Westhaven Residential Development Fast-track Substantive Application – Groundwater Level Assessment

Prepared for

Carter Group Limited

22 October 2026

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Limitations:

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Executive Summary

Carter Group Limited (CGL) is proposing to develop an approximately 263 ha area of land to the west of Rolleston Township, between State Highway 1 and Selwyn Road, for residential and commercial use. To inform stormwater design, the highest groundwater level across the development area has been estimated.

Four groundwater level monitoring bores (BH-001 through BH-004) were drilled in the southern part of the development area (Skellerup South Block) in April 2026 and monitoring of groundwater levels in these bores using pressure transducers has been occurring since the bores were installed. A piezometric survey was carried out in July 2026 utilising the new monitoring bores and 14 additional bores situated at and in proximity of the development area. The survey data was used to create groundwater contours over and adjacent to the development area representative of the groundwater elevation on the day of the survey. Based on these contours, LiDAR ground elevation data was used to estimate a depth to groundwater surface for the day of the survey.

Long-term groundwater level monitoring bore M36/0465 is situated in close proximity to the site. Groundwater levels have been monitored in this bore by ECan since June 2000. A good correlation is evident between the record in M36/0465 and the recent groundwater level data that is being collected in BH-001 through BH-004. As a result, the data record from M36/0465 was used to carry out regression analyses in onsite bores BH-001 through BH-004 and create long-term synthetic groundwater level records in the onsite bores.

The synthetic records in BH-001 through BH-004 were used to predict the highest groundwater level in these bores. Estimates of the highest groundwater level in the additional 14 bores included in the July 2026 piezometric survey were also made assuming that those bores experience the same level of groundwater level fluctuations observed in M36/0465. Based on these highest estimated groundwater levels, additional groundwater elevation contours were created to represent the highest expected groundwater elevation at and within proximity to the site. This surface was then used, together with LiDAR data to create a depth to groundwater surface representative of the shallowest groundwater conditions.

The results of this investigation indicate that the depth to groundwater is greatest in the north (Holmes Block), with the depth to groundwater under the highest groundwater conditions predicted to vary between approximately 10.5 and 7 m below ground level in the north. In the southern development area the highest predicted groundwater level is expected to vary between approximately 6.5 m bgl in the north of the Brookside Block to 1.5 m bgl in the south of the Skellerup South Block.

1.0 Introduction

Carter Group Limited (CGL) has engaged Pattle Delamore Partners (PDP) to carry out a groundwater level assessment relating to the proposed Westhaven Residential Development subdivision which will be constructed at the western outskirts of Rolleston township. CGL is applying for a substantive application for approvals under the Fast-track Approvals Act 2024 (FTAA) for the proposed subdivision. The Project is a listed project under Schedule 2 of the FTAA, which is referenced in Schedule 2 as the 'Rolleston West Residential Development'. To inform stormwater design, CGL has requested that PDP provides an estimate of the highest expected groundwater level across the development area. The location of the proposed subdivision is shown in Figure 1.

As shown in Figure 1, the development is split into various blocks. The Holmes Block is situated in the north between Main South Road and Burnham School Road. There is a gap between the Holmes Block and the areas to the south which incorporate the Brookside, Skellerup, and Skellerup South blocks. Westhaven Stage 1 is currently being developed within the eastern extents of the Skellerup Block and therefore this area is excluded from the Fast Track application.

Figure 1 also shows the locations of four newly drilled monitoring bores installed at the site (BH-001 through BH-004), in addition to the location of long-term Environment Canterbury (ECan) groundwater level monitoring bore M36/0465 (30.5 m deep), which is situated approximately 1 km west of Edwards Road.

To estimate groundwater levels across the site (including the highest expected groundwater levels), PDP reviewed details for shallow bores situated within approximately 1.5 km of the site. Based on this review, suitable bores were selected to carry out a piezometric survey across the site and wider area. The piezometric survey data was used, together with records from ECan bore M36/0465, to estimate the highest expected groundwater level surface over the subdivision area.

The investigation is summarised in this report and relevant groundwater elevation and depth to groundwater surfaces are estimated and presented. Curricula Vitae for the PDP staff that prepared this report are provided in Appendix A.

Expert Witness Code of Conduct

This assessment has been prepared in accordance with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. The authors confirm that they have read that Code and agree to comply with it. In that regard, the authors confirm that this Report is written within their expertise, except where stated that the authors are relying on the assessment of others. The authors confirm that they have not omitted to consider material facts known to them that might alter or detract from the opinions expressed.



Figure 1: Site Setting

2.0 Onsite Monitoring Bores and Groundwater Level Monitoring

Pro-Drill Limited (Pro-Drill) installed four groundwater monitoring bores (BH-001 through BH-004) in the southern part of the proposed development area (within the Skellerup and Skellerup South block areas) at the site between 2 April and 8 April 2026. Bores BH-001 through BH-003 were all drilled to depths of 10.6 m below ground level (bgl), while Bore BH-004 was drilled to 15.2 m bgl. Details for the bores are provided in Table 1 and the Pro-Drill logs are included in Appendix B. We note we do not have details for the screen interval in each bore but assume they are all screened from near ground level to the base of each bore.

Table 1: BH-001 through BH-004 Details

Bore ID	Depth (m bgl)	Diameter (mm)	Static Water Level (m bgl)[1]	Easting (NZTM)	Northing (NZTM)
BH-001	10.6	50	6.7	1549159	5169821
BH-002	10.6	50	5.9	1548838	5169062
BH-003	10.6	50	3.2	1549451	5169267
BH-004	15.2	50	5.6	1549436	5168461

Notes:
1. metres below ground level.

Following installation of the monitoring bores, PDP installed pressure transducers in each bore on 22 April 2026. The transducers were set to record total pressure at 15-minute intervals, and a barometric pressure transducer was also set at the site to record changes in barometric pressure at the same 15-minute intervals. At the time of the transducer installations, manual depth to groundwater measurements were taken in each bore by PDP, so that the transducer records (at the end of the monitoring period) could be converted to depth to groundwater.

PDP has downloaded the transducers on a number of occasions, most recently on 23 September 2026. The transducer depth to groundwater records in BH-001 through BH-004 up this date are shown in Figure 2. This figure indicates that groundwater levels were generally stable in all the bores across the initial 3 months of monitoring. However, groundwater levels in all bores display a significant increase in response to a significant rainfall event starting on 5 July 2026 and continuing through to 10 July 2026. Total rainfall of 47.5 mm is recorded over this period at the ECan Ryans Bridge (Tai Tapu) monitoring site, with the peak of 24.5 mm falling on 6 July 2026. Groundwater levels have

reduced in all bores following this event, however at the time of the last download were still elevated above the stable levels recorded during the initial monitoring period. It is noted there has been slightly more groundwater level variation seen in BH-002 (located in the south-west of the Skellerup Block) compared to the other onsite boreholes.

Figure 2 also shows six individual groundwater level manual measurements taken by ECan in M36/0465 over the transducer monitoring period in bores BH-001 through BH-004. The trends displayed in Figure 2 support a close correlation between the onsite bores and M35/0465 and in particular, the depth to groundwater records in BH-003 and M35/0465 are very similar.

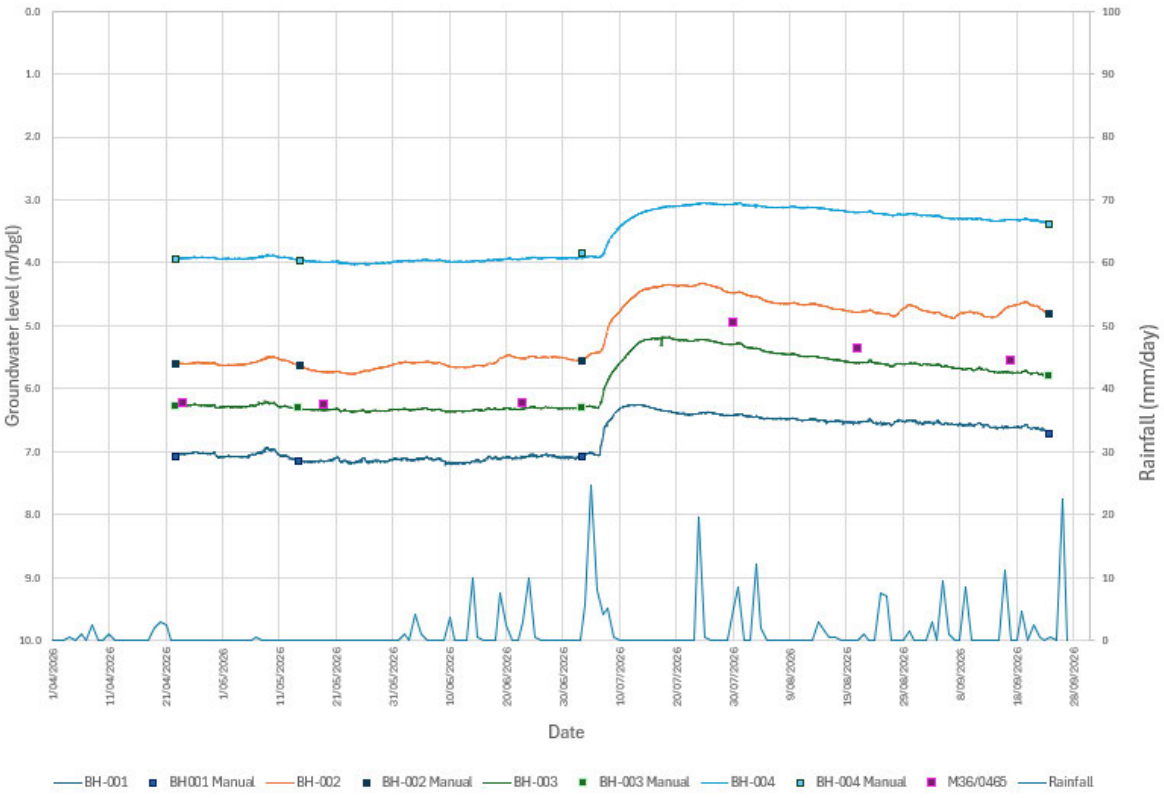


Figure 2: Groundwater Level Records in Onsite Bores BH-001 through BH-004

3.0 Groundwater Piezometric Survey

To estimate a piezometric surface over the full area of the site (all four development blocks) including an estimated highest groundwater level surface, PDP carried out a piezometric survey in a number of monitoring bores at and in proximity of the wider site area.

In the first instance, a number of potentially suitable bores were identified for measurement of depth to groundwater. Following this process and confirmation from bore owners that their bores could be included in the survey, PDP visited the site and surrounds on 3 July 2026 to carry out manual groundwater level measurements. In total, measurements were taken in 18 bores (including BH-001 through BH-004), seven of which were onsite and the remaining 11 are situated within approximately 1.5 km of the site. The locations of all the survey bores are shown in Figure 3.

In addition to the four newly drilled onsite bores, there are another three existing bores situated onsite within the Brookside Block of the proposed subdivision (M36/7225, M36/0015 and M36/5022). As shown in Figure 3, the offsite bores were mainly situated to the west or south-west of the site, while one bore (M36/5525) was located approximately 850 m north of the Holmes Block.

The site conditions during the groundwater level measurement round were typically fine with a temperature of 11°C. Based on the Ryans Bridge rainfall monitoring site, 43.5 mm of rainfall was recorded in the preceding 30 days prior to the survey being undertaken, with 13.5mm of rain occurring between 24 and 26 June 2026 (approximately one week prior to the measurement round).

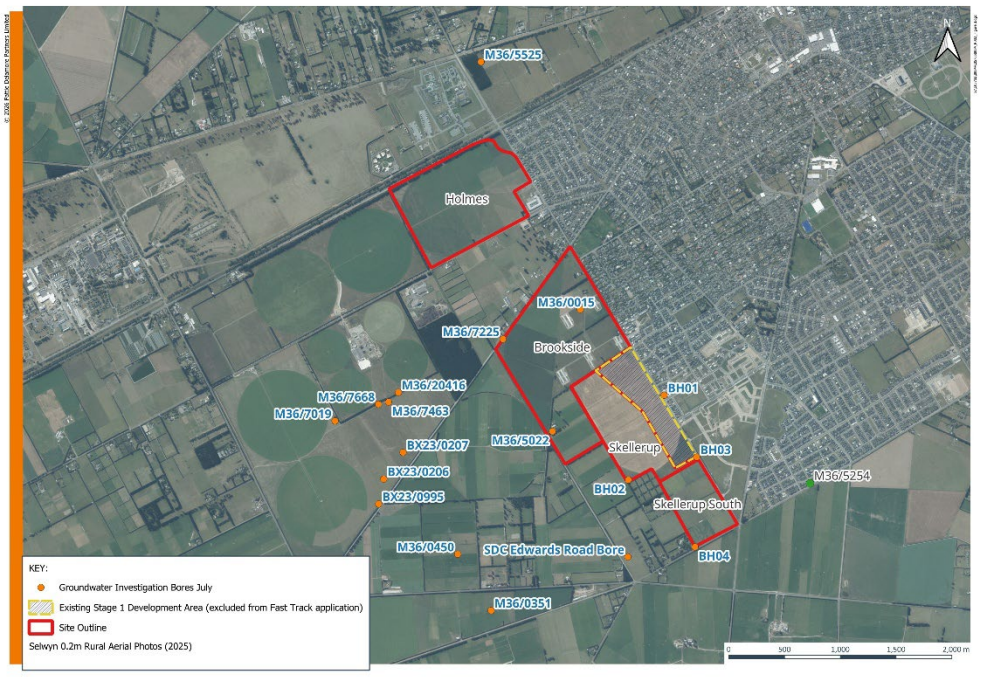


Figure 3: Groundwater Level Investigation Bores on 3 July 2026

Depth and coordinates for the 18 individual bores included in the survey (and shown in Figure 3) are presented in Table 2. In addition, the manual depth to groundwater measurements in each bore on the day of the survey are also shown in this table.

Table 2: Monitoring Bore Investigation Bores

Bore ID	Easting (NZTM)[1]	Northing (NZTM)[1]	Depth (m)[1]	Groundwater Level (mbgl)[2]
BH-001	1549159	5169821	10	7.09
BH-002	1548838	5169062	10	5.55
BH-003	1549451	5169267	10	6.31
BH-004	1549436	5168461	15	3.84
SDC Edwards Rd Bore	1547918	5168393	30	4.45
M36/5022	1548158	5169497	25.2	5.87
M36/7225	1547715	5170324	60	8.04
M36/0015	1548408	5170590	36.3	7.45
M36/20416	1546777	5169846	16.2	7.02
BX23/0206	1546646	5169070	13.9	6.28
BX23/0995	1546600	5168846	16.72	5.88
M36/7019	1546209	5169590	14	7.28
M36/7463	1546688	5169760	13.2	7.11
M36/7668	1546598	5169740	13	6.77
BX23/0207	1546819	5169308	14	6.39
M36/0351	1547608	5167891	24	3.36
M36/0450	1547309	5168396	24.4	6.00
M36/5525	1547518	5172809	47	16.19

Notes:

1. *Depths and coordinates based on available well data on Canterbury Maps (Wells and Bores - All)*
2. *Groundwater level as measured on 3 July 2026*

We note that onsite bore M36/7225 (on Brookside Road, near Edwards Road intersection) is screened significantly below the water table (recorded depth of 60 m and the top of the screen is at 52.5 m bgl). The drillers log for this bore also indicates a 2.5 m clay layer is present just above the well screen. Therefore,

it is possible that the groundwater level measured in this bore may not necessarily be representative of that at the water table, which could locally impact on the contours generated from the survey. However, we expect any difference is unlikely to be large enough to affect the resulting contours over the full survey area.

4.0 Groundwater Elevation Contours

Site LiDAR (1 m DEM 2023) elevation data obtained from Land Information New Zealand (LINZ)[1] was used to estimate ground elevation (New Zealand Vertical Datum (NZVD) 2016) at each of the bores shown in Figure 3. These estimated ground level elevations have also been used to estimate the measuring point elevation in each bore and convert the depth to groundwater measurements to groundwater elevations. Based on the groundwater elevation data, estimated groundwater piezometric contours over the full site area (all four development blocks) and surrounds have been created for 3 July 2026.

Figure 4 shows the inferred groundwater elevation contours that have been created for the day of the survey. As per Figure 3, there is only a single survey bore situated in the north of the investigation area and therefore the presented contours in the north of the study area may be less accurate that those generated to the south, where more measurement data is available.

The inferred contours vary between approximately 46 m NZVD in the north-west corner of the Homes Block to around 31.5 m NZVD in the south-east corner of the Skellerup South Block. The contours indicate groundwater flow direction is generally to the south-east over the study area. This interpretation is consistent with regional groundwater piezometric contours shown on ECan's Canterbury Maps database [2]. We note there is some bending of the contours onsite (in the north of the Brookside Block) around bores M36/0015 (41.2 m RL) and M36/7225 (41.7 m RL). Some of the contours on ECan's database also show this and therefore it is assumed this is a natural feature, however as discussed previously it is also possible that the measurement in M36/7225 is not fully representative of the water table and this could be having some local impact on the inferred contours in this area.

5.0 Depth to Groundwater Surface

The groundwater elevation raster surface shown in Figure 4 was subtracted from the LiDAR ground level surface over the investigation area to give an estimated depth to groundwater surface. The resulting surface is shown in Figure 5 and represents the estimated depth to groundwater on 3 July 2026.

[1] https://data.linz.govt.nz/layer/115805-canterbury-selwyn-lidar-1m-dem-2023/
[2] https://mapviewer.canterburymaps.govt.nz/

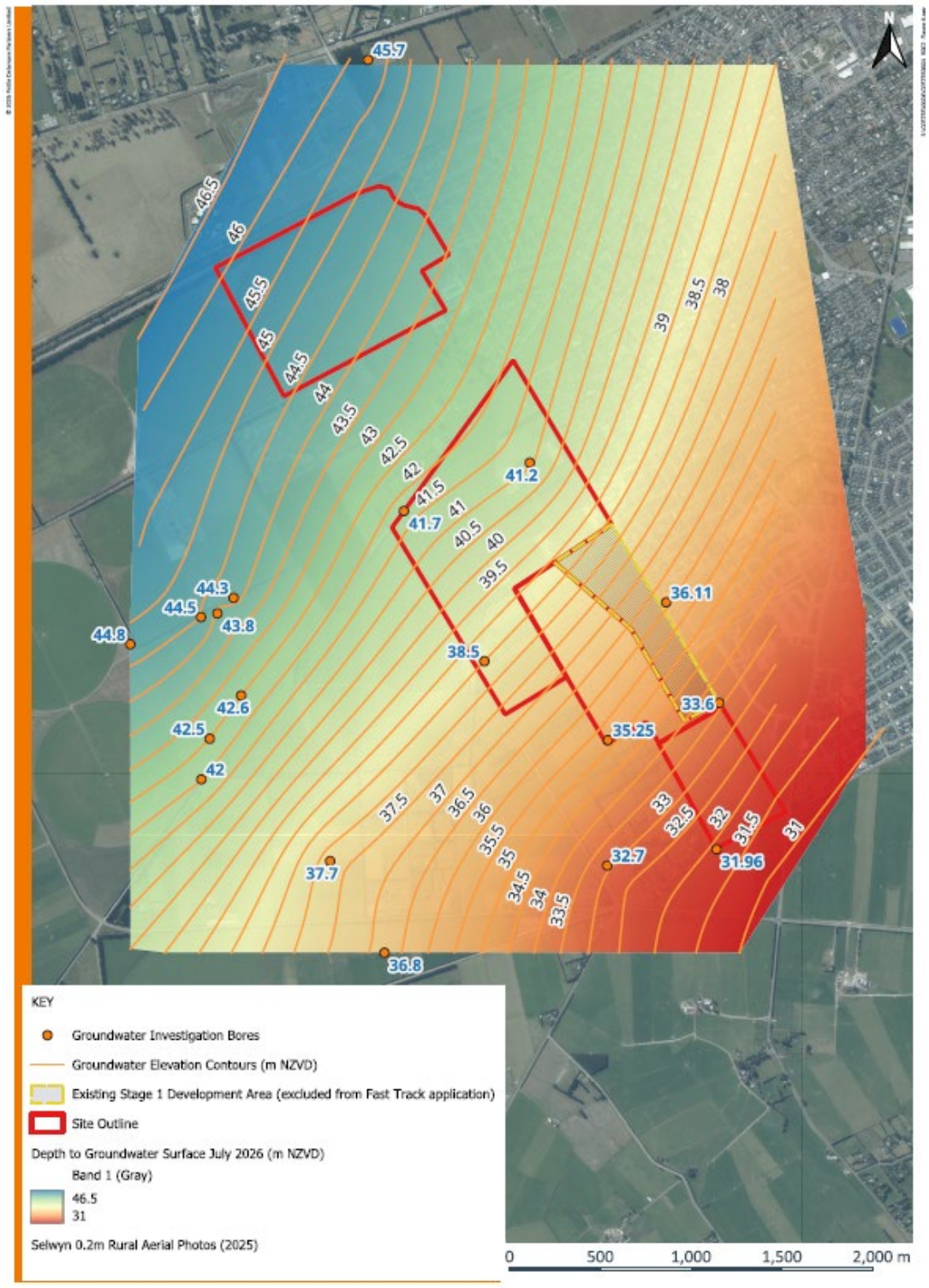


Figure 4: Groundwater Elevation Contours on 3 July 2026 (m NZVD)

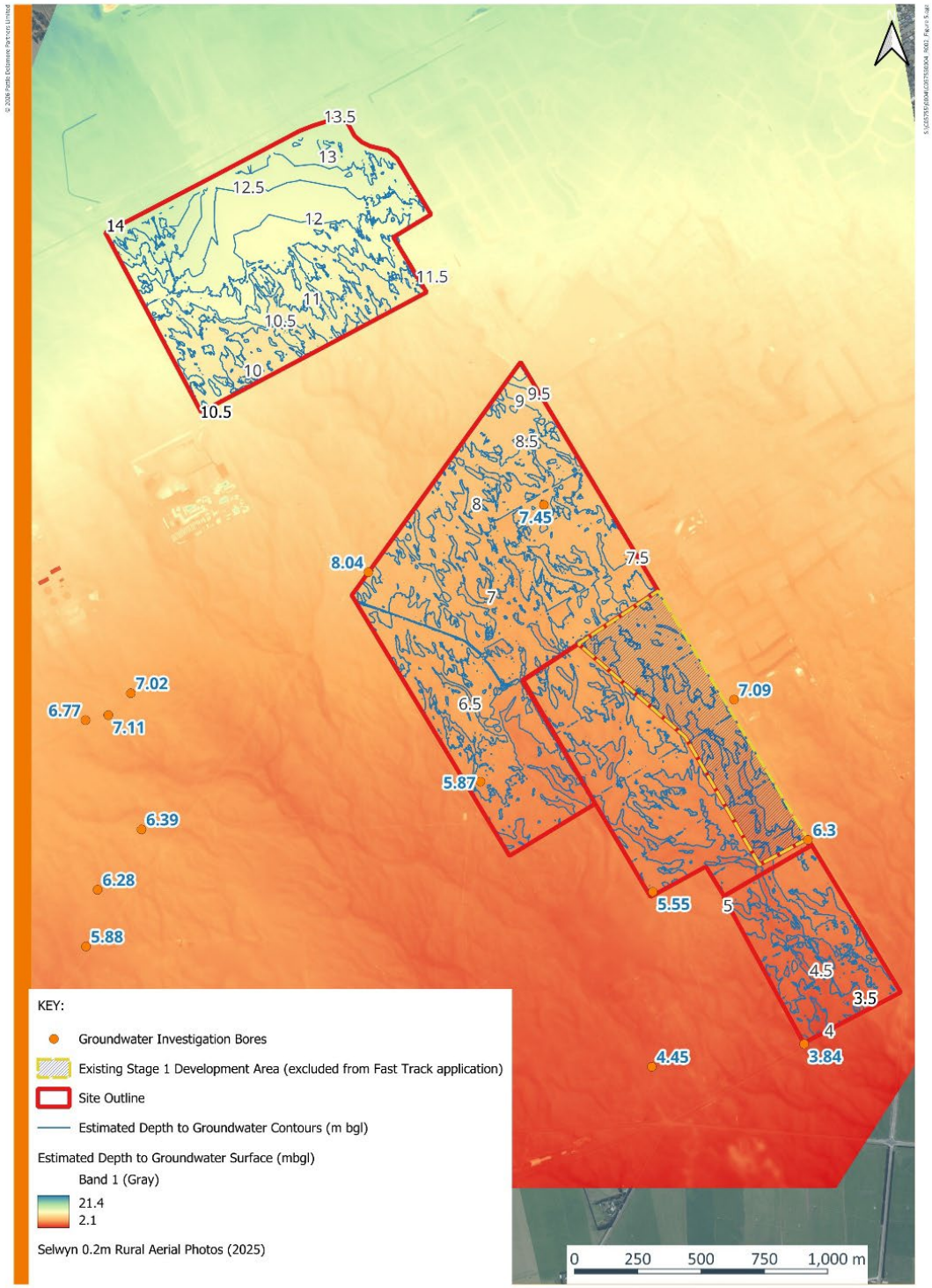


Figure 5: Estimated Depth to Groundwater Surface on 3 July 2026 (m bgl)

Figure 5 shows the estimated depth to groundwater varying between approximately 13.5 m bgl in the north and around 10.5 m bgl in the south of the Holmes Block on 3 July 2026. For the southern blocks, the estimated depth to groundwater varies between approximately 9.5 m bgl in the north of the Brookside Block and around 3.5 bgl in the south of the Skellerup South Block.

6.0 CMW Test Pitting

Six tests pits (TP-101 to TP-106) were excavated by CMW Geosciences (CMW) on 18 September 2026 within the Skellerup South Block. The locations of the test pits are shown in Figure 6.

The main purpose of the test pitting was for soakage testing, although the depth to groundwater in each pit was also measured by CMW. We understand the soakage testing was carried out at depths of between approximately 2.6 to 2.9 m bgl in TP-101 to TP-105, while TP-106 was excavated only for the purpose of measuring the depth to groundwater. Following the soakage testing in TP-101 through TP-105, these test pits were excavated deeper until groundwater was encountered and then the depth to groundwater in the pits was measured with a tape measure. Table 3 gives details for the test pits and the depth to water information measured by CMW.

On the same day of the test pitting the transducer data from onsite monitoring bore BH-004 indicates the depth to groundwater in that bore was approximately 3.3 m bgl. This is consistent but slightly shallower than the level in TP-106 excavated in close proximity to BH-004, while the depth to groundwater at test pit sites TP-101 through TP-105 was typically around a metre or slightly deeper.

It should be noted we are aware that the test pit depth to groundwater measurements recorded by CMW were taken with a tape measure and therefore we consider they are likely indicative only given the methodology and other factors that make it difficult to accurately measure the depth to groundwater in deep test pits. In addition, the fact that the soakage tests were carried out prior to the depth to groundwater measurements is another potential source of uncertainty and we are unsure how long the pits remained open to confirm the measured water levels were stable prior to measurement.

Table 3: CMW Test Pit Details

Test ID	Easting	Northing	Depth to Groundwater (mbgl)	Depth to Groundwater (m NZVD)	Ground level (m NZVD)[1]
TP-101	1549556	5168544	4.7	31.28	35.98
TP-102	1549659	5168603	4.7	31.09	35.79
TP-103	1549761	5168661	4.5	31.56	36.06
TP-104	1549760	5168702	4.8	31.4	36.2
TP-105	1549729	5168754	4.6	31.74	36.34
TP-106	1549447	5168472	3.6	31.98	35.58

Notes:

1. *Ground level elevation estimated from LINZ NZ Lidar data.*



Figure 6 CMW Test Pit Locations in south of Skellerup South Block

7.0 Estimated Highest Groundwater Elevation

As shown in Figure 1, ECan long-term groundwater level monitoring bore M36/0465 is located to the west of the site. This bore has a monitoring record extending between June 2000 to present. The full monitoring record in M36/0465 is shown in Figure 7.

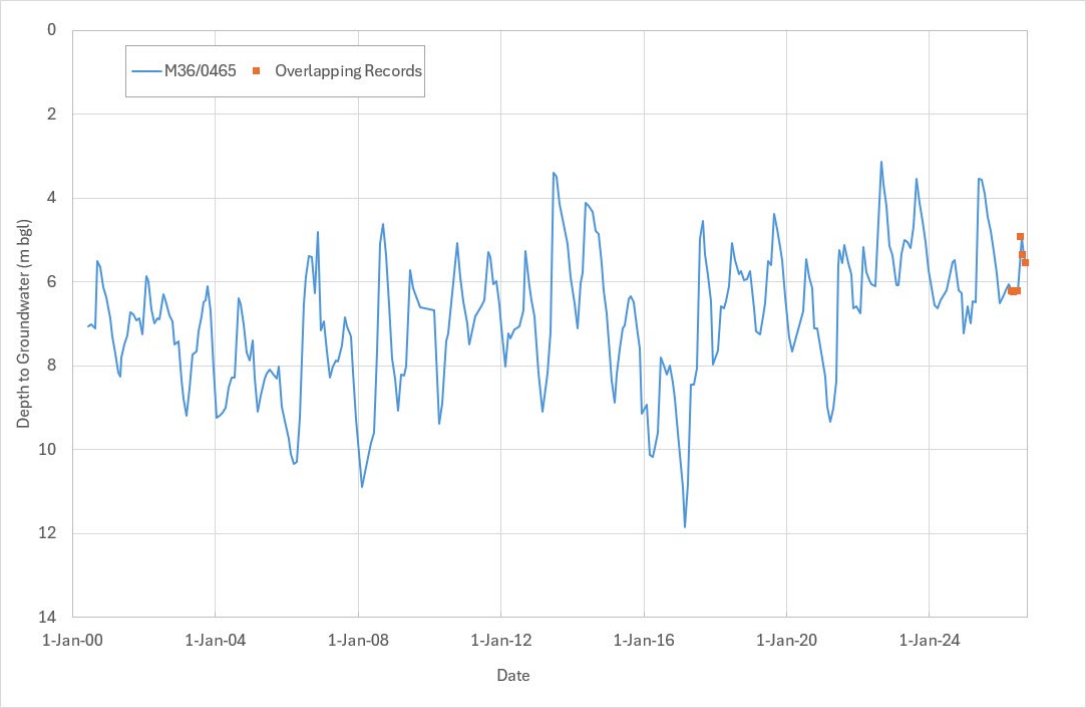


Figure 7: Groundwater Level Record in M36/0465

Figure 7 shows groundwater level fluctuations varying between 3.13 m (25 August 2022) and 11.84 m bgl (1 March 2017) in M36/0465. Figure 7 also shows the six manual measurements that have been made in M36/0465 (by ECan) that overlap with the onsite transducer monitoring period in BH-001 through BH-004. These six measurements have also been shown previously in Figure 2, where it is easier to differentiate them in Figure 2 given the shorter monitoring period presented in that figure.

Based on Figure 2, it can be seen that the survey on 3 July 2026 occurred during a period when groundwater levels had been relatively stable for some time (the entire onsite monitoring period prior to that date). The depth to groundwater in M36/0465 during that initial monitoring period remained at around 6.2 m bgl for the first three measurements shown in Figure 2. Since the survey on 3 July 2026 occurred during this period of stable groundwater levels, it is assumed that the depth to groundwater in M36/0465 was also around 6.2 m bgl on that day. Based on that assumption, the highest groundwater level measured in M36/0465

(3.13 m bgl in August 2022) is approximately 3.1 m higher than the assumed groundwater level in the bore on 3 July 2026.

To estimate the highest groundwater level over the investigation area, it is assumed that the bores included in the July 2026 piezometric survey experience the same groundwater level fluctuations as shown in the record from M36/0465. Therefore, based on the difference between the assumed level in M36/0465 on 3 July 2026 and the highest level in that bore on August 2022, we have added 3.1 m to the groundwater levels measured on 3 July 2026 to estimate the highest groundwater level in the majority of the piezometric survey bores.

A different methodology has been used to estimate the highest groundwater levels in BH-001 through BH-004. As shown previously in Figure 2, there is a good correlation between water level fluctuations in M36/0465 and those measured in onsite monitoring bores BH-001 through BH-004. As a result, a regression analysis has been carried out using the six manual water level measurements collected by ECan in M36/0465 over the onsite monitoring period and the data recorded BH-001 through BH-004. The correlation plots and equations are provided in Appendix C. All bores show a close correlation (0.93-0.99 R^2) with BH-003 showing the closest correlation. The resulting correlation equations were then used to calculate estimated synthetic water level records for the onsite bores over the same interval that measurements have been collected in M36/0465 (from June 2000).

Graphs showing the synthetic records in BH-001 through BH-004 (plotted together with the record in M36/0465 and the daily rainfall record) are also provided in Appendix C. All records show a close relationship to rainfall. When compared to the ECan bore, the synthetic records in BH-002 and BH-003 show a similar magnitude of fluctuations, while BH-001 and BH-004 show smaller fluctuations.

As per the record in M36/0465, the synthetic records also indicate the highest groundwater levels in BH-001 through BH-004 would have occurred on 25 August 2022. Based on the synthetic records, the highest estimated groundwater level (shallowest depth to groundwater) in each of these bores is as follows.

- BH-001 – 5.6 m bgl
- BH-002 – 2.64 m bgl
- BH-003 – 3.8 m bgl
- BH-004 – 1.61 m bgl

To create a highest groundwater level surface, we have used the values above for BH-001 through BH-0054, and for the other bores within the investigation area we have added 3.1 m to the measurements made on 3 July 2026. The resulting groundwater elevation contour surface is presented in Figure 8 and shows

predicted elevations varying between approximately 49 m and 47 m NZVD within the Holmes Block and around 45 m and 34 m NZVD from the north of the Brookside Block to the southern boundary of the Skellerup South Block.

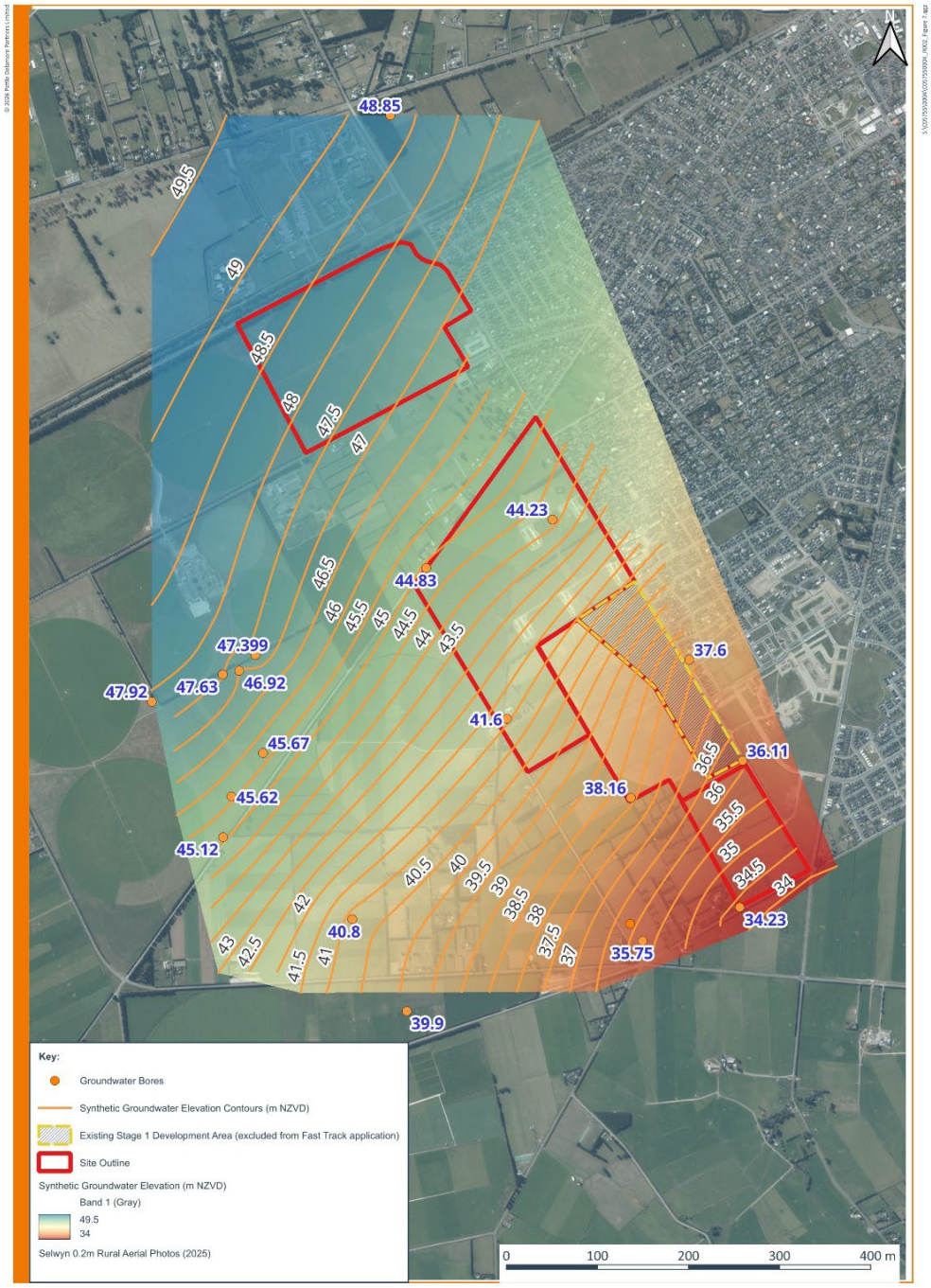


Figure 8: Highest Estimated Groundwater Level Surface (m NZVD)

8.0 Shallowest Depth to Groundwater Surface

As per the methodology for the depth to groundwater surface on 3 July 2026, the estimated highest groundwater surface (Figure 8) was subtracted from the available LiDAR surface. The resulting surface (representing the shallowest depth to groundwater over the investigation area) is shown in Figure 9.

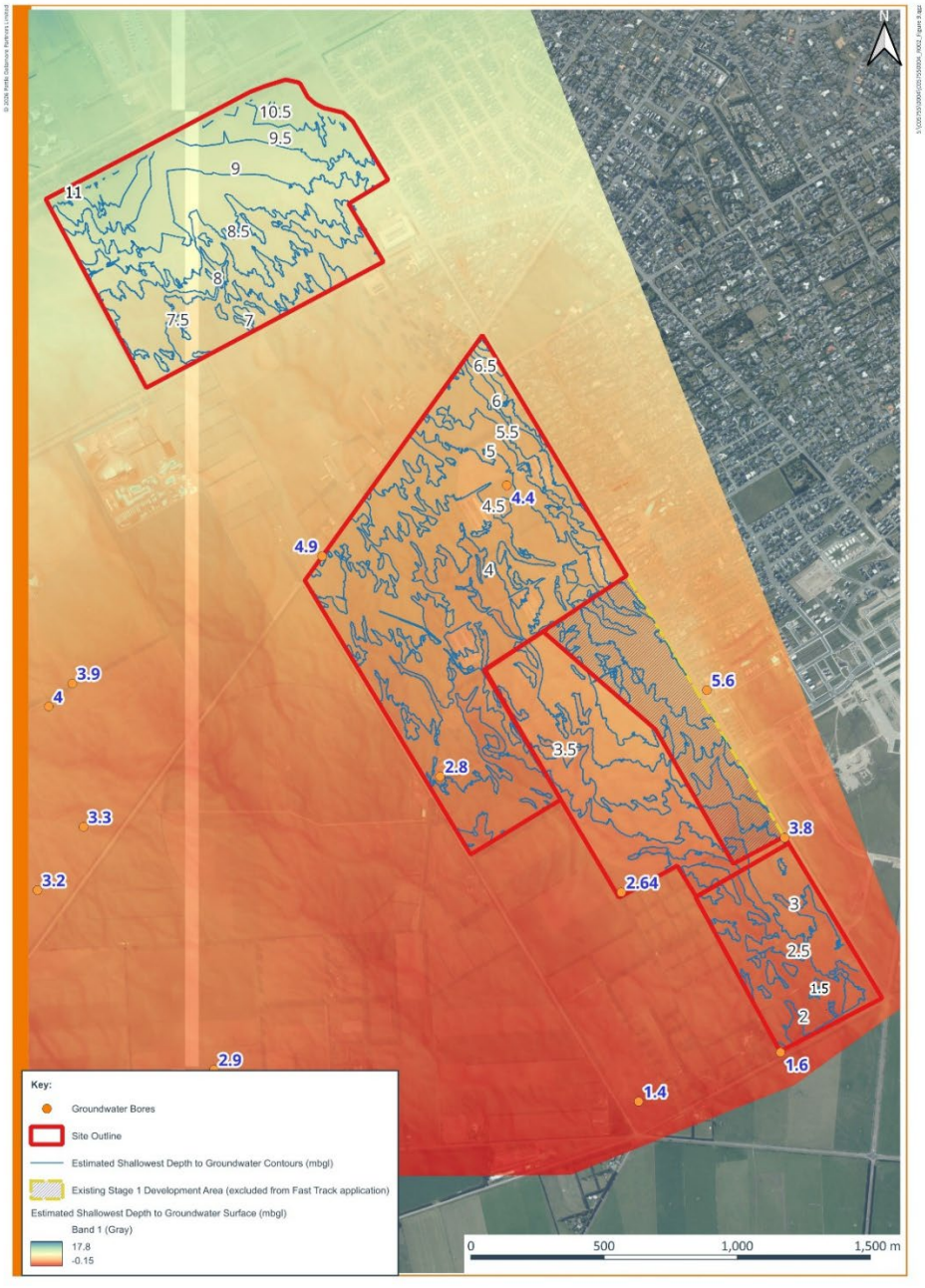


Figure 9: Estimated Shallowest Depth to Groundwater

Figure 9 shows the estimated minimum depth to groundwater over the Holmes Block varies between approximately 10.5 m bgl in the north and 7 m bgl in the south. In the north of the Brookside Block the estimated minimum depth to groundwater is approximately 6.5 m bgl, reducing to around 1.5 m bgl in the south of the Skellerup South Block.

9.0 Conclusions

Information from a groundwater level investigation (piezometric survey) completed on 3 July 2026, combined with groundwater level monitoring (between April and September 2026) in four recently drilled onsite bores and a long-term record in nearby ECan monitoring bore M36/0465 have been used to predict the highest groundwater level and shallowest depth to groundwater conditions at the proposed Westhaven Residential Development subdivision site at Rolleston.

The estimated shallowest depth to groundwater in the Northern area of the proposed development (Holmes Block) is between approximately 10.5 m and 7 m bgl. Groundwater is shallowest in the south, where the estimated shallowest depth to groundwater is predicted to be approximately 1.5 m bgl in the southern region of the Skellerup South Block (near Selwyn Road).

Our predictions are based on inferences and assumptions made from available groundwater level data at and in the vicinity of the site. The predictions in the Skellerup and Skellerup South blocks are considered to be more accurate than those further north, given the recent monitoring data in onsite bores BH-001 through BH-004 and the close correlations between the groundwater level datasets in these bores and the long-term record in ECan monitoring bore M36/0465. The estimated highest groundwater levels presented in this report are considered suitable for design and assessment purposes, particularly given the expected higher accuracy in the south where groundwater levels are shallower and groundwater will be closer to infrastructure. In the northern areas groundwater is deeper and more separated from underground infrastructure and therefore the potential lower accuracy is likely not a significant factor.

Appendix A: Curriculum Vitae



Carl Steffens

TECHNICAL DIRECTOR – WATER RESOURCES

Carl is a hydrogeologist with over 20 years experience working on and managing groundwater projects throughout NZ.

Qualifications

BSc Geological Sciences, 2001, University of Canterbury

PGDipSci (Engineering geology), 2004, University of Canterbury

Affiliations

Member of New Zealand Hydrological Society

Career Summary

2004 – Present

Technical Director – Water Resources, Pattle Delamore Partners Ltd, Christchurch

CORE EXPERTISE

- Groundwater resource evaluation and modelling
- Groundwater sampling and monitoring
- Hydrogeological field testing
- Construction dewatering
- Resource consent assessments and applications
- Preparation and presentation of evidence for hearings
- Project management

MANAGEMENT EXPERIENCE

- PDP Groundwater Services Leader
- Experienced Project Manager and Technical Lead

CAREER SUMMARY

Carl has broad experience in hydrogeological field testing, monitoring and sampling, data interpretation/analysis, analytical and numerical modelling and reporting. Carl has been involved in the preparation of Assessment of Environmental Effects (AEE) reports for consent applications and presenting evidence as an expert witness at hearings.

He has worked on a broad range of construction related groundwater projects including projects relating to construction dewatering, stormwater basins, wastewater systems, roading developments and subdivisions. He also has extensive experience on irrigation projects.

Carl has provided assistance to local councils including CCC on the development of groundwater drinking water supply sources including consenting requirements. He has also worked on projects for various regional councils throughout the country including ECan.

PROJECT EXPERIENCE

Aurecon

Technical assessment of construction dewatering rates and assessment of effects to support resource consent application for Parakiore Recreation and Sports Facility.

Brian Perry Civil

Construction dewatering advice relating to civil works across Cashmere Stream at Eastman Wetlands.

Christchurch City Council

Groundwater assessments, pump testing and preparation of resource consent applications for new Christchurch City Community Drinking-water Supply bores at various city pumping stations.

Christchurch City Council

Groundwater assessments and/or monitoring relating to proposed stormwater infiltration, retention and wetland sites including Milns Basin (Eastman Wetlands) Worsleys Basin and Quaifes Road.

Confidential Client

Hydrogeological investigations and numerical modelling of dewatering requirements and groundwater management issues associated with proposed open cast mine developments.

Danne Mora Holding Ltd

Development of a Modflow numerical groundwater flow model to assess potential drainage flows to permanently lower the water table at a proposed residential subdivision.

Environment Canterbury

Technical review of various resource consent applications for the taking, use and discharge of groundwater within Canterbury.

Fire and Emergency New Zealand

Assessment of effects relating to construction dewatering associated with site redevelopment at various fire station sites. Preparation of resource consent application to take, use and discharge groundwater for dewatering purposes.

Foodstuffs (South Island) Properties Limited

Assessment of dewatering impacts relating to proposed construction works at Foodstuffs Prestons Road site, Christchurch.

Fulton Hogan Limited

Field investigations including slug testing and stream gauging, data analysis, hydrogeological modelling and predictions of groundwater flows emerging from a groundwater drainage system installed beneath the roading network at Longhurst subdivision, Halswell.

Gillman Wheelans Limited

Field testing and assessments relating to new community groundwater supply bores, construction dewatering relating to service installation, dewatering induced settlement and associated resource consenting for various subdivision developments within Canterbury.

New Zealand Transport Agency

Preparation and presentation of evidence at a resource consent hearing relating to an application by NZTA to Waimakariri District Council for the alteration of a designation and the construction of a State Highway realignment and the widening of an existing State highway in relation to the Woodend Short Eastern Alignment.

Ngāi Tahu Property Limited

Hydrogeological assessments to support dewatering and excavation consent applications relating to a multistorey car park building in central Christchurch.

Prestons Road Limited

Quantifying groundwater inflows into proposed stormwater management basins and wetlands at a Christchurch residential development. Hydraulic onsite testing including piezo installation, trench excavation, pumping trials and slug testing. Data interpretation and analysis and estimates of groundwater inflows via analytical flow models.

Rae Paenga

Numerical modelling and review of contractor dewatering methodology at Parakiore Recreation and Sports Facility. Expert witness at arbitration hearing between Principle and Contractor.

University of Canterbury

Field testing, design and analysis of a large-scale groundwater dewatering system involving direct discharge of large dewatering flows to multiple re-injection bores for construction of the University biosciences building. Other specialist groundwater services for UC relating to construction dewatering and groundwater sourced air condition systems.

Various clients

Technical assessments and preparation of resource consent applications to take, use and discharge groundwater for heating and cooling purposes, including for cooling computer servers at data centres, at various sites withing Christchurch City.

Various clients

Supervision of field investigations including the drilling and installation of groundwater abstraction/monitoring bores. Groundwater quality sampling and groundwater level monitoring.

Various clients

Preparation of assessment of environmental effects (AEE) reports for groundwater take, use and discharge consent applications. Assessments of potential well yields, interpretation and analysis of pumping test data, well interference and groundwater mounding assessments associated with groundwater takes and discharges, interaction of surface water and groundwater, groundwater quality assessments, sea water intrusion assessments, design of groundwater level and quality monitoring programmes, analytical and numerical modelling applications.

West Coast Regional Council

Advising and technical reviews of resource consent applications to vary existing discharge resources consents held by Taylorville Resource Park Limited near Greymouth.

PATTLE DELAMORE PARTNERS LTD

Georgia Swan

Hydrogeologist



Georgia is a Hydrogeologist at PDP. She graduated from the University of Canterbury (Christchurch, New Zealand) with a BSc in Geology and a PGDipSci (Merit) in Environmental Science. Since beginning at Pattle Delamore Partners in 2021, Georgia has been involved in a wide variety of surface water and groundwater field work and technical assessments for both private clients and Territorial Authorities

Her recent experience in Western Australia includes pre-feasibility hydrogeologic assessments, Acid Mine Drainage risk assessment and various field investigation programs involving both hydrogeological and geotechnical programs in a number of geologically complex environments. She is proficient in geotechnical core logging and hydrogeological chip logging, along with experience supervising pumping tests and water sampling programs.

Qualifications

Post Graduate Diploma of Environmental Science with Merit (Hydrogeology, Environmental Geology and Water Resource Management) University of Canterbury 2021

Bachelor of Science (Geology) University of Canterbury 2020

Affiliations

Member of International Association of Hydrogeologists (IAH)

Training

NZ First Aid Certificate

PDP Health and Safety Training

Site Safe Consultants Passport (NZ)

Civil White Card (WA)

Full (Clean) Drivers Licence

4WD Training

Leapfrog™Works Fundamentals (Seequent) 2024

Australia Groundwater School (Flinders University) 2023

Career Summary

2026 – Present, Hydrogeologist,
Pattle Delamore Partners Ltd, Christchurch

2024 – 2025, Hydrogeologist, Pells Sullivan Meynik Ltd, Perth, Western Australia

2021 –2024
Graduate Hydrogeologist, Pattle Delamore Partners Ltd, Auckland

EXPERTISE

- Hydrogeological Assessment Reporting
- GIS mapping
- Project Management: client liaison, scoping, costing
- Groundwater investigation planning and implementation: borehole drilling, borehole design, hydraulic testing, groundwater monitoring and sampling
- Groundwater hydrogeological desktop assessments
- Data processing, interpretation and technical report writing

CAREER SUMMARY

Georgia joined PDP on completion of a Postgraduate Diploma of Environmental Science with a focus in Hydrogeology and Water Resource Management. Georgia was involved in projects relating to assessments of environmental effects, carrying out groundwater resource investigations and monitoring on a number of complex and varied projects, including; supervising machine drilling and installation of groundwater monitoring bores, geological logging, hydraulic testing and groundwater and surface water sampling. Pumping test analysis, surface water analysis. Georgia has also been involved in a number of land treatment projects, carrying out site suitability surveys, hydrogeological and soil permeability and infiltration site investigations and technical reporting.

Following this, Georgia was based in Perth, Western Australia and worked on a variety of Civil and Mining related groundwater projects across Australia and New Zealand. These projects focused on:

- Project management: Planning, management and implementation of groundwater projects
- Hydrogeological desktop assessments: Conceptual hydrogeological model development, risk assessments, groundwater monitoring plans, definitive pre feasibility studies, mine closure planning and AMD risk assessments
- Analytical assessments: Dewatering and drawdown assessments
- Borehole investigations: Drilling and borehole installations, bore design, aquifer testing, borehole inspections, and borehole decommissioning

Georgia has recently returned to New Zealand and PDP resuming her role as a Hydrogeologist.

NEW ZEALAND PROJECT EXPERIENCE

Napier City Council – Hydrogeology Investigations for Te Awa and Plantation Drain Upgrades (Napier)

Role: Supporting Hydrogeologist

Ryan has assisted in hydrogeological investigations in the Te Awa area, south of Napier. These investigations are critical to informing the design and construction of the upgrade works to stormwater infrastructure for this project. This has involved Georgia assisting with dewatering assessments and reporting deliverables.

Assessment of Environmental Effects, Graymont Limited (2026)

Lead Field Hydrogeologist & Technical Support

Georgia led field investigations including surface water sampling and soil testing, alongside and provided technical support in undertaking Groundwater and Surface water environmental effects assessment

Daiken New Zealand Limited, Reconsenting Application (2026-present)

Environmental Scientist

Environmental scientist for an ongoing monitoring programme to inform the reconsenting of multiple activities at the Daiken NZL site. prepared a comprehensive groundwater, stormwater, surface water and wastewater sampling plan and procedure. Conducted fieldwork to undertake environmental sampling and construct automatic sampling devices. Georgia also provides remote support to Daiken NZL staff with sampling programs.

Awarua Groundwater monitoring (2026)

Remote staff support and Project Management

Georgia conducted driller engagement, managed client and stakeholder liasion and remotely supervised onsite staff during drilling.

Groundwater Effects, Reference Design, Auckland Light Rail (ALR) 2022-2023

Field Hydrogeologist & Technical Support

Provided technical support for site investigation and reference design team for the proposed ALR construction. The role involved assisting with design and implementation of hydraulic testing and hydrogeological characterisation of the Onehunga, Three Kings, Mt Eden and Mt Roskill Volcanic (basalt flow) Aquifers.

Groundwater Assessment, Fonterra Limited, Kauri, 2022-Present

Field Hydrogeologist and technical support

Georgia provided supervision of drilling program for groundwater borehole monitoring design, machine drilling, well installation, and geological logging, Groundwater monitoring including low flow sampling and ongoing groundwater quality monitoring. Georgia also provided secondary works including infiltration testing of near surface soils including, in-situ saturated hydraulic conductivity testing using a Guelph Permeameter, soil logging and hydraulic soil sampling.

Georgia has provided technical support in a secondary package of works including aquifer confinement and availability and water supply feasibility and construction

McConnell Dowell, Corban Reserve Culvert Upgrade, 2022 - 2024

Field Hydrogeologist & Technical Support

Lead field hydrogeologist for the Corbans Avenue stormwater upgrade project. Roles including drilling superision, Geological logging, well development, instillation and collection of level logger data, monthly groundwater monitoring, data analysis and reporting.

Various Consent Reviews, Regional Councils, (2023–Present)

Technical Support

Assessment of resource consent applications for groundwater abstraction and leachate discharge. In the case of groundwater abstraction, this involved the review and reanalysis of pumping tests, well interference assessments, and assessments of pumping on the groundwater resource. In the case of leachate discharge this involved review of groundwater quality data, assessment of water quality impacts, and review of potential receptor bores.

Groundwater Supply Assessments, Various, 2022 – 2024

Hydrogeologist

Field hydrogeologist and technical support of various large-scale groundwater drinking water supply bore drilling programs. Works included supervision of production bore drilling, groundwater quality sampling and well-performance pump testing program (step test).

Groundwater Dewatering Assessment of Effects, Various Clients 2022- Present

Field Hydrogeologist & Technical Support

Geological logging and drilling supervsion, groundwater and surface water monitoring. Including stream gauging, slug testingIncluding monthly groundwater monitoring, maintence of data loggers and telemetry system, data analysis and reporting. Georgia also provided technical support and input for hydrogeological aspects of an assesment of environmental effects on groundwater and surface water receptors along with technical reporting

WWTP Site Suitability Assessments, Various Clients, 2022-Present

Field Hydrogeologist & Technical Support

Field hydrogeologist for infiltration testing of near surface soils including, in -situ saturated hydraulic conductivity testing using a Guelph Peremeater, soil coring, hand augers, geological logging and interpretation of sub surface geology.
Field hydrogeologist for infiltration testing of near surface soils including, in -situ saturated hydraulic conductivity testing using a Guelph Peremeater, soil coring, hand augers, geological logging and interpretation of sub surface geology and technical reporting.
Georgia provided technical support and input as part of a wider team for hydrogeological aspects of an assesment of environmental effects on groundwater and surface water receptors of treated wastewater irrigation, analysis of Air quality issues, contaminant recptiors in soils and irrigation type suitablity along with Technical reporting.

Hilary Lough

TECHNICAL DIRECTOR - WATER RESOURCES



Hilary is a Civil Engineer specialised in water resources management, in PDP's Christchurch Office. She is a Chartered Professional Engineer with experience in a wide range of environmental projects, including for water supply, wastewater, stormwater, landfills, quarries, mines, agricultural land use and irrigation, managed aquifer recharge, construction dewatering and hydropower. Hilary is recognised for her specialised skills in managing investigations and assessments relating to groundwater issues, including groundwater-surface water interaction, impacts of abstraction from and discharge to groundwater and contaminant transport through soil and groundwater.

Qualifications

B.E. (Hons) (Civil), University of Canterbury, 2002

M.E. (Civil), University of Canterbury, 2004

Affiliations

Chartered Professional Engineer (CPEng)

Professional Member of Engineering New Zealand (CMEngNZ)

Member of New Zealand Hydrological Society

Career Summary

2017 – Present
Technical Director - Water Resources, Pattle Delamore Partners Ltd, Christchurch

2004 – 2017
Environmental Engineer, Pattle Delamore Partners Ltd, Christchurch

2003 - 2004
Academic Tutor (Civil Engineering), University of Canterbury, Christchurch

2000 - 2003
Construction Management Assistant (Part Time), Fletcher Construction Company, Nelson/Wellington

CORE EXPERTISE

- Technical Peer Review of Consent Applications
- Groundwater Resource Evaluation and Modelling
- Groundwater-Surface Water Interaction Modelling
- Contaminant Transport Modelling in Soil and Water
- Assessment of Environmental Effects for Soil and Water
- Wastewater and Stormwater Management and Disposal

CAREER SUMMARY

Hilary is a professional engineer, experienced in resource consent work including peer review of applications and technical investigations, preparation and presentation of expert evidence at consent hearings and provision of technical advice to local government. Hilary is a technical director at PDP, providing co-ordination and technical oversight of the work undertaken by the strong team of water resources experts across the PDP offices. Hilary specialises in the modelling of groundwater resources, groundwater and surface water interaction and the transport of contaminants in soil and water.

PROJECT EXPERIENCE

Environment Canterbury, Technical Water Resources Advice (2004-present)
Technical Expert and Peer Review

Peer review of multiple applications and reports for Environment Canterbury including review of stream bed conductance investigations, stream depletion assessments, auditing groundwater consent applications and reviewing 763 groundwater and surface water consent applications to determine compliance with the Waimakariri River Regional Plan. Preparation of technical reports: "Vertical flow in Canterbury groundwater systems and its significance for groundwater management" and "Guidelines for the Assessment of Groundwater Abstraction Effects on Stream Flow". Audit of aquifer test results, groundwater consent and contaminant discharge applications including providing evidence at consent hearings. Assessment of effects for managed aquifer recharge projects.

Hawke's Bay Regional Council, Technical Water Resources Advice (2012-present)
Technical Expert and Peer Review

Technical reviews for a range of consent applications impacting soils, wetlands and water quality and quantity. Responsible for the peer review of technical consent review assessments completed by the PDP water resources team. Preparation and presentation of evidence at resource consent hearings. Advice on groundwater management and groundwater investigations, including risks to community drinking water supplies.

Otago Regional Council, Technical Water Resources Advice (2015-present)
Peer Reviewer and Technical Lead

Technical lead for PDP's water resources advice for Otago Regional Council including groundwater management and groundwater investigations, assessment of risks to community drinking water supplies. Previous work has included undertaking and project managing technical reviews for a range of consent applications for groundwater takes, closed landfills, large and small scale wastewater discharge consents, stream diversions, gravel abstractions and others.

Ministry for the Environment, Technical Guidelines for Drinking Water Source Protection Zones and Delineating Source Water Risk Management Areas (2018-present)
Project manager/author

Hilary was the project manager and lead author of technical guidelines for the delineation of both groundwater and surface water drinking water source protection zones including specifications for a 'default' national approach. The report was commissioned as part of the Review of the National Environmental Standard for Sources of Human Drinking Water. Hilary was the lead author of the subsequent guidelines providing further detailed delineation information.

Greater Wellington Regional Council, Technical Water Resources Advice (2011-present)
Technical Expert

Preparation of spreadsheet analysis tools and guideline document on aquifer test analysis and technical advice on groundwater management in the region.

Horizons Regional Council, Technical Water Resources Advice (2012-present)
Technical Expert

Technical advisor for regional community supply protection zone delineation project for community supplies and allocation advice reports. Overview of audits of consent applications. Groundwater allocation workshop for Horizons Regional Council and other regional councils.

Christchurch City Council, Water Supplies (2005 – present)
Technical Expert

Assistance with the design of aquifer testing and preparation of groundwater assessments, including source protection zones, for wells drilled for new city supply pumping stations. Assessment of potential groundwater effects arising from landfills and stormwater discharges.

Selwyn District Council, Water Supplies and Wastewater Discharges (2011-present)
Technical Expert

Modelling potential groundwater quality impacts of on-site sewage treatment systems in Darfield and Kirwee and outlining future sewage treatment and disposal options and associated effects. Assessment of the potential effects of stormwater discharge from the townships of Rolleston, Hororata, Darfield, Kirwee, West Melton and Leeston on groundwater quality for global stormwater discharge consent applications. Assessment of effects for closed landfills and council's drainage network. Guidance on source water protection zones for new water supplies.

New Zealand Defence Force, Tekapo Military and Burnham Camps (2005-2011)
Technical Expert

Investigation of existing wastewater system at Tekapo Army base; preparation of report detailing options for system upgrade; resource consent application assistance; detailed design of Twin Aerated Lagoons; tender documents preparation; construction supervision. Assessment of the potential for interference effects from proposed groundwater abstractions on NZ army wells at Burnham.

Various Clients, Water Supplies (2004-present)
Technical Expert

Hydrological and hydrogeological investigations, advice on well/infiltration gallery siting, aquifer testing and analysis and preparation of AEE's for numerous water supply projects.

Appendix B: Pro-Drill BH001 through BH002 Driller Logs

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

APRIL 14, 2026
DRILLING REPORT PREPARED FOR

WESTHAVEN ROLLESTON LIMITED

#JOB-5992 - Westhaven Rolleston - Groundwater Monitoring Bores

140 Dunns Crossing Road

Pro-Drill (Auck) Ltd
11 Alpito Place, Pukekohe, Auckland, New Zealand
www.prodrill.co.nz
0800 477 637

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

BORE HOLE REPORT

HOLE NAME	**BH-001**	DATE	02 04 2026
LOCATION	**E 1549159 N 5169821** 140 Dunns Crossing Road	JOB #	JOB-5992
CUSTOMER	**Westhaven Rolleston Limit-ed** [redacted]	RIG ID	FRASTE CRS XL1 (HE: 80.1%)

DRILL LOGS

0.0m	02 04 2026 09:32 AM	FRASTE CRS XL1 (HE: 80.1%)
0.0m	09:32 AM	Sonic
10.6m	13:32 PM	Sonic casing type 10.6m casing depth

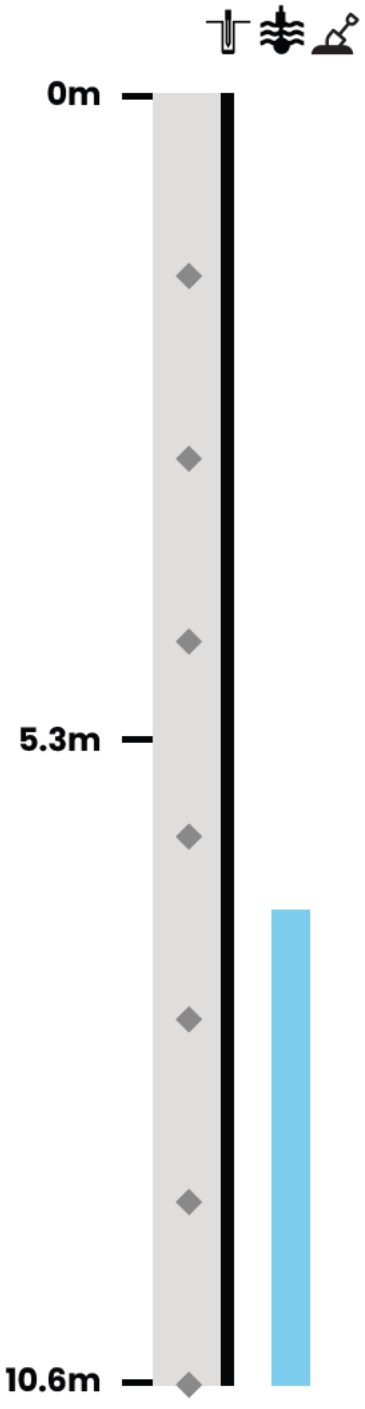
IN-SITU TESTING

1.5m	10/17/16/20/14	N=50	*Type: Open 50 for 55mm*
3.0m	11/17/20/30	N=50	*Type: Open 50 for 75mm*
4.5m	5/18/15/20/15	N=50	*Type: Open 50 for 70mm*
6.1m	8/10/12/11/16/11	N=50	*Type: Open 50 for 35mm*
7.6m	14/14/13/12/20/5	N=50	*Type: Open 50 for 5mm*
9.1m	10/21/22/28	N=50	*Type: Open 50 for 75mm*
10.6m	7/14/15/20/15	N=50	*Type: Open 50 for 40mm*

WATER

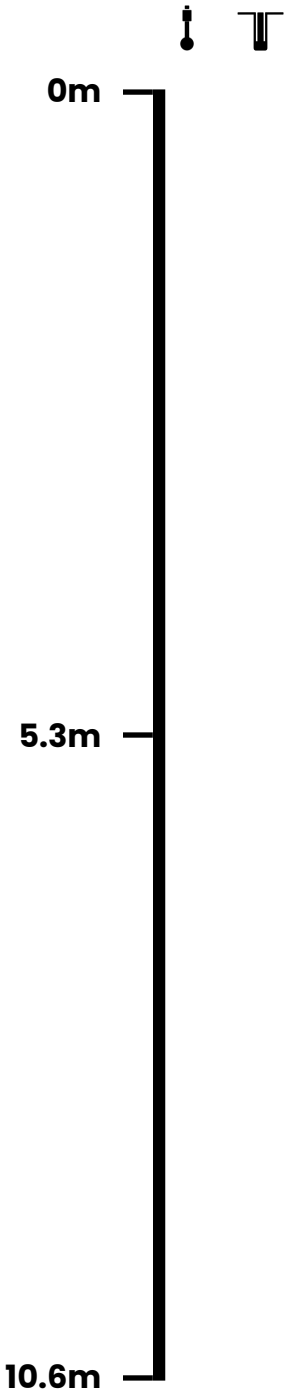
6.7m	Water level

SOIL LAYERS

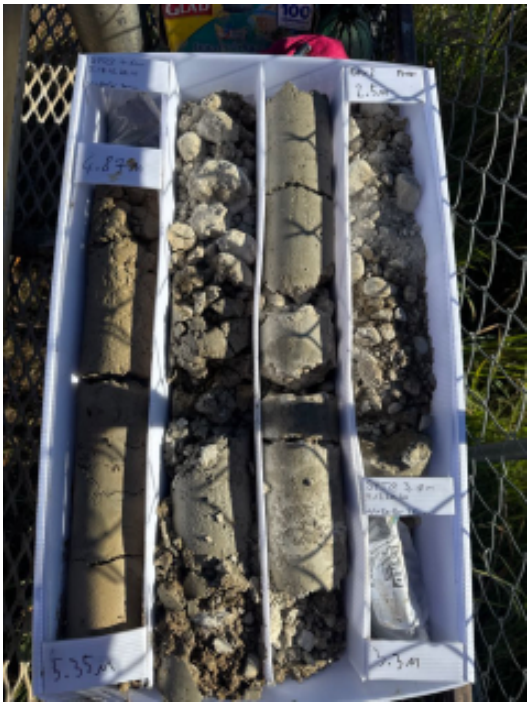


INSTALLS

BACKFILL LAYERS




1.855m
2.50m


5.35m


8.48m



PRO-DRILL
SPECIALIST DRILLING ENGINEERS

BORE HOLE REPORT

HOLE NAME	**BH-002**	DATE	02 04 2026
LOCATION	**E 1548838 N 5169062** 140 Dunns Crossing Road	JOB #	JOB-5992
CUSTOMER	**Westhaven Rolleston Limit-ed** [redacted]	RIG ID	FRASTE CRS XL1 (HE: 80.1%)

DRILL LOGS

0.0m	02 04 2026 15:35 PM	FRASTE CRS XL1 (HE: 80.1%)
0.0m	15:35 PM	Sonic
10.6m	07 04 2026 11:23 AM	Sonic casing type 10.6m casing depth

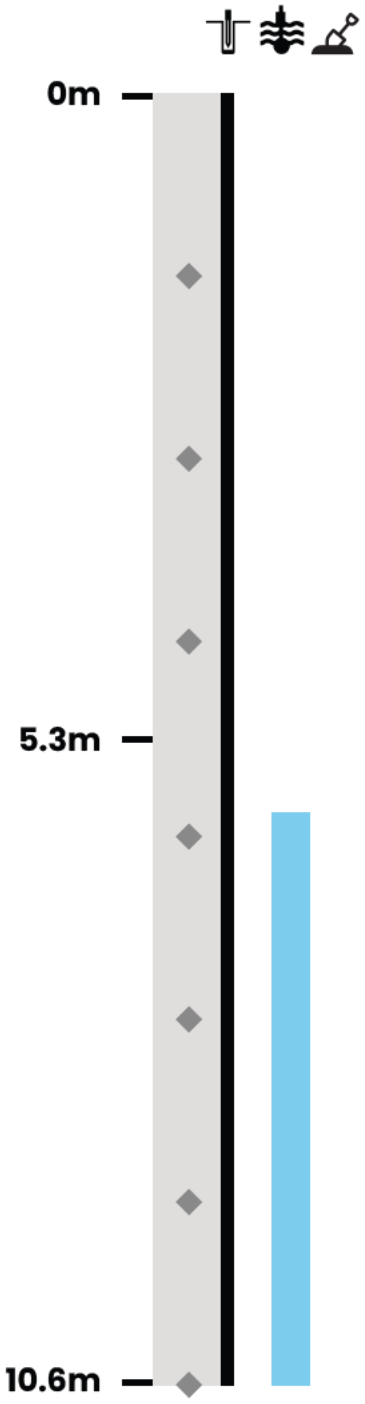
IN-SITU TESTING

1.5m	4/4/6/5/6/5	N=22	*Type: Open*
3.0m	5/6/5/10/15/13	N=43	*Type: Open*
4.5m	10/12/14/14/12/8	N=50	*Type: Open 50 for 45mm*
6.1m	7/12/11/14/25	N=50	*Type: Open 50 for 45mm*
7.6m	20/20/20/17/13	N=50	*Type: Open 50 for 75mm*
9.1m	8/12/15/15/20	N=50	*Type: Open 50 for 75mm*
10.6m	8/8/7/6/11/10	N=34	*Type: Open*

WATER

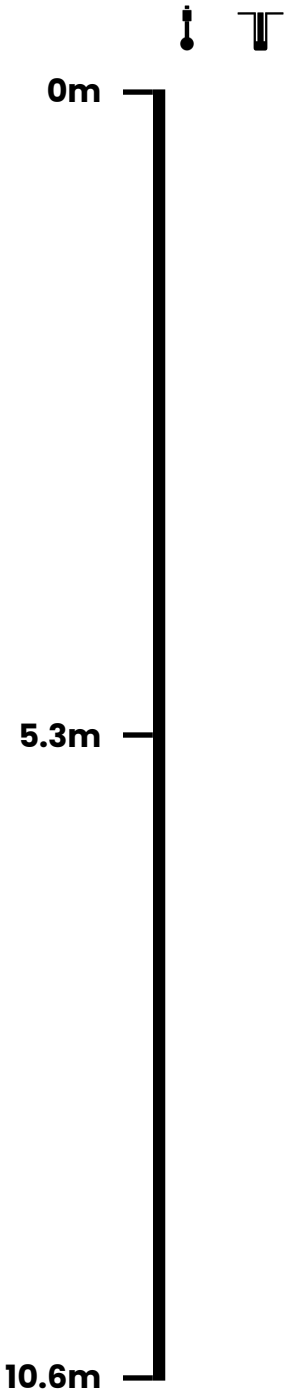
5.9m	Water level

SOIL LAYERS



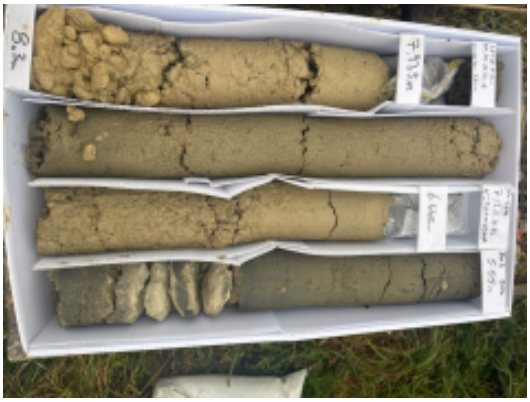
INSTALLS

BACKFILL LAYERS




1.95m
2.6m


3.45m
5.55m




11.05m
9.475m
8.2m

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

BORE HOLE REPORT

HOLE NAME	**BH-003**	DATE	07 04 2026
LOCATION	**E 1549451 N 5169267** 140 Dunns Crossing Road	JOB #	JOB-5992
CUSTOMER	**Westhaven Rolleston Limit-ed** [redacted]	RIG ID	FRASTE CRS XL1 (HE: 80.1%)

DRILL LOGS

0.0m	07 04 2026 11:24 AM	FRASTE CRS XL1 (HE: 80.1%)
0.0m	11:24 AM	Sonic
10.6m	17:41 PM	Sonic casing type 10.6m casing depth

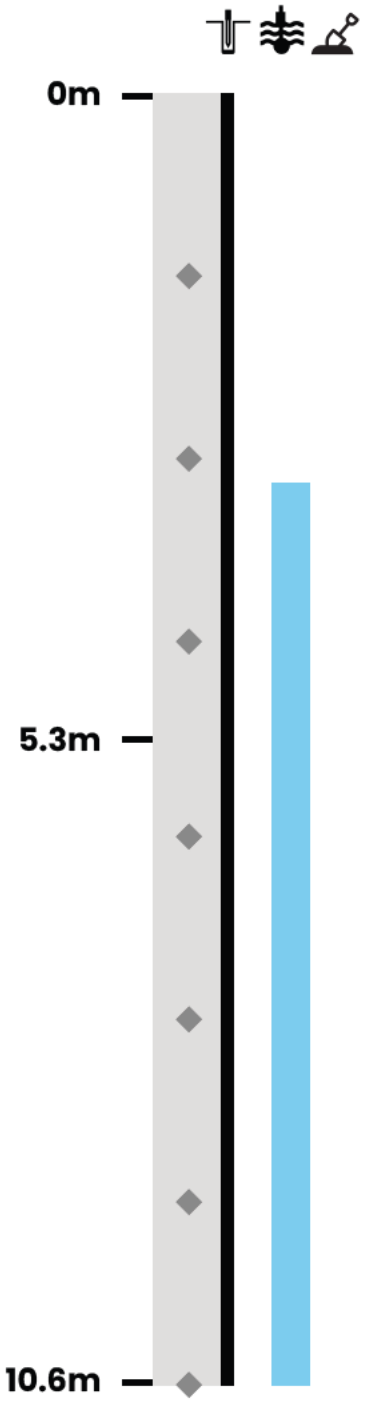
IN-SITU TESTING

1.5m	4/12/10/11/12/14	N=47	*Type: Open*
3.0m	6/10/8/12/10/11	N=41	*Type: Open*
4.5m	15/12/12/10/9/8	N=39	*Type: Open*
6.1m	13/17/20/15/15	N=50	*Type: Open 50 for 75mm*
7.6m	15/14/15/12/23	N=50	*Type: Open 50 for 75mm*
9.1m	16/17/22/19/9	N=50	*Type: Open 50 for 40mm*
10.6m	17/20/29/21	N=50	*Type: Open 50 for 45mm*

WATER

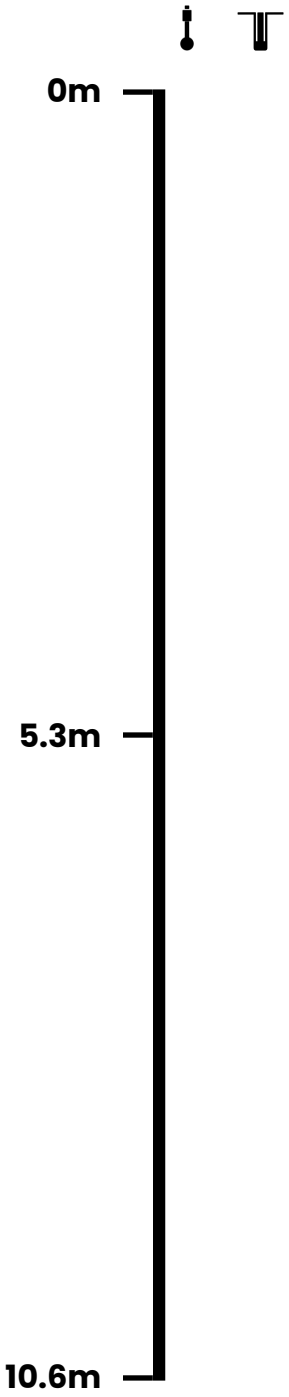
3.2m	Water level

SOIL LAYERS



INSTALLS

BACKFILL LAYERS




1.95m
2.7m


2.7m
4.95m
3.45m
5.85m


5.85m
2.975m
6.075m
8.9m


9.66m
10.87m

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

BORE HOLE REPORT

HOLE NAME	**BH-004**	DATE	08 04 2026
LOCATION	**E 1549436 N 5168461** 140 Dunns Crossing Road	JOB #	JOB-5992
CUSTOMER	**Westhaven Rolleston Limit-ed** [redacted]	RIG ID	FRASTE CRS XL1 (HE: 80.1%)

DRILL LOGS

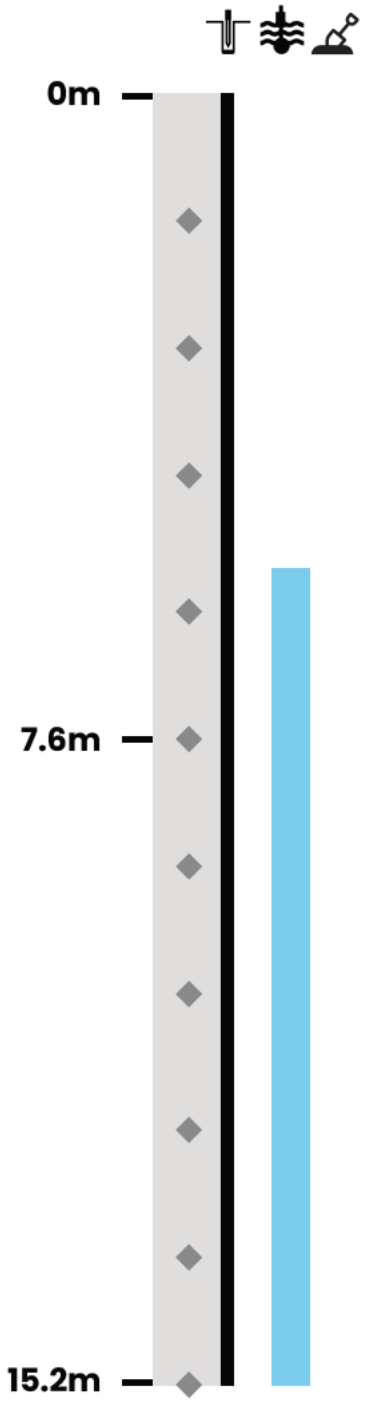
0.0m	08 04 2026 08:59 AM	FRASTE CRS XL1 (HE: 80.1%)
0.0m	08:59 AM	Sonic
15.2m	09 04 2026 13:19 PM	Sonic casing type 15.2m casing depth

IN-SITU TESTING

1.5m	12/20/20/26/4	N=50	*Type: Open 50 for 5mm*
3.0m	11/7/10/10/15/7	N=42	*Type: Open*
4.5m	6/5/6/7/7/7	N=27	*Type: Open*
6.1m	20/15/15/16/15/4	N=50	*Type: Open 50 for 10mm*
7.6m	10/13/17/18/15	N=50	*Type: Open 50 for 45mm*
9.1m	12/18/20/20/10	N=50	*Type: Open 50 for 10mm*
10.6m	25/25	N=50	*Type: Open 50 for 70mm*
12.2m	24/26	N=50	*Type: Open 50 for 70mm*
13.7m	8/12/25/25	N=50	*Type: Open 50 for 65mm*
15.2m	28/22	N=50	*Type: Open 50 for 70mm*

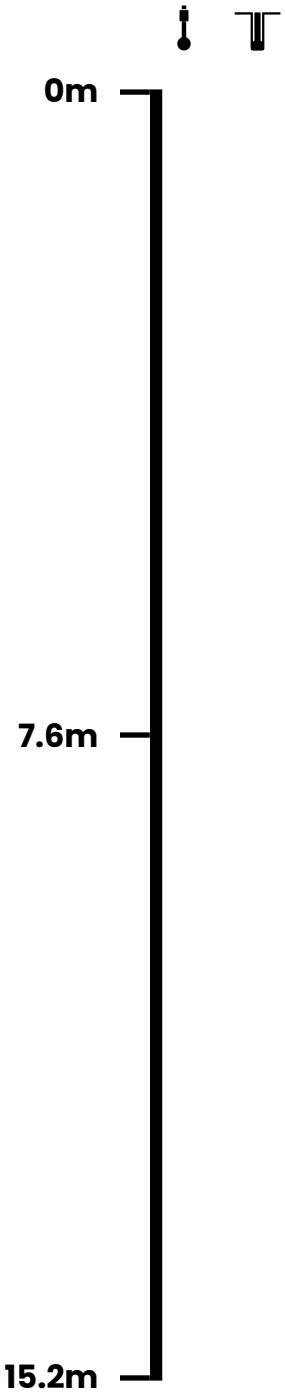
WATER

5.6m	Water level



INSTALLS

BACKFILL LAYERS




2.6m


5.6m
4.95m
3.45m


8.6m
7.945m
6.485m


11.35m
10.75m
9.41m


12.345m
13.99m


15.345m
13.44m

PRO-DRILL

0800 477 637

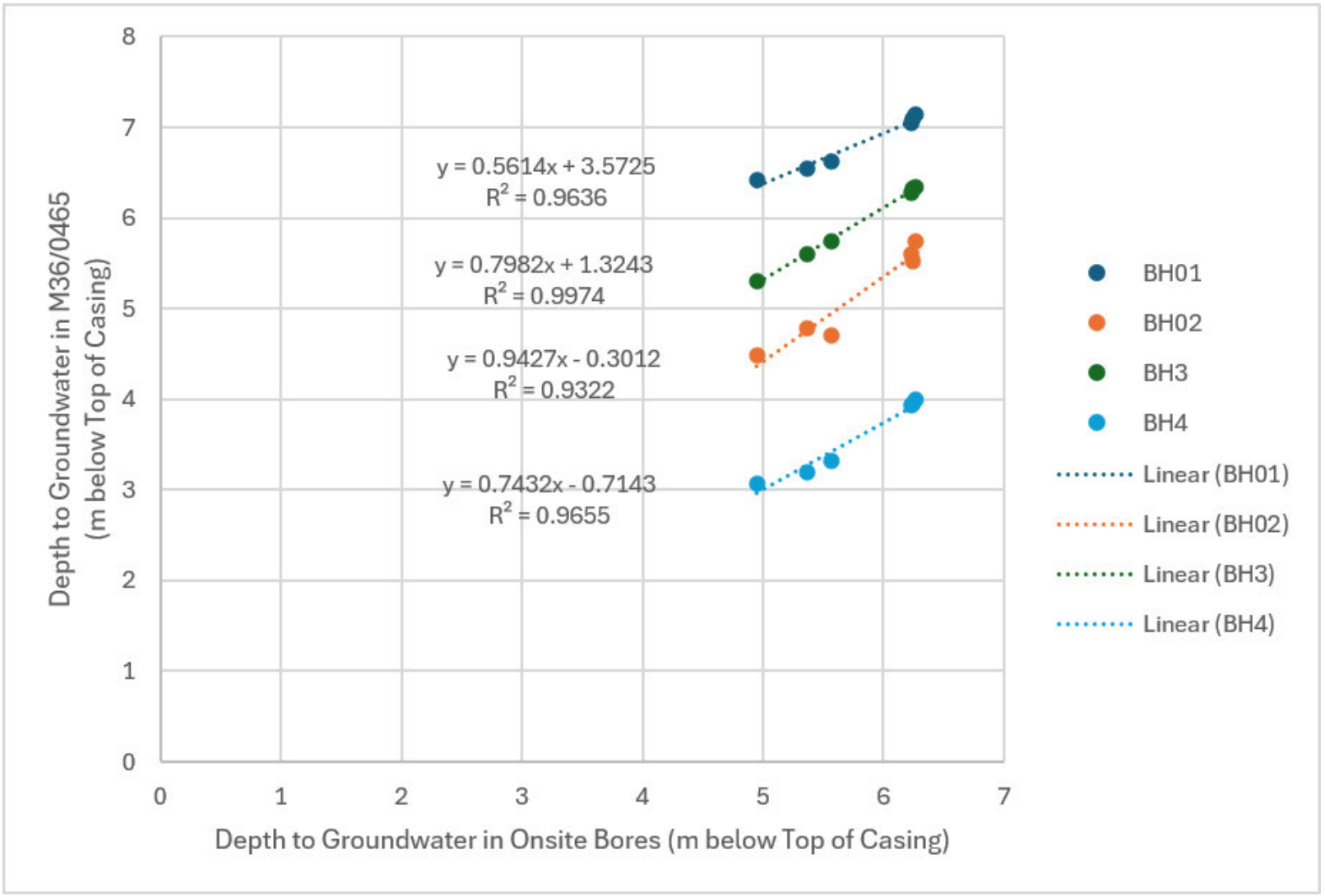
www.prodrill.co.nz
11 Alpito Place, Pukekohe, Auckland, New Zealand

This report was prepared in line with the New Zealand Ground Investigation Specification. Interpretation should be by a suitably qualified specialist.

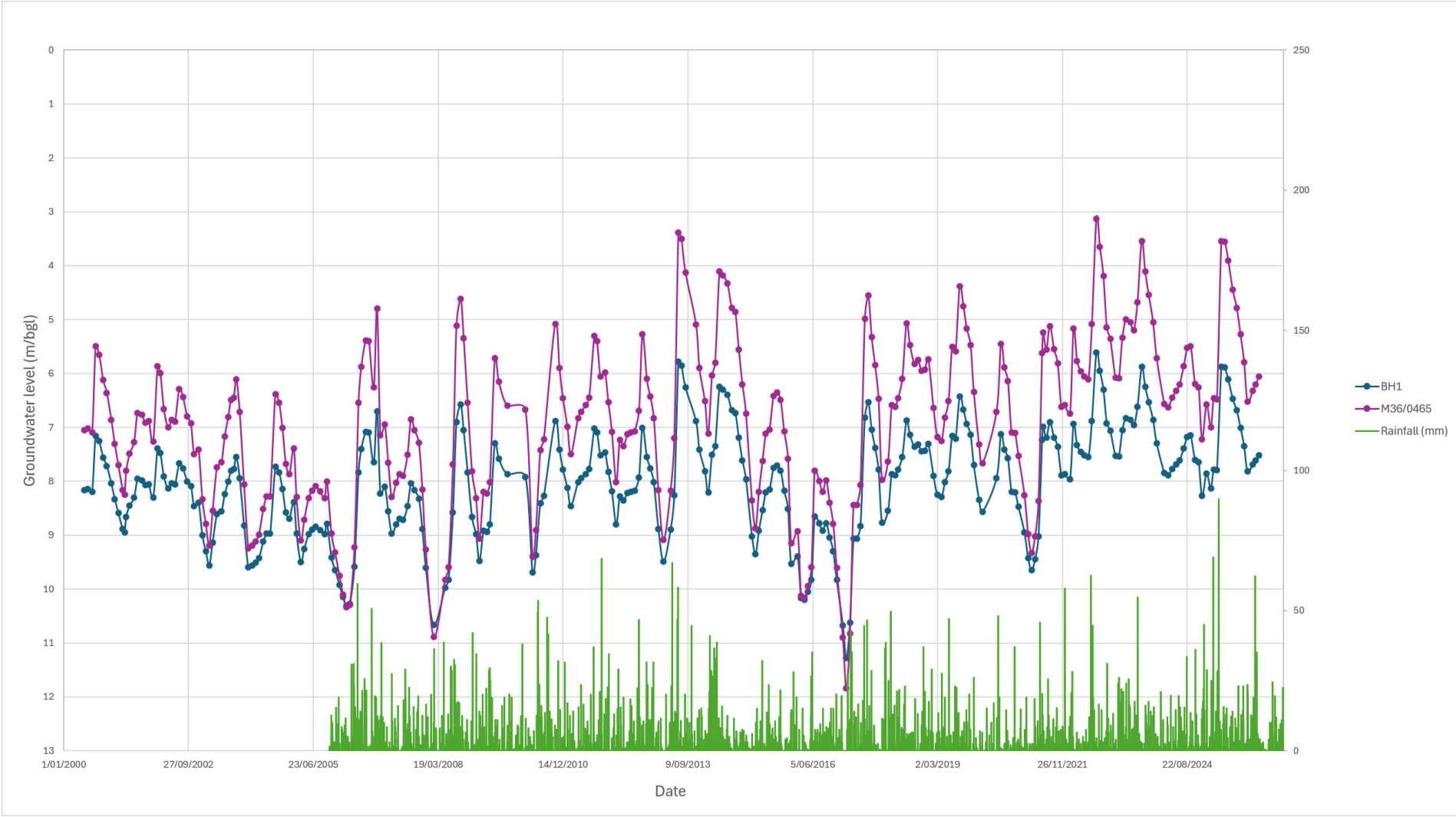
Magnetize

This report was created in Magnetize™, using the LIVE GEO™ Powerup
www.magnetize.co.nz

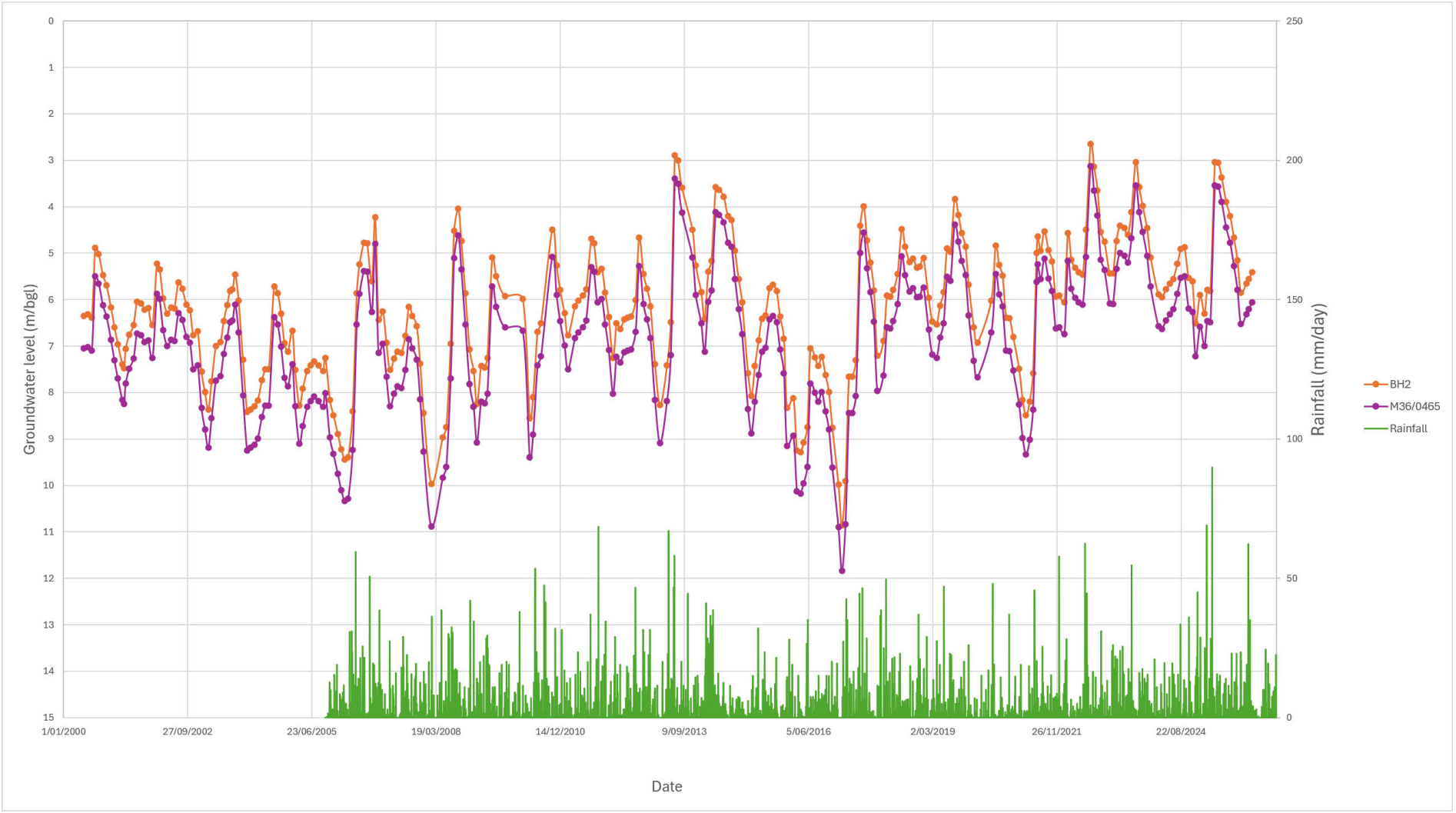
Appendix C: Groundwater Level regression analysis and Synthetic Groundwater level Plots



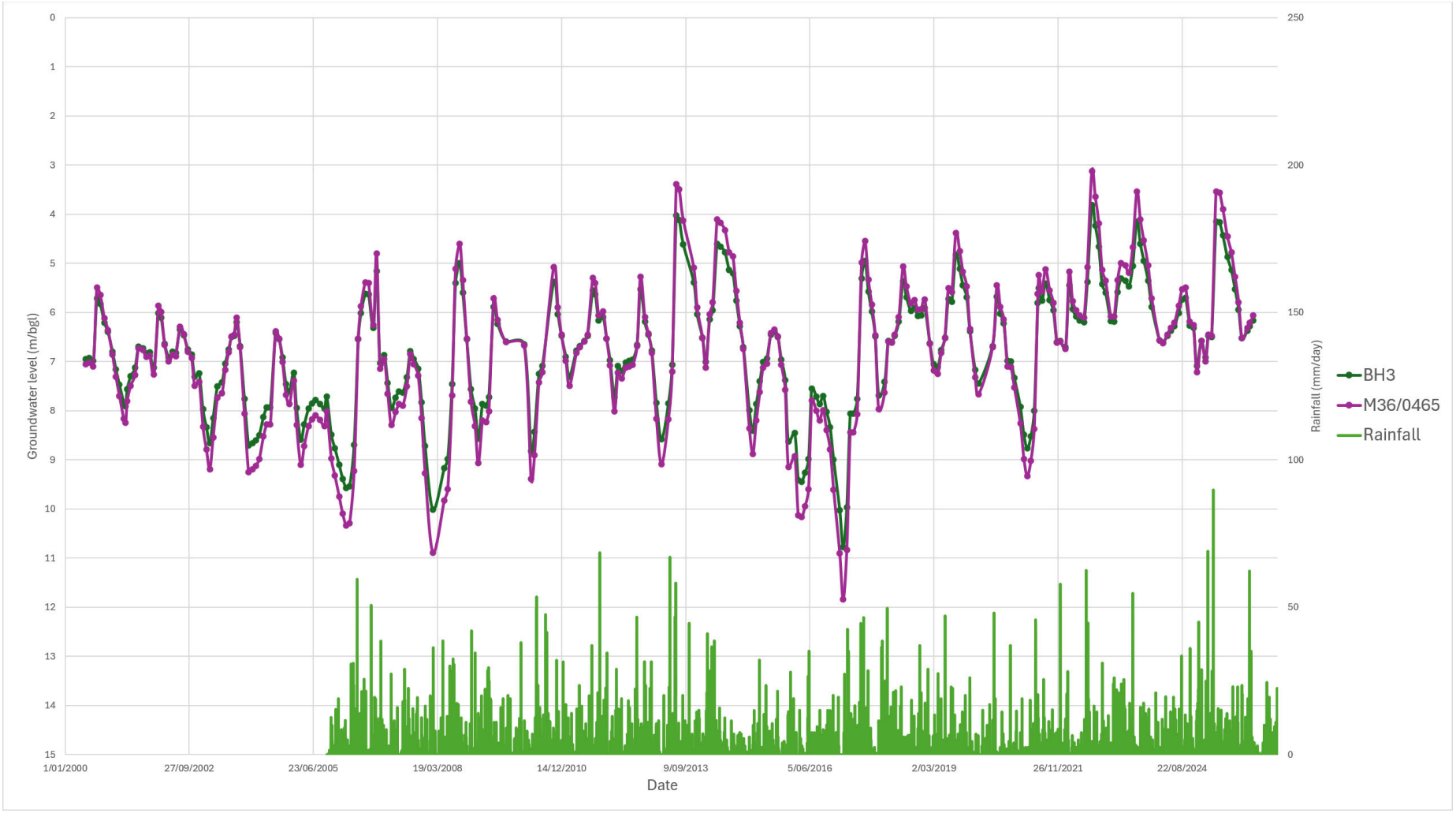
Regression Analysis



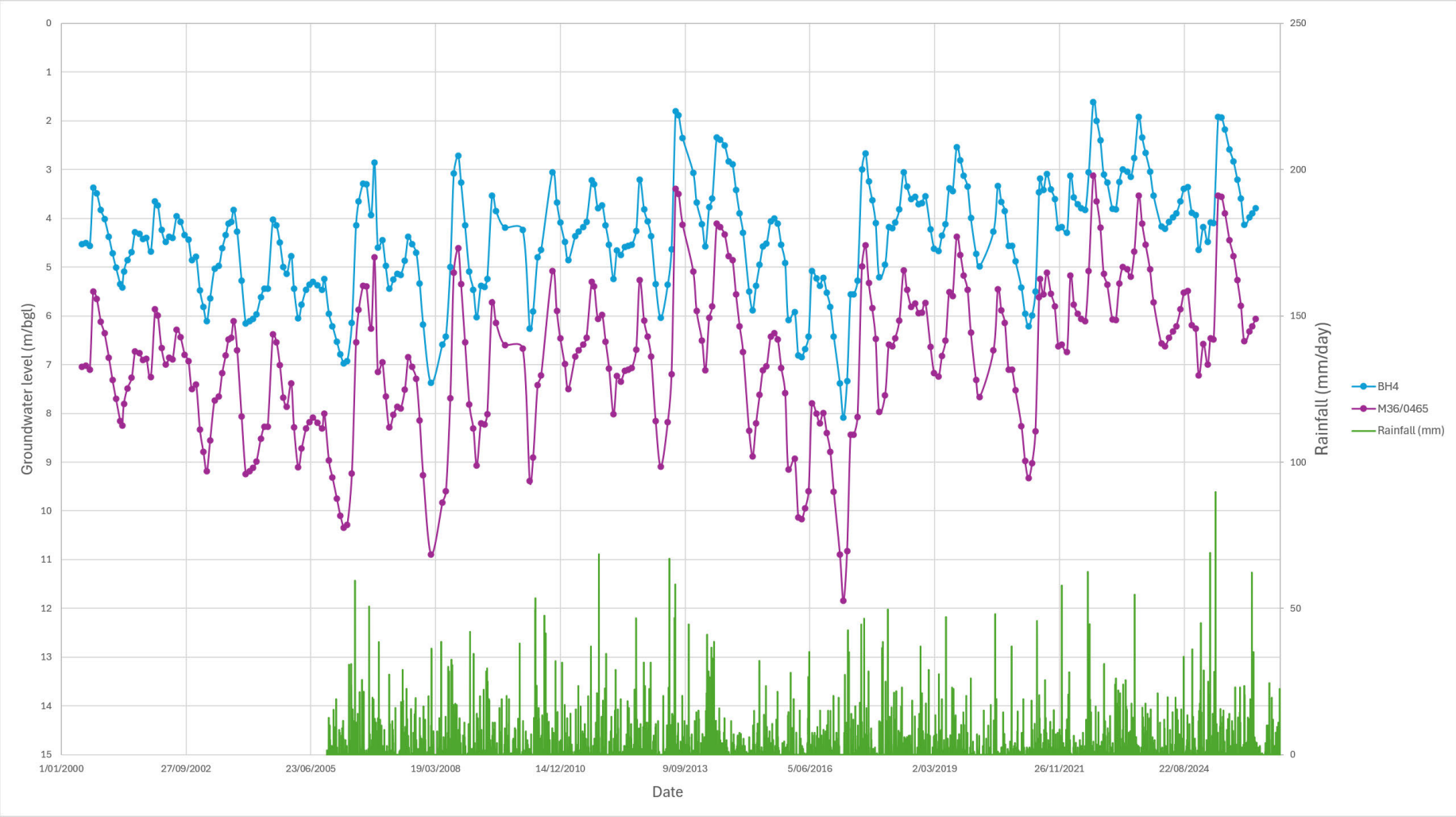
BH-001 Synthetic Groundwater Level Record



BH-002 Synthetic Groundwater Level Record



BH-003 Synthetic Groundwater Level Record



BH-004 Synthetic Groundwater Level Record