Fast Track Application – 531 and 535 Mill Road, Ohoka – Hydrology Assessment

Prepared for

Carter Group Ltd

June 2026

PATTLE DELAMORE PARTNERS LTD
Level 2, 134 Oxford Terrace
Christchurch Central, Christchurch 8011
PO Box 389, Christchurch 8140, New Zealand

Office +64 3 **345 7100**
Website **http://www.pdp.co.nz**

Quality Control Sheet

TITLE Fast Track Application – 531 and 535 Mill Road, Ohoka – Hydrology Assessment

CLIENT Carter Group Ltd

ISSUE DATE 2 June 2026

JOB REFERENCE C045180002

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
1	20/12/2025	Draft	Tom Garden	Bas Veendrick	Carl Steffens
2	03/07/2025	Draft	Tom Garden	Bas Veendrick	Carl Steffens
3	08/04/2026	Draft	Tom Garden	Bas Veendrick	Carl Steffens
4	28/5/2026	Final	Tom Garden	Bas Veendrick	Carl Steffens
5	02/6/2026	Final	Tom Garden	Bas Veendrick	Carl Steffens

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Tom Garden

Reviewed by

SIGNATURE

Bas Veendrick

Approved by

Carl Steffens

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Carter Group Ltd and others (not directly contracted by PDP for the work), including Environment Canterbury, Inovo, Tetra Tech Coffey Limited and Instream Consulting Ltd. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Carter Group Ltd for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Table of Contents

SECTION		PAGE
1.0	Introduction	3
2.0	Hydrogeological Setting	4
2.1	Soils	4
2.2	Geology	4
2.3	Hydrogeology	4
3.0	Local Groundwater and Surface Water Information	5
3.1	Groundwater Levels	5
3.2	Springs	7
3.3	Wetlands	8
3.4	Surface Water Flows	8
4.0	Potential Hydrological Effects of the Proposal	11
4.1	Change in Land Surface Recharge Contributing to Spring Flow due to the Increase in Impervious Area.	11
4.2	Potential for Re-Directing of Groundwater Flow Paths	12
4.3	Potential Effects on Hydrological Function of Wetlands	16
4.4	Potential Effects Downstream/Downgradient of the Site	16
5.0	Recommendations	17
6.0	Conclusions	17
7.0	References	18

Appendices

Appendix A: CVs

Appendix B: Figures

Appendix C: TetraTech Coffey and PDP groundwater level monitoring results

1.0 Introduction

Carter Group Ltd (Carter Group) has engaged Pattle Delamore Partners Ltd (PDP) to undertake a hydrology assessment for the proposed Ohoka Development to support its Fast-track application. The proposal involves the subdivision and development of 531 and 535 Mill Road, Ohoka, for residential and commercial use. Appendix A includes Curricula Vitae of the relevant PDP staff members involved in preparation of this report.

The site is approximately 154.4 hectares in area and located immediately southwest of the Ohoka settlement. The site includes multiple titles and consists predominantly of dry land and irrigated pasture that is mostly used for dairy farming. The topography of the site is generally flat, with a very gentle downward slope towards the east. The location of the site in the context of the regional geology is shown in Figure 1, Appendix B, while Figure 2 shows the site in more detail. The proposed subdivision plan is included in Figure 3. Proposed changes to existing waterways on the site are outlined in Figures 4A and 4B.

As shown in Figure 2, a tributary of Ohoka Stream crosses the northern part of the site, with additional waterways crossing the southern part of the site. Two springs are mapped on the site in the Canterbury Regional Council (ECan) online database, as shown in the figure. A seep is also present between Ohoka Stream and the Northern Spring Channel. Figure 2 also shows the location of a long-term groundwater level monitoring bore located onsite (M35/0596) near the middle of the site along Bradleys Road. As outlined in other consultant reports the main existing natural waterways such as the Ohoka Stream tributary and South Ohoka Branch will be retained as natural features. However, some existing drains will be removed or diverted to suit the proposed development layout.

PDP has been engaged to provide the following:

- An overview of the hydrogeological setting of the site, including groundwater flow patterns and water table depth.
- An assessment of the anticipated hydrological and hydrogeological effects of the proposed development at the site, including:
  - Assessment of the anticipated change in the surface derived rainfall recharge contributing to spring flow due to the increase in impervious area.
  - An assessment of the potential for re-directing/short-circuiting groundwater flow away from springs as a result of hardfill, drains, and service trenches.

2.0 Hydrogeological Setting

2.1 Soils

A review of soil information available on S-map (Landcare Research) indicates that the soil types underlying the site predominantly consist of Ayreburn moderately deep clay (Figure 5). Very small sections on the northern and southern part of the site consist of Ayreburn deep clay and Leeston shallow clay respectively. The Ayreburn moderately deep clay soil has a profile available water (PAW) of around 95 mm (for a rooting depth of 600 mm). The deep and shallow clay soils in the north and south have very similar PAW values of around 90 mm.

The soils determine the rate at which rainfall and associated stormwater infiltrate into the ground and recharge the underlying aquifer. S-map indicates that the Ayreburn moderately deep and deep clay and the Leeston shallow clay are poorly drained.

2.2 Geology

The site is located on the northern Canterbury Plains (i.e. the Waimakariri – Ashley Plains). The Canterbury Plains comprise a series of large coalescing fluvio-glacial fans built by large, braided rivers (e.g. the Rangitata, Rakaia and Waimakariri) that transported detritus (gravel with sand and silt) eastwards from rapidly rising and eroding mountains in the west. Most of the gravel deposition occurred during successive glaciations, when glaciers partly occupied the inland valleys and extended to the eastern foothills (Brown, L.J., 2001). Figure 1 shows the surface geology underlying the site.

The GNS geological map of the area (Forsyth *et al.*, 2008) maps the near-surface geology of the site as late Pleistocene brownish-grey river alluvium (Q2a). Geotechnical investigations at the site encountered silt, clayey silt and silty sand to depths of 0.6 to 1.5 m below ground level (bgl), and sandy gravel below this (Tetra Tech Coffey, 2025).

2.3 Hydrogeology

On the Waimakariri-Ashley Plains, groundwater is dominantly sourced from infiltrating rainwater (i.e. land surface recharge) across the inland plains (to the north-west (upgradient) of the site), together with some seepage losses from the Ashley and Waimakariri rivers. A map showing the location of the site within the context of the northern Canterbury Plains and the underlying geology is provided in Figure 1. Figure 1 also shows the general direction of groundwater movement in the overall area, indicating that groundwater generally flows to the southeast, towards the coast. Groundwater discharges into spring fed streams, including Ohoka Stream and the Cam River/Ruataniwha. Mapped springs are also shown on Figure 1.

The springs as depicted in Figure 1 (regional springs) and Figure 2 (onsite springs), represent regional groundwater discharge points. As a result, the source of water for the springs represents a spatially large groundwater catchment that extends a substantial distance upgradient (i.e. north-west) from the site. Delineating the precise capture zone for springs is uncertain, however based on available piezometric contours and our conceptual understanding of the groundwaters of the Ashley-Waimakariri Plains, groundwater discharging via the springs at the site is expected to be dominantly rainfall derived from upgradient of the site. Given the relatively high (but variable) permeability of the deeper strata that makes up much of the Canterbury Plains, and the generally deeper groundwater table upgradient of the site, a large overall spring capture zone is expected for the springs on the site.

3.0 Local Groundwater and Surface Water Information

3.1 Groundwater Levels

During geotechnical investigations at the site, conducted in May 2021, groundwater was encountered at a depth of 1 to 1.85 m bgl in 11 of 22 test pits excavated across the site (Tetra Tech Coffey, 2024). In the remaining 11 test pits, groundwater was not encountered at the base of the test pits, which ranged in depth from 0.6 – 1.7 m. The locations of these test pits, and the groundwater levels encountered, are shown in Figure 6.

A long-term record of groundwater table fluctuations is available from bore M35/0596, which is situated on the western-central part of the site and shown on Figure 2. This bore has a sporadic available record of water level measurements from September 1977 to October 1986, and weekly to monthly measurements from August 1999 to March 2026s as shown in Figure 7. The original depth of this bore was recorded as 9.6 m. In 2009 the depth of the bore was recorded as 2.9 m, presumably due to sediment accumulation in the bore, or collapse/ blockage of the bore casing.

The record from M35/0596 shows that the groundwater level at this site is generally shallow, with an average measured value of 0.73 m bgl. The highest measured groundwater level was 0.22 m bgl (March 2023) and the lowest recorded levels were 1.5 m bgl in July 1999 and 1.48 m bgl in February 2017. Seasonal fluctuations are relatively small, commonly being 0.5 – 0.8 m. As expected, groundwater levels are generally highest in winter/spring and lowest in summer/autumn.

Figure 7 also shows the period when test pitting occurred on the site (highlighted in red, May 2021). The data indicates that the test-pitting investigations were undertaken at a time of relatively low water levels.

Bore M35/0601 is located 1.4 km east of the site and 12.8 m deep. This bore also has a long-term groundwater level record (from August 1973 to December 2024 and shows generally similar patterns to bore M35/0596, though the average groundwater level is slightly shallower at approximately 0.5 m bgl.

Bore M35/0314 is 800 m northeast of the site and 15.8 m deep. This is a former monitoring bore and has a groundwater level record from 1974 to 1987. During this period groundwater levels fluctuated from 0.45 m to 1.74 m bgl.

A total of 37 shallow (up to 1.6 m deep) standpipes were installed at the site via hand auger by Tetra Tech Coffey in 2023. The locations are shown in Figure 8, and the data is provided in Appendix C. Groundwater levels were periodically measured in these standpipes from August 2023 to February 2025. The monitoring shows that the groundwater level across the site varies from approximately 0.05 – 1 m bgl, with relatively modest fluctuations over that time period in most standpipes, on the order of 0.2 – 0.4 m. The shallowest groundwater levels were measured in the standpipes near springs or streams.

A total of 23 new shallow piezometers were installed at the site via a machine drilling rig in early 2025. The 37 standpipes (mostly 3 m deep) installed via hand auger in 2023 are referred to as the 'old piezometers' in Appendix C. The new piezometers were installed by McMillan Drilling and were appropriately constructed for the soils on site, with permanent toby box installations and appropriate screens and associated filter pack. These purpose-drilled piezometers ensure that accurate and reliable groundwater level measurements can be taken. The new piezometers (labelled P1 – P23) have been measured on several occasions from March 2025 to April 2026, and their locations are shown in Figure 9. Tables and graphs showing the groundwater levels for the new piezometers are presented in Appendix C, alongside the data for the old piezometers. The monitoring thus far shows that the groundwater levels in the new piezometers across the site vary from approximately 0.01 to 2.28 m bgl. The shallowest groundwater levels so far were measured on the 2nd May 2025, and the highest levels occurred in the piezometers near springs or streams. Pressure transducers have been installed in several of the new piezometers to provide a continuous groundwater level record. The locations of these transducers and their groundwater level records are provided in the PDP water supply assessment report (PDP, 2026a).

Nearly all of the monitoring bores installed at the site were screened within the sandy gravel strata that underlies the thin relatively thin layer of fine grained lower permeable clay, silt and sand-based soils. The exception to this are bores P05 and P16. P05 is only 0.65 m deep with a screen between 0.3 m and the base of the borehole, while P16 is 0.75 m deep and screened from 0.4 to its base. P05 is located immediately adjacent to P04, while P16 is situated immediately adjacent to P20. P04 and P20 are both screened from 2 to 3 m below ground level. Ground elevations at P04/P05 are more or less the same and this is also the case at P16/P20. The groundwater level monitoring data indicates that relative levels in P04 and P05 are variable, where on some occasions levels have been slightly higher in P04 and at other times levels have been higher in P05. However, the maximum difference in levels between these two bores to date is only around 0.13 m. In contrast levels in P20 (deeper bore) have always been lower than those in P16 (by between approximately 0.15 and 0.56 m). The reason for higher measurements in the shallow bores could be due to the slower draining characteristics of the finer grained shallow strata following rainfall events.

Our conclusions based on the available data are that there is no evidence of a significant upwards gradient between the relatively shallow sandy gravel strata intercepted by the majority of monitoring bores onsite and the overlying thin layer of fine-grained clay, silt and sand-based deposits.

3.2 Springs

As stated in section 1 above, two springs (ECan reference M35/7485 and M35/7487) are mapped on the site, and are shown on Figure 2. M35/7485 is near the centre of the western site boundary, and is described in the ECan database as artesian, permanent and having a channel or linear morphology. This spring is the source for a waterway described as Northern Spring Channel. M35/7487 is near the centre of the site and is described in the ECan database as of undetermined type, permanent and having a channel or linear morphology. This spring is the source for the Southern Spring Channel waterway and forms a pond. The spring referred to as a seep is situated around 370 m east of spring M35/7487.

The occurrence of heavy soils and springfed waterways indicates that this site is located within a groundwater discharge zone, i.e. groundwater is discharging into surface waterways.

Several hand augerholes were advanced by Tetra Tech Coffey in November 2024 near the major springs on site in order to understand the thickness of the confining strata at these locations. Thickness was determined by the depth at which the hand augers reached refusal on gravel. The augers indicate the following:

- Near the western spring M35/7485 (headwaters of the Northern Spring Channel – see Figure 2), the surface confining layer is 0.4 m thick and consists of silt and sandy silt.
- Near the southern spring pond M35/7487, the surface confining layer is 0.9 – 1.2 m thick and consists of silt, silty sand to sandy silt, and peat.
- Near the groundwater seep, the surface confining layer is 0.5 – 0.6 m thick and consists of silt and silty sand.

It is noted that although spring M35/7485 is described in the ECan database as being artesian, as discussed in Section 3.1 above, the groundwater level monitoring shows that no elevated (e.g. artesian) pressures have been encountered in deeper bores screened in the sandy gravel strata that underlies the thin fine-grained surface strata. Therefore, it is assumed that springs at the site are typically gravity type features that are the result of a shallow water table intercepting low lying land rather than the result of shallow artesian groundwater conditions.

With regard to groundwater flow contribution to springs, the thin surficial soils underlying the site are fine grained and of low permeability and therefore we expect the contribution to spring flow from these soils is low. Therefore, it is expected that spring flows are mainly derived from the shallow sandy gravel strata that underlies the lower permeability deposits. Specific springs are expected to represent sites of local thinning of the fine-grained surface soils and/or downcutting into this layer by the stream network. Onsite recharge to the shallow gravels is expected to be low given the low drainage potential of the overlying surface soils, however there is a large groundwater catchment upstream of the site which is expected to provide the majority of this recharge.

3.3 Wetlands

Wetlands are areas where the groundwater table is permanently or intermittently at or close to the ground surface. There are 15 areas of wetland, as delineated by PDP (PDP, 2025). These are located in depressions, ephemeral channels and near springs, as shown on Figures 4A and 4B. Wetlands are being retained in the following locations:

- Around the site of spring M35/7485;
- Around the site of the groundwater seep, between Ohoka Stream and Northern Spring Channel;
- Around the channel of Ohoka Stream (South Branch), near its upstream end.

3.4 Surface Water Flows

Surface water flows have been measured in the onsite streams and drains in February 2025, July 2025, August 2025 and November 2025. Some of the drains on site do not have permanent flow and have been assessed to only drain stormwater after rain events (Instream, 2025). Surface water flows in these drains have not been measured. The gauging sites were initially located at the upstream and downstream ends of all streams or drains onsite in order to understand the baseline pre-development surface water flows, and estimate stream flow losses or gains to groundwater. The August and November 2025 gauging rounds included additional sites along the South Branch of Ohoka Stream and the Northern Spring Channel, in order to constrain where the main gains from groundwater occur along these waterways. The flow gauging results are provided in Table 1 below, and the gauging sites and results for the February, August and November 2025 rounds are provided in Figures 10 and 11 and 12, respectively. A figure of the July 2025 results is not provided due to the results being similar to the August round but with less detail due to fewer flow gauging sites.

Table 1: Flow gauging results

Gauging site	Waterway	Flow (L/s)			
		25/2/2025	11/7/2025	18/8/2025	27/11/2025
FG-1	Ohoka Stream South Branch	0	53	74.5	18.4
FG-13		-	-	116.3	17.8
FG-12		-	-	149.5	29.8
FG-2		17.8	123	143.3	56.1
FG-3	Northern Spring Channel	1.7	8	5.0	3.8
FG-11		-	-	17.0	5.7
FG-4		7.4	18	17.6	4.0
FG-5	Southern Spring Channel	4.6	-	11.0	2.3
FG-6		3.0	6	10.8	7.8
FG-7	Groundwater Seep Channel	2.5	-	4.4	3.6
FG-8		1.8	4	4.3	2.6
FG-9	Ohoka Stream Tributary	11.4	192	205.4	103.7
FG-10		14.9	200	192.6	101.5
Total Surface Water Inflows[1]		**13.1**	**253**	**284.9**	**125.9**
Total Surface Water Outflows[2]		**44.9**	**351**	**368.6**	**172.0**
Net Gains from Groundwater		**31.8**	**98**	**83.7**	**46.1**

Notes:

1. *Combined total of sites FG-1, FG-3 and FG-9*
2. *Combined total of FG-2, FG-6, FG-4, FG-8 and FG-10*

3.4.2 February 2025 Results

The February 2025 gaugings completed on the Ohoka Stream Tributary indicated stream flow gains from groundwater between the upstream (FG-9, 11.4 L/s) and downstream (FG-10, 14.9 L/s) locations. The Ohoka Stream (South Branch) was dry at the upstream end (FG-1), with water only beginning to flow approximately 600 m downstream. The downstream gauging site (FG-2) had a flow of 17.8 L/s, which indicates that this flow originates from groundwater gains in this reach. The Northern Spring Channel emerges as a spring on the site, and had an upstream (FG-3) flow of 1.6 L/s immediately downstream of the spring and a downstream (FG-4) flow of 7.4 L/s, indicating a groundwater gain in this reach as well.

The Southern Spring Channel emerges on site, which was gauged immediately downstream of spring M35/7487 (FG-5, 4.6 L/s) and at the downstream end (FG-6, 3 L/s), which potentially indicates a very small stream flow loss to groundwater, however the differences between these flows is small and the magnitude of flow is small. Lastly, a small unnamed waterway fed by the groundwater seep emerges on the site and was gauged immediately downstream of the seep (FG-7, 2.5 L/s) and at the downstream (1.8 L/s) end, which also indicates a potential very small loss in stream flow. The difference in stream flow in both of these unnamed waterways is less than 2 L/s, and the magnitude of flow is also small. Therefore, it is difficult to draw a definitive conclusion about the nature of groundwater gains or losses in these two locations.

3.4.3 July and August 2025 Results

The gaugings conducted in winter 2025 showed that surface water flows are generally significantly higher compared to the summer gauging round. The biggest differences in flows between summer and winter were in the Ohoka Stream Tributary and the South Branch of Ohoka Stream, with upstream flows of 205.4 L/s and 74.5 L/s, respectively. While flows were higher in the spring channels and groundwater seep, the difference was not as large compared to the summer gaugings, though flows were still roughly twice those in summer.

The additional gaugings conducted in the Northern Spring Channel and South Branch of Ohoka Stream in August 2025 showed that gains from groundwater in both of these waterways largely occurred in the western half of the site. In all the waterways across the site there is little gain from groundwater (or a very small/negligible loss for some waterways) across the eastern half of the site.

3.4.4 November 2025 Results

The gauging conducted in November 2025 showed that flows were generally higher than the summer round but lower than the winter rounds. Compared to the two rounds conducted in winter, in the November 2025 round a larger proportion of the gains in the Ohoka South Branch and Southern Spring Channel occurred towards the eastern side of the site. This may be due to differences in groundwater levels across the southeastern part of the site; in the November round groundwater levels were shallower at P14 than at P16, while in the August round groundwater levels groundwater levels were shallower at P16 than at P14. Both these bores are near the South Ohoka Branch, with P16 further upstream compared to P14. The shallower groundwater levels at the downstream end of the South Ohoka Branch may have meant more gains from groundwater occurred in the eastern part of the site.

Further flow gaugings are proposed during and after construction in order to monitor any potential changes as a result of the development. Consent conditions are proposed which require the applicant to undertake these flow gaugings. Further details are provided in section 4.2 and 5.0 below.

4.0 Potential Hydrological Effects of the Proposal

4.1 Change in Land Surface Recharge Contributing to Spring Flow due to the Increase in Impervious Area.

It is expected that the pattern of rainfall infiltration through the soil will change as a result of the proposed development and stormwater management within the site. Stormwater runoff volumes are likely to increase due to the increase in impervious surfaces (roofs and pavements) and the corresponding reduction in evapotranspiration. To address the increase in stormwater runoff volume, management of the stormwater runoff is required. Due to the poorly drained soils and high groundwater levels, stormwater from roofs and hardstand areas cannot be discharged to ground and will be managed using on-site stormwater treatment and attenuation prior to discharge to surface waterways. Further details on the proposed stormwater system for the site are provided in the Inovo infrastructure report (Inovo, June 2025) and the PDP stormwater management report (PDP, 2026b).

The reduction in groundwater recharge due to the increase in impervious surfaces has the potential to reduce land surface recharge at the site, which is a source of spring flow. However, as discussed in Section 2.3 above, the available information indicates that the groundwater catchment for the springs on the site is spatially large, and extends a substantial distance upgradient. In addition, and as described in sections 3.1 and 3.2, the shallow soils on the site are of low permeability and generally poorly drained and therefore the underlying shallow gravels are expected to be the dominant source of spring flows. These factors mean that the current contribution of land surface recharge within the development area to spring flow is likely to be small, and most of the recharge to the onsite shallow gravels is likely to be sourced from groundwater through-flow from areas upgradient of the site.

In addition, there are currently a number of shallow irrigation bores at the site, authorised by consents CRC991022 and CRC991827. These bores have relatively large consented rates of take (totalling up to 60 L/s for the bores listed in CRC991022 and up to 45.6 L/s for the bores listed in CRC991827). The irrigation bores are relatively shallow (9.4 – 30 m deep) and are expected to have a high to moderate degree of stream depletion effect. Post-development, these will no longer be used and deep community supply bores will be installed. Once the shallow irrigation bores on the site are decommissioned, then this is likely to have a positive impact on spring flows (PDP, 2026a).

It should be noted that most land surface recharge is expected to occur in winter and early spring, which is when groundwater levels are generally highest. Conversely, abstraction from the existing shallow irrigation bores largely occurs during the irrigation season over spring and summer, and therefore it is likely that the largest stream depletion effect from this abstraction occurs during the drier seasons when surface water flows are relatively low. In addition, the stormwater management areas (SMAs) will be constructed such that the outlet is at an elevation above the seasonal highest groundwater level (PDP, 2026b). This means that during times of low groundwater levels, a higher proportion of the stormwater runoff from the site will infiltrate to groundwater than during times of high groundwater levels. These aspects mean that the proposed development is not expected to adversely affect the seasonality of surface water flows on site, and, due to the shallow irrigation bores being decommissioned, is likely to result in an increase in flows at times of low flows.

Based on the above it is considered that the change in groundwater recharge contributing to spring flows as a result of the proposed development is relatively small and unlikely to be an issue.

4.2 Potential for Re-Directing of Groundwater Flow Paths

4.2.1 Potential Effects from Service Trenches and Hardfill Areas

One of the potential effects of urban development on spring flows is the potential for service trenches (for stormwater, sewer, telecommunication and electrical networks) and hardfill areas to intercept shallow groundwater and re-direct groundwater flow away from springs. Service trenches backfilled with gravels and hardfill areas can be much more permeable than the surrounding strata and if shallow groundwater is intercepted they may act as preferential groundwater flow paths lowering the groundwater level locally, diverting water away from spring heads. This potentially results in reduced spring flows.

Based on these considerations, construction measures should be utilised to ensure that shallow groundwater is not diverted away from its natural flow path. It is noted that this approach is not new. For example, Christchurch City Council (CCC) require that any new stormwater pipe networks will be designed and constructed so that any diversion and discharge of shallow groundwater that might impact baseflow in streams and springs is avoided by implementing appropriate mitigation measures (as noted in section 5.10.8 of the Council's Infrastructure Design Standard [CCC, 2018]). These measures involve ensuring that any groundwater in the water bearing layers will not be diverted to a new exit point through the backfill. More specifically, they require that backfill material with the same permeability as the surrounding ground will be used. In addition, CCC require low permeability backfill material to be used in trenches for underground services to provide a plug that avoids diversion of groundwater into a different catchment.

As detailed in the infrastructure report (Inovo, June 2025), hardfill may be required under roads and the excavation depth for roads is likely to be in the order of 0.6 m, much shallower than the anticipated excavated depth of service trenches (1.0-1.2 m deep). If required, engineered soils with low permeability or incorporation of geotextiles instead of granular hardfill can be used to avoid re-directing groundwater in areas of shallow groundwater.

For areas where shallow groundwater is likely to be intercepted, mitigation measures such as those described in the infrastructure report (Inovo, June 2025) and Infrastructure Design Standard (CCC, 2018) can be employed. It is likely that these mitigation measures will be mostly required in service trenches rather than under roads, due to the likely deeper excavations needed for service trenches although this will need to be confirmed by groundwater level monitoring and the nature of the soils encountered during excavation. Mitigation measures should focus on areas in the vicinity of the springs (refer to Figure 2).

It is also expected that the most significant potential effects are likely to be in areas where the sandy gravels underlying the site are shallow and excavations extend into or close to the gravels. Therefore, the most sensitive areas can be established prior to construction based on available geological information (including penetrative investigation and groundwater level data and proximity of proposed works to surface water).

It is recommended to monitor groundwater levels and spring flows during and following construction. This monitoring will inform which of the proposed mitigation measures described above are most appropriate in different parts of the site and where specific measures are required. This information will also help to ensure that the methods used are working as intended to avoid any potential effects on spring flows or other adverse hydrological effects. The proposed consent conditions include a requirement to undertake groundwater level monitoring and spring flow monitoring across the site.

Significant groundwater monitoring and surface water monitoring has already been undertaken and the results of the surface water monitoring since February 2025 have been described in this report. As described in section 3.1, substantial groundwater level information is available for the site and a total of 23 new piezometers were installed via a machine drilling rig in early 2025. These purpose-drilled piezometers ensure that accurate and reliable groundwater level measurements can be obtained. Three piezometers are installed in the vicinity of the springs and groundwater seep on the site (Refer to P10, P21 and P23 in Figure 9).

In addition, the proposed consent conditions also include a requirement to specify construction measures (in the vicinity of the springs and groundwater seep) to ensure that shallow groundwater (in water bearing seams and layers) is not diverted away from its natural flow path for those areas where the shallow groundwater is likely to be intercepted by service trenches and hardfill areas.

The site management plan (SMP) describes engineering measures able to manage these potential effects. Ongoing monitoring will ensure that the measures are effective and can be adapted if necessary to ensure that adverse effects can be adequately avoided or mitigated.

As detailed in the aquatic ecology assessment (instream, June 2025) it is also noted that a stream buffer setback distance of 30 metres between the developed areas and springs is proposed. A 20-metre stream buffer setback distance is also proposed between the developed areas and the groundwater seep shown in Figure 2. These separation distances were recommended by the project ecologists, and based on the hydrogeologic characteristics of the site the proposed separation distances should be more than sufficient to avoid any adverse hydrological effects on the springs and groundwater seep.

It should also be noted that groundwater may be intercepted by stormwater management areas (SMAs) such as attenuation basins and wetlands. This is intended to be reduced by the reuse of the natural silty soils in the base of the structures. The outlets from SMAs are also going to be constructed at an elevation above the highest seasonal groundwater level at these locations, hence only stormwater from rain events will discharge from the SMAs and there will be no discharge of groundwater. This is discussed further in the PDP Stormwater Management report (PDP, 2026b).

4.2.2 Potential Effects from Areas of Fill

The development will involve the filling of some depressions, drains and wetlands on site, as shown in Figures 4A and 4B. The filling of these lower elevation areas has the potential to change the pattern of groundwater contribution to surface water across the site.

The unnamed drains that will be filled are all drains that do not have permanent flow, and have been assessed to drain stormwater after rain events (Instream, 2025). The stormwater drainage function of these drains will be replaced by the constructed stormwater network post-development. These drains that will be filled in are not expected to have significant contribution to downstream surface water baseflows, and any groundwater contribution to these waterways is likely to be limited to areas of ponding when the groundwater table is particularly high. Similarly, the areas of wetland that will be filled do not contribute significant flow to downstream waterways. It is possible that there may be a slight increase in groundwater level at locations where drains or depressions are filled, however due to filling increasing the ground elevation it is not expected that there will be adverse flooding effects, and the waterways that are retained are still expected to limit the magnitude of any potential increase in groundwater level.

Some permanent waterways have sections that are proposed to be realigned, which will involve the filling of the existing channel for these reaches and excavation of a new channel. The waterways affected are parts of the South Ohoka Branch, Northern Spring Channel and the Groundwater Seep. These waterways are being realigned in an area with similar geology, and hence it is expected that similar groundwater – surface water interaction will occur in the realigned sections as currently occurs in the sections that will be filled in. Although there will be small changes in the pattern of groundwater levels across the site as a result of the realignment, overall we largely expect similar gains or losses to occur in the new realigned sections of waterways as currently occur in the sections to be filled in, and do not expect any significant change to the overall surface water flows that leave the site.

With regards to the Northern Spring Channel, the realignment of this waterway will result in it being closer to the Southern Spring Pond springhead than the existing waterway, which has the potential to result in a local lowering of groundwater levels, which could affect the spring flows at the Southern Spring Pond. This potential effect will be mitigated by the installation of a low permeability liner where it is close to the Southern Spring Pond, and the realigned channel will maintain a buffer distance of at least 10 m from this spring. With these measures in place, it is considered unlikely that any significant changes in the levels of the Southern Spring Pond would occur.

If any areas that receive significant groundwater contribution at times of high groundwater level are filled, it is expected that there could be changes in the pattern of groundwater contribution, and that this would be offset by an increase in groundwater seepage to nearby waterways that are retained. However, the total combined groundwater contribution to surface water, and hence surface water flows, from the site are not expected to change significantly. As stated above, the waterways that are retained on site, and the drain along Whites Road, are expected to limit the magnitude of any potential increase in groundwater levels that could affect properties downgradient.

4.3 Potential Effects on Hydrological Function of Wetlands

The changes in land surface recharge discussed in Section 4.1 above also have the potential to affect wetlands. If a reduction in land surface recharge were to cause a reduction in groundwater levels then the hydrological function of the wetland could be compromised by reducing the amount of time the ground is saturated. A change in groundwater levels could be expected if local land surface made a large contribution to the site groundwater balance compared to groundwater throughflow from upgradient. However as discussed in Section 4.1, it is expected that the current contribution of land surface recharge within the development area is small compared to groundwater through-flow, therefore any reduction in local land surface recharge is not expected to significantly affect groundwater levels or wetland hydrology.

There is also potential for re-directing of groundwater flow paths, as discussed in Section 4.2 above, to locally lower groundwater levels and therefore affect the hydrology of wetlands on site. However, given the proposed careful engineering measures to prevent such re-directing, it is not expected that there will be any such adverse effects on wetlands as a result of the proposal.

4.4 Potential Effects Downstream/Downgradient of the Site

There is potential that any change in groundwater contribution to surface water, and hence surface water flows, on site could affect properties downstream and/or downgradient of the site. If the development results in a decrease in surface water flows this could affect existing surface water takes downstream, while an increase in surface water flows or groundwater levels could affect flood risk to properties downstream/downgradient of the site.

While the sections above have addressed these concerns to a degree and concluded that there is unlikely to be a significant change in overall groundwater levels downgradient of the site, or surface water flows leaving the site, this section is intended to address the sensitivity of downstream/downgradient users if a change were to occur.

Regarding existing surface water takes downstream of the site, one active consent for the take of surface water from Ohoka Stream has been identified in the ECan database downstream of the site. This is consent CRC212993 which authorises the take of surface water when the flow in Ohoka Stream as estimated by ECan from measurements at the confluence with the Kaiapoi River is greater than 300 L/s. There are also three groundwater take and use consents (CRC133068, CRC140529 and CRC152471) downgradient of the site that are subject to minimum flow restrictions. These restrictions apply to the flow at the same site as the surface water take described above, with the maximum restrictions occurring when the flow at the confluence of Ohoka Stream and the Kaiapoi River is less than 300 L/s. As the site is a relatively small part of the

Ohoka Stream catchment, and changes to total surface water flows are expected to be small in comparison to the 300 L/s minimum flow in Ohoka Stream (at the confluence with the Kaiapoi River), impacts from the site are expected to be minimal, particularly when consideration of the large (a total of more than 100 L/s) stream-depleting groundwater takes that will be surrendered or transferred to deeper takes with lower stream depletion effect are taken into account.

Regarding any potential increase in flood risk to downstream/downgradient properties if groundwater levels rise or surface water flows increase, it is expected that any potential overall increase in groundwater levels downgradient of the site would be negligible, as the waterways retained on the site and along Whites Road will limit the magnitude of any potential increase in groundwater levels. Any potential increase in baseflows to surface waterways from groundwater is expected to be negligible in comparison to flood flows due to surface runoff from rain events and are not expected to materially impact flood risk to downstream properties. Impacts on flood risk due to the change in impervious area on site have been addressed by other technical reports.

5.0 Recommendations

The following recommendations should be incorporated into consent conditions:

- a requirement to specify construction measures to ensure that shallow groundwater is not diverted away from its natural flow path for those areas where the shallow groundwater (in water bearing seams or layers) is likely to be intercepted by service trenches and hardfill areas;
- A requirement to install a low permeability liner on the realigned Northern Spring Channel in the vicinity of the Southern Spring Pond springhead; and
- a requirement to undertake groundwater level and spring flow monitoring across the site during and after construction to inform the construction methodologies that are applied in different parts of the site, related to shallow groundwater issues.

6.0 Conclusions

The conclusions of this hydrological assessment are as follows:

- The potential decrease in groundwater recharge contributing flow to springs or wetlands due to an increase in impervious area is likely to be less than minor.
- With appropriate careful engineering measures, it is considered that re-directing of groundwater flow paths can be adequately mitigated such that spring flows on the site will not be adversely affected.

- The buffer distance of 20 - 30 meters between the developed areas and the springs and groundwater seep, further reduces the risk of any potential adverse hydrological effects on spring flows.
- The filling and/or realignment of drains and waterways may cause very small changes in the pattern of groundwater levels, however the total combined groundwater contribution to surface water, and hence surface water flows, from the site are not expected to change significantly.
- The requirement to install a low permeability liner on the realigned Northern Spring Channel in the vicinity of the Southern Spring Pond springhead will mitigate any potential adverse effects on the levels and flows of the Southern Spring Pond.
- There is unlikely to be a significant change in overall groundwater levels or surface water flows downgradient/downstream of the site, with negligible effects on downgradient consent holders subject to minimum flow restrictions, or downstream flooding, expected.

7.0 References

Brown, L. J. (2001). Canterbury. In M. Rosen, & P. White (eds), *Groundwaters of New Zealand* (pp. 441-459). New Zealand Hydrological Society Inc., Wellington.

Christchurch City Council. (2018). Infrastructure design standard, December 2018. Retrieved from https://ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/download-the-ids/

Forsyth, P., Barrell, D., & Jongens, R. (2008). *Geology of the Christchurch area.* 1:250 000 geological map 16, Institute of Geological & Nuclear Sciences, Lower Hutt.

Inovo (2025), Infrastructure report – Mill Road, Ohoka – Fast Track Application

Instream Consulting Ltd (2025). Fast Track Application – 531 & 535 Mill Road – Aquatic Ecology Assessment.

Pattle Delamore Partners Ltd. (2025). *Wetland Assessment – 531 & 535 Mill Road, Ohoka. PDP ref C045180001M002.*

Pattle Delamore Partners Ltd. (2026a). *Fast Track Application - 535 Mill Road, Ohoka - Water Supply Assessment of Environmental Effects. PDP ref C045180002R002.*

Pattle Delamore Partners Ltd. (2026b). *Fast Track Application – Stormwater Management for 531 and 531 & 535 Mill Road, Ohoka. PDP ref C045180001R002.*

Tetra Tech Coffey (2025). *Ohoka Development Geotechnical Assessment Report - Fast-track Application. Report reference number: 773-CHCGE288040AB.*

Appendix A: CVs

Bas Veendrick

TECHNICAL DIRECTOR – WATER RESOURCES

Bas is a Technical Director and senior hydrologist with nineteen years of experience working in consultancy. He has a wealth of experience in surface water and groundwater hydrology, catchment analyses and general water resources. As a senior hydrologist Bas has extensive experience with many hydrological and hydraulic modelling packages and has been involved in various projects related to stormwater assessments and general hydrology. He has specific experience with assessing the effects of urban development on Land Surface Recharge(LSR) and spring flow.

Qualifications

MSc (Hydrology), 2002, Utrecht University

BSc (Earth Sciences), 2000, Utrecht University

Affiliations

Member of New Zealand hydrological Society

Career Summary

2021 – Present

Technical Director/ Senior hydrologist Pattle Delamore Partners Ltd, Christchurch

2014 – 2020

Service Leader/Senior hydrologist , Pattle Delamore Partners Ltd

2012 – 2014

Senior hydrologist, Pattle Delamore Partners Ltd

2008 – 2012

Hydrologist, Pattle Delamore Partners Ltd

2006 – 2007

Hydrologist, Aurecon, Christchurch

2002 - 2003

Hydrologist, Waterboard De Stichtse Rijnlanden, The Netherlands

CORE EXPERTISE

- Surface water and groundwater hydrology assessments
- Catchment analysis
- Water resources management
- Assessment for hydro-power generation projects
- Large and small scale Irrigation studies

MANAGEMENT EXPERIENCE

- PDP Technical Director
- Experienced Project Manager and Technical Lead

CAREER SUMMARY

Bas has 19 years' experience as a senior hydrologist specialising in surface water and groundwater hydrology. This experience has included assessments related to the effects of urban development on spring flows, rainfall-runoff modelling, water resource assessments, irrigation demand-supply studies, site investigation and conceptual design.

Example projects Bas has recently undertaken include assessments of baseflow and water balance changes resulting from Stormwater Management Plans in Christchurch. Bas has undertaken these assessments for Christchurch City Council(CCC) for the Avon River, Halswell River, Heathcote River, Styx River and Otukaikino Creek catchments. Bas has also presented hydrology evidence for Private Plan Change 69 to the Selwyn Operative District Plan (Lincoln South) and for Private Plan Change 31 to the operative Waimakariri District Plan as well as the associated submission to the proposed Selwyn District Plan and the proposed Waimakariri District Plan.

Bas has been involved in several peer review projects for corporate clients, local and regional councils as well as the Environmental Protection Agency (EPA) and has experience in preparing and presenting evidence at resource consent and plan change hearings.

SELECTED PROJECT EXPERIENCE

Rolleston Industrial Developments Ltd, Hydrology evidence for Lincoln South Private Plan Change and proposed Selwyn District Plan

Expert Witness (hydrology)

Expert hydrology witness for Rolleston Industrial Developments Ltd for proposed Private Plan Change 69 (Lincoln South) to the Operative Selwyn District Plan and for an associated submission to the proposed Selwyn District Plan.

The hydrology evidence covered an assessment of the potential hydrological effects of the proposed plan change as a result of the proposed rezoning of the land and covered the following matters:

- An overview of the hydrogeological setting, groundwater flow patterns and water table depth at and in the vicinity of the proposed Lincoln South Development.
- An assessment of the potential change in groundwater recharge contributing flow to springs due to an increase in impervious area.
- An assessment on potential for short-circuiting groundwater flow paths caused by hard fill, drains and service trenches including suggested buffer zones around springs, from a hydrological perspective.

Bas prepared and presented evidence at the private plan change and proposed district plan hearings.

Rolleston Industrial Developments Ltd, Hydrology evidence for Ohoka Private Plan Change and proposed Waimakariri District Plan

Expert Witness (hydrology)

Expert hydrology witness for Rolleston Industrial Developments Ltd for Private Plan Change RCP31 (Ohoka) to the Operative Waimakariri District Plan and for an associated submission to the proposed Waimakariri District Plan. The hydrology evidence was written in response to evidence from submitters and covered an assessment of the potential hydrological effects of the proposed plan change as a result of the proposed rezoning of the land. The potential change in Land Surface Recharge (LSR) as a result of the increased amount of impervious area was assessed with respect to potential changes in spring flow. In addition, an assessment was made with regard to the risk of diverting groundwater away from springs due to short-circuiting groundwater flow paths.

Bas prepared and presented evidence at the private plan change and proposed district plan hearings.

Christchurch City Council, Anticipated Baseflow and Water Balance Changes resulting from Stormwater Management Plans in Christchurch

Senior Hydrologist and Technical Director

During the preparation of new Stormwater Management Plans (SMPs) for the Ōtākaro/Avon River, Heathcote, Halswell River, Styx River and Otukaikino River Catchments Christchurch City Council(CCC) engaged PDP to assess the effects of the SMPs on the water balance and baseflow in the relevant Christchurch rivers.

The assessments included quantifying the effect of:

- the diversion and discharge of stormwater on baseflow in waterways and springs that could be affected by the proposed stormwater management;
- the potential changes to the overall water balance for the SMP areas arising from the change in pervious area and the stormwater management systems proposed.

For this project Bas was the technical lead and project director responsible for all the assessments, associated reporting and project delivery.

Bellgrove Rangiora Limited(BRL), Effect of Proposed Bellgrove Subdivision on Spring Flow

Senior Hydrologist and Technical Director

The Bellgrove Subdivision in Rangiora is located upgradient of a number of springs. Environment Canterbury raised concerns about the potential effects of the increased hardstand and stormwater management on spring flows. BRL engaged PDP to assess these effects with a focus on changes in infiltration characteristics which may affect spring flows downgradient of the proposed development.

Bas was responsible for the assessments and reporting.

Grassmere Estates Ltd, Assessment of Effect of Urban Development on Spring Flows

Senior Hydrologist and Technical Director

The proposed Grassmere Street Development near Cranford Basin has the potential to change (reduce) the Land Surface Recharge (LSR) to the underlying strata and therefore has the potential to affect baseflow in the waterways at and downstream of the site. Baseflows in the waterways were estimated from available flow data and a water balance assessment was undertaken to assess the effect of the increased hardstand area on LSR and baseflows.

Bas was the technical lead and project director for this work.

PATTLE DELAMORE PARTNERS LTD

Carl Steffens

TECHNICAL DIRECTOR – WATER RESOURCES

Carl is a hydrogeologist with 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

Tom Garden

SENIOR HYDROGEOLOGIST

Tom is a geologist with extensive experience in both hydrogeology and engineering geology in New Zealand and Australia. Since joining PDP in the beginning of 2021, Tom has enjoying being a part of the largest consulting groundwater team in New Zealand, and has been involved in a wide variety of technical assessments for both private clients and Territorial Authorities.

Qualifications

PhD (Geology), University of Canterbury, 2017

Postgraduate Diploma in Science (Geology), University of Canterbury, 2011

Bachelor of Science (Geology and Biology), University of Auckland, 2010

Training

Site Safe Passport - Civil

Essential First Aid Certificate (Red Cross)

Leapfrog™ Works Fundamentals (Seequent)

Model Calibration with PEST and Groundwater Vistas (Jim Rumbaugh - Environmental Solutions Incorporated)

Career Summary

January 2021 – Present
Hydrogeologist, Pattle Delamore Partners Ltd, Christchurch

November 2017 - October 2020
Engineering Geologist, Bell Geoconsulting Ltd, Christchurch

January 2013 - June 2013
Field Technician, Soil & Rock Consultants, Christchurch

EXPERTISE

- 3D Geological Modelling
- Groundwater Modelling
- Pump test analysis
- Drawdown interference analysis
- Stream depletion analysis
- Technical reporting
- Field supervision, testing and monitoring

CAREER SUMMARY

Tom has over seven years of experience as a consulting geologist in both geotechnical and hydrogeological contexts, as well as significant experience in academic geological research, notably in relation to geothermal systems.

He is a hydrogeologist with extensive experience across a range of areas, from groundwater sampling to geological modelling to 3D contaminant transport modelling. He has conducted pump test analysis and environmental impacts assessment both in support of resource consent applications and as a technical reviewer for Hawkes Bay Regional Council, Environment Canterbury, and Horizons Regional Council. He also has numerical groundwater modelling experience using MODFLOW and FEFLOW, and 3D geological modelling experience using Leapfrog. He has written numerous technical reports, as well as academic research papers in international journals. His field experience includes drilling supervision, borehole logging, monitoring well installation and conducting pumping tests.

PROJECT EXPERIENCE

Christchurch City Council, Assessment of Effects of Development on Stream Baseflow in Banks Peninsula (2023)
Hydrogeologist/Project Manager

Assessment of the potential effects of future development in Banks Peninsula on spring flows and stream baseflows. Involved literature review of the geology and hydrogeology of Banks Peninsula, assessment of likely future population changes, preparation of a report to support the development of a Stormwater Management Plan for Banks Peninsula, and presentation of findings to Council.

Grassmere Estates Ltd, Groundwater and Surface Water Monitoring, and Assessment of Effects (2023 - Present)
Hydrogeologist

Preparation of a groundwater and surface water monitoring programme to support District Council and Regional Council consent applications for subdivision development. Analysis of large datasets and assessment of effects of subdivision development on groundwater quality and quantity, and on stream baseflow and water quality.

Winstone Aggregates, Pumping Test Supervision and Technical Assessment for Effects on Groundwater (2022 - 2024)
Hydrogeologist

Installation of a groundwater monitoring network and preparation of technical assessments in support of an application to renew a groundwater take and use application for high-yielding irrigation bores on the Canterbury Plains, and for effects of quarrying on groundwater. Included pumping test analysis and modelling of microbial contaminant transport.

Yoursection Ltd, Assessment of Effects of Stormwater Discharge (Heavy Metals) to Groundwater (2023 – 2024)
Hydrogeologist/Groundwater Modeller and Expert Witness

3D contaminant transport groundwater modelling using MODFLOW6 to assess the potential concentrations of heavy metals in groundwater due to stormwater discharge in Rolleston, Canterbury. Included preparation of expert witness evidence for a limited notification hearing.

Horizons Regional Council, Various Consent Reviews (2021 – Present)
Hydrogeologist/Project Manager

Assessment of resource consent applications for groundwater abstraction in the Horizons Region. This involved revew and re-analysis of pumping tests, well interference assessment, stream depletion assessment, and assessment of reasonable and efficient groundwater use.

Horizons Regional Council, Source Protection Zone Delineation and Prioritisation (2021 – 2022)
Hydrogeologist

Delineation of source protection zones for various marae spring-sourced drinking water supplies in the Manawatū-Whanganui region, using geographical information system (GIS) software and available hydrological data.

Assessment of all groundwater water supply source protection zones in the Manawatū-Whanganui region to create a schedule used to identify the zones most at risk of contamination from nearby bores.

YourSection Ltd, Temporary Dewatering Consents (2021 – 2022)
Hydrogeologist/Project Manager

Preparation and lodgement of consent applications for temporary site dewatering (groundwater take and discharge) at two subdivisions in Halswell, Christchurch. This involved estimation of groundwater flows, assessment of well interference effects, environmental impacts assessments, planning assessment, lodging of the resource consent application, and liaison with Environment Canterbury throughout the consent process.

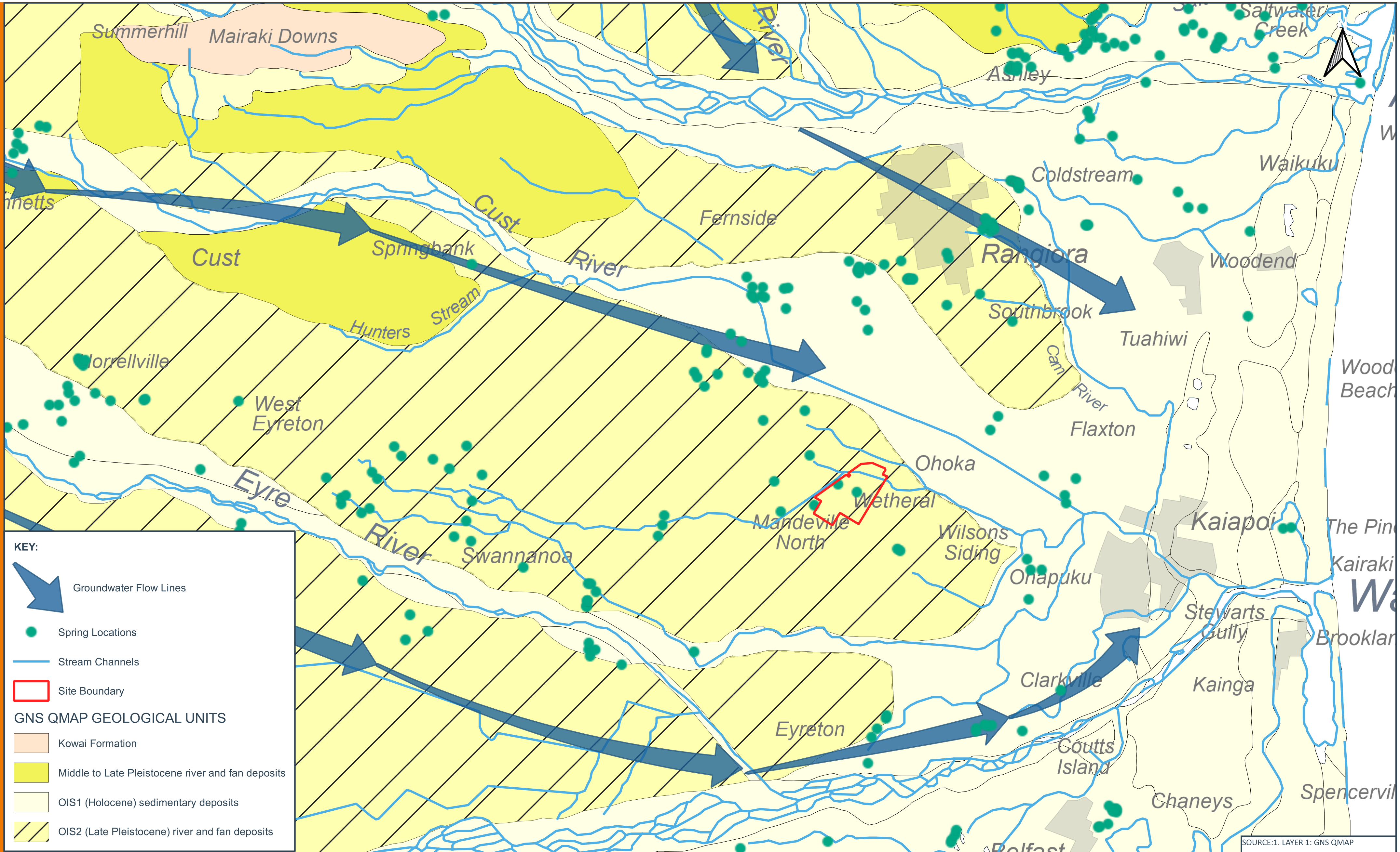
Otago Regional Council, Alexandra Basin Groundwater Modelling (2022 – 2023)
Hydrogeologist/Groundwater Modeller

Steady-state groundwater modelling using MODFLOW6 of two alluvial aquifers in the Alexandra Basin, Central Otago in order to support groundwater allocation decision-making. This project involved calibration to surface water flows and groundwater levels using parameter estimation (PEST), sensitivty analysis, and scenario modelling investigating impacts of irrigation race recharge.

Horizons Regional Council, Lake Horowhenua Groundwater Model (2021)
Hydrogeologist/Groundwater Modeller

3D geological modelling using Leapfrog, and groundwater modelling using MODFLOW6, to construct a steady-state district-scale groundwater model for the purpose of better understanding groundwater and surface water inputs to Lake Horowhenua, near Levin. This project has the ultimate goal of understanding and managing water quality degradation in Lake Horowhenua.

Appendix B: Figures



pdp

0 1 2 km

KILOMETRES

SCALE : 1:120,000 (A4)

NO.	REVISION	DATE	BY
A	FINAL	JUN 25	TG

CLIENT

CARTER GROUP LTD

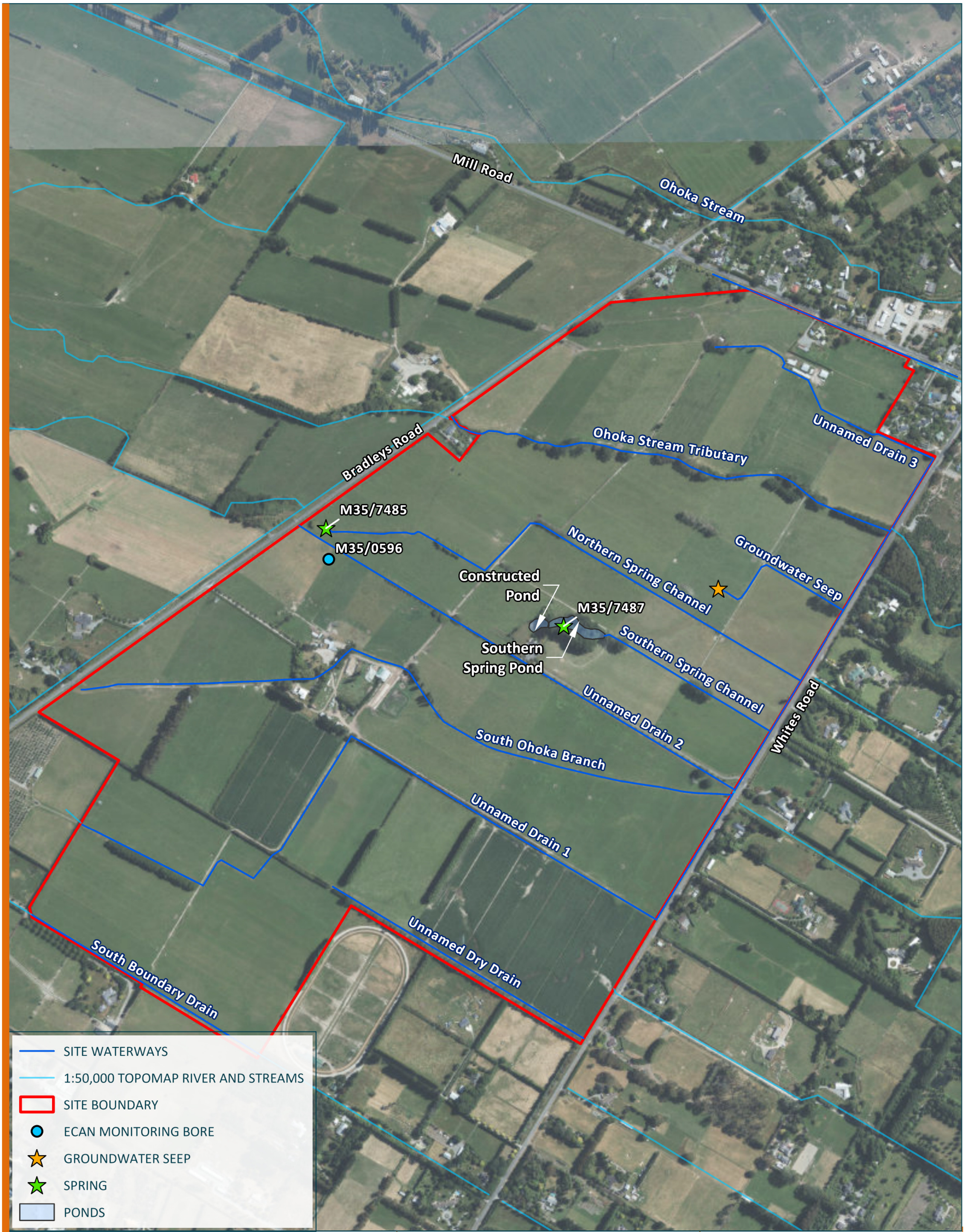
FIGURE

FIGURE 1: GROUNDWATER FLOW PATHS AND HYDROGEOLOGICAL SETTING

PROJECT

Hydrological Assessment - Ohoka Plan Change

S:\C04518\500\Projects\C04518500_Z001_Setting.qgz



SCALE : 1:10,000 (A4)

FIGURE 2: SITE DETAIL

HYDROLOGICAL ASSESSMENT - OHOKA FAST TRACK APPLICATION

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

REVISION: 01 | DATE: JUN 25 | BY: CF
CLIENT: CARTER GROUP LTD

C045180002_BV_Evidence

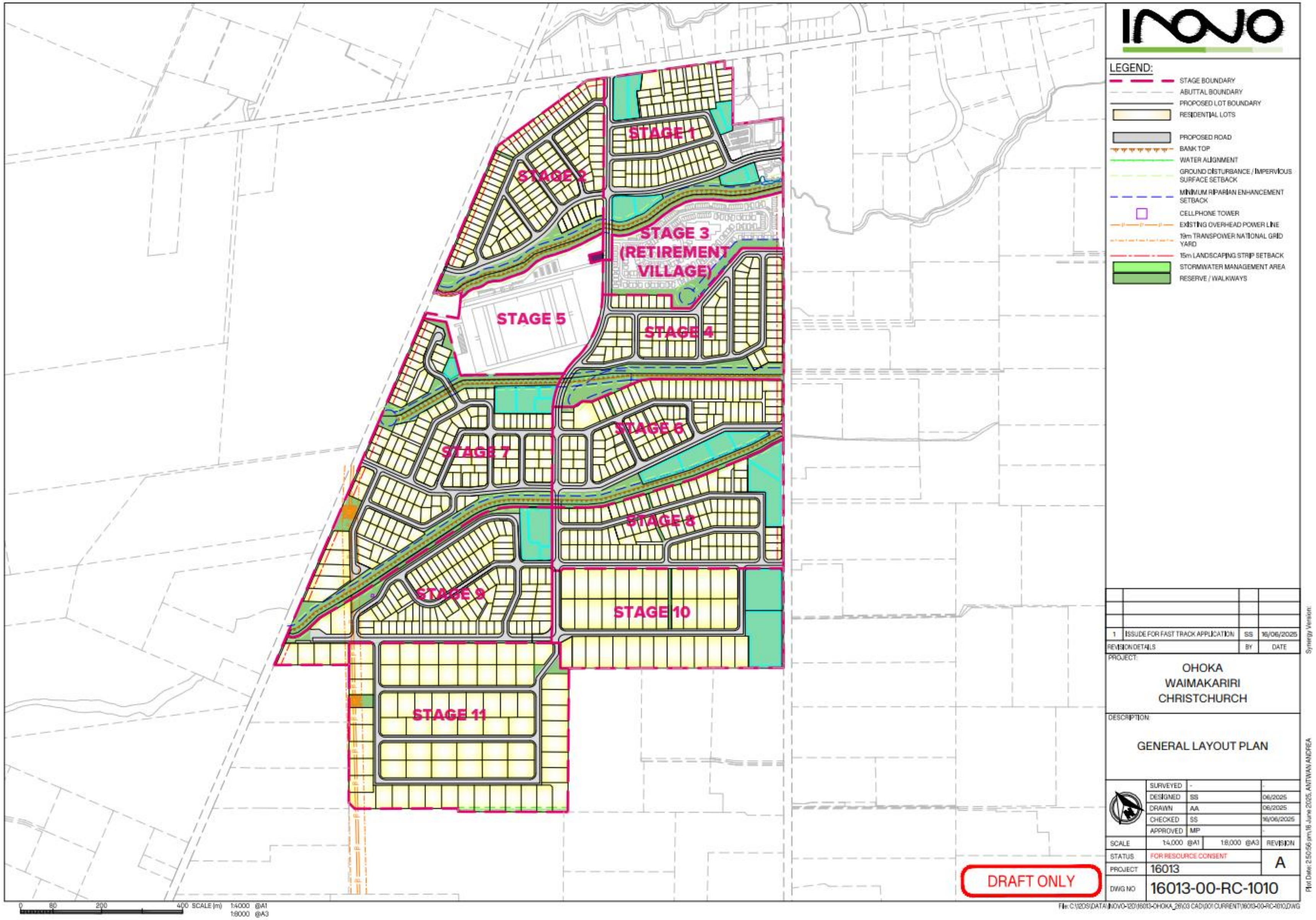


FIGURE 3: SUBDIVISION PLAN

WATERCOURSE AND WETLAND TOTALS		
FEATURE NAME	NO.	UNITS
WETLAND - EXISTING	5,176	m²
WETLAND - REMOVED	37,635	m²
SPRING POND - EXISTING	2,823	m²
POND - TO BE REMOVED	612	m²
STORMWATER MANAGEMENT AREAS (SMA)	90,358	m²

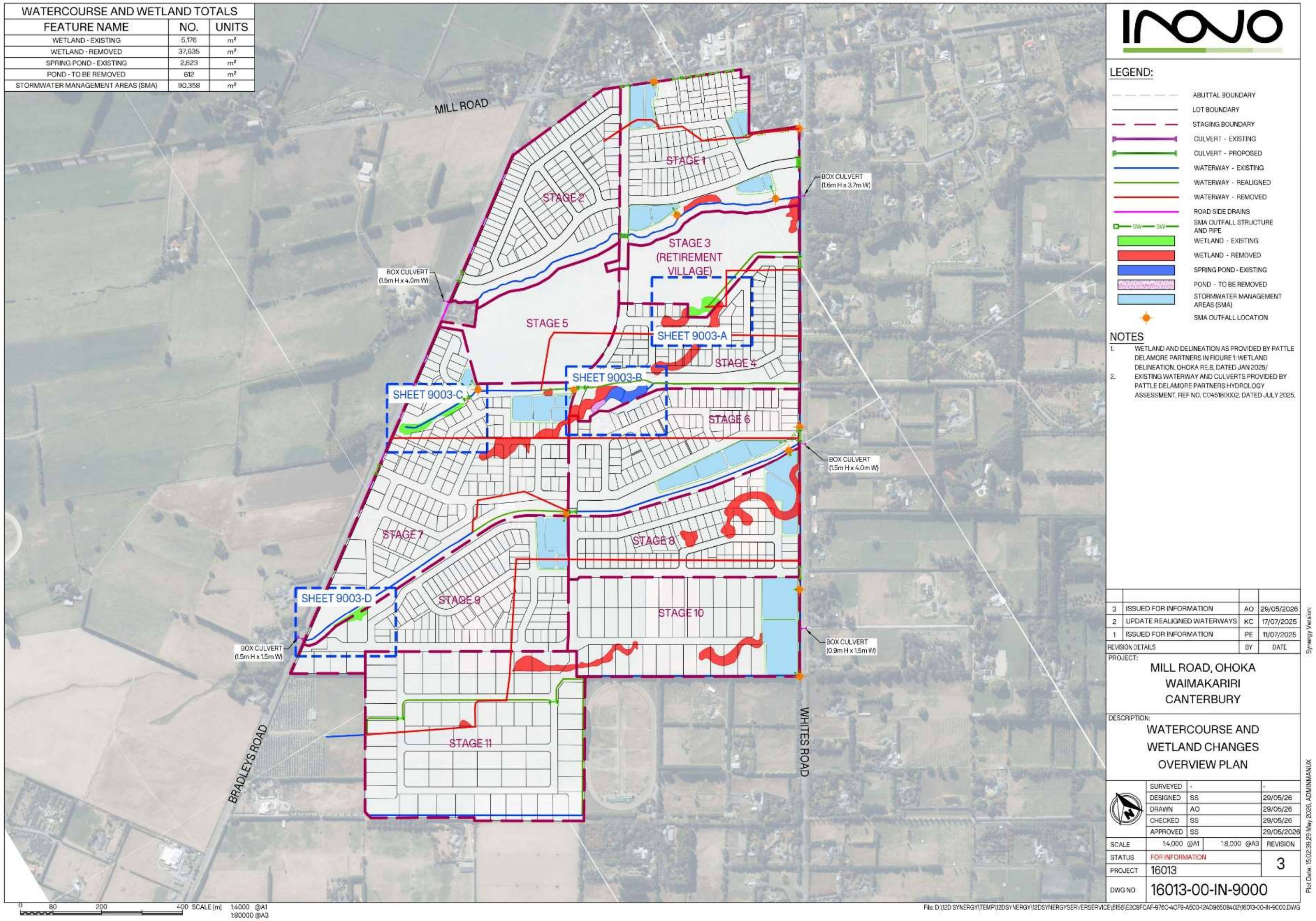


FIGURE 4A: WATERCOURSE PLAN

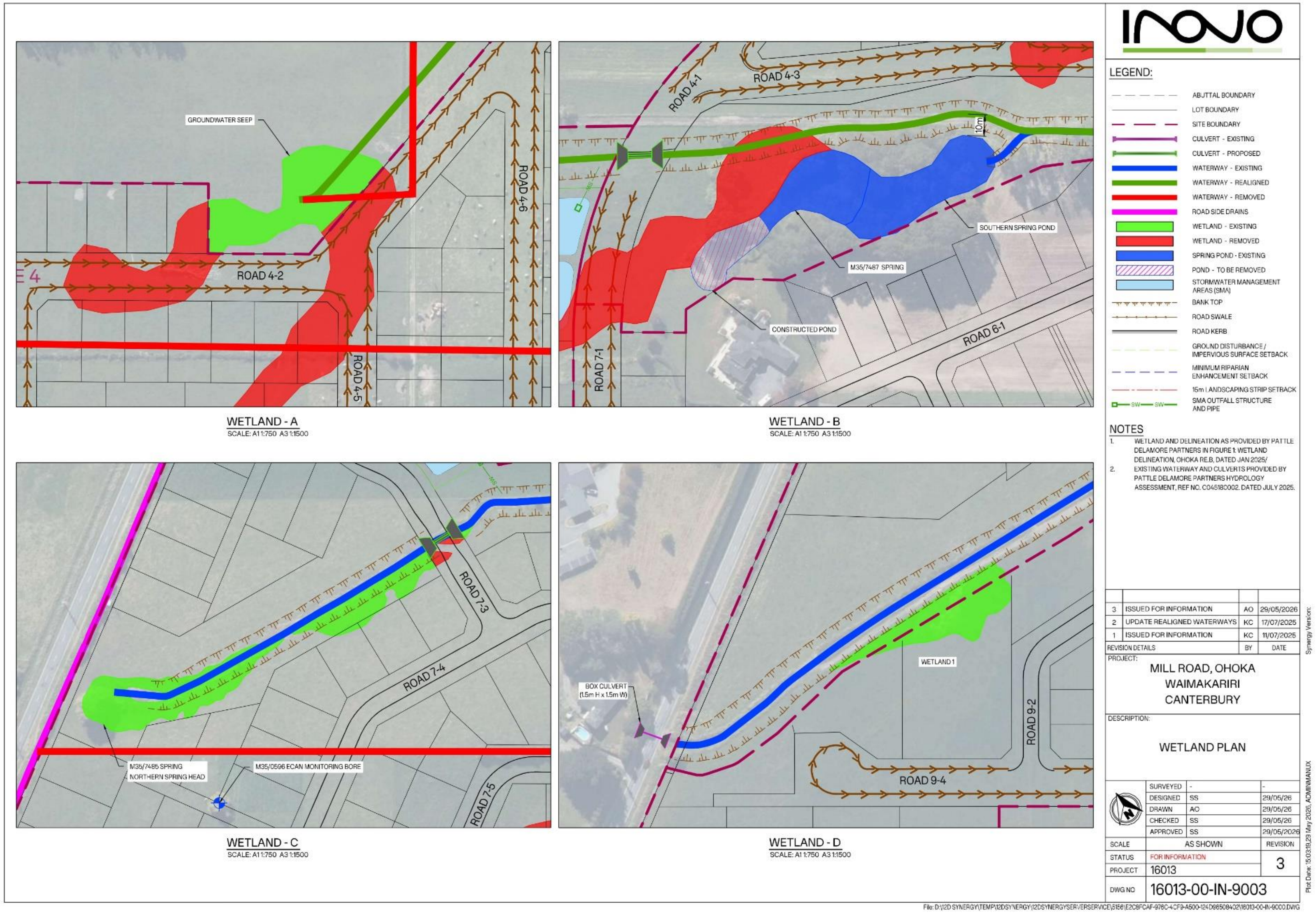


FIGURE 4B: WATERCOURSE PLAN (DETAIL)

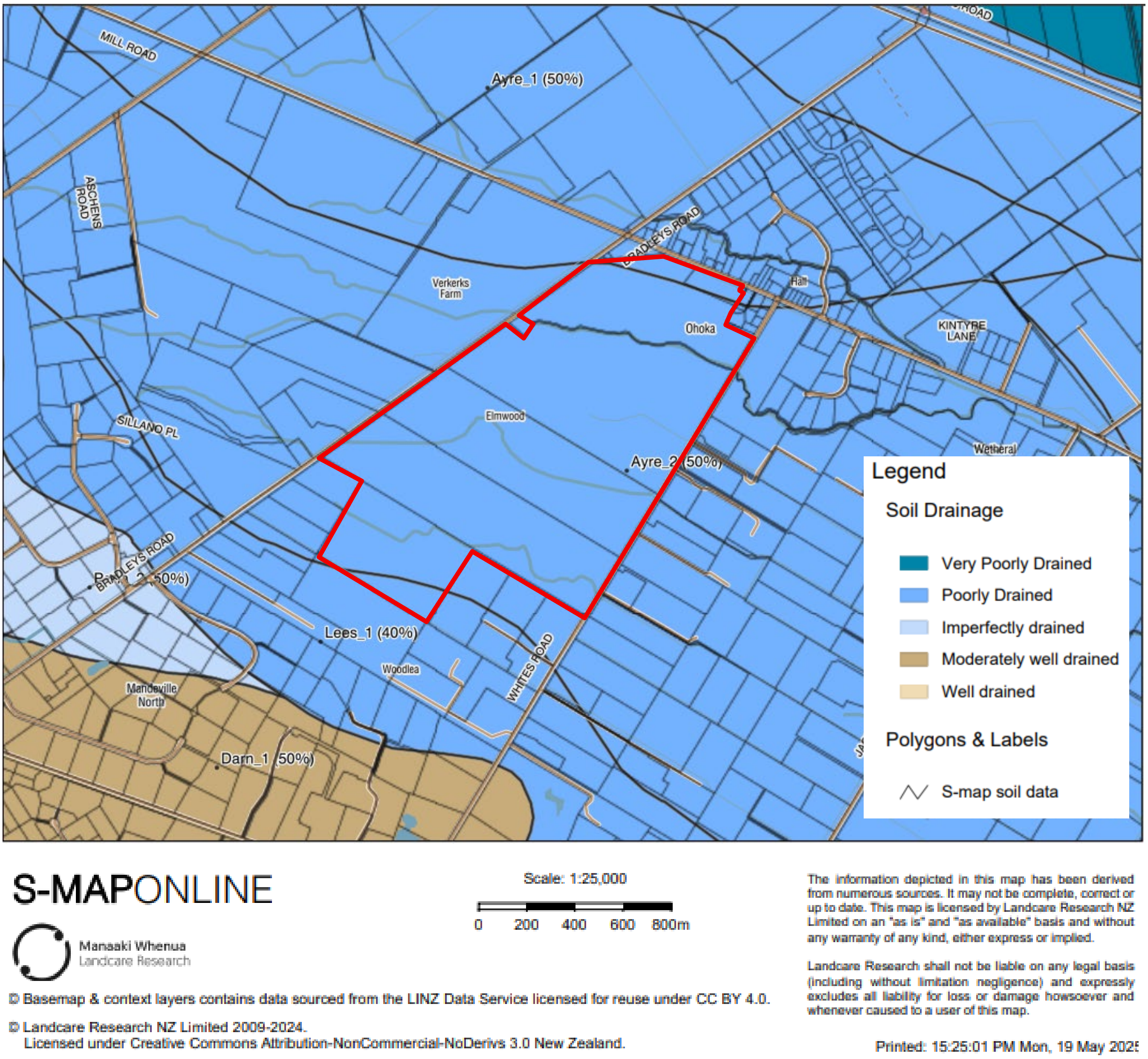
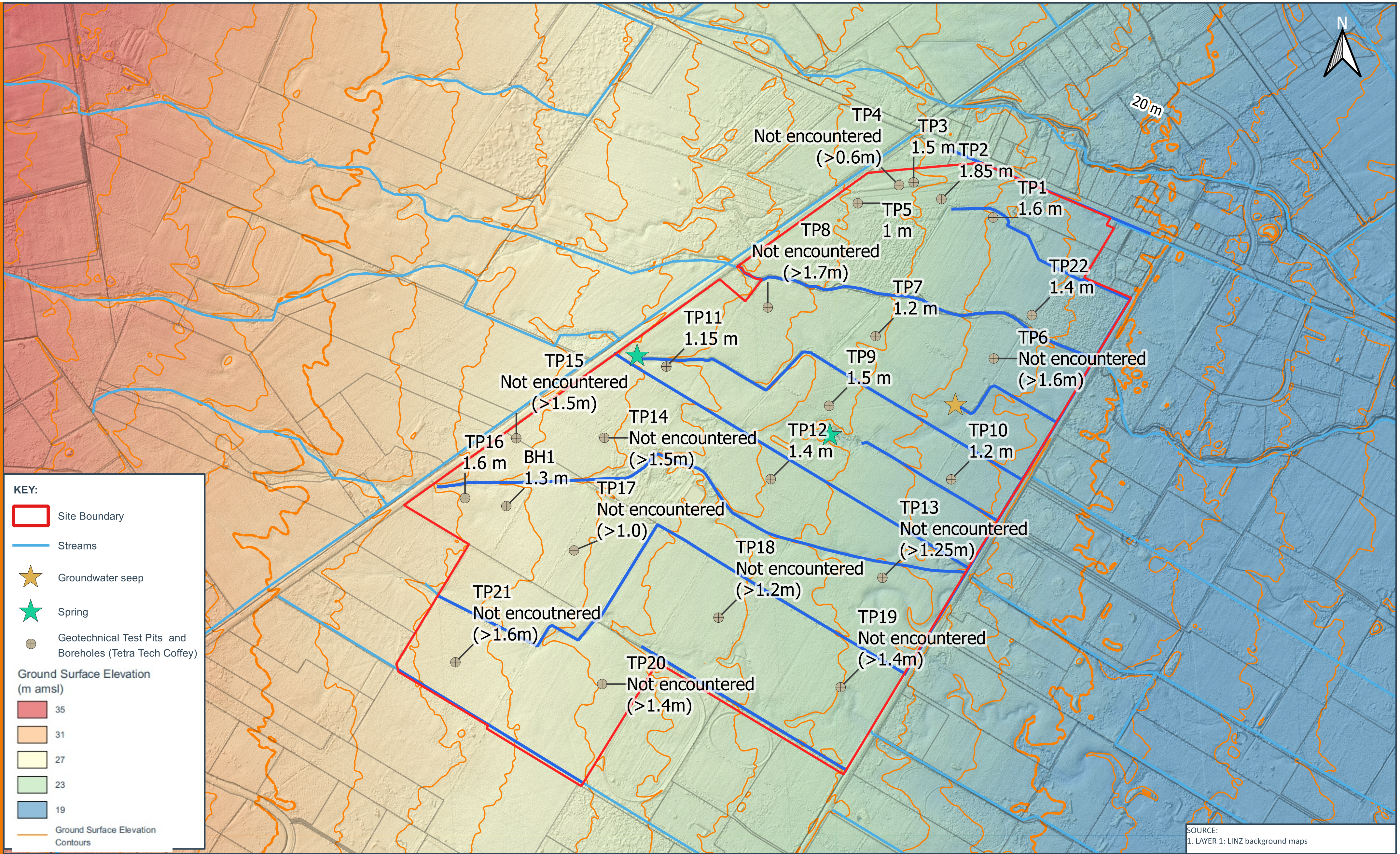


FIGURE 5: S-MAP SOIL TYPES AND SOIL DRAINAGE, SITE BOUNDARY SHOWN IN RED.



S:\C04518\500\Projects\C04518500_2004_GW_levels.qgz

pdp

0 100 200 m

METRES

SCALE : 1:12,000 (A4)

NO.	REVISION	DATE	BY
A.	FINAL	JUN 25	TG

CLIENT

CARTER GROUP LTD

FIGURE

FIGURE 6: DEPTH TO GROUNDWATER ACROSS SITE AS MEASURED IN TEST PITS

PROJECT

HYDROLOGICAL ASSESSMENT - OHOKA PLAN CHANGE

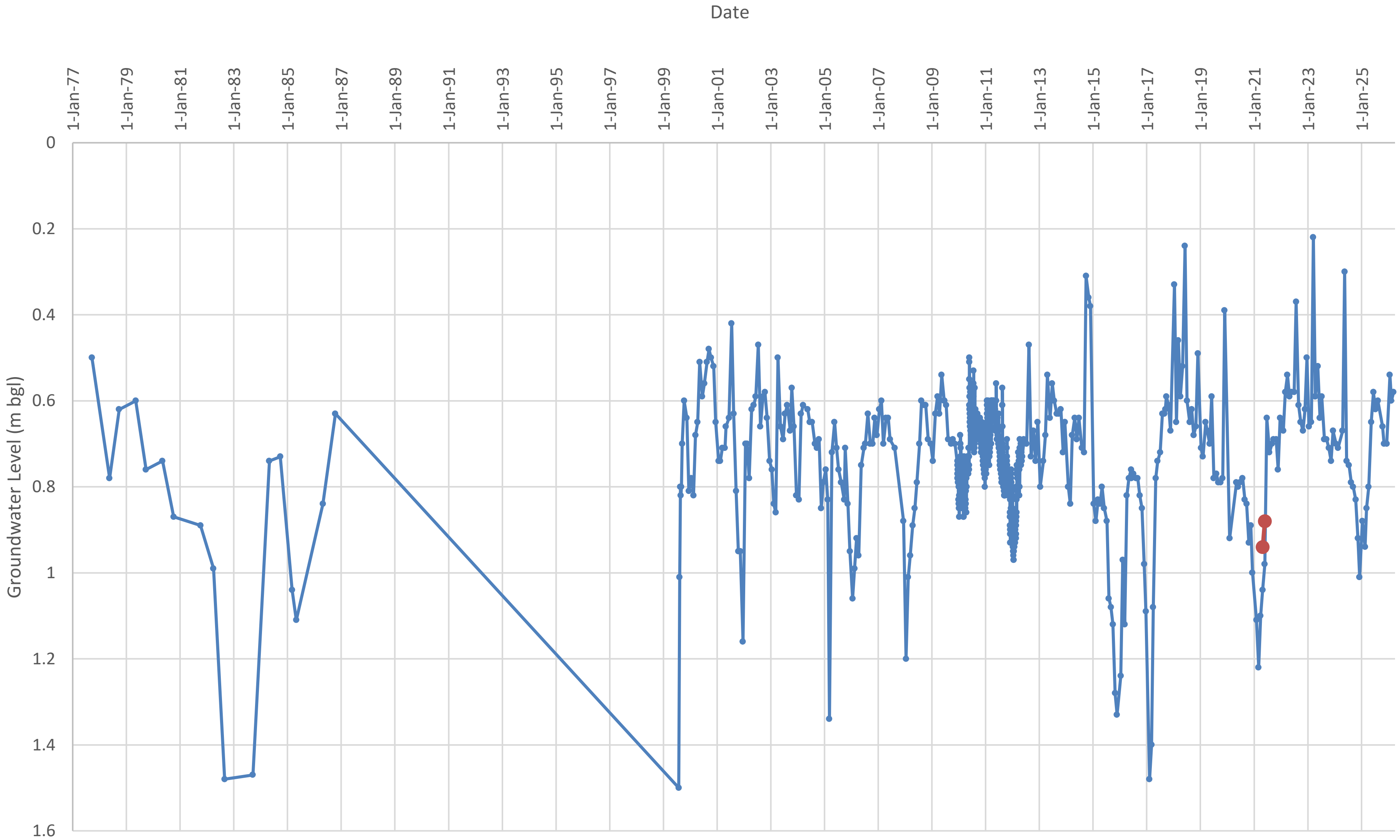


FIGURE 7: GROUNDWATER LEVEL RECORD FOR MONITORING BORE M35/0596 SOURCED FROM ECAN WELL DATABASE. THE MEASUREMENTS RECORDED IN APRIL AND MAY 2021 (THE TIME PERIOD WHEN TEST PITTING OCCURRED ON SITE) ARE HIGHLIGHTED IN RED.

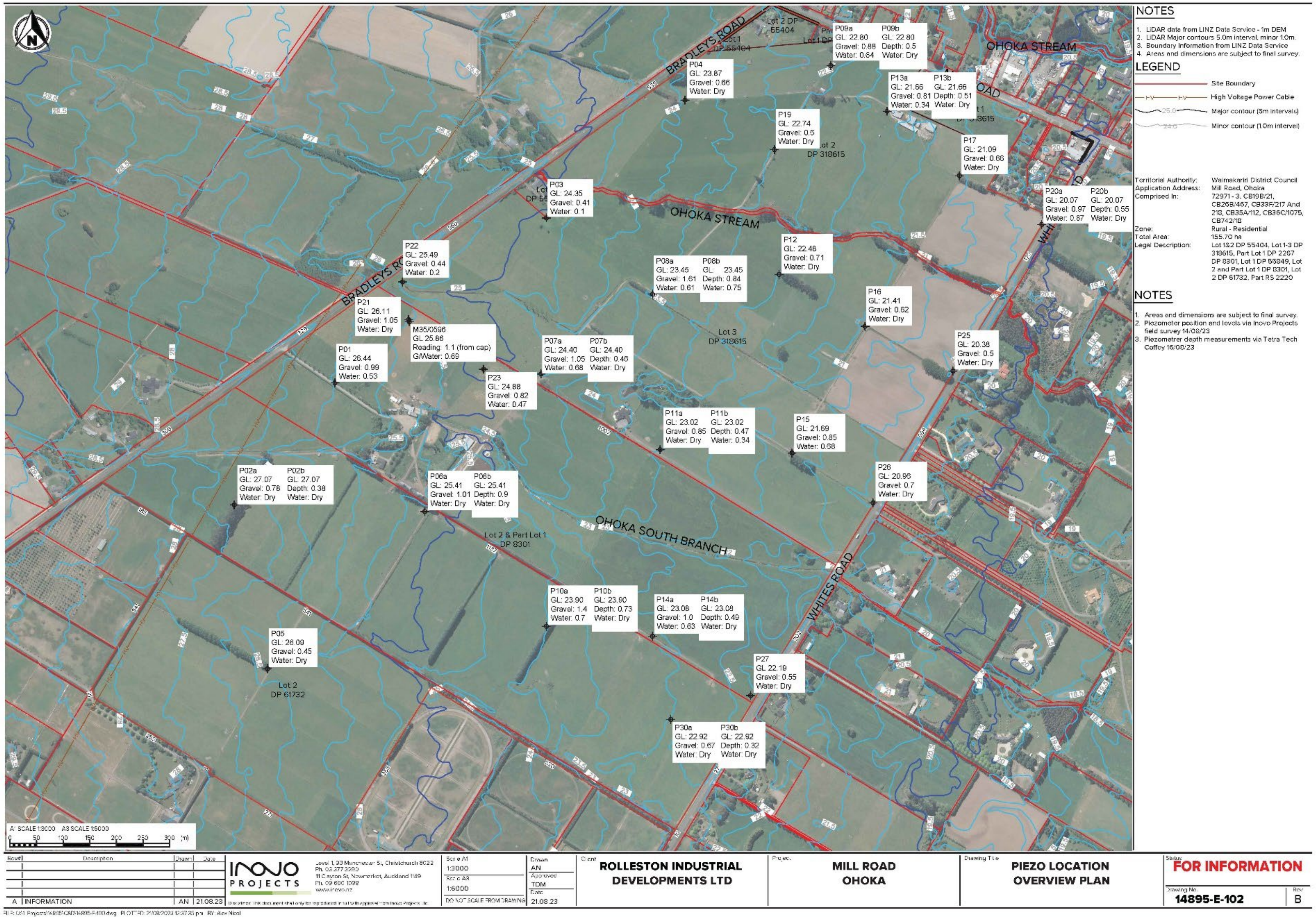


FIGURE 8: LOCATIONS OF TETRATECH COFFEY PIEZOMETERS

pdp

FIGURE 9: NEW GROUNDWATER MONITORING BORES

HYDROLOGICAL ASSESSMENT - OHOKA PLAN CHANGE

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

0 150 300
METRES
SCALE : 1:10,000 (A4)
N

REVISION: 01 | DATE: MAY 25 | BY: CF
CLIENT: CARTER GROUP LTD

C045180002_FIG1

pdp

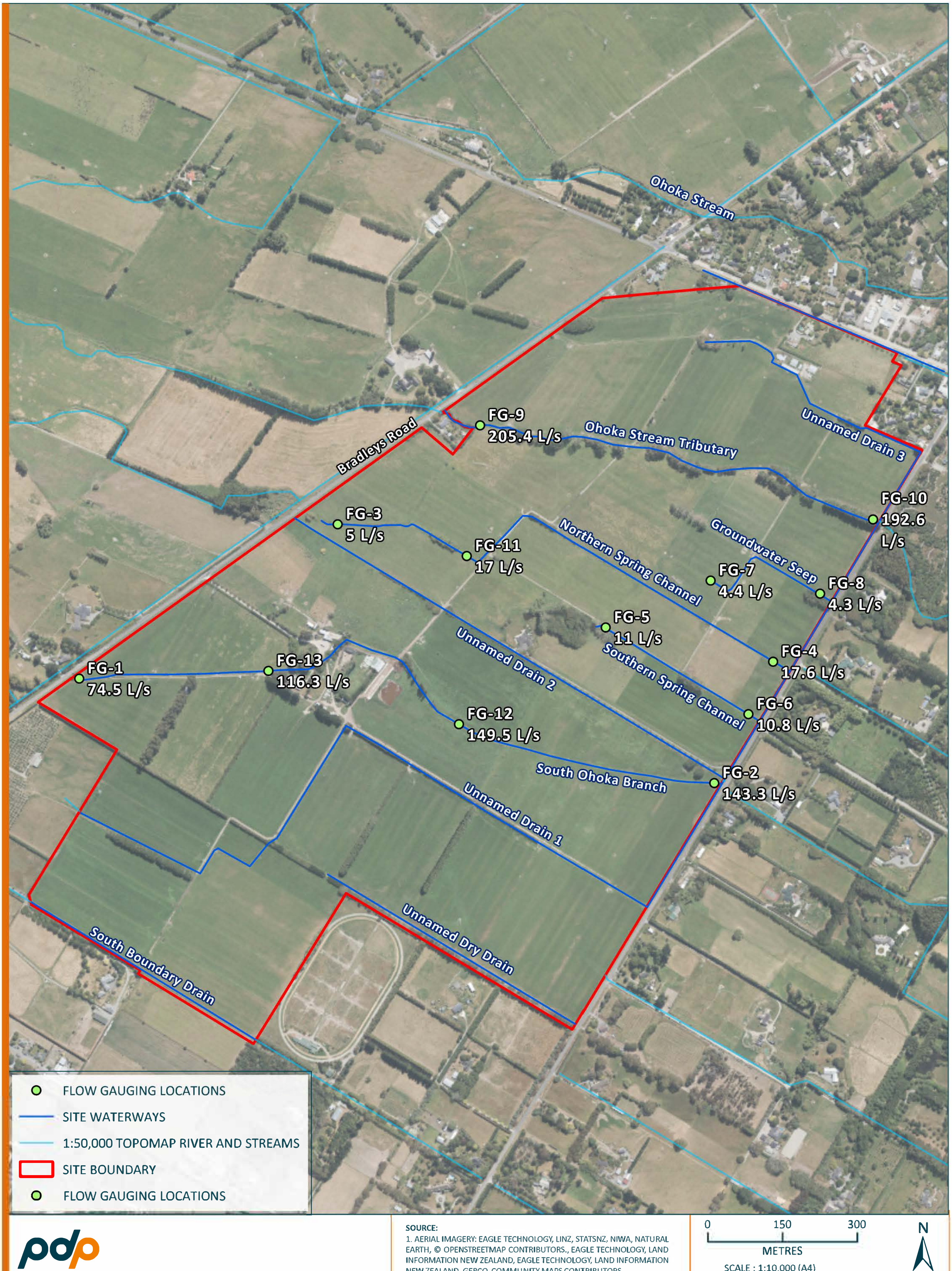
FIGURE 10: FLOW GAUGING LOCATIONS AND FLOWS GAUGED IN FEB 2025

HYDROLOGICAL ASSESSMENT - OHOKA FAST TRACK APPLICATION

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

REVISION: 01 | DATE: JUN 25 | BY: CF
CLIENT: CARTER GROUP LTD

C045180002R001_FIG10



pdp

FIGURE 11: FLOW GAUGING LOCATIONS AND FLOWS GAUGED IN AUG 2025

HYDROLOGICAL ASSESSMENT - OHOKA FAST TRACK APPLICATION

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

SCALE : 1:10,000 (A4)

REVISION: 01 | DATE: JUN 25 | BY: CF
CLIENT: CARTER GROUP LTD

C04518B002_FlowG_Aug25

pdp

FIGURE 12: FLOW GAUGING LOCATIONS AND FLOWS GAUGED IN NOV 2025

HYDROLOGICAL ASSESSMENT - OHOKA FAST TRACK APPLICATION

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS, EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND.

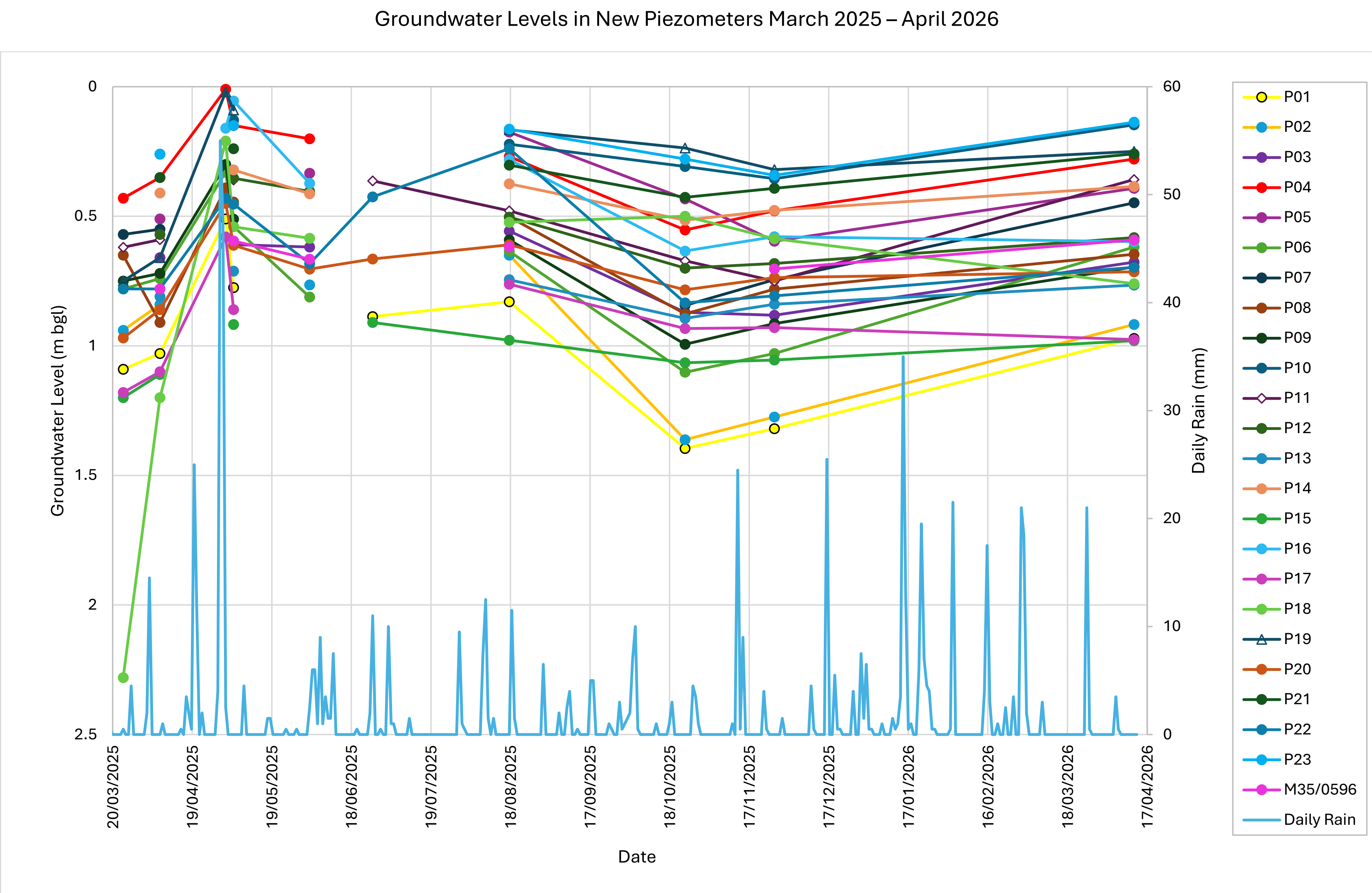
0 150 300
METRES
N

SCALE : 1:10,000 (A4)

REVISION: 02 | DATE: MAR 26 | BY: CF
CLIENT: CARTER GROUP LTD

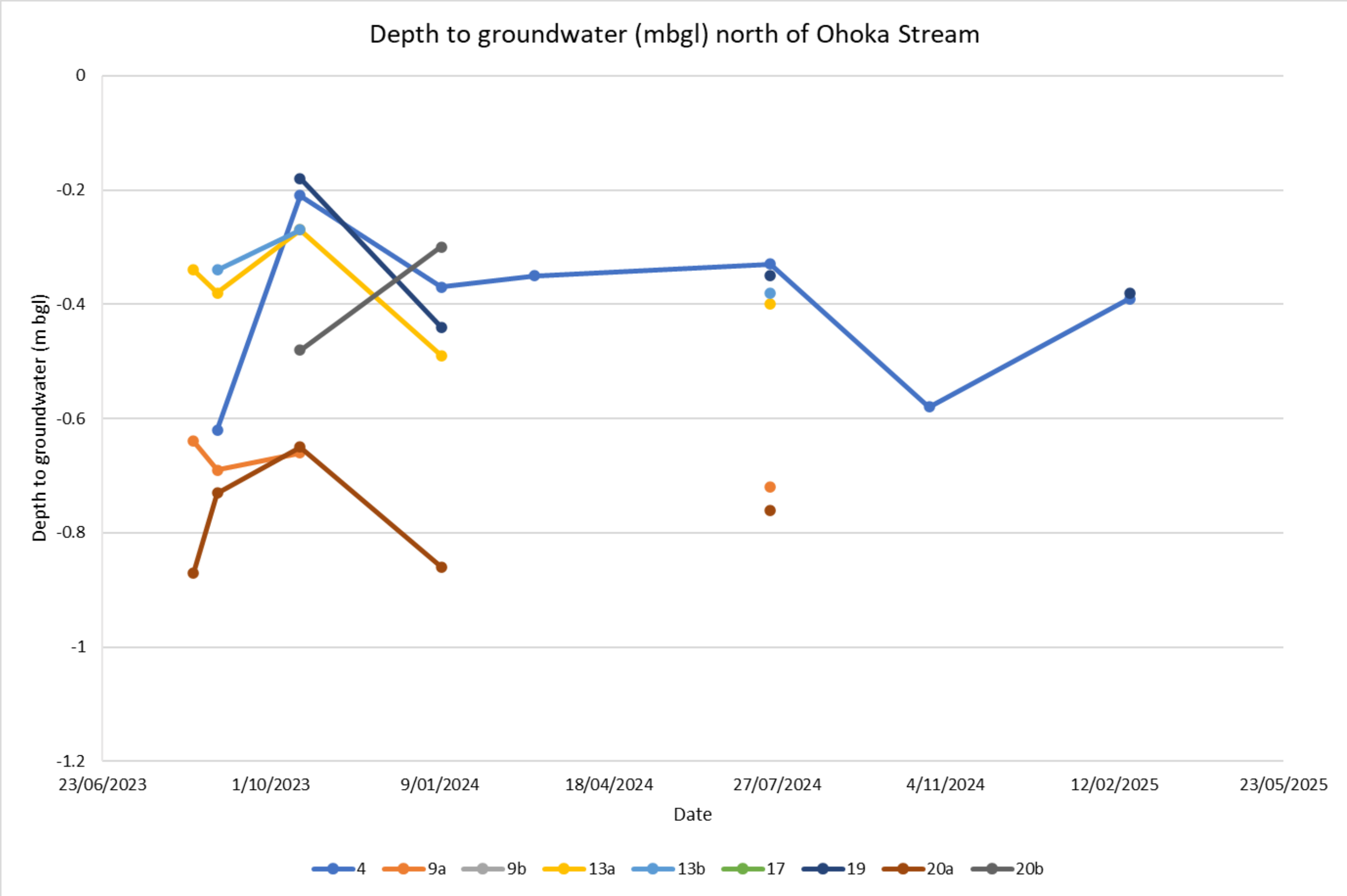
C045180002_FlowG_Nov25

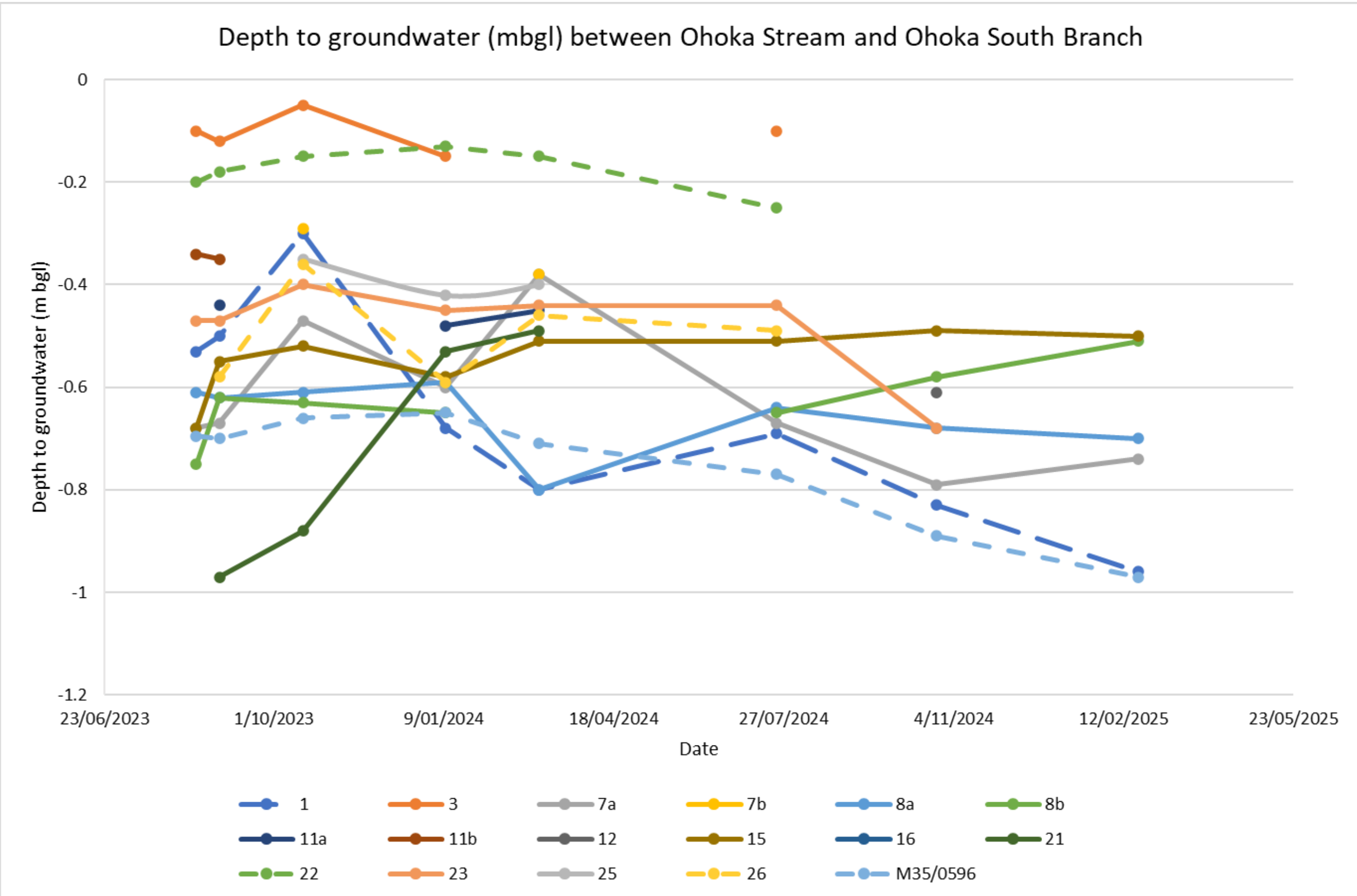
Appendix C: TetraTech Coffey and PDP groundwater level monitoring results

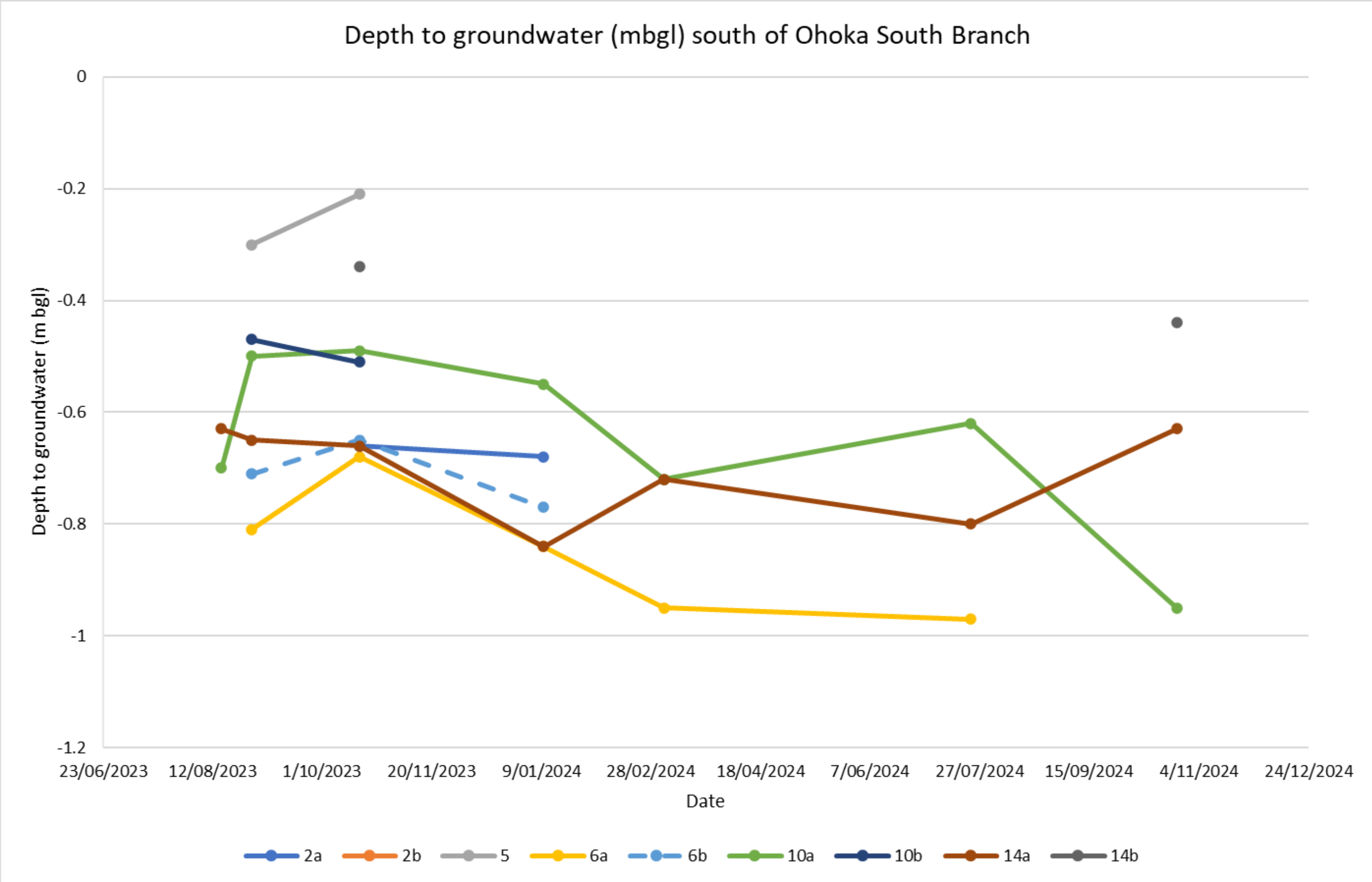


Groundwater Levels in New Piezometers March 2025 – April 2026
Groundwater Level (m bgl)
0
0.5
1
1.5
2
2.5
Daily Rain (mm)
60
50
40
30
20
10
0
Date
20/03/2025
19/04/2025
19/05/2025
18/06/2025
19/07/2025
18/08/2025
17/09/2025
18/10/2025
17/11/2025
17/12/2025
17/01/2026
16/02/2026
18/03/2026
17/04/2026
P01
P02
P03
P04
P05
P06
P07
P08
P09
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
P23
M35/0596
Daily Rain

Groundwater level measurements from new piezometers P01 - P23 (drilled by McMillan Drilling)													
Piezo Number (New piezos)	X-Coordinate	Y-Coordinate	Ground Level RL (m)	Depth to groundwater (m bgl)									
				24/03/2025	7/04/2025	2/05/2025	5/05/2025	3/06/2025	27/06/2025	18/08/2025	24/10/2025	27/11/2025	13/04/2026
P01	387476.771	825368.703	22.29	1.09	1.03	0.51	0.775		0.887	0.83	1.396	1.32	0.971
P02	387665.604	825198.503	20.75	0.94	0.84			0.765		0.65	1.362	1.275	0.918
P03	387577.033	824990.961	20.98		0.66		0.609	0.619		0.557	0.871	0.882	0.677
P04	387372.927	825058.163	21.91	0.43	0.35	0.01	0.15	0.201		0.27	0.553	0.479	0.279
P05	387375.524	825062.436	21.89		0.51			0.334		0.175	0.433	0.596	0.392
P06	387219.129	825116.572	23.09	0.78	0.74	0.33	0.54	0.812		0.635	1.102	1.03	0.619
P07	387137.897	825112.981	23.24	0.57	0.55						0.844	0.745	0.448
P08	387159.167	825051.885	23.07	0.65	0.91	0.39	0.445			0.502	0.877	0.781	0.647
P09	387237.834	825065.126	22.86	0.75	0.72	0.3	0.511			0.591	0.994	0.914	0.695
P10	387346.664	824820.677	21.38		0.26		0.129			0.222	0.308	0.355	0.147
P11	387604.692	824949.68	20.77	0.62	0.59		0.36		0.363	0.479	0.672	0.75	0.358
P12	387607.752	824806.96	20.58		0.57		0.353	0.404		0.503	0.7	0.682	0.582
P13	387365.121	824549.575	21.45		0.41		0.291			0.345	0.894	0.839	0.766
P14	387363.106	824452.269	21.61		0.81		0.742	0.413		0.775	0.515	0.477	0.385
P15	387212.668	824383.276	22.43	1.2	1.11		0.918		0.910	0.978	1.065	1.055	0.98
P16	387215.265	824387.548	24.71			0.16	0.055	0.373		0.281	0.634	0.579	0.598
P17	387238.364	824230.386	22.17	1.18	1.1	0.58	0.86			0.762	0.933	0.93	0.976
P18	387108.881	824032.473	22.38	2.28	1.2	0.21	0.541	0.585		0.523	0.5	0.587	0.76
P19	386596.166	824204.456	24.44	0.75	0.66	0.02	0.09			0.166	0.237	0.32	0.25
P20	386756.095	824572.636	24.69	0.97	0.86	0.45	0.612	0.704	0.665	0.61	0.784	0.737	0.714
P21	387060.499	824753.541	22.92		0.35		0.239			0.303	0.427	0.392	0.259
P22	386860.341	824823.301	24.37	0.78	0.78	0.43	0.453	0.683	0.425	0.239	0.834	0.807	0.697
P23	386559.623	824948.122	25.53		0.26		0.15			0.164	0.279	0.342	0.137
M35/0596			25.915		0.78		0.595	0.666		0.619		0.703	0.591


Depth to groundwater (mbgl) north of Ohoka Stream
Depth to groundwater (m bgl)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
23/06/2023
1/10/2023
9/01/2024
18/04/2024
27/07/2024
4/11/2024
12/02/2025
23/05/2025
Date
4
9a
9b
13a
13b
17
19
20a
20b


Depth to groundwater (mbgl) between Ohoka Stream and Ohoka South Branch
Depth to groundwater (m bgl)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
23/06/2023
1/10/2023
9/01/2024
18/04/2024
27/07/2024
4/11/2024
12/02/2025
23/05/2025
Date
1
3
7a
7b
8a
8b
11a
11b
12
15
16
21
22
23
25
26
M35/0596


Depth to groundwater (mbgl) south of Ohoka South Branch
Depth to groundwater (m bgl)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
23/06/2023
12/08/2023
1/10/2023
20/11/2023
9/01/2024
28/02/2024
18/04/2024
7/06/2024
27/07/2024
15/09/2024
4/11/2024
24/12/2024
Date
2a
2b
5
6a
6b
10a
10b
14a
14b

Groundwater level measurements from old piezometers from 2023 - 2025 (Piezos 1 - 30b hand augered by Tetra Tech Coffey)													
						Depth to water (mbgl)							
Piezo Number (old piezos)	N-S	E-W	Vert	Driller / Surveyor	Depth to bottom of hole (mbgl)	16/08/2023	30/08/2023	18/10/2023	10/01/2024	5/03/2024	23/07/2024	25/10/2024	21/02/2025
1	386437.104	824759.954	26.442	Alex & Louie	0.99	0.53	0.50	0.30	0.68	0.80	0.69	0.83	0.96
2a	386247.911	824530.99	27.074	Alex & Louie	0.78	Dry	Dry	0.66	0.68	Dry	Dry	Dry	Dry
2b				Alex & Louie	0.38	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
3	386834.477	825069.316	24.35	Nathan & Paul	0.41	0.1	0.12	0.05	0.15	Dry	0.10	Dry	Dry
4	387094.844	825290.539	23.871	Nathan & Paul	0.66	Dry	0.62	0.21	0.37	0.35	0.33	0.58	0.39
5	386310.208	824223.163	26.094	Alex & Louie	0.45	Dry	0.30	0.21	Destroyed				
6a	386605.656	824518.519	25.409	Alex & Louie	1.01	Dry	0.81	0.68	0.84	0.95	0.97	Dry	Dry
6b	386605.656	824518.519	25.409	Alex & Louie	0.9	Dry	0.71	0.65	0.77	Dry	Dry	Dry	Dry
7a	386824.365	824776.619	24.4	Alex & Louie	1.05	0.68	0.67	0.47	0.60	0.38	0.67	0.79	0.74
7b	386824.365	824776.619	24.4	Alex & Louie	0.46	Dry	Dry	0.29	Dry	0.38	Destroyed		
8a	387034.131	824926.39	23.453	Alex & Louie	1.61	0.61	0.62	0.61	0.59	0.80	0.64	0.68	0.7
8b	387034.131	824926.39	23.453	Alex & Louie	0.84	0.75	0.62	0.63	0.65	Dry	0.65	0.58	0.51
9a	387368.831	825355.261	22.797	Nathan & Paul	0.88	0.64	0.69	0.66	Dry	Dry	0.72	Dry	Dry
9b	387368.831	825355.261	22.797	Nathan & Paul	0.5	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
10a	386834.514	824302.886	23.899	Alex & Louie	1.4	0.7	0.50	0.49	0.55	0.72	0.62	0.95	Dry
10b				Alex & Louie	0.73	Dry	0.47	0.51	Dry	Dry	Dry	Dry	Dry
11a	387048.085	824634.429	23.021	Alex & Louie	0.85	Dry	0.44	Dry	0.48	0.45	Unable to locate		
11b				Alex & Louie	0.47	0.34	0.35	Destroyed					
12	387271.81	824963.194	22.479	Nathan & Paul	0.71	Dry	Dry	Dry	Dry	Dry	Dry	0.61	Broken
13a	387474.775	825269.718	21.665	Nathan & Paul	0.81	0.34	0.38	0.27	0.49	Dry	0.40	Dry	Dry
13b				Nathan	0.51	Dry	0.34	0.27	Dry	Dry	0.38	Dry	Dry
14a	387033.883	824284.078	23.082	Alex & Louie	1	0.63	0.65	0.66	0.84	0.72	0.80	0.63	Dry
14b	387033.883	824284.078	23.082	Alex & Louie	0.49	Dry	Dry	0.34	Dry	Dry	Dry	0.44	Dry
15	387296.004	824627.821	21.693	Nathan & Paul	0.85	0.68	0.55	0.52	0.58	0.51	0.51	0.49	0.5
16	387433.398	824865.892	21.408	Nathan & Paul	0.62	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
17	387610.488	825148.502	21.095	Nathan & Paul	0.66	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
19	387263.033	825197.4	22.74	Nathan & Paul	0.6	Dry	Dry	0.18	0.44	Dry	0.35	Dry	0.38
20a	387765.591	825056.935	20.068	Nathan & Paul	0.97	0.87	0.73	0.65	0.86	Dry	0.76	Dry	Dry
20b	387765.591	825056.935	20.068	Nathan & Paul	0.55	Dry	Dry	0.48	0.30	Dry	Dry	Dry	Dry
21	386575.493	824878.52	26.115	Alex & Louie	1.05	Dry	0.97	0.88	0.53	0.49	Dry	Dry	Dry
22	386563.997	824949.357	25.486	Alex & Louie	0.44	0.2	0.18	0.15	0.13	0.15	0.25	Blocked	
23	386716.247	824785.289	24.88	Alex & Louie	0.82	0.47	0.47	0.40	0.45	0.44	0.44	0.68	Dry
25	387598.445	824781.845	20.379	Nathan & Paul	0.5	Dry	Dry	0.35	0.42	0.40	Destroyed		
26	387448.255	824534.806	20.965	Nathan & Paul	0.7	Dry	0.58	0.36	0.59	0.46	0.49	Dry	Dry
27	387218.122	824172.953	22.194	Alex & Louie	0.55	Dry	Dry	Dry	Dry	Destroyed			
30a	387068.124	824127.759	22.92	Alex & Louie	0.67	Dry	Destroyed						
30b				Alex & Louie	0.32	Dry	Destroyed						
M35/0596					2.91	0.695	0.70	0.66	0.65	0.71	0.77	0.89	0.97