Appendix E: Stormwater and Flood Hazard Assessment

RM26-0317 Wairakei South Fast Track Development – Stormwater and Flood Hazard Assessment

• Prepared for

Bay of Plenty Regional Council

• 7 August 2026

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Bay of Plenty Regional Council [and] [others (not directly contracted by PDP for the work)], including [list]. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Executive Summary

Pattle Delamore Partners Limited (PDP) have been appointed by the Bay of Plenty Regional Council (BOPRC) to review the proposed stormwater drainage and flood hazard details related to the Fast Track Application for the Wairakei South Stormwater Drainage project.

This assessment has been structured into three technical components:

1. Stormwater Strategy
2. Flooding Effects and Hazard
3. Stormwater Treatment

While each component addresses a distinct aspect of stormwater management, they should not be considered in isolation.

The proposal is to develop approximately 2700 residential properties and approximately 55 ha of industrial properties & commercial development over 350 ha of land. The proposed stormwater system collects Bell Road Drainage system, which is currently managed and operated by BOPRC.

The development proposal is to manage stormwater drainage, and flood mitigation by raising ground levels of over 3.5m above MSL (NZVD) and substantially increasing the drainage capacity of the catchment's pumped stormwater pumping system with new pumps to discharge to the Kaituna River and Kopuaroa Canal. While the catchment receives some urban flows already, it was designed and built primarily for rural drainage only.

The stormwater drainage for the proposed development is reliant on a reliable, pumped drainage system. The drainage system is also dependent on pumping of groundwater derived flows to maintain required surface water levels and flood storage. and stormwater treatment swales during dry weather. Along with displacement of the floodplain, this creates risks of significance in the event of electro-mechanical failure and is considered contrary to recommended stormwater drainage practice both in New Zealand and internationally where stormwater pumping is avoided for greenfield developments. The proposal does not provide any consideration of increased gravity discharges when conditions permit.

BRLP have developed a 2-dimensional HEC RAS model to assess the flooding effects of the development. This has been independently peer reviewed and has been only found to suitable at concept level for the primary 1 % AEP (one in one hundred year) flood event. The applicant's model has not been verified against actual flood events, but only the 1% AEP flood is comparable with the peak water levels modelled by BOPRC, which has been verified against three large storm events. To date, the applicant's assessment only considers the effects of the

development at discrete locations immediately adjacent to the development and excludes effects over the wider floodplain.

It is considered essential that the effects of the development with a proven hydraulic model are assessed over a much wider range of flood events to adequately assess the expected effects of the development on flood hazard effects on property, people and critical infrastructure.

In lieu of a fully verified hydraulic model from the applicant, BOPRC adapted their own MIKE Flood model to assess the effects of the development over the wider flood plain. This is showing much greater effects over the wider floodplain including to adjacent critical transport links at Te Puke Highway and Tauranga Expressway (TEL). It is desirable that these effects are avoided.

The maximum flood levels in a 0.2% Flood event and with pump failure are approaching or in excess of the proposed minimum ground level for the development. Such effects are expected cause significant risk to life and property in these events. Therefore, the ability to resolve such effects should be addressed prior to granting of a consent and the proposed site levels are recommended to be reviewed once the flood model is properly verified.

The site is bounded by stopbanks adjacent to the Kopuaroa Canal and Kaituna River. In the event of a stopbank failure during a flood event the reduced floodplain volume will cause significant increases in flood levels and increased flood hazard to both the TEL and upstream properties.

No infrastructure upgrades are provided to divert additional stormwater to the upgraded Bell Road A pump station. We are not aware of any interrogation of the models that shows how this is achieved without additional flooding of private property between the development and proposed pump station upgrade.

The BOPRC model suggests that the diversion of additional flows to the Kopuaroa Canal will increase flooding at the Te Puke Highway, which already floods frequently in heavy rainfall events.

Based on recognised typical stormwater treatment performance, the proposed stormwater treatment train is not expected to meet the proposed treatment targets and the proposed treatment swales are outside the recommended design standard which would indicate a high risk of poor treatment performance with short circuiting of flows through the swales. The absence of effective primary treatment to remove sediment and litter is likely to lead to significant adverse visual effects and ultimately flushing through of contaminants to the receiving environment. An effective primary treatment stage in the treatment train is recommended to avoid this expected effect.

In summary, we consider the application leaves several issues unresolved and provides an incomplete assessment of effects. These matters create a risk of significant adverse effects on the physical environment through flooding of the natural environment, through stormwater-treatment impacts, and on the economic environment through the future costs of maintaining and renewing a pumped stormwater system, particularly in the context of climate change.

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1.0 Introduction

Pattle Delamore Partners Limited (PDP) have been appointed by the Bay of Plenty Regional Council (BOPRC) to review the proposed stormwater drainage and flood hazard details related to the Fast Track Application for the Wairakei South Stormwater Drainage project.

This assessment has been structured into three technical components:

1. Stormwater Strategy
2. Flooding Effects and Hazard
3. Stormwater Treatment

While each component addresses a distinct aspect of stormwater management, they should not be considered in isolation. The proposed development must demonstrate that stormwater quantity, stormwater quality, groundwater interactions, and flood hazard effects are managed as an integrated system that is appropriate for both the site and the wider catchment.

An effective stormwater management approach extends beyond the provision of individual treatment devices or attenuation measures. The overall stormwater strategy must show how runoff generated by the development will be collected, conveyed, treated, detained, and discharged, without creating unacceptable adverse effects on downstream or upstream properties, infrastructure, receiving environments, or adversely affect existing flood hazard conditions. Decisions regarding stormwater treatment, hydraulic design and flood mitigation are therefore inherently linked and must be evaluated collectively.

1.1 Catchment Context

The proposal is located within a catchment that is subject to existing hydrological, hydraulic and environmental constraints. Stormwater generated by the development ultimately interacts with the receiving environment, including downstream waterways, drainage networks, floodplains and associated ecological values. The capacity and characteristics of these systems influence the suitability of the proposed stormwater management approach.

Existing flood behaviour within the catchment is a key consideration. Areas already subject to ponding, overland flow, flooding or constrained drainage capacity may be sensitive to even small changes in runoff volume, timing or discharge rates. Consequently, assessment of flood hazard effects must consider not only the development site itself but also potential effects on neighbouring land and downstream catchment systems.

Groundwater conditions may also influence stormwater management outcomes. Factors such as groundwater levels, soil permeability and seasonal groundwater fluctuations can affect the performance of soakage systems, attenuation devices and other stormwater infrastructure. An understanding of groundwater behaviour is necessary to demonstrate that the proposed design will function as intended over the long term.

The assessment framework also reflects the relevant planning and engineering requirements applicable to the proposal, including regional and territorial authority planning provisions, stormwater management objectives, flood risk management considerations and accepted engineering practice. Compliance with individual requirements does not in itself demonstrate overall suitability; rather, the various requirements must be considered together to determine whether the proposed stormwater management system achieves an acceptable integrated outcome.

1.2 Assessment Framework

The three technical reviews have been prepared to examine different but interconnected aspects of the same stormwater management system.

The **Stormwater Strategy** review considers whether the overall stormwater management approach is appropriate for the scale, nature and location of the proposed development and whether the key design principles have been adequately addressed.

The **Flooding Effects and Hazard** review considers the extent to which the proposal may influence flood behaviour, flood storage, flow conveyance and flood risk, both on-site and elsewhere within the catchment.

The **Stormwater Treatment** review considers whether the proposed treatment systems are capable of achieving the intended water quality outcomes and protecting receiving environments from adverse contaminant effects.

Although reported separately for clarity, these assessments are interdependent. The hydrological assumptions, runoff volumes, flow rates and discharge controls adopted within the stormwater strategy underpin the flooding and treatment assessments. Similarly, the suitability of treatment devices may influence hydraulic performance, while flood mitigation measures may affect stormwater storage, conveyance and discharge characteristics. Conclusions reached within each review should therefore be considered alongside the findings of the other assessments.

Accordingly, the overall acceptability of the proposal depends not on the outcome of any individual assessment alone, but on whether the combined stormwater management system can appropriately manage stormwater quantity, stormwater quality and flood hazard effects within the context of the receiving catchment.

2.0 Documents Reviewed

The following documents have been provided prior to the substantive application to describe the proposal:

1. Flood Modelling Report – Wairakei South Rev 9, 24/3/26, Maven Bay of Plenty Ltd
2. Wairakei South Stormwater Management Plan Final Draft, 15/4/26, Maven Bay of Plenty Ltd (incomplete document provided without the referenced drawings, reports, and appendices)
3. Hydrogeological Assessment Wairakei South Development ENGEO Project 1936.000.001, Doc 15, revised draft dated 2/12/25
4. Peer Review Memo, Wairakei South Fast Track Independent Flood Modelling Peer Review V2.2, 4 March 2026 (for Bell Road Ltd Partnership)
5. Wairakei South Hydrogeological Assessment Technical Review, 9 March 2026, PDP Letter T015820034L001

The following documents included in the substantive application are considered relevant to the review:

- Substantive Application Wairakei South FTAA 12 May 2026
- Appendix C Masterplan
- Appendix D Proposed Plans
- C100 Staging Plans
- C200 Proposed Level Plans
- CC230 Sediment Control Plans
- C240 Erosion Control Details
- C400-0-1-CC400 0-4 Stormwater Layout Plans
- C400-1-1-CC400 1-7 Stormwater Layout Plans
- C400-1-8-CC400 1-13 Stormwater Layout Plans
- C400-14-13-CC400 18-11 Stormwater Layout Plans
- C440 Stormwater Wetland Swale Plans
- C450 Stormwater Catchment Plans
- C460 Stormwater Pump Station Details

- Appendix F Infrastructure Report
- Appendix G Stormwater Management Plan
- Appendix H Stormwater Modelling Report Part 1 of 2
- Appendix H Stormwater Modelling Report Part 2 of 2 (including applicants peer review)
- Appendix L Ecological Impact Assessment
- Appendix Q Natural Hazard Assessment Report Part 1 of 2
- Appendix Q Natural Hazard Assessment Report Part 2 of 2
- Appendix R Hydrogeological Assessment Report
- Appendix U Earthworks Management Plan
- Appendix Z Economic Assessment
- Appendix AA Climate Change and Sustainability Memorandum
- Appendix AB Consultation Summary Pack Part 2 of 3
- Appendix AD Proposed Conditions
- Appendix AE Proposed Industrial Design Guidelines
- Appendix AF Proposed Residential Design Guidelines
- Appendix AG Proposed Commercial Design Guidelines
- Appendix AH Ecological Management Plan
- Appendix AI Stormwater Monitoring Plan
- Appendix AL Construction Management Plan

3.0 Site Description

3.1 Overview

The proposal comprises approximately 350 ha of land, with the land to be ultimately intended for development comprising approximately 2,700 residential lots and approximately 55 ha of industrial/employment land. Ground levels are proposed to be built up to 3.5 mRL NZVD.

The Stormwater Management Plan forms the basis of the proposal.

Flooding currently occurs across the site after heavy rainfall when groundwater levels and downstream restrictions prevent water draining by gravity to the Kaituna River (refer Figure 1 below). It is proposed to raise platform levels between 1.5 m and 2.5 m and maintain groundwater levels up to 1 meter below the level of downstream waterways to facilitate the proposed stormwater drainage and flood hazard management measures. The catchment includes three major Tauranga City Council stormwater outfalls from the eastern Papamoa area. All outlets are provided with attenuation ponds to limit peak flows into the drainage network.

Figure 1: Flooding on 23 January 2026 (approximately 220 to 250 mm of rainfall on 21-22 January 2026)

3.2 Previous Studies and Review

The drainage of the area has been extensively studied and reviewed by BOPRC and New Zealand Transport Agency (NZTA) through the development of a DHI MIKE model that has been used by NZTA for the Tauranga Eastern Expressway and for the review of other urban stormwater discharges to the drainage system. This model continues to be the main tool for BOPRC in managing the capacity of the Bell Road drainage network. The model was initially verified against three

2017 floods in 2020 and verification confirmed 2025 with updated stormwater details.

4.0 Groundwater Assessment and Influences on Stormwater Drainage

4.1 Groundwater Assessment

ENGEO have developed a 3D groundwater model for BRLP to assess the hydrogeological effects of the proposal arising from changes in groundwater levels, pond levels, subsurface permeability, and groundwater recharge rates, including effects on:

- Groundwater levels surrounding the development.
- Groundwater discharges that may affect stormwater management.

4.2 Assessment Findings

The suitability of the model to assess the hydrogeological conditions for this development has been reviewed by PDP under a separate commission included in Appendix D

Findings of the review include:

- The groundwater model was considered to provide a reasonable and appropriate evaluation of groundwater effects associated with the development, with predicted effects largely confined to the development boundary.
- The groundwater discharge has been appropriately quantified for operational conditions and estimated low flow pumping rates in the context of the model uncertainty.
- The contribution of groundwater flows to flood flows is expected to be small relative to flood flows and has been suitably incorporated into the flood model.
- Additional sensitivity analysis is recommended to alternative conceptual models in which groundwater abstractions could be higher.
- Sea level rise effects would continue to be managed through ongoing pumping, but long-term operational implications, such as increased pumping heads, need to be incorporated into the proposal.
- Groundwater flows are only expected to be affected by a small amount due to sea level rise and existing predicted draw down rates are expected to be maintained with sea level rise owing to the low permeability soils present. Additional groundwater inflows are only expected locally adjacent to the water boundaries at the site boundary

- While groundwater inflows may not change over time with climate change downstream levels are predicted to change and limit the ability of gravity drainage to provide the necessary water levels and storage for the stormwater system to function as designed

The groundwater study showed that the groundwater effects are minor even if groundwater flows are increased by a factor of ten, with flows of the order of 43 L/s (3,700 m^3/day required to maintain storage in the base of the wetland and ponds at levels of 0.5 to 0.8 m NZVD. It is important to provide certainty in maintaining these levels to ensure stormwater treatment is not hydraulically overloaded and that full storage requirements as modelled are maintained.

The applicant used a factor of ten in their surface hydraulic model as a sensitivity test to conclude that groundwater abstraction has no effect on discharge and that uncertainties associated with the discharge can be managed. This provides a robust approach, and it is recommended that a similarly robust approach is applied at the detailed design stage when setting groundwater take requirements to manage any residual uncertainties and effects.

Final requirements will depend on the pump location relative to the wetland storage areas. Effects during construction must be managed, along with specific testing requirements for the earthworks fill material.

ENGEO have recommended the development of a groundwater monitoring and contingency plan. This recommendation is endorsed. It is also recommended that the groundwater model is confirmed and updated on completion of the detailed design.

4.3 Assessment Exclusions

- Groundwater take quantities and effects are not included in this review or the Geosciences assessment.
- The assessment does not quantify low level pumping durations for either existing for future conditions.
- The assessment does not address resilience and sustainability issues with pumping to maintain the development area
- The assessment does not address economic effects of pumping and the economic impact on existing and future generations
- The applicant has not assessed the potential impact on stopbank stability resulting from lowering of the groundwater table adjacent to the stopbanks.
- Construction dewatering drawdown details and effects are not included, with these expected to be much deeper due to pump station construction and removal of unsuitable material for earthworks.

4.4 Recommendations

The groundwater assessment recommended that a groundwater monitoring and contingency management plan be prepared. This should include, but not be limited to:

- Clearly define proposed pumping regime
- Management of groundwater levels and flows to ensure they do not adversely affect the treatment performance of the wetland.
- Groundwater abstraction rates required to maintain wetland levels to match the modelled storage assumptions.
- Demonstration of no increase in risk on adjacent stopbank stability through draw down of the water table adjacent to the stopbanks.
- The potential effects of groundwater abstraction on other groundwater users and groundwater-dependent ecosystems should also be assessed as part of the groundwater monitoring and contingency management plan.
- Given the long operational life of the proposed infrastructure, it is considered important that the governance, ownership, funding, renewal, and operational responsibilities for the drainage system are clearly defined before approval is granted.

5.0 Stormwater Drainage Philosophy

5.1 Stormwater Pumping

The proposal relies on pumping of both surface and groundwaters pumping to maintain necessary in-catchment storage and substantial surface and ground water pumping infrastructure to ensure that lifelines infrastructure is not flooded and that new flooding does not occur.

The scheme is contrary to established stormwater design practice in New Zealand and internationally for greenfield development due to the extent of pumping of stormwater and groundwater required to provide urban stormwater drainage.

The following provides a summary of the use of stormwater pumping within urban areas in the upper North Island:

- BOPRC Stormwater Guidelines do not consider stormwater pumping as a recommended or preferred drainage practice.
- Waikato RITS V2 states that "… considers that pumping of stormwater is rarely a practical option because of the need for continuity of power supply and a very conservative approach to pumping design. Applications for pumping stormwater as a smaller component (e.g., a low-lying sump) of an overall on-site solution need to have exhausted the other available options and provide significant risk mitigation for pump malfunction and power outages."
- Tauranga City Council generally does not permit the use of pumping a primary stormwater system (DS5.5) and does not permit the use of pumping as a secondary stormwater drainage solution DS 5.5-19.1; i.e., for the control of flooding.
- Western Bay of Plenty District Council Development Code of Practice does not recommend the use of stormwater pumping systems and specific approval is required.
- Similarly, Auckland Council does not permit stormwater pumping without specific approval from Auckland Council.
- NZ4404 states that pumped stormwater drainage is not normally used in New Zealand largely for economic reasons. No such justification has been presented or discussed as part of the proposal.

Furthermore, the proposed National Engineering Design Standards for Stormwater (working draft 2023) states:

> *There shall be no stormwater pumping within the public network without explicit approval from the WSE. This approval will be provided only in exceptional circumstances and where the WSE is of the opinion that there are no practicable alternatives.*

> *Stormwater pumping shall not be used to enable new development in any manner, whether greenfield or brownfield, and will only be considered as a potential option to resolve chronic stormwater issues in already-developed areas where no intensification is planned and where no gravity-based solutions exist.*

While these standards remain in draft, they are still live and under active consultation and development.

Notwithstanding this, the existing drainage system does utilise pumping of urban stormwater that has been connected to the drainage system over the last 20 years. The existing pumped drainage system has been developed with a primary gravity outfall and only uses pumping when gravity drainage is not available. Like most pumped urban stormwater drainage in New Zealand, the existing pumping system was originally installed for rural drainage to ensure that flooding of agricultural lands persists for no more than three days for up to a 20% AEP rainfall event**.**

The proposed stormwater pumps will be an integral part of the drainage network that currently services the surrounding rural area, as well as the south-eastern parts of Papamoa. It is not anticipated that these will be easily separated from existing drainage assets and the infrastructure will need to be taken into ownership and operated by the current managers of the drainage system.

With no CAPEX or OPEX details provided to date, it is not possible to understand the future public cost implications of managing the system. This should include both operating costs and future liabilities to be inherited by the public.

It is also considered essential that these matters are assessed in sufficient detail prior to committing to a long-term stormwater strategy that defers development costs to future operation, maintenance, and asset renewal requirements. This will include confirmation of appropriate sizing based on the developed hydraulic model.

5.2 International Stormwater Pumping Practice

5.2.1 Netherlands

While pumped drainage is both essential and common in the Netherlands, the use of stormwater pumping in the Netherlands is significantly different from this proposal in that pumping is used for specifically defined catchment areas designed for intensive land use as a whole that have been developed with [1, 2]:

[1] FAO (2010). *Dutch Polder System*. Food and Agriculture Organization of the United Nations. https://www.fao.org/fileadmin/templates/giahs/PDF/Dutch-Polder-System_2010.pdf

[2] NL for Beginners (n.d.). *How the Dutch Made Land Out of the Sea: The Story of Polders*. https://nlforbeginners.com/how-the-dutch-made-land-out-of-the-sea-the-story-of-polders/

a) National scale governance and funding

b) Extremely high redundancy

c) New pumped catchments are not created unnecessarily

d) These are long-standing drainage practices developed over many centuries as a result of subsidence and coastal erosion

5.2.2 United Kingdom

Key stormwater management methods identified in the CIRIA C753 SuDS Manual include the following:

- Infiltration
- Storage of excess runoff
- Use of gravity systems and outfalls

Pumping is accepted as a last resort and requires full lifecycle justification and failure planning.

While the existing drainage system uses pumped drainage with storage, the pumped drainage is downstream of the much wider floodplain, which minimise flooding impacts and limits the loss of floodplain storage with the existing drainage system.

5.2.3 United States of America

US FEMA / ASCE floodplain guidance (44 CFR Part 9) strongly discourages net loss of floodplain storage and requires no adverse impact to flood levels and hazards. Pump-reliant drainage systems are considered high risk unless fail-safe.

Despite this guidance, there have been very high-profile cases in the United States in the last twenty-five years where pumped systems have not proved to be fail-safe with devastating consequences (e.g., New Orleans and New York).

5.3 Gravity Drainage Options

The best national and international practice is to provide a gravity outlet with storage to mitigate the effects of urban stormwater.

No new gravity outlets are proposed and gravity drainage will be limited to existing drainage outlets only. The existing gravity outlets are considered minimal even for the existing rural runoff. The proposal does not appear to consider the feasibility or benefits of any improvements or enhancements that

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Schultz, B. (2024). *Water Management and Polders in the Netherlands Part II*. Flevolands Geheugen. https://www.flevolandsgeheugen.nl/page/12224/water-management-and-polders-in-the-netherlands-part-ii could provide gravity drainage within the catchment. Long term the gravity outlets are expected to diminish in effectiveness. This has not been considered in any detail in the application.

5.4 Loss of Floodplain Storage

The cut to fill plan in the application includes nearly 1,000,000 m^3 of imported fill and nearly 600,000 m^3 soil cut to waste. This would indicate that the flooding mitigation is largely reliant on stormwater pumping capacity. This transfers a significant portion of the flood management function from natural floodplain storage to engineered infrastructure.

The proposal reduces floodplain storage and replaces part of the existing floodplain function with pumped drainage and engineered storage. No consideration is provided as to how to incorporate additional development without creating cumulative effects and accentuating operational flooding risks.

This loss of floodplain storage is effectively irreversible once development is constructed, as there is no clear practical or financial incentive to restore the land to its existing floodplain function. There is no precedent to indicate that this is likely to occur.

5.5 Sustainability and Economic Assessment

The sustainability and economic assessments contained in Appendices Z and AA of the application do not provide any consideration of the stormwater requirements or effects with respect to the following:

- Cost-benefit and environmental assessment of the pumped stormwater system and filling required to raise land levels.
- Effects of loss of peat soils (allowance for cut and consolidation provided in the cut-fill analysis).
- Removal and consolidation of peat soils.
- Costs and power requirements for ongoing pumping of both storm flows and base flows.

5.6 Stormwater Strategy Summary

While it would be accepted that a primary pumped stormwater system may be the only practical drainage solution for the short and long-term development of this area, this approach defers a portion of the development cost to future operational power requirements and asset renewals that have not been considered with the application.

The consequences of failure mechanical requirements are significant both for the existing drainage system and proposed are significant, and the proposed drainage system increases these consequences significantly.

These ongoing costs and dependencies have the potential to create adverse legacy effects for future generations.

5.7 Climate adaptation and resilience

The proposed stormwater strategy creates a long-term dependence on mechanical pumping, groundwater control, stopbank performance, backup power, telemetry, maintenance access, operational decision-making and renewal funding. This is not simply a detailed design issue. It is central to whether the proposed development can be considered resilient under future climate conditions.

The application should demonstrate that the development remains safe, serviceable and financially sustainable under a reasonable range of future climate conditions, including higher tailwater levels, sea level rise, elevated groundwater, prolonged wet periods, pump outage, backup power failure, stopbank breach or overtopping, and coincident storm events.

In the absence of a whole-of-life resilience assessment, there remains uncertainty about whether the proposed development avoids, remedies or mitigates its long-term climate adaptation effects, or whether it transfers residual risk, operational cost and renewal liability to future communities and public asset owners.

6.0 Flooding Effects

6.1 Hydraulic Model

A robust and fit-for-purpose hydraulic model is an essential component of the stormwater management plan, as it provides the primary means of assessing the flood hazard and stormwater effects of the proposed development on the existing Bell Road drainage and floodplain system and the wider catchment including Papamoa.

BOPRC Rivers and Drainage developed and provided a detailed peer review scope to guide the assessment of flood and stormwater effects associated with the proposal.

The scope sought to confirm that the applicant's modelling was consistent with BOPRC Hydraulic Modelling Guidelines, relevant industry practice, and the specific characteristics of the Bell Road catchment, including groundwater influences, climate change, pumping infrastructure and floodplain storage effects. The scope also anticipated that the applicant's modelling would be reconciled against, and developed from, BOPRC's Bell Road catchment model (MIKE Model) following appropriate assessment and verification of model suitability for the intended purpose.

BOPRC subsequently made its calibrated MIKE Model available to the applicant under a model use agreement. The agreement envisaged the use of BOPRC modelling methodologies, including rainfall, climate change and runoff assumptions, to enable direct comparison with existing and future flood assessments and to support evaluation of mitigation measures.

It is understood that discussions occurred regarding a memorandum of understanding or agreed modelling framework to establish the scope of work required to verify model suitability and assess development effects. However, the parties did not reach agreement on all modelling requirements prior to lodgement. The reasons for this are not fully documented in the information available to me.

The suitability of the stormwater model for this purpose has been assessed for the applicant by AWA Environmental Ltd. It is understood that this assessment did not fully address the review scope requested by BOPRC Rivers and Drainage. Bell Road Ltd Partnership (BRLP) maintain that a large proportion of these requirements were not relevant to the application and could be deferred.

There are a number of differences between the hydraulic model developed for the application and BOPRC's Bell Road catchment model. BOPRC has provided the applicant with access to its hydraulic model, supporting documentation and modelling assumptions, together with a detailed peer review scope intended to support model reconciliation and assessment of development effects. While several differences between the two modelling approaches have been identified, these differences should be clearly documented, assessed and reconciled to understand their influence on the assessment outcomes.

Neither the BOPRC nor BRLP models appear to fully incorporate all consented future development areas within the wider catchment. As these future development areas are already approved ahead of this application and may influence future hydrology and hydraulic performance, considering that these areas should be included. As a result, the current assessment may underestimate future flood levels, displacement effects, flow conveyance requirements and pumping requirements. This is particularly important given the long-term reliance on pumped drainage infrastructure.

The assessment should demonstrate that the proposed development remains compatible with existing and approved future drainage and flood management infrastructure, including the Tauranga City Council (TCC) comprehensive stormwater consent and associated drainage network and Kaituna outfall arrangements, and that cumulative effects associated with approved future development have been appropriately considered. Key differences understood to exist between the models include:

a) BRLP advise that they have surveyed additional culverts.

b) BRLP have undertaken additional survey of the catchment.

c) BRLP has included additional inflows from the Papamoa Hills catchment.

d) BOPRC have allowed for programmed future stopbank upgrades.

e) Neither model provides for all consented future urban development areas across the wider catchment.

f) Less ponding and floodplain attenuation are allowed for on the western boundary of the catchment in BRLP Model.

g) There are boundary effects and interfaces to be considered in greater detail, namely the Te Puke Highway and interaction with TCC stormwater system.

The differences associated with additional culvert survey information and topographic survey updates (items a and b) are unlikely to materially influence the assessment of development effects, provided that these datasets are accurately represented and applied consistently throughout the model domain.

Items (c) to (e) have greater potential to influence model outcomes, as they relate to catchment inflows, future flood management infrastructure and assumptions regarding future land use. These factors may affect floodplain water levels, flow paths, flood storage behaviour and pumping requirements within the wider catchment. Differences in underlying assumptions between the

BOPRC and BRLP models may influence the interpretation of development effects and influence the magnitude of effects and therefore warrant reconciliation.

Differences in assumptions relating to upstream floodplain attenuation and storage upstream of the canal significant and affect both residential properties and increase flooding of life lines infrastructure, which is already considered unacceptable, particularly as BOPRC's modelling indicates increased flood levels when a larger model extent is considered. Similarly, the presentation of programmed flood management infrastructure upgrades, including future stopbank improvements, may influence the distribution of flood flows within the floodplain and the relative significance of development-related effects.

To improve confidence in the assessment outcomes, it is recommended that the key differences between the modelling approaches be reconciled and documented.

For completeness, it is recommended that BOPRC

- Updating surface and culvert information where additional verified survey data is available from BRLP. Confirming whether runoff from the Papamoa Hills catchment has been appropriately represented.
- Incorporating approved future development to assess the effects of consented development areas.
- Reviewing and confirming boundary conditions and integration with the TCC's stormwater system and Tauranga Expressway (TEL) infrastructure.
- Further assessing flood duration effects across the wider floodplain.
- Considering a broader range of stopbank breach and failure scenarios where relevant.
- Consider a wider range of breach scenarios for their purposes.

It is recommended that BRLP

- Assessing the implications of programmed BOPRC stopbank and flood management upgrades. Incorporating approved future development to assess the effects of consented development areas.
- Reviewing and confirming boundary conditions and integration with TCC's stormwater system and TEL's infrastructure.
- Consider method of verification is appropriate given the differences and changes from eth BOPRC model
- Demonstrating model convergence across the model domain rather than at a limited number of locations. Assessing flood extent, depth, velocity and duration effects across the wider floodplain rather than relying on a

limited number of representative locations. These items are discussed in further detail in the following sections.

Maven Bay of Plenty Ltd (Maven) undertook the flood assessment on behalf of BRLP. The differences in the two models are shown in Table 1 and Table 2 below. Table 1 provides results for the BOPRC flooding assessment, while Table 2 provides the corresponding model outputs from the BOPRC and BRLP models.

Table 1: BOPRC Flooding Assessment Results (levels in mRL Mouturiki)

	1% AEP existing climate				1% AEP future climate		
Scenario/ Location	Pre Dev	Post	Difference		Pre Dev	Post	Difference
20% AEP							
Upstream Mowing Culvert	0.963	0.904	**-0.059**		0.995	0.915	**-0.08**
Upstream of Site	2.370	2.478	**0.108**		2.533	2.547	**0.014**
Bell Road Berries	2.575	2.617	**0.042**		2.627	2.649	**0.022**
D/S Parton Road	2.990	3.005	**0.015**		2.990	3.055	**0.065**
1% AEP							
Upstream Mowing Culvert					2.597	2.565	**-0.032**
Upstream of Site					2.876	2.827	**-0.049**
Bell Road Berries					3.016	2.986	**-0.03**
D/S Parton Road					3.220	3.236	**0.016**
0.2% AEP							
Upstream Mowing Culvert					3.001	**3.22**	**0.219**
Upstream of Site					3.094	3.285	**0.191**
Bell Road Berries					3.095	3.34	**0.245**
D/S Parton Road					3.303	3.366	**0.063**
Pumps Off 1% AEP							
Upstream Mowing Culvert	2.921	3.011	**0.090**		**3.576**	**3.723**	**0.147**
Upstream of Site	2.933	3.166	**0.233**		3.581	3.791	**0.21**
Bell Road Berries	2.935	3.174	**0.239**		3.582	3.796	**0.214**
D/S Parton Road	3.137	3.198	**0.061**		3.584	3.798	**0.214**
Breach 1 % AEP (Kaituna)							
Upstream Mowing Culvert					2.827	**3.423**	**0.596**
Upstream of Site					2.829	3.396	**0.567**
Bell Road Berries					2.892	3.399	**0.507**
D/S Parton Road					3.090	3.395	**0.305**

Notes:

Tauranga Eastern Link (TEL) Critical level approximately 3.2 mRL NZVD. ***RED*** *= more than minor effects / flood hazards*

Table 2: Comparison of Maven and BOPRC Model Results – 1 % AEP with Climate change effects (levels in mRL Moturiki Datum)

Scenario / Location	Pre Dev	Difference with MIKE	Post	Difference with MIKE	[1]Maven Pre/ Post Difference
20% AEP					
Upstream Mowing Culvert	0.85	**-0.113**	0.52	**-0.395**	**-0.33**
Upstream of Site	1.61	**-0.76**	1.52	**-1.027**	**-0.09**
1% AEP					
Upstream Mowing Culvert	2.36	**-0.237**	2.25	**-0.315**	**-0.11**
Upstream of Site	2.36	**-0.516**	2.25	**-0.577**	**-0.11**
0.2% AEP					
Upstream Mowing Culvert	3.06	**0.059**	3.08	**-0.14**	**0.02**
Upstream of Site	3.06	**-0.034**	3.08	**-0.205**	**0.02**
Pumps Off 1% AEP					
Upstream Mowing Culvert			2.64	**-1.083**	

Notes:

1. *Refer to table 1 for BOPRC difference assessments*

6.2 Verification of Model Validity

The applicant has relied on calibration and verification work previously completed for the BOPRC Bell Road model. Where material changes have been made to model extent, inflows, boundary conditions, floodplain representation or hydraulic structures, it is important that the applicant demonstrates these changes do not affect the reliability of the model for the intended assessment purpose. The applicant to date continues to rely on BOPRC model despite the material changes completed and opportunities to verify the model 2026 with at least two significant flood events that would have been suitable for verifying the changes to the model.

To date, the peer review supports only the use of the hydraulic model for macro-scale assessment of floodplain filling effects associated with the proposed development for the 1% AEP (100-year ARI) event under the adopted 2130 climate change scenario.

This is limited to evaluating flood risks associated with the development-related filling of the floodplain and how those effects may be avoided, remedied, or mitigated effectively at a ***concept level only at this stage.***

The applicant's model has not been demonstrated to provide a level of confidence for detailed local-scale hazard assessment, flow path analysis, or assessment of a wider range of event magnitudes. In particular, the suitability of the model for assessing smaller, more frequent events and larger, less frequent events has not been fully demonstrated through the information reviewed to date.

It is anticipated that the effects of smaller and more frequent events may be managed through the proposed stormwater and pumping infrastructure. Further assessment may be required to demonstrate the performance of the system across a broader range of events and to better understand potential hazard effects associated with extreme flood scenarios.

As the proposal progresses through planning, consenting and detailed design phases, it is important that the assessment evolves beyond a macro-scale evaluation to a level capable of supporting detailed flow path analysis, localised hazard interpretation, infrastructure design and assessment of effects on individual properties and assets. This is particularly important for larger flood events where flood depths, duration and flow velocities may have significant consequences.

In addition, neither model appears to fully account for all approved future development areas within the wider catchment. Given that this information should be available through approved plan changes, structure plans and district plan provisions, incorporating these developments should be undertaken to demonstrate actual anticipated effects for approved future development.

Further sensitivity testing, to better understand cumulative effects of unforeseen climate change and population growth on flood levels, conveyance capacity, storage requirements and pumping demands. This is considered particularly relevant given the long-term reliance on pumped drainage infrastructure and the need to demonstrate compatibility with existing and approved future flood management systems.

6.3 Effect on Flooding

The following assessment has considered the hydraulic modelling information provided by BRLP, the associated peer reviews, BOPRC's Bell Road catchment modelling, and the various model comparison exercises have been undertaken as part of this review. In undertaking this assessment, greater emphasis has been placed on understanding the relative change between pre-development and post-development scenarios and the implications for flood behaviour across the wider floodplain.

The extent of this review of BOPRC model is only intended to be sufficient to identify the presence of significant issues and is not intended to be a full assessment of effects across the floodplain that would be expected of a full application.

The flood maps provided are not suitable for definitive specific property and building flood hazard risk and each area of interest needs to be reviewed by an experienced person who is familiar with the development and use of flood models. Particular care needs to be applied with interpreting the model results close to the model boundaries.

At this stage we have not considered effects to the south of the Kopuaroa Canal or to the north of the TEL in any detail, as the intent of our assessment is only to determine if significant effects may exist. These areas should also be considered with the assessment of the full application by the applicant

Detailed floor level information and property-specific flood vulnerability data were not interrogated for this review, and limited assessment has been undertaken for this review. The flood maps provided in Appendix C provide estimates of effects on the wide floodplain and building structures identified on the LINZ database. These are based on the flood modelling results and the survey and lidar data used to create the modelling surfaces. Where flood level increases have been identified, the significance of those changes should therefore be considered by an experienced person in the context of the wider floodplain, cumulative effects, flood hazard and potential consequences, rather than solely on the basis of individual property impacts.

In the absence of comprehensive floor level information, flood level differences provide an important indicator of development effects and assist in assessing consistency with the BOPRC Hydrological and Hydraulic Guidelines (2012/02), which require post-development flood level changes associated with floodplain filling to be mitigated through a catchment-wide assessment.

6.4 Flood Levels

The modelling results provided include very limited commentary on the effects across the surrounding floodplain. The applicant has shown that the post-development 1% AEP design event is lower than the pre-development 1% AEP flood event at two selected locations upstream and downstream of the catchment. These locations alone do not fully characterise the spatial extent, magnitude and duration of flooding effects across the broader floodplain.

The Bay of Plenty Regional Council Hydrological and Hydraulic Guidelines (2012/02) state that the maximum allowable difference between pre-development and post-development flood levels is 15 mm. The Guidelines further note that developments should mitigate floodplain filling effects such that post-development flood levels are no greater than pre-development levels, determined through a catchment-wide assessment. While a 15 mm threshold may appear conservative, it is expected to represent a large volume of water and it is recommended that the applicant quantifies effect of such an increase in flood level for the specific application.

As the Bell Road drainage system relies on pumped drainage and therefore differs from a conventional gravity-drained floodplain. The significance of such increases should ultimately be considered in the context of flood depth, duration, hazard, consequences and the ongoing reliance on active flood management measures. Such considerations should be assessed across the wider floodplain

A review of the available modelling indicates that flood level differences exceeding 100 mm occur across parts of the wider floodplain for a range of events. While some of these differences may potentially reflect model limitations, LiDAR accuracy, or differing modelling assumptions, the pre-development and post-development assessments utilise the same underlying terrain and modelling framework, with the proposed development representing the principal change between scenarios. Accordingly, the comparison should provide a reasonable indication of the flood level effects attributable to the proposal.

The modelled flood level changes extend to locations more than 3 km upstream of the development area. The extent and magnitude of these changes suggest that the effects are not confined to the development footprint and immediate surrounding area and warrant further examination through a catchment-wide assessment consistent with the intent of the BOPRC Hydrological and Hydraulic Guidelines and the detailed peer review scope Appendix E provided by BOPRC.

6.5 Climate Change Scenarios

20% AEP (Attachment C2-1 & C3-1)

Downstream of the development, no buildings or structures are expected to flood. Some increase in flood levels, up to 50 mm, is predicted to the south of Bell Road. It is recommended to inspect these areas further to assess if this is due to limitations of the model detail or extended duration with additional flows from the development restricting flows through the existing drainage system.

Upstream of the development, two buildings are expected to have flood depths of 50 to 300 mm above ground level at the building footprint, with a further two buildings expected to have flood depths of 300 to 600 mm. It is recommended to confirm the use of these buildings.

Increases in flood levels of up to, and greater than, 100 mm are indicated adjacent to the main drainage channel from around Bell Road Berries to upstream of Parton Road, including Pond H. It is recommended to inspect these areas further to assess if this is due to limitations of the model detail or extended duration with additional flows from the development restricting flows through the existing drainage system.

1% AEP (Attachment C2-2-2 & C3-2)

Downstream of the development, only one building or structure is expected to flood in the 1% AEP flood event, with a flood depth of 50 to 300 mm. Seven buildings are expected to have flood depths of 300 to 600 mm. These flood depths represent a significant hazard for property damage and evacuation. One building is identified with a flood depth of 50 to 300 mm to the west of the Te Puke Highway.

Only one of these buildings is predicted to have a significant increase in flood depth, between 100 and 300 mm. The other buildings are predicted to have increases in flood depth of less than 15 mm.

Upstream of the development, a total of 24 buildings is expected to have flood depths of 50 to 300 mm above ground level at the building footprint, with a further seven buildings expected to have flood depths of 300 to 600 mm.

Increases in flood level of 15-50 mm are indicated adjacent to the main drainage channel immediately upstream of the development and around Bell Road Berries. It is recommended to inspect these areas further to assess if this is due to limitations of the model detail or extended duration with additional flows from the development restricting flows through the existing drainage system. It is also recommended to confirm the use of these buildings.

6.5.1 1% AEP with Pump Failure (Attachment C2-2& C3-3)

Significant increases in flood levels are observed downstream of the development. Flood level increases of up to 300 mm are indicated for all building structures to the south of Bell Road, with flood depths exceeding 1.75 m. These flood depths represent a significant hazard for property damage, occupants remaining within flooded properties and constraints on evacuation routes. The motorway is also expected to flood in at least three locations, which represents a significant effect on a major transport link.

Upstream of the development, flood levels for 48 buildings and structures east of Te Puke Highway are expected to increase by up to 300 mm. Of these:

- nine building or structures are expected to have flood depths greater than 1,200 mm;
- 16 buildings are expected to have flood depths of 900 to 1,200 mm;
- six are expected to have flood depths of 600 to 900 mm;
- seven are expected to have flood depths to 300 to 600 mm; and,
- nine are expected to have flood depths of 50 to 300 mm.

These flood depths represent a significant increase in hazard for property damage, occupants remaining within flooded properties and constraints on evacuation routes.

1% AEP with Kaituna Stopbank Breach (Attachment C2-5 & C3-5)

Downstream of the development, only one building is predicted to have an increase in flood level of less than 50 mm.

Flood depths are expected to vary from 300 mm to greater than 1,200 mm across most properties. Approximately 200 to 300 mm of flooding is indicated on the Tauranga Eastern Link (TEL). Given the significance of the TEL as a strategic transport corridor and lifeline route, further review of the flood levels, flood durations and associated network resilience impacts is recommended.

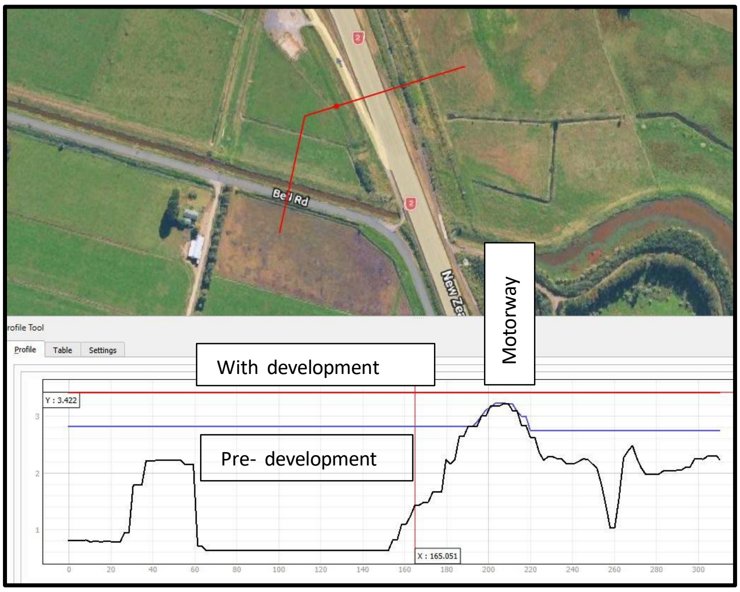

Figure 2: Expected Flood Depths in the 1% AEP Flood Event with Kaituna Stopbank Breach

Upstream of the development, no change in flood levels is indicated until Parton Road and Te Puke Highway, where significant increases in flood levels, between 50 mm and greater than 100 mm, are observed.

These increases are due to the stormwater diversion to the Kopuroa Canal and increased flows in the Bell Road Drain.

0.2% AEP (Attachment C2-4 & C3-4)

The 0.2% AEP flood event is examined for two spatial storm conditions:

A peak flood event in the Kaituna River.

A peak rainfall centered over the Bell Road catchment.

The modelling shows that the critical event for a pumped stormwater catchment is for the Bell Road event.

Downstream of the development, flood depths are increased 30-50mm and flood depths are generally 600 to 1200mm, or greater, at nine buildings and structures. The expected increase in flood level is not anticipated to be significantly increase in property damage or loss of lift.

One building or structure has flood depth of 50 to 300 mm. It is recommended to confirm floor levels for this property. Downstream of the development, flood levels increase by 30 to 50 mm for a 0.2% AEP Bell Road flood event.

Upstream of the development

- 1 Building has flood levels 300-600 mm deep with increased flood depths of 50mm
- 3 buildings have flood depths 50-300mm deep with 50-100mm increase
- 11 buildings/ structures have flood depth 300-600 mm deep with increases in flood levels 50-100mm deep
- 7 buildings have flood depths 600-900mm deep with 50-100mm increase
- 2 buildings have flood depths 900-1200mm deep with 50-100mm increase

Upstream of Te Puke Highway one building is identified with flood depths of 50-300mm and 300-600mm depth with increases in flood depth of over 100 mm.

It is recommended to inspect these areas further to assess the hydraulic mechanisms causing these increases in flooding or if these increases in flood levels are caused by other mechanisms.

6.5.2 Flooding Duration

Flood duration is a key component of flood hazard because of property damage, access disruption, evacuation constraints, infrastructure performance, and economic effects are influenced by both flood depth and duration of inundation.

The modelling results and flood duration effects do not appear to have been assessed across the full floodplain or incorporated into a formal hazard assessment. This is of concern because the model has not yet been deemed suitable for localised hazard assessment.

BOPRC is currently undertaking additional work to understand the difference in duration effects modelled by BOPRC.

6.6 Damming of Floodwaters, Stormwater Diversions and Earthworks Effects on Flooding

The floodplain is confined by the earthworks required to construct the development above predicted flood levels.

Initially, it is proposed to divert additional flows of up to 6 m^3/s to the Bell Road A Pump Station. No channel improvements are proposed to facilitate this diversion. Therefore, it is anticipated that this diversion is only likely to be effective during high flood levels and existing drain levels will be increased until floodwaters spill overland to the pump station. This is likely to result in increased flood levels for smaller flood events. However, this has yet to be investigated in depth with a verified flood model by either the applicant or BOPRC.

A formal diversion of the upstream Bell Road Drain catchment to the south is proposed, to pump up to 12 m^3/s into Kopuaroa Canal via a new southern pump station. This pump station is only proposed at Stage 4 of the development when the bulk of the land to the north of Bell Road is constructed. A channel is proposed to connect the upstream drainage channel from Bell Road to the new pump station.

Although not explicitly detailed in the application, floodwater will also need to be excluded from active construction areas during construction to avoid discharge of sediment-laden water being spread across adjacent land. To achieve this, full stormwater pumping infrastructure and temporary floodplain displacement measures will need to be installed before construction begins.

The diversion of stormwater from Bell Road Drain to Kopuaroa Canal will displace 12 m^3/s in the Kopuaroa Canal. This is shown to have minimal impact locally but shown to cause backwater effects upstream of the railway line and Te Puke Highway Culverts. Extensive flooding occurs in this area already and the diversion will limit the ability to mitigate these effects on these lifeline infrastructure links and upstream properties as well as exacerbate the existing flooding in this area

There are differences between the BRLP and BOPRC models as to upstream effects. We understand these are primarily due to the extent of the model upstream of the Te Puke Highway and the inclusion of flows spilling over the stopbanks. BOPRC have allowed for future stopbank upgrades to both the Kopuaroa and Kaituna Stopbanks, and it is understood that the detailed design of the stopbank upgrades is currently being progressed. Given the potential influence of these assumptions on model outcomes, reconciliation of the two modelling approaches remains important for understanding the magnitude and extent of flood hazard effects associated with the proposal.

6.7 Stopbank Failure Scenarios

Stopbank failure has been modelled using a Kaituna River flood peak and a smaller localised flood event within the Bell Road catchment.

This scenario has been used as an initial assessment of the effect of floodplain storage loss.

As well as upstream of Te Puke Highway, additional flooding is also indicated upstream of Parton Road and western end of Bell Road.

The additional flow into the floodplain from the Kaituna Stopbank breach appears to hold up flows further upstream.

The requirements outlined in the Dam Safety Guidelines are considered to represent best national and international practice. This will require additional investigations to consider additional breach scenarios and investigations, including :

- A failure of the Kopuaroa stopbanks (which is likely to further increase upstream flooding in the Bell Road catchment).
- A “cascade” or combined failure of both the Kopuaroa and Kaituna Stopbanks.
- A “sunny” day failure scenario with a flood only in the Kopuaroa or Kaituna stopbanks (this is expected to produce increased hazardous velocities).
- Consideration of flood duration and risk to life for both residents and vehicle drivers (including the increased use of Bell Road).
- Consideration of stopbank failure consequences and residual flood risk when establishing the design basis and resilience objectives for the development.
- Assessment of breach consequences for adjacent properties, infrastructure and floodplain users, together with appropriate emergency response and evacuation planning.

These scenarios are important because the development reduces natural floodplain storage and increases reliance on engineered drainage infrastructure. The consequences of stopbank failure may therefore differ materially from existing conditions and should be assessed before reliance is placed on the proposed mitigation strategy.

This initial assessment indicates flood levels to increase up to over 200 mm as shown in 6.2.4 and effects on Te Puke Highway and the TEL.

6.8 Maintenance of Flood Levels

Maintenance access will be required to inspect, operate and maintain drainage channels, wetland swales, pump stations and other flood level control infrastructure. To date, limited information has been provided regarding the proposed maintenance requirements, access arrangements and maintenance methodologies for the diversion channels and treatment swales through the site.

The wetland swales vary in width up to 32m, with only limited maintenance access provisions identified. Based on the layouts shown to date, maintenance will require either damaging the landscaping planting, hand clearance or large machinery operating within the road reserve.

As the hydraulic performance of the stormwater and flood management system will be dependent on ongoing maintenance, vegetation management and sediment removal, it is important that maintenance requirements are explicitly identified and incorporated into the design. This is particularly relevant where the proposed hydraulic performance relies on maintaining specific channel geometry, storage volumes, vegetation density and hydraulic roughness assumptions.

- Accordingly, it is recommended that the application clearly identifies:
- The intended maintenance responsibilities and asset ownership arrangements.
- Long-term access requirements for inspection, vegetation management, sediment removal and infrastructure maintenance.
- The anticipated maintenance methods and frequencies.
- Any areas where maintenance activities may conflict with landscaping, ecological values, amenity outcomes or transport functions.
- How the adopted hydraulic design assumptions will be maintained over the life of the development.

Providing this information would give greater confidence that future maintenance activities can be undertaken safely and effectively without compromising the flood management function, landscaping outcomes, amenity expectations or design assumptions relied upon in the assessment.

It would be preferable that the maintenance requirements and methods are explicitly identified with the application, so any future maintenance activities do not compromise any landscaping, amenity expectations, or design details included in the application.

6.9 Flood Hazard

The 0.2% AEP (500-year ARI) event is considered critical for assessing potential loss of life, residual flood hazard risk, and effects on lifeline infrastructure, particularly in the event of stopbank failure.

Areas of concern relating to the flood hazard effects of the development that need to be investigated and resolved include, but are not limited to:

- The extremities of the floodplain at the upstream end (i.e., Te Puke Highway and railway line), where water spills into the floodplain and also the interface with the TEL and TCC drainage systems.
- Lack of specific assessment of residential properties across the full floodplain affected before and after the development.
- Stopbank failure events, including the impact of a confined floodplain directing additional flows towards the TEL.
- Lack of clear details regarding access requirements and flood duration effects on existing infrastructure and lifelines across the full floodplain.

- It is not clear whether the model includes allowance for loss of storage volume due to wetland vegetation and low-flow channel shaping effects. These effects can be significant once detailed design and final configuration of the proposed design is completed.

As set out in the Regional Policy Statement (RPS) hazard assessment requirements, we would expect the hazard assessment to address the following:

1. Property damage, including effects on productive land.
2. Residential property flooding.
3. Effects on lifelines.
4. Social and cultural effects.

This assessment should include a baseline understanding of the existing hazard environment and the level of flood risk currently experienced across the floodplain. Given the extent of the floodplain and the existing reliance on flood management infrastructure, these effects are expected to be significant. We have not received any information that this assessment has been undertaken, and the model has been deemed unsuitable for localised effects assessments.

While the proposed development platforms are expected to be sufficiently elevated above the design flood levels, the RPS and the NPS-NH require consideration of the resulting natural hazard risk both within the development and on surrounding land. Accordingly, the assessment should include both an assessment of effects on flood hazard for adjacent residential properties and the Tauranga Eastern Link Expressway and Te Puke Highway as significant lifeline transport links, taking into account the confinement of the floodway by earthworks required to form the development.

It is also important to understand the residual hazard risk following implementation of the proposed mitigation measures. Additional assessment is therefore recommended to demonstrate that the proposal does not create or increase significant natural hazard risk on other sites and that the resulting risk remains consistent with the requirements of the RPS and NPS-NH.

Owing to the potentially significant consequences associated with flood hazard, public safety (including risk to loss of life), emergency access, and lifeline infrastructure disruption, this assessment is recommended to be undertaken prior to granting of consent. In addition to groundwater drawdown effects, the risks of stopbank failure also need to be considered. This may occur through both piping failure, as discussed above, and overtopping during extreme events.

6.10 Pump Redundancy

As per stormwater pumping practice discussed above, a conservative approach is required to address the effects of mechanical and electrical failure of the pumping systems. Failure of the pumping systems can occur for many reasons, including mechanical failure, loss of electrical power to the site, failure of the site switchboard, and lack of fuel. All of these failure mechanisms, individually or in combination, have been observed during stormwater flooding events in New Zealand over the last 10 years.

The applicant has undertaken a sensitivity assessment to the effect of pump failure for a 1% AEP design event. It is not clear if this includes groundwater pump failure as well. This is reported as resulting in a 370 mm increase in flood depth. There are significant differences in BOPRC and BRLP modelling results that need to be resolved.

BOPRC's modelling indicates significantly greater peak flood levels that would result in residential property flooding over two metres both with and without development. Such flooding depths are considered significant risks to life, and it would be considered unacceptable to increase these risks.

Given the nature of the hazard and the proposed long-term reliance on mechanical drainage infrastructure, it is recommended that consequence of pump failure is assessed in greater detail. As with the stopbank failure effects, the methodologies outlined in the dam safety guidelines would be considered appropriate to be used to determine the appropriate level of protection from flooding pump failure.

This places more emphasis on the loss of floodplain storage.

It is considered that critical stormwater pumping infrastructure should incorporate an appropriately high level of redundancy.

We would consider that critical pumping infrastructure systems should be provided with duty/duty/duty redundancy, which is considered to represent the most appropriate level of redundancy for stormwater pumping systems. Standby generators may provide some relief for network power failures. A minimum of up to three days of fuel supply is recommended for such a remote location that may be potentially cut off from vehicle access by floodwater. Local electrical failures of site switchboards, such as lightning strikes or power failures through harmonic effects from the power supply, may be much more difficult to reinstate quickly in emergency situations.

6.11 Construction

Outline sediment control provisions are provided with the application. These are generally in accordance with best practice guidance, and it is considered reasonable to expect that any adverse effects can be appropriately managed through detailed design, consent conditions and compliance monitoring.

Particular attention will be required for dust management given the scale and duration of the proposed earthworks. The outline erosion and sediment control measures do not appear to specifically address the management of floodwaters entering the site from the wider catchment during the construction. Given the site's location within an active floodplain, there is potential for floodwaters to inundate construction areas and mobilise sediment, resulting in off-site effects on neighbouring properties, drainage networks and receiving environments.

Construction staging should therefore demonstrate how active earthworks areas will be protected from floodwaters and how floodwater pathways will be maintained throughout the construction period.

This will require consideration of flood levels and bunding of construction areas to prevent flooding from the upstream catchment. It will be necessary to ensure that the appropriate infrastructure, including pump upgrades and floodplain storage, is provided prior to construction being undertaken.

6.12 Staging Development

The current SWMP indicates that the proposed development will be implemented over 18 stages.

Major infrastructure upgrades are proposed at the following stages:

1. Stage 1
   - Bell Road A Pump Station Upgrade.
2. Stage 2
   - Bell Road B Pump Station Upgrade.
3. Stage 4
   - South Block Pump Station initial construction, with further upgrades at Stages 6, 8, 9, and 11.

It is important that the required stormwater, drainage and flood management infrastructure is in place and operational prior to the commencement of each development stage taking into consideration the flows from the rest of the catchment and displacement. the Stormwater Management Plan (SWMP) is needed to reviewed and updated prior to each stage, demonstrating that:

- Existing levels of service and flood management objectives are maintained.
- 2-, 5-, 10-, 20-, 50-, and 100-year design levels are maintained.
- Existing consent requirements and performance criteria are maintained, e.g., flooding of the TEL and other critical infrastructure.
- There is no increase in flood hazard elsewhere within the catchment.

- The catchment is drained down to less than 1 m NZVD within three days for the 10% AEP event, to meet the original design intent.

A concern is that the wetland system, diversion channels and associated flood management infrastructure appear to be developed progressively over all 18 stages, resulting in prolonged earthworks within a flood-prone area. It is recommended that each development stage demonstrates that sufficient permanent drainage, pumping, conveyance and floodplain mitigation infrastructure is in place before the corresponding development area is established. This would provide the necessary requirements that flood risk, drainage performance, construction impacts and waterway disruption are appropriately managed throughout the development programme.

7.0 Summary Conclusions

This review has identified that the proposed Wairakei South development relies heavily on stormwater and groundwater pumping, infilling of the floodplain, and ongoing operational intervention to manage stormwater drainage and flood hazard effects.

While concept-level assessments indicate that flood risks within the development footprint may potentially be managed for design events up to the 1% AEP (100-year ARI) event, there remains uncertainty regarding the suitability of the applicant's hydraulic model for assessing both smaller and larger flood events, stopbank failure scenarios, residual flood risk and localised hazard effects beyond the development boundary. The current modelling peer review supports the model primarily for macro-scale assessment of floodplain filling effects and concept-level conclusions.

In particular, the potential effects on the Tauranga Eastern Link, Te Puke Highway, surrounding properties within the floodplain, and regional drainage infrastructure have not been adequately resolved. The absence of a verified and independently peer-reviewed hydraulic model suitable for a broader range of flood events up to the 0.2% AEP (500-year ARI), coupled with limited information on pump redundancy, failure response, emergency management requirements, long-term operational obligations, and asset management implications, constrains confidence in the proposal at this stage.

The proposal would convert a predominantly rural floodplain into an urban environment that is substantially more reliant on active flood management and emergency response measures.

The hydraulic model has not yet been demonstrated as suitable for the range of flood events required to fully evaluate the proposal with the requirements of the Bay of Plenty Regional Policy Statement, Natural Resources Plan and National Policy Statement for Natural Hazards 2025. In addition, the modelling has not consistently incorporated all approved future development areas and future flood management infrastructure assumptions across the wider catchment.

Notwithstanding this, the BOPRC modelling indicates that material flood hazard effects may occur under pump failure, stopbank breach and more extreme flood scenarios, including the 0.2% AEP (500-year ARI) event.

The Tauranga Eastern Link (TEL) appears to represent the most critical lifelines infrastructure affected by the proposal owing to its strategic transport and emergency management function. Greater emphasis should therefore be placed on confirming flood levels, flood durations, emergency access provisions, network resilience, and stopbank failure consequences affecting the TEL.

The lack of specific detail is a concern, and there is currently limited basis to benchmark the information provided to date. Resolution of these matters through updated modelling, completed hazard assessments, and robust consent conditions is recommended prior to granting of consent.

Failure to resolve the differences in hydraulic effects prior to approval of the application creates a risk of future delays for both the developer and regulatory bodies during future approval processes if the proposal is not fully understood by both parties.

A stormwater management planning process has been proposed to provide an adaptable development process. Provided the ultimate requirements are clearly understood by both parties, and the initially proposed measures presents best practical measures based on current knowledge, we see no reason why an adaptive approach incorporating the following management plans would not be appropriate:

1. Groundwater Management and Monitoring Plan.
2. Stormwater Management Plan (including monitoring requirements).
3. Construction Management Plans.

However, adaptive management is most effective where there is a clear understanding of the required outcomes, performance standards, responsibilities and contingency measures. At present, the level of information provided and the lack of alignment between the applicant's modelling and BOPRC's understanding of the floodplain system make it difficult to confirm that these matters have been adequately resolved.

Accordingly, further work is recommended to resolve the outstanding hydraulic modelling, flood hazard, groundwater, stormwater treatment, asset management and operational issues before significant reliance is placed on the proposed mitigation strategy. Resolving these matters at the current stage is likely to reduce uncertainty for the applicant, the consent authority and future infrastructure operators, and improve confidence that the proposal can be implemented in a safe, sustainable and resilient manner.

8.0 Water Quality

8.1 Stormwater Treatment Requirements

8.1.1 Approach

The applicant proposes a treatment train approach comprising wetland swales and a wetland area. No details are provided demonstrating that these measures will achieve the required water quality outcomes over the full life of the development and under the proposed operating conditions. Further information is recommended to demonstrate that the proposed stormwater treatment system has been appropriately sized, configured and designed to minimise adverse effects on the receiving environment and maintain long-term performance.

In particular, consideration should be given to:

- Provision of appropriate pre-treatment measures between the collection network and the wetland treatment system to capture gross pollutants and coarse sediments, minimise sediment accumulation and reduce ongoing maintenance requirements.
- Measures to prevent short-circuiting within the wetland swales and treatment systems, particularly where wide treatment corridors are proposed.
- Maintenance access arrangements for sediment removal, vegetation management and inspection activities.
- Public safety considerations associated with extensive artificial water bodies and drainage corridors within urban areas.
- Confirmation of the design sizing criteria, including treatment volume, detention time, hydraulic loading and design storm assumptions.
- Groundwater management and controls, including potential interactions between groundwater levels, treatment performance and hydraulic operation of the wetland systems.
- Demonstration that the proposed treatment devices will maintain their intended hydraulic and water quality performance throughout the life of the development, taking into account vegetation growth, sediment accumulation and maintenance requirements.

Given the scale of the proposal and the proposed reliance on wetland-based treatment systems, it is important that sufficient information is provided to demonstrate both water quality performance and long-term operational practicality. Failure to adequately address maintenance, hydraulic performance and groundwater interactions may result in reduced treatment effectiveness over time.

8.2 Hydraulic Effects

As outlined in the BOPRC stormwater design guidelines, a Manning's roughness of 0.10 is appropriate for wetland systems and wetland areas with open water areas.

The proposed design has maximum water depths of 100 mm to be maintained and median groundwater levels of 0.4 to 0.7 mRL NZVD, at or just below the base of the swale. The urban design guidelines indicate that wetland plants will include Carex and Sedges that grow 0.6 to 1.0 m high. This will result in an intermittently wetted channel that will be susceptible to high rates of vegetation growth. It is considered unlikely that the proposed wetland swales will consistently achieve the assumed hydraulic conditions adopted in the application. The maximum water level will be held in the root ball and clumped basal sheath of the proposed wetland plants (i.e., no open water areas formed with wetland plants 0.60 to 1.00 m high) as described in the planting plan. Water levels are likely to be maintained primarily within the root zone of the wetland vegetation, rather than forming the extent of open water areas assumed in the hydraulic assessment. This is likely to affect the adopted Manning's roughness, hydraulic performance with a much higher mannings N roughness.

It is important wetland planting requirements and wetland water levels are compatible with the assumed hydraulic conditions. While this may be provided in the consent conditions with confirmation that the proposed planting regime is compatible with the assumed hydraulic parameters, this may result in changes to the planting included in the application.

8.3 Expected Treatment Performance

Treatment performance of 70-90% removal of suspended solids and 50-80% removal of total heavy metals is expected to be achievable for wetland swales with heavy vegetation under favourable hydraulic and maintenance conditions. However, this treatment performance is not necessarily consistent with the application details and assumptions which include a Mannings roughness of 0.1 to allow for open water.

Notwithstanding this, the treatment performance indicated in Table 3 suggests that the proposed discharge quality targets are unlikely to be consistently achieved.

Limited treatment performance is expected through the downstream wetlands owing to the hydraulic loading provided from the upstream catchment. This is further discussed in section 6.6 below.

A target stormwater treatment of 80% Australia New Zealand Guidelines (ANZG) (2018) and suspended solids levels of 150 mg/L is provided.

Expected stormwater characteristics obtained from Earth Sciences UQGIS database identified the area as residential and light industrial/commercial land uses.

The following tables provide the expected stormwater discharge quality and range of treated stormwater characteristics for the stormwater discharges.

Table 3: Residential (Median Density)

Parameter	Median	90%
TSS (75% removal)	44 mg/L (11 mg/L)	250 mg/L (62.5 mg/L
Zinc (50%-80% Removal	0.12 mg/L (**0.06 – 0.024** mg/L)	0.44 mg/L (**0.22-0.088** mg/L)
Copper (50-80% Removal)	0.011 mg/L (**0.055-0.0022** mg/L)	0.038 mg/L (**0.014-0.0076** mg/L)

Notes:
Bold – in excess of ANZG (2018) 80% limits for Freshwater.

Table 4: Commercial Light industrial

Parameter	Median	90%
TSS (75% removal)	21 mg/L (11 mg/L)	150 mg/L (62.5 mg/L
Zinc (50%-80% Removal	0.50 mg/L (**0.100 – 0.250** mg/L)	0.86 mg/L (**0.170-0.430** mg/L)
Copper (50-80% Removal)	0.011 mg/L (**0.022-0.0055** mg/L)	0.038 mg/L (**0.0076-0.018** mg/L)

Notes:
Bold – in excess of ANZG (2018) 80% limits for Freshwater.

As detailed above, the stormwater treatment system is unlikely to meet the proposed stormwater discharge trigger values for either the residential or industrial areas of the development. No amount of monitoring is likely to improve this treatment performance.

The predicted treated concentrations for zinc and copper remain above the proposed ANZG (2018) trigger values for a range of scenarios. This indicates that achieving the proposed discharge targets is likely to require either improved treatment performance beyond that proposed or additional treatment stages beyond those currently proposed.

Further comment is provided for the individual components below.

8.4 Primary Treatment Requirements

We are advised that no primary treatment devices, other than stormwater sumps, have been proposed for economic and operational maintenance reasons. Performance is instead proposed to be managed through an active monitoring programme.

Monitoring will not improve treatment performance. It will only identify where improvements are required.

This is considered contrary to good practice for large wetland areas (e.g., NIWA Wetland Guidelines, GD04, and the Christchurch City Council Waterways, Wetlands and Drainage Guide (CCC WWDG)). Sediment build-up and litter accumulation are expected within the wetland swales, as illustrated in the photograph below of a similar, recently constructed wetland swale (less than 18 months old) that does not incorporate any primary treatment. As can be seen in Figure 3, sediment and litter are accumulating within the swale. Within large wetlands, these effects are much more difficult to manage and maintain over wide areas.

Figure 3. Sediment and Litter Accumulation in Wetland Swale

In the absence of additional pre-treatment measures, it is not clear how sediment accumulation, gross pollutant loading and maintenance requirements will be effectively managed over the life of the development.

It is recommended that the applicant provides a commitment to providing primary treatment devices at this stage to prevent accumulation of sediment and litter within the wetland and wetland swales.

8.5 Wetland Swales

Without primary treatment, the wetland swales provide the main physical treatment of the stormwater treatment train. This provides a very limited physical "treatment train" compared with that outlined in the application.

Base swale widths of between 11 and 32 meters are proposed for the wetland swales. BOPRC Stormwater Guidelines limit total widths to seven meters to avoid short-circuiting and poor flow distribution through wetland swales.

The proposed wetland swales are approximately two to over five times wider than the guideline recommendation. Wider systems are generally more susceptible to uneven flow distribution, localised stagnation, preferential flow paths, and hydraulic short-circuiting. These processes reduce effective treatment residence time and can significantly reduce treatment performance if active flow distribution measures are not incorporated. In practice, the wetland swales are expected to perform as wetlands and will require active distribution of flows through the swales to achieve effective treatment performance.

While wetland swales may effective remove sediment and litter, these contaminants are expected to accumulate and be difficult to remove from the proposed arrangements.

The applicant needs to provide assurance and evidence demonstrating how the wetland swales can perform to the required treatment performance standards.

8.6 Wetland Sizing

A wetland area equivalent to approximately 2-3% of the total catchment area is typically required, which equates to approximately 7 ha. A depth of 200-300 mm for the first flush volume (33 mm) requires a total wetland area of 20 ha.

Total stormwater reserve areas appear to be in excess of 70 ha. Based on the available area, it is concluded that there is sufficient area provided to develop stormwater wetlands for the site.

However, upstream flows are proposed to be diverted around the site through the common wetland areas to the south. Therefore, these areas are expected to provide limited treatment capacity with flows conveyed from the upstream catchment through the wetland system. Nevertheless, some polishing and biodiversity benefits may be obtained if they are developed effectively.

The proposed wetlands outside the wetland swales are unlikely to provide significant removal of heavy metals owing to the hydraulic loading from upstream of the site.

8.7 Risk and Benefits

The Stormwater Management Plan provides details of the risks and benefits associated with the proposed stormwater management system. The effectiveness of the proposed approach is dependent on the successful integration of stormwater treatment, flood management, groundwater control, pumping infrastructure and long-term operational management.

8.7.1 Ecological

Significant emphasis is placed on the potential ecological benefits of converting agricultural land to urban land use with stormwater treatment. While this may provide environmental benefits relative to the existing land use, there is no recognition of the changes in contaminants of concern associated with urban development, and no detailed assessment is provided to support the adequacy of the proposed treatment measures within the available layout. As illustrated above, heavy metal concentrations in stormwater are expected to exceed the proposed treatment targets.

8.7.2 Operation

Long-term operation of the proposed stormwater management system will require ongoing management of drainage infrastructure, flood protection assets, groundwater controls, wetlands, swales, pump stations and associated monitoring programmes. Agreement is required on the development of a long-term catchment management plan, asset ownership arrangements, levels of service and the associated capital and operational resource requirements.

Very limited detail is provided for the catchment outside the development area, including a significant number of existing properties within the floodplain or the capital commitments that may be required to be managed by other stakeholders. These matters should be assessed and incorporated into the SWMP and associated asset management framework.

8.8 Water Quality Summary Conclusions

The proposed pump stations, drainage channels, groundwater control systems, and associated flood management infrastructure form part of an integrated catchment-wide drainage network and cannot be readily separated from the wider drainage system. As a result, any future ownership, maintenance obligations, replacement costs, operational risks and emergency management responsibilities may ultimately need to be managed on a catchment wide basis.

The proposed stormwater treatment system would appear to be highly dependent on pumping both groundwater and surface water during dry weather to maintain flood storage and stormwater treatment function.

The proposed stormwater treatment does not appear to be sufficient to meet the proposed treatment standards a very limited treatment train is provided, which largely limited wetland swales. The swale details proposed are not in accordance with BOPRC SW guidelines are expected to be susceptible to short circuiting of flows and poor treatment and hydraulic performance. The absence of pre-treatment is expected to lead to difficult maintenance requirements removing litter and sediment from the wetland swales, which have been proposed with very limited maintenance access provisions.

9.0 Recommended Requirements and Consent Conditions

9.1 General

PDP & BOPRC have concerns about the proposal proceeding until the following matters have been resolved:

- An updated hydraulic model suitable for assessing flood behaviour across the full range of relevant design events, including stopbank breach scenarios, is prepared and independently peer reviewed.
- The applicants hydraulic model is reconciled with the BOPRC floodplain model and key differences are documented and justified.
- The consequences of pump failure, stopbank failure, groundwater drawdown and climate change are assessed using a risk-based approach.
- An assessment is undertaken demonstrating that the proposal does not create or increase significant natural hazard risk to people, property, lifeline infrastructure or other sites.
- Expected economic effects of the proposal are is completed identifying operational risks, and including asset renewal requirements, and emergency management implications.
- Construction staging demonstrates that flood protection, drainage and sediment control measures are installed prior to development occurring within each stage.

Should the proposal proceed with confirmation of the above the proposal conditions must include:

- Given the significant differences between the floodplain managers and the applicant with respect to the suitability of the hydraulic model for detailed design, and the complexity of the floodplain system, a fully verified hydraulic model shall be provided within six months of the consent approval and at least six months before any construction commences
- The consent holder demonstrates no increase in flood hazard to people property and lifelines in existing high and medium risk areas in accordance with eth RPS and NPS Natural Hazards
- The proposed solution is consistent with proposed National Engineering Design Standards for Stormwater prior to granting consent.
- An acceptable level of redundancy shall be provided for all stormwater pumping systems.

- Electrical and structural provisions for stormwater pumping facilities shall be completed in full prior to the development of any part of the development that utilises the pumping facilities.
- The risk of stopbank failure on the surrounding properties and the TEL shall be assessed, and any mitigation required as a result of development earthworks shall be implemented to an acceptable level prior to any work on the development site.
- Provision for future stopbank upgrades must be allowed for in the development layout.
- Effects on other groundwater users and groundwater-dependent ecosystems shall be assessed.
- Construction and Erosion and Sediment Management Plans shall be provided with a detailed explanation of how the applicant intends to prevent loss of sediment from the site in a flood event.
- Construction dewatering and drawdown effects shall be assessed.
- Spatial provision for stopbank upgrades shall be provided in the design of infrastructure.
- Infrastructure upgrades required for the exercise of the consent shall be the responsibility of the consent holder.

Take and Discharge Rates

The pumping rate of water from the Bell Road A Drain Pump Station upgrade and the Kopuarua Canal Pump Station to the Kaituna River shall be in accordance with the approved stormwater management plan and approved detailed design for both pump stations.

9.2 Stormwater Management Plan (SWMP)

The consent holder shall maintain a final SWMP for the duration of this consent.

The purpose of the SWMP is to:

1. Provide a stormwater management framework and toolbox of management options to achieve sustainable and best practical stormwater management outcomes and mitigate stormwater effects, while ensuring that the requirements of this consent are met; and

   a) Achieve stormwater management outcomes that are based on the latest version of the BOPRC Hydrological and Hydraulic Guidelines, the Stormwater Management Guidelines for the Bay of Plenty Region and the Regional Stormwater Strategy for the Bay of Plenty; and,

   b) Set minimum design criteria for stormwater infrastructure; and,

   c) Document the land use which the SWMP applies, including all high-risk land uses identified in Schedule 3 ; and,

d) Provide for low impact stormwater design practices that:

   a. Adopt a treatment train approach;

   b. Incorporate techniques that mitigate and manage stormwater flows, volumes and contaminants to achieve long-term positive stormwater quality and quantity outcomes; and,

   c. Avoid or mitigate adverse effects on the ecology and health of streams and wetlands, including from loss of baseflow.

An updated, verified hydraulic model suitable for assessing flooding design events from the 2- to 500-year ARI shall be provided and independently peer reviewed.

The consent holder shall update the SWMP within six months of the granting of this consent and submit the final SWMP to BOPRC for certification. The update of the SWMP and certification by the BOPRC shall confirm that the SWMP complies with and acknowledges the conditions of this consent and their requirements.

The SWMP and hydraulic model shall be updated and approved for each stage of the development and shall demonstrate that:

- 2-, 5-, 10-, 20-, 50-, and 100-year ARI design levels, inclusive of climate change effects to 2130, are maintained;
- The 100-year ARI design level plus 300 mm freeboard remains below the TEL catchment boundary;
- Existing consent criteria are maintained, including flooding of the TEL;
- There is no increase in flood hazard within the catchment;
- The catchment is drained down to less than 1 mRL NZVD within three days for the 10% AEP event, to meet its original design intent; and,
- A groundwater monitoring and management plan is implemented.

Discharges from stormwater infrastructure established after the commencement of this consent must meet the following design criteria:

a) Any overland flow paths must allow the passage of a 1% AEP (Q100) storm event without floodwater entering habitable buildings; with the provision of at least 500 mm freeboard;

b) Any catchment swales or wetlands must be designed to remove at least 75% of Total Suspended Sediment on a long-term average basis from the contributing area of urban development; and,

c) Any stormwater infrastructure that is constructed must not increase upstream or downstream flood hazards to people and property.

9.3 Infrastructure Design Requirements

Stormwater infrastructure must be designed and managed in general accordance with any operative and relevant National Environmental Standards and the following standards and guidelines in effect at the time of design:

a) Bay of Plenty Regional Council Hydrological and Hydraulic Guidelines;

b) The Stormwater Strategy for the Bay of Plenty Region and the Stormwater Management Guidelines for the Bay of Plenty Region;

c) Western Bay of Plenty District Council Development Code;

d) BOPRC Stopbank Design Guidelines;

e) The New Zealand Building Code;

f) Auckland Council's Water Sensitive Design for Stormwater March 2015 (GD2015/004); and,

g) Any alternative standards or national guidelines certified as appropriate by the Chief Executive of the BOPRC or delegate.

9.4 Water Quality

All roofing and exterior wall surfaces for buildings and structures shall be comprised of inert materials (inert materials are those that do not have an exposed surface made from contaminants of concern to water quality; including zinc, copper and lead).

The consent holder will ensure that no discharge resulting from the exercise of this consent, will result in any of the following:

a) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;

b) Any conspicuous change in the colour or visual clarity; and,

c) Any emission of objectionable odour; and,

d) Any significant adverse effects on aquatic life; and,

e) Aquatic organisms being rendered unsuitable for human consumption by the presence of contaminants.

Wetlands, swales and any other stormwater devices must be designed, located, constructed, operated and maintained in a manner consistent with the above infrastructure guidelines and approved SWMP or any approved departures.

Stormwater shall be managed, including through land use and subdivision and the design,

construction and operation of the stormwater network, in accordance with the SWMP Low Impact Design approach to achieve a level of treatment at the identified sampling points as shown on Plan TBC authorised under this consent which does not exceed the trigger levels listed in Table 5 below.

Table 5: Stormwater Discharge Quality Parameters

Water Quality Parameters	Trigger Values	Unit
Total Suspended Solids	150 (for < 10% AEP events)	g/m3
Total Petroleum Hydrocarbons	15	g/m3
Chemical Oxygen Demand	250	g/m3
Copper	TBC	µg/L

Appendix A: Development Layout

KEY INFORMATION

- PUMPSTATION TO KOPUAROA CANAL
- UPGRADE TO EX BELL RD PUMPSTATION
- NOTABLE CAUSEWAYS
- 50M+ WIDE GREENWAY DIVERTING UPSTREAM BELL ROAD DRAIN AND PROVIDING STORAGE
- STORMWATER ATTENUATION RESERVES
- :535MWIDE SWALES TREATING AND CONVEYING INTERNAL SW FLOWS
- 50M WIDE SWALES CONVEYING DEVELOPMENT SW FLOWS
- 20M WIDE BELL ROAD DRAIN CONVEYING DEVELOPMENT SW FLOWS

LEGEND

EX BOY
PROP BOY
FARMDRAINS
OVERLAND FLOW PATH
PROP WETLANDSWALE
PROP SW RESERVE
PROP BATTER SLOPE
PROP RESERVE

Rev	Description	By	Date
B	FOR CONSENT	MB	03126
A	FOR REVIEW	MB	12125

	By	Date
Survey	MAVEN	0512025
Design	MB	11/25
Drawn	MB	11/25
Checked	CS	11125

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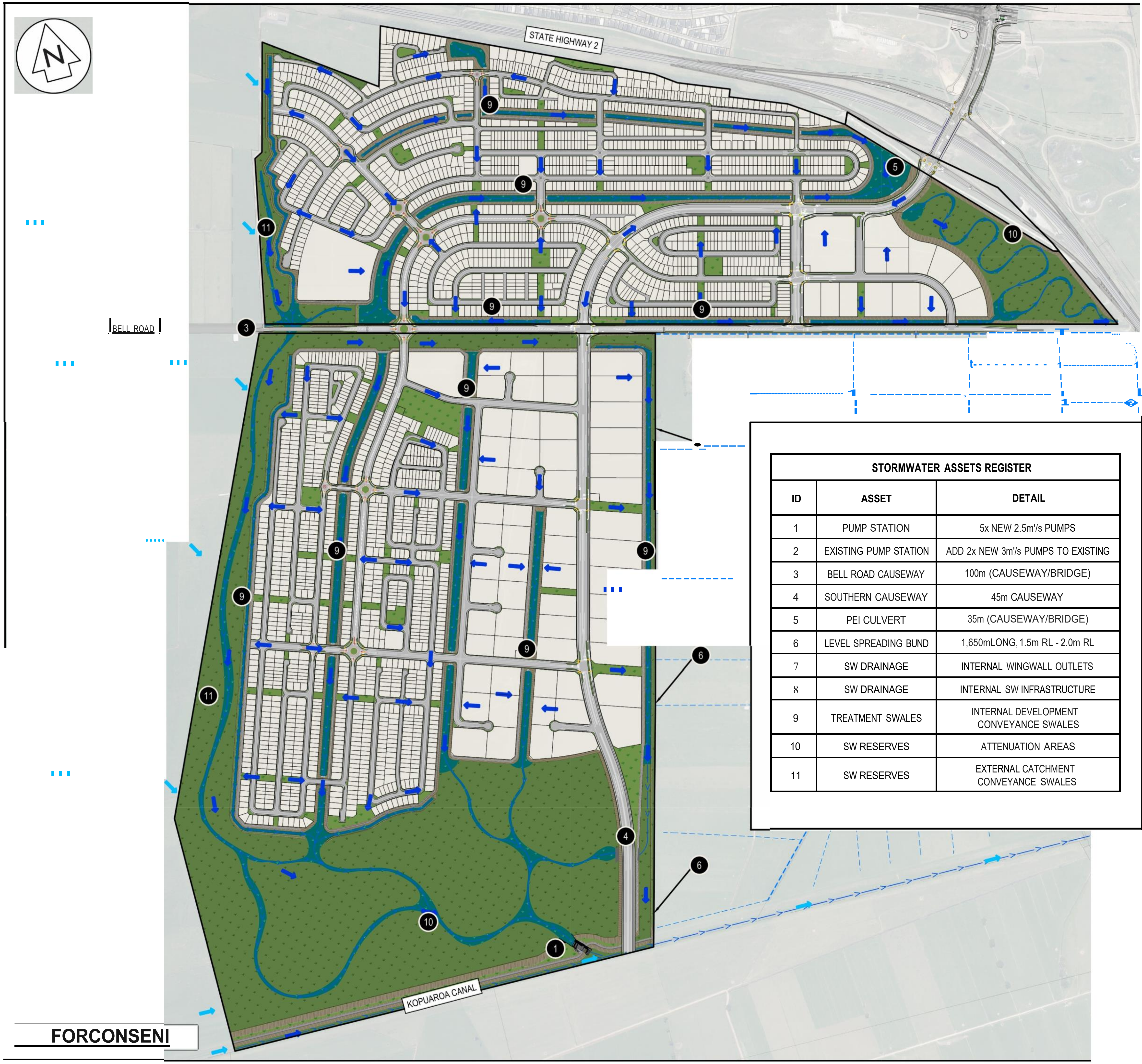
Project
WAIRAKEI SOUTH FTA090 DEVELOPMENT BELLROAD,PAPAMOA FOR BELL ROAD LIMITED PARTNERSHIP

Title
PROPOSED STORMWATER OVERVIEW PLAN

Project no.	BOP0?49
Scale	1:12000 @ A3
Cad file	BOP0749-C400.DWG
Drawing no.	C400-0-1

FOR CONSENT



ID	ASSET	DETAIL
1	PUMP STATION	5x NEW 2.5m³/s PUMPS
2	EXISTING PUMP STATION	ADD 2x NEW 3m³/s PUMPS TO EXISTING
3	BELL ROAD CAUSEWAY	100m (CAUSEWAY/BRIDGE)
4	SOUTHERN CAUSEWAY	45m CAUSEWAY
5	PEI CULVERT	35m (CAUSEWAY/BRIDGE)
6	LEVEL SPREADING BUND	1,650mLONG, 1.5m RL - 2.0m RL
7	SW DRAINAGE	INTERNAL WINGWALL OUTLETS
8	SW DRAINAGE	INTERNAL SW INFRASTRUCTURE
9	TREATMENT SWALES	INTERNAL DEVELOPMENT CONVEYANCE SWALES
10	SW RESERVES	ATTENUATION AREAS
11	SW RESERVES	EXTERNAL CATCHMENT CONVEYANCE SWALES

STORMWATER ASSETS REGISTER

NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITHWESTERN BAY OF PLENTY DEVELOPMENT CODE.
2. CO-ORDINATES IN TERMS OF BAY OF PLENTY 2000.
3. REDUCED LEVELS ARE IN TERMS OF NZVD 2016. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.
4. HEAVY DUTY MANHOLE LIDS AND FRAMES TO BE USED IN TRAFFICKED AREAS, ALLMANHOLES SHALL HAVESTAINLESSGRATES INSTALLED.
5. ALLLINES ARE TO BE RCRRJ CLASS 4 UNLESS SHOWN OTHERWISE.

LEGEND
EX BDY
PROPBDY
FARM DRAINS
OVERLAND FLOW PATH
UPSTREAM OLFP
POST-DEV OLFP
PROP WETLAND SWALE
PROP SW RESERVE
PROP BATTER SLOPE
PROP RESERVE

Rev	Description	By	Date
B	FOR CONSENT	MB	03/26
A	FOR REVIEW	MB	12/25

	By	Date
Survey	MAVEN	05/2025
Design	MB	11/25
Drawn	MB	11/25
Checked	SB	11/25

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Project
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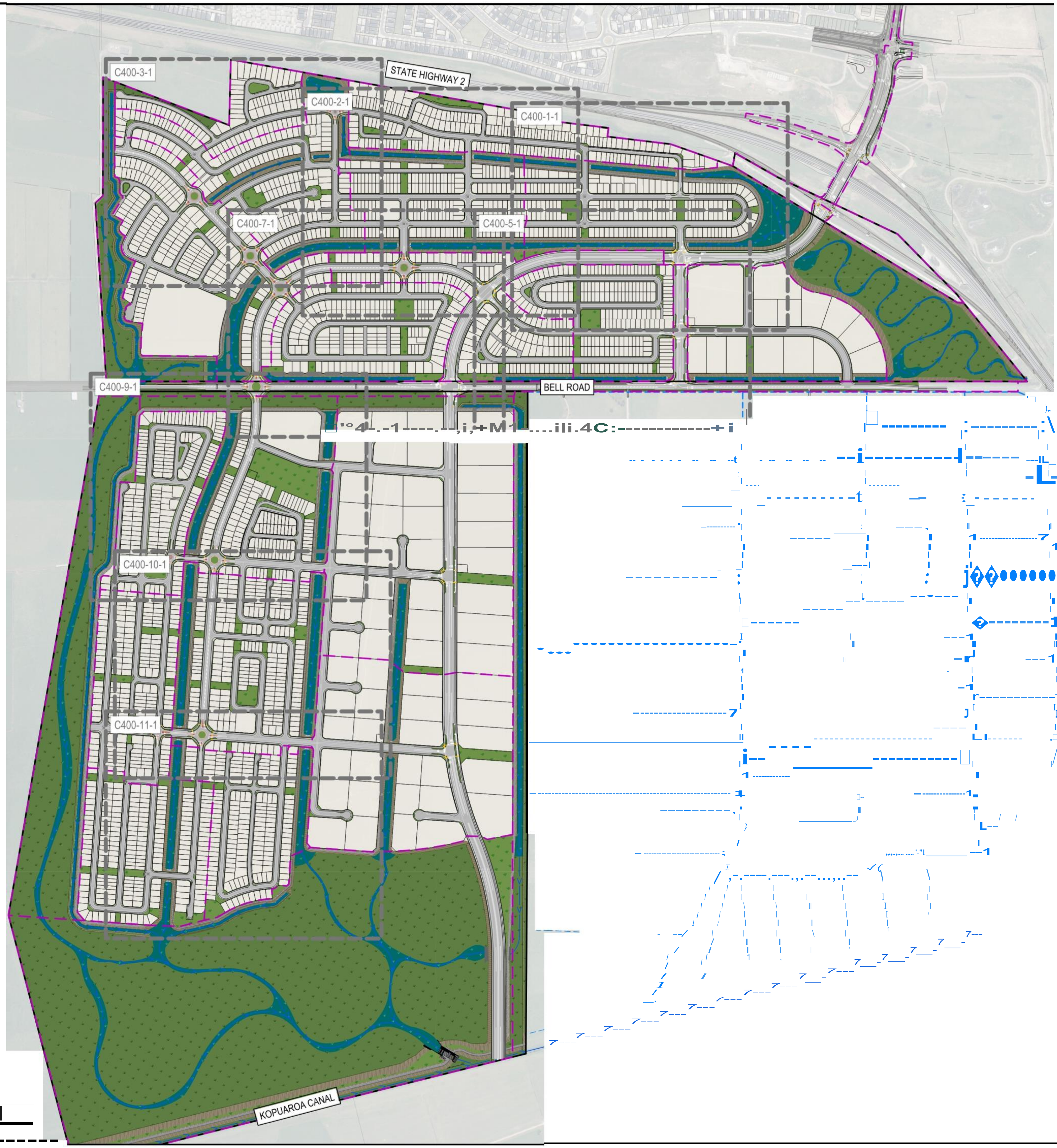
Title
PROPOSED STORMWATER ASSETS PLAN

Project no.	BOP0749
Scale	1:10000@A3
Cad file	BOP0749-C400.DWG
Drawing no.	C400-0-2 Rev B



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NOTES

1. ALL WORKS TO BE IN ACCORDANCE WITH WESTERN BAY OF PLENTY DEVELOPMENT CODE.
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3. REDUCED LEVELSARE IN TERMS OF NZVD 2016. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.
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5. ALL LINES ARE TO BE RCRRJ CLASS 4 UNLESS SHOWN OTHERWISE.

LEGEND

- EX BOY
- PROP BOY
- PROP STAGE BOY
- PROP STORMWATER
- FARM DRAINS
- OVERLAND FLOW PATH
- PROP WETLANDSWALE
- PROP SW RESERVE
- PROP BATTER SLOPE
- PROP RESERVE

Rev	Description	By	Date
B	FOR CONSENT	MB	03/26
A	FOR REVIEW	MB	12/25

	By	Date
Survey	MAVEN	0512025
Design	MB	11/25
Drawn	MB	12/25
Checked	CS	12/25

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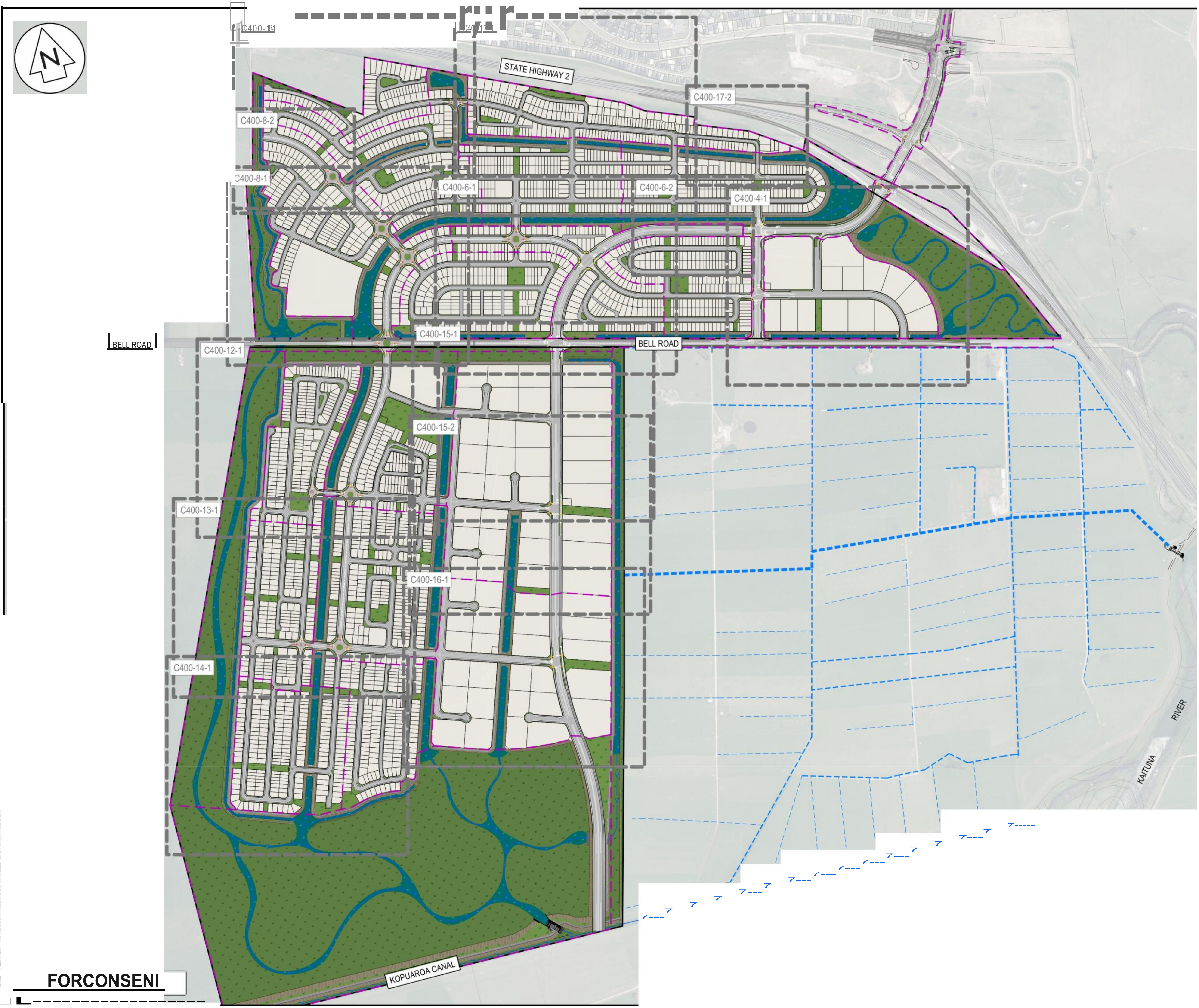
Project
WAIRAKEI SOUTH FTA090 DEVELOPMENT BELL ROAD, PAPAMOA FOR BELL ROAD LIMITED PARTNERSHIP

Title
PROPOSED STORMWATER LAYOUT OVERVIEW PLAN

Project no.	BOP0749
Scale	1:10000@A3
Cad file	BOP0749-C400.DWG
Drawing no.	C400-0-3 Rev B



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1. ALL WORKS TO BE IN ACCORDANCE WITH WESTERN BAY OF PLENTY DEVELOPMENT CODE.
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5. ALL LINES ARE TO BE RCRRJ CLASS 4 UNLESS SHOWN OTHERWISE.

LEGEND
- EX BOY
- PROP BOY
- PROP STAGE BOY
- PROP STORMWATER
- FARM DRAINS
- OVERLAND FLOW PATH
- PROP WETLAND SWALE
- PROP SW RESERVE
- PROP BATTER SLOPE
- PROP RESERVE

Rev	Description	By	Date
B	FOR CONSENT	MB	03/26
A	FOR REVIEW	MB	12/25

	By	Date
Survey	MAVEN	05/2025
Design	MB	11/25
Drawn	MB	12/25
Checked	CS	12/25

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Project
WAIRAKEI SOUTH FTA090 DEVELOPMENT BELL ROAD, PAPAMOA FOR BELL ROAD LIMITED PARTNERSHIP

Title
PROPOSED STORMWATER LAYOUT OVERVIEW PLAN

Project no.	BOP0749
Scale	1:10000 @ A3
Cad file	BOP0749-C400.DWG
Drawing no.	C400-0-4 Rev B

Appendix B: Long Sections

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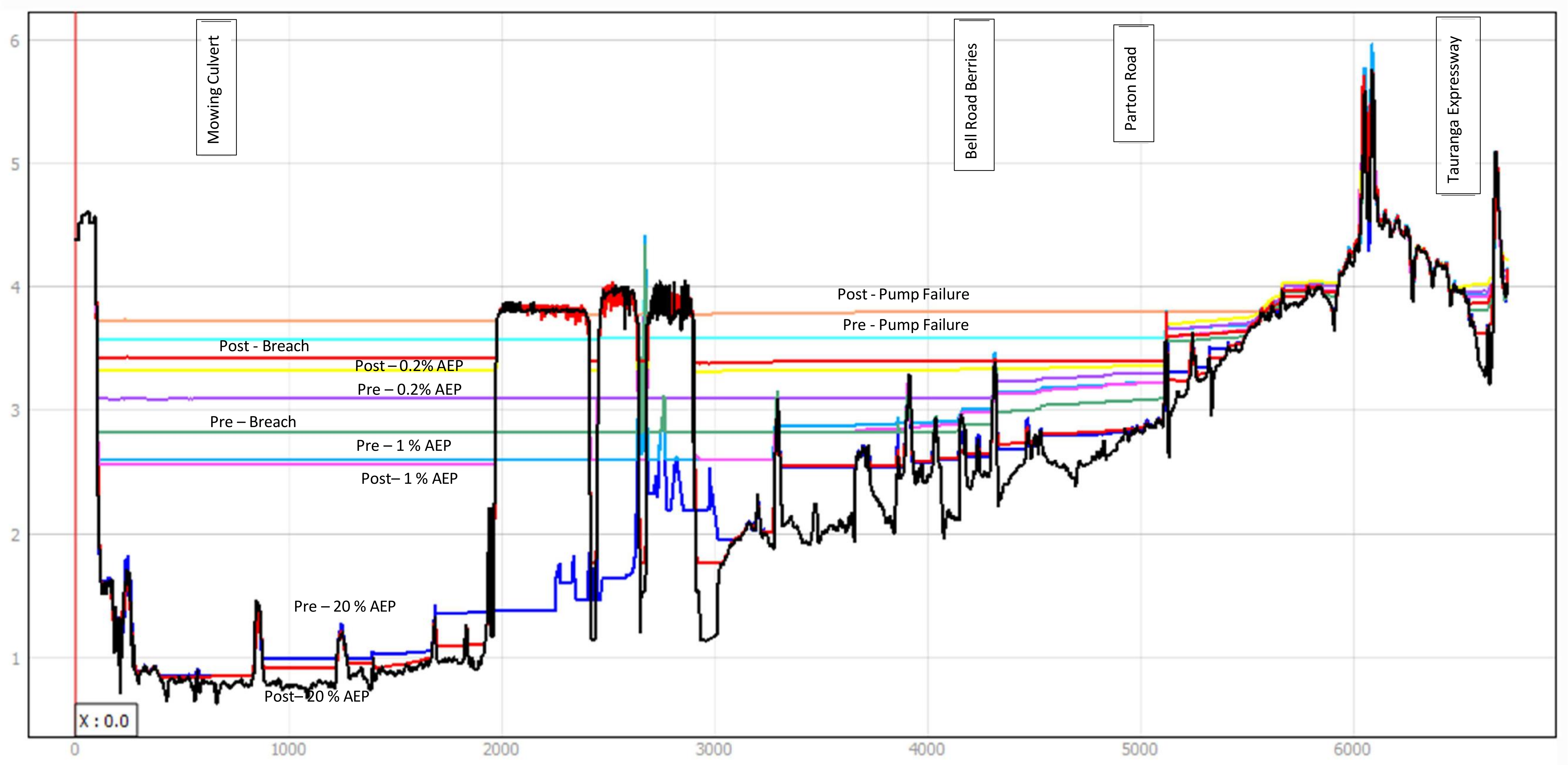
Mowing Culvert
Bell Road Berries
Parton Road
Tauranga Expressway
Post - Pump Failure
Pre - Pump Failure
Post - Breach
Post – 0.2% AEP
Pre – 0.2% AEP
Pre – Breach
Pre – 1 % AEP
Post– 1 % AEP
Pre – 20 % AEP
Post– 20 % AEP
X : 0.0
6
5
4
3
2
1
0
1000
2000
3000
4000
5000
6000

Appendix C: Flood Modelling Assessment Maps

Appendix D: GW Assessment

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9 March 2026

Mary Pappon
Senior Consents Planner
Bay of Plenty Regional Council
PO Box 364
WHAKATĀNE 3158

Dear Mary,

RM24-0608: BELL ROAD LIMITED PARTNERSHIP – WAIRAKEI SOUTH HYDROGEOLOGICAL ASSESSMENT TECHNICAL REVIEW

1.0 Introduction

Bay of Plenty Regional Council (BOPRC) has engaged Pattle Delamore Partners Limited (PDP) to undertake a technical review of a hydrogeological assessment prepared by ENGEO Limited on behalf of the Applicant, Bell Road Limited Partnership, associated with the Wairakei South development (the project) Fast Track application. At the time of this review, the substantive application has not been submitted to the Fast Track Panel. This technical review was undertaken on behalf of Bay of Plenty Regional Council as part of providing pre-application comments.

2.0 Background

The project involves development of 360 ha of agricultural land into residential and commercial use near Papamoa, Tauranga. Significant landform changes are proposed to raise foundation heights above potential flood inundation levels given the existing area is low-lying (0.5 – 2 mRL; NZVD).

Lowering of other parts of the site is proposed to provide stormwater attenuation storage capacity. The proposal is to create a network of swales and two stormwater attenuation wetland areas and maintain water levels in these at 0.5 and 0.8 mRL (NZVD). This will be achieved by continuous pumping at rates of up to 3,800 m^3/day (estimated). Existing groundwater levels across the site are typically shallower than 1 m below ground level and range between 0 and 2 mRL. Limited details of the proposed pump stations to achieve these target water levels has been provided to date.

Compaction of in situ peat, placement of imported fill, and development of impervious surfaces are all likely to contribute to reductions in infiltration and groundwater recharge rates, while increasing runoff.

Stated objectives of the hydrogeological assessment were to assess the hydrogeological effects of the proposal due to associated changes in ground level, drain/pond water levels, subsurface permeability, and groundwater recharge rates. Hence the focus of ENGEO's assessment was on effects to:

- groundwater levels surrounding the development, and
- groundwater discharge rates influencing stormwater management.

Of particular interest for the purposes of this review and the review of flooding assessments, is the influence of hydrogeological changes on flooding effects, and whether the flood assessment has been appropriately informed by and is consistent with the hydrogeological assessment.

3.0 Groundwater Modelling

The ENGEO report described the development and results of a three dimensional numerical groundwater flow model, which was used to simulate and compare groundwater levels and flows both pre- and post-development. A two-dimensional model was also used to evaluate smaller scale temporal effects of swale water levels on groundwater levels within the development area.

3.1 Model configuration and calibration

The three-dimensional model is the main focus of this review, as this was used to inform the key objectives. The model was developed in MODFLOW-USG (unstructured grid) code, comprising six layers to represent the hydrostratigraphy described in the hydrogeological conceptual model. Grid refinement was placed around drainage features.

Recharge to the model via rainfall infiltration was modelled using a soil water balance modelling approach considering soil hydrogeological characteristics.

Boundary conditions of the model included the coastline along Papamoa beach, represented as a constant head boundary, a river boundary condition for the Kaituna River and drain boundaries for all other drains, swales and canals in the model domain. No-flow boundaries were used for all other model cells at the domain edges and base. This may limit contributions from horizontal or vertical subsurface flows, however the potential significance of these is not well understood or described.

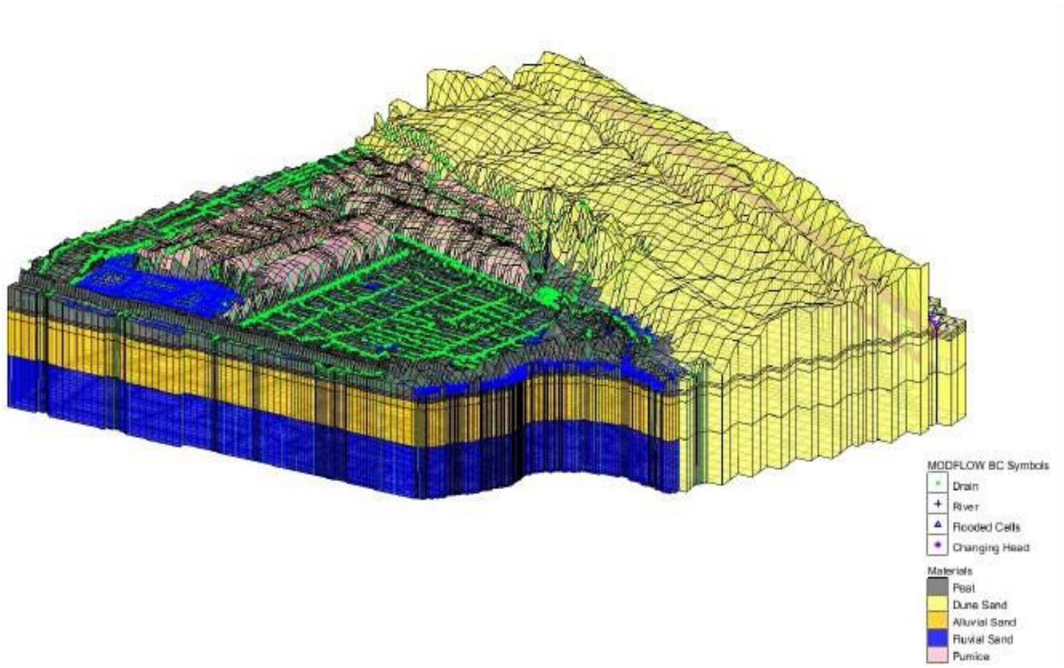

Figure 1: Orthographic view of the model domain, parameter zones and boundary conditions (ENGEO, 2025).

Parameterisation of the model was informed by on site investigations and testing, and calibration was performed to observed groundwater levels on site in 21 piezometers and from 13 surrounding TCC monitoring bores. Both steady state and transient calibrations were performed using average and time varying groundwater observation data.

The model setup, parameters and calibration are considered reasonable and appropriate with respect to the model objectives outlined in the ENGEO report.

3.2 Model scenarios

Five transient model simulations were developed using the 3D groundwater model. These covered pre- and post-development conditions and provided additional scenarios for consideration of sea level rise and to evaluate sensitivity of results to parameter variations (permeability and recharge).

The scenarios were developed to evaluate simulated changes to groundwater levels (drawdown and mounding) and associated changes in groundwater discharges to the surface (via drains, swales, etc).

The proposed landform changes will affect the spatial pattern of groundwater discharge across the site and modify groundwater levels and hydraulic gradients. In some areas this will present as a drawdown effect (compared to pre-development groundwater levels) and mounding in other areas. These effects will arise as existing drains are infilled (causing a relative rise in groundwater levels) or where new drains are installed, causing a relative decline in groundwater levels.

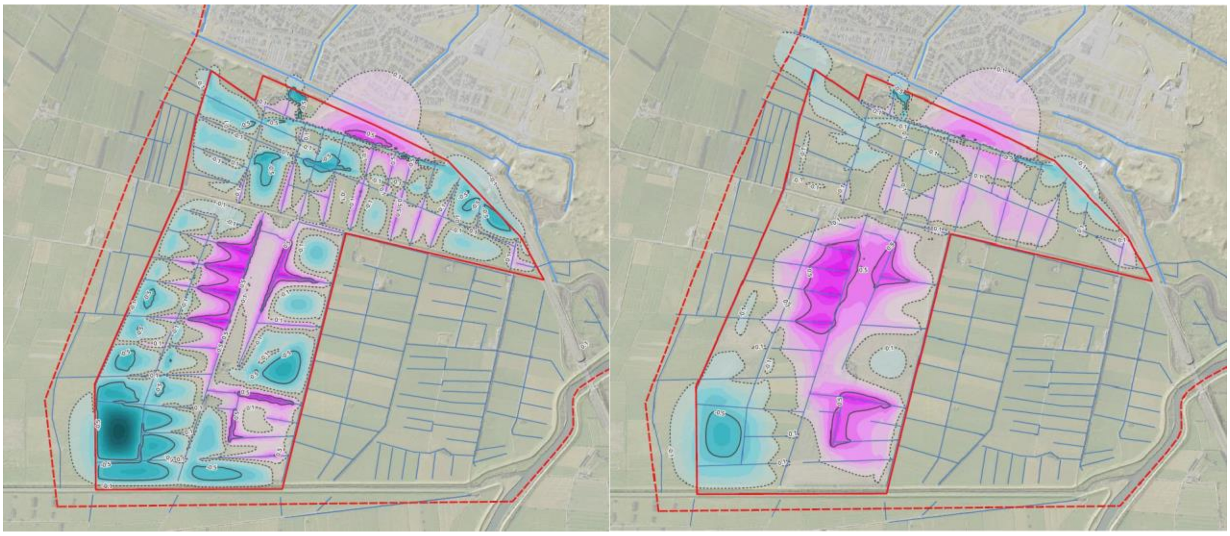

Figure 2: Modelled post-development drawdown (purple) and mounding (blue) during winter conditions (left) and summer conditions (right), compared to a pre-development baseline (ENGEO, 2025).

Predicted drawdown and mounding effects associated with the proposal are shown in Figure 2 and illustrate limited groundwater level impacts beyond the site boundaries. We agree that the effects of these groundwater level changes on neighbouring land, the groundwater resource and other groundwater users is considered negligible.

It is noted that only proposed landform changes have been considered and details regarding the pump stations proposed for maintaining low water levels have been provided to date. The assessment has not considered changes to drain water levels due to additional pumping downstream of existing drains e.g. in the farmland east of the development. However, the corresponding potential effects on drawdown in these paddocks is expected to be minimal, and greatest during wetter conditions. Hence the effect on these areas, if anything, is likely to be an improvement in the effectiveness of drainage during wet conditions with negligible lowering of groundwater levels during dry conditions.

The post development scenario considering sea level rise (SLR) indicated that SLR effects on predicted drawdown and mounding associated with the development would be negligible. Predicted groundwater levels near the coast and Kaituna River were higher than baseline conditions due to increased heads in these outflow boundaries. Effects are limited in extent because the proposed low flow pumping from attenuation ponds will provide a hydraulic control on minimum groundwater levels and head gradients. In the absence of these controls, a rise in head along the coastal boundary and Kaituna River would constrain groundwater discharge under gravity and result in broader groundwater level rise across the site.

The model was used to evaluate the rates of groundwater discharge to the swales and attenuation ponds, to understand the expected amount of low flow pumping that would be required to maintain operational water levels in the attenuation ponds. This was estimated to peak at 3,700 m^3/day, with an average rate closer to 2,000 m^3/day. This accounted for the proposed landform changes and distribution of topographic low points to which groundwater will discharge and reductions in infiltration rates due to the development. These rates are considered generally reasonable and based on appropriate modelling approach. A degree of uncertainty surrounding this rate remains, for example if the geology is more permeable than is represented by the model. However, these rates are considered unlikely to deviate substantially from the model results. Additional sensitivity analysis is recommended to evaluate alternative conceptual models in which estimated dewatering rates could be higher.

It is understood that groundwater seepage rates have been incorporated into the flood modelling assessment, noting they are very small (0.043 m^3/s) in the context of flows that would occur during a flood event.

3.3 Other considerations

Consideration should be given to the potential effects of the low flow pumping regime on the ultimate asset owner/operator in terms of operational costs. Low flow pumping, estimated to be in the order of 3,700 m^3/day, will be required on a continuous basis. Hence, operational pumping and maintenance costs are likely to be considerable.

BOPRC provided the details of another groundwater flow model which covers the study area (Kōmanawa Solutions Limited, 2024). This model was prepared for BOPRC and considered the potential effects of sea level rise on shallow groundwater levels and drain discharges across the Kaituna Plains. While this model produced some outputs of a similar nature to the ENGEO assessment, particularly in terms of sea level rise effects, results of this modelling are not considered directly applicable to the BRLP application and assessment for a range of reasons. These include (but are not limited to) the following:

- The model comprised a generalised representation of groundwater processes in the coastal plain, including only one model layer;
- Unlike the ENGEO model, the KSL model did not focus on representing hydrogeological processes at the BRLP site, and was not informed by site specific data;
- The KSL report did not provide sufficient detail to evaluate the appropriateness of model parameters, boundary conditions and recharge for the purposes of this assessment.

4.0 Conclusion and Recommendations

The hydrogeological assessment prepared by ENGEO provides a reasonable and appropriate evaluation of groundwater effects associated with the proposed Wairakei South development. The numerical groundwater modelling approach, including conceptualisation, parameterisation, calibration, and scenario testing, is suitable for the stated objectives and is supported by site specific data.

We agree with the conclusions the Applicant has drawn from their work, including:

- Model results indicate that post development changes in groundwater levels will be spatially variable, with localised drawdown and mounding driven by proposed landform changes. Predicted effects are largely contained within the site boundary, with negligible impacts on surrounding land, groundwater users, and the wider groundwater resource.

- Groundwater discharge to swales and attenuation ponds has been appropriately quantified for operational conditions, and the estimated low flow pumping rates are considered reasonable in the context of model uncertainty. The contribution of groundwater seepage to flood events is small relative to flood flows and has been suitably incorporated into the flood modelling assessment. Additional sensitivity analysis is recommended to evaluate alternative conceptual models in which estimated dewatering rates could be higher.
- Sea level rise scenarios indicate limited influence on development related groundwater effects due to hydraulic controls provided by the proposed drainage and pumping regime. In the absence of these controls, broader groundwater level rise would be expected, which reinforces the reliance on the proposed stormwater management system and its ongoing operation.

It is recommended that the hydrogeological assessment be accepted as a suitable basis for informing the assessment of effects on groundwater. Consideration should be given to the long term operational and maintenance implications of the proposed low flow pumping regime for the future asset owner or operator.

5.0 References

ENGEO Limited, 2025. Wairakei South Development. Hydrogeological Assessment. Draft technical report prepared for Bell Road Limited Partnership.

Kōmanawa Solutions Limited, 2024. Hydrogeological modelling for sea level rise adaptation decision support. Technical report prepared for Bay of Plenty Regional Council.

6.0 Limitations

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Bay of Plenty Regional Council and the Applicant. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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

Yours faithfully

PATTLE DELAMORE PARTNERS LIMITED

Prepared by	Reviewed and approved by
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Appendix E: Modelling Peer Review Scope

Wairakei-South development mitigation assessment modelling Peer review scope

Aim of the peer review

This scope has been developed to guide the independent peer review of the modelling and results of the proposed Wairakei South development. The independent peer-review should:

- provide support for a fast-track application under the *Fast-track Approvals Act 2024 (FTAA)* ;
- is to investigate the large scale land development proposal in a low lying flood-prone area, surrounded by complex urban and agricultural land, served by a river and drainage schemes;
- review and confirm that the information provided by the developer is in line with BOPRC hydraulic modelling guidelines (allowing for special characteristic of the area such as heavy ended design rainfall, groundwater levels, soils etc) NZ national modelling guidelines, industry best practice.
- should test all stormwater assessments (pre and post development) using BOPRC Bell Road model 2025 Mike+ model (available to the applicant). As the purpose of the model provided to Maven was not to assess a large scale development the model will need to go through updates to make it suitable. The peer review needs to investigate the suitability of the model for the assessment and also the appropriateness of the changes that have been made to the model for the mitigation options.

Model Review Methodology

The peer review to be based on BOPRC Modelling guidelines, using principles and methodology defined in the guidelines.

All assumptions have to be inline with BOPRC original model unless change is required due to future development or assumptions that were not incorporated in the original model as it was not needed for the original purpose of the model. eg. (but not limited to) future groundwater levels, future developments, allowance for overtopping stopbanks etc. These parameters need to be agreed with BOPRC.

Following steps to be followed for the peer review:

1. Receive the Mike+ model from the designers,
2. Model build report review,
3. Review all information/data needed to make the model fit for purpose for the whole assessment (rainfall, assumption for new development, climate change assumptions, groundwater assumptions etc). This includes current and future climate change scenarios with all consented developments.
4. Update base model provided by BOPRC with post development design information to enable updating the base BOPRC model.
5. Run simulations for scenarios agreed with BOPRC,
6. Model comparison (flood level, depth, volume, flood extent,pump duration and volume, LOS)
7. Reporting , summaries findings as provide outputs in the format requested by BOPRC to enable the consent assessment
8. Meeting with BOPRC and the developer
9. Finalise the peer review report

BOPRC requested the following scenarios to be analysed by the developer

As per of the pre application process BOPRC requested the developer to use a number of scenarios when assessing the effects on scheme, environment and other landowners. The assessment also needs to incorporate breach scenario analysis, pumpstation failure analysis, RPS risk analysis (overdesign events) while taking into consideration future developments, climate change effects on rainfall, tide and groundwater levels, LOS etc.

Table 1 sets out the parameters the Regional Council requested to be used and includes the rationale of each parameter. This advice has been provided by Council's Engineering Team to the developer in 2024.

Scenarios 1 to 12 are all required to assess effects on the catchment,including the drainage schemes and TCC urban system. This TCC urban assessment includes assessing effects on culverts and/or pipe network capacity, overland flowpaths, stormwater ponds, etc.

	Modelling Parameters/Scenarios:	Rationale:
1	5-year return period - current climate (0.13 m SLR) with and without development	The level of service is a 5yr event for the drainage scheme. Assessment and comparison required to understand the current level of service of the drains with and without development and the effects of the mitigation (including volume, level, extent, duration, etc.)
2	5-year return period - 3.68°C climate change (1.6 m SLR) with and without development	Assessment and comparison required to understand the current level of service of the drains with future climate, with and without development and the effects of the mitigation (including volume, level, extent, duration etc)
3	10-year return period - current climate (0.13 m SLR #) with and without development	Assessment and comparison required to understand the current level of service of the Bell Rd. stopbanks with future climate change, with and without development and the effects of the mitigation (including volume, level, extent, duration etc)
4	10-year return period - 3.68°C climate change (1.6 m SLR) with and without development	Assessment and comparison required to understand the current level of service of the Bell Rd. stopbanks with future climate, with and without development and the effects of the mitigation (including volume, level, extent, duration etc)
5	20-year return period - current climate (0.13 m SLR #) with and without development	As the long-term mitigation is unknown it cannot be determined whether the long-term mitigation will have an adverse effect under the present climate condition. Assessment of effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area to show no increase of flooding due to the flows generated by the proposed development (determining if between a 10yr and a 50yr there may be adverse effects).
6	20-year return period - 3.68°C climate change (1.6 m SLR) with and without development	Assessment effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area to show no increase of flooding due to the flows generated by the proposed development (determining if between a 10yr and a 50yr there may be adverse effects).
7	50-year return period - current climate (0.13 m SLR #) with and without development	As the long-term mitigation is unknown it cannot be determined whether the long-term mitigation has an adverse effect under the present climate condition. Assessment

		effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area.
8	50-year return period - 3.68°C climate change (1.6 m SLR) with and without development	RPS risk assessment and effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area.
9	100-year return period - current climate (0.13 m SLR) with and without development	The current Level of service requirement in the Tauranga City Plan for the urban stormwater system is the 100yr event. As the long-term mitigation is unknown it cannot be determined whether the long term mitigation has an adverse effect on the present climate condition. Assessment effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area.
10	100-year return period - 3.68°C climate change (1.6 m SLR) with and without development	Level of service requirement of Tauranga City Plan urban stormwater system is 100yr, and also requirement of the RPS risk assessment. Assessment of effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area.
11	500-year return period - current climate (0.13 m SLR) with and without development	As the long-term mitigation is unknown it cannot be determined whether the long term mitigation has an adverse effect on the present climate condition. Following the impact of cyclone Gabrielle Regional Council's across the country have been encouraged to assess the effects of over design events.
12	500-year return period - 3.68°C climate change (1.6 m SLR)[1] with and without development	RPS risk assessment requirement. Risk assessment and effects of the mitigation (including volume, level, extent, and duration etc) on private property and infrastructure in rural and urban area.

In addition to the above scenarios, BOPRC requires the following:

a. Heavy ended, nested 72hr rainfall event is to be used for the analysis. For the TCC pipe network the critical duration rainfall event is to be used (to be confirmed by TCC).

b. Bell Road pump stations to be modelled with no gravity outflow due to high river levels.

c. Detailed shallow groundwater analysis and modelling will be required for current and future scenarios. Groundwater modelling results need to be incorporated into the modelling of current and future scenarios of the surface water model. Groundwater levels and movement need to also be incorporated when assessing possible storage options.

d. Modelling is to be carried out in accordance with BOPRC Hydraulic modelling guideline (2024) and, where applicable, TCC's modelling guideline. This to be confirmed with WBOPDC.

e. Analysis of depth, velocity, hazard vulnerability (Depth x Velocity) and duration changes between the pre-development and post-development scenarios in the Bell Road catchment and any other connected catchments, including Tauranga.

f. Kaituna River stopbank breach scenario analysis is needed, with guidance from the BOPRC Engineering Team.

g. Overdesign event analysis is required following RPS methodology, with guidance from the BOPRC Engineering Team.

h. Within the catchment all developments/areas or other already consented features will need to be included in the model. The catchment area maybe larger during larger events or when modelling future scenarios.

Examples of some of the other parameters that need to be considered

The following outlines example tests, checks, and questions that need to be included (but not limited to) in the peer-review:

1. Purpose Definition

- Is the model suitable for future development planning, consenting, and hazard management assessment?
- Does the assessment explicitly link to flood hazard for urban development, structure planning, plan changes or consentable works?
- Are system failure, over design events and freeboard considerations addressed?

2. Modelling Approach and Engagement

- It is not currently known what stage of planning this development has reached and the requirements of national modelling guideline provides useful modelling methodology guidance for flood studies at different stages (e.g. growth planning vs engineering design).
- Was early engagement with BOPRC undertaken? Are design events aligned with Council agreements?
- Has the base model (MIKE+) been clearly referenced and acknowledged as a benchmark?

- Are the key hydraulic phenomena identified, particular large flood plain and rivers near the study site?
- Have assumptions been agreed on with BOPRC including current, future, breach scenario, over design events?
- Is the catchment area clearly defined and agreed on with BOPRC? Are there additional areas that need to be connected for specific events?

3. Simulation Schedule

- Are the design events clearly listed and appropriate?
- Are the rain, river, sea level, groundwater settings reflective of Council requirements?

BUILD PHASE

5. Schematisation and Assumptions

- Is the model build configuration reported, and critical parameters identified?
- Is the geometry described and appropriate, aligned with Council LIDAR and latest survey, base model, or otherwise appropriate?
- Are cross-sections adequately spaced to capture key hydraulic controls e.g. bridge constrictions, stopbanks, critical drains and channels, ponds?
- Are open channels modelled appropriately?
- Does grid resolution allow hydraulic and topographic features to be presented adequately?
- Is a single datum consistently used?
- Is a stormwater network included?
- Does the model extent cover a sufficient area?
- Has channel roughness (Manning's n) been justified spatially and agreed with BOPRC?
- Are complex structures e.g. pump stations modelled appropriately?
- Have culverts and bridges been schematised in sufficient detail (invert, shape)?
- How is 1D-2D coupling approached?

6. Boundary Conditions

- Have the following boundary conditions been agreed on with BOPRC?

- Are inflows based on design hydrology and are appropriate?
- Are tidal and water level boundaries appropriate
- Are lateral inflows, rainfall-on-grid, or surface inflow assumptions documented?
- Is groundwater appropriately incorporated into the assessment?

7. Model Stability, Validation and Verification

- Is the model hydraulic stability?
- Are there any signs of instability in outputs , unrealised peaks?
- Has the model been validated against the MIKE+ or verified against any other additional information?
- Do the results provided by Developer show similar inundation extents, depths, velocities, timing to MIKE+?
- Where discrepancies exist discussion needs to be carried out with BOPRC Engineering Team.
- Is there evidence of discrepancies between the BOPRC modelling assessment and the developers assessment? This includes differences in volume, level, flows, pumping rates, residual risk, etc.

9. Output Use and Interpretation

- What are the model outputs?
- Are maximum water level, velocity, VxD, duration outputs clearly presented?
- Are flood hazard categories used or depth x velocity output?
- Are any material recommendations (floor levels, stormwater system design etc) clearly traceable to model outputs?

10. Communication of Limitations

- Are the model's limitations clearly stated?
- Are the model's assumptions clearly stated?

11. Sensitivity and Scenarios

- Has sensitivity testing been undertaken? e.g. blockage, increased rainfall, channel roughness, river levels, infiltration
- Has freeboard been assessed?

12. Reproducibility and QA

- Are the modelling results presented by the developer inline with results of BOPRC MIKE+model?

APPENDIX C: FLOOD MODELLING ASSESSMENT FIGURES

APPENDIX C1 - FLOOD DEPTH MAPS – EXISTING CLIMATE
APPENDIX C2 - FLOOD DEPTH MAPS - CLIMATE CHANGE
APPENDIX C3 - FLOOD LEVEL DIFFERENCE MAPS – CLIMATE CHANGE
APPENDIX C4 - STOPBANK BREACH MAPS – CLIMATE CHANGE

APPENDIX C1 – FLOOD DEPTH MAPS – EXISTING CLIMATE

C1-1A - POST DEVELOPMENT 20% AEP FLOOD DEPTH WESTERN MAP – EXISTING CLIMATE
C1-1B - POST DEVELOPMENT 20% AEP FLOOD DEPTH EASTERN MAP – EXISTING CLIMATE
C1-2A - POST DEVELOPMENT 1% AEP FLOOD DEPTH WESTERN MAP – CLIMATE CHANGE – PUMP FAILURE
C1-2B - POST DEVELOPMENT 1% AEP FLOOD DEPTH EASTERN MAP – CLIMATECHANGE – PUMP FAILURE

0 100 200 300 m

SCALE 1 : 12500 (A3)

NO.	REVISION	DATE	BY
B	UPDATED	AUG 26	QM
A	REVIEW	JUL 26	QM

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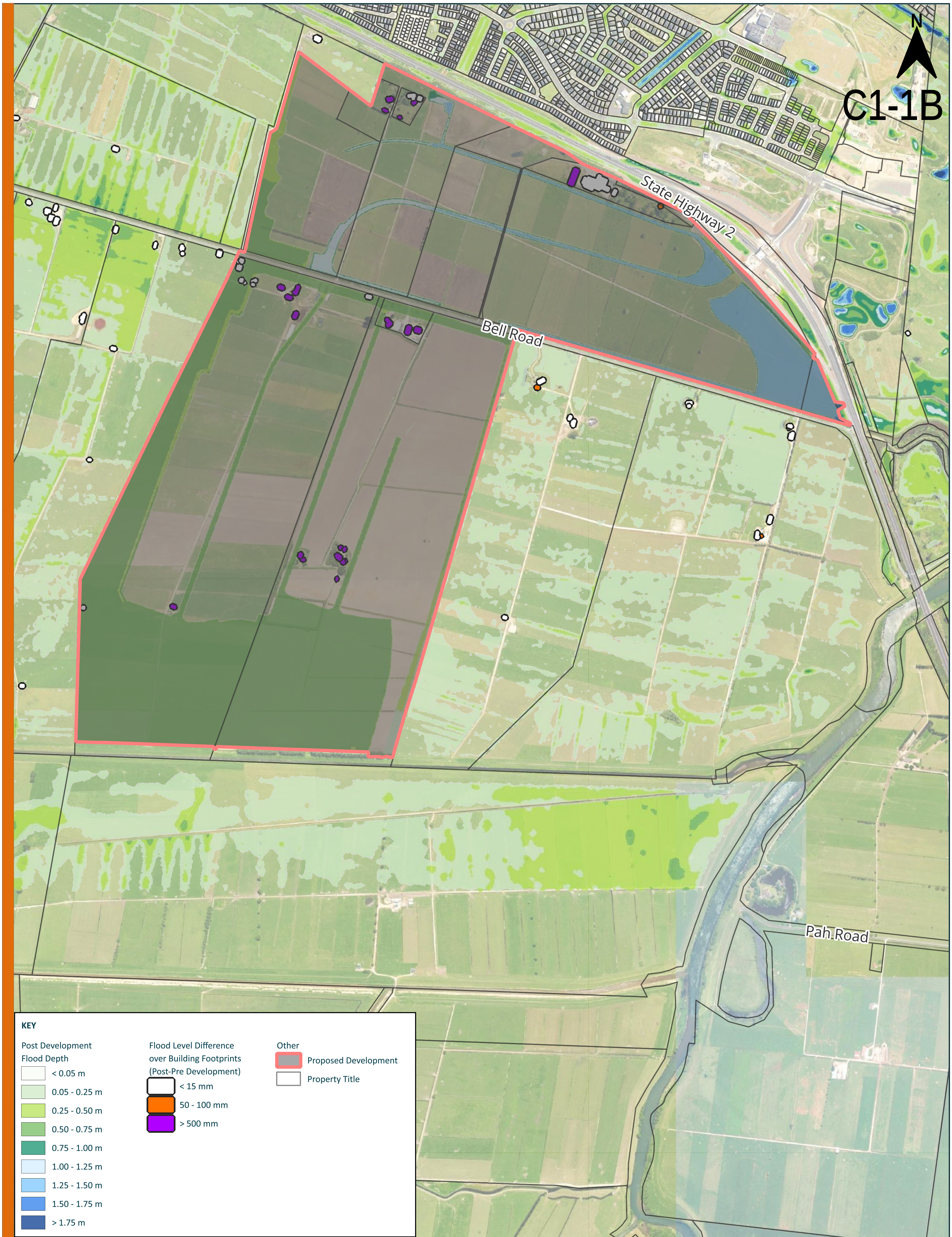
FIGURE

POST DEVELOPMENT 20% AEP FLOOD DEPTH WESTERN MAP – EXISTING CLIMATE

T020030001 BOPRC RM26-0317 WAIRAKEI SOUTH FLOODING ASSESSMENT



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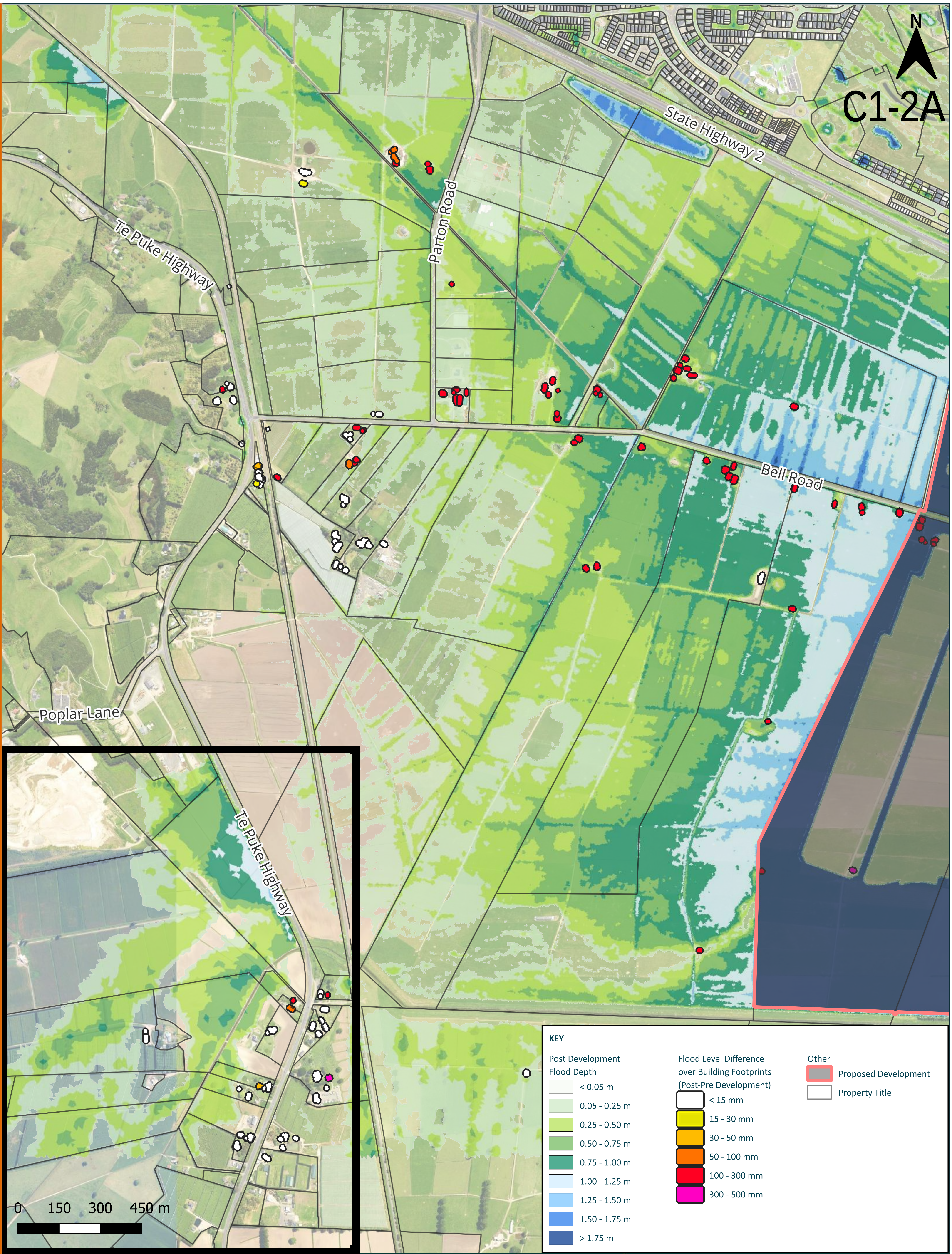
PDP PROJECT NO: T020030001

FIGURE

POST DEVELOPMENT 20% AEP FLOOD DEPTH EASTERN MAP – EXISTING CLIMATE

T020030001 BOPRC RM26-0317 WAIRAKEI SOUTH FLOODING ASSESSMENT



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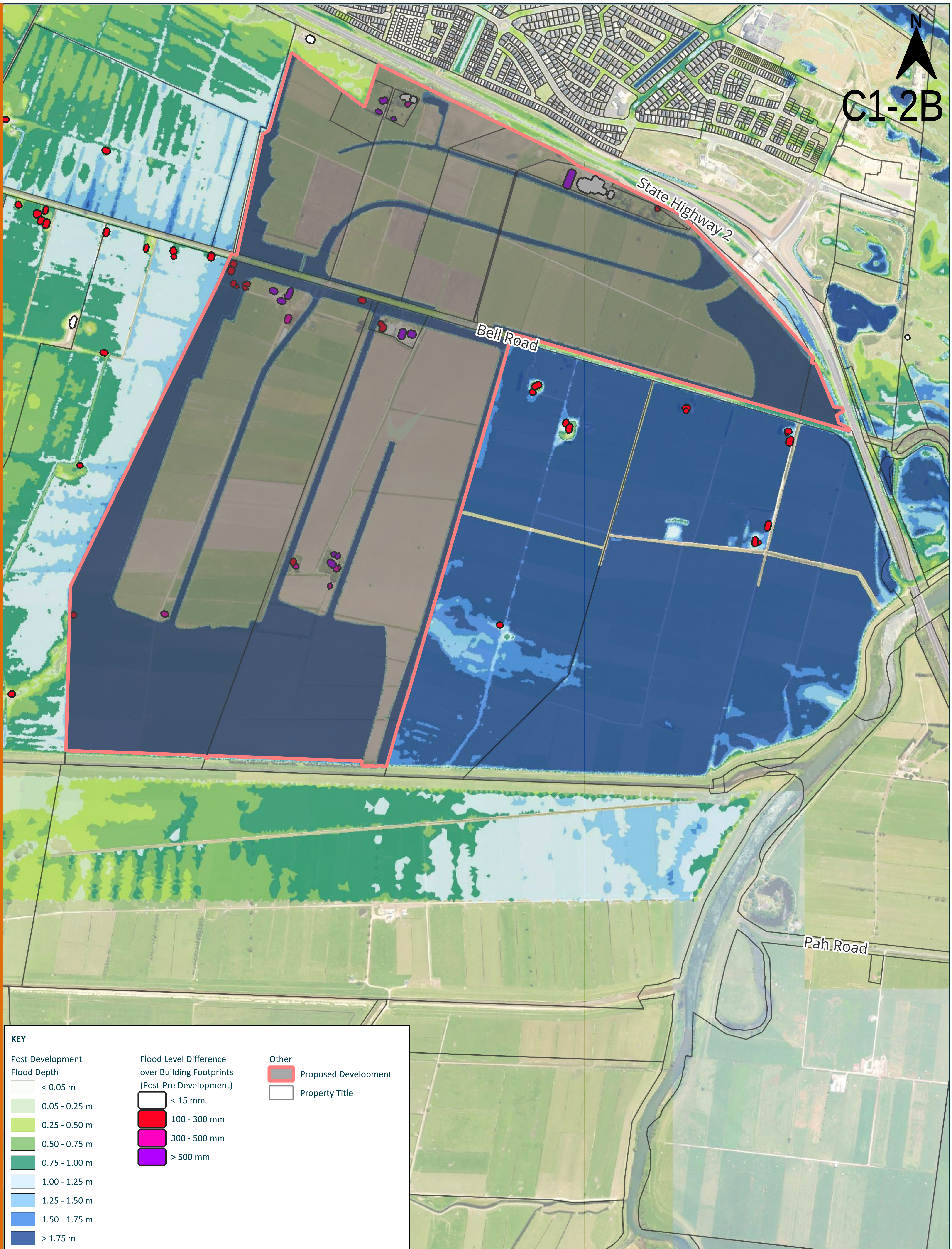
PDP PROJECT NO:
T020030001

FIGURE
POST DEVELOPMENT 1% AEP FLOOD DEPTH WESTERN MAP – EXISTING CLIMATE – PUMP FAILURE

T020030001 BOPRC RM26-0317 WAIRAKEI SOUTH FLOODING ASSESSMENT



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PDP PROJECT NO:
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FIGURE

POST DEVELOPMENT 1% AEP FLOOD DEPTH EASTERN MAP – EXISTING CLIMATE – PUMP FAILURE

T020030001 BOPRC RM26-0317 WAIRAKEI SOUTH FLOODING ASSESSMENT