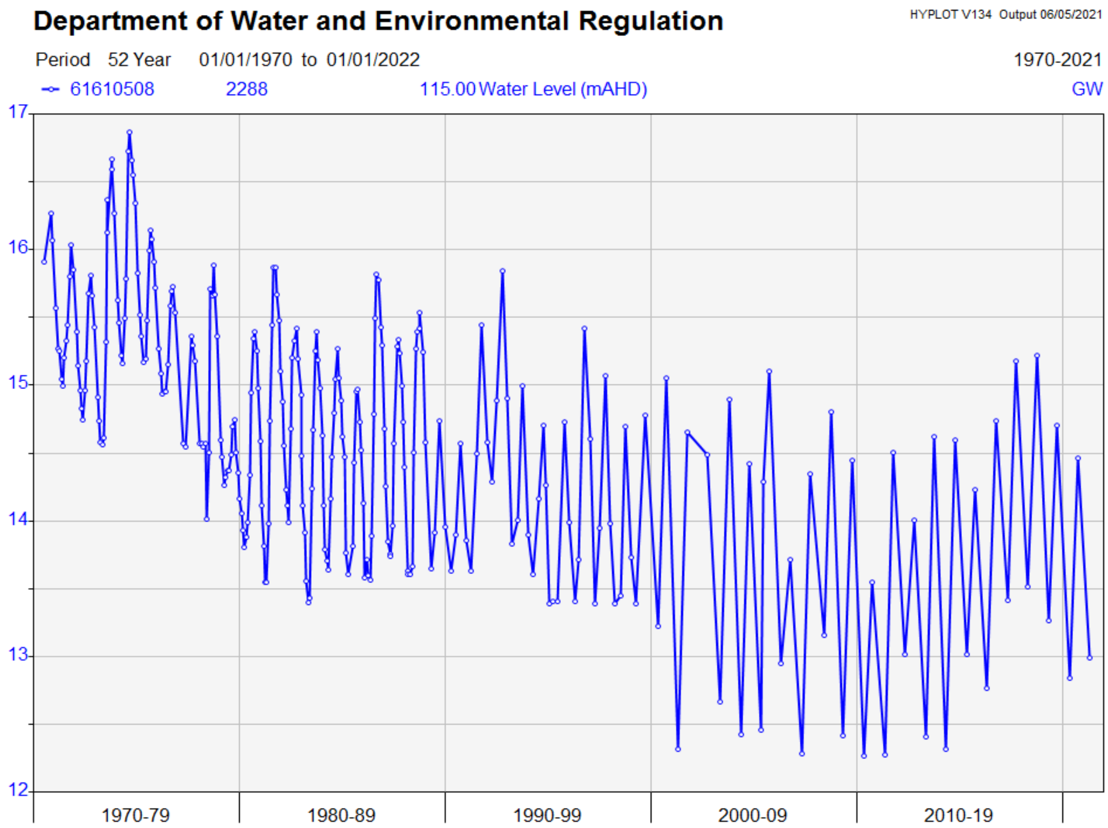
X19 - Historic
GW RL (mAHD)
30
25
20
15
10
5
0
1/10/2008
1/11/2008
1/12/2008
1/01/2009
1/02/2009
1/03/2009
1/04/2009

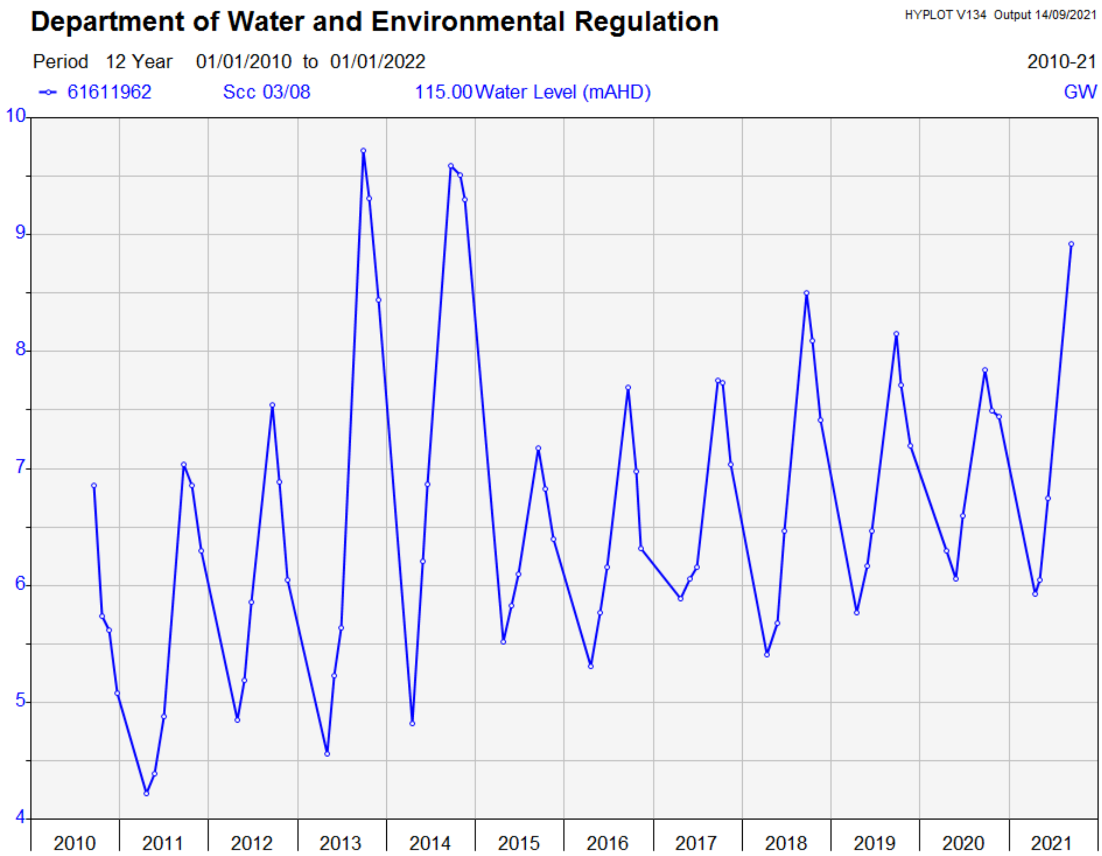
Appendix D – DWER Bore Hydrographs

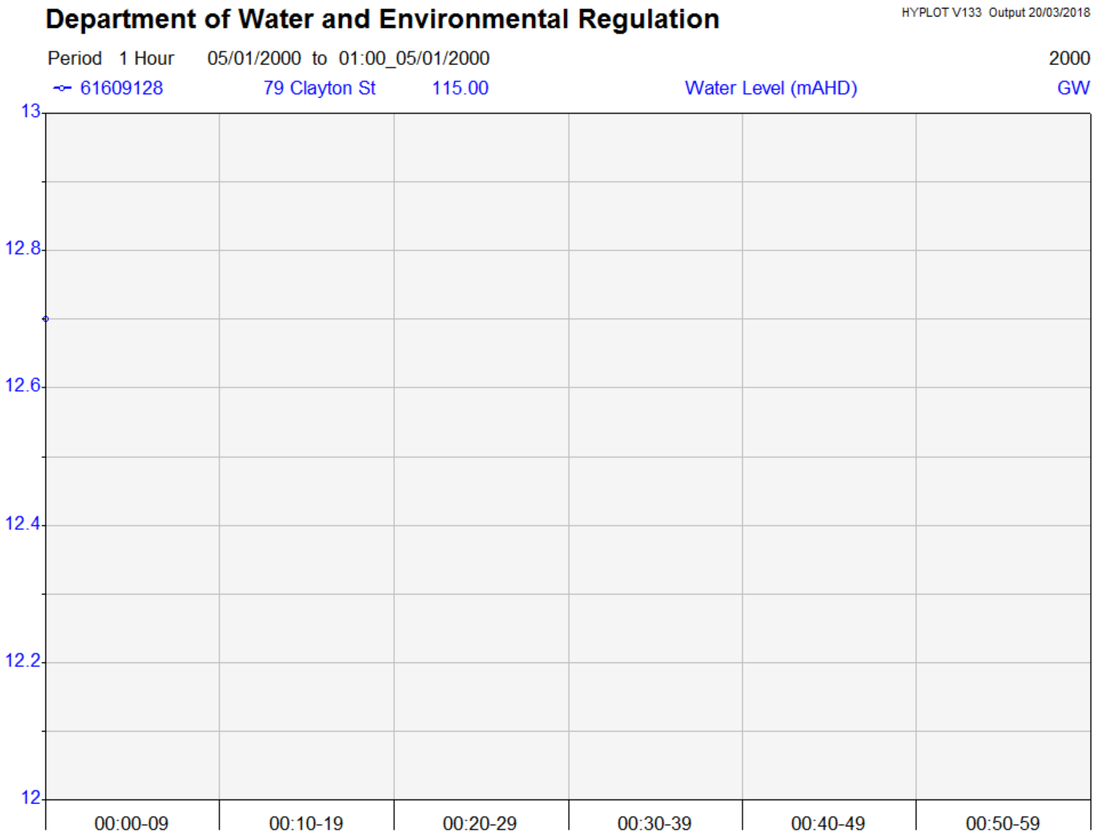


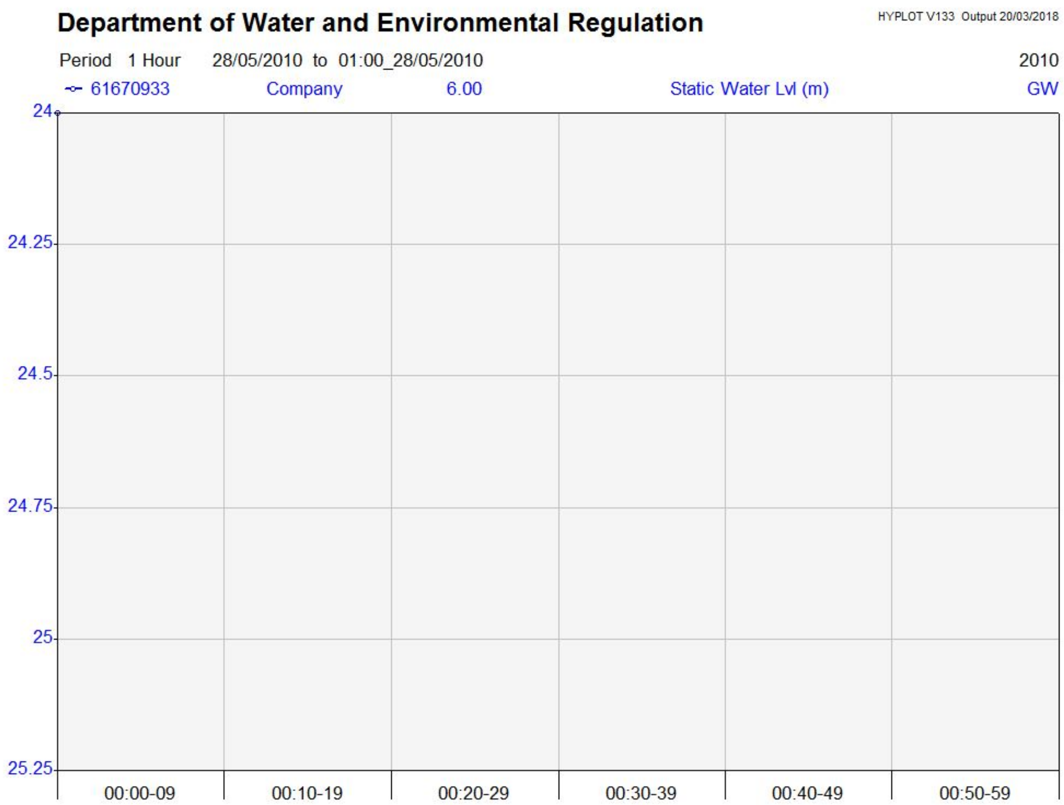

Department of Water and Environmental Regulation
HYPLOT V134 Output 28/05/2021
Period 37 Year 01/01/1985 to 01/01/2022
1985-2021
61619602 2/85 115.00 Water Level (mAHD)
GW
11.5
9
6.5
4
1985-94
1995-04
2005-14

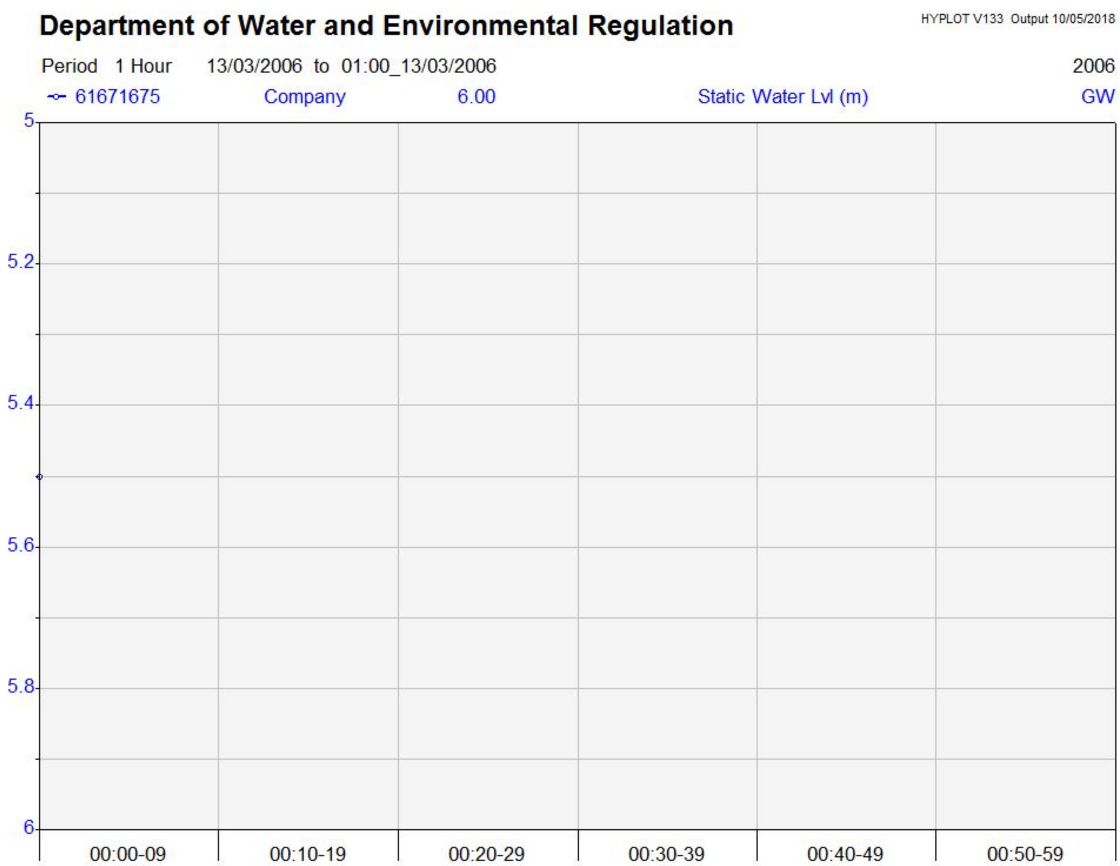

Department of Water and Environmental Regulation
HYPLOT V134 Output 28/05/2021
Period 37 Year 01/01/1985 to 01/01/2022
1985-2021
61619603 3/85 115.00 Water Level (mAHD)
GW
12
10
8
6
4
2
1985-94
1995-04
2005-14

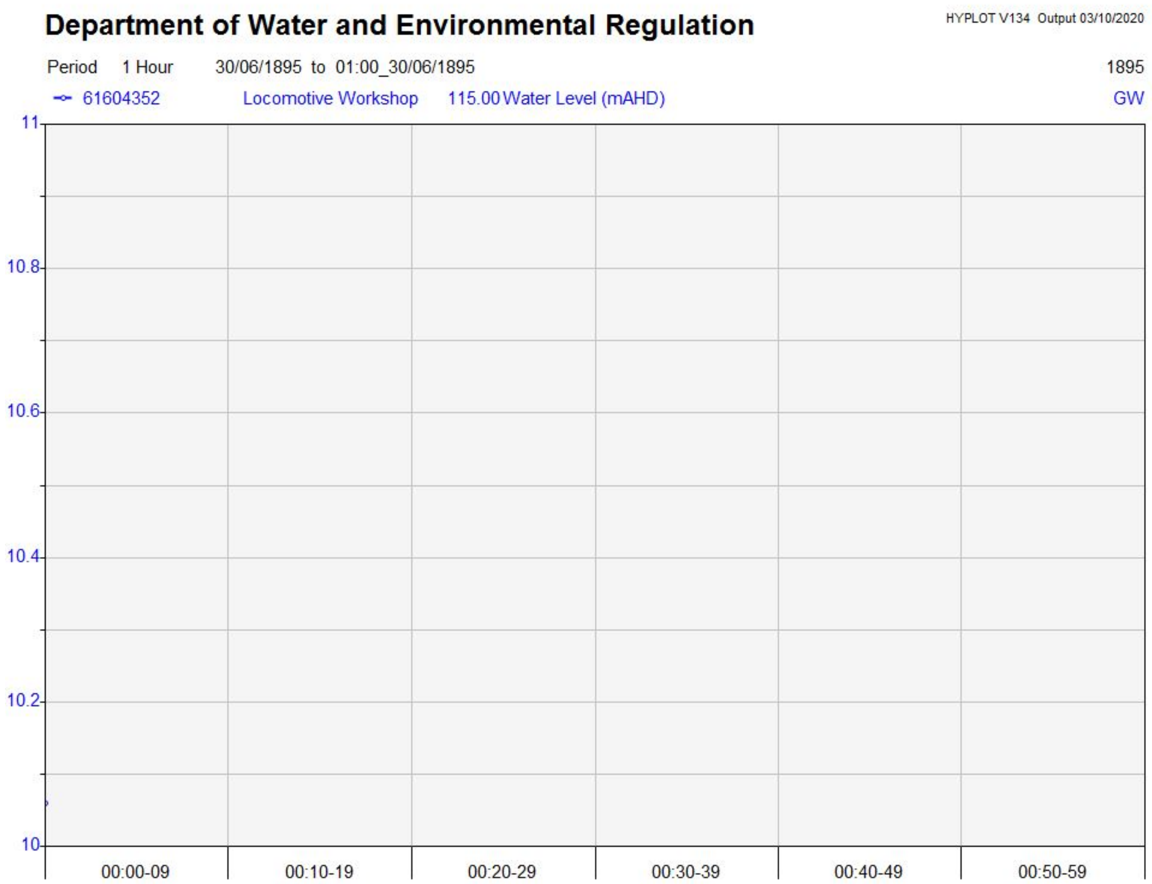

Department of Water and Environmental Regulation
HYPLOT V134 Output 06/05/2021
Period 52 Year 01/01/1970 to 01/01/2022
1970-2021
61610508
2288
115.00 Water Level (mAHD)
GW
17
16
15
14
13
12
1970-79
1980-89
1990-99
2000-09
2010-19

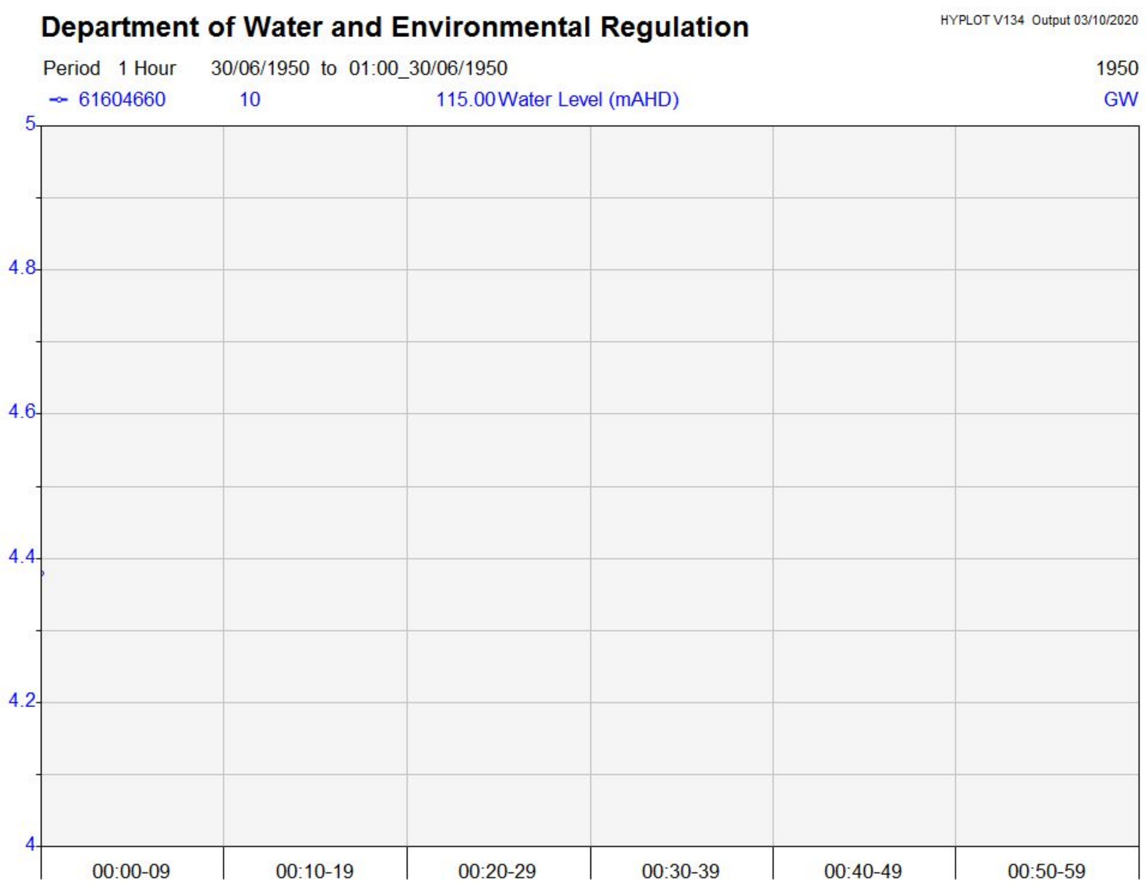

Department of Water and Environmental Regulation
HYPLOT V134 Output 14/09/2021
Period 12 Year 01/01/2010 to 01/01/2022
2010-21
61611962
Scc 03/08
115.00 Water Level (mAHD)
GW
10
9
8
7
6
5
4
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

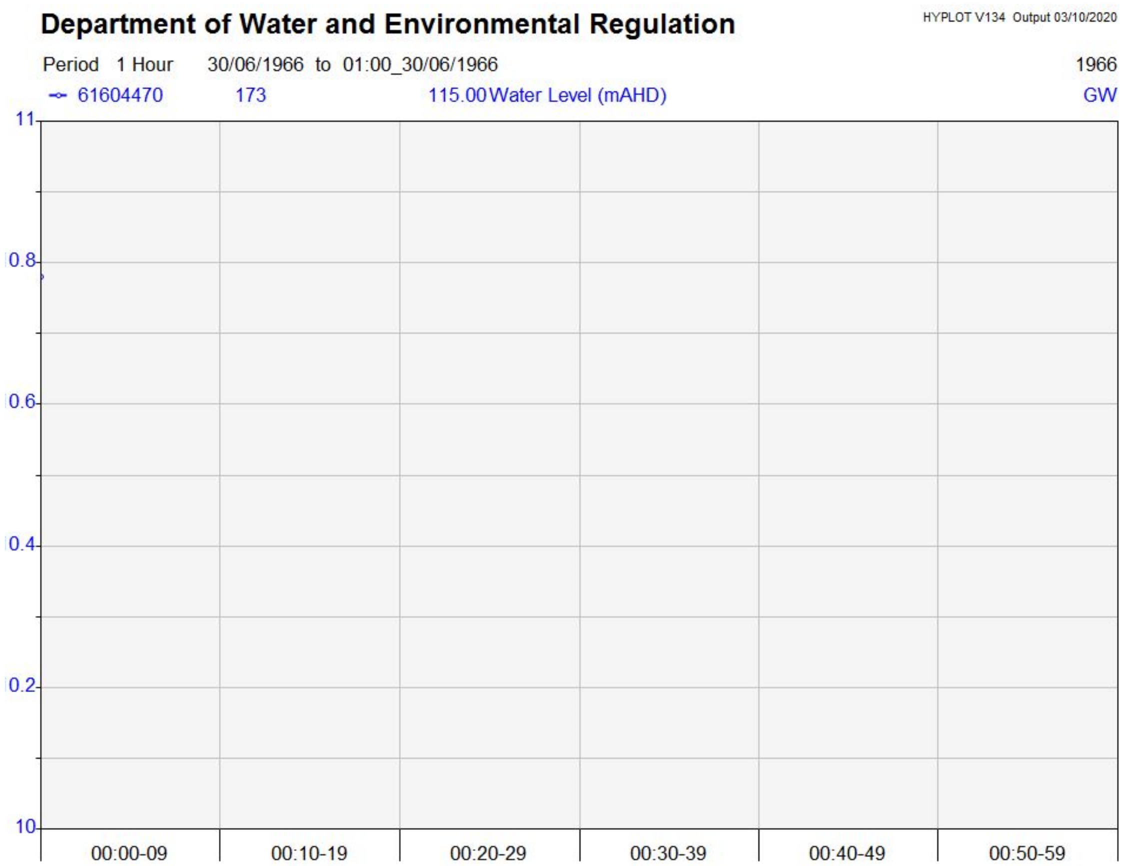

Department of Water and Environmental Regulation
HYPLOT V133 Output 20/03/2018
Period 1 Hour 05/01/2000 to 01:00_05/01/2000
2000
61609128
79 Clayton St
115.00
Water Level (mAHD)
GW
13
12.8
12.6
12.4
12.2
12
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

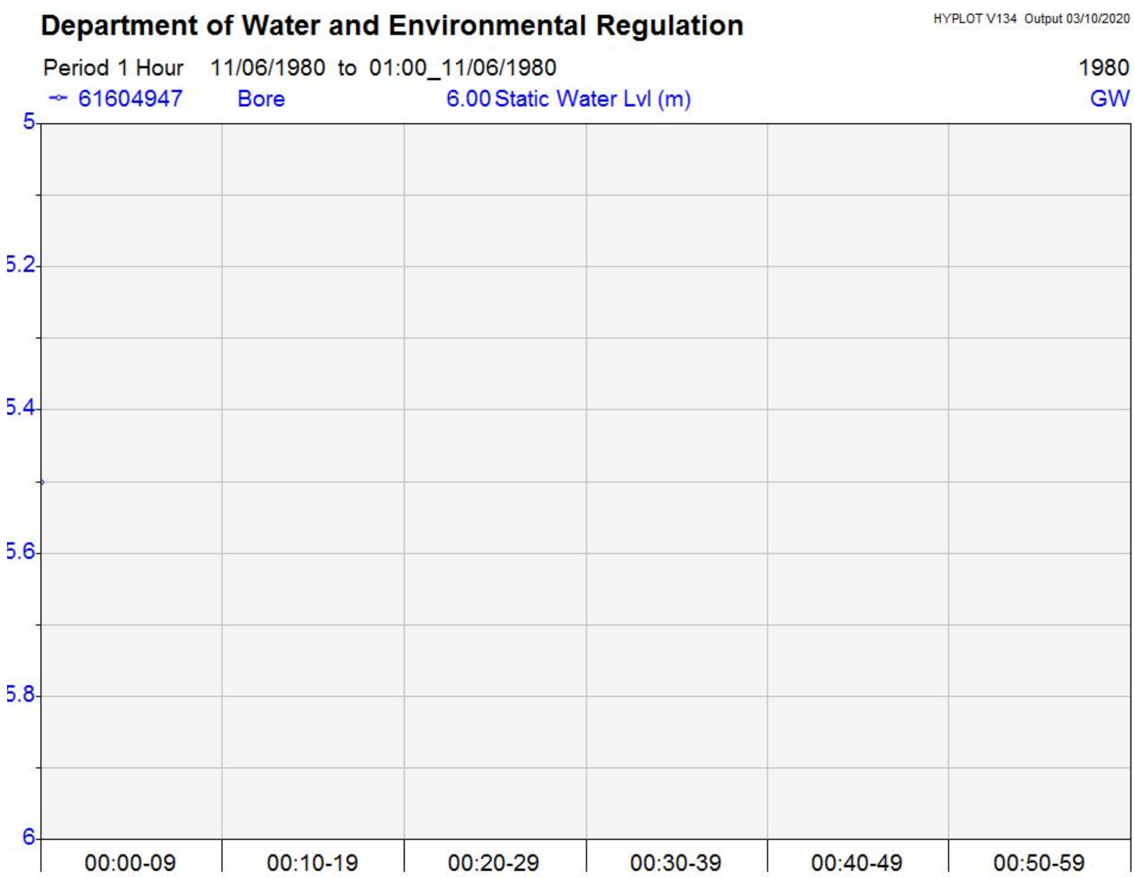

Department of Water and Environmental Regulation
HYPLOT V133 Output 20/03/2018
Period 1 Hour 28/05/2010 to 01:00_28/05/2010
2010
61670933
Company
6.00
Static Water Lvl (m)
GW
24
24.25
24.5
24.75
25
25.25
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

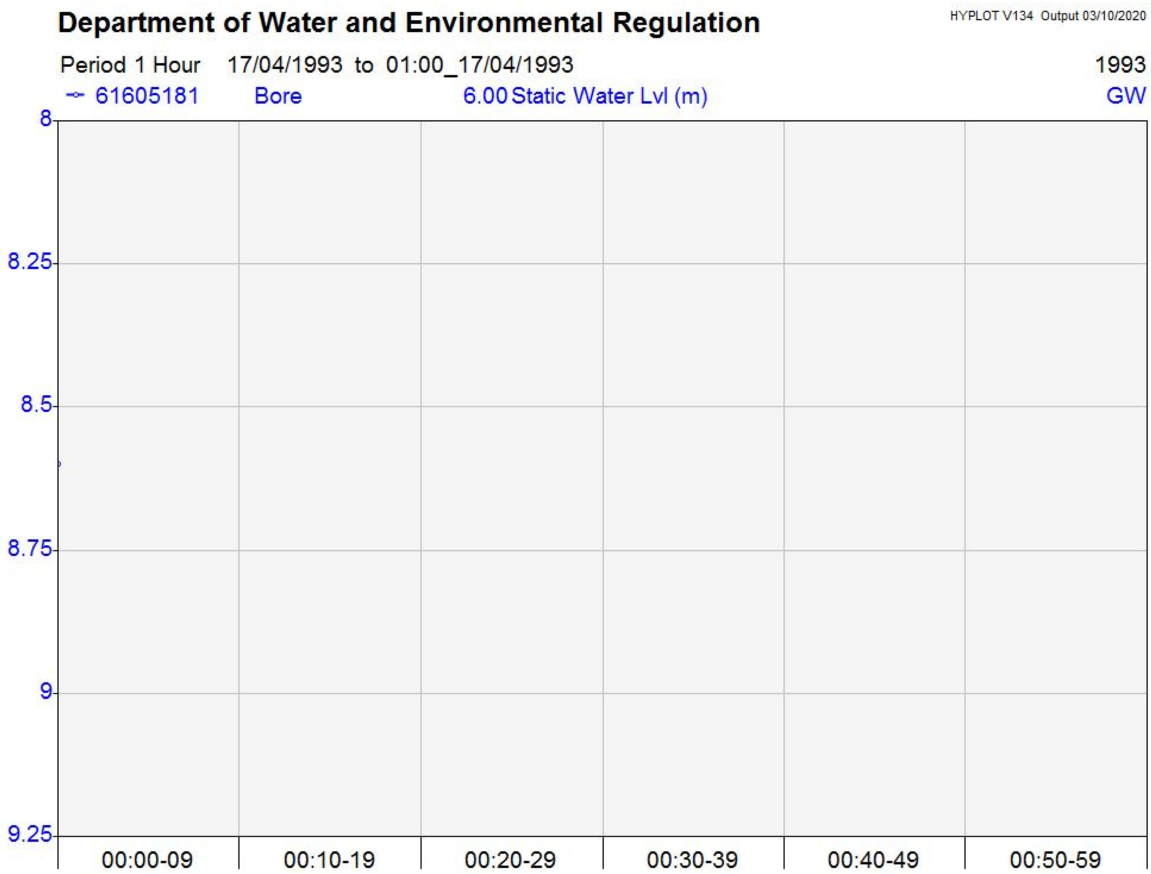

Department of Water and Environmental Regulation
HYPLOT V133 Output 10/05/2018
Period 1 Hour 13/03/2006 to 01:00_13/03/2006
2006
61671675
Company
6.00
Static Water Lvl (m)
GW
5
5.2
5.4
5.6
5.8
6
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

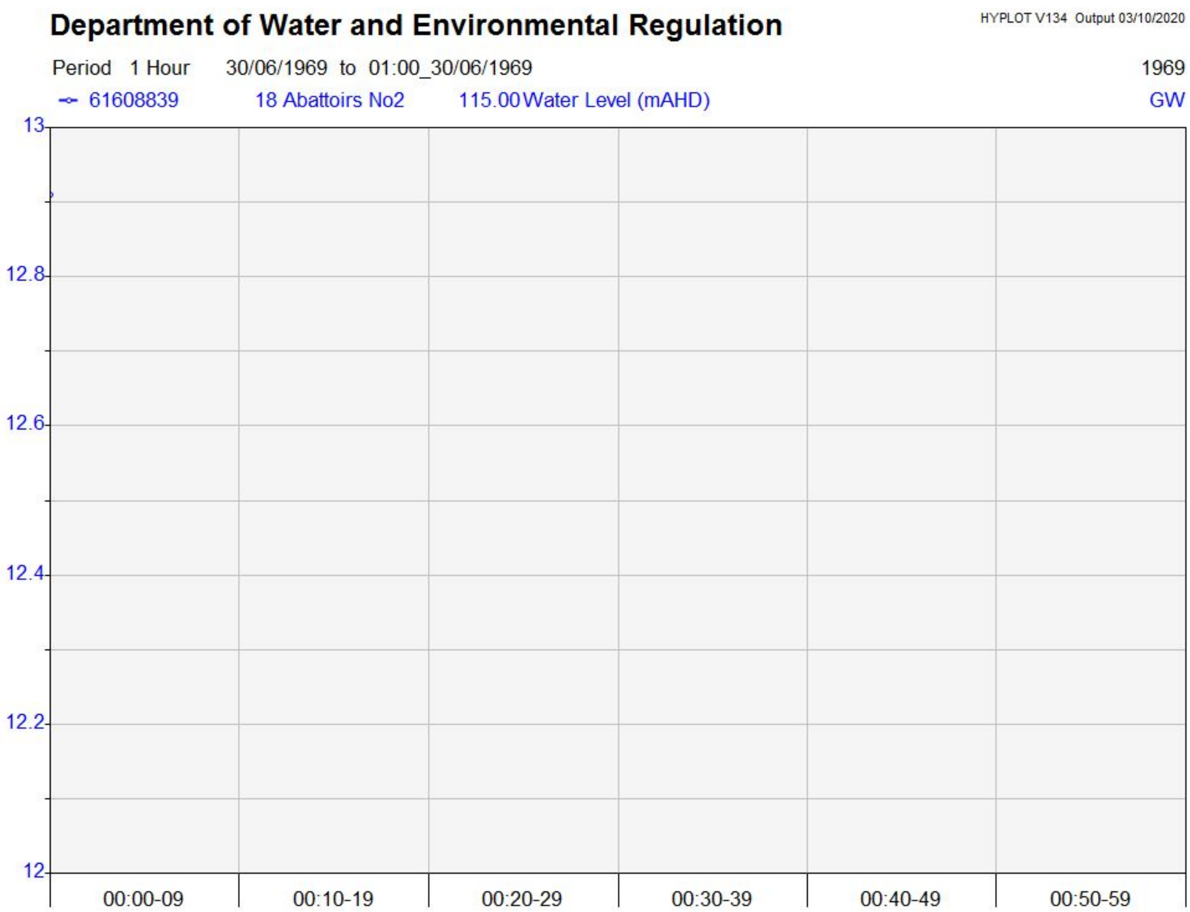

Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 30/06/1895 to 01:00_30/06/1895
1895
61604352
Locomotive Workshop
115.00 Water Level (mAHD)
GW
11
10.8
10.6
10.4
10.2
10
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

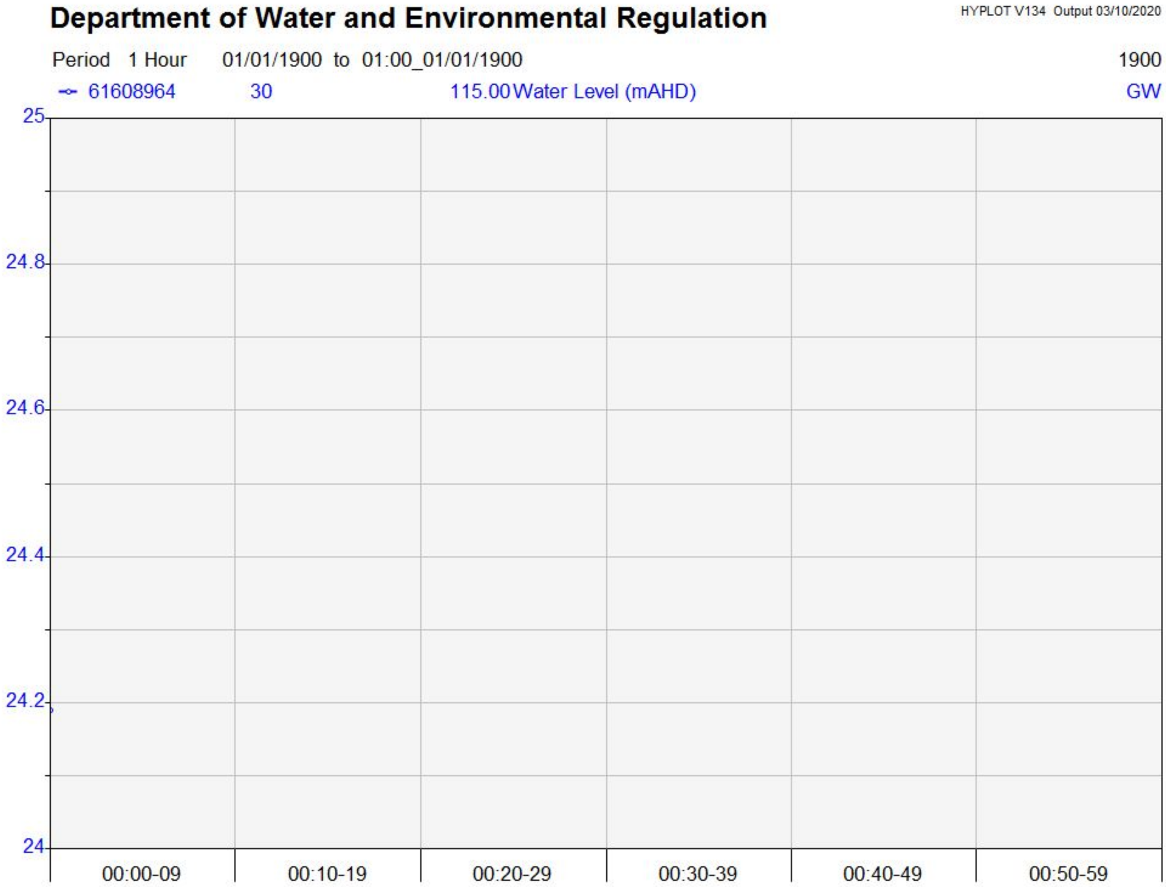

Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 30/06/1950 to 01:00_30/06/1950
1950
61604660
10
115.00 Water Level (mAHD)
GW
5
4.8
4.6
4.4
4.2
4
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

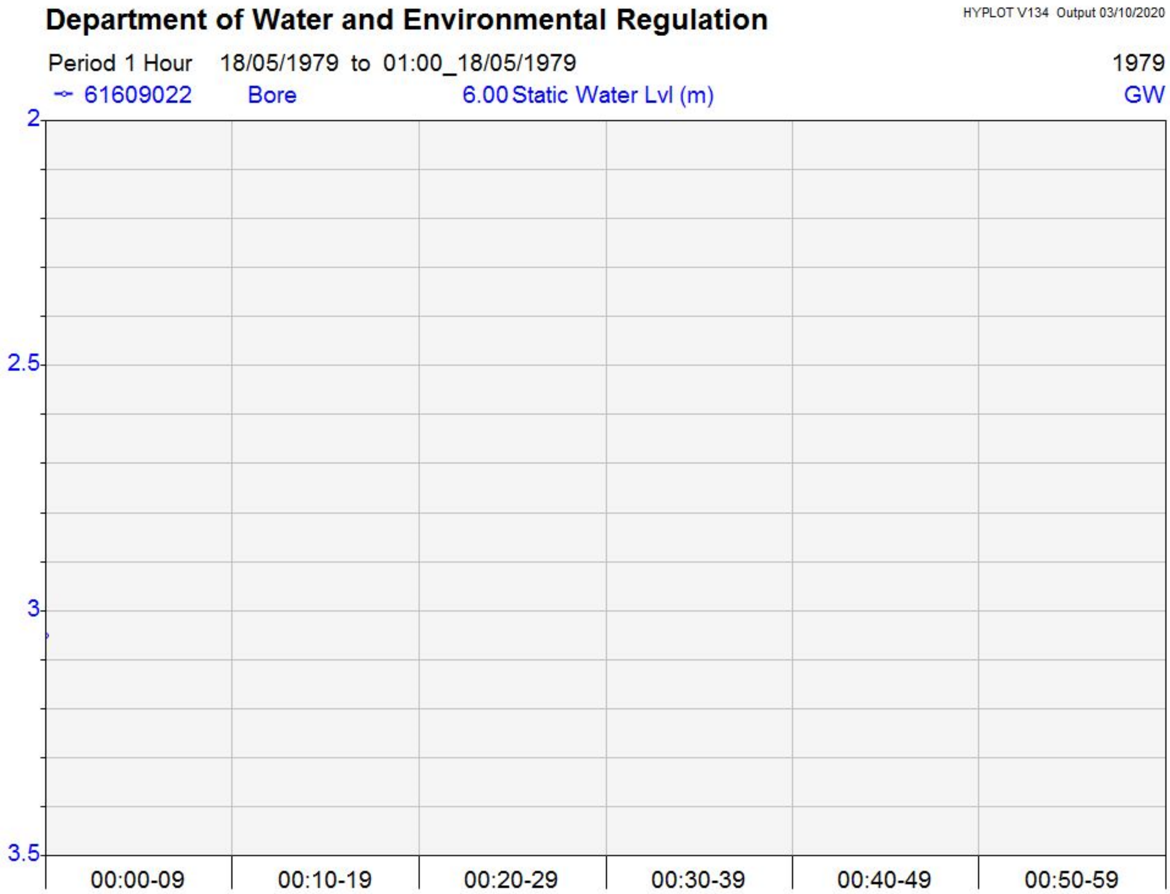

Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 30/06/1966 to 01:00_30/06/1966
1966
61604470
173
115.00 Water Level (mAHD)
GW
11
0.8
0.6
0.4
0.2
10
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

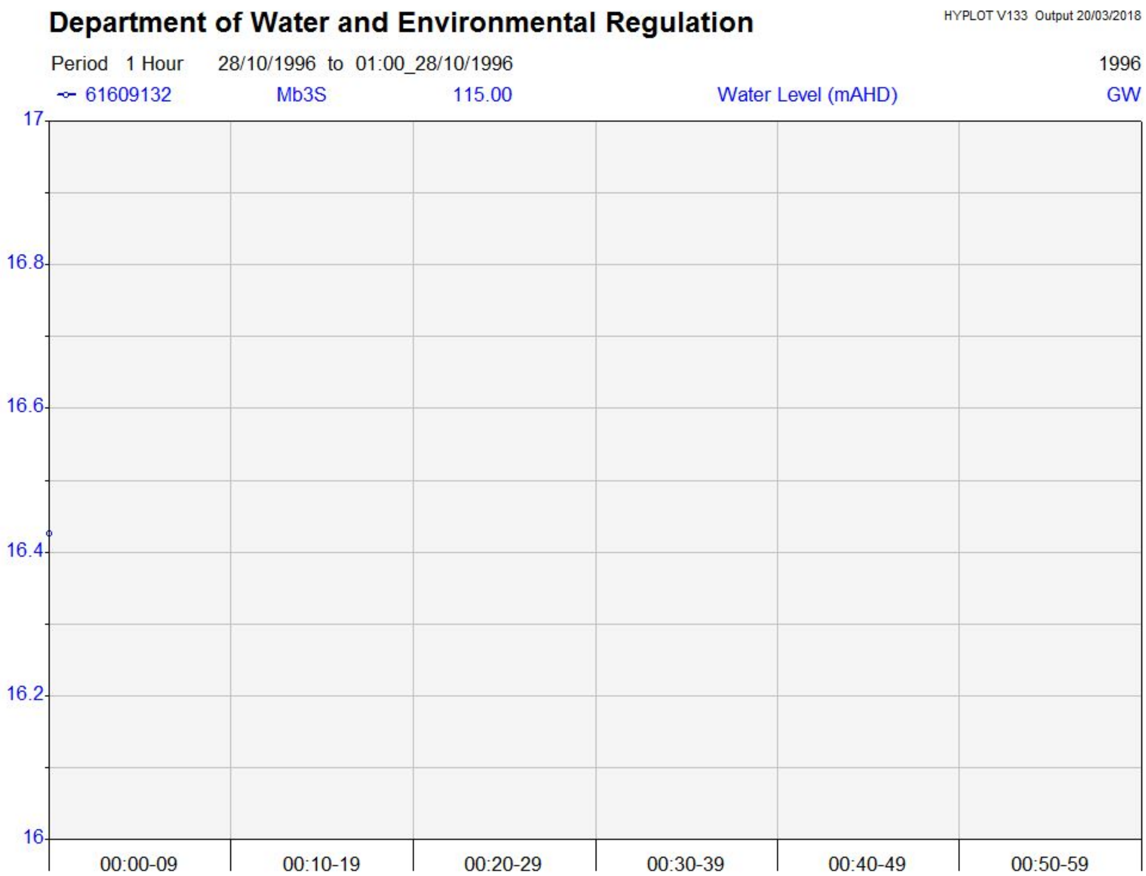

Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 11/06/1980 to 01:00_11/06/1980
1980
61604947
Bore
6.00 Static Water Lvl (m)
GW
5
5.2
5.4
5.6
5.8
6
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59

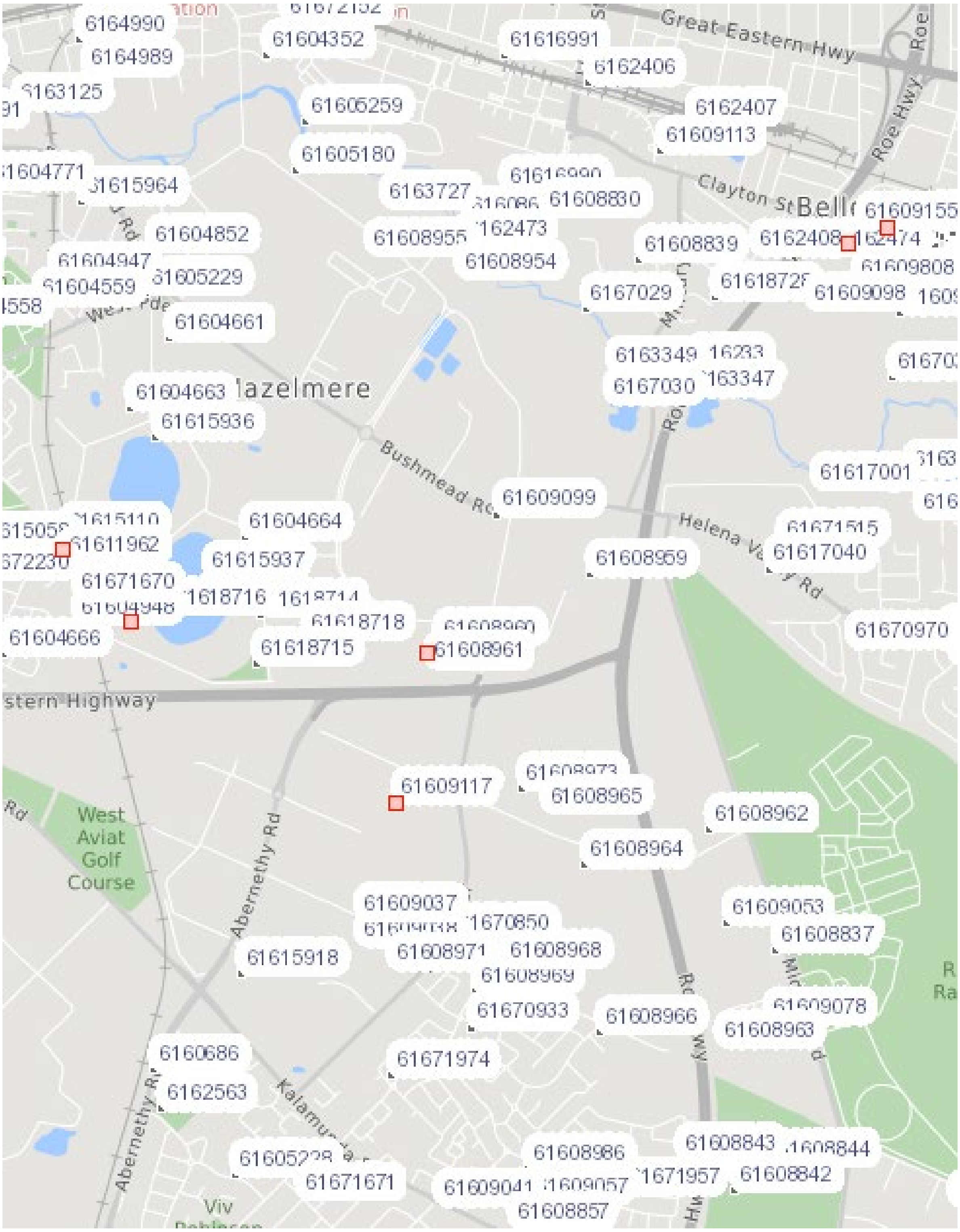

Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 17/04/1993 to 01:00_17/04/1993
1993
61605181 Bore 6.00 Static Water Lvl (m)
GW
8
8.25
8.5
8.75
9
9.25
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59


Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 30/06/1969 to 01:00_30/06/1969
1969
61608839 18 Abattoirs No2 115.00 Water Level (mAHD)
GW
13
12.8
12.6
12.4
12.2
12
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59


Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 01/01/1900 to 01:00_01/01/1900
1900
61608964 30 115.00 Water Level (mAHD)
GW
25
24.8
24.6
24.4
24.2
24
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59


Department of Water and Environmental Regulation
HYPLOT V134 Output 03/10/2020
Period 1 Hour 18/05/1979 to 01:00_18/05/1979
1979
61609022 Bore 6.00 Static Water Lvl (m)
GW
2
2.5
3
3.5
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59


Department of Water and Environmental Regulation
HYPLOT V133 Output 20/03/2018
Period 1 Hour 28/10/1996 to 01:00_28/10/1996
1996
61609132
Mb3S
115.00
Water Level (mAHD)
GW
17
16.8
16.6
16.4
16.2
16
00:00-09
00:10-19
00:20-29
00:30-39
00:40-49
00:50-59



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Appendix E – 15% Report: Responses from External Stakeholders

MAIN ROADS WESTERN AUSTRALIA C197.19
GEHBI - Great Eastern Highway Bypass Intersections Project

Design Pkg Title:	M910 - Groundwater 15% Design Report
Design Report No.:	GEHBI-GCA-RPT-M910-DN-00001
Reviewer/ Verifier:	MRWA
Design Stage:	A1 - 15% Design Review

REVIEWER COMMENT CLASSIFICATION:
O - Observation / Designer to acknowledge
P - Potential Non-Compliance: Moderate issue requires response from Designer
N - Non-Compliance: Significant design deficiencies requires immediate action
D - Deferred to next stage

REVIEW OUTCOME (LEAD REVIEWER TO ASSIGN): B - Accepted with Comments

REVIEW COMMENT/RESPONSE STATUS
O - Open
C - Closed
CA - Closed AGAINST this package (but open in other package)
CS - Closed SUBJECT TO additional action / information

Item	Reviewer (N. Last Name)	Reference (Dwg or Doc.)	Revision	Classification (O, P, N, D)	Reviewer Comment	Date	Comment Accepted?	Designer / Design Consult Response	Design Lead (N. Lastname)	Date	Response Status (O, C, CA, CS)	Reviewer Comment on Response	Date
<------ Reviewer to Fill ------>							<------ Designer to Complete ------>				<------ Reviewer to Complete ------>		
15 % DETAILED DESIGN REVIEW													
1	D. Macri	GEHBI-GCA-RPT-M910-DN-00001	15%	O	Suggest Main Roads Materials Engineering Branch also review, if not already issued.	21-Oct-2021	Accepted	Agreed - Alliance to issue to MRWA MEB	S.Salama	04-Nov-2021	Select		
2	D. Macri	GEHBI-GCA-RPT-M910-DN-00001	15%	O	The report mentions a risk-based approach where groundwater is supposedly above ground level, in which 800 mm cover to existing pavement has been assumed based on current condition. Are these areas being verified as part of the site-based groundwater investigation currently underway?	21-Oct-2021	Accepted	The MGL in these areas will be verified using data from the site investigations	D.Lacey	03-Nov-2021	Select		
3	D. Macri	GEHBI-GCA-RPT-M910-DN-00001	15%	O	In regards to SWTC 4.5(g)(i)(ii), consider clarifying what amount of capillary rise has been considered in the road design and how it has been determined. Has 800 mm been adopted throughout, as per the above comment?	21-Oct-2021	Accepted	The amount of capillary rise to the pavement being considered is 300mm as per the SWTC requirements... The 800mm below pavement surface assumed maximum groundwater level has only been adopted in areas where there is existing pavement infrastructure that does not appear to have any damage from groundwater and where the maximum groundwater level was higher than 800mm below the existing pavement infrastructure surface. It assumes a maximum existing pavement thickness of 500mm and 300mm capillary rise.	S.Salama	04-Nov-2021	Select		

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MAIN ROADS WESTERN AUSTRALIA C197.19
GEHBI - Great Eastern Highway Bypass Intersections Project

Design Pkg Title:	M910 - Groundwater 15% Design Report
Design Report No.:	GEHBI-GCA-RPT-M910-DN-00001
Reviewer/ Verifier:	PAPL
Design Stage:	A1 - 15% Design Review

REVIEWER COMMENT CLASSIFICATION:
O - Observation / Designer to acknowledge
P - Potential Non-Compliance: Moderate issue requires response from Designer
N - Non-Compliance: Significant design deficiencies requires immediate action
D - Deferred to next stage

REVIEW OUTCOME (LEAD REVIEWER TO ASSIGN): Select

REVIEW COMMENT/RESPONSE STATUS
O - Open
C - Closed
CA - Closed AGAINST this package (but open in other package)
CS - Closed SUBJECT TO additional action / information

Item	Reviewer (N. Last Name)	Reference (Dwg or Doc.)	Revision	Classification (O, P, N, D)	Reviewer Comment	Date	Comment Accepted?	Designer / Design Consult Response	Design Lead (N. Lastname)	Date	Response Status (O, C, CA, CS)	Reviewer Comment on Response	Date
<------------------------------------ Reviewer to Fill ------------------------------------>							<-------------------- Designer to Complete -------------------->				<-------------------- Reviewer to Complete -------------------->		
15 % DETAILED DESIGN REVIEW													
1	G Cooper	M910-Groundwater 15% Design Report	A1	O	Perth Airport (PAPL) commissioned a groundwater model for the airport estate and surrounding groundwater catchments to help predict groundwater levels across the estate for existing development conditionas and a future development scenario. The report was delivered in November 2020. PAPL has an extensive range of monitor bores across the estate, some with long periods of constant monitoring. The resultant groundwater contours, both recent and predicted maximum could be provided to GCA to complement or compare your own findings		Accepted	We now have this model report and will use it to inform our report as PAPL suggests	D.Lacey	22-Oct-2021	Select		
				Select							Select		
				Select							Select		
				Select							Select		
				Select							Select		
				Select							Select		
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				Select							Select		
				Select							Select		

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ALLIANCE