



Te Kowhai East Limited Partnership

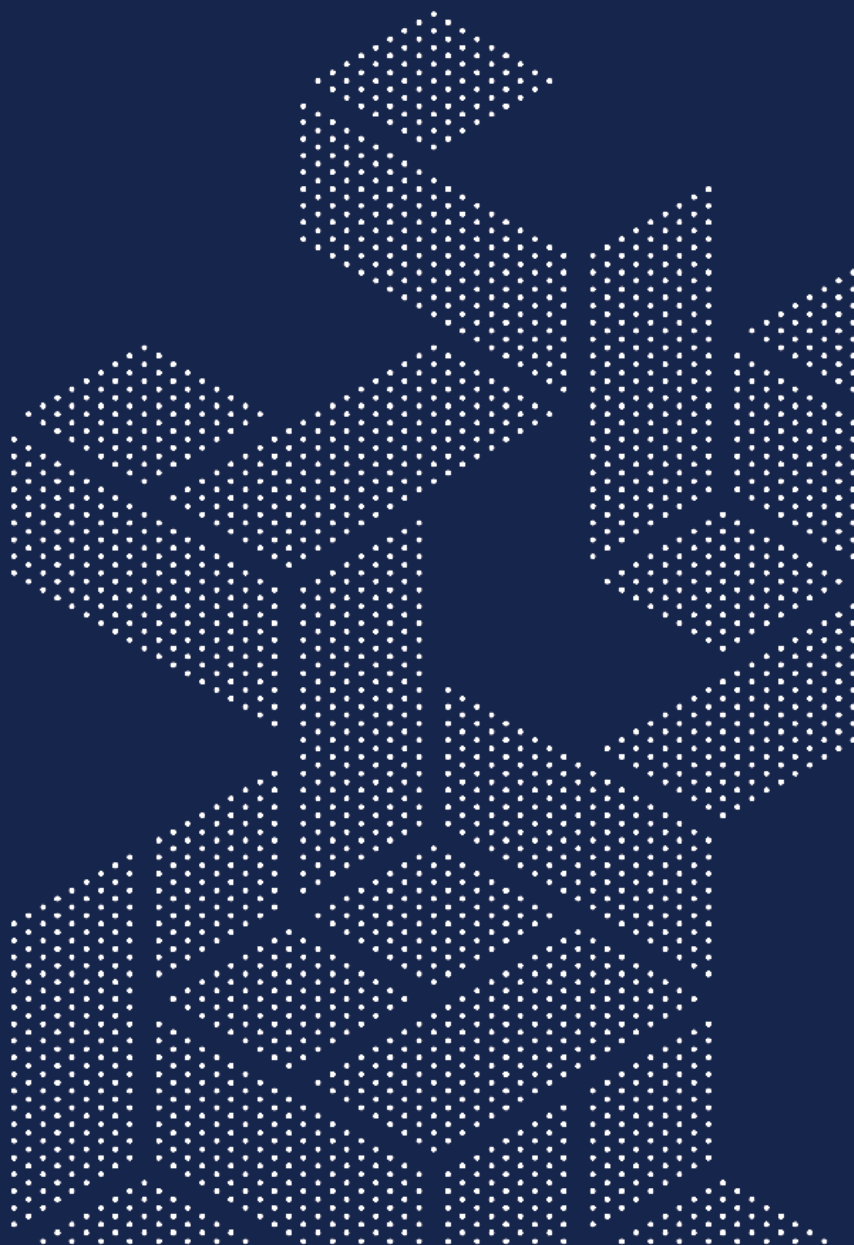
Te Kowhai East Industrial Development Hydrogeological Effects Assessment

ASSESSMENT OF EFFECTS

WGA212384

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The qualifications and experience of the authors and technical director/reviewer of this report are summarised in the table below. We confirm that we have read the Code of Conduct for Expert Witnesses contained in the Environment Court of New Zealand Practice Note 2023 and agree to comply with it. We confirm that the issues addressed in this report are within our areas of expertise, except where we state that we are relying on the evidence or advice of another person. We have not omitted to consider any material facts known to us that might alter or detract from the opinions expressed in this report.

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APPENDIX B STORMWATER CATCHMENTS

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APPENDIX G WASTEWATER PUMPING STATION DESIGN

1 INTRODUCTION

1.1 Background

The report has been prepared to support Te Kowhai East Limited Partnership's substantive application for approvals under the Fast-track Approvals Act 2024 (FTAA). The Project is a large-scale industrial development located on the north-western edge of Hamilton, adjacent to the established Te Rapa industrial area. The application provides for the creation of an integrated industrial precinct, including approximately 210 industrial lots, land for neighbourhood centre activities, reserves for recreation, stormwater management and ecological mitigation, and associated roading and infrastructure services.

Te Kowhai East Limited Partnership (TKE) has contracted WGA to undertake a hydrogeological assessment including site visits, groundwater monitoring, aquifer characterisation and assessing the temporary and long-term hydrogeological effects from constructing the development. This report documents the assessments undertaken by WGA and summarises the results.

1.2 Site Description

The Project site comprises a large, contiguous landholding located on the north-western edge of Hamilton. It is generally bounded by Te Kowhai Road to the south, Koura Drive and State Highway 1C to the east, and Onion Road to the north. The site is made up of multiple land titles, legal descriptions, and associated physical addresses.

For identification purposes, the site is commonly referred to by the primary addresses of 270 Te Kowhai Road and 28 Mathers Road. Full details of the landholdings are provided in the Substantive Application Report (SAR).

The total area of the site is approximately 187.5 ha and is bounded by Te Kowhai Road (State Highway 39) to the south, Koura Drive and State Highway 1C to the east, and Mathers Road and Onion Road to the north. The TKE stormwater overview plan is shown on Figure 1 (Maven Associates 2026, Figure 1 and Appendix A).

The current site and its surroundings are rural and comprise part of the upper Mangaheka Stream and Te Rapa catchment. Existing on-site drains, some of which form mudfish habitat, flow into the modified Mangaheka Stream, which flows as a highly modified, straight channelised drain from southeast to northwest through the site. The Te Otamanui Stream crosses the site at the southern boundary, and was connected via a small stream feeding from the Mangaheka Catchment but is now disconnected (EcoLogical 2026). A stand of Kahikatea trees are located to the south of the site¹, on the opposite side of Te Kowhai Road, beyond Te Otamanui Stream to the south. The existing Te Otamanui Stream is up to approximately 1 m deep.

1.3 Proposed Activity

From a hydrogeological perspective, the principal components of the TKE development with the potential to interact with the existing groundwater system are the proposed stormwater and wastewater networks.

The proposed stormwater system comprises a reticulated pipe network, ten raingardens, eight constructed wetlands, vegetated conveyance swales and the Mangaheka Stream. The existing rural drainage network across the Site will largely be replaced by the proposed stormwater system as development occurs. The Mangaheka Stream, which currently forms a highly modified and channelised drain through the Site, will be lowered, widened and enhanced to provide stormwater and flood conveyance through the development. Key stormwater plans are provided in Appendix A (Maven Associates 2026).

¹ On land owned by Hamilton City Council

Some of the existing artificial drains to be removed or modified provide habitat for black mudfish. To address the resulting loss of habitat, dedicated replacement black mudfish habitat is proposed within a specified area in the southeastern part of the Site. The replacement habitat will comprise purpose-designed wetland habitat formed to interact with shallow groundwater and provide both permanent aquatic refuge and seasonally wet habitat. The hydrogeological basis for this habitat is addressed further in Section 6.

The wastewater system will comprise a reticulated gravity pipeline network and wastewater pump station (WWPS). The wastewater pipelines will generally be installed at depths of approximately 3.5 m below ground level, while the WWPS wet well will extend to approximately 6 m below ground level. As shallow groundwater occurs across much of the Site, construction of portions of this infrastructure will extend below the existing groundwater table.

The proposed development therefore has the potential to influence groundwater levels and catchment water balances in two principal ways:

- Short-term groundwater dewatering during construction of the stormwater wetlands, raingardens and wastewater infrastructure, including the pipelines and WWPS. Where these excavations extend below the groundwater table, temporary dewatering will be required to enable construction.
- Long-term groundwater interception by the completed stormwater wetlands, swales and deepened Mangaheka Stream. These features will locally intersect shallow groundwater and act as persistent hydraulic boundaries, with the potential to result in localised drawdown relative to existing summer groundwater levels. The raingardens do not form part of this long-term assessment, as they are effectively windows to the water table rather than causing any long-term drawdown.

Key stormwater and wastewater plans are provided in Appendices A and G, respectively, showing the location and configuration of the infrastructure relevant to this assessment. Further details of the stormwater system and its design are provided in the project Stormwater Management Plan and Civil Infrastructure Report, while further details of the wastewater servicing strategy and infrastructure are provided in the Civil Infrastructure Report.

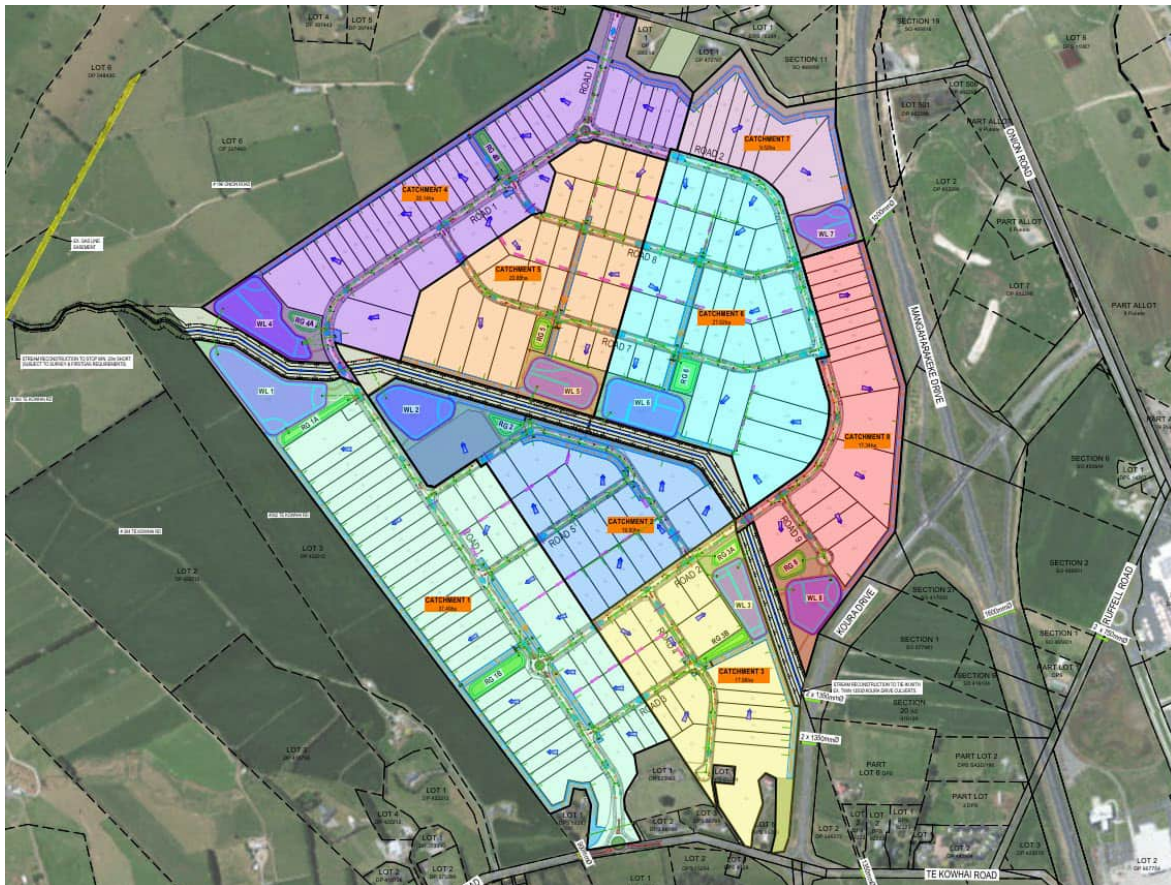


Figure 1: Te Kowhai East Industrial Development Stormwater Overview Plan (Maven Associates 2026)

2 EXISTING ENVIRONMENT

2.1 Rainfall

Rainfall data recorded at the Ruakura weather station (approximately 10 km southeast of the site) spans from November 2005 to the present, with a peak daily rainfall of 87.8 mm recorded in 2023 (Figure 2).

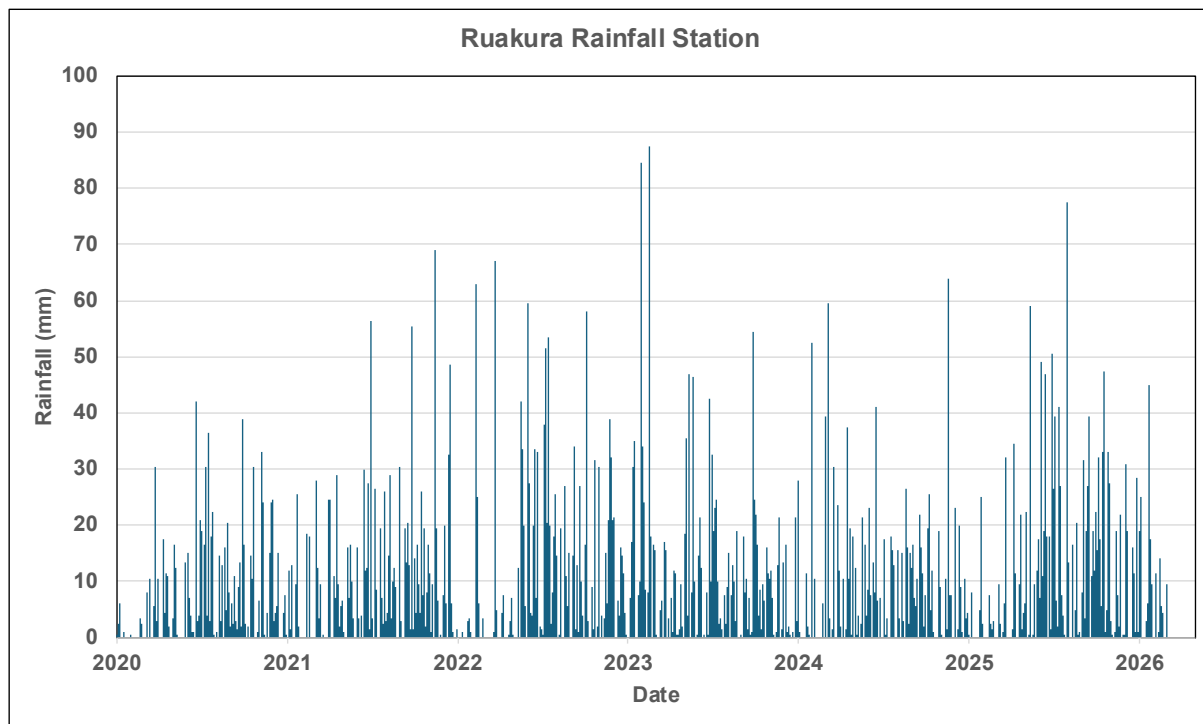


Figure 2: Rainfall Record at Ruakura

The month preceding the 20 March 2026 static groundwater level measurements was relatively dry, with approximately 16 mm of rainfall recorded, around 48 mm below the comparable long-term average. February 2026 rainfall was also below average, with 29.6 mm recorded compared with an average of 73.5 mm. Although relatively high rainfall occurred in January 2026, the low rainfall immediately preceding the March measurements indicates that the recorded groundwater levels are broadly representative of late-summer conditions, when groundwater levels across the site are expected to be near their seasonal low. These levels have therefore been used as the baseline for the summer groundwater levels described in Section 2.3.3.

2.2 Surface Water Bodies and Catchment Boundary

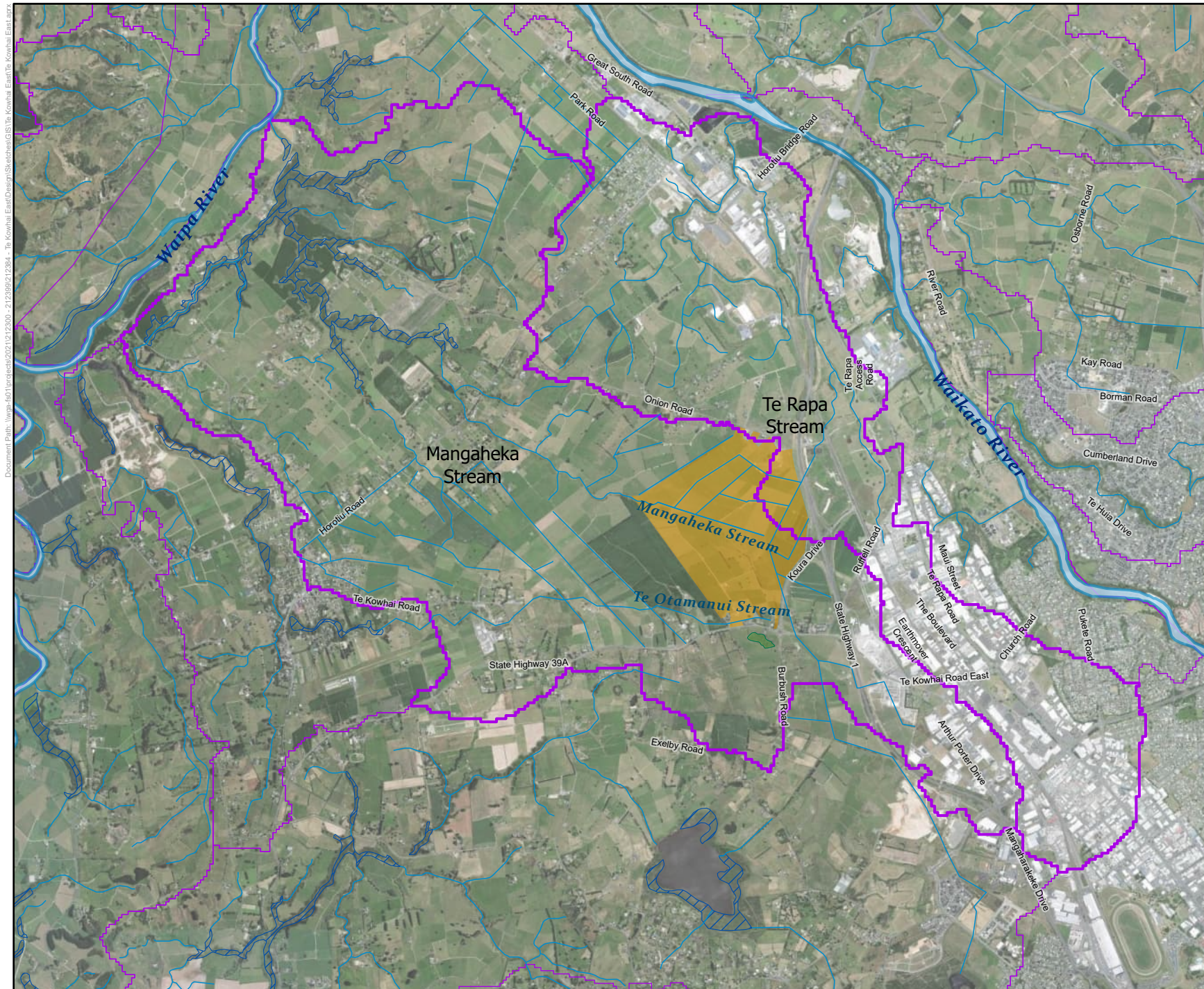
There are no major surface water bodies in close proximity to the TKE development site. The Mangaheka Stream flows through the site connecting with the Waipa River, approximately 5 km to the northwest (Figure 3). The Waikato River is located approximately 1.8 km to the east of the proposed development. Water in Mangaheka Stream eventually reaches the Waikato River via the Waipa River.

The site is predominantly within the Mangaheka Catchment and is traversed by the Mangaheka Stream. The adjacent/nearby waterbodies are Te Rapa Stream to the east (discharging into the Waikato River), Lake Rotokauri to the south (discharging into the Waipa River), and Te Otamanui Stream crossing the southern most extent of the site (discharging into the Waipa River). A small portion of the easternmost area of the TKE site is located within the Te Rapa Stream Catchment. This part of the catchment is highly modified that comprises an existing drain network that conveys runoff from the Site beneath SH1C, through an existing culvert, before ultimately discharging into the Te Rapa Stream (Figure 3).

Most of the site comprises low-lying land, with existing drainage flowing northwest into the Mangaheka Stream. The Mangaheka Stream is currently incised by approximately 1 m in the southeast of the site, 2 m in the central area, and 3 m in the northwest near the stream outflow. The Mangaheka Stream within the site is expected to draw shallow groundwater towards it and therefore influence the local groundwater flow pattern, together with the northwest gradient of the site. A number of artificial drains across the Site, that flow into the modified reach of Mangaheka Stream, are known or considered likely to provide habitat for black mudfish (EcoLogical Solutions 2026).

The Hamilton City Council Integrated Catchment Management Plan (2019) for Mangaheka Stream, provides detailed information and mapping of the Mangaheka Stream catchment, which encompasses approximately 2,080 ha, including the proposed TKE development site (Appendix B). The Te Rapa Stream catchment as delineated by Hamilton City Council (2025) is provided in Appendix B. This catchment delineation within the TKE site area is similar to, but not the same as, the WRC catchment delineation, as the upper urban catchment area is better defined by the city stormwater management infrastructure.

Existing drainage on the east side of the site for the Te Rapa stream is known to provide habitat for black mudfish, which is interpreted to be episodically connected to shallow groundwater. A stand of Kahikatea trees exists beyond Te Otamanui Stream. This existing drain is approximately 2 m lower than the land surface further south at the Kahikatea trees.



Hamilton

LEGEND

- Property Boundary
- Catchment Outlines
- River Polygons
- Swamp
- Kahikatea Stand
- Drains

Scale 1:50,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 3
WRC Catchments of Mangaheka
and Te Rapa Streams

Te Kowhai East

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any reliance placed on such information shall be at the risk of the user.

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2.3 Geology and Hydrogeology

2.3.1 Regional Geology and Hydrogeology

The proposed TKE development is located within the Hamilton Basin, a large tectonic basin centred on Hamilton City with an area of approximately 2,000 km² and traversed by the Waikato River. The basin is surrounded by ranges of Mesozoic (Manaia Hill Group) and Tertiary age rocks (Te Kuiti and Waitemata Groups). At depth, basement greywacke underlies the sedimentary deposits that infill the basin (GNS 2005).

The basin is infilled with Tauranga Group alluvial sediments dating from the Pliocene to the middle Holocene, overlain by late Holocene unconsolidated alluvial and colluvial sediments. Localised Holocene floodplain deposits, valley and coastal alluvium and colluvium are present throughout the area. These deposits are most extensively associated with the Waikato River and Waipa River. Basement greywacke underlies the sedimentary deposits at depth (GNS 2005).

The Tauranga Group sediments include gravels, sands, silt, muds and peats of fluvial, lacustrine and distal ignimbrite origin. Two subgroups are recognised locally within the Tauranga Group, the Walton Subgroup (Late Pliocene to Middle Quaternary) and the Piako Subgroup (Late Quaternary), which together form a sequence up to 300 m thick. Underlying the low hills within the basin are older ignimbrites, tephra deposits, and alluvium of the Walton Subgroup (Lowe 2021; Figure 4).

The Piako Subgroup is the youngest unit of the Tauranga Group and has been deposited within the last 20,000 years. The Hinuera Formation and the Taupo Pumice Alluvium are the most widespread formations of this group. The Hinuera Formation underlies much of the Hamilton basin and comprises a variable, discontinuous sequence of rhyolitic and pumiceous gravelly sands, interspersed with pumiceous silt, clay and peat. The Hinuera Formation was deposited by braided river systems of the Waikato River, initiated by volcanism in the Taupo Volcanic zone (Petch 1987).

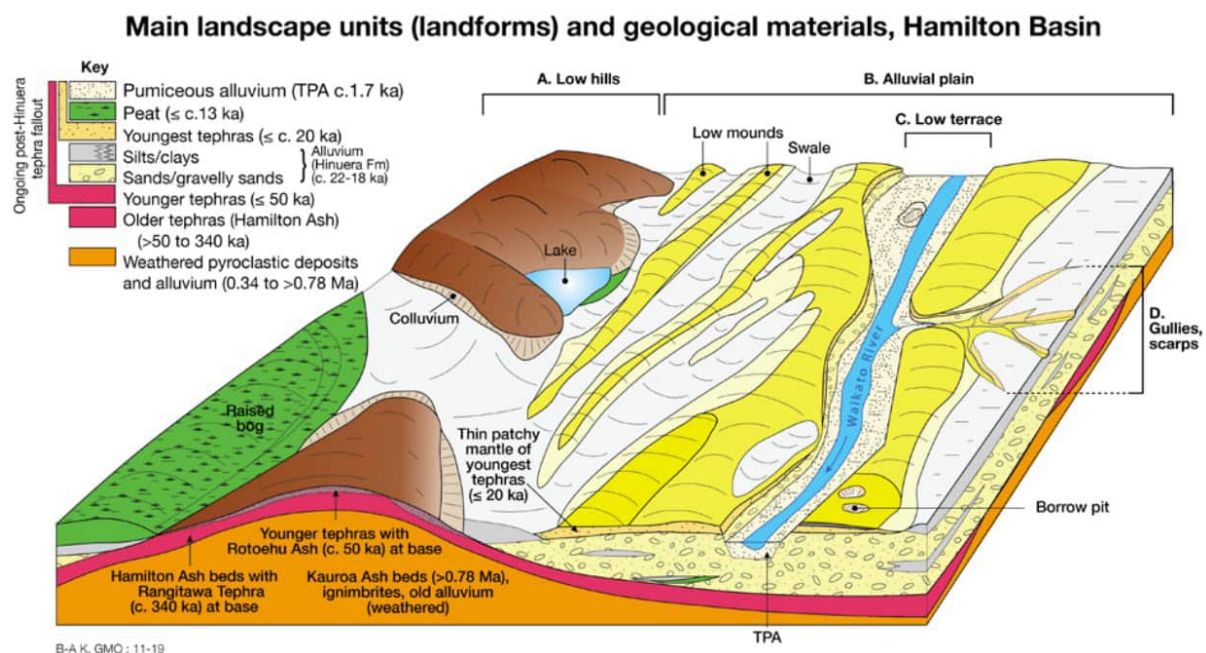


Figure 4: Main Landscape Units of the Hamilton Basin (Lowe 2021)

The Tauranga Group sediments contain the aquifers used most extensively across the Hamilton Basin. Within these formations, the most productive aquifers consist of well sorted coarse sands and gravels. Lithological variability generally results in a number of zones of higher permeability within each of these formations rather than a single, continuous aquifer (Schofield, 1972). The shallow aquifer in the Hinuera Formation is named the Hinuera Aquifer and is used locally as water source by landowners.

Literature values for hydraulic conductivity in the Tauranga Group in the Hamilton Basin range from 0.5 m/day in the silts and peat layers to 13.5 m/day in the coarse gravelly sands. Aquifer transmissivity values derived from pumping tests range from 10 m²/day to 1,000 m²/day but are usually less than 100 m²/day. Aquifer transmissivities tend to be lower in the deeper deposits as they are older, more intensely weathered and have a greater proportion of clays and silts (Marshall and Petch 1985). Storativity values vary from 0.0001 for deeper, confined or semi-confined aquifers to 0.1 for shallower, unconfined aquifers in the Hamilton Basin (Petch and Marshall 1988). In some areas these discontinuous aquifers may yield up to 30 L/s (Petch 1987).

The piezometric surface in the Hamilton Basin is closely related to surface topography. Piezometric gradients beneath undissected areas of the Hamilton Basin surface have a gentle slope that steepens near incised stream channels. Groundwater is recharged from rainfall, predominantly during the winter when soil moisture deficits are satisfied. The shallow groundwater subsequently discharges to the incised drains, streams, and the Waikato River. Isotopic analyses suggest that the groundwater flux is mainly through shallow aquifers. Groundwater in deeper aquifers within the basin is significantly older, having been dated at up to 6,500 years old (Marshall and Petch 1985).

The site is across the upper catchment of Mangaheka Stream, with the main stem of the stream running through the centre of the site. According to Lowe (2021), the site vicinity is characterised by old river courses of the Waikato River to the west of its main alignment connecting to the Waipa River (Figure 5). Given this setting, together with on-site borehole logs showing gravels and discontinuous silt layers (refer Section 2.3.2), permeable subsurface paleochannels are expected at the site. The approximate site vicinity is shown in red on Figure 5, with old river courses mapped by Lowe (2021).

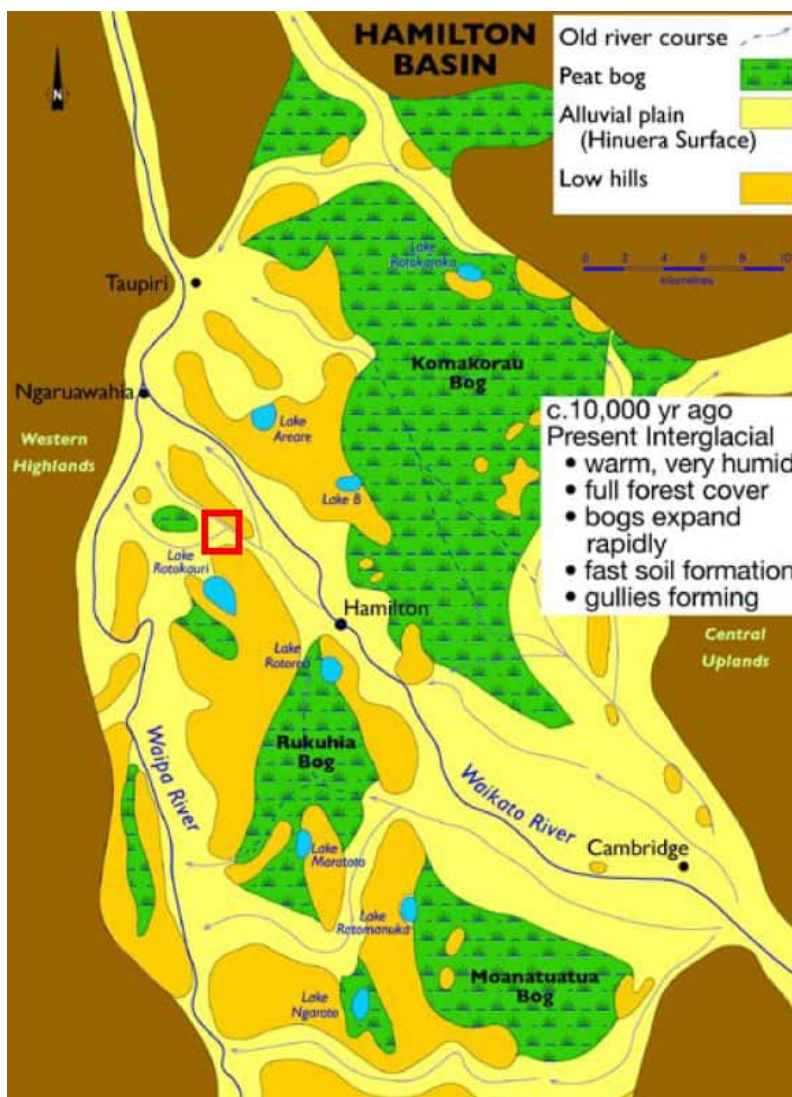
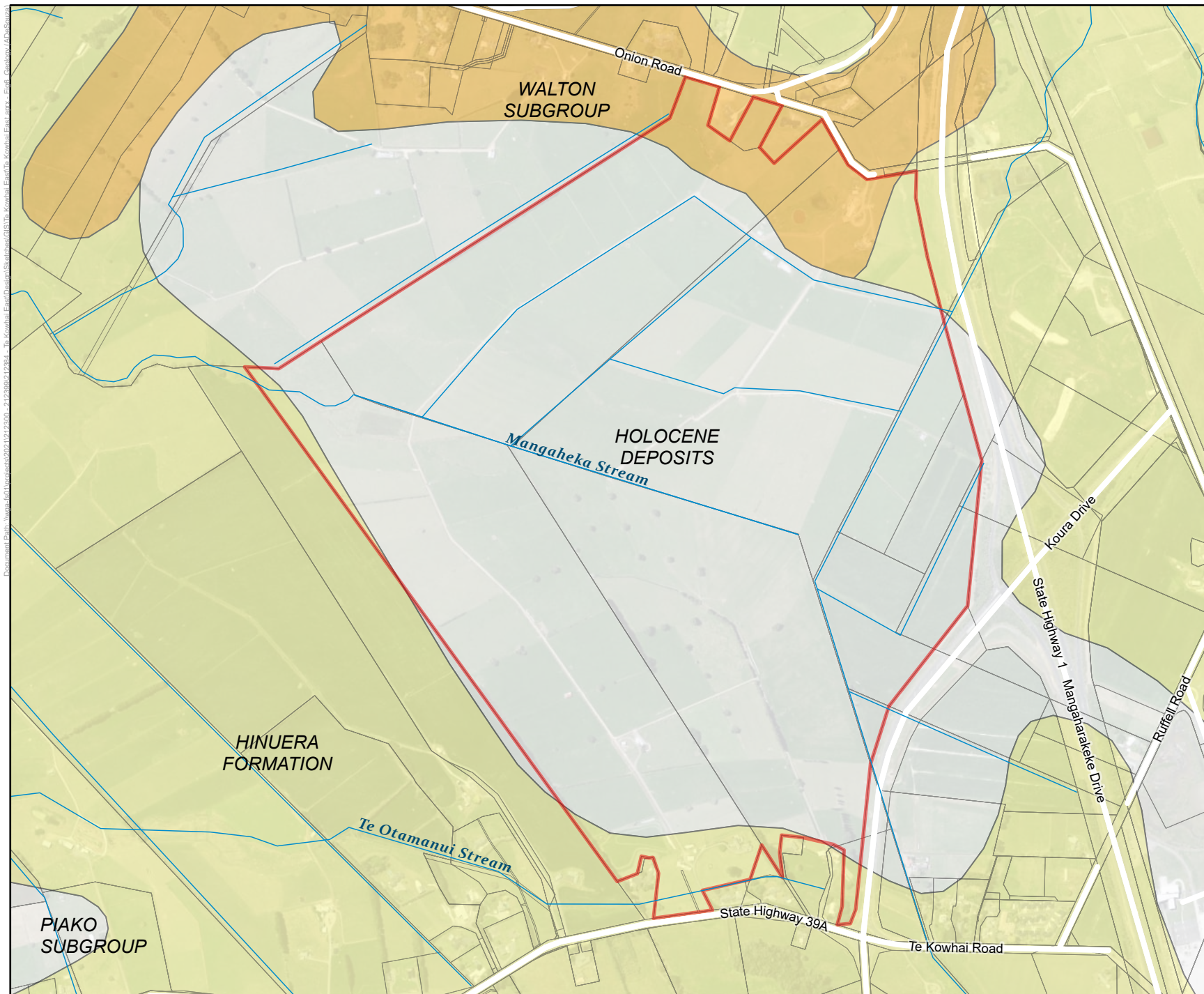


Figure 5: Old River Courses in Hamilton Basin (Lowe 2021) with Approximate Site Area

2.3.2 Local Geology and Hydrogeology

The site is predominantly underlain by sediments of the Hinuera Formation with Walton Subgroup outcropping as a small hill form on the north edge of the site. The Hinuera Formation consists of Late Pleistocene river deposits, including cross-bedded pumice sand, silt and gravel with interbedded peat. GNS Science mapping of surface geological units (GNS 2005; Geology of the Waikato Area) shows Piako Subgroup Holocene deposits (noted as swamp deposits by GNS) are overlying the Hinuera Formation sediments across the site (Figure 6).



LEGEND

- Parcel Cadastre
- Property Boundary
- Geology**
 - Q1.swp
 - Q14+Q12.alvsnd
 - Q3Q2.alvpum
 - Drains



Scale 1:12,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 6
Surface Geological Unit

Te Kowhai East

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Site investigations were undertaken by CMW in November 2025 (CMW 2025), including hand and machine-auger boreholes, dynamic and cone penetrometer testing, and the drilling of deeper investigation holes followed by installation of piezometers for groundwater level monitoring. For the purposes of the hydrogeology modelling and assessment herein, the results of these investigations were used. WGA hydrogeologists were onsite for the piezometer installation and setting screen levels. The locations of the shallow subsurface investigations are shown in Figure 7 with relevant borehole logs provided by CMW (2026).

The Walton Subgroup forms a hill on the north edge of the site that is approximately 10 m higher than most of the flat site area Figure 7. The shallow hand auger borehole logs SO25-01 and SO25-02 are located on this hill on the north edge of the site and show clayey strata (Appendix C).

The rest of the shallow hand auger borehole logs across the site show the surficial Holocene swamp deposits comprised of silts with some clays and organics underlain by sandy Hinuera Formation strata. This is consistent with the GNS (2005) surface geology mapping across the site area (Figure 6).

The extensive surficial silt layer overlying the Hinuera Formation strata across the site is approximately 0.2 to 2.3 m thick when assessed in combination with the eight deeper investigation boreholes (groundwater monitoring wells with piezometers) completed by CMW in January to February 2026 (MH25-01 to MH25-08; Figure 7). Detailed borehole logs for these investigation boreholes are provided in Appendix C.

The deeper investigation boreholes MH25-02 and MH25-01 show low permeability strata and Walton Subgroup to the bore termination depths of approximately 15.5 m bgl. As these termination depths are below the ground level across the flat area of the site, the surficial Holocene deposits and underlying Hinuera Formation strata across the site are interpreted to pinch out laterally toward the Walton Subgroup hill to the north. This is interpreted to form a hydraulic boundary, with shallow groundwater expected to flow generally northwest through Hinuera Formation sands and gravels, preferentially through paleochannel sand deposits, into and along the alignment of Mangaheka Stream.

A summary of the underlying geology encountered from the subsurface site investigations (where the Walton Subgroup is not present) is presented in Table 1. This summary is relevant to most of the site with the exception of the Walton Subgroup hill.

Table 1: Stratigraphic Units Summary

UNIT	DEPTH TO TOP OF SOIL UNIT (m)		THICKNESS (m)	
	Min	Max	Min	Max
Topsoil/Organic Silt/Peat (Holocene Deposits)	0.0		0.2	2.3
Sands and gravels interbedded with silts and clays (Hinuera Formation) ⁽¹⁾	0.2	2.3	7.2 ⁽¹⁾	9.3 ⁽¹⁾

Notes:

⁽¹⁾ Base of unit not encountered.

Boreholes MH25_03, MH25_04, MH25_07, and MH25_08 show multiple minor layers of silts and clays with variable thicknesses interbedded within the sandy and gravelly Hinuera Formation strata (Appendix C). These bores are located on the east and west area of the site. These layers are interpreted to be discontinuous (not fully laterally extensive or connected) across the site. Boreholes MH25_05 and MH25_06 on the south side of the site show no significant layers of silts or clays interbedded within the sandy and gravelly Hinuera Formation strata (Appendix C). These two bores also show a relatively higher proportion of interbedded gravels compared to the other bores. The presence of permeable paleochannels, shallow groundwater conditions, and existing deep drains across the site is interpreted to result in groundwater discharge to Mangaheka Stream.

2.3.3 Groundwater Levels

Shallow groundwater level measurements were made by CMW in the hand auger investigation sites in November 2025. The recorded shallow groundwater level measurements ranged from approximately 0.5 to 1.2 m below ground level (bgl) and are provided in Table 2 along with groundwater elevations above mean sea level (m RL). In addition, a site-specific investigation was carried out by CMW for the proposed mudfish habitat area (CMW 2026; Appendix D).

Table 2: Hand Auger Groundwater Levels Recorded November 2025

SITE NUMBER	AUGER HOLE DEPTH (m)	GROUNDWATER LEVEL (m bgl)	EXISTING GROUND LEVEL (m RL)	GROUNDWATER ELEVATION (m RL)
SO25-01 ⁽¹⁾	2.15	Not encountered	37.3	-
SO25-02 ⁽¹⁾	2	Not encountered	41.6	-
SO25-03	1.3	1.1	28	26.9
SO25-04	1.3	1.2	29.4	28.2
SO25-05	0.9	0.9	27.9	27
SO25-06	1	0.8	28.6	27.8
SO25-07	0.9	0.5	28.1	27.6
SO25-08	1.2	1.0	28.6	27.6
SO25-09	1	1.0	29	28
SO25-10	1.8	1.8	29.6	27.8
SO25-11	0.9	0.5	28.5	28
SO25-12	1.2	1.0	29.7	28.7

Notes:

⁽¹⁾ Hand auger completed in elevated Walton Subgroup landform.

Static groundwater levels, measured as part of hydraulic testing of the monitoring wells on 20 March 2026, ranged from approximately 1.8 m to 2.2 m bgl. The shallow Hinuera Formation aquifer groundwater levels and lithology description are provided in Table 3.

As discussed in Section 2.1, the March 2026 piezometer measurements are considered representative of late-summer groundwater conditions. Following these manual measurements, continuous groundwater level monitoring was undertaken using pressure transducers. Groundwater depth hydrographs for each piezometer are shown in Figure 8 and groundwater elevation records are shown in Figure 9.

Table 3: Piezometer Groundwater Levels Recorded in March 2026

PIEZOMETER	SCREEN DEPTH (m bgl)	STATIC GROUNDWATER LEVEL (m)		LITHOLOGY DESCRIPTION
		m bgl ⁽¹⁾	m RL ⁽²⁾	
MH25_03	3.8 - 7.3	1.8	27.3	Well graded fine to coarse SAND with trace gravel
MH25_04 ⁽¹⁾	4.3 - 5.3	2.2	27.5	Well graded medium to coarse SAND
MH25_05 ⁽²⁾	5.5 - 7.5	2.0	27.1	Well graded SAND with fine gravel.
MH25_06 ⁽¹⁾	3.0 - 5.0	1.8	27.9	Medium to coarse GRAVEL, underlain by well graded medium to coarse SAND with fine gravel.
MH25_07 ⁽¹⁾	3.8 - 5.3	1.9	25.5	Well graded medium to coarse SAND with fine gravel.
MH25_08 ⁽¹⁾	2.4 - 3.7	2.0	26.1	Well graded medium to coarse SAND with fine gravel.

Notes:

(1) m bgl is metres below ground level.

(2) m RL is groundwater elevation in metres above mean sea level.

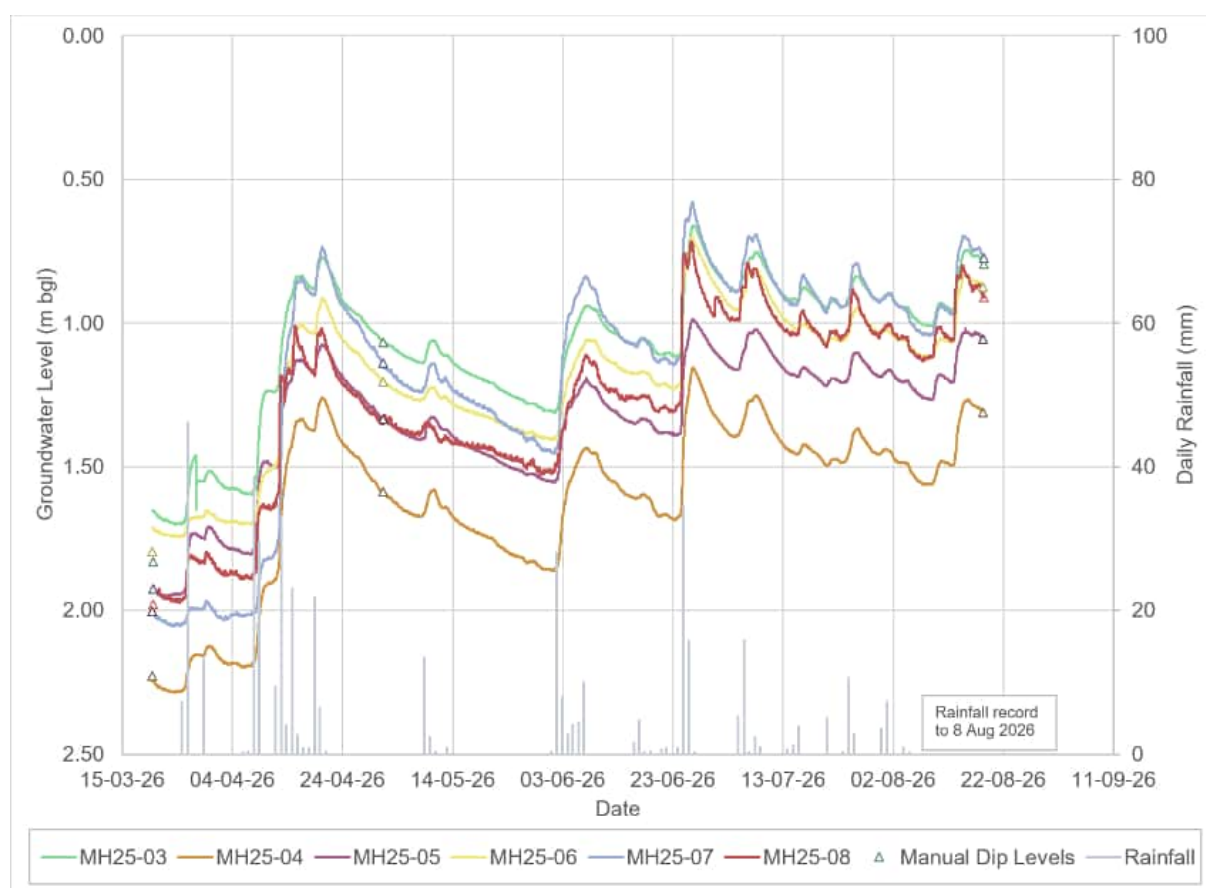


Figure 8: Depth to Groundwater Level in all Piezometers

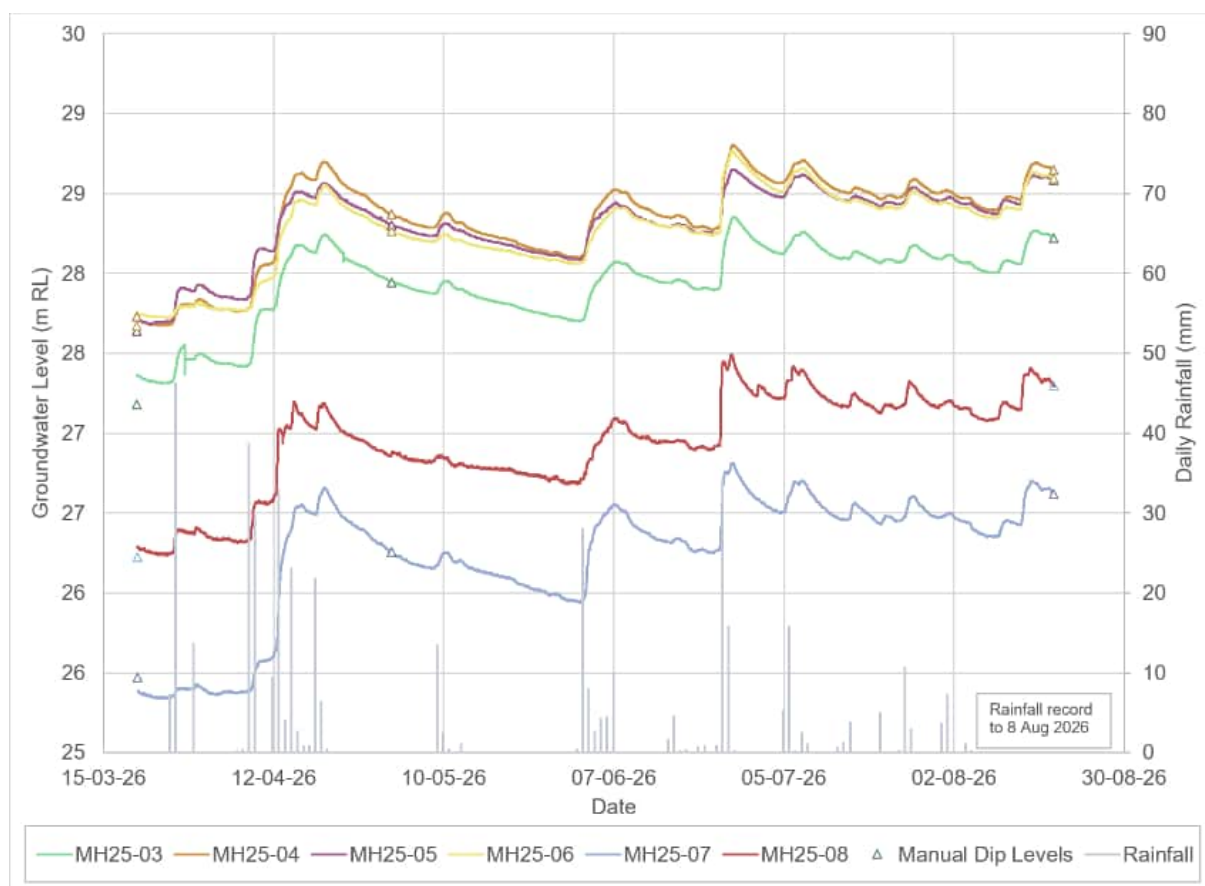


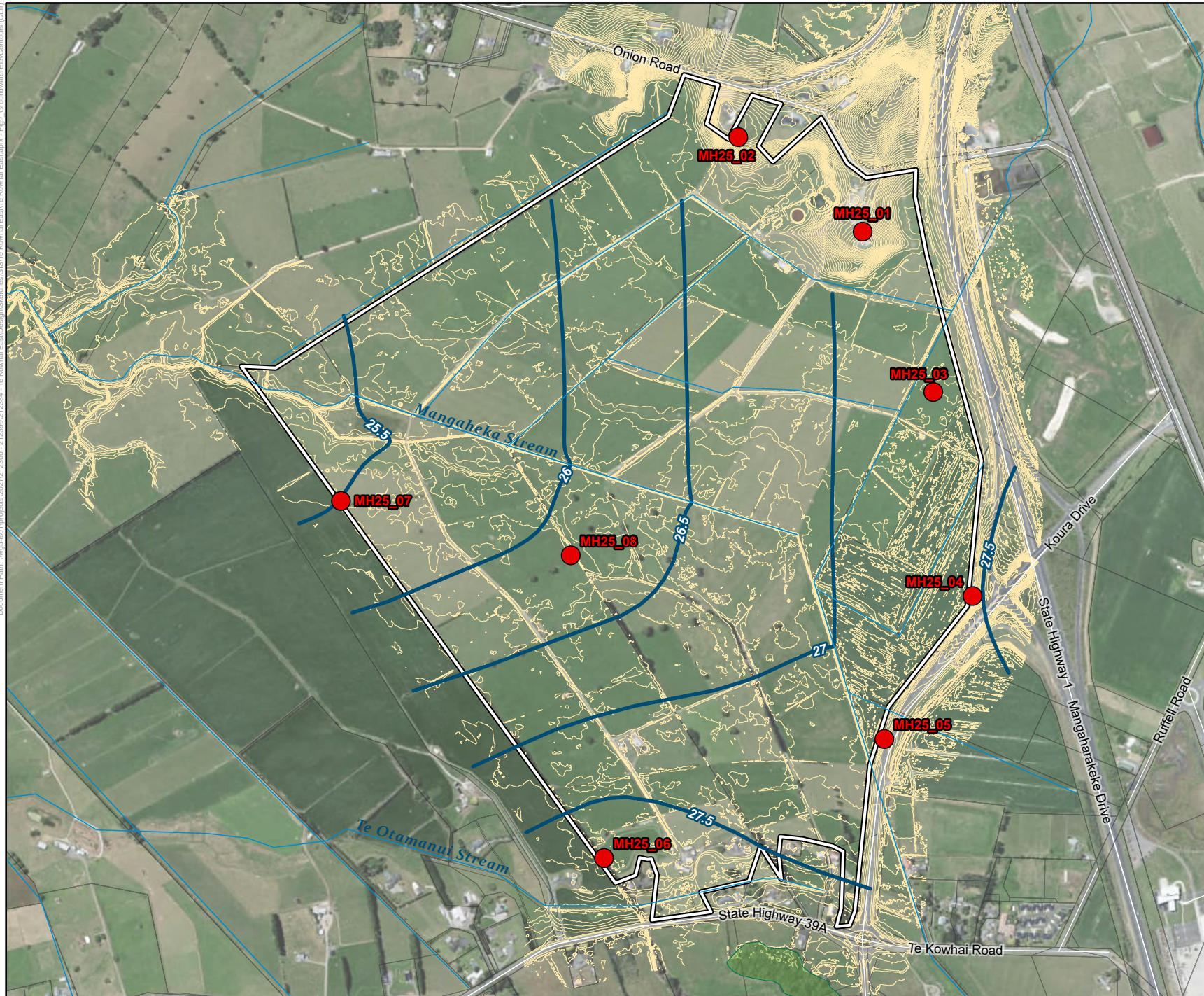
Figure 9: Groundwater Elevation in all Piezometers

The groundwater level hydrographs indicate the initial groundwater conditions in March 2026 are the deepest recorded at the site over the monitoring period to date. These records show increasing groundwater level trend on the order of a metre with individual rising responses to rainfall events. Each piezometer exhibits relatively similar responses and trends, which is assessed as indicative of a connected shallow groundwater system across the site. The largest increasing groundwater level trend was recorded at MH25_07, which is the most downgradient piezometer at the site in the vicinity of Mangaheka Stream. This response is interpreted to potentially be a result of groundwater flow across the site being concentrated toward the west where Mangaheka Stream deepens into its natural alignment flowing out of the site.

The November 2025 groundwater level measurements at the hand auger locations were as shallow as 0.5 m bgl and are considered generally representative of seasonally elevated groundwater conditions. Overall, shallow groundwater conditions are expected across the site, varying seasonally from approximately 0.5 m to 2 m bgl. An assessment of long-term groundwater level records to the south of the site indicates a similar range in shallow groundwater depth. The shallow groundwater is expected to be hydraulically connected and to discharge into Mangaheka Stream on a perennial basis under both the existing condition and the proposed stormwater management plan, where the modified stream is deepened.

Contouring of the late summer groundwater levels (phreatic surface) indicates shallow groundwater flow is toward the Mangaheka Stream and northwest. The groundwater elevation contours are shown in Figure 10 along with existing land surface elevation contours.

A similar groundwater flow direction toward Mangaheka Stream is expected during winter, when groundwater levels are higher. As described in Sections 2.2 and 2.6, the incised Mangaheka Stream and associated drains are interpreted to act as local hydraulic controls, receiving shallow groundwater discharge and influencing the groundwater gradient toward the northwest.



Ngāruawāhia
Hamilton

LEGEND

- Property Boundary
- Piezometer
- Groundwater Elevation Contours (m)
- Existing Gound Level Contours (m)
- Road
- Parcel Cadastre
- Kahikatea Stand
- Drains

Scale 1:12,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 10
Groundwater
Elevation Contours

Te Kowhai East

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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2.4 Hydrogeological Parameters

Marshall and Petch (1988) indicate the hydraulic conductivity of Tauranga Group sediments ranges from about 0.1 m/day (indicative for silts) to over 1 m/day for sands. Falling head permeability tests have been undertaken by CMW (2026a) at the site at the hand auger locations shown on Figure 8. The tests have been analysed by CMW using both the CIRIA 113 (Somerville 1986 and Hvorslev 1951) methods. CMW (2026a) notes that the CIRIA 113 method is considered the most appropriate analysis method. The CMW hydraulic conductivity analyses are provided in Appendix E. The tests show variability in estimated hydraulic conductivity between approximately 0.1 m/day to 10 m/day. This is interpreted to be related to variable sands encountered by the hand augers at depth below the overlying silts. The hydraulic conductivity estimates for the hand augers are expected to be representative of the variable near-surface deposits across the site where variably sandy paleochannels are interbedded within silts. The surficial deposits across the site are expected to primarily be silty Holocene deposits with effective vertical hydraulic conductivity on the order of 0.1 m/day.

During March 2026, WGA undertook hydraulic testing in the borehole piezometers MH25-04 to MH25-08 (Figure 7). MH25-01 and MH25-02 (Walton Subgroup) were not tested as they are not considered representative of the shallow groundwater system across the site (Hinuera Formation). MH25-03 could not be tested due to an in-bore obstruction, however, a static groundwater was able to be recorded along with continuous transducer monitoring. Hydraulic conductivity results are presented in Table 4 with lithology descriptions of the tested strata for each of the tested piezometers. Detailed hydraulic test results are attached in Appendix E.

Table 4: Borehole Piezometer Hydraulic Conductivity Test Results

PIEZOMETER	SCREEN DEPTH (m bgl)	HYDRAULIC CONDUCTIVITY (m/day)		LITHOLOGY DESCRIPTION
		max	min	
MH25_03	3.8 - 7.3	-	-	Well graded fine to coarse SAND with trace gravel
MH25_04 ⁽¹⁾	4.3 - 5.3	2.7	0.6	Well graded medium to coarse SAND
MH25_05 ⁽²⁾	5.5 - 7.5	35	31	Well graded SAND with fine gravel.
MH25_06 ⁽¹⁾	3.0 - 5.0	6.2	4.9	Medium to coarse GRAVEL, underlain by well graded medium to coarse SAND with fine gravel.
MH25_07 ⁽¹⁾	3.8 - 5.3	2.6	0.5	Well graded medium to coarse SAND with fine gravel.
MH25_08 ⁽¹⁾	2.4 - 3.7	3.2	0.3	Well graded medium to coarse SAND with fine gravel.

Notes:

⁽¹⁾ Analysis undertaken using the Bouwer-Rice method.

⁽²⁾ Analysis undertaken using the Springer-Gelhar method.

The hydraulic testing indicates that the Hinuera Formation piezometers MH25_03 to MH25_08 are screened within sandy to gravelly shallow aquifer strata. Excluding MH25_05, tested hydraulic conductivities range from 0.3 m/day to 6.2 m/day. The substantially higher value recorded at MH25_05, up to 35 m/day, is interpreted to represent a localised higher-permeability paleochannel in the vicinity of the modified Mangaheka Stream, rather than a site-wide hydraulic conductivity value.

The shallow Hinuera Formation aquifer is expected to be vertically anisotropic, with lower vertical permeability than horizontal permeability due to the interbedded silt, sand and gravel depositional environment. As a result, groundwater flow is expected to preferentially occur laterally through more permeable sand and gravel intervals, including localised paleochannel deposits. The drawdown assessments therefore apply location-specific hydraulic conductivity values, with the MH25_05 value used only where a paleochannel connection is interpreted or as a conservative sensitivity case.

2.5 Groundwater Recharge

The shallow groundwater and surface waterbodies of the catchment are predominantly recharged directly by local rainfall. The Ruakura Lysimeter is located approximately 10 km southeast of the proposed development. Annual recharge (soil drainage) from the lysimeters is generally expected to be in the range of 235 mm to 428 mm². Given the close proximity, WGA considers that groundwater recharge at the proposed site will be similar to the Ruakura Lysimeter.

A recharge value at the lower end of the estimated range (250 mm per annum) was adopted for groundwater modelling purposes, to provide a conservative assessment of potential groundwater drawdown and associated dewatering effects. The value is conservative because lower recharge increases the modelled drawdown for long-term drainage features.

2.6 Surface Water Interactions

Based on the groundwater elevations described in Section 2.3, shallow groundwater is interpreted to flow generally toward Mangaheka Stream and associated drains. These features are incised below the surrounding ground surface and are therefore expected to act as hydraulic controls on the shallow groundwater system (Figure 10).

Under seasonally high groundwater conditions, the drains and the Mangaheka Stream in its current form are expected to receive groundwater discharge. Under lower groundwater conditions, some drains may be episodically disconnected from groundwater or may act locally as recharge features where stormwater flow is present. Overall, the existing drainage network forms an established hydraulic boundary condition across parts of the site.

In the northeast area of the site, existing drains of the upper Te Rapa Stream locally induce shallow groundwater to flow northeast out of the site. This is likely to occur within Te Rapa Stream in the northeast off the site (Figure 3).

Along the east side of the site, an existing drain supports mudfish habitat (EcoLogical Solutions 2026). Groundwater levels recorded in MH25_04 indicate that summer groundwater levels fall below the drain invert on a seasonal basis. Groundwater levels near the drain were up to 2.2 m bgl. Based on the March 2026 groundwater elevation of 27.5 m RL and LiDAR derived drain elevation of approximately 28.8 m RL, groundwater was approximately 1.3 m below the drain at that time. This indicates that the mudfish habitat is already seasonally or episodically disconnected from shallow groundwater contributions during summer conditions.

South of the site, the Kahikatea stand identified as a Significant Natural Area is separated from the TKE site by Te Otamanui Stream. The base of this drain is approximately 2 m below the ground level at the Kahikatea stand, and shallow groundwater is interpreted to discharge toward it. The drain is therefore expected to act as an existing hydraulic boundary between the proposed works and the Kahikatea stand.

2.7 Surrounding Groundwater Users

2.7.1 Nearby Water Resource Consents and Flow Rates

Water supply bores and groundwater abstraction consents within one kilometre of the TKE site are shown in Figure 11, with consents summarised in Table 5. Current groundwater abstraction resource consents within one kilometre of the site are generally for agricultural and industrial uses, as well as construction-related dewatering activities which appear to not have a maximum daily groundwater take (Table 5).

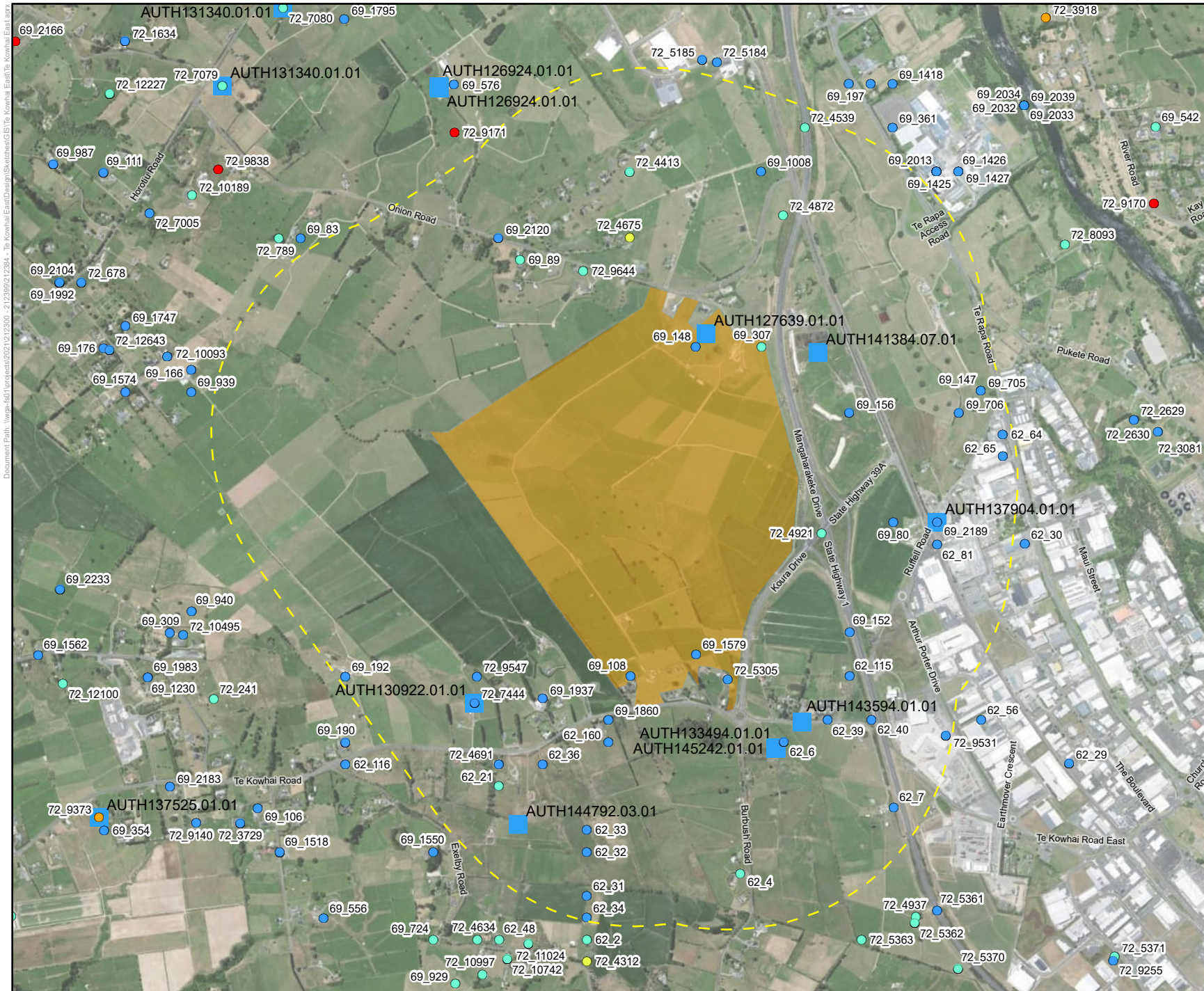
² WRC estimates that rainfall recharge is 22% to 40% in the Waikato region. Based on the normal annual rainfall for Waikato of 1,072 mm, this results in a recharge rate of 235 mm to 428 mm.

Table 5: Nearby Groundwater Takes

CONSENT NUMBER	WATER USAGES	CONSENTED MAXIMUM DAILY FLOW RATE (m³)
AUTH127639.01.01	Agriculture farming dairy, shed wash	22.8
AUTH133494.01.01	Agriculture farming dairy, stock water and shed wash	20.3
AUTH130922.01.01	Agriculture farming dairy, stock water and shed wash	44.3
AUTH137904.01.01	Industry (Electricity generation), factory/industry processing	30
AUTH143594.01.01 ⁽¹⁾	Industry (Construction/roading), dewatering/water level control	0
AUTH141384.07.01 ⁽¹⁾	Industry (Construction/roading), dewatering/water level control	0
AUTH144792.03.01 ⁽¹⁾	Industry (Construction/roading), dewatering/water level control	0
AUTH145242.01.01	Agriculture farming dairy, shed wash	20.3

Notes:

⁽¹⁾ Land development consents are “net zero” takes associated with groundwater dewatering.



LEGEND

- Ground water take
- Unknown
- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- > 100
- Property Boundary
- 1km Buffer

0 200 400 600 800 m

Scale 1:24,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 11
Surrounding Groundwater
Bores and Consents

Te Kowhai East

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any reliance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2026

3 DRAWDOWN EFFECTS OF WASTEWATER INFRASTRUCTURE

3.1 Introduction

WGA has assessed temporary groundwater drawdown and inflows associated with construction of the proposed wastewater pipeline network and wastewater pump station. Summer groundwater levels have been used to assess potential drawdown below seasonal low groundwater conditions, which is relevant to the geotechnical assessment of settlement effects. Winter groundwater levels have been used to estimate potential construction inflows, when groundwater levels are expected to be higher.

The assessment is based on hydrogeological parameters derived from on-site testing, as described in Section 2.4, and the wastewater design information provided by Maven in Appendix G.

3.2 Analytical Modelling Methodology for Wastewater Pipelines

The construction of the planned wastewater pipeline network requires the excavation of trenches below the groundwater table, with the requirement that these trenches are maintained in a dry state until backfilling starts. WGA understands that the wastewater pipeline is likely to be constructed in 80 m sections, and that each section will be completed within a period of 10 days. This has been used as the basis of the groundwater drawdown and inflow modelling. The trench excavation depths have been provided by Maven to WGA as per the wastewater pipeline designs (Appendix G).

An analytical modelling approach for the wastewater pipeline was used to calculate temporary groundwater drawdown curves and expected inflows to the trenches. The analytical model used equations from McWhorter and Sunada (1977), which estimate transient drawdown and groundwater inflows into trenches.

WGA understands that the wastewater pipelines will be constructed at varying depths throughout the site. In order to assess the potential effects WGA have assessed the drawdown in the pipeline sections located closest to sensitive features, i.e. houses and roads. Conservative values have been used for the aquifer parameters in the modelling. WGA understand that the wastewater pipelines will be installed in up to 80 m lengths at a time. Therefore, WGA has completed the following scenarios for consideration of drawdown effects:

- Sections of 80 m pipeline trench in the southern to southeastern area of the site, requiring temporary dewatering in the upper Hinuera Formation in the vicinity of shallow paleochannels apparent in bore logs for MH25_05 and MH25_06.
- Sections of 80 m pipeline trench in the eastern area of the site, requiring temporary dewatering in the upper Hinuera Formation sands in the vicinity of bore logs for MH25_03 and MH25_04. This scenario applies parameters and levels related to bores MH25_03 and MH25_04.

For the south to southeast dewatering drawdown scenario, WGA has assumed that the trenching for the wastewater pipeline will occur during the summer. Winter dewatering rates have also been estimated as a conservative worst-case for trench inflows and pumping. The winter analysis assumes a groundwater level approximately 1 m bgl and a 3 m dewatered trench depth, requiring 2 m of drawdown at the trench. The summer scenario applies the expected deeper groundwater level, with the piezometric surface approximately 2 m bgl, resulting in 1 m of drawdown within the 3 m deep trench.

The analyses apply a conservative aquifer thickness of 8 m, consistent with the nearby MH25_06 log to the south. MH25_06 shows a similar total aquifer thickness, shallow paleochannel deposits with gravels within 1 m depth, and a higher range of tested hydraulic conductivity. The original alignment of Mangaheka Stream is interpreted from the existing ground level model surface to lie between MH25_05 and MH25_06. The paleochannel scenario applied to the south and southeast trenches is therefore considered a conservative worst-case scenario for temporary groundwater inflow effects associated with dewatering of localised paleochannel deposits.

For the eastern site area scenario in the vicinity of bores MH25_03 and MH25_04, less permeable sand deposits are expected relative to the potential southeast and south paleochannels. The eastern site area analyses consider the slightly deeper trenching depth of 3.5 m and the slightly shallower summer groundwater level of about 1.8 m bgl where 1.7 m dewatering at the trench during summer could be required. The input parameters for the wastewater pipeline trench dewatering analyses are provided in Table 6. The range in trench drawdown required reflects the summer and winter groundwater levels applied for drawdown and inflows respectively.

The adopted hydraulic conductivity values are based on the site-specific interpretation in Section 2.4 (Table 6). The MH25_05 value has been applied to the south/southeast wastewater trench scenario because those earthworks are interpreted to intersect, or lie close to, the former Mangaheka Stream paleochannel corridor. Lower tested values from nearby piezometers have been applied to the eastern trench scenario to reflect the local lithology.

Table 6: Input Parameters for Wastewater Pipeline Analytical Modelling

DEWATERING SCENARIO	HYDRAULIC CONDUCTIVITY	AQUIFER SPECIFIC YIELD	NUMBER OF DAYS TRENCH OPEN	TRENCH DRAWDOWN REQUIRED (m)
South/southeast 80 m long, 3 m deep, trench pumped dry	4×10^{-4} m/s or 35 m/day	0.25	10	1.0 – 2.0
Eastern 80 m long, 3.5 m deep, trench pumped dry	3×10^{-5} m/s or 2.6 m/day	0.25	10	1.7 – 2.7

3.2.1 Wastewater Pipeline Analytical Modelling Results

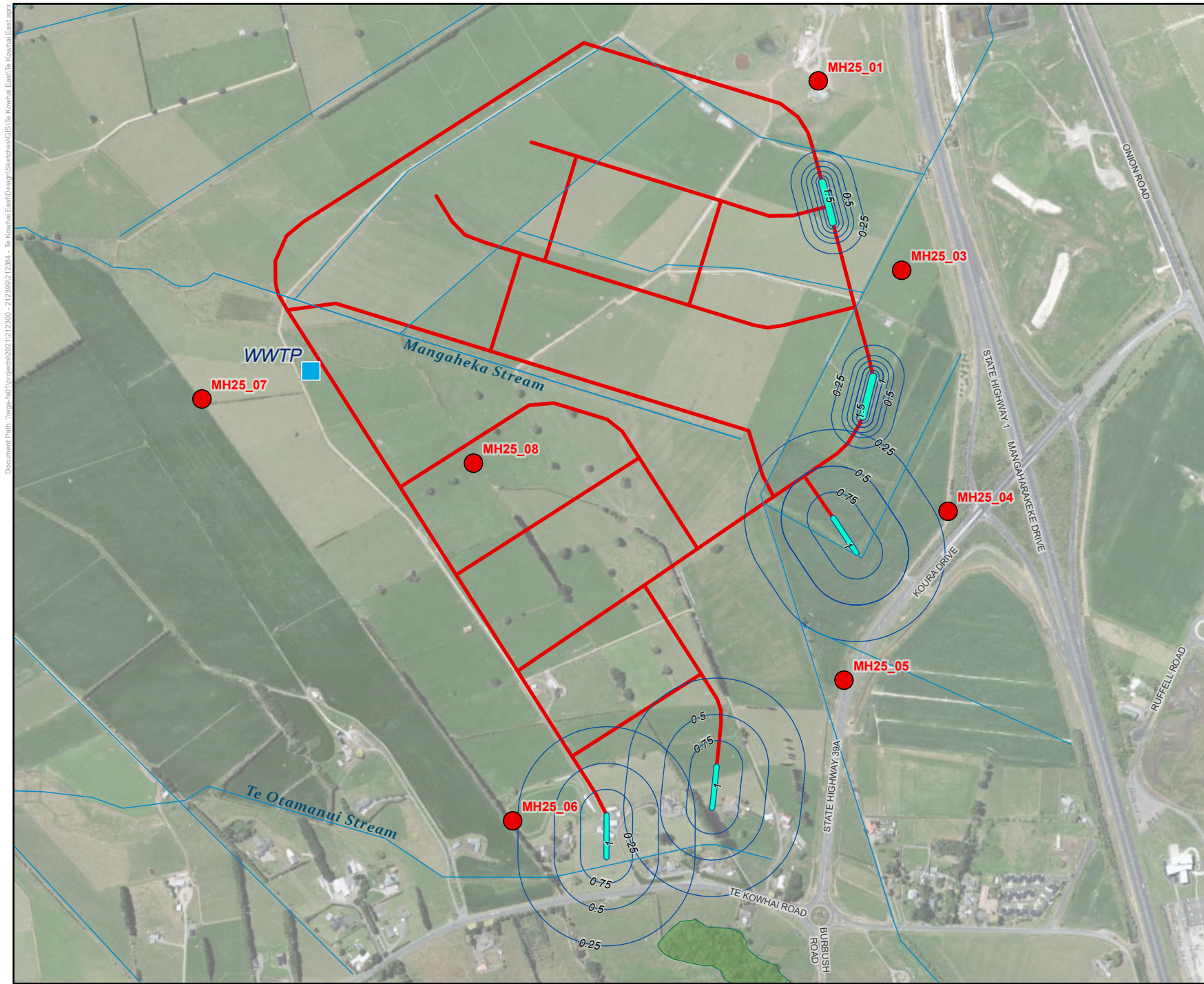
Projected drawdown and dewatering rates for representative south/southeast and eastern wastewater pipeline trenches are summarised in Table 7, Figure 13 and Figure 14. Projected groundwater inflows are shown in Figure 15 and Figure 16.

Table 7: Projected Distance of Influence

WASTEWATER PIPELINE	DISTANCE OF INFLUENCE (m)
South/Southeast Wastewater Pipelines: Summer	170
Eastern Wastewater Pipelines: Summer	60

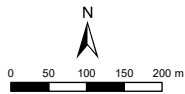
Note: Distance of influence considered to be defined at 0.25 m drawdown.

Drawdown contours relative to the modelling with summer groundwater levels applied for representative south/southeast and eastern 80 m trench sections are mapped in Figure 12.



LEGEND

- WWTP
- Piezometer
- Proposed Wastewater Infrastructure
- Trench Sections
- Summer Drawdown Contours (m)
- Drains
- Kahikatea Stand



Scale 1:10,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 12
Summer Drawdown Contours
for Selected Wastewater
Pipeline 80 m Trenches
Te Kowhai East

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any reliance placed on such information shall be at the risk of the user.
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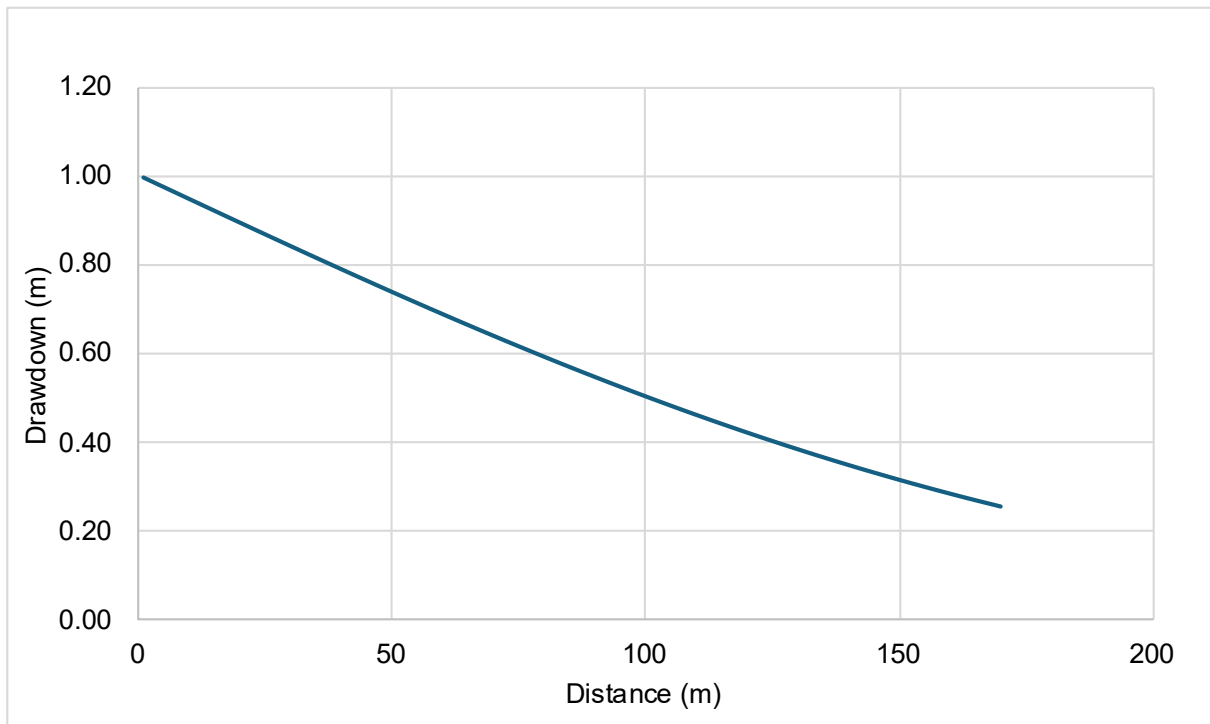


Figure 13: Projected Drawdown from South/Southeast Wastewater Pipelines During Summer

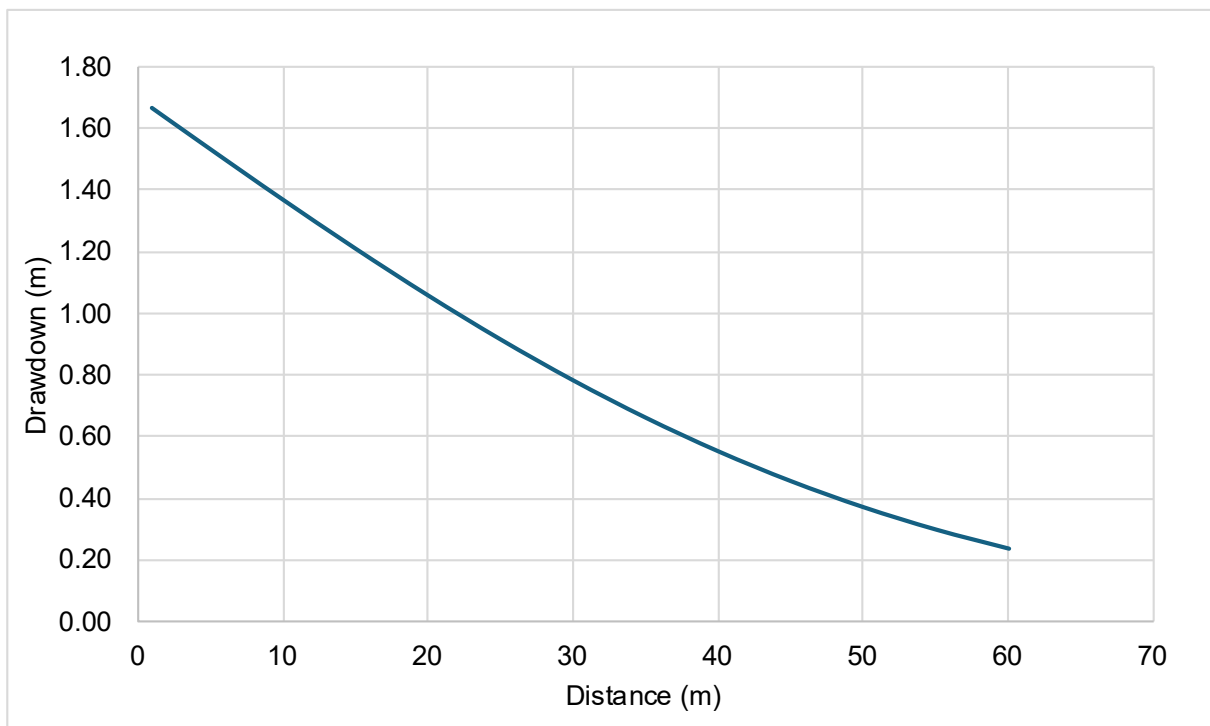


Figure 14: Projected Drawdown from Eastern Wastewater Pipelines During Summer

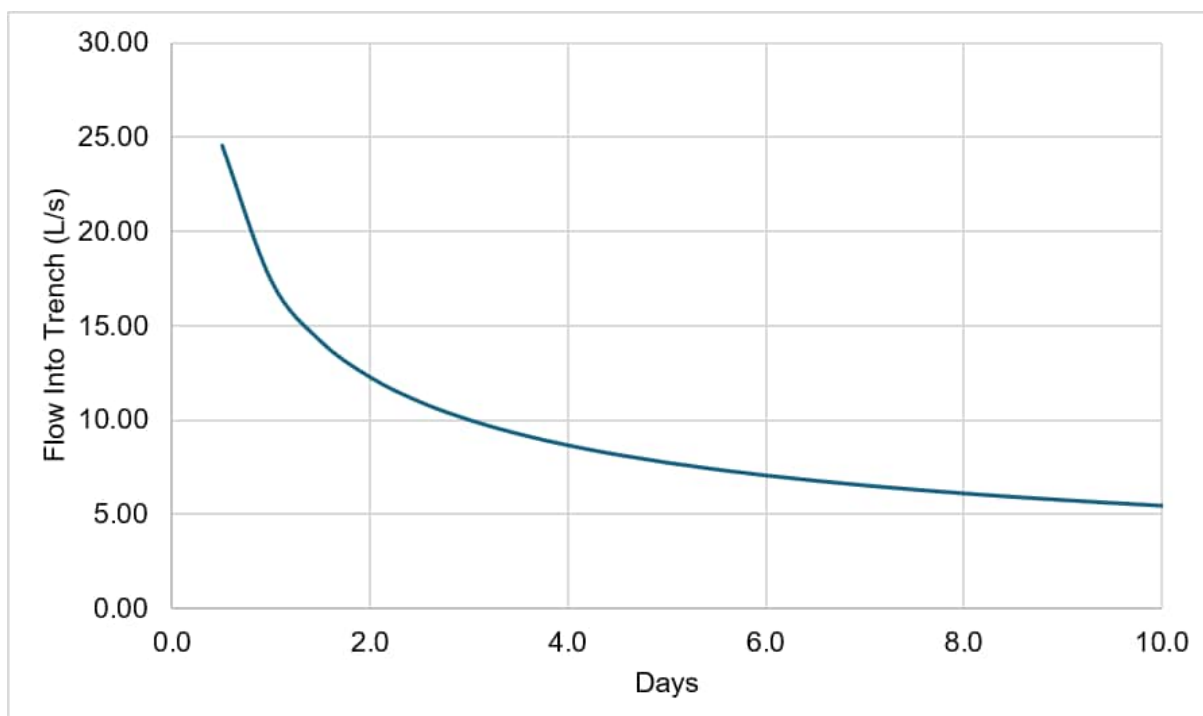


Figure 15: Projected Groundwater Inflows into South/Southeast 80 m Trench During Winter

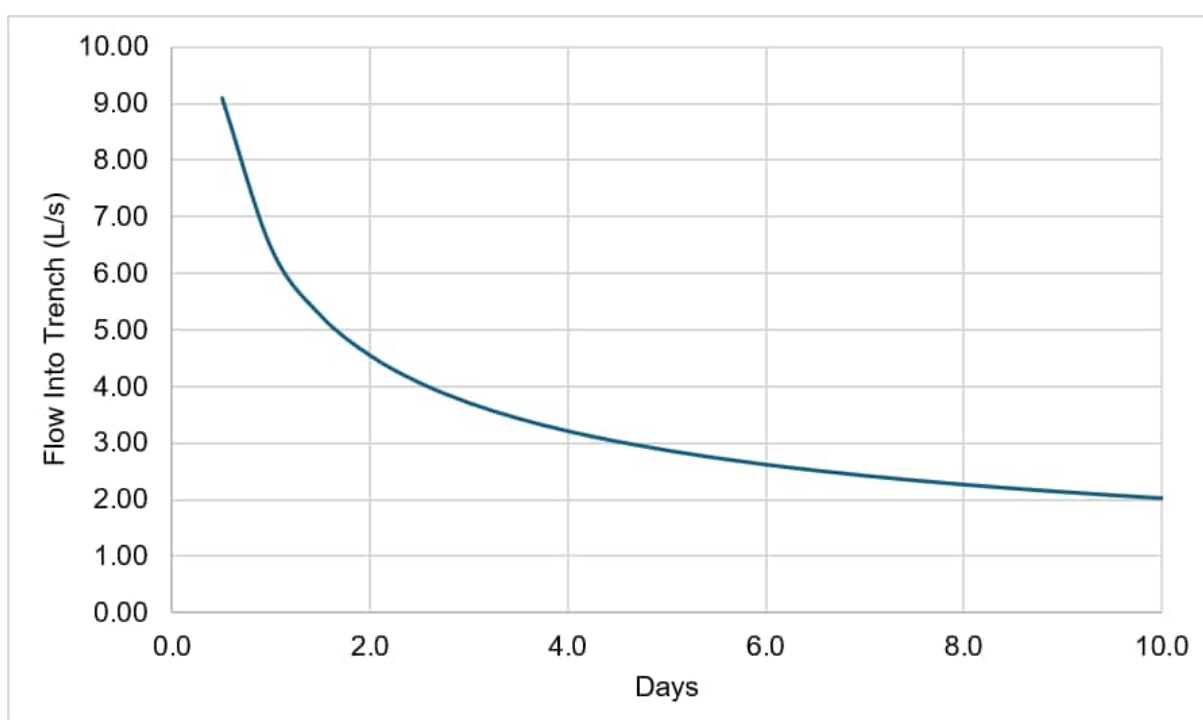


Figure 16: Projected Groundwater Inflows into Eastern 80 m Trench During Winter

The modelling results indicate potential temporary drawdown effects below summer groundwater levels approaching 0.5 m at Koura Drive to the southeast and Te Kowhai Road to the south. The modelling suggests no temporary drawdown is expected at the Koura Drive culverts further to the southeast. Potential temporary drawdown effects are modelled up to 0.8 m at neighbouring properties to the south. No drawdown effects are expected at the Kahikatea trees further south beyond the existing Te Otamanui Stream drain.

3.3 Drawdown Effects of Wastewater Pump Station Installation

3.3.1 Construction

A WWPS is proposed to be located in the northwest downstream area of the TKE site (Figure 12). The draft engineering designs for the proposed WWPS are included in Appendix G for the 6 m deep (2.8 m diameter) wet well and associated shallower (4 m deep) storage tanks.

Earthworks associated with the WWPS wet well involve excavations in the vicinity of bores MH25_07 and MH25_08 below the groundwater table and a semi-confining, low permeability, silty aquitard layer that extends up to about 2.2 m bgl. While the log MH25_07 indicates the shallow silty strata is continuous to ground level, the bore MH25_08 log indicates potential for shallow, gravelly, unconfined materials above the silt at the WWPS location.

The wet well depth necessitates specialised construction techniques to minimise excavation size and the groundwater dewatering required. In accordance with environmental regulations and guidelines, the contractor will implement erosion and sediment control measures as stipulated by the Waikato Region Standard TR2009/02.

The schedule for the construction of the WWPS remains undetermined at this stage. For the purposes of this assessment, it is assumed that installation of the wet well and related infrastructure will require 15 days of dewatering.

Due to the position of the low permeability aquitard layer within the wet well excavation, aquifer strata above and below the confining layer may require dewatering. To achieve this, a combination of top-down and bottom-up dewatering methods is anticipated. Assessments assume the use of a sheet pile wall to support the excavation. A dewatering bore situated outside the sheet pile wall is expected to be employed to facilitate dewatering beneath the low permeability aquitard layer within the semi-confined aquifer. Additionally, a surface water pump may be utilized during earthworks to temporarily lower shallow groundwater levels, where necessary, ensuring safe and efficient excavation above the low permeability aquitard layer. The sheet pile wall is expected to reduce horizontal groundwater inflows from the aquifer strata.

3.3.2 Dewatering for Wet Well Installation

The excavation for the installation of the wet well is expected with the following dimensions:

- WWPS wet well 2.8 m width and 6 m depth with installation beneath the groundwater level and aquitard.
- further excavations required for WWPS storage tank infrastructure can be dewatered with similar volumes as the south/southeast wastewater pipeline trenching dewatering excavations described in Section 3.2.1.

The wet well excavation may intersect groundwater within shallow unconfined aquifer strata above a silt layer and deeper semi-confined aquifer strata below the silt layer. An assessment applying the Hunt and Scott (2007) solution for pumped drawdown in a two-aquifer system has been used to assess the potential drawdown effects of the excavation.

Due to the limited area of the excavation, it is expected that one bore is sufficient to achieve the required dewatering for wet well construction. Multiple bores may be used for dewatering, but for modelling purposes, using one bore is a reasonable assumption. Aquifer transmissivities have been derived from hydraulic conductivity values from on-site testing for the relevant bores MH25_07 and MH25_08 (Section 2.4), along with the groundwater monitoring results and bore logs. Table 8 presents the hydraulic parameters applied to each drawdown assessment. A period of 15 days of dewatering was modelled to allow for delays over the planned duration of the works.

Table 8: Input Parameters for Hunt and Scott Assessment of Dewatering WWPS

INPUT PARAMETER	WWPS
Transmissivity in pumped deeper aquifer	23 m ² /day Based on a saturated aquifer thickness of 7.3 m at WWPS and hydraulic conductivity value of 3.2 m/day as maximum tested value from MH25_07 and MH25_08 (Table 4)
Storativity of pumped aquifer	0.001 Typical of a semi-confined aquifer in the Hinuera Formation
Transmissivity in overlying aquifer	35 m ² /day Based on a saturated aquifer thickness of 1 m and a K value of 35 m/day representative of gravelly strata in the area (Table 4)
Specific yield in overlying aquifer	0.25 Value for sandy material (Heath, 1983).
Aquitard thickness	0.5 m (thickness of shallow silt layer in bore MH25_08, Appendix C).
Vertical hydraulic conductivity for the aquitard	0.1 m/day (Section 2.4)
Starting groundwater level	0.8 m bgl from MH25_07
Target drawdown required to dewater 0.5 m below excavation	5.7 m drawdown

3.3.2.1 Deep Dewatering Results

Results of the Hunt and Scott analysis are shown in Figure 17. The WWPS analysis indicates that pumping from a bore at a rate of 5.7 L/s (492 m³/day) will achieve a drawdown in the semi-confined aquifer of 5.7 m at a distance of 5 m from the pumped bore. Provided the bore was positioned alongside the wet well, this drawdown would enable the excavation to be undertaken while maintaining a dry floor (Table 8). After 15 days pumping at this rate the area of influence (drawdown of 0.25 m) extends 110 m from the pumping bore within the semi-confined aquifer. Drawdown in the overlying unconfined aquifer is estimated to reach 0.25 m also at 110 m from the pumped bore.

The potential temporary drawdown for the WWPS construction is modelled to occur within the TKE site boundary at about 200 m on its closest approach.

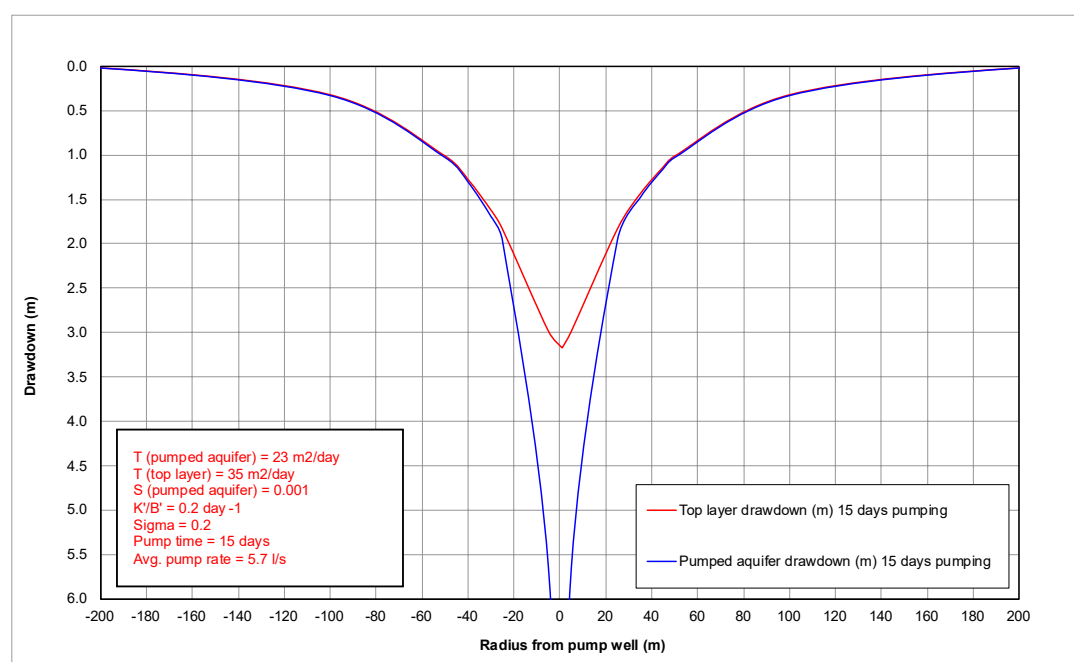


Figure 17: Projected Drawdown in Semi-confined and Unconfined Aquifers Following Dewatering of WWPS Wet Well Excavation

3.3.3 Shallow Aquifer Dewatering During Wet Well Excavation

If construction of the wet well is undertaken using a technique that requires dewatering of the unconfined aquifer until the excavation reaches the silty, semi-confining layer, at 1.8 m depth, temporary dewatering of the aquifer may be required to support the excavation process. This dewatering would result in a direct drawdown of the groundwater table within the gravelly, unconfined, strata. For completeness, an assessment has been undertaken to estimate how much water would flow into this excavation and therefore, require pumping. The extent of the consequent drawdown in the unconfined aquifer has been estimated from these assessments. The modelling has a conservative assumption that the dewatering method leads to floor heave within the excavation and consequent unhindered flows upward from the underlying semi-confined aquifer.

The shallower excavation dewatering has been assessed using the published method of estimating groundwater inflows to open cut pits (Marinelli and Niccoli 2000). The pit model accounts for two zones of inflow, the upper zone being Zone 1 and the lower being Zone 2, with a flow boundary between them at a level equivalent to the position of the semi-confining layer. The hydraulic conductivity for the Upper Hinuera Formation has been applied to Zone 1 and Lower Hinuera Formation to Zone 2 as described with modelling parameters in Table 8 with the addition of recharge (250 mm per annum) and an assumed anisotropy for Zone 2 where the vertical hydraulic conductivity is half of the horizontal conductivity.

The pit dewatering model applied in this assessment functions on a steady-state basis, which means the equations used apply for permanent dewatering. As the wet well construction process is expected to require only a few days, the extent of the zone of influence calculated using this methodology is conservatively large. The pit model assumes Zone 2 is infinite in depth, therefore, inflows from Zone 2 may be overestimated in the modelling. Despite this, the large majority of the inflow is modelled as horizontal through shallow gravels (Zone 1), which is expected. The results of the pit dewatering modelling are summarised in Table 9 with detailed model results provided in Appendix F.

The modelled potential drawdown and inflows for the shallow aquifer dewatering during wet well excavation are less than effects modelled for deep dewatering during construction.

Table 9: Projected Effects of Wet Well Excavation Through Upper Aquifer Only

SITE	DEPTH TO GROUNDWATER (m)	INITIAL SATURATED THICKNESS ABOVE BASIN BASE (m)	RADIUS OF INFLUENCE (m) ⁽¹⁾	CALCULATED GROUNDWATER INFLOW (m ³ /day)	DISTANCE TO NEAREST BUILDING (m)	DRAWDOWN AT NEAREST BUILDING (m)
WWPS	0.8	1.4	24	61	620	0.0

Notes:

⁽¹⁾ Radius of influence is considered to be defined by 0.25 m drawdown.

4 DRAWDOWN EFFECTS OF STORMWATER INFRASTRUCTURE

4.1 Introduction

WGA has assessed the potential groundwater effects of the proposed stormwater wetlands, raingardens, swales and deepened Mangaheka Stream. The assessment considers long-term groundwater drawdown below interpreted summer groundwater levels, as well as potential temporary inflows during construction where active dewatering may be required. The modelling is based on the hydrogeological parameters described in Section 2.4 and the TKE stormwater design information provided by Maven Associates.

Maven has confirmed that soakage is not required for the stormwater wetland function. The wetlands, enhanced drains and deepened Mangaheka Stream are designed to retain and convey stormwater to manage flooding effects within the catchment. As the operational wetland water levels are below surrounding groundwater levels, groundwater mounding is not expected.

4.2 Stormwater Wetlands

4.2.1 Analytical Pit Modelling Methodology for Stormwater Wetlands

Potential groundwater inflows to the proposed stormwater wetlands have been assessed using the Marinelli and Niccoli (2000) method for estimating inflows to open-cut pits. The method approximates horizontal inflows through the sides of an excavation and vertical inflows through the base, as described in Appendix F.

Since the method assumes radial groundwater flow toward a circular excavation, each wetland footprint was converted to an equivalent circular area for modelling. The resulting effective radii are provided in Table 10.

Long-term drawdown has been modelled using the Maven defined design permanent water levels for the stormwater basins and interpreted summer groundwater levels. Temporary construction inflows have been estimated by modelling the wetland base as dry, with a dewatering level 0.5 m below the “deep marsh” base and winter groundwater levels as the starting condition. Recharge of 250 mm/year has been applied, with vertical hydraulic conductivity assumed to be half the horizontal hydraulic conductivity. Contours for the proposed site are provided in Figure 21, which includes the base elevations for the proposed Stormwater Wetlands 1 through 8 as shown in Figure 1.

Under both short-term construction dewatering and long-term groundwater diversion, the analytical pit models conservatively assume the base of the stormwater basins are a constant depth at the levels provided as “deep marsh” areas by Maven (2026). The long-term model assumes water in the stormwater wetland at the permanent water level as defined by Maven (2026).

Table 10: Inputs for Stormwater Wetland Analytical Groundwater Models

WETLAND NUMBER	DESIGN WATER LEVEL (m RL) ⁽¹⁾	BASE OF DEEP MARSH (m RL) ⁽¹⁾	HYDRAULIC CONDUCTIVITY (m/day)	EFFECTIVE RADIUS (m) ⁽¹⁾	LONG-TERM SCENARIO: SUMMER GROUNDWATER R LEVEL (m RL)	SHORT-TERM CONSTRUCTIO N: WINTER GROUNDWATER R LEVEL (m RL)
1	23.9	23.60	3.2	80	25.50	26.50
2	24.9	24.55	3.2	60	25.80	26.80
3	26.6	26.25	6.2	50	27.00	28.00
4	23.9	23.60	3.2	68	25.50	26.50
5	25.5	25.10	3.2	55	26.30	27.30
6	25.8	25.45	3.2	65	26.60	27.60
7	28.2	27.80	3.2	48	27.50	28.50
8	26.7	26.35	6.2	55	27.10	28.10

Notes:

⁽¹⁾ Existing land and wetland design levels provided by Maven Associates (2026).

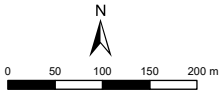
4.2.2 Long-term Drawdown Results

The long-term groundwater drawdown below summer groundwater levels is relevant to potential ground settlement at nearby infrastructure. The extent of the modelled long-term drawdown effect up to 0.25 m is mapped for each proposed wetland on Figure 18. Detailed analyses results are provided in Appendix F. The wetland drawdown modelling results do not consider the drawdown effects of the deepened stream and proposed swales; therefore, the mapped wetland drawdown extent is considered a maximum potential effect that may otherwise be superseded by other, greater, drawdown effects described and mapped in Section 4.5. The wetland drawdown extents also do not apply the existing stream as a hydraulic boundary condition, which may limit the drawdown condition within the site. The results indicate that the proposed wetland 8 may induce drawdown in the vicinity of Koura Drive on the order of 0.3 m. This potential effect is less than the modelled effect of the proposed, deeper, Mangaheka Stream discussed in Section 4.5. The modelling indicates no long-term drawdown associated with the wetlands is expected at the culverts under Koura Drive further to the south. No long-term drawdown is expected for Stormwater Wetland 7 due to the depth of expected summer groundwater level in the wetland area (27.5 mRL) being slightly below the invert level (27.8 mRL).



LEGEND

- Proposed Ground Elevation Contours (m)
- Property Boundary
- Wetlands
- Drains
- Projected Drawdown Contours (0.25m)



Scale 1:8,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 18
Projected Drawdown Extent for
Stormwater Wetlands

Te Kowhai East

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4.3 Raingardens

4.3.1 Analytical Pit Modelling Methodology for Raingardens

Potential construction groundwater inflows to the proposed raingardens have been assessed using the Marinelli and Niccoli (2000) method for estimating inflows to open-cut pits. This is similar to the approach for the stormwater wetlands described in Section 4.2. The raingardens are designed to function as points for collection and treatment of stormwater runoff without dedicated drainage outlets. As such, the raingardens do not form permanent hydraulic boundary conditions or cause any long-term groundwater diversion.

Temporary dewatering inflows for construction of the raingardens have been estimated by modelling the raingarden base as dry with a dewatering level 0.5 m below invert the level low point and winter groundwater levels as the starting condition. Recharge of 250 mm/year has been applied, with vertical hydraulic conductivity assumed to be half the horizontal hydraulic conductivity. Detailed analysis results are provided in Appendix F with input parameters summarised below on Table 11.

Table 11: Inputs for Raingarden Analytical Groundwater Models

RAINGARDEN NUMBER	INVERT LEVEL LOW POINT (m RL) ⁽¹⁾	HYDRAULIC CONDUCTIVITY (m/day)	EFFECTIVE RADIUS (m) ⁽¹⁾	WINTER GROUNDWATER LEVEL ABOVE INVERT LOW POINT (m)
1A	25.0	3.2	19	1.6
1B	25.7	6.2	30	2.3
2	25.5	3.2	18	1.5
3A	26.6	6.2	19	1.3
3B	26.8	6.2	17	1.3
4A	24.4	3.2	19	2.1
4B	26.0	3.2	20	1.1
5	25.9	3.2	19	1.3
6	26.0	3.2	26	1.7
8	26.9	6.2	22	1.2

Notes:

⁽¹⁾ Existing land and wetland design levels provided by Maven Associates (2026).

4.3.2 Construction Dewatering Inflow Results

The results indicate that dewatering construction inflows to the raingardens during the simulated winter scenario range from 310 m³/day 1,600 m³/day. Results for individual raingardens are provided in Appendix F and the summary Table 14.

4.4 Drawdown Effects of Proposed Swales

4.4.1 Introduction

Summer groundwater levels have been used to assess potential drawdown below seasonal low groundwater conditions, which is relevant to the geotechnical assessment of settlement effects. The proposed east and south swales are designed to intersect the interpreted summer groundwater table and are therefore expected to induce localised long-term groundwater drawdown. WGA understands that active dewatering for swale construction is not expected.

The assessment is based on the hydrogeological parameters described in Section 2.4 and the proposed ground elevation model provided by Maven. Proposed ground elevation contours are shown in Figure 21.

4.4.2 Analytical Modelling Methodology for Swales and Deepened Stream

Planned swales in the east and south of the site are designed below the interpreted summer groundwater table. This is expected to result in a long-term groundwater drawdown effect. Other TKE site swales have a design above the summer groundwater level.

Summer groundwater levels interpreted from monitoring bore data have been used as the basis of the groundwater drawdown modelling. The design depths as a proposed ground level model have been provided by Maven to WGA (Figure 21).

An analytical modelling approach for the proposed ground level has been used to calculate long-term groundwater drawdown effects in accordance with Hooghoudt (1940). Input parameters for the modelling are presented in Table 12, which includes the expected hydraulic properties for the primary aquifer layer intersected by the proposed swales. The long-term drawdown effects are modelled with the expected, conservative, 250 mm per annum recharge as per Section 2.5.

Table 12: Inputs for Swale Analytical Groundwater Models

STREAM AND SWALE LOCATION	HYDRAULIC CONDUCTIVITY (m/day)	DRAINAGE DEPTH BELOW SUMMER GROUNDWATER LEVEL (m)	LAYER THICKNESS BELOW DRAINAGE DEPTH (m)	DRAIN BOTTOM WIDTH (m)
East Swale	3.2	0.4	6.3	0.6
South Swales	6.2	1.0	6.3	0.6

4.4.3 Long-term Drawdown Results

The modelled groundwater drawdown effects related to the proposed deepening of the swales are plotted on Figure 19 and Figure 20.

The projected long-term drawdown effects up to 0.25 m below interpreted existing summer groundwater levels are mapped in Figure 22, Figure 23, and Figure 26. The projected drawdown for the south swales (Figure 22) extends to and in the vicinity of neighbouring properties south of the site up to a magnitude of about 0.8 m.

The modelled drawdown extent for the south swales does not extend to the Kahikatea stand. Therefore, no drawdown effect is predicted at the Kahikatea stand based on the modelled results alone. Te Otamanui Stream, as described in Section 2.6, may provide an additional hydraulic control between the proposed works and the Kahikatea stand; however, the assessment conclusion does not rely on this boundary condition.

The east swale is modelled to induce drawdown of approximately 0.35 m near the existing mudfish drain. However, as described in Section 2.6, summer groundwater levels in this area are already below the drain invert, indicating that the drain is seasonally disconnected from shallow groundwater under existing summer conditions.

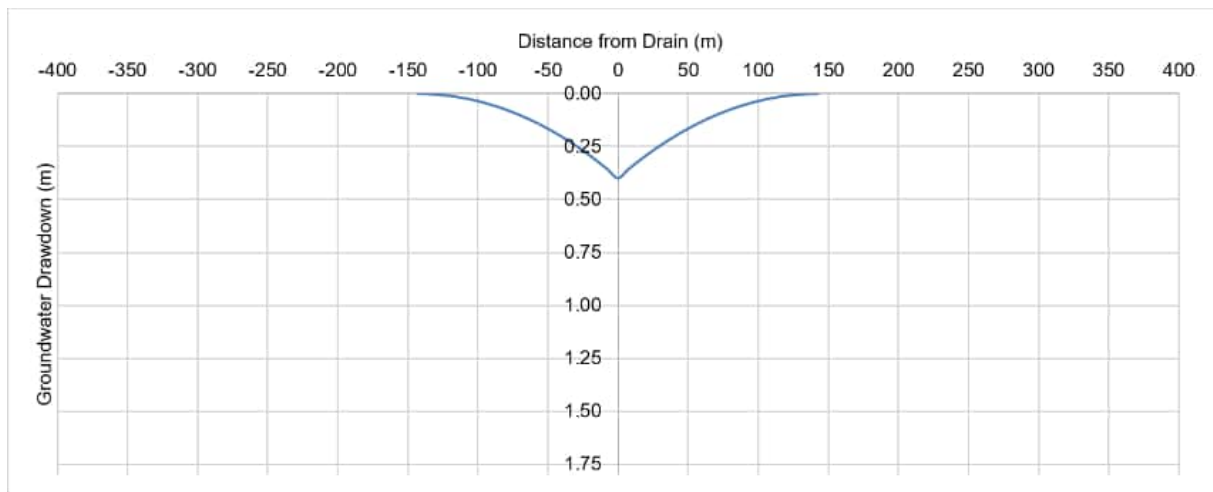


Figure 19: Projected Long-term Drawdown East Swale

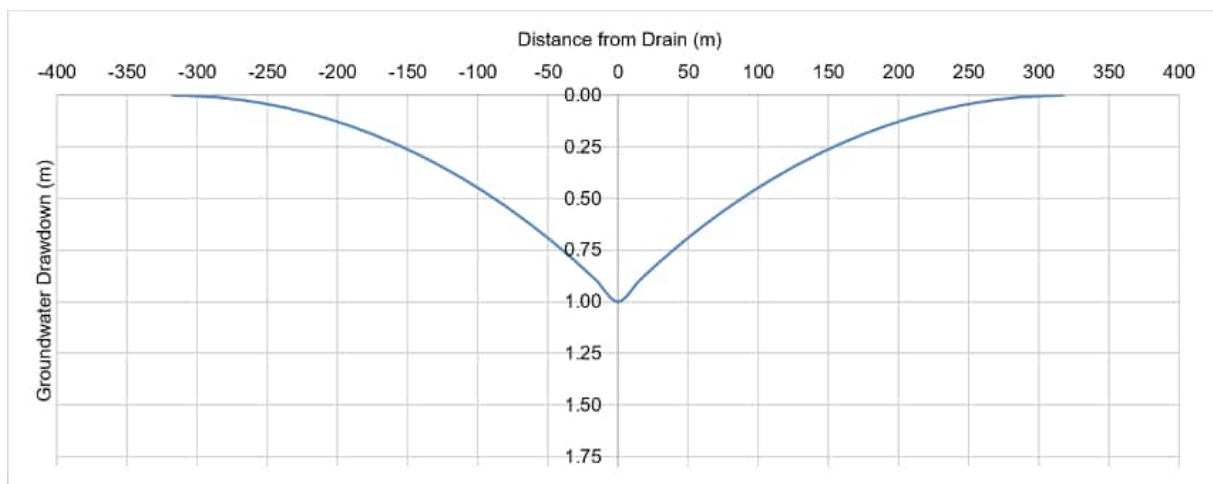
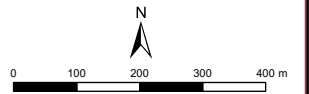


Figure 20: Projected Long-term Drawdown South Swales



LEGEND

- Proposed Ground Elevation Contours (m)
- Property Boundary



Scale 1:12,000 @ A4

Coordinate System: NZGD 2000 Mount Eden Circuit

WGA

Figure 21:
Proposed Ground
Elevation Contours

Te Kowhai East

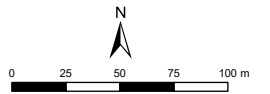
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LEGEND

- South Swales
- Proposed Ground Elevation Contours (m)
- Projected Drawdown Extent
- Property Boundary
- Kahikatea Stand
- Drains



Scale 1:3,500 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 22
Projected Drawdown
Extent for South Swale

Te Kowhai East

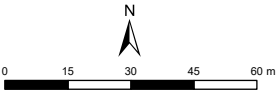
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LEGEND

- East Swale
- Proposed Ground Elevation Contours (m)
- Property Boundary
- East Swale Drawdown Extent
- Drains



Scale 1:1,800 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 23
Projected Drawdown
Extent for East Swale

Te Kowhai East

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4.5 Drawdown Effects of Deepened Stream

4.5.1 Introduction

The proposed deepening of Mangaheka Stream is expected to form a persistent hydraulic control within the development. WGA has assessed the resulting long-term groundwater drawdown below interpreted summer groundwater levels using the hydrogeological parameters described in Section 2.4 and the proposed ground elevation model provided by Maven.

4.5.2 Analytical Modelling Methodology for the Deepened Stream

The stream deepening as designed is below the interpreted summer groundwater surface. This is expected to result in a long-term groundwater drawdown effect.

An analytical modelling approach for the proposed ground level has been used to calculate long-term groundwater drawdown effects in accordance with Hooghoudt (1940). Input parameters for the modelling are presented in Table 13, which includes the expected hydraulic properties. The long-term drawdown effects are modelled with the expected, conservative, 250 mm per annum recharge as per Section 2.5.

Table 13: Inputs for Deepened Stream Analytical Groundwater Models

STREAM AND SWALE LOCATION	HYDRAULIC CONDUCTIVITY (m/day)	DRAINAGE DEPTH BELOW SUMMER GROUNDWATER LEVEL (m)	LAYER THICKNESS BELOW DRAINAGE DEPTH (m)	DRAIN BOTTOM WIDTH (m)
Southeast Mangaheka Stream	6.2	1.2	5.9	2.0
Mid-site and West Mangaheka Stream	3.2	1.6	5.3	2.0

4.5.3 Long-term Drawdown Results

The modelled groundwater drawdown effects related to the proposed deepening of Mangaheka Stream, plotted on Figure 24, Figure 25. Under the expected hydraulic conditions, the projected drawdown from the deepened Mangaheka Stream is up to approximately 0.65 m at Koura Drive and 0.55 m at the nearest associated NZTA culvert. The deepened Mangaheka Stream is also modelled to induce a potential drawdown effect of about 0.2 m at the second NZTA culvert further to the south.

In the southeast area of the proposed deepened Mangaheka Stream there was evidence in the lithological logs of a potential sand filled paleochannel. Given the identified zone and higher hydraulic conductivity results an additional paleochannel scenario was modelled. Under the more conservative scenario where a deepened area of the southeast Mangaheka stream intersects a subsurface paleochannel at the highest tested hydraulic conductivity of 35 m/day with a potential paleochannel width on the order of 150 m, potential drawdown effects at Koura Drive at its closest approach are estimated on the order of 1.0 m. This is in the vicinity of the existing MH25_05 location as per Figure 7. The potential 150 m length of the paleochannel has been assessed from review of available satellite imagery showing up to this width along the Mangaheka Stream alignment.

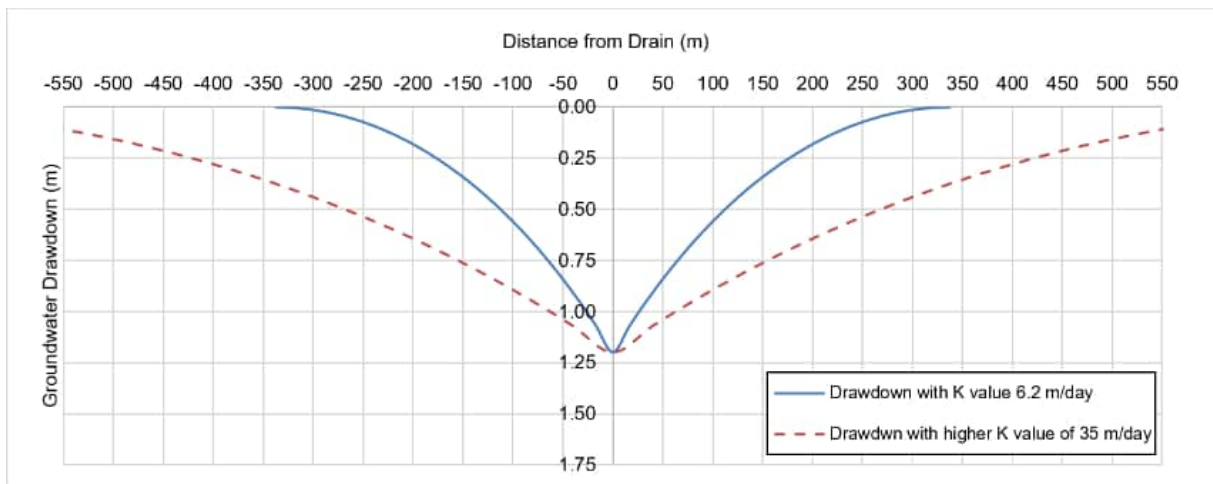


Figure 24: Projected Long-term Drawdown Southeast Deepened Mangaheka Stream

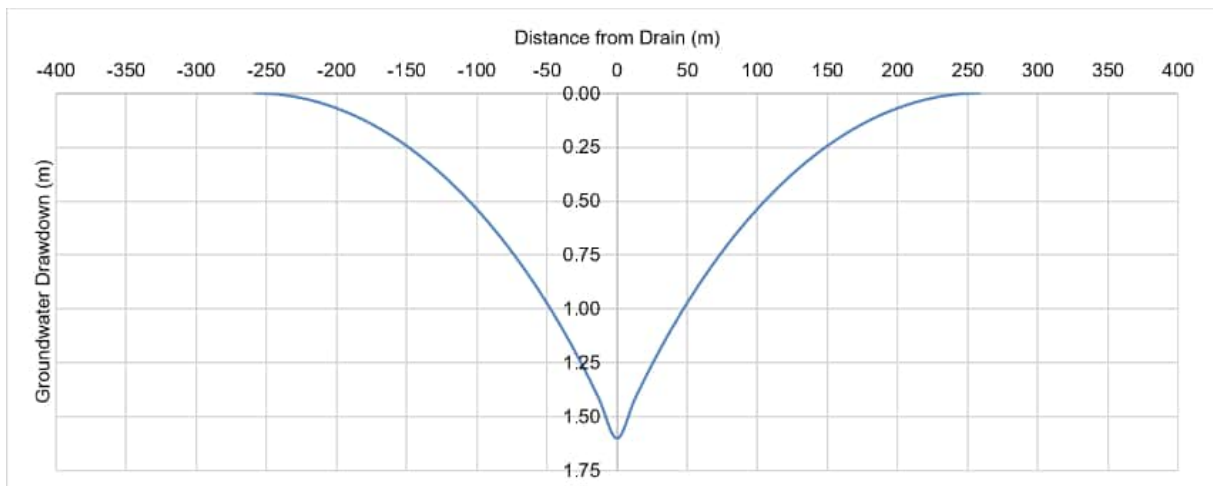
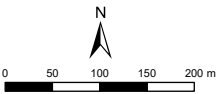


Figure 25: Projected Long-term Drawdown Mid-site and West Deepened Mangaheka Stream



LEGEND

- Stream
- Proposed Ground Elevation Contours (m)
- Stream Drawdown Extent
- Property Boundary
- Drains



Scale 1:8,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 26
Projected Drawdown Extent for
Deepened Mangaheka Stream

Te Kowhai East

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5 GROUNDWATER EFFECTS ASSESSMENT

5.1 Effects Overview on Catchment Water Balance

The proposed TKE development is located in the upper catchments of Mangaheka and Te Rapa Stream, a low-lying, flat area with strong groundwater-surface water interactions. Shallow groundwater at the site flows generally northwest toward the modified Mangaheka Stream, which currently act as gaining drains (Section 2.3 and Figure 10). Locally within the northeast area of the site groundwater may flow northeast along the course of the upper Te Rapa catchment drains. These features, along with existing drains that provide mudfish habitat, are integral to the hydrology of the Mangaheka and Te Rapa Stream catchments.

The proposed activity has two main components with potential to influence catchment water balances (Figure 27):

1. Short-term, temporary groundwater dewatering during construction of stormwater wetlands, raingardens and wastewater infrastructure (pipelines and WWPS).
2. Long-term groundwater interception by the completed stormwater wetlands, swales, and deepened Mangaheka Stream, which will function as persistent hydraulic features.

Water diverted through the stormwater wetlands and abstracted during construction dewatering will be discharged to the closest stream or drain. Given shallow groundwater is currently moving toward these streams and drains the effect of the proposed activity on groundwater will not alter the overall catchment water balance.

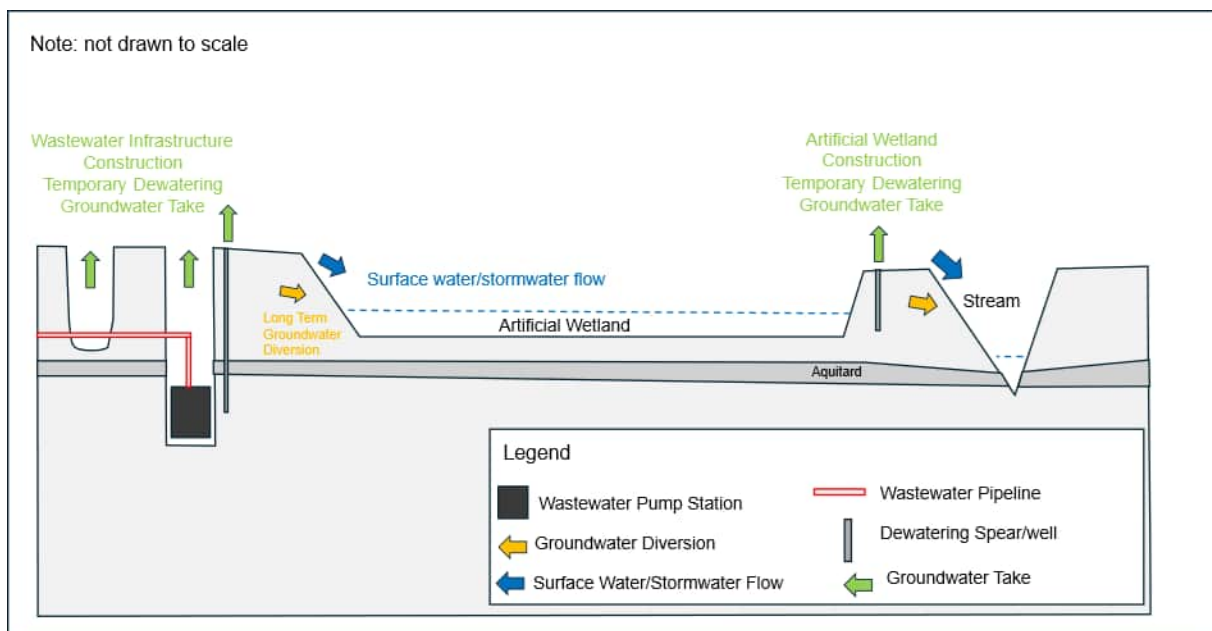


Figure 27: Conceptual Schematic of Water Flow Required and Induced by the Proposed Activity

The development represents a land use change from rural (dairy/pastoral) to industrial. This is expected to increase impervious surfaces, reduce diffuse groundwater recharge relative to the existing condition, and route a greater proportion of rainfall as managed stormwater runoff into the proposed treatment and conveyance system (raingardens, wetlands, swales, and deepened stream).

In the long-term, the site water balance will shift from distributed recharge and diffuse runoff toward a more engineered regime, with increased capture, attenuation, and discharge to the Mangaheka Stream and locally to Te Rapa Stream. Localised long-term drawdown effects are expected around the deepened stream, proposed swales, and wetlands but groundwater will continue to flow to the same catchments as pre-development.

5.2 Dewatering Effects Assessment

Summer groundwater levels have been used for drawdown as they are most relevant to the geotechnical assessment of settlement effects. In addition, the inflow during higher groundwater level periods (winter) has been used to model groundwater inflow during construction. Construction dewatering and associated controlled, active, pumping is expected to be localised and temporary to enable completion of the wastewater infrastructure and stormwater wetlands. Long-term, passive, groundwater interception by the deepened stream, swales, and wetlands has also been modelled to result in localised drawdown effects relative to summer groundwater levels. These long-term drawdown effects are provided in Sections 4.2.2 and 4.4.3. No active dewatering methods are expected to be required to enable construction of the swales and deepened stream.

The potential construction dewatering flow rates adapted from the modelling results presented in the Sections 3 and 4 and summarised in Table 14. These modelled dewatering rates apply winter conditions when groundwater levels are higher in a conservative construction dewatering scenario where the water level is actively pumped deeper than operational levels to enable construction. The summary of long-term groundwater diversion flow rates is also provided in Table 14.

Table 14: Summary of Construction Dewatering Flow Rates and Long-term Diversions

EXCAVATION TYPE	CONSTRUCTION INFLOW (m ³ /day)	LONG-TERM DIVERSION (m ³ /day)
Stormwater Wetlands and Raingardens (Section 4)		
Stormwater Wetland 1	2,600	1,200
Stormwater Wetland 2	1,600	520
Stormwater Wetland 3	2,100	370
Stormwater Wetland 4	2,200	1,000
Stormwater Wetland 5	1,400	450
Stormwater Wetland 6	1,600	500
Stormwater Wetland 7	550	N/A
Stormwater Wetland 8	2,300	410
Raingarden 1A	390	N/A
Raingarden 1B	1,600	
Raingarden 2	350	
Raingarden 3A	640	
Raingarden 3B	580	
Raingarden 4A	490	
Raingarden 4B	310	
Raingarden 5	330	
Raingarden 6	560	
Raingarden 8	700	

EXCAVATION TYPE	CONSTRUCTION INFLOW (m³/day)	LONG-TERM DIVERSION (m³/day)
Wastewater Infrastructure (Section 3)		
Wastewater Pump Station: Wet Well Installation	490	N/A
Wastewater Pipeline: 80 m Section, East	670	
Wastewater Pipeline: 80 m Section, Southeast	1,810	
Proposed Swales (Section 4.3)		
East Swale (360 m Section)		71
South Swales (1,230 m total length)		535
Deepened Mangaheka Stream (Section 4.4)		
Southeast Deepened Mangaheka Stream (427 m Section)	N/A	197
Mid/West Deepened Mangaheka Stream (1,150 m Section)		407

Notes: This table includes results from multiple groundwater assessments, including steady state and transient dewatering analyses. These values are not directly comparable and should be interpreted with reference to the relevant methodology in Sections 3 to 5.

WGA understands that wastewater pipelines will be installed in 80 m sections with short-term dewatering. The WWPS wet well requires targeted, temporary, deep dewatering. Stormwater wetlands will involve staged excavation and deeper dewatering before becoming permanent interception features with higher operational levels plus passive groundwater interception. The deepened stream and swales are expected to result in a potential long-term drawdown effect with an associated, passive, groundwater diversion. The largest individual abstraction is estimated for the construction of Stormwater Wetland 1 at 2,600 m³/day. However, dewatering for the WWPS, pipelines and a raingarden could be occurring on the same day. Therefore, a proposed daily limit for construction dewatering is proposed of **7,170 m³/day**, representing the dewatering for wastewater infrastructure (Wet Well and two sections of pipeline), a raingarden (1B) and a stormwater basin (1).

The water abstracted for dewatering is non-consumptive and groundwater will be discharged the local streams that would have received the under pre-development conditions. Some of the abstracted water is planned to be used for dust suppression from onsite water storage (as part of the ESCP). This water represents a consumptive volume. WGA understands TKE plan to be actively developing approximately 20 Ha at a time. Based on an application rate of up to 5 mm per day to cover evaporation rates in summer a daily volume of up to **1,000 m³/day** is proposed for dust suppression.

5.2.1 Effects on Nearby Bores

Neither the temporary or long-term modelled drawdown effect extends to any of the surrounding current groundwater take consents within one kilometre of the Site (Figure 11 and Table 5). The furthest radial extent of potential drawdown from proposed site activities assessed in this report is the 300 m extent of long-term drawdown from the southeast area of the deepened Mangaheka Stream.

Of the existing groundwater bores outside of and within one kilometre of the site, no bores are expected to be potentially impacted by drawdown from the site. The shallow, 3.6 m deep, bore 69_108 is within the modelled drawdown effects of the southernmost swale, however it is located within the TKE site/parcel boundary. Bore 72_5305 to the south of the site at a neighbouring property is located outside, south, of the modelled extent of drawdown extending from the southeast Mangaheka Stream. There are no other potential drawdown effects, assessed in this report, that are expected to extend to neighbouring bores outside of the site parcel boundaries.

5.2.2 Effects on Surface Water Features

Where construction activities temporarily intercept groundwater that would otherwise discharge to local drains or the Mangaheka and Te Rapa streams, it is recommended that the intercepted groundwater be discharged back to the receiving drainage network upstream of the works under the ESCP. This measure maintains continuity of surface water flows and mitigates short-term stream depletion effects during construction. With these measures in place, no sustained reduction in surface water flows or substantial changes to downstream hydrology are expected. Overall effects on stream flows are assessed to be minor and temporary.

5.2.3 Effects on Mudfish Drains

The projected summer drawdown effect of the east swale is on the order of 0.35 m in the vicinity of the existing drain with mudfish habitat on the east side of the site. According to groundwater levels recorded from MH25_04, existing groundwater levels appear to drop below the base of this existing drain during the summer. The existing mudfish habitat drain feature is interpreted to become disconnected from shallow groundwater contributions during the summer. A hydrogeological cross-section showing the existing summer groundwater level at the piezometer MH25_04 is approximately 1.3 m below the existing mudfish habitat drain location (Figure 28).

Further drawdown below existing summer levels associated with the east swale is therefore considered to not influence the seasonal water balance for the mudfish habitat.

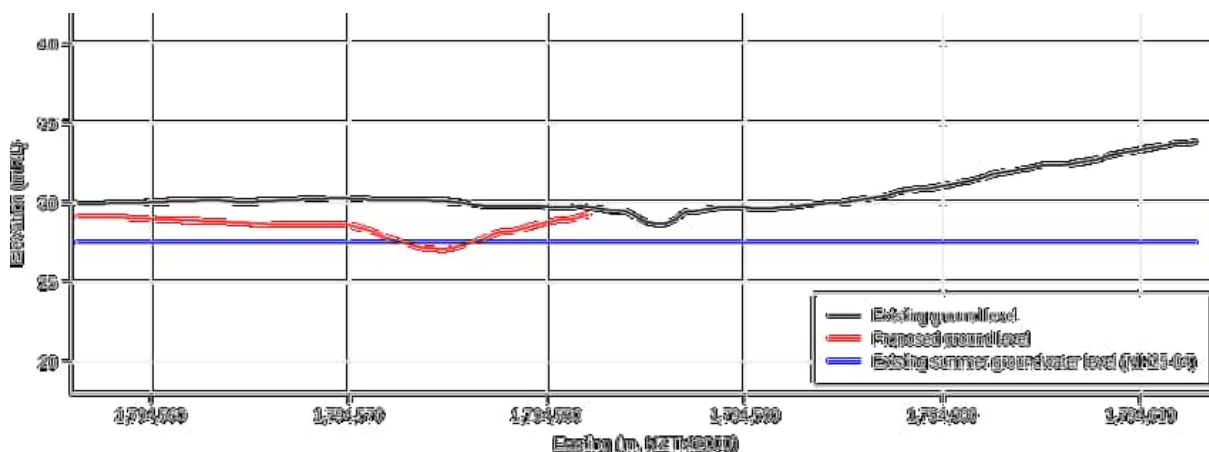


Figure 28: Hydrogeological Cross-section of Existing Summer Groundwater Level at Mudfish Habitat Drain

5.2.4 Effects on Kahikatea Stand

The stand of Kahikatea trees, identified as a Significant Natural Area, is located south of the Te Kowhai East development site beyond Te Otamanui Stream. This drain functions as a hydraulic boundary condition limiting the propagation of drawdown from the south swales and other proposed features. Analytical groundwater modelling of the proposed activities, including long-term interception by the deepened Mangaheka Stream, south swales, stormwater wetlands, and temporary construction dewatering associated with wastewater pipelines, indicates no drawdown effect on the Kahikatea trees.

Consequently, the proposed development is not anticipated to result in measurable changes to groundwater levels or contributions supporting the Kahikatea trees. The stand of trees is expected to continue to be sustained by the upper Mangaheka Stream catchment and the existing drainage network. No construction-related effects are predicted to influence the area, and the overall hydrogeological effects on this feature are assessed as negligible.

5.2.5 Effects on Ground Subsidence

The temporary construction dewatering associated with wastewater pipelines, the wastewater pump station wet well, and stormwater wetlands, together with the long-term groundwater interception by the proposed deepened Mangaheka Stream, vegetated swales, and stormwater wetlands, will induce localised drawdown below existing summer groundwater levels. The greatest magnitudes of drawdown are projected in the vicinity of the deepened central stream channel and south swales, with more moderate effects around the wetlands and construction excavations. Where these drawdown effects occur within near-surface compressible Holocene silts, peats, or organic-rich deposits, there is potential for some ground subsidence, particularly if groundwater levels are lowered beyond the range of natural seasonal fluctuations.

While this hydrogeological assessment has quantified the extent and magnitude of both temporary and long-term groundwater drawdown across the site, it does not evaluate the resulting subsidence response of the underlying soils or the implications for existing or proposed infrastructure and foundations. CMW (2026b) assesses the potential subsidence risk and requirement for monitoring measures during construction and operation, consistent with relevant regional engineering requirements. WGA understands that CMW (2026b) estimates the resulting settlements to be in the order of 5 to 10 mm, assesses cross-boundary effects as negligible, and recommends no specific mitigation.

5.3 Anticipated Implications for Water Quality

The land use change together with the introduction of stormwater wetlands and raingardens is expected to result in reduced nutrient inputs to shallow groundwater and the Mangaheka and Te Rapa Streams over time. While construction activities can temporarily elevate sediment related risks, this risk is to be addressed through the development and implementation of an ESCP.

6 MUDFISH HABITAT

6.1 Introduction

WGA understands a mudfish habitat needs to be established on the site for relocating mudfish from the drains on site (EcoLogical Solutions 2026). WGA understands the wetland habitat is to provide permanent aquatic refuge and seasonally saturated habitat of equivalent or better quality than the existing drain habitat, and that it is to be located within the eastern area of the site.

This section outlines the hydrogeological setting in the area that has been set aside for the wetland and the information that was used to generate the Mudfish Habitat concept design (Figure 30). The design was based on hydrogeological conditions, engineering requirements and ecological function requirements.

The assessment draws on the hand auger investigations along the proposed swale alignment (Appendix D), the piezometer records described in Section 2.3.3, and a synthetic groundwater hydrograph developed to place the relatively short site monitoring record into a longer-term seasonal context (Figure 29).

6.2 Site Hydrogeology

Shallow groundwater conditions in the vicinity of the proposed mudfish habitat are consistent with those described for the wider site in Section 2.3.

Hand auger investigations along the proposed swale alignment encountered organic silt topsoil and Holocene alluvial organic silts overlying silts and well graded sands of the Hinuera Formation, with an approximate paleochannel of infilled organic silt mapped through the eastern investigation area. Groundwater was encountered at most locations at depths between approximately 0.8 m and 2.1 m bgl and was not encountered only at the location terminated on gravel within uncontrolled fill. Piezometers were installed at two of the hand auger locations to provide local monitoring control.

A synthetic hydrograph was derived by fitting groundwater levels observed at the nearest site monitoring location to the long-term monitoring bore record used for the Rotokauri Greenway project (Figure 29). The fitted relationship was then applied to the long-term record to generate an extended synthetic series representative of the proposed mudfish habitat area. The synthetic hydrograph is an indicative long-term sequence rather than a measured record at the mudfish habitat area, and is used to assess the likely seasonal range, frequency and duration of groundwater support to the habitat rather than to predict levels on any particular date.

6.3 Proposed Mudfish Habitat

The concept design for the mudfish habitat is shown in Figure 30 and Figure 31. The design comprises deeper pools, a shallow wetland zone, an aquatic macrophyte zone and riparian planting. The existing drain has been avoided in the concept design to avoid inflow from the drain.

Figure 31 shows the design mudfish habitat contours relative to the modelled seasonal groundwater range of approximately 27.5 m RL to 28.5 m RL.

The deeper pools are set below the modelled minimum groundwater level and are therefore expected to retain water and remain in connection with shallow groundwater year-round, including through late summer when groundwater levels are at their seasonal low. The shallow wetland and aquatic macrophyte zones lie within the modelled seasonal range and are expected to be saturated or inundated through winter and spring, with progressive drawdown and partial drying through summer.

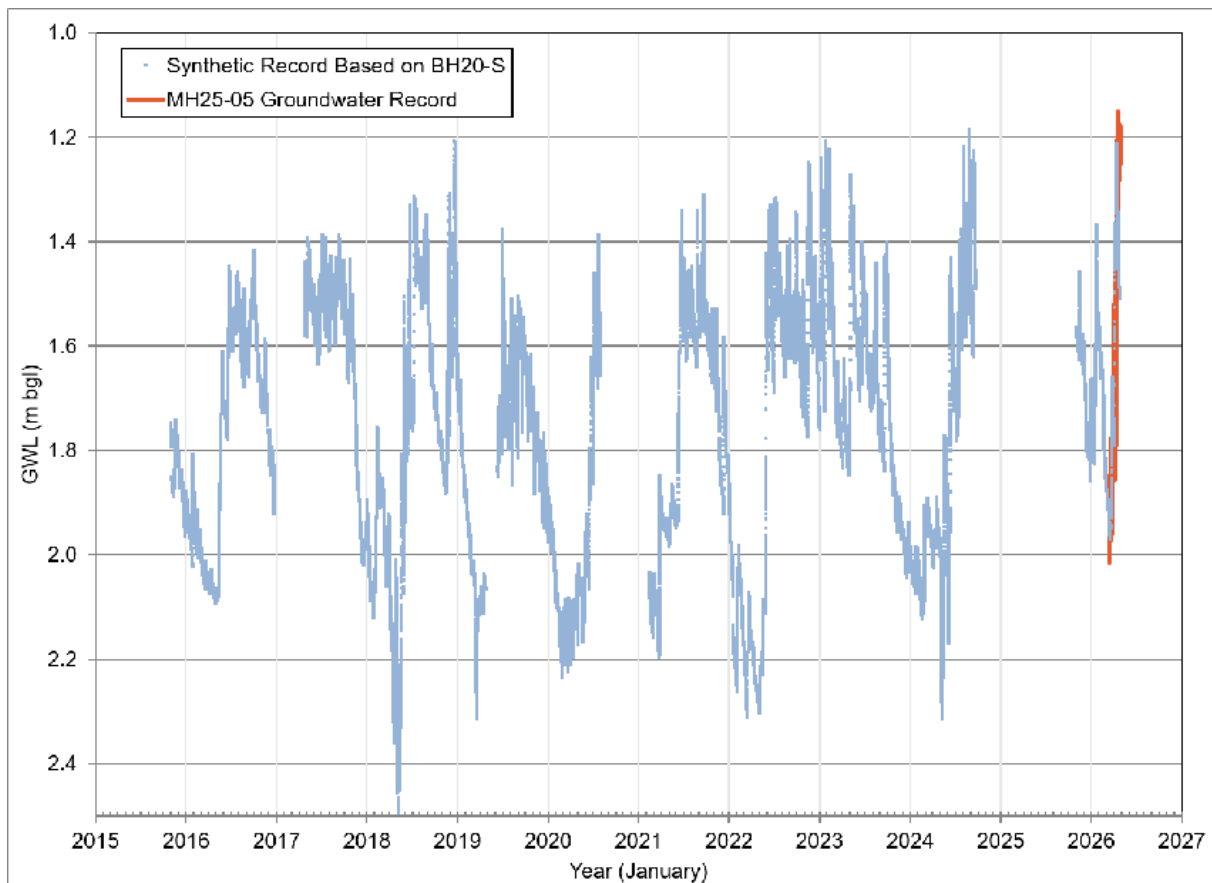


Figure 29: Synthetic Hydrograph for Nearby Piezometer MH25-05

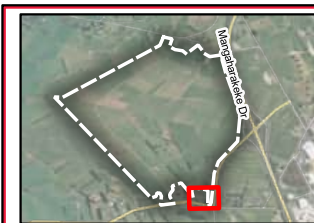
From a hydrogeological perspective, this configuration is considered appropriate for the intended habitat function. The deeper pools provide permanent aquatic refuge that is not reliant on seasonally high groundwater, while the shallow zones provide the seasonally wet, vegetated margins characteristic of mudfish habitat.

Continued groundwater level monitoring at the piezometers installed along the swale alignment is recommended through construction and establishment, to confirm that observed groundwater behaviour is consistent with the synthetic hydrograph and the assumed seasonal range.

6.3.1 Temporary Mudfish Habitat Construction Dewatering

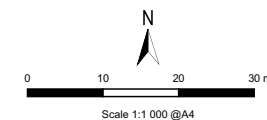
Potential construction groundwater inflow to the proposed mudfish habitat has been assessed using the Marinelli and Niccoli (2000) method for estimating inflows to open-cut pits. This is similar to the approach for the raingardens described above. The mudfish habitat is designed to intercept groundwater levels without dedicated drainage outlets. As such, the habitat will not form permanent hydraulic boundary conditions or long-term groundwater diversion. The habitat has been split into two assessed basins (north and south) for the purpose of the construction dewatering assessment.

Temporary dewatering inflows for construction of the habitat has been estimated by modelling the base (27 mRL) with an effective basal area radius of approximately 12 m for the north basin and 8 m for the south basin. The winter groundwater level (28.5 mRL) was used as the starting condition. Recharge of 250 mm/year has been applied, with vertical hydraulic conductivity assumed to be half the horizontal hydraulic conductivity (6.2 m/day). Detailed analysis results are provided in Appendix F. Temporary construction dewatering is estimated to be 340 m³/day for the northern mudfish habitat and 230 m³/day for the southern habitat with a temporary drawdown 0.25 m at a distance of 30 m and 28 m respectively.



LEGEND

-  Aquatic Macrophyte Zone
-  Deeper Wetland Pools
-  Riparian Planting
-  Shallow Wetland Zone
-  Site Boundary
-  Existing Drain

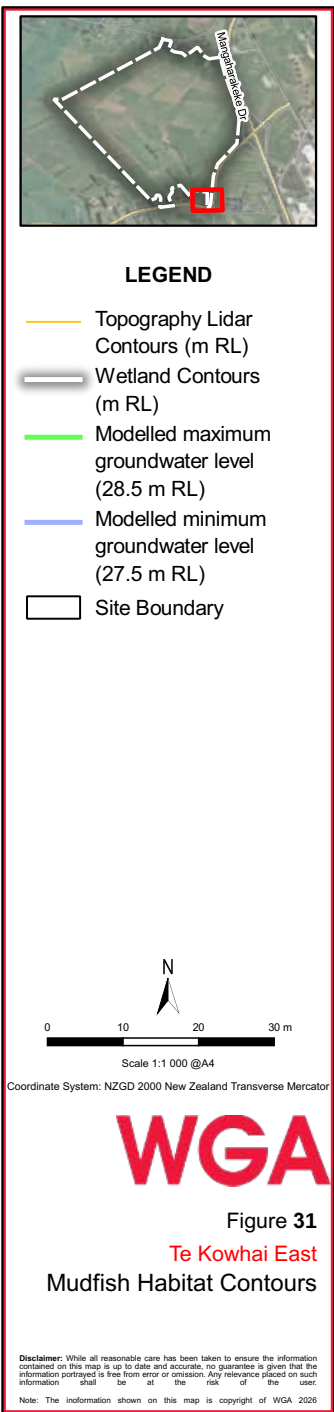


Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 30
Te Kowhai East
Mudfish Habitat Concept
Design

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any reliance placed on such information shall be at the risk of the user.
 Note: The information shown on this map is copyright of WGA 2026



7 RECOMMENDATIONS

7.1 Groundwater Monitoring

Groundwater levels across the site have been characterised by monitoring a network of eight piezometers in conjunction with test pitting and long-term groundwater level records. Seasonal groundwater level variability is expected along with hydraulic connectivity to local drains. In addition, piezometers were installed within the planned mudfish habitat area.

The predicted groundwater drawdown effects are localised, in some cases are temporary (during construction), and have been conservatively assessed using site-specific tested hydraulic parameters. Groundwater drawdown effects are not expected to impact the availability of water at nearby groundwater abstraction bores. The long-term groundwater diversion to the stormwater wetlands, deepened stream, and swales represents a redistribution of groundwater discharge within the site catchment rather than a net loss.

Groundwater level monitoring may be required to support the identification and mitigation of potential ground settlement effects in the vicinity of NZTA culverts at Koura Drive neighbouring properties on the south side of the site. Subsidence risks have been assessed by geotechnical specialists at CMW (2026b) from the groundwater drawdown predicted in this report to confirm further monitoring requirements to allow adaptation to any unforeseen effect.

WGA recommends that the site piezometers are continued to be monitored automatically and downloaded at three monthly intervals to be used for detailed design of the stormwater infrastructure and mudfish habitat wetland.

7.2 Surface Water Monitoring

Surface water features within and downstream of the TKE site comprise drains and the headwaters of the Mangaheka and Te Rapa Streams. Potential effects on surface waters are limited to localised interception of groundwater contributions during construction dewatering for stormwater wetlands and wastewater infrastructure. These effects have been assessed as temporary and manageable through construction methodology and the appropriate placement of temporary water discharge points rather than ongoing operational controls.

Given the short duration of dewatering activities, the absence of predicted long-term surface water drawdown effects, and the implementation of erosion and sediment control measures under the project's construction management framework, additional surface water flow or level monitoring is not considered necessary for the development. Visual inspections of drains/streams during construction, undertaken as part of standard environmental compliance checks under the ESCP, are considered sufficient to confirm expected performance in terms of the groundwater components.

8 CONCLUSIONS

This hydrogeological assessment has evaluated the potential groundwater effects associated with the Te Kowhai East Industrial Development. The assessment has focused on temporary construction dewatering for wastewater infrastructure, including pipelines and the pump station, and stormwater wetlands, as well as longer-term groundwater interception and drawdown associated with the proposed stormwater wetlands, vegetated swales, and deepened Mangaheka Stream.

Site-specific investigations, including hand auger and borehole drilling, falling-head permeability testing, and groundwater monitoring, have confirmed the presence of a shallow aquifer within the Hinuera Formation. This aquifer consists of sands and gravels, including potential paleochannels, interbedded with discontinuous silts and clays, with lower-permeability Walton Subgroup materials present in places. Shallow groundwater occurs at depths of generally 0.5 m to 2 m bgl, varies seasonally, and flows primarily northwest toward the existing modified Mangaheka Stream and associated drains, which act as gaining features and key hydraulic boundaries within the upper catchment.

Analytical groundwater modelling suggests that groundwater drawdown effects associated with construction dewatering of wastewater pipelines, the wastewater pump station wet well, and stormwater wetlands will be localised and temporary. Conservative assumptions have been adopted throughout the assessment, including for hydraulic conductivity, seasonal groundwater levels, and construction scenarios. The greatest temporary construction inflows are associated with stormwater wetland excavation, with an estimated peak abstraction for construction of up to approximately **7,170 m³/day**. Of this total volume, a daily maximum of up to **1,000 m³/day** is proposed for dust suppression, based on an application rate of up to 5 mm per day over 20 Ha.

Where construction dewatering temporarily intercepts groundwater that would otherwise contribute to local drains or stream baseflow, effects can be effectively managed through controlled abstraction, erosion and sediment controls, and discharge of intercepted water back to the receiving drainage network upstream of the works. This maintains surface water continuity during the short-term construction period.

Long-term drawdown below summer groundwater levels from the deepened Mangaheka Stream, swales, and wetlands is projected to be localised, with maximum effects in the vicinity of these features being 0.65 m to 1.0 m at Koura Drive and 0.55 m at the nearest associated NZTA culvert from the deepened stream and up to 0.8 m under southern neighbouring properties. These features will function as persistent hydraulic features, modifying and redistributing groundwater discharge paths within the catchment in a manner similar to the existing drains and stream. Long-term drawdown effects on nearby groundwater bores, natural wetlands (including mudfish habitat), the Kahikatea Significant Natural Area, and connected surface water bodies are assessed as less than minor or negligible.

These changes to the hydrogeology do not affect the availability of water at any nearby bore, natural wetland or connected surface water body, and the effects are assessed as less than minor. The potential for the predicted drawdown to cause ground settlement at the Koura Drive infrastructure and the southern neighbouring properties has been assessed by CMW (2026b), which assesses cross-boundary effects as negligible, and no specific mitigation is recommended.

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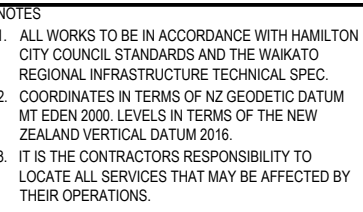
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WGA 2025b. Te Kowhai East Water Management Plan. Report No. WGA212384-RP-HG-0005_D.

APPENDIX A

STORMWATER MANAGEMENT PLANS





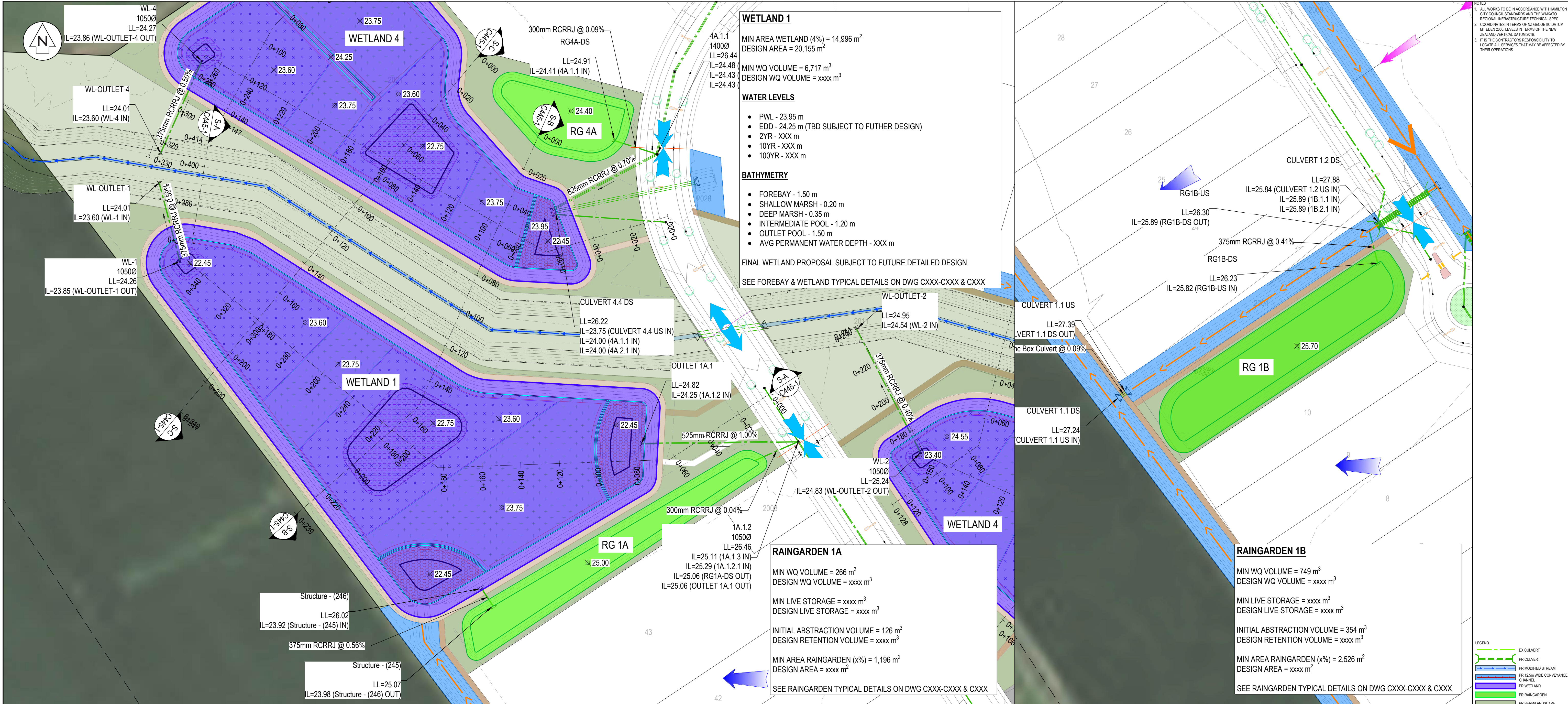
LEGEND

	EX STORMWATER
	PR STORMWATER
	PR LOT CONNECTION
	EXPR SWHM
	PR CULVERT
	PR MODIFIED STREAM
	PR 12.5m WIDE CONVEYANCE CHANNEL
	PR WETLAND
	PR RAINGARDEN
	PR BERM LANDSCAPE
	PR LOT SHEET FLOW
	PR MINOR OULF
	PR ROADING OLF DRAIN
	PR ROADING CREST/RIGHT PT
	PR ROADING SAGFLOW PT

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www.maven.co.nz
5 Owens Road, Epsom
Auckland 1023

PROPOSED STORMWATER OVERVIEW PLAN

Project no.	180010		
Scale	1:4000 @ A1		
Cad file	180010-C400.DWG		
Drawing no.	C400	Rev	A



WETLAND 1

MIN AREA WETLAND (4%) = 14,996 m²
DESIGN AREA = 20,155 m²

MIN WQ VOLUME = 6,717 m³
DESIGN WQ VOLUME = xxxx m³

WATER LEVELS

- PWL - 23.95 m
- EDD - 24.25 m (TBD SUBJECT TO FUTHER DESIGN)
- 2YR - XXX m
- 10YR - XXX m
- 100YR - XXX m

BATHYMETRY

- FOREBAY - 1.50 m
- SHALLOW MARSH - 0.20 m
- DEEP MARSH - 0.35 m
- INTERMEDIATE POOL - 1.20 m
- OUTLET POOL - 1.50 m
- AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.

SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

RAINGARDEN 1A

MIN WQ VOLUME = 266 m³
DESIGN WQ VOLUME = xxxx m³

MIN LIVE STORAGE = xxxx m³
DESIGN LIVE STORAGE = xxxx m³

INITIAL ABSTRACTION VOLUME = 126 m³
DESIGN RETENTION VOLUME = xxxx m³

MIN AREA RAINGARDEN (x%) = 1,196 m²
DESIGN AREA = xxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

RAINGARDEN 1B

MIN WQ VOLUME = 749 m³
DESIGN WQ VOLUME = xxxx m³

MIN LIVE STORAGE = xxxx m³
DESIGN LIVE STORAGE = xxxx m³

INITIAL ABSTRACTION VOLUME = 354 m³
DESIGN RETENTION VOLUME = xxxx m³

MIN AREA RAINGARDEN (x%) = 2,526 m²
DESIGN AREA = xxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

- NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
 2. COORDINATES IN TERMS OF NZ GEODETIC DATUM 1949/2000. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
 3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

- LEGEND
- EX CULVERT
 - PR CULVERT
 - PR MODIFIED STREAM
 - PR 12.5m WIDE CONVEYANCE CHANNEL
 - PR WETLAND
 - PR RAINGARDEN
 - PR BERM/LANDSCAPE
 - PR FOREBAY
 - PR MARSH SHALLOW
 - PR MARSH DEEP
 - PR WETLAND POOLS
 - PR LOT SHEET FLOW
 - PR MINOR CULP
 - PR ROADING CULP/DIRECTION
 - PR ROADING CREST/HIGH PT
 - PR ROADING SAG/LOW PT

DATUM 20.00m		PWL = 23.95m	
EXISTING LEVELS	26.59	26.76	27.17
DESIGN LEVELS	27.04	27.07	27.17
CUT/FILL	0.45	0.31	-0.59
CHAINAGE	0.00	20.00	40.00

WETLAND 1 - SECTION A
SCALE: HORI 1:1500 VERT 1:300

DATUM 20.00m		PWL = 23.95m	
EXISTING LEVELS	27.41	27.57	27.59
DESIGN LEVELS	24.40	26.27	27.22
CUT/FILL	-3.01	-1.30	-3.84
CHAINAGE	0.00	20.00	40.00

WETLAND 1 & 4 - SECTION B
SCALE: HORI 1:1500 VERT 1:300

DATUM 20.00m		PWL = 23.95m	
EXISTING LEVELS	27.56	27.52	27.46
DESIGN LEVELS	26.26	25.44	27.46
CUT/FILL	-1.31	-2.09	-3.86
CHAINAGE	0.00	20.00	40.00

WETLAND 1 & 4 - SECTION C
SCALE: HORI 1:1500 VERT 1:300

DRAFT FOR REVIEW

Revisions

Ref	Revisions	By	Date
A	DRAFT	KY	07/2025

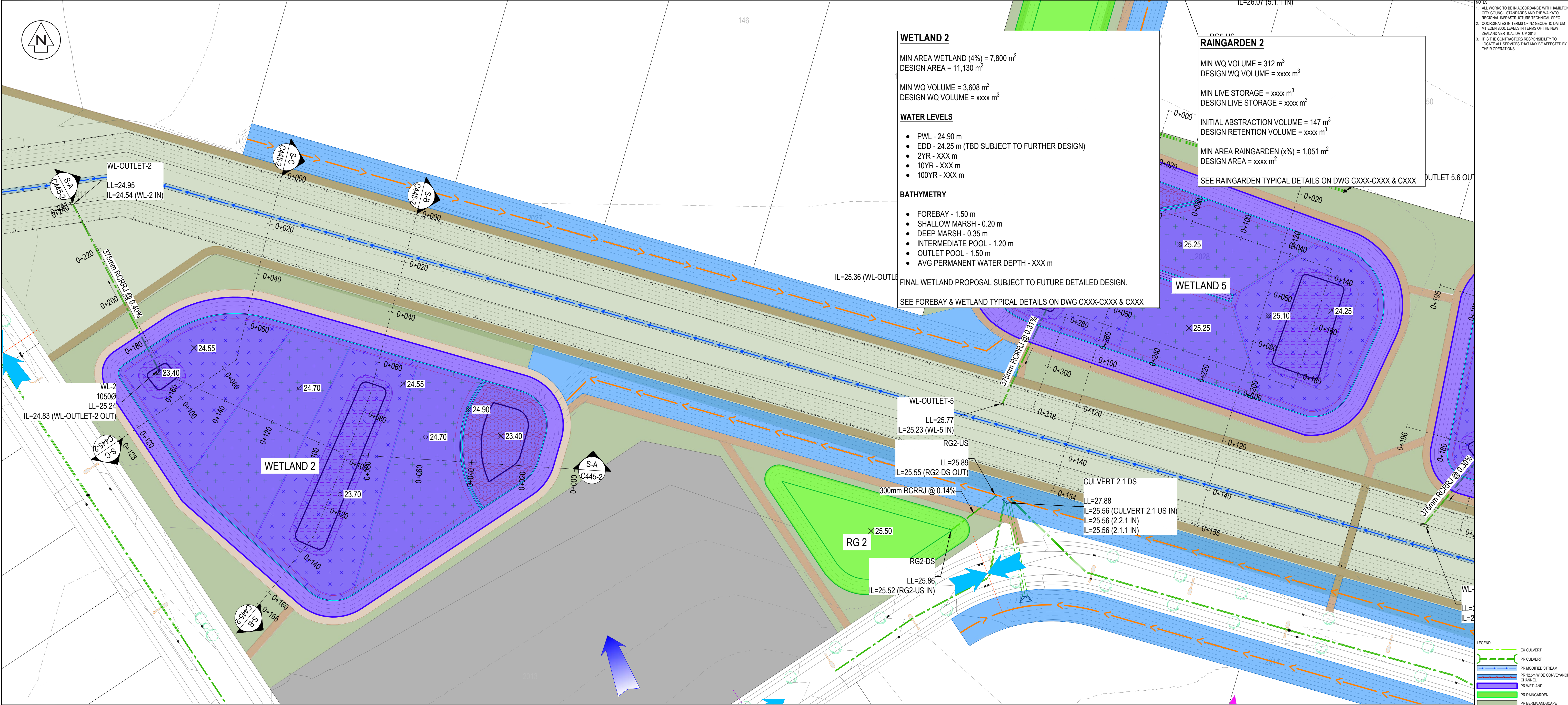
Survey: MAVEN 10/2025
Design: KY 10/2025
Drawn: KY 10/2025
Checked: RW 07/2025

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Project: PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

Title: PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 1

Project no: 180010
Scale: 1:4000 @ A1
Cad file: 180010-CAD.DWG
Drawing no: C445-1 Rev: A



WETLAND 2 - SECTION A SCALE: HORI 1:1500 VERT 1:300												
DATUM 20.00m												
EXISTING LEVELS	27.22	27.50	27.48	27.09	26.87	26.39	27.29	27.22	27.30	27.56	27.52	27.99
DESIGN LEVELS	27.12	24.13	24.49	24.70	24.55	24.55	24.70	24.55	23.71	25.83	27.07	26.99
CUT/FILL	-0.10	-3.37	-2.99	-2.39	-2.32	-1.84	-2.59	-2.67	-3.59	-1.72	-0.45	-0.99
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 2 - SECTION B SCALE: HORI 1:1500 VERT 1:300												
DATUM 20.00m												
EXISTING LEVELS	27.75	26.23	27.55	27.52	27.41	26.82	27.41	27.58	27.42	27.15	27.08	27.65
DESIGN LEVELS	27.29	24.51	27.22	24.55	23.70	23.70	23.70	24.55	27.03	26.36	27.03	27.42
CUT/FILL	-0.46	-1.73	-0.32	-2.97	-3.71	-3.12	-3.71	-3.03	-0.39	-0.78	-0.05	-0.23
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 2 - SECTION C SCALE: HORI 1:1500 VERT 1:300												
DATUM 20.00m												
EXISTING LEVELS	27.21	26.77	27.46	27.62	27.42	26.81	27.15	27.29	27.15	27.15	27.15	27.29
DESIGN LEVELS	27.19	24.41	27.15	24.55	27.42	24.55	26.81	27.15	27.15	27.15	27.15	27.29
CUT/FILL	-0.02	-2.35	-0.32	-3.07	-0.04	-2.26	-0.34	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 2

MIN AREA WETLAND (4%) = 7,800 m²
DESIGN AREA = 11,130 m²

MIN WQ VOLUME = 3,608 m³
DESIGN WQ VOLUME = xxxxx m³

WATER LEVELS

- PWL - 24.90 m
- EDD - 24.25 m (TBD SUBJECT TO FURTHER DESIGN)
- 2YR - XXX m
- 10YR - XXX m
- 100YR - XXX m

BATHYMETRY

- FOREBAY - 1.50 m
- SHALLOW MARSH - 0.20 m
- DEEP MARSH - 0.35 m
- INTERMEDIATE POOL - 1.20 m
- OUTLET POOL - 1.50 m
- AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.

SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

RAINGARDEN 2

MIN WQ VOLUME = 312 m³
DESIGN WQ VOLUME = xxxxx m³

MIN LIVE STORAGE = xxxxx m³
DESIGN LIVE STORAGE = xxxxx m³

INITIAL ABSTRACTION VOLUME = 147 m³
DESIGN RETENTION VOLUME = xxxxx m³

MIN AREA RAINGARDEN (x%) = 1,051 m²
DESIGN AREA = xxxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

WETLAND 5

- NOTES
- ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
 - COORDINATES IN TERMS OF NZ GRID DATUM 2016. ELEVATIONS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
 - IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

- LEGEND
- EX CULVERT
 - PR CULVERT
 - PR MODIFIED STREAM
 - PR 12.5m WIDE CONVEYANCE CHANNEL
 - PR WETLAND
 - PR RAINGARDEN
 - PR BERM/LANDSCAPE
 - PR FOREBAY
 - PR MARSH SHALLOW
 - PR MARSH DEEP
 - PR WETLAND POOLS
 - PR LOT SHEET FLOW
 - PR MINOR CULP
 - PR ROADING CULP DIRECTION
 - PR ROADING CREST/HIGH PT
 - PR ROADING SAG/LOW PT

A DRAFT		KY 07/2025	
Ref	Revisions	By	Date
Survey	MAVEN		10/2025
Design	KY		10/2025
Drawn	KY		10/2025
Checked	RW		07/2025



PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 2

Project no.	180010
Scale	1:4000 @ A1
Cad file	180010-CAD.DWG
Drawing no.	C445-2
Rev	A

DRAFT FOR REVIEW



- NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE HAWKATU REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
 2. COORDINATES IN TERMS OF NZ GEODETIC DATUM 1950/2000. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
 3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

RAINGARDEN 3A

MIN WQ VOLUME = 257 m³
DESIGN WQ VOLUME = xxxxx m³

MIN LIVE STORAGE = xxxxx m³
DESIGN LIVE STORAGE = xxxxx m³

INITIAL ABSTRACTION VOLUME = 121 m³
DESIGN RETENTION VOLUME = xxxxx m³

MIN AREA RAINGARDEN (x%) = 1,156 m²
DESIGN AREA = xxxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

SECTION 1
SO 577981

RAINGARDEN 3B

MIN WQ VOLUME = 258 m³
DESIGN WQ VOLUME = xxxxx m³

MIN LIVE STORAGE = xxxxx m³
DESIGN LIVE STORAGE = xxxxx m³

INITIAL ABSTRACTION VOLUME = 122 m³
DESIGN RETENTION VOLUME = xxxxx m³

MIN AREA RAINGARDEN (x%) = 870 m²
DESIGN AREA = xxxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

WETLAND 3

MIN AREA WETLAND (4%) = 7,236 m²
DESIGN AREA = 7,940 m²

MIN WQ VOLUME = 3,283 m³
DESIGN WQ VOLUME = xxxxx m³

WATER LEVELS

- PWL - 26.60 m
- EDD - 24.25 m (TBD SUBJECT TO FURTHER DESIGN)
- 2YR - XXX m
- 10YR - XXX m
- 100YR - XXX m

BATHYMETRY

- FOREBAY - 1.50 m
- SHALLOW MARSH - 0.20 m
- DEEP MARSH - 0.35 m
- INTERMEDIATE POOL - 1.20 m
- OUTLET POOL - 1.50 m
- AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.

SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

- LEGEND
- EX CULVERT
 - PR CULVERT
 - PR MODIFIED STREAM
 - PR 12.5m WIDE CONVEYANCE CHANNEL
 - PR WETLAND
 - PR RAINGARDEN
 - PR BERM/LANDSCAPE
 - PR FOREBAY
 - PR MARSH SHALLOW
 - PR MARSH DEEP
 - PR WETLAND POOLS
 - PR LOT SHEET FLOW
 - PR MINOR CULP
 - PR ROADING CULP DIRECTION
 - PR ROADING CREST/HIGH PT
 - PR ROADING SAG/LOW PT

DATUM 22.00m											
EXISTING LEVELS	28.73	28.81	28.93	28.76	28.99	29.04	29.09	29.19	28.91	29.14	29.11
DESIGN LEVELS	28.76	26.21	26.40	26.25	25.40	26.25	26.40	26.40	26.40	25.46	29.13
CUT/FILL	0.03	-2.61	-2.53	-2.51	-3.59	-2.79	-2.69	-2.79	-2.51	-3.68	-0.02
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

WETLAND 3 - SECTION A
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m											
EXISTING LEVELS	29.81	29.44	29.61	29.29	28.96	28.96	28.70	28.96	28.76	28.76	28.76
DESIGN LEVELS	28.99	26.24	26.85	26.25	25.40	25.40	26.40	26.40	26.40	26.40	26.40
CUT/FILL	-0.82	-3.20	-0.76	-3.04	-3.56	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

WETLAND 3 - SECTION C
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m											
EXISTING LEVELS	28.74	28.81	28.99	28.78	28.99	29.34	29.54	29.39	29.06	28.91	28.83
DESIGN LEVELS	28.78	25.84	26.40	26.25	26.25	25.40	26.25	26.40	26.25	26.25	26.25
CUT/FILL	0.04	-2.97	-2.59	-2.74	-2.74	-3.94	-3.29	-2.99	-2.81	-2.66	-2.58
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

WETLAND 3 - SECTION B
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m											
EXISTING LEVELS	29.46	29.25	29.09	28.86	29.08	28.90	29.02	28.76	28.76	28.76	28.76
DESIGN LEVELS	28.86	26.14	26.66	26.25	26.25	26.32	26.40	26.40	26.40	26.40	26.40
CUT/FILL	-0.60	-3.11	-0.43	-2.61	-2.83	-2.58	-2.62	-2.36	-2.36	-2.36	-2.36
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

WETLAND 3 - SECTION D
SCALE: HORI 1:1500 VERT 1:300

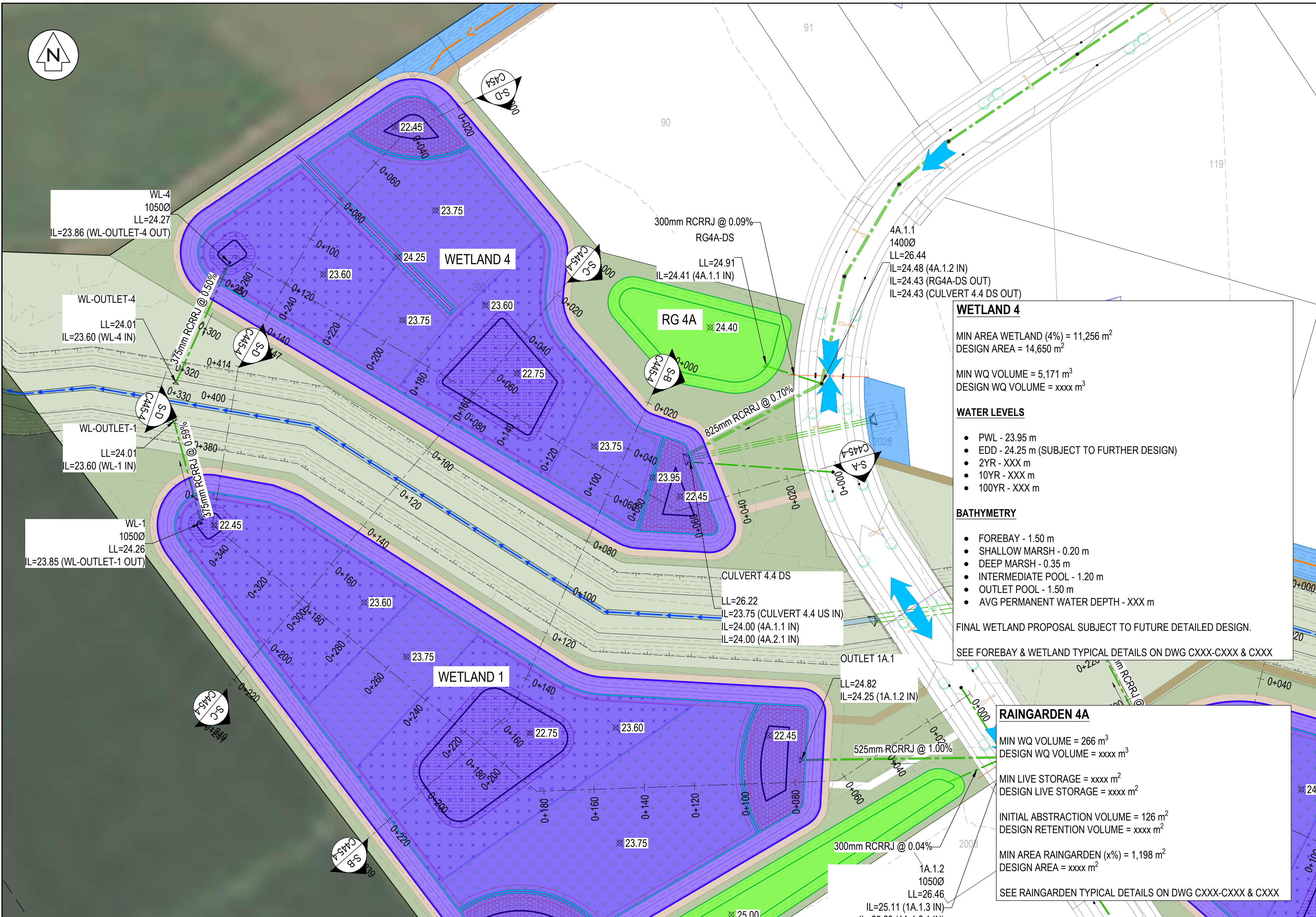
DRAFT FOR REVIEW

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Project
PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

Title
PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 3

Project no. 180010
Scale 1:4000 @ A1
Cad file 180010-CAD-003
Drawing no. C445-3 Rev A



WETLAND 4

MIN AREA WETLAND (4%) = 11,256 m²
DESIGN AREA = 14,650 m²

MIN WQ VOLUME = 5,171 m³
DESIGN WQ VOLUME = xxxx m³

WATER LEVELS

- PWL - 23.95 m
- EDD - 24.25 m (SUBJECT TO FURTHER DESIGN)
- 2YR - XXX m
- 10YR - XXX m
- 100YR - XXX m

BATHYMETRY

- FOREBAY - 1.50 m
- SHALLOW MARSH - 0.20 m
- DEEP MARSH - 0.35 m
- INTERMEDIATE POOL - 1.20 m
- OUTLET POOL - 1.50 m
- AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.
SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

RAINGARDEN 4A

MIN WQ VOLUME = 266 m³
DESIGN WQ VOLUME = xxxx m³

MIN LIVE STORAGE = xxxx m³
DESIGN LIVE STORAGE = xxxx m³

INITIAL ABSTRACTION VOLUME = 126 m³
DESIGN RETENTION VOLUME = xxxx m³

MIN AREA RAINGARDEN (x%) = 1,198 m²
DESIGN AREA = xxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

RAINGARDEN 4B

MIN WQ VOLUME = 502 m³
DESIGN WQ VOLUME = xxxx m³

MIN LIVE STORAGE = xxxx m³
DESIGN LIVE STORAGE = xxxx m³

INITIAL ABSTRACTION VOLUME = 237 m³
DESIGN RETENTION VOLUME = xxxx m³

MIN AREA RAINGARDEN (x%) = 1,354 m²
DESIGN AREA = xxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

NOTES

- ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
- COORDINATES IN TERMS OF NZ GEODETIC DATUM 1949/2000. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
- IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

LEGEND

- EX CULVERT
- PR CULVERT
- PR MODIFIED STREAM
- PR 12.5m WIDE CONVEYANCE CHANNEL
- PR WETLAND
- PR RAINGARDEN
- PR BERM/LANDSCAPE
- PR FOREBAY
- PR MARSH SHALLOW
- PR MARSH DEEP
- PR WETLAND POOLS
- PR LOT SHEET FLOW
- PR MINOR CULP
- PR ROADING CULP DIRECTION
- PR ROADING CREST/HIGH PT
- PR ROADING SAG/LOW PT

Ref	Revisions	By	Date
A	DRAFT	KY	07/2025

Survey	By	Date
MAVEN	10/2025	

Design	By	Date
KY	10/2025	

Drawn	By	Date
KY	10/2025	

Checked	By	Date
RW	07/2025	

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Project:
PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

Title:
PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 4

Project no.	180010
Scale	1:4000 @ A1
Cad file	18010-CAD.DWG
Drawing no.	C445-4
Rev	A

DATUM 20.00m												
EXISTING LEVELS	27.66	26.93	27.66	26.51	26.51	27.76	27.60	27.61	27.41	27.51	27.22	27.22
DESIGN LEVELS	26.93	26.87	26.51	26.37	27.76	27.60	27.61	27.41	27.51	27.22	27.22	27.22
CUT/FILL	-0.73	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 4 - SECTION A
SCALE: HORI 1:1500 VERT 1:300

DATUM 20.00m												
EXISTING LEVELS	27.41	27.57	27.57	27.59	27.59	27.41	27.22	26.24	27.06	27.42	27.48	27.32
DESIGN LEVELS	24.40	26.27	26.27	26.37	27.59	27.59	27.41	27.22	26.56	27.42	27.48	27.32
CUT/FILL	-3.01	-1.30	-1.30	-1.30	-1.30	-1.30	-1.30	-1.30	-0.86	-0.86	-0.86	-0.86
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 4 - SECTION B
SCALE: HORI 1:1500 VERT 1:300

DATUM 20.00m												
EXISTING LEVELS	27.56	27.52	27.46	27.39	27.44	27.03	25.50	24.79	26.49	27.02	27.27	26.66
DESIGN LEVELS	26.26	25.44	23.60	22.75	23.60	26.37	23.59	26.31	23.60	23.60	23.60	26.66
CUT/FILL	-1.31	-2.09	-3.86	-4.64	-3.84	-0.65	-1.90	1.52	-2.89	-3.42	-3.67	-0.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 4 - SECTION C
SCALE: HORI 1:1500 VERT 1:300

DATUM 20.00m												
EXISTING LEVELS	27.84	27.74	27.70	27.67	27.41	27.40	27.43	27.47	27.47	27.47	27.47	27.47
DESIGN LEVELS	26.76	26.03	22.45	23.75	24.25	23.60	23.60	26.03	26.03	26.03	26.03	26.03
CUT/FILL	-1.08	-1.72	-5.25	-3.92	-3.16	-3.80	-3.83	-1.47	-1.47	-1.47	-1.47	-1.47
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

WETLAND 4 - SECTION D
SCALE: HORI 1:1500 VERT 1:300



RAINGARDEN 5

MIN WQ VOLUME = 259 m³
DESIGN WQ VOLUME = xxxx m³

MIN LIVE STORAGE = xxxx m³
DESIGN LIVE STORAGE = xxxx m³

INITIAL ABSTRACTION VOLUME = 122 m³
DESIGN RETENTION VOLUME = xxxx m³

MIN AREA RAINGARDEN (x%) = 1,167 m²
DESIGN AREA = xxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

WETLAND 5

MIN AREA WETLAND (4%) = 8,352 m²
DESIGN AREA = 9,600 m²

MIN WQ VOLUME = 3,928 m³
DESIGN WQ VOLUME = xxxx m³

WATER LEVELS

- PWL - 25.45 m
- EDD - 24.25 m (SUBJECT TO FURTHER DESIGN)
- 2YR - XXX m
- 10YR - XXX m
- 100YR - XXX m

BATHYMETRY

- FOREBAY - 1.50 m
- SHALLOW MARSH - 0.20 m
- DEEP MARSH - 0.35 m
- INTERMEDIATE POOL - 1.20 m
- OUTLET POOL - 1.50 m
- AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.

SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

DATUM 20.00m												
EXISTING LEVELS	28.12	27.73	27.75	27.85	27.83	27.95	28.12	28.22	28.44	28.34	28.22	28.16
DESIGN LEVELS	27.96	24.87	23.95	25.25	25.83	25.25	25.25	24.94	24.25	24.40	25.10	25.62
CUT/FILL	-0.16	-2.86	-3.80	-2.60	-2.58	-2.70	-2.87	-3.28	-4.19	-3.94	-3.12	-2.53
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	317.51

WETLAND 5 - SECTION A
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m												
EXISTING LEVELS	28.05	27.85	27.86	27.85	27.97	28.03	28.19	27.74	28.14	27.64	27.74	28.14
DESIGN LEVELS	27.98	27.83	25.41	25.57	25.10	27.12	27.52	25.09	27.64	27.64	27.74	28.14
CUT/FILL	-0.07	-0.02	-2.45	-2.28	-2.87	-0.91	-0.68	-2.65	-0.51	-0.51	-0.51	-0.51
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	317.51

WETLAND 5 - SECTION B
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m												
EXISTING LEVELS	28.16	27.97	28.02	27.93	28.18	28.21	28.33	26.79	28.39	27.88	27.88	28.39
DESIGN LEVELS	28.06	27.90	25.25	25.10	25.10	25.39	27.88	25.05	27.88	27.88	27.88	28.39
CUT/FILL	-0.10	-0.07	-2.77	-2.83	-3.08	-2.82	-0.44	-1.74	-0.50	-0.50	-0.50	-0.50
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	317.51

WETLAND 5 - SECTION C
SCALE: HORI 1:1500 VERT 1:300

DRAFT FOR REVIEW

NOTES

- ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
- COORDINATES IN TERMS OF NZ GEODETIC DATUM 1983/2003. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
- IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

LEGEND

- EX CULVERT
- PR CULVERT
- PR MODIFIED STREAM
- PR 12.5m WIDE CONVEYANCE CHANNEL
- PR WETLAND
- PR RAINGARDEN
- PR BERM/LANDSCAPE
- PR FOREBAY
- PR MARSH SHALLOW
- PR MARSH DEEP
- PR WETLAND POOLS
- PR LOT SHEET FLOW
- PR MINOR CULP
- PR ROADING CULP DIRECTION
- PR ROADING CREST/HIGH PT
- PR ROADING SAG/LOW PT

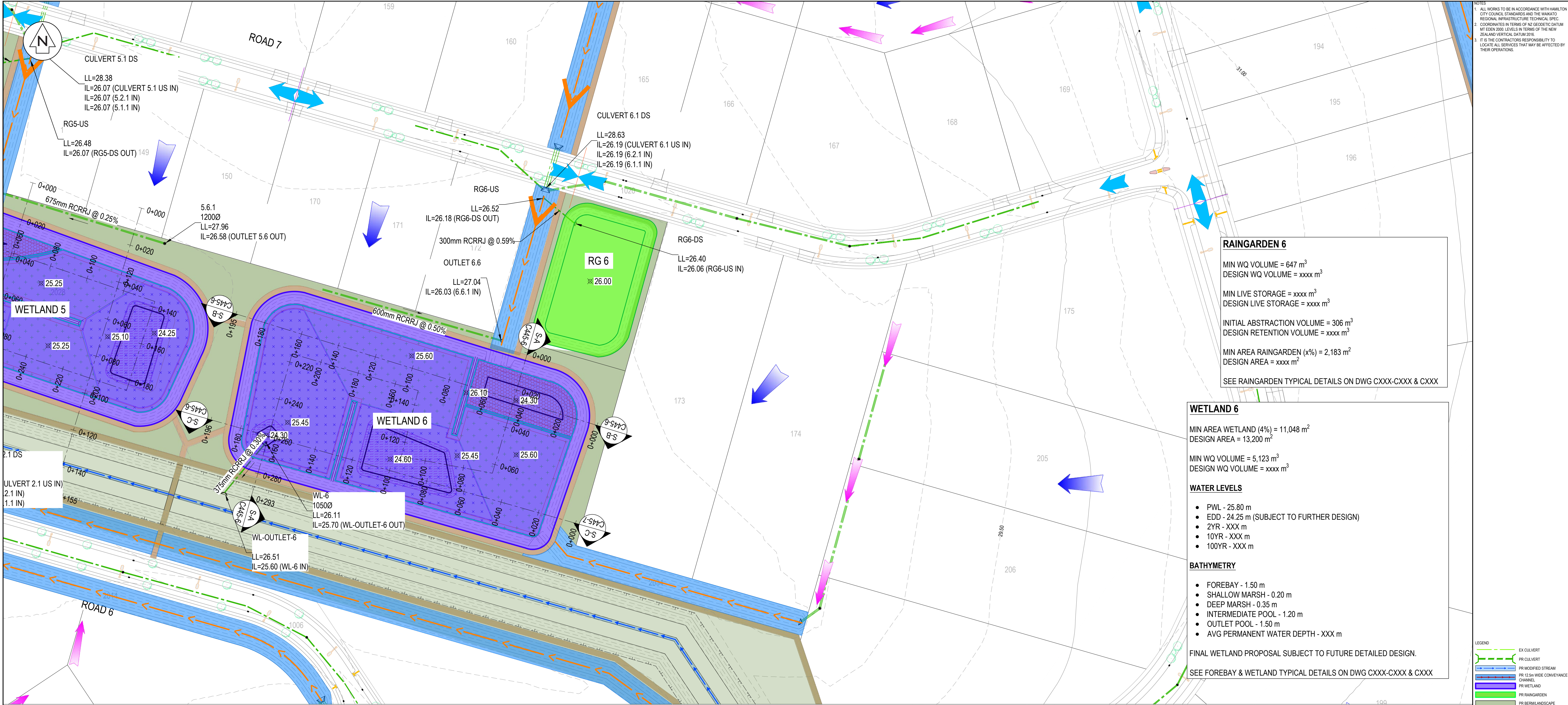
A DRAFT		KY	07/2026
Ref	Revisions	By	Date
Survey	MAVEN	10/2025	
Design	KY	10/2025	
Drawn	KY	10/2025	
Checked	RW	07/2026	

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Project
PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

Title
PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 5

Project no. 180010
Scale 1:4000 @ A1
Cad file 180010-CAD.DWG
Drawing no. C445-5 Rev A



NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH HAMILTON CITY COUNCIL STANDARDS AND THE WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPEC.
2. COORDINATES IN TERMS OF NZ GEODETIC DATUM 1983/2000. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.

RAINGARDEN 6

MIN WQ VOLUME = 647 m³
DESIGN WQ VOLUME = xxxxx m³

MIN LIVE STORAGE = xxxxx m³
DESIGN LIVE STORAGE = xxxxx m³

INITIAL ABSTRACTION VOLUME = 306 m³
DESIGN RETENTION VOLUME = xxxxx m³

MIN AREA RAINGARDEN (x%) = 2,183 m²
DESIGN AREA = xxxxx m²

SEE RAINGARDEN TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

WETLAND 6

MIN AREA WETLAND (4%) = 11,048 m²
DESIGN AREA = 13,200 m²

MIN WQ VOLUME = 5,123 m³
DESIGN WQ VOLUME = xxxxx m³

- WATER LEVELS**
- PWL - 25.80 m
 - EDD - 24.25 m (SUBJECT TO FURTHER DESIGN)
 - 2YR - XXX m
 - 10YR - XXX m
 - 100YR - XXX m

- BATHYMETRY**
- FOREBAY - 1.50 m
 - SHALLOW MARSH - 0.20 m
 - DEEP MARSH - 0.35 m
 - INTERMEDIATE POOL - 1.20 m
 - OUTLET POOL - 1.50 m
 - AVG PERMANENT WATER DEPTH - XXX m

FINAL WETLAND PROPOSAL SUBJECT TO FUTURE DETAILED DESIGN.
SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

- LEGEND**
- EX CULVERT
 - PR CULVERT
 - PR MODIFIED STREAM
 - PR 12.5m WIDE CONVEYANCE CHANNEL
 - PR WETLAND
 - PR RAINGARDEN
 - PR BERM/LANDSCAPE
 - PR FOREBAY
 - PR MARSH SHALLOW
 - PR MARSH DEEP
 - PR WETLAND POOLS
 - PR LOT SHEET FLOW
 - PR MINOR CULP
 - PR ROADING CULP DIRECTION
 - PR ROADING CREST/HIGH PT
 - PR ROADING SAGLOW PT

DATUM 22.00m											
EXISTING LEVELS	28.53	28.56	28.67	28.52	28.56	28.51	28.49	28.46	28.31	28.35	28.65
DESIGN LEVELS	28.00	24.30	25.60	25.60	24.60	24.60	25.60	25.60	25.60	25.45	26.11
CUT/FILL	-0.53	-4.26	-3.07	-2.92	-3.96	-3.91	-2.89	-2.86	-2.71	-2.90	-2.54
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

WETLAND 6 - SECTION A
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m											
EXISTING LEVELS	28.77	28.64	28.62	28.64	28.46	28.52	28.49	28.41	28.54	28.61	28.50
DESIGN LEVELS	28.21	25.60	25.60	25.45	24.60	24.60	25.45	25.45	24.90	26.30	28.04
CUT/FILL	-0.56	-3.04	-3.02	-3.19	-3.86	-3.92	-3.04	-2.96	-3.63	-2.31	-0.46
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	195.97

WETLAND 6 - SECTION C
SCALE: HORI 1:1500 VERT 1:300

DATUM 22.00m											
EXISTING LEVELS	28.45	28.60	28.62	28.41	28.31	28.25	28.27	28.35	28.33	28.47	28.57
DESIGN LEVELS	28.14	24.30	24.30	24.30	25.60	25.60	25.60	25.60	25.45	26.10	28.12
CUT/FILL	-0.31	-4.30	-4.32	-4.11	-2.71	-2.65	-2.67	-2.75	-2.88	-2.37	-0.44
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	195.40

WETLAND 6 - SECTION B
SCALE: HORI 1:1500 VERT 1:300

DRAFT FOR REVIEW

Project: PROPOSED INDUSTRIAL DEVELOPMENT AT TE KOWHAI EAST FOR TE KOWHAI EAST LIMITED PARTNERSHIP

Title: PROPOSED STORMWATER MANAGEMENT DEVICES CATCHMENT 6

Project no. 180010

Scale 1:4000 @ A1

Cad file 180010-CAD.DWG

Drawing no. C445-6

Rev A

Revisions

Ref	Revisions	By	Date
A	DRAFT	KY	07/2026

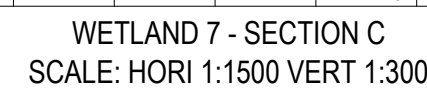
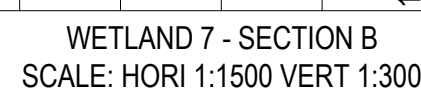
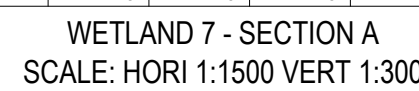
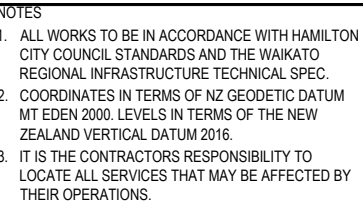
Survey: MAVEN 10/2025

Design: KY 10/2025

Drawn: KY 10/2025

Checked: RW 07/2026

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Auckland 1050



SEE FOREBAY & WETLAND TYPICAL DETAILS ON DWG CXXX-CXXX & CXXX

LEGEND

-  EX CULVERT
-  PR CULVERT
-  PR MODIFIED STREAM
-  PR 12.5m WIDE CONVEYANCE CHANNEL
-  PR WETLAND
-  PR RAINGARDEN
-  PR BERM/LANDSCAPE
-  PR FOREBAY
-  PR MARSH SHALLOW
-  PR MARSH DEEP
-  PR WETLAND POOLS
-  PR LOT SHEET FLOW
-  PR MINOR OLPF
-  PR ROADING CULP DIRECTION
-  PR ROADING CREST/HIGH PT
-  PR ROADING SAG/LOW PT

A	DRAFT	KY	07/2026
Ref	Revisions	By	Date
	By	Date	

Survey	MAVEN	10/2025
Design	KY	10/2025
Design	KY	10/2025

ROWN	KT	10/20/25
Checked	RW	07/20/26

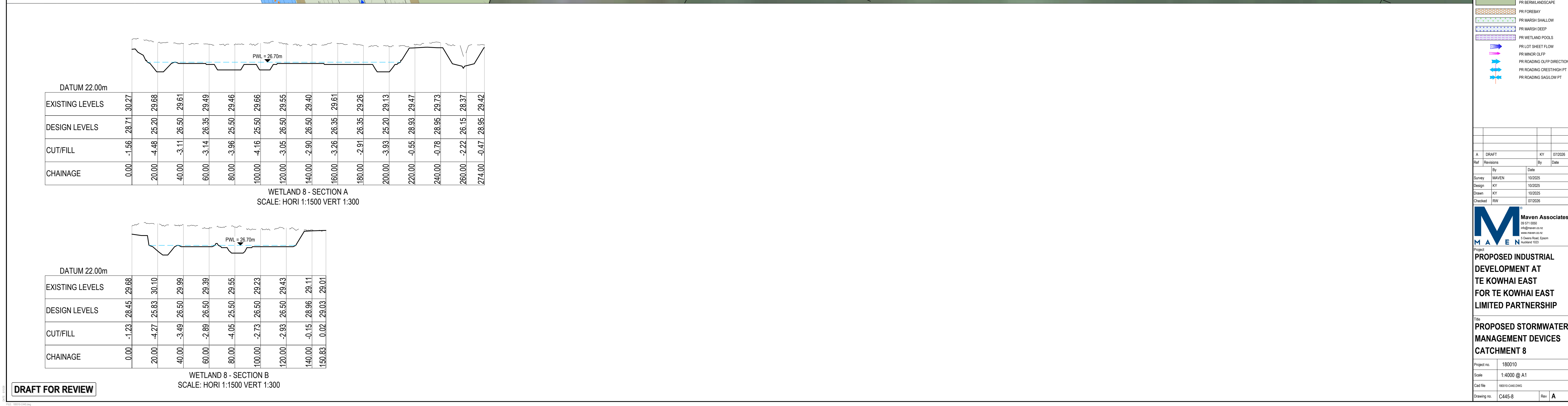
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**PROPOSED INDUSTRIAL
DEVELOPMENT AT
TE KOWHAI EAST
FOR TE KOWHAI EAST
LIMITED PARTNERSHIP**

**PROPOSED STORMWATER
MANAGEMENT DEVICES
CATCHMENT 7**

Project no.	180010
Scale	1:4000 @ A1

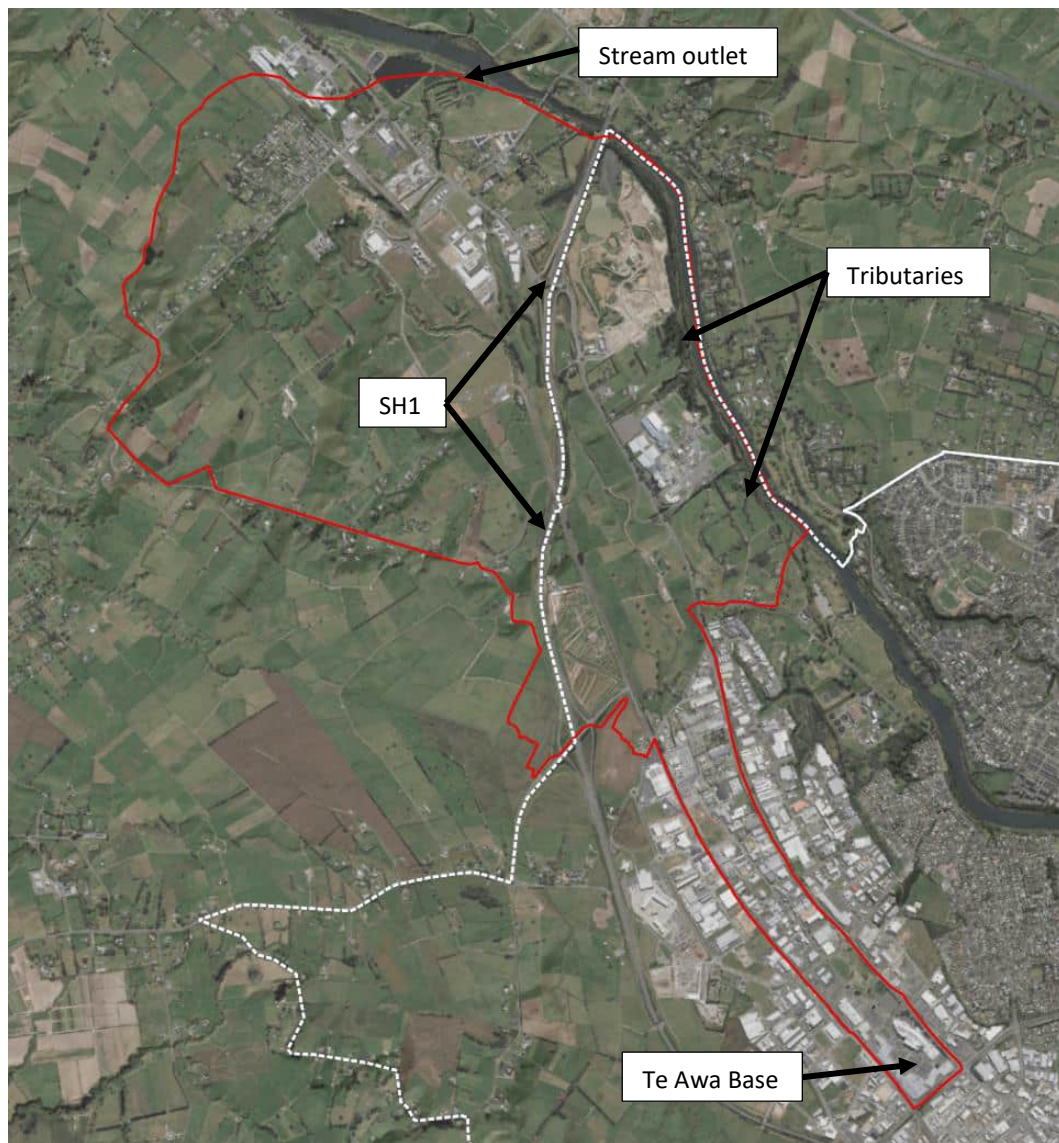
Cad file	180010-C440.DWG		
Drawing no.	C445-7	Rev	A



APPENDIX B

STORMWATER CATCHMENTS





Te Rapa North ICMP area. ICMP area shown in red, territorial boundary in white.

APPENDIX C

BOREHOLE LOGS



HAND AUGER BOREHOLE LOG - SO25-01

Client: Te Kowhai East LP
 Project: Te Kowhai East Industrial Development
 Site Location: 270 Te Kowhai Road
 Project No.: HAM2025-0116
 Date: 03/11/2025
 Borehole Location: Site Plan



Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 438614.3mE; 706154.3mN Projection: Mt Eden 2000
 Datum: NZVD2016

Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)					
	0.3	Peak = 122kPa Residual = 38kPa				CL: Silty CLAY: brown. Low plasticity. (Walton Subgroup)					
						... at 0.40m, becoming orange brown.					
	0.6	Peak = 76kPa Residual = 34kPa									
						... at 0.80m, becoming mottled light brown.					
	0.9	Peak = 110kPa Residual = 31kPa		1		... at 1.00m, becoming yellowish brown.	M	St to VSt			
	1.2	Peak = 116kPa Residual = 40kPa									
	1.6	Peak = 122kPa Residual = 33kPa									
	2.0	Peak = 90kPa Residual = 25kPa		2							
						Borehole terminated at 2.2 m					
				3							
				4							
				5							

Termination Reason:

Shear Vane No: 2993

DCP No:

Remarks: Groundwater not encountered

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 03/11/2025
Borehole Location: Site Plan



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Sheet 1 of 1

Position: 438881.4mE; 705977.6mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

Termination Reason:	
Shear Vane No: 2993	DCP No:
Remarks: Groundwater not encountered	

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - SO25-03

Client: Te Kowhai East LP
 Project: Te Kowhai East Industrial Development
 Site Location: 270 Te Kowhai Road
 Project No.: HAM2025-0116
 Date: 03/11/2025
 Borehole Location: Site Plan



Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 438276.5mE; 705885.5mN Projection: Mt Eden 2000
 Datum: NZVD2016

Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
03-11-2025	0.3	Peak = 60kPa Residual = 8kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)			2		
						ML: Clayey SILT: with trace fine sand; brown. Low plasticity. (Hinuera Formation)		St	1		
						SM: Silty Fine to coarse SAND: light brownish grey streaked light orange. Well graded (Hinuera Formation)	M		1		
								L to MD	4		
									2		
									1		
	1.0	Peak = 80kPa Residual = 18kPa		1		ML: SILT: with some fine to medium sand; light brownish grey. Low plasticity. (Hinuera Formation)		St	1		
						SW: Fine to coarse SAND: with minor silt; light greyish brown streaked light orange. Well graded. (Hinuera Formation)	S	MD to D	3		
									5		
						Borehole terminated at 1.3 m			10		
									4		
				2							
				3							
				4							
				5							

Termination Reason:

Shear Vane No: 2993 DCP No: 34

Remarks: Groundwater encountered at 1.1m

HAND AUGER BOREHOLE LOG - SO25-04

Client: Te Kowhai East LP
 Project: Te Kowhai East Industrial Development
 Site Location: 270 Te Kowhai Road
 Project No.: HAM2025-0116
 Date: 03/11/2025
 Borehole Location: Site Plan



Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 439029.4mE; 705728.3mN Projection: Mt Eden 2000
 Datum: NZVD2016

Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/ geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)			
	Depth	Type & Results										
									5	10	15	
03-11-2025 ▼	0.4	Peak = 87kPa Residual = 24kPa		1		OL: Organic SILT: dark brown. Low plasticity. (Topsoil)	M	St		1		
						2						
						1						
	1.0	Peak = 63kPa Residual = 13kPa			1							
					2							
					3							
					3							
					2							
					2							
					2							
			2									
			4									
			3									
			5									
			3									
										4		

Termination Reason:
 Shear Vane No: 2993 DCP No: 34
 Remarks: Groundwater encountered at 1.2m

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Borehole Location: Site Plan Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Survey Source: Hand Held GPS

03-11-2025

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 03/11/2025
Borehole Location: Site Plan



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Sheet 1 of 1

Position: 438388.8mE; 705574.3mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

03-11-2025

Remarks: Groundwater encountered at 0.8m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 03/11/2025
Borehole Location: Site Plan



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Sheet 1 of 1

Position: 438129.3mE; 705257.5mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

Termination Reason:			
Shear Vane No:	2993	DCP No:	34
Remarks: Groundwater encountered at 0.45m			

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

HAND AUGER BOREHOLE LOG - SO25-08

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 04/11/2025
Borehole Location: Site Plan



Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 438628.0mE; 705297.3mN Projection: Mt Eden 2000
Datum: NZVD2016 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
04-11-2025 ▼						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)	M to W	St			
	0.4	Peak = 56kPa Residual = 13kPa				ML: Clayey SILT: light greyish brown streaked orange brown. Low plasticity. (Hinuera Formation)					
	0.7	Peak = 80kPa Residual = 10kPa				SM: Silty Fine to coarse SAND: light brownish grey. Well graded. (Hinuera Formation)					
				1		Borehole terminated at 1.2 m	S	LP			
				2							
				3							
				4							
				5							

Termination Reason:
Shear Vane No: 2993 DCP No:
Remarks: Groundwater encountered at 1.0m

HAND AUGER BOREHOLE LOG - SO25-09

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 03/11/2025
Borehole Location: Site Plan



Logged by: OP Checked by: NK Scale: 1:25 Sheet 1 of 1

Position: 438206.7mE; 704852.0mN Projection: Mt Eden 2000
Datum: NZVD2016 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
03-11-2025	0.5	Peak = 102kPa Residual = 16kPa		1		Pt: Organic SILT: dark brown. Low plasticity. (Topsoil)	M	VSt	1		
						ML: Sandy SILT: greyish brown mottled orange brown streaked dark grey. Low plasticity. (Hinuera Formation)			1		
						SW: Fine to coarse SAND: greyish brown. Well graded. (Hinuera Formation)			2		
							W	MD	4		
							S		6		
Borehole terminated at 1.0 m											
				2							
				3							
				4							
				5							

Termination Reason:
Shear Vane No: 2993 DCP No: 34
Remarks: Groundwater encountered at 1.0m

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 04/11/2025
Borehole Location: Site Plan



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Sheet 1 of 1

Position: 438849.2mE; 704965.8mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

04-11-2025

Remarks: Groundwater encountered at 1.8m

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 04/11/2025
Borehole Location: Site Plan



Sheet 1 of 1

Position: 438496.2mE; 704479.5mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

Termination Reason: Target Depth Reached
Shear Vane No: 2560 DCP No:
Remarks: Groundwater encountered at 0.5m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial Development
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116
Date: 04/11/2025
Borehole Location: Site Plan



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Sheet 1 of 1

Position: 438827.3mE; 704630.6mN Projection: Mt Eden 2000
Datum: NZVD2016

Logged by: OP Checked by: NK Scale: 1:25

Survey Source: Hand Held GPS

04-11-2025

Remarks: Groundwater encountered at 1.0m

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 4 - April 2023.

BOREHOLE LOG - MH25-01

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 27/01/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 4

Position: 438879.1mE; 705981.8mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000			>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
		1.5	Peak = 134kPa Residual = 43kPa		1		OL: Organic SILT: Dark brown. Low plasticity. (Topsoil) CH: Silty CLAY: Light brown. High plasticity, moderately sensitive. (Hamilton Ash)		F							100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-01

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 27/01/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 2 of 4

Position: 438879.1mE; 705981.8mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
		Depth	Type & Results							RS	CW	HW	MW	SW			UW	EW	W	MS	S	VS	ES	<20	20-60	60-200			200-600	600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
		6.0 6.0	Peak = 85kPa Residual = 14kPa SPT: N* = 0 (1, 0 / 0, 0, 0, 0)		6		ML: Clayey SILT with trace sand: Light greyish brown, mottled reddish brown. Low plasticity, extra sensitive to quick; sand, fine. (Puketoka Formation)								83																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-01

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 27/01/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 3 of 4

Position: 438879.1mE; 705981.8mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities; Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks			
		Depth	Type & Results							RS	CW	HW	MW	SW			UW	EW	W	MS	S	VS	ES	<20	20-60	60-200			200-600	600-2000	>2000
		10.5 10.5	Peak = 17kPa SPT: N* = 0 (0, 0 / 0, 0, 0, 0)		11										100																
		12.0 12.0	Peak = 14kPa SPT: N* = 0 (0, 0 / 0, 0, 0, 0)		12										100																
		13.5 13.5	Peak = 6kPa SPT: N* = 19 (1, 0 / 5, 4, 6, 4)		13										100																
					14										100																
							SM: Fine SAND: Light brownish grey. Uniformly graded. (Walton Subgroup)	M	MD						81																
		15.0	SPT: N* = 34 (8, 6 / 6, 7, 9, 12)		15																										14.8-15.0m: Core loss

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-01

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 27/01/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 4 of 4

Position: 438879.1mE; 705981.8mN Projection: Mt Eden 2000
Datum: NZVD 2016

Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
		Depth	Type & Results							RS	CW	HW	MW	SW			UW	FW	LV	W	MS	S	VS	ES	<20	20-60			60-200	200-600	600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-02

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 03/02/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 4

Position: 438593.1mE; 706190.6mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000			>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							OL: Organic SILT: Dark brown. Low plasticity. (Topsoil)	M																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

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Sheet 2 of 4

Survey Source: Handheld GPS

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

BOREHOLE LOG - MH25-02

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 03/02/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 3 of 4

Position: 438593.1mE; 706190.6mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
		Depth	Type & Results							RS	CW	HW	MW	SW			UW	EW	W	MS	S	VS	ES	<20	20-60	60-200			200-600	600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
		10.5 10.5	Peak = 100kPa Residual = 14kPa SPT: N* = 7 (2, 2 / 2, 2, 2, 1)		11		CH: Silty CLAY: Light brown. High plasticity. (Kauroa Ashes)		VSt																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-02

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 03/02/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 4 of 4

Position: 438593.1mE; 706190.6mN Projection: Mt Eden 2000
Datum: NZVD 2016

Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
		Depth	Type & Results							RS	CW	HW	MW	SW			UW	FW	LV	W	MS	S	VS	ES	<20	20-60			60-200	200-600	600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
							SM: Fine SAND with trace silt; Light grey mottled yellowish brown. Uniformly graded. (Walton Subgroup)								89																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

Termination Reason: Target Depth Reached.
Shear Vane No: 2532 DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-03

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 05/02/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 2

Position: 439980.5mE; 705718.3mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering					Recovery	RQD	Estimated Strength					Defect Spacing (mm)	Drilling Method/Support	Structure & Other Observations
		Depth	Type & Results							RS	CW	HW	MW	SW	UW		EW	W	MS	S	VS			
							Pt: PEAT: Black. Low plasticity, contains rootlets. (Hinuera Formation)																	
							OL: Organic SILT: Dark brown. Low plasticity. (Hinuera Formation)																	
					1		ML: Sandy SILT: Brown. Low plasticity; sand, fine. (Hinuera Formation)	M	F							67								
		1.5	SPT: N* = 7 (0, 1 / 1, 1, 2, 3)				SM: Fine SAND with trace silt: Light grey, mottled yellowish brown. Uniformly graded. (Hinuera Formation)		L							100								
					2		ML: SILT with trace sand: Light grey. Low plasticity; sand, fine. (Hinuera Formation)		S															
							OL: Organic SILT: Dark brown. Low plasticity. (Hinuera Formation)		S							100								
							SW: Fine SAND: Grey. Well graded. (Hinuera Formation)																	
		3.0	SPT: N* = 9 (0, 0 / 1, 3, 2, 3)		3											89								
							ML: SILT with trace sand: Light grey. Low plasticity; sand, fine. (Hinuera Formation)																	
							SM: Silty SAND: Grey. Uniformly graded. (Hinuera Formation)																	
							SW: Medium to coarse SAND with trace gravel: Light grey. Well graded; gravel, fine, pumiceous. (Hinuera Formation)									81								
					4		SM: Fine SAND with trace silt: Grey. Well graded. (Hinuera Formation)																	
		4.5	SPT: N* = 14 (2, 2 / 2, 3, 4, 5)													84								
					5																			

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-03

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 05/02/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 2 of 2

Position: 439980.5mE; 705718.3mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering						Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results							RS	CW	HW	MW	SW	UW			EW	W	MS	S	VS	ES	<20	20-60	60-200	200-600		
		6.0	SPT: N* = 23 (4, 5 / 5, 5, 6, 7)		6		SM: Fine SAND with trace silt: Grey. Well graded. (Hinuera Formation)								100														
							SW: Medium to coarse SAND with trace fine gravel: Light grey. Well graded; gravel, fine, pumiceous. (Hinuera Formation)									82													
		7.5	SPT: N* = 4 (0, 0 / 1, 0, 1, 2)		7		SW: Fine SAND: Grey. Uniformly graded. (Hinuera Formation)	M							74														
					8		OL: Organic SILT: Dark grey. Low plasticity. (Hinuera Formation)																						
							ML: SILT with trace sand: Light grey. Low plasticity. (Hinuera Formation)																						
							SW: Fine SAND: Grey. Uniformly graded. (Hinuera Formation)									100													
							SW: Fine to medium SAND with trace gravel: Light grey. Well graded; gravel, fine, pumiceous. (Hinuera Formation)																						
							SM: Fine SAND with trace silt: Grey. Uniformly graded. (Hinuera Formation)																						
		9.0	SPT: N* = 10 (4, 3 / 3, 1, 2, 4)		9		ML: SILT with trace sand: Light grey. Low plasticity; sand, fine. (Hinuera Formation)								98														
							Borehole terminated at 9.45 m																						
					10																								

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-04

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 28/01/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 2

Position: 439140.5mE; 705158.8mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)							Drilling Method/ Support	Structure & Other Observations Discontinuities; Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			SW	W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							OL: Organic SILT: Dark brown. Low plasticity. (Topsoil)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 28/01/2026



Sheet 2 of 2

Datum: NZVD 2016

Survey Source: Handheld GPS

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

BOREHOLE LOG - MH25-05

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 29/01/2026
Borehole Location: Refer to Site Plan



Logged by: LM Checked by: AS Scale: 1:25 Sheet 1 of 2

Position: 438953.0mE; 704832.4mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering						Recovery	RQD	Estimated Strength						Defect Spacing (mm)	Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results							RS	CW	HW	MW	SW	UW			EW	W	MS	S	VS	ES			
							OL: Organic SILT: Dark brown Low plasticity. (Topsoil)																			
							ML: SILT: Brown. Low plasticity. (Uncontrolled Fill)																			
							ML: Clayey SILT: Light brown, mottled grey and orange brown. Low plasticity. (Hinuera Formation)		St							91										
		1.5	SPT: N* = 18 (5, 4 / 4, 4, 5, 5)		1		SW: Fine to medium SAND: Brown. Well graded. (Hinuera Formation)		D to M							96										
					2		SW: Fine to medium SAND: Brownish grey. Well graded. (Hinuera Formation)									63										
		3.0	SPT: N* = 6 (1, 0 / 1, 2, 2, 1)		3		SW: Fine SAND: Light grey. Uniformly graded. (Hinuera Formation)									100										
							SM: Silty Fine to coarse SAND: Grey. Well graded. (Hinuera Formation)																			
									M to W							91										
		4.5	SPT: N* = 12 (1, 1 / 2, 3, 3, 4)													100										
					5																					

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 29/01/2026



Sheet 2 of 2

Datum: NZVD 2016

Survey Source: Handheld GPS

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

BOREHOLE LOG - MH25-06

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 30/01/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 2

Position: 438312.8mE; 704547.0mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering						Recovery	RQD	Estimated Strength						Defect Spacing (mm)	Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results							RS	CW	HW	MW	SW	UW			EW	W	MS	S	VS	ES			
							OL: Organic SILT: Dark brown. Low plasticity, contains rootlets. (Topsoil)																			
							ML: Sandy SILT: Light greyish brown. Low plasticity; sand, fine. (Hinuera Formation)	M	F																	
							SM: Silty fine SAND: Light grey. Well graded. (Hinuera Formation)									100										
		1.5	SPT: N* = 16 (2, 3 / 4, 3, 4, 5)		1		GW: Medium to coarse GRAVEL with some sand: Greyish brown. Uniformly graded, subangular, pumiceous; sand, fine to medium. (Hinuera Formation)																			
					2											100										
					3			L to MD								57										
		3.0	SPT: N* = 6 (2, 3 / 2, 1, 1, 2)													84										
					4		SW: Medium to coarse SAND with minor gravel: Light grey. Well graded; gravel, fine to medium. (Hinuera Formation)									90										
		4.5	SPT: N* = 13 (1, 2 / 3, 4, 3, 3)													93										
					5																					

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-06

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 30/01/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 2 of 2

Position: 438312.8mE; 704547.0mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000			>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
		6.0	SPT: N* = 13 (0, 1 / 2, 2, 3, 6)		6	SW: Medium to coarse SAND with minor gravel: Light grey. Well graded; gravel, fine to medium. (Hinuera Formation) OL: Organic SILT: Dark brown. Low plasticity. (Hinuera Formation) SW: Medium to coarse SAND with minor gravel: Dark grey. Well graded; gravel, fine, pumicious. (Hinuera Formation)			S							90																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

BOREHOLE LOG - MH25-07

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 02/02/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 2

Position: 437702.7mE; 705346.2mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000			>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
		1.5	SPT: N* = 3 (1, 0 / 0, 1, 1, 1)		1		OL: Organic SILT: Dark brown. Low plasticity. (Topsoil)	M	L																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

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Sheet 2 of 2

Survey Source: Handheld GPS

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered. Piezometer installed.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

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Sheet 1 of 2

Survey Source: Handheld GPS

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

BOREHOLE LOG - MH25-08

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 02/02/2026
Borehole Location: Refer to Site Plan



Logged by: PT Checked by: AS Scale: 1:25 Sheet 2 of 2

Position: 440801.8mE; 704495.1mN Projection: Mt Eden 2000 Datum: NZVD 2016 Survey Source: Handheld GPS

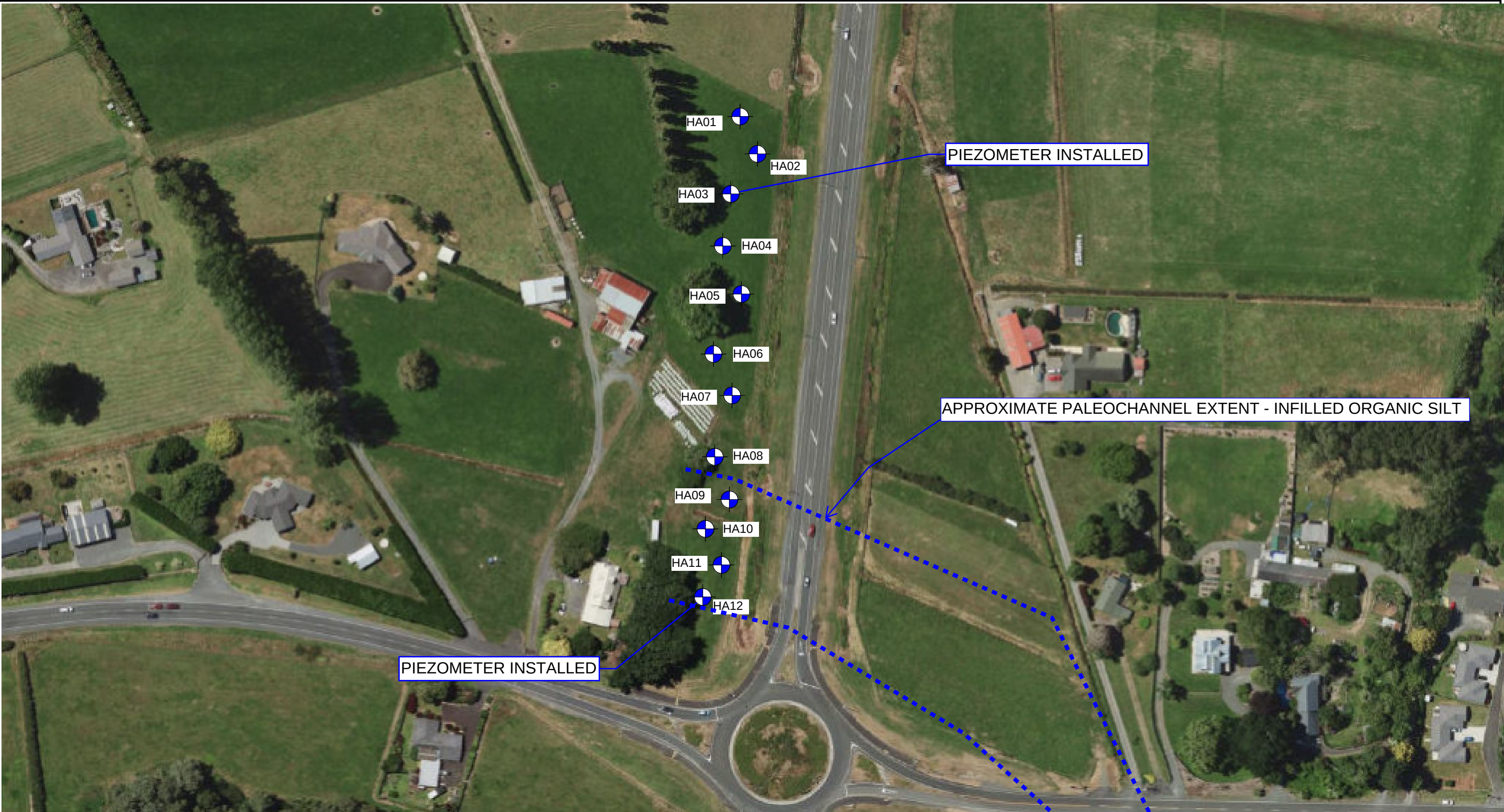
Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/ Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			W	MS	S	VS	ES	<20	20-60	60-200	200-600	600-2000		
		6.0	SPT: N* = 20 (3, 3 / 2, 4, 6, 8)		6	ML: SILT with trace sand: Light grey Low plasticity; sand, fine. (Hinuera Formation) OL: Organic SILT: Dark brown. Low plasticity. (Hinuera Formation) ML: Sandy SILT: Light grey. Low plasticity; sand, fine (Hinuera Formation) SW: Fine to medium SAND: Light grey. Well graded. (Hinuera Formation)		S								100														
		7.5	SPT: N* = 24 (2, 1 / 4, 4, 7, 9)		7	ML: SILT with trace sand: Light grey Low plasticity; sand, fine. (Hinuera Formation) SW: Fine to medium SAND: Light grey. Well graded. (Hinuera Formation) ... from 7.40m to 7.50m, Becoming grey, mottled dark grey.		S								100														
		9.0	SPT: N* = 22 (2, 1 / 2, 6, 6, 8)		8	SW: Medium to coarse SAND: with some fine to medium pumicous gravels. Grey. Well graded. (Hinuera Formation)		MD								58														
					9											100														
					10		Borehole terminated at 9.45 m									80														

Termination Reason: Target Depth Reached.
Shear Vane No: DCP No:
Remarks: Groundwater encountered at 1.5m Piezometer installed.

APPENDIX D

MUDFISH WETLAND INVESTIGATION





LEGEND:
 HA01 HAND AUGER (HA) LOCATION

 CMW Geosciences Great People Practical Solutions	CLIENT:	TE KOWHAI EAST LP		DRAWN:	PT	PROJECT:	HAM2025-0116
	PROJECT:	TE KOWHAI EAST INDUSTRIAL DEVELOPMENT, KOURA DRIVE, TE KOWHAI		CHECKED:		DRAWING:	
	TITLE:	SITE INVESTIGATION PLAN		REVISION:	A	SCALE:	NTS
				DATE:	09/06/2026	SHEET:	A3

HAND AUGER BOREHOLE LOG - SWALE HA01

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026
Borehole Location: Refer to Site Plan



CMW Geosciences
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Logged by: OP Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438885.7mE; 704627.2mN Projection: Mt Eden 2000 Survey Source: Hand-held GPS
Elevation: m Datum: NZVD2016

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results									
									5	10	15
04-06-2026 						OL: Organic SILT: dark brown. Low plasticity. (Topsoil)					
	0.3	Peak = 124kPa Residual = 22kPa				ML: SILT with trace sand: light greyish brown streaked light orange. Low plasticity. Moderately sensitive to sensitive: Sand, fine. (Hinuera Formation)	M	VSt to H			
	0.6	Peak = 101kPa Residual = 24kPa									
	0.9	Peak = 207kPa									
	1.2	Peak = 124kPa Residual = 24kPa		1		S					
	1.5	Peak = 163kPa Residual = 44kPa									
	1.8	Peak = UTP									
						... at 1.50m, minimal sample recovery.					
						... at 1.60m, becoming grey.					
						SM: Silty Fine to coarse SAND: greyish brown. Well graded. (Hinuera Formation)		TP			
						Borehole terminated at 2.0 m					

Termination Reason: Hole collapse.
Shear Vane No: 2993 DCP No:
Remarks: Groundwater encountered at 1.2m.

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Sheet 1 of 1

Survey Source: Hand-held GPS

Datum: NZVD 2016

Remarks: Groundwater encountered at 1.1m

HAND AUGER BOREHOLE LOG - SWALE HA03

Client: Te Kowhai East LP
 Project: Te Kowhai East Industrial
 Site Location: 270 Te Kowhai Road
 Project No.: HAM2025-0116A
 Date: 04/06/2026



Borehole Location: Refer to Site Plan Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438888.3mE; 704606.0mN Projection: Mt Eden 2000
 Datum: NZVD2016

Survey Source: Hand-held GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Recovery	Drilling Method/Support	Dynamic Cone Penetrometer (Blows/100mm)			Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results									5	10	15	
		0.3	Peak = 142kPa Residual = 35kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)								
		0.6	Peak = 177kPa Residual = 31kPa				ML: SILT with minor sand : light brownish grey. Low plasticity. Sensitive: Sand, fine. (Hinuera Formation)	D to M							
		0.9	Peak = >200kPa				ML: Sandy SILT: light grey. Low plasticity. Sensitive: Sand, fine. (Hinuera Formation)	VSt to H							
							ML: SILT with trace sand : light grey streaked orange. Low plasticity: Sand, fine. (Hinuera Formation)	M							
							SM: Silty Fine to coarse SAND: greyish brown. Well graded. (Hinuera Formation) ... from 1.20m to 1.25m, band of SILT.	S	MD to D						9
							... at 1.50m, no sample recovery.								5
															5
															5
															5
															6
							Borehole terminated at 1.7 m								
					2										
					3										
					4										
					5										

Termination Reason: Hole collapse.

Shear Vane No: 2993 DCP No: 27

Remarks: Groundwater encountered at 1.08m. Piezometer installed.

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Sheet 1 of 1

Survey Source: Hand-held GPS

Datum: NZVD 2016

Remarks: Groundwater encountered at 1.5m.

HAND AUGER BOREHOLE LOG - SWALE HA05

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026
Borehole Location: Refer to Site Plan



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Logged by: OP Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438885.4mE; 704564.3mN Projection: Mt Eden 2000 Survey Source: Hand-held GPS
Elevation: m Datum: NZVD2016

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
04-06-2026	0.3	Peak = 127kPa Residual = 27kPa				OL: Organic SILT: dark brown. Low plasticity. (Topsoil)					
	0.6	Peak = 121kPa Residual = 25kPa				ML: SILT with trace sand: light greyish brown streaked light orange. Low plasticity. Sensitive; Sand, fine. (Hinuera Formation)					
	0.9	Peak = 126kPa Residual = 27kPa					M				
	1.2	Peak = 170kPa Residual = 30kPa		1				VSt			
	1.5	Peak = 180kPa Residual = 27kPa									
				2		SM: Silty Fine to coarse SAND: greyish brown. Well graded. (Hinuera Formation)	S	MD to D	5	7	9
									11		
									12		
						Borehole terminated at 2.3 m					
				3							
				4							
				5							

Termination Reason: Hole collapse.
Shear Vane No: 2993 DCP No: 27
Remarks: Groundwater encountered at 1.7m.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026



Sheet 1 of 1

Survey Source: Hand-held GPS

Remarks: Ground water encountered at 2.1m

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Borehole Location: Refer to Site Plan Logged by: OP Checked by: AS Scale: 1:25 Sheet 1 of 1

Survey Source: Hand-held GPS

04-06-2026

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 5 - August 2024.

HAND AUGER BOREHOLE LOG - SWALE HA08

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026
Borehole Location: Refer to Site Plan



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Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438951.9mE; 704459.1mN Projection: Mount Eden 2000 Survey Source: Hand-held GPS
Elevation: m Datum: NZVD 2016

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results									
									5	10	15
	0.4	Peak = 218kPa		1		OL: Organic SILT: Dark brown Low plasticity. (Topsoil)	D to M	VSt to H			
	0.7	Peak = 93kPa Residual = 19kPa				ML: Clayey SILT: with some medium to coarse gravel. Dark greyish brown Low plasticity. (Uncontrolled Fill)					
	1.0	Peak = 112kPa Residual = 31kPa									
	1.3	Peak = UTP									
	Borehole terminated at 1.5 m										
				2							
				3							
				4							
				5							

Termination Reason: Refusal at 1.5m on gravel
Shear Vane No: 1911 DCP No:
Remarks: Groundwater not encountered

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Position: 438841.4mE; 704453.6mN	Projection: Mt Eden 2000	
Elevation: m	Datum: NZVD2016	Survey Source: Hand-held GPS

Termination Reason: Refusal on dense sand.
Shear Vane No: 2993 DCP No: 27
Remarks: Groundwater encountered at 0.9m.

HAND AUGER BOREHOLE LOG - SWALE HA10

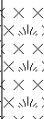
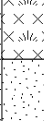
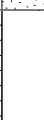
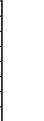
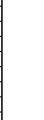
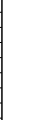
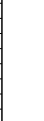
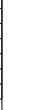
Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026
Borehole Location: Refer to Site Plan



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Logged by: PT Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438935.9mE; 704555.1mN Projection: Mount Eden 2000 Survey Source: Hand-held GPS
Elevation: m Datum: NZVD2016

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							51015		
	0.4	Peak = 53kPa Residual = 16kPa				OL: Organic SILT: Dark brown Low plasticity. (Topsoil)	M to W				
	0.7	Peak = 28kPa Residual = 12kPa				OL: Organic SILT: Dark grey High plasticity. Moderately sensitive. (Holocene Alluvium)					
	1.0	Peak = 12kPa Residual = 6kPa		1							
	1.3	Peak = 28kPa Residual = 12kPa				... from 1.20m to 1.90m, No recovery	S to F				
	1.6	Peak = 65kPa Residual = 25kPa									
											
				2		SW: Medium to coarse SAND: Dark grey. Well graded. (Hinuera Formation)	S				
											
											
								L to MD			
											
											
											
						Borehole terminated at 2.6 m					
				3							
				4							
				5							

Termination Reason: Hole collapse at 2.6m
Shear Vane No: 1911 DCP No: 27
Remarks: Groundwater encountered at 1.

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026



Sheet 1 of 1

Survey Source: Hand-held GPS

04-06-2026

Remarks: Groundwater encountered at 0.8m.

HAND AUGER BOREHOLE LOG - SWALE HA12

Client: Te Kowhai East LP
Project: Te Kowhai East Industrial
Site Location: 270 Te Kowhai Road
Project No.: HAM2025-0116A
Date: 04/06/2026



Borehole Location: Refer to Site Plan Logged by: OP Checked by: AS Scale: 1:25 Sheet 1 of 1

Position: 438839.5mE; 704456.9mN

Projection: Mt Eden 2000

Datum: NZVD2016

Survey Source: Hand-held GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Recovery	Drilling Method/ Support	Dynamic Cone Penetrometer (Blows/100mm)			Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
		Depth	Type & Results									5	10	15																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
		0.4	Peak = 92kPa Residual = 18kPa		0.4		OL: Organic SILT with minor gravel: dark brown. Low plasticity: Gravel, fine to medium, angular. (Topsoil)	M	St		HA		2																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
															0.8	Peak = 41kPa Residual = 6kPa	0.8		OL: Organic SILT with minor gravel: dark brown. Low plasticity. (Holocene Alluvium)	F	2	1	1	1	1	2	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																
																												1.2	Peak = 83kPa Residual = 24kPa	1.2		ML: SILT with minor sand: light brownish grey. Low plasticity. Sensitive; Sand, fine to medium. (Hinuera Formation)	S	4	3	3	6	7	4	6	7	9																																																																																																																																																																																																																																																																																																																																																																																																																																																	
																																											2.1	Borehole terminated at 2.1 m																																																																																																																																																																																																																																																																																																																																																																																																																																															

APPENDIX E

HYDRAULIC TEST ANALYSIS





CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-01 Falling Head Permeability Test**

DESIGNER: **OP**

CHECKED: **NK**

REVISION: **0**

DATE: **5/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

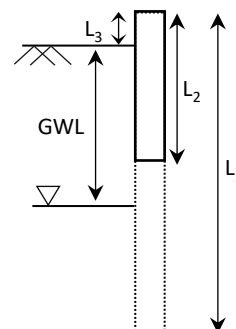
Length L_1 : **2.15** m
 Diameter: **100** mm
 Non-Perm L_2 : **0** m
 Above Gnd L_3 : **0** m

Ground Conditions

GWL: **3.00** m BGL (Blank = Bottom of hole)

Permeability Anisotropy
 m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **3.00** m BGL



Hydraulic Conductivity (k)

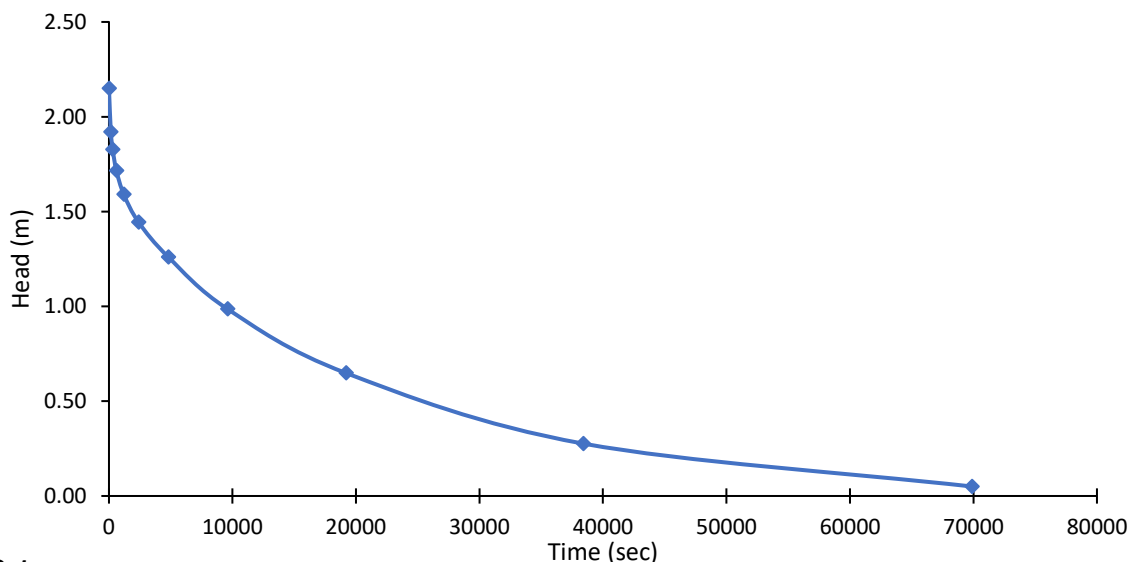
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 3.71\text{E-}06 \text{ ms}^{-1} = 0.32 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 4.93\text{E-}07 \text{ ms}^{-1} = 0.04 \text{ m/day}$$



STRATIGRAPHIC LOG

Clay

EOH @ 2.15m

Data

Time (sec)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	2.150	2.035	1.71E-06	1.60E-05
150	0.230	1.920	1.874	7.99E-07	6.99E-06
300	0.323	1.828	1.772	5.27E-07	4.43E-06
600	0.434	1.716	1.654	3.34E-07	2.67E-06
1200	0.559	1.591	1.517	2.28E-07	1.70E-06
2400	0.706	1.444	1.352	1.72E-07	1.19E-06
4800	0.889	1.261	1.123	1.77E-07	1.07E-06
9600	1.164	0.986	0.817	1.87E-07	9.18E-07
19200	1.502	0.648	0.462	2.68E-07	9.62E-07
38400	1.874	0.276	0.163	5.26E-07	1.19E-06
69891	2.100	0.050			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT:	Te Kowhai East LP	DESIGNER:	NK
PROJECT:	Te Kowhai East Industrial Development	CHECKED:	AS
		REVISION:	0
TITLE:	SO25-02 Falling Head Permeability Test	DATE:	6/11/2025
		PROJECT:	HAM2025-0116

Specifications - Open-Ended Tube

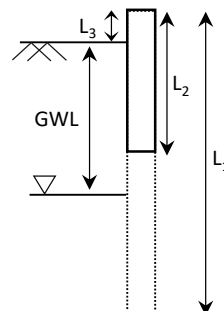
Length L_1 : 2 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

Ground Conditions

GWL: m BGL (Blank = Bottom of hole)

Permeability Anisotropy
 $m = \sqrt{k_h/k_v}$
 m : 1

Bottom of Test Hole: 2.00 m BGL



Hydraulic Conductivity (k)

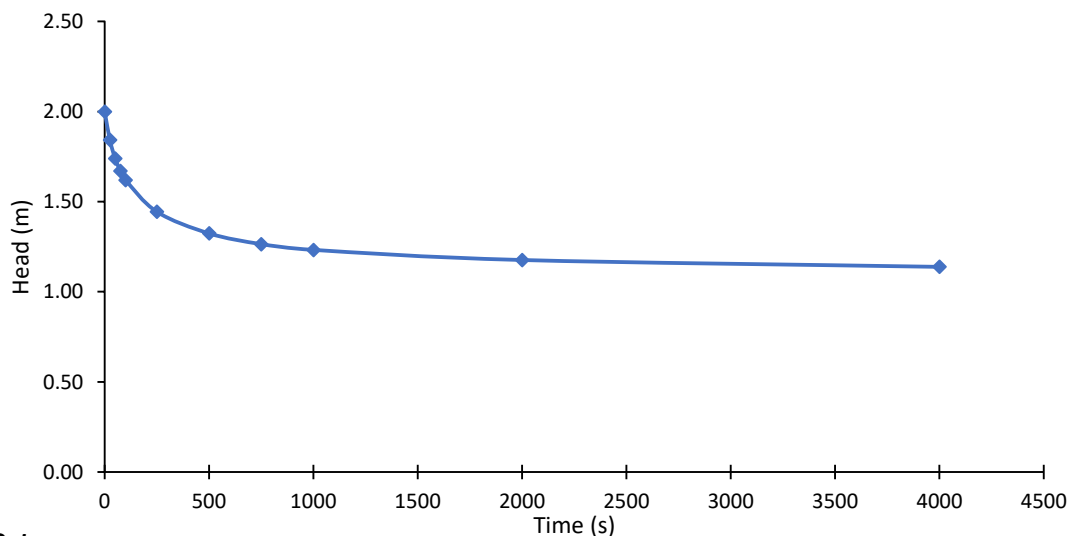
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 1.89\text{E-}05 \text{ ms}^{-1} = 1.63 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 2.11\text{E-}06 \text{ ms}^{-1} = 0.18 \text{ m/day}$$



STRATIGRAPHIC LOG

Clay

EOH @ 2m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	2.000				
25	0.158	1.842	1.921		6.53E-06	6.31E-05
50	0.260	1.740	1.791		4.74E-06	4.34E-05
75	0.329	1.671	1.705		3.50E-06	3.09E-05
100	0.380	1.620	1.645		2.71E-06	2.33E-05
250	0.556	1.444	1.532		1.79E-06	1.46E-05
500	0.676	1.324	1.384		8.70E-07	6.57E-06
750	0.736	1.264	1.294		4.84E-07	3.48E-06
1000	0.768	1.232	1.248		2.76E-07	1.93E-06
2000	0.824	1.176	1.204		1.29E-07	8.80E-07
4000	0.862	1.138	1.157		4.68E-08	3.10E-07

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-03 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : **1.3 m**
 Diameter: **90 mm**
 Non-Perm L_2 : **0 m**
 Above Gnd L_3 : **0 m**

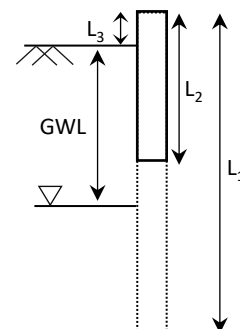
Ground Conditions

GWL: **1.1 m BGL** (Blank = Bottom of hole)

Permeability Anisotropy

m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **1.30 m BGL**



Hydraulic Conductivity (k)

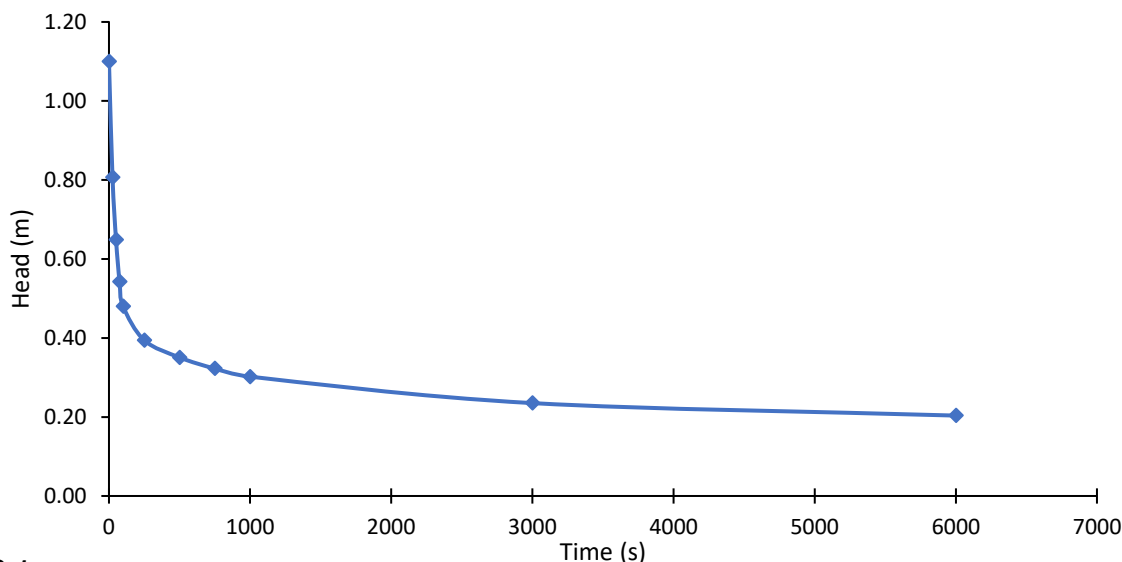
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 6.60\text{E-}05 \text{ ms}^{-1} = 5.70 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 1.21\text{E-}05 \text{ ms}^{-1} = 1.05 \text{ m/day}$$



STRATIGRAPHIC LOG

	Silt
	Sand
	Sandy Silt
EOH @ 1.3m	

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.100	1.153	3.53E-05	2.35E-04
25	0.293	0.807	0.928	2.88E-05	1.62E-04
50	0.451	0.649	0.796	2.62E-05	1.31E-04
75	0.558	0.542	0.711	1.93E-05	8.81E-05
100	0.620	0.480	0.637	5.54E-06	2.34E-05
250	0.706	0.394	0.572	2.11E-06	8.17E-06
500	0.749	0.351	0.537	1.57E-06	5.79E-06
750	0.778	0.323	0.512	1.26E-06	4.47E-06
1000	0.798	0.302	0.469	6.37E-07	2.12E-06
3000	0.865	0.235	0.419	2.61E-07	7.82E-07
6000	0.897	0.204			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-04 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : **1.3 m**
 Diameter: **90 mm**
 Non-Perm L_2 : **0 m**
 Above Gnd L_3 : **0 m**

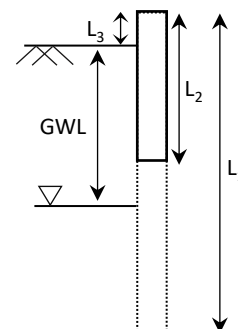
Ground Conditions

GWL: **1.2 m BGL** (Blank = Bottom of hole)

Permeability Anisotropy

m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **1.30 m BGL**



Hydraulic Conductivity (k)

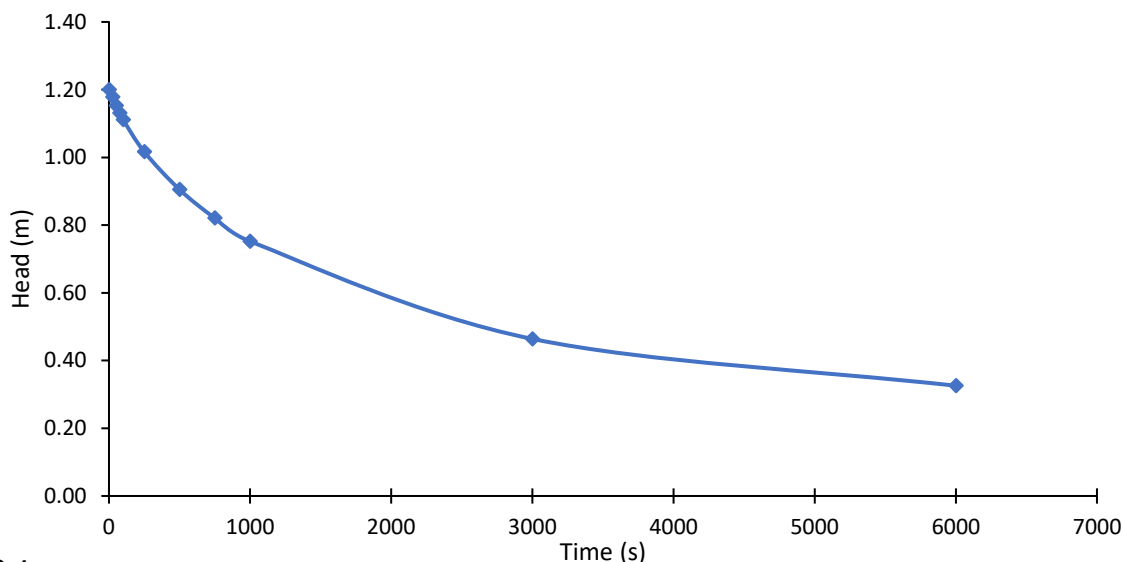
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 9.80\text{E-}06 \text{ ms}^{-1} = 0.85 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 1.53\text{E-}06 \text{ ms}^{-1} = 0.13 \text{ m/day}$$



STRATIGRAPHIC LOG

	Sandy Silt
	Sand
	Sandy Silt
EOH @ 1.3m	

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.200			
25	0.022	1.178	1.289	1.95E-06	1.39E-05
50	0.047	1.153	1.265	2.34E-06	1.65E-05
75	0.069	1.131	1.242	2.06E-06	1.43E-05
100	0.089	1.111	1.221	1.90E-06	1.30E-05
250	0.184	1.017	1.164	1.68E-06	1.12E-05
500	0.295	0.905	1.061	1.40E-06	8.69E-06
750	0.379	0.821	0.963	1.26E-06	7.28E-06
1000	0.448	0.752	0.886	1.19E-06	6.47E-06
3000	0.736	0.464	0.708	9.54E-07	4.55E-06
6000	0.874	0.326	0.495	5.81E-07	2.11E-06

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-02 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : 0.9 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

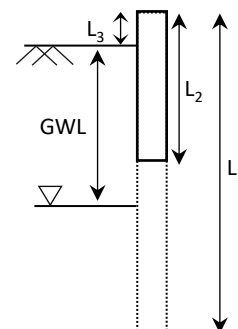
Ground Conditions

GWL: 0.9 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m : 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 0.90 m BGL



Hydraulic Conductivity (k)

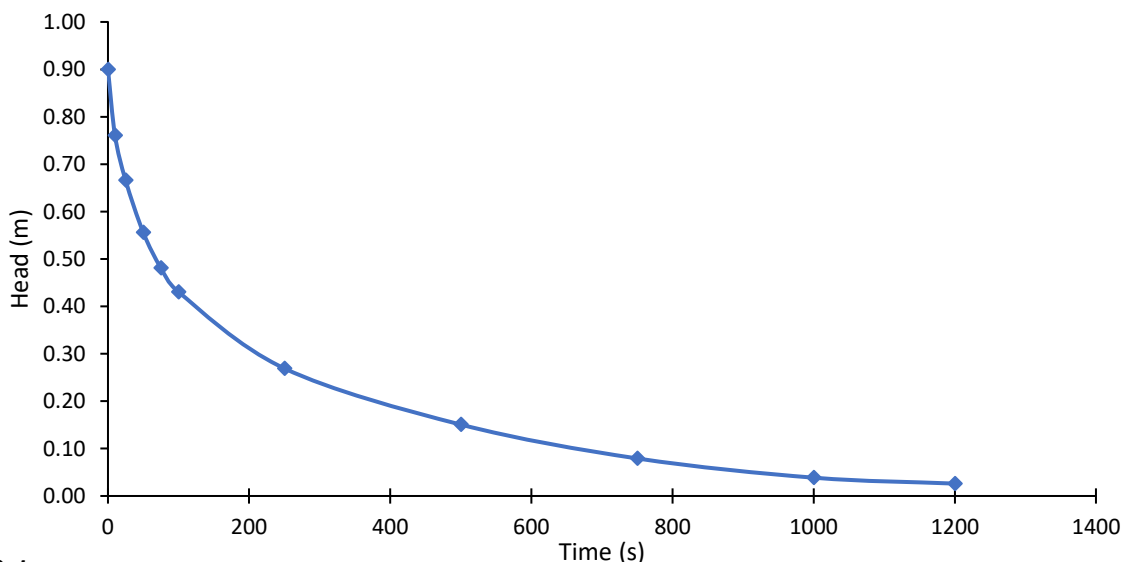
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 9.74\text{E-}05 \text{ ms}^{-1} = 8.42 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 2.89\text{E-}05 \text{ ms}^{-1} = 2.50 \text{ m/day}$$



STRATIGRAPHIC LOG

Sandy Silt

Sand

EOH @ 0.9m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	0.900	0.830	6.00E-05	3.14E-04
10	0.140	0.760	0.713	3.48E-05	1.63E-04
25	0.234	0.666	0.611	3.13E-05	1.32E-04
50	0.344	0.556	0.518	2.77E-05	1.04E-04
75	0.419	0.481	0.456	2.30E-05	7.92E-05
100	0.470	0.430	0.350	1.87E-05	5.59E-05
250	0.631	0.269	0.210	1.77E-05	3.89E-05
500	0.749	0.151	0.115	2.41E-05	3.76E-05
750	0.821	0.079	0.059	3.04E-05	3.30E-05
1000	0.861	0.039	0.032	2.16E-05	1.61E-05
1200	0.874	0.026			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-06 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : **1 m**
 Diameter: **90 mm**
 Non-Perm L_2 : **0 m**
 Above Gnd L_3 : **0 m**

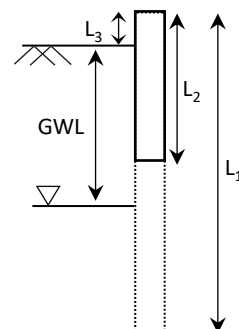
Ground Conditions

GWL: **0.8 m BGL** (Blank = Bottom of hole)

Permeability Anisotropy

m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **1.00 m BGL**



Hydraulic Conductivity (k)

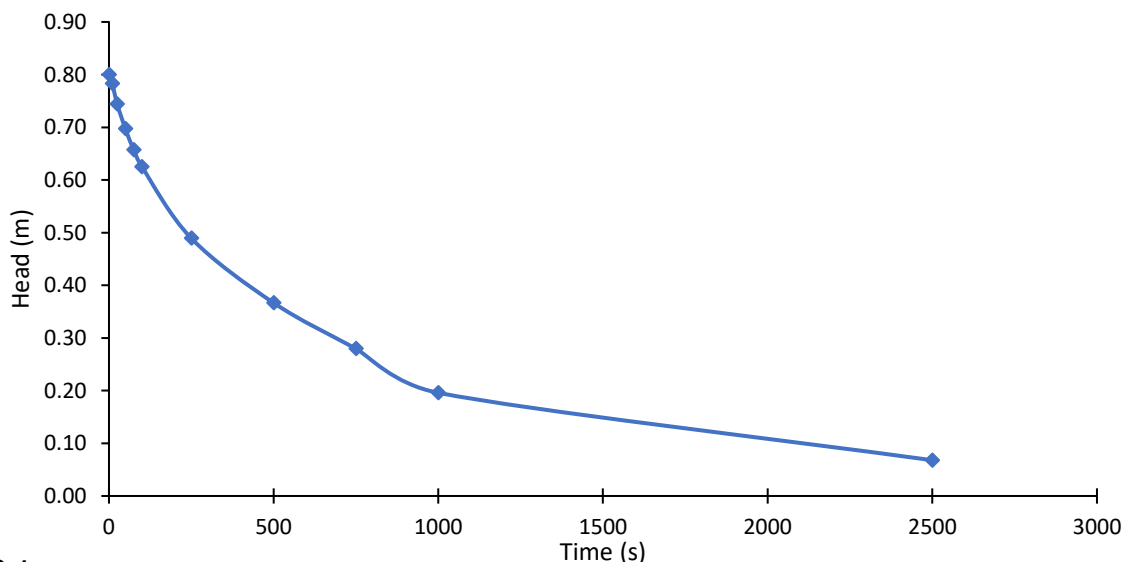
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 3.35\text{E-}05 \text{ ms}^{-1} = 2.89 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 6.97\text{E-}06 \text{ ms}^{-1} = 0.60 \text{ m/day}$$



STRATIGRAPHIC LOG

Silt

Sand

EOH @ 1m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	0.800				
10	0.017	0.783	0.991		6.79E-06	3.97E-05
25	0.056	0.744	0.963		1.10E-05	6.32E-05
50	0.103	0.697	0.920		8.64E-06	4.78E-05
75	0.143	0.657	0.877		8.07E-06	4.31E-05
100	0.175	0.625	0.841		7.07E-06	3.66E-05
250	0.311	0.489	0.757		6.18E-06	2.98E-05
500	0.433	0.367	0.628		4.91E-06	2.07E-05
750	0.520	0.280	0.523		5.16E-06	1.88E-05
1000	0.604	0.196	0.438		7.52E-06	2.38E-05
2500	0.732	0.068	0.332		4.34E-06	1.15E-05

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-07 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : 0.9 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

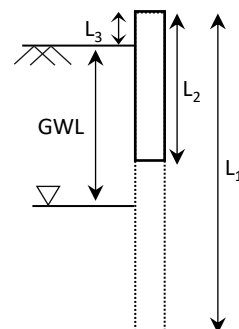
Ground Conditions

GWL: 0.45 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m : 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 0.90 m BGL



Hydraulic Conductivity (k)

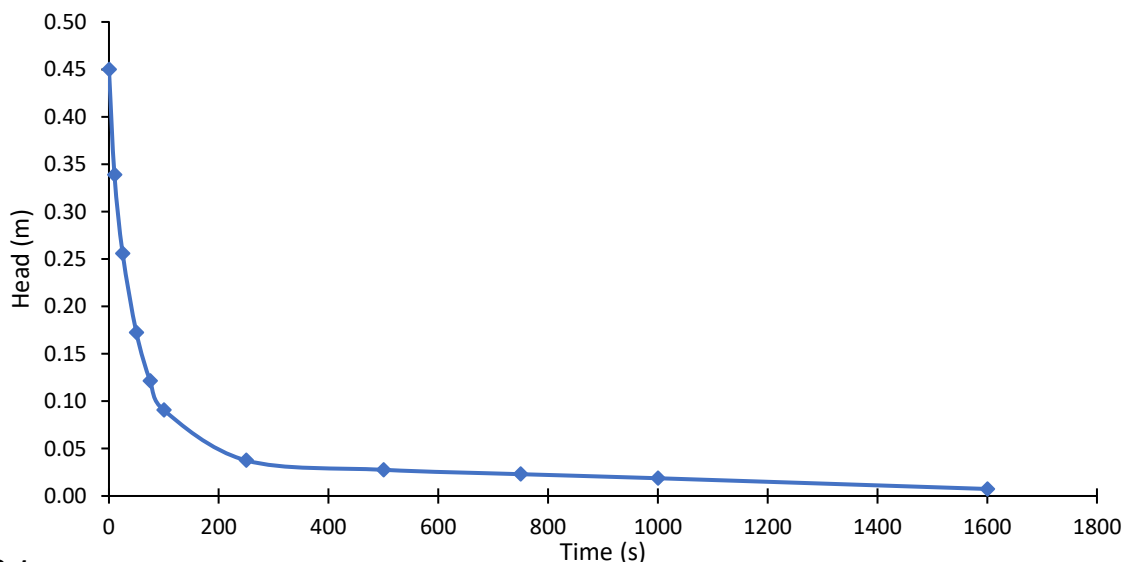
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 1.56\text{E-}04 \text{ ms}^{-1} = 13.47 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 4.02\text{E-}05 \text{ ms}^{-1} = 3.47 \text{ m/day}$$



STRATIGRAPHIC LOG

Fill
Sand
EOH @ 0.9m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	0.450	0.844	9.99E-05	5.04E-04
10	0.111	0.339	0.747	7.16E-05	3.22E-04
25	0.194	0.256	0.664	6.49E-05	2.60E-04
50	0.278	0.172	0.597	6.17E-05	2.13E-04
75	0.329	0.121	0.556	5.38E-05	1.62E-04
100	0.359	0.091	0.514	2.83E-05	7.13E-05
250	0.413	0.038	0.483	6.13E-06	1.01E-05
500	0.422	0.028	0.475	3.68E-06	5.14E-06
750	0.427	0.023	0.471	4.20E-06	5.13E-06
1000	0.431	0.019	0.463	7.91E-06	6.91E-06
1600	0.443	0.007			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-08 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : 1.2 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

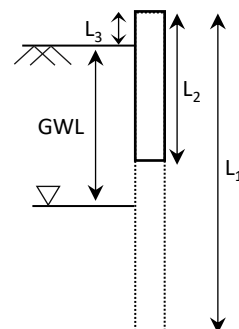
Ground Conditions

GWL: 1 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m : 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 1.20 m BGL



Hydraulic Conductivity (k)

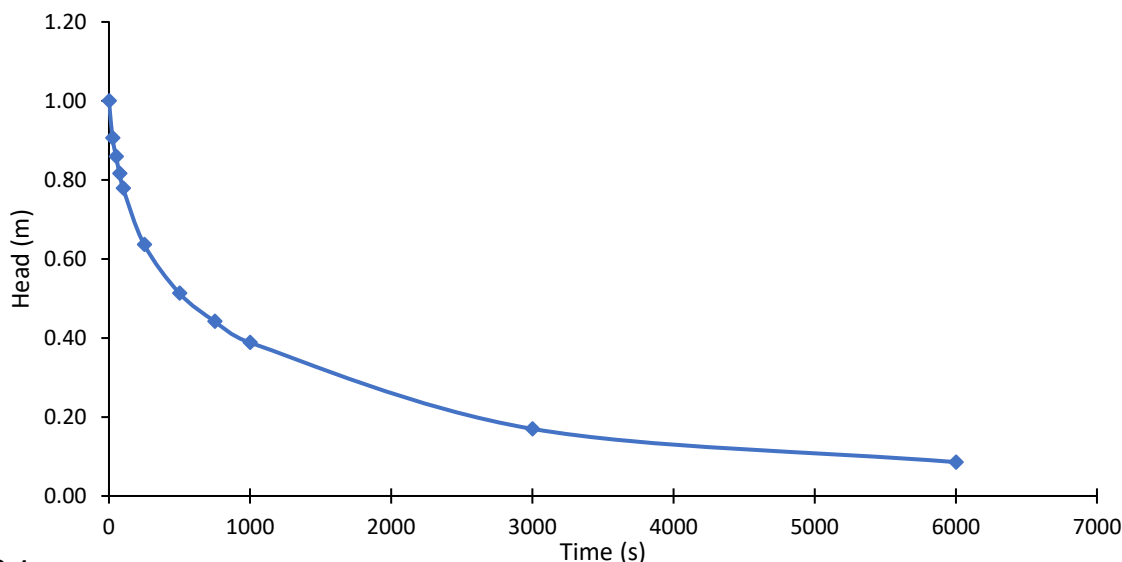
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 2.57\text{E-}05 \text{ ms}^{-1} = 2.22 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 4.56\text{E-}06 \text{ ms}^{-1} = 0.39 \text{ m/day}$$



STRATIGRAPHIC LOG

Silt

Sand

EOH @ 1.2m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.000				
25	0.093	0.907	1.153		1.12E-05	7.33E-05
50	0.140	0.860	1.083		6.34E-06	3.96E-05
75	0.184	0.816	1.038		6.36E-06	3.85E-05
100	0.221	0.779	0.998		5.81E-06	3.42E-05
250	0.364	0.636	0.908		4.54E-06	2.50E-05
500	0.487	0.513	0.775		3.21E-06	1.57E-05
750	0.558	0.442	0.677		2.42E-06	1.07E-05
1000	0.612	0.388	0.615		2.24E-06	9.16E-06
3000	0.830	0.170	0.479		2.07E-06	7.59E-06
6000	0.914	0.086	0.328		1.41E-06	3.46E-06

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-09 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : **1 m**
 Diameter: **90 mm**
 Non-Perm L_2 : **0 m**
 Above Gnd L_3 : **0 m**

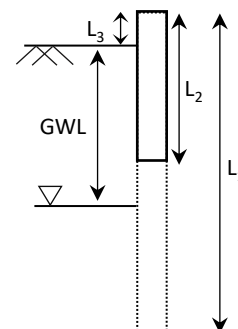
Ground Conditions

GWL: **1 m BGL** (Blank = Bottom of hole)

Permeability Anisotropy

m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **1.00 m BGL**



Hydraulic Conductivity (k)

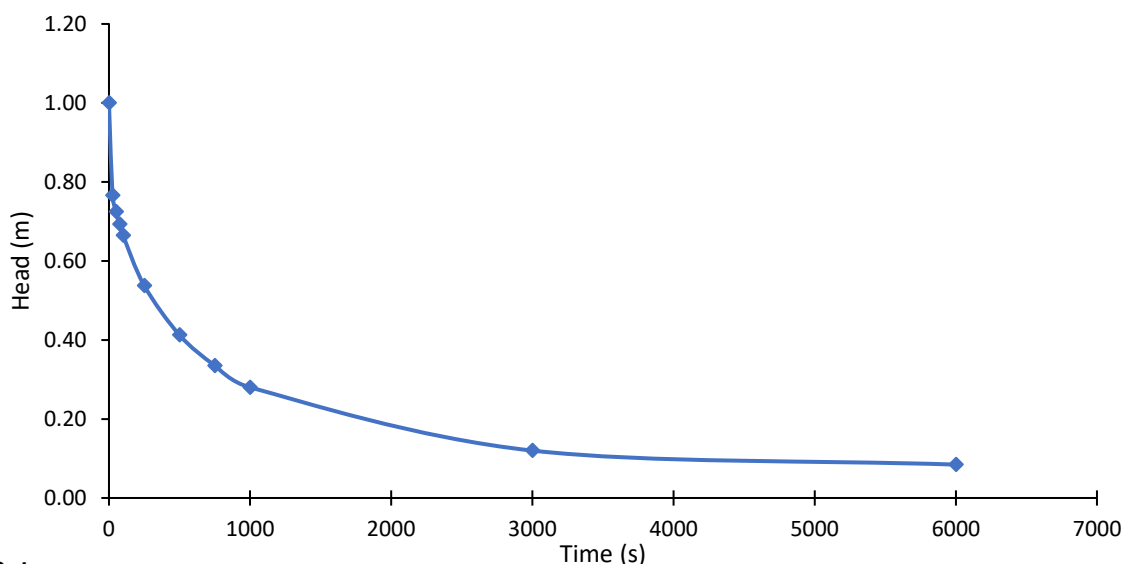
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 3.86\text{E-}05 \text{ ms}^{-1} = 3.33 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 8.40\text{E-}06 \text{ ms}^{-1} = 0.73 \text{ m/day}$$



STRATIGRAPHIC LOG

Silt

Sand

EOH @ 1m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.000			
25	0.234	0.766	0.883	3.63E-05	2.00E-04
50	0.276	0.724	0.745	8.61E-06	4.16E-05
75	0.307	0.693	0.709	6.95E-06	3.24E-05
100	0.335	0.665	0.679	6.78E-06	3.07E-05
250	0.462	0.538	0.601	6.19E-06	2.59E-05
500	0.588	0.412	0.475	5.35E-06	1.91E-05
750	0.665	0.335	0.374	4.79E-06	1.45E-05
1000	0.720	0.280	0.308	4.60E-06	1.23E-05
3000	0.880	0.120	0.200	3.30E-06	7.37E-06
6000	0.916	0.085	0.102	1.13E-06	1.60E-06

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-10 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : **1.8 m**
 Diameter: **90 mm**
 Non-Perm L_2 : **0 m**
 Above Gnd L_3 : **0 m**

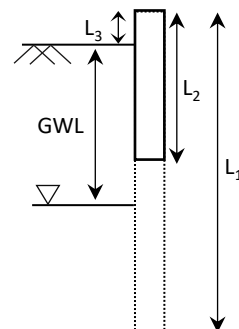
Ground Conditions

GWL: **1.8 m BGL** (Blank = Bottom of hole)

Permeability Anisotropy

m : **1** $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: **1.80 m BGL**



Hydraulic Conductivity (k)

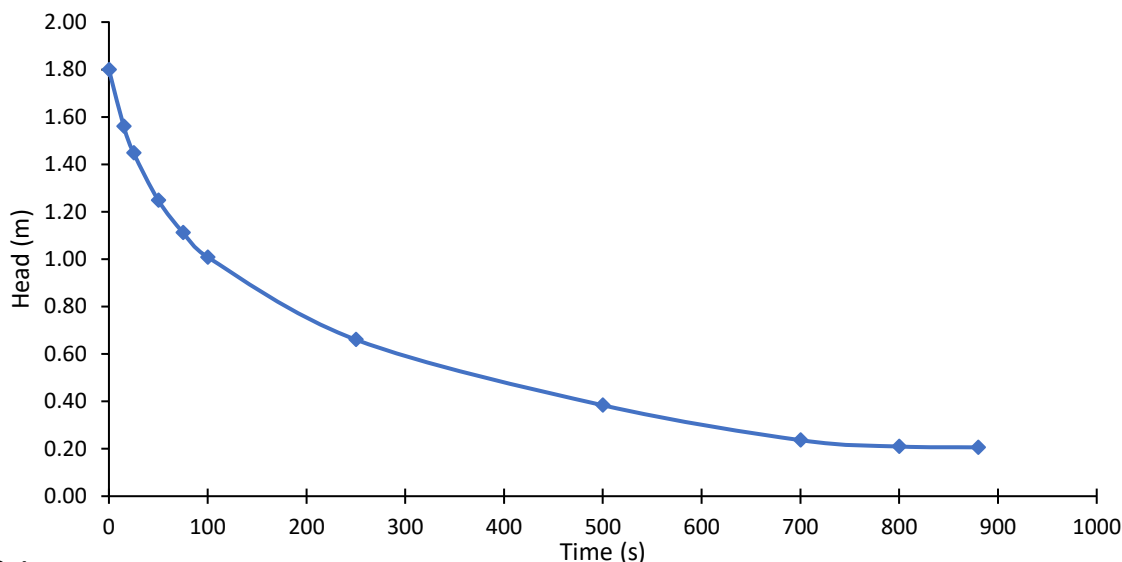
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 7.57\text{E-}05 \text{ ms}^{-1} = 6.54 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 1.25\text{E-}05 \text{ ms}^{-1} = 1.08 \text{ m/day}$$



STRATIGRAPHIC LOG

Fill
Sand
EOH @ 1.8m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.800	1.680	2.08E-05	1.82E-04
15	0.240	1.560	1.504	1.76E-05	1.42E-04
25	0.352	1.448	1.348	1.52E-05	1.13E-04
50	0.552	1.248	1.180	1.30E-05	8.72E-05
75	0.688	1.112	1.060	1.18E-05	7.35E-05
100	0.792	1.008	0.834	1.00E-05	5.38E-05
250	1.140	0.660	0.522	1.04E-05	4.08E-05
500	1.416	0.384	0.310	1.54E-05	4.26E-05
700	1.564	0.237	0.223	8.95E-06	1.96E-05
800	1.590	0.210	0.208	1.66E-06	3.48E-06
880	1.594	0.206			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-11 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : 0.9 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

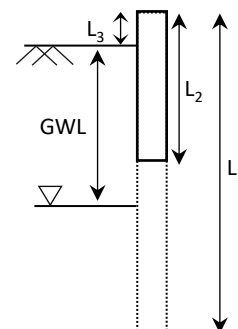
Ground Conditions

GWL: 0.5 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m : 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 0.90 m BGL



Hydraulic Conductivity (k)

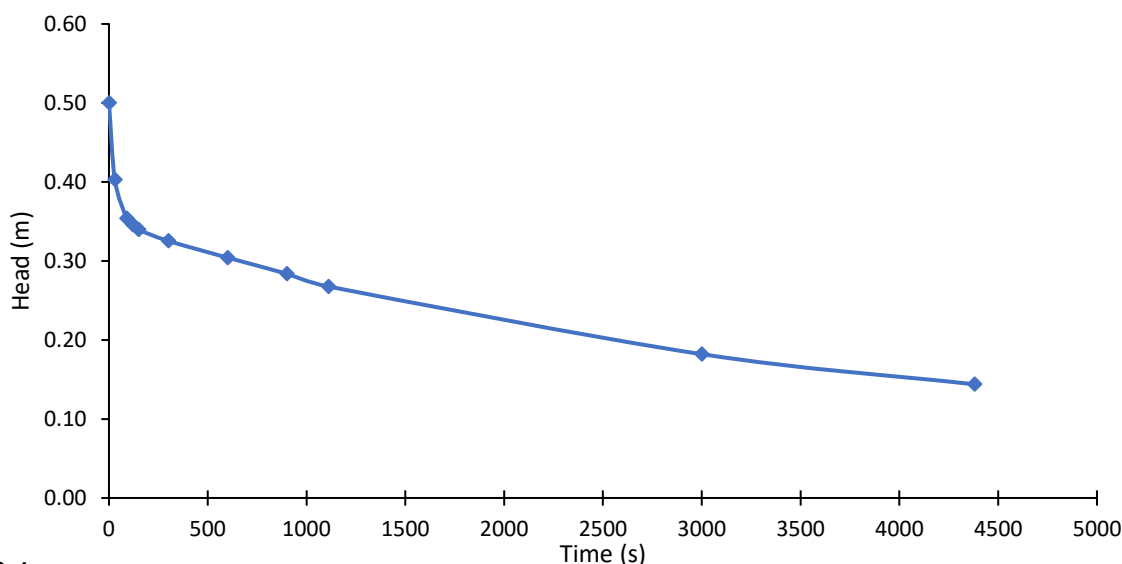
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 2.14\text{E-}05 \text{ ms}^{-1} = 1.85 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 4.42\text{E-}06 \text{ ms}^{-1} = 0.38 \text{ m/day}$$



STRATIGRAPHIC LOG

Silt

EOH @ 0.9m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)	Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	0.500	0.851	2.52E-05	1.29E-04
30	0.097	0.403	0.778	7.99E-06	3.77E-05
90	0.146	0.354	0.750	2.97E-06	1.35E-05
120	0.154	0.346	0.743	2.27E-06	1.03E-05
150	0.160	0.340	0.732	1.10E-06	4.90E-06
300	0.175	0.325	0.715	8.81E-07	3.84E-06
600	0.196	0.304	0.694	9.25E-07	3.92E-06
900	0.216	0.284	0.676	1.13E-06	4.67E-06
1110	0.232	0.268	0.625	8.72E-07	3.39E-06
3000	0.318	0.182	0.563	7.75E-07	2.62E-06
4380	0.356	0.144			

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



CLIENT: **Te Kowhai East LP**

PROJECT: **Te Kowhai East Industrial Development**

TITLE: **SO25-12 Falling Head Permeability Test**

DESIGNER: **NK**

CHECKED: **AS**

REVISION: **0**

DATE: **6/11/2025**

PROJECT: **HAM2025-0116**

Specifications - Open-Ended Tube

Length L_1 : 1.2 m
Diameter: 90 mm
Non-Perm L_2 : 0 m
Above Gnd L_3 : 0 m

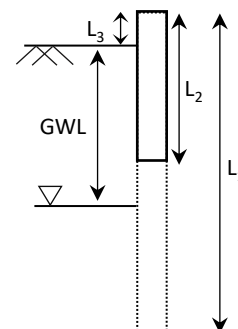
Ground Conditions

GWL: 1 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m : 1 $m = \sqrt{k_h/k_v}$

Bottom of Test Hole: 1.20 m BGL



Hydraulic Conductivity (k)

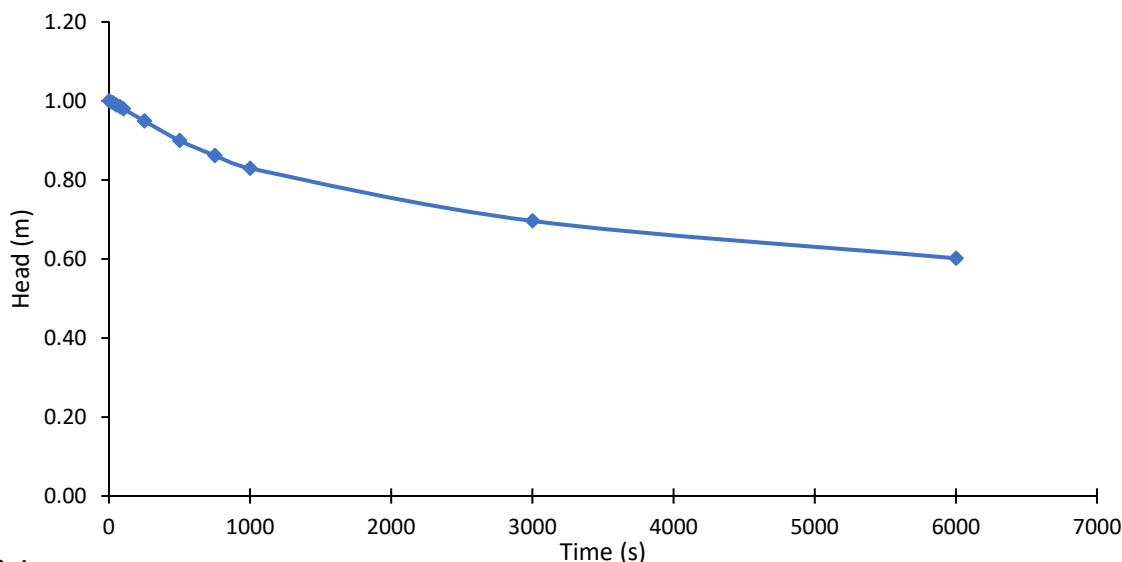
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), Control of groundwater for temporary works, CIRIA Report 113, Appendix 4

$$k = \left(\log \frac{h_1}{h_2} - \log \frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} = 3.14E-06 \text{ ms}^{-1} = 0.27 \text{ m/day}$$

Hvorslev: Hvorslev (1951) Time Lag and Soil Permeability in Ground-Water Observations, Fig 18, p49

$$k = \frac{d^2 \ln \left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d} \right)^2 + 1} \right)}{8L(t_2 - t_1)} \ln \frac{H_1}{H_2} = 4.88E-07 \text{ ms}^{-1} = 0.04 \text{ m/day}$$



STRATIGRAPHIC LOG

Silt

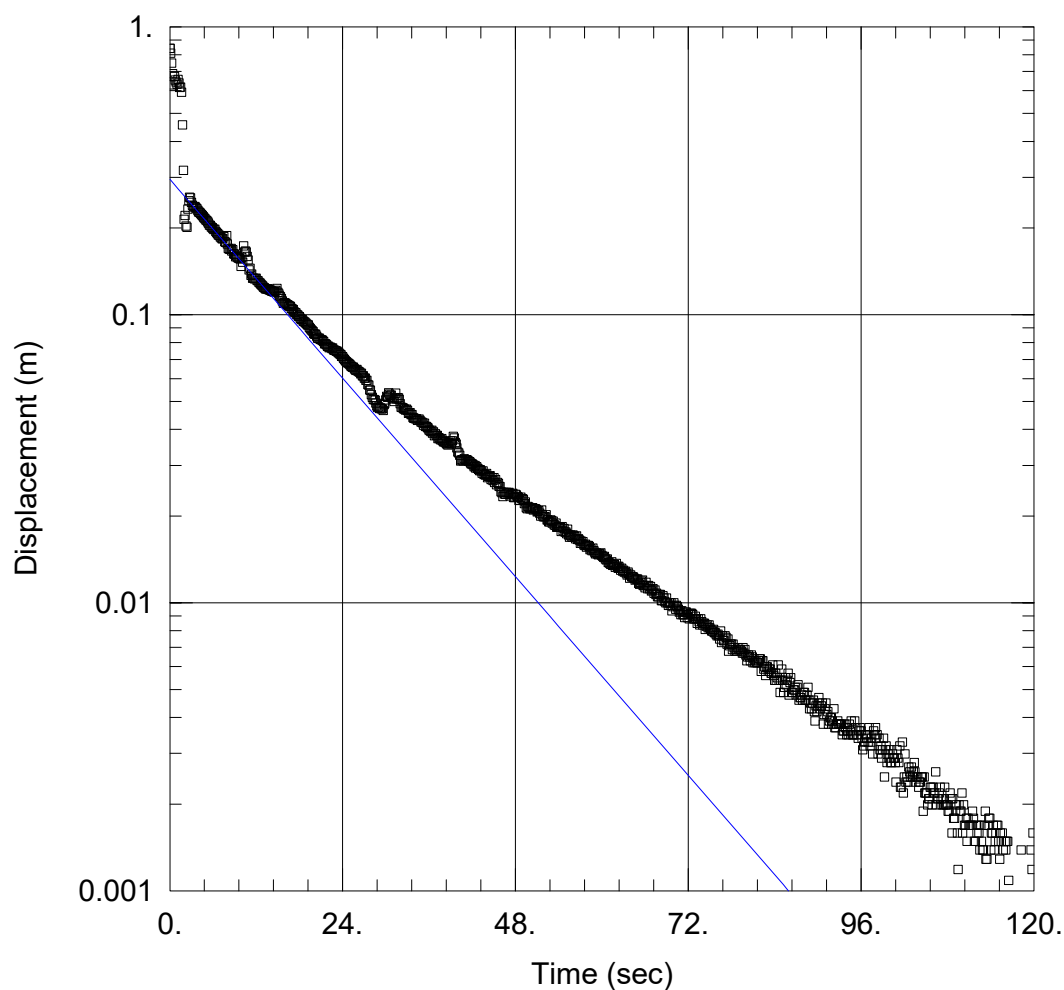
Sand

EOH @ 1.2m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms ⁻¹)	CIRIA 113 'k' (ms ⁻¹)
0	0.000	1.000				
25	0.005	0.995	1.198		5.23E-07	3.52E-06
50	0.010	0.990	1.192		6.40E-07	4.30E-06
75	0.015	0.985	1.188		4.75E-07	3.18E-06
100	0.020	0.980	1.183		5.81E-07	3.88E-06
250	0.051	0.949	1.165		6.04E-07	3.99E-06
500	0.100	0.900	1.125		6.22E-07	4.00E-06
750	0.138	0.862	1.081		5.11E-07	3.19E-06
1000	0.171	0.829	1.046		4.70E-07	2.86E-06
3000	0.304	0.696	0.963		2.82E-07	1.62E-06
6000	0.398	0.602	0.849		1.71E-07	8.92E-07

The hydraulic conductivity values above are calculated as an average across the whole data set. Any designer using these values may consider the raw data and other calculation methods, and must satisfy themselves as to their suitability.



MH25-04_FHT1_1

Data Set: V:\...\MH25-04_FHT1.aqt

Date: 04/01/26

Time: 11:29:21

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-04

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 3.321 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-04)

Initial Displacement: 0.8415 m

Static Water Column Height: 3.321 m

Total Well Penetration Depth: 3.071 m

Screen Length: 1. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

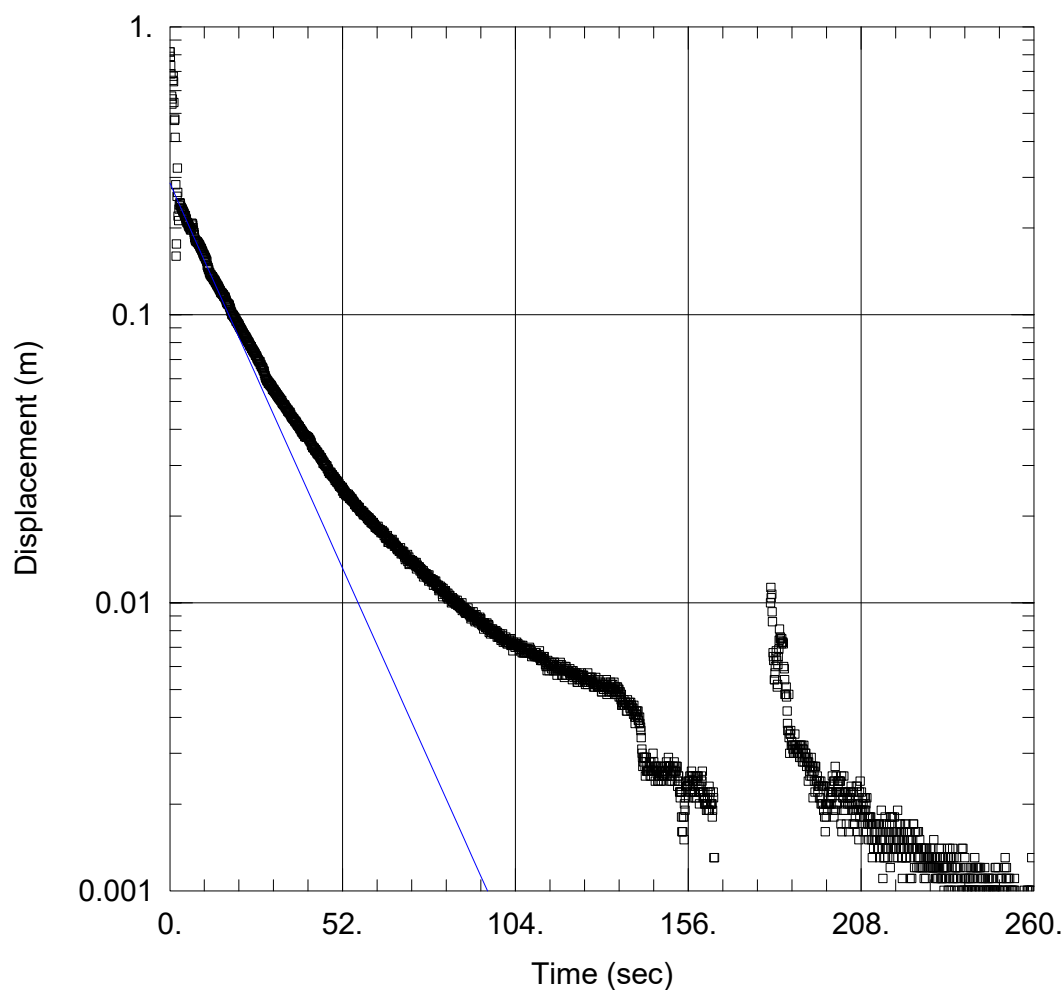
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 2.847$ m/day

$y_0 = 0.2954$ m



MH25-04_FHT2_1

Data Set: V:\...\MH25-04_FHT2.aqt

Date: 04/01/26

Time: 12:07:14

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-04

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 3.321 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-04)

Initial Displacement: 0.818 m

Static Water Column Height: 3.321 m

Total Well Penetration Depth: 3.071 m

Screen Length: 1. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

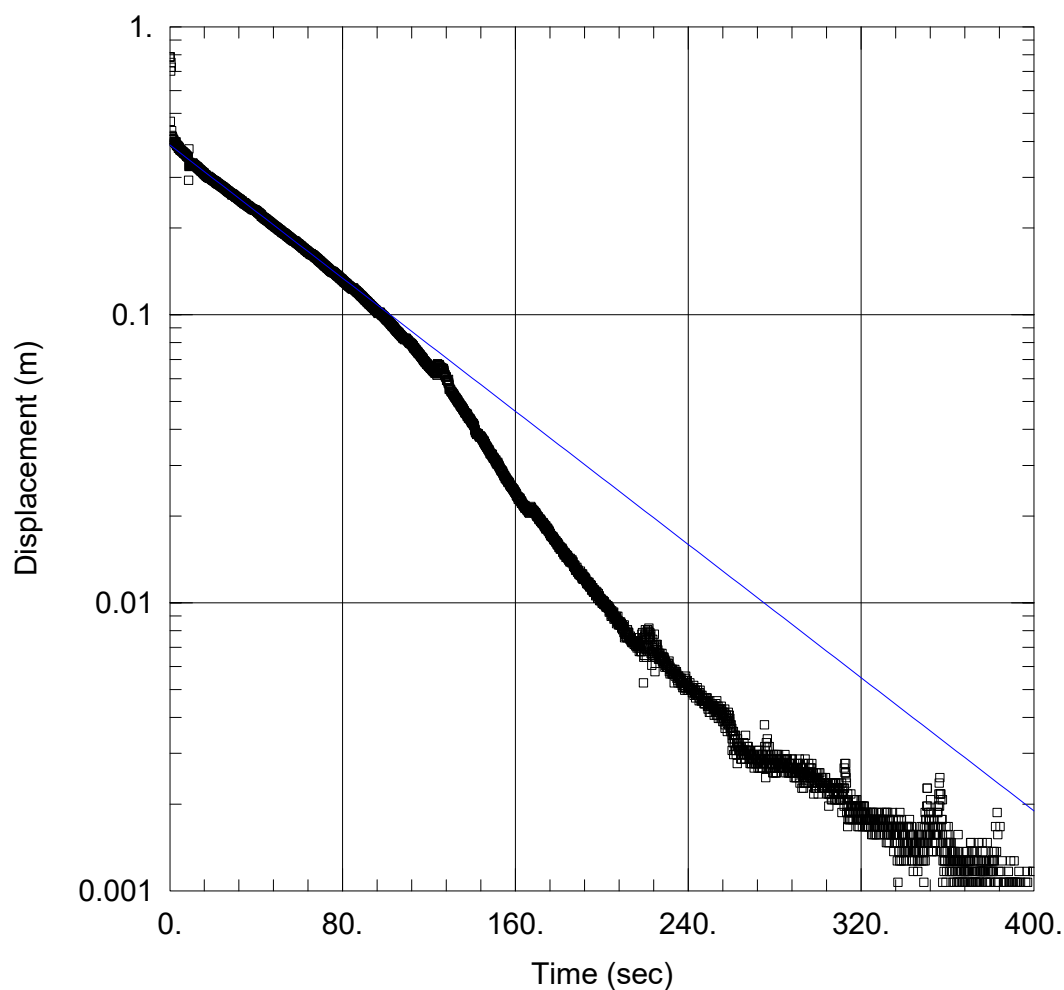
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 2.546$ m/day

$y_0 = 0.2863$ m



MH25-04_RHT1_1

Data Set: V:\...\MH25-04_RHT1.aqt

Date: 04/01/26

Time: 11:48:19

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-04

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 3.321 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-04)

Initial Displacement: 0.7865 m

Static Water Column Height: 3.321 m

Total Well Penetration Depth: 3.071 m

Screen Length: 1. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

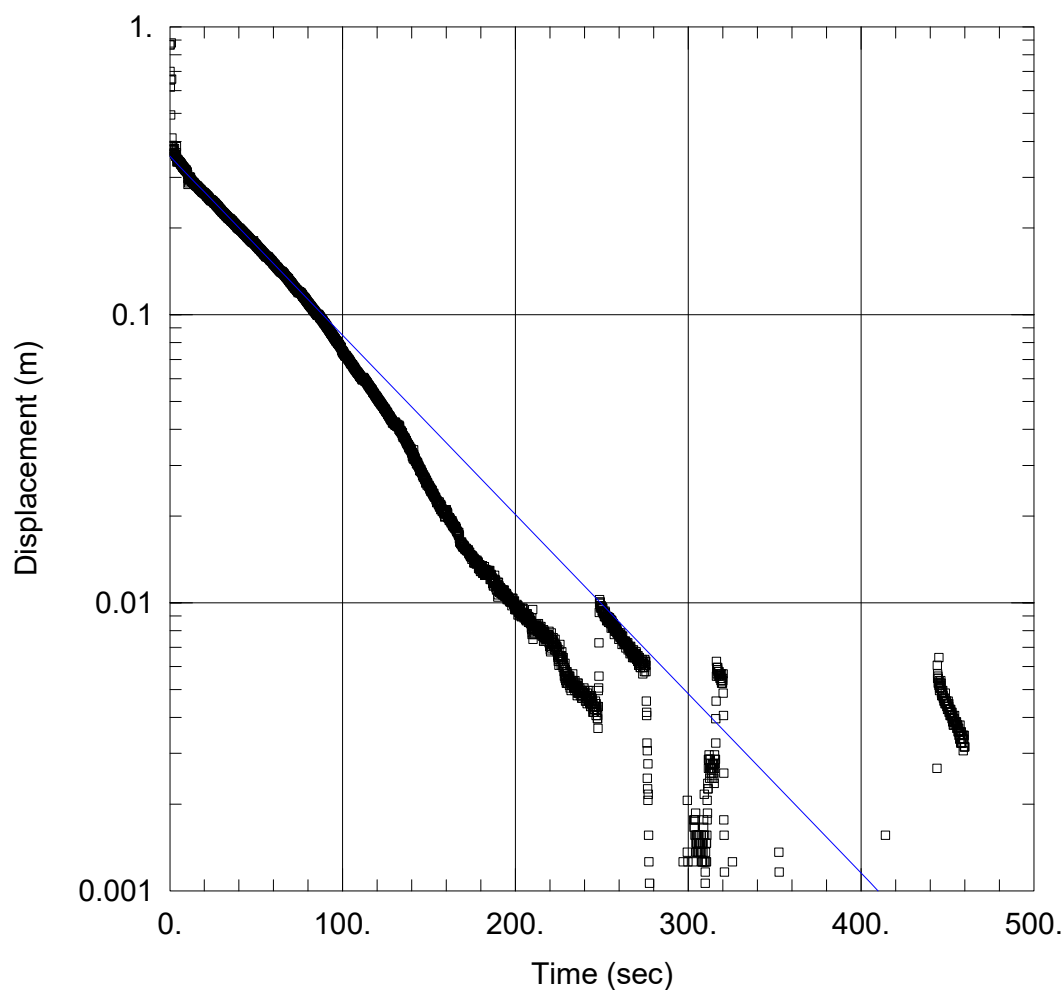
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 0.5725$ m/day

$y_0 = 0.3889$ m



MH25-04_RHT2_1

Data Set: V:\...\MH25-04_RHT2.aqt

Date: 04/01/26

Time: 12:29:45

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-04

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 3.321 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-04)

Initial Displacement: 0.865 m

Static Water Column Height: 3.321 m

Total Well Penetration Depth: 3.071 m

Screen Length: 1. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

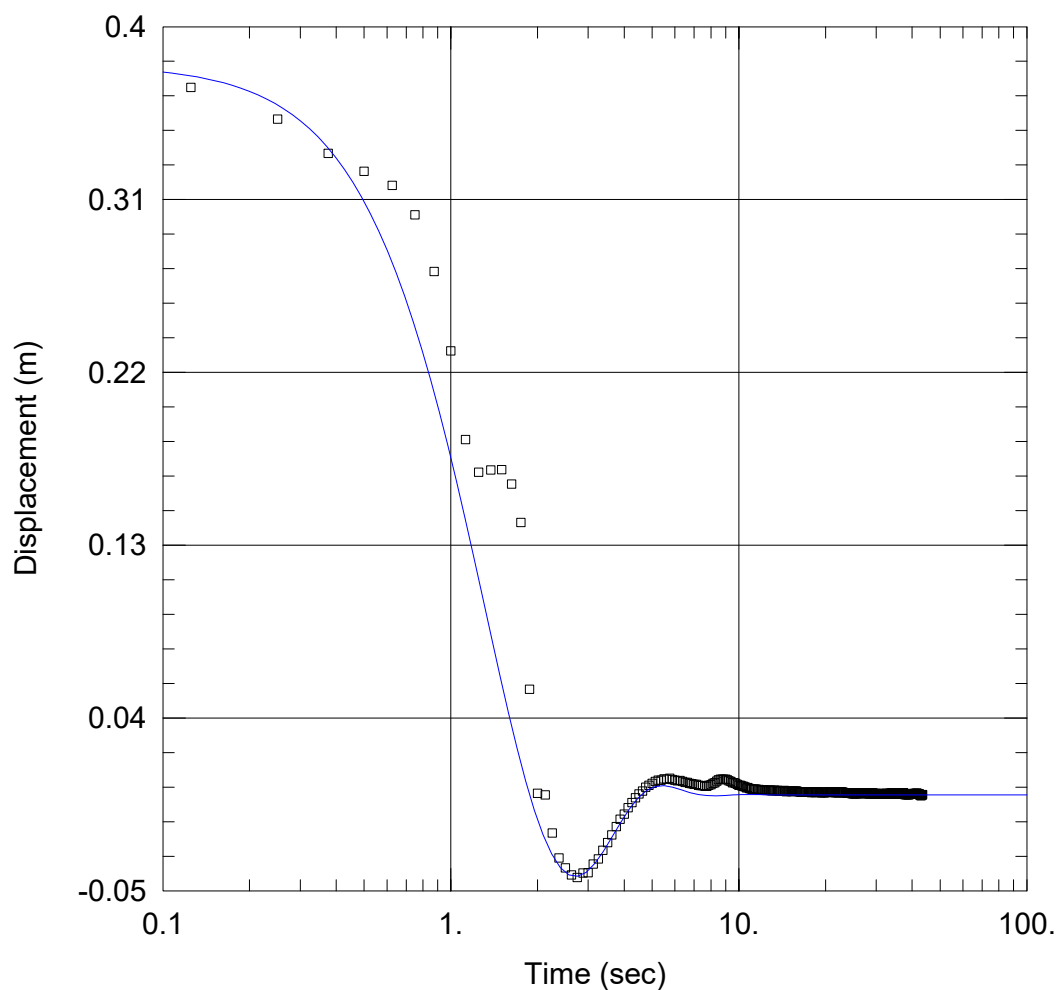
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

$K = 0.6163$ m/day

$y_0 = 0.3556$ m



MH25-05_FHT1_1

Data Set: V:\...\MH25-05_FHT1.aqt

Date: 04/01/26

Time: 14:13:34

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-05

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.388 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-05)

Initial Displacement: 0.38 m

Static Water Column Height: 6.388 m

Total Well Penetration Depth: 4.438 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

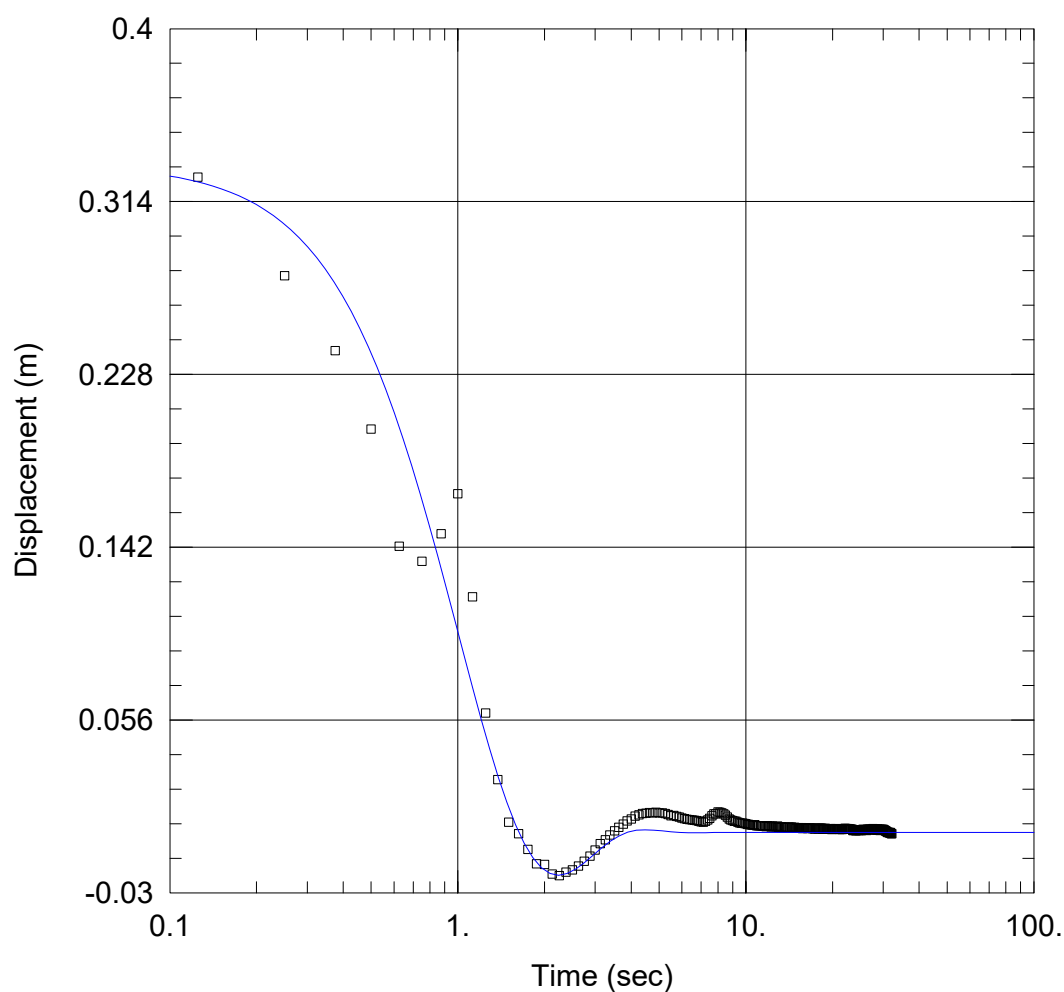
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

$K = 30.5$ m/day

$L_e = 4.9$ m



MH25-05_FHT2_1

Data Set: V:\...\MH25-05_FHT2.aqt

Date: 04/02/26

Time: 08:43:59

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-05

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.388 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-05)

Initial Displacement: 0.332 m

Static Water Column Height: 6.388 m

Total Well Penetration Depth: 4.438 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

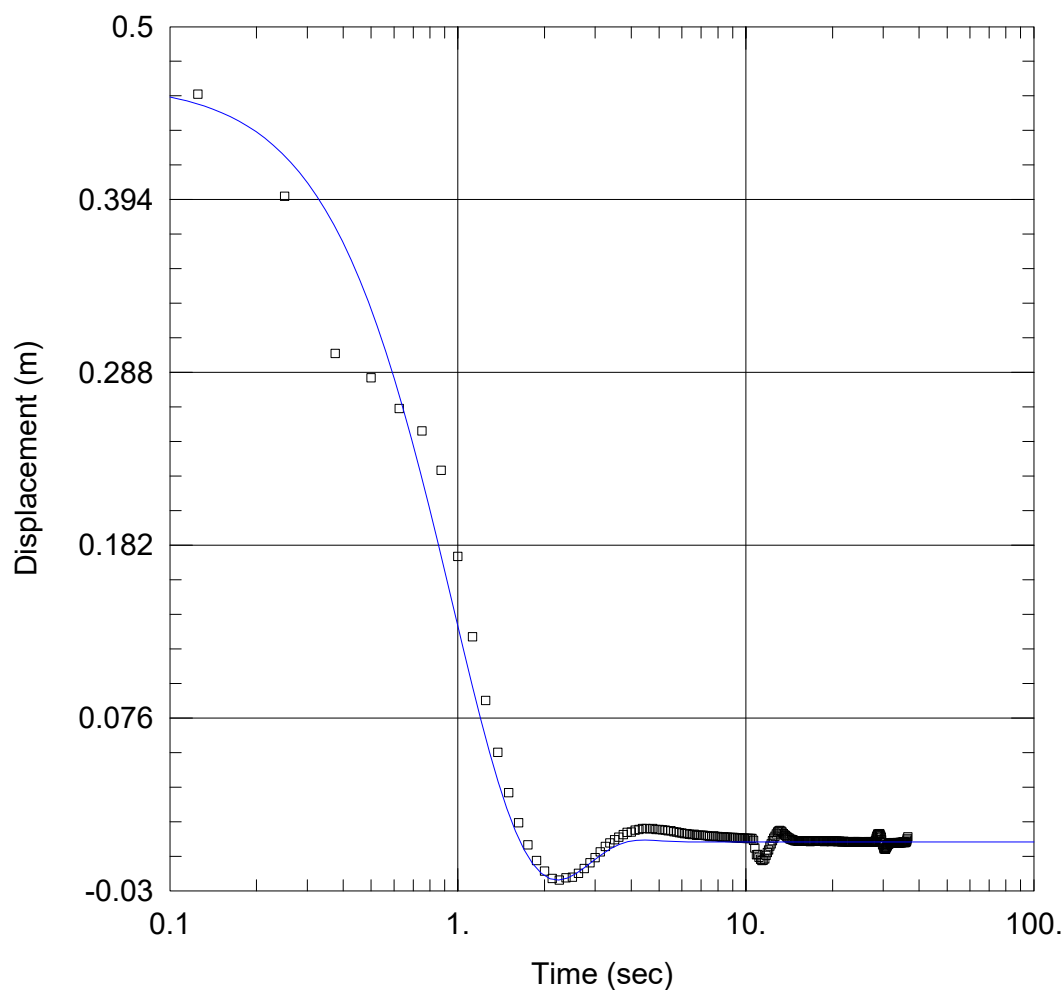
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 35. m/day

L_e = 2.818 m



MH25-05_RHT1_1

Data Set: V:\...\MH25-05_RHT1.aqt

Date: 04/02/26

Time: 08:30:46

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-05

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.388 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MH25-05)

Initial Displacement: 0.465 m

Static Water Column Height: 6.388 m

Total Well Penetration Depth: 4.438 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

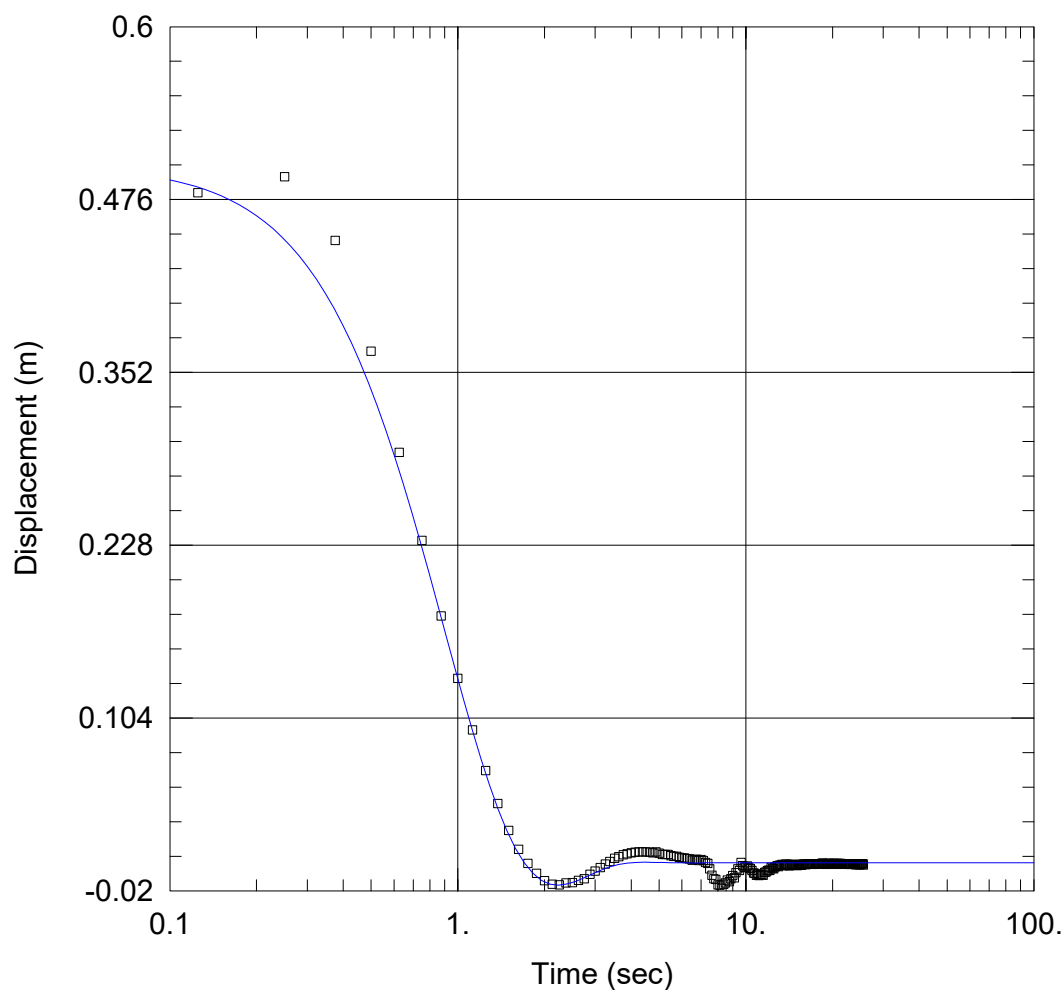
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 35. m/day

Le = 2.57 m



MH25-05_RHT2_1

Data Set: V:\...\MH25-05_RHT2.aqt

Date: 04/02/26

Time: 08:56:58

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-05

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.388 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MH25-05)

Initial Displacement: 0.5 m

Static Water Column Height: 6.388 m

Total Well Penetration Depth: 4.438 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

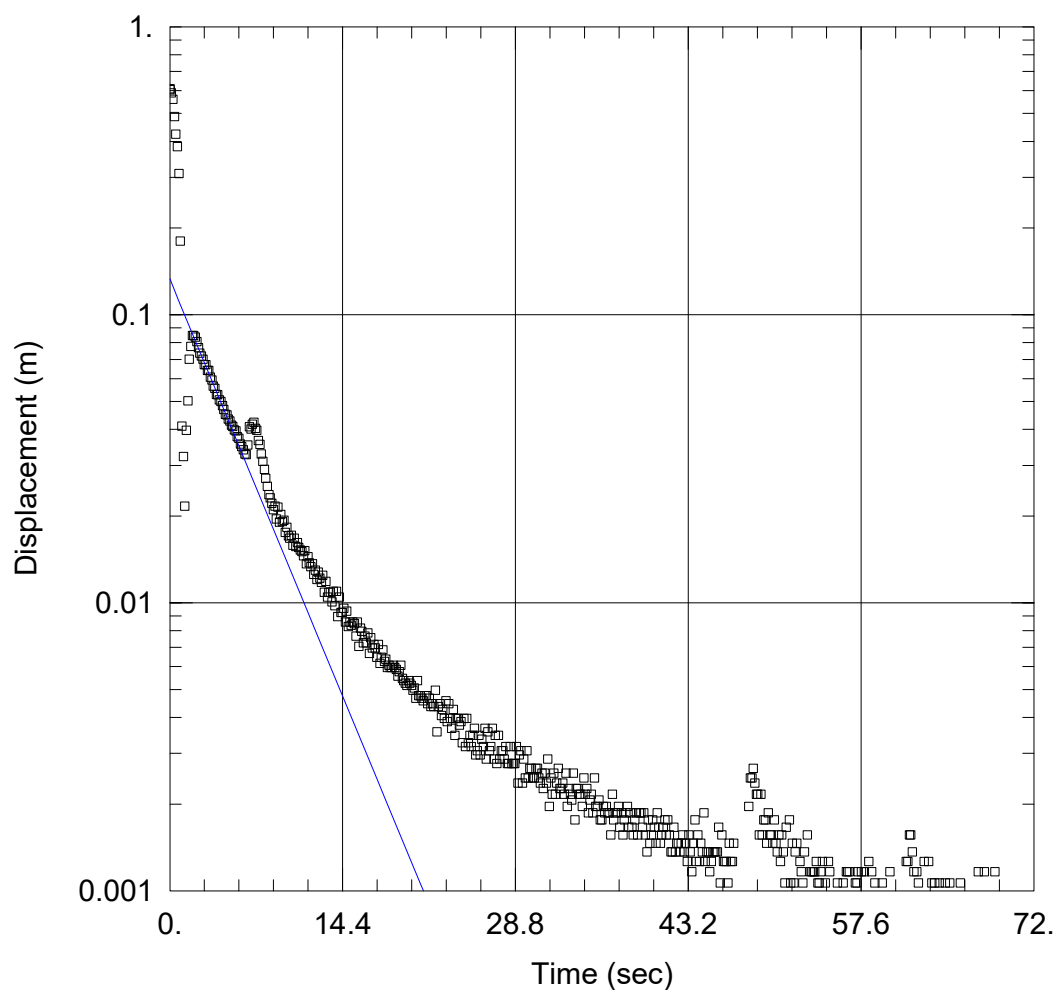
SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 35. m/day

Le = 2.238 m



MH25-06_FHT1_1

Data Set: V:\...\MH25-06_FHT1.aqt

Date: 04/02/26

Time: 11:07:11

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-06

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.646 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-06)

Initial Displacement: 0.61 m

Static Water Column Height: 6.646 m

Total Well Penetration Depth: 2.196 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

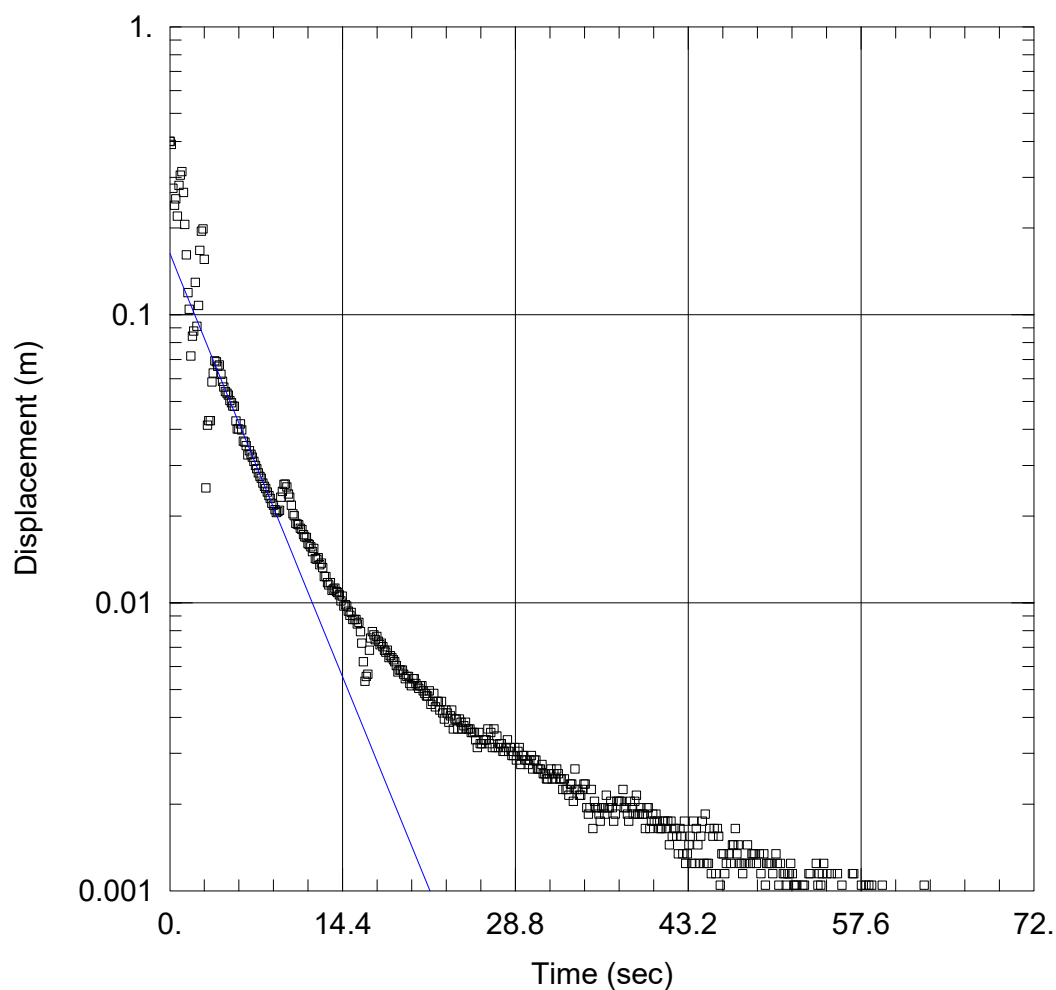
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 4.878$ m/day

$y_0 = 0.1331$ m



MH25-06_FHT2_1

Data Set: V:\...\MH25-06_FHT2.aqt

Date: 04/02/26

Time: 11:35:43

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-06

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.646 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-06)

Initial Displacement: 0.4 m

Static Water Column Height: 6.646 m

Total Well Penetration Depth: 2.196 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

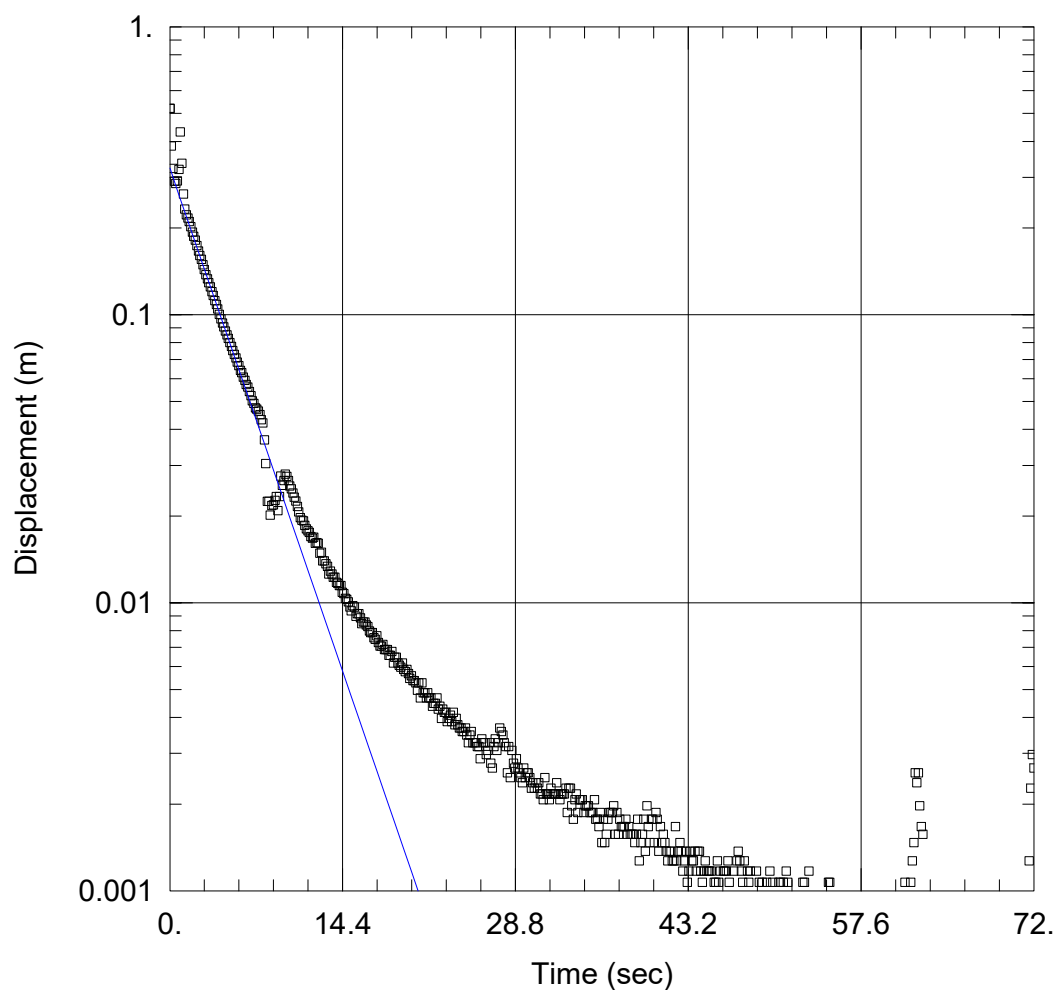
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 4.951$ m/day

$y_0 = 0.1631$ m



MH25-06_RHT1_1

Data Set: V:\...\MH25-06_RHT1.aqt

Date: 04/02/26

Time: 11:24:57

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-06

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.646 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-06)

Initial Displacement: 0.52 m

Static Water Column Height: 6.646 m

Total Well Penetration Depth: 2.196 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

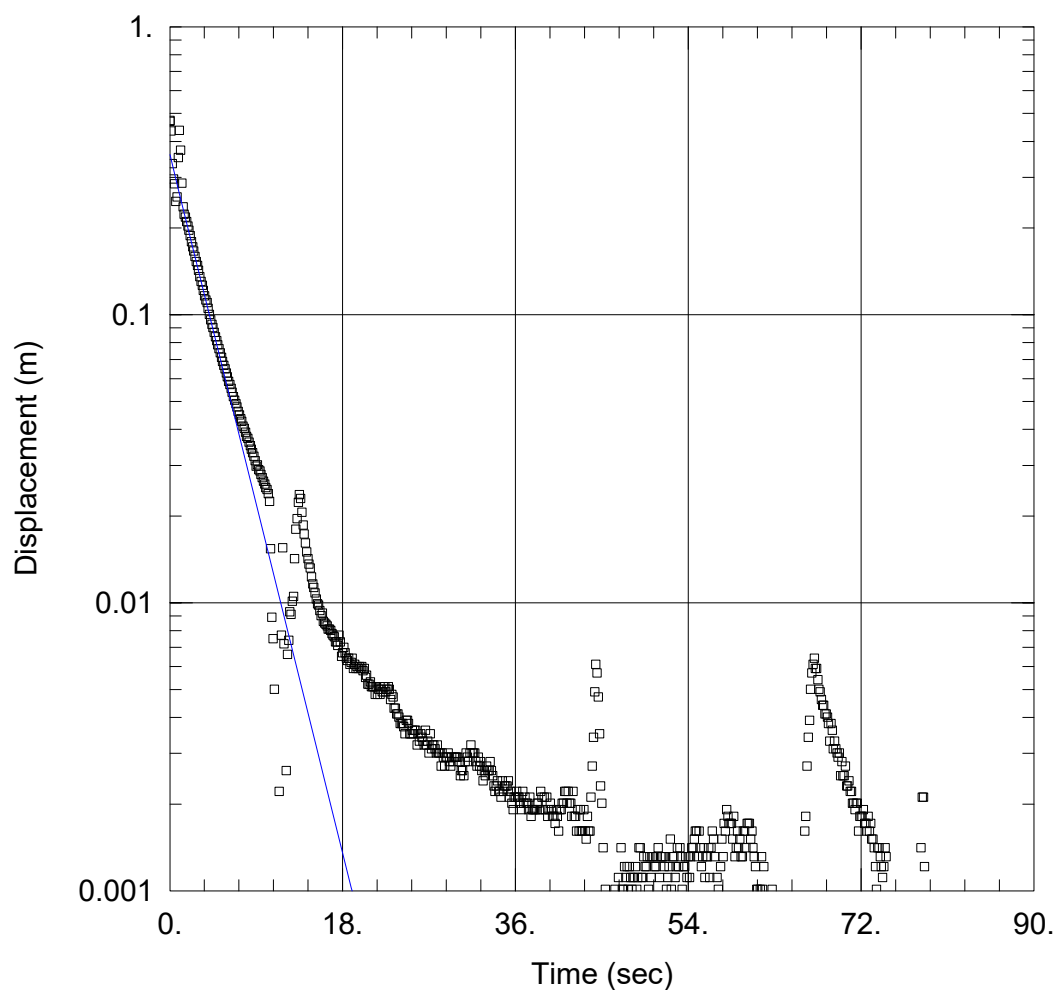
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 5.882$ m/day

$y_0 = 0.3227$ m



MH25-06_RHT2_1

Data Set: V:\...\MH25-06_RHT2.aqt

Date: 04/02/26

Time: 12:19:40

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-06

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.646 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-06)

Initial Displacement: 0.47 m

Static Water Column Height: 6.646 m

Total Well Penetration Depth: 2.196 m

Screen Length: 2. m

Casing Radius: 0.02 m

Well Radius: 0.05 m

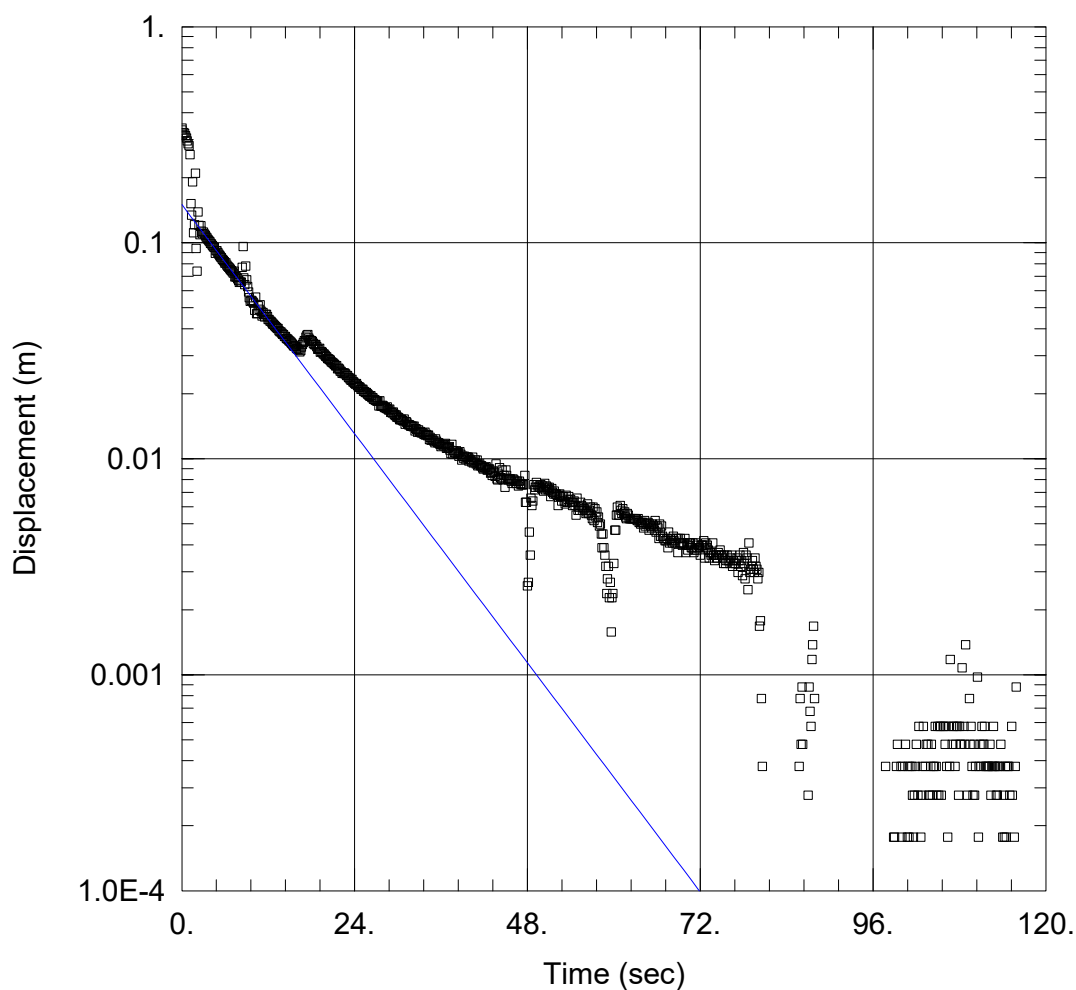
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 6.532$ m/day

$y_0 = 0.3595$ m



MH25-07_FHT1_1

Data Set: V:\...\MH25-07_FHT1.aqt

Date: 04/02/26

Time: 13:47:59

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-07

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 5.939 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-07)

Initial Displacement: 0.34 m

Total Well Penetration Depth: 1.789 m

Casing Radius: 0.02 m

Static Water Column Height: 5.939 m

Screen Length: 1.5 m

Well Radius: 0.05 m

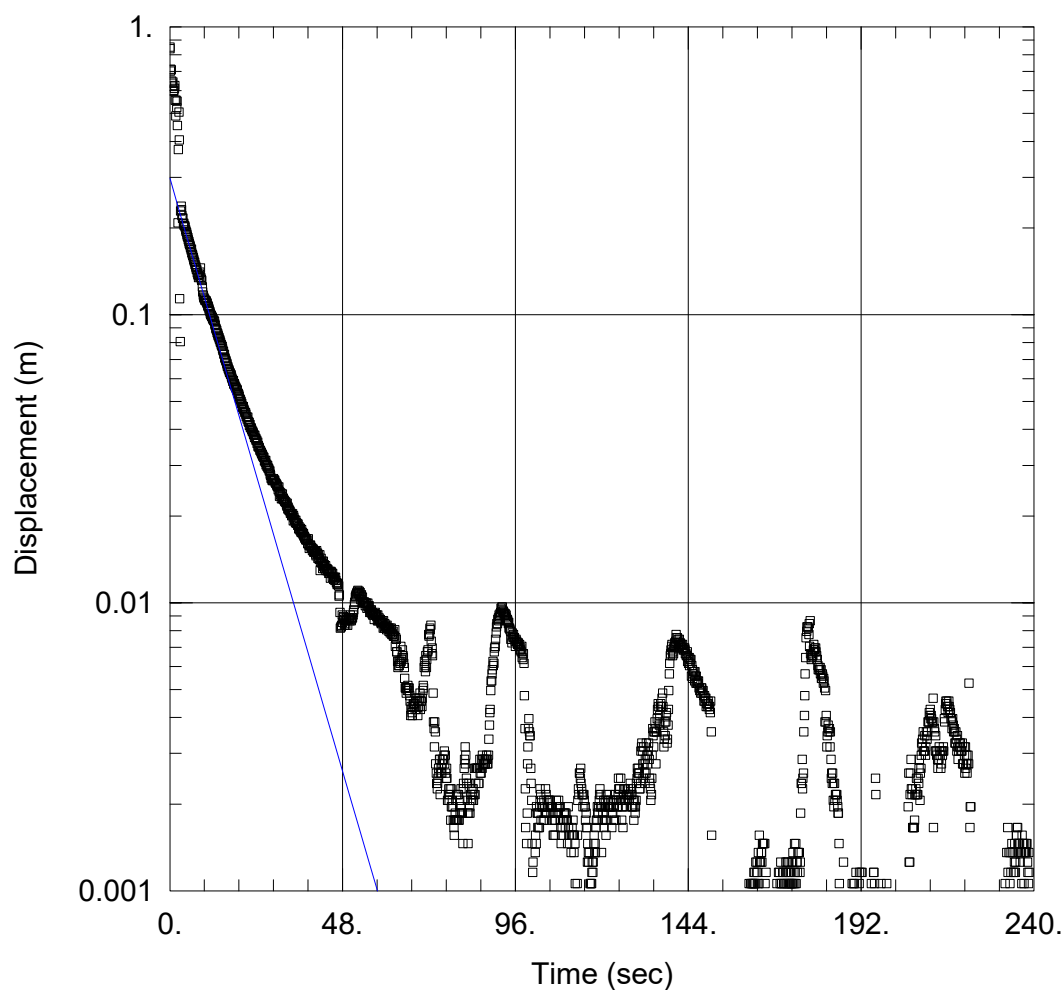
SOLUTION

Aquifer Model: Unconfined

$K = 2.62$ m/day

Solution Method: Bouwer-Rice

$y_0 = 0.1503$ m



MH25-07_FHT2_1

Data Set: V:\...\MH25-07_FHT2.aqt

Date: 04/02/26

Time: 14:38:54

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-07

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 5.939 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-07)

Initial Displacement: 0.84 m

Static Water Column Height: 5.939 m

Total Well Penetration Depth: 1.789 m

Screen Length: 1.5 m

Casing Radius: 0.02 m

Well Radius: 0.05 m

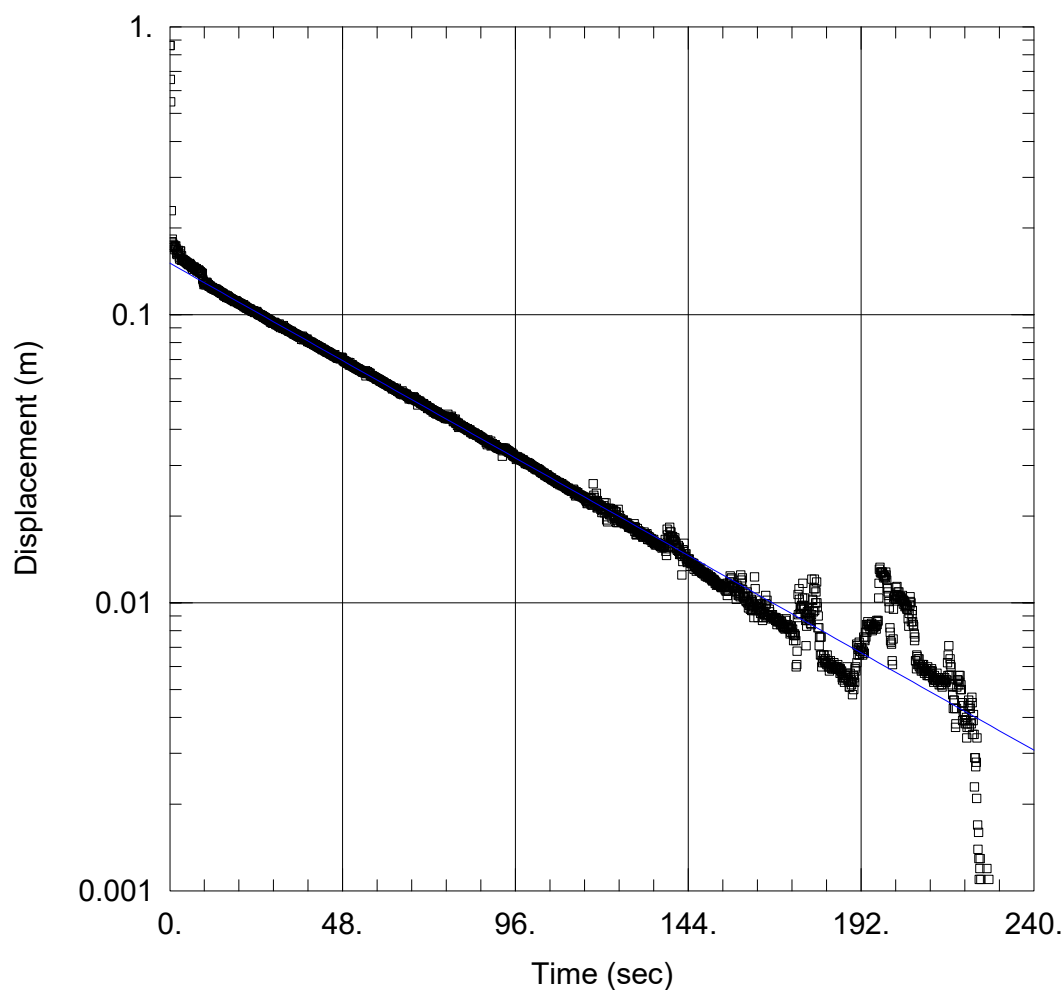
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 2.543$ m/day

$y_0 = 0.298$ m



MH25-07_RHT1_2

Data Set: V:\...\MH25-07_RHT1.aqt

Date: 04/02/26

Time: 14:26:09

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-07

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 5.939 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-07)

Initial Displacement: 0.862 m

Static Water Column Height: 5.939 m

Total Well Penetration Depth: 1.789 m

Screen Length: 1.5 m

Casing Radius: 0.02 m

Well Radius: 0.05 m

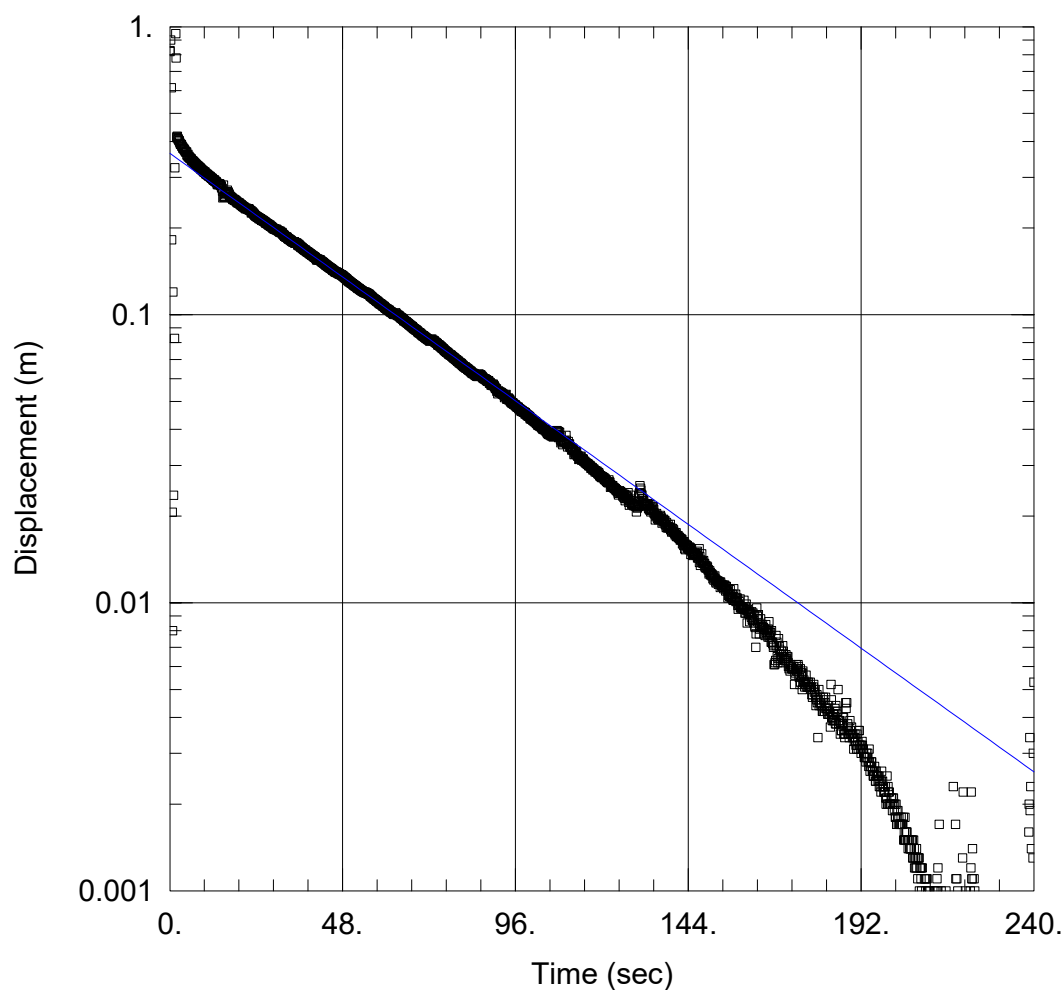
SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 0.4177$ m/day

$y_0 = 0.1511$ m



MH25-07_RHT2_2

Data Set: V:\...\MH25-07_RHT2.aqt

Date: 04/02/26

Time: 15:02:51

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-07

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 5.939 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MH25-07)

Initial Displacement: 0.82 m

Total Well Penetration Depth: 1.789 m

Casing Radius: 0.02 m

Static Water Column Height: 5.939 m

Screen Length: 1.5 m

Well Radius: 0.05 m

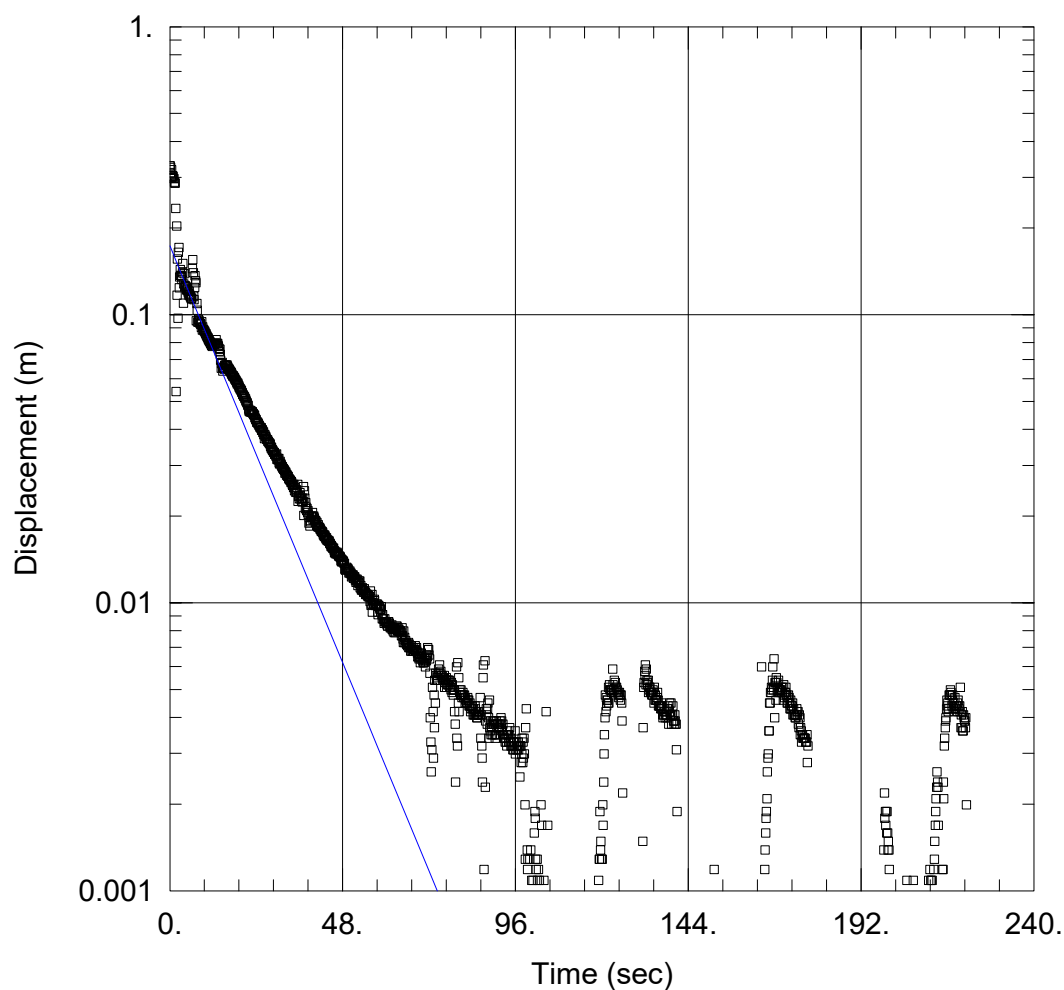
SOLUTION

Aquifer Model: Unconfined

K = 0.5305 m/day

Solution Method: Bouwer-Rice

y0 = 0.3638 m



MH25-08_FHT1_1

Data Set: V:\...\MH25-08_FHT1.aqt

Date: 04/07/26

Time: 13:54:56

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-08

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.12 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-08)

Initial Displacement: 0.329 m

Total Well Penetration Depth: 1.3 m

Casing Radius: 0.02 m

Static Water Column Height: 6.12 m

Screen Length: 1.3 m

Well Radius: 0.05 m

Gravel Pack Porosity: 0.2

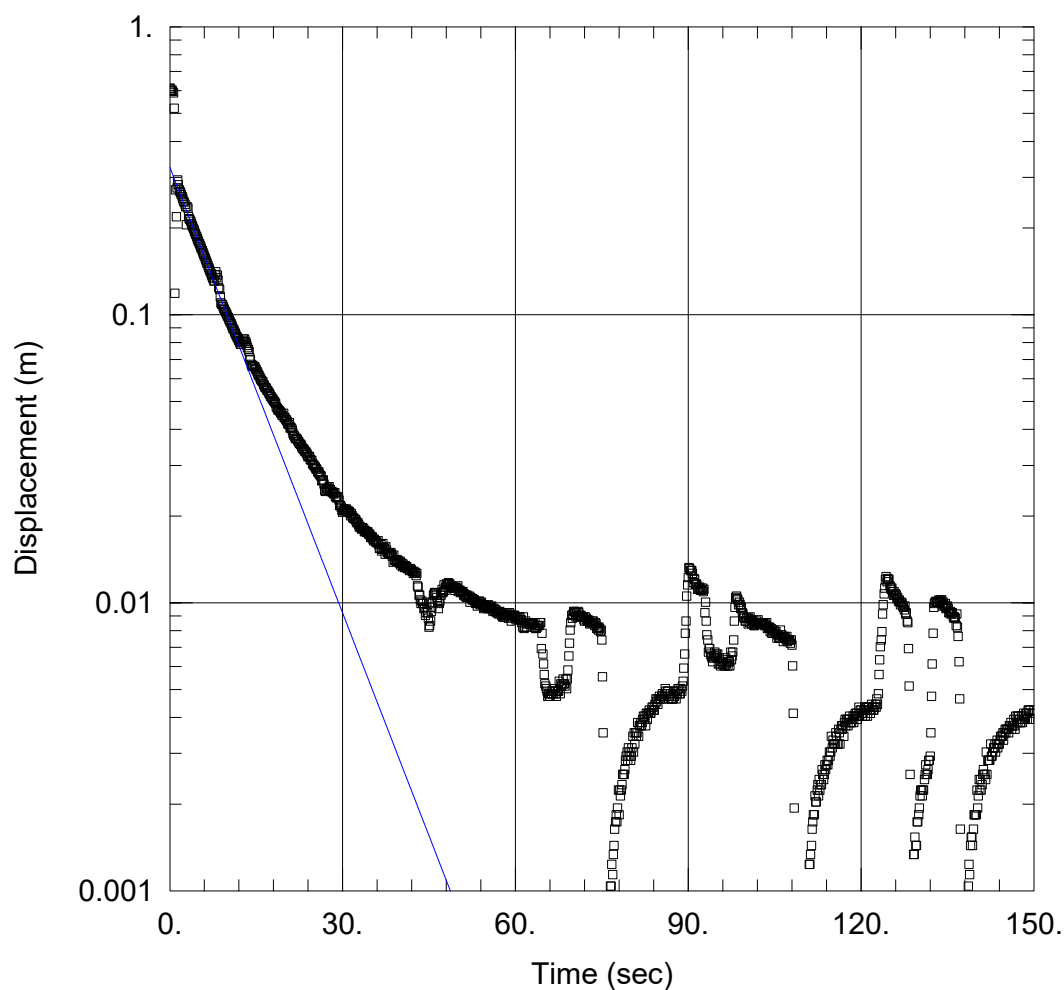
SOLUTION

Aquifer Model: Confined

$K = 1.872$ m/day

Solution Method: Bouwer-Rice

$y_0 = 0.1735$ m



MH25-08_FHT2_1

Data Set: V:\...\MH25-08_FHT2.aqt

Date: 04/07/26

Time: 15:04:16

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-08

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.12 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MH25-08)

Initial Displacement: 0.61 m

Total Well Penetration Depth: 1.3 m

Casing Radius: 0.02 m

Static Water Column Height: 6.12 m

Screen Length: 1.3 m

Well Radius: 0.05 m

Gravel Pack Porosity: 0.2

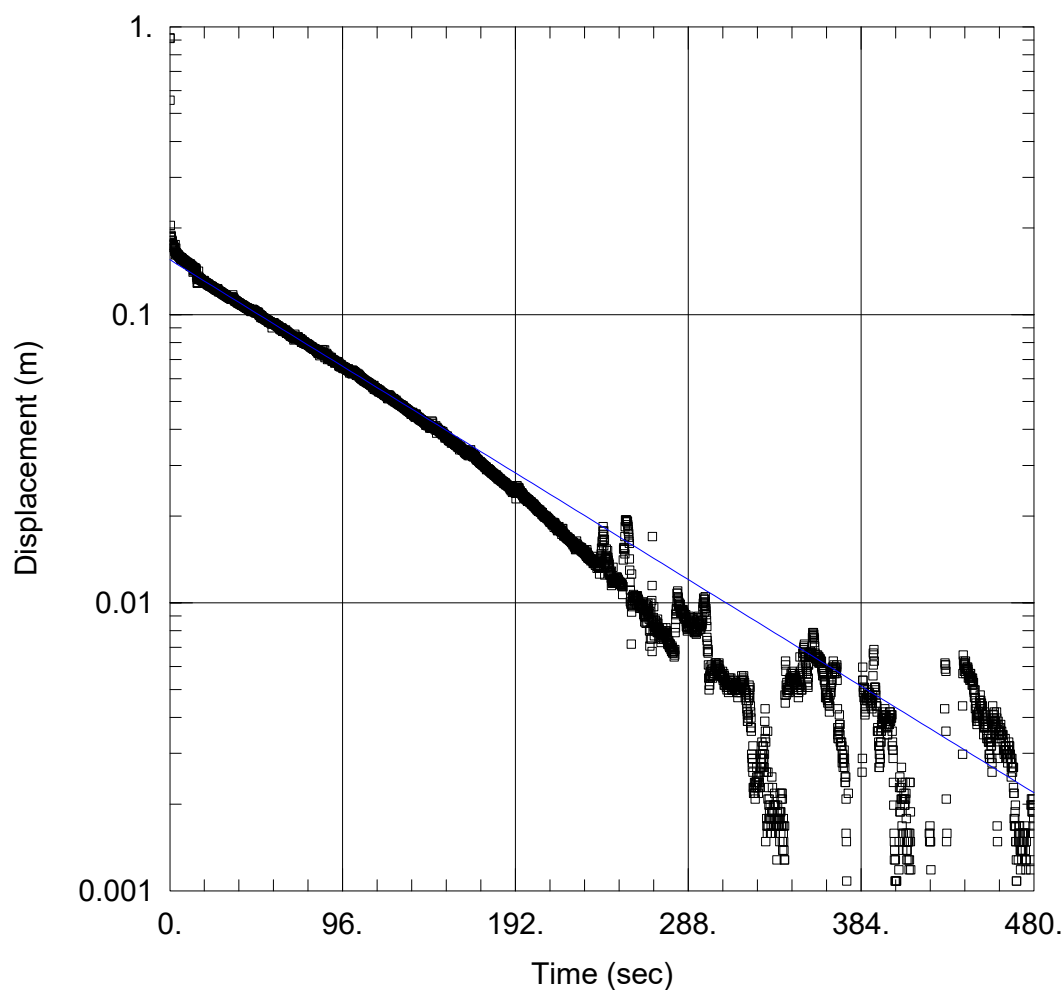
SOLUTION

Aquifer Model: Confined

K = 3.203 m/day

Solution Method: Bouwer-Rice

y0 = 0.3251 m



MH25-08_RHT1_2

Data Set: V:\...\MH25-08_RHT1.aqt

Date: 04/07/26

Time: 14:40:33

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-08

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.12 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-08)

Initial Displacement: 0.91 m

Total Well Penetration Depth: 1.3 m

Casing Radius: 0.02 m

Static Water Column Height: 6.12 m

Screen Length: 1.3 m

Well Radius: 0.05 m

Gravel Pack Porosity: 0.2

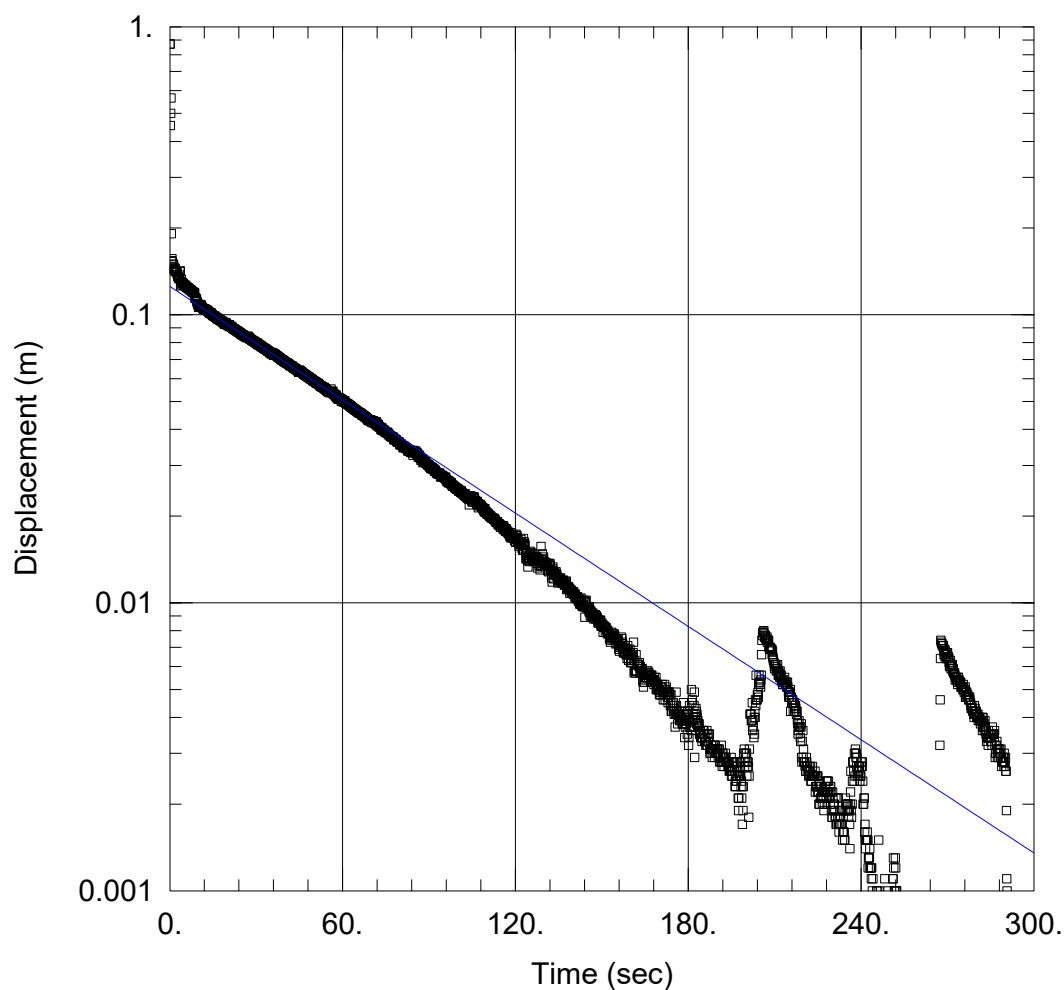
SOLUTION

Aquifer Model: Confined

$K = 0.2395$ m/day

Solution Method: Bouwer-Rice

$y_0 = 0.1553$ m



MH25-08_RHT2_2

Data Set: V:\...\MH25-08_RHT2.aqt

Date: 04/07/26

Time: 15:21:58

PROJECT INFORMATION

Company: WGA

Client: Te Kowhai East Ltd Partnership

Project: WGA212384

Location: Horotiu

Test Well: MH25-08

Test Date: 20 March 2026

AQUIFER DATA

Saturated Thickness: 6.12 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (MH25-08)

Initial Displacement: 0.87 m

Total Well Penetration Depth: 1.3 m

Casing Radius: 0.02 m

Static Water Column Height: 6.12 m

Screen Length: 1.3 m

Well Radius: 0.05 m

Gravel Pack Porosity: 0.2

SOLUTION

Aquifer Model: Confined

$K = 0.4072$ m/day

Solution Method: Bouwer-Rice

$y_0 = 0.1254$ m

APPENDIX F

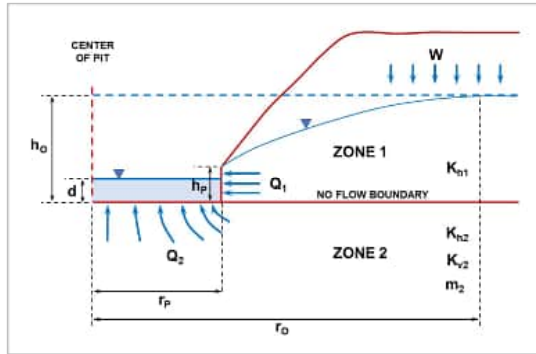
GROUNDWATER MODELLING



INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Mudfish Habitat North: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.5	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	12	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r _o calculated by iterating equation A	109	m
Known h _o	1.5	m
h _o calculated using Equation A	1.5	m
Q ₁	2.9E-04	m ³ /s
	2.53E+01	m ³ /day

Inflow from Zone 2

Anisotropy parameter calculated using equation D	1.414214	
Q ₂	3.7E-03	m ³ /s
	3.2E+02	m ³ /day

Total Pit Inflow

Q _{TOT}	4.0E-03	m ³ /s
	3.4E+02	m ³ /day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

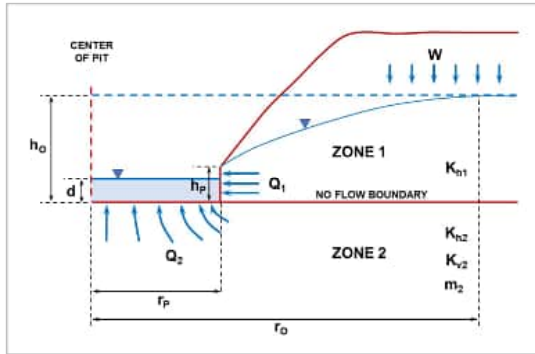
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained base of excavation.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Mudfish Habitat South: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.5	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	8	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 100 m

Known h_o 1.5 m

h_o calculated using Equation A 1.5 m

Q₁ 2.5E-04 m³/s
2.14E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 2.4E-03 m³/s
2.1E+02 m³/day

Total Pit Inflow

Q_{TOT} 2.7E-03 m³/s
2.3E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

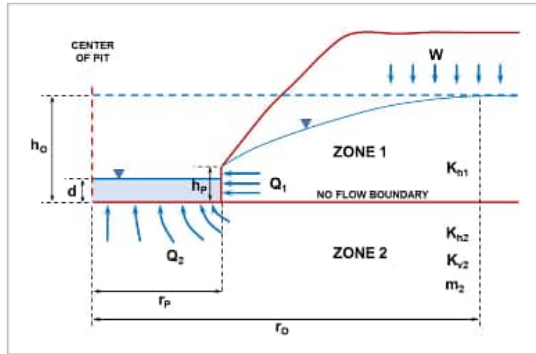
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained at base of excavation.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 1A: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.1	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	19	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 122 m

Known h_o 2.1 m

h_o calculated using Equation A 2.1 m

Q₁ 3.6E-04 m³/s
3.13E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 4.2E-03 m³/s
3.6E+02 m³/day

Total Pit Inflow

Q_{TOT} 4.5E-03 m³/s
3.9E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

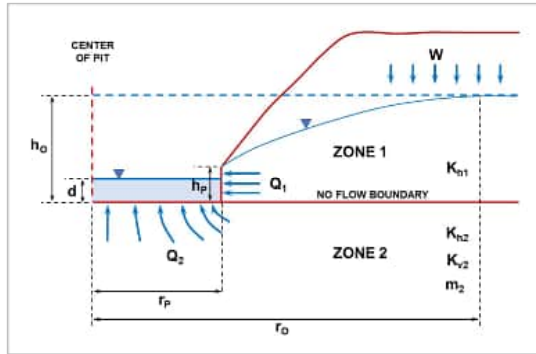
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 1B: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.8	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	30	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 217 m

Known h_o 2.8 m

h_o calculated using Equation A 2.8 m

Q₁ 1.2E-03 m³/s
9.94E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 1.7E-02 m³/s
1.5E+03 m³/day

Total Pit Inflow

Q_{TOT} 1.8E-02 m³/s
1.6E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

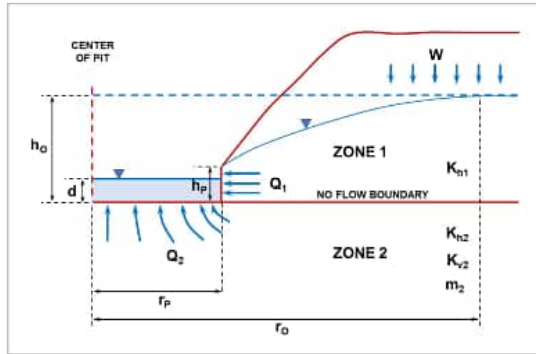
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 2: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	18	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 116 m

Known h_o 2 m

h_o calculated using Equation A 2.0 m

Q₁ 3.3E-04 m³/s
2.83E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 3.8E-03 m³/s
3.3E+02 m³/day

Total Pit Inflow

Q_{TOT} 4.1E-03 m³/s
3.5E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

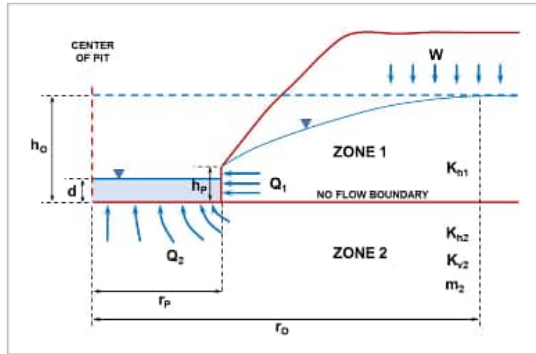
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 3A: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.8	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	19	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 139 m

Known h_o 1.8 m

h_o calculated using Equation A 1.8 m

Q₁ 4.7E-04 m³/s
4.08E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 7.0E-03 m³/s
6.0E+02 m³/day

Total Pit Inflow

Q_{TOT} 7.4E-03 m³/s
6.4E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

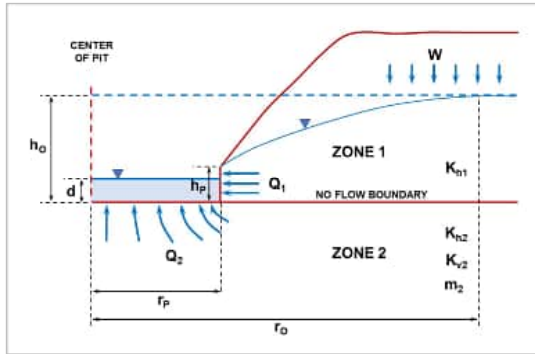
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 3B: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.8	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	17	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 136 m

Known h_o 1.8 m

h_o calculated using Equation A 1.8 m

Q₁ 4.5E-04 m³/s
3.92E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 6.2E-03 m³/s
5.4E+02 m³/day

Total Pit Inflow

Q_{TOT} 6.7E-03 m³/s
5.8E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

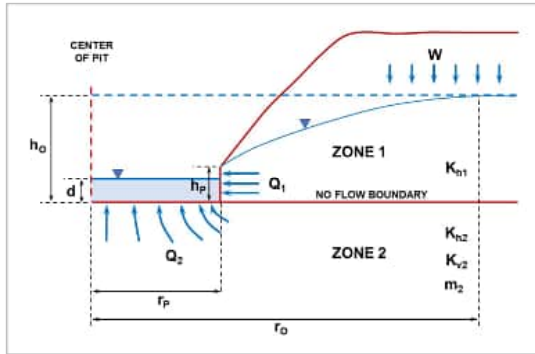
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 4A: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.6	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	19	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 143 m

Known h_o 2.6 m

h_o calculated using Equation A 2.6 m

Q₁ 5.0E-04 m³/s
4.32E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 5.2E-03 m³/s
4.5E+02 m³/day

Total Pit Inflow

Q_{TOT} 5.7E-03 m³/s
4.9E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

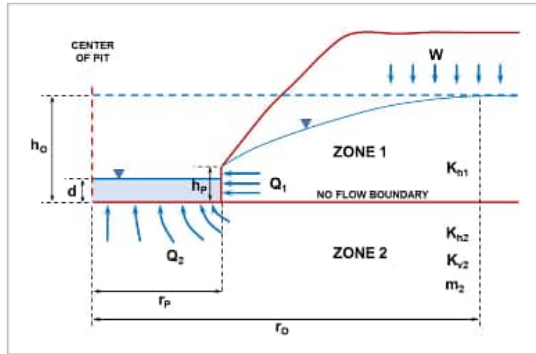
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 4B: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.6	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	20	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r _o calculated by iterating equation A	101	m
Known h _o	1.6	m
h _o calculated using Equation A	1.6	m
Q ₁	2.4E-04	m ³ /s
	2.11E+01	m ³ /day

Inflow from Zone 2

Anisotropy parameter calculated using equation D	1.414214	
Q ₂	3.3E-03	m ³ /s
	2.9E+02	m ³ /day

Total Pit Inflow

Q _{TOT}	3.6E-03	m ³ /s
	3.1E+02	m ³ /day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

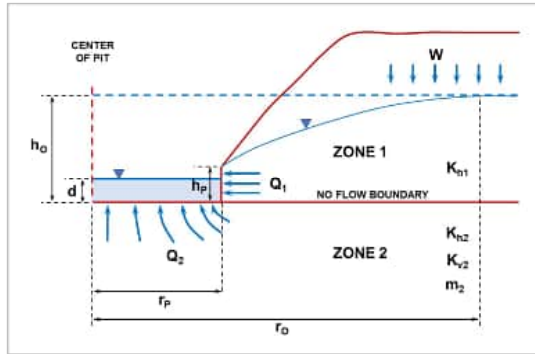
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 5: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.8	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	19	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r _o calculated by iterating equation A	109	m
Known h _o	1.8	m
h _o calculated using Equation A	1.8	m
Q ₁	2.9E-04	m ³ /s
	2.48E+01	m ³ /day

Inflow from Zone 2

Anisotropy parameter calculated using equation D	1.414214	
Q ₂	3.6E-03	m ³ /s
	3.1E+02	m ³ /day

Total Pit Inflow

Q _{TOT}	3.9E-03	m ³ /s
	3.3E+02	m ³ /day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

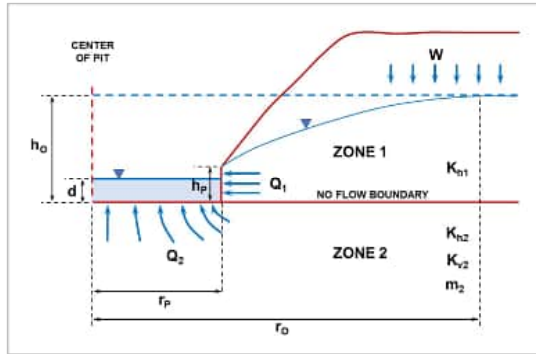
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 5: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.2	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	26	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 137 m

Known h_o 2.2 m

h_o calculated using Equation A 2.2 m

Q₁ 4.5E-04 m³/s
3.89E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 6.0E-03 m³/s
5.2E+02 m³/day

Total Pit Inflow

Q_{TOT} 6.4E-03 m³/s
5.6E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

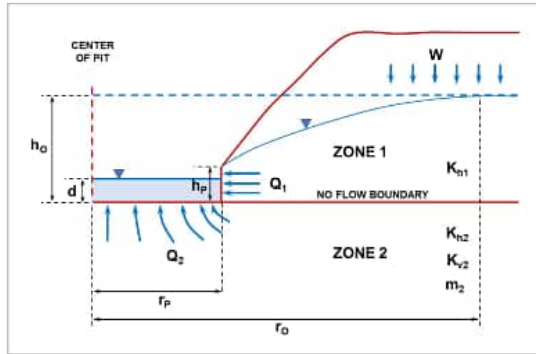
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Raingarden 8: CONSTRUCTION
Date: Monday, 24 August 2026
Document #: WGA212384-RP-HG-0007_E



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.2	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	22	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 139 m

Known h_o 1.2 m

h_o calculated using Equation A 1.7 m

Q₁ 4.7E-04 m³/s
4.05E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 5.4E-03 m³/s
4.6E+02 m³/day

Total Pit Inflow

Q_{TOT} 5.8E-03 m³/s
5.1E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

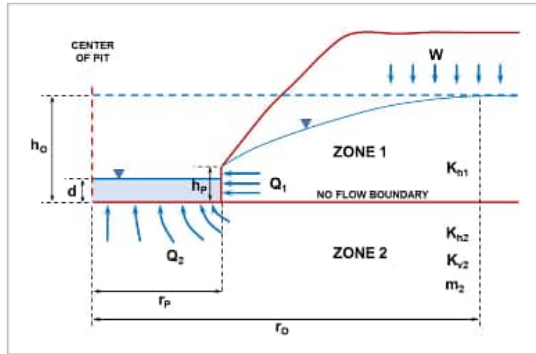
Analysed by: CAJ 24/08/2026
Checked by: CHO 24/08/2026

Notes: For construction with winter groundwater level and dewatering level maintained 0.5 m below invert level.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 1: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	3.4	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	80	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 267 m

Known h_o 3.4 m

h_o calculated using Equation A 3.4 m

Q₁ 1.6E-03 m³/s
1.40E+02 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 2.8E-02 m³/s
2.5E+03 m³/day

Total Pit Inflow

Q_{TOT} 3.0E-02 m³/s
2.6E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

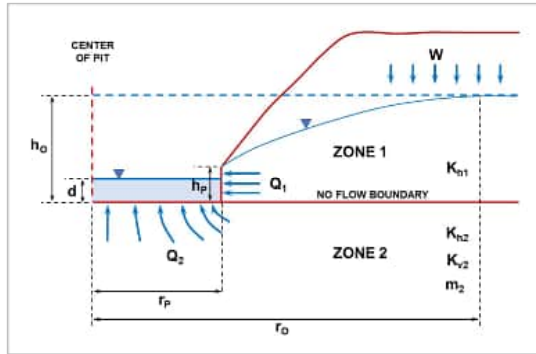
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 1: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.9	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	80	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 189 m

Known h_o 1.9 m

h_o calculated using Equation A 1.9 m

Q₁ 7.3E-04 m³/s
6.34E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 1.3E-02 m³/s
1.1E+03 m³/day

Total Pit Inflow

Q_{TOT} 1.4E-02 m³/s
1.2E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

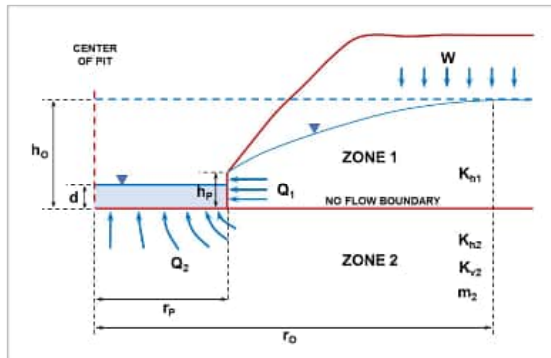
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 1: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[r_0^2 \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

$$dH_{Zone2} = \frac{2(h_0 - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

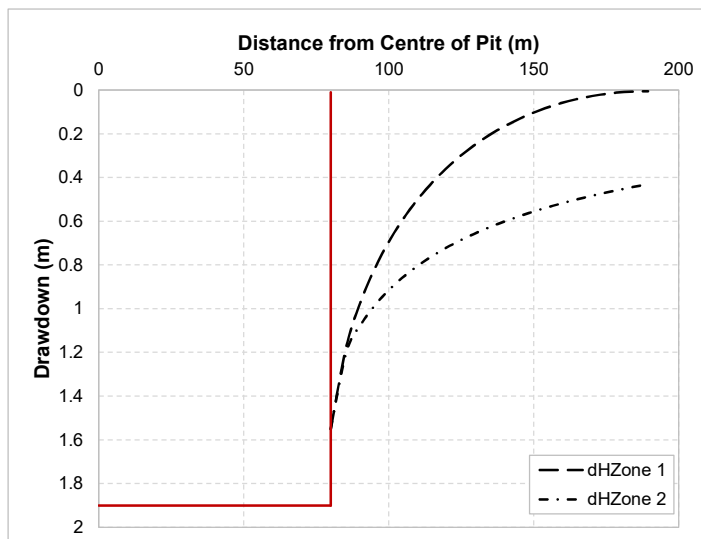
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K_{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K_{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K_{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h_0	1.9	m	initial saturated thickness above the base of Zone 1
h_p	0.35	m	saturated thickness at the pit wall
r_p	80	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_o calculated by iterating equation A in analysis sheet 1

189 m



Drawdown curves

r	dH_{Zone1}	dH_{Zone2}
80	1.55	1.6
85.5	1.2	1.2
90.9	0.9	1.1
96.4	0.8	1.0
101.9	0.7	0.9
107.4	0.5	0.8
112.8	0.5	0.8
118.3	0.4	0.7
123.8	0.3	0.7
129.2	0.3	0.7
134.7	0.2	0.6
140.2	0.2	0.6
145.6	0.1	0.6
151.1	0.10	0.6
156.6	0.07	0.5
162.1	0.05	0.5
167.5	0.03	0.5
173.0	0.02	0.5
178.5	0.01	0.5
183.9	0.01	0.4
189.4	0.01	0.4

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

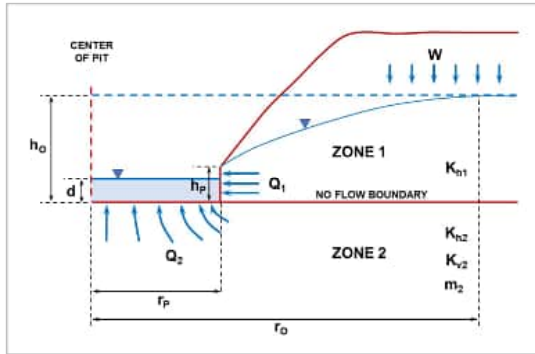
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 2: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.75	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	60	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 210 m

Known h_o 2.75 m

h_o calculated using Equation A 2.7 m

Q₁ 1.0E-03 m³/s
8.72E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 1.7E-02 m³/s
1.5E+03 m³/day

Total Pit Inflow

Q_{TOT} 1.8E-02 m³/s
1.6E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

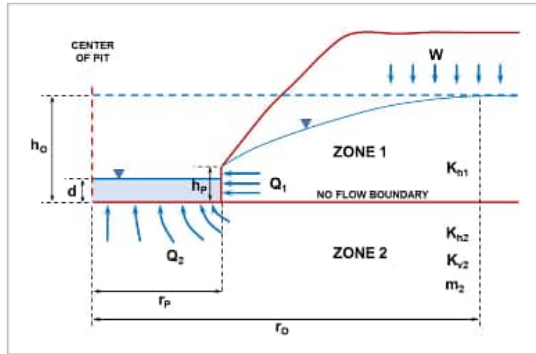
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 2: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.25	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	60	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 131 m

Known h_o 1.25 m

h_o calculated using Equation A 1.2 m

Q₁ 3.4E-04 m³/s
2.93E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 5.7E-03 m³/s
4.9E+02 m³/day

Total Pit Inflow

Q_{TOT} 6.0E-03 m³/s
5.2E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

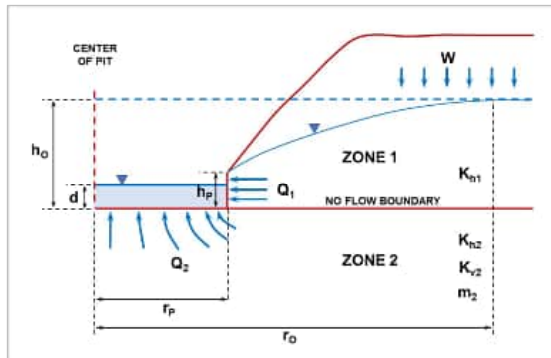
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 2: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_o - \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

$$dH_{Zone2} = \frac{2(h_o - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

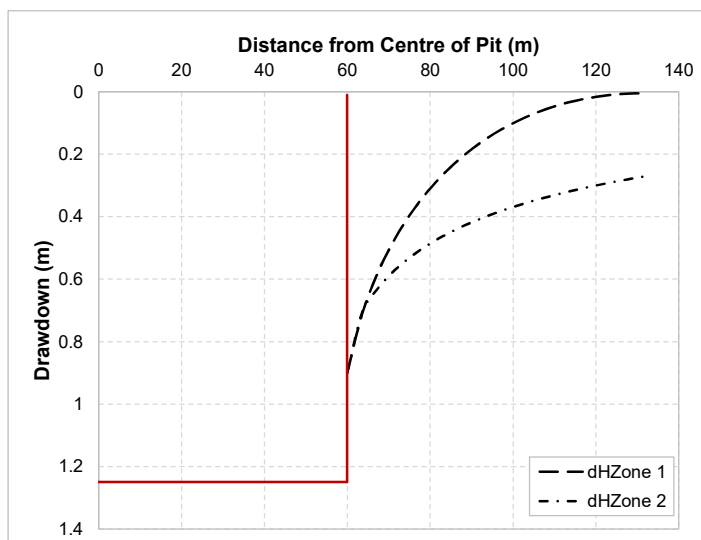
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.25	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	60	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_o calculated by iterating equation A in analysis sheet 1

131 m



Drawdown curves

r	dH _{Zone 1}	dH _{Zone 2}
60	0.9	0.9
63.6	0.7	0.7
67.1	0.6	0.6
70.7	0.5	0.6
74.2	0.41	0.5
77.8	0.3	0.5
81.4	0.3	0.5
84.9	0.2	0.4
88.5	0.2	0.4
92.0	0.2	0.4
95.6	0.1	0.4
99.2	0.1	0.4
102.7	0.1	0.4
106.3	0.06	0.3
109.8	0.05	0.3
113.4	0.03	0.3
117.0	0.02	0.3
120.5	0.02	0.3
124.1	0.01	0.3
127.6	0.01	0.3
131.2	0.00	0.3

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

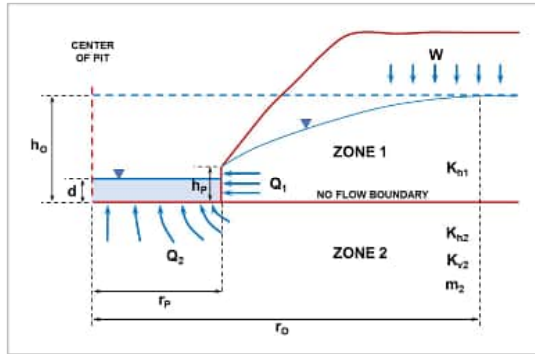
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 3: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.25	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	50	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 215 m

Known h_o 2.25 m

h_o calculated using Equation A 2.2 m

Q₁ 1.1E-03 m³/s
9.41E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 2.3E-02 m³/s
2.0E+03 m³/day

Total Pit Inflow

Q_{TOT} 2.4E-02 m³/s
2.1E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

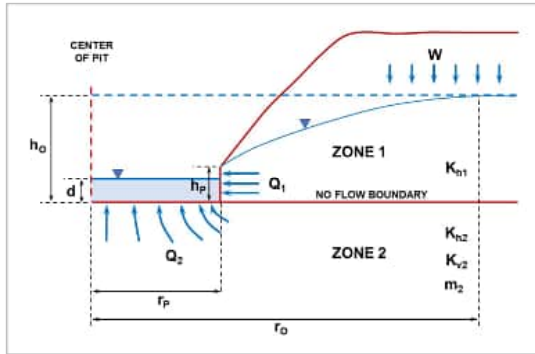
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 3: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K_{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K_{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K_{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h_o	0.75	m	initial saturated thickness above the base of Zone 1
h_p	0.35	m	saturated thickness at the pit wall
r_p	50	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 105 m

Known h_o 0.75 m

h_o calculated using Equation A 0.7 m

Q_1 2.1E-04 m³/s
1.84E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q_2 4.1E-03 m³/s
3.5E+02 m³/day

Total Pit Inflow

Q_{TOT} 4.3E-03 m³/s
3.7E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

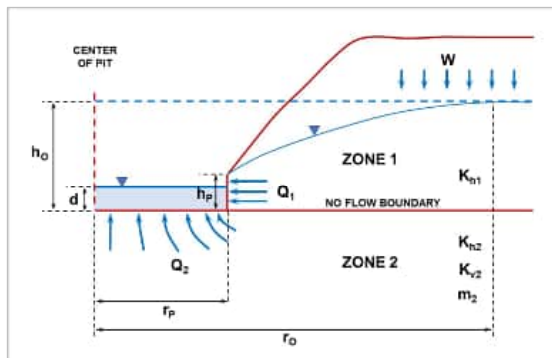
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 3: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[r_0^2 \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

$$dH_{Zone2} = \frac{2(h_0 - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

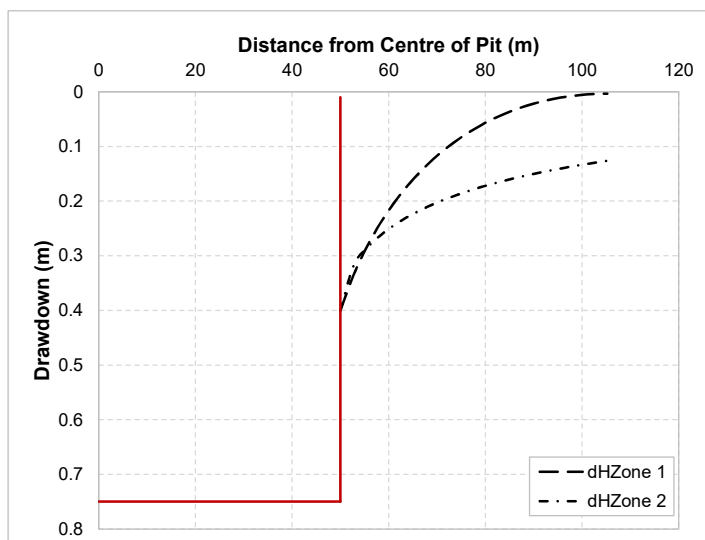
W	7.93E-09	m/s	recharge flux
K_{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K_{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K_{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h_0	0.75	m	initial saturated thickness above the base of Zone 1
h_p	0.35	m	saturated thickness at the pit wall
r_p	50	m	effective pit radius
d	0.35	m	depth of the pit lake

r_0 is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_0 calculated by iterating equation A in analysis sheet 1

105 m

Drawdown curves



r	dH_{Zone1}	dH_{Zone2}
50	0.4	0.4
52.8	0.3	0.3
55.5	0.3	0.3
58.3	0.2	0.3
61.0	0.2	0.2
63.8	0.2	0.2
66.6	0.1	0.2
69.3	0.1	0.2
72.1	0.1	0.2
74.8	0.1	0.2
77.6	0.1	0.2
80.4	0.1	0.2
83.1	0.0	0.2
85.9	0.03	0.2
88.6	0.03	0.2
91.4	0.02	0.1
94.2	0.01	0.1
96.9	0.01	0.1
99.7	0.01	0.1
102.4	0.00	0.1
105.2	0.00	0.1

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

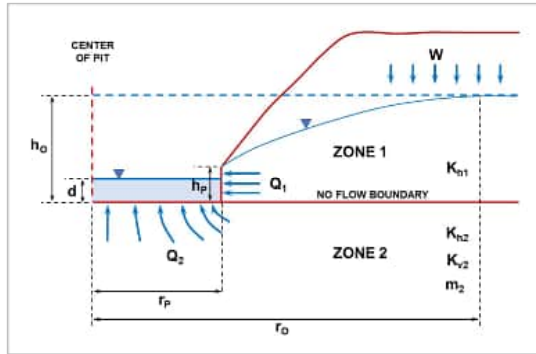
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 4: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	3.4	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	68	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 252 m

Known h_o 3.4 m

h_o calculated using Equation A 3.4 m

Q₁ 1.5E-03 m³/s
1.27E+02 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 2.4E-02 m³/s
2.1E+03 m³/day

Total Pit Inflow

Q_{TOT} 2.6E-02 m³/s
2.2E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

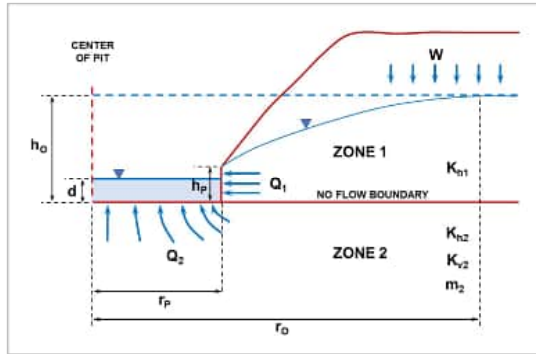
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 4: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.9	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	68	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r _o calculated by iterating equation A	176	m
Known h _o	1.9	m
h _o calculated using Equation A	1.9	m
Q ₁	6.5E-04	m ³ /s
	5.63E+01	m ³ /day

Inflow from Zone 2

Anisotropy parameter calculated using equation D	1.414214	
Q ₂	1.1E-02	m ³ /s
	9.5E+02	m ³ /day

Total Pit Inflow

Q _{TOT}	1.2E-02	m ³ /s
	1.0E+03	m ³ /day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

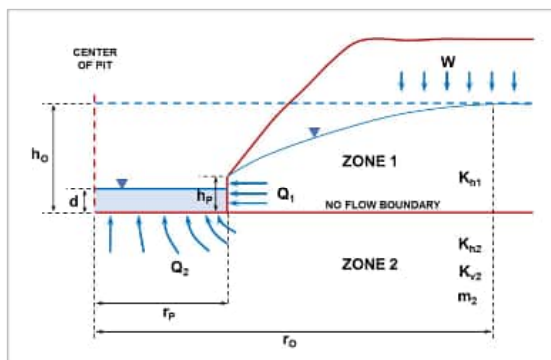
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 4: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[r_0^2 \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

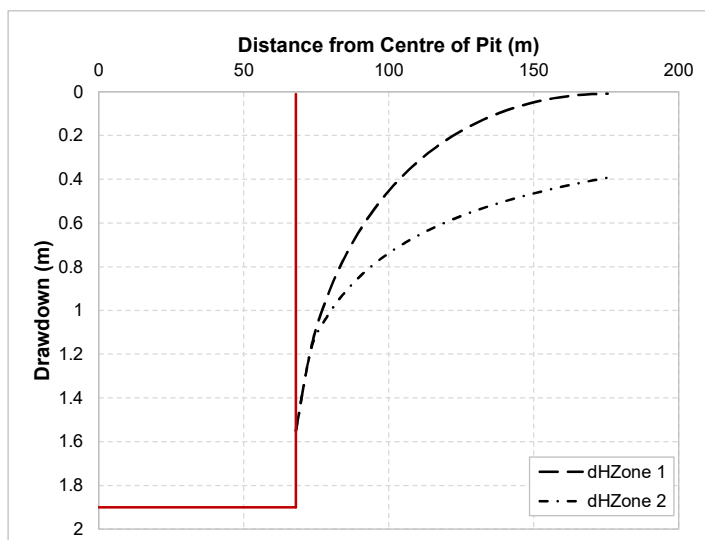
$$dH_{Zone2} = \frac{2(h_0 - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h ₀	1.9	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	68	m	effective pit radius
d	0.35	m	depth of the pit lake

r₀ is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r₀ calculated by iterating equation A in analysis sheet 1 176 m



Drawdown curves

r	dH _{Zone 1}	dH _{Zone 2}
68	1.55	1.6
73.4	1.2	1.2
78.8	0.9	1.0
84.1	0.8	0.9
89.5	0.6	0.9
94.9	0.5	0.8
100.3	0.4	0.7
105.6	0.4	0.7
111.0	0.3	0.7
116.4	0.3	0.6
121.8	0.2	0.6
127.1	0.2	0.6
132.5	0.1	0.5
137.9	0.10	0.5
143.3	0.07	0.5
148.6	0.05	0.5
154.0	0.04	0.5
159.4	0.02	0.4
164.8	0.02	0.4
170.1	0.01	0.4
175.5	0.01	0.4

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

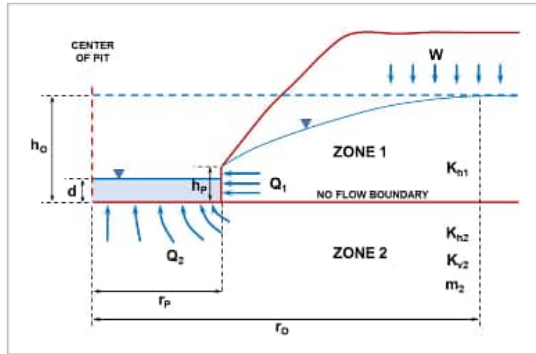
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 5: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.7	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	55	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 201 m

Known h_o 2.7 m

h_o calculated using Equation A 2.7 m

Q₁ 9.3E-04 m³/s
 8.05E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 1.6E-02 m³/s
 1.3E+03 m³/day

Total Pit Inflow

Q_{TOT} 1.6E-02 m³/s
 1.4E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

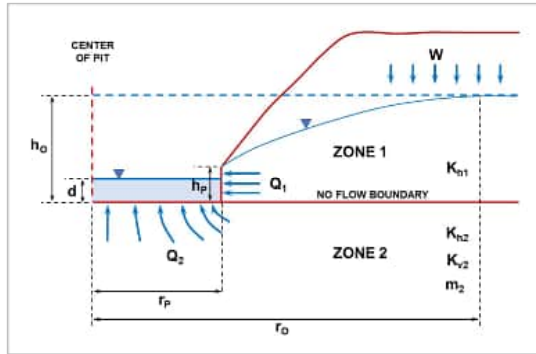
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 5: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.2	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	55	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 123 m

Known h_o 1.2 m

h_o calculated using Equation A 1.2 m

Q₁ 3.0E-04 m³/s
2.61E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 4.9E-03 m³/s
4.2E+02 m³/day

Total Pit Inflow

Q_{TOT} 5.2E-03 m³/s
4.5E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

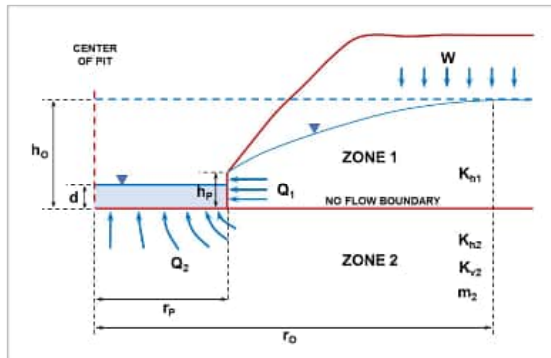
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 5: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[\frac{r^2}{r_p^2} \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

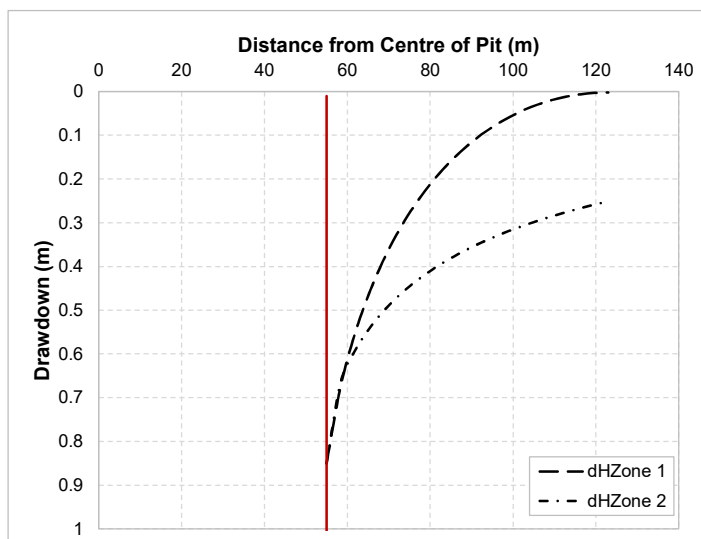
$$dH_{Zone2} = \frac{2(h_0 - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K_{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K_{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K_{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h_0	1.2	m	initial saturated thickness above the base of Zone 1
h_p	0.35	m	saturated thickness at the pit wall
r_p	55	m	effective pit radius
d	0.35	m	depth of the pit lake

r_0 is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_0 calculated by iterating equation A in analysis sheet 1 123 m



Drawdown curves

r	dH_{Zone1}	dH_{Zone2}
55	0.85	0.9
58.4	0.7	0.7
61.8	0.6	0.6
65.2	0.5	0.5
68.6	0.4	0.5
72.0	0.3	0.5
75.4	0.3	0.4
78.8	0.2	0.4
82.2	0.2	0.4
85.6	0.2	0.4
89.0	0.1	0.4
92.4	0.1	0.3
95.8	0.1	0.3
99.2	0.06	0.3
102.6	0.04	0.3
106.0	0.03	0.3
109.4	0.02	0.3
112.8	0.01	0.3
116.2	0.01	0.3
119.6	0.00	0.3
123.0	0.00	0.3

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

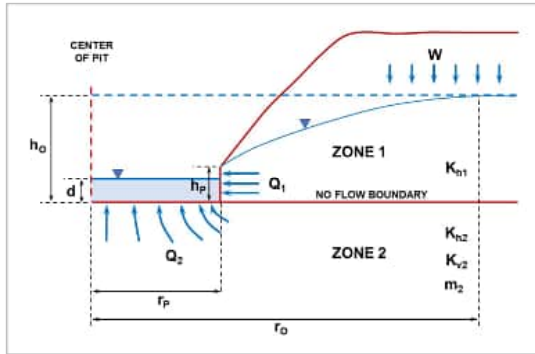
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 6: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.65	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	65	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 211 m

Known h_o 2.65 m

h_o calculated using Equation A 2.6 m

Q₁ 1.0E-03 m³/s
8.67E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 1.8E-02 m³/s
1.6E+03 m³/day

Total Pit Inflow

Q_{TOT} 1.9E-02 m³/s
1.6E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

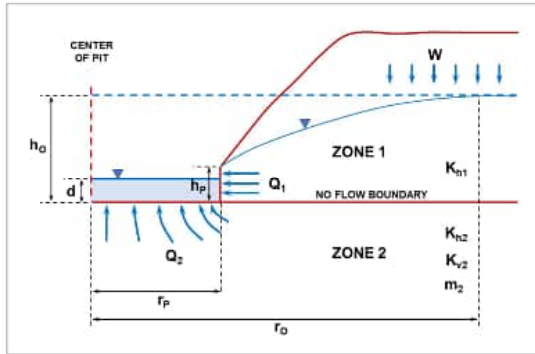
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 6: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2) \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.15	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	65	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 131 m

Known h_o 1.15 m

h_o calculated using Equation A 1.1 m

Q₁ 3.2E-04 m³/s
2.78E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 5.4E-03 m³/s
4.7E+02 m³/day

Total Pit Inflow

Q_{TOT} 5.8E-03 m³/s
5.0E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

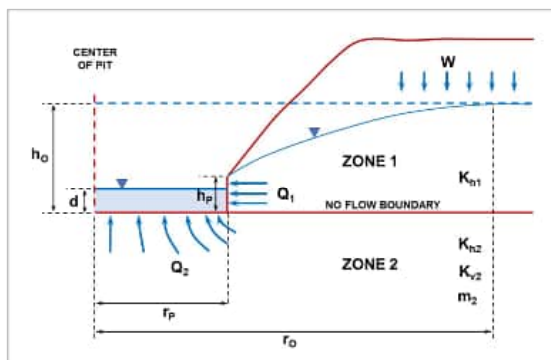
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 6: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[\frac{r^2}{r_p^2} \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

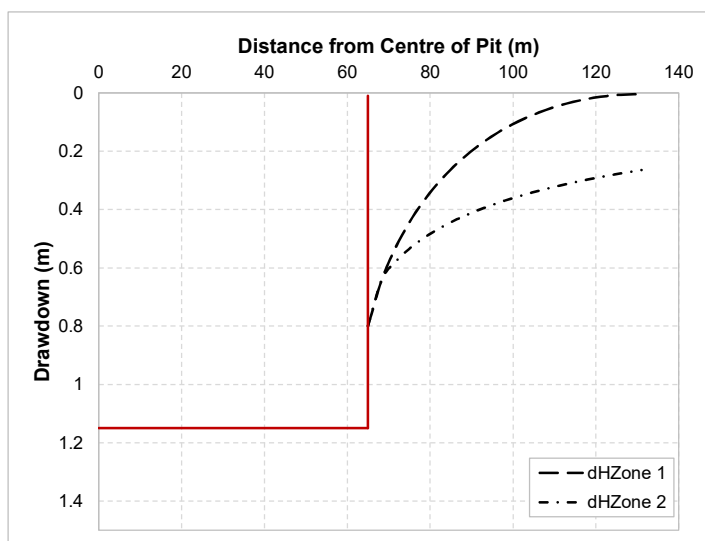
$$dH_{Zone2} = \frac{2(h_0 - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K_{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K_{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K_{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h_0	1.15	m	initial saturated thickness above the base of Zone 1
h_p	0.35	m	saturated thickness at the pit wall
r_p	65	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_o calculated by iterating equation A in analysis sheet 1 131 m



Drawdown curves

r	dH_{Zone1}	dH_{Zone2}
65	0.8	0.8
68.3	0.6	0.6
71.6	0.5	0.6
74.9	0.4	0.5
78.2	0.4	0.5
81.5	0.3	0.5
84.8	0.3	0.4
88.1	0.2	0.4
91.4	0.2	0.4
94.7	0.2	0.4
98.0	0.1	0.4
101.3	0.1	0.4
104.6	0.1	0.3
107.9	0.06	0.3
111.2	0.04	0.3
114.5	0.03	0.3
117.8	0.02	0.3
121.1	0.01	0.3
124.4	0.01	0.3
127.7	0.00	0.3
131.0	0.00	0.3

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

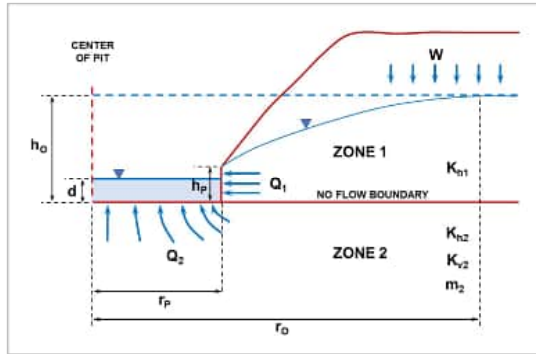
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 7: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000037	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	1.85E-05	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.2	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	48	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 118 m

Known h_o 1.2 m

h_o calculated using Equation A 1.2 m

Q₁ 2.9E-04 m³/s
2.50E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 6.0E-03 m³/s
5.2E+02 m³/day

Total Pit Inflow

Q_{TOT} 6.3E-03 m³/s
5.5E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

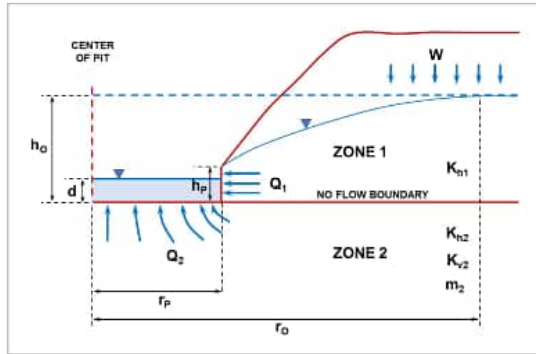
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level applied and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 8: CONSTRUCTION
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	2.25	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	55	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 222 m

Known h_o 2.25 m

h_o calculated using Equation A 2.2 m

Q₁ 1.2E-03 m³/s
9.96E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 2.5E-02 m³/s
2.2E+03 m³/day

Total Pit Inflow

Q_{TOT} 2.6E-02 m³/s
2.3E+03 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

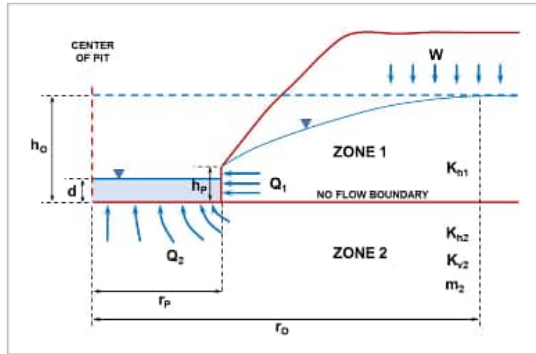
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: For construction with winter groundwater level and dewatering level maintained 0.5 m below base of deep marsh.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 8: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$\begin{aligned}
 \text{A } h_o &= \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}, \\
 \text{B } Q_1 &= W \pi (r_o^2 - r_p^2), \\
 \text{C } Q_2 &= 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d), \\
 \text{D } m_2 &= \sqrt{\frac{K_{h2}}{K_{v2}}}
 \end{aligned}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	0.75	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	55	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 111 m

Known h_o 0.75 m

h_o calculated using Equation A 0.7 m

Q₁ 2.3E-04 m³/s
1.98E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 1.414214

Q₂ 4.5E-03 m³/s
3.9E+02 m³/day

Total Pit Inflow

Q_{TOT} 4.7E-03 m³/s
4.1E+02 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

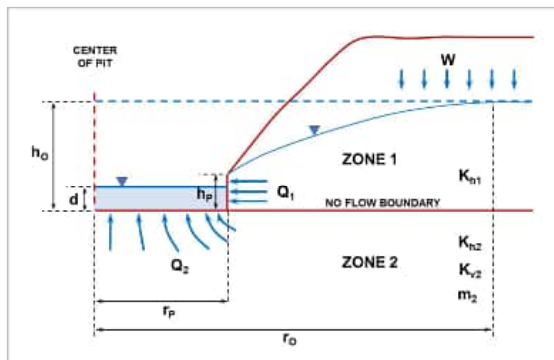
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: Long term drawdown effect below summer groundwater level with design water level applied.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East Hydrogeological Effects Assessment
Project #: WGA212384
Location: Stormwater Wetland 8: LONG-TERM
Date: Tuesday, 23 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone1} = h_o - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[r_o^2 \ln\left(\frac{r}{r_p}\right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

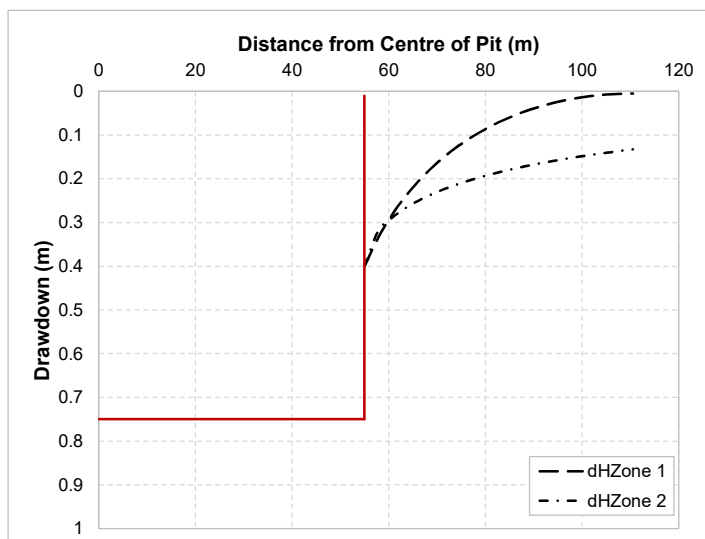
$$dH_{Zone2} = \frac{2(h_o - d)}{\pi} \sin^{-1}\left(\frac{r_p}{r}\right)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	0.000072	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	0.000072	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	0.000036	m/s	vertical hydraulic conductivity in Zone 2
h _o	0.75	m	initial saturated thickness above the base of Zone 1
h _p	0.35	m	saturated thickness at the pit wall
r _p	55	m	effective pit radius
d	0.35	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_o calculated by iterating equation A in analysis sheet 1 111 m



Drawdown curves

r	dH _{Zone 1}	dH _{Zone 2}
55	0.4	0.4
57.8	0.3	0.3
60.6	0.3	0.3
63.3	0.2	0.3
66.1	0.2	0.3
68.9	0.2	0.2
71.7	0.1	0.2
74.4	0.1	0.2
77.2	0.1	0.2
80.0	0.1	0.2
82.8	0.1	0.2
85.5	0.1	0.2
88.3	0.0	0.2
91.1	0.04	0.2
93.9	0.03	0.2
96.6	0.02	0.2
99.4	0.01	0.1
102.2	0.01	0.1
105.0	0.01	0.1
107.7	0.01	0.1
110.5	0.01	0.1

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

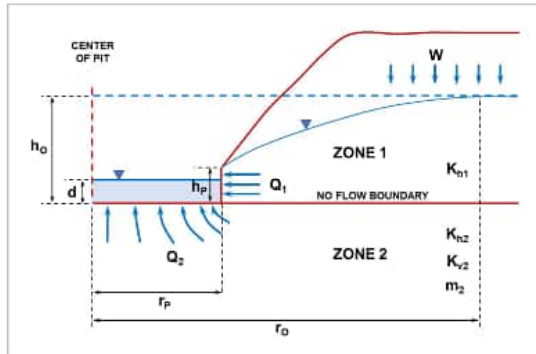
Analysed by: CAJ 23/06/2026
Checked by: CHO 23/06/2026

Notes: The drawdown curves apply along the no-flow boundary line at an elevation equivalent to the base of the pit.
 The dH_{Zone2} line does not take into account recharge from above.
 Drawdown projections are initial approximations only.

INFLOW TO OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
 PROJECT: Te Kowhai East
 Project #: WGA212384
 Location: WWPS Shallow Pit
 Date: Tuesday, 9 June 2026
 Document #: WGA212384-RP-HG-0007_B



$$A \quad h_o = \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]}$$

$$B \quad Q_1 = W \pi (r_o^2 - r_p^2)$$

$$C \quad Q_2 = 4 r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d)$$

$$D \quad m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
K _{h1}	4.00E-04	m/s	horizontal hydraulic conductivity in Zone 1
K _{h2}	3.70E-05	m/s	horizontal hydraulic conductivity in Zone 2
K _{v2}	6.17E-06	m/s	vertical hydraulic conductivity in Zone 2
h _o	1.4	m	initial saturated thickness above the base of Zone 1
h _p	0	m	saturated thickness at the pit wall
r _p	1.40	m	effective pit radius
d	0	m	depth of the pit lake

r_o is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Inflow from Zone 1

Radius of influence r_o calculated by iterating equation A 154 m

Known h_o 1.40 m

h_o calculated using Equation A 1.40 m

Q₁ 5.9E-04 m³/s
 5.1E+01 m³/day

Inflow from Zone 2

Anisotropy parameter calculated using equation D 2.44949

Q₂ 1.2E-04 m³/s
 1.0E+01 m³/day

Total Pit Inflow

Q_{TOT} 7.1E-04 m³/s
 60.93 m³/day

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

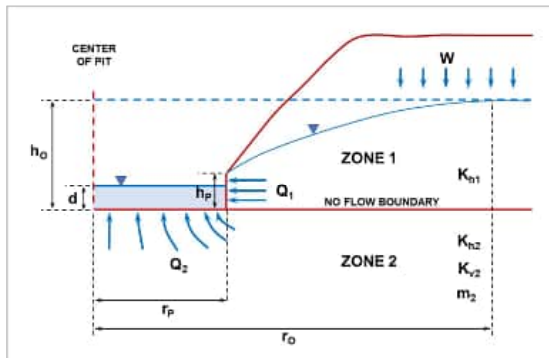
Analysed by: CAJ 9/06/2026
 Checked by: CHO 9/06/2026

Notes: If a sheet pile wall is used to support the excavation, the likely inflows through the pile wall will be much smaller than those calculated in this sheet.

GROUNDWATER DRAWDOWN AROUND OPEN PIT - APPROXIMATION

WGA

CLIENT: Te Kowhai East Limited Partnership
PROJECT: Te Kowhai East
Project #: WGA212384
Location: WWPS Shallow Pit
Date: Tuesday, 9 June 2026
Document #: WGA212384-RP-HG-0007_B



$$dH_{Zone 1} = h_0 - \sqrt{h_p^2 + \frac{W}{k_{h1}} \left[r_0^2 \ln \left(\frac{r}{r_p} \right) - \frac{(r^2 - r_p^2)}{2} \right]}$$

$$dH_{Zone 2} = \frac{2(h_0 - d)}{\pi} \sin^{-1} \left(\frac{r_p}{r} \right)$$

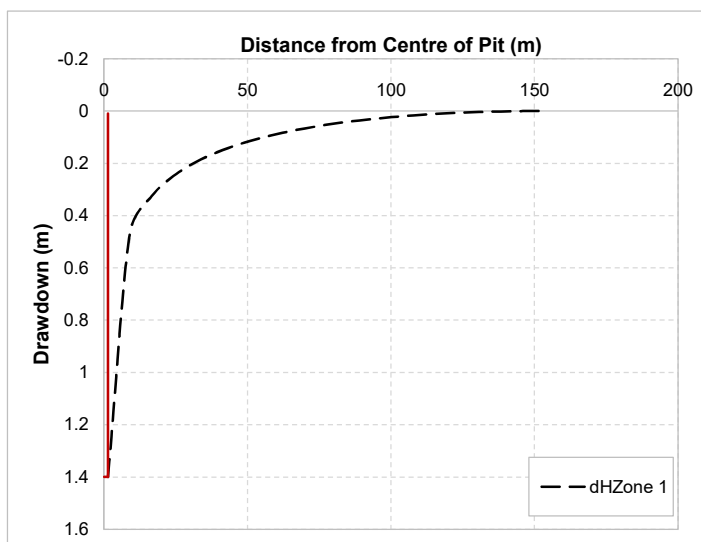
$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

W	7.93E-09	m/s	recharge flux
Kh1	0.0004	m/s	horizontal hydraulic conductivity in Zone 1
Kh2	0.000037	m/s	horizontal hydraulic conductivity in Zone 2
Kv2	6.17E-06	m/s	vertical hydraulic conductivity in Zone 2
h0	1.4	m	initial saturated thickness above the base of Zone 1
hp	0	m	saturated thickness at the pit wall
rp	1.4	m	effective pit radius
d	0	m	depth of the pit lake

r_0 is the radius of influence measured from the center of the pit beyond which groundwater drawdown is nil.

Radius of influence r_0 calculated by iterating equation A in analysis sheet 1

154 m



Drawdown curves

r	dH _{Zone 1}	dH _{Zone 2}
1.4	1.4	1.4
9.0	0.47	0.1
16.6	0.33	0.1
24.2	0.25	0.1
31.8	0.20	0.0
39.4	0.16	0.0
47.0	0.13	0.0
54.6	0.10	0.0
62.2	0.08	0.0
69.8	0.07	0.0
77.5	0.05	0.0
85.1	0.04	0.0
92.7	0.03	0.0
100.3	0.02	0.0
107.9	0.02	0.0
115.5	0.01	0.0
123.1	0.01	0.0
130.7	0.00	0.0
138.3	0.00	0.0
145.9	0.00	0.0
153.5	0.00	0.0

Reference: Marinelli, F. & Niccoli W. L. 2000.
 Simple analytical equations for estimating ground water
 inflow to a mine pit. Ground Water 38, no. 2: 311-314.

Analysed by: CAJ 9/06/2026
Checked by: CHO 9/06/2026

Notes: Drawdown projections are initial approximations only.

If a sheet pile wall is used to support the excavation, the likely inflows through the pile wall and consequent drawdown will be much smaller than that calculated in this sheet.

APPENDIX G

WASTEWATER PUMPING STATION DESIGN





FOR FURTHER INFORMATION CONTACT:

Cameron Jasper
Senior Hydrogeologist

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WGANZ.CO.NZ

