Auckland Council
Te Kaunihera o Tāmaki Makaurau

Sunfield Fast-track

Auckland Council Specialist Memo

Annexure 3:

Healthy Waters and Flood Resilience Memo

Andrew Chin

4 August 2025

Healthy Waters and Flood Resilience Memo

Prepared by: Andrew Chin, Head of Healthy Waters Strategic Initiatives
Date: 4 August 2025

1. INTRODUCTION

1.1 This memorandum provides Healthy Waters and Flood Resilience Departmental (**HWFR**) comments on the stormwater aspects of the Sunfield fast-track approval application (**Application**).

1.2 It is structured as follows:

(a) Introduction

1.1.1. Qualifications / Relevant Experience and Code of Conduct

1.1.2. Executive summary

1.1.3. Documents reviewed

1.1.4. Engagement with the Applicant

1.1.5. Site visit

(b) Reasons for consent relevant to stormwater

(c) Assessment of the stormwater aspects of the Application

(d) Proposed conditions.

Qualifications / Relevant Experience and Code of Conduct

1.3 I hold the qualifications of Bachelor of Technology (Environmental Engineering) from Massey University, and Master of Planning Practice from the University of Auckland. I have 25 years of experience in the fields of water engineering and planning. I am a Chartered Engineer under the Chartered Institute of Water and Environmental Management (Engineering Council UK), and a Chartered Environmentalist under the Society for the Environment (UK). I have prepared expert evidence and technical assessments for resource consent applications, plan changes, notices of requirement for designation, and fast-track applications, and have appeared as an expert witness for Council before consent authorities and the Environment Court.

1.4 I confirm that I have read the Environment Court Practice Note 2023 – Code of Conduct for Expert Witnesses (**Code**), and have complied with it in the preparation of this memorandum. I also agree to follow the Code when participating in any subsequent processes, such as expert conferencing, directed by the Panel. I confirm that the opinions I have expressed are within my area of expertise and are my own, except where I have stated that I am relying on the work or evidence of others, which I have specified.

Executive Summary

1.5 This memorandum provides a technical assessment of the Application's proposed stormwater management strategy to service a master planned community to be known as "Sunfield" (the **Site**).

1.6 The Site is located in an area that is challenging to develop, subject to extensive floodplain (approximately 80% of the site), underlain by complex peat soils, with flat topography, and high groundwater levels. Most of the Site (188ha) is zoned *Rural – Mixed Rural* and drains north to the Papakura Stream catchment. The remainder of the site (56.5ha) is zoned *Future Urban* and drains south to the Pahurehure Inlet catchment.

1.7 To mitigate the effects of increased flooding caused by the proposed development, the Application proposes a complex scheme of stormwater attenuation ponds and catchment diversions. This includes diverting approximately 54.9 hectares of catchment from the Papakura Stream catchment to the Pahurehure Inlet catchment, as shown in Figure 1.

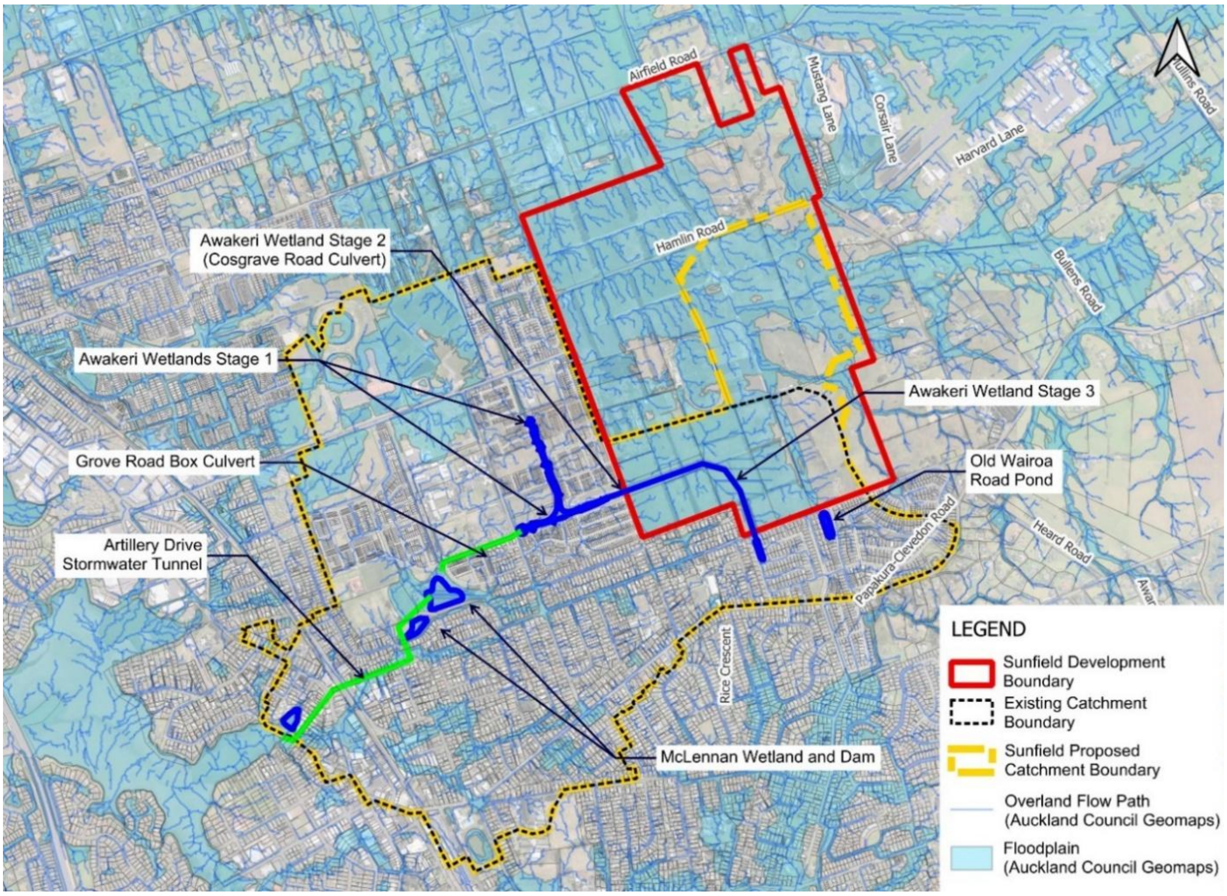

Figure 1. Catchments

1.8 HWFR specialists have identified a number of significant concerns regarding the proposed development, particularly in relation to the feasibility of the stormwater infrastructure required to service the site and mitigate adverse effects on the downstream receiving environment. The key issues are summarised below:

- **Stormwater Management Plan (SMP) and Network Discharge Consent (NDC) Compliance.** It has been incorrectly asserted that the diversion and discharge from the proposed development can be authorised under Auckland Council's Network Discharge Consent (**NDC**). Condition 13 of the NDC outlines the process for adopting SMPs under the consent. For new greenfield developments that are not currently zoned for urban use, an SMP may only be adopted following a notified plan change, and only where the plan change is consistent with the SMP. This requirement has not been met.

- **Dependence on Stormwater Basins.** Flood risk mitigation for both catchments is entirely reliant on four very large stormwater attenuation basins. These basins are expected to perform multiple functions, yet their design introduces significant vulnerabilities. They are located below the groundwater table, with flat bases and no internal gradients, benches, or low-flow channels. Critically, they lack redundancy and offer no resilience to blockage or operational failure. The feasibility of accommodating these basins within the allocated space has not been confirmed. Given the extreme flood sensitivity of the catchment, the assumptions underpinning the attenuation strategy are critical – any failure in design, construction, or operation could represent a fatal flaw in the overall flood management approach.

- **Inadequate Conveyance via Informal Drainage Network.** The proposed drainage strategy in the Papakura Stream catchment relies on discharging stormwater through an informal network of farm drains and roadside table drains, which traverse private property and are known to be under capacity. These drains currently cannot convey a 2-year rainfall event without overtopping, resulting in flooding across both Airfield Road (Figure 2) and Hamlin Road (Figure 3). With the proposed development, these roads will become key collector routes serving residential areas and must remain passable during at least a 10-year event. Ensuring adequate stormwater conveyance to meet this service level is a critical safety requirement under the Auckland Code of Practice. The current reliance on informal, flood-prone infrastructure presents a serious risk to public safety and network reliability.

- **Ground Settlement Risks from Earthworks and Groundwater Drawdown.** No assessment has been provided regarding the potential effects of approximately 1,000,000m^3 of earthworks and associated groundwater drawdown on the settlement of peat soils. This poses a risk to both infrastructure and private property and must be addressed through geotechnical investigation and modelling.

- **Unassessed Catchment Diversion Impacts.** The proposed diversion of a 54.9ha catchment into the existing McLennan Dam has not been evaluated. This dam currently provides flood protection and water quality treatment for the existing catchment. It is unclear how these functions may be affected by the additional inflows, and inadequate supporting analysis has been provided.

- **Lack of Consideration for Overland Flow Paths.** Despite the extensive earthworks and flat topography of the site, local overland flow paths have not been considered. This omission could result in unmanaged surface water flows and increased flood risk to neighbouring roads and properties.

- **Incomplete Stormwater Quality Strategy.** The proposed use of existing downstream infrastructure as tertiary treatment devices is not supported by capacity assessments or hydraulic modelling.

Figure 2. 269 Airfield Rd. West facing, 27 June 2025 12:28pm, Approximately 2yr ARI rain event.

Figure 3. 115 Hamlin Rd. South facing, 27 June 2025 12:51pm, Approximately 2yr ARI rain event.

1.9 Based on the information provided in the Application, development of the catchment areas beyond the extent of the existing Future Urban Zone is not supported. The current stormwater infrastructure within the Pahurehure Inlet catchment was specifically designed to accommodate development within this zoned area. Expansion beyond this boundary, without comprehensive assessment and confirmation of infrastructure feasibility, poses unacceptable risks to flood management, water quality, and public safety.

1.10 In June 2025, the New Zealand Transport Agency (**NZTA**) lodged a Notice of Requirement (NoR) to designate land for the Mill Road Stage 2 (Takanini Section) Project. The proposed corridor intersects the eastern portion of the Sunfield development site, overlapping a critical area of the proposed stormwater system intended to capture and convey flows from eastern catchments northward to the Papakura Stream. This overlap necessitates a fundamental reconsideration of Sunfield's stormwater management approach.

1.11 On 23 July 2025, representatives from HWFR, NZTA, and Winton Land Group met to discuss the challenges and opportunities associated with integrating the stormwater management strategies of the NoR and the Sunfield development. The meeting concluded with a shared intention to begin formalising a collaborative approach toward developing a coordinated, catchment-wide solution that could address existing infrastructure constraints and support resilient, future-proofed outcomes for both transport and urban development. Realising this opportunity may require additional downstream land acquisition to accommodate both the Mill Road corridor and the necessary stormwater infrastructure.

1.12 There are also other large-scale land development proposals at different stages of planning and consenting in the Papakura Stream catchment, in addition to the proposed Sunfield Development. Each of these developments proposes to manage stormwater and flooding effects on-site in different ways. To ensure the combined effects of development in the catchment are managed in a consistent and integrated manner, a catchment-scale approach to managing stormwater is necessary. Considering this need, HWFR has begun development of an adaptive management plan and integrated stormwater solution for the catchment, which considers necessary funding mechanisms to implement alongside the range of development scenarios planned to occur.

1.13 It is recommended that the current stormwater management proposal be paused and re-evaluated in partnership with NZTA, Winton Land Group, and other adjacent landowners such as Ardmore Airport. A coordinated approach will be essential to deliver a robust, cost-effective, and sustainable stormwater system that meets the needs of all stakeholders.

1.14 The key assessment issues and findings, addressed in more detail in Section 3 below, are as follows:

(a) **Flooding**

(b) **Stormwater Assets**

(c) **Water Quality**

(d) **Stream Works**

(e) **Vesting of Land**

1.15 The key recommendations arising from the assessment outlined in this memorandum are summarised in **Section 4** below. Comments on the Applicant's proposed conditions are provided in **Section 5** and **Appendix A**.

Documents Reviewed

1.16 The following documents have been reviewed in preparing this memorandum:

- Document 01A: *Sunfield Fast-track Approvals Act 2024 Substantive Application, Planning Report* – dated 31 March 2025 (**AEE**)
- Document 01C: *Sunfield Conditions of Consent* – dated 11 February 2025
- Document 07: *Three Waters Strategy Report, Sunfield – Fast-Track Approvals Application, Ardmore, Auckland* – Revision E, dated 07 February 2025
- Document 08 (Part A to Part O): *Infrastructure Report, Sunfield – Fast-Track Approvals Application, Ardmore, Auckland* – Revision A, dated 07 February 2025
- Document 09: *Stormwater Management Plan, Sunfield – Fast-Track Approvals Application, Ardmore, Auckland* – Revision A, dated 07 February 2025
- Document 10 (Part A to Part O): *Sunfield Engineering Plans*
- Document 11: *Sunfield Scheme Plans (including Staging Plan)*
- Document 13: *Sunfield Development Stormwater Strategy Technical Review* – dated 20 February 2025
- Document 14: *Sunfield Development – Takanini, Stormwater Management – Proof of Concept Review* (Rev A) – dated 10 February 2025
- Document 15: *Sunfield Fast Track Application – 3 Waters* Review – dated 24 January 2025
- Document 24 (Part A to Part J): *Sunfield Developments Limited, Geotechnical Assessment Report* – Revision 0, dated 6 December 2024
- Document 25: *Groundwater Dewatering and Ground Settlement Effects Assessment, Review of Awakeri Wetlands Stage 1 Construction and Assessment for Stages and 3* – Revision B, dated 13 June 2024
- Document 26: *Awakeri Wetlands Stages 2 and 3 Construction, Groundwater Settlement Monitoring and Contingency Plan* – Revision D, dated 25 March 2025
- Document 34: *Sunfield Baseline Ecological Assessment* – Version: Draft A, dated 2 December 2024
- *Sunfield Developments Limited Response to Auckland Councils Memorandum – S67 Matters* dated 17 July 2025, prepared by Tattico
- *Memorandum – S67 Matters* dated 17 June 2025, prepared by Maven.

Engagement

1.17 The HWFR department of Auckland Council entered into an agreement with Winton Land Group on 19 March 2024 to design and deliver Stages 2 and 3 of the Awakeri Wetlands. These works are located on two Council-owned lots within the Fast Track Application area (SECT 1 SO 495342 and SECT 2 SO 495342).

1.18 The consented catchment area for stormwater discharge into the Awakeri Wetlands was limited to approximately 90 hectares, comprising land within the existing and Future Urban Zones. This aligns with the capacity of the stormwater infrastructure and the authorisations provided under Auckland Council's Stormwater NDC.

1.19 However, documentation submitted as part of the Fast Track Application indicates that

Winton Land Group intends to divert an additional 54.9 hectares from the Papakura Stream catchment into the Awakeri Wetlands and its downstream stormwater system. This proposed expansion significantly exceeds the catchment area authorised under the NDC and introduces substantial uncertainty regarding infrastructure capacity and environmental effects.

1.20 In February 2025, Winton Land Group sought to progress the Outline Plan of Works for Awakeri Stages 2 and 3 under the existing designation. At that time, HWFR halted the process due to the inclusion of the additional catchment area, which lies outside the scope authorised by the NDC. In March 2025, HWFR formally requested further information from Winton Land Group to assess the validity of the underlying assumptions and stormwater modelling, confirm alignment with the Design Deed specifications, and evaluate the broader impacts of the Fast-track proposal on the stormwater system.

1.21 This request was declined. Winton Land Group advised that all information related to the Fast Track Approval Process must be formally sought through the mechanisms provided under the Fast-track Approvals Act 2024 (FTAA). Accordingly, the required information was formally requested under Section 67 of the FTAA in June 2025.

1.22 A response to the Section 67 request under the Fast-track Approvals Act 2024 was received on 21 July 2025. However, there has not yet been sufficient time to undertake a comprehensive review of the material provided. In parallel, on 23 July 2025, representatives from HWFR, NZTA, and Winton Land Group met to discuss the challenges and opportunities of integrating the stormwater management strategies for the Mill Road NoR and the Sunfield development. The meeting concluded with a shared intention to begin formalising a collaborative approach toward developing a coordinated, catchment-wide solution that could address existing infrastructure constraints and support resilient, future-proofed outcomes for both transport and urban development.

Site visit

1.23 A site visit was undertaken by HWFR staff (Carmel O'Sullivan, Jesse Peeters, James Taylor (Consultant Specialist)), on the 11th July 2025, alongside the Applicant's representatives.

2. REASONS FOR CONSENT

2.1 The Planning Report[1] incorrectly asserts that that the diversion and discharge from the proposed development can be authorised under Auckland Council's NDC. In response to S67 comments in this regard, the Applicant's Agent has outlined this section of the Planning Report is redundant.

2.2 Condition 13 of the NDC sets out the process SMPs to be adopted into the NDC to authorise the diversion and discharge of stormwater. In particular, for new greenfield development which is not currently urban zoned, an SMP can only be adopted following a notified plan change, where the plan change is consistent with the SMP.

2.3 The diversion and discharge of stormwater from this fast-track application therefore cannot be authorised by the NDC and a private consent for diversion and discharge of stormwater will be needed. In addition to assertions regarding the authorisation under the NDC, the

[1] Section 5.6.2, page 66.

Applicant's Agent has identified that diversion and discharge consent is required as a Discretionary Activity under rule E8.4.1.(A11)[2].

2.4 A SMP for the development has been prepared and submitted as part of the Application. This has been reviewed in the context of explaining the proposed stormwater management for the development, but has not been reviewed in the context of adoption under Schedule 4 of the NDC.

2.5 Given the substantial additional catchment area proposed to be diverted to the Awakeri Wetlands, Auckland Council has serious concerns about the hydraulic and water quality capacity of the existing infrastructure. Auckland Council holds a Designation for the Awakeri Wetlands. Before authorising any connections to the stormwater system, or permitting the Applicant to proceed as Council's Agent for the Outline Plan of Works for Awakeri Wetlands Stages 2 and 3, the additional catchment area will need to have an authorised diversion and discharge consent.

3. ASSESSMENT OF STORMWATER ASPECTS OF APPLICATION

3.1. The Site is located in an area that is challenging to develop given the flat nature of the catchment, existing flooding issues both downstream and within the site, soft compressible ground, high water tables, and nearby critical infrastructure (Waikato No.1 Watermain along Cosgrave Road which supplies approximately 60% of Auckland's water and a high-pressure transmission gas pipeline which runs through the Site). These issues present challenges for the Applicant and long-term risks to Council assets and infrastructure, as well as to existing residential development.

3.2. Most of the Site (188ha) is currently zoned *Rural – Mixed Rural* and drains north to the Papakura Stream catchment. The remainder of the site (56.5 ha) is zoned *Future Urban* and drains south to the Pahurehure Inlet catchment. Both catchments have existing flooding issues. During a 100-year Average Recurrence Interval (**ARI**) future climate storm event, downstream of the proposed Sunfield development there are approximately:

- 442 properties in the Papakura Stream Catchment predicted to be exposed to moderate or higher Flood Hazard, including 263 habitable floors and commercial buildings.

- 108 Properties in the Pahurehure Inlet Catchment predicted to be exposed to moderate or higher Flood Hazard, including 60 residential and commercial buildings.

3.3. If stormwater discharges from the proposed development, including associated residual risks, are not effectively mitigated, the flood risk and hazards to existing downstream properties and communities will also increase.

Flooding

3.4. The site and its surrounds are subject to significant flood hazards. Approximately 80% of the site is within the 1% Annual Exceedance Probability (**AEP**) flood plain (Figure 4). Flood depths are generally 200mm to 800mm deep across the site during this storm event.

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[2] Section 5.2, page 60.

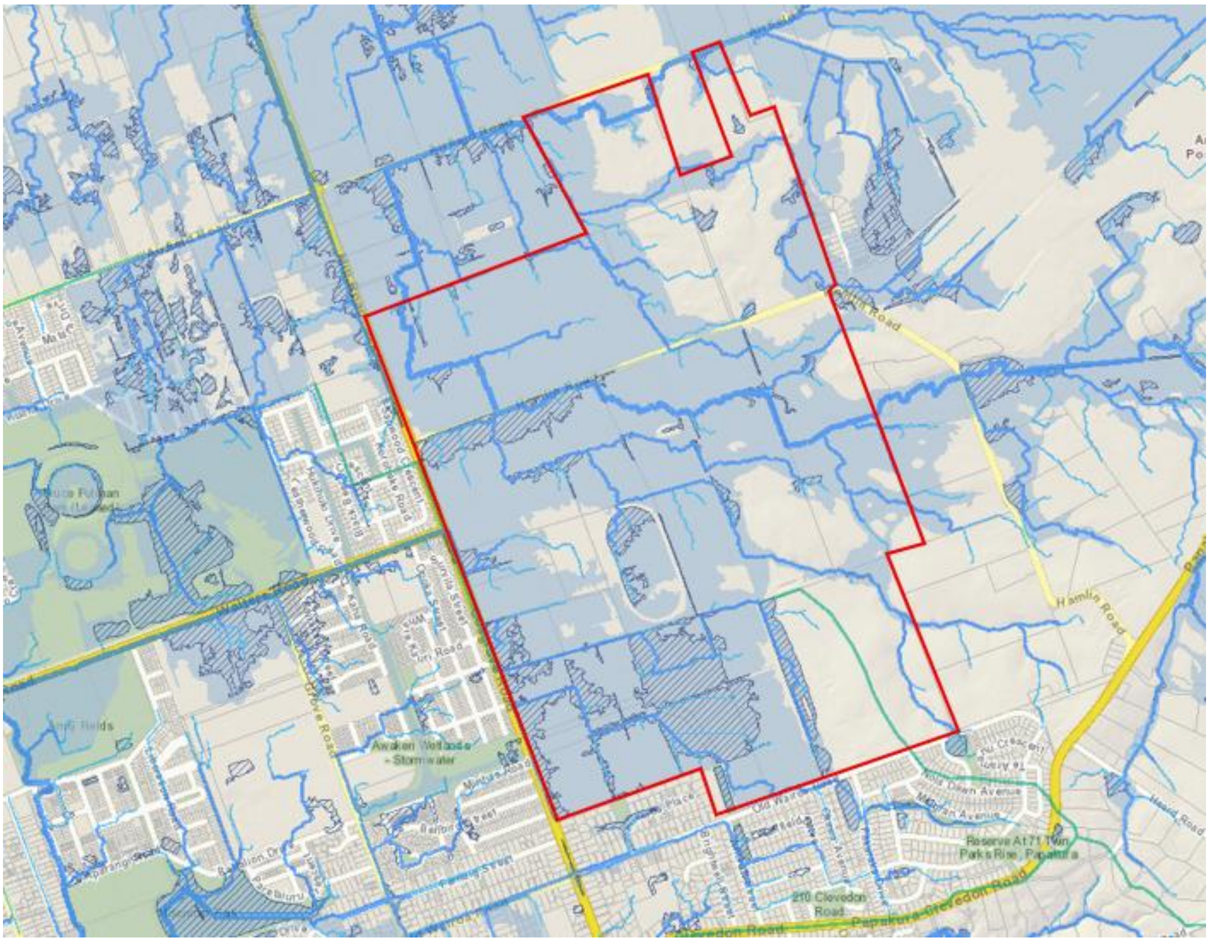

Figure 4. Sunfield development site (red) underlain by Auckland Council Geomaps OLFP, Flood-Prone and Floodplain layers

3.5. In the Papakura Stream catchment, engineering consultancy WSP have undertaken work for Auckland Council to assess flood effects from development in the Takanini Future Urban Zone[3]. This work identifies *"significant existing flood hazards downstream of the proposed development, including the predicted overtopping of key roads and flooding of a large number of private properties, including inundation of over 130 habitable floors, and 65 commercial floors during the future climate 100-year ARI event. Additionally, the predicted flooding downstream can occur in a variety of storm types, due to the complex interaction between the flows from rural and urban areas for different events."*

3.6. Auckland Council's Future Development Strategy 2023-2053 identified a large area of land in the Papakura Catchment downstream of the site, that was previously identified as a Future Urban Area, as either 'red-flagged area' or 'area for removal'. The areas are considered to be inappropriate for future development due to being within the 1% AEP floodplain and underlain by peat soils. It was considered that flooding in these areas poses risks to life and property that cannot be feasibly mitigated. It is noted that the majority of the Sunfield Development was never considered as Future Urban Area (instead being zoned *Rural – Mixed Rural*) however, it is subject to the same flood hazards and underlain by the same peat soils

[3] WSP. (December 2024). *Takanini Future Urban Zone Flood Effects Testing: Testing of Effects for Storms of Varying Duration and Spatial Distribution.* WSP reference: 3-AWD30.78.

as the Takanini 'red-flagged area' and 'area for removal' that was deemed inappropriate for future development.

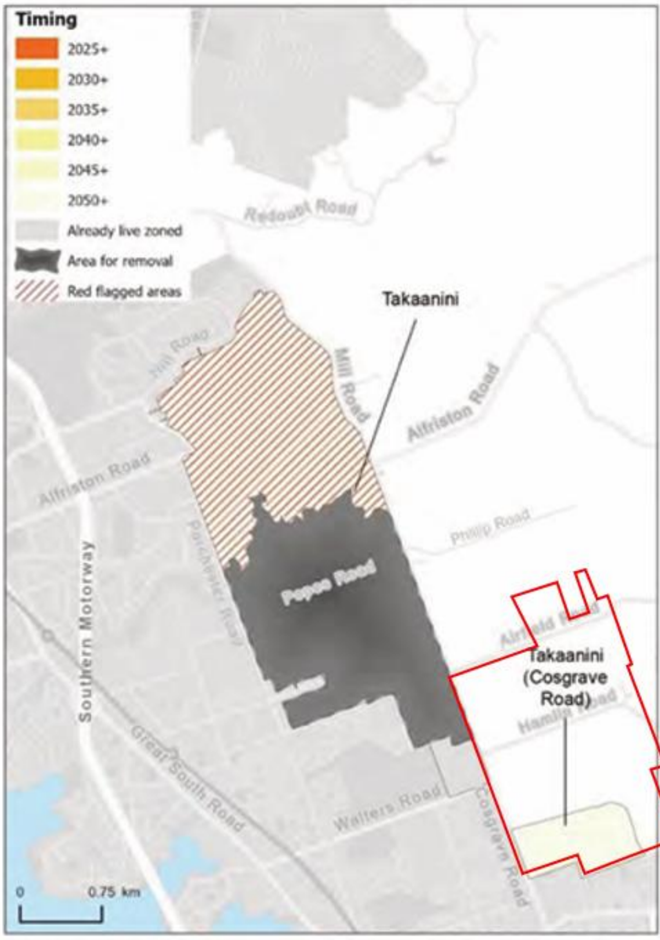

Figure 5. Extract from Auckland Future Development Strategy 2023 – 2053 showing land in the Papakura Stream Catchment to be removed from FUA – Sunfield overlain in red.

3.7. In general, the development of the Sunfield site presents a high risk of creating significant adverse impacts, and worsening existing flood hazards in the downstream Papakura Stream catchment. The areas that drain to the Papakura Stream are generally considered unsuitable for further development.

3.8. Stormwater runoff in the Pahurehure Inlet catchment is managed by a series of significant infrastructure assets owned and managed by Auckland Council. This includes the Awakeri Wetlands and conveyance channels, the Grove Road Box Culvert, McLennan Dam, and the Artillery Drive Stormwater Tunnel. However, this infrastructure was designed to manage flooding for up to the 100-year ARI storm event with an allowance for 2.1 degree climate change, and only considers land currently zoned for future development. Development of rural land not zoned for future development has not been considered in the design of these assets, nor the development and diversion of an additional 54.9 hectares from the neighbouring catchment as proposed by this Application. If this infrastructure is overwhelmed, there is a significant risk of creating flood hazards to existing and recently developed land which relies on this infrastructure for mitigating hazards.

3.9. The Application does not include sufficient information for Auckland Council to undertake a technical review of the Applicant's flood modelling to assess downstream effects of the Sunfield Development. Following the provision of further information requested in Auckland Council's Section 67 request, the Applicant's flood modelling was provided. However, there has been insufficient time for Auckland Council to conduct a detailed review of this flood modelling. Auckland Council has undertaken its own flood hazard assessment of the potential effects of the development, and the proposed infrastructure required to mitigate adverse effects. For the Papakura Stream catchment, WSP have updated the Papakura Stream catchment model to represent the Sunfield Development. A technical report has been prepared by WSP (*Papakura Stream Flood Hazard Modelling – Sunfield Development* DRAFT dated 11 July 2025) and is **attached** to this memo, which summarises the flood hazard modelling undertaken. For the Pahurehure Inlet catchment, GHD have updated the Pahurehure Inlet catchment model to represent the Sunfield development. This modelling is currently in draft, and is not yet completed at the time of writing this memo. However, some preliminary findings were able to drawn.

3.10. The WSP technical report makes the following conclusions relating to the Papakura Stream Catchment:

- The existing farm drains and road culverts to the north of the proposed development do not have capacity to convey 10-year ARI storms. WSP's modelling predicts localised flood hazard impacts within the open drains downstream of the Sunfield site due to a concentration of flows from the development discharged into a single location. Of the scenarios modelled, the most significant effects are observed during the relatively frequent 2-year ARI storm event.

- Flooding in the downstream catchment is sensitive to the assumed ability of the peat soils to infiltrate rainfall and surface water. The Application makes optimistic assumptions of infiltration rates in the peat soils through selection of a Curve Number of 74 to represent the existing (undeveloped condition) in their hydraulic analysis. Use of this curve number is expected to underpredict the relative increase in runoff volume due to development during dry conditions (i.e. low ground water levels), and may lead to under sizing of attenuation devices. In reality the infiltration rates will vary based on antecedent soil saturation and seasonally variable ground water levels.

- The open drains downstream of the development, both public and private, are subject to existing capacity constraints and are highly sensitive to increased runoff, particularly during relatively frequent storm events (e.g. 2-year ARI). Due to the flat topography of both the development site and the adjacent downstream properties, elevated water levels in these drains can result in backflow into the proposed attenuation ponds. This backflow reduces the available attenuation volume within the ponds, thereby compromising their ability to effectively mitigate flooding effects. Hydraulic modelling indicates that during a 100-year ARI event, floodwaters backflow into Sunfield's proposed Pond 2, highlighting a critical vulnerability in the stormwater design. Without measures to prevent or manage this backflow, the attenuation system may fail to perform as intended during high-flow events.

- The proposed diversion of the 54.9-hectare catchment away from the Papakura Stream catchment to the Pahurehure Inlet catchment (along with the proposed attenuation) has the potential to mitigate increases in downstream flood hazards further afield within the

Papakura Stream main channel, provided the attenuation volumes are available when required and have not been depleted from backwater flow or ground water ingress.

3.11. The modelling undertaken by WSP clearly shows that diverting flows from the Papakura Stream to the Pahurehure Inlet catchments is essential to mitigating flood effects within the Papakura Stream catchment. Therefore, demonstrating engineering feasibility of both the diversion and the receiving infrastructure is a critical requirement.

3.12. Analysis undertaken by HWFR, supported by draft modelling undertaken by GHD for the Pahurehure Inlet catchment, shows the proposed 94,000m^3 attenuation basin (Pond 4) has the potential to avoid increases in flood levels downstream of the site in the 2-year, 10-year and 100-year ARI scenarios, for the Maximum Probable Development scenario, provided the attenuation volumes are available when required and have not been depleted from backwater flow or ground water ingress. This storage volume is therefore critical for managing downstream flood effects in the Pahurehure Inlet catchment from the development and diversion of the additional catchment.

3.13. Draft modelling undertaken by GHD for the Pahurehure Inlet catchment also indicates that the proposed earthworks on the site may result in an increase in floodwater that is directed via overland flows to Old Wairoa Road during the 100-year ARI 3.8-degree climate change adjusted storm event. Without mitigation, this increase in flooding will result in a worsening of flood hazards to vehicles, pedestrians, and adverse flooding effects to property in the downstream catchment. Engineering solutions may be available to address these effects; however they have not been identified in the Application.

3.14. Based on the preceding points, it is evident that effective flood mitigation across both the Papakura Stream and Pahurehure Inlet catchments is contingent upon the successful implementation of the proposed 94,000m^3 attenuation basin. This basin represents a key hydraulic control structure within the broader stormwater management system for the development, to regulate peak flows and avoid increases in downstream flood risk. Its engineering feasibility, including its size, shape, location, and integration with wider development, is therefore a critical determinant of the overall viability of the flood mitigation strategy. Further assessment on engineering feasibility is provided in the 'Stormwater Assets' section of this memo.

3.15. The flood modelling described in the Application is inadequate to enable an understanding of flood risk within the site. The modelling methodology does not account for local overland flow paths within the site, and instead all floodwater is loaded directly into the downstream channels or detention basins. This approach creates a misleading impression that all of the proposed lots and road corridors will be flood free, which does not reflect the actual conditions. Consequentially, the modelling approach undertaken is not suitable for evaluating flood risk to the individual proposed lots to be created by the development.

3.16. Given the scale of the development, the flat topography, and extensive earthworks required, a more detailed flood modelling assessment is required. This needs to consider how rainfall-runoff will interact with the proposed topography of the site and interact with local overland flow paths. Without this assessment, it is not possible to assess or understand the flood risk posed to individual lots within the development, set finished floor levels to an appropriate height to meet Building Code and Stormwater Code of Practice Requirements, or to understand the risk of local overland flow paths in terms of vehicle and pedestrian safety.

Stormwater Assets

3.17. The Application's documented approach to flood mitigation and stormwater management provides a high-level, conceptual strategy for managing stormwater effects. The infrastructure and works proposed are significant in both scale and extent. The Site is subject to significant natural hazards, complex geology, and flat topography, each of which makes the site difficult to develop. The high-level and conceptual nature of the infrastructure design has not been developed to a level of detail commensurate to these challenges. The Application therefore risks significantly under-estimating the scale of mitigation works that maybe required in practice to service the development, and mitigate the adverse effects associated with developing the land, including the necessary land/footprints required for infrastructure.

3.18. Many major concerns have been identified with the Application, which indicates that the feasibility of the infrastructure has not been adequately considered. There is a significant risk that engineering challenges are identified during later design stages that have not been adequately considered or allowed for, which may either inhibit the ability of the Application to adequately mitigate the effects, or otherwise may result in the vesting of assets to Auckland Council which are unfit-for-purpose and costly, difficult, and unsafe to maintain.

3.19. The Application proposes four very large attenuation basins for flood detention purposes across the site; however, the conceptual design of these basins are oversimplified, being generally rectangular in shape, proposed to take all the available space up to the boundary with neighbouring lots, assume flat bases, and do not incorporate any benches or terracing to incorporate planting, shading or any amenity infrastructure above frequent flooding levels. These are critical features required for the infrastructure to function acceptably.

3.20. The lack of these features will result in large devices that are at risk of erosion due to unmanaged channelisation, deposition of sediment in 'dead zones' that will form, waterlogging of soils, frequent shallow ponding during day-to-day rainfall for extended periods, and a lack of shading. These devices will be unfit for purpose and may become significant liability for Auckland Council to operate and maintain, generate significant residual risks, as well as present adverse water quality and associated odour, aesthetic and pest issues.

3.21. To incorporate features into these attenuation basins to provide for well-functioning stormwater devices will require the formation of low flow channels and benches/terraces above the frequent flood level. This in turn will significantly reduce the available volume for flood storage and will either necessitate a much larger area to be made available for the basins or will result in the basins not achieving the required attenuation. As noted however, due to the simplified nature of the concept design, it is not clear that there will be any space available to incorporate these features without encroaching upon land allocated for other infrastructure and property. Further information provided in the Applicant's Section 67 response does not clarify these matters.

3.22. Pond 4 is a major component of the Application's overall flood management strategy. This pond is proposed to comprise 94,000m^3 of storage for attenuation covering an area of approximately 70,000m^2. However, the contour plans show this pond to have a flat base, approximately 80m wide and 700m long. The above-described features have not been allowed for within the design.

3.23. An indicative cross section for a more suitable channel design is shown below compared to the current Sunfield Pond 4 design. However, this cross section provides less than 50% volume compared to the current pond design, which would necessitate more than double the area currently allocated to this basin to provide the same volume. HWFR are concerned that the sizing of this pond lacks consideration of aspects beyond water storage, and that there are insufficient factors of safety allowed in the conceptual design to provide sufficient space for a well-functioning and fit for purpose attenuation basin. The other basins across the site present similar concerns.

Figure 6. Sunfield Pond 4 cross-section (left) vs a more feasible pond cross section (right).

3.24. Pond 4 is proposed over the Vector Gas Transmission pipeline and designation, however the applicant has not provided any details about the gas pipeline such as its depth and location (other than the designation area). Effects associated with the gas pipeline have also not been considered, such as whether it clashes with the pond, how the asset owner will access the gas pipeline within the pond, what the effects of the pond could be on the gas main (i.e. potential settlement or ground heave) or effects of the gas pipeline on the pond (loss of flood storage if the pond can't be excavated to the proposed depth over the gas pipeline due to cover restrictions or access requirements).

3.25. The attenuation basins are also proposed to provide a range of other stormwater management functions. In particular, Pond 1 is proposed to manage runoff from a 415-hectare catchment, however other than a conceptual layout indicating a relatively complicated arrangement of overflow basins, low flow culverts, check valves and other hydraulic controls, there is limited information provided for how this very significant structure would be proposed to function.

3.26. Pond 1 is shown to include a constructed treatment wetland; however, it appears that this wetland is proposed to have flows diverted to it from the entirety of the 415-hectare catchment. Treatment wetlands are typically conceptually sized at 5% of their upstream receiving catchment, however this would make the minimum wetland 20.75 hectares in area, which there is very clearly insufficient space for.

3.27. The wetland will either need to be relocated to a location where it only receives runoff from its intended treatment catchment, or redesigned, otherwise the device will not achieve its treatment objectives and will become an operational and maintenance liability for HWFR. Similar to Pond 4, we consider that this matter is not a detail that can be left for another stage, as due to the current concept design there is no space for any changes to be made without encroaching neighbouring property.

3.28. No sensitivity analysis or risk assessment has been undertaken to assess the potential effects in the event of blockages on the stormwater basins. There are significant concerns in relation to the risks associated with vesting infrastructure required to service a development of this scale, which will be reliant on only six very large, complex devices to manage runoff from a wide range of storm events. Something as simple and frequent as a minor blockage of an outlet pipe could have significant adverse consequences downstream from a water quality, stream erosion, and flooding impact perspective.

3.29. Without an understanding of the effect of blockage, it is not feasible to understand the necessary operation and maintenance regime that will need to be implemented to manage this risk. It is also not considered appropriate to leave this matter to a later detailed design stage, noting that there is limited to no space available for the design of these structures to be modified once consent is granted.

3.30. It is proposed that the development site discharge its stormwater to a series of farm drains within private property downstream of the site in the Papakura Stream Catchment. These farms drains are well understood to lack capacity to manage even a 2-year ARI storm event without flooding (recent rainfall in the catchment, understood to be approximately 1.25 year ARI event resulted in widespread flooding within these farm drains). In the existing pre-development state, runoff generated from the site during low-intensity, frequent events is likely to pond within the site and infiltrate to ground where soil conditions allow. However, post development, with an increase in impervious coverage, even in these small intensity frequent storms, a significant volume of runoff will be directed to these farm drains which may create significant adverse impacts. The Application has provided no assessment into the capacity of these drains, or on the potential for an increase in both frequency and duration of flooding, during small intensity, frequent rainfall events.

Figure 7.2 Overwhelmed farm drains downstream of the site during rainfall on 27th June 2025

3.31. The proposed development will significantly increase traffic volumes—including vehicles, cyclists, pedestrians, and public transport—on roads already prone to flooding, such as Hamlin Road, Mill Road, and Airfield Road. While attenuation may help maintain peak flow rates, it also prolongs flood duration, increasing the time these key routes remain impassable. This raises serious concerns about exposing more people to existing flood hazards, particularly as Airfield Road currently overtops in events less frequent than the 2-year ARI. It is recommended that flood hazard exposure be addressed through integrated planning and infrastructure upgrades to ensure safe and reliable access for all transport modes.

3.32. There are significant concerns about the feasibility of the 700m long weir on Pond 1, that is proposed to activate in relatively frequent flood events, discharging into farm drains on private property downstream. This structure is shown to be parallel to the direction of flow in the diversion channel, and the assumption that there will be uniform flow across a parallel, broad grassed weir is unrealistic. In practice, it is likely that minor variations in the level (from construction tolerances, settlement over time and vegetation growth) will lead to this structure being subject to preferential flow paths, which could lead to erosion and subsequent failure of the structure. Given it manages flows from a 450-hectare catchment, and impounds up to 141,000m^3 of floodwater, this may have significant hazardous effects on downstream persons and property in the event of a breach of the embankment.

3.33. Each of the proposed attenuation basins are shown to include constructed stormwater treatment wetlands within their bases, however noting the assumptions for the attenuation basins (flat wide bases, no gradient), it is not clear how the treatment wetlands will be able to function. There is a concern that these devices are not well integrated into the wider stormwater management areas, and that water quality will be compromised.

3.34. There are discrepancies between the visuals shown in the Masterplan compared to the Engineering drawings which are misleading. The masterplan shows a meandering stream-like feature running through the centre of the development, whereas the engineering drawings show this as a long, flat, wide area utilised for stormwater attenuation. The Sunfield Open Space Strategy also shows the ponds with large, grassed areas provided as ‘flood basin parkland’, however based on the engineering design, most if not all this land will be inundated in frequent storm events and is unlikely to be suitable for public use and amenity without significant redesign, which as stated previously would result in a significant reduction in the available flood storage.

3.35. Ponds 5 and 6 referenced in the Application have no design documentation provided whatsoever. These ponds are stated to be necessary to attenuate peak flows from their receiving catchment, however their feasibility and connections are completely unknown. These ponds are omitted from many relevant plans, including the engineering plans and masterplan documents.

3.36. There is inadequate information or assessment included in the Application on the impact of the proposed development and diversion of the additional 54.6ha catchment on the existing McLennan Dam, except for modelling results suggesting that the maximum flood level within the dam will not increase and the duration of spilling is increased by 5 minutes (from 1hr 10min to 1hr 15min). This dam is a High Potential Impact Classification (**PIC**) dam, which has been designed to manage specific flows and volumes from its upstream catchment in accordance with its associated resource consents.

3.37. Assessment of High PIC dams generally requires consideration of a higher than 100-year ARI storm event. It is noted that even if the infrastructure proposed as part of the application is able to mitigate effects for the 100-year ARI event, it is not understood to provide for any flood mitigation beyond this event. For larger events, it can be assumed that there will be limited or no attenuation, leading to an increase in peak flows and volumes that will need to be managed by the dam. It is unclear what the impact of this will be on the performance, or structural stability of the dam, and the residual risk to downstream persons and property.

3.38. There is inadequate information or assessment included demonstrating the feasibility of stormwater drainage for the site. Buried stormwater networks are proposed to drain into the stormwater channels and ponds across the site, however, there has been no stormwater capacity analysis provided demonstrating these networks can provide the minimum level of service required to be vested to Auckland Council. Given the flat topography of the site, and the use of storage basins to provide for attenuation of stormwater runoff, we are concerned that tailwater impacts on the stormwater networks may present challenges in providing adequate drainage to the site to avoid nuisance effects and property damage.

3.39. Both the Infrastructure Design Report and the Geotechnical Design Report are ambiguous as to how groundwater will be managed in relation to the ponds and conveyance channels, noting that they are currently shown to be cut to below existing groundwater levels measured and observed across the site. However, the stability analysis included in the Geotechnical Assessment Report appendices appears to be based on the assumption that the groundwater level will be lowered to the permanent long term, low water level in the channel. This approach will require careful consideration of the area affected by this drawdown and the implications of settlement effects on the proposed development and associated infrastructure. As shown in Figure 8, within the basins and channels, earthworks are proposed well below the existing groundwater table.

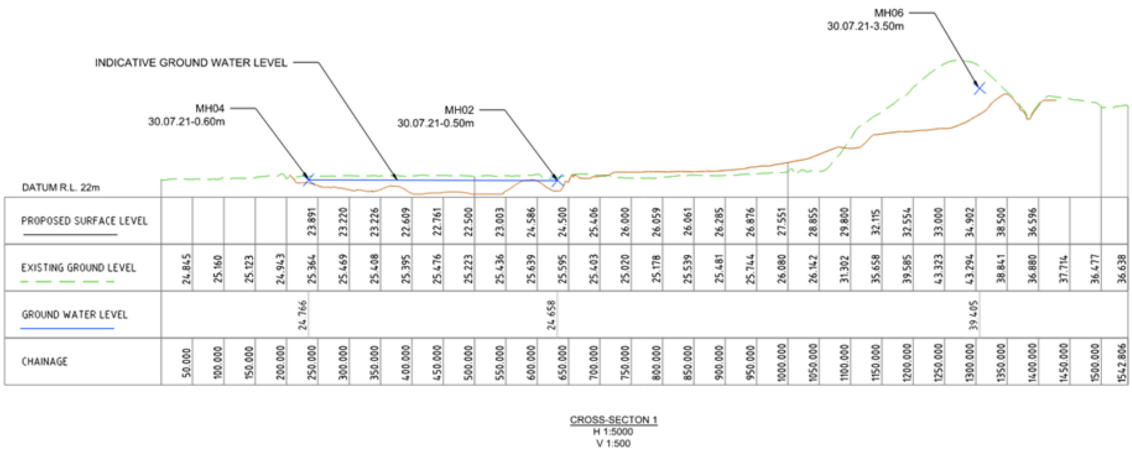

Figure 8. Profile through the site showing proposed earthworks topography (orange line), compared to existing (green dash), the blue line shows the measured groundwater levels.

3.40. The Geotechnical Design Report presents a discussion on the consolidation settlements of compressible soils; however, this is limited to a theoretical analysis of the one, two and three storey building loads. However, these values presented are highly optimistic, in that they do not address or consider any of the effects of bulk earthworks, change in landform, the import and placement of fill materials, or the effect of groundwater drawdown.

3.41. The geotechnical engineering implications of the ground conditions have been poorly presented by the Application and masks the challenges that the extensive development proposal will have to address. We consider this to be a critical omission given the likely impact and effect that short-term and long-term ground settlements can have on:

- Proposed bulk earthworks programme, cut / fill balance, staging and stockpiling
- Bulk material import for pre-load / ground improvement / engineered fill
- Bulk material export of unsuitable spoil / availability of landscape fill
- Building foundation design, serviceability, and maintenance of building platform flood protection levels
- Roads and pavements, drainage channels and overland flow paths
- Buried infrastructure, pipelines and services

3.42. Bulk earthworks and dewatering in peat soils can present a risk of oxidation of acid sulphate soils. This can release low pH, acidic leachate which can cause rapid corrosion, damage to underground assets and harmful effects on the environment and ecology. This risk has not been considered in the application.

3.43. In summary, the infrastructure proposed to manage stormwater is considered too heavily reliant on unrealistic assumptions, including the scale and extent of infrastructure required. There is significant uncertainty as to whether the space allocated for infrastructure is sufficient to provide for an integrated stormwater management design whilst mitigating downstream effects. At a conceptual design stage, where significant uncertainty is present, it is engineering best practice to allow for factors of safety to be allowed for within designs. No such factors of safety have been included in the design presented in this Application.

Water Quality

3.44. The proposed stormwater management strategy for Sunfield includes a treatment train approach including at-source, mid-catchment, and end-of-line treatment devices.

3.45. There are specific concerns relating to the reliance on downstream devices for water quality treatment without clear evidence that they can accommodate the additional runoff from the Sunfield development. The McLennan Wetland, identified as a tertiary treatment device for Catchment A, was not designed to service the increased contributing area proposed in the application. Without a full assessment of how the additional 54.9 hectares of catchment will affect the wetland's performance, including the risk of reduced residence time and re-suspension of contaminants during high-flow events, its use as a tertiary treatment device for the Sunfield development cannot be supported.

3.46. The proposed stormwater management strategy for the Sunfield development includes integration of water quality treatment with groundwater recharge where maintaining existing groundwater levels in peaty soils is critical to avoid consolidation and settlement. Geological assessments emphasise the importance of stormwater recharge pits to sustain groundwater levels, while the Three Waters Strategy Report outlines a treatment train approach to stormwater quality. This includes source control measures such as low-contaminating building materials, grated catchpits, and proprietary gross pollutant filters (e.g. tetra traps) to ensure high-quality recharge into underlying soils.

3.47. While the use of low-contaminant building materials and the integration of water quality and recharge objectives is supported, the widespread use of small-scale treatment devices—such as roadside raingardens and tetra trap catchpit inserts— is not supported where these are intended to be vested to Auckland Council or Auckland Transport. These devices carry high long-term maintenance costs and are generally not supported by Auckland Transport. Instead, it is recommended consolidating treatment infrastructure into a small number of larger, more efficient devices that can be feasibly maintained over time.

Stream Works and Watercourse Diversions

3.48. The Sunfield development proposal includes the diversion and reclamation of sections of two permanent streams. These works are detailed in the Sunfield Wai Mauri Stream Remediation Design Report, which outlines a range of mitigation measures for restoring existing stream environments and design elements for newly created watercourses resulting from the proposed diversions.

3.49. A significant portion of the proposed stream diversion overlaps with the land identified in the NZTA's NoR for the Mill Road Stage 2 (Takanini Section) Project, lodged in June 2025. This overlap necessitates a fundamental reconsideration of Sunfield's stormwater and stream management strategy. However, it also presents a strategic opportunity to address long-standing issues associated with under-capacity land drains through an integrated solution developed in collaboration with NZTA.

3.50. The ecological and hydraulic outcomes sought in the Wai Mauri Stream Remediation Design Report are supported. With the NoR now in place, there is an opportunity to revisit the extent of stream diversions and explore alternative approaches that may enhance both environmental and flood resilience outcomes.

3.51. There is a contradiction between the Wai Mauri Stream Remediation Design Report which shows the Wai Mauri stream flowing to the Pahurehure Inlet catchment and the engineering plans which show it flowing to the Papakura Stream catchment via the trapezoidal diversion channel with subsoil pipes. The feasibility of the development relies on this catchment discharging to the Papakura Stream as the flood modelling has not allowed for this flow discharging to the Pahurehure Inlet catchment.

3.52. An integrated approach to stream and stormwater management—coordinated with NZTA and other adjacent landowners such as Ardmore Airport—will be essential to ensure the long-term resilience, ecological integrity, and cost-efficiency of the stormwater system.

Vesting of Land (HWFR)

3.53. The Application proposes to vest land containing stormwater channels as *Local Purpose Reserve (Drainage).* However, the supporting documents do not sufficiently demonstrate whether the extent of the proposed land to vest is appropriate and will deliver additional public benefit that cannot otherwise be achieved through private ownership and maintenance.

3.54. While the proposal identifies areas of open space associated with the stormwater network, it is unclear how these areas function beyond a stormwater purpose. Vesting of land for stormwater management to Council must be limited to only what is essential for ongoing network performance, maintenance, and resilience. In general, HWFR does not support vesting of wider floodplain or overland flowpath land where that land does not contribute meaningfully to stormwater function or deliver additional recreational, ecological, or amenity value.

3.55. In the absence of clear justification, including an assessment of how the land supports stormwater outcomes *and* broader public benefit, HWFR cannot support the extent of land proposed for vesting. Clarification is required to ensure that the areas to be vested are functionally necessary and represent an efficient and appropriate use of public land ownership.

3.56. In addition, the land proposed for vesting is referred to on Application Plans as '*Local Purpose Reserve (Drainage)',* which is not an accepted mechanism for vesting. Where vesting of land is proposed, it must be offered as '*Land in Lieu of Reserve – for Drainage Purposes*' to align with HWFR acquisition processes.

4. RECOMMENDATIONS

Key recommendations for the Applicant to address the issues and concerns outlined in the above assessment are summarised below. It is considered that these recommendations are critical to understanding effects and feasibility of the development. It is not considered that these can deferred to later stages, due to the impact they may have on the overall viability of the development.

4.1 Flooding

(a) Provide more detailed flood modelling and an updated hazard analysis that more accurately considers the necessary design updates for well-functioning stormwater management devices (more detail is described below "Stormwater Assets"), including factors of safety that are commensurate with the degree of risk and uncertainty associated with the development.

(b) Undertake a sensitivity analysis of the effect of key assumptions and uncertainties on flood risk, such as soil infiltration, antecedent conditions, and blockage risk of critical infrastructure.

(c) It is recommended that the Applicant liaise and work with HWFR to ensure the flood mitigation strategy is integrated with HWFR infrastructure and existing assets. To this extent, the Applicant providing HWFR with further information on the proposed landforms and infrastructure within the site, to be incorporated into HWFR existing catchment wide flood models would allow for a better understanding of the effects of the development on downstream flood risk. Information provided by the Application in response to HWFR Section 67 request to the FTAA may be sufficient to undertake this modelling, however there has been insufficient time to do so between receiving the information and this memo being due.

4.2 Stormwater Assets

(a) Provide an updated engineering design and analysis of the flood detention basins to incorporate the necessary features to make for well-functioning, fit-for-purpose assets, and confirm the land area required to integrate these devices into the wider development. This should include consideration of low flow channels, water quality treatment devices, and benches/terraces for planting and amenity use above the 2-year ARI level, all of which are shown in the Masterplan document.

(b) Provide a risk assessment of blockage within the flood attenuation basins to understand the freeboard requirements and operation maintenance regime that will be necessary to ensure the devices achieve their intended objectives.

(c) Provide a feasibility assessment from a Dam Safety Perspective from a suitably qualified Dam Safety Engineer on the diversion of an additional 54.9 hectare catchment into the McLennan Dam

(d) Provide more detailed information on the feasibility of the farm drains downstream of the site, within the Papakura Stream Catchment to accept the additional runoff flows and volumes on the site, and the effects in terms of flood frequency and duration of flooding.

(e) It is recommended that the Applicant liaise and work with HWFR on identifying more appropriate discharge methods for managing stormwater runoff from the Papakura Stream Catchment rather than utilise the downstream network of private farm drains.

(f) Further clarity is required on the strategy for managing groundwater, and the effect of groundwater management on infrastructure and property in terms of ground settlement, both short and long-term.

4.3 **Water Quality**

(a) An options assessment must be provided to demonstrate how the proposed stormwater treatment approach represents the BPO for each catchment, including evaluation of alternative device types, sensitivity to site constraints (e.g. peat soils, groundwater), and 100-year lifecycle costs (capital, maintenance, and renewal).

(b) A full assessment of the McLennan Wetland’s capacity is required to confirm whether it can provide adequate tertiary treatment for the additional 54.9 ha of contributing catchment. This should include modelling of flow, detention time, and treatment performance under increased load.

(c) Further information should be provided on the function and design intent of the Northern Wetland and Takanini Stormwater Conveyance Channel, including whether they are ‘online’ or ‘offline’ devices, how high flows will be managed, and how water quality objectives will be achieved without compromising flood performance or vegetation stability.

(d) Further information should be provided on water quality treatment proposed for Catchments D1 and D2, including swale and wetland design parameters, expected contaminant loads, and how GD01 compliance will be achieved in these high-risk industrial/employment areas.

(e) Confirm ownership of all proposed treatment devices. For assets intended for vesting to Auckland Council, provide operation and maintenance plans, safe maintenance access and sediment drying areas, and full lifecycle costings. Acceptance of assets for vesting will be subject to these details and HWFR review.

(f) Swales are proposed as providing secondary treatment for catchments A, B and D. Primary treatment of these catchments is proposed via non-contaminant generating materials, grated catchpits and inlets to stormwater. The feasibility of how stormwater will get from catch pits to the swales needs to be made clear.

4.4 **Vesting of Land (HWFR)**

(a) The Applicant should provide justification for the extent and location of land proposed for vesting, including evidence that the land delivers essential stormwater function *as well as* wider public benefit. Areas proposed for vesting must be offered as '*Land in Lieu of Reserve – for Drainage Purposes*' and will remain subject to Auckland Council's standard asset acceptance and acquisition processes.

5. PROPOSED CONDITIONS

5.1 Initial comments on the Applicant's proposed stormwater related conditions,[4] as well as on additional conditions sought, if the Panel is minded to grant approval, are provided as **Appendix A** and **Appendix B** respectively.

5.2 These initial suggestions are provided to assist the Panel, but are offered without prejudice to the Council's ability to make more comprehensive comments on any draft conditions under section 70 of the Fast-track Approvals Act 2024, should the Panel decide to grant approval.

[4] Attachment 2 to the AEE.

APPENDIX A: PROPOSED CONDITIONS COMMENTS REGISTER

<table>
<tr><th>#</th><th>APPLICANT'S PROPOSED CONDITIONS</th><th>HEALTHY WATERS COMMENT</th></tr>
<tr><td>3</td><td>
<u>Activity in accordance with the application</u>
The development must proceed in general accordance with the information and plans submitted with the application and formally approved by the Environmental Protection Authority (EPA) on XXX, including all supporting and additional information submitted. In the event that any of the provisions of the following documents conflict with the requirements of these conditions of consent, these conditions shall prevail.
<table>
<tr><td colspan="5"><u>Plans</u></td></tr>
<tr><td>Drawing Ref.</td><td>Drawing Title</td><td>Author</td><td>Revision</td><td>Dated</td></tr>
<tr><td><u>TO BE ADDED POST LODGEMENT, BUT ALL KEY PLANS/DOCUMENTS WILL BE INCLUDED IN THIS LIST</u></td><td></td><td></td><td></td><td></td></tr>
</table>
. . .
<table>
<tr><td>ENGINEERING</td><td>EARTHWORKS/CUT-FILL</td><td></td><td></td><td></td></tr>
<tr><td></td><td>SEDIMENT CONTROL</td><td></td><td></td><td></td></tr>
<tr><td></td><td>ROADING
DRAINAGE
STORMWATER
WASTEWATER</td><td></td><td></td><td></td></tr>
<tr><td colspan="5"><u>Technical Documents</u></td></tr>
</table>
. . .
</td><td>No objection. Standard condition.</td></tr>
</table>

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	STORMWATER MANAGEMENT PLAN	
9	Management plans The management plans required under the following conditions must be submitted to Council in electronic copy form for certification that the management plan(s) meet the objective(s) specified and give effect to the relevant conditions of consent to which each plan relates: . . . f. SMP – refer Condition XX . . .	No objection. Standard condition.
10	Works to which a management plan relates must not commence until the Consent Holder has received written certification from Council.	No objection.
27	<u>**Stormwater Management Plan**</u> Prior to the commencement of any works relating to stormwater, a **SMP** must be certified by the Council. The **SMP** must be prepared by the Consent Holder in consultation with Mana Whenua and in accordance with the requirements of Council's Regionwide Network Discharge Consent. The Plan must include: a. Details of any feedback provided by Mana Whenua on the design of stormwater management devices; and b. Identification of any Mana Whenua feedback not incorporated, with reasons.	Proposed revised condition: **Stormwater Management Plan** Prior to the commencement of any physical works on the site (including earthworks), the Consent Holder must prepare a Stormwater Management Plan (SMP), in consultation with Mana Whenua, and submit to Auckland Council Healthy Waters for certification. The SMP must be consistent with best practice stormwater management principles and the relevant objectives of the Council's Regionwide Network Discharge Consent (RWNDC). The SMP must include: a. Details of any feedback provided by Mana Whenua on the design of stormwater management devices; and b. Identification of any Mana Whenua feedback not incorporated, with reasons. *Advice Note:* Acknowledging that the development cannot be authorised under the RWNDC due to the underlying zoning, Auckland Council Healthy Waters approval of the SMP is required to

<table>
<tr><th>#</th><th>APPLICANT'S PROPOSED CONDITIONS</th><th>HEALTHY WATERS COMMENT</th></tr>
<tr><td></td><td></td><td>ensure that stormwater management outcomes are consistent with the Council's stormwater network design standards and long-term asset ownership requirements.</td></tr>
<tr><td>33</td><td><u>Engineering Plan Approvals</u>

Prior to the commencement of the construction of any new public assets to be vested in Council, the Consent Holder must obtain Engineering Plan approval from Council for those assets.

The relevant Engineering Plan(s) must include information regarding the following engineering works:

a. A road safety audit must be undertaken of all roads to vest in Aukland Council, by a SQEP. The findings of the safety audit must be used to guide the detailed design of the road(s). The road safety audit must be provided to Council for certification.
b. Plans of all the streetscape landscaping must be provided to Council for certification.
c. All new public assets including streetscape landscaping assets must be designed to Auckland Code of Practice for Land Development and Subdivision: Chapter 7: Green Assets and Landscaping.</td><td>Proposed revised condition:

Engineering Plan Approvals

Prior to the commencement of the construction of any new public assets intended to be vested in Council, the Consent Holder must obtain Engineering Plan Approval (EPA) from the relevant parts of Council.

The Engineering Plan(s) must include, but are not limited to, the following:

a. A road safety audit of all roads proposed to vest in Auckland Council, undertaken by a suitably qualified and experienced professional (SQEP). The findings of the safety audit must inform the detailed design of the roads, and the audit must be submitted to Council for certification.
b. Plans of all the streetscape landscaping must be provided to Council for certification.
c. All new public assets including streetscape landscaping assets must be designed to Auckland Code of Practice for Land Development and Subdivision: Chapter 7: Green Assets and Landscaping.
d. All public stormwater assets intended to vest in Council must be designed and constructed in accordance with the Auckland Council Code of Practice for Stormwater (2021) and any other relevant Council guidance or standards.

Advice Note:
All EPAs must be obtained prior to construction of the relevant assets. For stormwater assets, Auckland Council Healthy Waters must certify the engineering plans to ensure compliance with Council requirements for long-term asset ownership.</td></tr>
<tr><td>34</td><td><u>Pre-commencement Meeting</u>

Prior to the commencement of enabling works, construction and / or earthworks on the Site, the Consent Holder must hold a pre-commencement meeting that:

a. Is located on the Site;</td><td>Proposed revised condition:

Pre-commencement Meeting

Prior to the commencement of any enabling works, construction and / or earthworks on the site, the Consent Holder must arrange and hold a pre-commencement meeting that:</td></tr>
</table>

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	b. Is scheduled not less than 5 Working Days before the anticipated commencement of any enabling works, construction and / or earthworks; c. Includes representation from the contractors who will undertake the works; d. Includes the Council Compliance and Monitoring officer; e. Includes the project archaeologist; f. Includes the project arborist; and g. Includes an Auckland Transport representative.	a. Is held on site; b. Is scheduled not less than 5 working days prior to the anticipated commencement of any enabling works, construction and/or earthworks; c. Includes representation from the contractors who will undertake the works; d. Includes the Council Compliance and Monitoring Officer; e. Includes the project archaeologist; f. Includes the project arborist; g. Includes an Auckland Transport representative; and h. Includes a representative from Auckland Council Healthy Waters Operations (where public stormwater assets are proposed to vest in Council).
35	The purpose of the meeting is to discuss the erosion and sediment control measures, earthworks methodologies, tree protection / removal, Archaeological Authority conditions, stormwater management, relevant management plans, timeframes for the work, agree on the existing condition of Auckland Transport assets and to ensure all parties are aware of and familiar with the relevant conditions of this consent.	No objection.
42	Dewatering The take (dewatering) and diversion of groundwater associated with the construction of the proposed stormwater channels must be carried out in accordance with the plans and all information submitted with the application, detailed below and referenced in Condition [XX] .	No objection.
46	Design and Construction of Channel and Culverts The design and construction of the stormwater channel and culverts must be undertaken in accordance with the specifications contained in the Dewatering Report. Where any conflict exists the most recent report must take precedence over older reports.	No objection.
105	**Protect assets** Adequate provision must be made during earthworks associated with construction to protect any existing public stormwater, wastewater or water supply networks that traverse or pass close to the Site. Any damage to the networks must be repaired by the Consent Holder as soon as reasonably practicable at their cost.	No objection. Standard Condition.

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	Advice note: the general requirements in this condition are additional to the specific requirements of other conditions regarding potential damage caused by vibration to Watercare's infrastructure or potential damage to First Gas Limited's gas pipeline which traverses the Site.	
115	Three Waters Infrastructure Prior to the occupation of any building all the necessary pipes and ancillary equipment must be supplied and laid to divert, relay and upgrade existing public stormwater, wastewater and water supply lines and to provide the building with stormwater, wastewater and water supply connections to the reticulated networks in general accordance with the plans and information referenced in Condition [XX] 1.	No objection.
116	As-Built Plans for Public Infrastructure All as-built documentation must be provided to the Council for all new public assets to be vested in the Council. *Advice Note: The documentation must be in accordance with the Council's Development Engineering As-Built Requirements. The as-built information will require approval by the Council's Regulatory Engineering department. Vesting of public assets to the Council and close off and completion of relating Engineering Approval consent will be required to be completed.*	No objection.
117	The Consent Holder shall ensure that buildings within the area discharging stormwater under this consent must have roofs that are constructed using inert roofing materials, i.e. materials that do not leach contaminants such as copper, zinc or treated timber.	Proposed revised condition: **Stormwater Quality** New buildings, and additions to buildings, must be constructed using cladding, roofing and spouting building materials that avoid the use of contaminant generating building products which have: a. Exposed surface(s) or surface coating of metallic zinc or any alloy containing greater than 10% zinc; or b. Exposed surface(s) or surface coating of metallic copper or any alloy containing greater than 10% copper; or c. Exposed treated timber surface(s) or any roof material with a copper containing or zinc-containing algaecide.

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
118	The infrastructure required for each stage of the development is set out in the table below. The infrastructure specified for each stage of the development must be constructed and operational prior to any building within that stage being occupied. . . .	Proposed revision: Include catchment diversion of Papakura Stream catchment to Pahurehure Inlet Catchment, and provision of Pond 4 and Stage 3 Awakeri Wetland as part of stormwater works for every stage
153	All roads, stormwater, wastewater, and water supply infrastructure must be in general accordance with the Engineering Drawings referenced in Condition [XX]. Where the Consent Holder requires that matters of detail within the Engineering Drawings and design are adjusted to meet the needs of the subdivision in compliance with the Auckland Council Code of Practice for Land Development and Subdivision, the Consent Holder must seek the prior approval of the Council's Regulatory Engineering Team Leader.	The engineering drawings we have been provided as part of this RC are limited in detail. The SMP notes that further detailed design will be provided at EPA stage. This condition is not supported – the RC will be granted prior to the EPA. This condition is not appropriate unless more detailed engineering design of the stormwater management assets is provided as part of RC.
156	Easements in Gross Easements in gross in favour of the Council for the purpose of maintaining overland flow of stormwater, must be created over parts of Lots XX & XX and must be included in a memorandum of easements endorsed on the survey plan and be granted or reserved. The Consent Holder must meet the costs for the preparation, review, and registration of the easement instruments on the relevant records of title.	This condition is not supported. There is concern that the survey plans submitted in support of RC will not be accurate if the design changes following granting of the RC.
158	Drainage Reserve to Vest The proposed drainage reserve shown as Lot XX on the approved plans referenced in Condition [XX] shall vest in the Council as Local Purpose Drainage Reserves. The Consent Holder must meet all costs associated with the vesting of the reserves.	HWFR do not agree with this mechanism, preference is for '*land in lieu of reserve – for drainage purposes*' . This condition is not supported. There is concern that the survey plans submitted in support of the RC won't be accurate if the design changes following granting of the RC.
159	Pre-Commencement: Engineering Plan Approval Prior to commencement of any public works required for the development (as indicated on the approved plans in Condition [XX]), the consent holder must provide design plans and specifications detailing the following works required in respect to this consent, to the satisfaction of the Council. Details of the registered engineer who will act as the Consent Holder's representative for the duration of the development must also be provided with the application for Engineering Plan Approval.	Proposed revision: **Pre-Construction Meeting – Public Stormwater Assets** A pre-construction meeting must be held by the consent holder, prior to commencement of the construction of any stormwater devices intended to be vested as public, that: a. Is arranged five working days prior to initiation of the construction of any intended public stormwater devices on the site; b. Is located on the subject area;

<table>
<tr><th>#</th><th>APPLICANT'S PROPOSED CONDITIONS</th><th>HEALTHY WATERS COMMENT</th></tr>
<tr><td></td><td></td><td>c. Includes representation from the Council, including but not limited to Auckland Council Healthy Waters – Operations Team; and
d. Includes representation from the site stormwater engineer (or) contractors who will undertake the works and any other relevant parties.

The following information must be made available before or at the meeting:
e. Timeframes for key stages of the works authorised under this consent;
f. Contact details of the site contractor and site stormwater engineer; and
g. Construction plans approved (signed/stamped) by the Council.

Advice Note:
To arrange the pre-construction meeting required by this consent, please contact the Council on email at monitoring@aucklandcouncil.govt.nz.</td></tr>
<tr><td>160</td><td>The engineering plans submitted for approval must detail all works associated with, and be in accordance with current Council Engineering Standards, including but not limited to;
• Public Stormwater Reticulation
. . .
The engineering plans must include but not be limited to the following information:
. . .
b. As part of the application for Engineering Plan Approval, a registered engineer must:
i) Certify that the proposed stormwater system or devices proposed have been designed in accordance with the Council's Code of Practice for Land Development and Subdivision: Chapter 4 - Stormwater.
ii) Provide a statement that the proposed infrastructure has been designed for the long-term operation and maintenance of the asset.
iii) Confirm that all practical measures are included in the design to facilitate safe working conditions in and around the asset.
. . .
v) Provide a statement that the proposed infrastructure has been designed for the long-term operation and maintenance of the asset.

vi) Provide stormwater catchment plan(s) and stormwater calculations
. . .</td><td>This condition contains requirements for both proposed public roads and proposed public SW assets – suggest the condition is split into two conditions, with one for SW assets and one for roads. Management of compliance of a condition where these requirements are combined will be difficult for both the Applicant and Council.

It is understood that Auckland Transport have sought amendments to Clause e. and clause o.

The engineering drawings we have been provided as part of this RC are limited in detail. The SMP notes that further detailed design will be provided at EPA stage. This condition is not supported – the RC will be granted prior to the EPA. This condition is not appropriate unless more detailed engineering design of the stormwater management assets is provided as part of RC.</td></tr>
</table>

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	e. Culvert hydraulic calculations must be provided to demonstrate the road proposed under this application has sufficient freeboard to the 1% AEP + climate change water level at the culvert. . . . o. Detailed design of the stormwater system and devices for the management of both quantity and quality of the stormwater runoff from the contributing development upstream catchment (including treatment devices and all ancillary equipment/structure etc.). The stormwater system and devices must be designed in accordance with the Council's Code of Practice for Land Development and Subdivision: Chapter 4 - Stormwater; in particular: p. Pipes appropriately sized to accommodate 10% AEP flows – _relevant calculations to be provided. q. The proposed stormwater system must be designed to identify health and safety risks for the public, operating personnel, contractor and Council employees. r. The proposed stormwater system must have an asset life of a minimum of 100 years. s. Principles of Water-Sensitive Design and "Best Management Practices" _to minimise stormwater run-off volumes and peak flow rates and to improve the quality of stormwater run-off entering the receiving environment must be utilised for the design of the proposed stormwater system. t. The system must cater for stormwater run-off from the site being developed together with any run-off from upstream catchments in accordance with TP108 (Guidelines for Stormwater Runoff Modelling in the Auckland Region 1999) and allowances for climate changes. The upstream catchment must be considered for the Maximum Probable Development scenario. u. Mitigation measures (e.g. peak flow attenuations and/or velocity control) to mitigate the downstream effects must be taken into account during the design of the stormwater system . . .	
168	Stormwater Reticulation Networks	No objection. Standard Condition.

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	The Consent Holder must design and construct connections to the public stormwater reticulation network to serve the development in accordance with the requirements of the utility provider and the approved engineering plans as required by Condition [XX] . Certification from the utility provider that works have been satisfactorily undertaken must be provided when applying for a certificate under section 224(c) of the RMA. *Advice Notes:* • *Acceptable forms of evidence include Engineering Approval Completion Certificates.* • *Stormwater utility provider is Auckland Council Healthy Waters.* • *Public connections are to be constructed in accordance with the Stormwater Code of Practice.* • *Alterations to the public stormwater reticulation network require Engineering Plan Approval.*	
169	Operation and Maintenance Manual for the Stormwater Management Devices The Consent Holder must engage a SQEP who must prepare an Operation and Maintenance Manual for all stormwater devices (stormwater ponds/wetlands, outfalls etc.), setting out the principles for the general operation and maintenance for the stormwater system, outlet channel and the associated management devices. The Operation and Maintenance Manual must be submitted for certification by the Council. The Operation and Maintenance plan shall include, but not be limited to: a. a detailed technical data sheet; b. all the requirements as defined within the Stormwater Management Device Design Guidelines Manual (TP 10) or Auckland Council Guideline Document 2016/001 (GD01); c. details of who will hold responsibility for short-term and long-term maintenance of the stormwater devices; d. a programme for regular maintenance and inspection of the stormwater system; e. a programme for the collection and disposal of debris and sediment collected by the stormwater management device or practices; f. a programme for post storm maintenance; g. a programme for inspection and maintenance of outfall erosion;	Proposed revision: **Operation and Maintenance Manual for Stormwater Management Devices** For all stormwater management devices (including but not limited to ponds, wetlands, outlet structures, and outfalls), the Consent Holder must engage a Suitably Qualified and Experienced Professional (SQEP) to prepare an Operation and Maintenance Plan (OMP) setting out the principles for the general operation and ongoing maintenance of the stormwater system and associated management devices. For any stormwater devices intended to vest in Auckland Council, the OMP must be submitted to Healthy Waters for approval at the time of Engineering Plan Approval (EPA). The OMP must be prepared in accordance with the Healthy Waters Operation and Maintenance Plan Template (6 July 2023) or any subsequent updates. The OMP must include, but not be limited to: a. A detailed technical data sheet; b. All requirements as defined within Auckland Council's Stormwater Management Devices Design Guidelines Manual (TP10) and/or Guideline Document 2016/001 (GD01), as applicable;

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	h. general inspection checklists for all aspects of the stormwater system, including visual check of roadside catch pits, recharge pits and outfalls; i. a programme for inspection and maintenance of vegetation, if any, associated with the stormwater devices, and j. recommended on-going control methodology to eradicate established pests and invasive weeds from both terrestrial and aquatic areas.	c. Clear identification of responsibility for both short-term and long-term maintenance of the stormwater devices; d. A programme for regular maintenance and inspection of the stormwater system; e. A programme for the collection and disposal of debris and sediment from the stormwater management devices; f. A programme for post-storm maintenance; g. A programme for inspection and maintenance of outfall erosion; h. General inspection checklists for all components of the stormwater system, including roadside catchpits, recharge pits, and outfalls; i. A programme for inspection and maintenance of vegetation associated with the stormwater devices; and j. A methodology for the ongoing control and eradication of established pest species and invasive weeds within both terrestrial and aquatic areas of the stormwater device. *Advice Note:* For stormwater assets to vest in Council, the OMP must be consistent with Healthy Waters' operational requirements and approved prior to construction commencing on those devices.
173	The infrastructure required for each stage of the development is set out in the table below. The infrastructure specified for each stage of the development must be constructed and operational prior to any building within that stage being occupied. . . .	The condition should be amended to include catchment diversion of Papakura Stream catchment to Pahurehure Inlet Catchment, and provision of Pond 4 and Stage 3 Awakeri Wetland as part of stormwater works for every stage.
175	Final Flood Report When applying for a certificate under section 224(c) of the RMA, the Consent Holder must provide a Stormwater Report prepared by a SQEP to the satisfaction of the Council identifying: a. The 1% AEP flood level for the Site and the surrounding road reserves; b. A layout plan of the overland flow paths for the Site and the adjacent land along the boundary in accordance with the approved Resource Consent/Engineering Plan; c. The overland flow path plan with as-built cross sections of all roads including the ponding areas with levels before overtopping; d. As built longitudinal plan and cross sections for overland flow path locations;	Proposed revision: **Final Flood Report** Prior to the commencement of any earthworks, the Consent Holder must provide a Final Flood Report prepared by a Suitably Qualified and Experienced Professional (SQEP) to Auckland Council Healthy Waters for review and certification. The report must identify and confirm: a. The 1% Annual Exceedance Probability (AEP) flood level for the site and the surrounding road reserves; b. A layout plan showing the overland flow paths for the site and any adjacent land along the boundary, in accordance with the approved resource consent and/or engineering plans;

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
		c. Overland flow path plans, including as-built cross sections of all roads and any ponding areas, with levels identified prior to overtopping; and d. As-built longitudinal and cross-sectional drawings for overland flow path locations. If the Final Flood Report identifies that the development will result in increased flooding effects (including any increase in depth, velocity, extent, or frequency) on other properties or buildings, the Consent Holder must provide details of proposed mitigation measures to the satisfaction of Healthy Waters. These measures must be implemented to avoid or appropriately mitigate those adverse effects, to the satisfaction of Council, prior to the continuation of earthworks. *Advice Note:* The Final Flood Report must be assessed and certified by Auckland Council Healthy Waters. It must demonstrate that flood risks have been appropriately identified, assessed, and addressed in accordance with best practice and the Auckland Unitary Plan requirements.
176	If the Stormwater Report identifies that any future building within the development is subject to 1% AEP flooding, the Stormwater Code of Practice must be followed to confirm the minimum floor level. This may be enforced through a consent notice on the property, and no buildings, structures or other obstructions are to be erected in the overland flow paths without prior written permission from the Council.	Proposed revision: If the Final Flood Report required under Condition [175] identifies that any future building site within the development is subject to 1% AEP flooding, the minimum floor level for that site must be confirmed in accordance with the *Auckland Council Stormwater Code of Practice* (2021). The confirmed minimum floor level shall be enforced by a consent notice registered on the relevant Record(s) of Title under section 221 of the Resource Management Act 1991. No buildings, structures, or other obstructions may be erected within any overland flow paths identified in the Final Flood Report without the prior written approval of Auckland Council.
205	Stormwater Reticulation Networks The Consent Holder must design and construct connections to the public stormwater reticulation network to serve the lots in accordance with the requirements of the stormwater utility service provider. Certification from the utility provider that works have been satisfactorily undertaken must be provided when applying for a certificate under section 224(c).	No objection. Standard Condition.

#	APPLICANT'S PROPOSED CONDITIONS	HEALTHY WATERS COMMENT
	Advice Notes: • *Acceptable forms of evidence include Engineering Approval Completion Certificates.* • *Stormwater utility provider is Auckland Council Healthy Waters.* • *Public connections are to be constructed in accordance with the Stormwater Code of Practice.* • *Alterations to the public stormwater reticulation network require Engineering Plan Approval.* • *The required Engineering Plan Approval can be combined with an Engineering Plan approval for the underlying superlot subdivision if applicable.* • *There are ongoing stormwater consent notices that will continue to apply to the individual lots.*	

APPENDIX B: ADDITIONAL RECOMMENDED CONDITIONS REGISTER

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
1.	The following recommended condition will ensure any communal stormwater devices are properly maintained during development and handed over to Council in a functional and compliant state.	**Maintenance of Communal Stormwater Management Devices** The consent holder must maintain the communal stormwater management devices serving the development in accordance with the following requirements: a. The consent holder must maintain the communal devices until the earlier of: i. 80% of the building sites discharging to the devices have been developed, and ii. A period of ten (10) years has passed from the date of issue of the final section 224(c) certificate under the Resource Management Act 1991 for the subdivision, b. The consent holder must remove any sediment from the communal device that has resulted from development activities within the subdivision, if required by the Council, prior to acceptance of the device(s) by Council for ongoing maintenance. c. At the time of transfer of any stormwater management devices to Council for ongoing maintenance, all planted areas associated with the stormwater management devices must achieve a minimum plant survival rate of 95%. d. Updated Operation and Maintenance Manuals for all communal stormwater management devices must be provided to the Council at the time of transfer of any stormwater management devices to Council for ongoing maintenance. e. A bond must be provided at the time of application for the section 224(c) certificate to ensure the ongoing maintenance of the communal stormwater management devices until transfer of any stormwater management devices to Council for ongoing maintenance.

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
2.		**Consent Notice – Ongoing Maintenance of Communal Stormwater Management Devices** Pursuant to section 221 of the Resource Management Act 1991, the following condition shall be registered as a consent notice on the Record(s) of Title of all lots that are to be serviced by communal stormwater management devices: The consent holder must ensure the ongoing maintenance of the communal stormwater management devices that service the development, in accordance with the following requirements: a. The devices must be maintained in accordance with the approved Operation and Maintenance Manual, or as otherwise directed by the Council; b. The consent holder must ensure that any sediment entering the communal stormwater devices as a result of site development is removed promptly, and prior to the transfer of any device to Council (where applicable); c. The consent holder must ensure that, at the time of transfer of any stormwater management device to Council, any associated planted areas have achieved a minimum plant survival rate of 95%; d. The obligation for the consent holder to maintain the devices shall continue until the earlier of: i. 80% of the building sites discharging to the device(s) have been developed; or ii. Ten (10) years from the date of issue of the final section 224(c) certificate for the subdivision. This consent notice may only be varied or cancelled in accordance with the provisions of section 221(3) of the Resource Management Act 1991.

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
3.	A condition requiring establishment of a bond will secure proper maintenance and completion of any communal raingarden devices, protecting the Council from costs if the consent holder fails to meet their obligations.	**Requirement for Bond** Prior to the issue of the section 224(c) certificate under the RMA, the consent holder must provide a bond to the Council in accordance with Section 222 of the RMA to ensure the performance of the communal devices. The bond must: a. Be provided in the form of a cash deposit, a bank bond guaranteed by a New Zealand-registered bank, or another form of security (e.g., an encumbrance) as agreed with the Council. b. Be documented and executed by the Council's solicitor. All legal and administrative costs associated with preparation, execution, variation, administration, or release of the bond must be met by the consent holder. c. Be released once the relevant condition(s) have been satisfied and all associated Council costs have been paid. *Advice Notes:* *The Council may use the bond to restore the communal stormwater device(s) to comply with Auckland Council's GD01 standards if the consent holder fails to meet the condition requirements.* *The final bond amount will be confirmed and agreed by Council prior to Engineering Plan Approval. It will be calculated based on a per-square-metre rate of communal device area, with the rate to be determined at that time. The bond value will be adjusted for inflation using the Reserve Bank inflation calculator or another method agreed with Council*.
4.	A condition clarifying ownership of retaining walls is important to ensure that long-term ownership and maintenance responsibilities are clearly defined. Retaining structures are not stormwater assets and are not maintained by Healthy Waters due to their structural complexity, ongoing maintenance requirements, and associated liability.	**Exclusion of Retaining Walls from Vesting** No retaining walls shall be vested in Auckland Council's Healthy Waters department. All retaining structures shall remain in private ownership and maintenance responsibility unless otherwise agreed in writing by Auckland Council (Healthy Waters).

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
5.	This condition will ensure that the development does not exacerbate flooding on neighbouring properties, maintain existing levels of flood risk, and protect both public and private assets from adverse effects during a range of storm events.	**Flood Risk and Nuisance** The consent holder must ensure that the development does not result in any increase in flood risk or flood nuisance to upstream or downstream properties, measured against the existing rainfall and land use conditions for the 50% AEP, 10% AEP, and 1% AEP storm events.
6.	This condition will ensure that any stormwater management devices intended for public ownership and maintenance are assessed and accepted by Auckland Council's Healthy Waters team before progressing to detailed engineering design or legal subdivision.	**Stormwater Asset Acceptance** Prior to the submission of any Engineering Plan Approval and prior to Auckland Council approving a survey plan pursuant to s223 of RMA for any stage, the consent holder must obtain written confirmation from Auckland Council Healthy Waters regarding the acceptance of all stormwater devices proposed to vest to Auckland Council Healthy Waters. Should any stormwater devices and/or associated land not be accepted by Auckland Council Healthy Waters for vesting, the relevant plan must be updated to show such assets/land as a separate allotment or allotments on the survey plan and must be owned by a common entity as outlined in the conditions. *Advice Note: Auckland Council Healthy Waters has sole discretion to determine whether any stormwater device or associated land is acceptable for vesting.*
7.	This condition is important to ensure that all permanent structures within the development are designed and located in a way that avoids long-term erosion risk, protecting both public safety and infrastructure integrity.	**Erosion Risk Assessment** The consent holder must demonstrate, to the satisfaction of the Auckland Council Healthy Waters Department – Waterways Planning, that all permanent structures associated with the development including buildings, stormwater outfalls, retaining walls, and other infrastructure are not at risk of being undermined by erosion over their intended design life (50 to 100 years). This must be confirmed through a geotechnical and/or hydraulic assessment prepared by a suitably qualified and experienced professional, taking into account site-specific erosion potential, hydrological conditions, and the effects of climate change.

<table>
<tr><th></th><th>HEALTHY WATERS COMMENT</th><th>ADDITIONALLY RECOMMENDED CONDITIONS</th></tr>
<tr><td>8.</td><td>This condition is necessary to ensure that critical stormwater management infrastructure is constructed and operational before any discharges occur from the site. It provides clear performance requirements for each pond to manage flood risk and water quality effects in accordance with GD01 and the Auckland Council Stormwater Code of Practice. These works are essential to avoid downstream flooding, protect sensitive receiving environments (such as Awakeri Wetland and McLennan Dam), and ensure compliance with best practice design standards.</td><td>Stormwater management Works

The following stormwater management works shall be constructed for the following catchment areas and design requirements, and shall be completed prior to discharges commencing from the site:

<table>
<tr><th>Works to be undertaken</th><th>Design requirement(s)</th></tr>
<tr><td>Pond 1</td><td>Peak flow attenuation for all storm events up to the 1% AEP event such that there is no increase in flood levels within the flood plain downstream
Water Quality Treatment to meet GD01 requirements</td></tr>
<tr><td>Pond 2</td><td>Peak flow attenuation for all storm events up to the 1% AEP event such that there is no increase in flood levels within the flood plain downstream
Water Quality Treatment to meet GD01 requirements</td></tr>
<tr><td>Pond 3</td><td>Peak flow attenuation for all storm events up to the 1% AEP event such that there is no increase in flood levels within the flood plain downstream
Water Quality Treatment to meet GD01 requirements</td></tr>
<tr><td>Pond 4</td><td>Peak Flow Attenuation of runoff from storm events up to the 1% AEP event such that there is no increase in flows at the Cosgrave Road culvert.
Peak flow attenuation such that there is no increase in the peak levels within the Awakeri Wetland Stage 2 for up to the 50% AEP storm event.
Peak flow attenuation such that there is no increase in water levels in McLennan Dam, nor any increase in overtopping duration for any storm event up to the 1% AEP event.
Peak flow attenuation such that the MacLennan Dam spillway can safely manage flow for the required thresholds of a High PIC dam under the relevant NZSOLD Dam Safety guidance.
Water Quality Treatment to meet GD01 requirements</td></tr>
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<table>
<tr><th></th><th>HEALTHY WATERS COMMENT</th><th>ADDITIONALLY RECOMMENDED CONDITIONS</th></tr>
<tr><td></td><td></td><td><table><tr><td>Pond 5</td><td>• Peak flow attenuation for all storm events up to the 1% AEP event such that there is no increase in flood levels within the floodplain downstream</td></tr><tr><td>Pond 6</td><td>Peak flow attenuation for all storm events up to the 1% AEP event such that there is no increase in flood levels within the floodplain downstream</td></tr></table></td></tr>
<tr><td>9.</td><td>An additional condition is necessary to ensure that the McLennan Dam has sufficient capacity and structural integrity to safely accommodate additional runoff from the proposed development. Given the dam's role in managing flood flows downstream, a dam safety review prior to earthworks is essential to avoid increased flood risk or structural failure, and to ensure compliance with best practice and public safety obligations.</td><td>Dam Safety Review

Prior to the commencement of any earthworks, the Consent Holder must provide to Council a dam safety review of the McLennan Dam, prepared by a suitably qualified and experienced professional (SQEP). The review must demonstrate that the dam structure can safely accommodate any additional runoff resulting from the proposed development, including for storm events up to and including the 1% AEP.

Any upgrades or mitigation measures identified in the review as necessary to maintain dam safety or performance must be implemented to the satisfaction of Auckland Council prior to any runoff being discharged to the dam.</td></tr>
<tr><td>10.</td><td>The Annual Stormwater and Flood Management Plan (AMP) provides a mechanism to ensure ongoing oversight of flood risk and stormwater management across multiple construction seasons for a large, staged development. Given the dynamic nature of landform changes, earthworks sequencing, and infrastructure rollout, annual review and approval of stormwater-related works is essential to protect public safety, and maintain downstream network performance.

The AMP will enable HWFR, to verify that the evolving stormwater and flood risk profile remains within the parameters assessed under the original resource consent. It also allows for adaptation to site-specific findings, progressive as-built information, and any new regulatory guidance or best practice updates. This approach ensures environmental outcomes and asset performance remain aligned with consent conditions while managing cumulative effects responsibly.
The AMP preparation and approval condition will ensure that HWFR have oversight of stormwater and flood-related activities each year before works begin. Submitting the AMP by 31 July provides sufficient time for review ahead of the October start of the</td><td>Annual Stormwater and Flood Management Plan (AMP)

AMP Preparation and Approval

Prior to 31 July each year, and prior to the commencement of any physical works within the subsequent earthworks season (1 October – 30 April), the Consent Holder must prepare and submit an Annual Stormwater and Flood Management Plan (AMP) for review and written certification by the Council, in consultation with Auckland Council Healthy Waters and Flood Resilience.

The AMP must outline all proposed stormwater-related construction activities for the upcoming construction season, including (where applicable) bulk earthworks, staged landform changes, culvert/stream diversion works, and the construction of stormwater management devices (e.g. ponds, wetlands, outfalls, overland flow path reshaping).</td></tr>
</table>

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
	construction season. Requiring approval helps avoid the risk of unmanaged changes to the stormwater system, supports integrated staging, and ensures that mitigation measures are in place before discharges or runoff can occur.	
11.	This condition ties together multiple stormwater-related management plans to ensure they are reviewed, updated, and implemented holistically each year. By confirming how performance standards and consent conditions will be achieved, the AMP becomes the central tool for compliance, rather than relying on fragmented or outdated plans. It also ensures that changes are coordinated across plans and properly managed.	**Purpose of AMP and Confirmed Plans** The AMP must confirm how the implementation of the following plans will occur during the upcoming season, identify any amendments required, and confirm how the performance standards and outcomes of each will be achieved: a. Stormwater Management Plan (SMP); b. Flood Risk Mitigation Plan (FRMP); c. Erosion and Sediment Control Plan (ESCP); d. Operation and Maintenance Plan(s) for completed stormwater infrastructure; e. Overland Flow Path Protection and Management Plan (if applicable); f. Ground Settlement and Groundwater Drawdown Monitoring Plan.
12.	This condition is critical to prevent increased flood risk on neighbouring properties, particularly as the development modifies landform, flow paths, and runoff volumes over time. It requires explicit modelling to demonstrate compliance and provides a safeguard by requiring written agreement from affected parties where unavoidable effects occur.	**Flood Risk and Property Protection** The AMP must demonstrate that no property (other than land owned or controlled by the Consent Holder) will experience increased flood effects beyond pre-development levels, including but not limited to frequency, duration, extent, or depth, for all events up to and including the 1% AEP (100-year ARI) storm event. If increased flooding effects are identified, the AMP must include written approval from the affected property owner(s), confirming their understanding and acceptance of the effects. For the avoidance of doubt, this assessment must include both major and minor overland flow paths altered by proposed works, and must be based on verified modelling of cumulative landform and stormwater management changes.
13.	By requiring confirmation of as-built and modelling updates based on actual implementation, this condition will ensure that each stage of development builds reliably	**Staging and Verification Requirements**

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
	on the last. Without such verification, there is a risk that changes in landform or staging could lead to unanticipated downstream effects. This requirement also supports Council in holding the Consent Holder accountable for consistency with certified designs and maintaining the integrity of overland flow paths and flood plains.	The AMP must include: a. A staging plan and sequencing of proposed stormwater works (including cut/fill and structure installation); b. Updated hydrological and hydraulic modelling demonstrating that stormwater and flood risk management remains consistent with previously certified AMPs and approved resource consent conditions; c. Verification that earthworks and/or stormwater management devices constructed under the previous AMP have been implemented as certified, including an updated digital terrain model (DTM) and as-built data used in current modelling. d. Flood impact modelling based on the latest as-built contours, certified landforms, and catchment hydrology.
14.	Groundwater drawdown can influence ground settlement and flow paths, particularly where sub-surface conditions are altered. This condition provides a link between the AMP and the Groundwater Settlement Monitoring and Contingency Plan, ensuring that any associated effects on flood storage capacity or overland flow are considered and addressed in advance of seasonal works. It promotes integrated management of surface and subsurface hydrological risks.	Where any groundwater take or diversion is proposed as part of works in the upcoming season, the AMP must confirm whether this has the potential to affect overland flow behaviour or flood storage volumes. The AMP must also confirm compliance with the Groundwater Settlement Monitoring and Contingency Plan (Condition XXX).
15.	The purpose of Condition [18] is to ensure that properties, floor levels and existing infrastructure outside the resource consent area are not adversely affected by this development and identify additional mitigation measures which may be required in order to achieve this.	**Stormwater Implementation Management Plan** The consent holder must prepare and submit a Stormwater Implementation Management Plan to Auckland Council for certification and prior to submission for Engineering Plan Approval (EPA). The SIMP must: a. Describe all the proposed public devices for stormwater attenuation, quality and hydrological SMAF-1 mitigation. This must include a description of the type of device, dimensions (including detention volume), number and location of devices, and the proposed function of the device including hydrological mitigation and/or water quality mitigation and catchment attenuation where applicable; b. Undertake hydraulic modelling and provide an assessment of flood hazard risk using proposed known landforms within the proposed development area including the proposed public stormwater networks

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		c. Undertake hydraulic modelling of flood flows in the floodplain to the north of the Sunfield development to test sensitivity of the proposed finished floor levels of the lowest parts part of the subdivision approved in this consent to flood levels in the flood plain. The modelling must address the sensitivity of floodplain flood levels to the final planting proposed within the conveyance channels, wetlands and ponds shown on the final Landscape Plans. The results of the modelling must be provided to Council and used to establish appropriate design against the 1% AEP flood level and demonstrating that sufficient freeboard is provided within the approved subdivision. d. If the assessment in part [c] above identifies an increase in flood extent, flood depth, flood frequency, flood hazard on properties, floors and infrastructure upstream and downstream of the site (measured against existing rainfall and existing land use for the 50% AEP, 10% AEP, and 1% AEP storm events) then additional flood mitigation must be provided so that post development flood extent, flood depth, flood frequency or flood hazard does not exceed predevelopment levels. e. The flood mitigation must be provided before impervious surfaces are created. *Advice Note:* Flood mitigation measures will be subject to review and approval by Auckland Council Healthy Waters at Engineering Plan Approval stage.
16.	A condition is recommended to identify and manage potential adverse effects of groundwater drawdown and earthworks on ground settlement within the wider catchment. Long-term monitoring will ensure early detection of any unexpected impacts on nearby land and infrastructure, enabling timely mitigation. This proactive approach aligns with best practice and helps protect the integrity of surrounding properties and Council assets.	**Groundwater Drawdown** Prior to the commencement of any earthworks, the Consent Holder must commission a suitably qualified and experienced professional (SQEP) to prepare an assessment of the potential effects of groundwater drawdown and proposed earthworks on both short- and long-term ground settlement within the wider catchment. The assessment must include: a. Identification of potential settlement impacts on surrounding land and infrastructure; b. Proposed measures to avoid, remedy, or mitigate any adverse settlement effects; and c. A detailed long-term groundwater and ground settlement monitoring programme.

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		The monitoring programme must be implemented throughout construction and post-construction phases, with results reported to Auckland Council Healthy Waters at agreed intervals. Should monitoring identify any material adverse settlement or groundwater drawdown effects, the Consent Holder shall promptly implement mitigation or remediation measures to the satisfaction of Council.
17.	The currently proposed conditions of consent relating to groundwater management are not considered sufficiently comprehensive. It is recommended additional conditions be included, consistent with those applying to the existing parts of Awakeri Wetland.	**Pre-load trial** Prior to any earthworks commencing, a preload trial a must be undertaken in accordance with the LDE Geotechnical Report, and a preload design must be prepared by a Geotechnical Engineer. This will need to consider the final earthworks proposal, building typologies and uniformly distributed loads (UDLs) as well as the preferred preload material type
18.		Building foundations shall be designed in accordance with the LDE Geotechnical Report. No buildings greater than three storeys in Zone 2 shall be allowed unless further geotechnical investigation and assessment is undertaken in accordance with the LDE Geotechnical Report to confirm foundation requirements (which may include piling).
19.		**Detailed groundwater drawdown analysis** Prior to any earthworks commencing, a detailed groundwater drawdown assessment shall be prepared by a qualified geotechnical engineer. The assessment shall consider the final earthworks levels and cut depths in relation to seasonal low groundwater levels to determine the lateral extent affected by any drawdown. The assessment shall be informed by dewatering trials and baseline groundwater monitoring.
20.		**Detailed settlement analysis** Prior to any earthworks commencing, a detailed settlement analysis shall be prepared which considers the extent of total settlement and differential settlement across the site as a result of any groundwater drawdown, loading from earthworks and other activities. Effects on structures such stormwater, wastewater, water, gas, power, buildings, roads and other above and below ground assets shall be assessed.

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
21.		**Notice of Commencement of Dewatering** The Senior Monitoring Officer (DPO) shall be advised in writing at least 10 working days prior to the date of the commencement of dewatering.
22.		**Damage avoidance** All excavation, dewatering systems, structures and works associated with the diversion or taking of groundwater, shall be designed, constructed and maintained so as to avoid any damage to buildings, structures and services on the site or adjacent properties, unless otherwise agreed in writing with the asset owner.
23.		**Groundwater and Settlement Monitoring and Contingency Plan** At least 10 days prior to the Commencement of Construction, a Groundwater and Settlement Monitoring and Contingency Plan (GSMCP) prepared by a suitably qualified engineering professional, shall be submitted to the Senior Compliance Advisor (DPO) for written certification. Any proposed amendment to the GSMCP shall also be submitted to the Senior Compliance Advisor (DPO) for written approval. The overall objective of the GSMCP shall be to set out the practices and procedures to be adopted to ensure compliance with the consent conditions and shall include, at a minimum, the following information: a. A monitoring location plan, showing the location and type of all Monitoring Stations including groundwater monitoring bores, ground movement pins, and deformation pins. b. Final completed Schedules B to D (as per the conditions below) for ground surface and building deformation monitoring programme (including any proposed changes to the monitoring frequency) as required by conditions below.

<table>
<tr><th></th><th>HEALTHY WATERS COMMENT</th><th>ADDITIONALLY RECOMMENDED CONDITIONS</th></tr>
<tr><td></td><td></td><td>c. All monitoring data, the identification of Services susceptible to Damage and all building/service condition surveys undertaken to date, and required by conditions below.
d. A bar chart (such as a Gantt chart) showing the timing and frequency of condition surveys, visual inspections and all other monitoring required by this consent, and a sample report template for the required 2 monthly monitoring.
e. All Alert and Alarm Level Triggers (including reasons if changes to such are proposed, for example as a result of recommendations in the building condition surveys or data obtained from pre-dewatering monitoring).
f. Details of the contingency actions to be implemented if Alert or Alarm Levels are exceeded.</td></tr>
<tr><td>24.</td><td></td><td>Activities to be carried out in accordance with the Groundwater and Settlement Monitoring and Contingency Plan (GSMCP)

All construction, dewatering, monitoring and contingency actions shall be carried out in accordance with the approved GSMCP. No Bulk Excavation (that may affect groundwater levels) or other dewatering activities shall commence until the GSMCP is approved in writing by the Senior Monitoring Advisor (DPO).
The GSMCP and detailed design of the Cosgrave Road box culvert shall be submitted to Watercare for approval prior to commencement of works on the box culvert (Stage 2 of the Channel works). No excavation or works that may affect the Watercare watermain may commence until written approval from Watercare is obtained.</td></tr>
<tr><td>25.</td><td></td><td>Alert and Alarm Levels:

The activity shall not cause any settlement or movement greater than the Alarm Level thresholds specified in Schedule A below. Alert and Alarm Levels are triggered when the following Alert and Alarm Trigger thresholds are exceeded:

Schedule A

<table><tr><th></th><th>Movement</th><th>Alert</th><th>Alarm</th></tr><tr><td>a)</td><td>Total Settlement Alert and Alarm levels to be set in the GSMCP based on settlement preditions.</td><td>TBC</td><td>TBC</td></tr></table></td></tr>
</table>

<table>
<tr><th></th><th>HEALTHY WATERS COMMENT</th><th>ADDITIONALLY RECOMMENDED CONDITIONS</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>b)</td><td>Differential vertical settlement between any two Ground Surface Settlement Monitoring Stations (the Differential Ground Surface Settlement Alarm or Alert Level)</td><td>1:160</td><td>1:200</td></tr>
<tr><td>c)</td><td>Differential vertical settlement between any two adjacent Building Settlement Monitoring Stations (the Differential Building Settlement Alarm or Alert Level):</td><td>1:500</td><td>1:700</td></tr>
<tr><td>d)</td><td>Differential vertical settlement between any two Watermain Settlement Monitoring Stations (the Differential Watermain1 Settlement Alarm or Alert Level)</td><td>1:600</td><td>1:800</td></tr>
<tr><td>e)</td><td>Distance below the pre-dewatering Seasonal Low Groundwater Level at any monitoring bore (the Groundwater Alarm or Alert Level). Levels to be set in the GSMCP based on drawdown predictions.</td><td>TBC</td><td>TBC</td></tr>
</table>
These levels may be amended subject to approval by the Senior Compliance Advisor (DPO) as part of the Groundwater Settlement Monitoring and Contingency Plan (GSMCP) approval process, and, after the receipt of pre-dewatering monitoring data, building condition surveys and recommendations from a suitably qualified engineering professional, but only to the extent that avoidance of Damage to building, structures and services can still be achieved.
</td></tr>
<tr><td>26.</td><td></td><td>
Alert Level Actions
In the event of any Alert Trigger Level exceedance the Consent Holder shall:
a. Notify the Senior Compliance Advisor (DPO) within 24 hours.
b. Re-measure all Monitoring Stations within 50 metres of the affected monitoring
b. location(s) to confirm the extent of apparent movement
c. Ensure the data is reviewed, and advice provided, by a suitably qualified engineering professional on the need for mitigation measures or other actions necessary to avoid further deformation. Where mitigation measures or other actions are recommended those measures shall be implemented.
</td></tr>
</table>

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		d. Submit a written report, prepared by the suitably qualified engineering professional responsible for overviewing the monitoring, to the Senior Compliance Advisor (DPO) within 5 working days of Alert Trigger Level exceedance. The report shall provide analysis of all monitoring data (including wall deflection) relating to the exceedance, actions taken to date to address the issue and recommendations for future remedial actions necessary to prevent Alarm Levels being exceeded. e. e. Measure and record all Monitoring Stations within 50 metres of the location of any Alert Level exceedance every two days until such time the written report referred to above has been submitted to the Senior Compliance Advisor (DPO).
27.		**Alarm level actions** In the event of any Alarm Level being exceeded at any ground, building, or retaining wall deflection Monitoring Station the consent holder shall: a. Immediately halt construction activity, including excavation, dewatering and any other works that may result in increased deformation, unless halting the activity is considered by a suitably qualified person to be likely to be more harmful (in terms of effects on the environment) than continuing to carry out the activity. b. Notify the Senior Compliance Advisor (DPO) within 24 hours of the Alarm Level exceedance being detected and provide details of the measurements taken. c. Take advice from the author of the Alert Level exceedance report (if there was one) or another suitably qualified engineering professional on actions required to avoid, remedy or mitigate adverse effects on ground, buildings or structure that may occur as a result of the exceedance. d. Not resume construction activities (or any associated activities), subject to any contrary recommendation made in accordance with paragraph (a) above, until mitigation measures have been implemented, to the satisfaction of a suitably qualified engineering professional, that will avoid further damage. e. Report to the Senior Compliance Advisor (DPO) on the mitigation measures implemented and any remedial works and/or agreements with affected parties within 5 working days of recommencement of works.

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
28.		**Pre-Dewatering Services Survey** Prior to the Commencement of Dewatering, a condition survey (e.g. CCTV, acoustic or other) of potentially affected gas, water, stormwater and wastewater services shall be undertaken in consultation with the relevant service provider. This condition does not apply to any service where written evidence is provided to the Senior Monitoring Advisor (DPO) that the owner of that service has confirmed they do not require a condition survey.
29.		**Pre-dewatering building and structure survey** Prior to the Commencement of Dewatering, an external visual inspection or a detailed condition survey of buildings and structures as specified in the GSMCP and prepared by a suitably qualified engineering professional shall be submitted for certification by the Senior Compliance Advisor (DPO). The condition survey/s shall include: a. Confirmation of the installation of deformation pins as required in the GSMCP b. A description of the type of foundations. c. A description of existing levels of Damage considered to be of an aesthetic or superficial nature. d. A description of existing levels of Damage considered to affect the serviceability of the building where visually apparent without recourse to intrusive or destructive investigation. e. An assessment as to whether existing Damage may or may not be associated with actual structural Damage and an assessment of the susceptibility of buildings/structures to further movement and Damage. f. Photographic evidence of existing observable Damage. g. A review of proposed Alarm and Alert Levels to confirm they are appropriately set and confirmation that any ground settlement less than the Alarm Level will not cause Damage. h. An assessment of whether the monitoring frequency is appropriate. i. An assessment of where the location and density of existing deformation pins is adequate and appropriate for the effective detection of change to building and structure condition. j. The external visual inspection/s shall include:

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		i. A visual inspection of all exterior observable Damage. ii. Photographic evidence of all exterior observable Damage.
30.		**External Visual Inspections during dewatering to completion of construction** External visual inspections shall be undertaken of the surrounding ground and neighbouring buildings and structures (as listed in Schedule B and included in the GSMCP) for the purpose of detecting any new external Damage or deterioration of existing external Damage. Inspections are to be carried out from the Commencement of Dewatering to Completion of Construction in accordance with the frequency specified in Schedule D (see condition below). A photographic record is to be kept of the time and date of each inspection and all observations made during the inspection. This condition does not apply to any land, building or structure where written evidence is provided to the Senior Monitoring Advisor (DPO) confirming that the owner of the land, building or structure does not require visual inspections to be carried out.
31.		**Completion of Construction Building, Structure and Services Surveys** Between 18 and 24 months after Completion of Construction for each period of works being monitored a detailed condition survey of all previously surveyed buildings, structures and water, stormwater and wastewater Services, shall be prepared by a suitably qualified engineering professional. If ground settlement or building deformation monitoring indicates movement is still occurring at a level that may result in Damage to buildings, structures, or Services, the period where condition surveys are required will be extended until monitoring shows that movement has stabilised and the risk of Damage to buildings, structures and Services as a result of the dewatering is no longer present. The monitoring period shall include all monitoring points within 250m of the stage of construction. The condition survey report shall report on those matters identified in the pre-dewatering conditions survey. It shall also identify any new Damage that has occurred

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		since the predewatering condition survey was undertaken and provide an assessment of the likely cause of any such Damage. This condition does not apply to any building, structure or Service where written evidence is provided to the Senior Monitoring Advisor (DPO) confirming that the owner of that building, structure, or service does not require a condition survey to be undertaken.
32.		**Additional Surveys** Additional conditions surveys of any building, structure, or Service within the area defined by the extent of groundwater drawdown shown in the GSMCP shall be undertaken, if requested by the Senior Compliance Advisor (DPO), for the purpose of investigating any Damage potentially caused by dewatering. The requirement for any such additional condition survey will cease 18 months after the Completion of Construction for each period of works being monitored unless ground settlement or building deformation monitoring indicates movement is still occurring at a level that may result in Damage to buildings, structures, or Services. In such circumstances the period where additional condition surveys may be required will be extended until monitoring shows that movement has stabilised and the risk of Damage to buildings, structures and Services as a result of the dewatering is no longer present. The monitoring period shall include all monitoring points within 250m of the stage of construction.
33.		**Groundwater Monitoring** Groundwater monitoring bores are to be installed and hereafter maintained at least two months before commencement of Dewatering, at the locations stated in the approved GSMCP. Groundwater level monitoring is to be undertaken in accordance with Schedule C below:

Schedule C: Groundwater level monitoring frequency (to an accuracy of 10mm)		
From bore construction until one month before Commencement of Dewatering	One month before Commencement of Dewatering to Completion of Construction	From Completion of Construction until 18 months later

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		Monthly | Weekly | Monthly The monitoring frequency may be changed if approved by the Senior Compliance Advisor (DPO). Any change shall be specified in the GSMCP. In addition, the 18 month monitoring period post Completion of Construction for each period of works being monitored may be revised, by the Senior Compliance Advisor (DPO), if groundwater levels indicate a rate of settlement unlikely to result in damage or if measured groundwater levels are not consistent with inferred seasonal trends or predicted groundwater movement. Revisions could include extending the monitoring duration or reducing the monitoring duration. The monitoring period shall include all monitoring points within 250m of the stage of construction.
34.		**Ground Surface and Building Deformation Monitoring** Ground surface and building deformation Monitoring Stations shall be established and maintained at the locations shown in the approved GSMCP. The Monitoring Stations will be monitored at the frequency set out in Schedule D. The purpose of the Monitoring Stations is to record any vertical or horizontal movement. The monitoring frequency may be changed, if approved by the Senior Compliance Advisor (DPO), through the GSMCP. In addition, the 18 month monitoring period post Completion of Construction for each period of works being monitored may be revised, by the Senior Compliance Advisor (DPO), if groundwater levels indicate a rate of settlement unlikely to result in damage if measured groundwater levels are not consistent with inferred seasonal trends or predicted groundwater movement. Revisions could include extending the monitoring duration or reducing the monitoring duration. The monitoring period shall include all monitoring points within 250m of the stage of construction. **Schedule D: Ground and Building Monitoring frequency** Pre-Commencement of Dewatering | One month before Commencement of Dewatering to Completion of Construction | From Completion of Construction until 18 months later

<table>
<tr><th></th><th>HEALTHY WATERS COMMENT</th><th>ADDITIONALLY RECOMMENDED CONDITIONS</th></tr>
<tr><td></td><td></td><td><table><tr><td>Twice to a horizontal and vertical accuracy of +/- 2mm (achieved by precise levelling)</td><td>Weekly</td><td>Monthly</td></tr></table></td></tr>
<tr><td>35.</td><td></td><td>Access to Third Party Property

Where any monitoring, inspection or condition survey in this consent requires access to property/s owned by a third party, and access is declined or subject to what the consent holder considers to be unreasonable terms, the Senior Compliance Advisor (DPO) shall be notified and provided with all relevant details relating to access problems as soon as is practicable. If access cannot reasonably be obtained then a report prepared by a suitable qualified engineering professional identifying whether reasonably available alternative monitoring options are possible, shall be provided to the Senior Compliance Advisor (DPO). The report shall state whether the alternative monitoring options will provide sufficient early detection of deformation to enable measures to be implemented to prevent Damage to buildings, structures or Services. Written approval from the Senior Compliance Advisor (DPO) shall be obtained before any alternative monitoring option is implemented.</td></tr>
<tr><td>36.</td><td></td><td>Contingency Actions

If the consent holder becomes aware of any damage to buildings, structures or services potentially caused or wholly, or in part, by the exercise of this consent, the consent holder shall:

a. Notify the Senior Monitoring Officer (DPO) and the asset owner within 5 working days of consent holder becoming aware of the damage.
b. Engage a suitably qualified engineering professional to prepare a report that: describes the damage; identifies the cause of the damage; identifies methods to remedy and/or mitigate the damage that has been caused; identifies the potential for further damage to occur, and describes the actions that will be taken to avoid further damage.</td></tr>
</table>

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		c. Provide a copy of the report prepared under (b) above, to the Senior Compliance Advisor (DPO) and the asset owner within 10 working days of notification under (a) above.
37.		**Building, Structure, and Services Surveys and Inspections** copy of all pre-dewatering building, structure, and Service condition surveys and photographic records of external visual inspections required by this consent shall be submitted to the Senior Compliance Advisor (DPO) with the GSMCP. All other condition surveys and photographic records required by this consent shall be provided to the Senior Compliance Advisor (DPO) upon request.
38.		**Reporting of Monitoring Data** At two monthly intervals a report containing all monitoring data required by conditions of this consent shall be submitted to the Senior Compliance Advisor (DPO). This report shall include a construction progress timeline, the monitoring data recorded in that period, and, a comparison of that data with previously recorded date and with the Alert and Alarm Levels for each Monitoring Station
39.		**Notice of Completion** The Senior Compliance Advisor (DPO) shall be advised in writing within 10 working days of when excavation and dewatering has been completed the date of Completion of Construction and excavation.
40.		The conditions of this consent may be reviewed by the Senior Monitoring Advisor (DPO), pursuant to Section 128 of the RMA, by the giving of notice pursuant to Section 129 of the Act, within six months after Completion of Construction and subsequently at intervals of not less than one year thereafter in order: a. To vary the quantities, monitoring and reporting requirements, and performance standards in order to take account of information, including the results of previous monitoring and changed environmental knowledge, on:-

	HEALTHY WATERS COMMENT	ADDITIONALLY RECOMMENDED CONDITIONS
		i. ground conditions; ii. aquifer parameters; iii. groundwater levels; and iv. ground surface deformation b. To deal with any adverse effect on the environment arising or potentially arising from the exercise of this consent, and in particular effects on buildings, structures and services.

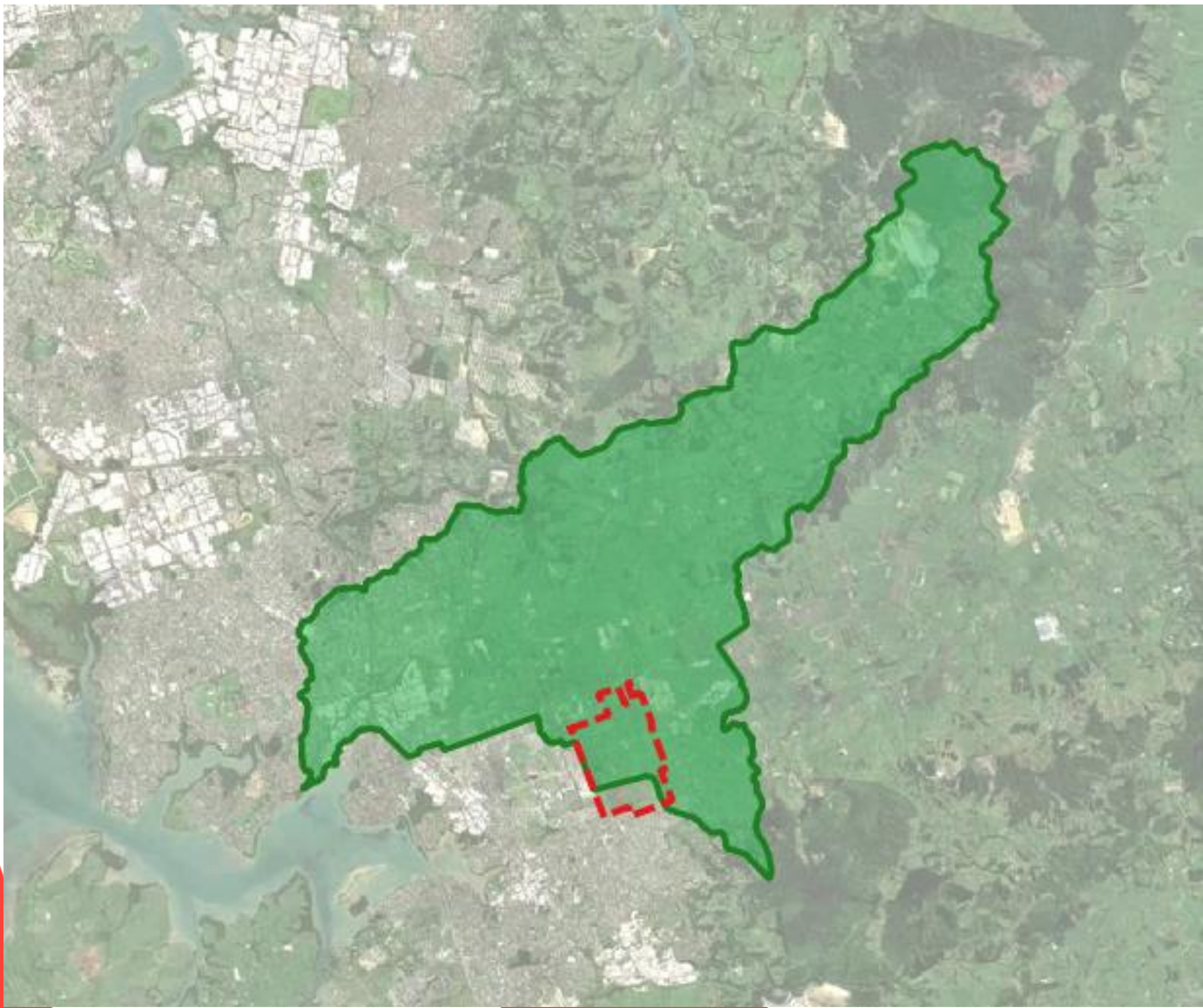
Confidential

Auckland Council

Papakura Stream Flood Hazard Modelling – Sunfield Development

11 July 2025

3-AWD30.AP



Papakura Stream Plan Change Modelling Support

Sunfield Modelling

Auckland Council

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REV	DATE	DETAILS
1	11 July 2025	Issued

	NAME	DATE	SIGNATURE
Prepared by:	Etienne Gil-Goldsbrough	10/07/2025	
Reviewed by:	Thomas Nikkel	11/07/2025	
Approved by:	James Reddish	11/07/2025	

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ABBREVIATIONS AND DEFINITIONS

3WSR	Three Waters Strategy Report
AC	Auckland Council
ARI	Average Recurrence Interval
AUK46	Auckland 1946 Vertical Datum
CC	Climate Change
CN	Curve Number
CoP	The Auckland Code of Practice for Land Development and Subdivision Chapter 4: Stormwater Version 4.0
ED	Existing Development
FUZ	Future Urban Zone
HEC-HMS	Hydrologic Engineering Center - Hydrologic Modeling System (hydrological modelling software)
ICM	InfoWorks ICM (hydraulic modelling software)
MPD	Maximum Probable Development
NZVD2016	New Zealand Vertical Datum 2016
PWL	Permanent Water Level
SWMP	Stormwater Management Plan
T+T	Tonkin + Taylor
ToC	Time of Concentration
TP108	Technical Publication 108: Guidelines for stormwater runoff modelling in the Auckland Region
Effects / Impacts	Use of the term “effects” and/or “impacts” in this report refers specifically to the potential change in predicted existing flood hazard as a results of stormwater management proposed by the Sunfield Development.

EXECUTIVE SUMMARY

Purpose and Scope

This report was prepared for Auckland Council (**AC**) to analyse the impacts on flood hazard of the proposed Sunfield master planned community development (**Sunfield development**) within the Papakura Stream catchment. We have modelled the proposed land use changes and attenuation devices of the Sunfield development, as proposed by Sunfield Developments Limited (**the applicant**). We have not analysed the flood hazard within proposed Sunfield Development.

There are existing flood hazards downstream of the proposed development, including the predicted overtopping of key roads and flooding of private properties. Inundation of 130 habitable floors, and 65 commercial floors is predicted during the future climate 100-year ARI event. The predicted flooding downstream can occur in a variety of rainfall patterns, due to the complex interaction between the flood flows from rural and urban areas.

The purpose of this work is to analyse the potential effects of the proposed development on the predicted downstream flood hazard to improve AC's confidence in the findings of the applicant's modelling report. As the applicant did not provide their model files, we have replicated the proposed attenuation devices from the provided reports and plans.

This study uses AC's latest available model of the Papakura Stream catchment. This model is built in InfoWorks ICM. We updated the ICM model to improve representation around the proposed development, such as adding in open drains based on survey data provided by AC.

Modelling Approach

We modelled 56 scenarios by varied the following and summarised in the table below:

- **Development scenarios**: Post development scenarios, compared to a baseline of the existing development scenario as well as compared a baseline of the maximum probable development.
- **Rainfall events**: We analysed the 2,10 and 100 year ARI events, both with and without climate change. We also analysed spatially varying rainfall, in order to represent conditions when the attenuated flow from the development coincides with flows from upstream rural catchment.
- **Peat soil curve numbers**: We analysed four different curve numbers for peat soils. This comparison was done due to the uncertainty associated with perviousness of the peat soils.

Scenario Categories	Development	Rainfall	Peat CN
Current Development	**E** – Existing development **E+SUN** – Existing development with Sunfield	Rainfall ARI: • 2 Year (No CC) • 10 Year (No CC) • 100 Year (No CC)	Lower Bound (CN 39) Group B Soil (CN 61) Group C Soil (CN 74) Upper Bound (CN 98)
Maximum Probable Development	**M** – Maximum probable development, not including Sunfield.	Rainfall ARI: • 2 Year (2.1°C), • 10 Year (2.1°C)	Lower Bound (CN 39)

Scenario Categories	Development	Rainfall	Peat CN
	M+SUN – Maximum probable development including Sunfield.	• 100 year (3.8°C)	Group B Soil (CN 61) Group C Soil (CN 74) Upper Bound (CN 98)
Spatially Varying Rainfall	**M** – as above **M+SUN** – as above	Spatial Rainfall ARI: • 10 Year (3.8°C) • 100 year (3.8°C)	Lower Bound (CN 39) Group C Soil (CN 74)

Conclusions

- **The applicant did not provide complete technical details** regarding their proposal, limiting the scope of our analysis:
  - The engineering plans that the applicant provided have missing information. We have had to assume some details based on engineering judgement (including dimensions and arrangement of outlet structures).
  - The applicant did not provide their model files, and therefore our analysis is based on the provided 3WSR report and attached engineering plans.
  - The previous peer reviews that are included in the lodged documents did not review the hydraulic models directly.
- **Peat Soils:** Our modelling shows that the impacts of the development on the downstream properties varies depending on the amount of infiltration available within peat soil. With lower CN values (higher infiltration) the upstream catchment flows are lower, but the increase in downstream flood level due to the development is relatively greater. Overall, our results show greater flood level increases immediately downstream of the Sunfield development when considering a lower curve number for peat.
- **Local Flood Hazard Impacts (Within nearby open drains):** Our modelling predicts that the Sunfield development can result in an increased flood level on nearby downstream properties. An increase in flood hazard is predicted immediately downstream of pond 1 in the 2-year ARI event. In the 2-year ARI, peat CN61 scenario our modelling predicts that the flood depth downstream of pond 1 will increase by approximately 100mm on neighbouring properties due to the Sunfield development. This increase in flood hazard is likely in part due to the applicant's proposal to combine the existing overland flow paths into a single discharge location.
- **Downstream Flood Hazard Impacts (Within Papakura Stream main channel):** Our modelling does not predict an increase in flood depth within the Papakura Stream in any of the scenarios modelled. We believe that this is due to the applicant's proposal to divert part of the existing Papakura Stream catchment to the Awakeri basin.
- **Downstream open drains:** The downstream open drains have existing capacity constraints, and hence are sensitive to increased runoff, for example during relatively frequent events (i.e. 2-year ARI). Due to the flat topography of the development site and adjacent downstream properties, the water level in these drains may influence the performance of the applicant's proposed attenuation devices.

Our modelling predicts that in the 100-Year ARI events the downstream flood level causes water to flow back into pond 2.

- **Catchment Diversion**: The applicant's proposal to divert part of the current Papakura Stream catchment into the Pahurehure Inlet via the Awakeri Wetlands plays a key part in limiting the potential impacts on existing flood hazard in the Papakura Stream.

Recommendations

- Regarding the peat soils;
    - The applicant's modelling uses a single curve number of 74 for all pre-development peat soils.
    - The peat soils are known to be highly variable, and subject to seasonal variation.
    - Our modelling shows that the impacts of the development can vary based on the assumed peat CN values.
    - Therefore further consideration of the perviousness of the peat soils is recommended. This could include assessing the likely range of possible CN values for the existing peat ground and incorporate that into their modelling. We consider this critical to determining the sizing of attenuation devices to avoid increasing flows above the pre-development condition.
- Our modelling indicates that the applicant's proposal to combine the existing overland flow paths into one discharge point could increase the flood hazard of properties immediately downstream of pond 1. We recommend that the applicant carries out more detailed hydraulic analysis of the existing conveyance channels downstream of pond. A more in-depth hydraulic analysis of the open drains will give AC greater confidence of the impacts of the applicant's proposal on the flood hazard of the properties downstream of the development.

1 PROJECT BACKGROUND

This report was prepared for Auckland Council (**AC**) to analyse the flood hazard impacts of the proposed Sunfield master planned community development (**Sunfield development**) within the Papakura Stream catchment. The Sunfield development consists of approximately 4,000 residential lots and 56.5 Ha of industrial land. We have analysed the proposed land use changes and attenuation devices of the Sunfield development, as proposed by Sunfield Developments Limited (**the applicant**). AC is working in parallel with GHD to analyse the impacts of the development in the Pahurehure inlet catchment. In the applicant's proposal a ~55 Ha section of the development site is re-routed from discharging to the Papakura Stream, and is routed to the Pahurehure inlet catchment instead. We have worked collaboratively with GHD to ensure that both catchment models are in alignment and capture this proposed change.

This study uses AC's latest available model of the Papakura Stream catchment. This model is built in InfoWorks ICM. The model build is described in Papakura Stream Model Update, Model Build Report (WSP, 2021). This model has previously been updated based on high-level calibration of several historic events. This catchment model was built for AC in order to assist with catchment planning. Previous work has also included the running of historical rain events, analysis of the impacts of developing parts of the catchment, including the Takanini North Future Urban Zone (FUZ). We have also previously analysed the impacts of spatially varying rainfall events within the catchment.

The proposed Sunfield development spans across two catchments. The northern part of the site drains into the Papakura Stream catchment, and the southern part of the catchment drains into the Pahurehure inlet via the Awakeri basins. The Papakura stream catchment is known to have historical flooding issues. Previous modelling by WSP analysed the flood risk in a number of scenarios.

There are significant existing flood hazards downstream of the proposed development, including the predicted overtopping of key roads and flooding of a large number of private properties, including inundation of over 130 habitable floors, and 65 commercial floors during the future climate 100-year ARI event (WSP, December 2024). Additionally, the predicted flooding downstream can occur in a variety of storms types, due to the complex interaction between the flows from rural and urban areas for different events.

The lower parts of the catchment are flat with peat soils. The stream catchment has two distinct sections, with a rural upstream section and urbanized downstream section. The overall catchment and location of the Sunfield development is shown in Figure 1-1.

AC's ICM model was schematised for analysing the potential flooding associated with the stream (i.e. flooding associated with overland flow paths or surcharging stormwater network were not represented in this model). While this model has several limitations, which are detailed in the Model Build Report (WSP, 2021), it is considered suitable to complete this analysis with the updates described in this report.

The purpose of this work is to analyse the potential effects of the proposed development on the predicted downstream flood hazard to improve AC's confidence in the findings of the applicant's modelling report. As the applicant did not provide their model files, we have replicated the key proposed attenuation devices from the provided reports and plans.

The ICM model was updated to allow for the assessment of the Sunfield development. These updates consisted of refining the catchment boundaries around the Sunfield site and adding surveyed farm drains around the proposed Sunfield development site.

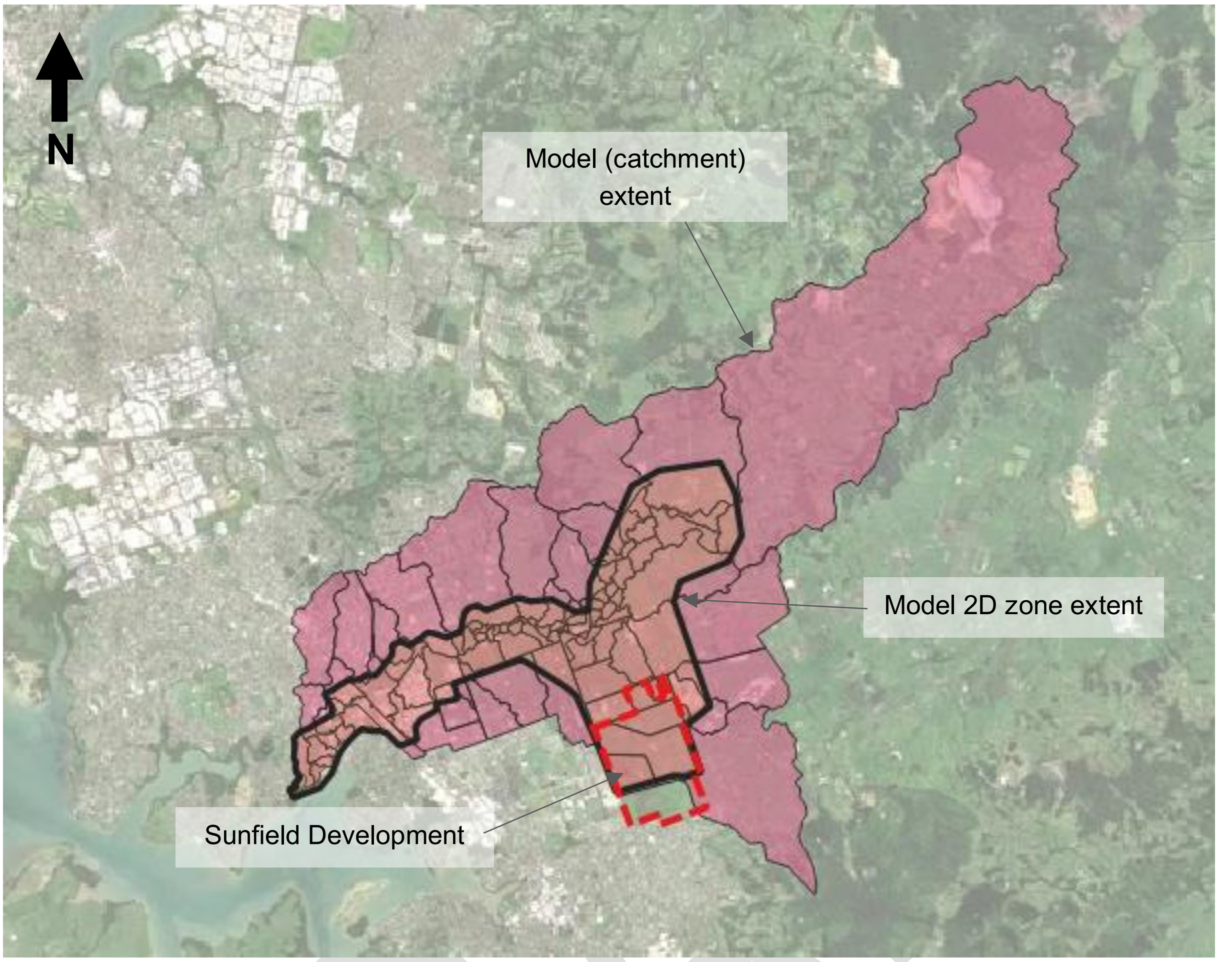


Figure 1-1: Overview of the Papakura Stream hydraulic model, showing location of Sunfield Development.

1.1 PROVIDED DATA

The following files were provided to WSP to carry out this analysis:

- Sunfield lodged documents. Provided by Weir Consulting on behalf of Auckland Council 15/04/2025.
- Farm drain survey data (.csv). Provided by Auckland Council on 02/04/2025.
- Tonkin + Taylor HEC-HMS Model for Alfriston / Randwick Rise proposed land use change (May 2025).

2 MODEL UPDATES

We updated the existing ICM model in order to enable appropriate representation of the proposed Sunfield development. Model updates were:

- Base model updates, as discussed in Section 2.1
- Model updates to represent Sunfield, as discussed in Section 2.2
- Model updates to represent other development areas, as discussed in Section 2.3

2.1 BASE MODEL UPDATES

The “base model” represents the existing development and underpins all scenarios; changes to the base model are reflected in each scenario unless a scenario overrides them (e.g. some surveyed open drains within the Sunfield development area are removed in scenarios that include the development).

2.1.1 SUBCATCHMENT DELINEATION

We revised the Papakura Stream subcatchments to match property boundaries as well as with:

- The extents of the proposed Sunfield development. This was done so that the proposed Sunfield land use changes could be readily implemented.
- The extent of the Pahurehure Inlet catchment model (email from Scott Wilkinson (GHD) on 4 April 2025). This was done so that both model boundaries did not have overlaps or gaps.

Figure 2-1 shows the subcatchments that we updated.

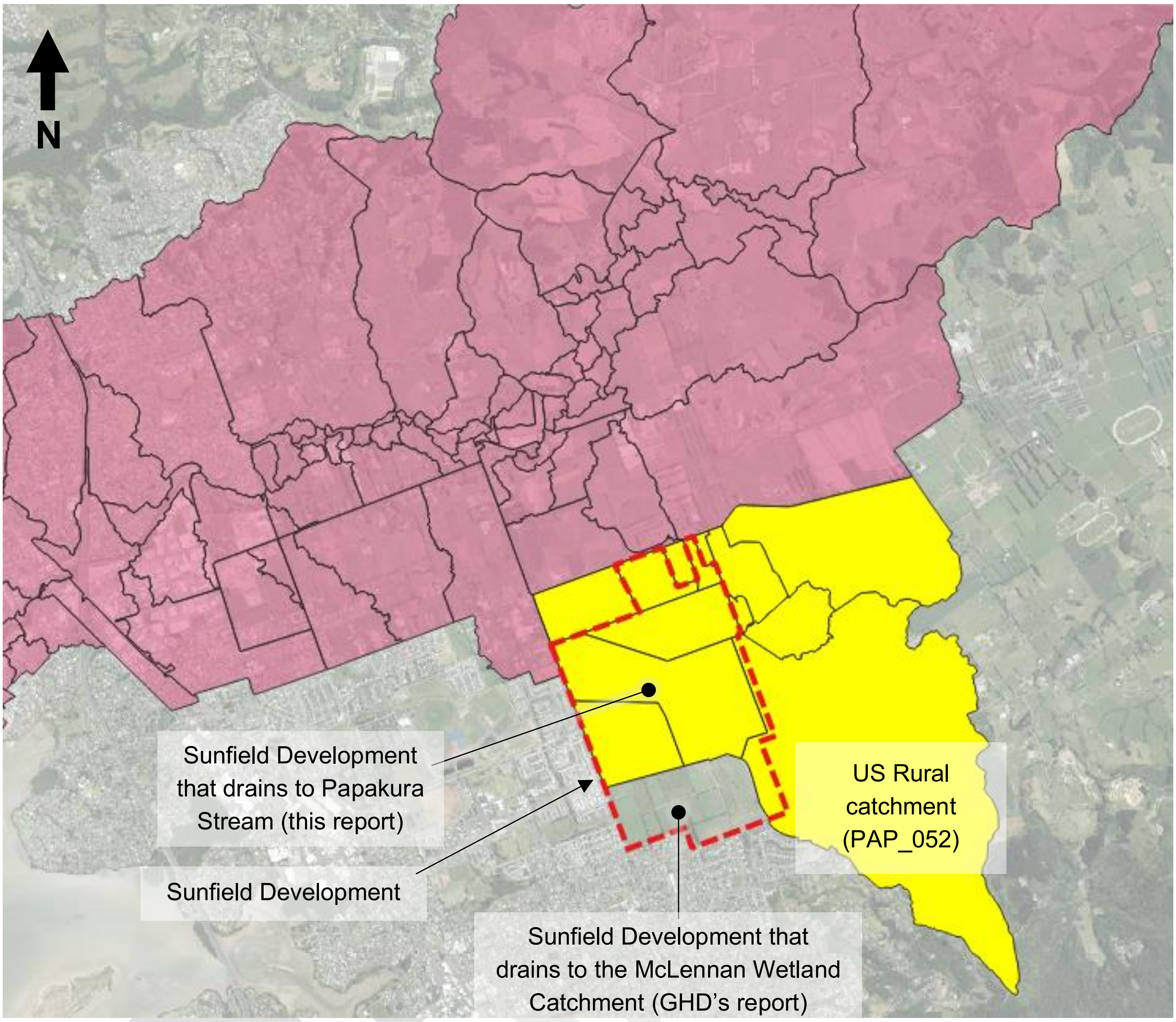


Figure 2-1: Base model subcatchments that were updated shown in yellow.

The following points summarise the subcatchment updates completed as part of this analysis:

- We set the impervious area of the subcatchments using the “Impervious Surfaces 2017” layer, downloaded from Auckland Council’s Open Data portal in April 2025 (AC, 2025).
- We calculated the time of concentration (ToC) using Equation 4.3 from TP108 (ARC, 1999). For this we used:
  - Channelisation factor of 0.8 assumed. For the upstream rural catchment (PAP_052) we assumed a channelisation factor of 1.0, as this catchment has no fewer constructed drains.
  - Catchment length from Council’s overland flow paths.
- Curve number assumed to be 74.
- Slope calculated using the equal area method and the 2016 LiDAR (i.e. the same LiDAR as the overland flow paths).
- All updated subcatchments except one were within the peat soil zone, as shown in Figure 2-2. For these subcatchments, all pervious areas in the existing development scenarios were set to peat.

- For subcatchment PAP_052 (called catchment C in the Sunfield 3WSR), we assumed the impervious area was evenly distributed, so the ratio of the pervious was the same as the soil coverage shown in Figure 2-2. We did not adjust the different soil areas based on the location of impervious surfaces.

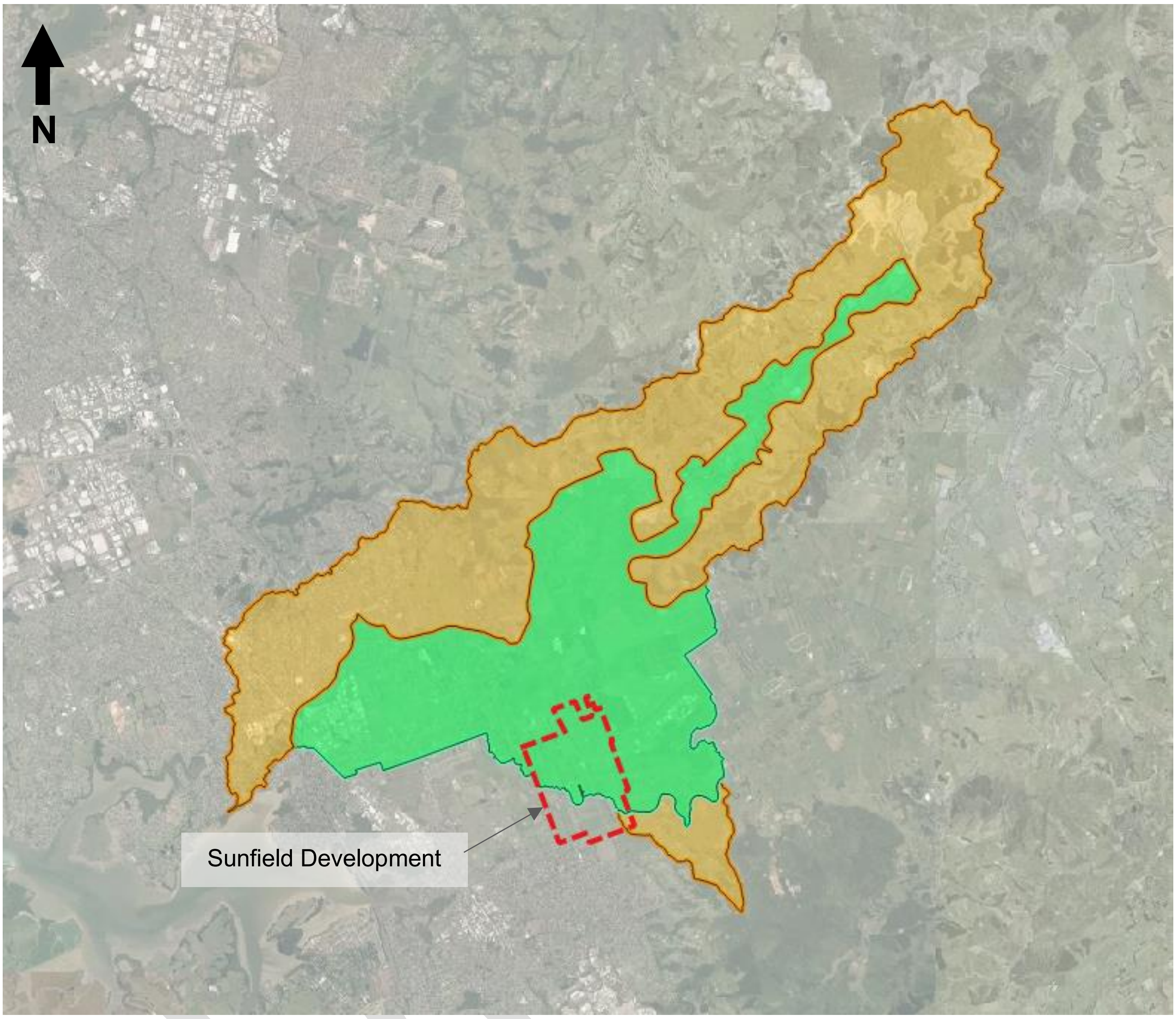


Figure 2-2: Soil types – Peat shown in green, Waitemata Mudstone shown in orange.

2.1.2 OPEN DRAINS

The area surrounding the proposed Sunfield development is flat with seasonally high groundwater. A network of private and roadside table drains provide land drainage. We will refer to these as open drains. Anecdotally these drains have standing water in them during winter, and have limited capacity to convey surface water during extreme events (there is anecdotal evidence of flooding in less than 2 year ARI events).

These open drains were not specifically included in the original Papakura model, but were represented in the ground surface model, albeit at a low level of detail. As the development is proposing discharge into these drains we determined that directed representation of these drains was important for this analysis and that available survey data should be added to the model to improve the accuracy of modelling low ARI events (e.g. 2-year ARI).

We added the open drains based on the survey undertaken by Aurecon in 2012, which was provided by AC on 2 April 2025. This survey also included the culverts along these drains, and we added the culverts relevant to this analysis into the updated model. In total we added 49 culverts and approximately 5.8 km of open drains. Some of the open drains and culverts in the survey data were not downstream of the Sunfield development. We did not add these open drains and culverts, as they were not critical to this analysis. However, they could be added in future analyses if necessary. The extent of the modelled drains modelled is shown in Figure 2-3.

There were some gaps in the survey data, as circled in Figure 2-3. In this area we increased the resolution of the ground model mesh size. This was done to improve the representation of open drains that were only were captured via LiDAR.

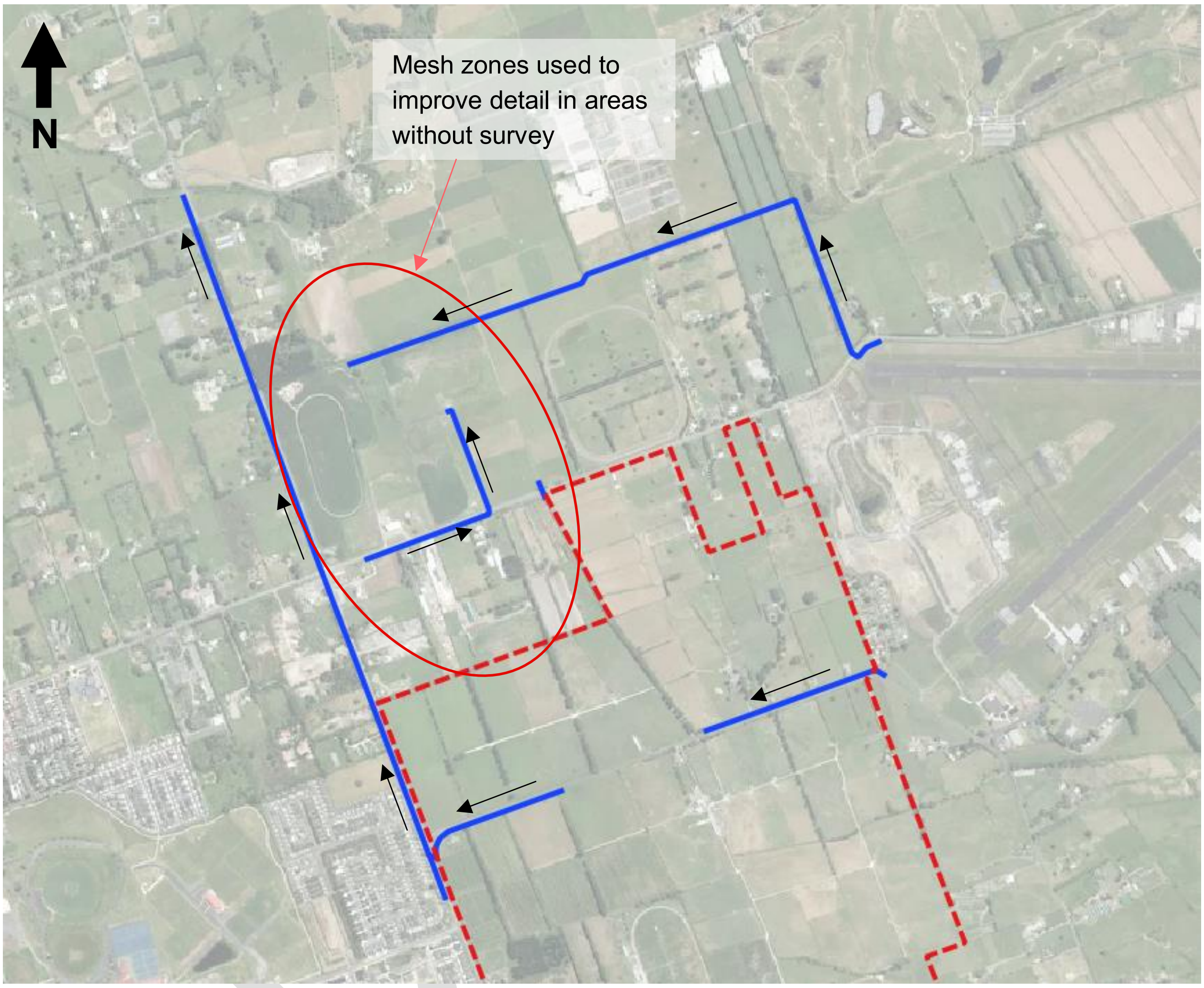


Figure 2-3: Extent of surveyed farm drains and culverts added to model.

We modelled the open drains in 2D by setting the invert to match the surveyed bottom of bank levels and assuming vertical walls. We also set the Mannings roughness coefficient to n=0.05 to reflect the increased drain conveyance resulting from channelising the flow.

Open drains in other areas are represented in the 2016 LiDAR surface, however their representation is limited by the accuracy of the 2016 LiDAR (for example interference from overgrown vegetation on the banks can reduce cross sectional area).

The open drains along Hamlin Road were included only in the scenarios without the Sunfield development, as this area is proposed to be re-developed in the scenarios with the proposed Sunfield development.

2.2 SUNFIELD DEVELOPMENT

As per the applicant's 3WSR, the proposed development consists of approximately 4,000 residential lots, as well as 56.5 Ha of industrial land. We have analysed the proposed Sunfield development within the Papakura Stream catchment based on the applicant's design. We have included representation of the key proposed attenuation devices from the provided reports and plans.

The following lodged files were used in this analysis:

- Infrastructure Report (Maven, 2025a)
  - Engineering drawings from Appendix B of the infrastructure report were used in replicating the proposed stormwater structures.
- Three Waters Strategy Report (Maven, 2025b).

Apart from the diversion channel, no internal flows within the Sunfield Development were modelled.

Pond 1 was modelled in 2D, with culverts and base linear structures representing the weirs. Ponds 2 and 3 were modelled in 1D. These structures are described in more detail below.

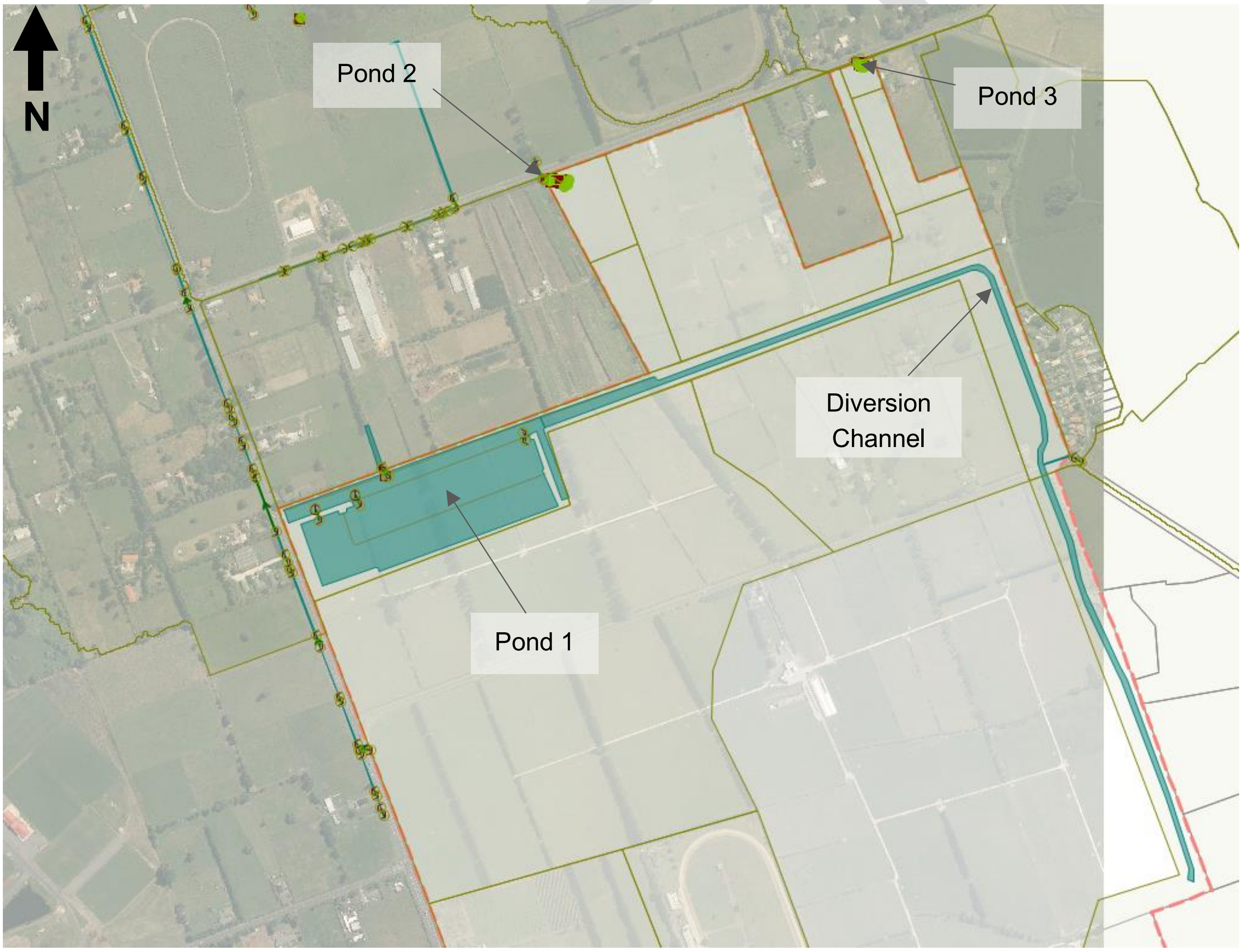


Figure 2-4: Overview of key modelled assets within Sunfield development

Datum Conversion:

The Sunfield drawings were provided in the NZVD2016 vertical datum. As the ICM model is in AUK1946 all vertical values had to be converted. A single offset value of 0.288m was used across the Sunfield development site.

AUK46 = NZVD2016 + 0.288m

Where vertical datums are discussed we have labelled them as either AUK46 for Auckland Vertical datum 1946 or NZVD2016 for NZ Vertical Datum 2016. This single offset value has been sourced from the Land Information New Zealand (LINZ) Auckland 1946 to NZVD2016 Conversion Raster. There is some variation in offset value depending on location, however due to the size of the proposed development a single offset value provides an acceptable level of detail.

2.2.1 PROPOSED MODIFICATION TO CATCHMENT BOUNDARY

The applicant proposes to reroute part of the current Papakura Stream catchment into the Pahurehure inlet via the Awakeri Wetlands, as shown in Figure 2-5.

The 3WSR states that the yellow highlighted area (approx. 55 Ha) currently discharges to the Papakura Stream catchment, and the applicant proposes to modify the topography of the area in order to reroute this area to the Awakeri wetlands.

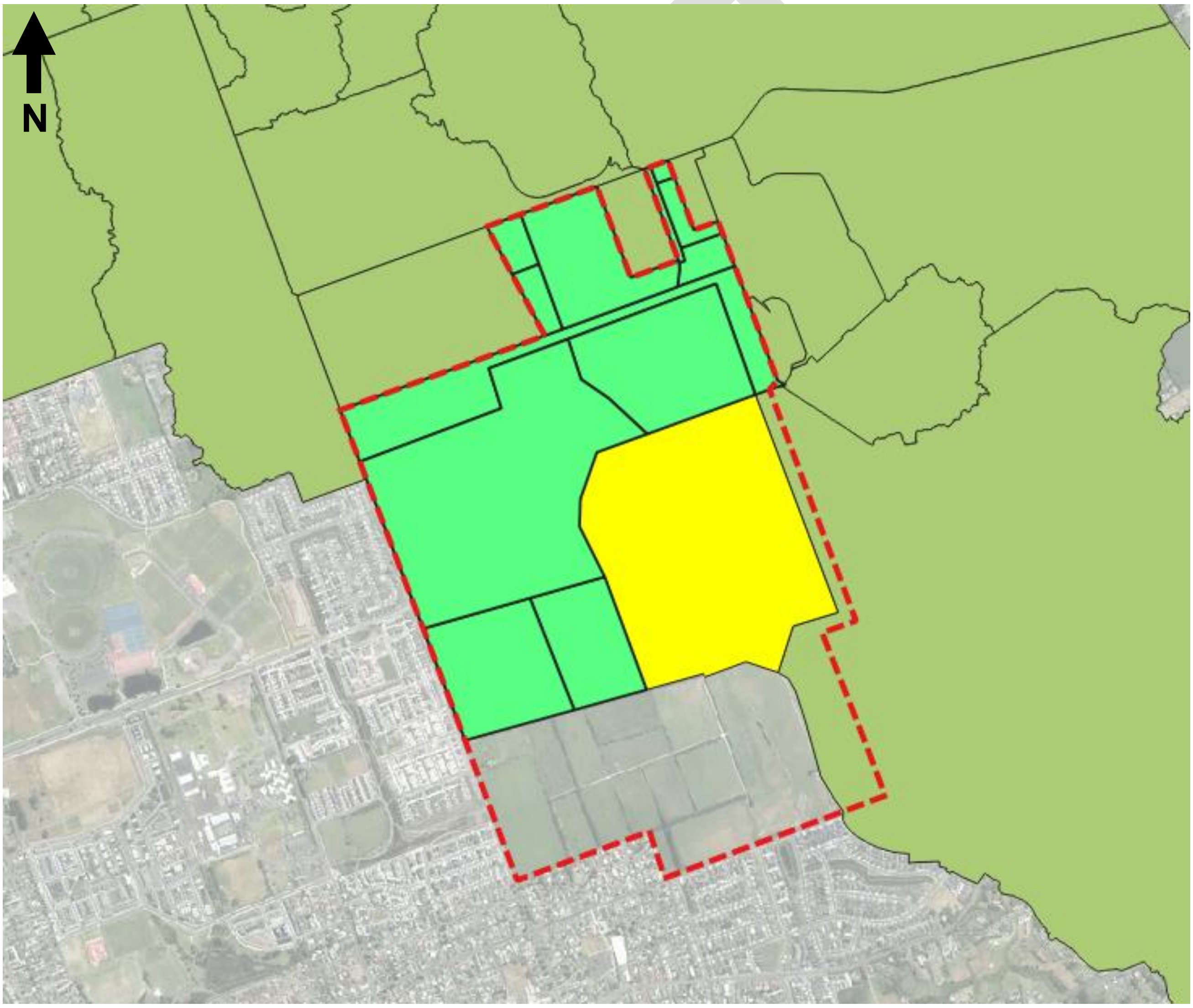


Figure 2-5: Catchment area within Sunfield Development that is diverted to Awakeri wetlands.

2.2.2 DIVERSION CHANNEL

The proposed development includes a diversion channel running around the eastern and northern boundaries of the development, to the proposed Pond 1 discharge point. We understand that the purpose of this channel is to allow connectivity for the upstream rural catchment, while avoiding the need to convey flows through the site

We modelled the diversion channel using invert levels from drawing M-C4511 and created a mesh level zone with vertical walls. We have not analysed the capacity of the channel itself, therefore accurately modelling the side slopes is not considered to be critical.

The downstream end of the channel (where it connects to pond 1) has an invert set to 21.010 (AUK46).

The upstream end of the channel in the ICM model was at chainage 2020m as shown on M-C4511, with an invert level of 30.128 (AUK46).

All intermediate points are interpolated, assuming a constant channel grade.

2.2.3 POND 1

Pond 1 was modelled in 2D, with the extents of each basin traced from the provided drawings.

Pond 1 outfalls pipe:

The applicant’s drawings only shows one outlet pipe, although the label on the drawing lists two inverts. We have therefore assumed that the intent is for two different outlet pipes at this location.

We have assumed a size of DN450 for the pipe downstream of the orifice, as this size is not given on the drawings.
Figure 2-6 shows how we have included these outlet pipes within our model.

Figure 2-6: Pond 1 outfall pipes configuration in model. Orange flagged values are from Sunfield SWMP (with datum conversion). Red flagged values are inferred/assumed.

Pond 1 internal pipes:

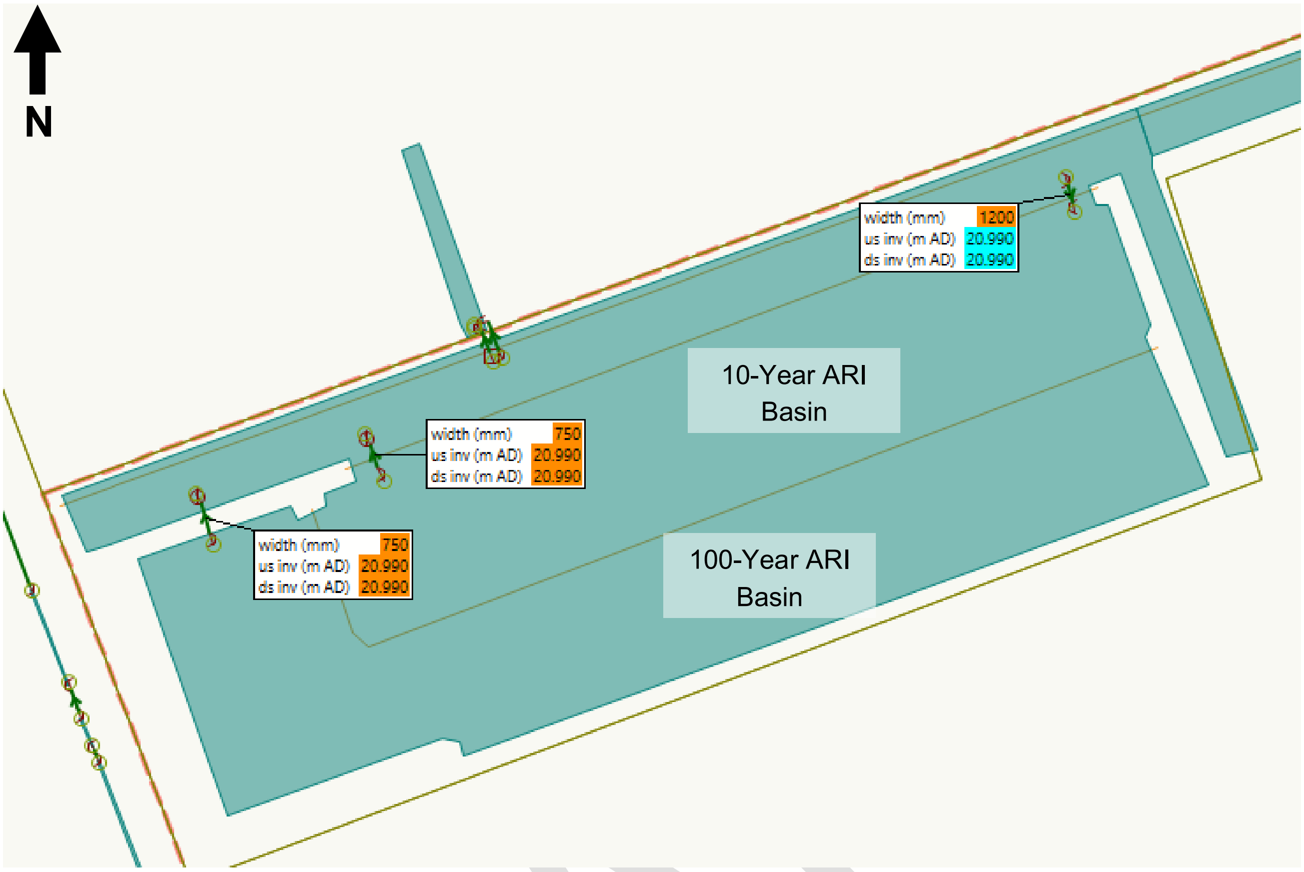


Figure 2-7: Pond 1 internal culverts configuration in model. Orange flagged values are from Sunfield SWMP (with datum conversion). Blue flagged values are based on engineering judgement (i.e. details not provided by applicant).

The two DN750 pipes connecting the 10-year and 100-year ARI basins to the diversion channel were modelled with a flap gate to only allow flows to drain down the basins following a storm event, as per the applicant's plan.

The drawing M-C4602 shows a box culvert connecting the diversion channel to the 10-year ARI basin of pond 1, as shown in Figure 2-8. The drawing does not show the invert of this box culvert, and no further information is provided. We have therefore assumed that this is an open culvert (no flap gates) at the invert level of the pond.

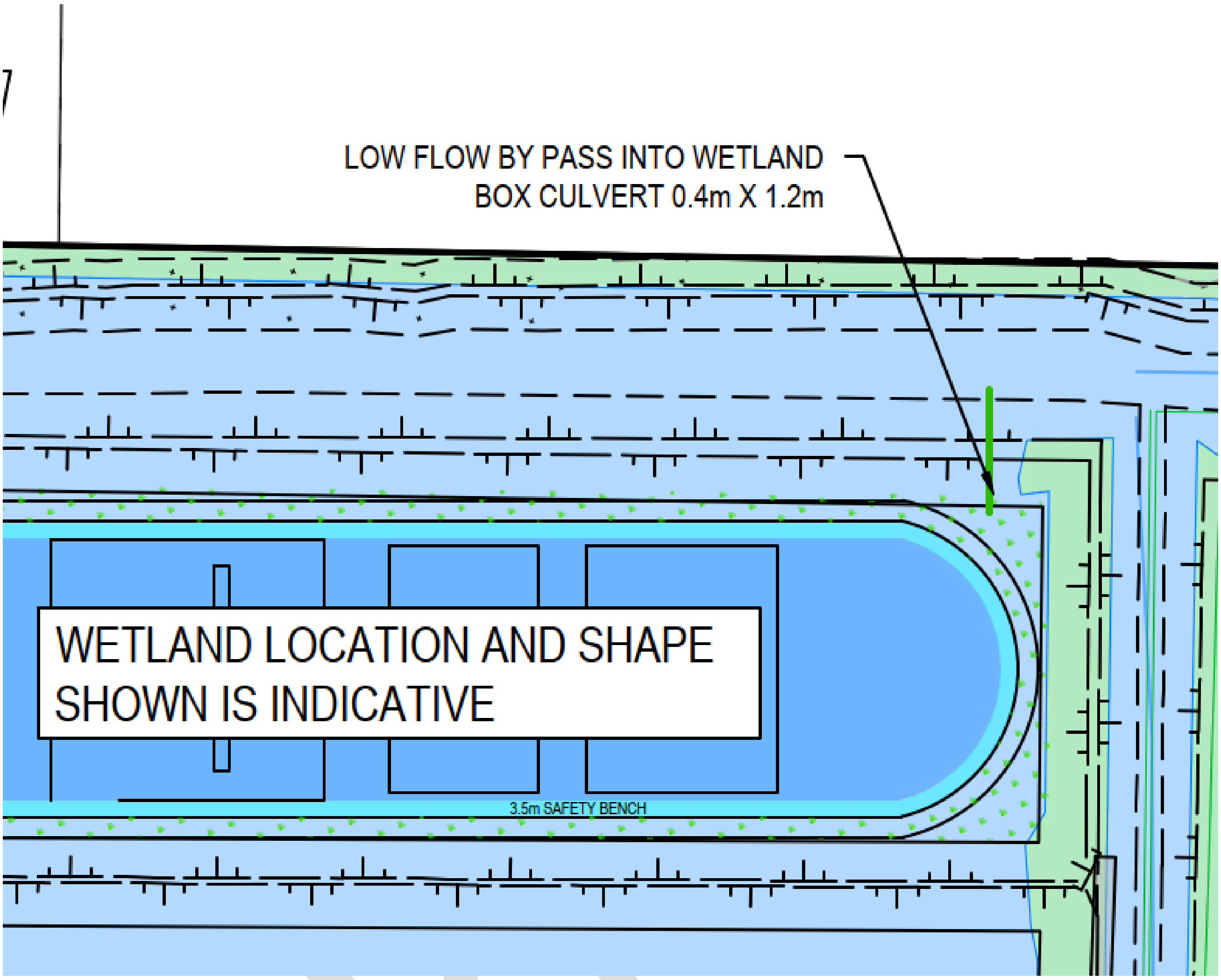


Figure 2-8: Snip from M-C4602, reproduced from applicant's lodged document. Box culvert location shown.

Pond 1 weirs:

There are three weirs within pond 1. The outflow weir allows the pond to discharge out from the site to the North. The 10-year ARI weir connects the diversion channel to the 10-year ARI pond basin, and the 100-year ARI weir connects the 10-year ARI pond basin to the 100-year ARI pond basin. The length and position of the weirs traced from the DWG REF. All three weirs were modelled using base linear 2D structures in ICM. The base linear structures were set as broad crested weirs, with the crest width set to 2m.

The 10-year ARI weir has a constant crest height of 22.808 (AUK46), and a length of 345m.

The 100-year ARI weir has a constant crest height of 22.808 (AUK46), and a length of 345m.

The outflow weir has a varying crest height, as shown in Figure 2-10.

Note a label on M-C4605 drawings states that the 22.47m AD (NZVD2016) section of bund is 20m long, however the geometry length is close to 60m long. This difference results in a significant change in the performance of the bund. We have assumed that the geometry is correct, and that the label is wrong. This is shown as the second section of 22.758m AD (AUK46) weir in Figure 2-10.

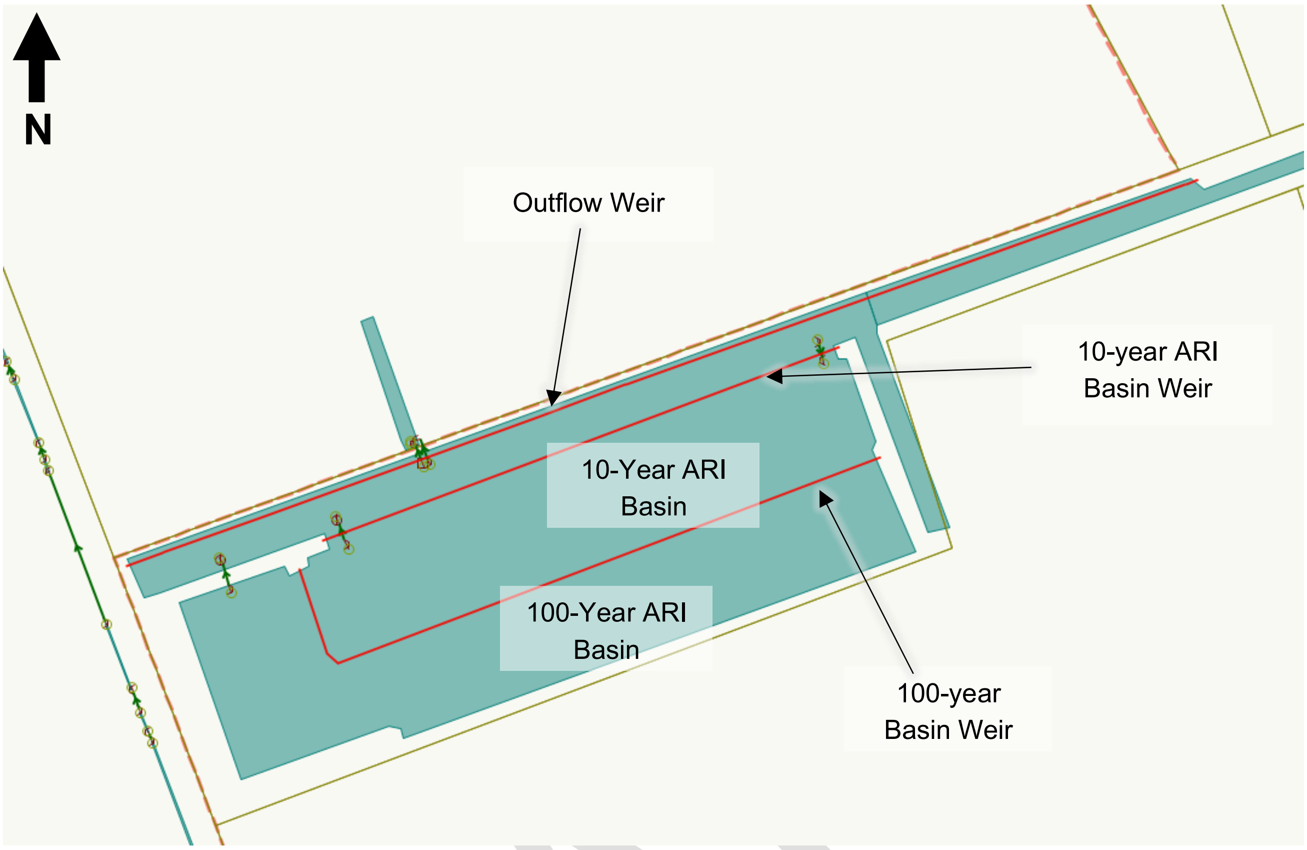
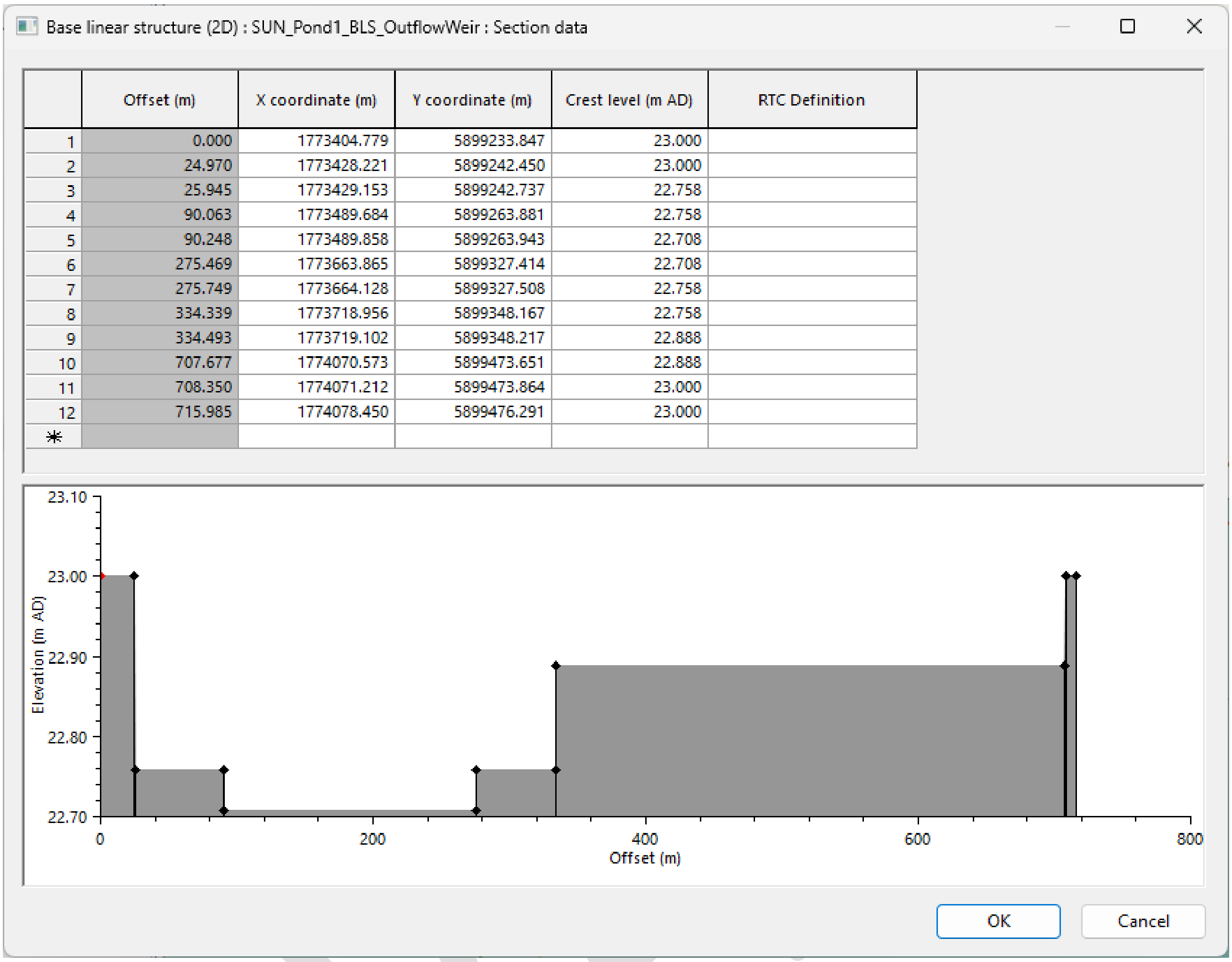


Figure 2-9: Location of weirs within pond 1.



Base linear structure (2D) : SUN_Pond1_BLS_OutflowWeir : Section data

	Offset (m)	X coordinate (m)	Y coordinate (m)	Crest level (m AD)	RTC Definition
1	0.000	1773404.779	5899233.847	23.000	
2	24.970	1773428.221	5899242.450	23.000	
3	25.945	1773429.153	5899242.737	22.758	
4	90.063	1773489.684	5899263.881	22.758	
5	90.248	1773489.858	5899263.943	22.708	
6	275.469	1773663.865	5899327.414	22.708	
7	275.749	1773664.128	5899327.508	22.758	
8	334.339	1773718.956	5899348.167	22.758	
9	334.493	1773719.102	5899348.217	22.888	
10	707.677	1774070.573	5899473.651	22.888	
11	708.350	1774071.212	5899473.864	23.000	
12	715.985	1774078.450	5899476.291	23.000	
*					

Figure 2-10: Pond 1 Outfall weir profile.

2.2.4 POND 2

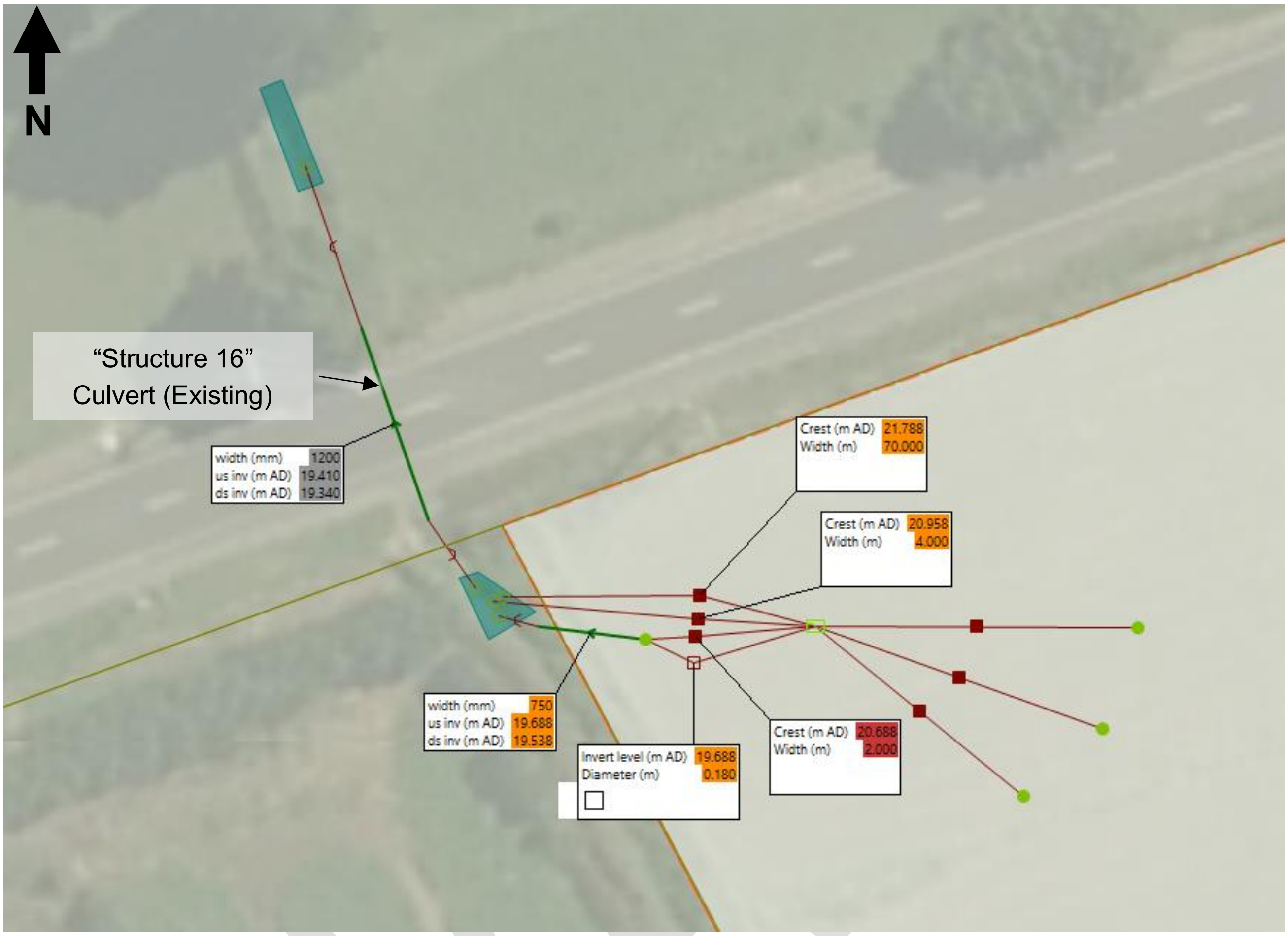


Figure 2-11: Pond 2 configuration in model. Orange flagged values are from Sunfield SWMP (with datum conversion). Red flagged values are inferred/assumed. Grey flagged values are from survey.

The pond 2 base width was digitized from the applicant's engineering plans (M-C4500). We have assumed that the extent shown on the plan is the PWL of the ponds, aka the invert of the pond. We have assumed a 1:4 side slope for this pond.

	Level (m AD)	Area (m2)
1	19.688	10984.60
2	21.788	14829.87
3	23.000	14829.87

Figure 2-12: Pond 2 stage table

The pond 2 lowest outlet is below the model grid level in the surrounding area. We have included the downstream existing culvert (known as the "structure 16" culvert in the provided open drain survey data), which is lower than the pond 2 outfall. However, the open drain in the model downstream of the existing culvert is based only on LiDAR. As the ground surface recorded in the ground model is higher than the pond 2 invert the pond is unable to drain fully after a rain event. Pond 2 does not drain below ~800mm depth (38% of the pond maximum depth). This limitation is unlikely to have a significant impact on the peak flow through the ponds, but it does mean that slightly too much volume will be detained in the model.

2.2.5 POND 3

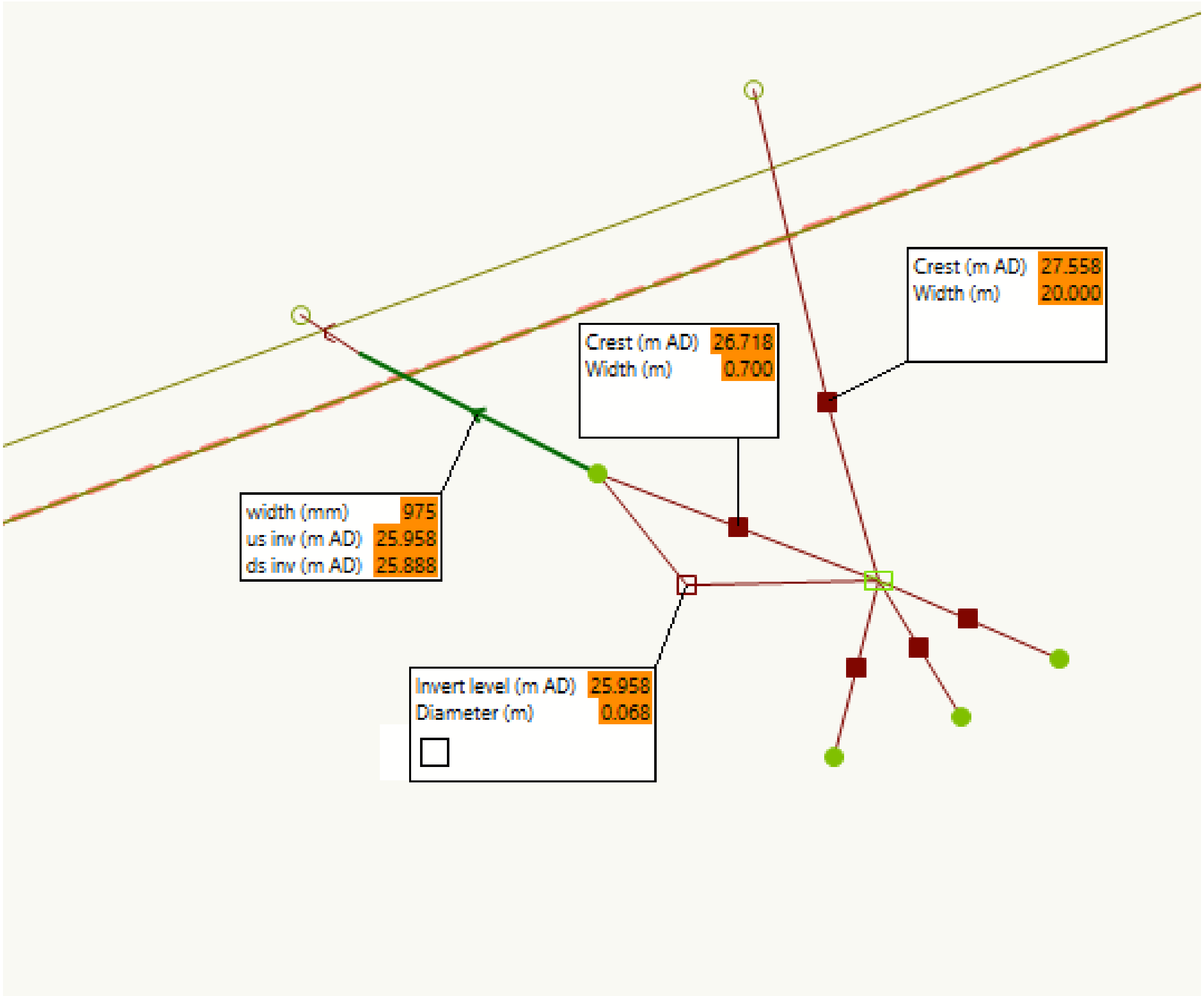


Figure 2-13: Pond 3 configuration in model. Orange flagged values are from Sunfield SWMP (with datum conversion). Red flagged values are inferred/assumed.

The pond 3 base width was digitized from the applicant's engineering plans (M-C4500). We have assumed that the extent shown on the plan is the PWL of the ponds, aka the invert of the pond. We have assumed a 1:4 side slope for this pond.

	Level (m AD)	Area (m2)
1	25.958	1415.70
2	27.558	2535.39
3	28.000	2535.39

Figure 2-14: Pond 3 stage table

The pond 3 lowest outlet is below the model grid level in the surrounding area. As the ground surface is higher than the pond 3 invert the pond is unable to drain fully after a rain event. Pond 3 does not drain below ~550mm depth (34% of the pond maximum depth). This limitation is unlikely to have a significant impact on the peak flow through the ponds, but it does mean that slightly too much volume will be detained in the model.

The applicant's plans shown an existing DN300 culvert under Airfield Road, however no data was available for this culvert so we could not add it to our model.

2.2.6 GENERAL POND ASSUMPTIONS

The following assumptions were applied to all 3 proposed ponds:

- We have used a discharge coefficient of 0.88 on all orifices.
- For the 1d weirs used on ponds 2 and 3, we have assumed a discharge coefficient of 0.85.
- Culvert pipe roughness: CW roughness of 1.5mm used.
- All outfalls from ponds had their 1D-2D linkage basis set to “elevation” in model.

2.2.7 POST DEVELOPMENT GROUND SURFACE

We have assumed there is no flooding within the Sunfield development, and no additional storage apart from ponds 1,2,3 and the diversion channel. This assumes that the internal design and proposed re-grading of land within Sunfield will be designed to convey flows to the detention ponds for all modelled scenarios.

In the model we have prevented any ponding from occurring within Sunfield development by setting all areas of Sunfield site to a nominal elevation of 50m. This was done to prevent any overland flow from outside the site from entering the site. The only location where outside overland flows are allowed into the development area is into the diversion channel along Hamlin Road.

2.2.8 POST DEVELOPMENT LAND USE

We have used a post development impervious areas and percentages as described in the 3WSR. The extents of each land use are shown in Figure 2-15, with the impervious cover shown in Figure 2-16.

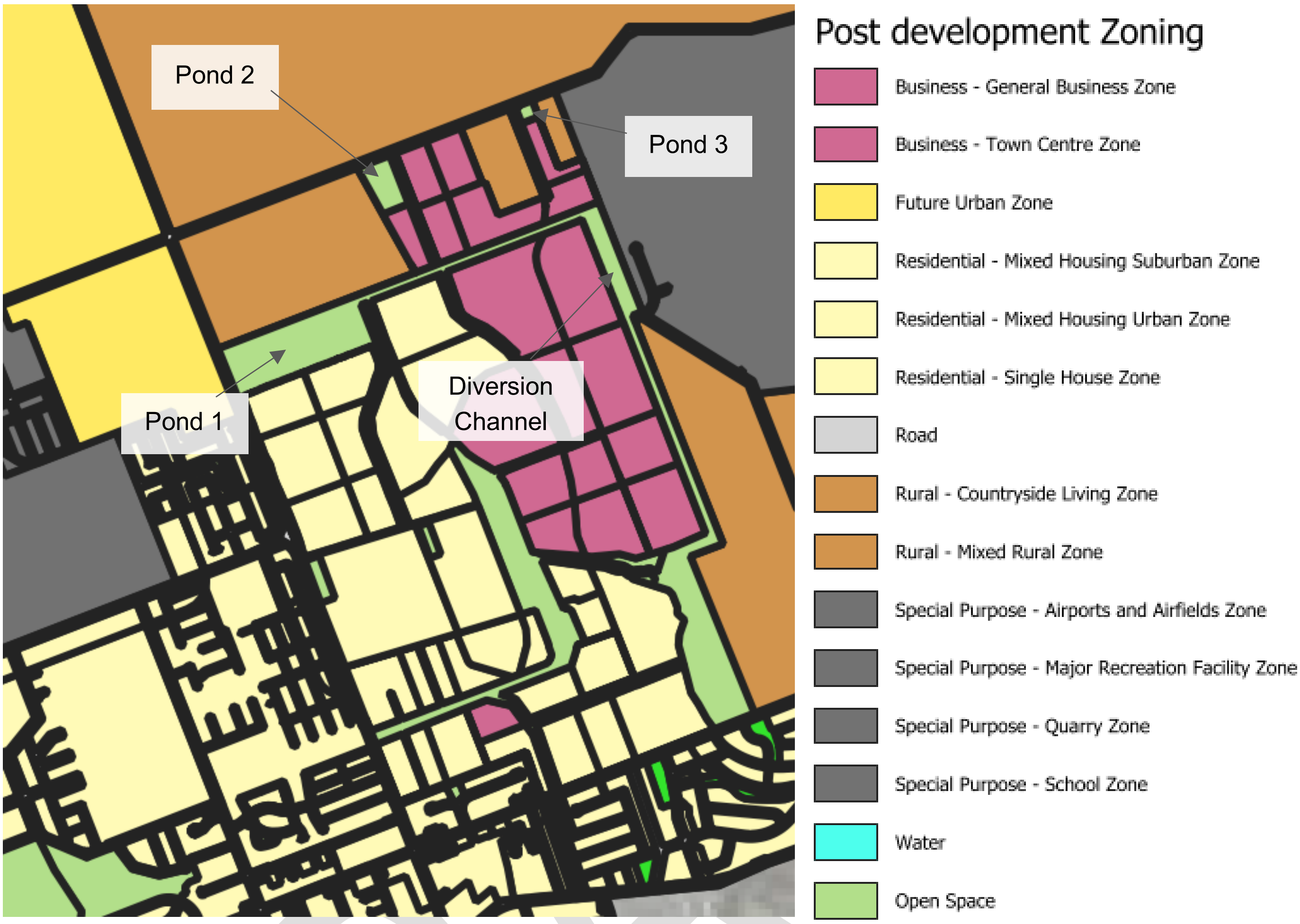


Figure 2-15: Post development proposed land uses reproduced form 3WSR, reproduced from page 225 of the 3WSR.

Zone	Impervious %
Commercial, Town Center	100
Industrial	90
Residential, retirement village	60
Road	85
Open space	10
SW channel (Awakeri Wetlands)	10

Figure 2-16: Post development proposed land uses impervious cover, reproduced from page 108 of the 3WSR.

2.3 MPD BASELINE SCENARIO

We created a maximum probable development (MPD) scenario to represent a potential future state of development incorporating the wider catchment area. Other development areas were included to create a baseline for comparison, rather than to evaluate their individual impacts, so that the effects of the Sunfield development on existing flood haxard could be analysed relative to a plausible future scenario.

The MPD scenario follows the same approach used in previous Papakura Stream modelling, where imperviousness is set to the greater of either the existing imperviousness or that permitted by the Auckland Unitary Plan, with the exception of specific development areas where future urban areas are either consented, the subject of a current application, or planned (i.e. FUZ).

The following specific development areas were identified:

- Sunfield development modelled as per received documents (Section 2.2)
- Alfriston Structure Plan Area (Section 2.3.1)
- Ardmore Airport (Section 2.3.2)
- Future Urban Zone (FUZ) (Section 2.3.3)
  - FUZ between Alfriston and Randwick Rise and Popes Road assumed to not fully develop.
  - FUZ south of Popes Road assumed to fully develop.

Note: This modelling work does not analyse the impacts of these other development, and inclusion in this modelling work does not constitute any implied acceptance of any proposed elements of ongoing plan changes.

Figure 2-17 shows the different areas the MPD assumptions were applied to. Additionally for the Ardmore Airport and FUZ area south of Popes Road we assumed these areas would have detention ponds so that the post-development flow does not exceed the pre-development flow (refer to Section 2.3.4).

Future imperviousness was based on the recommended (rather than upper) values in *Appendix 4: Recommended Impervious Coverage for Auckland Unitary Plan Zones* from the *Stormwater Modelling Specifications (Final Issue 1)* (AC, December 2023).

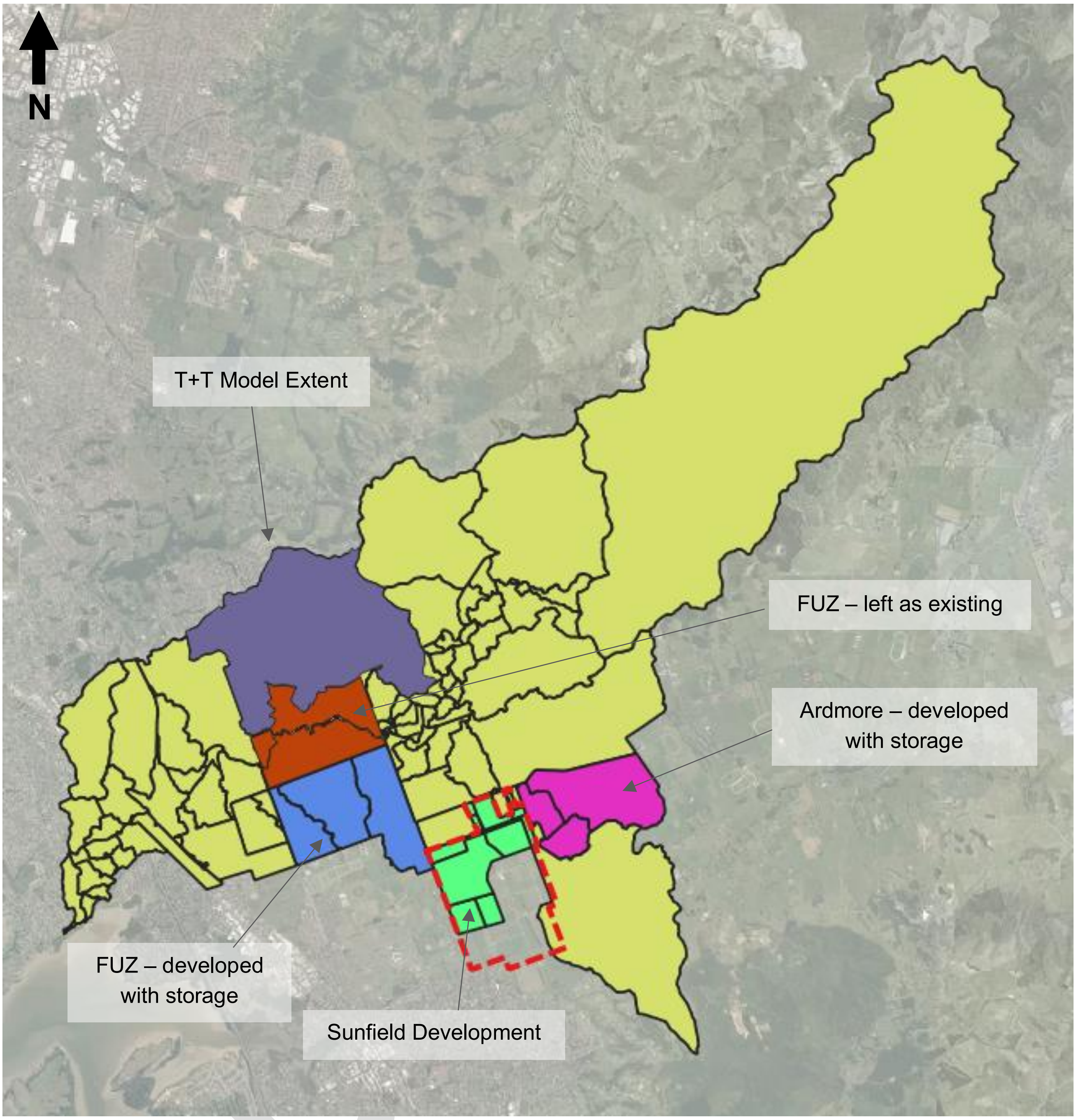


Figure 2-17: Overview of MPD land use changes modelled.

2.3.1 ALFRISTON STRUCTURE PLAN AREA

As part of two private plan changes within the FUZ (as well as some land to the east of Mill Road), a structure plan was submitted to council.

Tonkin + Taylor (T+T) previously developed storage and attenuation for the proposed developments at Alfriston and Randwick Rise. We replaced the subcatchments for this area in our Papakura Stream catchment model with the attenuated outflows from the T+T HEC-HMS model.

It is important to note that the incorporation of this structure plan modelling results is intended to allow for future development based on readily available information. It does not constitute acceptance by Council of the stormwater management strategies presented either the private plan change applications in this area, or the structure plan itself. This modelling work does not analyse the impacts of these other development.

With Councils permission, we re-ran the HEC-HMS model (using software version 4.12) for the same ARI and climate change events that the inflows would be applied to in our model. The scenarios were:

- TP108_2y_2p1_24h_TPD
- TP108_10y_2p1_24h_TPD
- TP108_100y_3p8_24h_TPD

The: “PostDevMinPondsTakaniniManagementAreaA” version of the model was used.

We had to make some minor changes to the T+T HEC-HMS model so that it would run. Elevation-storage tables “Pond1a_TP_Storage” and “Pond12_TP_Storage” had duplicated rows which prevented the model from running. We resolved this by deleting the duplicated rows in the elevation-storage tables as shown by the example in Figure 2-18.

ERROR 41557: Values in elevation-storage table "Pond1a_TP_Storage" are not ascending for reservoir "Pond 1a".
ERROR 41557: Values in elevation-storage table "Pond12_TP_Storage" are not ascending for reservoir "Pond 12".
ERROR 40052: Found "2" errors in basin model "Takanini".
WARNING 15303: Aborted run "TP108_100y_3p8_24h_TPD" at time 25Jun2025, 13:38:21.

HEC-HMS error message

Paired Data | Table | Graph

Elevation (M)	Storage (1000 M3)
18.78	0.0000
21.78	2.6000
30.00	15.0000
30.00	30.0000
30.00	30.0000
30.00	30.0000
30.00	30.0000
30.00	30.0000

Received model

Paired Data | Table | Graph

Elevation (M)	Storage (1000 M3)
18.78	0.0000
21.78	2.6000
30.00	15.0000
30.01	30.0000

Our change (duplicate rows deleted)

Figure 2-18: HEC-HMS error message and elevation-storage tables

Table 2-1 shows our comparison between the rainfall depths in the T+T HEC-HMS model to our values. The rainfall depths are slightly different (at most 6 mm difference for the 2-year event) but match well between the two models.

Table 2-1: Comparison of rainfall depths in the WSP ICM model and T+T HEC-HMS model

Rainfall Event	Rainfall Depth (mm)	
	ICM Model – Rural Profile	T+T HEC-HMS Model
2-year 2.1°C climate change	82	88
10-year 2.1°C climate change	164	166
100-year 3.8°C climate change	293	293

Figure 2-19 shows where we loaded the outflows from the T+T HEC-HMS model into our model.

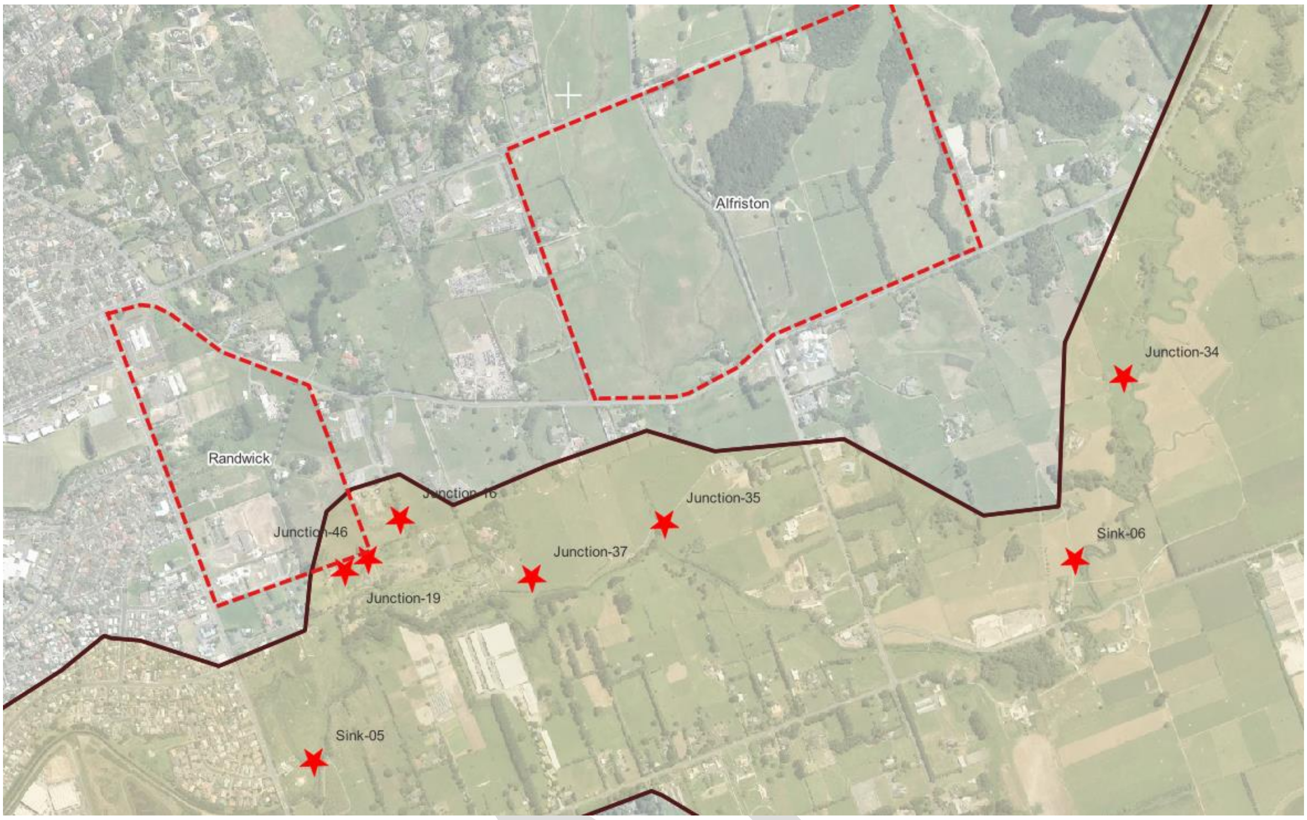


Figure 2-19: Loading points for T+T HEC-HMS model into the ICM model.

2.3.2 ARDMORE AIRPORT DEVELOPMENT

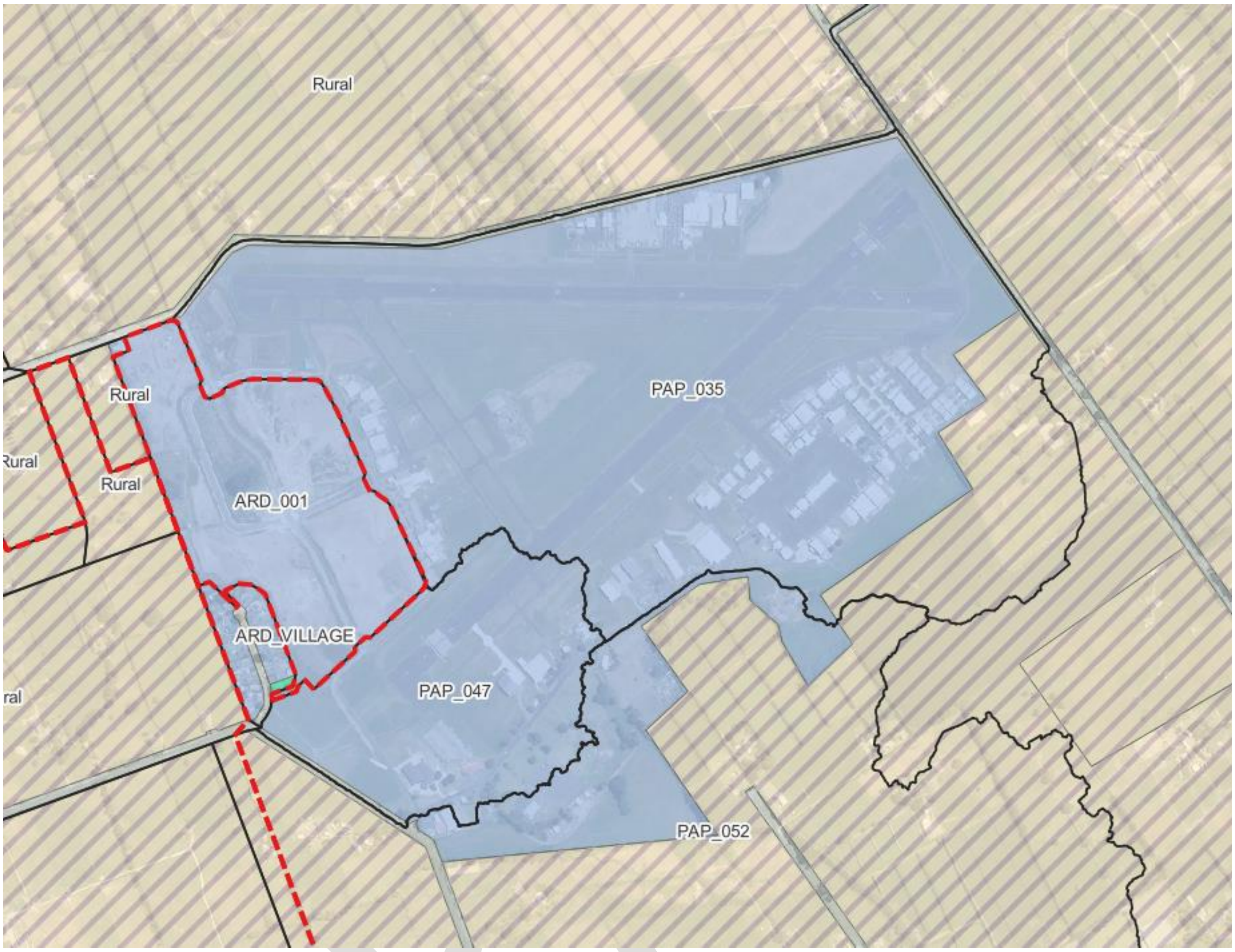


Figure 2-20: Zoning around Ardmore airport. Blue zone indicates Airport zone. Remaining areas are rural mixed zone.

The existing model subcatchments were updated with the airport zoned area set to 80% impervious, and rural areas set to 10% impervious. The affected subcatchments are those intersecting with the blue area shown in Figure 2-20. This resulted in the final impervious percentages shown in Table 2-2.

Table 2-2: MPD percentage impervious for subcatchments around Ardmore airport

Subcatchment	MPD - % Impervious	MPD - % Pervious
ARD_001	80.0	20.0
ARD_VILLAGE	68.0	32.0
PAP_035	70.0	30.0
PAP_047	79.0	21.1
PAP_052	12.8	87.2

2.3.3 FUTURE URBAN ZONE

Some areas between Porchester Road and Mil Road in the Papakura Stream catchment are zoned as Future Urban Zone (FUZ). For this analysis we have assumed that:

- The FUZ area between Alfriston/Randwick Rise and Popes Road will either maintain current impervious coverage or increase to a maximum of 10% as per Rural zoning, as this area is fully within the Papakura Stream floodplain.
- The FUZ area south of Popes Road (Figure 2-21) may feasibly develop to a maximum of 70% impervious.

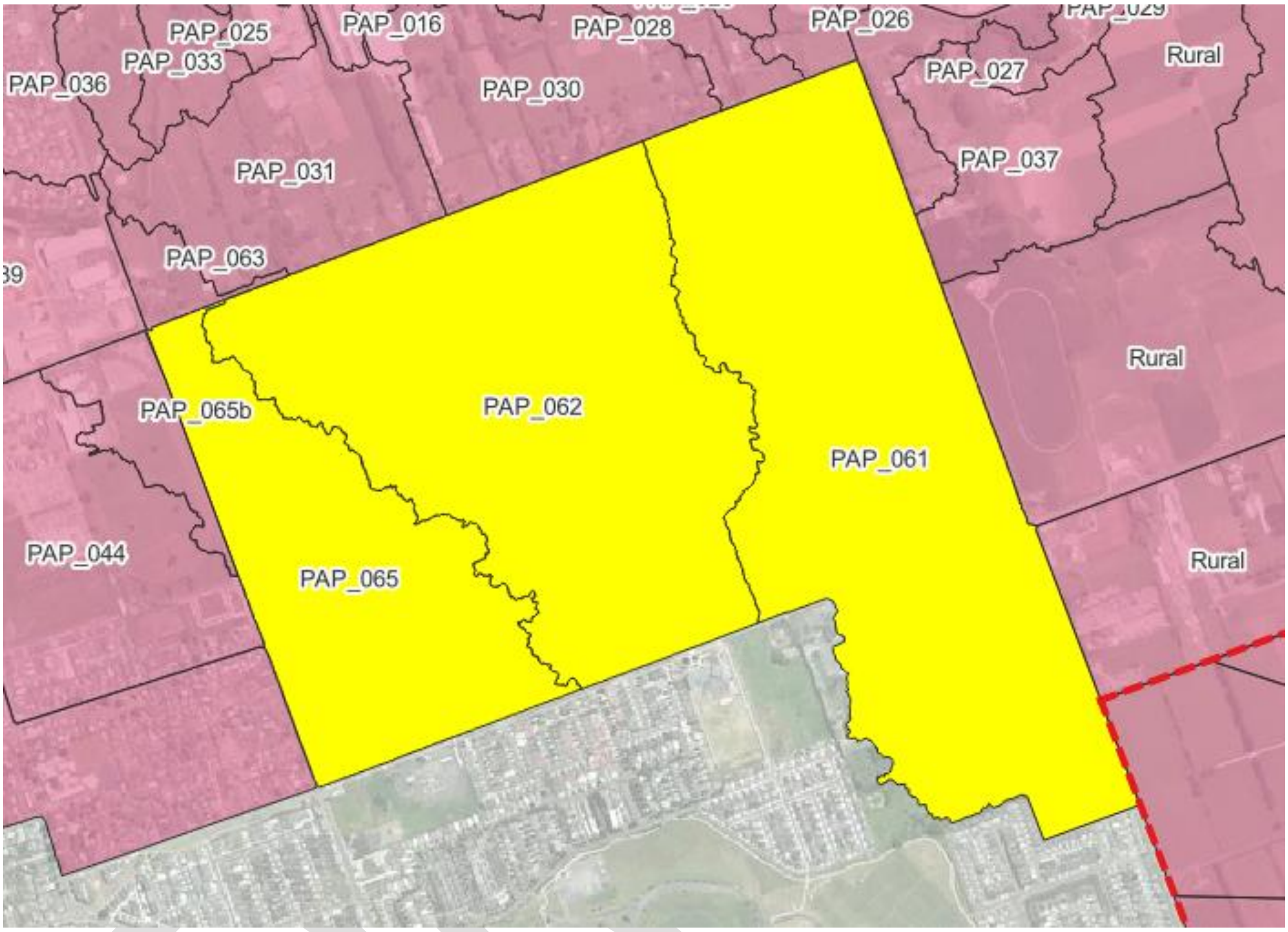


Figure 2-21: Future Urban Zone south of Popes Road in the Papakura Stream catchment model

2.3.4 ARDMORE AND FUZ PONDS SIZING

The three primary sub catchments of Ardmore and the three developed FUZ subcatchments were modelled with indicative ponds to restrict future runoff flows to a pre-development level.

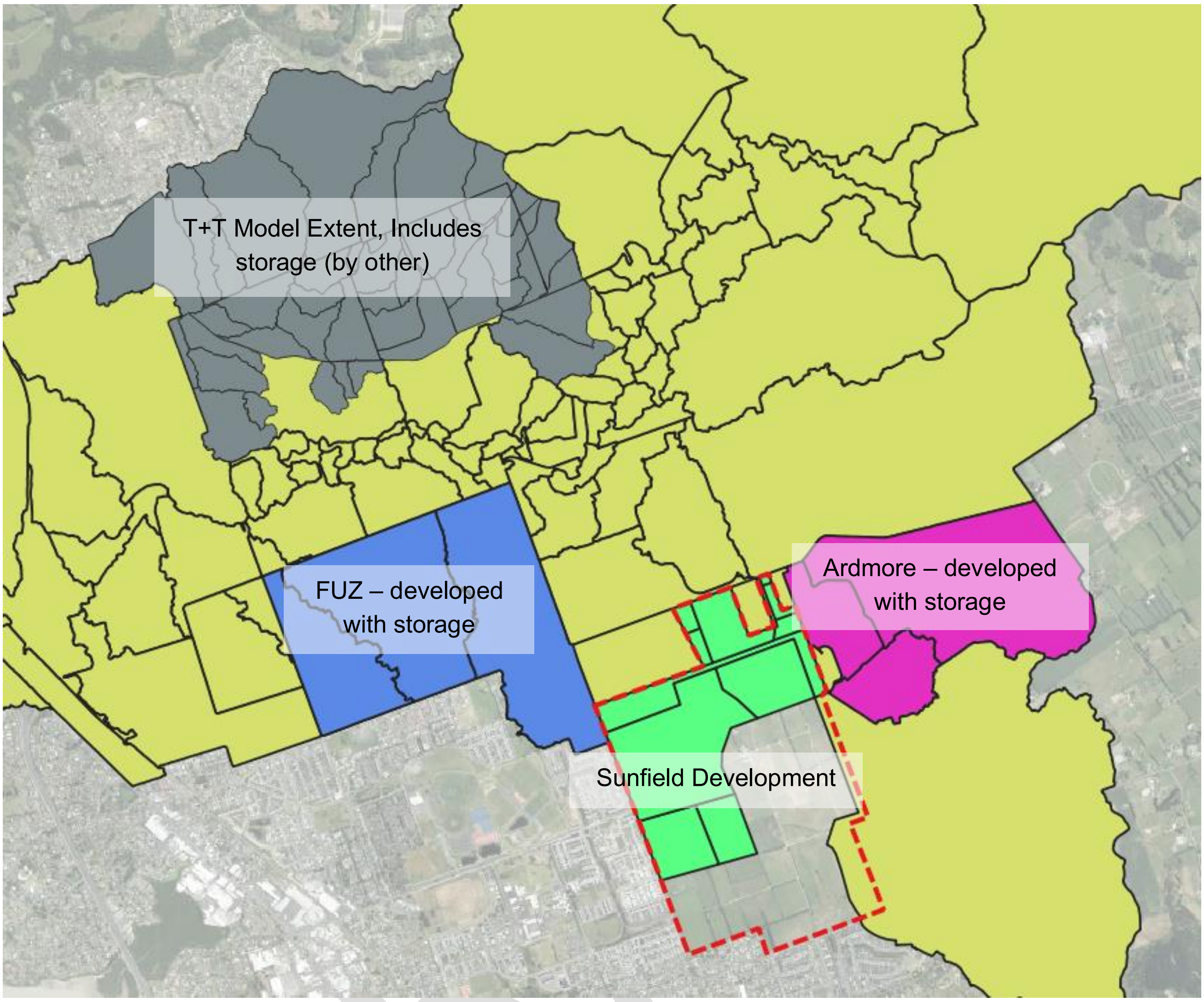


Figure 2-22: Subcatchments that had indicative storage added in the MPD scenario (FUZ and Ardmore).

Pond Sizing Method:

The following points summarise the criteria used to size ponds for the areas indicated in Figure 2-22:

- Size pond such that there is no increase in runoff in 10-year or 100-year ARI with CC TP108 rainfall event. Increase relative to the existing development
- Assumed CN61 for both pre and post development options.
- Only considered 10-year ARI 2.1CC and 100-year ARI 3.8CC (TP108 nested storms only)
- All ponds sized to limit depth to less than 1.5m.
- Ponds assumed to be square with 1:4 side slope.

Ponds were all sized from a standard template, with two orifices. The first at 0.0m elevation and the second at 0.9m elevation. An emergency spill weir was added at 1.5m elevation.

In the 10-year ARI event the lower orifice is sized to limit discharge to the greenfield peak flow, and set a maximum water level between 0.8 and 0.9 m.

In the 100-year ARI event the 2^{nd} orifice is sized to limit discharge to the greenfield peak flow, and set a maximum water level below 1.5m

Ponds were sized using standard WSP pond staged sizing spreadsheet. Used ICM subcatchment hydrographs for as pre and post development flows.

Table 2-3: Indicative pond sizing applied to Ardmore and FUZ in MPD scenario

Location	Subcatchment	Orifice 1 Diameter (m) (at pond invert)	Orifice 2 Diameter (m) (at 0.9m depth)	Bottom Area (m^2)	Top Area (m^2) (At 1.5m elevation)
Admore	ARD_001	1.8	1.8	9,000	10,174
Admore	PAP_035	9	5	30,000	32,114
Admore	PAP_047	1.8	1	7,000	8,040
FUZ	PAP_065	2	2.2	14,000	15,456
FUZ	PAP_062	3.1	4	35,000	37,281
FUZ	PAP_061	2.7	2.7	40,000	42,436

Note these ponds and orifices are sized purely to limit flows. The orifice sizes are not feasible in practice and therefore further work is required to confirm the actual pond sizing required.

Implementation of ponds in MPD scenario:

Ponds set to prevent backwater impact, ponds all set at nominal 50m elevation so downstream water levels do not impact orifices and weirs (i.e. outlet controlled only).

Orifices modelled as screw pumps with specified head discharge curves. This was done to overcome model limitations. The head discharge table copied into ICM model from T-WED 109 Stormwater Routing Model for each pond/orifice configuration.

2.4 DESIGN RAINFALL

Two types of rainfall patterns were used in the analysis of potential changes to downstream flood hazard due to development.

- Homogenous; and
- Spatially Varying

Homogenous rainfall is in line with the current modelling specifications for flood hazard models, and is typically used to analyse maximum flows and hence flood hazard in this catchment.

Spatially varying rainfall scenarios are also included, with the intention of identifying rainfall distributions (which are considered equally likely to occur as a homogenous event) where the proposed development is expected to have a higher relative impact.

These two rainfall approaches are presented in Sections 2.4.1 and 2.4.2.

2.4.1 HOMOGENEOUS RAINFALL

The homogenous rainfall (i.e. rainfall applied uniformly across the catchment) events were applied with two rain zones, as shown in Figure 2-23. This was done since due to the size of the catchment there is some variation in the rainfall depths between the upper and lower reaches.

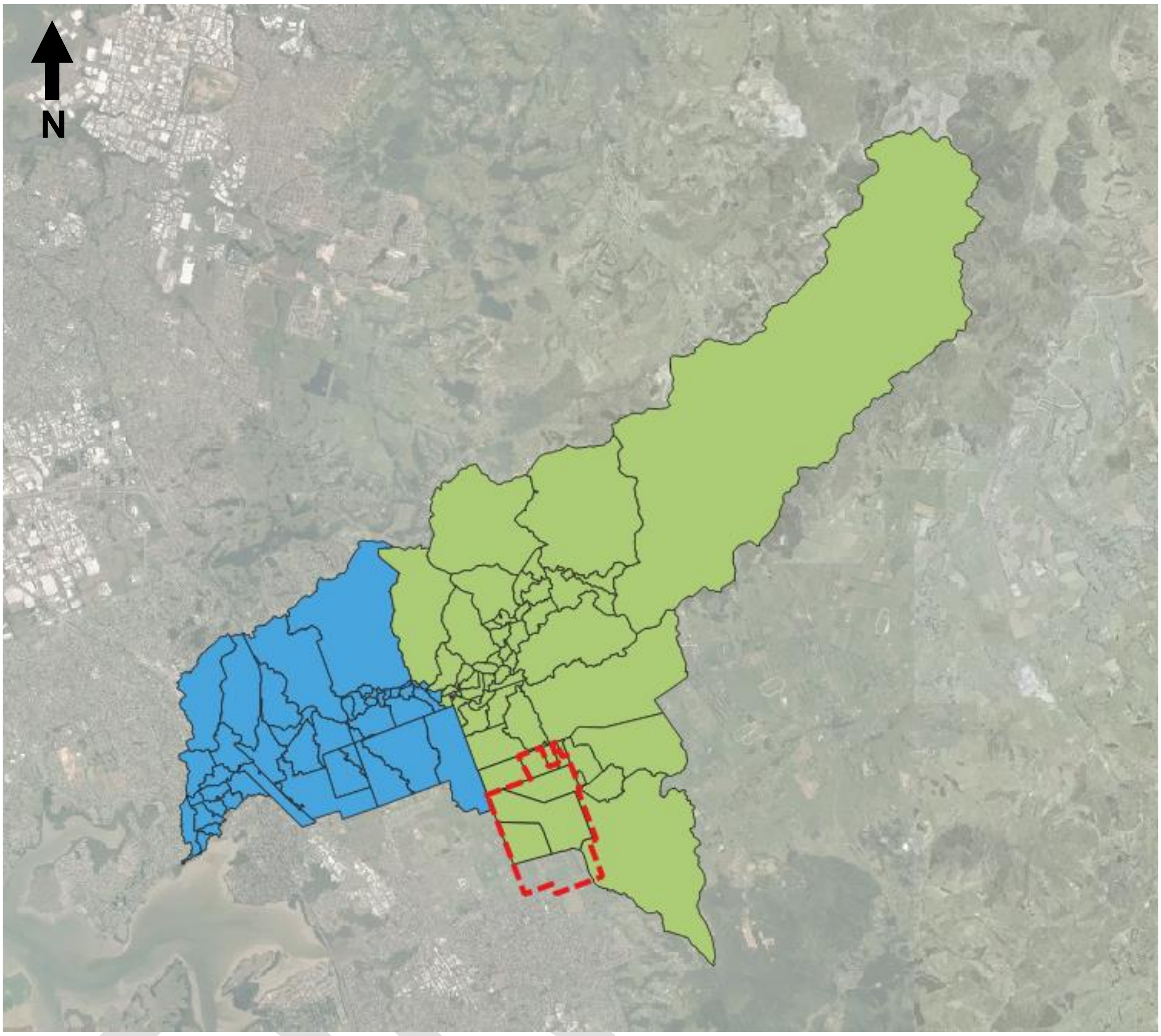


Figure 2-23: Urban vs Rural rainfall profile areas as applied in the Papakura ICM model (Blue = Urban, Green = Rural).

The climate change temperature increases we used were as per Section 4.2.11 of The Auckland Code of Practice for Land Development and Subdivision Chapter 4: Stormwater Version 4.0 (AC, July 2025) (hereafter referred to as the CoP):

- 2.1°C for the 2- and 10-year ARI events
- 3.8°C for the 100-year ARI event.

This corresponds to the percentage increases in rainfall depth shown in Figure 2-24.

Annual exceedance probability (AEP)	Percentage Increase in 24-hour design rainfall depth due to future climate change – 2.1°	Percentage Increase in 24-hour design rainfall depth due to future climate change – 3.8°
50%	15.1%	27.4%
20%	16.4%	29.6%
10%	17.0%	30.8%
5%	17.2%	31.2%
2%	17.6%	31.9%
1%	18.1%	32.7%

Figure 2-24: Percentage increase in TP108 24-hour design rainfall depth (Table 1 from the CoP)

We used the same historic rainfall depths as the previous modelling and adjusted these for climate change. Table 2-4 shows the design rainfall depths used for this analysis.

Table 2-4: Design rainfall depths

ARI	Historic Rainfall Depths		Climate Change Temperature Increase	Climate Change Rainfall Depths	
	Urban	**Rural**		**Urban**	**Rural**
2 Yr	71 mm	71 mm	2.1°C	82 mm	82 mm
10 Yr	135 mm	140 mm	2.1°C	158 mm	164 mm
100 Yr	213 mm	221 mm	3.8°C	282 mm	293 mm

We used the TP108 normalised 24-hour temporal rainfall intensity profile from Table 2 of the CoP, reproduced in Table 2-5.

Table 2-5: TP108 Normalised 24-hour temporal rainfall intensity profile (Reproduced from CoP v4 table 2)

Time (hrs:mins)	Time Interval (min)	TP108 Normalised Rainfall Intensity (I/I24)		
		Historic Climate	**Future Climate change – 2.1°C**	**Future Climate change – 3.8°C**
0:00 – 6:00	360	0.34	0.29	0.27
6:00 – 9:00	180	0.74	0.69	0.66
9:00 – 10:00	60	0.96	0.89	0.85
10:00 – 11:00	60	1.40	1.40	1.40
11:00 – 11:30	30	2.20	2.30	2.36
11:30 – 11:40	10	3.80	4.14	4.35
11:40 – 11:50	10	4.80	5.23	5.50
11:50 – 12:00	10	8.70	9.49	9.97
12:00 – 12:10	10	16.20	17.66	18.56
12:10 – 12:20	10	5.90	6.43	6.76
12:20 – 12:30	10	4.20	4.58	4.81
12:30 – 13:00	30	2.90	3.08	3.20
13:00 – 14:00	60	1.70	1.75	1.77

Time (hrs:mins)	Time Interval (min)	TP108 Normalised Rainfall Intensity (I/I24)		
		Historic Climate	**Future Climate change – 2.1°C**	**Future Climate change – 3.8°C**
14:00 – 15:00	60	1.20	1.16	1.14
15:00 – 18:00	180	0.75	0.72	0.7
18:00 – 24:00	360	0.40	0.36	0.34

Comparison with rainfall used in Sunfield 3W strategy report:

Sunfield falls within "rural" section of catchment in our model, so comparing the "rural" rainfall depths with the values used in the Sunfield 3WSR:

ARI	Historic Rainfall Depths		Climate Change Rainfall Depths	
	WSP – Rural Profile	**Sunfield 3WSR**	**WSP – Rural Profile**	**Sunfield 3WSR**
2 Yr	71 mm	75 mm	82 mm	86 mm
10 Yr	140 mm	145 mm	164 mm	170 mm
100 Yr	221 mm	225 mm	293 mm	298 mm

The rainfall depths used are all within 5mm, and based on rounding + variance of location selected, these rainfall depths are in alignment, so there we find no issue with the rain depths used in the Sunfield 3WSR.

2.4.2 SPATIALLY VARYING RAINFALL

We considered a variety of spatially varying rainfall events. The rainfall spatially varying rainfall events consists of the full rainfall depth applied in the downstream part of the catchment, with 50% of the event rainfall depth being applied in the upper part of the catchment. The boundary between these two zones was varied, as shown in Figure 2-25.

The intention of this is to analyse potential conditions where the attenuated flow from the development coincides with flows from upstream (specifically areas which will have a similar time of concentration to the attenuated peak flows).

Not all these rainfall options result in useful comparisons for the analysis of the impacts of the Sunfield development. Results are only presented for the spatially varying rainfall where the split is at the Alfriston-Ardmore Rd line shown in Figure 2-25. In this scenario the Sunfield development, as well as the upstream rural catchment flowing through the Sunfield diversion channel, receive 100% of the rainfall depth. The area to the north of Alfriston-Ardmore Rd receives 50% of the rainfall depth. In this scenario peak flow from the rural area is more aligned with the attenuated peak discharge from the basins, which is expected to highlight potential changes in flood hazard due to the Sunfield development.

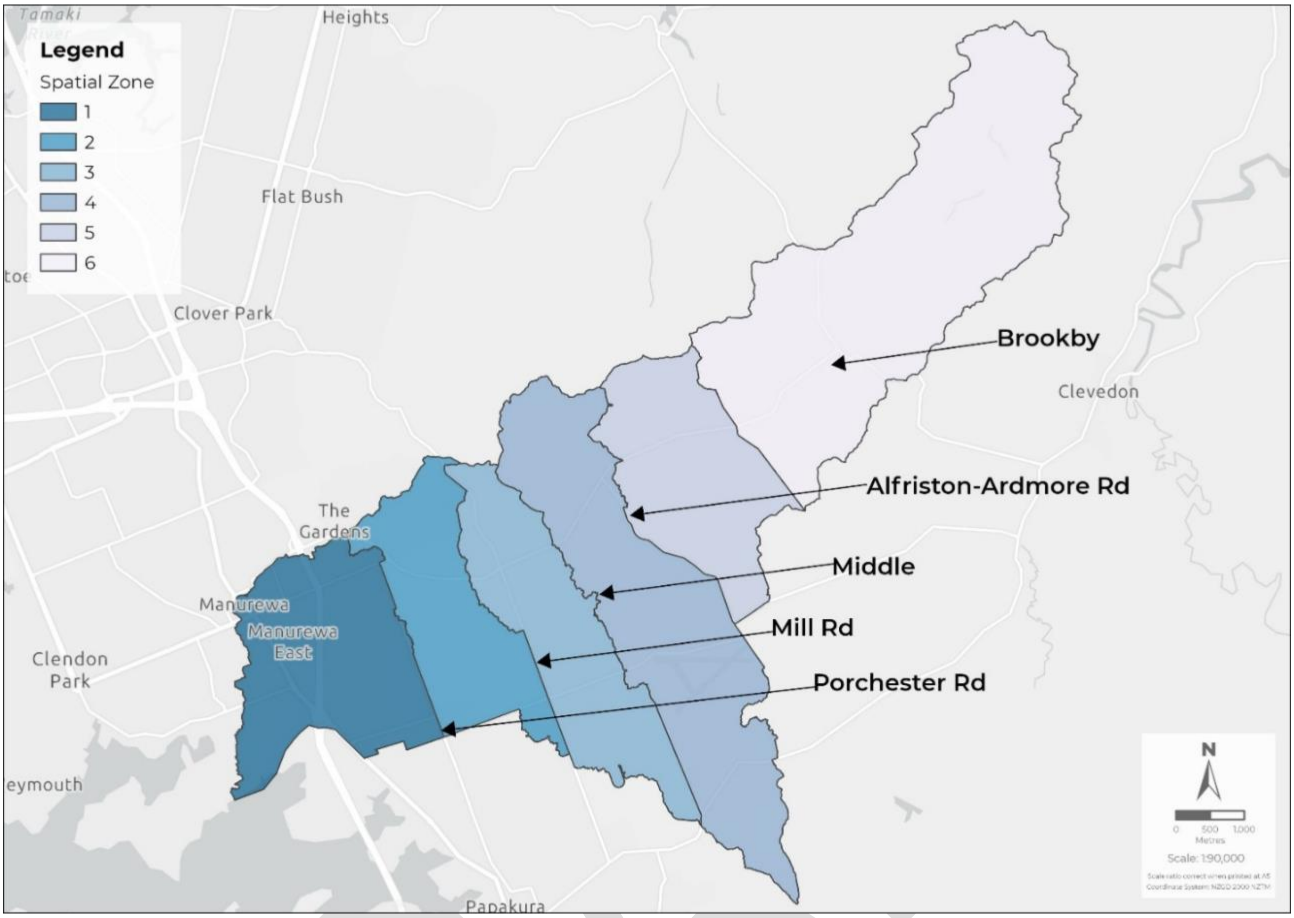


Figure 2-25. Locations where spatial split between 50% and 100% rainfall was considered.

3 MODELLED SCENARIOS

We modelled scenarios based on the combination of three parts: development, ARI, and peat CN. The values for each part are listed in **Error! Reference source not found.**.

Table 3-1: Scenario parts and values

Scenario Categories	Development	Rainfall	Peat CN
Current Development	**E** – Existing development **E+SUN** – Existing development with Sunfield	Rainfall ARI: • 2 Year (No CC) • 10 Year (No CC) • 100 Year (No CC) Homogenous rainfall	Lower Bound (CN 39) Group B Soil (CN 61) Group C Soil (CN 74) Upper Bound (CN 98)
Maximum Probable Development	**M** – Maximum probable development, not including Sunfield. **M+SUN** – Maximum probable development including Sunfield.	Rainfall ARI: • 2 Year (2.1°C), • 10 Year (2.1°C) • 100 year (3.8°C) homogenous rainfall	Lower Bound (CN 39) Group B Soil (CN 61) Group C Soil (CN 74) Upper Bound (CN 98)
Spatially Varying Rainfall	**M** – Maximum probable development, not including Sunfield. **M+SUN** – Maximum probable development including Sunfield.	Spatial Rainfall ARI: • 10 Year (3.8°C) • 100 year (3.8°C) Spatial variation: • 100% rainfall depth to Alfriston-Ardmore Rd	Lower Bound (CN 39) Group C Soil (CN 74)

This gave a total of 56 scenarios, as shown in **Error! Reference source not found.**.

Table 3-2: Total number of scenario runs done.

Scenario Categories	Development	Rainfall	Peat CN	Number of runs
Current Development	2	x3	x4	= 24
Maximum Probable Development	2	x3	x4	= 24
Spatially Varying Rainfall	2	x2	x2	= 8
			Total	= 56

3.1.1 DEVELOPMENT SCENARIOS

Four development scenarios were analysed:

E: Existing development, incudes base model updates (open drains and subcatchment updates). Refer to Section 0 for further details.

E+SUN: Sunfield development with no other proposed development included. Connectivity and attenuation devices reproduced from provided reports and engineering plans. Refer to Section 2.2 for further details.

M: Maximum probable development, not including Sunfield development. Refer to Section 2.3 for further details.

M+SUN: Maximum probable development including Sunfield development. The Sunfield development connectivity and attenuation devices are the same as in the “E+SUN” scenario.

Table 3-3: Changes in options compared to the Existing Development scenario

Scenario	Sunfield	Alfriston and Randwick Rise	Ardmore Development and Assumed Ponds	FUZ South of Popes Road and Assumed Ponds	FUZ North of Popes Road
ED Baseline	✗	✗	✗	✗	✗
ED+SUN	✓	✗	✗	✗	✗
MPD Baseline	✗	✓	✓	✓	✗
MPD+SUN	✓	✓	✓	✓	✗

3.1.2 TIME OF CONCENTRATION

Time of concentration (TOC) is recommended to be amended for very large events (i.e. greater than 1 in 10-year ARI) to represent the faster catchment response associated with larger events. This means for this study the TOC is reduced in the 100-year ARI event.

The ToC for catchments in 100-year ARI events was reduced by 33%. Note this reduction was only applied to the larger catchments in the model. The pre and post development subcatchments within the Sunfield development area did not have their ToC modified from the TP108 value.

3.1.3 PERVIOUS SURFACE CURVE NUMBERS

Based on a previous desktop analysis, there a two main classes of soil types within the Papakura Stream catchment:

- Soils over of Waitemata Group (sandstone / mudstone) geological formation
- Alluvial sediments over large areas of peat. For the purpose of this study, it is assumed that all of the alluvial type soils within the valley floor are over peat.

Waitemata Group:

For simplicity, A CN of 74 is applied to the non-peat areas of the catchment to represent typical antecedent moisture conditions, as per Auckland Councils latest modelling specification (for running design events).

Peat Soils:

While clayey soils associated with the Waitemata group sandstones / mudstones are reasonably typical across much of the Auckland Region, the Peat soils represent a significant source of uncertainty.

Available information on this area, indicates that the infiltration capacity being subject to seasonal variation based on the ground water levels. The following excerpts are provided:

- Auckland Council Technical Report 2013/040 (2013) identifies the Papakura Peat areas as having "Good" soakage potential.
- The Central Papakura Area ICMP (2016) states that "The groundwater level is reported to rise to the surface in winter in parts of the area (to be confirmed by monitoring) causing localised ponding"
- Plan change documents for the nearby Takanini area refer to the PDP report above
  - "Soakage test results indicate some of the highest soakage rates were found within peat areas", but goes on to add "However, sample testing indicated the peat also had low permeability."
  - Section 6.1: "Groundwater is seen to fluctuate throughout the year, with only minor seasonal variation. The reason for the small variance between summer and winter could be due to the anticipated high porosity of the peat (where water level fluctuations are within the peat) and/or low recharge rates, and needs to be further explored. For the most part the entire thickness of peat is saturated with the water table lying close to the upper boundary as stated in the PDP report3"

Due to the uncertainty associated with this soil type, a sensitivity approach was taken, using four different CN values. The CN for "Pasture" for Group B and Group C soils were tested, as well as upper and lower bound values for fully saturated and unsaturated soils. The Group B and Group C CN values taken from Table 3.3 of TP108 were 61 and 74 respectively. We adopted upper and lower bound values of 98 and 39 respectively. This effectively assumes that during wetter months that the water table is at or near the surface resulting in no infiltration in the peat. During the drier months, when the water table is typically lower, the infiltration potential is assumed to be very high. The curve numbers for peat areas are summarised in Table 3-4**Error! Reference source not found.**.

Table 3-4: Peat CN scenarios and corresponding curve number

Peat CN	Curve Number
Lower	39
Group B	61
Group C	74
Upper	98

It is acknowledged that this is a sensitivity-based approach only: it is not intended to be an accurate description of the peat soils seasonal infiltration capacity. Additional information may be sought to decrease this uncertainty including site survey of peat extents, infiltration testing, or review of soil moisture / water table variation.

The Peat soils represent a significant source of uncertainty, with several sources indicating the infiltration capacity being subject to seasonal variation based on the ground water levels. While not a comprehensive hydrological review, this variation appears to be confirmed by the validation / calibration results presented in Appendix A

4 ASSUMPTIONS AND LIMITATIONS

4.1 GENERAL

The following assumptions and limitations relate to all scenarios modelled as part of this analysis:

- The model simulations were run assuming all areas started dry. Consecutive events could result in greater flooding than predicted in this report if the network's storage retains water from previous rainfall.
- The following assumptions are for the open drains and culverts added to the model as part of this analysis (see Section 2.1.2):
  1. Only the open drains and culverts near the Sunfield development were added to the model. Drains and culverts considered to be non-critical for this analysis (primarily due to their distance from the Sunfield site) were not added to the model. This is unlikely to impact the pre/post development flood hazard results.
  2. Culverts were assumed to be in good condition without sediment or blockage. Actual maintenance conditions may differ, potentially reducing flow capacity compared to the model assumptions.
  3. Open drains were modelled in 2D with a rectangular cross section, with the invert set to match surveyed bottom-of-bank levels and with vertical walls.
  4. Due to the number of culverts and their limited influence during more extreme events, the 2D mesh ground levels were not set to match the 1D culvert invert levels; instead, the 2D mesh ground levels were as per the 2D rectangular representation of the open drains. This approach may lead to differences in the head applied to the culvert. The primary objective was to incorporate the culverts for conveyance during more frequent, less intense events (e.g. 2-year ARI). Other culvert assumptions, such as the absence of sediment or blockage, are considered to have a more substantial impact on model results.
  5. No baseflow was added to the open drains in the model. It was assumed that baseflow in these drains is small compared to stormwater runoff. For less frequent, high-intensity rainfall events (10-year ARI or higher), this is likely a reasonable assumption. However, for more frequent, low-intensity rainfall events (e.g. 2-year ARI), the baseflow in the drains may be comparable to stormwater runoff, and this assumption could lead to under-estimation of ponding for these events.
  6. When calculating ToC we have used the TP108 method, and assumed a CN of 74. The ToC is not adjusted based on the different peat CN values.

4.2 SUNFIELD DEVELOPMENT

Infrastructure

1. All proposed assets relating to the Sunfield development were digitised from PDF plans or 3WSR report. The applicant did not provide their model files or proposed ground model. Therefore we had to digitize the location and extents of proposed attenuation devices from the provided PDF plans.
2. Our model is built in the AUK46 vertical datum. We have assumed that the provided engineering plans are in NZVD2016. There is conflicting info shown on the applicant's engineering drawings, with most stating to be in NZVD2016, but some drawings labelled as AUK46. Given the flatness of the site, even the small differences between these datums can significantly affect hydraulic performance.

3. We have not included any storage within the Sunfield development site apart from the ponds and diversion channel.
4. Pond 1 and the diversion channel are modelled with vertical walls. The diversion channel does not include the side slope as we do not have the applicant's proposed ground model.
5. Assumed no overland flow paths through site – notable towards pond 2 and 3 where existing overland flow from rural lots goes through Sunfield site.
6. Pond 1 we have assumed two separate outlets, being the SMAF orifice and Post Storm Drain down pipe.
7. Pond 1 box culvert – The box culvert inlet to the 10-year ARI basin of pond 1. This is a critical structure which controls how the pond will operate, whether it can perform as described and therefore whether the development is feasible from a stormwater perspective. The applicant did not provide details for this structure. We have assumed this is a box culvert at the invert of pond, with no flow controls (i.e. flap gates or similar).
8. Pond 1 weirs modelled as broad crested weirs, with 2m crest width in ICM hydraulic model.
9. Pond 1 outflow weir: Drawn as scaled from drawing M-C4605. A label on the drawings states that the 22.47m AD (NZVD2016) section of bund is 20m long, however the geometry length is close to 60m long. This difference results in a significant change in the performance of the bund. We have assumed that the geometry is correct, and that the label is wrong.
10. Ponds 2 and 3 base areas scaled from applicant's drawings, with an assumed side slope of 1:4.
11. Ponds 2 and 3 lowest outlets are below the model grid level. This means that these ponds are unable to drain fully after the rain event. Pond 2 does not drain below ~800mm, and pond 3 does not drain below ~550mm. This limitation is unlikely to have a significant impact on the peak flow through the ponds, but it does mean that too much volume is being detained.
12. Ponds 5 and 6 areas not developed. The applicant does not include any details for proposed attenuation for these two ponds. Imperviousness for the Ponds 5 and 6 catchment set to match applicants modelling. Although these areas are shown as residential, these have been modelled as open space due to property acquisition issues so set to 10% impervious. See page 118 of the 3WSR. For these areas we are assuming peat soil as undeveloped.

Hydrology

13. A Post development pervious CN of 74 was adopted within the Sunfield development site. This was done regardless of pre-development peat CN used in each scenario to account for the effects of development on flood hazard (i.e. site fill and compaction).
14. We were unable to review the applicant's model. We are therefore unable to fully review all of their proposed hydraulic and hydrological assumptions.
15. We have inferred the extents of the proposed land zoning has from images within the 3WSR report (page 225 of the 3WSR). The image within the 3WSR does not show much detail. We have not included any Commercial, Town Centre or Road zones within our model.
16. We have used the same impervious percentage values given in the 3WSR report for each zone.
17. We have assumed 10% impervious cover in the stormwater diversion channel, which may be a slight underestimate as water surfaces could have a higher runoff.

4.3 MPD SCENARIO

1. We have assumed 10% impervious cover in rural zoned areas (Mixed rural zone).
2. Assumed development of FUZ south of Papakura Stream is only south of Popes Road. The area between T+Ts Randwick/Alfriston HEC-HMS model and Popes Road is not developed. This area is fully within a flood zone, so we have assumed will be unlikely to be developed.
3. The T+T HEC HMS model results for Randwick/Alfriston only cover 24 hrs duration. This captures the peak rainfall (which occurs at 12:00 hrs), however does not fully represent drain down flows post rain event. In practice this is a minor issue we are mainly concerned with the peak depth in stream, and this occurs within the first 24 hrs.
4. We have included indicative storage devices for the MPD growth for Ardmore and the Southern FUZ area. These ponds were sized to restrict post development peak flows to the pre-development rate. These ponds are indicative only, and do not consider site conditions or any potential changes to subcatchment boundaries.
5. Ponds outflow orifices are set using screw pumps in model, with head discharge curves specified based on the orifices.
6. No future sea level rise has been included at downstream boundary of the model. The Sunfield development is elevated above sea level (~20+ m RL) so the impacts of sea level rise are expected to be negligible in the area of interest.

4.4 LEGACY ASSUMPTIONS AND LIMITATIONS

Assumptions and limitations from previous modelling of the Papakura Stream catchment apply to this work. These legacy assumptions and limitations are included in Appendix A.

The most impactful legacy assumptions/limitations are:

1. 2D floodplain element levels are derived from the Auckland Council 2016 LiDAR dataset. Detailed topographic features such as kerb and channel, retaining walls, narrow channels are not expected to be represented in this model. This may result in different flow directions (especially for lower flow) than observed during actual flooding events.
2. The 1D stream channel cross sections are derived from the 2016 LiDAR. The representation of the low flow channel may result in reduced conveyance especially for low flow events, which would normally be contained within the low flow channel.
3. Subcatchment sizes are typically much larger than the range recommended by Auckland Councils' modelling specification. In some cases the peak flows may be sensitive to upstream attenuation, network connectivity etc, particularly for smaller events.
4. This model has been schematised to analyse flooding associated with the Papakura Stream, and has undergone high level calibration to improve the modelled response compared to gauged flow for selected historic events.
5. The runoff surface proportions within each subcatchment were based on the estimated proportion of peat and the impervious and pervious proportion based on current development and the Auckland Unitary Plan.

5 RESULTS

The results for the all modelled scenarios are discussed below. Flood depth and flood depth difference maps for the peat CN61 scenarios modelled are provided in Appendix B.

5.1 CHECK OF UNMITIGATED SUNFIELD DISCHARGE

We tested the impacts of the Sunfield development without any of the proposed attenuation devices. These runs were done to confirm what impacts the development could have if the attenuation devices were not included. These results showed that without mitigation, the Sunfield development will increase peak flow downstream of the development site, with probable negative impacts on downstream properties. This confirms the need for the development to include attenuation of stormwater runoff.

5.2 LOCAL IMPACTS

The local impacts of the Sunfield development are discussed here. The impacts of the Sunfield development in the Papakura Stream are discussed in section 5.3.

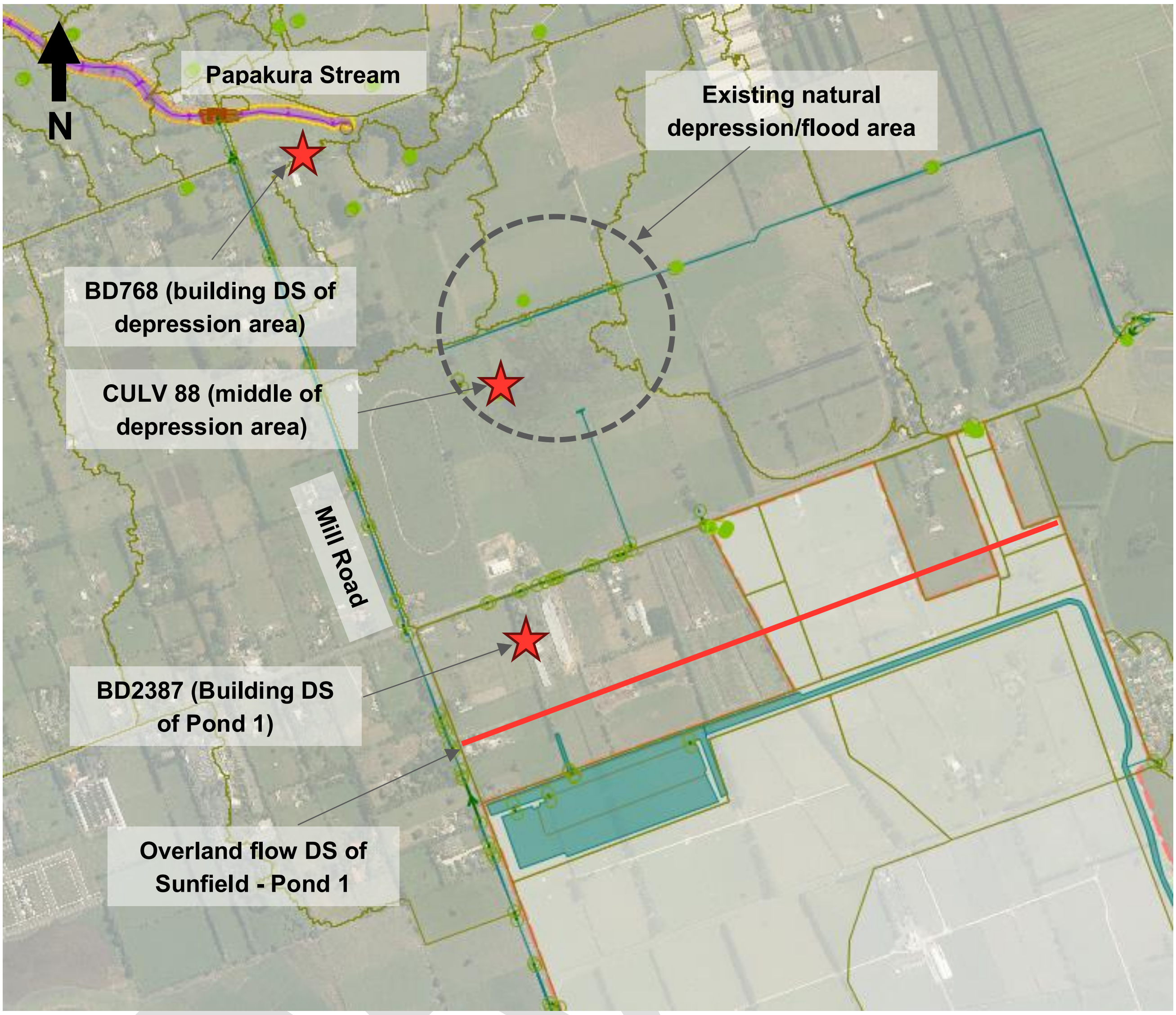


Figure 5-1: 1D Results locations immediately downstream of the Sunfield development site. Stars indicate location with depth results. Red line indicates location with flow results.

5.2.1 EXISTING DEVELOPMENT

Table 5-1 shows the flow results through the “Overland flow DS of Sunfield - Pond 1” line. These results show an increase in flow due to the Sunfield development in the 2 year ARI events, as well as increases in the 10 year and 100 year events when a peat CN of 39 is used.

Table 5-2 shows the depth results at the three locations indicated in Figure 5-1. These results show an increase in predicted peak flood depth at BD2387, which is a building structure immediately downstream of the Sunfield pond 1. The other two results locations do not predict any increase in flood depth in any of the events modelled.

Table 5-1: Existing development flow results (homogeneous rainfall, local impacts)

Event ARI	Peat CN	Overland flow DS of Sunfield - Pond 1		
		ED [m³/s]	ED + SUN [m³/s]	Difference [m³/s]
2	39	3.1	3.5	+0.5
	61	4.0	4.7	+0.7
	74	5.3	5.8	+0.5
	98	11.4	10.4	-1.1
10	39	13.2	14.1	+0.9
	61	17.3	16.3	-1.1
	74	20.5	17.9	-2.6
	98	27.1	25.7	-1.4
100	39	32.6	33.8	+1.1
	61	43.1	39.3	-3.7
	74	49.6	42.6	-7.0
	98	58.9	47.1	-11.8

Table 5-2: Existing development depth results (homogeneous rainfall, local impacts)

Event ARI	Peat CN	BD768 (Building DS of depression area)			CULV 88 (middle of depression area)			BD2387 (Building DS of pond 1)		
		ED [m]	ED + SUN [m]	Difference [m]	ED [m]	ED + SUN [m]	Difference [m]	ED [m]	ED + SUN [m]	Difference [m]
2	39	0.00	0.00	0.00	1.67	1.64	-0.03	0.00	0.08	+0.07
	61	0.00	0.00	0.00	1.82	1.77	-0.05	0.04	0.12	+0.07
	74	0.00	0.00	0.00	1.94	1.88	-0.06	0.10	0.15	+0.05
	98	0.00	0.00	0.00	2.34	2.25	-0.09	0.21	0.24	+0.02
10	39	0.24	0.24	0.00	2.51	2.50	-0.01	0.24	0.29	+0.05
	61	0.34	0.33	-0.02	2.66	2.64	-0.02	0.29	0.31	+0.02
	74	0.42	0.40	-0.02	2.76	2.73	-0.03	0.31	0.33	+0.01
	98	0.56	0.54	-0.03	2.96	2.90	-0.05	0.36	0.38	+0.02
100	39	0.72	0.72	-0.01	3.11	3.10	-0.01	0.40	0.43	+0.04
	61	0.79	0.78	-0.02	3.22	3.19	-0.03	0.45	0.46	+0.01
	74	0.83	0.81	-0.02	3.27	3.24	-0.04	0.48	0.47	+0.00
	98	0.89	0.86	-0.03	3.38	3.33	-0.05	0.52	0.49	-0.02

5.2.2 *MAXIMUM PROBABLE DEVELOPMENT*

Table 5-3 shows the flow results through the “Overland flow DS of Sunfield - Pond 1” line in the homogenous rainfall events. These results show an increase in flow due to the Sunfield development in the 2 year ARI events, as well as increases in the 10 year and 100 year events when a peat CN of 39 is used.

Table 5-4 shows the flows through the “Overland flow DS of Sunfield - Pond 1” line in the spatially varying rainfall events. These results only show an increase in flow during the 10 year ARI event events when a peat CN of 39 is used.

Table 5-5 shows the depth results during the homogeneous rainfall events at the three locations indicated in Figure 5-1. As in the existing development scenario these results show an increase in predicted peak flood depth at BD2387 in the 2 year and 10 year events. BD2387 is a building structure immediately downstream of the Sunfield pond 1. The other two results locations do not predict any increase in flood depth in any of the events modelled.

Table 5-6 shows the depth results during the spatially varying rainfall events. As in Table 5-5 the model predicts and increase in peak flood depth at BD2387 in the 10 year ARI event.

Table 5-3: Maximum probable development flow results (homogeneous rainfall, local impacts)

Event ARI	Peat CN	Overland flow DS of Sunfield - Pond 1		
		MPD [m^3/s]	MPD + SUN [m^3/s]	Difference [m^3/s]
2	39	4.8	6.5	+1.7
	61	6.9	7.9	+1.0
	74	8.8	9.2	+0.3
	98	14.8	13.4	-1.4
10	39	19.4	18.6	-0.8
	61	24.4	22.8	-1.6
	74	28.1	26.9	-1.2
	98	35.1	31.9	-3.2
100	39	60.7	53.2	-7.5
	61	75.1	59.2	-15.9
	74	83.0	62.3	-20.8
	98	92.7	66.0	-26.7

Table 5-4: Maximum probable development flow results (Spatially varying rainfall, local impacts)

Event	Peat CN	Overland flow DS of Sunfield - Pond 1		
		MPD [m^3/s]	MPD + SUN [m^3/s]	Difference [m^3/s]
10	39	25.4	26.3	+1.0
	74	36.4	33.3	-3.1
100	39	63.6	55.0	-8.6
	74	86.5	64.0	-22.5

Table 5-5: Maximum probable development depth results (homogeneous rainfall, local impacts)

Event ARI	Peat CN	BD768 (building DS of depression area)			CULV 88 (middle of depression area)			BD2387 (DS of pond 1)		
		MPD [m]	MPD + SUN [m]	Difference [m]	MPD [m]	MPD + SUN [m]	Difference [m]	MPD [m]	MPD + SUN [m]	Difference [m]
2	39	0.00	0.00	0.00	1.98	1.94	-0.04	0.08	0.16	+0.09
	61	0.00	0.00	0.00	2.10	2.05	-0.05	0.13	0.19	+0.06
	74	0.00	0.00	0.00	2.20	2.14	-0.06	0.17	0.22	+0.05
	98	0.20	0.15	-0.04	2.50	2.42	-0.08	0.26	0.28	+0.02
10	39	0.48	0.47	-0.01	2.81	2.80	-0.01	0.30	0.33	+0.03
	61	0.57	0.55	-0.02	2.92	2.90	-0.02	0.34	0.36	+0.02
	74	0.61	0.59	-0.02	2.98	2.95	-0.03	0.37	0.39	+0.02
	98	0.68	0.66	-0.02	3.11	3.07	-0.04	0.41	0.42	+0.01
100	39	0.98	0.96	-0.02	3.50	3.47	-0.03	0.52	0.52	0.00
	61	1.04	1.01	-0.03	3.58	3.55	-0.04	0.57	0.54	-0.03
	74	1.07	1.04	-0.03	3.63	3.58	-0.04	0.60	0.55	-0.05
	98	1.13	1.09	-0.04	3.72	3.67	-0.04	0.66	0.60	-0.05

Table 5-6: Maximum probable development depth results (Spatially varying rainfall, local impacts)

Event ARI	Peat CN	BD768 (building DS of depression area)			CULV 88 (middle of depression area)			BD2387 (DS of pond 1)		
		MPD [m]	MPD + SUN [m]	Difference [m]	MPD [m]	MPD + SUN [m]	Difference [m]	MPD [m]	MPD + SUN [m]	Difference [m]
10	39	0.33	0.33	0.00	2.72	2.73	+0.01	0.35	0.39	+0.04
	74	0.52	0.50	-0.01	3.00	2.97	-0.03	0.42	0.43	+0.01
100	39	0.76	0.74	-0.02	3.23	3.22	-0.02	0.53	0.52	-0.01
	74	0.90	0.88	-0.02	3.46	3.43	-0.04	0.61	0.56	-0.05

5.3 PAPAKURA STREAM IMPACTS

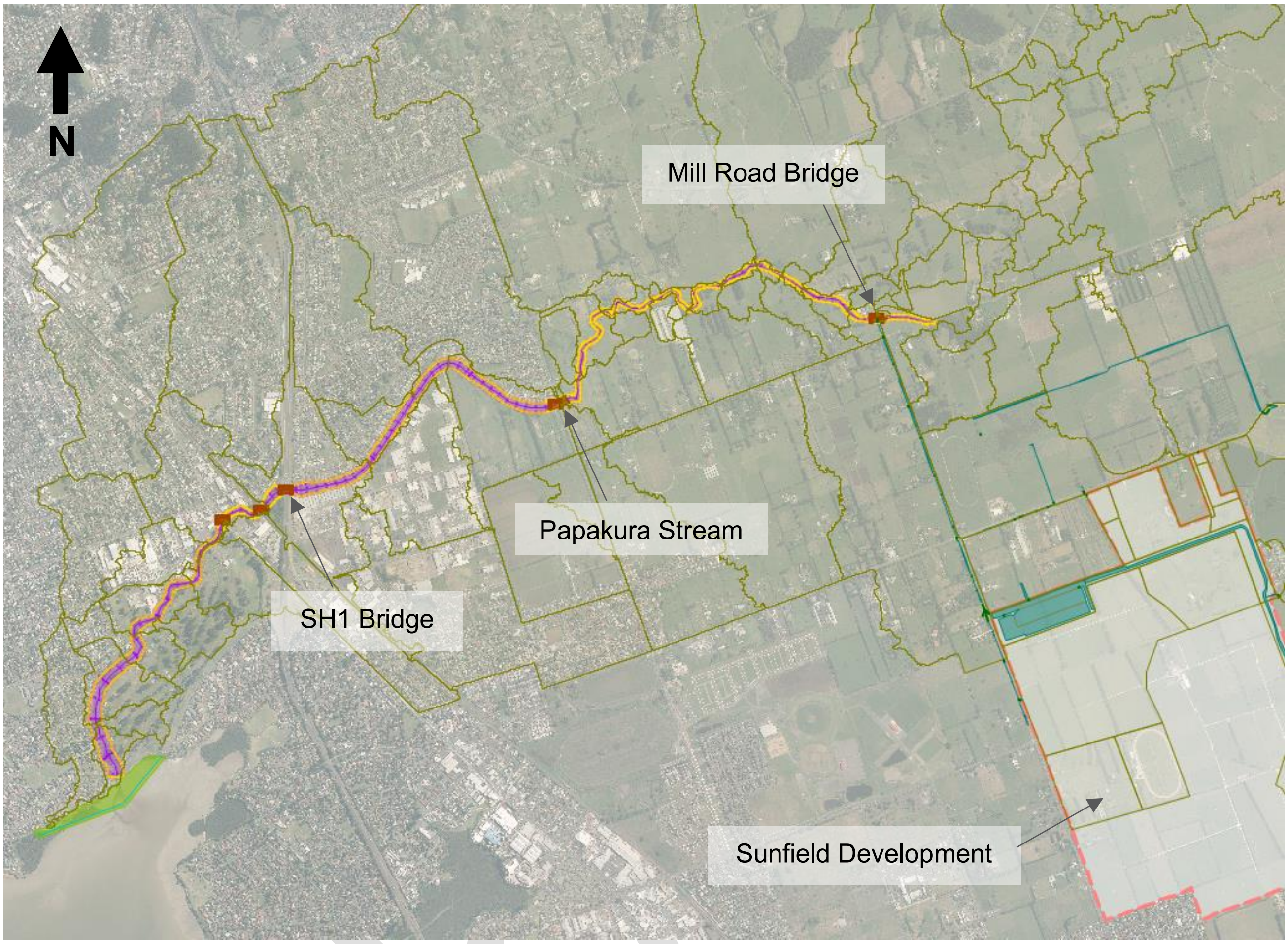


Figure 5-2: 1D Results locations within Papakura Stream.

5.3.1 EXISTING DEVELOPMENT

Table 5-7 shows the flow results in Papakura Stream at Mill Road and SH1. These results show a small increase in flow at Mill Road due to the Sunfield development in the 10-year and 100-year ARI events. The depth results shown in Table 5-8 indicate that although a small increase in flow is predicted, the Sunfield development does not have any impact on the depth in the stream at either location.

Table 5-7: Existing development flow results (homogeneous rainfall, Papakura Stream impacts)

Event ARI	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		ED [m³/s]	ED + SUN [m³/s]	Difference [m³/s]	ED [m³/s]	ED + SUN [m³/s]	Difference [m³/s]
2	39	14.8	14.0	-0.7	12.5	12.3	-0.2
	61	17.3	16.4	-1.0	14.7	14.3	-0.4
	74	19.7	18.6	-1.2	16.8	16.2	-0.6
	98	29.6	27.3	-2.3	23.0	22.3	-0.7
10	39	47.2	46.8	-0.4	27.8	27.9	+0.1
	61	57.2	55.8	-1.4	28.3	28.3	-0.1
	74	64.3	62.3	-2.0	28.2	28.2	0.0
	98	84.4	79.1	-5.3	29.1	29.3	+0.1
100	39	122.7	122.1	-0.6	30.0	30.6	+0.6
	61	148.3	143.8	-4.4	30.3	30.8	+0.4
	74	165.6	158.7	-6.9	30.4	30.7	+0.3
	98	188.8	179.5	-9.2	29.9	30.0	+0.2

Table 5-8: Existing development depth results (homogeneous rainfall, Papakura Stream impacts)

Event ARI	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		ED [m]	ED + SUN [m]	Difference [m]	ED [m]	ED + SUN [m]	Difference [m]
2	39	1.28	1.25	-0.03	2.26	2.23	-0.03
	61	1.37	1.34	-0.03	2.39	2.35	-0.04
	74	1.45	1.41	-0.04	2.51	2.46	-0.05
	98	1.73	1.67	-0.06	2.91	2.83	-0.08
10	39	2.11	2.10	-0.01	3.37	3.36	-0.01
	61	2.30	2.28	-0.02	3.54	3.52	-0.02
	74	2.43	2.39	-0.03	3.64	3.61	-0.03
	98	2.75	2.67	-0.08	3.82	3.79	-0.03
100	39	3.33	3.33	-0.01	4.08	4.07	-0.01
	61	3.69	3.63	-0.06	4.17	4.13	-0.04
	74	3.91	3.82	-0.08	4.19	4.17	-0.02
	98	4.22	4.11	-0.11	4.27	4.23	-0.05

5.3.2 *MAXIMUM PROBABLE DEVELOPMENT*

Table 5-9 shows the flow results in Papakura Stream at Mill Road and SH1 in the homogenous rain events. Table 5-10 shows the flow results in Papakura Stream at Mill Road and SH1 in the spatially varying rainfall events. These results show a small increase in flow at Mill Road due to the Sunfield development in the 10 year and 100 year ARI events.

The depth results shown in Table 5-11 and Table 5-12 indicate that although a small increase in flow is predicted in some scenarios, the Sunfield development does not have any impact on the depth in the stream at either location.

Table 5-9: Maximum probable development flow results (homogeneous rainfall, Papakura Stream impacts)

Event ARI	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		MPD [m³/s]	MPD + SUN [m³/s]	Difference [m³/s]	MPD [m³/s]	MPD + SUN [m³/s]	Difference [m³/s]
2	39	24.3	23.5	-0.8	19.8	19.6	-0.2
	61	27.4	26.1	-1.3	21.8	21.4	-0.4
	74	30.2	28.7	-1.5	23.3	22.8	-0.5
	98	40.9	38.3	-2.7	26.6	26.3	-0.3
10	39	75.9	75.4	-0.4	28.2	28.3	+0.1
	61	89.2	86.5	-2.7	28.9	29.2	+0.3
	74	98.3	94.7	-3.7	29.4	29.6	+0.2
	98	121.4	115.0	-6.3	29.8	29.9	+0.2
100	39	226.3	219.0	-7.3	29.9	30.4	+0.4
	61	248.1	238.2	-9.9	32.5	29.7	-2.8
	74	261.1	250.4	-10.7	35.2	29.1	-6.0
	98	286.3	273.2	-13.1	32.0	29.0	-3.1

Table 5-10: Maximum probable development flow results (Spatially varying rainfall, Papakura Stream impacts)

Event	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		MPD [m³/s]	MPD + SUN [m³/s]	Difference [m³/s]	MPD [m³/s]	MPD + SUN [m³/s]	Difference [m³/s]
10	39	59.1	61.3	+2.2	27.5	27.8	+0.3
	74	83.8	82.7	-1.0	29.2	29.3	+0.2
100	39	160.3	159.3	-1.0	29.6	30.1	+0.5
	74	210.1	204.6	-5.6	29.0	29.3	+0.3

Table 5-11: Maximum probable development depth results (homogeneous rainfall, Papakura Stream impacts)

Event ARI	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		MPD [m]	MPD + SUN [m]	Difference [m]	MPD [m]	MPD + SUN [m]	Difference [m]
2	39	1.59	1.57	-0.02	2.68	2.65	-0.03
	61	1.67	1.64	-0.03	2.79	2.75	-0.04
	74	1.74	1.71	-0.04	2.89	2.84	-0.05
	98	1.99	1.93	-0.06	3.21	3.13	-0.08
10	39	2.62	2.61	-0.01	3.74	3.73	-0.01
	61	2.83	2.79	-0.04	3.86	3.83	-0.02
	74	2.97	2.92	-0.05	3.92	3.89	-0.03
	98	3.32	3.23	-0.09	4.01	3.97	-0.04
100	39	4.72	4.65	-0.08	4.38	4.34	-0.03
	61	4.95	4.88	-0.07	4.47	4.40	-0.07
	74	5.07	4.99	-0.08	4.50	4.43	-0.07
	98	5.26	5.14	-0.12	4.53	4.49	-0.04

Table 5-12: Maximum probable development depth results (Spatially varying rainfall, local impacts)

Event ARI	Peat CN	Papakura Stream at SH1			Papakura Stream at Mill Road		
		ED [m]	ED + SUN [m]	Difference [m]	ED [m]	ED + SUN [m]	Difference [m]
10	39	2.35	2.39	+0.03	3.45	3.44	-0.01
	74	2.75	2.74	-0.02	3.70	3.68	-0.02
100	39	3.86	3.85	-0.01	4.10	4.06	-0.04
	74	4.47	4.41	-0.06	4.25	4.22	-0.03

6 DISCUSSION

6.1 PEAT CN SENSITIVITY

As seen in the results tables in section 5, there are some different impacts of the development depending on what curve number is used for the peat soils. Infiltration in Peat soils is expected to vary significantly depending on the ground water level. Refer to Section 3.1.3 for further discussion.

The main conclusions are:

- A lower CN means that relative impacts of the development on flood hazard are higher. With lower CN the upstream catchment flows are lower, but the impact of the development is relatively greater. Overall, our results show greater impacts on predicted depths immediately downstream of the Sunfield development when considering a lower curve number.
- As the applicant has only assessed CN of 74, their pre-development flows will not represent a case where the peat is relatively dry and has low runoff. This means that the sizing of the attenuation devices may not attenuate to pre-development flow rates in some cases.

6.2 CONCENTRATION OF FLOWS DOWNSTREAM OF POND 1

The Sunfield development (as per the provided drawings) will remove existing overland flow paths that currently flow through the site. The existing flow path shown in Figure 6-2.

Currently flows are predicted to cross Hamlin Road mainly at two locations:

- Main flow path under a bridge near 51 Hamlin Road (Blue circle in Figure 6-1).
- Hamlin Road retains some runoff, with flows eventually spilling over at the western end of Hamlin Road (Green circle in Figure 6-1)

Current flows out of the Sunfield site are spread across multiple properties, as shown with red arrows.

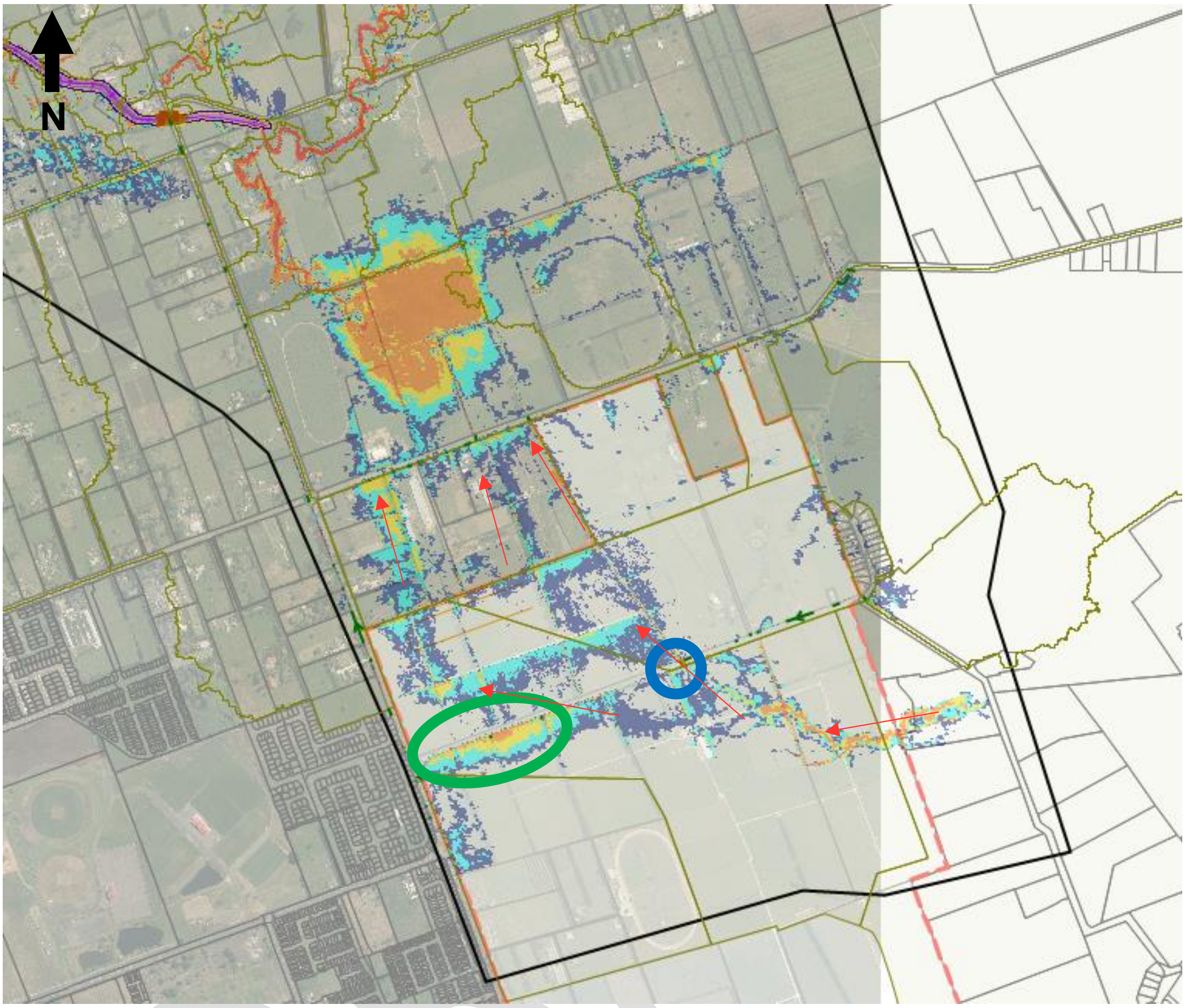


Figure 6-1: Example of existing overland flow paths through the Sunfield development site – 2-year ARI CN61 E.

Proposed flow path:

The applicant proposes to collect and discharge all the upstream rural flows through the diversion channel into pond 1. This will concentrate the current overland flow paths and discharge them all into private property at one location.

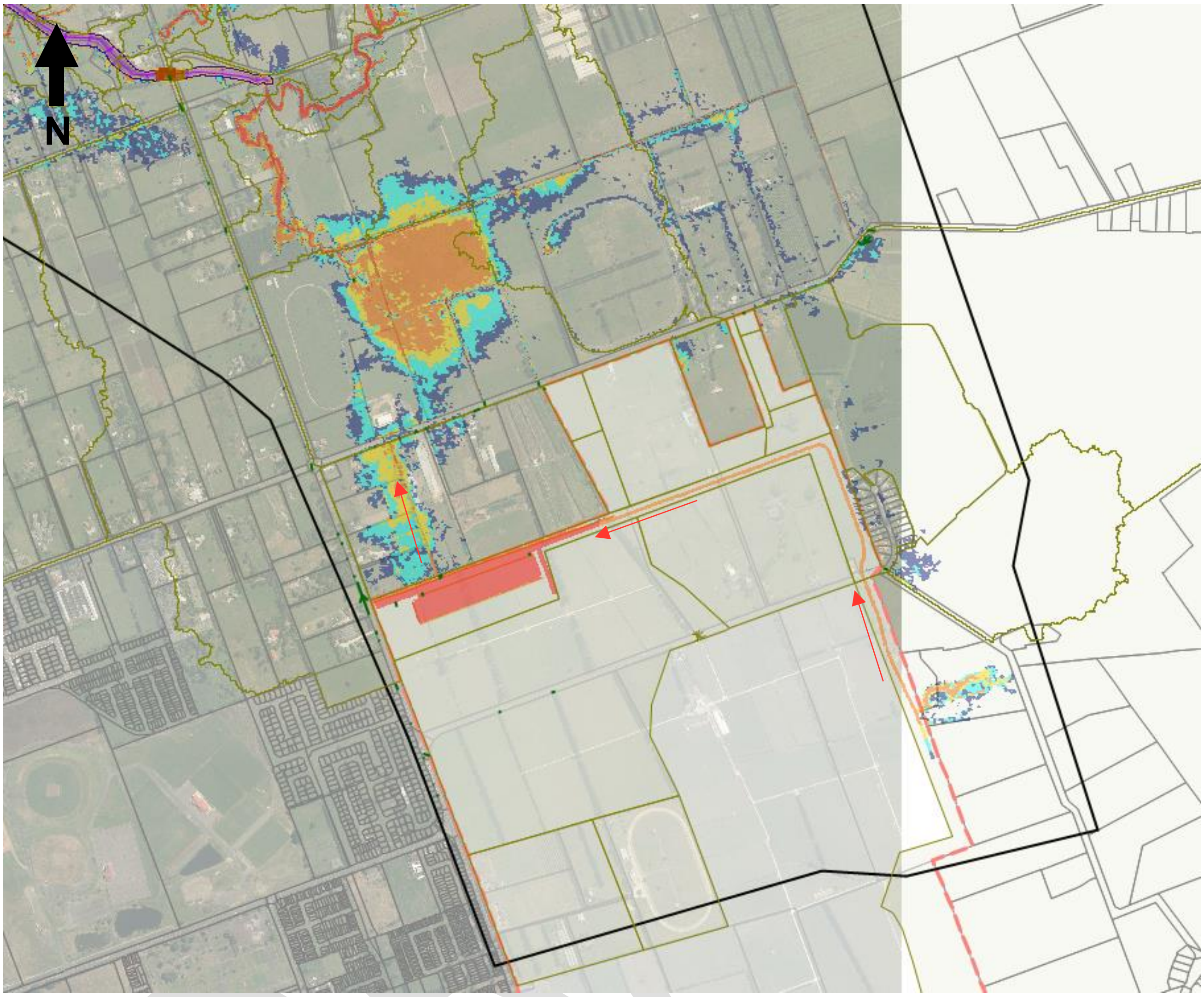


Figure 6-2: Proposed overland flow path through Sunfield development site – 2-year CN61 E+SUN.

Since the proposal involves concentrating the overland flow paths into a single location, it is not sufficient to analyse the overall flows and to maintain the total pre-development flow rate. Loading all the flow into one location requires a more in-depth analysis of the current capacity of the open drains immediately downstream of pond 1.

Compounding the concentration of the overland flow paths, our results indicate that in some events the overall pre-development flow rate is exceeded when including the Sunfield development. Based on our modelling the pond 1 outfalls do not always attenuate outflows to the pre-development flow rate, as shown in Table 5-1. In particular, the post-development flows exceed the pre-development flows in all modelled 2 year ARI events, except when a CN value of 98 is used.

The combination of increasing the total flow rate in some events, as well as concentrating the existing flow paths means that properties immediately downstream of Sunfield pond 1 are predicted to have an increase in flood depth, as seen in Table 5-2.

In some scenarios the increase in flood depth is greater than 100mm, and increases the predicted flood hazard to properties downstream. In the 2-year ARI CN61 scenario there is an increase in flood depth of greater than 100 mm downstream of the pond 1 outfall, as shown in Figure 6-3.

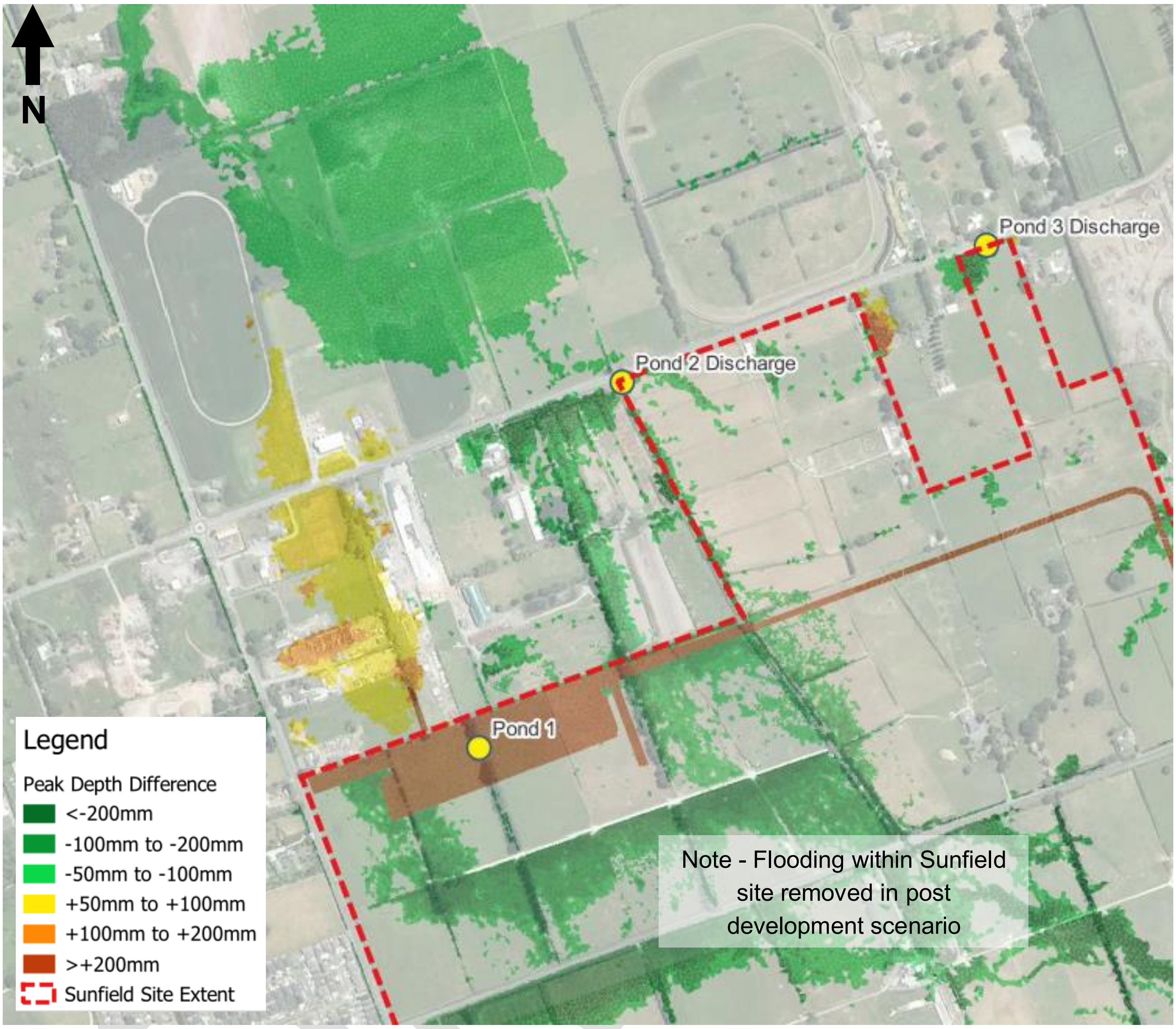


Figure 6-3: Change in predicted peak flood depth in the 2-year ARI, CN61 scenario, showing increase in predicted flood depth downstream of Pond 1.

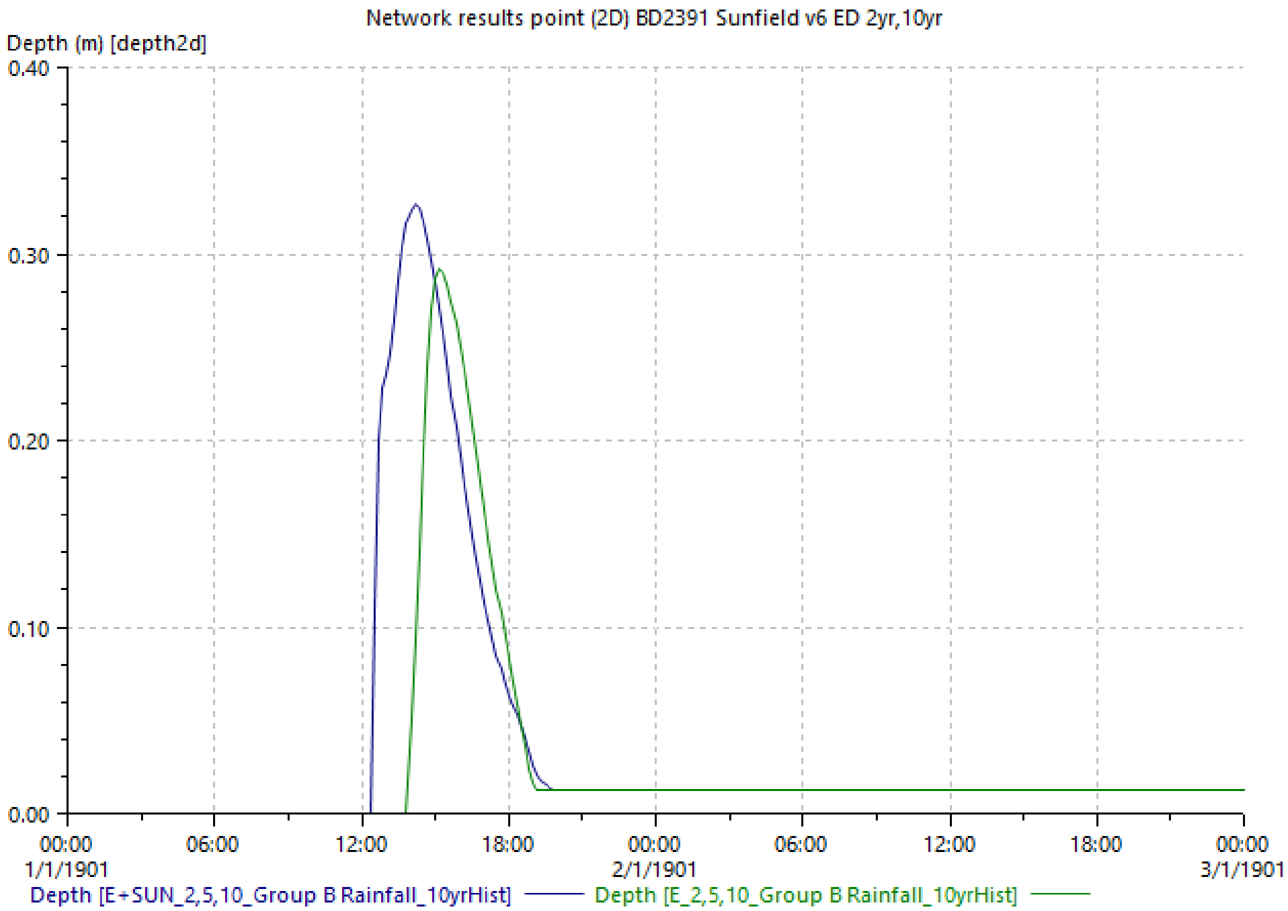


Figure 6-4: CN61 10-year ARI historical rainfall – showing predicted flood depth increase at building footprint.

Figure 6-4 shows the increase in predicted flood depth at a building downstream of pond 1 in the 10-year ARI CN61 scenario. The location of this building is shown in Figure 6-5. This result is not apparent on the flood depth difference maps as the increase is less than 50 mm, however it is still a negative impact that should be considered.

Figure 6-5: Location of BD2391 building, downstream of pond 1.

6.3 EXISTING DRAINS

The applicant's proposal is to discharge into the existing farm and roadside drains. As we have not received their model, we cannot confirm if the open drains and culverts were explicitly modelled by the applicant. However, it appears that the applicant has only relied on unmodified terrain to represent conveyance downstream of their development.

As discussed in section 6.2 areas immediately downstream of pond 1 will have an increase in flows due to the concentration of existing overland flow paths. These properties have small private drains, with likely very limited capacity for any additional flows. The applicant has not assessed the capacity of these drains to see if there will be any negative effects from the increased runoff from the development.

We have modelled some of the downstream roadside drains and culverts, as discussed in section 2.1.2. The available survey does not include the privately owned farm drains. Based on anecdotal information, the survey data, as well as photos during storm events, we believe that the existing farm drains and roadside drains have limited capacity for event relatively small events. Therefore these open drains are likely unable to convey additional flows from the Sunfield development without negative impacts on the surrounding properties.

During a recent rain event, which was assessed to have an ARI of less than 2 years, the open drains around the Sunfield development site were observed to overflow into the road, as seen in the photographs below.

Figure 6-6: Flooding near 115 Hamlin Road on 27 June 2025. Photo credit Andrew Chin (AC).

Figure 6-6 shows flooding is at upstream end of the Sunfield development, where the large rural upstream catchment is proposed to enter the diversion channel.

Figure 6-7: Flooding near 269 Airfield Road on 27 June 2025. Photo credit Andrew Chin (AC).

This flooding in Figure 6-7 shows the area immediately downstream of the Sunfield pond 2. This flooding extended into the roadway, and indicates an existing capacity issues of the open drains downstream of the Sunfield development area

6.4 PONDS 2 AND 3 BACKWATER

Our modelling indicates some backwater issues at pond 2 and 3. Figure 6-8 shows the flows through the different outlets from Pond 2, as well as the pond level on the secondary Y axis. Due to the high downstream water level the model predicts backflow into the pond via the 2m wider “10 year ARI” weir.

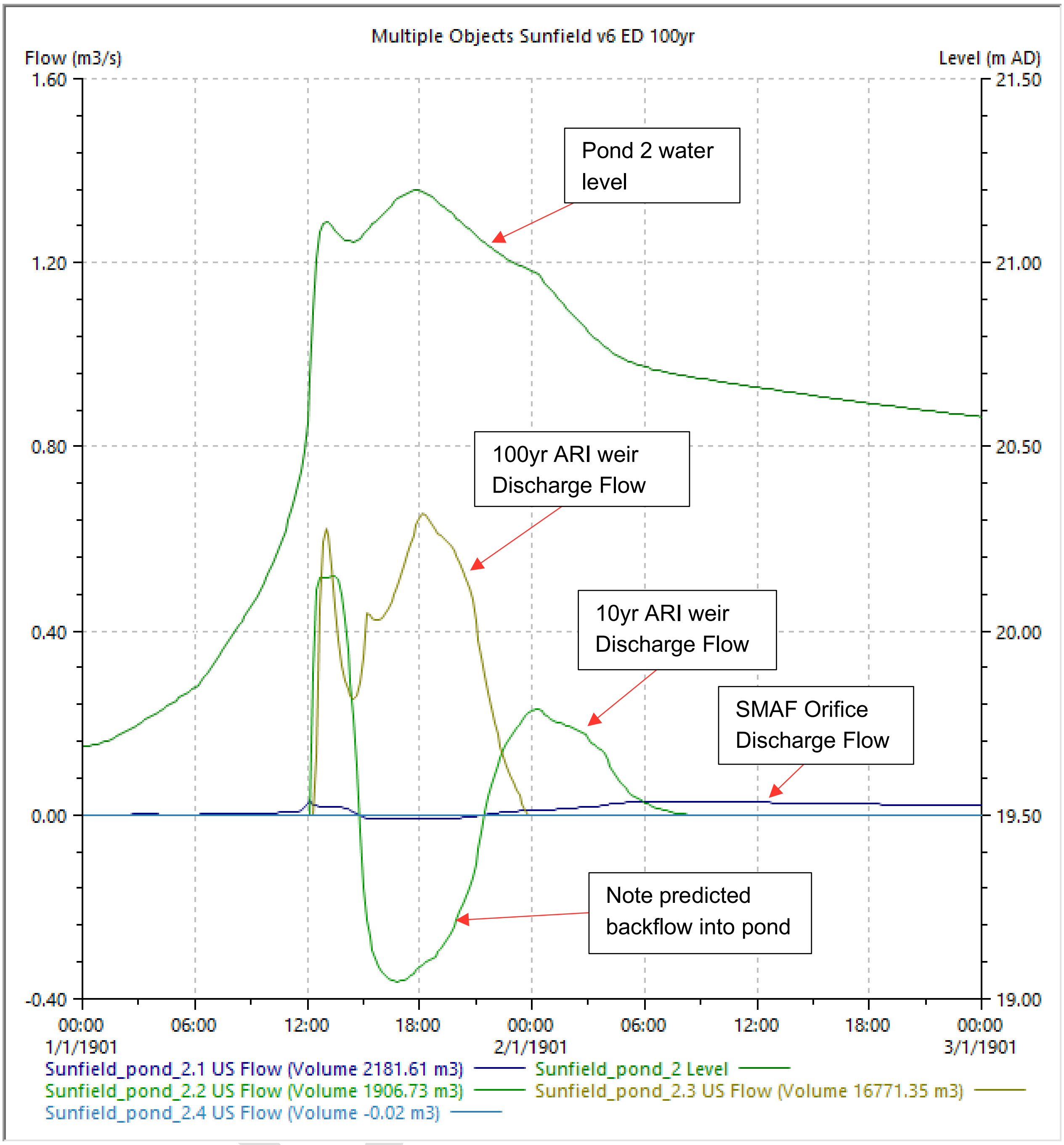


Figure 6-8: Predicted operation of pond 2 in 100 year ARI E+SUN scenario, CN 61.

The culvert "Structure 16" is immediately downstream of the proposed pond 2. This culvert was added into the ICM model based on the farm drain survey provided by AC. This structure does not appear to be restricting flows, as the model predicts very similar peak depths on both sides of the culvert. Figure 6-9 shows the water level in pond 2 compared to the water level downstream of the "structure 16" culvert on the north side of Airfield Road.

We note that high water levels in this location are a known issue, as is demonstrated by photos during a recent rain event shown in Figure 6-7.

Due to the model not including survey of the open drains downstream of pond 2, we have lower confidence in the model results in smaller rain events (i.e. 2 year ARI). However, in larger (10 and 100 year ARI) rain events, the downstream area floods and therefore the drains become less critical to the result.

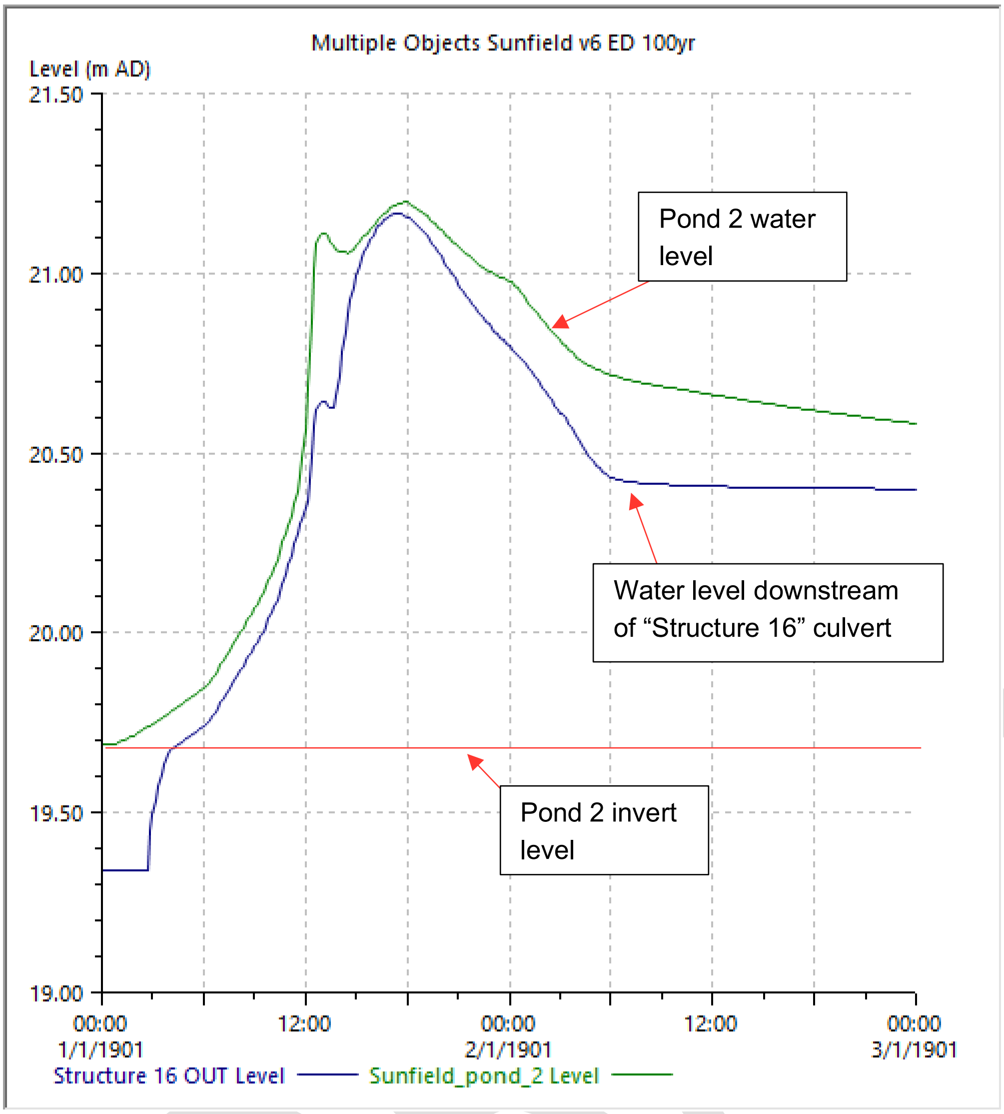


Figure 6-9: Predicted water level within Pond 2 and downstream north of Airfield Road. 100 year ARI E+SUN CN 61.

The applicant's hydraulic model for ponds 2 and 3 does not appear to consider backwater effects from the downstream flood area, and they do not discuss this backwater issue. The 3WSR states that the applicant has modelled these ponds in HEC-HMS, and loaded the discharge flows into their HEC-RAS model to assess downstream flood depths. As we have not received their models, we cannot confirm how the interaction between these models was implemented in the applicant's models, and whether backwater effects were considered.

6.5 IMPACT OF MODIFYING CATCHMENT BOUNDARY

A key part of the applicant's plan is the proposal to reroute part of the current Papakura Stream catchment into the Pahurehure inlet via the Awakeri Wetlands, as discussed in section 2.2.1. The reduction in catchment area flowing to Papakura Stream acts to offset the increased runoff from impervious area of the Sunfield Development. Table 6-1 summarises the total runoff volume in Papakura Stream with and without the Sunfield Development in the 10-year ARI existing development scenarios and quantifies the change in volume.

We believe that the diversion of this large portion of the catchment is a key factor in mitigation of potential downstream effects. If the proposed rerouted subcatchment were to discharge into the Papakura Stream instead (even if un-developed) it is likely that this will result in an increase in downstream flood hazard.

The volume discharging to the Papakura stream catchment increases in scenarios with peat CN values of 61 and 39. With the proposed diversion, the volume draining to Papakura stream reduces in the scenarios where the peat is assumed to CN74 or CN98.

Without the diversion to Awakeri, the volume draining to Papakura stream would increase in all peat CN scenarios except when the peat is fully saturated (CN of 98).

Table 6-1: Comparison of runoff volume in from the Sunfield development subcatchments in the 10-year ARI homogenous rainfall (No climate change).

Peat CN	Pre-Development (E) Runoff Volume to Papakura Stream Catchment (m^3)	Post-Development (E+SUN) Runoff Volume (m^3)		Difference in Volume to Papakura Stream (m^3)	Percentage Difference Volume to Papakura Stream (%)
		To Papakura Stream	Diverted to Awakeri		
39 (Lower)	68,041	126,074	60,289	58,033	+85.3%
61 (Group B)	114,268	131,943	60,289	17,675	+15.5%
74 (Group C)	148,372	136,273	60,289	-12,099	-8.2%
98 (Upper)	240,141	147,924	60,289	-92,217	-38.4%

6.6 PEER REVIEW OF APPLICANT'S MODEL

Based on the documents provided by the applicant, it appears that an independent peer review of their models has been carried out. The lodged documents include:

- the McKenzie & Co "Sunfield Fast Track Application – 3 Waters Review memorandum (Lodged document #14, dated 24/01/2025), and
- the CKL "Stormwater Management - Proof of Concept Review" memorandum (Lodged document #13, dated 10/02/2025).

The McKenzie & Co memorandum states that their review is "subject to an independent flood model peer review". The CKL memorandum states that they reviewed inputs into the model based on the Stormwater Modelling Report, but they did not review the models directly. CKL's memorandum recommends that a formal peer review of the hydraulic models be undertaken. The applicant has not provided any evidence of an independent peer review of the hydraulic models. Given the complexity of the proposed attenuation devices, as well as the existing flood hazards downstream of the development we recommend that an independent peer review of the applicant's models is carried out.

7 CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- **The applicant did not provide complete technical details** regarding their proposal, limiting some aspects of our analysis:
  - The engineering plans that the applicant provided have some gaps with missing information. We have had to assume some details based on engineering judgement (including dimensions and arrangement of outlet structures).
  - The applicant did not provide their model files, and therefore our analysis is based on the provided 3WSR report and attached engineering plans.
  - The previous peer reviews that are included in the lodged documents did not review the hydraulic models directly.
- **Peat Soils:** Our modelling shows that the impacts of the development on the downstream properties varies depending on the amount of infiltration available within peat soil. With lower CN values (higher infiltration) the upstream catchment flows are lower, but the increase in downstream flood level due to the development is relatively greater. Overall, our results show greater flood level increases immediately downstream of the Sunfield development when considering a lower curve number for peat.
- **Local effects (Within nearby open drains):** Our modelling predicts that the Sunfield development can result in an increased flood level on nearby downstream properties. An increase in flood hazard is predicted immediately downstream of pond 1 in the 2-year ARI event. In the 2-year ARI, peat CN61 scenario our modelling predicts that the flood depth downstream of pond 1 will increase by approximately 100mm on neighbouring properties due to the Sunfield development. This increase in flood hazard is likely in part due to the applicant's proposal to combine the existing overland flow paths into a single discharge location.
- **Downstream effects (Within Papakura Stream main channel):** Our modelling does not predict an increase in flood depth within the Papakura Stream in any of the scenarios modelled. We believe that this is due to the applicant's proposal to divert part of the existing Papakura Stream catchment to the Awakeri basin.
- **Downstream open drains:** The downstream open drains have existing capacity constraints, and hence are sensitive to increased runoff, for example during relatively frequent events (i.e. 2-year ARI). Due to the flat topography of the development site and adjacent downstream properties, the water level in these drains may influence the performance of the applicant's proposed attenuation devices. Our modelling predicts that in the 100-Year ARI events the downstream flood level causes water to flow back into pond 2.
- **Catchment Diversion**: The applicant's proposal to divert part of the current Papakura Stream catchment into the Pahurehure Inlet via the Awakeri Wetlands plays a key part in limiting the effects of the development in the Papakura Stream.

Recommendations:

- Regarding the peat soils;

- The applicant's modelling uses a single curve number of 74 for all pre-development peat soils.
- The peat soils are known to be highly variable, and subject to seasonal variation.
- Our modelling shows that the impacts of the development can vary based on the assumed peat CN values.
- Therefore further consideration of the perviousness of the peat soils is recommended. This could include assessing the likely range of possible CN values for the existing peat ground and incorporate that into their modelling. We consider this critical to determining the sizing of attenuation devices to avoid increasing flows above the pre-development condition.

- Our modelling indicates that the applicant's proposal to combine the existing overland flow paths into one discharge point could increase the flood hazard of properties immediately downstream of pond 1. We recommend that the applicant carries out more detailed hydraulic analysis of the existing conveyance channels downstream of pond. A more in-depth hydraulic analysis of the open drains will give AC greater confidence of the impacts of the applicant's proposal on the flood hazard to the properties downstream of the development.

8 LIMITATIONS

This report ('Report') has been prepared by WSP exclusively for Auckland Council ('Client') in relation to the assessment of the proposed Sunfield development ('Purpose') and in accordance with the "Papakura Stream Plan Change Modelling Support" Statement of Works dated 28 February 2025. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

9 BIBLIOGRAPHY

AC. (2025). *Auckland Council Open Data*. Retrieved from Auckland Council: https://data-aucklandcouncil.opendata.arcgis.com/

AC. (December 2023). *Stormwater Modelling Specifications (Final Issue 1).* Auckland Council.

AC. (July 2025). *The Auckland Code of Practice for Land Development and Subdivision Chapter 4: Stormwater Version 4.0.* Auckland Council.

ARC. (1999). *TP108 Guidelines for stormwater runoff modelling in the Auckland Region.* Auckland: Auckland Regional Council.

Maven. (2025a). *Sunfield - Fast Track Approvals Application Infrastructure Report.*

Maven. (2025b). *Sunfield - Fast Track Approvals Application Three Waters Strategy Report.*

WSP. (December 2024). *Takanini Future Urban Zone Flood Effects Testing: Testing of Effects for Storms of Varying Duration and Spatial Distribution.* WSP reference: 3-AWD30.78.

WSP. (September 2021). *Papakura Stream Model Update: Model Build Report.* WSP reference: 3-AWD30.41.

APPENDIX A – LEGACY ASSUMPTIONS AND LIMITATIONS

Papakura Stream Model Update: Model Build Report (WSP, September 2021)

2D floodplain element levels are derived from the Auckland Council 2016 LiDAR dataset. Detailed topographic features such as kerb and channel, retaining walls, narrow channels are not expected to be represented in this model. This may result in different flow directions (especially for lower flow) than observed during actual flooding events.

The 1D stream channel cross sections are derived from the 2016 LiDAR. The representation of the low flow channel may result in reduced conveyance especially for low flow events, which would normally be contained within the low flow channel.

1D roughness values were estimated using available photographs and aerial photography, applying the CES methodology.

The use of single roughness values may impact on the conveyance during low flows especially flows that would typically be confined to the low flow channel (i.e. less than 2-year ARI).

River Reach Lateral linking uses lower than the typical values in some select locations to improve the overall stability of the model. The impact of this is that the overbank flow is expected to apply the submerged weir equation for a longer proportion of the time, which may result in higher hydraulic losses across these boundaries under certain flow conditions.

Hydrological parameters for soils were selected using TP108, based on the underlying geological layers (GNS online maps). These were determined to provide a reasonable representation of known soil types (i.e. approximate extent of peat). However, it is noted that in some locations the selected curve numbers may not be representative of the actual soil characteristics.

Bridge contraction and expansion coefficients have been determined using recommended typical values. While a sensitivity test was undertaken to confirm that the predicted water levels were not sensitive to these parameters, it is noted that these loss coefficients may not be appropriate for all events.

Bridge opening geometry is based on previous modelling data. This has not been validated against previous survey data.

Subcatchment sizes are typically much larger than the range recommended by Auckland Councils' modelling specification. In some cases the peak flows may be sensitive to upstream attenuation, network connectivity etc, particularly for smaller events.

Takanini Future Urban Zone Flood Effects Testing: Testing of Effects for Storms of Varying Duration and Spatial Distribution (WSP, December 2024)

This model has been schematised to assess flooding associated with the Papakura Stream, and has undergone high level calibration to improve the modelled response compared to gauged flow for selected historic events.

The runoff surface proportions within each subcatchment were based on the estimated proportion of peat and the impervious and pervious proportion based on current development and the Auckland Unitary Plan.

Modelled rainfall events use homogenous timing (i.e., all the different duration and spatial distribution runs assume the same timing for rainfall across the catchment). Actual events are expected to have some variation, which may impact the results; especially storms that track across the catchment from west to east or vice versa.

Analysis of historic rainfall events showed a different proportion of rainfall in the upper catchment is varies from 60% lower and 30% higher than the lower portion of the catchment, which were typically storms of relatively small ARI (i.e. 1 in 10 year and less). Review of the January 2023 Auckland Anniversary storm event rain radar showed the rainfall depth in the Manukau Harbour vs. the bottom of the Papakura catchment was approximately double (i.e. the depth of rainfall across the lower reaches of the Papakura stream was approximately 50% of the rainfall depth in the Manukau Harbour. Therefore for the design runs tested in this scenario, a 50% factor for reducing upstream rainfall depths was adopted as a plausible value.

The boundaries used for testing higher rainfall in the lower catchment vs. lower rainfall in the upper catchment were selected to limit the number of zones while providing a reasonable understanding of the potential areas where a demarcation between higher and lower rainfall zones may lead to a potential increase in downstream effects on flood hazard due to development within the FUZ.

The spatially varying rainfall zones are demarcated perpendicular to the stream flow direction. Boundaries between areas of higher and lower rainfall could occur from any direction or distribution. The boundaries tested were chosen as they would be allowed for reasonable assessment of this development location, as well as reasonable precedent for being possible based on reviewed rainfall events.

The approach taken for this analysis was to assume higher rainfall depths / intensities in the lower reaches compared to the upper reaches. This is considered to represent a scenario where effects from development in the lower portion of the catchment will be more apparent. It is noted that testing of effects of mitigation strategies (i.e. attenuation) may require the reverse scenarios; i.e. higher rainfall in the upper catchment.

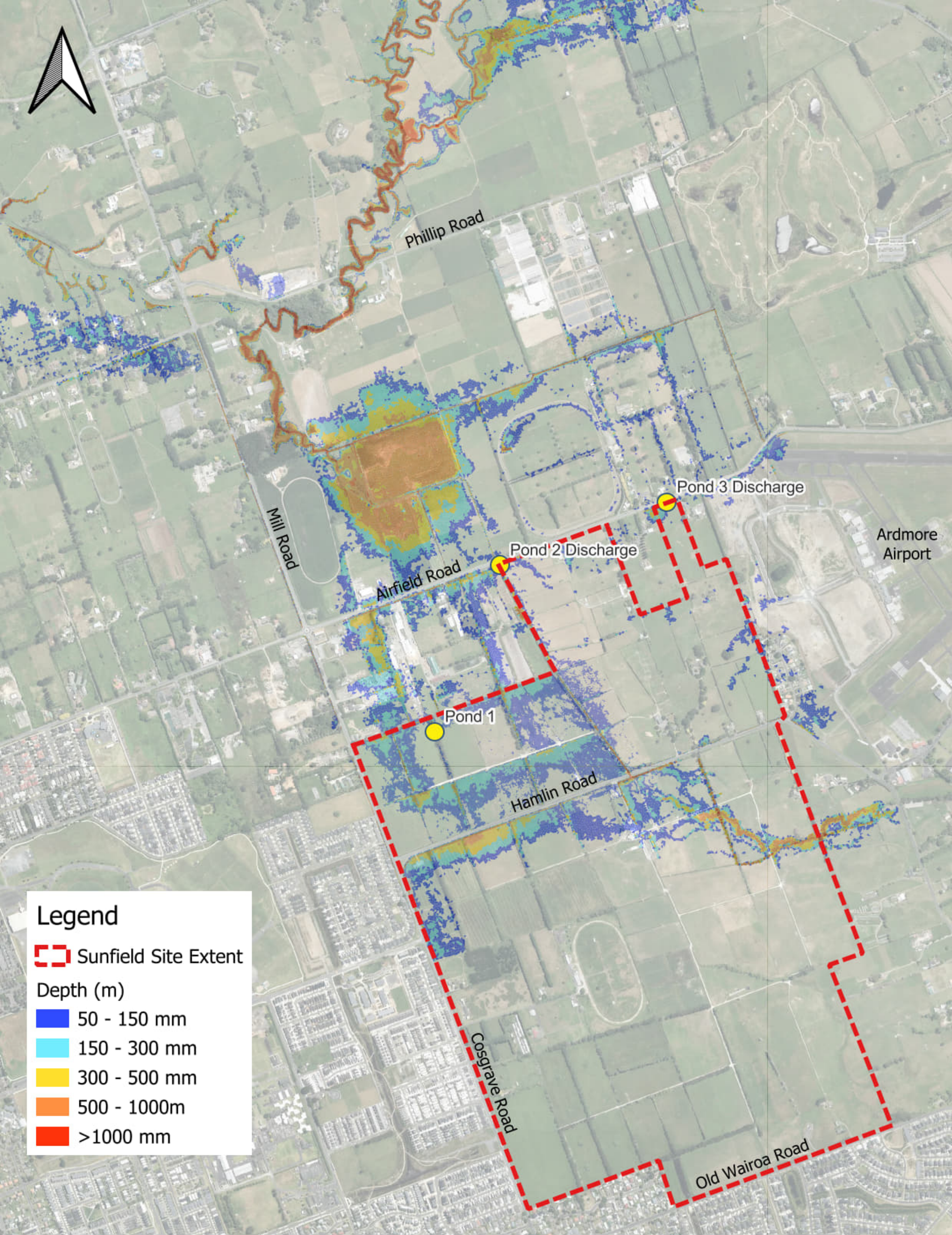
The peat extents used in the model are based on high level data provided by Auckland Council. The actual peat extent will create a different subcatchment runoff and may impact the potential flood hazard predicted in the downstream reaches of the stream.

For a given subcatchment, the distribution of impervious and pervious land cover on top of the peat was assumed to be equal as the distribution of future development (FUZ and infill) is unknown.

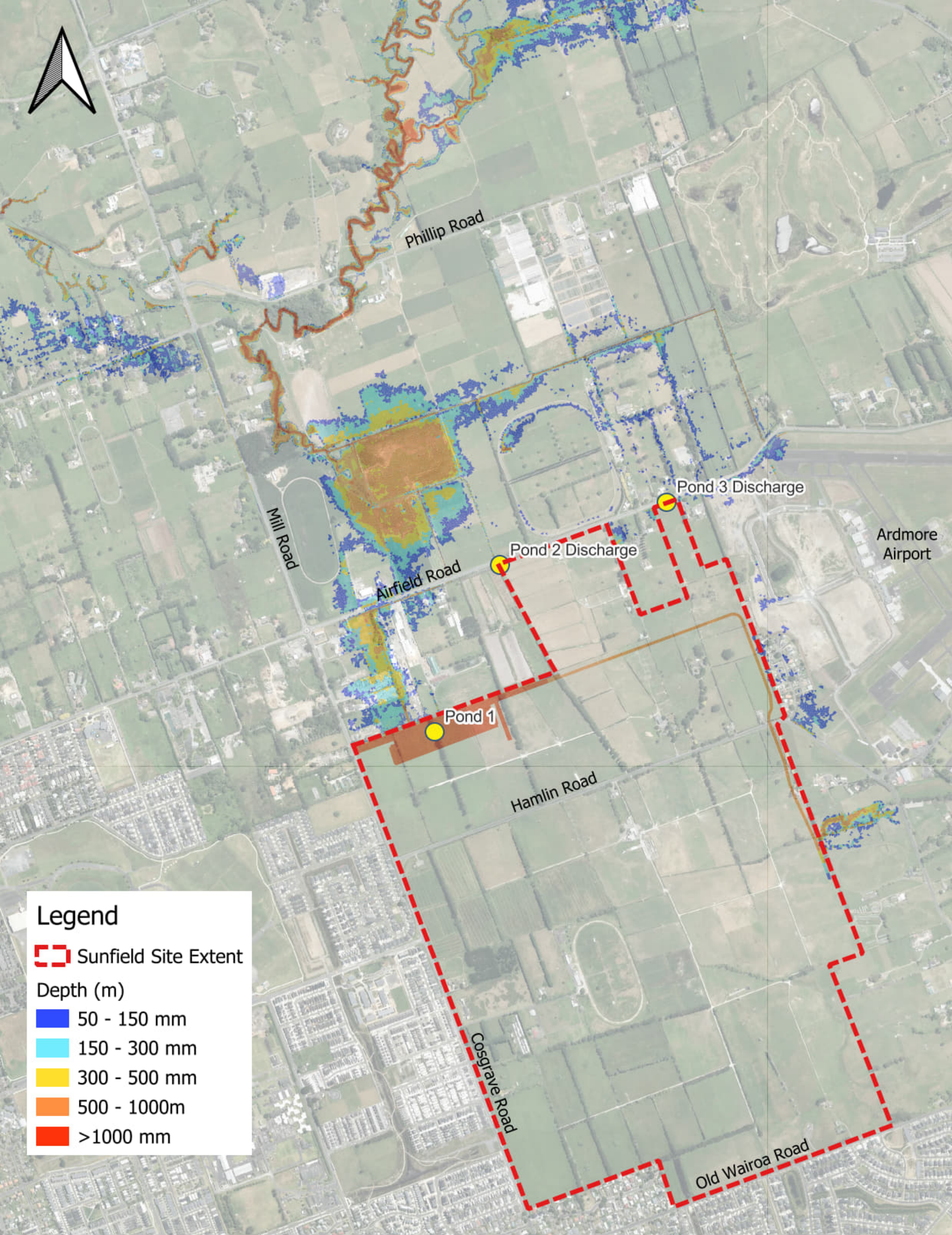
The CN39 (Lower) and CN98 (Upper) peat SCS depths selected are considered to be a sensitivity approach only. The selected values are intended to represent reasonable upper and low bounds for the peaty portion based of the catchment on limited validation events; additional testing would reduce the uncertainty of this assumption.

Baseflow or secondary contribution from subsurface flow has not been represented directly in this model.

APPENDIX B – RESULTS MAPS



wsp / Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: E Peat CN: 61, Rainfall ARI: 2yr	0 250 500 m
		R0 / 09/07/2025	



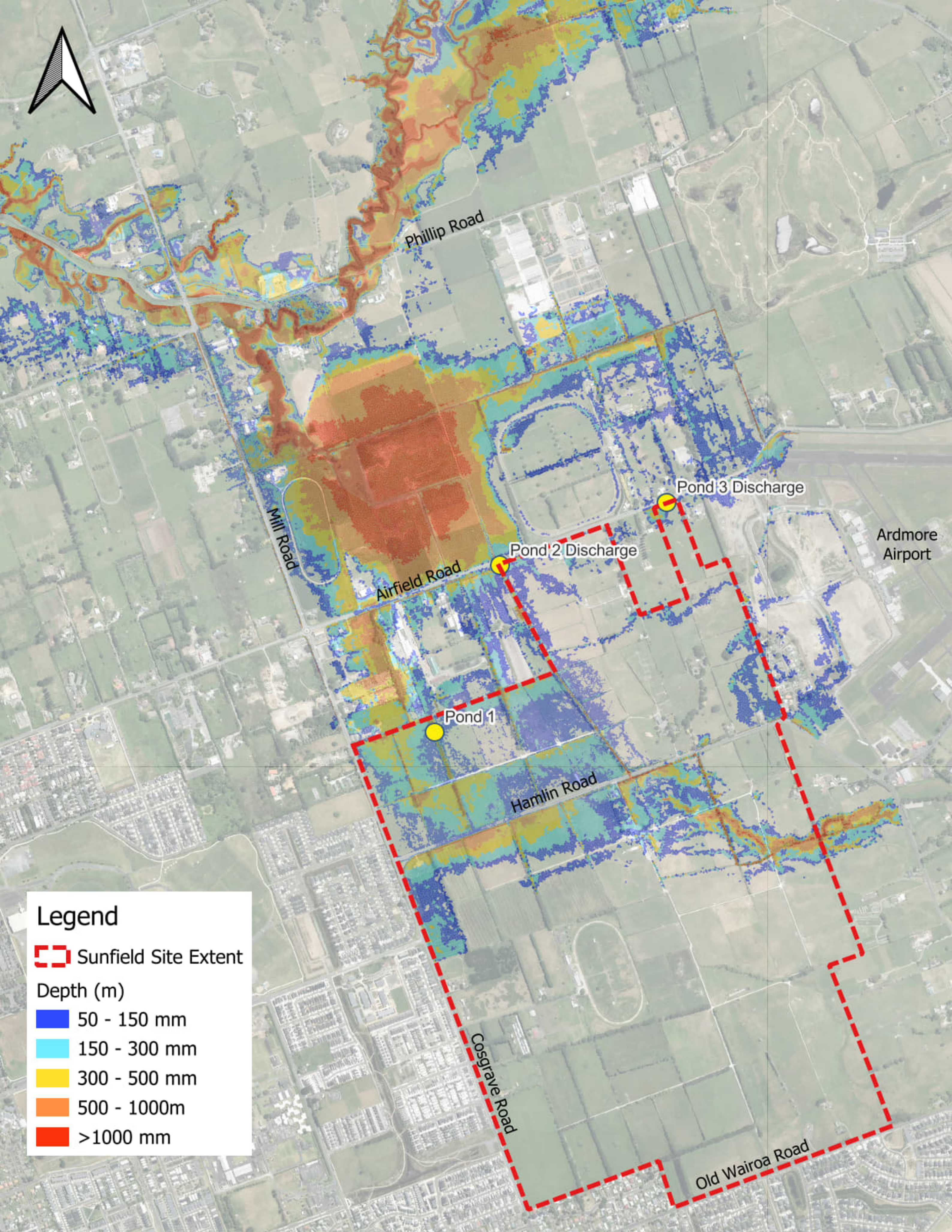
Sunfield Proposed Development Assessment - Papakura Stream Catchment

Peak Depth
Scenario: E+SUN
Peat CN: 61, Rainfall ARI: 2yr

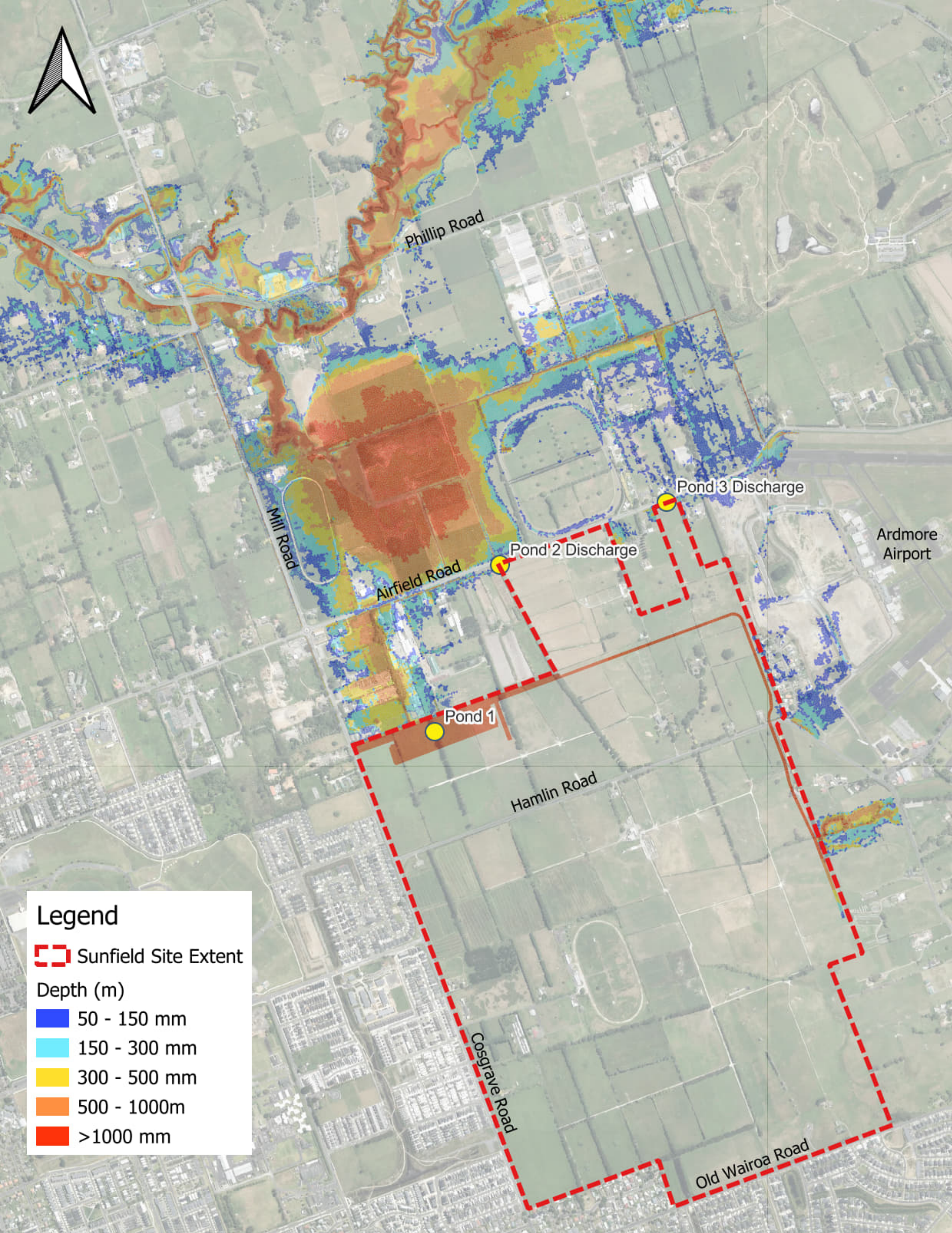
R0

09/07/2025

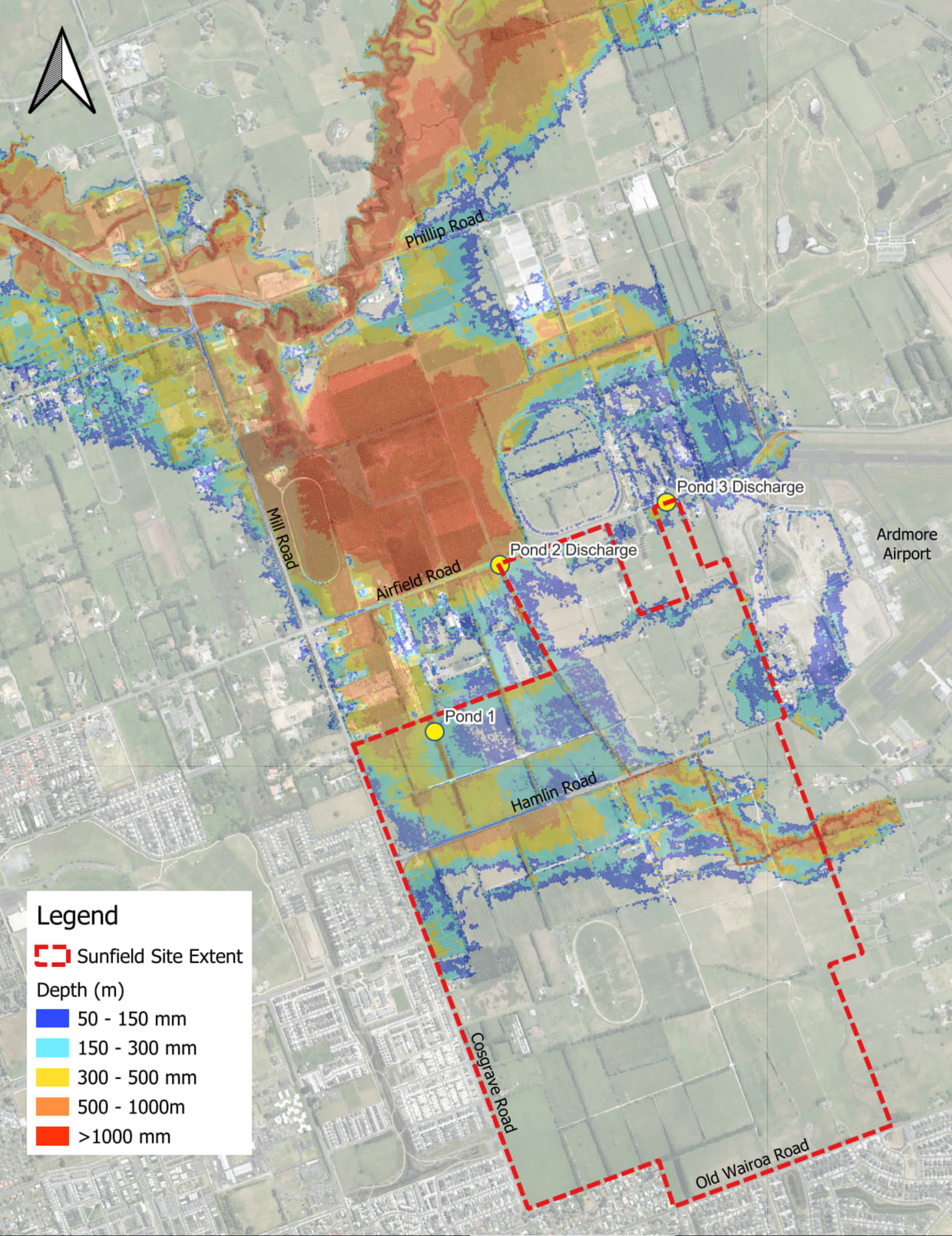
0 250 500 m



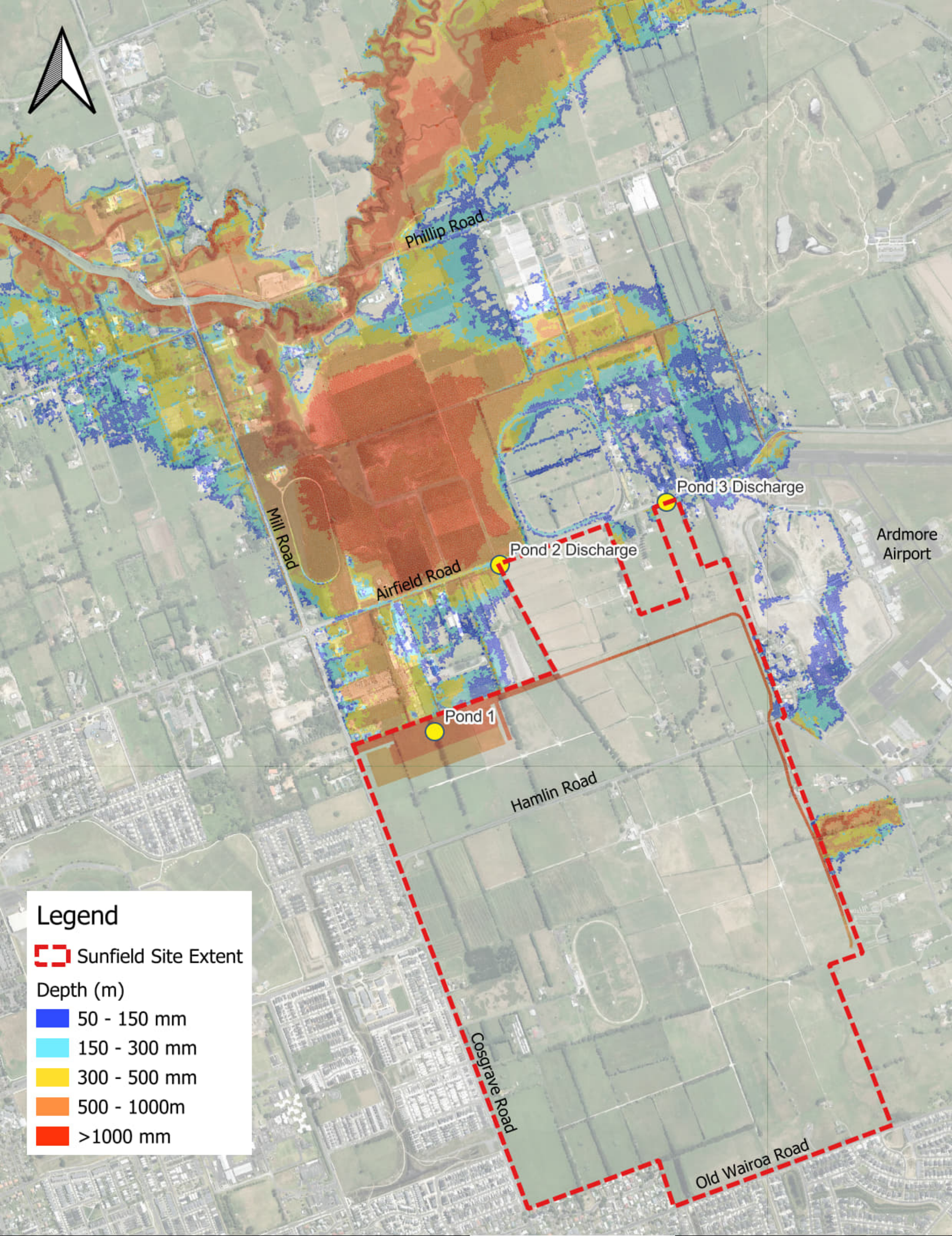
Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: E Peat CN: 61, Rainfall ARI: 10yr	0 250 500 m
	R0	09/07/2025



Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: E+SUN Peat CN: 61, Rainfall ARI: 10yr	0 250 500 m
	R0	09/07/2025



wsp / Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: E Peat CN: 61, Rainfall ARI: 100yr	0 250 500 m
		R0 / 09/07/2025	



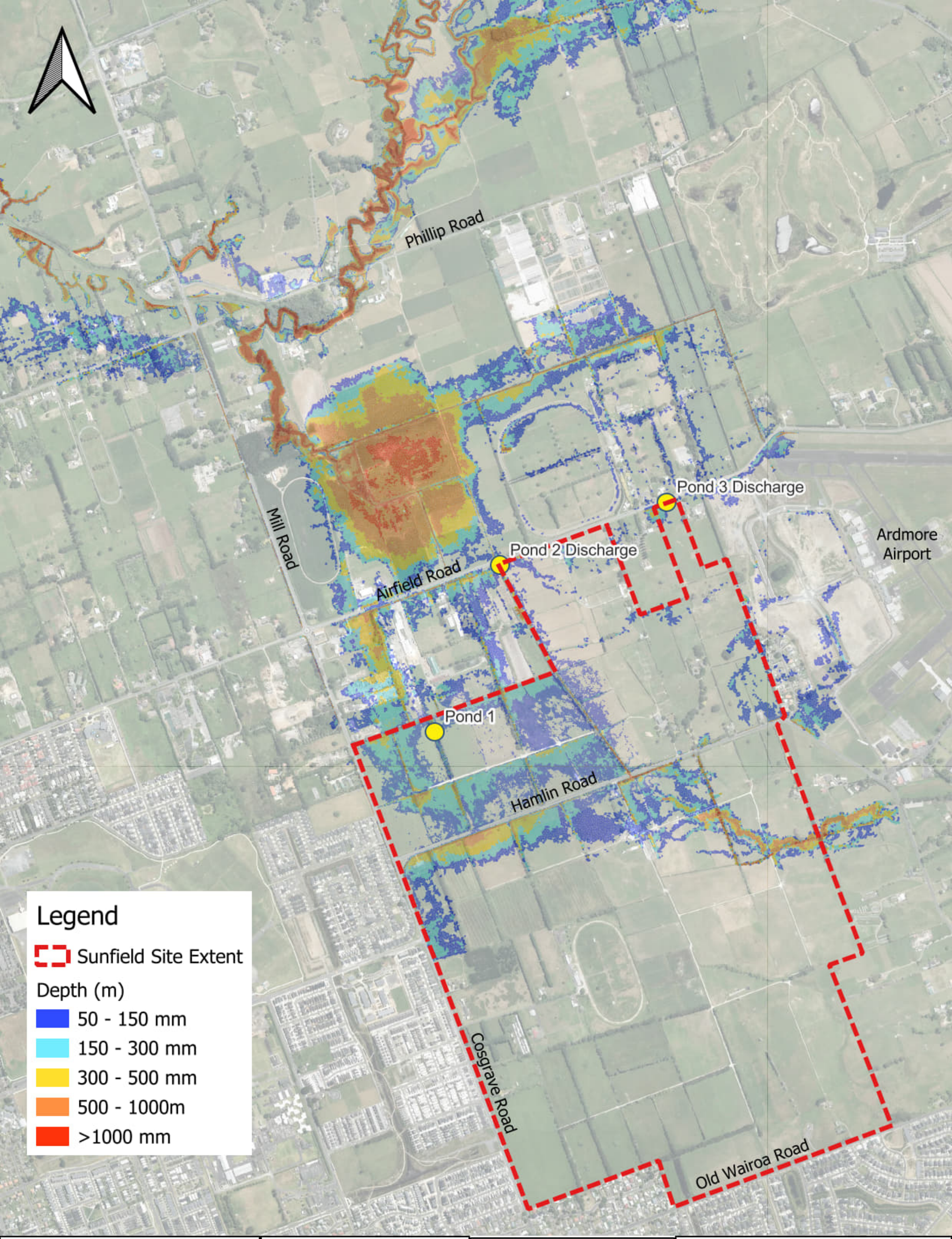
wsp | Auckland Council Te Kaunihera o Tāmaki Makaurau

Sunfield Proposed Development Assessment - Papakura Stream Catchment

Peak Depth
Scenario: E+SUN
Peat CN: 61, Rainfall ARI: 100yr

R0 | 09/07/2025

0 250 500 m



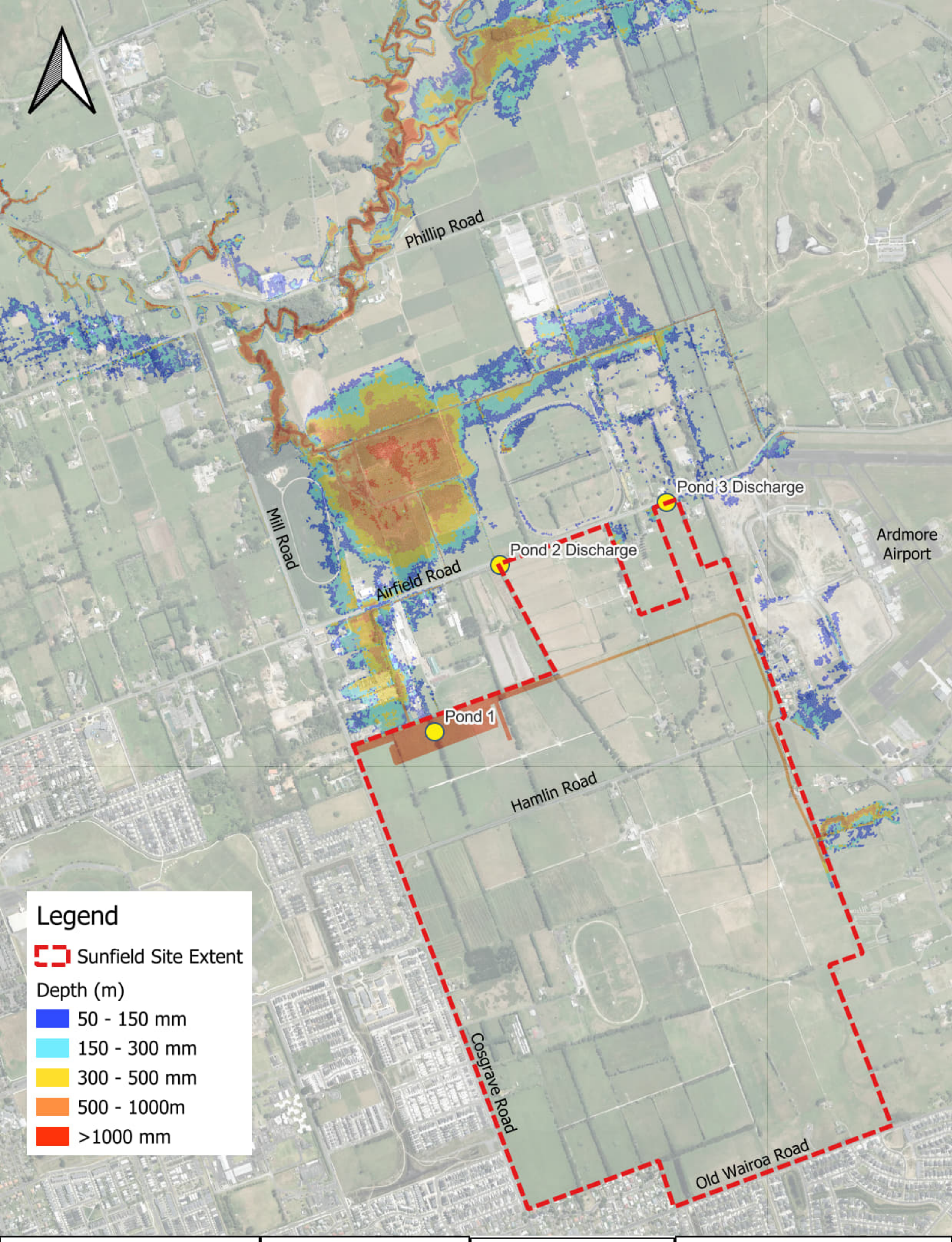
wsp | Auckland Council | Te Kaunihera o Tāmaki Makaurau

Sunfield Proposed Development Assessment - Papakura Stream Catchment

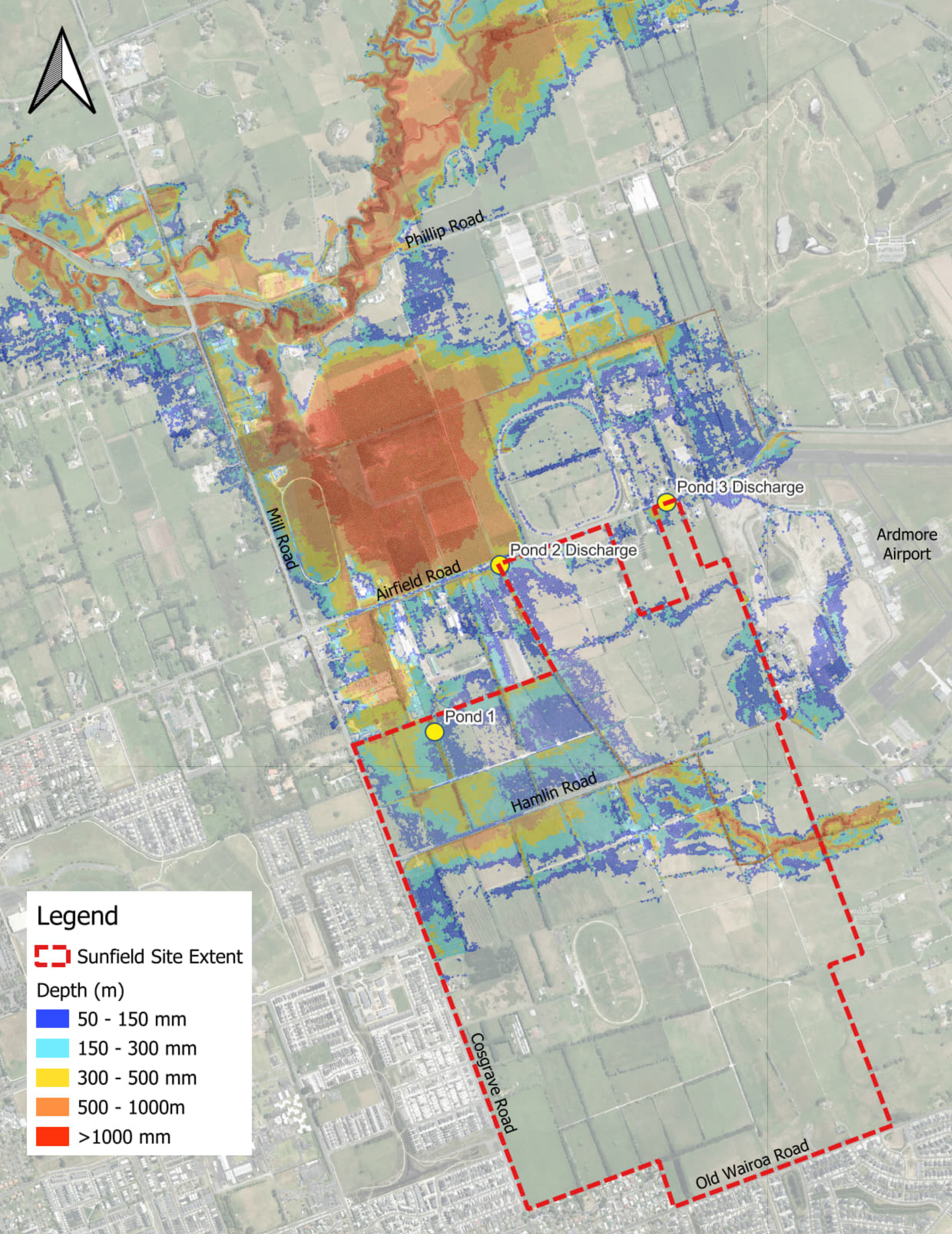
Peak Depth
Scenario: M
Peat CN: 61, Rainfall ARI: 2yr

R0 | 09/07/2025

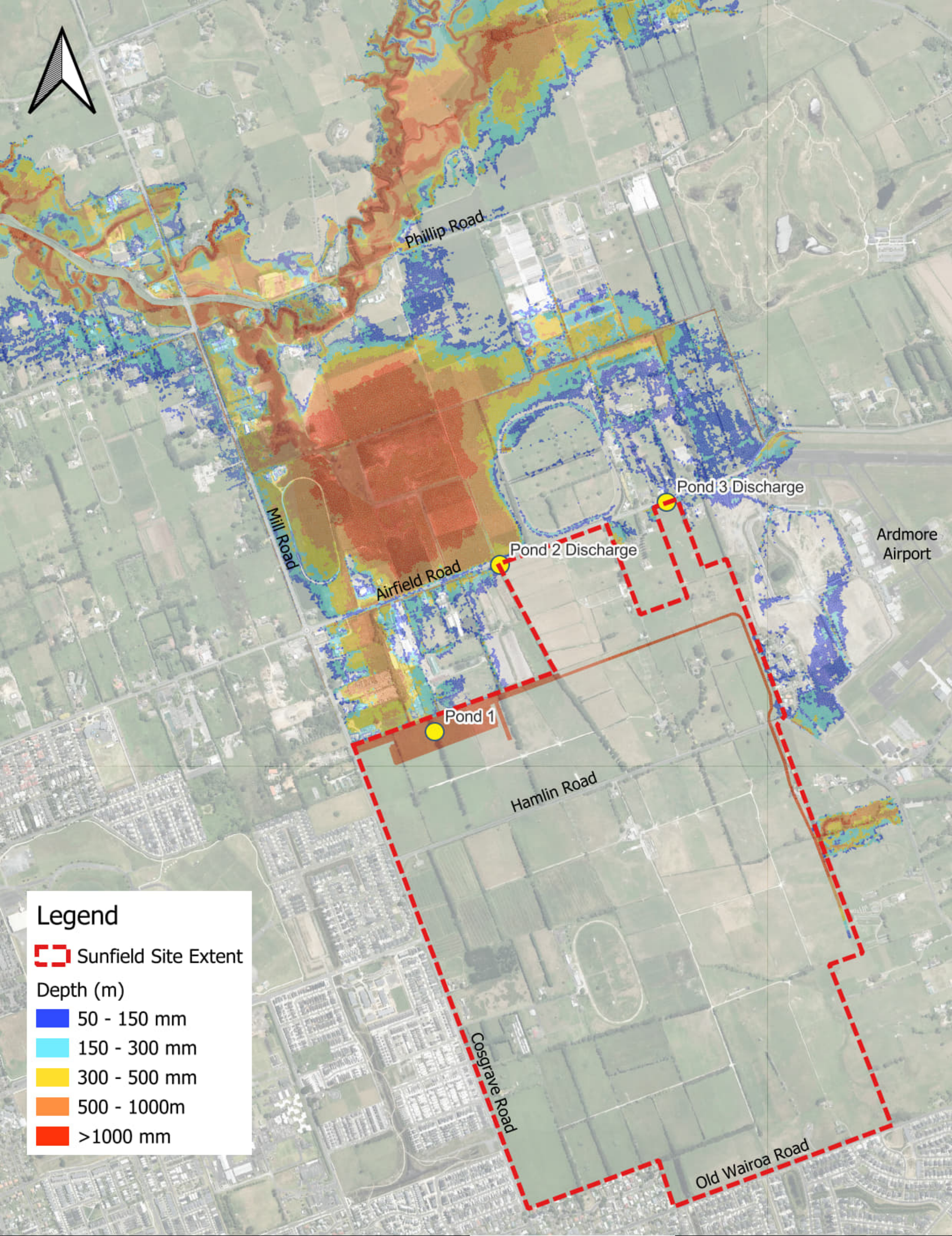
0 250 500 m



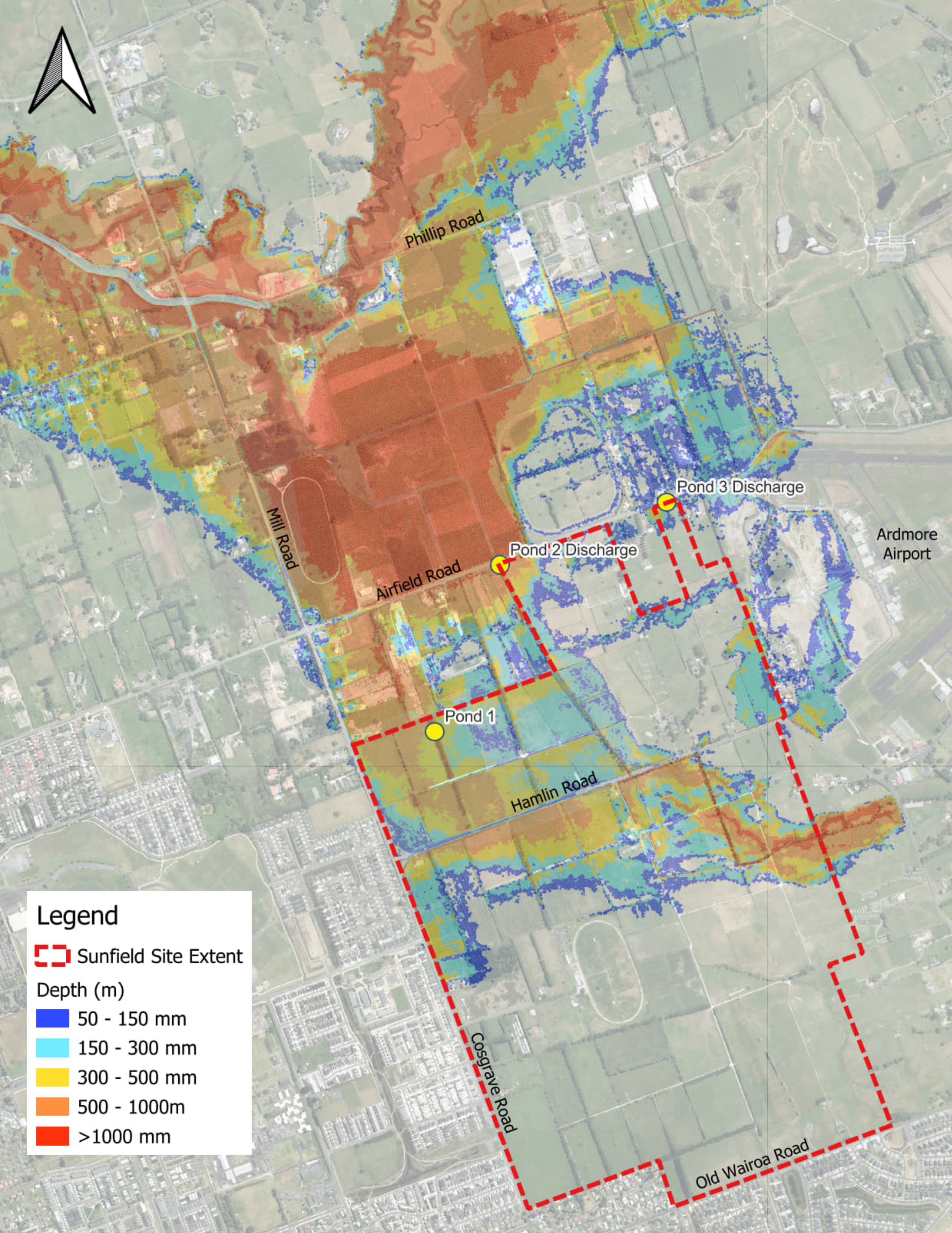
wsp / Auckland Council	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: M+SUN Peat CN: 61, Rainfall ARI: 2yr	0 250 500 m
		R0 / 09/07/2025	



wsp / Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: M Peat CN: 61, Rainfall ARI: 10yr	0 250 500 m
		R0 / 09/07/2025	

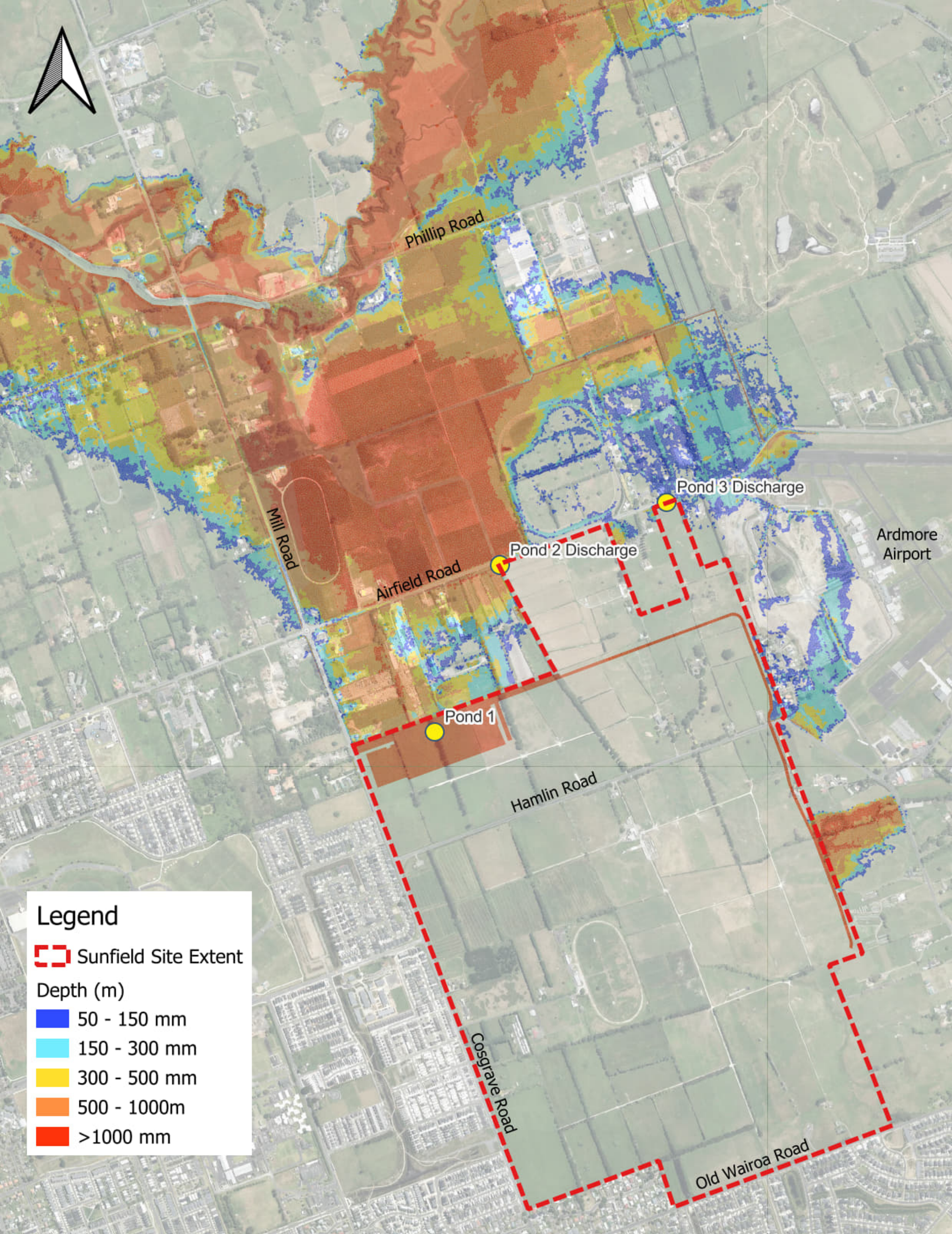


wsp Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: M+SUN Peat CN: 61, Rainfall ARI: 10yr	0 250 500 m
		R0 / 09/07/2025	



wsp Auckland Council Te Kaunihera o Tāmaki Makaurau

Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Scenario: M Peat CN: 61, Rainfall ARI: 100yr		0 250 500 m
	R0	09/07/2025	



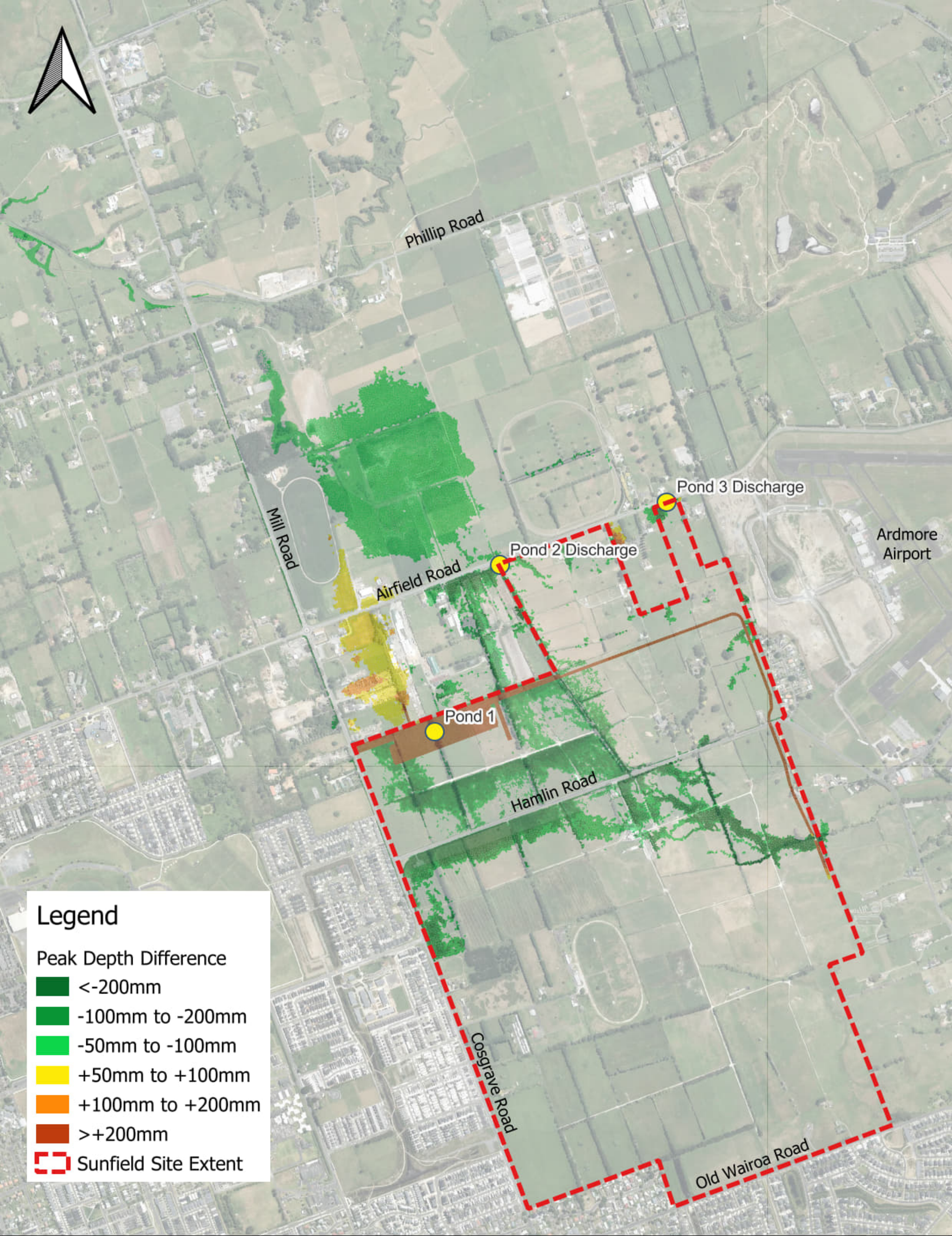
wsp | Auckland Council Te Kaunihera o Tāmaki Makaurau

Sunfield Proposed Development Assessment - Papakura Stream Catchment

Peak Depth
Scenario: M+SUN
Peat CN: 61, Rainfall ARI: 100yr

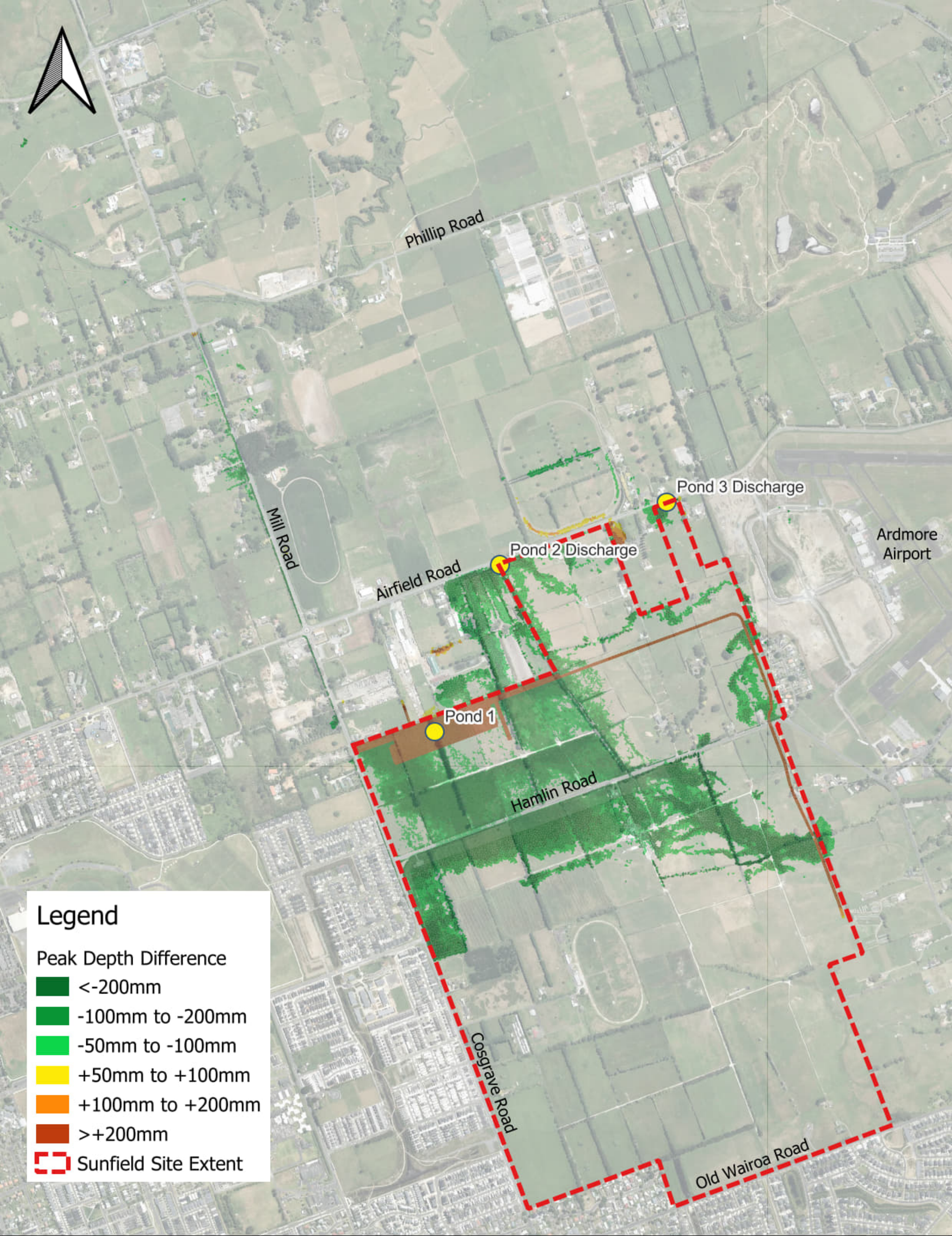
R0 | 09/07/2025

0 250 500 m

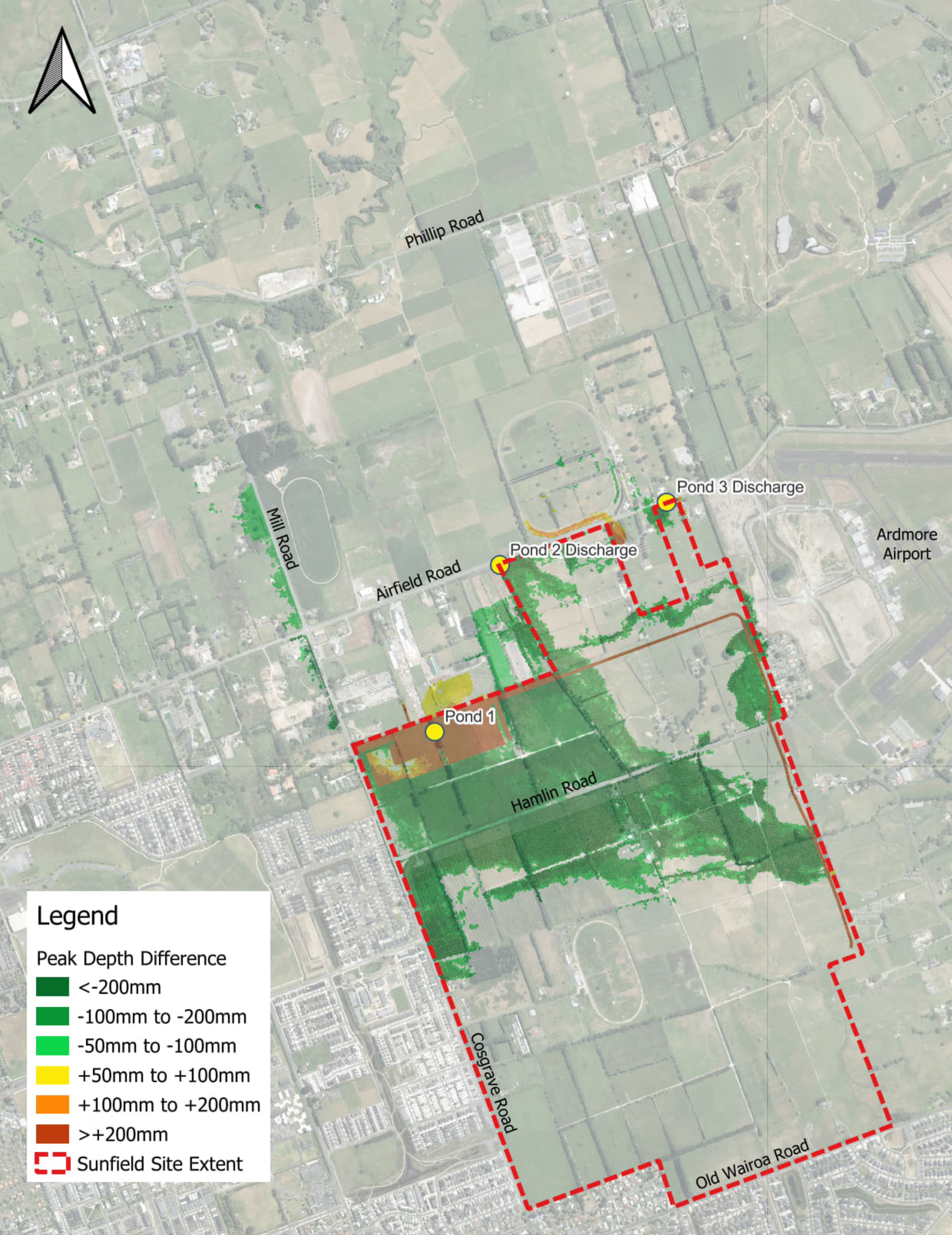


Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield E vs E+SUN Peat CN: 61, Rainfall ARI: 2yr
	R0 — 09/07/2025

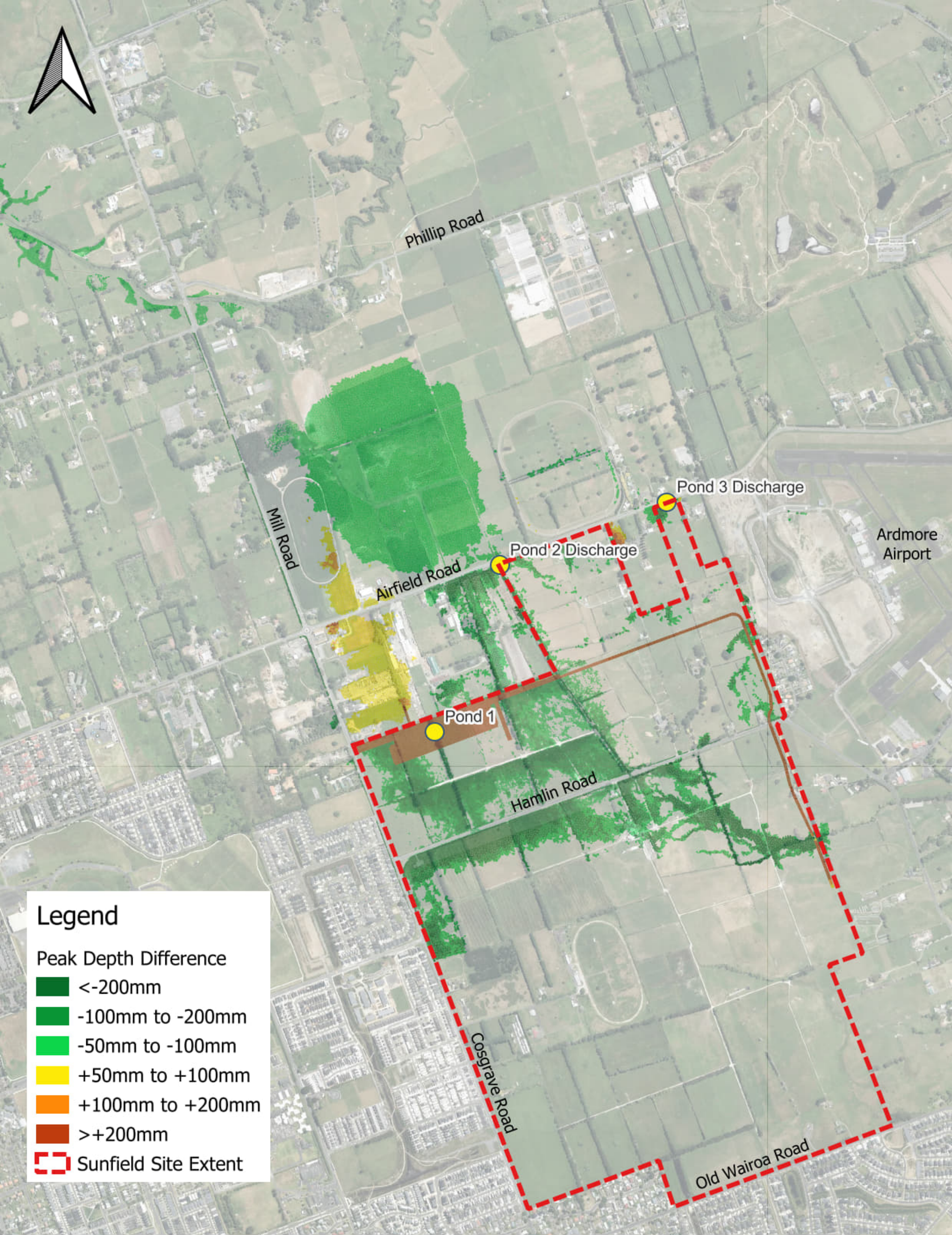
Auckland Council
Te Kaunihera o Tāmaki Makaurau



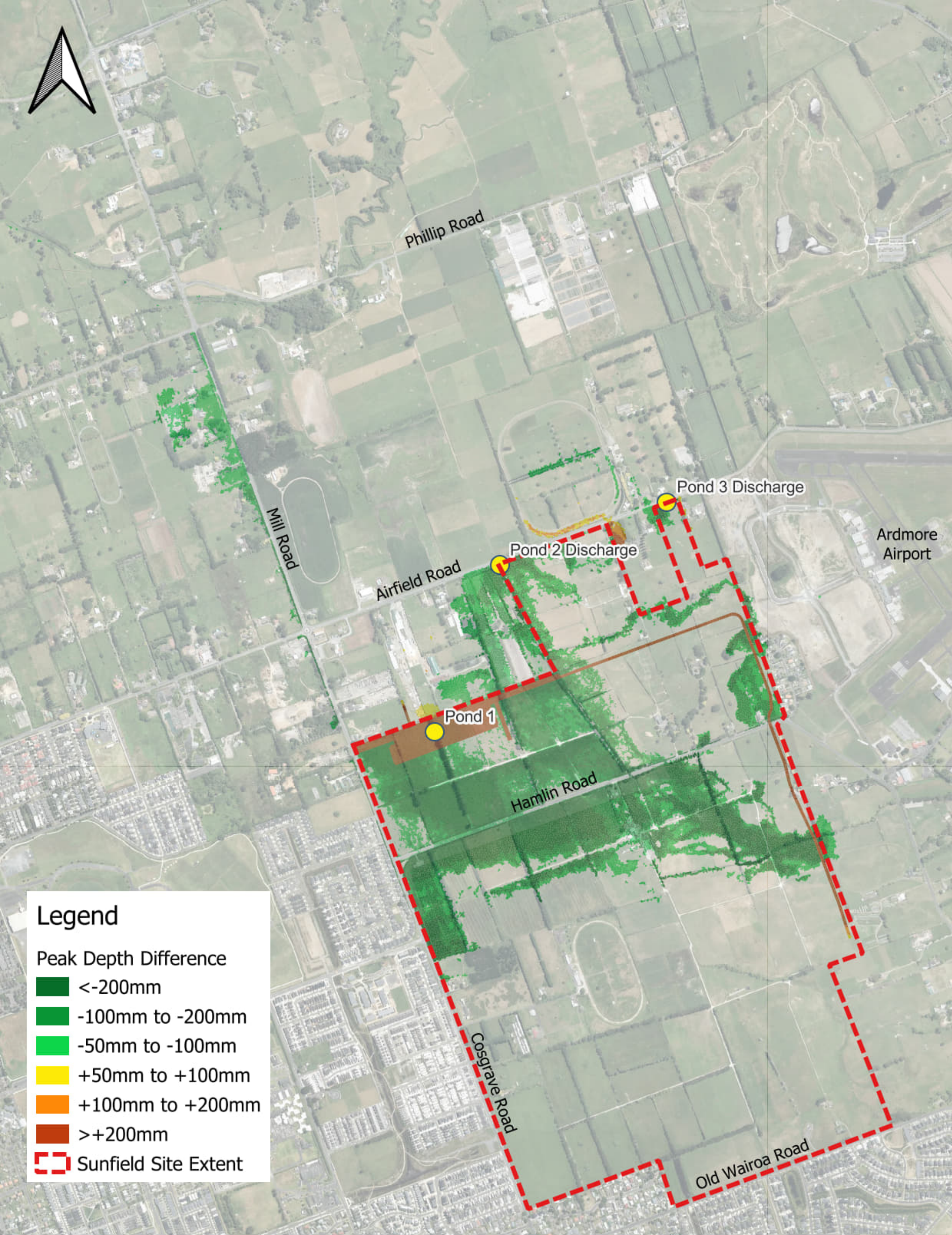
Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield E vs E+SUN Peat CN: 61, Rainfall ARI: 10yr		0 250 500 m
	R0	09/07/2025	



Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield E vs E+SUN Peat CN: 61, Rainfall ARI: 100yr	0 250 500 m
	R0 / 09/07/2025	



wsp / Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield M vs M+SUN Peat CN: 61, Rainfall ARI: 2yr	0 250 500 m
		R0	09/07/2025



Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield M vs M+SUN Peat CN: 61, Rainfall ARI: 10yr	0 250 500 m
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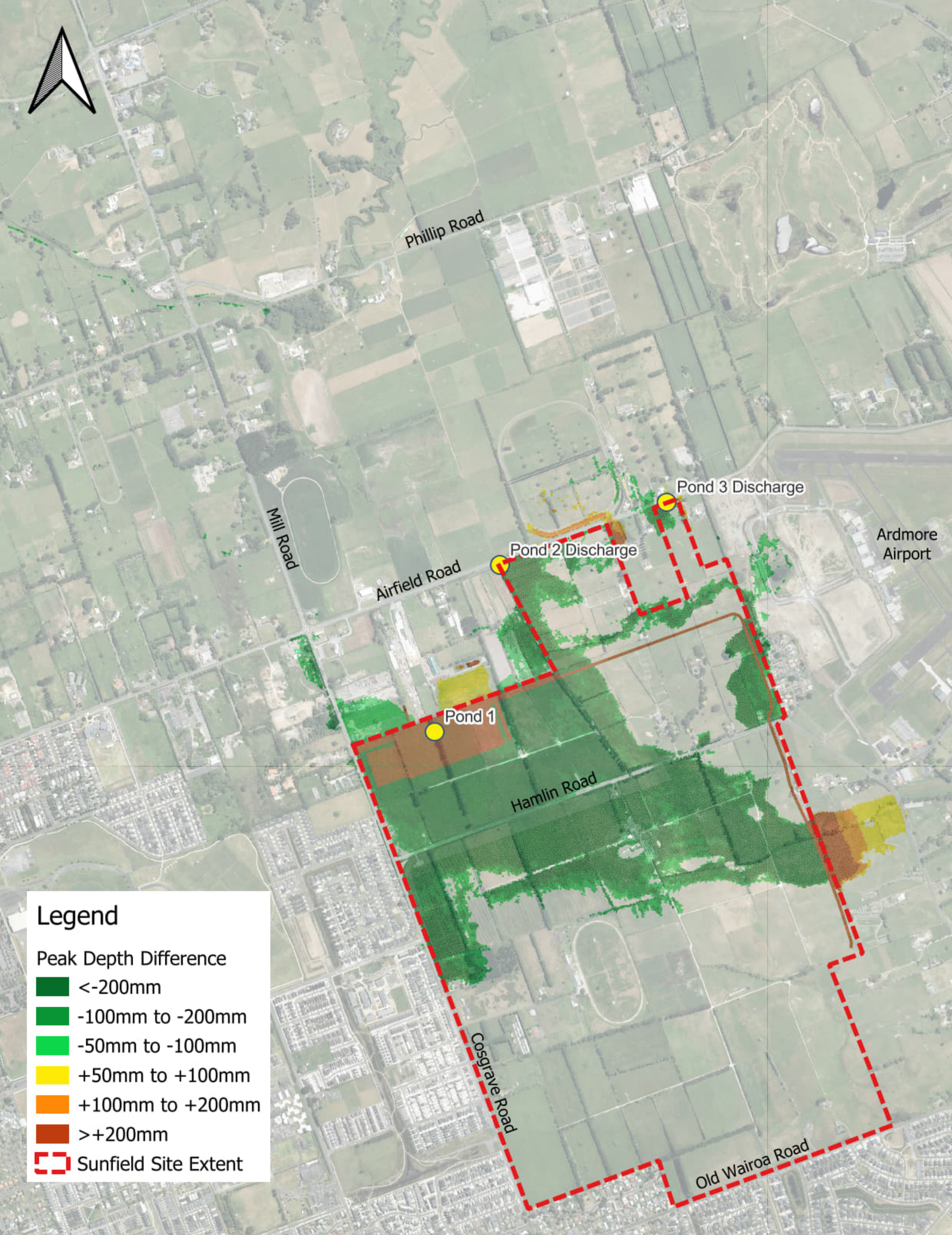

WSP / Auckland Council Te Kaunihera o Tāmaki Makaurau	Sunfield Proposed Development Assessment - Papakura Stream Catchment	Peak Depth Difference Sunfield M vs M+SUN Peat CN: 61, Rainfall ARI: 100yr	
		R0	09/07/2025