FLOWSTATE CONSULTING

STORMWATER ASSESSMENT

PEGASUS WEST - FTAA

WOLFBROOK DEVELOPMENT (PEGASUS) LIMITED

26/07/2026

FINAL

Image: Wairau Valley, Marlborough, New Zealand

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This document has been prepared by Flowstate Consulting LP for Wolfbrook Developments (Pegasus) Limited for the purpose of supporting a referral application under the Fast-track Approvals Act 2024, and may be relied upon by the Environmental Protection Authority, the Minister, and commenting parties in the fast track process. This assessment is based on preliminary design information available at the referral stage and will be refined through detailed technical work at the substantive application stage. No liability is accepted by Flowstate Consulting LP, or any employee or sub-consultant of the company, for any use of this document other than for its intended purpose, or in reliance on it prior to the completion of detailed design.

FLOWSTATE CONSULTING LP

4 Williamson Avenue, Ponsonby, Auckland, New Zealand

W: www.fsconsulting.co.nz

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Statement of Qualifications & Experience

Pranil Wadan

I am a Director of Flowstate Consulting LP and act as a Technical Consultant to Wood and Partners Consultants Limited, trading as Woods.

I hold a Bachelor of Engineering from the University of Auckland, completed in 2007. I am a Chartered Professional Engineer and a member of Engineering New Zealand and Water New Zealand. My additional professional qualifications and appointments include International Professional Engineer (IntPE(NZ)), Certified Independent Hearing Commissioner, and a Certificate in Company Direction and Governance.

I have more than 18 years' experience in stormwater design, hydrodynamic modelling, flood risk assessment, water infrastructure, and stormwater management for land development projects. I have acted as principal author and lead stormwater engineer for a wide range of stormwater management plans and flood modelling assessments prepared for projects across New Zealand.

My experience includes the development of catchment-scale flood models, detailed stormwater network models, and integrated catchment management plans for both private sector clients and territorial and regional authorities.

In my role as originator and reviewer of this report, I confirm that I have read and comply with the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Gina Nicholas

I am a Principal Engineer with Flowstate Consulting LP and a Chartered Professional Engineer. I have over 15 years' experience across stormwater, wastewater, and water supply in New Zealand.

I have led stormwater catchment modelling and master planning projects for multiple councils, including mitigation and conveyance assessments, level of service reviews, option development, and capital expenditure planning. Following the 2023 Auckland flood events, I contributed to the Tāmaki Makaurau Flood Recovery programme, undertaking property-level flood hazard assessments and technical reviews.

My technical expertise spans hydraulic modelling, flood hazard assessment, catchment management, infrastructure master planning, and long-term network planning.

I am experienced in InfoWorks ICM, DHI, H2OMAP, HEC-RAS, HEC-HMS, ArcGIS, and QGIS, and I work across the full project lifecycle, collaborating with councils, consultants, and project teams to deliver practical, technically robust infrastructure outcomes.

Executive Summary

Flowstate Consulting LP was engaged by Wolfbrook Developments (Pegasus) Limited to prepare a stormwater assessment to support a referral application under the Fast-track Approvals Act 2024 for the redevelopment of the former Pegasus Golf and Sports Club in North Canterbury.

Given the preliminary nature of a referral-stage application, this assessment sets out an overarching stormwater management strategy and includes indicative flood modelling. Detailed engineering design will be developed at the substantive application stage.

The key findings of the assessment are:

A swale-led, low-impact stormwater design approach is proposed, consistent with the established stormwater management approach used across Pegasus township. This will be supported by a range of complementary treatment and attenuation devices, sized in accordance with Part 5 of the Waimakariri District Council Engineering Code of Practice.

The principal development area is located outside the modelled Ashley River/Rakahuri breakout inundation extent, although a portion of the mapped breakout flood area extend into the Taranaki Stream and Taerutu Gully.

Preliminary hydraulic modelling indicates that hydraulic neutrality can be achieved, with no material increase in peak downstream flood levels as a result of the development.

Localised changes in flood depths and flow paths within and adjacent to the site are associated with the proposed earthworks and platform raising. These matters can be readily addressed through refinement of finished ground levels, overland flow paths, and compensatory storage during detailed design.

On this basis, stormwater effects associated with the Pegasus West Development can be appropriately managed, and the site can be serviced from a stormwater perspective. The remaining stormwater design matters, including final attenuation basin sizing and treatment device selection, are typical detailed design items and do not present a constraint to the development proceeding.

No stormwater-related matters have been identified that would prevent the development from being addressed through the substantive FTAA application process.

1. Introduction

Flowstate Consulting LP (Flowstate) has been engaged by Wolfbrook Developments (Pegasus) Limited (Wolfbrook) to provide stormwater engineering services in support of a referral application under the Fast-track Approvals Act 2024 (FTAA) for the proposed redevelopment of the former Pegasus Golf and Sports Club, located at 8 Mapleham Drive, Pegasus, North Canterbury. The proposal is referred to as the Pegasus West Development.

This memorandum presents a preliminary stormwater assessment to support the referral phase of the FTAA process. Consistent with the requirements of a referral application, whilst flood modelling has been undertaken, detailed engineering design has not commenced. Instead, this assessment establishes an overarching stormwater management strategy and demonstrates that no fundamental impediments exist to managing stormwater effects arising from the proposed development.

The scope of this assessment addresses the following stormwater matters:

- Summary of the existing site and its stormwater characteristics;
- Description of the proposed development and anticipated change in impervious coverage;
- Relevant regulatory framework and consent requirements;
- Proposed stormwater management strategy, including water quality, quantity attenuation, and flood management;
- Ashley River / Rakahuri breakout flood hazard assessment and confirmation of the site's position relative to the modelled breach inundation extent;
- Hydraulic modelling methodology, including modelling scenarios, flood effects assessment approach, and pre-development model review requirements;
- Stormwater treatment toolbox, with emphasis on the roadside swale-led low-impact design approach consistent with the established Pegasus area; and
- Key stormwater constraints and proposed mitigation measures.

2. Existing Site Description

The Pegasus West Development is located between Pegasus and Ravenswood and Woodend in North Canterbury. The site previously functioned as the privately owned Pegasus Golf and Sports Club, comprising an 18-hole golfing facility with accompanying clubrooms and café located at 8 Mapleham Drive. The site comprises an area of approximately 77 ha over multiple titles. It is bounded by the Taerutu Gully/ Pegasus township to the east, Main North Road (State Highway 1) to the east and rural property to the north and south. The Ravenswood Key Activity Centre is located immediately to the west of SH1.

Pegasus Boulevard bisects the site in generally a west to east alignment providing connectivity from Main Road North to the Pegasus township. There are a number of existing residential dwellings/lots that surround the former golf course and are accessed via various roads from Pegasus Boulevard.

2.1 Topography and Drainage

The site is generally gently undulating, reflecting its former use as a golf course fairway landscape. Some localised steeper terrain is present in the vicinity of the existing stormwater ponds. The general topographic fall is from the south-west to the north-east, with site elevations ranging from approximately RL 10 m to RL 4.5 m. This gradient broadly directs surface runoff toward the eastern portion of the site and the Taerutu Stream corridor.

Two natural watercourses are present within the site. The Taerutu Stream is located within the eastern portion of the site and has an established riparian corridor. The Taranaki Stream is present in the north-west quadrant and drains northwards to a confluence with the Taerutu Stream near Mapleham Drive as shown in Figure 1.

Figure 1: Watercourses / Stream Locations

2.2 Existing Stormwater Infrastructure

The existing stormwater network within the site and the surrounding Pegasus township reflects the low-impact design philosophy adopted during the original development of the township. Roadside grass swales provide primary stormwater conveyance and water quality treatment along existing road corridors, and drain to a series of shallow engineered stormwater ponds distributed across the golf course. These ponds are understood to have served a dual function - providing flood storage and acting as a source water reservoir for irrigation of the golf course fairways.

In general, the extent of piped stormwater infrastructure is limited, being largely confined to swale outlets discharging to the ponds and culverted road crossings. This low-impact approach is well established in the Pegasus area and provides the template for the proposed future stormwater servicing strategy. The Taerutu wetland is present within the eastern portion of the site.

2.3 Existing Flood Hazard

The site is generally not located within a high flood hazard area under the Waimakariri District Natural Hazards Flood Model (Figure 2),; the maps indicate that the site is generally free of flood hazards, with isolated areas of medium/high hazard corresponding to the topography of the former golf course.

In addition to the Natural Hazards Flood Model, the site is also subject to the Natural Hazards and Urban Flood Assessment Overlay shown in the Appeals Version of the Waimakariri District Plan, which distinguishes between the Non-Urban Flood Assessment (dark blue) and Urban Flood Assessment (light blue) overlays. A portion of the site falls within the Urban Flood Assessment overlay under this mapping (Figure 3).

The principal development area is located outside of the Ashley River / Rakahuri breakout flood hazard, although a portion of the mapped breakout flood area does extend into the Taranaki Stream and Taerutu Gully. Figure 4. The Ashley River / Rakahuri breakout flood hazards are discussed further in Section 5.

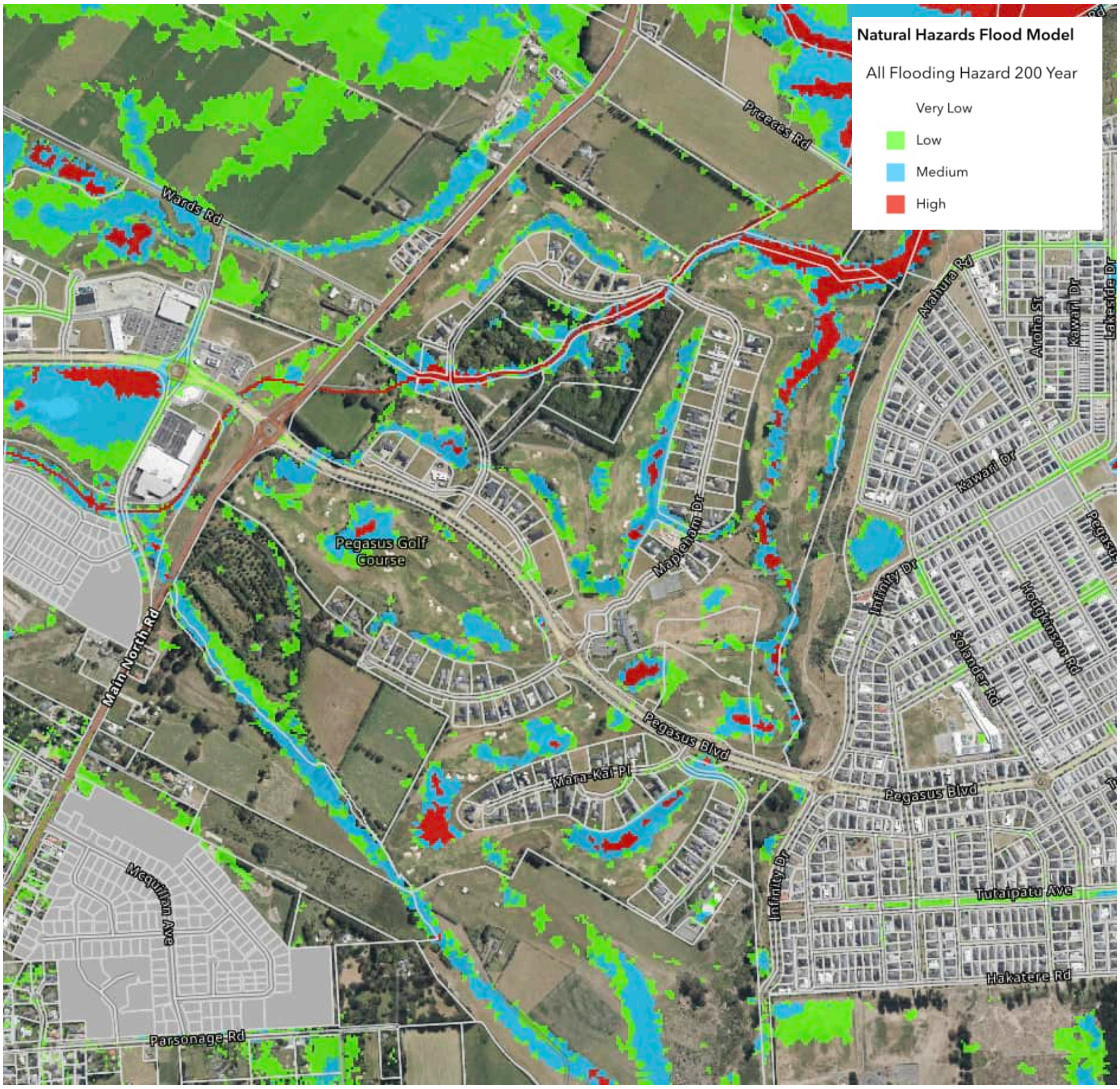


Figure 2: 200yr Flood Hazards (Source: Waimakariri District Natural Hazards Viewer)

Figure 3: Flood Overlay (Source: Appeals Version of the Waimakariri District Plan)

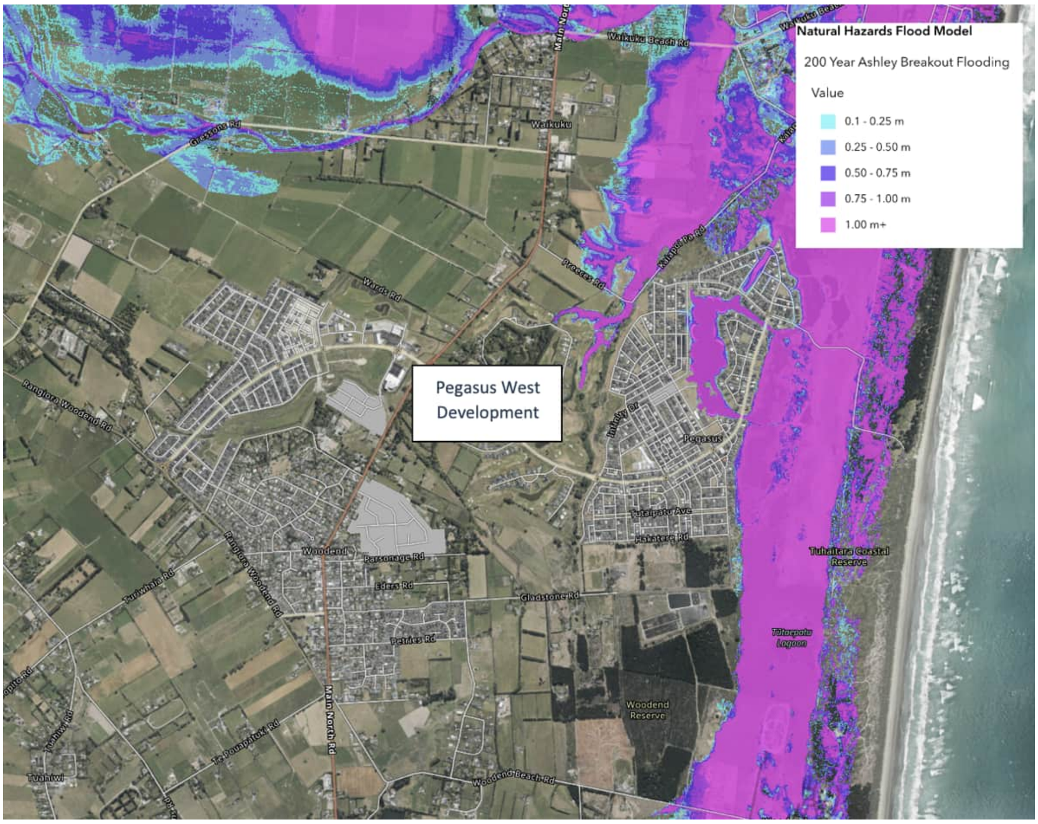


Figure 4: Ashley River / Rakahuri Breakout Scenario (Source: Waimakariri District Natural Hazards Viewer)

3. Proposed Development

The Project is a master-planned residential development with a neighbourhood scale commercial / community node and associated infrastructure, provided as a contiguous extension to the Pegasus, Ravenswood and Woodend urban area. The approximate 77-hectare site is known as 8 Mapleham Drive, Pegasus.

The Project will include the following:

- Staged subdivision and development to enable up to 1,000 residential allotments / dwellings across a range of residential densities and to cater for a range of typologies;
- Development of a commercial/community node that enables provision of day-to-day needs such as retail, service, healthcare, education, recreation and/or related activities for the community, with specific uses determined through community and market needs;
- Associated three waters infrastructure; including an integrated stormwater management and open space network featuring neighbourhood parks and green links;
- Minor alterations to Pegasus Boulevard to provide for the access requirements of the development including intersection improvements and a new road access;
- Associated earthworks, servicing, landscaping and related works to be implemented in stages.
- Areas of land set aside to recognise and provide for cultural and archaeological values including retention of archaeological site M35/440 (pā site) which is registered as a wāhi tapu on the New Zealand Heritage List / Rārangi Kōrero.

4. Design Framework

Stormwater management for the Pegasus West Development will be primarily governed by the Waimakariri District Council Engineering Code of Practice (WDC ECoP), specifically Part 5, Stormwater and Land Drainage. Part 5 was updated in February 2025 and includes revised design storm requirements and clarified modelling obligations.

The WDC ECoP Part 5 references the Christchurch City Council Waterways, Wetlands and Drainage Guide (CCC WWDG) for specific design parameters, including inundation design in Chapter 20, rainfall-runoff methodology in Chapter 21, and hydraulics in Chapter 22. Where there is any inconsistency between the WDC ECoP and the CCC WWDG, the WDC ECoP takes precedence.

4.1 Peak Flow Attenuation

WDC ECoP Part 5, Clause 5.52 (February 2025) sets out the peak flow attenuation requirements for new development. The requirement states: post-development peak flows must be less than pre-development peak flows for all rainfall intensity events assessed.

Compliance must be demonstrated across the 5-year, 10-year, 50-year, and 100-year ARI design events, and across storm durations ranging from 10 minutes to 72 hours. The assessment must also consider potential off-site effects.

As a minimum, stormwater management areas (SMA) must be sized to manage flows from the 10-year and 100-year ARI events. The effects of the other design events within the specified range must also be assessed and demonstrated. This requirement is broader than the CCC trigger-based approach and effectively requires hydrological neutrality to be demonstrated across a wide range of design scenarios. This requirement informs the hydraulic modelling scenarios for the development, and the indicative attenuation volume assessment presented in Section 8.

4.2 Minimum Design Standards

The minimum design storm standards required by the WDC ECoP for stormwater infrastructure are set out in the following table. These define the level of service to be achieved by each infrastructure type and inform the design of both the primary swale network and the secondary overland flow path system.

Table 1: Design Standards

System / Infrastructure	Minimum Design AEP
Primary reticulation (swales, pipes)	10% AEP (1-in-10-year)
Secondary system — overland flow paths	1% AEP (1-in-100-year)
Culverts	10% AEP (1-in-10-year)
Bridges	1% AEP (1-in-100-year)

4.3 Off-Site Flooding Effects

WDC requires new development to avoid increasing the depth or duration of off-site flooding up to the relevant design event, unless any increase is negligible and can be demonstrated to have no detrimental effect on downstream or adjacent properties.

The flood assessment for the Pegasus West Development will therefore address the following matters in relation to off-site flood effects:

- Downstream culvert and watercourse capacity, confirming that post-development flows do not exceed the capacity of existing downstream infrastructure.
- Floodplain extent, confirming that post-development flood levels and floodplain boundaries are not adversely affected when compared with pre-development conditions.
- Upstream ponding risk, assessing whether backwater effects from proposed infrastructure could increase flood risk on upstream properties.
- Secondary flow paths, confirming that defined overland flow paths are maintained under post-development conditions and that secondary flows do not create new adverse effects on adjacent properties.

4.4 Rainfall Design Inputs, Climate Change, and Detention Volume Method

Rainfall design inputs have been derived in accordance with WWDG Chapter 21, which references HIRDS V4 and adopts the RCP8.5 climate change scenario for assessing future rainfall intensities. The use of HIRDS V4 RCP8.5 allows the design rainfall inputs to account for projected increases in rainfall intensity under a high-emissions climate trajectory. This is consistent with a precautionary design approach.

WWDG Chapter 21, Section 21.5 sets out a detention volume calculation method for sizing flood attenuation storage. The method is based on detaining a longer-duration storm event, with the critical duration determined by the characteristics of the receiving catchment.

The WWDG method is a single-event design check calibrated to the 2% AEP, 50-year ARI event for Christchurch City zoning and soil conditions. This differs from the broader hydrological neutrality assessment required under the WDC ECoP, which requires post-development peak flows to be no greater than pre-development peak flows across the 5-year, 10-year, 50-year, and 100-year ARI events, and across the full 10-minute to 72-hour storm duration range.

On this basis, the WDC ECoP requirement is considered the controlling design standard for this development, given its explicit multi-event, multi-duration assessment basis, and the FTAA referral context.

Accordingly, the primary attenuation volume assessment for the Pegasus West Development, presented in Section 8, adopts a depth-based volumetric method consistent with the broader WDC ECoP hydrological neutrality requirements. This assessment uses site-specific HIRDS V4 RCP8.5 rainfall depths across the full range of required ARI events and storm durations.

4.5 Minimum Finished Floor Levels

Minimum finished floor levels (FFLs) for habitable buildings must be set to manage flood risk and meet the relevant planning and Building Code requirements.

FFLs must comply with Waimakariri District Plan Part 2 - District Wide Matters - Natural Hazards and Urban Flood Assessment Overlay, where those provisions apply. Where the District Plan provisions do not apply, FFLs must comply with Building Code Clause E1/AS1, subject to the limitations of that document. The applicable freeboard allowance should be confirmed with WDC at detailed design stage.

4.6 Water Quality

Stormwater treatment for the development must be designed to meet WDC ECoP Part 5 requirements. Alternative treatment methods may be proposed where they are supported by evidence from recognised authorities as stated in WDC ECoP Part 5 - 5.8.4.

The baseline treatment standard is 75% total suspended solids, TSS, removal. This applies to runoff from new impervious areas, including roads, accessways, parking areas, roofs, and other hardstand surfaces.

First flush treatment will be required for new hardstand areas. For volume-based treatment devices, the first flush is generally the runoff from the first 25 mm of rainfall over impervious surfaces. For flow-based treatment systems, it generally relates to rainfall intensities up to 5 mm/hr.

Where appropriate, Auckland Council GD01 (note as this supersedes ARC TP10 which is referenced in the WDC ECoP) may be used as best-practice guidance for sizing treatment devices and developing treatment train solutions, subject to confirmation with WDC.

Stormwater runoff from the proposed residential and commercial areas may also contain hydrocarbons, heavy metals, and nutrients. The need for specific treatment requirements or monitoring for these contaminants will be confirmed with WDC and ECan during the substantive consenting process.

The stormwater treatment options described in Section 8 include devices that can manage TSS and other common urban stormwater contaminants.

5. Ashley River/Rakahuri Breakout Assessment

5.1 Background — Ashley Breakout Flooding

The Ashley River / Rakahuri is located approximately 4 km north of the Pegasus West Development site. Ashley River breakout flooding refers to flooding that may occur if the Ashley River stopbank system is overtopped or breached during a flood event.

Breakout flood events include two components. The first is floodwater entering the floodplain directly from the Ashley River as a result of the breach, referred to as the fluvial component. The second is local rainfall occurring at the same time as the breach event, referred to as the pluvial component.

The Ashley River stopbank system protects low-lying land on both the north and south banks from inundation during river flood events. In a breach scenario, floodwaters may enter the downstream floodplain. The resulting extent and depth of inundation depend on the breach location, breach characteristics, flood magnitude, and the surrounding ground levels.

5.2 Site Position Relative to the Breach Inundation Extent

Based on a review of the available Ashley River breakout flood hazard mapping, the principal urban development area of the Pegasus West Development site is not located within the modelled Ashley River breach inundation extent. A portion of the mapped breakout flood area extend into the Taranaki Stream and Taerutu Gully. This is shown on the Waimakariri District Natural Hazards Viewer as shown in Figure 5.

The site is located south of the Ashley River on the elevated landform of the former Pegasus Golf and Sports Club. Existing site levels range from approximately RL 4.5 m to RL 10 m. The site is topographically separated from the Ashley River floodplain, and Pegasus township is generally elevated relative to the lower-lying land to the north. On this basis, the site is not expected to be directly inundated by an Ashley River breakout event under the currently modelled scenarios.

Figure 5: Ashley River / Rakahuri Breakout Scenario (Source: Waimakariri District Natural Hazards Viewer)

5.3 Implications for the Development

As the site is located outside the modelled Ashley River breach inundation extent, no specific Ashley River breakout flood mitigation measures are required for the Pegasus West Development. The stormwater management strategy described in this report addresses local post-development flood hazard arising from increased runoff, which is independent of the Ashley River breach scenario.

6. Stormwater Management Strategy

The stormwater management strategy for the Pegasus West Development builds on the low-impact design approach already established across Pegasus township.

The strategy adopts a swale-led treatment and conveyance system, supported by a toolbox of complementary stormwater devices. These devices will be selected and combined to manage stormwater quality, conveyance, and quantity in a way that responds to the site conditions, meets the relevant design requirements, and aligns with local stormwater management precedent.

6.1 Primary Conveyance and Treatment Swales

Roadside grass swales will form the primary stormwater conveyance and treatment system for the development. This approach is consistent with the stormwater design already used throughout the established Pegasus township.

The swales will be designed and sized in accordance with the WDC ECoP to convey the 10% AEP storm event within the swale channel. The vegetated base and side slopes will provide stormwater treatment through filtration, settling, and biological uptake. This will assist with the removal of suspended solids, heavy metals, and other common urban stormwater contaminants.

Swales are well suited to the Pegasus West site for the following reasons:

- They are consistent with the existing Pegasus stormwater design approach.
- The topography is suitable for swale construction.
- The road corridors can accommodate swales without compromising lot layout.
- Incidental infiltration can help support pre-development baseflow to receiving watercourses.

6.2 Secondary Flow Conveyance

Road corridors will provide the secondary flow path system for the development. They will convey flows that exceed the primary swale capacity.

Overland flow paths will be directed along defined road corridors toward the stormwater management basins. Road cross-sections and intersection layouts will be designed to keep flows safely within the road reserve during the design event.

6.3 Flood Attenuation Devices

Flood attenuation will be provided to manage post-development runoff volumes and peak flow rates in accordance with WDC requirements.

Where appropriate, existing golf course stormwater ponds could be retained or reconfigured to form part of the attenuation network.

7. Stormwater Management Toolbox

The following table summarises the stormwater treatment and management devices proposed for the Pegasus West Development. Roadside grass swales are the primary device and are able to be applied throughout the development. Additional devices from the toolbox may be applied at detailed design stage to address specific site or catchment constraints, or to enhance treatment performance where required.

Table 2: Stormwater Management Toolbox

Device	Private Applications	Public Applications	Design Details	Performance Standard TSS Removal*	Key Considerations
Roadside Grass Swale (Primary Device)	Residential and commercial hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	Trapezoidal or parabolic grassed channel running adjacent to road corridors. Sized to convey the 10% AEP flow within the channel cross-section with appropriate freeboard. Check dams incorporated where longitudinal grade is low or additional hydraulic retention time is required.	**> 70%-75%**	Primary device applied throughout the development, consistent with the established Pegasus design typology. Provides combined conveyance and water quality treatment. Incidental infiltration supports baseflow to receiving watercourses. Maintained by Council as part of road reserve.
Bioretention Devices (rain gardens / tree pits)	Private roads, accessways, carparks	Public roads, parking bays, footpaths	Possible devices include, but are not limited to, rain gardens (individual or communal) and tree pits. Indicative sizing to be conducted on a per unit area basis at detailed design stage.	**> 75%**	Preferred primary at-source treatment device for public and private roads. To be integrated into landscape and planting schemes, providing opportunities for biodiversity and habitat. Good contaminant removal performance makes these appropriate for meeting reduction targets for sensitive receiving environments. Pre-treatment via structural devices to trap sediment, litter and debris to be considered at detailed design. Private devices maintained by lot owners or body corporate; public devices maintained by Council.
Communal Device (wetland)	Residential hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	A communal device can be placed within downstream areas of a catchment, prior to discharge to a stream or watercourse. The device will be sized to treat the water quality flow and will comprise a footprint of approximately 3–5% of the contributing impervious area, in accordance with appropriate design standards.	**> 75%**	Communal treatment can be provided in areas draining to a single discharge point. Devices are to be placed within downstream sections of the catchment to maximise runoff capture from the upstream area. To be integrated into landscape and planting schemes with opportunities for biodiversity and habitat. Public devices maintained by Council.

Gross Pollutant Traps	Residential and commercial hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	A list of possible devices is included below: – Hynds Downstream Defender – Atlan Vortceptor – Atlan Baffle Box – Atlan Flowguard	**< 73% – 93%**	Used to remove contaminants including litter, debris and gravel. Numerous commercial products available. Private devices maintained by lot owners or body corporate; public devices maintained by Council.
Catchpit Inserts	Residential hardstand (small areas)	Passive applications	A list of possible devices is included below: – Atlan Stormsack – Stormwater 360 EnviroPod – Stormwater 360 LittaTrap	**< 45% – 50%**	Suitable for capturing runoff from small hardstand areas that are low contaminant generating. Simple, low-cost passive device.
Inert Roofing Materials	Residential and commercial roofing	Not applicable	Not applicable	**–**	Buildings to incorporate low-contaminant generating roofing and spouting materials to minimise contaminant generation at source. A source control measure rather than a treatment device.
Proprietary Treatment Devices	Private roads, accessways, carparks and commercial areas	Roads, parking bays	A list of possible devices is included below: – Hynds Upflow Filter or similar – Stormwater 360 Jellyfish Filter – Stormwater 360 StormFilter	**< 80% – 90%**	To be considered where other options have been assessed and found to be unsuitable or impractical. Can be used as part of a treatment train in conjunction with bioretention devices or infiltration where subsurface conditions allow. Numerous commercial products available. Specific design required for each application.

Note:

Devices will be selected and sized to meet WDC ECoP performance standards for the specific land use context at substantive application stage.

** TSS Removal performance figures are indicative only and are based on published literature and device manufacturer data. Actual performance will depend on device sizing, configuration, and maintenance regime.*

8. Preliminary Attenuation Volume Assessment

A preliminary attenuation volume assessment has been carried out for the Pegasus West Development to support the stormwater management strategy and provide an early conservative estimate of the storage infrastructure likely to be required.

The assessment uses a volumetric method consistent with WDC ECoP .It is based on HIRDS V4 RCP8.5 end-century rainfall depths for the Pegasus / Woodend area, together with runoff coefficients representative of the pre-development and post-development land use conditions.

A full set of calculations can be found in Appendix A. The key assumptions and results are summarised as follows.

- Development area: approx. 77 ha
- Pre-development runoff coefficient: 0.35, adopted for the former Pegasus Golf Course to reflect maintained turf with engineered drainage.
- Post-development runoff coefficient: 0.725
- Rainfall design inputs: HIRDS V4 RCP8.5, 2081 to 2100, rainfall depths for the site location, latitude -43.3107, longitude 172.6818, sourced directly from the NIWA HIRDS V4.
- Storm durations assessed: 10 minutes to 72 hours, in accordance with WDC ECoP.
- The 72-hour duration is both the maximum duration required by the ECoP and the governing duration for basin volume sizing at this site, as calculated volumes increase progressively up to 72 hours within the required assessment range.
- ARI events assessed: 5-year, 10-year, 50-year, and 100-year events, as required by WDC ECoP.
- A volumetric method has been used, where incremental runoff volume is calculated as rainfall depth × site area × change in runoff coefficient. This provides a conservative upper-bound estimate of the attenuation storage likely to be required.

8.1 Attenuation Volumes

The indicative incremental attenuation volumes are summarised below for the critical storm duration at each ARI event. The assessment adopts a pre-development runoff coefficient of Cpre = 0.35.

The critical storm duration for basin volume sizing is 72 hours. This is the maximum duration required by WDC ECoP Part 5, and is the governing case for this site, as calculated attenuation volumes increase progressively from 10 minutes to 72 hours across the required assessment range.

Detailed results for all assessed storm durations are provided in Appendix A, A summary of the results is shown in Table 3.

Table 3: Attenuation Volume Summary for Critical Duration

ARI Event	Critical Duration	Rainfall (mm) HIRDS V4 RCP8.5	Pre-dev Runoff Vol (m^3)	Post-dev Runoff Vol (m^3)	Attenuation Vol (m^3)
5-year	72 hours	116.0	31,262	64,757	**33,495**
10-year	72 hours	140.0	37,730	78,155	**40,425**
50-year	72 hours	199.0	53,630	111,092	**57,461**
100-year	72 hours	225.0	60,637	125,606	**64,969**

8.2 Pre-Development Runoff Coefficient

A pre-development runoff coefficient of Cpre = 0.35 has been adopted for the Pegasus West Development. This value reflects the former golf course land use and the existing drainage characteristics of the site.

The site is not considered representative of unimproved pasture or long grass. The former golf course has been maintained as closely mown turf, with regular mowing, rolling, and mechanical management. These activities are expected to resulted in a more compacted surface layer and a faster runoff response than would occur from unmanaged grassed land.

The site also contains existing drainage infrastructure, including grass swales, subsurface drainage, and stormwater ponds. These systems were established to drain the golf course and convey runoff from the playing surfaces.

Groundwater conditions are also relevant. The site is located near Pegasus Lake and the Taerutu and Taranaki stream systems, where shallow groundwater conditions may be present in lower-lying areas. A shallow groundwater table can reduce available soil storage and limit infiltration, particularly during longer-duration storm events. On this basis, Cpre = 0.35 is considered appropriate

As a result, the pre-development catchment is expected to generate a higher runoff response than undrained rural land of equivalent area, reflecting the influence of compacted turf surfaces, the existing engineered drainage network, and shallow groundwater conditions.

8.3 Attenuation Device Areas

The design requirement under WDC ECoP Part 5, Clause 5.52, is the 100-year ARI event at the 72-hour critical duration. Based on the adopted pre-development runoff coefficient of Cpre = 0.35, the indicative attenuation volume for the 100-year ARI event is approximately 64,969 m^3.

The indicative basin footprint depends on the average operating depth adopted at detailed design. At an average basin depth of 1.0 m, the required footprint would be approximately 6.5 ha. At an average basin depth of 1.5 m, the required footprint would reduce to approximately 4.3 ha.

These areas represent approximately 8.4% and 5.5% of the 77 ha site area respectively. Based on the indicative masterplan, the required attenuation area is noted to be achievable.

9. Hydraulic Flood Assessment

A preliminary flood model for the Pegasus West Development using InfoWorks ICM v26.3 to assess the flood risk associated with the proposed development and compare pre-development (base) and post-development scenarios. The model simulates overland flows in a 2D domain and was run for 100-year and 200-year ARI storm events with climate change. The following sections describe the model build, key parameters, and results.

9.1 Methodology and Scope

The methodology followed in this assessment is as follows:

- Develop a model for the existing (pre-development / base) scenario using the latest available LiDAR data and site-specific information;
- Define the model extent and boundary conditions based on the contributing catchment and overland flow paths discharging toward the site;
- Run the base scenario for 100-year and 200-year ARI storm events with climate change;
- Develop a post-development scenario modelling the indicative masterplan and elevated development levels and run for 100-year and 200-year ARI storm events with climate change;
- Assess the difference in flood levels between the base and post-development scenarios

9.2 Model Extents

The model is created based on the latest LiDAR 2025 data using the NZVD2016 datum as shown in Figure 6. The model extent covers an area of 5902 hectares, capturing the upstream contributing area based on overland flow paths discharging towards the site location.

Figure 6 Site & Model Extent

9.3 2D Modelling

The Rain On Grid (ROG) model is created by developing a 2D Zone (extent shown in Figure 6). LiDAR data is used with Vertical Accuracy Specification is +/- 0.2m (95%), Horizontal Accuracy Specification is +/- 0.6m (95%), and Vertical datum is NZVD2016. The clip–meshing approach was adopted, along with the 'Normal Condition' boundary type, for modelling using InfoWorks ICM.

The mesh resolution was set to a maximum element size of 30 m² and a minimum element size of 10 m² for the 2D Zone.

A mesh zone is created with max element size of 30m² and min element size 5m² to obtain more accurate spatial results in vicinity. Detailed element size of 10m² and 5m² was used in the vicinity of the site.

Roughness zones were modelled based on the Manning's (n) roughness values as described in Table 4.

9.4 Rainfall

A rainfall time series was generated for the 24-hour rainfall depths corresponding to the 100- and 200-year Average Recurrence Interval (ARI) design storms, based on the WDC design rainfall isohyets graphs used for the districtwide modelling undertaken.

Table 1: Rainfall

ARI	Rainfall depth (mm)
100-year	205.95
200-year	230.27

9.5 Surface Hydrology and Infiltration Modelling

9.5.1 Basis of Existing Flood Modelling

The original district-wide flood modelling undertaken by DHI for Waimakariri District Council utilised the MIKE 21 Infiltration and Leakage Module to represent rainfall losses and infiltration processes. Rather than applying fixed runoff coefficients, infiltration parameters were developed from a detailed MIKE SHE catchment model, which simulated long-term soil moisture, unsaturated zone processes, and groundwater interactions. The objective was to ensure that the simplified flood model reproduced the hydrological behaviour of the more physically based MIKE SHE model. The DHI methodology generated spatially varying layers representing:

- Initial infiltration rate
- Final infiltration rate (saturated hydraulic conductivity)
- Initial soil saturation
- Effective porosity
- Soil storage depth (assumed as 1 m)

These parameters were derived from calibrated Canterbury soil properties and 24 years of climate simulation using MIKE SHE.

9.5.2 Representation of Impervious Areas in the DHI Model

The DHI model recognised that the base soil infiltration rates reflected natural soil conditions and therefore required adjustment to account for urban development and impervious surfaces. As a result, land use modifiers were applied as follows:

Table 2: Landuse & Infiltration Capacity

Land Use	Applied Infiltration Capacity
Buildings	0% (fully impervious)
Roads	0% (fully impervious)
Residential Areas	50% of original soil infiltration
Industrial Areas	20% of original soil infiltration

Wastewater Treatment Plants	Unchanged
Crop Land	Unchanged

Roads were buffered by 5 m either side of centrelines and assigned zero infiltration. Building footprints were also assigned zero infiltration. Residential development was represented with an effective imperviousness of approximately 50%, while business and industrial zones were assigned substantially lower infiltration capacities.

9.5.3 Equivalent Representation in InfoWorks ICM

To replicate the hydrological behaviour of the DHI base model within InfoWorks ICM, a surface-based infiltration approach was adopted.

Pervious surfaces within the base case were modelled using the Green-Ampt infiltration method in InfoWorks ICM. Parameters were selected to replicate the infiltration response of the original DHI flood hazard modelling, which was developed from calibrated MIKE SHE and MIKE 21 soil infiltration datasets. The adopted parameter ranges included Green-Ampt suction heads between 100 and 200 mm, saturated hydraulic conductivities between 1.7 and 7.5 mm/hr, and initial soil moisture deficits between 0.27 and 0.69. These parameters were assigned spatially according to the mapped soil drainage classes and represent varying infiltration capacities across the study area. Impervious roofs, roads and hardstand areas were excluded from Green-Ampt infiltration and modelled separately using an impervious surface category.

9.5.4 Green-Ampt Infiltration Parameter Selection

Surface infiltration within the InfoWorks ICM model was represented using the Green-Ampt infiltration method for all pervious land surfaces. The Green-Ampt method was selected because it provides a physically based representation of infiltration processes and enables infiltration capacity to vary dynamically according to soil moisture conditions throughout a storm event.

The adopted Green-Ampt parameters were selected to replicate, as closely as practicable, the infiltration behaviour represented in the original DHI flood hazard modelling. The DHI methodology developed spatially varying infiltration parameters from a calibrated MIKE SHE model, which simulated long-term soil moisture conditions, unsaturated zone processes and infiltration dynamics across the catchment. The resulting infiltration layers incorporated variations in soil type, hydraulic conductivity, effective porosity and antecedent soil moisture conditions across the study area.

To maintain consistency with the original modelling, the InfoWorks ICM infiltration surfaces were grouped into a series of representative soil classes with Green-Ampt parameters reflecting the range of infiltration properties identified by DHI. These parameters included suction heads between 100 mm and 200 mm, saturated hydraulic conductivities between 1.7 mm/hr and 7.5 mm/hr, and initial moisture deficits between 0.27 and 0.69. The variation in parameters reflects differences in drainage characteristics across the mapped soil types, ranging from relatively poorly drained soils to more freely draining soils. The adopted conductivity values are also consistent with the calibrated infiltration rates documented in the DHI infiltration layer development work.

The initial moisture deficit parameter was used to represent antecedent soil moisture conditions and available storage within the soil profile at the commencement of the simulation. Higher deficit values correspond to drier soil conditions and therefore greater infiltration potential, while lower deficits represent soils with a greater degree of saturation prior to rainfall. This approach allows the infiltration response to vary naturally throughout the event rather than relying on fixed runoff coefficients. The maximum moisture deficit was set at 0.20 m consistent with the infiltration surface definitions developed for the model.

The Green-Ampt parameterisation was applied only to pervious surfaces. Roads, roofs, driveways and other impervious areas were excluded from the Green-Ampt infiltration process and represented separately using a dedicated impervious land use category. This approach is consistent with the original DHI methodology, which assigned zero infiltration to roads and building footprints and reduced infiltration within urban areas to account for increased impervious cover.

The adopted Green-Ampt parameters therefore provide a physically realistic representation of infiltration while preserving consistency with the underlying hydrological assumptions used in the original flood hazard model. This enables meaningful comparison between pre-development and post-development scenarios and ensures that changes in runoff response are primarily driven by changes in land use and imperviousness rather than changes in underlying soil properties.

Pervious surfaces were represented using the Green-Ampt infiltration model, which provides a physically based simulation of infiltration through the soil profile. The Green-Ampt parameters were selected to broadly replicate the infiltration response used within the DHI MIKE 21 models.

Pervious surfaces within the base case were modelled using the Green-Ampt infiltration method in InfoWorks ICM. Parameters were selected to replicate the infiltration response of the original DHI flood hazard modelling, which was developed from calibrated MIKE SHE and MIKE 21 soil infiltration datasets. The adopted parameter ranges included Green-Ampt suction heads between 100 and 200 mm, saturated hydraulic conductivities between 1.7 and 7.5 mm/hr, and initial soil moisture deficits between 0.27 and 0.69. These parameters were assigned spatially according to the mapped soil drainage classes and represent varying infiltration capacities across the study area. Impervious roofs, roads and hardstand areas were excluded from Green-Ampt infiltration and modelled separately using an impervious surface category. The adopted Green-Ampt parameters included:

Table 3: Green-Ampt Parameters

Parameter	Value Range
Suction Head	100 - 200 mm
Hydraulic Conductivity	1.7 - 7.5 mm/hr
Initial Soil Moisture Deficit	0.27 - 0.69
Maximum Deficit	0.20 m

These values represent varying soil drainage classes and are consistent with the soil infiltration ranges reported within the DHI infiltration layer development, where calibrated initial infiltration rates ranged from approximately 1.7 mm/hr to over 20 mm/hr and final infiltration rates ranged from approximately 0.125 mm/hr to 7.5 mm/hr depending on soil type.

9.5.5 Post-Development Imperviousness Modelling

For the post-development scenario, urbanisation was represented through modifications to the land use allocation within the InfoWorks ICM subcatchments.

Areas converted to roads, roofs, driveways and other developed surfaces were assigned to a dedicated IMP (impervious) surface category. These surfaces were represented using a fixed runoff relationship with a runoff coefficient of 0.95, equivalent to approximately 95% runoff generation and 5% depression storage loss.

This approach reflects the methodology adopted in the DHI modelling whereby roads and buildings were treated as effectively impermeable surfaces with negligible infiltration potential. The use of a high runoff coefficient ensures that the increase in imperviousness associated with development is explicitly represented while maintaining consistency with the hydrological assumptions underpinning the original flood modelling.

Post-development modelling retained the existing Green-Ampt infiltration parameters for all undeveloped pervious areas. Newly created impervious surfaces associated with the proposed development were assigned a separate infiltration category (IMP) using a Fixed runoff approach with a runoff coefficient of 0.95, representing near-complete runoff generation from roofs, pavements and other hard surfaces.

9.5.6 Consistency with Original Flood Hazard Modelling

The adopted InfoWorks ICM approach was developed to maintain consistency with the original DHI flood modelling philosophy by:

- Retaining physically based infiltration processes on pervious surfaces through Green-Ampt infiltration.
- Replicating the calibrated infiltration behaviour derived from MIKE SHE.
- Treating roads and buildings as effectively impervious surfaces.
- Increasing the proportion of impervious surfaces in the post-development scenario to represent urbanisation effects.
- Ensuring that changes in runoff response are driven by land use change rather than arbitrary adjustments to soil infiltration parameters.

This methodology provides a robust basis for comparing pre-development and post-development runoff behaviour while maintaining alignment with the hydrological assumptions used in the Waimakariri District flood hazard model used and discussed above.

Other key hydrological parameters in the InfoWorks ICM model are summarised in Table 4.

Table 4: Hydrology Parameters

Parameter	Details
2D Zone - ROG	Model is created as Rain on Grid. Gross rainfall is directly applied to 2D mesh
Manning's (n) roughness values	- Sand and Gravel – 0.02 - Gravel and Rock – 0.02 - Surface Mine or Dump – 0.02 - Esturine Open Water – 0.029 - Lake or Pond – 0.029 - River – 0.029 - High Producing Exotic Grassland – 0.05 - Mixed Exotic Shrubland – 0.05 - Orchard, Vineyard or Other Perennial Crop – 0.05 - Short-rotation Cropland – 0.05 - Urban Parkland/Open Space – 0.05 - Built-up Area (settlement) – 0.1 - Herbaceous Freshwater Vegetation – 0.1 - Low Producing Grassland – 0.1 - Deciduous Hardwoods – 0.125 - Exotic Forest – 0.125 - Forest – Harvested – 0.125 - Gorse and/or Broom – 0.125 - Everywhere else – 0.03 (applied to 2D mesh)
Land use	Updated based on latest landcover database (LCDB v6.1)

10. Model Results

The post-development scenario was modelled to assess the potential flooding effects of the proposed development, including the introduction of additional impervious surfaces, site regrading, and the raising of lot and building platform levels.

The modelling results indicate spatially variable changes in flood levels across the site, with localised increases in some areas and decreases in others (refer Appendix B). These changes are generally associated with the redistribution of flood flows resulting from proposed earthworks and modifications to site levels. The observed changes are largely confined to the development site and the immediate surrounding area, with no differences identified within the wider downstream catchment.

Analysis of model outputs demonstrates that flood behaviour within the lower reaches of the catchment is predominantly controlled by downstream water levels and backwater effects from the receiving stream. During approximately the first nine hours of the simulation, elevated water levels downstream of the site influence the local hydraulic regime and restrict the ability of floodwaters to drain freely. Following this period, water levels within the receiving system gradually recede and floodwaters progressively drain from the site towards the downstream reaches.

The modelling shows that peak water levels at downstream assessment locations occur significantly later than the peak runoff generated from the development site. As a result, the critical downstream flood levels are governed by receiving stream conditions and catchment-wide hydrological processes rather than local runoff contributions from the proposed development. While the development increases impervious area and therefore generates additional runoff locally, this runoff does not coincide with the timing of the critical downstream flood peak. Consequently, no material increase in peak downstream flood levels is predicted as a result of the proposed development.

The proposed development includes raising lot and building platform levels to improve flood resilience and reduce flood hazard risks to future residents. Whilst filling and regrading are proposed within parts of the site, the development layout will be refined during detailed design to ensure that existing flood conveyance pathways are maintained. Appropriate overland flow corridors will be incorporated within roads, reserves, drainage easements and other open space areas to allow floodwaters originating upstream of the development to continue passing through the site without significant obstruction. This approach will ensure that upstream flood flows are conveyed through the development in a controlled manner and that adverse afflux effects are avoided.

The detailed design phase will also incorporate compensatory flood storage where required to offset any loss of existing floodplain storage associated with site filling. The volume, configuration and location of compensatory storage will be confirmed as part of the detailed earthworks and stormwater design process. This storage will be integrated with the overall site drainage strategy to ensure that floodplain functionality is maintained and that flood storage losses are adequately mitigated.

Overall, the modelling indicates that the proposed development can be accommodated without creating adverse flooding effects on upstream, adjacent or downstream properties. The development will be designed to maintain flood conveyance across the site, provide compensatory storage where required, and ensure that downstream flood behaviour continues to be dominated by receiving stream conditions rather than development-generated runoff. Subject to detailed design, the proposed development is therefore expected to remain hydraulically neutral with respect to both flood storage and flood conveyance.

Key Findings

- Localised increases and decreases in flood levels occur as a result of flow redistribution associated with proposed earthworks and regrading.
- Downstream flood levels are primarily controlled by receiving stream levels and backwater effects rather than runoff from the development site.
- Peak runoff from the development does not coincide with the critical downstream flood peak.
- No material increase in peak downstream flood levels is predicted.
- Raised lots and building platforms will be designed to maintain existing flood conveyance routes through the site.

- Overland flow corridors will be incorporated into the detailed design to ensure unobstructed passage of upstream floodwaters.
- Compensatory flood storage will be confirmed during detailed design the modelling to date indicates may not be required given the flood levels governed by downstream water levels.
- Subject to detailed design, the development is expected to achieve hydraulic neutrality and avoid adverse flooding effects on neighbouring or downstream properties.

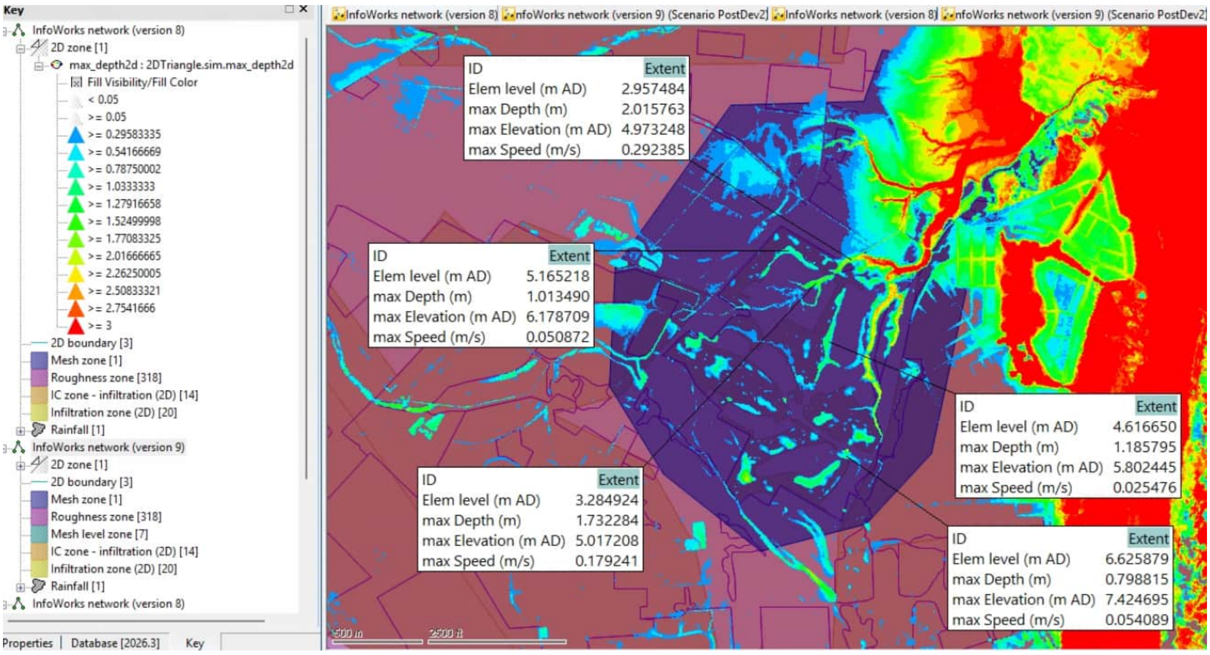


Figure 7: Base 100yr Results

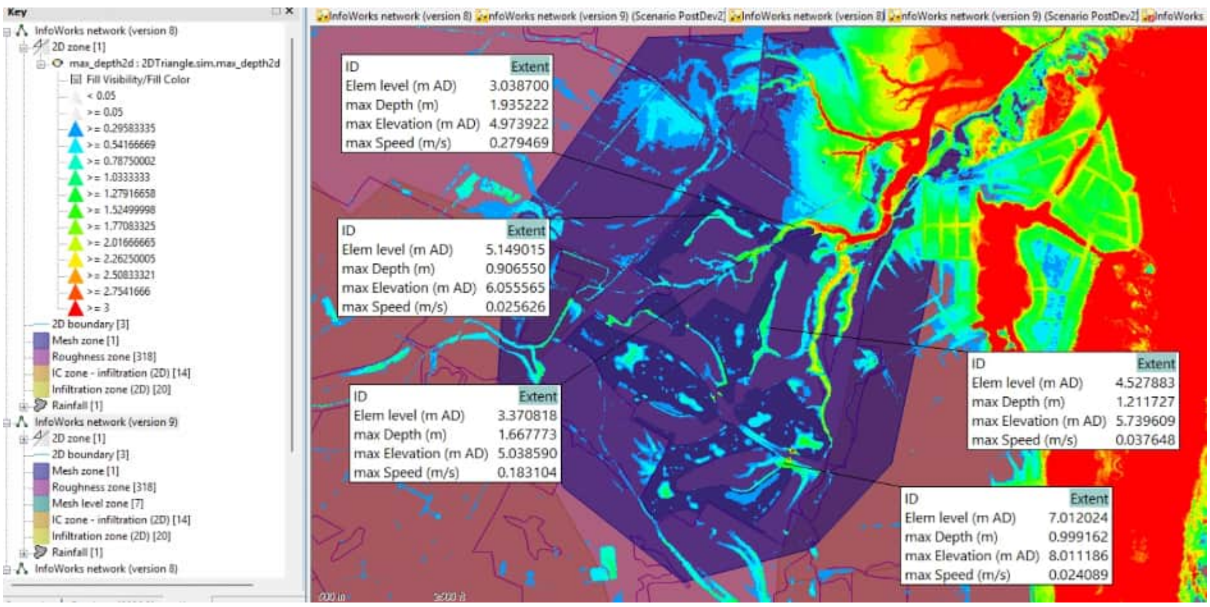


Figure 8: 100yr Post Development Results

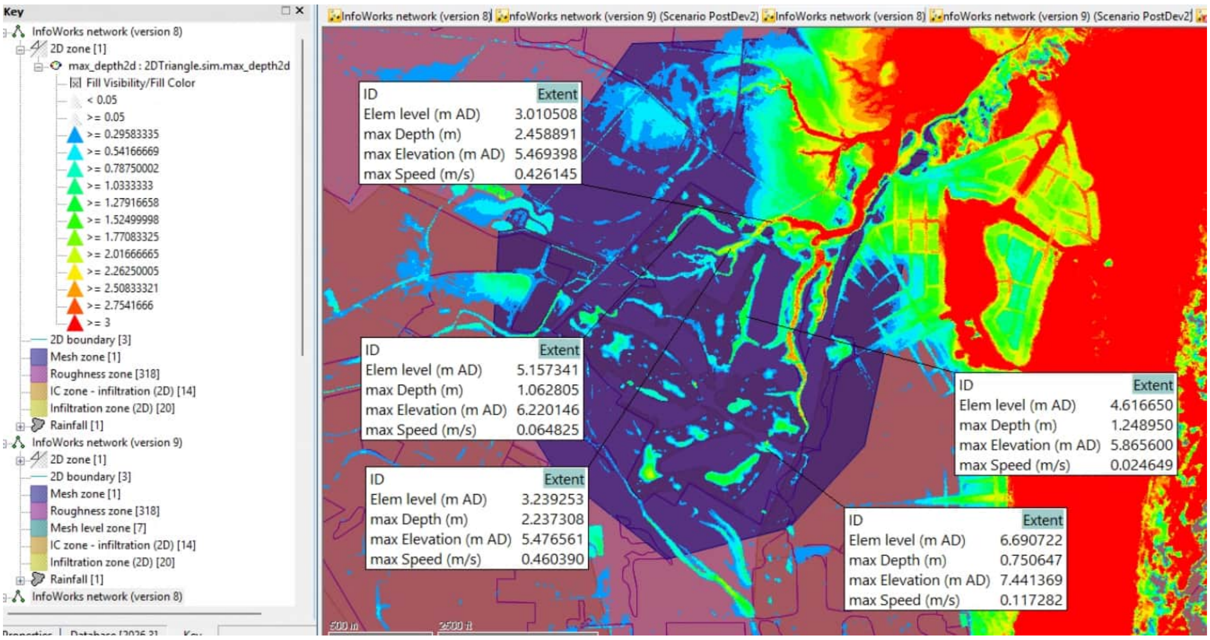


Figure 9: Base 200yr Results

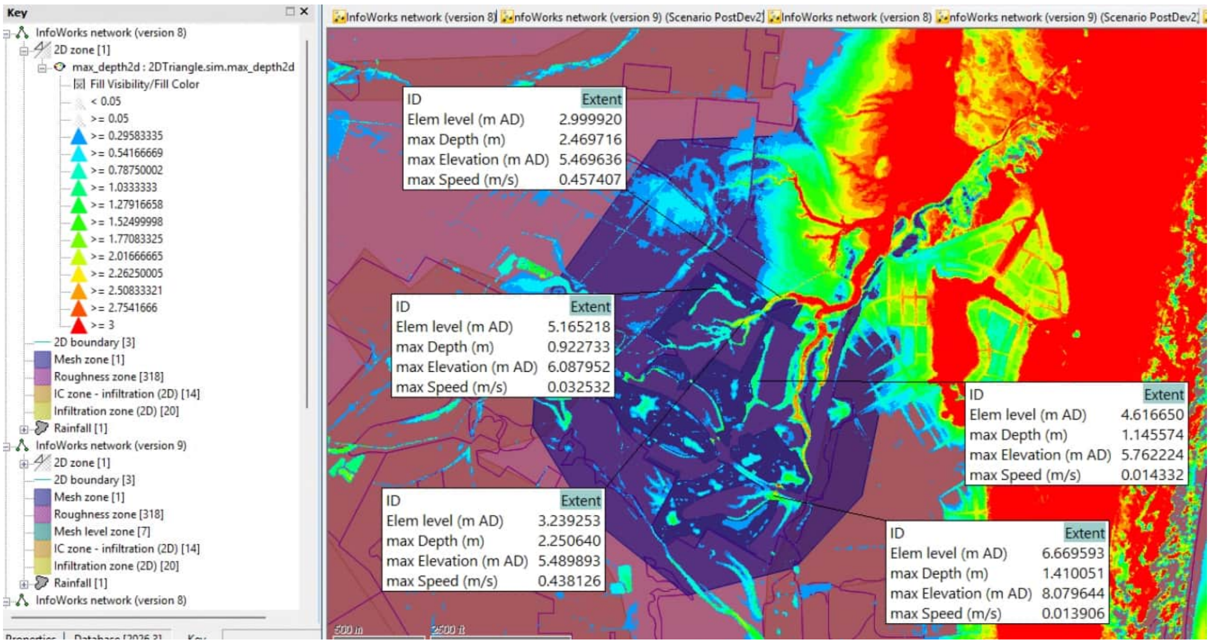


Figure 10: 200yr Post Development Results

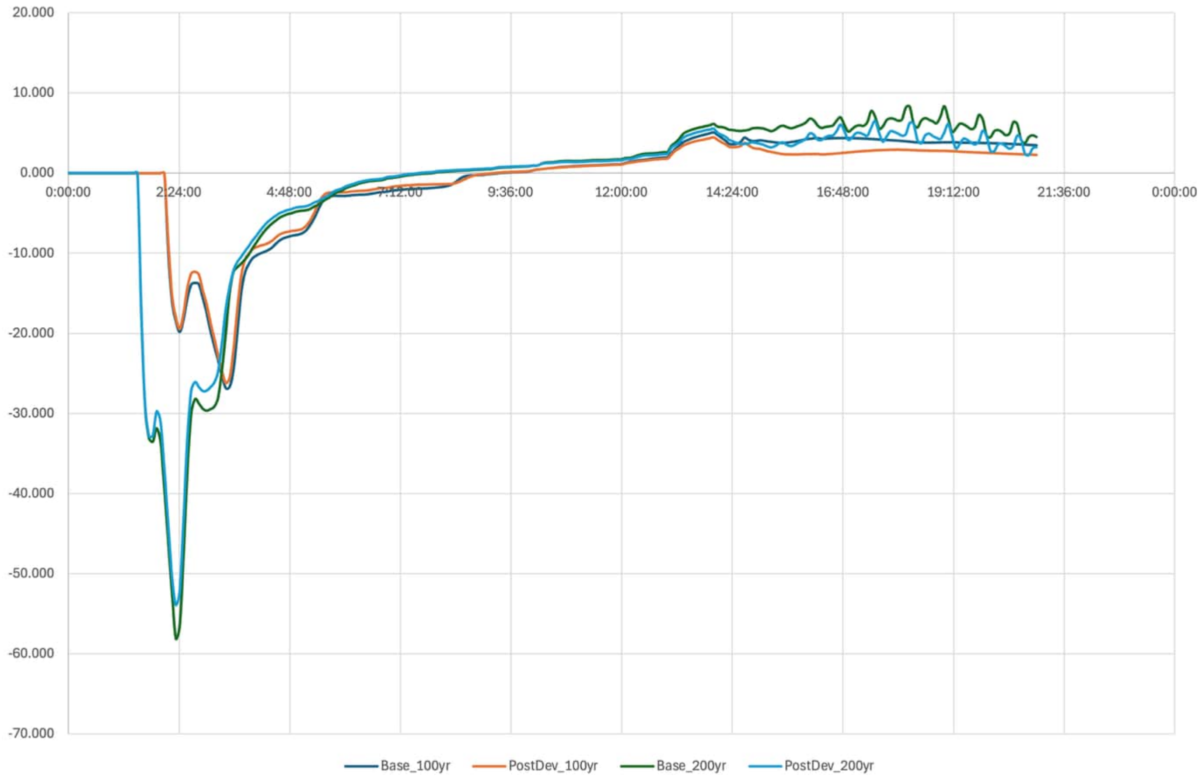


Figure 11: Model Results - Outflows from Site

11. Preliminary Assessment of Effects

The proposed development will increase impervious surface coverage relative to the existing golf course land use, resulting in increased stormwater runoff volumes and peak flow rates. Preliminary hydraulic modelling indicates that this results in spatially variable, localised changes in flood depths and flow paths within and adjacent to the site, associated primarily with proposed earthworks and platform raising, with both localised increases and decreases in flood levels observed. These changes are largely confined to the development site and immediate surrounding area, with no significant adverse effects identified within the wider downstream catchment. The site is not located within the modelled Ashley River/Rakahuri breakout inundation extent, and is therefore not subject to fluvial breach risk from that hazard.

On this basis, the construction and operational stormwater effects of the development are not considered significantly adverse, and are capable of being appropriately mitigated through the proposed stormwater management strategy. Some uncertainty remains around the precise magnitude and distribution of localised flood level changes, given that downstream flood behaviour is influenced by backwater effects and receiving stream conditions; however, this is a typical characteristic of preliminary-stage modelling and is capable of resolution through refinement at detailed design. Matters such as final attenuation basin sizing, treatment device selection, and finished floor levels also remain to be confirmed, consistent with the preliminary nature of this assessment, and are considered typical detailed design items rather than constraints on the development proceeding.

12. Key Matters for Further Assessment

The following matters will be confirmed and refined through the substantive application and detailed design stages:

- Final sizing, configuration, and location of stormwater attenuation basins.
- Selection and detailed design of stormwater treatment devices.
- Refinement of hydraulic modelling, including confirmation of finished ground levels, overland flow paths, and compensatory storage requirements.
- Determination of minimum finished floor levels, incorporating appropriate freeboard.
- Detailed design of secondary overland flow conveyance through road corridors.
- Confirmation that the post-development modelling remains consistent with the original flood hazard modelling basis.
- Assessment of the potential retention or reconfiguration of existing golf course ponds as part of the wider attenuation network.

13. Conclusion

This assessment has considered the stormwater management, water quality treatment, attenuation, and flood hazard matters relevant to the Pegasus West Development.

The proposed stormwater strategy adopts a swale-led, low-impact design approach that is consistent with the established Pegasus township. This is supported by a suite of complementary treatment devices, indicative attenuation provision in accordance with WDC ECoP Part 5, and preliminary flood modelling of the development area. Together, these demonstrate that the site can be appropriately serviced from a stormwater perspective.

The principal development area is not located within the modelled Ashley River breakout inundation extent, although a portion of the mapped breakout flood area extend into the Taranaki Stream and Taerutu Gully, as discussed in Section 5. Preliminary flood modelling also indicates that the proposed development will not result in a material increase in peak downstream flood levels. Localised changes in flood depths and flow paths within and adjacent to the site are primarily associated with site regrading and platform raising. These matters can be addressed through the refinement of finished ground levels, overland flow paths, flood conveyance routes, and compensatory storage during detailed design.

Several design elements remain to be confirmed, including final attenuation basin sizing and configuration, treatment device selection, and detailed flood conveyance design. This is consistent with the preliminary nature of the current assessment. These matters are considered typical detailed design items and do not represent constraints to the development proceeding.

On this basis, no stormwater-related matters have been identified that would prevent the development from being appropriately resolved at the substantive Fast-track Approvals Act application stage.

Limitations

This document has been prepared by Flowstate Consulting LP for Wolfbrook Developments (Pegasus) Limited for the purpose of supporting a referral application under the Fast-track Approvals Act 2024, and may be relied upon by the Environmental Protection Authority, the Minister, and commenting parties in the fast track process. This assessment is based on preliminary design information available at the referral stage and will be refined through detailed technical work at the substantive application stage. No liability is accepted by Flowstate Consulting LP, or any employee or sub-consultant of the company, for any use of this document other than for its intended purpose, or in reliance on it prior to the completion of detailed design.

This assessment represents a preliminary evaluation prepared for the purpose of supporting the FTAA referral application. It is based on information available at the time of preparation, including the Civix Engineering and Infrastructure Report (Draft, 26 June 2026), WDC GIS data, ECan regional hazard mapping, and publicly available information. Detailed engineering design, hydraulic modelling, and geotechnical investigation have not been undertaken at this stage and will be required to confirm the stormwater management strategy at subdivision design stage.

The assessment has been prepared on the basis that information provided is accurate, complete, and adequate. To the extent that any information proves to be inaccurate or inadequate, Flowstate Consulting LP takes no responsibility for any loss or damage that may result.

Appendix A – Preliminary Attenuation Calculations

Attenuation Volume Calculation

Inputs

Site area, A	77 ha (770,000 m^2)
Impervious fraction (post-development)	0.75
Runoff coefficient, impervious surfaces (C_imp)	0.90
Runoff coefficient, pervious surfaces (C_perv)	0.20
Post-development runoff coefficient, C_post	0.725
Pre-development runoff coefficient, C_pre	0.35
ΔC = C_post − C_pre	0.725 − 0.35 = 0.375
Rainfall depth, 100-year ARI, 72hr duration, HIRDS V4 RCP8.5 end-century (2081–2100)	225 mm (Refer Hirds Output below)

Method

Incremental (attenuation) volume = Rainfall depth × Site area × ΔC

Calculation

Pre-development runoff volume

	V_pre = (Rainfall ÷ 1000) × Area × C_pre	
	= (225 ÷ 1000) × 770,000 × 0.35	**= 60,637 m^3**

Post-development runoff volume

	V_post = (Rainfall ÷ 1000) × Area × C_post	
	= (225 ÷ 1000) × 770,000 × 0.725	**= 125,606 m^3**

Attenuation volume required

	V_atten = V_post − V_pre	
	=125,606 − 60,637	**= 64,969 m^3**

Result

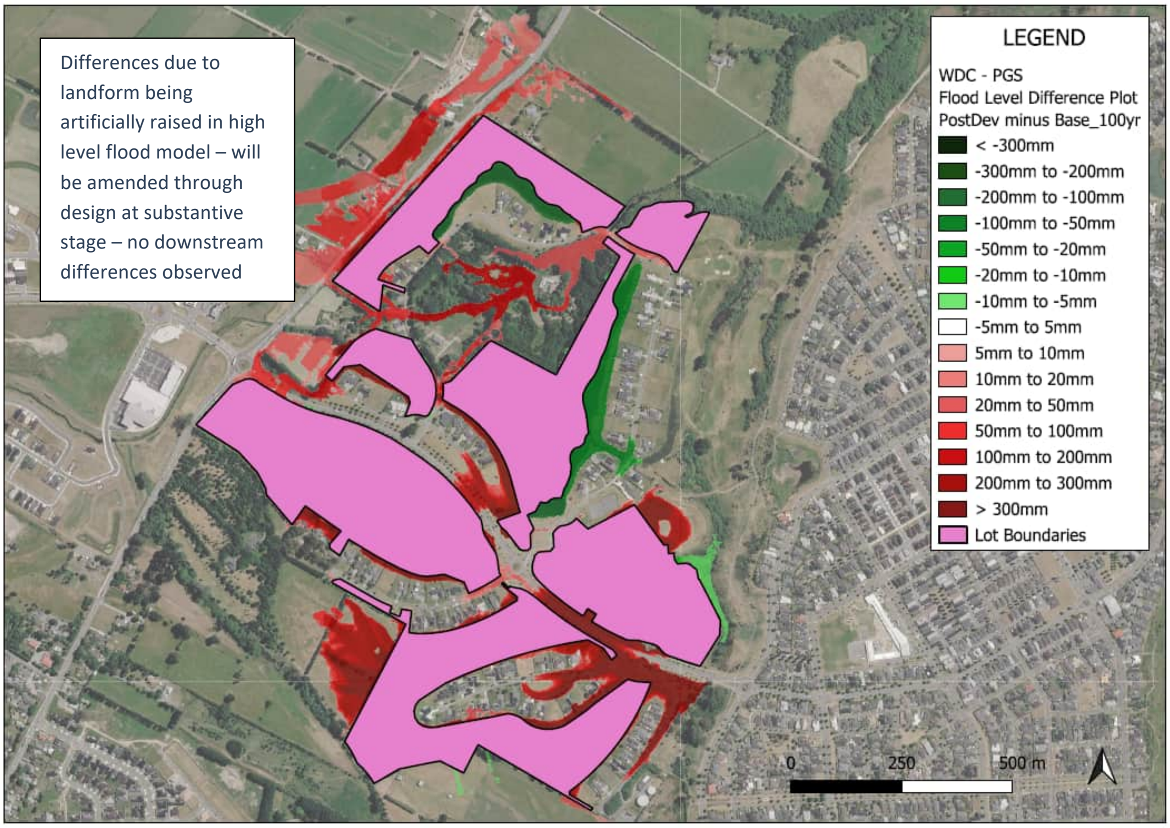
100-year ARI attenuation volume required (72hr critical duration): **64,969 m^3**

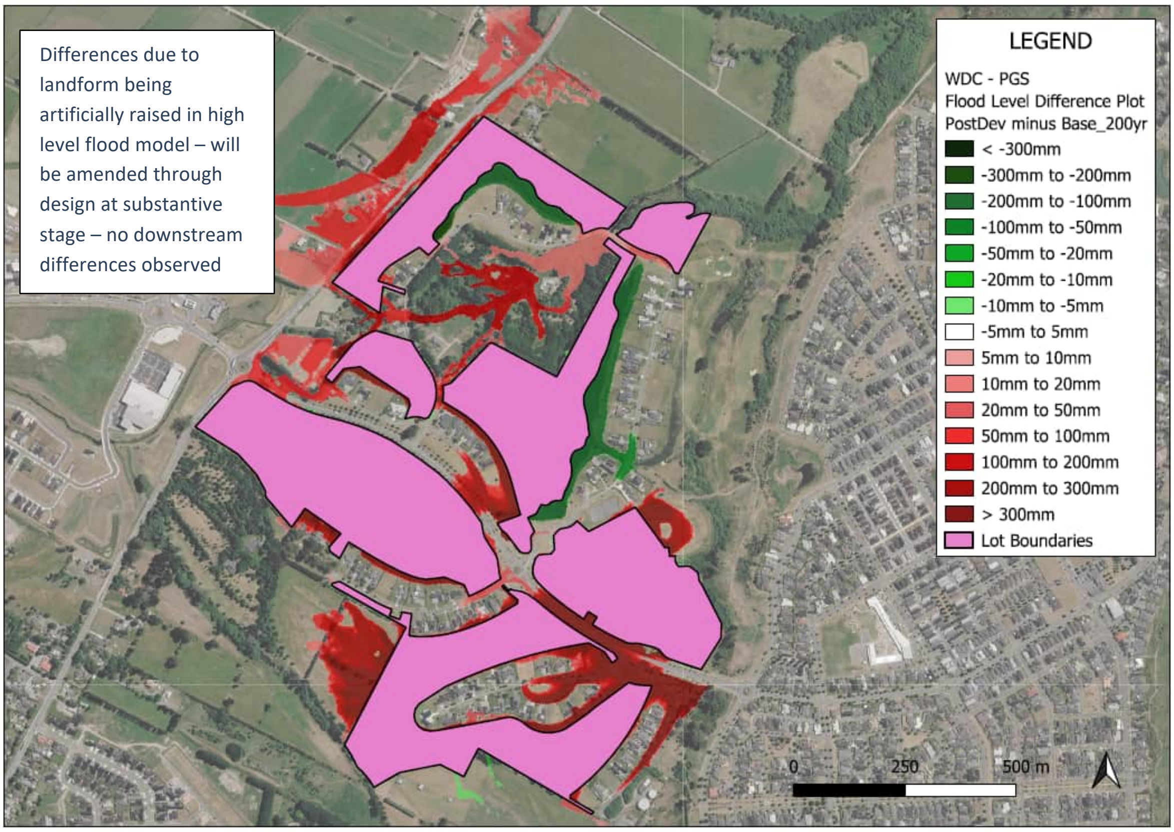
HIRDS V4

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

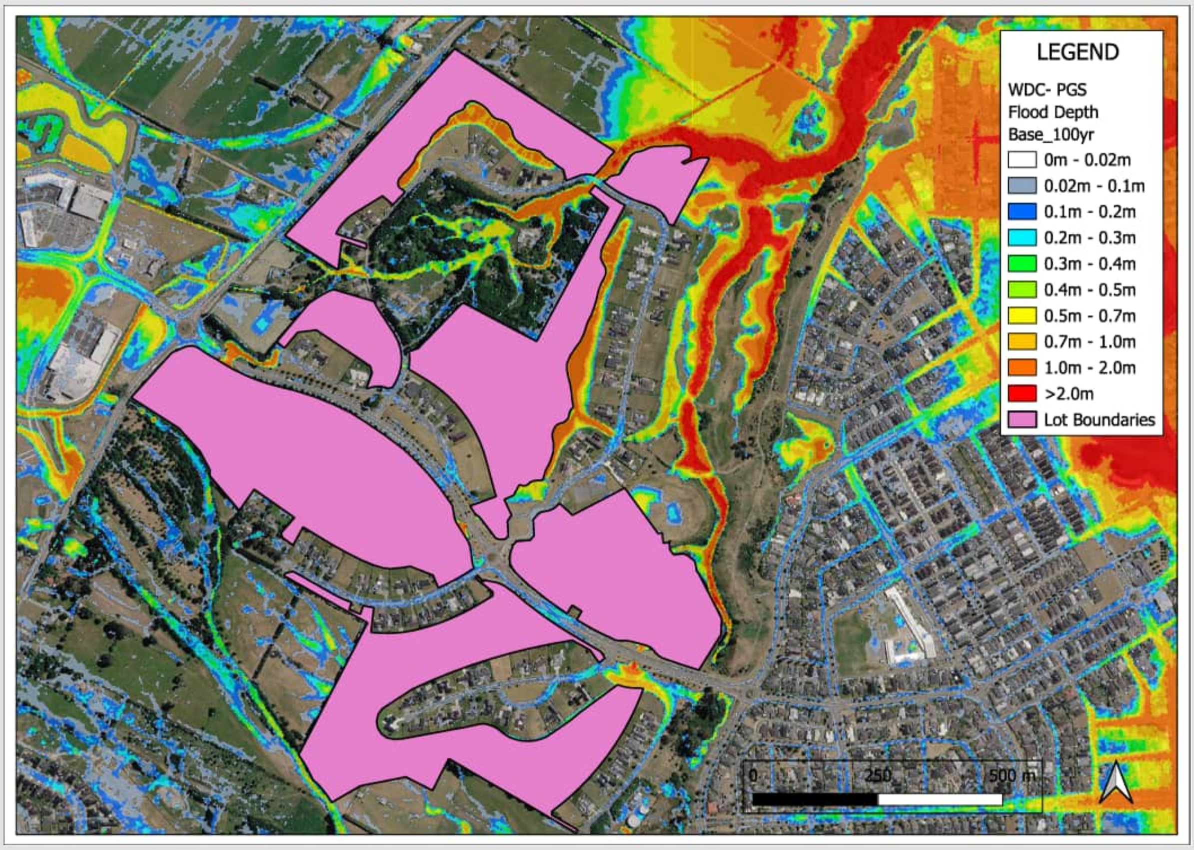
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	4.33	6.14	7.64	11.3	16.5	29.2	40.3	53.9	68.1	75.7	80.7	84.1
2	0.5	4.95	7	8.7	12.8	18.7	33	45.5	60.4	76.2	84.9	90.3	93.9
5	0.2	7.25	10.2	12.6	18.3	26.7	46.5	63.7	83.6	105	116	123	128
10	0.1	9.15	12.8	15.7	22.8	33	57	77.7	102	127	140	148	153
20	0.05	11.2	15.6	19.2	27.7	39.8	68.4	92.6	120	149	165	174	179
30	0.033	12.6	17.4	21.4	30.7	44.1	75.4	102	132	163	180	189	195
40	0.025	13.6	18.7	22.9	32.9	47.2	80.5	108	140	173	190	200	207
50	0.02	14.4	19.8	24.3	34.8	49.7	84.5	114	146	181	199	209	215
60	0.017	15	20.7	25.3	36.2	51.7	87.9	118	152	187	206	216	222
80	0.013	16.1	22.2	27.1	38.7	55.1	93.2	125	161	198	217	227	234
100	0.01	17	23.3	28.5	40.6	57.7	97.5	131	167	205	225	236	243
250	0.004	20.7	28.2	34.3	48.6	68.7	115	153	195	237	259	271	278

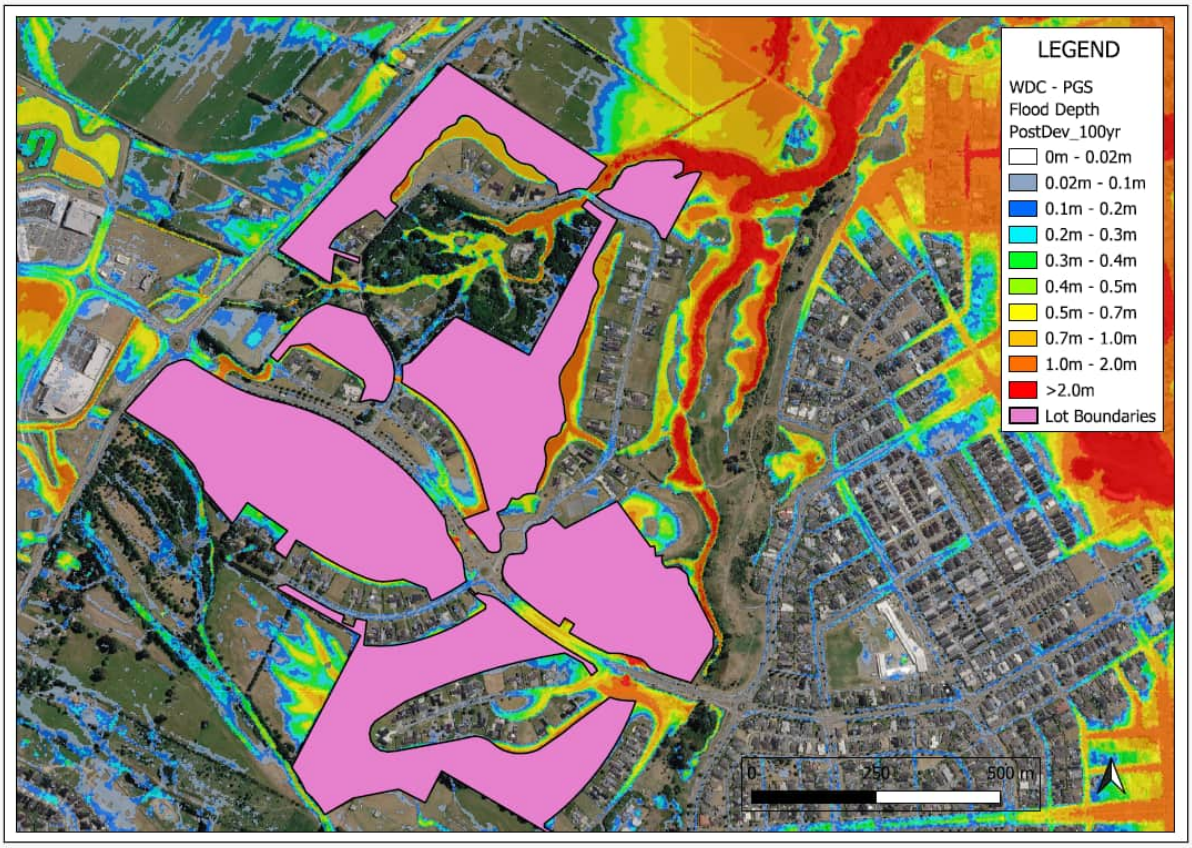
Appendix B – Flood Level Difference Plots

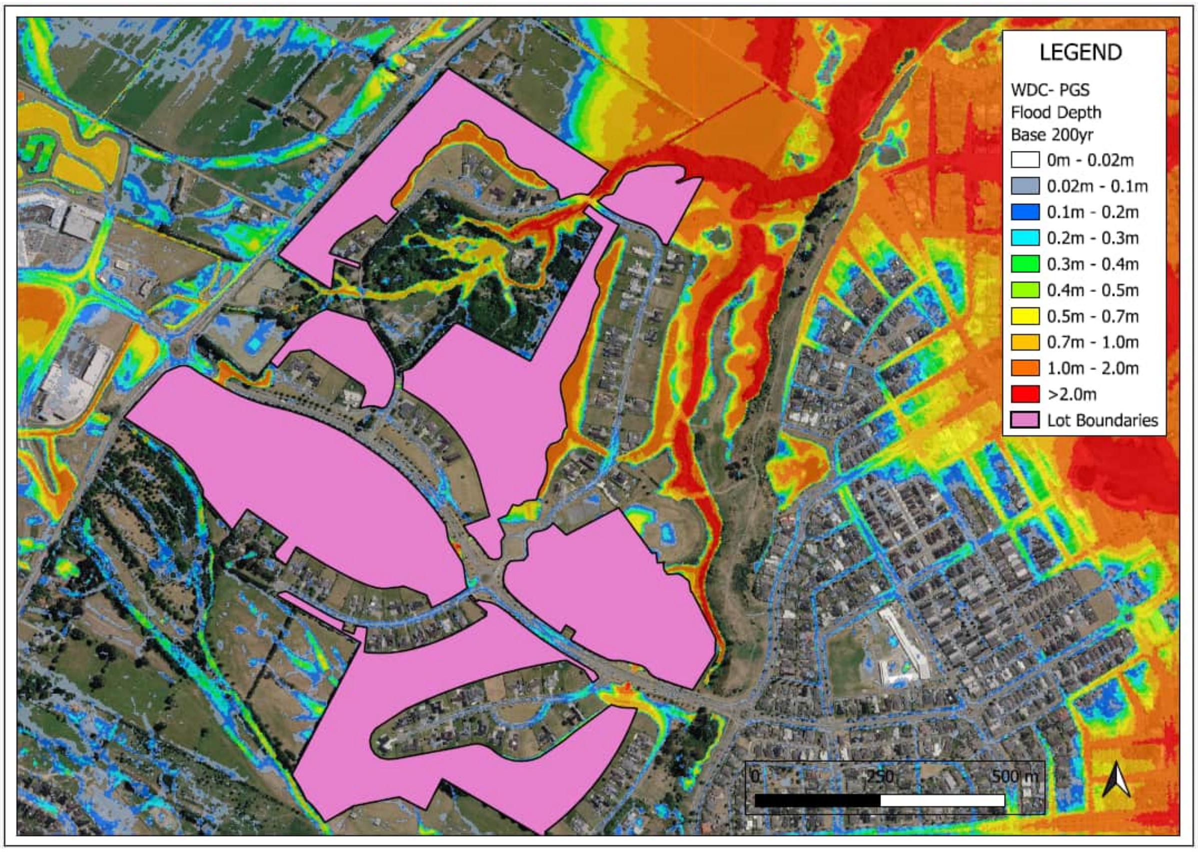


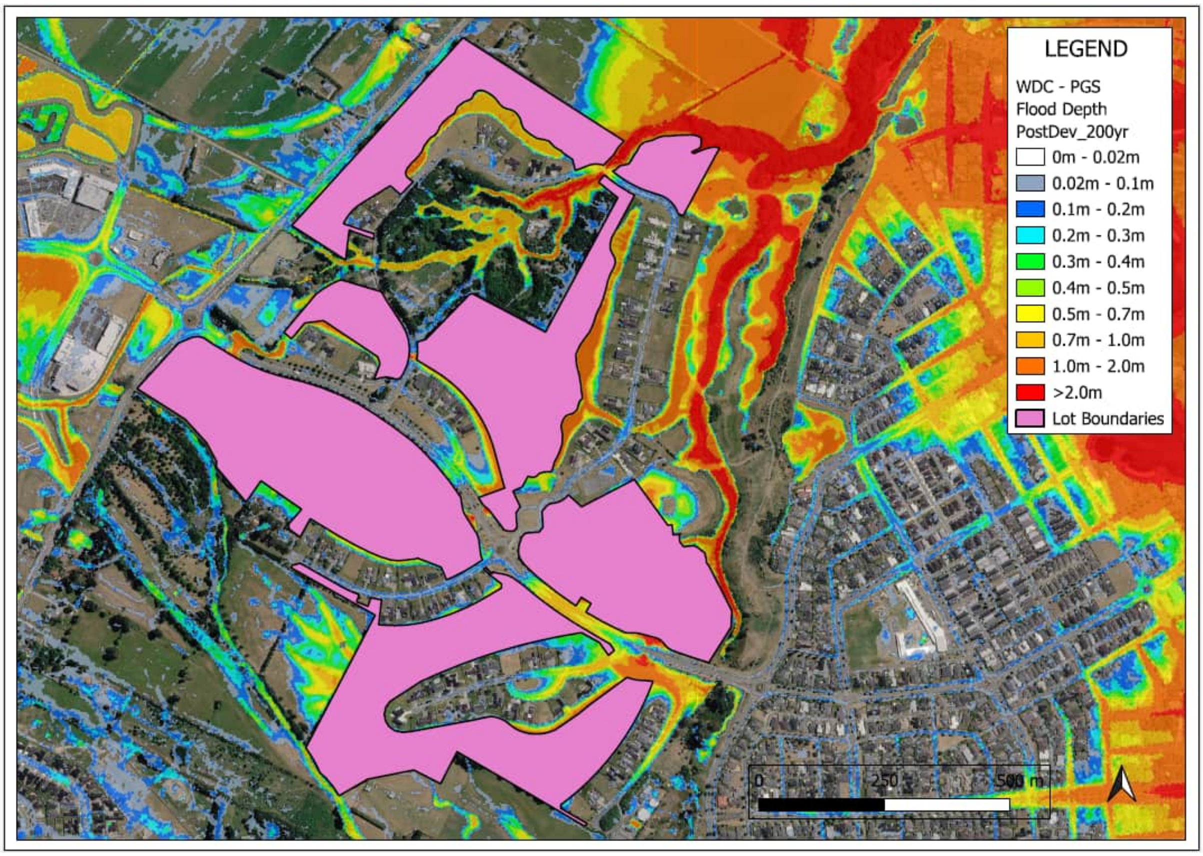


Appendix C – Flood Depths






LEGEND
WDC- PGS
Flood Depth
Base 200yr
0m - 0.02m
0.02m - 0.1m
0.1m - 0.2m
0.2m - 0.3m
0.3m - 0.4m
0.4m - 0.5m
0.5m - 0.7m
0.7m - 1.0m
1.0m - 2.0m
>2.0m
Lot Boundaries
0
250
500 m


LEGEND
WDC - PGS
Flood Depth
PostDev_200yr
0m - 0.02m
0.02m - 0.1m
0.1m - 0.2m
0.2m - 0.3m
0.3m - 0.4m
0.4m - 0.5m
0.5m - 0.7m
0.7m - 1.0m
1.0m - 2.0m
>2.0m
Lot Boundaries
0
250
500 m