



Assessment of Environmental Effects

Milldale Stage 14-17 - Proposed Groundwater Take

FULTON HOGAN LAND DEVELOPMENT LTD

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Milldale Stage 14-17 - Proposed Groundwater Take

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Williamson Water & Land Advisory

P.O. Box 314
Kumeu
New Zealand
www.wwla.kiwi

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Statement of Qualifications and Experience

Author

My full name is Kevin Edward Burdette.

I am a hydrogeologist at Williamson Water & Land Advisory (WWLA). I hold the qualifications of PhD in Geology (McMaster University, Ontario, Canada) and have over 10 years' professional experience in the field of geology and environmental/hydrogeological consulting. My experience includes stratigraphic interpretation and geophysical analysis of subsurface sedimentary sequences, gained through doctoral research into Quaternary coastal stratigraphy and geochronology using ground penetrating radar (GPR) and other subsurface characterisation techniques. This was complemented by eight years' experience as a remote geosteerer in the oil and gas industry, involving detailed subsurface stratigraphic correlation and formation evaluation, followed by several years in environmental consulting where I applied this geological expertise to hydrogeological and environmental assessment projects within multidisciplinary teams.

Reviewer

My full name is Jonathan (Jon) Lindsay Williamson.

I am the Managing Director at Williamson Water & Land Advisory. I hold the qualifications of Bachelor of Science, and Master of Science and Technology (Earth Science) from the University of Waikato and have over 30 years' professional experience in the field of hydrology and hydrogeology. My experience includes professional consultancy with experience in research and assessment of environmental impacts for a wide range of projects. My experience includes appearances at Council, Environment Court, Board of Enquiry, and EPA Fast-track Legislation Hearings, along with involvement in joint witness processes.

Ethical Declaration

We have been engaged by Fulton Hogan Land Development Limited (FHLD) (the Applicant) to undertake an assessment of environmental effects associated with the Milldale Stages 14-17 project and to prepare this report in support of the substantive application under the Fast-track Approvals Act 2024 (FTAA).

While this is not an Environment Court proceeding, we confirm that we have prepared this assessment in accordance with the applicable professional and ethical obligations of our profession and that the opinions expressed are within our area of expertise.

1. Introduction

This report has been prepared in support of the substantive application for the Milldale Stages 14-17 (Milldale North) Project under the Fast-track Approvals Act 2024 (FTAA).

The Project relates to approximately 231 ha of land centred around Wainui Road in Wainui, Auckland. The proposal provides for a comprehensively planned urban development including residential neighbourhoods, a supporting commercial node, transport and servicing infrastructure, open space, wetland and ecological restoration, and associated enabling works.

The application seeks approvals necessary to facilitate the staged development of the Project, including a suite of resource consents required under the FTAA framework.

The substantive application is supported by a comprehensive set of technical assessments and plans addressing the environmental, servicing and infrastructure matters associated with the proposal. This report should be read alongside the Planning Report and the appended technical reports and drawings lodged in support of the substantive application.

1.1 Purpose and Scope of this Report

This Assessment of Environmental Effects (AEE) report has been prepared on behalf of Fulton Hogan Land Development Limited (the Applicant) and addresses matters relating to hydrogeology, groundwater allocation, and potential environmental effects associated with a proposed groundwater abstraction for the Project proposal.

Specifically, this report addresses:

- Assessment of the local geological and hydrogeological setting within the Ōrewa Waitematā Aquifer Management Unit (ŌWAMU).
- Re-evaluation of the current groundwater allocation status and allocation limit within the ŌWAMU under the Auckland Unitary Plan (AUP) framework.
- Predictive modelling of groundwater drawdown, bore interference effects on neighbouring consented wells, and potential ground settlement.
- Quantitative evaluation of stream depletion effects on the Ōrewa River and nearby surface water bodies.
- Assessment of potential drawdown and hydrological impacts on nearby natural wetlands.
- Evaluation of regional groundwater mass balance and potential saline intrusion risks along the coastal margin.
- Alignment with the provisions of the FTAA, RMA, National Environmental Standards (NES), National Policy Statements (NPS), and the AUP.

The AEE supports a resource consent application to Auckland Council for a groundwater take for a maximum daily volume of 454.5 m³/day, with a maximum annual take of 165,893 m³/year, for the purposes of supplying potable groundwater to the proposed Milldale Stages 14-17 site (as described below).

Groundwater will be supplied from a new bore, which should this consent to take water be granted, will need to be constructed.

This report has been prepared having regard to the relevant statutory and technical framework applicable to the proposal, including the AUP.

1.2 Site Description

The site comprises approximately 231 ha of land located to the north of the existing Milldale development. The site comprises two distinct areas:

- Residential subdivision area to the south of the Ōrewa river (shown in red in **Figure 1**); and
- Te Korowai o Maraeariki to the north of the Ōrewa river (shown in orange in **Figure 1**).

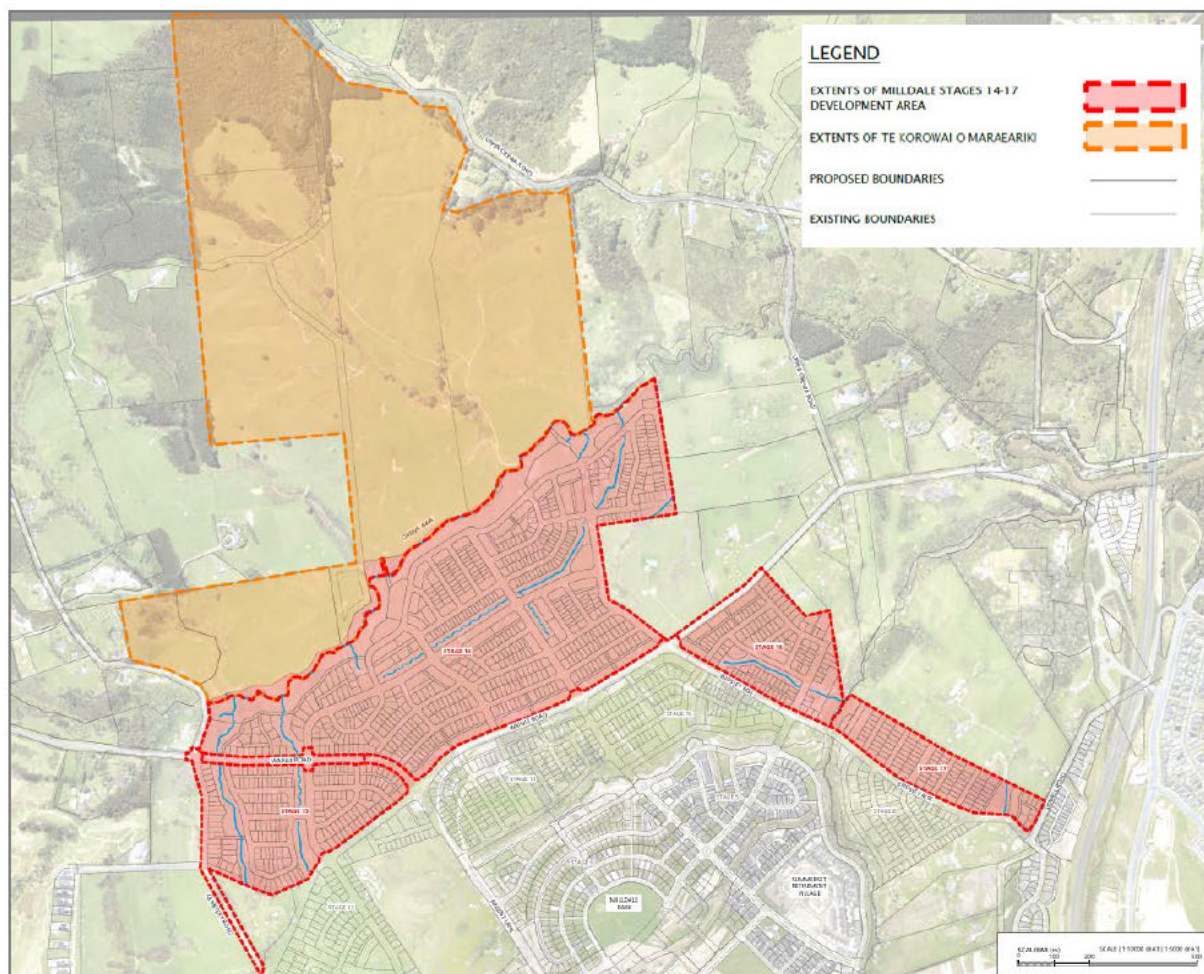


Figure 1. Site Location Plan.

The proposed residential subdivision area is located within the Future Urban Zone under the AUP. This part of the site is characterised by gently undulating to rolling pasture, with several streams, natural wetlands, constructed ponds and artificial drains traversing the area.

Te Korowai o Maraeariki is located to the north of the Ōrewa River and is zoned Rural Production under the AUP. This area is characterised by more undulating to steep terrain, with a series of ridgelines separated by incised gullies extending from the Ōrewa River. The land is predominantly managed pasture interspersed with streams and natural wetlands, together with pine plantations, exotic vegetation and gorse scrub. Relatively large areas of indigenous vegetation are also present, including a Significant Ecological Area – Terrestrial Overlay in the north-western portion of the site.

There is existing water, stormwater and wastewater infrastructure surrounding the site as a result of the extensive development within previous Milldale Stages. However, the site itself is not currently serviced in terms of supply and infrastructure. The surrounding roading network has been progressively developed in accordance with the staging of the Milldale development.

The surrounding area is now substantially developed. Milldale Stages 1 to 6 and 9 are complete, while Stage 7 is well advanced, with subdivision completed for Stages 7A–7C and construction of Stage 7D underway and due to be completed by the end of 2026. Stage 8A has been completed and enabling works are underway for Stages 8B and 8C. The Milldale Local Centre has also been constructed, together with associated roads, accessways and drainage reserves. Community infrastructure within the surrounding area includes Ahutoetoe Primary School, two early childhood education centres and the Summerset retirement village. Beyond the urban extent of Milldale, the site adjoins a number of rural residential properties.

Further detail regarding the site, surrounding environment and planning framework is provided within the Planning Report and technical reports appended to the application.

1.3 Description of the Proposal

The Milldale Stages 14-17 project seeks approvals for an urban development on the site. The proposal provides for up to 1,425 dwellings across a range of housing typologies and densities. In addition, the proposal includes provision for a small commercial area, transport infrastructure, servicing and stormwater infrastructure, subdivision, earthworks, stream works, and neighbourhood parks.

To the north of the Ōrewa River within Te Korowai o Maraeariki, the project includes private water and wastewater infrastructure if required, ecological restoration, as well as walking and cycling trails to enhance recreation and amenity.

Development of the Project will require a suite of approvals under the FTAA, including resource consents associated with subdivision, land use activities, bulk earthworks, infrastructure works, stream works, water take, diversion and discharge; along with NES for contamination and freshwater.

The aspects of the proposal relevant to this report include a groundwater water take diversion.

A full description of the proposal is provided in the Planning Report and technical reports and drawings appended to the substantive application and should be read in conjunction with this report.

2. Environmental Setting

2.1 Allocation Setting

A new bore is proposed for the site for the purpose of providing potable water sourced from the underlying aquifer, in conjunction with a surface water take. The location of the proposed bore, which is immediately north of the Milldale Stages 14-17 Development Area, is shown in **Figure 2**.

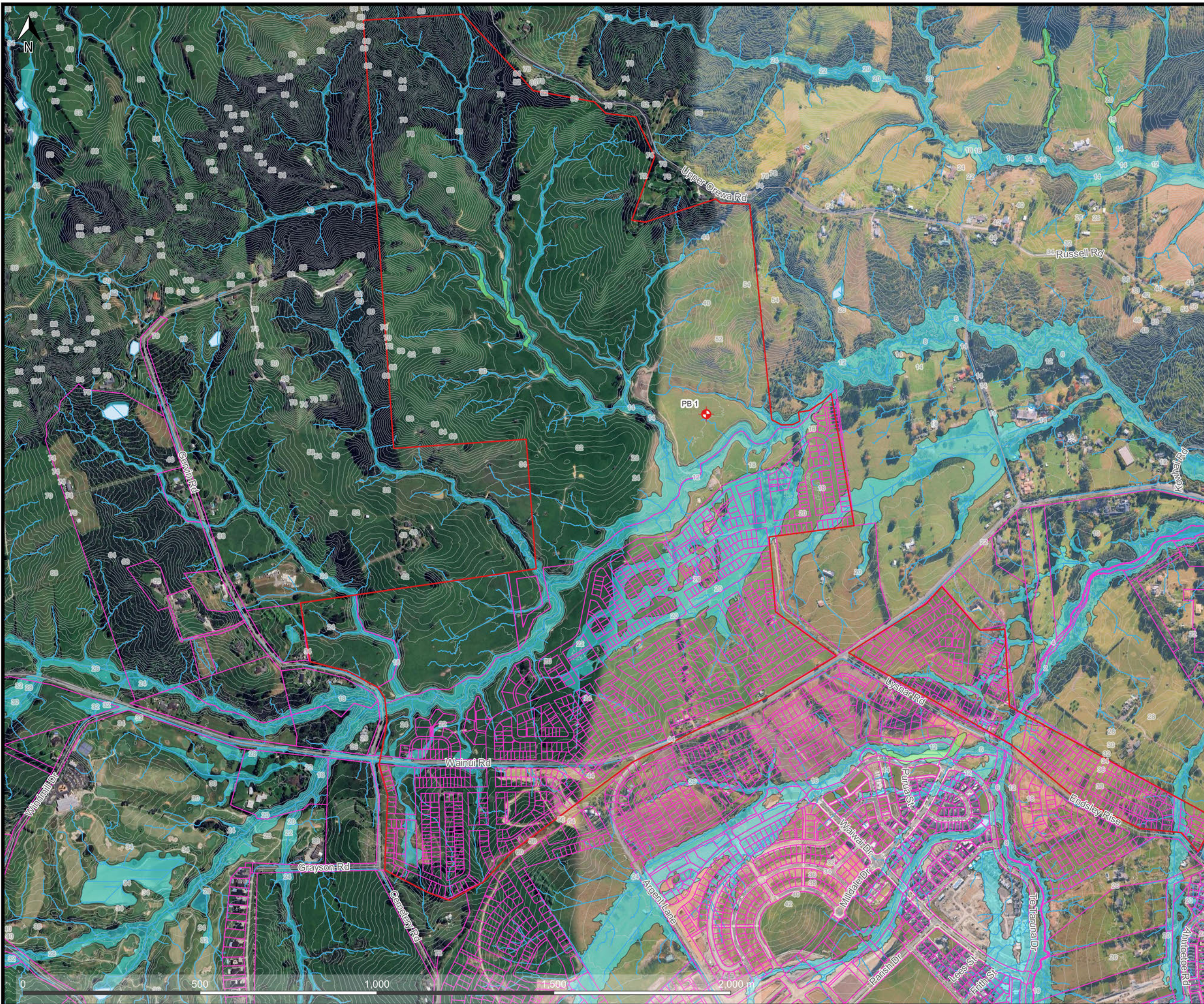
The site falls within the Orewa Waitematā Aquifer Management Unit (ÖWAMU) and is not classified as a High Use Management Area under Policy D1 of the AUP. The aquifer has a current allocation limit of water availability of 858,000 m³/year as defined in *Table 1, Aquifer water availabilities, Appendix 3* of the AUP and the remaining availability is 33,927 m³/year. However, as detailed in **Appendix B**, the applicant's research suggests that the annual allocation limit could sustainably be increased to 990,000 m³/year given the following key findings:

- **Hydrogeological Disconnection:** Data from 33 local bores (averaging 212 m depth) indicates the water is drawn from a deep aquifer zone separated from surface water by low-permeability rock and sediments.
- **Aquifer Reclassification:** The aquifer should be reclassified from "connected" to "disconnected" from surface water, which increases the allowable allocation from 35% to 65% of groundwater throughflow in the deep aquifer.
- **Recharge Rate:** The proposal adopts a conservative 3.3% recharge rate (consistent with regional defaults) despite site-specific modelling suggesting rates as high as 9% in the local area.

Using the analysis outlined above, this would provide a further 165,927 m³/year available for allocation. This is the basis for the total annual groundwater take being sought in this application.

Table 1. Allocation status summary.

	m ³ /year
Current allocation	824,073
Current allocation limit	858,000
Remaining current	33,927
Proposed allocation limit	990,000
Remaining proposed	165,927



Map Title:
Location map of Proposed Bore

Project:
**Milldale North
Groundwater Take Consent Application**

Client:
Fulton Hogan Land Development LTD



- Legend**
- Proposed Bore Location
 - Bakers Preliminary Boundary
 - 2 m LiDAR Contours
 - Roads
 - Streams and Rivers
 - Lake
 - Milldale North Proposed Subdivision
 - Wetlands
 - Flood_Plains

Data Provenance
Google Satellite Background Imagery
QGIS

Drawn by: Kevin Burdette
24/07/2026

Layout & Project File
Milldale North WWLA1603



Figure 2

2.2 Geology

The geologic conditions used in this analysis was sourced from the QMAP¹ database of the Auckland area, shown in **Figure 3** and summarised from the published text for the 1:250 000 geology map for Auckland² in **Table 2**.

The area is directly underlain by older (Late-Middle Pleistocene) Tauranga Group alluvium (IQa) primarily comprising locally derived stream alluvium. These deposits are usually less than 20m thick (Edbrooke, 2001).

The alluvial deposits are likely underlain by Northland Allochthon melange. The Northland Allochthon was emplaced during the Cretaceous and Paleogene and consist mainly of thrust sheets and mélangé and the rocks are highly faulted, folded and sheared. Thrusting occurred consistently towards the southwest. The thrust sheets and mélangé contain Cretaceous to early Miocene sedimentary and igneous rocks, but because of complex structure and poor exposure, stratigraphic classification is difficult. These rocks have thus been classified into lithologically distinctive complexes.

Table 2 Lithological classification for the Milldale area.

QMAP unit(s)	Name	Description
IQa	Tauranga Group older alluvium	River and hill slope deposits. Predominantly pumiceous sand, silt, mud and clay, with interbedded gravel and peat.
Mwe	Waitematā Group sandstone/siltstone	Alternating sandstone and mudstone with variable volcanic content and interbedded volcanoclastic grits.
Omm	Mahurangi Limestone	Blue-grey to white, micritic, coccolith foraminiferal, muddy limestone, commonly with thin glauconitic sandstone beds: commonly closely shattered. Rare crystalline limestone.
Kk	Mangakahia Complex mudstone	Closely fractured to sheared, light or dark coloured, siliceous and sometimes calcareous mudstone, with micaceous sandstone, siltstone, green and brown shale and some muddy limestone.
Kkh	Hukerenui mudstone	Red, brown, green and grey, typically noncalcareous, commonly highly sheared mudstone, with small serpentinite bodies.
Kkw	Whangai Formation mudstone	Cream to grey, siliceous and sometimes calcareous mudstone to fine sandy siltstone.

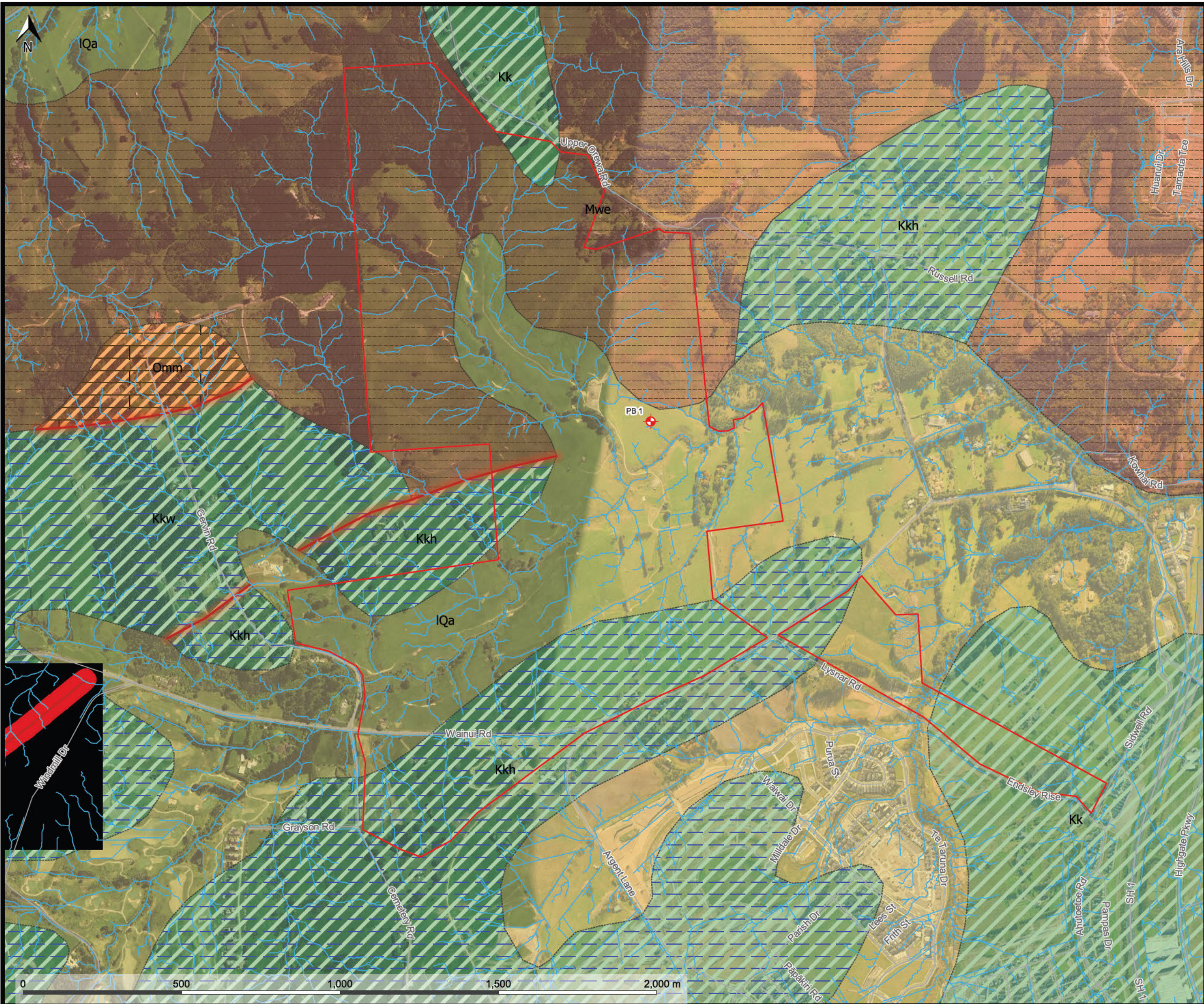
The undifferentiated Mangakahia Complex (Kk) outcrops to the east of the site and comprise deep water sedimentary rocks that are structurally complex and include intercalated Punakitere Sandstone and Whangai Mudstone. The Hukerenui Formation (Kkh) outcrops west of the site and is classified as part of the Mangakahia Complex. The Hukerenui Formation comprise weakly indurated, commonly sheared, red, brown, grey and green mudstone.

It is likely that the East Coast Bays Formation sandstone of the Waitematā Group, that outcrops to the northeast and southwest of site, underlies the Northland Allochthon mudstone. The Waitemata Group typically comprise alternating medium to fine sandstone, and siltstones, and is known to provide groundwater yields of between 1.3 to 13 L/s (4.7 to 47 m³/hr) depending on bore depth and construction detail. This is the target aquifer for these production bores.

Geological mapping identifies a fault to the west that may persist sub-surface beneath the valley floor. This fault pre-dates the alluvial deposits.

¹ GNS Science. (2012). 1:250 000 Geological Map of New Zealand [Data set]. GNS Science. <https://doi.org/10.21420/QF82-7D42>

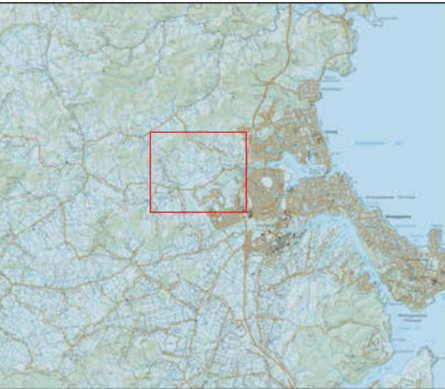
² Edbrooke, S.W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3. 1 sheet +74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.



Map Title:
Geology map of Proposed Bore

Project:
**Milldale North
Groundwater Take Consent Application**

Client:
Fulton Hogan Land Development LTD



- Legend**
- Proposed Bore Location
 - Roads
 - Streams and Rivers
 - Faults
 - Milldale North Proposed Subdivision
 - Geology
 - Tauranga Group - older alluvium (IQa)
 - Waitemata Group sandstone/siltstone (Mwe)
 - Mahurangi Limestone (Omm)
 - Mangakahia Complex mudstone (Kk)
 - Hukerenui mudstone (Kkh)
 - Whangai Formation mudstone (Kkw)

Data Provenance
Google Satellite Background Imagery
QGIS

Drawn by: Kevin Burdette
07/07/2026

Layout & Project File
Milldale North WWLA1603

2.3 Geomorphology and Surface Water

The Milldale area is situated within the Orewa River Catchment, with the proposed development site characterised by a north-south oriented ridge line at an elevation of approximately 80 mAMSLL which forms the western catchment boundary. The hills are drained by a series of small streams which flow into larger channels and ultimately discharge to the out to the eastern coast via the Orewa River. The site lies along the base of the hills with an average elevation of approximately 17 mAMSLL, featuring shallow sloping topography that merges into an estuary to the east of the study area.

The Ōrewa River, which is the northern boundary of the proposed development, is a 5 km waterway that flows east into the Whangaparaoa Bay near the town of Orewa and is the main tributary to the upper portion of the Te Ara Tahuna Estuary.

The New Zealand Ministry for the Environment GIS database indicates that there are 6 wetlands within a 1.5 km radius of the proposed bore locations, as shown in **Figure 2**. Wetland types are classified variously as swamp, gumland, and seepage. The closest wetland is a gumland 133 m to the west.

2.4 Hydrogeology

As alluded to above, Auckland Council has mapped the aquifers present in the Auckland Region. Under this framework, the site falls within the ŌWAMU.

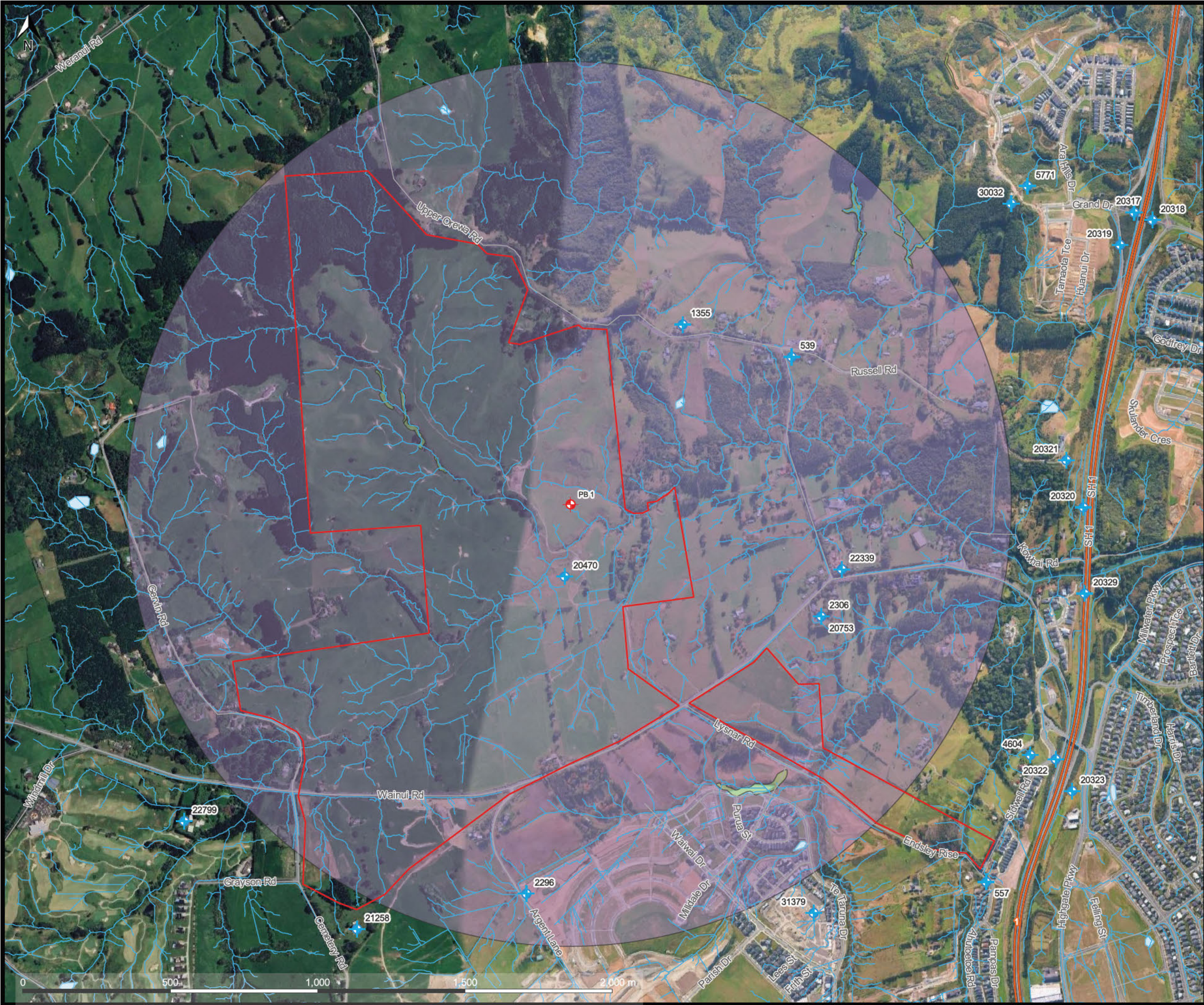
The hydrological characteristics for the ŌWAMU are as follows:

- Waitemata group comprises interbedded layers of silt and sandstone typically greater than 200 m thick;
- Groundwater flow is primarily along interbedded layers of coarser sandstones materials, or through fractures;
- Permeability is generally low with a hydraulic conductivity range of 1×10^{-7} m/s to 1×10^{-6} m/s;
- The characteristic interlayering of sandstone and siltstones creates confined beds with horizontal permeability greater than vertical permeability, with an exception in areas of high fracture zones. The resulting vertical anisotropy (K_h/K_v) is within the range of 10-300;
- Deep aquifer recharge is considered to be low at between 3% to 10% of rainfall due to poor infiltration and drainage characteristics of the overlying soils. However, flatter areas increase the likelihood of infiltration to ground as opposed to surface runoff; and
- The static water levels in nearby bores are reported to be at depths between 7.5 and 49.95 mBGL (refer following section).

2.5 Surrounding Bores

A review of bore data from WellsNZ within a 1.5 km radius of the site indicated that there are 7 production bores (**Table 3 & Figure 4**) within this distance. The potential effects on these groundwater users are discussed further in **Section 5.1.3**.

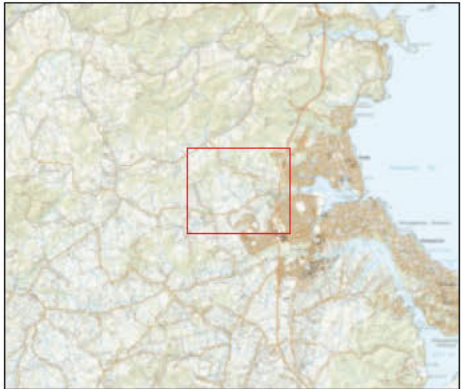
The bore logs indicate that nearby bores are drilled to depths between 20 and 311.4 mBGL and are typically around 200 m in depth. The most common bore type comprises cement grouted casing to 0 to 80 m and long “open hole” production zones beneath the casing to the end of hole (EOH). The implication of the predominance of relatively deep bore depths is that the shallow mudstone and clay-rich materials near the surface are not productive and there are greater yields in the deeper portion of the Waitemata aquifer.



Map Title:
Map of Surrounding Bores

Project:
**Milldale North
Groundwater Take Consent Application**

Client:
Fulton Hogan Land Development LTD



- Legend**
- Proposed Bore Location
 - Existing Bores
 - State Highway
 - Roads
 - Streams and Rivers
 - Wetlands
 - Lake
 - PB1 Radius 1.5km
 - Milldale North Proposed Subdivision

Data Provenance
Google Satellite Background Imagery
QGIS

Drawn by: Kevin Burdette
11/08/2026

Layout & Project File
Milldale North WWLA1603



Figure 4

Table 3. Consented water takes within 1.5 km radius.

Bore ID	Bore Depth (m)	Static Water Level (m)	Issued Date	Coordinates (NZTM)	
				X	Y
20470	220	7.5	16/01/2000	1746940	5948370
1355	200	49.95	2/11/1994	1747330	5949230
20753	128.1	13	16/04/1999	1747800	5948240
22339	180	18	22/06/2005	1747870	5948400
2296	194	22.7	23/11/1984	1746800	5947300
2306	107	13	1/01/2000	1747800	5948240
539	311.4	29	30/04/1990	1747700	5949120
Note: Bores indicated above are a record of all historical bores within the area, some may be decommissioned. And newly installed bore within the last year may not be present due to delay in data update					

2.6 Proposed Bore Details

A new production bore is proposed to obtain the volume of groundwater requested in this application and has been positioned to minimise interference effects on neighbouring bores, while being proximate to a suitable power supply and accessible for heavy machinery. To avoid any possible interaction with water infiltration, it is proposed to install a sanitary seal in the form of cement grouted steel casing to a depth of at least 80 m.

For further bore specification details refer to the specimen design in **Appendix C**.

3. Description of Proposed Activity

3.1 Overview

It is proposed to abstract 454.5 m³/day and up to a maximum of 165,893 m³/annum of groundwater from the Ōrewa Waitemata Aquifer from the proposed bore. The abstracted water will be used as a potable groundwater supply on the proposed Milldale North development site.

3.2 Consent Duration

Resource consent is sought for a duration of 35 years. The reasons for requesting the maximum duration permissible under the RMA are as follows:

- The Applicant has a significant investment in the site that is reliant on a long-term secure water supply.
- The proposed development will significantly benefit the local community.

3.3 Water Use Requirements

The proposed Milldale Stages 14-17 development will require a private potable water supply for the foreseeable future, if Watercare or Council do not allow a connection to the public network. This is a matter that is currently unclear, thus the need to pursue a private on-site solution.

Woods has advised that an average daily demand of 880 m³/day is required for potable supply. This is equivalent to a constant abstraction rate of 10.2 L/s, and an annual volume of 321,200 m³/year. The average daily demand includes an allowance for treatment plant efficiency (the plant will be 95% efficient – i.e., 5% of raw water is lost during treatment).

Raw water will be sourced from a combination of groundwater and surface water. Groundwater abstractions will supply 454.5 m³/day, with the remaining 425.5 m³/day supplied via stored surface water.

The annual groundwater take proposed in this application is for 165,893 m³ per annum.

3.4 Consideration of Alternatives

Schedule 4 of the RMA requires that consideration of alternatives is given where it is likely that the activity will result in any significant adverse effect on the environment. As discussed in **Section 5**, the proposed groundwater take is expected to result in less than minor effects on the environment. On that basis, a consideration of alternatives is not required for this activity.

However, because the supply of groundwater was not adequate in isolation to meet the proposed developments entire water requirement, an additional source of water will also be utilised. The additional water source is documented in a separate WWLA report³, and comprises a high flow take from the Orewa River. The take will supply a water storage reservoir.

³ WWLA. 2026. Catchment Hydrology Assessment. Milldale Stages 14-17 Fast Track. Consultancy report prepared for Fulton Hogan Land Development Ltd. WWLA1603. Rev 2.

4. Resource Consent Requirements

4.1 Auckland Unitary Plan

The proposal involves a daily take of up to 454.5 m³/day, with an annual take of up to 165,893 m³/year of groundwater from the Ōrewa Waitemata Aquifer.

The following rules under the AUP are relevant and permissions will be required:

- Rule E7.4.1(A26) - The take and use of groundwater not otherwise provided for is a **discretionary** activity pursuant to Rule.
- Rule E7.4.1(A41) - The drilling of one bore associated with this groundwater take requires consent as a **controlled activity**. To maintain controlled activity status, the drilling and use of the new bore must comply with the controlled activity standard E7.6.2.3.

Objective / Policy	Comment
Auckland Unitary Plan	
Standard E7.6.2.3	
Wetlands Overlay Restrictions: The bore must not be located within a Wetland Management Areas Overlay	The bore is not located in a Wetland Management Area Overlay.
Historic Heritage Protection: The drilling of the hole or bore must not destroy, damage, or modify any scheduled places within the Historic Heritage Overlay	The bore is not located in a Historic Heritage Overlay area.
Aquifer Contamination Control: The bore must be constructed to prevent and avoid contaminants from entering the aquifer penetrated by the bore.	The bore will be constructed to comply with standard New Zealand drilling practices NZS4411: Environmental Standard for Drilling of Soil and Rock.

Overall, resource consent is sought as a **discretionary** activity.

4.2 Other Approvals

The proposed water take is not the subject of any resource consent requirement in National Environmental Standards or regulations. Regulation 45C(4) classifies the taking, use, damming, or diversion of water within a 100-metre setback of a natural inland wetland for the purpose of urban development as a Restricted Discretionary Activity. The closest natural inland wetland to the proposed production bore is 433 m to the northwest, and hence does not trigger Regulation 45C(4).

5. Assessment of Effects on the Environment

The following assessment identifies and assesses the types of effects that may arise from the proposed activity. This assessment also outlines the measures that the applicant proposes to avoid, remedy or mitigate any potential adverse effects on the environment.

Actual and potential effects on the environment associated with the proposed groundwater take include:

- Groundwater effects;
- Stream depletion effects;
- Wetland effects;
- Saline intrusion effects; and
- Ground settlement effects.

To assist in the assessment of pumping effects of the proposed water take, an analytical groundwater model was developed to simulate the groundwater response from the proposed maximum abstraction rate of 165,893 m³/annum. Details of the model construction, methodology and results are included in **Appendix B**.

The potential effects predicted by the analysis are summarised in the following sections.

5.1 Effects on Groundwater

5.1.1 Allocation Limits

Groundwater in the Auckland region is regulated in aquifer management zones. The relevant zone for the Milldale North site is the ŌWAMU, which has a total allocation limit of 858,000 m³/year as defined in *Table 1. Aquifer water availabilities, Appendix 3* of the AUP.

The aquifer is not classified as a High Use Aquifer Management Area under Policy D1 of the AUP.

There are only three active consented groundwater takes in the immediate area, both considered to be for small groundwater takes (0.2 ha of glasshouse crops, domestic use for an early childhood development centre, and landscape irrigation at the Summerset Milldale retirement village).

The current level of allocation for the ŌWAMU is understood to be 824,073 m³/year and a remaining availability is 33,927 m³/year. As discussed in **Section 1.2**, under the current allocation limit there would not be enough allocation available to support the take proposed in this application. However, as part of this application the applicant proposes that the allocation limit be increased to 990,000 m³/year based on hydrogeological analysis and the groundwater allocation criteria stated in the AUP (Chapter E2 & E7). Evidence supporting this increase is provided in **Appendix A**. Based on this analysis, the allocation limit can be increased by 165,927 m³/year, which means that there is sufficient groundwater available for the proposed take.

5.1.2 Groundwater Drawdown

An analytical model was used to calculate the drawdown associated with the groundwater take under a maximum pumping scenario. The drawdown was modelled for the proposed bore, with maximum daily abstraction for a duration of time sufficient to meet the proposed annual limit (454.5 m³/day x 365 days = 165,893 m³/year), hence providing the maximum combined drawdown effect.

The calculated drawdown from pumping after 365 days is presented in **Figure 6-Appendix B**. The magnitude of drawdown is greatest in the deep aquifer within the production zone, reaching 36.1 m. The magnitude of drawdown reduces towards the surface and is 0.2 m in close proximity to the pumping bore. This is consistent with the interbedded nature of the Waitemata Group lithology, and the significant casing depth of the bore.

Figure 7– Appendix C presents the maximum predicted drawdown in the production zone, which is where the greatest effects will manifest.

The key findings are summarised as follows:

- the extent of potential groundwater drawdown effects, taken to be the area within the 0.20 m drawdown contour in the Waitemata Group Aquifer is 2,036 m;
- The maximum drawdown is 49 m, immediately adjacent to the bore;
- No drawdown was predicted to occur in the shallow aquifer, confirming the hydraulic separation of the aquifer layers on account of the low-permeability sediments overlying the deep-aquifer production zone.

The predicted drawdown has the potential to affect other groundwater users and surface water features. These potential effects are considered in further detail below.

5.1.3 Neighbouring Groundwater Users

There are total of 19 bores⁴ within the area potentially affected by drawdown from the proposed take. **Table 4** shows the level of predicted drawdown from the proposed take on all neighbouring bores where the estimated drawdown exceeds 0.2 m. The maximum predicted drawdown was 6.13 m at Bore ID 20470, which is located on property owned by the applicant, hence is not a matter for further consideration. This bore will be utilized as a monitoring well to be measured quarterly to confirm the validity of the FWM. The predicted drawdown was considered in comparison to available drawdown, defined as the height of the water column between the static water level and the bore pump. Where the available drawdown is less than 5 m and no data is available to support the bore being a viable groundwater supply, we have assumed these bores were constructed for the purposes of geotechnical investigation. Hence, whilst these bores with <5 m available drawdown are shown in **Table 4**, they have been excluded from our analysis (marked with N/A).

The following assumptions were applied to calculate available drawdown and total drawdown as shown in **Table 4**:

- Bore pump has been positioned 2 m above the casing bottom;
- The FWM (as described in **Appendix C**) has been used to calculate drawdown in the production zone.
- Drawdown in neighbouring bores is based on the FWM layer that correlates to the depth of the given bore; and
- There is no groundwater recharge (a conservative assumption).

Based on the drawdown effect on bores within the zone of influence, the overall effect on neighbouring groundwater users is considered less than minor.

Table 4. Drawdown effect on neighbouring bores.

Unique ID	Bore usage	Distance from site (m)	Bore depth* (m)	Base of casing *(mBGL)	Static Water Level (mBGL)	Available Drawdown ** (m)	Drawdown from proposed take (m)	Remaining Allowable Drawdown (m)	% Reduction
20470	N/A	245	220	80	7.5	70.5	6.13	64.37	8.7
1355	N/A	719	200	80	49.95	28.05	1.93	26.12	6.9
539	N/A	902	311.4	80	29	49	1.34	47.66	2.7
2306	N/A	931	107	80	13	65	1.26	63.74	1.9
20753	N/A	931	128.1	80	13	65	1.26	63.74	1.9
22339	Domestic	946	180	80	18	60	1.22	58.78	2.0
2296	N/A	1329	194	80	22.7	55.3	0.59	54.71	1.1
21258	Domestic	1612	317	80	17	61	0.35	60.65	0.6

⁴ <https://wellsnz.teurukahika.nz/>

Unique ID	Bore usage	Distance from site (m)	Bore depth* (m)	Base of casing *(mBGL)	Static Water Level (mBGL)	Available Drawdown ** (m)	Drawdown from proposed take (m)	Remaining Allowable Drawdown (m)	% Reduction
31379	N/A	1613	160	80	14	64	0.34	63.66	0.5
20321	N/A	1689	40	37	25.5	9.5	0.0025	9.498	0.03
22799	Domestic	1695	585	80	17	61	0.30	60.70	0.49
20320	N/A	1740	25	22	19	1	0.0024	N/A	N/A
20329	N/A	1770	30	27	2.6	22.4	0.0022	22.398	0.01
4604	N/A	1777	196	80	16	62	0.25	61.75	0.40
30032	GW Investigation	1810	252	80	50.3	27.7	0.24	27.46	0.87
20322	N/A	1859	25	22	6.5	13.5	0.0018	13.498	0.01
5771	N/A	1889	20	17	11	4	0.0017	N/A	N/A
557	N/A	1905	207.8	80	<u>12</u>	66	0.20	65.80	0.3
20323	N/A	1960	25	22	13	7	0.0014	6.99	0.02

Notes:

*If bore depth is > 100 m, base of casing is 80 mBGL, otherwise the base of casing is 3 m above the total; depth of the bore.

**Available drawdown calculation assumes pump is 2 m above the bottom of the casing.

#Bore Depths between 20m – 60m will have Drawdown calculated from Layer 1 of the FWM.

Underline - Interpolate Static Water Level (SWL)

-Remaining Allowable Drawdown (m) – is the drawdown available after accounting for the drawdown from the proposed applicants bore.

-Drawdown from the neighbour's pumping within their own bores was not considered in the cumulative drawdown assessment because the impact % from the applicants bore were so small that plenty of available drawdown remained.

5.2 Effects on Surface Water

Surface water effects were considered by calculating the portion of the groundwater take that is derived from the uppermost layer of the FWM model, presented in **Figure 8-Appendix C**. For the purpose of assessing stream depletion, it was conservatively assumed that all the water deriving from model Layer 1 was directly contributing to stream depletion effects.

The simulation results indicate that after 365 days of continuous pumping, 46.5% of the abstraction volume derives from Layer 1, equating to a potential stream depletion effect of 211.6 m³/day (2.45 L/s). A stream depletion ratio of less than 60% after a significant period of pumping is typically considered to be an indirectly connected groundwater system. On that basis, the groundwater allocation would not be taken as surface water.

The maximum rate of stream depletion effect that could manifest of 2.45 L/s exceeds the Mean Annual Low Flow (MALF) of approximately 0.5 L/s (47.5 m³/day) at the Auckland Council flow gauge on the Orewa River. However, under the broader Milldale Stage 14-17 development, with treated wastewater discharges polished through a nature-based engineered cascading wetland system, the MALF increases to 6.9 L/s. Therefore, the maximum stream depletion effect represents approximately 35% of MALF. But the key point to note with regard to the catchment water balance, is that there is a net benefit under the proposal because the residual flow of 4.45 L/s is nine times greater than the current MALF of 0.5 L/s.

On this basis effects on surface water, and in particular stream depletion effects, are considered to be less than minor.

5.3 Effects on Wetlands

Based on information available through the Auckland Council GeoMaps service and the LINZ 2013 wetland extent survey, the nearest wetland to the site is at about 133 m west of the proposed bore.

The wetlands in this area are surface water fed features and hydraulically separate from the deep aquifer that comprises the production zone for the Applicant's bore, with minimal drawdown propagating to the surface layers. The maximum predicted drawdown at the wetland as a result of the groundwater abstraction is 0.03 m (Layer 1 after 365 days), which would in practice be difficult to measure against seasonal variability. Furthermore, the model does not account for rainfall recharge, and hence the calculated effects, especially near the surface, are considered to be extremely conservative.

Given that rainfall and surface water flow are the predominant water source for maintenance of the wetland, and with the minimal predicted impact on surface water flows generally, it is considered that potential impacts on wetlands from the proposed deep aquifer abstraction will be less than minor.

5.4 Saline Intrusion Effects

Saline intrusion can occur when groundwater drawdown occurs at or near the coast to a degree that depressurises the aquifer enough to allow denser seawater to migrate inland. Maintaining groundwater pressures at above mean sea level at the coast is typically adequate to withstand saline intrusion effects.

Saline intrusion in the Orewa Waitematā Aquifer is a major consideration of the Auckland Council's resource consenting process. The Council relies heavily on Technical Paper 007⁵ (TP007), a 1992 management plan for the Orewa and Whangaparaoa areas, to calculate water balance and ensure saline intrusion does not occur. However, recent reviews⁶ argue that the Council's continued reliance on TP007 to manage allocation limits is based on outdated methodologies, a miscalculated catchment area, and miscalculated recharge allocation.

A numerical groundwater model for the Orewa River Catchment was developed and calibrated to estimate the regional water balance. This work is presented in **Appendix B**, with the overall water balance for scenarios with and without the proposed abstraction presented in **Table 5**.

This analysis indicates that 19.6% of the recharge into the aquifer ultimately discharge as deep aquifer flow throughflow to the ocean under current conditions. With the proposed abstraction, the deep aquifer throughflow reduces by approximately 2% of recharge to 17.7% of recharge. This amounts to 10% reduction in throughflow in the deep aquifer, which is well within the allowable limit of a 65% reduction. The implication of these results is that the proposed take does not disrupt the flux of groundwater flow toward to ocean to a degree that would cause saline intrusion.

Table 5. Propose bore pumping simulated average daily flux.

Water Balance Component		Current Conditions (no abstraction)		Proposed Abstraction	
		m ³ /day	Percentage	m ³ /day	Percentage
Inflows	Recharge	8,582	100%	8,582.0	100.0%
	Total	8,582	-	8,582.0	-
Outflows	Discharge to streams	6,812	79.4%	6,527.3	76.0%
	Bore pumping (Layer 2)	-	0%	454.5	5.3%
	Layer 1 - Discharge to Ocean	87	1.0%	86.7	1.0%
	Layer 2 - Discharge to Ocean	1,685	19.6%	1,515.6	17.7%

⁵ Kelly, T. (1992). *Orewa/Whangaparaoa Groundwater Allocation and Management Plan* (Technical Publication No. 7). Environment and Planning Division, Auckland Regional Council

⁶ WWLA. (2026). *Review of TP007 - Orewa-Waitematā Aquifer Management Unit – Allocation Reassessment*. Consultancy Report prepared for Fulton-Hogan Land Development Ltd. 15 April 2026.

Water Balance Component		Current Conditions (no abstraction)		Proposed Abstraction	
		m ³ /day	Percentage	m ³ /day	Percentage
	Total	8,583	-	8,584.2	-

Furthermore, the modelled drawdown associated with this take does not extend to the coast (**Figure 7**) and therefore positive groundwater pressures along the coast are sustained while pumping. Therefore, the risk of horizontal migration of the saline interface is considered negligible.

5.5 Ground Settlement Effects

Land settlement effects have the potential to occur when compressible layers within the ground are dewatered.

For this proposal the maximum drawdown occurs at depth in the Waitemata Group. The Waitemata Group rocks comprise interbedded sandstone and siltstone that have low compressibility, and hence the risk of land settlement is negligible.

The overlying sediments of the Tauranga Group Alluvium and Hukerenui Formation in the upper 65 m of the area are more susceptible to compressibility; however, the magnitude of drawdown is less than 1 m in these layers, and therefore the risk of land settlement is considered less than minor.

5.6 Cultural Effects

In accordance with the decision-making obligations under the FTAA regarding Treaty settlements and recognised customary rights:

- **Resource Isolation:** Hydrogeological modelling demonstrates that extraction is restricted to a deep, aquifer stratum that lacks any hydraulic connection to surface water systems or customary marine/coastal environments.
- **Statutory Alignment:** The proposal does not intersect with, nor adversely affect, any statutory acknowledgements, Treaty settlement mechanisms, or customary rights identified in the project area.

Given the total physical separation of the resource and the lack of adverse effects on the receiving environment, the proposal aligns with the purpose of the FTAA while ensuring existing Treaty settlement obligations are respected.

6. Recommended Consent Conditions

It is recommended that the following set of consent conditions be proffered in association with this application. These conditions are based on the findings of the Assessment of Environmental Effects detailed in the preceding Section.

Table 6. Recommended Consent Conditions.

Condition	Description						
Groundwater							
Condition 1	The cumulative abstraction from the production bore must comply with the following: a) The total daily abstraction must not exceed 454.5 m³/day. b) The total volume of water abstracted in a 12-month period, must not exceed 165,893 m³/year.						
Condition 2	The consent holder must take a water meter reading once every 15 minutes. The date, time and the water meter reading must be recorded and provided to the council in accordance with the Water Reporting condition (Condition 5). If no water is taken during any time period, the current meter reading must still be recorded and reported.						
Condition 3	Groundwater levels in the monitoring bore (Bore ID 20470) must be measured and recorded from the date at which exercise of the permit commences, in accordance with the frequency set out in the Water Reporting condition (Condition 5).						
Condition 4	The groundwater level must be: a) Measured from the top of the casing. b) Must be recorded to an accuracy of +/- 1 cm. The consent holder must record the time, date and the water level measurement(s) and supply these measurements to the Council in accordance with the Water Reporting condition (Condition 5).						
Condition 5	The consent holder must enter the following information, at the frequency and date specified, into the Council's Water Use Data Management System or into any replacement database identified in writing by the council. <table border="1"> <thead> <tr> <th>Information</th><th>Due Dates for Reporting</th></tr> </thead> <tbody> <tr> <td>• Water use meter reading and date</td><td>• Quarterly</td></tr> <tr> <td>• Groundwater level reading including date and time</td><td>• Annual</td></tr> </tbody> </table>	Information	Due Dates for Reporting	• Water use meter reading and date	• Quarterly	• Groundwater level reading including date and time	• Annual
Information	Due Dates for Reporting						
• Water use meter reading and date	• Quarterly						
• Groundwater level reading including date and time	• Annual						
Condition 6	A report which provides analysis of the water use (actual used volumes vs. predicted) and a trend analysis of monitored water levels (actual levels vs. predicted) required by Conditions of this resource consent must be submitted to the Council each year. The report must be prepared to a standard acceptable to the Council and consider all data collected from the date of the commencement of this consent and in particular evaluate any effects on the environment during the previous year.						

7. Conclusion

The proposal involves a groundwater take to support a planned development at 231 ha of land centred around Wainui Road in Wainui, Auckland. Based on the above report it is considered that:

- The proposal accords with the relevant AUP objectives and policies; and
- Any adverse effects in relation to the proposed groundwater take will be less than minor and acceptable when considering the positive effects of the proposal, which includes the provision of a long-term, reliable water supply to meet the potable water needs of the development.
- Recommended conditions for the groundwater take and associated groundwater monitoring have been proffered based on the findings of the Assessment of Environmental Effects.

It is therefore concluded that the proposal satisfies all matters the FTAA Panel is required to assess, and that it can be granted.

Appendix A. Allocation Reassessment

A.1 Introduction

This reassessment has been prepared following three previous memos discussing the groundwater allocation status and the potential to increase the allocation limit in the Orewa–Waitematā Aquifer Management Unit (OWAMU) earlier in the year⁷⁸⁹.

This reassessment extends the previous analyses by incorporating conceptual hydrogeological elements and water balance of the aquifer system as recommended by Philip Kelsey of EarthTech based on the work his firm successfully undertook for Auckland Council in the Franklin deep Waitematā Aquifer for a similar purpose.¹⁰

The initial investigations (mentioned above) concluded that the current limit is overly conservative, and an increase can be justified based on:

- The estimated groundwater recharge rate is conservatively estimated relative to recent site-specific modelling and other groundwater investigations; and
- Groundwater of meaningful and productive yields occurs at depths typically greater than 100 m within the area, beneath low permeability sediments that separate the aquifer from surface water bodies.

The implication is that allocation should be set at the AUP standard of 65% of annual recharge for deep semi-confined aquifers, rather than 35%, which appears to be the basis for the current limit and is typically used in aquifers that are connected to surface water.

A.2 Methodology

A conceptual-level numerical groundwater model encompassing an area of 25.2 km², previously developed to support Groundwater Effects Assessments for several FHLD projects¹¹ was updated for this investigation.

Model Configuration

The model was updated by adding an additional layer that represented the deep aquifer, which as indicated above is the water source for most production bores in the area. The two model layers can be described as follows:

- **Layer 1:** Consolidated sandstone and mudstone - known to be of low-permeability with poor groundwater yield, with alluvial areas featuring deposits of fine-grained Tauranga Group alluvium that is also low permeability. The surface elevation was derived from 1 m LiDAR data sourced from Land Information New Zealand (LINZ).
- **Layer 2:** Orewa-Waitematā Aquifer comprised of interbedded sandstone and mudstone of the East Coast Bays Formation, with the production zones corresponding to relatively coarse and/or fractured layers. This aquifer is under semi-confined conditions due to the impermeable nature of the overlying sediments in Layer 1.

An investigation of production bores in the focus area showed that bores were cased, on average, to a depth of 100 m which was taken as an indication of the depth where viable groundwater production started to become available.

⁷ WWLA, 2026c. Review of TP007 - Orewa-Waitematā Aquifer Management Unit – Allocation Reassessment. *Consultancy Report prepared for Fulton-Hogan Land Development Ltd.* 15 April 2026.

⁸ WWLA, 2026b. Orewa-Waitematā Aquifer Management Unit – Allocation Reassessment. *Consultancy Report prepared for Fulton-Hogan Land Development Ltd.* 25 March 2026.

⁹ WWLA, 2026a. Evaluation of Groundwater Allocation Framework: Orewa–Waitematā Aquifer Management Unit. *Consultancy Report prepared for Fulton-Hogan Land Development Ltd.* 10 March 2026.

¹⁰ EarthTech, 2018. Franklin Deep Waitemata Aquifer - Groundwater Availability Study. *Consultancy Report prepared for Auckland Council.* October 2018.

¹¹ WWLA (2023). Milldale Numerical Groundwater Model Development – Factual Technical Report. *Consultancy report prepared for FHLD.*

The depth of the deep bores in the focus area ranged from 160 to 585 m, with an average of 282 m. The interface between Layer 1 and Layer 2 was set at -67 mAMS, which is 100 m below the average surface elevation (33 mAMS) of the deep production bores. The base of Layer 2 was set at -250 mAMS.

Boundary Conditions

Drain boundaries were assigned to streams and the Orewa River, with drain elevations determined by intersecting the LiDAR data with the model grid.

Deep groundwater flow to the ocean was represented by a general head boundary (GHB) condition that was assigned to the downgradient reach of the model boundary. A 0 m head was assigned to the GHB to represent the interface with the ocean, and conductivity through the GHB was adjusted for Layer 1 and Layer 2 as part of the calibration process.

Recharge across the model area was assigned as 9.9% of mean annual rainfall (1,255 mm/year), amounting to 0.34 mm/day, as determined in the process of calibrating the groundwater model to shallow bore water levels as part of the previous assessments referenced earlier in this report.

Model Calibration

The model was calibrated in a conceptual manner to two key elements:

- 1) **Stream Baseflow** - measured by Auckland Council in the Orewa River Gauge at Kowhai Ave¹². Baseflow separation was undertaken using a rainfall runoff model¹³ calibrated to the gauge data, with consideration for the purposes of this analysis on only the groundwater flow component of that model.
- 2) **Groundwater hydraulic gradient** - the indicative hydraulic gradient between measured groundwater levels in select bores in the deep aquifer¹⁴. There is no long-term groundwater monitoring data available in the focus area.

Stream Baseflow

Figure 5 shows the correlation between the measured and simulated flow rates. We note that:

- the missing tail in the measured data corresponds to dry summer periods where the river level drops below the gauge and no flow is measured; and
- the divergence between the simulated flow and measured flow at very low flows, whilst highlighted on the log-scale is not significant because the absolute discrepancy relates to very small flows in the overall water balance between approximately 0.02 to 1 L/s (1.7 to 86.4 m³/day).

Further detail of the SMWBM calibration will be provided in a forthcoming WWLA report comprising an assessment of surface water hydrology.

¹² <https://environmentauckland.org.nz/Data/Dashboard/440>

¹³ The rainfall runoff model used was WWLA's Soil Moisture Water Balance Model (SMWBM) - <https://www.wwla.kiwi/software/detail/smwbm>

¹⁴ The selection of these bores for calibration was based on a review of the water levels and bore details. Anomalous water level measurements were not considered and bores that were not representative on account of being far deeper than others were given less weight in the calibration process.

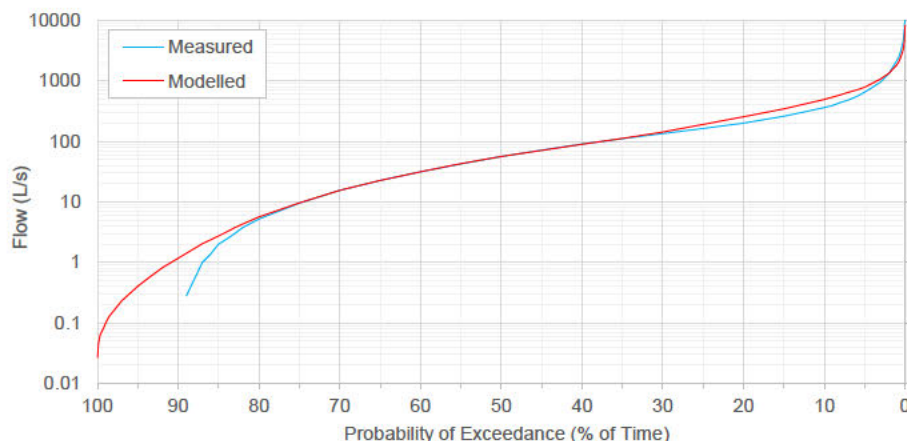


Figure 5. Flow duration curve from calibrated SMWBM.

The baseflow rate at the gauge ranges from approximately 2 m³/day to 12,280 m³/day, with an average of 2,620 m³/day. The baseflow from the gauge catchment area (9.7 km²) was scaled using the specific discharge approach (m³/day/km²) to the area of the groundwater model (25.2 km²) to represent baseflow in all streams in the model domain, which is 6,814 m³/day.

Table 7 compares the average (scaled up) measured versus modelled baseflow for the entire model domain and shows that the model replicates the measured baseflow accurately.

Table 7. Comparison of measured versus simulated baseflow.

Data Source	Simulated Baseflow
SMWBM Baseflow Separation	6,814 m ³ /day
Groundwater Model Baseflow	6,812 m ³ /day

Groundwater Hydraulic Gradient

Simulated groundwater hydraulic gradient between deep aquifer bores was also a focus for calibration, with bores 4604 and 81139 being considered particularly good representations of the target aquifer. This is because their depths and screen zones correspond to the anticipated configuration of a production bore for the FHLD development, and in the latter case the groundwater level measurement was taken recently by WWLA staff.

Calibrated Hydraulic Properties

Table 8 summarised the model hydraulic properties applied to achieve the model calibration. The parameters reflect the conceptual hydrogeological model of low permeability surficial sediments and clay rich weathered Waitemata Group rocks overlaying a more conductive fractured Waitemata Group rock aquifer.

Table 8. Parameters from the calibrated groundwater model.

Model Layer	Material Description	Hydraulic Parameters			Comment
		Conductivity (m/s)	Vertical Anisotropy	Sy (Layer 1) Ss (Layer2)	
Layer 1	Tauranga Group Alluvium	4.9×10^{-6}	30	0.02	Conductivity aligns with the results of infiltration testing which averaged 3.2×10^{-6} m/s across 40 tests ¹⁵
	Low-permeability Sandstone / Mudstone formations	8.1×10^{-8}	120	0.02	Conductivity is in the range of typical values used for the low-permeability sediments of the shallow ECBF.
Layer 2	Orewa – Waitemata Deep Aquifer	2.9×10^{-6}	10	0.0001	Conductivity aligns with hydraulic testing results for deep aquifer bores in the OWAMU

A.3 Water Balance Results

The daily water balance derived from the 25.2 km² groundwater model is shown in **Table 9**. The water balance data shows that 79% of groundwater recharge is discharged to streams (6,812 m³/day), with the remaining portion flowing through the aquifer to the ocean (1,772 m³/day). This analysis indicates that 95% of the groundwater throughflow occurs in the deeper aquifer (1,685 m³/day) reflecting the higher permeability of the materials at depth and conversely the impermeability of the shallower sediments.

Table 9. Simulated mass balance – model water budget summary.

Water balance component		Average daily flux	
		m ³ /day	Percentage
Inflows	Recharge	8,582	100%
	Total	8,582	-
Outflows	Discharge to streams	6,812	79.4%
	Layer 1 - Discharge to Ocean	87	1.0%
	Layer 2 - Discharge to Ocean	1,685	19.6%
	Total	8,583	-

Table 10 scales the output from the model to the area of the OWAMU (62.35 km²).

¹⁵ WWLA, 2025. Milldale Ground Infiltration and Soil Classification. Consultancy Report prepared for Fulton-Hogan Land Development Ltd.

Table 10. Simulated mass balance – scaled to OWAMU.

Water balance component		Average daily flux	
		m ³ /day	Percentage
Inflows	Recharge	21,234	100%
	Total	21,234	-
Outflows	Baseflow discharge to streams	16,854	79.4%
	Layer 1 - Discharge to Ocean	215	1.0%
	Layer 2 - Discharge to Ocean	4,169	19.6%
	Total	21,236	-

Proposed Allocation Limit

Based on the above water balance for the OWAMU we propose an allocation limit equivalent to 65% of the throughflow in the deep aquifer (4,169 m³/day) of 2,710 m³/day or 990,000 m³/year.

The current allocation for the OWAMU is 858,000 m³/year, hence the proposal represents an increase of 132,000 m³/year or 15%. The current level of allocation is understood to be 824,073 m³/year, which means that if our proposal is accepted, an additional 165,927 m³/year would be available for allocation.

Appendix B. Groundwater Response Modelling

B.1 Introduction

The assessment used the Feather Williamson Analytical Model to simulate the potential groundwater effects resulting from the proposed take.

B.2 Feather Williamson Analytical Model

The Feather and Williamson Model (FWM) is an analytical solution for drawdown calculation in a multi-layer aquifer system. By assigning the hydrogeologic parameters and thicknesses of individual layers based on the documented geology, drawdown is calculated for each individual layer the inverse Laplace transform of the groundwater flow equation. The model is available as freeware at <https://www.wwla.kiwi/softwaredetail/fwm> and we encourage Council staff or appointed peer reviewers of this application to download the software and confirm/test sensitivity of our predictions if desired.

In response to s92 requests on other recent groundwater take applications, which sought a comparison of the FWM to the Theis model, we provide the following comments:

- a) The Feather-Williamson Model (FWM) computes the drawdown through multiple layers in the bore.
- b) This approach is more accurate than Theis due to consideration of storage and leakage effects from overlying and underlying layers;
- c) The model provides a similar response to that of a numerical model.
- d) The FWM has been used widely throughout New Zealand for groundwater take applications and has passed scrutiny through the technical reviewer at Northland Regional Council, Waikato Regional Council, Bay of Plenty Regional Council, Hawkes Bay Regional Council, Gisborne District Council and Greater Wellington Regional Council by virtue of numerous consents being granted in these regions.
- e) Furthermore, it has recently been used in the Auckland region for the following consents, without any concerns:
 - **Watercare Services Limited** - Rautawhiri Park irrigation bore;
 - **Tapora Resources Limited** – Sand quarry groundwater supply;
 - **Parakai Birds Limited** – Chicken farm drinking water supply;
 - **Summerset Retirement Villages** – Groundwater irrigation supply for landscaped areas for Milldale and Warkworth developments.
 - **Kumeu River Wines** – Renewal for wine processing facility.
 - **Zaknich Farms Limited** – Renewal for strawberry growing operation in Taupaki.
 - **DG & BD Speedy Enterprise Limited** – Potable water cartage operation in Waimauku.
 - **Murray Jones & Lyn Thackwray** – Farm take renewal in Kumeu.
 - **Nga Raukau Nurseries** – Irrigation for plant growing operation in Taupaki.

B.3 Model Set-up and Calibration

This stratigraphic layering used in this application of the FWM was based on the bore logs from the bores adjacent to the applicant's proposed bore location (Table 11).

Table 11. Bore logs analysed for FWM setup

Council well ID	Drilling date	Drilled depth (mBGL)	Static water level (mBGL)	Distance from proposed bore (m)
20470	16/01/2000	220	7.5	245
539	30/04/1990	311.4	29	902

Council well ID	Drilling date	Drilled depth (mBGL)	Static water level (mBGL)	Distance from proposed bore (m)
22339	22/06/2005	180	18	946
2296	23/11/1984	194	22.7	1329
31379	01/03/2023	160	14	1613

The model was run to simulate the maximum drawdown generated by the maximum daily abstraction rate (455 m³/day) operating continuously for 365 days, noting that any period where the abstraction rate decreases the drawdown will automatically reduce.

The model is comprised of four layers, with each layer assigned hydraulic parameters to represent the geological units inferred at the site, based on the materials and layering that are typically observed in the area. These layers, as represented in the model are shown in **Table 12**. Abstraction is assigned to Model Layer 3, which represents the lower portion of the bore production zone.

The following assumptions are applied:

- There is no recharge to the aquifer;
- Proposed bores will be cased to 80 mBGL; and
- Each unit is assumed to be homogeneous across the model domain.

The geological material and thicknesses for each modelled layer are simplified based on the surrounding bore logs (**Table 12**), with some layers were combined for modelling purposes.

WWLA (2019)¹⁶ summarised aquifer hydraulic parameters for the Waitemata Group rock types from a range of previous studies. The report concluded that the Waitemata Group maintains a hydraulic conductivity of 10⁻⁹ to 10⁻⁷ m/s for largely unfractured rock, with fractured Waitemata Group having conductivity as high as 10⁻⁵ m/s. To represent the Hukerenui Formation and highly weathered Waitemata Group materials, the hydraulic conductivity was lowered from 10⁻⁷ m/s. Using lower hydraulic conductivity values results in reduces vertical flow of groundwater to the production zone being simulated and a greater magnitude of drawdown in the production zone.

To inform parameterisation of the model, a step-drawdown test was conducted on the closest bore (Bore ID 20470) to the proposed bore (**Appendix D**). The test concluded that the aquifer, in close proximity to the proposed bore, had a transmissivity value of 17.71 m²/day and a hydraulic conductivity of 1.19x10⁻⁶ m/s. These values were then used as the production layer (Layer 3) parameters.

Table 12. Hydrogeologic parameterisation in the FWM.

Layer	Layer thickness (m)	Total thickness (m)	Transmissivity (m ² /day)	Kh (m/s)	Kh/Kv ratio	Specific Storage (/m)	Storativity (-)	Geology
0	20	20	0	0	0	0.1	0	Unsaturated
1	50	70	0.4	9.26E-08	10	0.01	0.5	Hukerenui FM
2	15	85	1.4	1.08E-06	10	0.0005	0.0075	Weathered Waitemata
3	115	200	13	1.31E-06	10	1E-06	0.000115	Fractured Waitemata
4	100	300	1.5	1.74E-07	10	1E-07	1E-05	Waitemata Basement

¹⁶ WWLA, 2019. Grey Lynn Tunnel - Groundwater Effects Assessment. Consultancy report prepared for McMillen Jacobs Associates on behalf of Watercare Services Limited. WWA0047 | Rev. 11. 19 February 2019.

B.4 Simulation Results

Groundwater Drawdown

The estimated drawdown within each aquifer layer at the bore location, where maximum drawdown will occur, is shown in **Figure 6**. The peak volume of abstraction in a given year will vary based on climatic factors like rainfall and temperature, however the simulated condition where maximum abstraction is applied on a daily basis will not occur in practice and assures that the drawdown estimation can be considered conservative.

The greatest drawdown is simulated to occur within the pumped aquifer, as would be expected, and amounts to 49 m with requested groundwater take applied. Maximum estimated drawdown in Model Layer 1, which is conservatively assumed to be directly connected to surface water, amounts to 0.12 m.

It is noted that all predicted drawdown can be considered a conservative estimate because the FWM model does not account for any rainfall recharge.

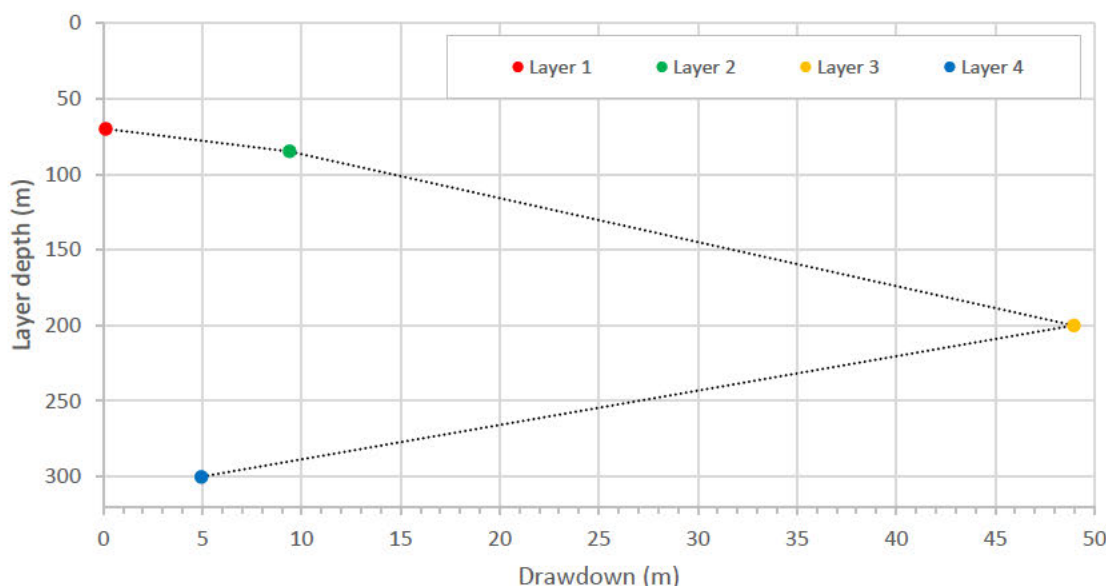


Figure 6. Simulated drawdown in each model layer (455 m³/day abstraction).

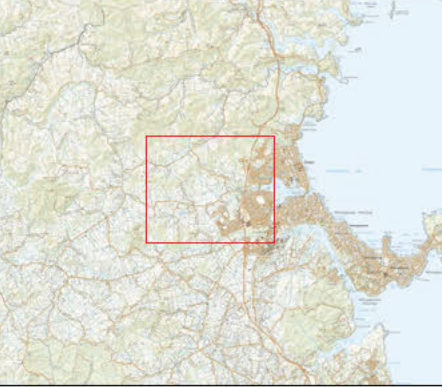
The lateral extent of drawdown in the production zone is presented in **Figure 7**. The drawdown is greatest in close proximity to the proposed bore, reducing with distance. The 0.20 m drawdown contour is considered to be the point at which effects on other groundwater users are considered to be negligible. These results indicate that the most significant potential bore interference effects will be limited to within a close proximity to the proposed bores, as shown in **Figure 7**. The simulated groundwater drawdown is addressed in terms of the potential effects on other groundwater users in **Section Error! Reference source not found**.



Map Title:
Drawdown Contours of Proposed Bore

Project:
**Milldale North
Groundwater Take Consent Application**

Client:
Fulton Hogan Land Development LTD



- Legend**
- Proposed Bore Location
 - Existing Bores
 - Drawdown Contours
 - Roads
 - Lake
 - Wetlands
 - Milldale North Proposed Subdivision

Data Provenance
Google Satellite Background Imagery
QGIS

Drawn by: Kevin Burdette
11/08/2026

Layout & Project File
Milldale North WWLA1603



Figure 7

Surface Water Connectivity

The FWM calculates the percentage of pumped groundwater derived from each layer in the model, as shown in **Figure 8**. For the purpose of assessing the potential impact of the groundwater abstraction on surface water features, it is assumed that Layer 1 is hydraulically connected with surface water bodies.

The key features to note from this analysis are as follows:

- As pumping begins, 100 % of the pumped water is derived from the production zone (Layer 3);
- Over time, the contribution of Layer 3 decreases while Layer 1 and 2 contribution increases.
- After 365 days of pumping, Layer 3 contributes about 0.1 % of the total volume and Layer 2 contribution increased to about 52.5 %, as the cone of depression migrates upwards. The model has simulated the maximum pumping scenario; therefore, this magnitude of abstraction is rare to occur.
- Layer 1 contribution after continued pumping is about 46.5 % of the pumped volume.

The implications of this analysis for surface water depletion are discussed in further detail in the assessment of hydrological effects section (**Section 5.2**).

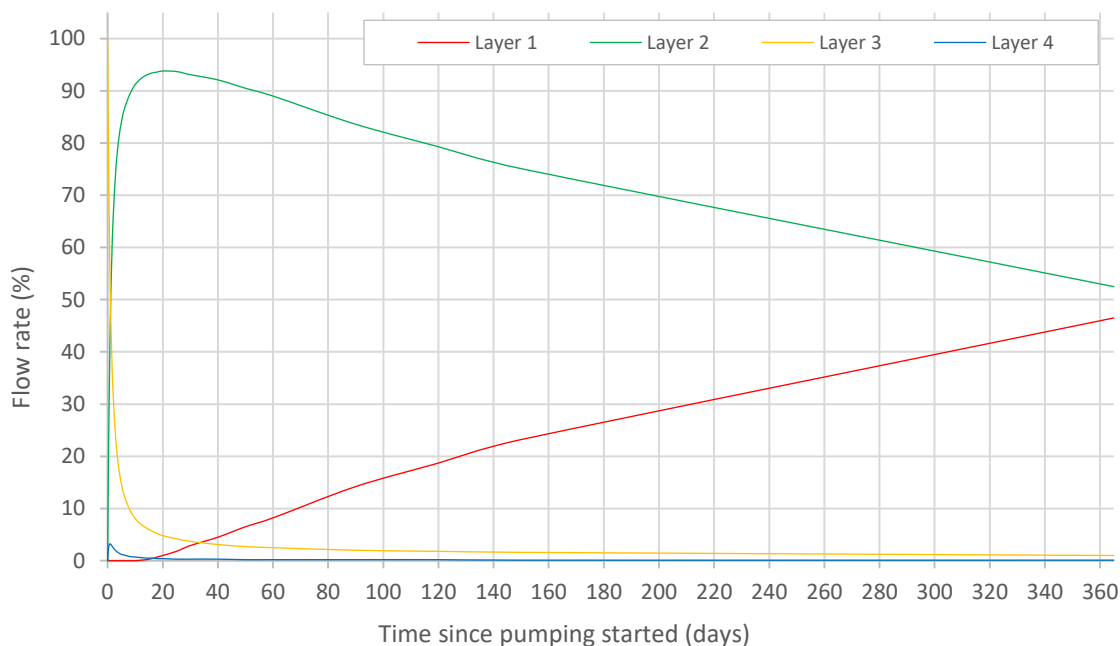


Figure 8. Flow partitioning of abstracted groundwater within the FWM layers.

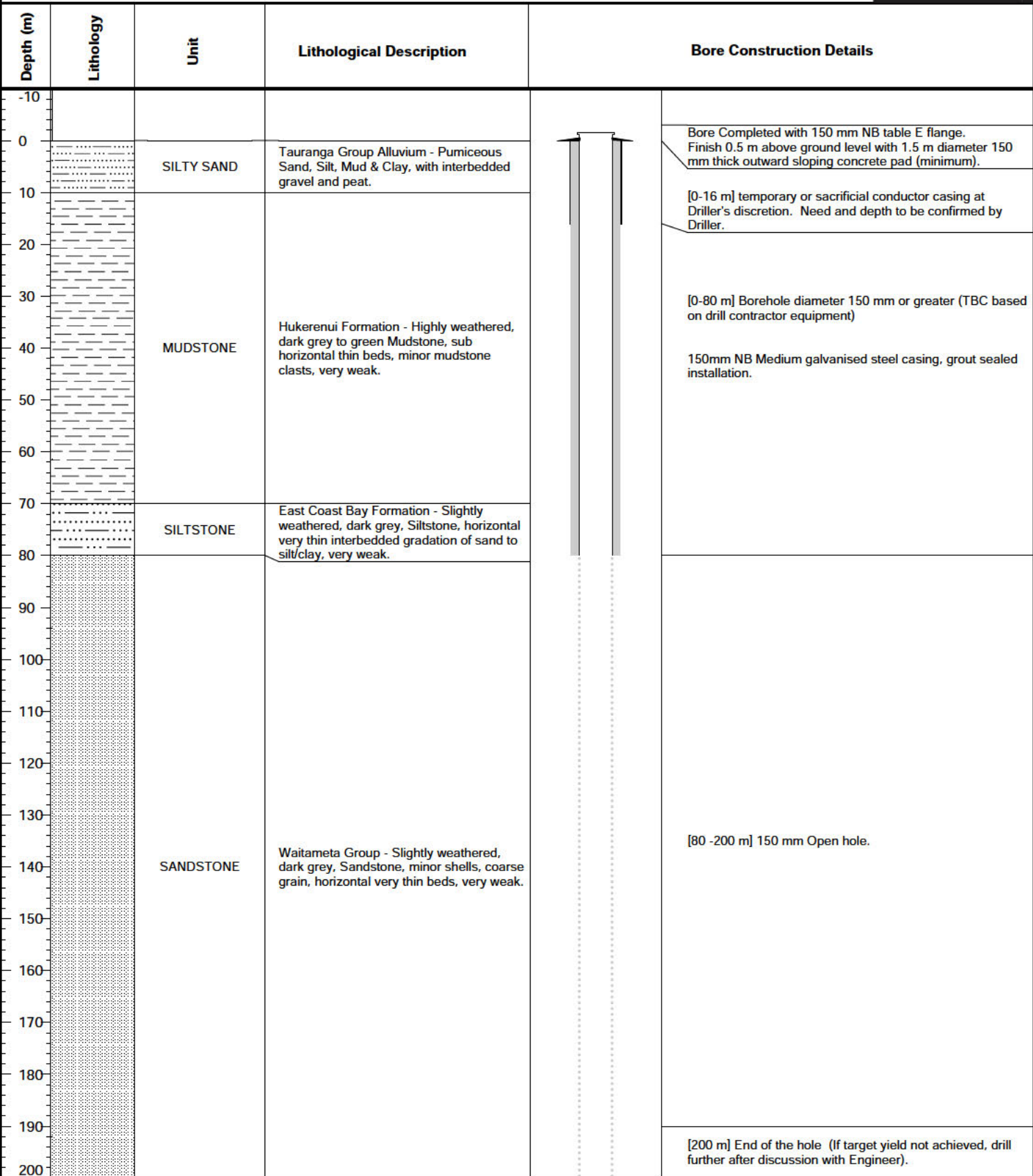
Appendix C. Bore Specifications

Production Bore Specimen Design		Bore:	PB1
Project Name:	Milldale North	Location:	Milldale
Project Number:	WWLA 1603	Designer:	Kevin Burdette



WWLA

BORE DRILLING DETAILS			
Drilling Company:	TBC	Diameter (mm):	150
Drilling Date:	TBD	Easting (m):	1746949
Drilling Method:	Rotary Mud	Depth (m):	200
		Northing (m):	5948619
		Ground Elev.(approx.):	23 mAMSL



Grainsize Classification (mm):

Boulders		Cobbles		Gravel			Sand			Silt			Clay
				Coarse	Medium	Fine	Coarse	Medium	Fine	Coarse	Medium	Fine	
	200	60	20	6	2	0.6	0.2	0.06	0.02	0.006	0.002		

Appendix D. Bore Step Testing



Memo

To	Grant Fahey (grant.fahey@fultonhogan.com)	Date	27 May 2026
From	Jon Williamson	Project No	WWLA1603
Copy	Greg Dewe		
Subject	Bore Step Testing		

1. Introduction

Fulton Hogan Land Development Limited (FHLD) commissioned WWLA to undertake a test pump exercise on an existing bore on their property at Lot 10 DP 198205, Wainui Road, Wainui. The purpose of the test pumping exercise was to define aquifer hydraulic properties to support a resource consent application for a groundwater take.

1.1 Bore Details

The bore was drilled for Sunny Heights Nursery, completed on 16/01/2000 and is currently not in use. **Table 1** provides a summary of the bore's as-built details and **Appendix A** provides the as-built bore log.

Table 1. Summary of bore as-built details.

Parameter	Value	Units
Casing Diameter	100	mm
Depth	220	mBGL
Casing Depth	48	mBGL
Casing Type	PVC	-
Recommended Pump Depth	45	mBGL
Aquifer type	Fractured alternating fine sandstone and mudstone	

2. Test Methodology

A step-drawdown test¹ (or step test) is a single-well pumping test designed to investigate the performance of a pumping well under controlled variable discharge conditions. In a step-drawdown test, the discharge rate in the pumping well is increased from an initially low constant rate through a sequence of pumping intervals (steps) of progressively higher constant rates. Each step is typically of equal duration, lasting from approximately 30 minutes to 2 hours.

The step was conducted on 07 May 2026 using the WWLA supplied Grundfos SQE 7-55N submersible pump. The static groundwater level (SWL) was recorded at 7.5 m below the

¹ Kruseman, G.P. and N.A. de Ridder, 1994. *Analysis and Evaluation of Pumping Test Data (2nd ed.)*, Publication 47, Intern. Inst. for Land Reclamation and Improvement, Wageningen, The Netherlands

measuring point (mBMP) and allowable drawdown in the bore was approximately 39.5 mBMP, given the pump was set at 47 mBMP.

The test was commenced at 11:26 am and each step lasted until a near steady state was achieved (refer **Table 2**). The flow rate was controlled by a turn valve and a pressure gauge. The flow rate was held constant during each step. The last step was extended overnight.

Table 2. Details of pumping steps

Step	Duration (minutes)	Flow Rate (L/s)
1	65	0.80
2	81	1.04
3	47	1.34
4	128	1.59
5	803	1.94

3. Test Pumping Results

The drawdown observed during the test is presented in **Figure 1**.

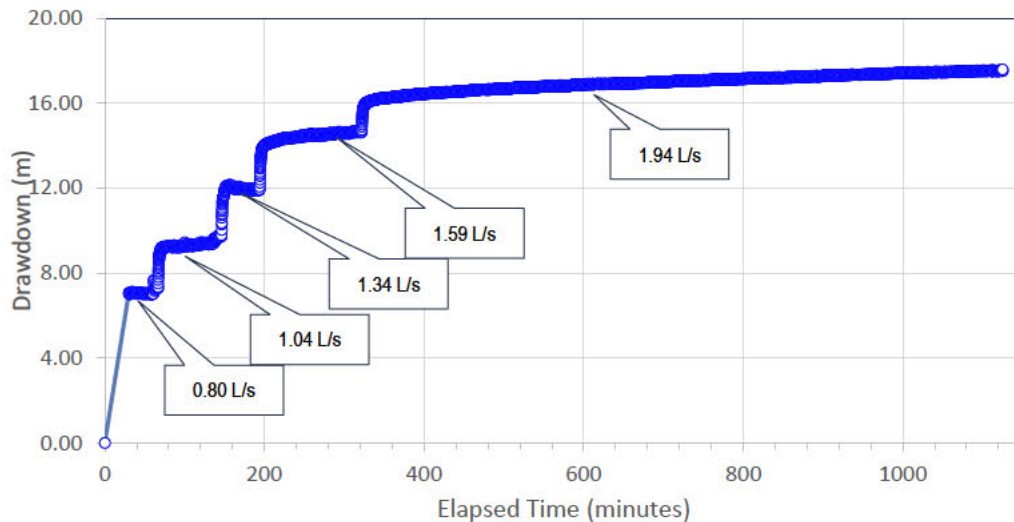


Figure 1. Step test drawdown with time.

The step data has been analysed using the Eden-Hazel method, as shown in **Figure 2**. The method requires steady state drawdown to be achieved in each step to be highly accurate.

A transmissivity value of $17.71 \text{ m}^2/\text{day}$ was determined by the Eden-Hazel method as shown in **Figure 2**. This relates to a hydraulic conductivity of $1.19 \times 10^{-6} \text{ m/s}$ given a production zone thickness of 172 m, which is consistent with published values for fractured rock, and is at the higher end of the anticipated range for sandstone or siltstone of the Waitemata Group Formation, which is the formation within the production zone (refer bore log in **Appendix A**).

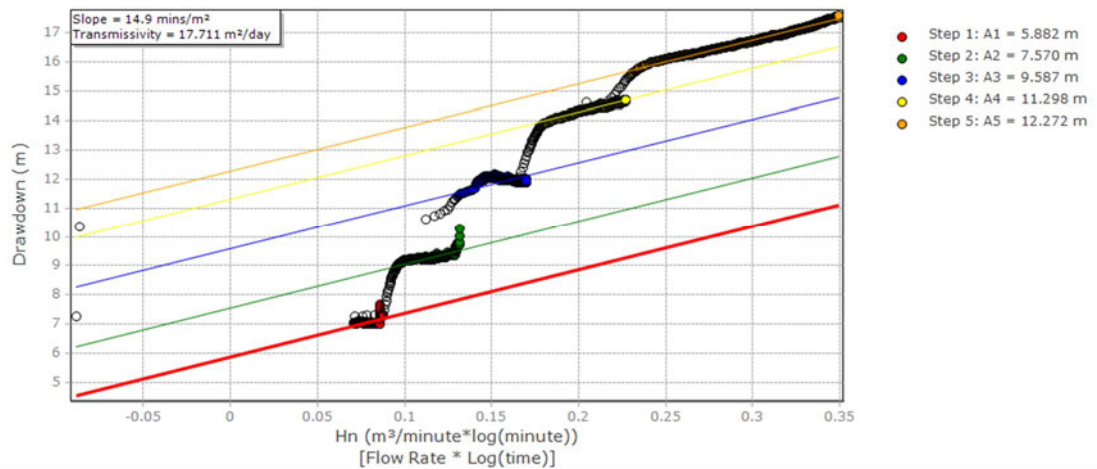


Figure 2. Eden-Hazel Analysis.

The Milldale North Development site requires a daily volume of 944 m³/day or 10.9 L/s if pumped 24 hours a day. We have proposed to use a 2 bore system to achieve this which equates to 5.4 L/s per bore. The proposed bores will be 150 mm in diameter and 300 m deep with a casing to 120 m. Using a very conservative static water level (SWL) of 25 m below ground level (mBGL) and the pump submerged to a depth of 110 mBGL, there is an approximately 85 m of available drawdown.

Using the Hantush method in predictive mode, pumping at the required 5.45 L/s for 24 hours a day would induce a drawdown of ~43.7 m (**Figure 3**). This means the drawdown would not exceed the available drawdown of 85 m.

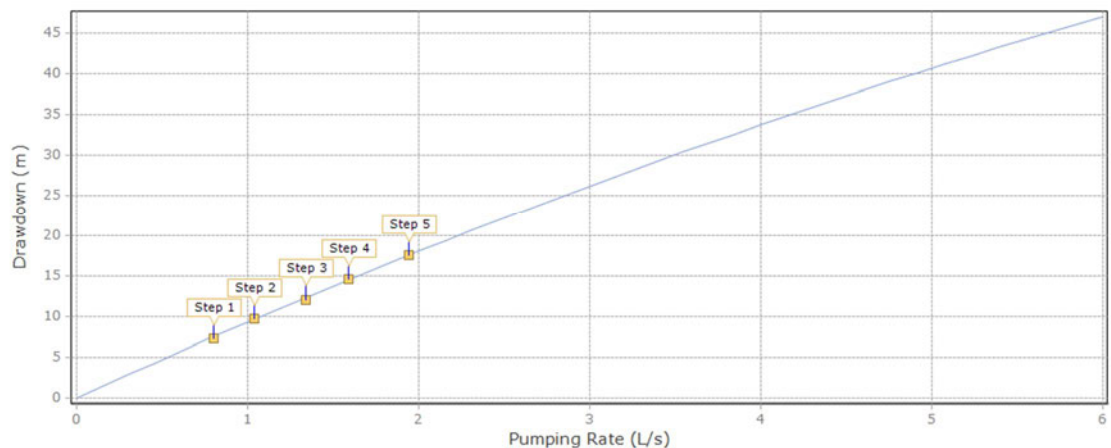


Figure 3. Predicted drawdowns based on aquifer parameters.

4. Water Quality Analysis

At the conclusion of the test pumping exercise, a sample was collected to test the water quality. **Table 3** provides the results from the Hill Labs and compare them to the Drinking Water Standards NZ (DWSNZ). Results indicate that

- pH** – the groundwater is strongly basic, which is normal for the Waitemata Group rocks.

- **Turbidity** – is elevated.
- **Iron** – slightly elevated, although in a similar bore recently tested by WWLA values around 0.5 mg/L reduced by two orders of magnitude after one week of continuous pumping. Furthermore, it is known that the iron concentration in the Waitemata Group rocks decreases with depth./ The current bore has a casing depth of approximately 50 m and the proposed bore with a casing of 120 m is likely to have significantly reduced iron concentration.
- **Langelier Index** - of 0.3 at 20 °C means your water is slightly scale-forming and non-corrosive.

Table 3. Water Quality Analysis

Sample information	Units	Sample	Drinking Water MAV	Aesthetic Value (AV)
		09-May-2026		
Physical Parameters				
pH	pH	9.7		7.0-8.5
Electrical Conductivity (EC)	mS/m	43.0		
Turbidity	NTU	11.5		≤5
Apparent Colour	Hazen Units	<10		≤15
Total Alkalinity (as CaCO3)	mg/L	165		
Total Hardness (as CaCO3)	mg/L	2.5		≤200
Approx. Total Dissolved Solids	mg/L	250		≤1000
Langelier Index (at 20 °C)		0.3		
Nutrients				
Nitrate (as N)	mg/L	<0.002	≤11.3	
Nitrite (as N)	mg/L	<0.002	≤0.92	
Nitrite (as N) + Nitrate (as N)	mg/L	<0.002		
Major Anions				
Chloride	mg/L	32		≤250
Sulphate	mg/L	4.9		≤250
Bicarbonate	mg/L	135		
Fluoride	mg/L	0.20		
Major Cations				
Sodium (Total)	mg/L	105		≤200
Calcium (Total)	mg/L	0.96		
Magnesium (Total)	mg/L	<0.02		
Potassium (Total)	mg/L	0.25		
Metals				
Arsenic (Total)	mg/L	<0.0011	≤0.01	
Boron (Total)	mg/L	0.25	≤2.4	
Copper (Total)	mg/L	0.00092	≤2	≤1
Iron (Total)	mg/L	0.52		≤0.3
Lead (Total)	mg/L	<0.00018	≤0.01	
Manganese (Total)	mg/L	0.0107	≤0.4	≤0.04

A Piper Diagram is a specialised graph used to visualise and classify water sample chemistry. It helps hydrogeologists determine the water's origin, ionic makeup, and overall quality by plotting concentrations of major dissolved ions.

The Piper Diagram provided in **Figure 4** presents the results of five water samples collected from the Waitemata Group Aquifer in the Rodney area, and illustrates the consistency of groundwater quality within the aquifer. The Milldale bore is consistent with all other samples tested.

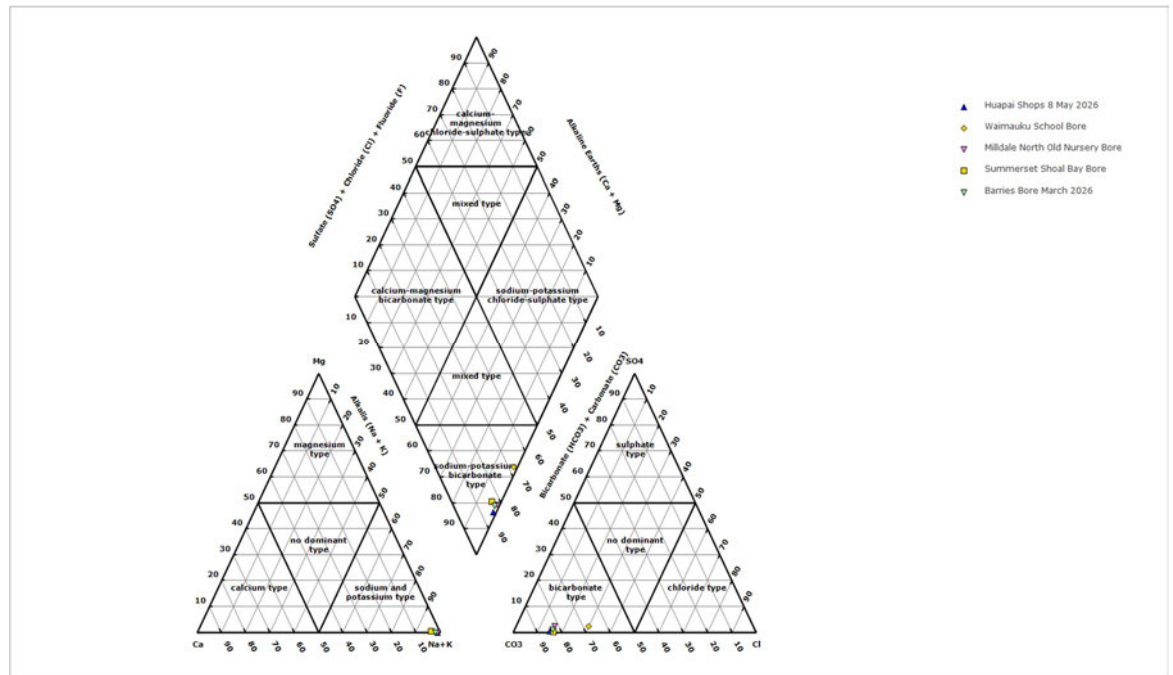


Figure 4. Waitemata Group Piper Diagram

5. Conclusion

A step test was conducted on the existing 100 mm bore to determine the permeability of the aquifer in the Milldale North area. The test concluded that the aquifer had a transmissivity value of 17.71 m²/day and a hydraulic conductivity of 1.19x10⁻⁶ m/s, which is at the higher end of the spectrum for rocks of the Waitemata Group.

Pumping the proposed bore at the required rate of 5.4 L/s would induce a drawdown of 43.7 m, well below the available 85 m.

Overall, the test was a success, and the new data should assist with the aquifer allocation request presented to the Council.

The water quality sample results indicate that the water is slightly elevated in iron, but overall is good quality and consistent with other Waitemata Group samples. With regard to iron, it is known that iron concentrations in the Waitemata Group rocks decreases with depth. The current bore has a casing depth of approximately 50 m and the proposed bore with a casing of 120 m is likely to have significantly reduced iron concentration.

6. Closure

If you have any questions regarding the information provided, or details around the next steps, please do not hesitate to contact us.

Yours sincerely,



Jon Williamson
Managing Director



Appendix A Bore log

NZGD ID: 81139