

Appendix J Hydrogeology Memo

Memorandum

Subject: ARL Project – Hydrogeology Memorandum
Reference No: 1101798
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1 Introduction

WM New Zealand (WMNZ) has engaged Tonkin & Taylor Ltd (T+T) to prepare technical memoranda for the proposed new solid waste management and disposal facility in the Wayby Valley, north of Auckland ('**ARL**' or '**Project**').

The Project will involve constructing, operating, closing and providing aftercare for a new 24 Mm³ landfill facility and associated infrastructure at Wayby Valley, Wellsford. Ngāti Manuhiri are Project partners and will work with WMNZ on the proposed management and mitigation measures. Once landfilling ceases, the land will be returned to Ngāti Manuhiri as tāngata whenua.

The new landfill will be a Class 1 landfill, as defined in the Technical Guidelines for Disposal to Land (WasteMINZ Technical Guidelines)¹, accepting municipal solid waste. This includes residential and commercial waste, construction and demolition waste, some industrial wastes that meet acceptance criteria, and contaminated soils. Following waste settlement, the landfill cap surface will have a maximum height of 205 m RL.

WMNZ landholdings in the Wayby Valley area comprise a total area of 1020 ha, with the landfill footprint being approximately 60 ha. The WMNZ landholdings have been divided into five general areas; the Eastern Block, the Western Block, the Southern Block, the Waiwhiu Tributary Block and the Waiteraire Tributary Block. The proposed works will involve the following:

- **Site access and operation:** Construction of site access roads, weighbridges, and a vehicle wheel wash.
- **Landfill development:** Major earthworks and the installation of environmental management systems, including a landfill lining system and collection networks for leachate, stormwater, and landfill gas (LFG).
- **Leachate and landfill gas management:** A dedicated leachate management system and a LFG treatment facility, including a LFG flare and a LFG waste-to-energy plant.
- **Support infrastructure:** Facilities for site staff, plant maintenance, and water supply.
- **Terrestrial, freshwater and wetland biodiversity measures:** This includes native revegetation, and a weed and animal pest management programme to offset or compensate for residual adverse effects on terrestrial, freshwater and wetland ecology.

This memorandum provides an outline of the initial findings of the assessment of hydrogeological effects and has been prepared for inclusion in an application for Ministerial referral of the Project under the Fast-track Approvals Act 2024 ('**FTAA**'). Specifically, this memorandum responds to the requirements under section 3.4 of the Fast-track Approvals Referral Application Form and section

¹ Technical Guidelines for Disposal to Land, WasteMINZ, September 2023, Revision 3.1.

13(4)(h) of the FTAA. A full description of the draft proposal is included in the accompanying information attached to the application form for the referral.

2 Summary of findings

Desktop studies, field investigations, drilling, monitoring, pumping tests, and analytical modelling confirm that the site comprises three distinct groundwater systems: perched water in residual soils, shallow groundwater in fractured Pakiri Formation sandstone (of the Waitemata Group), and a deeper regional aquifer flowing predominantly toward Te Awa o Hōteu. The rock mass is anisotropic² with limited open fractures (<1% of rock mass), resulting in slow vertical travel time (e.g., downward travel time to the regional aquifer is approximately 150 years).

Assessment of the indicative landfill design indicates that the engineered liner and subsoil drainage system will locally lower groundwater levels within the landfill footprint but are not expected to cause adverse off-site drawdown effects. The proposed abstraction from the deep aquifer shows a negligible influence on neighbouring groundwater users or regional baseflows. While the landfill will create a recharge shadow, the resulting reductions in groundwater levels and stream baseflows in adjacent catchments are expected to be small. Baseline monitoring is underway to inform any necessary mitigation measures, particularly in adjacent valley streams and around the Kahikatea forest wetland and the wetland located adjacent to the stockpile identified to the west of the potential landfilling area.

Overall, the findings indicate that hydrogeological effects can be appropriately managed through the proposed design, monitoring programmes, and targeted mitigation measures.

3 Assessment methodology

The methodology to inform the assessment to date has been a combination of desktop based and field-based tasks.

The following desktop-based tasks and assessment have been undertaken to inform the assessment:

- Literature, mapping and data review including published geological records, rainfall records and recharge studies.
- Compilation and analysis of existing and new data including groundwater levels and groundwater quality.
- Development of the conceptual hydrogeological model to define the groundwater systems and the influence of structural features (e.g., bedding planes and fracture orientation) and position of groundwater divides.
- Groundwater effects assessments using analytical modelling to consider aspects including groundwater drawdown, groundwater take and diversion, saline intrusion and contaminant fate and transport modelling.
- Data compilation and reporting.

Field work to inform the assessments undertaken to date has included:

- Installation of groundwater monitoring wells to depths between 25 and 50 m.
- Test bore drilling to 251 m to characterise the deeper regional aquifer to assess its potential as a water supply option.
- Installation of four vibrating wire piezometers (VWPs) to measure groundwater levels at a location near the base of the area identified for potential landfilling.

² Describes different physical characteristics, such as hydraulic conductivity, when measured in different directions.

- Groundwater level monitoring comprising manual readings and automated continuous monitoring at selected wells using levelloggers (and barologger) and VVPs.
- Groundwater quality sampling within the majority of monitoring wells to collect baseline data.
- Pumping tests to estimate the transmissivity of the regional aquifer (i.e., ability of groundwater to flow through an aquifer).

Modelling undertaken to inform this assessment has included:

- Water budget modelling using proprietary water budget software, WATYIELD³ to assess potential changes to stream flows.
- Subsoil drains pathway modelling (mass balance / conservation of mass) to assess contaminant transport.
- Pumping test interpretation modelling (parameter estimation) using AquiferTest Pro.
- Groundwater drawdown modelling for proposed future abstraction for water supply.
- Groundwater take/divert modelling (Darcy flow calculation).
- Groundwater modelling using an Analytic Element Method AEM) using proprietary software 'Analytical Aquifer Simulator' (Anaqsim)⁴ to assess horizontal and vertical groundwater flow paths and travel times.⁵
- Wetland catchment changes using analytical calculations to evaluate potential changes in groundwater recharge volumes.

4 Site and project context

A general description of the site and surrounding locality is included in the accompanying information as part of the referral application. The following elements of the site and project are key to the Hydrogeological Assessment:

Geological and structural setting:

- Pakiri Formation bedrock with interbedded sandstone and siltstone forming a generally low-permeability rock mass with localised fracture zones. The rock mass is anisotropic and dominated by two opposing fracture sets. Beneath the potential landfilling area thick zones of unfractured sandstone are present with ~1% fracture occurrence.

Three distinct groundwater systems characterise the hydrogeology of the potential landfilling area:

- A shallow perched system in the residual soils, directly influenced by rainfall recharge and contributing to the baseflow to the streams within the potential landfilling area.
- Shallow groundwater in the upper Pakiri Formation, flowing along fracture zones and bedding planes. Groundwater levels form a muted reflection of the topography, forming local groundwater divides beneath ridgelines. A bore hole within the potential landfilling area recorded the lowest shallow groundwater level at ~90 mRL.
- Deep regional groundwater system (encountered at ~35 mRL in a test bore hole) flowing predominantly west toward Te Awa o Hōteu, with some flow south toward the Waiteraire Stream. Downward flow to the deep aquifer is impeded by competent, unfractured sandstone. This is supported by the ~55 m difference between the shallow groundwater

³ Landcare Research, January 2004. User's Guide for the Land Use Change Water Balance Model (WATYIELD), Ref: LC0203/185. Prepared for Ministry for the Environment.

⁴ [Anaqsim - Meshless Groundwater Simulator for Engineers](#)

system and the deep regional groundwater system in addition to the predicted 150-year travel time.

Aquifer hydraulic characteristics:

- Rock mass horizontal hydraulic conductivity generally between 1×10^{-5} m/s to 4×10^{-7} m/s. The vertical hydraulic conductivity is estimated to be 40 to 250 times lower than the horizontal, supporting pronounced anisotropy.

Landfill design features:

- Key landfill design features were reviewed to understand their influence on groundwater conditions. The engineered lining system creates a very low-permeability barrier that prevents connection between leachate and groundwater in the underlying aquifer. The landfill and lining system will form a recharge shadow that alters the local water balance. This barrier is expected to reduce recharge to the potential landfilling area catchment by approximately 13%, though without materially affecting overall streamflows downstream of the landfill.
- In adjacent catchments, the reduced recharge may lower groundwater levels and decrease baseflows to streams. Subsoil drains installed beneath the lining system will intercept shallow groundwater and help maintain low groundwater levels beneath the landfill footprint.

Surface water environment:

- Several intermittent and permanent streams existing within the potential landfilling area and surrounding catchments and Te Awa o Hōteio and Waiteraire Stream form sensitive environmental receptors.

Wetland ecosystems:

- A Kahikatea Forest wetland and a wetland on lower lying pastoral land to the west of the potential landfilling area. These wetlands are located in a localised catchment area within which one of the potential stockpiles may be placed. This potential stockpile placement will create a recharge shadow and potentially affect the wetland hydrology.

Contaminant transport pathways:

- Points of exposure have been identified as the stream confluence of the potential landfilling area and valley to the north, Te Awa o Hōteio, a Farm Bore and the Waiteraire Stream. The shallow and deep groundwater systems may provide the contaminant transport pathways to these receptors.

5 Assessment of potential effects

Based on the proposal and the information available, an assessment of potential hydrogeological effects has been undertaken and these effects are summarised below:

Shallow groundwater drawdown:

- Drawdown associated with the subsoil drains is likely to be local to the subsoil drains and any effects limited to within the footprint of the landfill. Based on the current information there is no anticipated potential for off-site adverse effects from groundwater drawdown associated with the subsoil drains.

Regional groundwater drawdown:

- Drawdown from a production bore based on testing indicates that there are no potential adverse effects on groundwater users associated with establishing a groundwater take from

the regional aquifer. The down-gradient Farm Bore was predicted to experience ~0.02 m of drawdown after 150 days of pumping from TB01 at 0.55 L/s.

Groundwater take and divert from the potential landfilling area:

- Perched and shallow groundwater in the Upper Pakiri Formation will be taken and diverted as a result of the landfill construction and the installation of subsoil drains. The anticipated shallow groundwater diversion has been assessed to result in a negligible effect on baseflow.

Effects on regional groundwater resources:

- Based on the current understanding, the proposed groundwater take from the regional aquifer is that ~20,000 m³/year is required. A take of this size will have no measurable effect on the allocation of the regional groundwater resource in the Hōteio groundwater catchment. This will be reassessed at a later stage when there is a more complete understanding of the required groundwater take.

Surface water and stream depletion effects:

- Significant Ecological Area – Terrestrial: Located west of the area identified as potential landfilling at a lower elevation, we assessed the regional groundwater is not providing baseflow and so there is no effect.
- Te Awa o Hōteio: The regional groundwater provides baseflow to the river but the drawdown from pumping a test bore estimates a negligible effect.
- Upper Waiteraire Stream and North Valley Stream: The recharge shadow created by the landfill lining system can result in lower groundwater levels beneath the ridgelines. The reduction in groundwater levels has the potential to affect baseflow to the streams in the catchments adjacent to the area identified for potential landfilling. Predicted reduction in baseflows equate to 0.07 L/s in the Upper Waiteraire Stream and 0.32 L/s in the North Valley Stream. These effects can be monitored and, if needed, offset via compensation flows.
- Monitoring of groundwater levels and streamflows is being undertaken to determine baseline conditions to inform possible mitigation measures.

Kahikatea Forest and wetland:

- A potential stockpile (on the low lying area to the west of the potential landfilling area) may be constructed in an isolated catchment area that contains a Kahikatea Forest and adjacent wetland. The recharge shadow created by the main stockpile is likely to cause a fall in the shallow groundwater levels in the catchment. This fall is predicted to be in the order of 0.1 m to 0.6 m. Monitoring of groundwater levels and streamflows is being undertaken to determine baseline conditions so that appropriate mitigation measures can be put in place by ecologists.

Water budget modelling:

- The area identified for potential landfilling and downstream catchments form one combined isolated catchment, which means the inputs into the catchments are almost solely from rainfall, groundwater throughflow and surface water from upstream parts of the catchment. The majority of outflows comprise actual evapotranspiration, surface water runoff and groundwater baseflow, the latter two both support streamflow.
- The water budget indicated that although recharge reduces by 13%, mean and median streamflow increases by 8 – 11%, respectively.

Monitoring and mitigation:

- A baseline monitoring programme is underway, collecting groundwater quality, groundwater level and streamflow data to support implementation of mitigation measures, if required.

Additional bores will be constructed prior to waste placement at other agreed locations downgradient of the area identified for potential landfilling (e.g., on low lying ground between the this area and the Watercare Hōteu River inlet).

6 Conclusions

The hydrogeological assessment indicates that the proposed solid waste management and disposal facility can be constructed and operated with localised, manageable, and predictable effects on groundwater systems. The three groundwater systems present beneath the potential landfilling area comprise, perched water, shallow Pakiri Formation groundwater, and the deeper regional aquifer (of the Waitemata Group). These are all hydraulically separated, with limited vertical connectivity due to the predominantly unfractured sandstone beneath the identified potential landfilling area.

Shallow groundwater drawdown associated with the subsoil drains is expected to remain confined within the landfill footprint, with no measurable off-site effects. Modelling confirms that the proposed abstraction from the deep regional aquifer will have negligible influence on neighbouring groundwater users or regional baseflows, with predicted drawdown at the nearest downgradient user (the Farm Bore) of approximately 0.02 m after 150 days of pumping.

The landfill lining system and main stockpile will create localised recharge shadows, reducing recharge to adjacent catchments and producing small reductions in groundwater levels. Resulting changes to baseflows in nearby streams, including the Upper Waiterāire Stream and North Valley Stream, are predicted to be small, with reductions of 0.07 L/s and 0.32 L/s respectively. These effects can be monitored and, if required, addressed through mitigation such as compensation flows. Predicted reductions in shallow groundwater levels within the Kahikatea forest and the adjacent wetland catchment (0.1–0.6 m) will be further assessed through ongoing baseline monitoring to inform ecological management responses.

Overall, the assessment concludes that potential hydrogeological effects can be effectively avoided, remedied, or mitigated through the proposed engineering design, monitoring programme, and standard mitigation measures. The ongoing baseline monitoring of groundwater levels, groundwater quality, and stream flows will ensure that any required mitigation measures can be implemented in a timely manner.

7 Applicability

This technical memorandum has been prepared for the exclusive use of our client WMNZ, with respect to the particular brief given to us, and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that WMNZ will submit this technical memorandum to the Environmental Protection Authority in support of a referral application under the Fast-track Approvals Act 2024 for the works described herein, and that the Environmental Protection Authority will rely on this technical memorandum for the purpose of assessing that application.

Tonkin & Taylor Ltd

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Authorised for Tonkin & Taylor Ltd by:

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