



memorandum



TO	Carter Group Limited	FROM	Emma Rhodes, Bas Veendrick and Carl Steffens
		DATE	31 August 2026
RE	Change in water balance for the proposed Ohoka Development at 531 and 535 Mill Road, Ohoka		

1.0 Introduction and background

Carter Group Ltd (Carter Group) has engaged Pattle Delamore Partners Ltd (PDP) to undertake a water balance assessment for the proposed Ohoka Development to support its Fast-track application. The proposal involves the subdivision and development of 154.8 hectares of land at 531 and 535 Mill Road, Ohoka, for residential and commercial use.

This memorandum includes:

- ✧ Assessment of changes in land surface recharge (LSR) associated with the proposed development.
- ✧ Assessment of changes in the water balance at the site associated with the redistribution of groundwater abstraction from shallow bores to deeper bores.
- ✧ Assessment of overall changes in the site water balance, taking into account both altered LSR and changes in stream depletion resulting from the redistribution of groundwater abstraction.

1.1 Pre-development state

The site has a total area of 154.8 ha and the majority of the site is currently utilised as irrigated grassland. There are a number of existing shallow bores located on the site which are authorised to take groundwater for irrigation purposes via Environment Canterbury resource consents CRC991022 and CRC991827. Consent CRC991022 allows for abstraction via bores M35/9423 (this bore was never drilled), M35/3064 (12.5 m deep) and M35/3065 (12 m deep), while consent CRC991827 authorises abstraction via bores M35/0326 (13.7 m deep) and M35/0367 (9.4 m deep). Irrigation records were provided by the current land owner for the period from the 2016/17 to 2025/26 water years and are provided in Appendix B. These records indicate a range in abstraction volumes from 183,593 to 503,318 m³/year, with an average seasonal irrigation volume (based on a 150-day irrigation season) of 329,154 m³, equivalent to 2,195 m³/day. Records for the 2022/23 to 2025/26 water years contain gaps or no data relating to consent CRC991827, which we understand represents an issue with the consent monitoring and recording rather than being reflective of this consent not being used. Consequently, the maximum, minimum, and average numbers reported above are from water year data from 2016/17 to 2021/22 only.

1.2 Post-development state

The proposed development comprises a mix of residential lots, roads, footpaths, commercial areas, stormwater management areas, a polo field, and a retirement village. Inovo Ltd has provided PDP with preliminary estimates of the proposed land use and hardstand coverage across the site (Appendix A). Based on these estimates, hardstand surfaces are expected to comprise approximately 40% of the total 154.8 ha site area, with the remaining 92.9 ha (60%) comprising pervious surfaces, including grassed, landscaped, and stormwater management areas. It is proposed that stormwater will be managed using on-site stormwater treatment and attenuation prior to discharge to surface waterways. Stormwater management areas are proposed to cover 9.27 ha. Parts of the stormwater management areas and planned polo field (4.8 ha) are proposed to be irrigated as part of ongoing operation (as outlined in PDP, 2026a).

Groundwater abstraction from the existing shallow irrigation bores (as described in Section 1.1) is proposed to cease as part of the redevelopment. To meet the community water supply requirements of the development, a number of new groundwater supply bores are proposed. These bores are anticipated to be screened at depths similar to, or greater than, nearby Waimakariri District Council (WDC) supply bore BW24/0262, which has a screened interval between 78.0 m and 84.0 m below ground level. The proposed subdivision is forecast to require a maximum total annual use volume of 474,636 m³/year. These supply requirements include water for irrigation of the polo field and stormwater management areas which will also be sourced from the deeper community supply bores. Based on these requirements, it is estimated that up to five new supply bores may be required to service the development while providing N+1 redundancy (PDP, 2026a).

2.0 Technical assessments

2.1 Introduction

This section summarises the assessments which estimate the changes in land surface recharge (LSR), stream depletion and overall water balance as a result of the proposed development. It is noted that the assessments described below are based on a set of conservative assumptions including:

- ✧ The water balance assessment assumes that none of the runoff from the hardstand area will contribute to recharge of the underlying aquifer. In reality, the runoff from the hardstand areas will be collected in Stormwater Management Areas (SMAs) which are designed to capture some of the runoff before discharging to surface water. The 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. Some of this 'captured' water will recharge the underlying aquifer. The assumption that none of the rainfall on the hardstand areas will contribute to aquifer recharge is therefore likely to over-estimate the reduction in LSR as a result of the proposed development.
- ✧ The assumption that the full site in the pre-development state is irrigated. In reality there are some areas of 154.8 ha site that are not irrigated (i.e. building, yard areas etc.). This is likely to result in a small over-estimation of the LSR in the pre-development state.
- ✧ The assumption that no irrigation will occur in the post development state. In reality, there are some areas that will be irrigated including the polo field and stormwater management areas (PDP, 2026a). In addition, it can be expected that some residents will water their gardens. This is likely to result in a small under-estimation of the LSR in the post-development state.

- ✧ In addition, and as described in the Hydrology Assessment (PDP, 2026b), 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 (in local areas where surface water bodies cut through the shallow soils into the gravels). 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.

2.2 Changes in land surface recharge

Development of the site is expected to result in changes to land surface recharge, primarily due to the introduction of impervious surfaces and the cessation of irrigation currently occurring across the site. To quantify these effects, land surface recharge (LSR) was estimated for both the pre-development and post-development conditions based on the following assumptions:

- ✧ Average annual rainfall estimate of 650 mm/year at the site (NIWA, 2016).
- ✧ A dry grassland recharge rate equivalent to 30% of average annual rainfall, based on Recharge Investigations on the Canterbury Plains (White et al., 2003), resulting in an LSR rate of 195 mm/year.
- ✧ Irrigation losses were assumed to contribute to recharge at a rate of 20% of applied irrigation (i.e. as per assumed in section 7.2 of Dodson et al., 2012). Based on the average seasonal irrigation volume of 329,154 m³ over a 150-day irrigation season (equivalent to 2,195 m³/day), irrigation contributes an estimated 42.5 mm/year of recharge. Irrigation recharge has been included in the pre-development scenario. Dry grassland recharge rates were applied to the post-development scenario.
- ✧ Hardstand surfaces are assumed to comprise 40% (70.0 ha) of the total 154.8 ha site area. The remaining 60% (92.8 ha) is assumed to comprise pervious surfaces, including grassed, landscaped, and stormwater management areas.

Potential future irrigation of the polo field and stormwater management areas has not been included in the assessment. Similarly, potential groundwater recharge resulting from infiltration within the proposed stormwater management areas has not been considered. As a result, the assessment is considered to provide a conservative estimate (i.e. an underestimation) of post-development land surface recharge.

Calculated changes in annual land surface recharge (LSR) are presented in Table 1. The assessment indicates that the proposed development may result in an average net reduction in LSR of approximately 186,656 m³/year, equivalent to ~6 L/s.

Table 1: Annual Changes in Land Surface Recharge

LSR (m ³ /year)	Pervious Irrigated Grassland	Pervious Grassland (Dryland)	Impervious Areas
Pre-development State	367,691 m ³ /year		
Post-development State		181,035 m ³ /year	0.00 m ³ /year
		Difference	-186,656 m³/year
LSR (L/s)	Pervious Grassland + Irrigation	Pervious Grassland	Impervious Areas
Pre-development State	11.7 L/s		
Post-development State		5.7 L/s	0.00 L/s
		Difference	-6 L/s

2.3 Changes in groundwater abstraction

The proposed development will also alter the site's water balance through the redistribution of groundwater abstraction from existing shallow irrigation bores to deeper community water supply bores. To quantify the effect of this change, stream depletion was assessed under both pre-development and post-development conditions. As the proposed supply bores will abstract groundwater from a deeper semi-confined aquifer, the resulting stream depletion effects are expected to reduce due to the reduced hydraulic connection with surface water features. Stream depletion comparisons were undertaken between the pre and post development states as follows:

Pre-development state:

- Due to the shallow water table and spring fed streams present at the site, the shallow irrigation bores are assumed to be in direct connection with the surface waterways. Therefore, stream depletion equal to 90% of the abstraction rate has been assumed, which is consistent with the direct category of stream depletion effect under Schedule 9 of the Canterbury LWRP. Based on the average irrigation volume of 329,154 m³ per 150-day irrigation season (equivalent to 2,195 m³/day or 25.40 L/s), this equates to an estimated stream depletion of approximately 22.86 L/s.

Post development state:

- Stream depletion from the proposed deep community water supply bores was assessed using the analytical solution developed by Ward and Lough (2011) for a semi-confined aquifer within a two-layer leaky aquifer system. This approach is considered appropriate as the proposed bores will abstract from deeper sandy gravel aquifer units that are separated from the shallow water-table aquifer by lower-permeability clay and clayey gravel layers, as observed in Waimakariri District Council bore BW24/0262 and regionally across the area. The assessment adopted aquifer parameters derived from pumping tests undertaken at bore BW24/0262 to represent the deeper aquifer, together with representative properties for the overlying water-table aquifer and a streambed conductance of 1.04 m/day for the Ōhoka Stream, based on testing undertaken by PDP and reported by Sanders and Lovell (1999). Further details of the methodology and assessment assumptions are provided in PDP (2026a).
- As the stream depletion effects of the existing irrigation take were assessed using an average annual abstraction volume, the proposed community water supply take has also been assessed on an estimated average annual basis to enable a consistent comparison. An average annual abstraction rate equivalent to 80% of the proposed maximum annual volume (474,636 m³/year) for the water supply was adopted. This is possibly conservative, as the Aqualinc (2010) report states that utilisation of drinking water supply allocations may be closer to 50% of the consented volume. Accordingly, a pumping rate of 1,040.3 m³/day over a full year was assumed, equivalent 379,708 m³/year. On this basis, the predicted stream depletion effect is 5.2 L/s. Note, this annual abstraction volume is comparable to the average irrigation volumes assessed for the existing shallow irrigation bores.

Overall, the redistribution of groundwater abstraction from shallow irrigation bores to deeper community supply bores is expected to result in a reduction in stream depletion effects during the irrigation season and an increase in effects outside of the irrigation season. Based on the assumptions outlined above, total stream depletion is estimated to decrease from approximately 22.9 L/s during the irrigation season under the pre-development scenario to around 5.2 L/s year-round under the post-development scenario, representing a reduction of approximately 17.7 L/s during the irrigation season, or an increase of 5.2 L/s outside of the irrigation season.

2.4 Overall changes in water balance due to development

Overall changes in water balance should be considered separately for the irrigation and non-irrigation seasons, as the effects of groundwater abstraction and irrigation recharge vary throughout the year. Key conclusions are as follows:

- ✧ During the irrigation season, the reduction in stream depletion resulting from the redistribution of groundwater abstraction from shallow to deeper bores (17.7 L/s) is greater than the reduction in land surface recharge (~6 L/s), resulting in a net positive change in the site water balance of approximately ~11.7 L/s within the shallow aquifer system. This reduction is considered conservative as it assumes rainfall recharge is distributed evenly throughout the year, whereas recharge is likely to be seasonally variable and weighted towards the non-irrigation period. Furthermore, the LSR calculations do not take into account irrigation of the proposed stormwater management areas/polo fields, and any stormwater infiltration within the stormwater management/retention areas.
- ✧ Outside of the irrigation season, the existing shallow irrigation bores would not be operating and therefore would not contribute to stream depletion (or irrigation recharge) under the pre-development scenario. However, the proposed community water supply bores are expected to operate year-round and are estimated to cause stream depletion of approximately 5.2 L/s. In addition, the development is estimated to reduce land surface recharge. On an annual-average basis, this equates to a reduction in recharge of approximately ~6 L/s. While most rainfall and recharge are likely to occur during the non-irrigation season, the timing of recharge is highly variable. Accordingly, the non-irrigation season is expected to be characterised by a reduction in the site water balance due to the combined effects of year-round stream depletion from the community water supply bores and a reduction in rainfall-derived recharge. Based on annual average rates, these effects are estimated to equate to approximately 11.2 L/s.
- ✧ The estimated reduction in water balance by LSR during the non-irrigation season is likely to be conservative. During winter and spring, when groundwater levels are elevated and soils are near saturation, a greater proportion of rainfall is likely to be conveyed as surface runoff rather than contributing to groundwater recharge. This was also noted by Environment Canterbury in its Technical Advice regarding Groundwater Resources on the Fast-track Approvals application¹. Consequently, reductions in land surface recharge during these periods are unlikely to translate directly into equivalent reductions in groundwater discharge and stream baseflow.

In addition to the conclusions above it is re-iterated that 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. This, along with the conclusions from the water balance assessment outlined above indicates that the likely result of the proposed development is an increase in flows at times when flows in the springs and waterways are typically low.

¹ Page 6, point 40 of Environment Canterbury Fast Track Approvals Act 2024 Technical Advice: Ōhoka Residential Development – Groundwater Resources states “The hydrogeological model for the site shows patchy soil and surficial fine sediments. Recharge to groundwater can still occur through these sediments, particularly when the water table is lower. During periods when the water table is high, soils are at full capacity (saturated) and land surface recharge is more likely to run off.”

3.0 Summary

Overall, the conservative assessment undertaken indicates that the proposed development will result in a net improvement in the shallow groundwater and surface water balance during the irrigation season through a substantial reduction in stream depletion associated with existing irrigation abstraction. While reductions in rainfall-derived recharge and year-round abstraction from the proposed community water supply bores may reduce the water balance during the non-irrigation season, these effects are likely to be overstated due to conservative assumptions regarding recharge processes and because potential recharge associated with stormwater retention and management systems has not been included. Key concerns related to changes in flow generally focus on low flow periods. Considering that the water balance assessment indicates an increase in shallow aquifer recharge and connected surface water features during times of low flow it is considered that overall effects are expected to be no more than minor.

4.0 Reference List

- Aqualinc. (2010). Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes 2009-10. Report prepared for the Ministry of the Environment (Report no H10002/3)
- Dodson, M., Aitchison-Earl, P. Scott, L. (2012) Ashley-Waimakariri groundwater resources investigation. Environment Canterbury Report No. R12/69
- Dudley Ward, N., & Lough, H. (2011). Stream depletion from pumping a semiconfined aquifer in a two-layer leaky aquifer system. *Journal of Hydrologic Engineering*, 16(11).
- Sanders, R., & Lovell, M. (1999). Observations of the Ohoka Stream System in a Drought. Report No. U99/32.
- NIWA. (2016). The Climate and Weather of Canterbury (2nd ed.). NIWA Science and Technology Series No. 68.
- Pattle Delamore Partners Ltd (PDP). (2026a). Fast-track Application – 535 Mill Road, Ōhoka – Water Supply Assessment of Environmental Effects. Report No. C045180002R001.
- Pattle Delamore Partners Ltd (PDP). (2026b). Fast-track Application – 535 Mill Road, Ōhoka – Groundwater Assessment of Environmental Effects Report. Report No. C045180002R002.
- White, P.A., Hong, Y.-S., Murray, D.L., Scott, D.M., & Thorpe, H.R. (2003). Evaluation of regional models of rainfall recharge to groundwater by comparison with lysimeter measurements, Canterbury, New Zealand. *Journal of Hydrology (New Zealand)*, 42(1), 39-64.

5.0 Limitations

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

This memorandum has been prepared by PDP on the specific instructions of Carter Group Limited for the limited purposes described in the memorandum. PDP accepts no liability if the memorandum 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.

© 2026 Pattle Delamore Partners Limited

Prepared by



Emma Rhodes

Senior Hydrogeologist

Reviewed by



Carl Steffens

Technical Director – Water Resources

Approved by



Bas Veendrick

Technical Director – Water Resources



Appendix A: Impervious coverage estimates provided by Inovo 3/8/2026



AREAS			IMPERVIOUS COVERAGE		
ROADS	124,800.00	m ²	124,800.00	m ²	
FOOTPATHS	53,400.00	m ²	53,400.00	m ²	
SMALL LOTS (<2000m ²)	513,300.00	m ²	307,980.00	m ²	
LARGE LOTS (>2000m ²)	310,852.00	m ²	62,170.40	m ²	
POLO FIELD	89,000.00	m ²	4,450.00	m ²	
COMMERCIAL	14,912.00	m ²	14,166.40	m ²	
SMA AREAS	92,753.70	m ²	0	m ²	
RET. VILLAGE	74,000.00	m ²	44,400.00	m ²	Assuming 60% impervious surfaces as per guidance from Inovo
REMAINDER	274,982.30	m ²	8,249.47	m ²	Conservative estimate of impervious surfaces as per guidance from Inovo
TOTAL AREA	1,548,000.00	m²	IMPERVIOUS COVERAGE		619,616.27
			PERVIOUS COVERAGE		928,383.73

Note: The areas presented above are approximate values and may have been rounded.



Appendix B: CRC991022 and CRC991827 Irrigation Use Records



CARTER GROUP LIMITED - CHANGE IN WATER BALANCE FOR THE PROPOSED OHOKA DEVELOPMENT AT 531
AND 535 MILL ROAD, OHOKA

Consents	Bores	Irrigation Season									
		2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
CRC991022	M35/3064	106,686	72,409	83,018	90,304	113,531	44,998	45,091	105,836	126,559	32,074
	M35/3065	101,547	76,379	39,594	160,317	176,202	82,984	102,165	143,443	62,472	81,285
	Total	208,233	148,788	122,612	250,622	289,732	127,982	147,256	249,279	189,031	113,359
CRC991827	M35/3026	68,835	56,129	49,449	104,174	122,443	13,987	0	0	0	0
	M35/0367	68,403	46,702	63,072	100,995	91,143	41,624	13,953	0	0	0
	Total	137,238	102,831	112,521	205,170	213,586	55,611	13,953	0	0	0
CRC991022 + CRC991827	All	345,471	251,619	235,133	455,791	503,318	183,593	161,209	249,279	189,031	113,359
Note: all numbers reported are volumes in m ³ /year											