Heights Road Plan Change

9, 33 & 39 Heights Road

GBar Properties

Final – Clause 23 Revision

Document Control

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Executive Summary

Woods has been engaged by G Bar Properties to provide a Stormwater Management Plan for a Proposed Plan Change (**PPC**) at 9, 33 and 49 Heights Road, Pukekohe. The PPC seeks to rezone 5.35ha of land from Future Urban to Business – Light Industry. Part of the PPC land has long been used for business activities and is currently occupied by existing consented rural business activities, including the Tractor Centre and BMC Engineering. The PPC provides an opportunity to provide a zoning reflecting of the existing business activities operating and extend this rezoning to the remainder of the undeveloped PPC extent.

The purpose of this Stormwater Management Plan (**SMP**) is to demonstrate to Auckland Council how stormwater will be managed within the PPC area and to identify technical solutions to rezone the plan change extent to 'Light Industry'.

The masterplan which supports the PPC application aims to retain two existing buildings (referred to as "existing roof areas") and proposes new buildings and other trafficable hardstand areas. At the time of this SMP being written, the intention is to retain the existing Tractor Centre and BMC buildings. Future development may require the removal of these buildings, and the stormwater management measures outlined in this document are flexible to enable both retaining or removing the existing buildings.

The plan change also seeks to include the PPC extent under the Auckland Unitary Plan SMAF1 overlay. The application of the SMAF1 overlay to the PPC land will provide satisfactory and appropriate mechanisms to address the stormwater mitigation measures proposed for the PPC.

The Heights Road PPC area is shown in Figure E1.

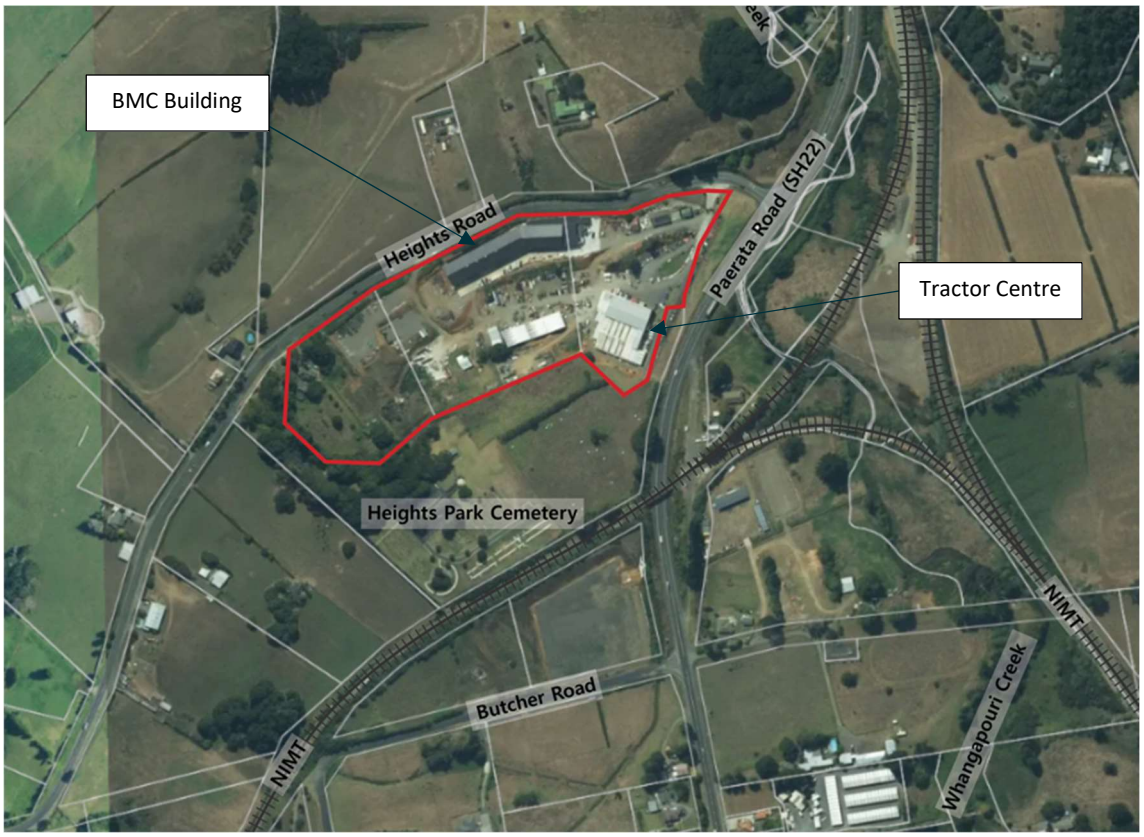


Figure E1: Subject site location

Flooding

Flood modelling was undertaken to:

- Quantify existing flooding within the PPC and downstream of the PPC,
- Quantify future flood effects resulting from the PPC within and downstream of the PPC, and
- Develop flood management options to enable the PPC.

The flood model was based on the Whangapouri Creek model, as provided by Healthy Waters. The model has been updated with topographical survey information (survey and asset data). Details around the modelling assumptions has been included in a separate Model Build Report, which is included as part of this report. The flood modelling was undertaken for 10 year and 100 year ARI storm events with allowance for a 3.8ºC temperature increase due to future climate change (**CC).**

The recommended flood management options for the PPC includes flood storage attenuation for the runoff generated within the plan change area in a wetland. The wetland will be designed to attenuate runoff in the 10 year and 100 year ARI storm events to existing peak flow rates.

Water Quality

Water quality treatment for all impervious areas on site (new and existing) will be achieved via a central proprietary device and a centralised wetland. A list of Healthy Waters approved proprietary devices has been included with this report. It is noted that appropriate selection is required based on contaminants of concern to ensure that the selected device achieves its intended function.

Further avoidance measures for water quality are provided in the recommendation that new buildings be constructed with inert roofing material and cladding material.

Given the PPC is proposed to be rezoned to 'Light Industry', a wetland in conjunction with a proprietary treatment device will address any contaminants of concern resulting from intensification within the PPC.

All stormwater management devices within the PPC will be privately owned and maintained.

Stream Hydrology

The plan change seeks to include the PPC extent under the Auckland Unitary Plan SMAF1 overlay. The stormwater management measures recommended in this report require:

- Retention (volume reduction) of a minimum of 5mm of runoff from all impervious areas; and
- Detention (temporary storage) with a draindown period of 24 hours for the difference between the pre-development (grassed state) and post development runoff volumes from the 95th percentile, 24 hour rainfall event minus the retention volume for all impervious areas.

It is noted that the existing BMC building currently has tanks that capture roof runoff. The tanks can be retained/retrofitted to meet the SMAF1 retention requirements.

Runoff from new impervious areas will be routed via the proposed wetland, which has been conservatively designed to provide the volume reduction and temporary storage requirements for all impervious areas on site.

Future resource consent applications will seek to optimise the amount of retention to ground based on location specific infiltration testing. It is noted that while 5mm is the minimum requirement, the PPC will seek to maximise infiltration to ground given the three high use aquifers that underlay the site.

1. Introduction

1.1. Background

GBar Properties are undertaking a Private Plan Change (PPC) at 9, 33 and 49 Heights Road Pukekohe. The PPC seeks to rezone 5.35ha of land from Future Urban to Business – Light Industry. The location of the Heights Road PPC area is shown in Figure 1.

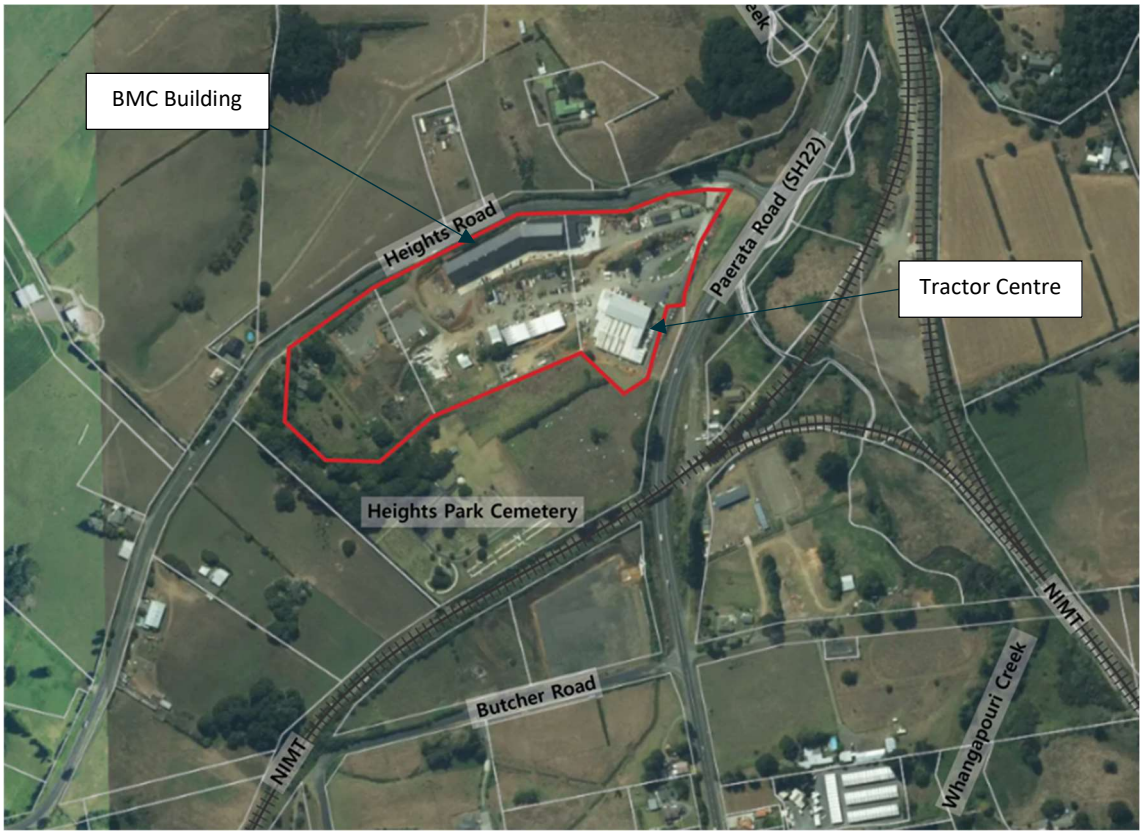


Figure 1: Heights Road PPC area

A Stormwater Management Plan (SMP) has been prepared to support the PPC. Part of the PPC land has long been used for business activities and is currently occupied by existing consented rural business activities, including the Tractor Centre and BMC Engineering.

Early consultation with Healthy Waters has found that the SMP cannot be authorised under Auckland Council's Regionwide Network Discharge Consent (NDC) for the following reasons:

- The plan change proposes private drainage infrastructure, and
- Runoff from the plan change extent is discharged to a DN450 culvert under State Highway 22. This asset is owned by Waka Kotahi New Zealand Transport Agency.

The overall purpose of this SMP is summarised as follows:

- Provide guidance to the applicant and inform Auckland Council on how stormwater will be managed for the PPC area, which considers existing impervious areas to be retained and future impervious areas;
- Meet the requirements set out in Chapters E1, E8, E9, E10 and E36 of the Auckland Unitary Plan; and
- Identify flood risk areas and demonstrate that the PPC can be rezoned without creating or exacerbating adverse flooding effects at properties upstream or downstream of the development.

2. Existing site appraisal

The PPC area is located at 9, 33 and 49 Heights Road. The legal descriptions of the sites comprising the plan change area is summarised in Table 1.

Table 1: Existing parcel – legal descriptions

Existing site element	
Legal description	Lot 1 DP 73273 Lot 1 DP 109824 Lot 2 DP 109824
Current Land Use	Currently used for 'light industry' businesses; land is zoned 'Future Urban Zone' under the AUP
Historical Land Use	Grazed pasture

The PPC is bound by Heights Road to the north, State Highway 22 (Paerata Road) to the east and the Heights Park Cemetery to the south. The total PPC area is approximately 5.35ha, with a collective impervious coverage of 3.30ha or 62% of the total area.

The PPC currently house industrial businesses, with associated impermeable concrete accessways and parking areas. There is a newly constructed building along the northern property boundary with paved areas providing access to the building.

Figure 2 shows the existing site plan and includes all existing impervious areas.

Figure 2: Existing site plan

The PPC area is currently zoned Future Urban Zone **(FUZ)**. The site to the south is zoned Special Zone (Cemetery) and the sites to the north are zoned Rural Production Zone. Figure 3 shows the existing zoning plan.

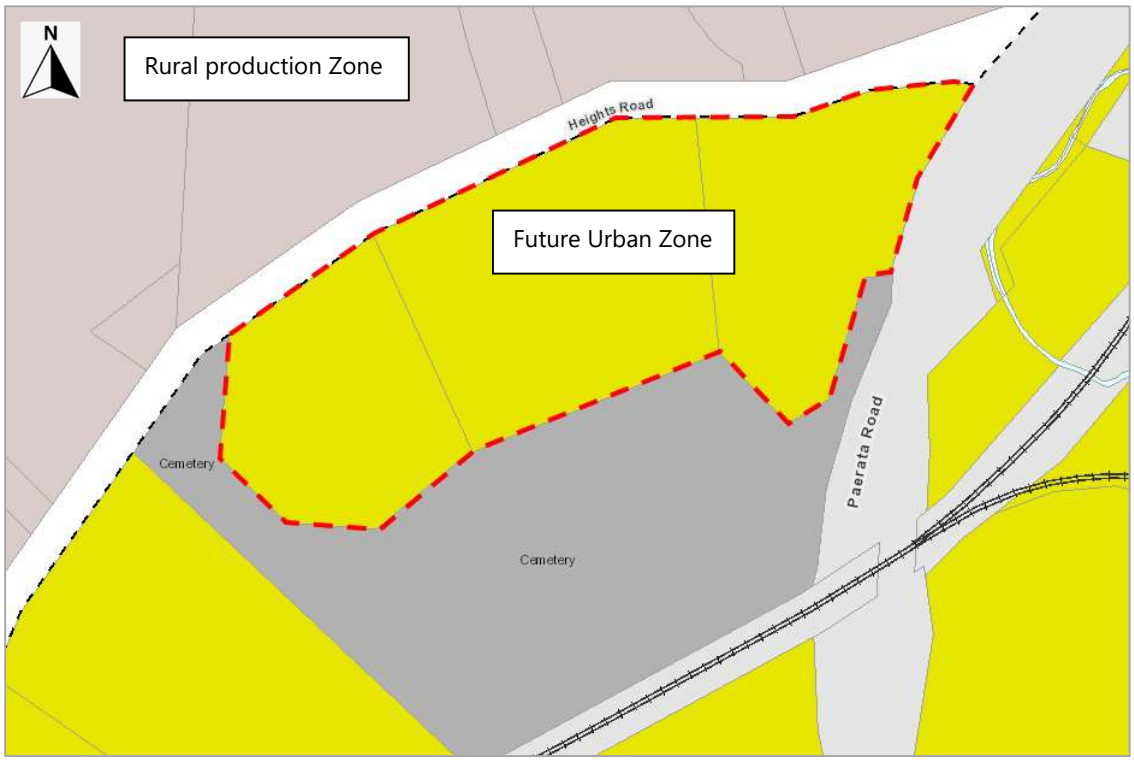


Figure 3: Existing AUP zoning (Source: Auckland Council Geomaps)

2.1. Topography

The elevations in the plan change area vary between 60mRL in the north-western corner falling to 45mRL towards the east on the Paerata Road frontage. Auckland Council Geomaps contours shows a shallow gully within the western portion of the plan change that contains an overland flow path. The topography through the eastern portion of the PPC is flat.

The existing ground contour sourced from AC GeoMaps can be seen in Figure 4.

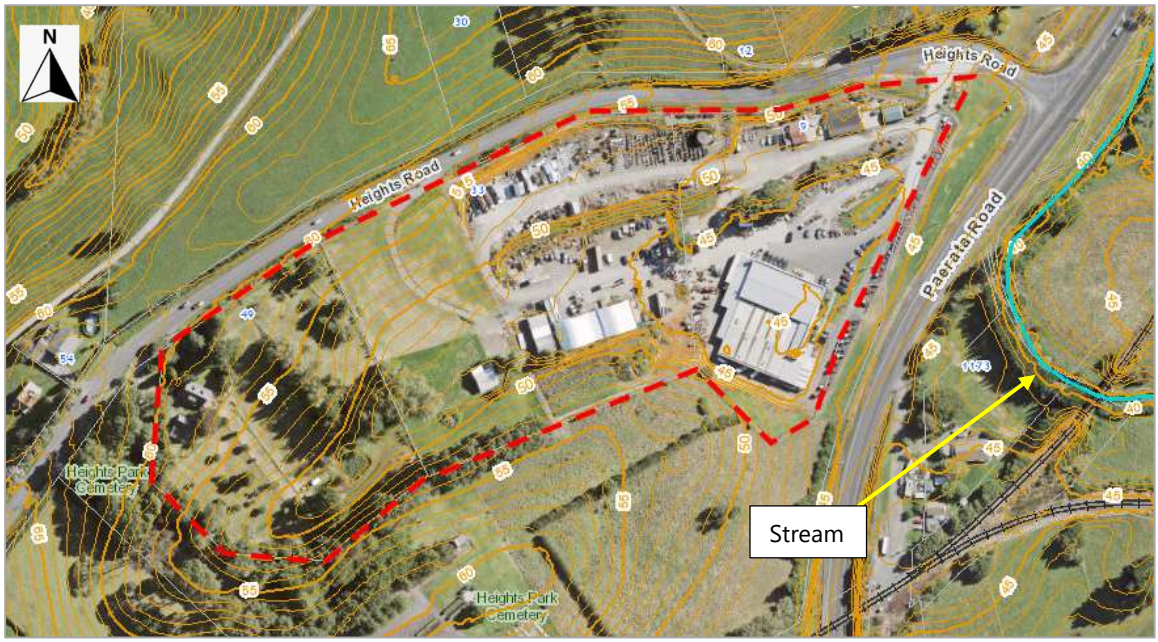


Figure 4: Existing ground contours – (Source: Auckland Council GeoMaps)

Woods have undertaken a topographical survey of the PPC in 2020. This has been included in Appendix A of this report. It is noted that the 2020 survey doesn't identify work that has been undertaken within the

PPC since 2020, which includes a new building along the northern boundary (henceforth referred to as the BMC Building) and associated hardstand areas.

The 2020 topographic survey information is considered fit for purpose as the construction of the BMC building includes retaining walls which have formalised the 5m height difference between the northern boundary and the centre of the site. The 2020 topographic survey has been used to inform the flood modelling and design calculations to support the PPC, noting that future resource consent applications will need to address flood considerations and device design when earthworks surfaces are finalised.

2.2. Existing drainage features and stormwater infrastructure

2.2.1. Existing stormwater infrastructure

Auckland Council GeoMaps shows the primary drainage infrastructure within the plan change area as private. Runoff is captured in a DN600 pipe which collects and discharges runoff into the Whangapouri Stream via a DN600 culvert under SH22 (Paerata Road). Flood modelling, discussed in subsequent sections of this report, has found that the culvert doesn't have adequate conveyance capacity for 10 year or 100 year ARI flows under existing conditions and runoff is contained within the PPC extent as Paerata Road is topographically higher than the PPC.

The DN600 under SH22 is a Waka Kotahi owned asset. The private drainage infrastructure alignment, as shown on Auckland Council Geomaps, can be seen in Figure 5. Asset information such as invert levels, lid levels and line diameters have been identified through a topographical survey.

Figure 5: Existing infrastructure (Source: Auckland Council GeoMaps)

Other private drainage features within the plan change area include a raingarden that receives runoff from the BMC building, a soakage pit and a communal underground detention tank. No design details are available for these devices.

2.3. Ecological

An ecological assessment undertaken by RMA Ecology Ltd did not identify any natural wetlands, streams or indigenous vegetation within the plan change area. The assessment concluded that development within the plan change area will result in:

- Very low or nil value for bat or lizard habitats, and
- No loss of values for wetlands, streams and indigenous vegetation.

The assessment concluded that there is no need for ecologically focused mitigation or for offsetting any vegetation removal across the plan change area.

2.4. Geotechnical

Published geological maps for the area obtained from the Auckland Council soils layer indicate the underlying soil to be Pukekohe Volcanic soils with a soil ID D2 (Figure 6). The S-map indicates that the underlying soil varies from imperfectly drained to moderately well drained as shown in Figure 7 .

A geotechnical assessment prepared by ENGEO Ltd indicates the plan change area is underlain with volcanic deposits of the South Auckland Volcanic Field including Kerikeri Volcanic group tuff and basaltic lava.

ENGEO has also carried out a soakage assessment to determine the soakage rate/infiltration potential of the native soils within the PPC. The report concluded that the maximum and minimum observed infiltration ratee were 10mm/hr and 4mm/hr, respectively. The average infiltration rate was 8mm/hr across all tested locations. This is higher than the minimum 2mm/hr infiltration rate required to achieve retention/infiltration to the ground.

Further information can be found in the geotechnical report submitted in Appendix 6 and 6A of the Assessment of Environmental Effects (AEE).

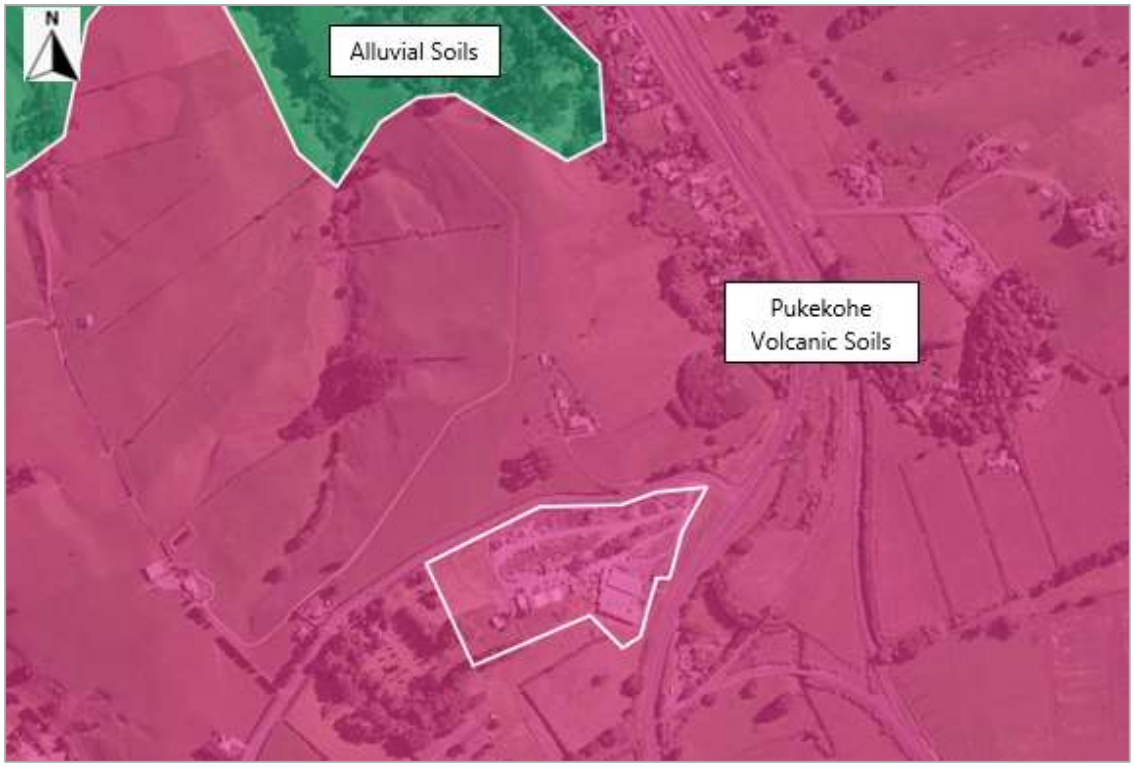


Figure 6: Underlying soil type (source: Auckland Council)

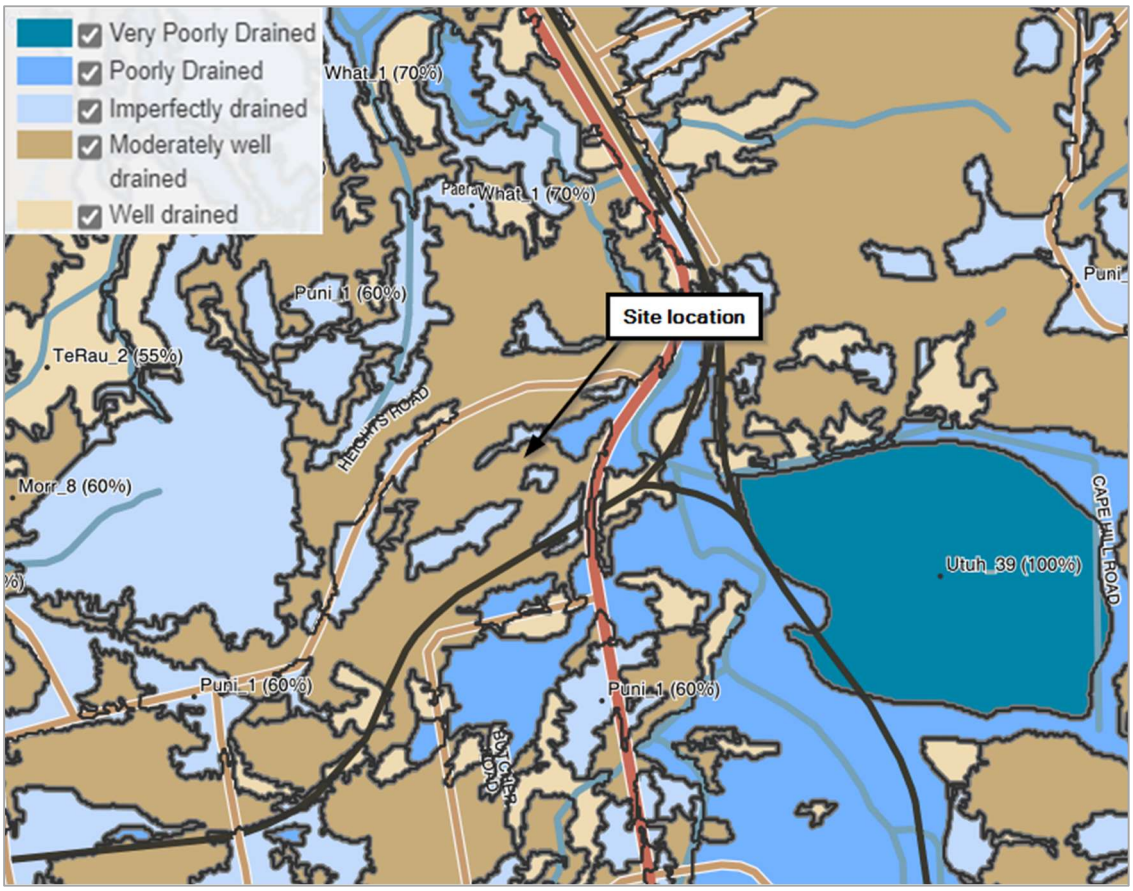


Figure 7: Soil Drainage (Source: S-map)

It is noted that there is discrepancy between the infiltration test results on site and the information provided on S-Maps (Figure 7). Specific testing at the location of any infiltration devices is recommended during subsequent consenting stages to maximise infiltration potential, noting that there are three high use aquifers in the vicinity of the PPC.

2.5. Receiving environment

The plan change area is located within the upper regions of the Whangapouri catchment, which ultimately discharges to the Manukau Harbour via the Whangapouri Creek (Figure 8).

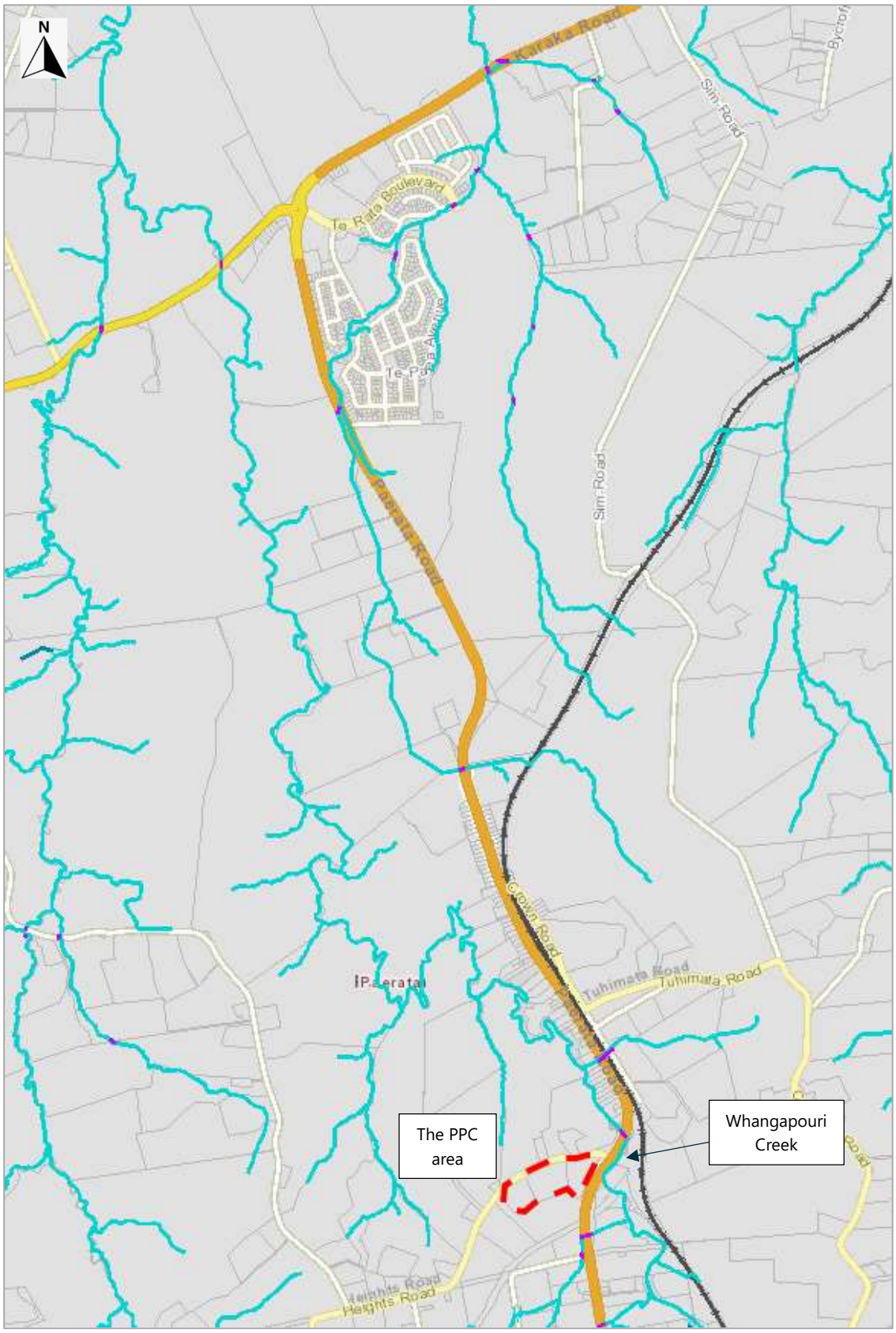


Figure 8: Receiving environment (Source: Auckland Council Geomaps)

2.5.1. Whangapouri Creek

The Whangapouri Creek is a permanent stream, which ultimately discharges into the Manukau Harbour, located north of Paerata. The Whangapouri Creek is classified as a Significant Ecological Area – Terrestrial on the AUP Viewer.

The tributary of the Whangapouri Creek that the SH22 culvert discharges to receives runoff from a contributing catchment area of approximately 1,530 hectares. The Auckland Council Whangapouri Creek Watercourse Assessment Report, undertaken in 2015, noted the following issues identified within the Whangapouri Catchment:

- No significant point source pollutants or contaminated discharge was observed as part of a Stream Ecological Values (SEV) assessment in the catchment. The SEV noted that water clarity and turbidity tests indicated uncontrolled sediment input into the stream system. The summary of water course contamination noted no petroleum or hydrocarbons in the assessed watercourses.
- The catchment features man-made engineering structures such as dams, pipe bridges and bridges.
- Erosion hotspots were prevalent in rural areas but were of little concern to public safety.

2.5.2. Manukau Harbour

The Manukau Harbour is a large, enclosed harbour estuary complex connected to the Tasman Sea. It is the second largest harbour in New Zealand and is the ultimate receiving environment for the subject PPC area. According to the latest Marine Report card by Auckland Council (2016), the Manukau Harbour water quality has been classified 'poor' due to the high concentration of nutrients and turbid water. Water quality, sediment and ecology have an overall grade of D (on a scale of A to F). While concentrations of contaminants are generally low, the ecological health is ranked 'unhealthy'.

2.5.3. High-Use Aquifers

There are three underlying aquifers (Te Hihi South Waitemata and Pukekohe Central Volcanic and Pukekohe Kaawa) within the plan change area. These are high use aquifers and aquifer recharge is considered important to ensure base flows in streams and to meet future water take demands).

The SMP recognizes the importance of the high-use aquifers present under the PPC and proposes retention to ground via infiltration. Geotechnical investigation confirms that infiltration rates within the PPC favour retention to ground via infiltration, however specific testing at the location of any future infiltration devices is recommended to maximise infiltration to ground.

At the time of this SMP written, the plan change seeks to meet the minimum retention requirement of 5mm per E10 of the Auckland Unitary Plan. Woods acknowledge that this is the minimum requirement and that detailed design at subsequent resource consent stages will seek to maximise infiltration to ground, subject to specific infiltration rates where infiltration devices are proposed and groundwater levels at the device locations.

2.6. Flooding and flow paths

Auckland Council GeoMaps indicates that the PPC is affected by the following flood related features (Figure 9):

- A major overland flow path (more than 4,000m^2) running west to east across the PPC, with several minor overland flow paths draining to it. The trajectory of the overland flow paths identified on AC GeoMaps does not align with the location of the culvert under SH22 and drains to the south of culvert alignment.
- Extensive floodplains across the eastern part of the PPC, which contained within the PPC and does not overtop Paerata Road.
- A flood prone area with a spill elevation of 45.05mRL (NZVD) and a volume of approximately 5,704m^3.

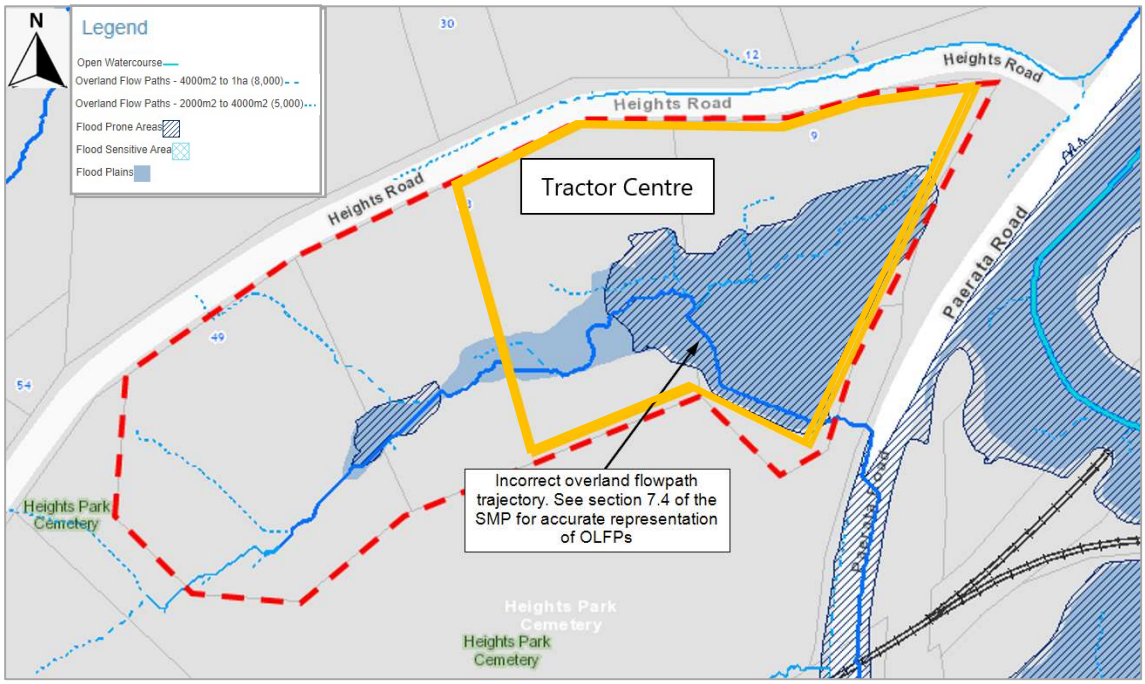


Figure 9: Existing secondary network/ flooding (Source: Auckland Council Geomaps)

2.7. Biodiversity

No significant ecological areas have been identified within the plan change area on the AUP maps or in the ecology report provided by RMA Ecology Ltd. The Ecology Report has been included in Appendix 9 of the AEE.

Macroinvertebrate community index- exotic and macroinvertebrate community index- rural are identified within the Heights Road PPC area on the AUP Viewer (Figure 10).

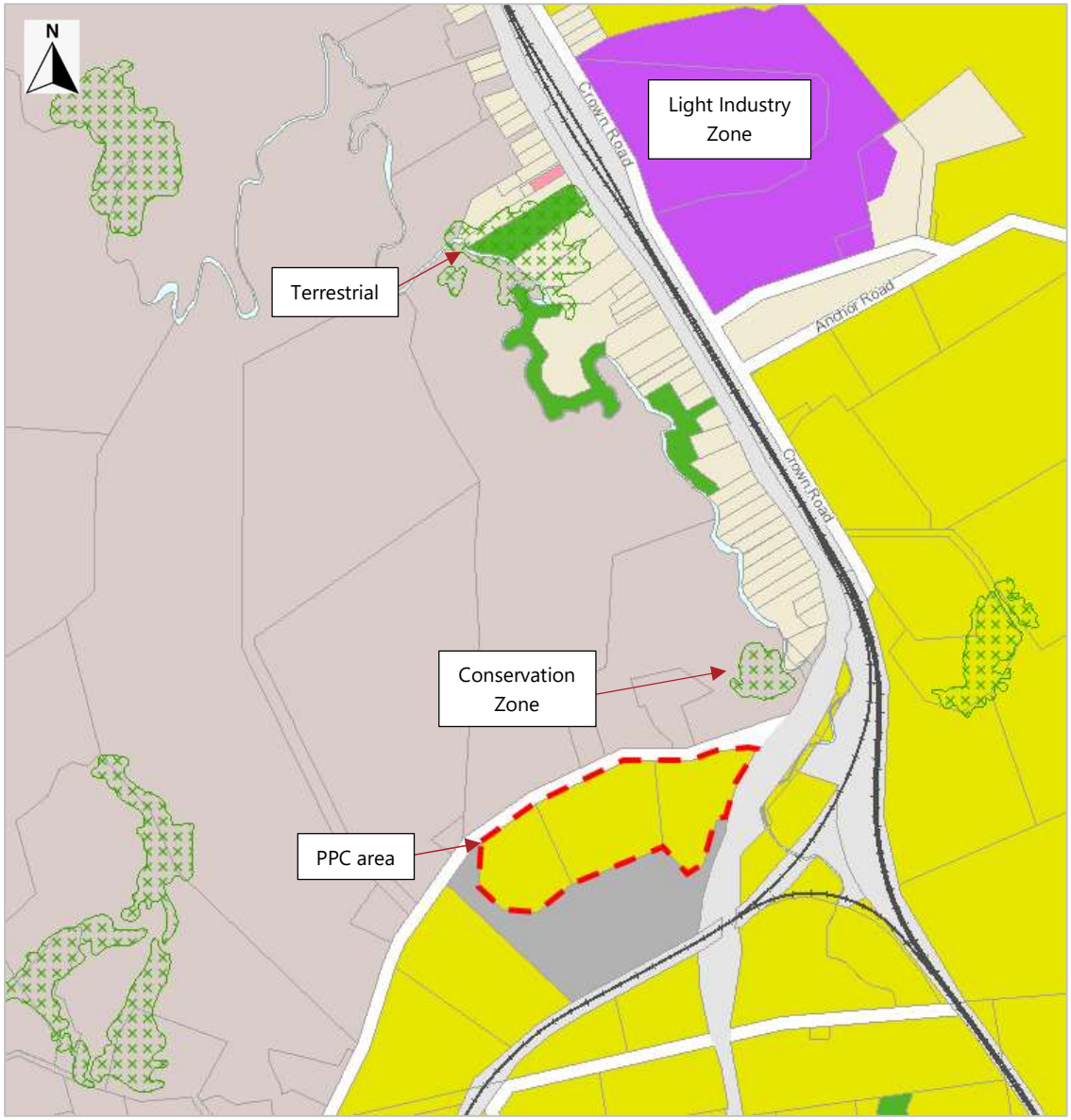


Figure 10: Significant ecological areas – (Sources AC AUP Viewer)

2.8. Cultural and heritage sites

Auckland Council Geomaps shows none of the following overlays within the plan change area:

- Historical/heritage sites,
- Special character/natural heritage overlay or
- Places of significance to Mana Whenua.

2.9. Contaminated land

A Preliminary Site Investigation (PSI) has been conducted by ENGEO Ltd, which concluded that contaminants may be present within the shallow soils, therefore, these excavated soils may require testing/approval from Auckland Council prior to disposal or reuse. ENGEO Ltd recommends a Detailed Site Investigation (DSI) be undertaken to assess the contaminated land provisions of the AUP in accordance with the requirements of the National Environmental Standard.

A copy of the contaminated land report has been included Appendix 7 of the AEE.

3. Development summary and planning context

The requirements of the AUP provisions and the requirements of the NDC are discussed in detail in the following subsections.

3.1. Regulatory and design requirements

The relevant regulatory and design requirements have been reviewed and are listed in Table 2. A summary of each listed requirement or policy is presented in sub-sections below.

Table 2: Regulatory and design requirements

Requirement	Relevant regulatory /design to flow
Natural resources of the Regional Policy Statement	AUP Chapter B7
Significant ecological areas	AUP Chapter D9
Water quality and integrated management	AUP Chapter E1
Lakes, rivers, streams and wetlands	AUP Chapter E3
Stormwater management devices design	GD01
Application of principles of water sensitive design	GD04
Discharge and diversion	AUP Chapter E8
High contaminant generating areas	AUP Chapter E9
Unitary Plan – SMAF hydrology mitigation	AUP Chapter E10
Natural Hazards and Flooding	AUP Chapter E36
Existing Catchment Management Plan	N/A
Structure Plan	N/A
Auckland Council Regionwide Network Discharge Consent	Schedules 2 & 4
Hydrology in Auckland Region	Auckland Regional Council - Guidelines for Stormwater Runoff Modelling in the Auckland Region – Technical Publication 108 (1999)
Design and Construction of Stormwater systems for Land development and Subdivision	Auckland Council - Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 - Stormwater), also called Stormwater Code of Practice (SWCOP), Version 4.
Diversion, discharges, takes and earthworks associated with freshwater systems (stream and wetlands	Ministry for the Environment Resource Management - National Environmental Standards for Freshwater (2020)
Detail on Stormwater Management including WSD, Flood Risk Management, Freeboard allowance	NZS4404 – Land development and Subdivision infrastructure (2010)

Further details regarding the regulatory framework, policies and guidelines used for the preparation of SMP are provided in Appendix B of this SMP and the AEE.

4. Mana whenua

The proposed plan change has been circulated to the seven Mana Whenua groups identified as having an interest in the area. Of these iwi groups, Ngāti Tamaoho has sought further engagement with the project. An on-site meeting was undertaken with Ngāti Tamaoho on 14 April 2023 to discuss the plan change and a draft SMP was provided to iwi in July 2024 for consideration. A summary of iwi consultation has been included in Appendix 12 of the AEE.

Ngāti Tamaoho have provided a memo highlighting their key areas of interest. Ngāti Tamaoho have not raised any concerns with respect to stormwater and flooding, and have one recommendation for stormwater, as below:

> *We recommend water tanks for the reuse of the rainwater off the roofs. Rain tanks are pivotal to easing the water shortage in Auckland due to the intensification of housing going on and can also be beneficial in times of flooding. The issue of where water will come from in the future is not being accounted for with such intense developments around Tāmaki Makaurau.*

This SMP sets out requirements for roof areas to meet SMAF1 hydrology mitigation requirements, including a minimum re-use volume to meet retention requirements. This is further discussed in Section 8.2 of this SMP.

Ngāti Tamaoho will have the opportunity to further engage with the project as development progresses within the plan change area.

5. Stakeholder engagement and consultation

Engagement has been undertaken with key stakeholders. A summary of the consultation to date has been provided in Table 3.

Table 3: Summary of consultation with Stakeholders

Date	Stakeholders	Summary of discussion
11/12/2020, 17/05/2023 and 11/07/2024	Healthy Waters	• As the PPC discharges to a culvert beneath SH22 (a Waka Kotahi asset) prior to discharge to the Auckland Council owned network (Whangapouri Creek), stormwater discharges from the PPC cannot be authorised under the NDC. • Proprietary stormwater treatment devices can be explored, but most devices are not acceptable to Healthy Waters. It is noted that the SMP is no longer being authorised under the NDC and no assets are proposed to be vested in Council. • HW requested a long section of the pipe showing flow rate/velocities and hydrograph at exit of the Waka Kotahi owned culvert. • HW requested the applicant provide further details of the modelling which suggested the post development flooding of the existing buildings will be reduced from 700mm to 225mm. • HW required the applicant to confirm the proposal for conveyance of the upstream overland flow path, which is shown to be piped. • HW requested infiltration testing to guide the hydrological mitigation approach, with reference to AUP Chapter E1 and the presence of the three underlying high use aquifers.

14/04/2023	Waka Kotahi	• Waka Kotahi have identified significant flood risk on SH22 at the railway underpass and have subsequently requested that the proposed plan change:
		  ○ Provide attenuation of the 1% AEP event, and
		  ○ Consider an upgrade of the existing 600mm culvert under SH22.
		• The Waka Kotahi P46 Stormwater Specification should be considered as part of the SMP. The SMP has been updated to address culvert design requirements for the culvert upgrade option. The P46 Specifications do not include measures to account for climate change related flood risks for developments. The flood modelling undertaken to inform this SMP accounts for a 3.8°C temperature increase resulting from climate change in accordance with version 4 of the Auckland Council Stormwater Code of Practice.

6. Proposed development

6.1. General development information

The proposed plan change at 9, 33 and 49 Heights Road seeks to rezone 5.35ha of land from Future Urban Zone to Business – Light Industrial Zone.

Chapter H17 of the AUP states that Business – Light Industrial Zone can be developed to 100% impervious coverage. It is noted that 100% impervious coverage is unlikely to be achieved for the plan change area due to some areas being utilised for stormwater devices and landscape planting.

The indicative masterplan proposes nine new buildings, car parks, driveways and other hardstand areas. The plan change proposes to retain two buildings (BMC building and Tractor Centre) with no changes proposed to the existing building configuration or floor levels. While the indicative masterplan assumes these buildings will be retained, the overall stormwater management strategy for the site has been formulated to be flexible to the possibility of the entire PPC being redeveloped.

No public roads are proposed as part of the plan change. Any proposed stormwater infrastructure as part of the plan change application, including pipes, manholes and stormwater management devices, are intended to be maintained privately.

It is noted that the SMP does not seek authorisation under Auckland Council's Network Discharge Consent.

6.2. Location and area

Refer to section 2.2 for general information regarding the location and area of the proposed development.

6.3. Purpose of the development

The purpose and objective of the PPC is to enable the ongoing operation and expansion of light industrial activities on the PPC land to meet current and future demand for industrial growth, consistent with the Pukekohe-Paerata Structure Plan whilst avoiding, remedying and mitigating adverse effects on the environment.

6.4. Site layout and urban form

An indicative masterplan has been prepared which shows the proposed layout in the plan change area. It is to be noted that the masterplan has been prepared as a possible proposed layout to demonstrate that intensification within the plan change area is possible. The Indicative Masterplan for the PPC is outlined in Figure 11.

	EXISTING BUILDING 1	EXISTING BUILDING 2	NEW BUILDING 1	NEW BUILDING 2	NEW BUILDING 3	NEW BUILDING 4	NEW BUILDING 5	NEW BUILDING 6	NEW BUILDING 7	NEW BUILDING 8	NEW BUILDING 9
GFA	2,414m²	2,666m²	1,819m²	1,962m²	950m²	1,000m²	900m²	1,550m²	1,500m²	1,500m²	1,382m²
PARKING PROVIDED	15	45	20	51	16	30	35	44	35	30	20

Figure 11: Height Road Tractor Masterplan (Scheme and Area)

The masterplan identifies existing buildings to be retained and areas proposed to be developed in the future. It is noted that the masterplan is indicative for plan change and existing buildings intended to remain may not be retained as part of future development. For the purposes of the SMP, "new and redeveloped impervious areas" excludes existing hardstand and roof areas.

The plan change proposes to retain the tractor centre and the BMC building ('Existing Building 1' and 'Existing Building 2', respectively in dark blue in Figure 11). The total area covered by the existing roof areas is approximately 5,080m^2. The total area covered by "new and redeveloped impervious area" is approximately 4.85ha inclusive of hardstand areas.

6.4.1. Existing impervious areas

The PPC land has a long history of light industrial use. A substantial portion of the PPC land is currently utilised for existing consented rural business activities, including the Tractor Centre, BMC Engineering, machinery hire, building businesses and storage facilities which support the local rural sector. Other historic uses include the Cavalier Meat Works and the King Coleslaw factory.

In this regard, the existing site has a significant amount of impervious cover, including buildings, equipment storage areas, car parking and other trafficable hardstand areas (Figure 12). The trafficable hardstand areas within the PPC currently exceeds 30 parking spaces and would be classified as 'high contaminant generating activities' under Auckland Unitary Plan definitions.

Figure 12: Existing hardstand areas (source: Google maps)

A review of the property files has found that the Tractor Centre and Total Span offices at 9 Heights Road was consented for in 2002 under LUC60107631/LO1146. The stormwater particulars state the following:

- Private stormwater drainage for the consented works currently discharge to a soak pit designed to ARC TP10 standards with 12m^3 of storage within 9 Heights Road.
- An ephemeral watercourse with a contributing catchment area of 6 hectares is piped through most of the site. Approximately 25m of open watercourse was consented to be piped. The pipe system connects to the 600mm diameter culvert under SH22, which discharges directly to the Whangapouri Stream.
- Any maintenance and cleaning activities will be conducted within buildings or under covered areas, and any washdown water will be contained and passed through an oil and grit separator before discharge to the public sewer.

Building consent for the BMC building at 33 Heights Road was granted in 2020 under BCO10314466. The consenting documentation outlines the following stormwater particulars, which are in accordance with the design standards at the time of consent being granted:

- A raingarden provides treatment for the water quality volume from parking areas in front of the BMC building.
- Tanks capturing roof runoff have been established. These tanks have not been designed for SMAF hydrology mitigation as the site is currently not in a SMAF overlay.

In accordance with Auckland Unitary Plan requirements, any future hydrology mitigation and water quality treatment devices will be constructed/installed prior to new/redeveloped impervious areas being established within the PPC. If existing treatment devices are removed as part of development, stormwater management for existing surfaces that are to remain will need to be provided for.

6.5. Earthworks

A preliminary post development earthworks surface was prepared for undertaking flood modelling. This surface incorporated tie ins with the existing area around the PPC, retained the two existing building floor levels (proposed to be part of PPC) and allowed for approximate future building levels. The purpose of the post development earthworks surface was to formulate a flood management strategy to support the plan change application.

No earthworks plans or cut/fill volumes calculations have been formulated to support the plan change application. These will be prepared and submitted with future consent applications.

7. Stormwater management

This section presents the stormwater management approach for the plan change. The management approach recommended in this report meets the objectives and design requirements outlined in the Auckland Unitary Plan. The purpose and scope of this report is to identify the technical stormwater management solutions to rezone the PPC to light industrial.

This section covers the proposed stormwater discharge, water quality and hydrological mitigation requirements.

7.1. Principles of stormwater management

The stormwater management principles for the integrated stormwater management approach described below are consistent with:

- The guidance and planning context as identified in Section 3 of this report.
- The AUP policies on integrated stormwater management and the requirements under the Auckland Unitary Plan.

7.1.1. Original principles

The overall objective of this document includes the following:

- Enabling well-functioning urban environments that meet the changing needs.
- Improving the health and well-being of degraded water bodies and freshwater ecosystems and maintaining the health and well-being of all other water bodies and freshwater ecosystems.
- Minimising the generation and discharge of contaminants, particularly from high contaminant generating car parks and high use roads and into sensitive receiving environments.
- Minimising or mitigating changes in hydrology, including loss of infiltration.
- Where practicable, minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges.
- Providing for the management of gross stormwater pollutants,
- Ensuring the upstream and downstream flood effects are no more than minor.

7.2. Proposed stormwater management

The stormwater management strategy for the PPC proposes water quality and SMAF1 hydrology mitigation for all impervious areas within the proposed plan change extent, which includes the two existing buildings to be retained. The flood management strategy for the PPC includes attenuation of flows to pre-development/existing peak flow rates discharging to the SH22 culvert.

The PPC extent is currently not in a SMAF overlay. The plan change seeks to include the PPC extent under the Auckland Unitary Plan SMAF1 overlay (Figure 13). Inclusion in the SMAF1 overlay will require any future development to comply with the requirements set out in Chapter E10 of the Auckland Unitary Plan.

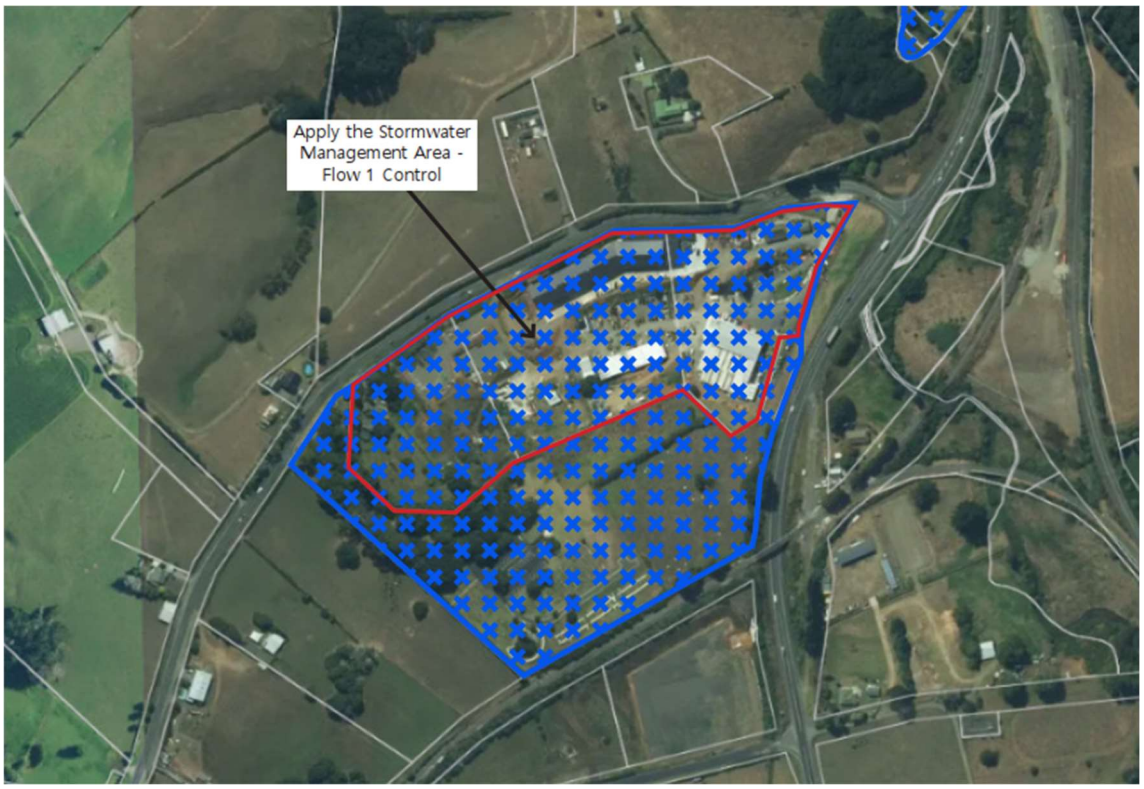


Figure 13: Proposed SMAF1 area

7.2.1. Water Quality

The SMP requires new buildings be constructed with inert roofing material and cladding material as a means of avoiding contaminants leaching into runoff.

The PPC proposes parking areas exceeding 30 vehicles. These areas are defined as 'high contaminant generating activities' under the Auckland Unitary Plan and will require water quality treatment per E9 of the Auckland Unitary Plan. The contaminants of concern for the proposed land use includes total suspended solids, heavy metals and temperature.

A matrix of the proprietary devices considered suitable to target the contaminants of concern is included in Appendix C of this report. It is anticipated that a centralised proprietary device(s) will address total suspended solids and heavy metals.

The plan change also proposes two centralised wetlands to provide water quality treatment, SMAF1 retention and detention and attenuation, which are discussed in subsequent sections. All surfaces are to be routed through the wetlands to meet the 100 year ARI attenuation requirements for the site.

If existing treatment devices are removed as part of development, stormwater management for existing high contaminant generating activities will need to be provided for.

Any trade activities on-site in the future will be mitigated separately as part of a trade waste management plan. This is outside the scope of this report.

7.2.2. Stream Hydrology

As the PPC seeks to go under the SMAF1 overlay, the requirements set out in Chapter E10 of the Auckland Unitary Plan will apply to the PPC. Chapter E10 of the AUP requires SMAF1 hydrology mitigation for all new impervious areas exceeding 50m^2 within the SMAF overlay. This section summarises how the plan change proposes to meet the SMAF1 hydrology mitigation requirements.

The SMAF1 design rainfall depths are summarised in Table 4.

Table 4: 95th Percentile Rainfall Depth

	Depth (mm)
95th percentile rainfall depth	33
Rainfall depth for Retention	5
Rainfall depth for Detention	28

Retention

Chapter E10 of the Auckland Unitary Plan requires retention (volume reduction) of at least 5mm runoff depth for the impervious area for which hydrology mitigation is required.

Healthy Waters have requested infiltration testing to be undertaken as part of the plan change process to understand the potential for groundwater recharge of the three high use aquifers in the area. Falling head percolation testing has been included in Appendix 6A of the AEE.

A high-level assessment has been undertaken to evaluate if the plan change will be able to meet the existing groundwater recharge rate. Based on the National Groundwater Recharge Model (NGRM), the current rainfall recharge rate for the PPC is 200mm/year.

Using continuous rainfall data from the year 2023 and assuming 5mm of retention can be infiltrated within 72 hours, the annual recharge for the PPC is approximately 395mm. By providing 5mm of retention on-site, the recharge to the aquifer is expected to be no less than existing. The calculations to quantify yearly groundwater recharge is included in Appendix D.

Woods acknowledge that the retention of 5mm of runoff depth is the minimum requirement for retention and subsequent resource consent stages will seek to maximise infiltration to ground. Woods also note that maximising infiltration to ground is subject to specific infiltration rates and groundwater levels at the proposed device locations.

Retention is to be provided in the following ways, in order of priority:

1. Infiltration to ground – A geotechnical assessment has confirmed that the underlying soil permeability is more than 2mm/hr, however the rates vary across the site. During the RC stage, groundwater levels will be checked where retention via infiltration is proposed. Consideration will be given to ground water levels to ensure that devices providing retention are feasible.
2. Re-use – runoff from roof areas only may be re-used for non-potable water supply into the buildings. Re-use may not be appropriate runoff from paved areas and infiltration to ground is recommended for these areas.
3. Full detention – If any of the retention measures described above are not feasible, the retention volume will be included in the detention volume.

Detention

Chapter E10 of the Auckland Unitary Plan requires detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the 5mm retention volume or any greater retention volume that is achieved, over the impervious area for which hydrology mitigation is required.

Detention requirements will be evaluated based on the infiltration volumes outlined in future consent applications. Detention volume will be held in an appropriate management device that includes an orifice to gradually release the stored volume over a 24-hour period. At the time of this SMP being written, it is anticipated that retention and detention will be provided in two centralised wetlands, which have been indicatively shown on the masterplan in Figure 11.

Alternative solutions, like underground storage tanks designed for retention through infiltration and detention, may also be considered in later consent stages. Table 5 provides an overview of the SMAF1 hydrology mitigation volumes required for the PPC extent. It is noted that any SMAF1 hydrology mitigation

met outside of the wetland will require water quality treatment in a proprietary water quality treatment device, from the list agreed upon with Healthy Waters.

Table 5: Required hydrology mitigation volume summary

	"New and redeveloped impervious areas"	"Existing roof areas"
Total area (ha)	4.85	0.5
Runoff depth required for retention (mm)	5	5
Retention volume (m^3)	242.5	25
Runoff depth required for detention (m^3)	19.4	19.4
Detention volume	940.9	97
Total hydrology mitigation volume (m^3)	1183.4	122

7.2.3. Stormwater Management Summary

Figure 14 provides a schematic of the overall proposed stormwater management strategy for the PPC. The schematic shows all options presented in the SMP and highlights the recommended strategy.

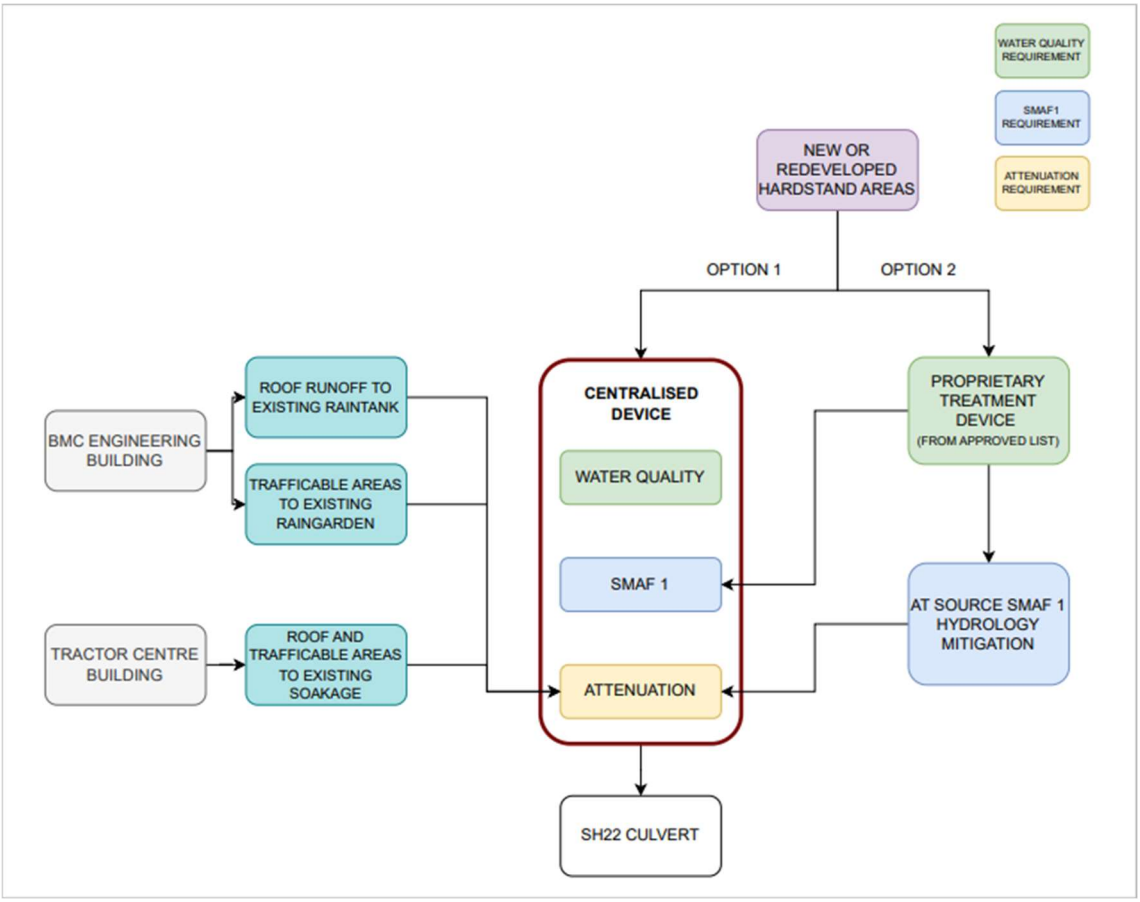


Figure 14: Overall proposed stormwater management strategy

7.2.4. Conveyance Network

7.2.4.1. 10 year ARI storm event

Section 2.5.1 of this report has identified that the current stormwater infrastructure does not have sufficient capacity to convey either primary or secondary flows from catchment directly upstream of the plan change area. It also identifies that erosion is a concern in the Whangapouri catchment.

The existing private stormwater assets on site will be reused or removed to facilitate the additional impervious areas proposed as part of the plan change. A stormwater network has not been designed at the time of this SMP being written.

The primary stormwater reticulation network within the development site will be designed to accommodate the 10 year ARI MPD (2.1°C temperature increase due to climate change) flows from the PPC and external catchment, in order to future-proof the network design for development in these areas.

The proposed stormwater management strategy does not include the following for external secondary flows:

- Water quality treatment for flows from the external catchment,
- SMAF1 hydrology mitigation for flows from the external catchment to address erosion concerns, and
- Attenuation of external inflows in the 10 year and 100 year ARI storm events.

7.2.4.2. 100 year ARI storm event

The flood management strategy for the plan change (discussed in Section 8 of this report) recommends the attenuation of post development peak flows back to pre-development/existing rates that discharge to the SH22 culvert. This option includes the attenuation of peak flows in the 10 and 100 year ARI storm events (inclusive of the relevant climate change considerations for each event).

The wetlands have indicatively been sized in the InfoWorks ICM flood modelling software, as part of flood mitigation optioneering for the PPC. The wetlands have been modelled as 1D storage nodes with an overtopping weir to storage and a gravity return. The 1D storage nodes have been sized for 100 year ARI (3.8°C temperature increase due to climate change) MPD flows from the PPC, as well as any floodplain displacement resulting from the preliminary earthworks surface.

Finished floor levels for vulnerable activities will be recommended at subsequent consent applications in accordance with the freeboard requirements in Auckland Council's Stormwater Code of Practice/other alternative guideline document. No changes are proposed to the finished floor levels of the existing buildings to be retained as part of the plan change.

7.2.4.3. Overland flow path and floodplain management

Secondary flows (events greater than the 10 year ARI storm event and up to a 100 year ARI storm event), will be conveyed along road corridors or conveyance channels. Overland flow path conveyance routes will depend on the built environment and the plan change proposes to maintain existing overland flow path discharge locations.

The overland flow path management strategy will meet the following design criteria:

- Conveyance routes for overland flow paths will be designed with sufficient capacity to accommodate the 100 year ARI (allowing for future temperature increases due to climate change) storm event with the contributing catchment at MPD impervious coverages,
- Overland flows from any external properties entering the plan change area will be maintained and accommodated within the overland flow path conveyance routes within the plan change area,
- Overland flow paths will remain unobstructed and comply with the velocity and depth values required for pedestrian and vehicular safety within the site, as per Auckland Transport – Transport Design Manual **(TDM)**. AT TDM states that the product of maximum depth and average velocity should be less than $0.3m^2/s$
- Overland flows will meet the design criteria outlined in Auckland Council's Stormwater Code of Practice.

Auckland Council Geomaps shows an overland flow path from sites to the west of the PPC, which currently flows east through the plan change extent. Healthy Waters have asked whether external flows from the upstream catchment can be conveyed safely through the plan change extent.

The plan change assumes that any development upstream of the site will provide attenuation to pre-development flow rates for the 100 year event to prevent any effects on the PPC. Consequently, the open channel analysis assumes 100 year flows from the upstream catchment at ED impervious coverages and site generated 100 year flows at MPD impervious coverages.

A design surface has not been formulated to enable the plan change, however a representative cross-section with a single cross-fall has been used for this analysis. The design surface assumes that external inflows will be split between the two accessways shown in Figure 15.

The cross-section analysed was taken for the narrowest point along the proposed accessway, which is also shown in Figure 15. The longitudinal fall along the channel has been calculated as an average of the slope along the post development overland flow path route.

Figure 15 shows the snippet from Hydraulic Toolbox (Version 5). The calculation predicts flow depths of 122mm in the representative cross-section. The predicted depth is a function of the longitudinal slope, which has been conservatively estimated.

Flood depths of 122mm do not affect the trafficability of passenger vehicles and does not pose a risk to pedestrian safety. The analysis demonstrates that overland flows generated from upstream of the site can be accommodated within the overall overland flow path management of PPC.

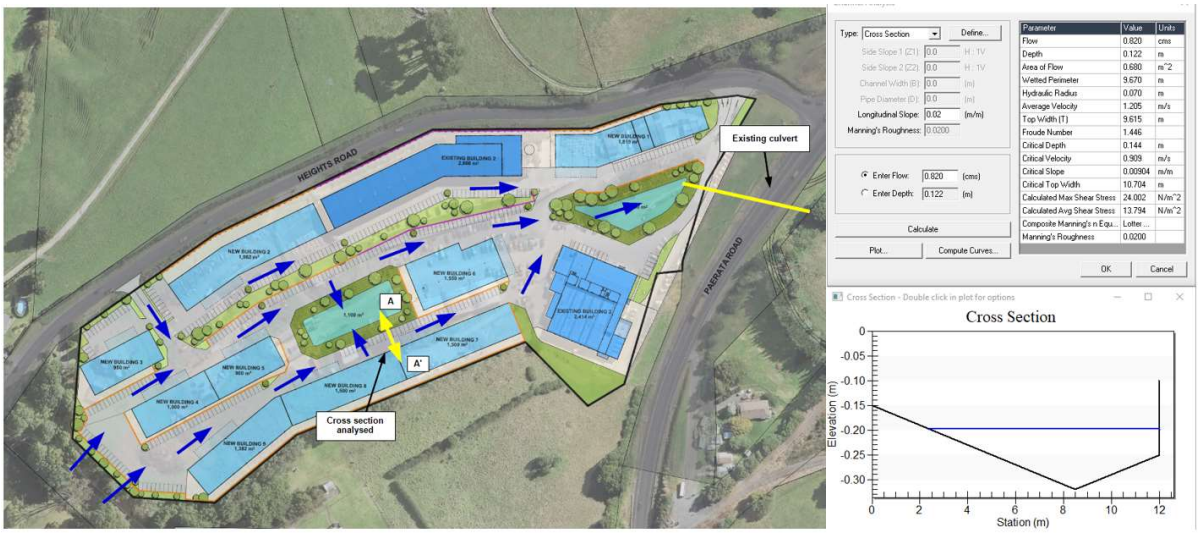


Figure 15: Hydraulic toolbox snippet demostrating conveyance of external upstream overland flows

It should be noted that the design surface might change as part of subsequent consent applications and reassessment will be required to confirm depths and trafficability. Adequate freeboard to the floor levels of new buildings will be provided relative to the water level.

7.3. Development staging

****Development Staging is to be addressed at Resource Consent****

7.4. Hydraulic connectivity

Runoff from the 10-year ARI event will be managed through a stormwater network. For storm events exceeding the 10-year but not surpassing the 100-year event, runoff will be directed through Jointly Owned Access Lots (JOALs). The design of both the primary and secondary systems will incorporate relevant climate change factors, as required at the time of consent applications.

7.5. Asset ownership

All devices and assets proposed within the PPC extent will be privately owned and maintained. Ownership of publicly owned assets will not change following any upgrades undertaken as part of future development.

7.6. Ongoing maintenance requirements

****Maintenance requirements is to be addressed at Building Consent****

Operation and maintenance manuals for the proposed stormwater management devices are to be provided to Auckland Council for approval as part of the future building consent applications. Maintenance of proprietary treatment devices, wetlands and other proposed infrastructure such as pipes, manholes and other stormwater management devices located within the site will be the sole responsibility of the owner. The stormwater strategy to enable PPC does not propose any new assets to be publicly vested.

7.7. Dependencies

Achieving retention via infiltration is dependent on specific geotechnical testing required at the location of any proposed device(s). Geotechnical testing across the site has identified infiltration rates more than 2mm/hr and up to 10mm/hr. If specific geotechnical testing identifies high ground water levels or any other geotechnical constraints that makes retention to ground unfeasible, other options may be explored such as tanking or including the retention volume as part of the detention volume.

7.8. Risks

The risks to the proposed stormwater management within the plan change area are outlined in Table 6.

Table 6: Risks

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Ground stability issues affecting provision of flood storage	Further detailed geotechnical assessment and earthworks design	N/A	During design/ Resource Consent phase	Moderate
Overland flow paths – Due to only preliminary earthworks design being undertaken during the plan change state, the overland flow paths regime traversing through the site is not finalised.	The preliminary calculations show that the overland flow paths can be accommodated within the acceptable thresholds. Final overland flow paths design should be in line with AC SWCOP V4	Reassess during design phase	During design/ Resource Consent phase	Moderate
Post development floodplains – site earthworks and the location of the stormwater basins is not finalised; therefore, post developments floodplains within the site may change	Location of stormwater basins and earthworks design should be finalised after the completion of flood analysis	Reassess during design phase	During design/ Resource Consent phase	Moderate
Achieving retention function via infiltration at specific device	Complete detailed geotechnical assessment	Use hierarchy stipulated in Table E10.6.3.1.1, item (2) of the AUP to achieve retention function	During design/ Resource Consent phase	Moderate

8. Flood modelling

Woods has undertaken preliminary flood modelling to understand existing flood risk in the area and to quantify any increases to existing flood risk resulting from the proposed plan change.

Healthy Waters has supplied the "Whangapouri catchment model (July 2019)" to Woods. Updates have been made to the flood model within and around the PPC area to undertake the flood assessment. A flood model build report has been prepared which outlines model build assumptions, results and model limitations. The model build report is included in Appendix E of this report. The model extent can be seen in Figure 16.

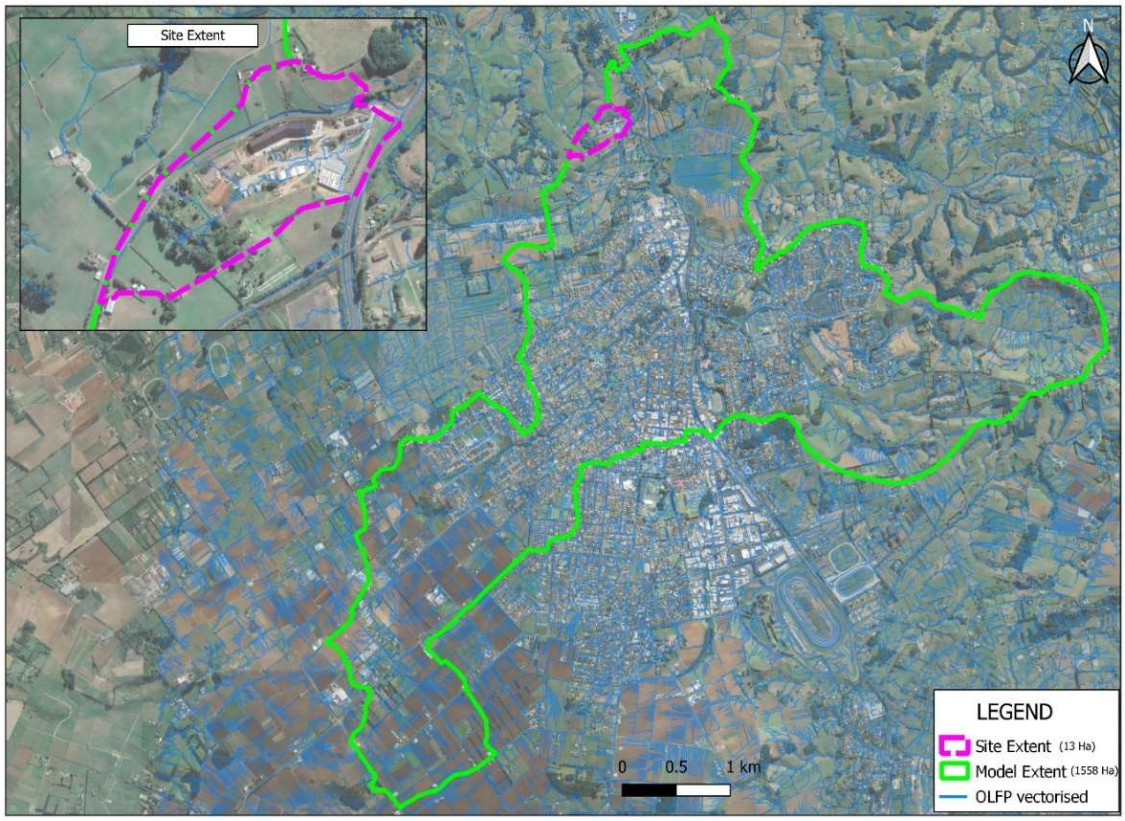


Figure 16: Model and site extent

8.1. Climate change and simulated storm events

Healthy Waters have requested that the flood models account future climate change effects, and that a temperature increase of 3.8°C should be applied. Using a 3.8°C future climate change factor ensures more resilience in the design of the secondary system.

All the models have been simulated for 10 year and 100 year ARI storm event with inclusion of future 3.8°C climate change.

8.2. Modelled scenarios

8.2.1. Base model scenario

A base model was developed to understand flooding in the existing conditions as well as to guide and assess the suitability of the flood management strategy.

The 'base model' scenario has been developed with the following impervious coverage assumptions:

- Existing development **(ED)** impervious coverage for all areas within and outside the development site. For the purposes of the report, this scenario is referred to as "Base ED" scenario.

- Areas outside the site are modelled at maximum probable development **(MPD)** coverage, per the AUP, which is consistent with Whangapouri Catchment model. For the purposes of the report, this scenario is referred to as "Base MPD" scenario.

The 'base model' scenarios use a surface based on a combination of topographical survey data and LiDAR2016. All the existing assets in the model extent (including the SH22 culvert) were surveyed.

Figure 17 shows a schematic of 'base model' scenario.

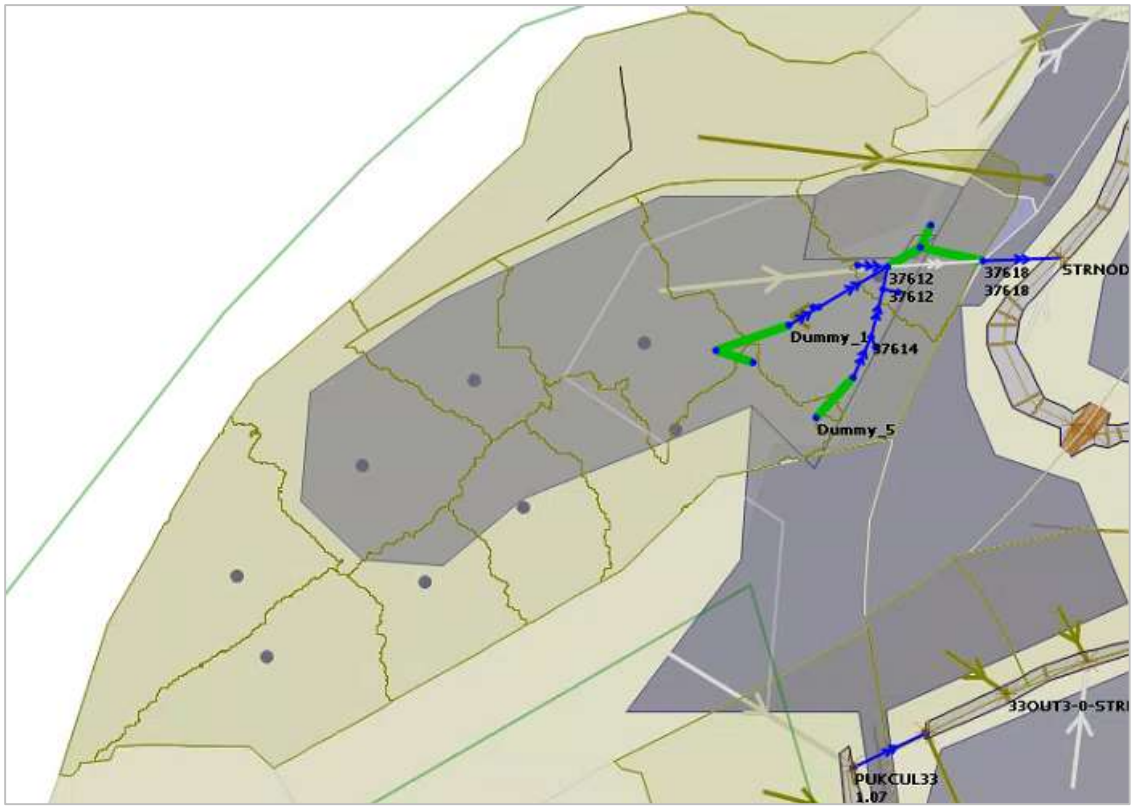


Figure 17: Existing (base model) stormwater pipe network

8.2.2. Post development model scenario

The post development model scenario further builds on the 'base model' scenario. This post development model allows for an increase in impervious coverage to 100% within the PPC in accordance with the proposed zoning. The modelling also includes a wetland for flood management.

The post development flood management strategy is predicated on the fact that the existing 600mm diameter culvert under SH22 doesn't have conveyance capacity for the 10 year storm event and Waka Kotahi having identified significant flood risk on SH22 at the railway underpass.

This flood management strategy proposes the attenuation of post development peak flows from the plan change area to less than pre-development peak flows for the 10 and 100 year ARI (for a temperature increase of 3.8ºC to allow for climate change) storm event.

The post development model uses a combination of preliminary design surfaces, survey information and LiDAR 2016 to represent topography.

Further information including model build assumptions has been included in the Model Build Report included in Appendix E of this SMP.

8.2.3. Model Scenario Summary

Table 7 below summarises information used for all model scenarios.

Table 7: Modelled Scenarios

#	Scenario Name	ARI	Land Use	Landform	Stormwater Network
1	Base ED	10 year + 3.8°C climate change	ED for all the areas in the model	Topo survey + LIDAR2016	Existing stormwater network
		100 year + 3.8°C climate change			
	Base MPD	10 year + 3.8°C climate change	ED for areas within the site, MPD for all the areas outside the site extent.		
		100 year + 3.8°C climate change			
2	Option 1 – Flood storage (ED)	10 year + 3.8°C climate change	Plan change zoning for site, ED for all areas outside the site	Preliminary design surface + topo survey + LIDAR2016	Proposed stormwater network + storage device + existing network
		100 year + 3.8°C climate change			
	Option 1 – Flood storage (MPD)	10 year + 3.8°C climate change	Plan change zoning for site, ED* for area upstream to the site MPD for all the other areas		
		100 year + 3.8°C climate change			

**ED has been represented for upstream sites to simulate these sites providing attenuation to pre-development (grassed) peak flow rates*

8.3. Model Results

Model results (flood extents, flood depths, water levels) were extracted and flood depth difference plots (afflux plots) between the base and post development scenarios were generated

A complete set of modelled extents, flood depth results and afflux plots of all scenarios are included in Appendix F. The model results for 10 year and 100 year ARI storm events with inclusion of future 3.8°C climate change with consideration are discussed in the following sections. These relate to scenarios that include MPD impervious coverages outside the plan change extent.

8.3.1. Base Model

8.3.1.1. Base MPD 10 year ARI +3.8°C

The maximum modelled flood depths for Base MPD scenario for 10 year and 100 year ARI storm events with inclusion of future 3.8°C climate change are shown in Figure 18 and Figure 19 respectively.

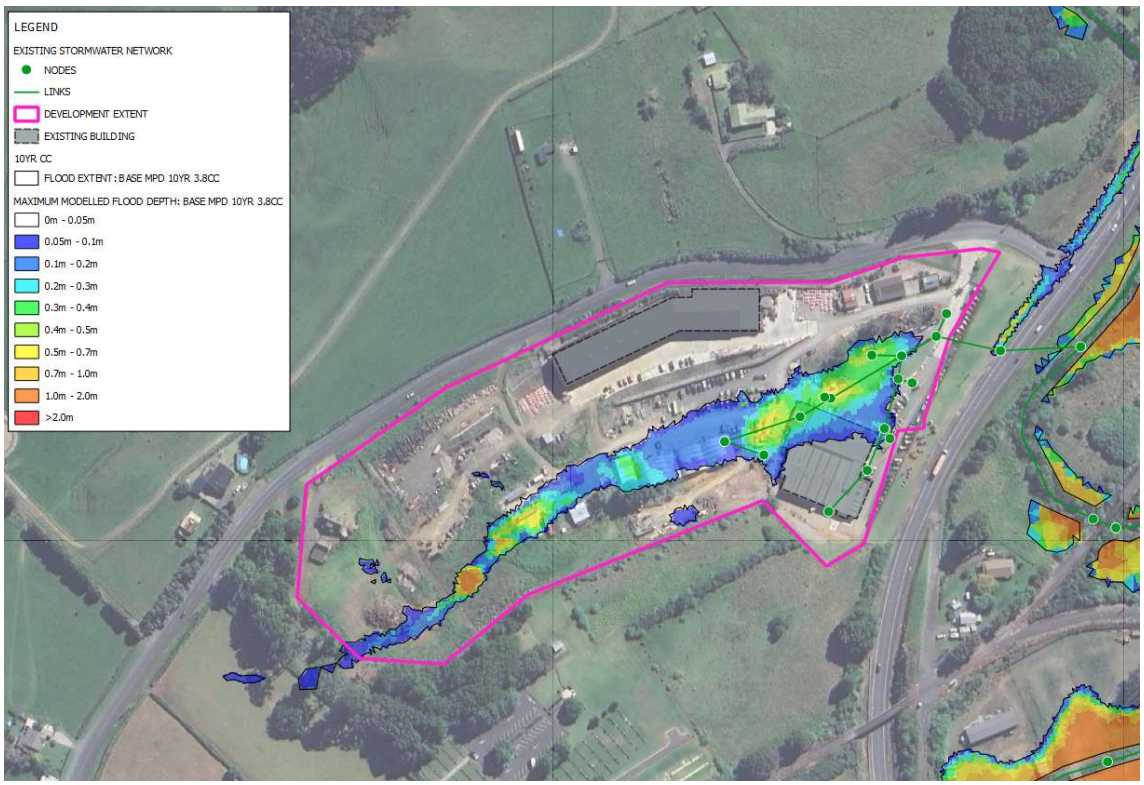


Figure 18: Maximum flood depth – Base MPD model (10YR CC +3.8°C)

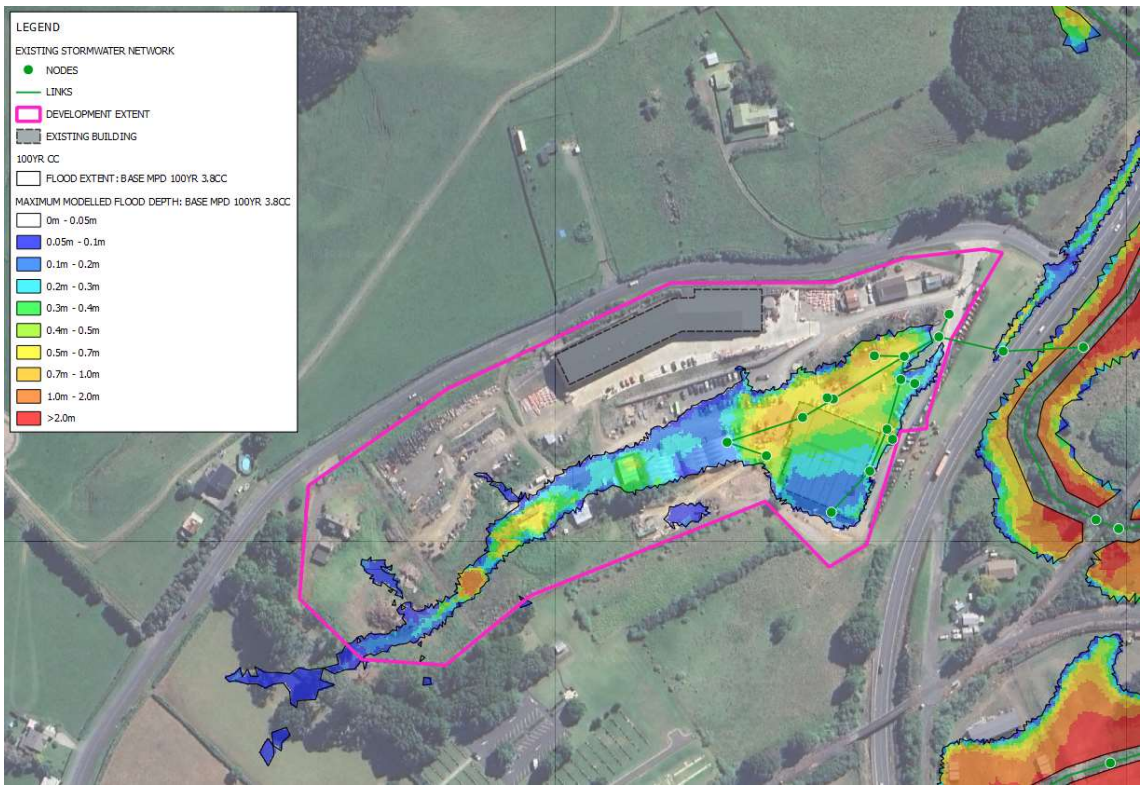


Figure 19: Maximum flood depth – Base MPD model (100YR CC +3.8°C)

The flood model results show that:

- The existing 600mm diameter culvert under SH22 motorway has insufficient conveyance capacity for flows in both the 10 year and 100 year ARI storm events. This results in flooding within the plan change area for both events.

- The maximum flood depth within the plan change area (with no flood management) is:
    - Approximately 580mm for 10 year ARI storm event, and
    - Approximately 890mm for 100 year ARI storm event.
- The maximum volume of water contained within the floodplain (Figure 19) is approximately 4,445m^3 for 100 year ARI storm event.
- The maximum conveyance capacity in the 600mm diameter culvert is 1.06m^3/s for both storm events.
- All runoff ultimately discharges to the Whangapouri stream via the existing culvert.

Flood depth plans have been included in Appendix F.

8.3.2. Post Development Model

The afflux plots showing flood level changes between the base MPD model and the post development MPD model for the 10 and 100 year storm events have been provided in Figure 20 and Figure 21 respectively.

Figure 20: Afflux Plot: Flood Storage MPD with Base MPD (10YR CC + 3.8°C)

Figure 21: Afflux Plot: Flood Storage MPD with Base MPD (100YR CC + 3.8°C)

The afflux plots comparison show that:

- Flood levels decrease between existing and post development models. This can be attributed to surface flooding now being stored in the two basin structures.

  It should be noted that the model represents basin structures in the 1D. The location of the basins has been blocked out in the Figures.

- At the existing tractor centre building, the modelling shows:

  - The base MPD model scenario shows flood depths of approximately 380mm for the 10 year ARI storm event with inclusion of future 3.8°C climate change. The afflux plots show a flooding improvement (denoted in green) of 240mm in the 10 year ARI storm event with inclusion of future 3.8°C climate change.

  - The Base MPD model scenario shows flood depth of approximately 700mm for 100 year ARI storm event with inclusion of future 3.8°C climate change. The afflux plots show a flooding improvement (denoted in green) of 560mm is noted for 100 year ARI storm event.

- The afflux plots show some flood level increases (denoted in red) within the plan change area for the 100 year storm event. This is observed within the proposed JOALs/accessways in the masterplan. It is noted that the increases in flood depths are a result of the preliminary earthworks surface and the depth increases observed in these areas can be resolved during detailed design.

- An approximate volume of 4,000m^3 has been allowed for in the storage ponds, which are represented as 1D nodes in the models. The model results show that a peak flow of approximately 0.96m^3/s is conveyed through the SH22 culvert for 10 year and 100 year ARI storm events. This is less than the culvert flows in the base MPD model scenario (1.06m^3/s).

- The flood depth and extent outside the plan change area for the post development scenario are consistent with the base MPD scenario. The afflux plots between the existing and post development scenarios show no increase in flood depths or extents. This is also true for the afflux plots comparing the Storage Option ED model scenario and Base ED model scenario. Refer to Appendix F for the flood depth plots.

8.3.2.1. Additional Requests (Healthy Waters)

Healthy Waters have requested outflow hydrographs for the 600mm diameter culvert under SH22, as well as a long section of the modelled network.

Flow hydrographs for the existing 600mm culvert underneath SH22 were extracted for Flood Storage ED scenario and Base model ED scenario in the 100-year ARI storm event (Figure 22). Additional flow hydrographs for the post development scenario with flood storage and base model scenario have been included as part of Appendix G of this SMP

The flow hydrographs show that there is a post development reduction in the peak flows in the SH22 culvert as the runoff is attenuated in the proposed basins. It should be noted that the shape of the curves at the culvert reflect the existing impervious area coverage currently on site.

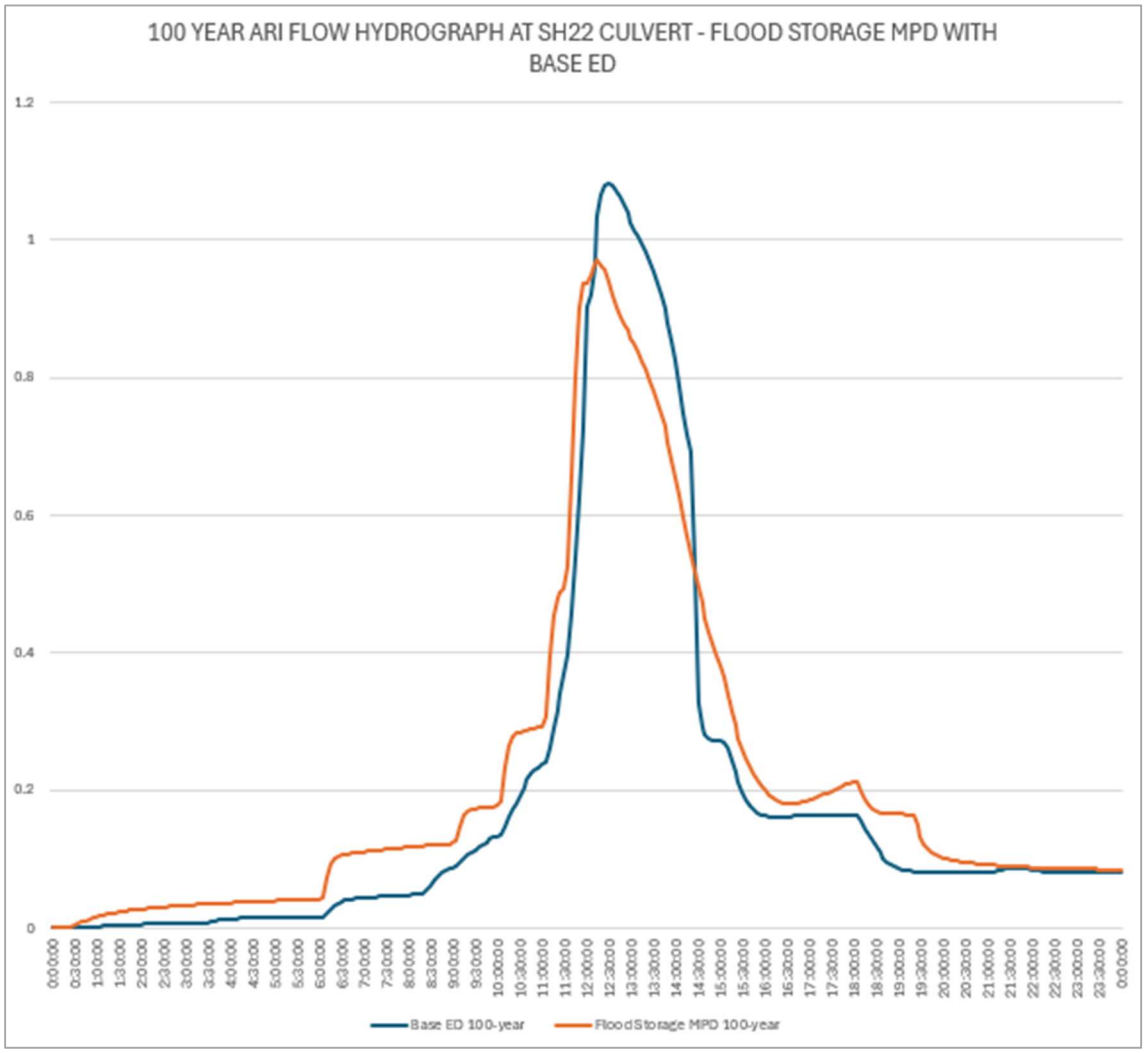
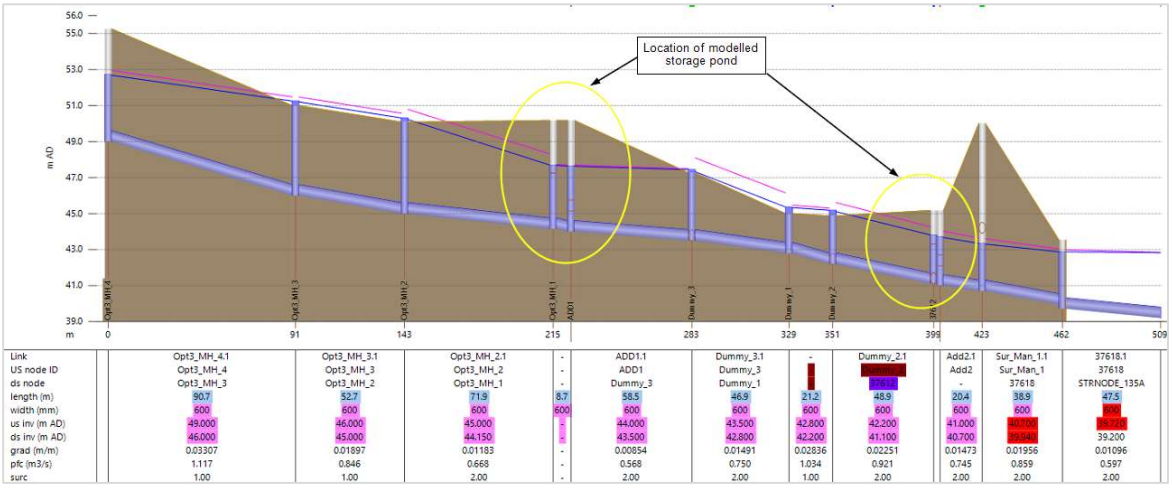


Figure 22: 600mm diameter culvert flow hydrograph – Flood storage option MPD scenario in comparison with Base ED scenario for 100 year ARI (+3.8°C)

A long section of the modelled network which has been provided in Figure 23. As previously noted, the modelled network in the post development scenario is preliminary and is not a representation of the final design for future development. This work will be undertaken during the detailed design stage for future resource consent applications.



Link	Opt3_MH_4.1	Opt3_MH_3.1	Opt3_MH_2.1	-	ADD1.1	Dummy_3.1	-	Dummy_2.1	Add2.1	Sur_Man_1.1	37618.1
US node ID	Opt3_MH_4	Opt3_MH_3	Opt3_MH_2	-	ADD1	Dummy_3		Dummy_2	Add2	Sur_Man_1	37618
ds node	Opt3_MH_3	Opt3_MH_2	Opt3_MH_1	-	Dummy_3	Dummy_1		37618	-	37618	STRNODE_135A
length (m)	90.7	52.7	71.9	8.7	58.5	46.9	21.2	48.9	20.4	38.9	47.5
width (mm)	600	600	600	600	600	600	600	600	600	600	600
us inv (m AD)	49.000	46.000	45.000		44.000	43.500	42.800	42.200	41.000	40.700	39.710
ds inv (m AD)	46.000	45.000	44.150		43.500	42.800	42.200	41.100	40.700	39.940	39.200
grad (m/m)	0.03307	0.01897	0.01183	-	0.00854	0.01491	0.02836	0.02251	0.01473	0.01956	0.01096
pfc (m3/s)	1.117	0.846	0.668	-	0.568	0.750	1.034	0.921	0.745	0.859	0.597
surc	1.00	1.00	2.00	-	2.00	2.00	1.00	2.00	2.00	2.00	2.00

Figure 23: Long section of the modelled stormwater network for Flood Storage MPD option scenario (100 year ARI + 3.8°C)

9. Departures from regulatory or design codes

The stormwater management approach proposed for the PPC meets the minimum regulatory and design codes and standards and are in accordance with Auckland Unitary Plan Chapters E1, E8, E9 and E10.

10. Conclusion

Woods has been engaged by GBar Properties Ltd to provide a SMP for a Proposed Plan Change (**PPC**) at 9, 33 and 49 Heights Road, Pukekohe. The PPC seeks to rezone 5.35ha of land from Future Urban to Business – Light Industry. The purpose and scope of this SMP is to identify the technical stormwater management solutions to rezone the site to light industrial.

Water quality treatment for all impervious areas will be provided via a central proprietary device. A list of Healthy Waters approved devices has been included with this report. Further avoidance measures to preserve water quality is included in the recommendation that new buildings be constructed with inert roofing and cladding material.

The plan change seeks to include the PPC extent under the AUP SMAF1 overlay, which will require the retention (volume reduction) of the first 5mm of runoff from all impervious areas and detention (slow release) of the 95th percentile rainfall event.

It is noted that the existing BMC building currently has tanks that capture roof runoff. The tanks can be retained/retrofitted to meet the SMAF1 retention requirements.

Centralised wetlands are recommended to provide SMAF1 retention and detention for new impervious areas, the tractor centre building and detention of runoff from the BMC building. Specific design of the basin will be undertaken at resource consent stage to facilitate retention to ground, which forms an important part of groundwater recharge for the high use aquifers in the vicinity of the PPC.

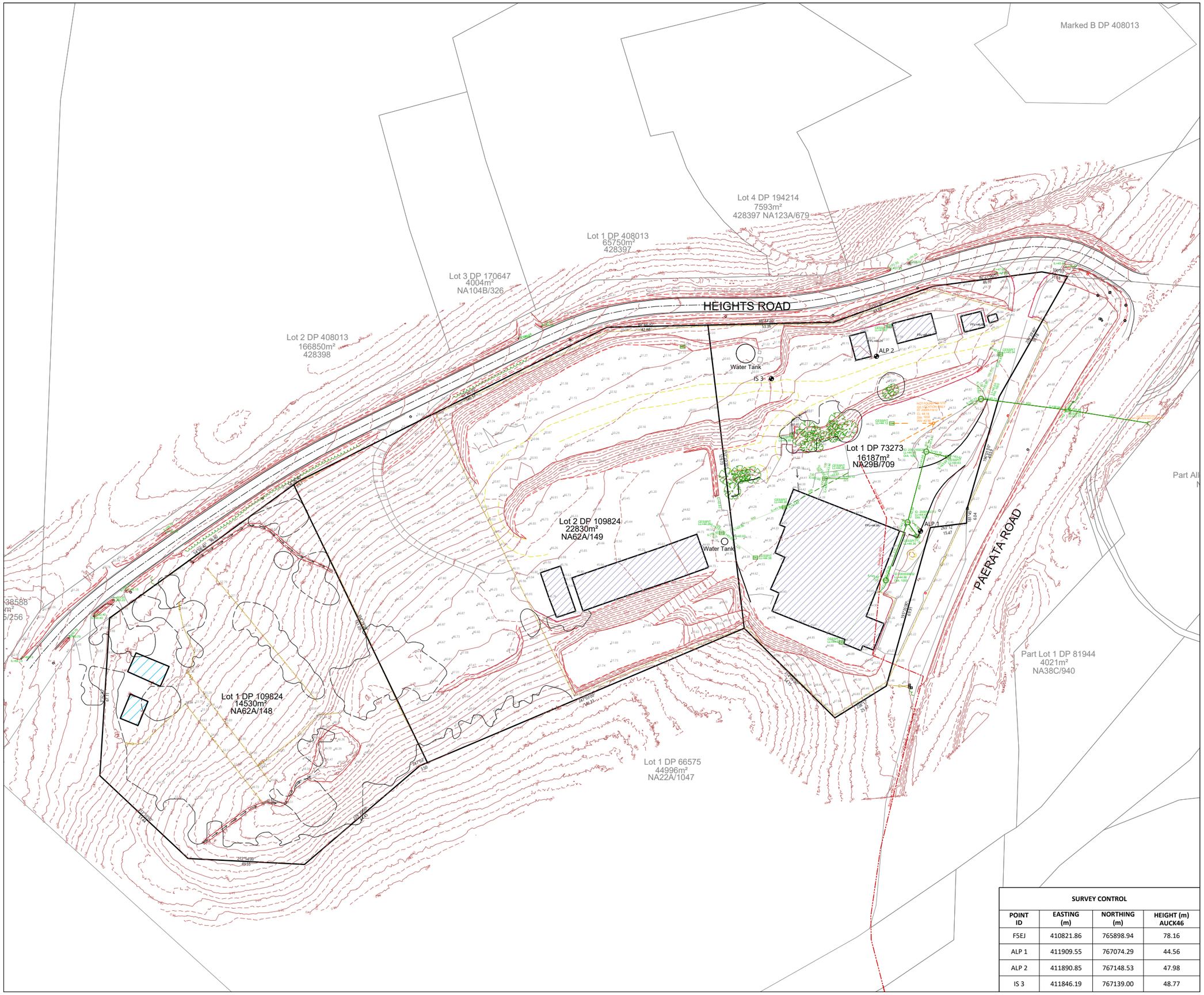
Flood modelling was undertaken to:

- Quantify existing flooding within the PPC and downstream of the PPC,
- Quantify future flood effects resulting from the PPC within and downstream of the PPC, and
- Develop flood management options to enable the PPC.

The recommended flood management strategy for the PPC is to provide flood storage attenuation for the runoff generated within the plan change area in centralised wetlands. The wetlands have been designed to attenuate runoff in the 10 year and 100 year ARI storm events. Device sizing will be supported by updated flood modelling assessments at Resource Consent stage.

The stormwater management plan demonstrates that stormwater generated within the PPC can be adequately managed within the plan change extent to meet water quality and SMAF1 hydrology mitigation requirements. Flood modelling has determined that there is no adverse flood effects anticipated upstream or downstream of the PPC with wetlands that provide attenuation. The calculations and analyses undertaken to date conclude that there are technical stormwater solutions available to enable the plan change with less than minor effects on areas upstream of downstream of the PPC.

Appendix A
Topographical Survey (2020)



SURVEY CONTROL			
POINT ID	EASTING (m)	NORTHING (m)	HEIGHT (m) AUCK46
F5EJ	410821.86	765898.94	78.16
ALP 1	411909.55	767074.29	44.56
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IS 3	411846.19	767139.00	48.77

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KEY

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- MINOR CONTOURS
- SS PIPE
- SW PIPE
- W WATER METER
- CESSPIT
- LIGHT POLE
- SW SW MANHOLE
- TREE
- S STREET SIGN
- P POWER BOX
- H FIRE HYDRANT
- 23.4 SPOT HEIGHT

SCALEBAR (m) 0 15 30 75 — SCALE | 1:1500 @A3 | 1:750 @A1|

REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION		07/10/20

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SCALE	1:1500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P18-088-00-0500-SU	

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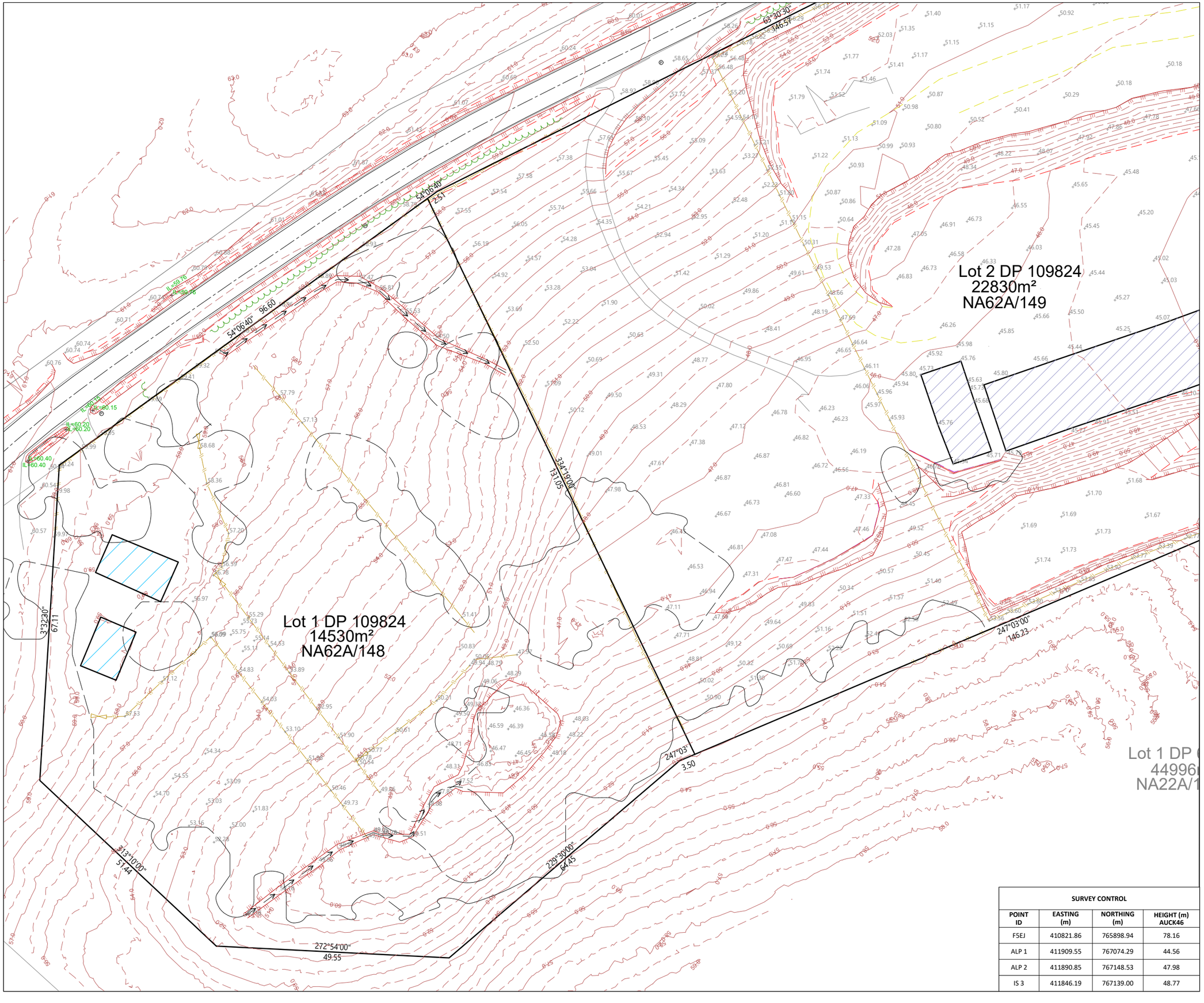

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- SW PIPE
- W WATER METER
- CESSPIT
- LIGHT POLE
- SW MANHOLE
- TREE
- S STREET SIGN
- P POWER BOX
- H FIRE HYDRANT
- 23.4 SPOT HEIGHT

SCALEBAR (m) 0 7.5 15 37.5

SCALE | 1:750 @A3 | 1:375 @A1|

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DWG NO	P18-088-00-0501-SU	

SURVEY CONTROL

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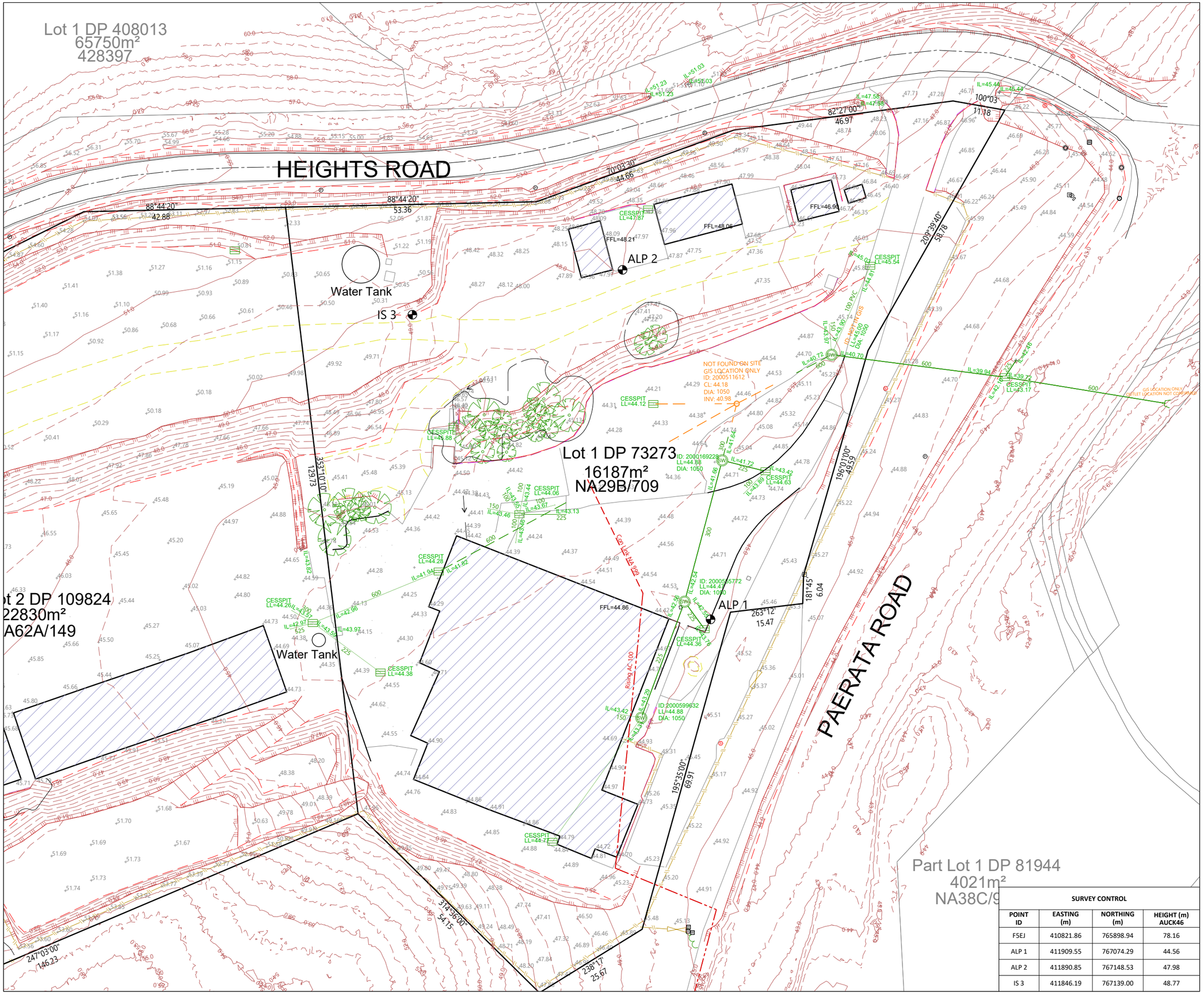

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DWG NO	P18-088-00-0502-SU	

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Appendix B

Regulatory framework, policies and guidelines

Natural resource of the Regional Policy Statement

AUP Chapter B7 sets out the policies for indigenous biodiversity, freshwater systems, coastal water, freshwater and geothermal water, air.

B7.2.2. Policies

(1) Identify and evaluate areas of indigenous vegetation and the habitats of indigenous fauna in terrestrial and freshwater environments considering the following factors in terms of the descriptors contained in Schedule 3 Significant Ecological Areas – Terrestrial Schedule

(2) Include an area of indigenous vegetation or a habitat of indigenous fauna in terrestrial or freshwater environments in the Schedule 3 of Significant Ecological Areas – Terrestrial Schedule if the area or habitat is significant.

(3) Include an area of indigenous vegetation or a habitat of indigenous fauna in the coastal marine area in the Schedule 4 Significant Ecological Areas – Marine Schedule if the area or habitat is significant.

(4) Avoid adverse effects on areas listed in the Schedule 3 of Significant Ecological Areas – Terrestrial Schedule and Schedule 4 Significant Ecological Areas – Marine Schedule.

B7.3.2. Policies

Integrated management of land use and freshwater systems

(1) Integrate the management of subdivision, use and development and freshwater systems

Management of freshwater systems

(2) Identify degraded freshwater systems.

(3) Promote the enhancement of freshwater systems identified as being degraded to progressively reduce adverse effects.

(4) Avoid the permanent loss and significant modification or diversion of lakes, rivers, streams (excluding ephemeral streams), and wetlands and their margins, unless all of the following apply:

(5) Manage subdivision, use, development, including discharges and activities in the beds of lakes, rivers, streams, and in wetlands,

(6) Restore and enhance freshwater systems where practicable when development, change of land use, and subdivision occur

B7.4.2. Policies

Integrated management

(1) Integrate the management of subdivision, use, development and coastal water and freshwater,

National Policy Statement for Freshwater Management

(2) Give effect to the National Policy Statement for Freshwater Management 2014

(3) Integrate Mana Whenua values, mātauranga and tikanga when giving effect to the National Policy Statement for Freshwater Management 2014

Water quality

(4) Identify areas of coastal water and freshwater bodies that have been degraded by human activities

(5) Engage with Mana Whenua

(6) *Progressively improve water quality in areas identified as having degraded water quality through managing subdivision, use, development and discharges*

(7) *Manage the discharges of contaminants into water from subdivision, use and development to avoid where practicable, and otherwise minimise*

Sediment runoff

(8) *Minimise the loss of sediment from subdivision, use and development, and manage the discharge of sediment into freshwater and coastal water*

Stormwater management

(9) *Manage stormwater*

Freshwater and geothermal water quantity, allocation and use

(14) *Enable the harvesting and storage of freshwater and rainwater to meet increasing demand for water and to manage water scarcity conditions, including those made worse by climate change*

Significant ecological areas

AUP Chapter D9 sets out the policies for Significant ecological areas.

D9.3. Policies [rcp/rp/dp]

Managing effects on significant ecological areas – terrestrial and marine

(1) *Manage the effects of activities on the indigenous biodiversity values of areas identified as significant ecological areas*

(2) *Adverse effects on indigenous biodiversity values in significant ecological areas that are required to be avoided, remedied, mitigated or offset*

(3) *Enhance indigenous biodiversity values in significant ecological areas*

(4) *Enable activities which enhance the ecological integrity and functioning of significant ecological areas*

Vegetation management

(5) *Enable the following vegetation management activities in significant ecological areas to provide for the reasonable use and management of land*

(6) *While also applying Policies D9.3(9) and (10) in the coastal environment, avoid as far as practicable the removal of vegetation and loss of biodiversity in significant ecological areas from the construction of building platforms, access ways or infrastructure*

(7) *Provide for the role of Mana Whenua as kaitiaki in managing biodiversity, particularly in Treaty Settlement areas, and for cultural practices and cultural harvesting in significant ecological areas where the mauri of the resource is sustained*

(8) *Manage the adverse effects from the use, maintenance, upgrade and development of infrastructure in accordance with the policies above, recognising that it is not always practicable to locate and design infrastructure to avoid significant ecological areas*

Protecting significant ecological areas in the coastal environment

(9) *Avoid activities in the coastal environment where they will result in any of the following: please refer to AUP Chapter D9 for information;*

(10) *Avoid (while giving effect to Policy D9.3(9) above) activities in the coastal environment which result in significant adverse effects, and avoid, remedy or mitigate other adverse effects of activities*

(11) *In addition to Policies D9.3(9) and (10), avoid subdivision, use and development in the coastal environment where it will result in any of the following: please refer to AUP Chapter D9 for information;*

(12) Manage the adverse effects of use and development on the values of Significant Ecological Areas – Marine, in addition to the policies above, taking into account all of the following: please refer to AUP Chapter D9 for information;

(13) In addition to Policies D9.3(9) and (10), avoid structures in Significant Ecological Areas – Marine 1 (SEA-M1)

(14) In addition to Policies D9.3(9) and (10), avoid the extension to, or alteration of, any existing lawful structure in Significant Ecological Areas – Marine 1 (SEA-M1)

(15) Avoid mangrove removal within Significant Ecological Areas – Marine where it will threaten the viability or significance of the ecological values identified.

(16) Avoid mangrove removal within Significant Ecological Areas – Marine 1 (SEAM1) unless the removal

Water quality and integrated management

AUP Chapter E1 sets out the policies for Water quality and integrated management.

E1.3. Policies [rp/rcp/dp]

(1) Manage discharges, until such time as objectives and limits are established in accordance with Policy E1.3(7),

(2) Manage discharges, subdivision, use, and development that affect freshwater systems to: please refer to AUP Chapter E1 for information

(3) Require freshwater systems to be enhanced unless existing intensive land use and development has irreversibly modified them such that it practicably precludes enhancement.

(4) When considering any application for a discharge, the Council must have regard to the following matters

(5) When considering any application for a discharge the Council must have regard to the following matters:

(6) Policies E1.3(4) and (5) apply to the following discharges (including a diffuse discharge by any person or animal):

(7) Develop Freshwater Management Unit specific objectives and limits for freshwater with Mana Whenua, through community engagement, scientific research and mātauranga Māori, to replace the Macroinvertebrate Community Index interim guideline and to give full effect to the National Policy Statement for Freshwater Management

(8) Avoid as far as practicable, or otherwise minimise or mitigate, adverse effects of stormwater runoff from greenfield development on freshwater systems, freshwater and coastal water by: please refer to AUP Chapter E1 for information

(9) Minimise or mitigate new adverse effects of stormwater runoff, and where practicable progressively reduce existing adverse effects of stormwater runoff, on freshwater systems, freshwater and coastal waters during intensification and redevelopment of existing urban areas by all of the following: please refer to AUP Chapter E1 for information

(10) In taking an integrated stormwater management approach have regard to all of the following:

(11) Avoid as far as practicable, or otherwise minimise or mitigate adverse effects of stormwater diversions and discharges, having particular regard to: please refer to AUP Chapter E1 for information

(12) Manage contaminants in stormwater runoff from high contaminant generating car parks and high use roads to minimise new adverse effects and progressively reduce existing adverse effects on water and sediment quality in freshwater systems, freshwater and coastal waters

(13) Require stormwater quality or flow management to be achieved on-site unless there is a downstream communal device or facility designed to cater for the site's stormwater runoff

(14) Adopt the best practicable option to minimise the adverse effects of stormwater discharges from stormwater network and infrastructure including road, and rail having regard to all of the following: please refer to AUP Chapter E1 for information

(15) Utilise stormwater discharge to ground soakage in areas underlain by shallow or highly permeable aquifers provided that: please refer to AUP Chapter E1 for information

(26)) Prevent or minimise the adverse effects from construction, maintenance, investigation and other activities on the quality of freshwater and coastal water by: please refer to AUP Chapter E1 for information

The SMP demonstrate the integrated stormwater management approach by considering:

- Reducing contaminants at source by using inert material that does not leach contaminants such as copper and zinc.
- Provide GD01/TP10 level of treatment for all other impervious areas such as roads, JOAL, and driveways.
- Provide hydrology mitigation for all impervious areas and use green infrastructure where practicable.

Lakes, rivers, streams and wetlands

AUP Chapter E3 sets out the policies for lakes, rivers, streams and wetlands.

(1) Avoid significant adverse effects, and avoid where practicable or otherwise remedy or mitigate other adverse effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands within the following overlays: D4,D5,D6,D9 and D8

(2) Manage the effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands outside the overlays identified in Policy E3.3(1) by: please refer to AUP Chapter E3 for information.

(3) Enable the enhancement, maintenance and restoration of lakes, rivers, streams or wetlands.

(4) Restoration and enhancement actions, which may form part of an offsetting proposal, for a specific activity should: please refer to AUP Chapter E3 for information.

(5) Avoid significant adverse effects, and avoid, remedy or mitigate other adverse effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands on: please refer to AUP Chapter E3 for information.

(6) Manage the adverse effects on Mana Whenua cultural heritage that is identified prior to, or discovered during, subdivision, use and development by: please refer to AUP Chapter E3 for information.

(7) Provide for the operation, use, maintenance, repair, erection, reconstruction, placement, alteration or extension, of any structure or part of any structure in, on, under, or over the bed of a lake, river, stream or wetland, and any associated diversion of water, where the structure complies with all of the following: please refer to AUP Chapter E3 for information.

(8) Enable the removal or demolition of any structure or part of any structure in, on, under, or over the bed of a lake, river, stream or wetland, and any associated diversion of water, provided adverse effects are avoided, remedied or mitigated.

(9) Provide for the excavation, drilling, tunnelling, thrusting or boring or other disturbance, and the depositing of any substance in, on or under the bed of a lake, river, stream or wetland, where it complies with all of the following: please refer to AUP Chapter E3 for information.

(10) Enable the planting of any plant, excluding pest species, in, on, or under the bed of a lake, river, stream or wetland where it is suitable for habitat establishment, restoration or enhancement, the maintenance and enhancement of amenity values, flood or erosion protection or stormwater runoff control provided it does not create or exacerbate flooding.

(11) Encourage the planting of plants that are native to the area.

(12) Encourage the incorporation of Mana Whenua mātauranga, values and tikanga in any planting in, on, or under the bed of a lake, river, stream or wetland.

(13) Avoid the reclamation and drainage of the bed of lakes, rivers, streams and wetlands, including any extension to existing reclamations or drained areas unless all of the following apply: please refer to AUP Chapter E3 for information.

(14) Avoid more than minor adverse effects on freshwater and coastal water from livestock grazing.

(15) Protect the riparian margins of lakes, rivers, streams, and wetlands from inappropriate use and development and promote their enhancement to through all of the following: please refer to AUP Chapter E3 for information.

(16)) Protect land alongside streams for public access through the use of esplanade reserves and esplanade strips, marginal strips, drainage reserves, easements or covenants where appropriate and for water quality, ecological and landscape protection purposes.

(17) The loss of extent of natural inland wetlands is avoided, their values are protected, and their restoration is promoted, except where: please refer to AUP Chapter E3 for information.

(18) The loss of river extent and values is avoided, unless the council is satisfied

Water sensitive design (GD04)

GD04 is a guidance document by Auckland Council which introduces principles and objectives for Water Sensitive Design (WSD). These include inter-disciplinary design approach, using at-source stormwater management practices to mimic natural systems and protect functions of natural ecosystems. WSD approaches focus on reducing or eliminating stormwater runoff generation through source control and utilising natural systems and processes to manage stormwater quantity and quality effects. The objectives include:

- Reducing stormwater runoff - reduce stormwater runoff volume and peak flow to predevelopment levels.
- Managing stormwater quality - manage stormwater quality to avoid adverse environmental effects.
- Minimising soil disturbance - minimise sediment in stormwater runoff, especially during construction, and protect site soil resources from modification.
- Promoting ecosystem health - promote the health of regional ecosystems and their associated environmental services through the management of stormwater at the catchment and site scale.
- Delivering best practice - deliver best practice urban design and broader community outcomes as part of stormwater management delivery.
- Maximising return on investment - achieve maximum value from stormwater management through the consideration of a broad range of benefits.

Discharge and diversion

AUP Chapter E1 and E2 sets out the policies for stormwater discharge and diversion. All permitted activities, controlled activities and restricted discretionary activities must meet the following standards, except for activity E8.4.1(A1) Stormwater runoff from lawfully established impervious areas directed into an authorised stormwater network or a combined sewer network.

(1) The design of the proposed stormwater management device(s) must be consistent with any relevant precinct plan that addresses or addressed stormwater matters.

(2) The diversion and discharge must not cause or increase scouring or erosion at the point of discharge or downstream.

(3) The diversion and discharge must not result in or increase the following:

(a) flooding of other properties in rainfall events up to the 10 per cent annual exceedance probability (AEP);

(b) inundation of buildings on other properties in events up to the 1 per cent annual exceedance probability (AEP).

(4) The diversion and discharge must not cause or increase nuisance or damage to other properties.

High contaminant generating areas

AUP Chapter E1 sets out the policies for Stormwater quality – High contaminant generating car parks and high use roads. All activities listed as permitted in Table E9.4.1 Activity table must comply with Standard E9.6.1.1 and the specified permitted activity standards for the activity.

Standard E9.6.1.1. General

(1) Any required stormwater management device or system is built generally in accordance with design specifications and is fully operational within three months of commencement of the high contaminant generating car park or high use road. (2) 'As built' plans for any required stormwater management device or system are provided to the Council within three months of the practical completion of the works.

(2) Any required stormwater management device or system is operated and maintained in accordance with best practice for the device or system.

Hydrological mitigation

The subject PPC area will provide hydrological mitigation as per the requirements under Chapter E10 of the Auckland Unitary Plan. A method of achieving equivalent hydrology to pre-development (grassed state) levels is to:

- Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious areas; and
- Provide detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas.

Natural Hazards and flooding

Section E36 sets out the policies for Natural hazards and flooding.

E36.3. Policies

(1) Identify land that may be subject to natural hazards, taking into account the likely effects of climate change, including all of the following: please refer to AUP Chapter E1 for information

(2) Investigate other natural hazards to assess whether risks to people, property or the environment should be managed through the Plan or otherwise.

(3) Consider all of the following, as part of a risk assessment of proposals to subdivide, use or develop land that is subject to natural hazards: please refer to AUP Chapter E1 for information

(4) Control subdivision, use and development of land that is subject to natural hazards so that the proposed activity does not increase, and where practicable reduces, risk associated with all of the following adverse effects:

Floodplains in urban areas

(13) In existing urban areas require new buildings designed to accommodate more vulnerable activities to be located: (a) outside of the 1 per cent annual exceedance probability (AEP) floodplain; or (b) within or above the 1 per cent annual exceedance probability (AEP) floodplain where safe evacuation routes or refuges are provided.

(14) Require redevelopment of sites where existing more vulnerable activities are located within the 1 per cent annual exceedance probability (AEP) floodplain to address all of the following; please refer to AUP Chapter E1 for information

(15) Within existing urban areas, enable buildings containing less vulnerable activities to locate in the 1 per cent annual exceedance probability (AEP) floodplains where that activity avoids, remedies or mitigates effects from flood hazards on other properties.

Water quality

- Treatment of all impervious areas by a water quality device designed in accordance with GD01/ TP10 for relevant contaminants.

Stream Hydrology

The PPC proposes to apply the SMAF – 1 control to the site. In addition, the site discharges to a stream, and therefore the following hydrology mitigation is proposed: :

- Achieve equivalent hydrology (infiltration, runoff volume, peak flow) to pre-development (grassed state) levels:
    - Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious surfaces; and
    - Provide detention (temporary storage) with a drain down period of 24 hours for the difference between pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas.

Flooding – Property/ pipe capacity 10% AEP event

- Ensure sufficient capacity in downstream network
- As there are currently no piped stormwater network within the PPC area, the proposed network will be designed in accordance with Auckland Council Stormwater Code of Practice

Flooding – Buildings 1% AEP event

- To be developed to Auckland Council Stormwater Code of Practice

If the above requirements on water quality, stream hydrology and flooding cannot be met, then an alternative level of mitigation can be determined through a SMP that:

- Applies an Integrated Stormwater Management Approach
- Meets the NDC Objectives and Outcomes in Schedule 2

National Policy Statement of Freshwater Management:

The National Policy Statement (NPS) for Freshwater 2020 provides local authorities with updated direction on how they should manage freshwater under the Resource Management Act 1991. This NPS comes into force on 3 September 2020. The NPS sets out the following policies:

(1) Freshwater is managed in a way that gives effect to Te Mana o te Wai.

(2) Tangata whenua are actively involved in freshwater management (including decision making processes), and Māori freshwater values are identified and provided for.

(3) Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

(4) Freshwater is managed as part of New Zealand's integrated response to climate change.

(5) Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and

well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.

(6) There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

(7) The loss of river extent and values is avoided to the extent practicable.

(8) The significant values of outstanding water bodies are protected.

(9) The habitats of indigenous freshwater species are protected.

(10) The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

(11) Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.

(12) The national target (as set out in Appendix 3) for water quality improvement is achieved.

(13) The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends. 10 National Policy Statement for Freshwater Management 2020

(14) Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.

(15) Communities are enabled to provide for their social, economic, and cultural wellbeing in a way that is consistent with this National Policy Statement.

Appendix C

Proprietary devices Performance Criterion

Proprietary Stormwater Treatment Performance Criterion

Supplier	Device/ product name		Device properties					Contaminant removal rates										Maintenance	Additional comments/ information
			Design Treatment Flow Rate L/s	Maximum catchment area treated (m^2)	Maximum Treatable Hardstand Area (sq. m)	Driving head	Head loss through device	TSS	Total Metals – Pb, Cu, Zn	Dissolved Metals (Zinc, Copper)	TPH	Total Nitrogen	Nutrients	Gross Pollutants	Temperature	BTEX	Microorganisms/ Pathogens	Required maintenance frequency	
ATLAN	SPELBasin	MWS-L-3-6		500			1200mm	86%					65% TP,	99%					Will treat up to 720m2
		MWS-L-4-17		2000			1200mm	86%					65% TP, 50% TN	99%					https://spel.co.nz/spel-basin/
	Hydrosystem	HS.400.HM		500			250mm	85%	80% Cu & Pb, 70% Zn		82%		66% TP, 43% TN	100%					Will treat up to 900m2
		SHS.150D-1500C-02.225.PVC		2000			250mm	85%	80% Cu & Pb, 70% Zn		82%		66% TP, 43% TN	100%					Will treat up to 2900m2
		SHS.150D-1500C-04.225.PVC		5000			250mm	85%	80% Cu & Pb, 70% Zn		82%		66% TP, 43% TN	100%					Will treat up to 5800m2 Typical cartridge life is 3 years
Hynds	UpFlo Filter units		Sized to suit	Sized to suit		510mm	750mm	75%	75%		✓			95%	N/A		✓	6monthly inspect or following major event	Part of their 'Plug & Play' install range And O&M guide supplied
	Hynds Smart Chamber/s		< 12L/s			100mm		75%	65%		✓			95%	N/A	-		6monthly inspect or following major event	Part of their 'Plug & Play' install range And O&M guide supplied
	Hynds Sand Filters		Sized to suit	Sized to suit		On site application	min.	100	90%		✓		✓	100			✓	6monthly inspect or following major event	Free design and operations guide avaible as part of purchase
Stormwater 360	Stormfilter		1.4 - 426	50000	592 - 180198	770mm for 69cm cartridge	150mm - 900mm at treatment flow	60 - 90% (98%)	40 - 70% (99% TZN, 99% Tcu)	20 - 40%(64% Dcu, 56%DZn)	50 - 70% (92%)	30 - 40% (88%)		100%				- 18 months as a standalone device - 24 - 48 months with upstream pre-treatment - Every 6 months for extreme unforeseen events	- Adopted by Auckland Council - Multiple Cartridges for reduced driving head
	Jellyfish		7.5 - 125	100000	3173 - 52875	Standard = 460mm Minimum = 150mm	150mm - 900mm at treatment flow	60 - 90% (98%)	40 - 70% (99% TZN, 99% Tcu)	20 - 40%(64% Dcu, 56%DZn)	50 - 70% (92%)	30 - 40% (88%)		100%				- At least once every 12 months - Cartridge requires replacement every 3 - 6 years	- Large membrance surface resulting in high flow rates - High removal of TSS down to 2 microns - Smaller footprint, more flexible and no replaceable mdeia
	Filterra		1.02 - 93.5	Max of 3000000 (internationally)	431 - 39551		Direct proportion between headloss, treatable flowrate and footprint	80 - 90% (99%)	60 - 70% (99% TZN , 80% Tcu)	60 - 90% (99%)	60 - 80% (90%)	30 - 50% (85%)		100%				- Every 6 months - Maintenance requirements as per O&M manual	Part of their 'Plug & Play' install range And O&M guide supplied
	Bioscape		1.02 - 93.5	Max of 3000000 (internationally)	431 - 39551		Direct proportion between headloss, treatable flowrate and footprint	80 - 90% (99%)	60 - 70% (99% TZN , 80% Tcu)	60 - 90% (99%)	60 - 80% (90%)	30 - 50% (85%)		100%				- Every 6 months - Maintenance requirements as per O&M manual	Part of their 'Plug & Play' install range And O&M guide supplied

Appendix D

Yearly Groundwater Recharge Calculation

Groundwater Recharge Assessment

PROJECT NUMBER: P18-088
ADDRESS: Heights Road
BY: TW
REVIEWED: SS
DATE: 3/2024

Duration	1	years	year2023
Recharge per year	200	mm/year	
Total recharge	200	mm	
5mm retention recharge	389.5	mm	

#Bulk Export - Points every 3 day(s)
Station 741813
Whangamaire @ Culvert
Rainfall.Continuous

3 days event		3 days accumulative rainfall	
Start of Interval (UTC+12:00)	End of Interval (UTC+12:00)	Total (mm)	Total (mm)
2023-03-01 0:00	2023-03-04 0:00	0	0
2023-03-04 0:00	2023-03-07 0:00	0	0
2023-03-07 0:00	2023-03-10 0:00	0	0
2023-03-10 0:00	2023-03-13 0:00	8.51	5
2023-03-13 0:00	2023-03-16 0:00	2	2
2023-03-16 0:00	2023-03-19 0:00	28.55	5
2023-03-19 0:00	2023-03-22 0:00	18.04	5
2023-03-22 0:00	2023-03-25 0:00	0.5	0.5
2023-03-25 0:00	2023-03-28 0:00	1.5	1.5
2023-03-28 0:00	2023-03-31 0:00	6.51	5
2023-03-31 0:00	2023-04-03 0:00	9.02	5
2023-04-03 0:00	2023-04-06 0:00	0	0
2023-04-06 0:00	2023-04-09 0:00	6.51	5
2023-04-09 0:00	2023-04-12 0:00	7.51	5
2023-04-12 0:00	2023-04-15 0:00	4.51	4.51
2023-04-15 0:00	2023-04-18 0:00	0	0
2023-04-18 0:00	2023-04-21 0:00	0	0
2023-04-21 0:00	2023-04-24 0:00	20.53	5
2023-04-24 0:00	2023-04-27 0:00	4.51	4.51
2023-04-27 0:00	2023-04-30 0:00	0	0
2023-04-30 0:00	2023-05-03 0:00	37.07	5
2023-05-03 0:00	2023-05-06 0:00	35.88	5
2023-05-06 0:00	2023-05-09 0:00	2.99	2.99
2023-05-09 0:00	2023-05-12 0:00	100.15	5
2023-05-12 0:00	2023-05-15 0:00	1.5	1.5
2023-05-15 0:00	2023-05-18 0:00	7.37	5
2023-05-18 0:00	2023-05-21 0:00	24.06	5
2023-05-21 0:00	2023-05-24 0:00	15.41	5
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2023-05-27 0:00	2023-05-30 0:00	14.44	5
2023-05-30 0:00	2023-06-02 0:00	7.7	5
2023-06-02 0:00	2023-06-05 0:00	4.33	4.33
2023-06-05 0:00	2023-06-08 0:00	13.96	5
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2023-06-11 0:00	2023-06-14 0:00	0.48	0.48
2023-06-14 0:00	2023-06-17 0:00	2.41	2.41
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2023-06-20 0:00	2023-06-23 0:00	38.03	5
2023-06-23 0:00	2023-06-26 0:00	1.92	1.92
2023-06-26 0:00	2023-06-29 0:00	12.04	5
2023-06-29 0:00	2023-07-02 0:00	39.95	5
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2023-08-31 0:00	2023-09-03 0:00	0.51	0.51
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2023-09-30 0:00	2023-10-03 0:00	15.66	5
2023-10-03 0:00	2023-10-06 0:00	1.52	1.52
2023-10-06 0:00	2023-10-09 0:00	11.12	5
2023-10-09 0:00	2023-10-12 0:00	6.06	5
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2023-10-15 0:00	2023-10-18 0:00	1.51	1.51
2023-10-18 0:00	2023-10-21 0:00	0.51	0.51
2023-10-21 0:00	2023-10-24 0:00	0.5	0.5
2023-10-24 0:00	2023-10-27 0:00	7.08	5
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2023-11-08 0:00	2023-11-11 0:00	0	0
2023-11-11 0:00	2023-11-14 0:00	0	0
2023-11-14 0:00	2023-11-17 0:00	4.09	4.09
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2023-11-26 0:00	2023-11-29 0:00	3.07	3.07
2023-11-29 0:00	2023-12-02 0:00	0	0
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2023-12-05 0:00	2023-12-08 0:00	19.93	5
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2023-12-20 0:00	2023-12-23 0:00	0	0
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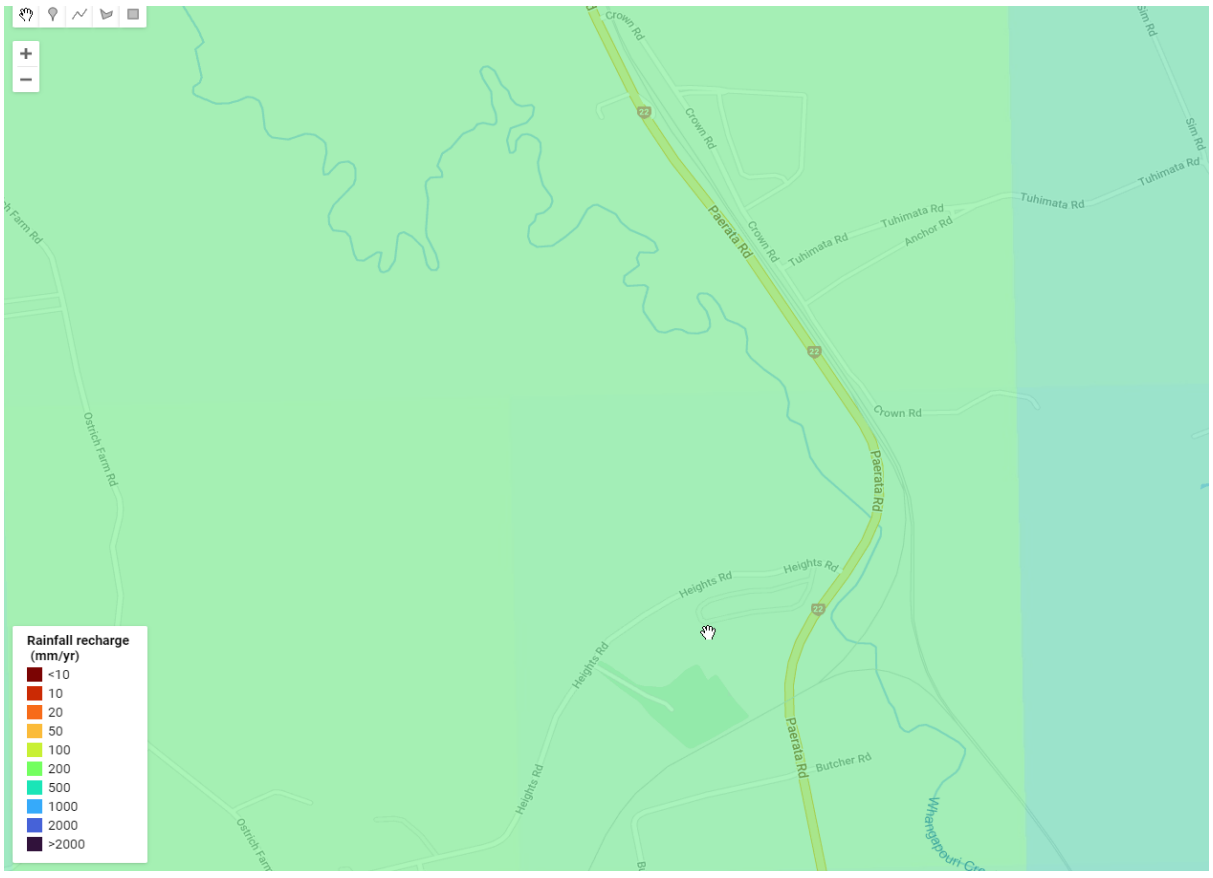
2024-01-22 0:00	2024-01-25 0:00	5.5	5
2024-01-25 0:00	2024-01-28 0:00	4.5	4.5
2024-01-28 0:00	2024-01-31 0:00	29	5
2024-01-31 0:00	2024-02-03 0:00	7	5
2024-02-03 0:00	2024-02-06 0:00	15	5
2024-02-06 0:00	2024-02-09 0:00	0	0
2024-02-09 0:00	2024-02-12 0:00	0	0
2024-02-12 0:00	2024-02-15 0:00	0	0
2024-02-15 0:00	2024-02-18 0:00	1	1
2024-02-18 0:00	2024-02-21 0:00	2.5	2.5
2024-02-21 0:00	2024-02-24 0:00	0	0
2024-02-24 0:00	2024-02-27 0:00	32	5
2024-02-27 0:00	2024-03-01 0:00	5	5
2024-03-01 0:00	2024-03-04 0:00	9.5	5
2024-03-04 0:00	2024-03-07 0:00	NaN	



Appendix E

Flood Model Build Report

Flood Model Build Report

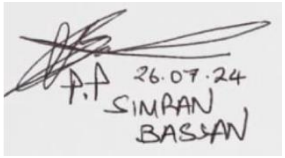
P18-088 Heights Road

9, 33 & 49 Heights Road

G Bar Properties

Final

Document Control

Project Number	P18-088
Project Name	P18-088 Heights Road
Client	G Bar Properties
Date	12/09/2024
Version	V3
Issue Status	Final
Originator	Shakti Singh – Intermediate Three Waters Engineer 
Reviewer	Tony Wang – Three Waters Engineer  Ajay Desai – Principal Engineer 
Approval	Pranil Wadan - Principal Engineer: Three Waters Manager 
Consultant details	Woods (Wood & Partners Consultants Ltd) Level 1, Building B, 8 Nugent St, Grafton, Auckland 1023 PO Box 6752 Victoria St West, Auckland 1142 E: info@woods.co.nz P: 09-308-9229 **woods.co.nz**
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1. Introduction

Woods has been engaged by G Bar Properties to provide a Stormwater Management report for a proposed plan change (**PPC**) at 9, 33 and 49 Heights Road, Pukekohe. The PPC seeks to rezone 5.35ha of land from Future Urban to Business – Light. This site includes the existing Heights Road Tractor Centre.

Flood modelling has been undertaken to identify any flood effects that may result from the PPC (if any) on areas upstream and downstream of the site and assess suitable flood management options. Woods received the Whangapouri Catchment Model upon request from Healthy Waters. This catchment model was utilised for developing a baseline scenario that was used to test stormwater options and undertake effects assessment for the PPC. This model build report outlines the model build parameters and assumptions used to update/modify the Whangapouri catchment model. The model scenario results have been discussed in the Stormwater Management Plan (SMP), which is the parent document of this model build report.

2. Background

The Heights Road development is located west of the Heights Road/Paerata Road intersection and north of Heights Park Cemetery and shown in Figure 1. The eastern portion of the site is an existing Tractor Centre, consisting of a large industrial building and smaller buildings as well as impermeable concrete accessways and parking. There is another warehouse building located towards the northern portion of the site along with paved area to facilitate access. The remainder of the site is greenfield (pervious surfaces).

The site is within the Whangapouri creek catchment and discharges into Whangapouri Stream via an existing 600mm diameter culvert under Paerata Road, before discharging into Drury Creek and ultimately Manukau Harbour. The primary drainage is predominantly via overland flow and the Tractor Centre's private network.

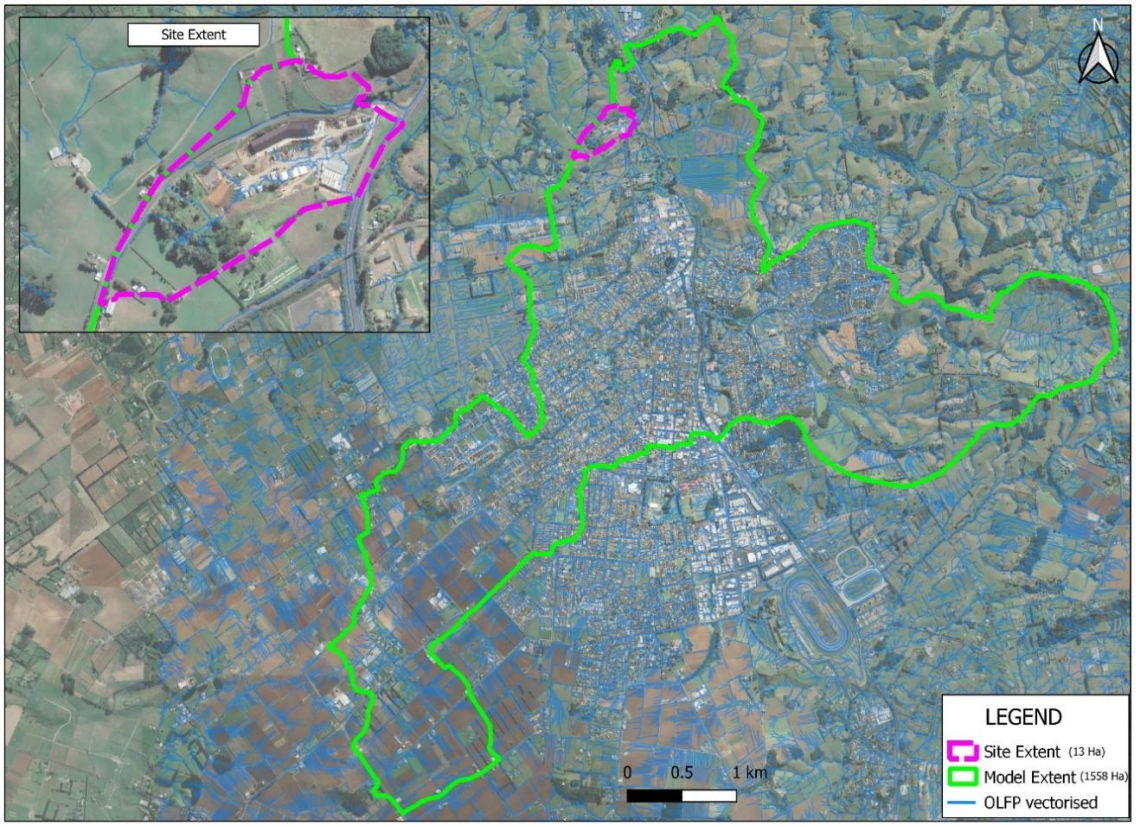

Figure 1. Site location and Flood Model parameters

3. Proposed Development

The PPC at 9, 33 and 49 Heights Road seeks to rezone 5.35ha of land from Future Urban Zone to Business – Light Industrial Zone. As per Chapter H17 of the AUP, the Business – Light Industrial Zone can be developed as 100% impervious area. However, this is unlikely to be achieved due to land being utilised for stormwater devices and landscaping.

The indicative Masterplan proposes nine new buildings, car parks, driveways and other hardstand areas. In addition, public and private drainage, services and landscaping is also proposed. PPC also includes retaining two existing buildings - tractor centre and building located towards north.

The Heights Road Indicative Masterplan applies to the PPC area and is outlined in Figure 2.

OPTION 2: AREA SCHEDULE SUMMARY

	EXISTING BUILDING 1	EXISTING BUILDING 2	NEW BUILDING 1	NEW BUILDING 2	NEW BUILDING 3	NEW BUILDING 4	NEW BUILDING 5	NEW BUILDING 6	NEW BUILDING 7	NEW BUILDING 8	NEW BUILDING 9
GFA	2,414m²	2,666m²	1,819m²	1,962m²	950m²	1,000m²	900m²	1,550m²	1,500m²	1,500m²	1,382m²
PARKING PROVIDED	15	45	20	51	16	30	35	44	35	30	20

TOTAL STORMWATER POND AREA	2,000m²
TOTAL GFA (EXISTING + NEW)	17,643m²
TOTAL PARKING PROVIDED	341

Figure 2: Proposed masterplan

4. Summary Changes

The flood assessment for the proposed development used a 1D-2D coupled hydraulic model based on the flood models provided by the Auckland Council (Healthy Waters department), as listed below:

- Whangapouri catchment model (July 2019)- 1D-2D coupled hydraulic model developed using InfoWork ICM modelling package representing the Maximum Probable Development (MPD) scenario.

To develop the base models, the Whangapouri model was updated to InfoWorks ICM v2021.7.1 and further extended to include the stormwater network around the project site extent (49 Heights Road, Pukekohe).

Table 1 provides a summary of the changes undertaken in order to generate the base pre-development and post- development scenarios.

Table 1. Summary of model changes

Item	Information	Changes undertaken
Hydrology Updates		
Subcatchments	Total subcatchments within Whangapouri creek catchment model: 392	***Base scenarios and Post development scenarios*** • Subcatchment boundaries within the proposed development extent were updated based on revised delineation. • 11 additional modelled subcatchments were imported within SC078 catchment extent. • Total subcatchments: 402
Imperviousness	Existing development (ED) impervious coverage is based on Auckland Council GeoMaps information. Maximum Probable Development (MPD) is based on Unitary Plan zonings. Plan Change proposed zoning imperviousness is assumed to be 100% (conservatively).	***Base scenarios*** • Base ED model scenario – This scenario assumes existing impervious coverage for areas within and outside the site. • Base MPD model scenario – This scenario assumes MPD impervious coverage for areas outside the site. All areas within the site are modelled with ED impervious coverage. ***Post development scenario*** • Flood storage ED model scenario - Proposed zoning for site, ED for all areas outside the site. • Flood storage MPD model scenario - Proposed zoning for site, ED for area upstream to the site, MPD for all the other areas.
Rainfall	24-hour rainfall depth obtained from TP108 guidelines and climate change uplift based on Stormwater Code of Practice version 3	***Base and post development scenarios*** • 24-hour rainfall depth obtained from TP108 guidelines and climate change uplift based on Stormwater Code of Practice Version 3. • It was agreed with Auckland Council to use climate change considerations related to temperature increment of 3.8°C by 2110.

Item	Information	Changes undertaken

Hydrological parameters	As documented in Whangapouri Creek catchment model	***Base scenario and post development scenario***
		• Updates made for subcatchments within and near development area. The hydrological parameters used for flood modelling area consistent with the parameters document in Whangapouri Creek catchment model. Parameters as below:
		  o CN (pervious) – 74; CN (impervious) – 98
		  o Ia (pervious) – 5mm; Ia (impervious) – 0mm
		  o Tc – minimum of 10mins

Topography		
Topography	Council models were developed based on LiDAR 2013 DEM data	***Base scenarios*** • Modelled topography was updated using LiDAR 2016 DEM data and topographical survey undertaken by Woods within the Site extent. ***Post development scenarios*** • A preliminary post development earthworks surface was prepared for undertaking flood modelling. This surface incorporated with the existing area around the site, retained the two existing building floor levels and allowed for approximate future building levels.
Stormwater Network		
Pipes	414 modelled pipes (public and dummy pipes)	***Base scenarios*** • 14 new pipes added in site Extent according to site survey and AC GeoMaps. • In total, the base scenario, named as "Base_2023" contains 414 links/pipes. ***Post development scenario*** • Building on the base model, a preliminary stormwater network was modelled. This concept network is solely a representation of what conveyance might be proposed for post-development scenario and modelled. • The preliminary network consisted of 18 links. All links were modelled with 600mm diameter circular pipes. • Two stormwater basins allowed for flood storage. As part of the basins, o Two weirs were added to allow for flows to enter the basins at a certain height. • Two flap valves were added to represent unidirectional outflows from the ponds.
Manholes	997 manholes modelled (public manholes, outlets, dummy manholes, dummy outlets)	***Base scenarios*** • 13 nodes added in the Whangapouri Model along with Heights Road according to survey. • Base scenario has a total of 997 nodes modelled. ***Post development scenarios*** • Manholes were added to the preliminary stormwater network.

Item	Information	Changes undertaken
		• Two storage nodes were added to the model scenario utilising storage.
Roughness and surface	Spatially varying roughness modelled	***Base scenarios*** • Roughness modelled for building footprints and road layers with a Manning (n) of 1 and 0.02 respectively as per the values adopted in the Whangapouri creek models. ***Post development scenarios*** • Roughness within the proposed development is updated as per the design layout with the following manning's 'n' value: o Roads/paved area – 0.02 o Buildings – 1 o Other areas (global) – 0.1
Boundary Conditions		
Water Levels		***Base and Post development scenarios:*** Unchanged from supplied model

5. Updated Sub-catchment Delineation

The model extent was based on the Whangapouri Creek model provided by Auckland Council and was extended to include the Heights Road addition. The updated model extent is shown in Figure 1.

Based on the information available on Auckland Council GeoMaps and site survey completed by Woods, the primary and secondary flows discharge via existing 600mmø culvert under SH22. The subcatchment delineation within the site is shown in Figure 3.

For the area outside of the site, the subcatchments delineation was retained as per the original catchment model.

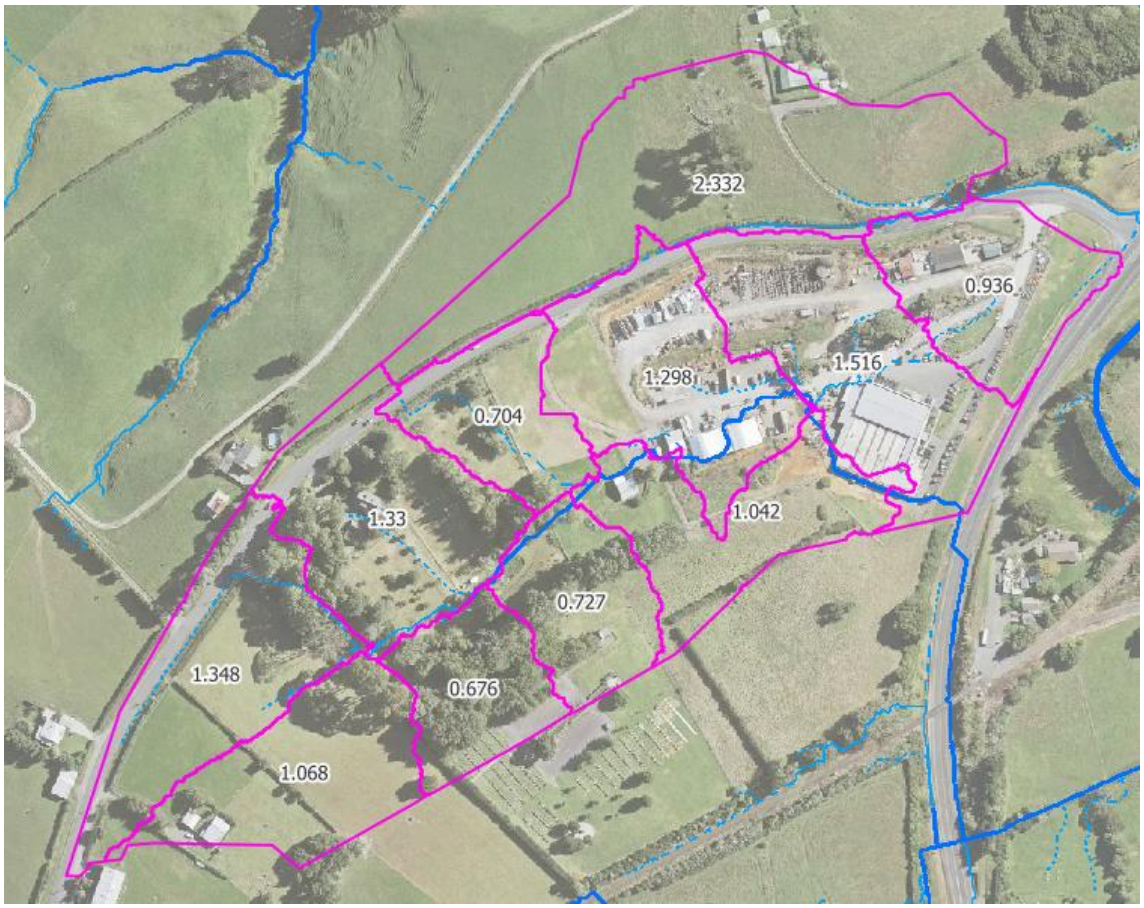

Figure 3: Sub-catchment delineation

6. Hydrological model

Stormwater catchment runoff was modelled following the guidelines outlined in the ARC Technical Publication No. 108 document (TP108). The key assumptions are listed below:

- A standard 24-hour temporal rainfall pattern, having peak rainfall intensity at mid-duration. Shorter duration rainfall bursts with a range of durations from 1 minute to 24 hours are nested within the 24-hour temporal pattern. Climate change has been estimated in accordance with the guideline provided by Auckland Council's Stormwater Code of Practice v3 (related to temperature increment of 3.8°C by 2100).
- Runoff depth calculated using SCS (Soil Conservation Services) rainfall-runoff curves, with curve numbers determined from the SCS guidelines according to classifications assigned to Auckland soil types.
- Runoff hydrograph calculated using the standard SCS unit hydrograph.
- The time of concentration was estimated using the time of concentration calculation mentioned in TP108. A minimum of 10 minutes was used for time of concentration.

6.1. Time of concentration

A time of concentration of 10 minutes has been used for all subcatchments within the site.

6.2. Initial abstraction

The amendments within the development area are as follows:

- Impervious areas were given a 0mm initial abstraction and pervious areas were given a 5mm initial abstraction.

6.3. Curve number

The amendments within the development area are as follows:

- A Curve Number (CN) of 98 was used for impervious areas, and for the pervious areas a CN value of 74 was used.

7. Site coverage

Imperviousness has been updated for the 11 additional subcatchments with remaining subcatchments retained the original imperviousness as per Healthy Waters model. The adopted MPD and ED land use coverage are discussed in this section.

7.1. MPD land use coverage

The MPD land use assumptions were derived from the zoning plan as per Auckland Unitary Plan – Operative in Part (AUP). MPD land use was incorporated for areas within the subcatchments where future maximum probable development was required to be modelled.

The Future Urban Zone **(FUZ)** impervious coverage depends on the model scenario (refer to Section 10). Rest of the subcatchments with FUZ which are not upstream to the development or contribute runoff towards the development are noted to be modelled with 70% impervious coverage.

The existing zoning as per AUP is shown in Figure 4.

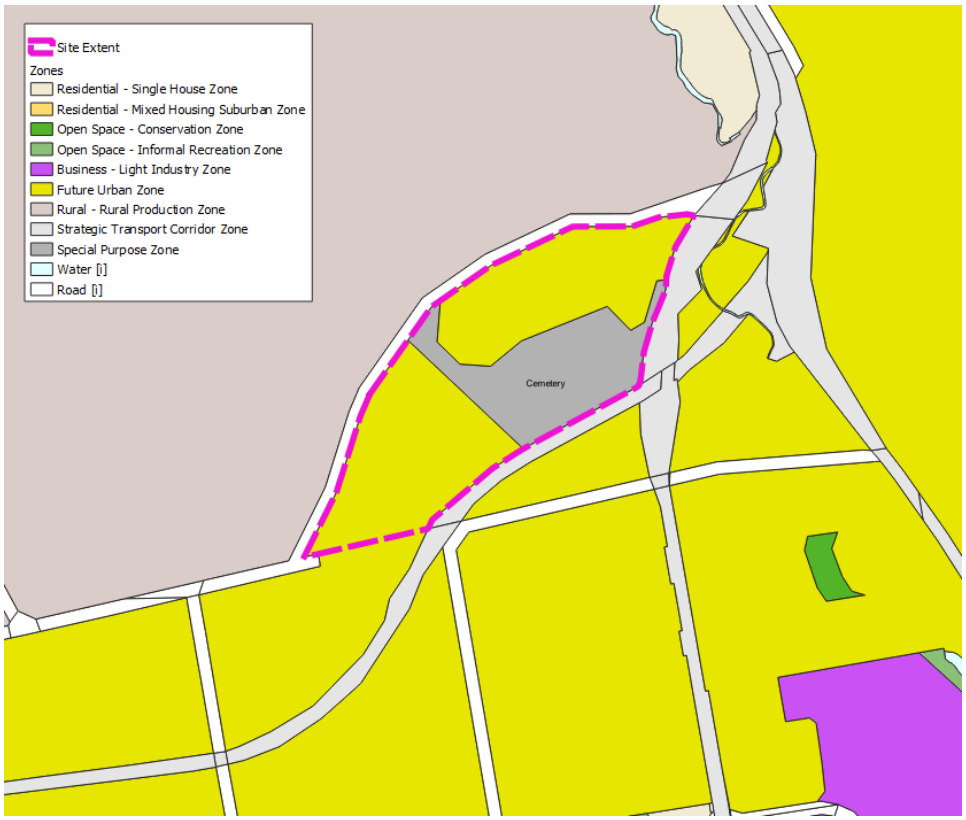

Figure 4: AUP operative in part for the Site

The imperviousness percentage values used for the zones were taken from Healthy Waters memorandum, provided in Appendix A and summarised below.

- Future Urban Zone (depends on Model Scenario – refer to Section 10)
- 100% for Strategic transport Corridor Zone
- 90% for the Roads
- 100% for Water
- 60% for the Special Purpose – Cemetery Zone
- 5% for the Rural Production Zone
- 60% for Residential – Single House Zone

7.2. Existing Land Use Coverage

The existing site and upstream coverage have been calculated based on building footprints and impervious surface layer extracted from Auckland Council GeoMaps. The existing impervious coverage is shown in Figure 5.

Figure 5. Existing development impervious coverage

8. Topography

8.1. Base models

Site survey and LiDAR 2016 DEM data has been used to update the terrain surface in the model for the Base scenario. The base model site terrain information has been provided in Figure 6.

Figure 6: Base model site topography

8.2. Post development model

A preliminary post development earthworks surface was prepared for undertaking the flood modelling. The surface modelling was guided by the indicative site masterplan (as shown in Figure 2). The surface modelling included:

- Existing boundary levels,
- Retaining the two existing building floor levels (included to be part of PPC)
- Allowance for approximate future building levels.
- Standard crossfalls and longitudinal grades of JOALs

The purpose of the post development earthworks surface was to enable the guidance of the suitable flood management strategy where existing upstream flows are retained and allowed to enter the site.

No earthworks plans or cut/fill volumes calculations have been developed at this stage, however, these will be prepared and submitted at future stages, e.g. Resource Consents.

Figure 7 shows the preliminary earthworks surface incorporated in the flood model.

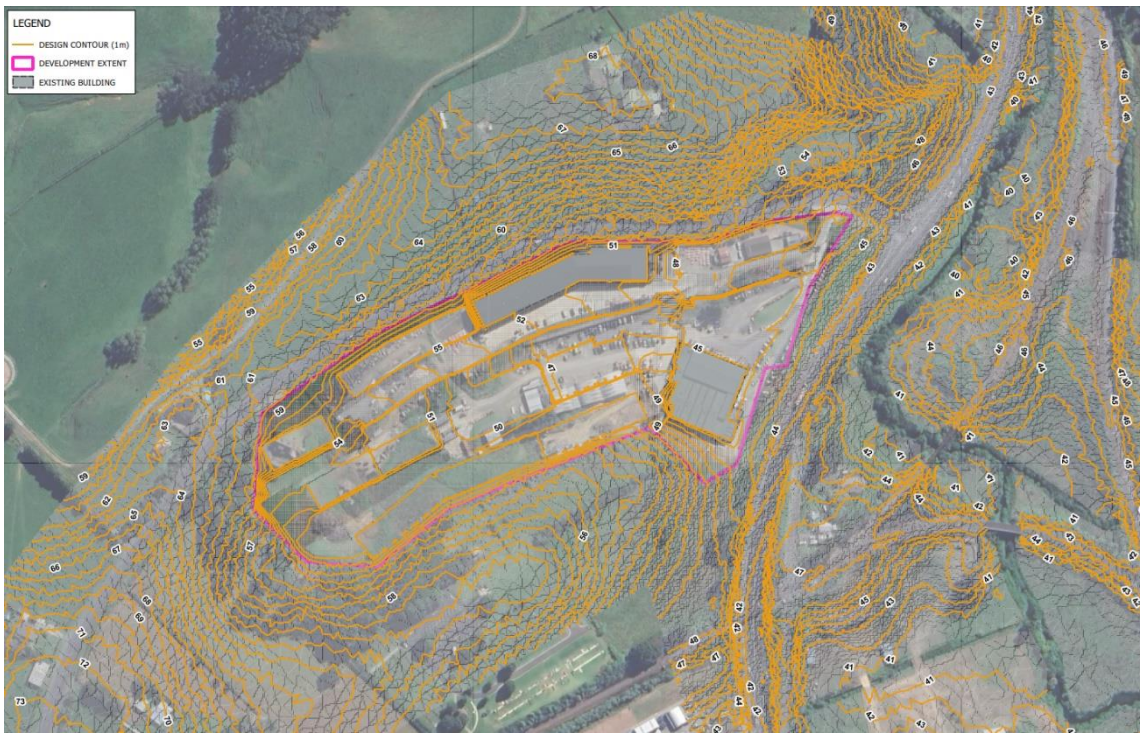

Figure 7: Preliminary earthworks topography

9. Hydraulic Model

9.1. Existing stormwater network

The existing stormwater network within site extent includes a total of 14 pipes with diameters ranging of 225mm and 600mm, and an overall length of 670 meters. The information (such as ILs, diameters, etc.) is based on the survey and LiDAR 2016.

Table 2 provides a summary of the existing network elements modelled with details shown in Figure 8.

Table 2. Heights Road network summary

Node Type	Number
Manholes	5
Catchpits	11
Outlets / Inlets	1
Links	14

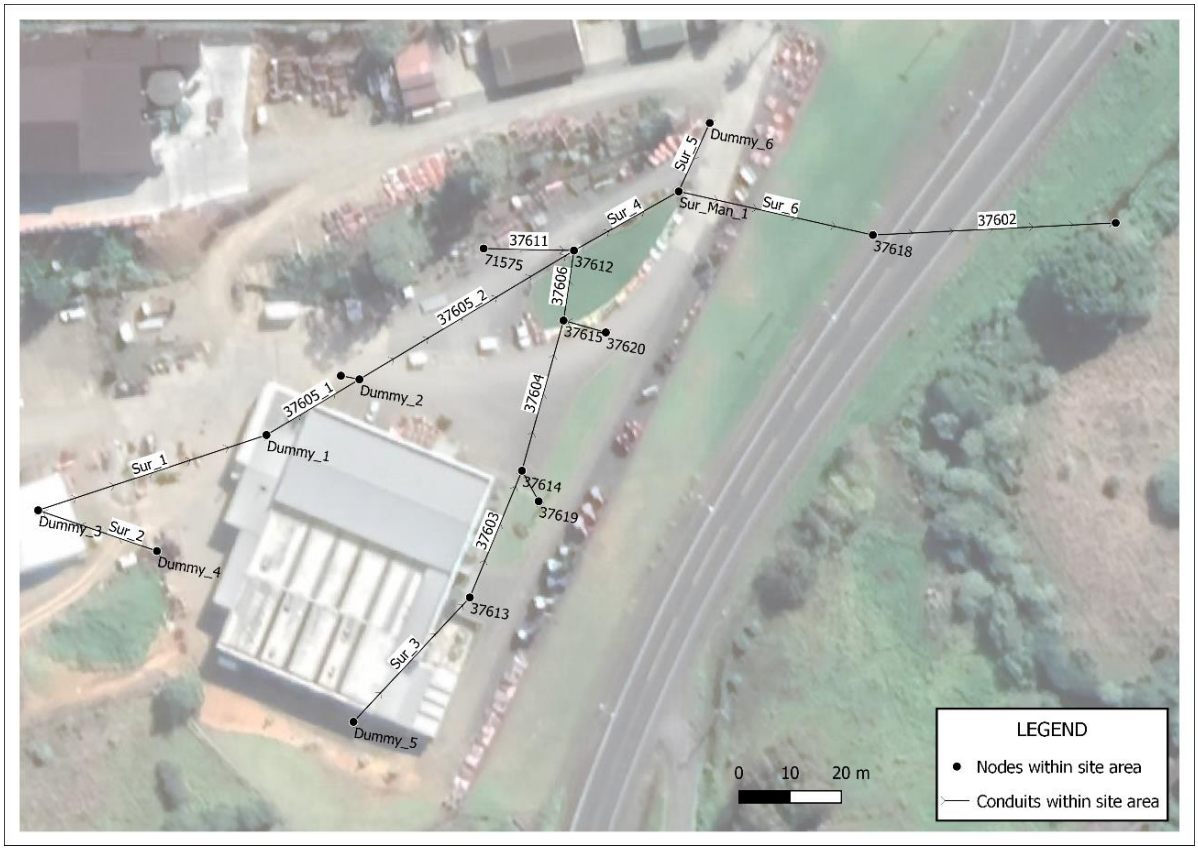

Figure 8: Existing stormwater network

9.2. Roughness

Roughness was incorporated in the models with the use of manning's 'n' values as shown in Table 3.

Table 3: Roughness values

Land Use	Manning's n
Buildings	1.0
Roads and other impervious area	0.02
Other area	0.1

The mesh resolution was set to a maximum of $5m^{2,}$ and a minimum of $2m^2$ which is considered suitable to generate flow paths and floodplains.

Roughness for option model scenarios is based on the proposed masterplan as detailed in Section 3. Roughness is only modelled for buildings and paved areas while a constant 0.1 manning's value is used for the remaining areas.

9.3. Rainfall

The model scenarios have been simulated for 10-year and 100-year ARI storm events as based on the TP108 design rainfall approach. The rainfall depth and profile have been adjusted to allow for 3.8^0C temperature increase by 2110 which has been discussed and agreed with Healthy Waters.

A summary of the rainfall depths for 10-year and 100-year storm event are provided in Table 4.

Table 4. Rainfall depths summary

ARI	Existing rainfall depth (mm)	Rainfall depth with allowance for 3.8°C (mm)	% Increase
10 Year	100	131	30.80%
100 Year	155	206	32.70%

10. Model Scenarios

10.1. Base Model

A base model was developed to understand flooding in the existing conditions as well as to guide and develop the flood management strategy.

The Base model scenario has been developed with the following impervious coverage assumptions:

- Existing development **(ED)** impervious coverage for all the areas within and outside the development site. For the purposes of the report, this scenario is referred to as "Base ED" scenario.
- Existing development impervious coverage for the areas within the development site as well any further areas located upstream which discharge runoff towards the site. Remaining of the areas outside the site are modelled with maximum probable development **(MPD)** coverage, as per AUP, which is consistent with Whangapouri Catchment model. For the purposes of the report, this scenario is referred to as "Base MPD" scenario.

The Base model scenario makes uses of existing topographical information which is based on a combination of topographical survey undertaken by Woods and LiDAR2016. All the existing assets modelled within the site and culvert downstream were surveyed and replicated in the flood model.

Figure 9 shows a schematic of Base model scenario.

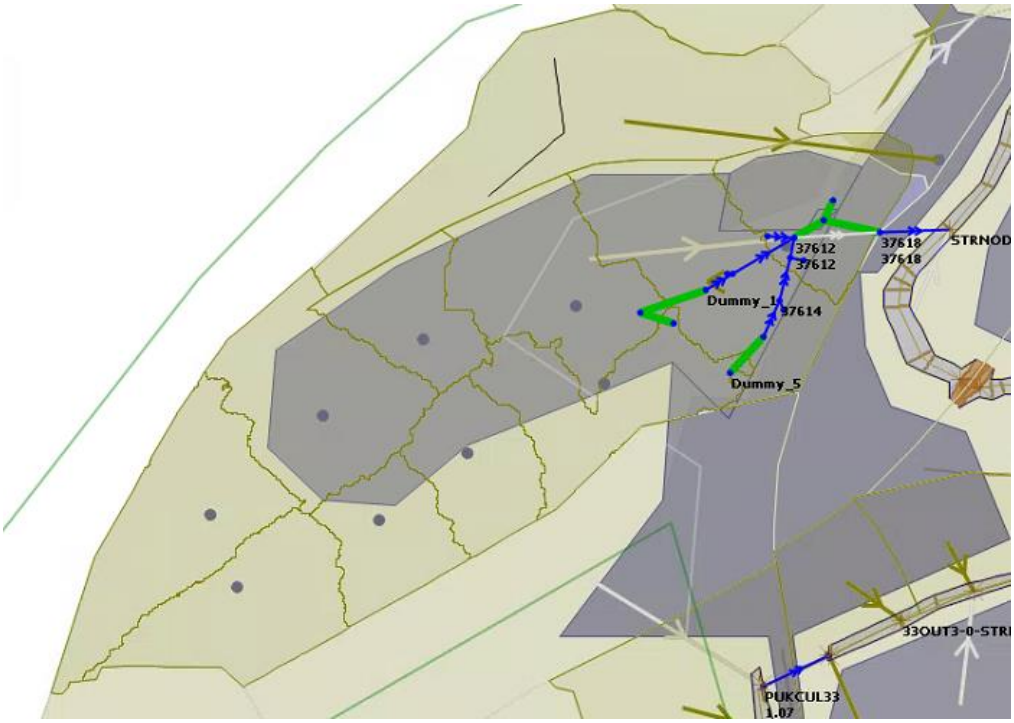

Figure 9: Base model scenario schematic

10.2. Post development model

The post development model scenario further builds on the 'base model' scenario. This post development model allows for an uplift in imperviousness within the plan change area and includes a dry basin for flood management.

The post development flood management strategy is predicated on the fact that the existing 600mm diameter culvert under SH22 doesn't have conveyance capacity for the 10 year storm event and Waka Kotahi having identified significant flood risk on SH22 at the railway underpass.

This flood management strategy proposes the attenuation of post development peak flows from the plan change area to less than pre development peak flows for the 10 and 100 year ARI (for a temperature increase of 3.8°C to allow for climate change) storm event.

The post development model uses a combination of preliminary design surfaces, survey information and LiDAR 2016 to represent topography.

The management strategy allow for 2 stormwater basins which have been modelled as 1D storage nodes with a depth of 2.5m and base area of 800m^2 and 1000m^2. The flows enter the storage nodes before the peak of the storm via a weir. The outlet from the ponds includes unidirectional flap valves to minimise backflows entering the pond.

It should be noted that the modelled location of ponds is indicative only and will be finalised in the detailed design stages. A schematic of the storage pond arrangement is provided in Figure 10.

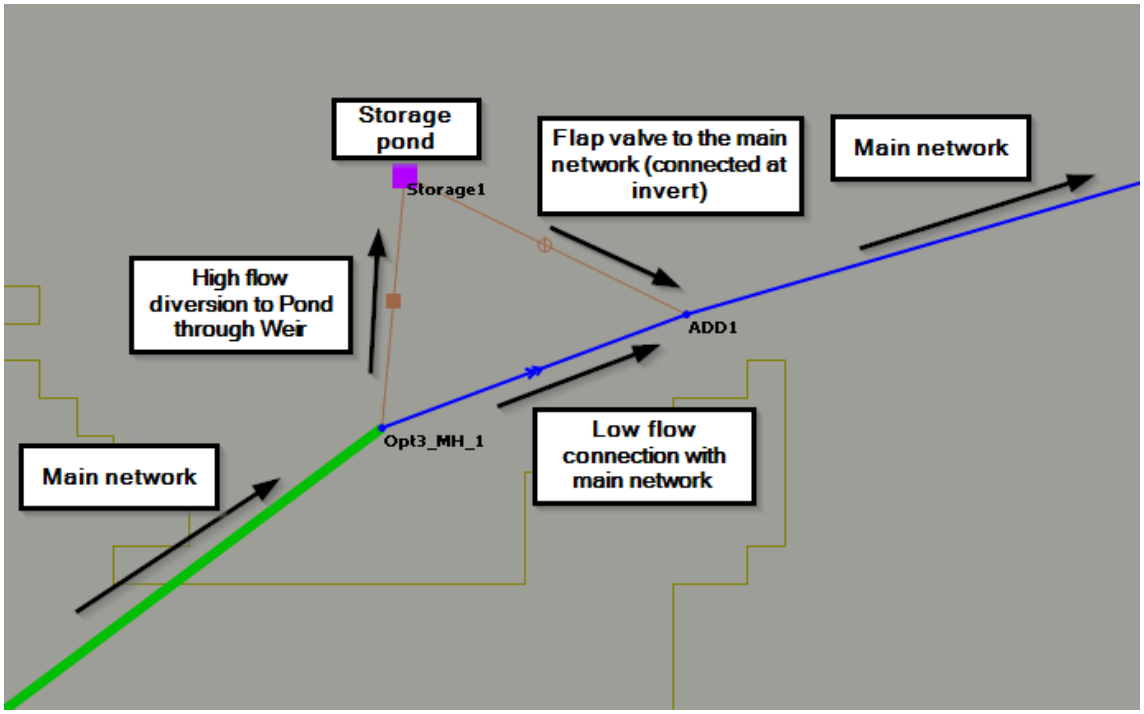

Figure 10: Storage Pond arrangement

10.3. Model scenario summary

Table 5 provides a summary of the modelled scenarios.

Table 5. Model scenarios

#	Scenario Name	ARI	Land Use	Landform	Stormwater Network
1	Base ED	10-Year + 3.8°C climate change	ED for all the areas in the model	Topo survey + LIDAR2016	Existing stormwater network
		100-Year + 3.8°C climate change			
	Base MPD	10-Year + 3.8°C climate change	ED for areas within the site, MPD for all the areas outside the site extent		
		100-Year + 3.8°C climate change			
2	Post development – Flood storage (ED)	10-Year + 3.8°C climate change	Proposed zoning for site, ED for all areas outside the site	Preliminary design surface + topo survey + LIDAR2016	Proposed stormwater network + storage device + existing network
		100-Year + 3.8°C climate change			
	Post development – Flood storage (MPD)	10-Year + 3.8°C climate change	Proposed zoning for site, ED for area upstream to the site, MPD for all the other areas		
		100-Year + 3.8°C climate change			

11. Model Limitations

The following assumptions and limitations are noted:

- This model has been prepared to provide guidance on any effects that may result from the PPC (if any). The purpose of the flood models is limited to enable a comparative assessment and suitability of the flood management options.
- The runoff flows calculated by the hydrological model are loaded in the hydraulic model at specified nodes inside the two-dimensional model extents (structured mesh). Inside the two-dimensional model extents, water can flow in all directions from the loading node. The extents of the flow paths may vary based on the location of the loading node, the elevation of the two-dimensional grid cells (from LiDAR data) and other model assumptions. The location of the loading determines the origin of the overland flow path.
- Modelling process relies on a range of assumptions and simplifications and may be subject to errors and inaccuracies. The compounding effects of the uncertainties in the TP108 rainfall model (ARC, 1999), the uncertainties in the LiDAR data and the uncertainties in hydraulic parameters such as roughness could result in the water level varying from the mapped levels.
- The LiDAR data has an absolute vertical accuracy of +/- 0.10m. Deviations in vertical accuracy can occur in areas of dense vegetation. Below water ground levels are not reliably represented in the LiDAR data. As a result of the water level variability, the lateral extent of flood extent may vary significantly from that shown on the plans. This can have a compounding effect with other uncertainties.
- There is no measured flow data considered in this assessment; therefore, it is not possible to validate the peak water levels or flows.

12. Conclusions

Woods have undertaken a flooding assessment to provide guidance on any flood effects that may results from the PPC (if any). Woods received the Whangapouri catchment model upon request from Healthy Waters. The flood model was updated within the site extent to represent the existing and future conditions of the site.

Base model was developed to establish a baseline and, guide the suitability of flood management options. A post development model scenario was also developed which allowed for Flood Storage within the site.

Flood Storage management strategy allows for two storage ponds where runoff is stored and attenuated before discharging to the downstream environment.

All the flood models were simulated for 10-year ARI and 100-year ARI with inclusion of 3.8°C future climate change. All the parameters and assumptions used for the modelled scenarios are provided in this report. The simulated model results discussion is provided in Stormwater Management Report (SMP).

APPENDICES

Memorandum

04/09/2019

To:	Nick Brown
CC:	Dukessa Blackburn-Huettner; Kieren Daji; Scott Speed; Mark Iszard; Paula Vincent; Shaun McAuley
Subject:	Land Use Zone Imperviousness for Hydraulic Modelling based on the Auckland Unitary Plan Operative in Part (AUP OiP)
From:	Cheryl Bai
Contact information:	cheryl.bai@aucklandcouncil.govt.nz

Purpose

1. The purpose of the memo is to address the current inconsistencies regarding the percentage imperviousness applied for hydraulic modelling using the Auckland Unitary Plan provisions. The memo provides a table of percentage imperviousness for the Maximum Probable Development (MPD) scenarios based on the rules provided in the AUP Operative in Part.

Summary

2. This imperviousness table lists out recommended percentage imperviousness for each AUP zone, as well as the data source and rationale for deriving the percentage numbers. An upper percentage allowance has also been provided for the Rural Countryside Living Zone and some Business Zones. This is to cover both the likely situation as well as the maximum allowable situation as per the AUP.

Context

3. Additional notes and recommendations are listed below.

    1) The recommended percentage imperviousness numbers given in the table are provided for consistency purposes for hydraulic modelling. The table should be used as a reference or "starting point" when determining what future imperviousness is to be used for a specific study. The information given above is not a replacement for project specific analysis. Variations/deviations from the imperviousness numbers given in the table should be noted and rationale provided, with approval sought from Auckland Council.

    2) Rural Zones: As maximum percentage imperviousness is not specified in AUP for rural zones, the imperviousness numbers were worked out based on the minimum site size requirement (E39) and the stormwater discharge and diversion rule E8 (A7). However, for some rural zones, existing lots may have a size smaller than the current AUP subdivision requirements. It is therefore important to carry out project specific analysis and verify the imperviousness for rural zones before applying the number in subsequent hydraulic modelling activities.

    3) Business Zones: Only Business Park Zone has a maximum imperviousness specified in AUP. According to advice from planning, theoretically all other business zones could develop up to 100% impervious. However, practically with the riparian rules and existing green features, a likely percentage imperviousness was determined based on definitions and objectives for each individual land use zone.

    4) Special Purpose - Airports and Airfields Zone: the specified 80% imperviousness is based on a Planner's recommendation. It could be conservative for most of the airport/airfields

zones, therefore site-specific imperviousness analysis is recommended on a case by case basis. Precinct rules would also apply for specific airport zones.

5) More detailed zoning is to be used for Future Urban Zones, when and if it becomes available through structure planning activities.

6) Sensitivity analysis is recommended to test impact of % imperviousness greater than allowed by AUP for Residential - Terrace Housing and Apartment Buildings Zone, Residential - Mixed Housing Urban Zone and Residential - Mixed Housing Suburban Zone.

Attachments

The attached table shows the percentage imperviousness coverage of each AUP zones for hydraulic modelling purposes.

Cheryl Bai | Principal - Hydraulic Modelling Delivery | Catchment Planning Team
Healthy Waters | Infrastructure & Environmental Services

Auckland Council, Level 3 South, 24 Wellesley Street, Auckland Central

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ZONE ID	Zone Description	Recommended MPD % impervious coverage based on AUP OiP for hydraulic modelling[1]	Upper % impervious coverage allowed by AUP OiP for hydraulc modelling[1]	Notes extracted from AUP Document	Data Source & Rationale
1	Business - Business Park Zone	80	-	80% max imperviousness	Max imperviousness as per H15.6.4. The Business – Business Park Zone enables moderate to intensive office activity and some ancillary services such as gymnasiums, child care and food and beverage outlets.
3	Rural - Countryside Living Zone[2]	25	50	Min net site area mostly in the range of 1-2 ha, most at 2ha, except Swanson & Okura West at 4ha, and point wells at 5,000m2, without transferable rural site subdivision. If transferable rural site subdivision is considered, the minimum net site area would be reduced to 8,000m2 and average minimum to 1ha for most specified locations.	Minimum net site area as per Table E39.6.5.2.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
4	Future Urban Zone[5]	70	-	NA	Minimum 70% impervious assumed in all future urban areas. The make of the future urban zone is assumed to be mostly residential with some business zones, approx 25% road corridors and 10% open spaces, etc.
5	Business - Heavy Industry Zone[3]	90	100	NA	Assumed to have small pockets of green areas. 'Imperviousness assumed between Business Park Zone and City, Metropolitan, Town Centre Zones. Based on advises from planning.
7	Business - Local Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Provides for the local convenience needs of surrounding residential areas, including local retail, commercial services, offices, food and beverage, and appropriately scaled supermarkets.
8	Residential - Terrace Housing and Apartment Buildings Zone[6]	70	-	max 70% impervious	Max imperviousness as per H6.6.10
10	Business - Metropolitan Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to centres located in different subregional catchments of Auckland.
11	Rural - Mixed Rural Zone[2]	10	-	min site size 40-50ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
12	Business - Mixed Use Zone[3]	80	100	NA	Assumed to be the same as H15 Business Park Zone. Typical transition zone between residential zone and city, metropolitan, town centre zones. Supposingly larger green areas compared to other business zones, based on zone definition. However from spot checks on GeoMap the % imperviousness could be up to 100% depending on locations.
15	Rural - Rural Conservation Zone[2]	10	-	min site size 10-20ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
16	Rural - Rural Production Zone[2]	5	-	min site size 80-100ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
17	Business - Light Industry Zone[3]	90	100	NA	Assumed to have small pockets of green areas. 'Imperviousness assumed between Business Park Zone and City, Metropolitan, Town Centre Zones
18	Residential - Mixed Housing Suburban Zone[6]	60	-	max 60% impervious	Max imperviousness as per H4.6.8
19	Residential - Single House Zone	60	-	max 60% impervious	Max imperviousness as per H3.6.9
20	Residential - Rural and Coastal Settlement Zone	35	-	35% or 1400m2, whichever is lesser	Max imperviousness as per H2.6.8
22	Business - Town Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to suburban centres throughout Auckland, the satellite centres of Warkworth and Pukekohe, and the rural towns of Helensville and Wellsford.
23	Residential - Large Lot Zone	35	-	35% or 1400m2, whichever is lesser	Max imperviousness as per H1.6.6.
25	Water [i]	100	-	NA	Water is effectively impervious
26	Strategic Transport Corridor	100	-	NA	Assumed to be completely impervious. These areas will be the minority in any catchment and variations in assumptions are not likely to significantly affect modelling outcomes.
27	Road [i]	90	-	NA	Assumption. Road corridor instead of just areas between kerblines. Includes berm, footpath, etc.
30	Coastal - General Coastal Marine Zone [rcp]	100	-	NA	Coastal areas mostly covered by water and esturay
31	Open Space - Conservation Zone	10	-	lesser of 10% or 5000m2	Maximum Impervious Areas as per H7.11.7
32	Open Space - Informal Recreation Zone	10	-	lesser of 10% or 5000m2	Maximum Impervious Areas as per H7.11.7
33	Open Space - Sport and Active Recreation Zone	40	-	40% max imperviousness	Maximum Impervious Areas as per H7.11.7
34	Open Space - Community Zone	70	100	70% or no limit depending on adjacent zone	Maximum Impervious Areas as per H7.11.7, 70 per cent where the adjacent zone is a residential zone, Business – Business Park Zone or Business – General Business Zone. No limit in the Business – Mixed Use Zone or the business centre zones.
35	Business - City Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to centres located in different subregional catchments of Auckland.
37	Coastal - Minor Port Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
39	Coastal - Defence Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
40	Coastal - Marina Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
41	Coastal - Mooring Zone [rcp]	100	-	NA	Water.
43	Hauraki Gulf Islands	*Per project basis*	-	NA	Special consideration required
44	Business - Neighbourhood Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Single corner stores or small shopping strips located in residential neighbourhoods.
45	Coastal - Ferry Terminal Zone [rcp/dp]	100	-	NA	Very few green areas in such areas
46	Rural - Rural Coastal Zone[2]	10	-	min site size 40-50ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
49	Business - General Business Zone[3]	80	100	NA	Assumed to be the same as H15 Business Park Zone. Based on zone definition, supposingly larger green areas compared to other business zones. This zone provides for business activities from light industrial to limited office, large format retail and trade suppliers.
51	Special Purpose - Quarry Zone	80	-	NA	Assuming quarry surfaces are mostly impervious, with some green areas remained in the fringe of the zone.

ZONE ID	Zone Description	Recommended MPD % impervious coverage based on AUP OiP for hydraulic modelling[1]	Upper % impervious coverage allowed by AUP OiP for hydraulc modelling[1]	Notes extracted from AUP Document	Data Source & Rationale
52	Special Purpose - Maori Purpose Zone	60	-	60% max imperviousness	Max imperviousness as per H27.6.6
53	Special Purpose - Cemetery Zone	60	-	60% max imperviousness	Max imperviousness as per H24.6.7
54	Special Purpose - Major Recreation Facility Zone	80	-	NA	Assuming sports field with underdrains as impervious. Assuming a higher % imperviousness based on analysis from aerial phots. This zone applies to major recreation facilities include sports arenas, showgrounds, events centres, racecourses, motor-racing tracks, the Auckland Zoo, and Museum of Transport and Technology (MOTAT).
55	Special Purpose - Healthcare Facility and Hospital Zone	80	-	80% max imperviousness	Max imperviousness as per H25.6.4
56	Special Purpose - Airports and Airfields Zone[4]	80	-	NA	Based on numbers given by Planner (Email dated 24/09/2014), 80%. Precinct rules apply for specific airport zones. Site specific analysis may be required to determine % imperviousness on a case by case basis.
59	Coastal - Coastal Transition Zone	10	-	NA	Coastal fringe areas unlikely to be developed, mostly green spaces
60	Residential - Mixed Housing Urban Zone[6]	60	-	max 60% impervious	Max imperviousness as per H5.6.9.
61	Green Infrastructure Corridor (Operative in somne Special Housing Areas)	10	-	NA	Based on numbers given by planner (Email dated 24/09/2014), lesser of 10% or 5000m2. Assumed to be mostly green with minimal imperviousness
62	Open Space - Civic Spaces Zone	100	-	no limit	Max impervious Areas as per H7.11.7
63	Special Purpose - School Zone	70	-	70% max imperviousness	Max imperviousness as per H29.6.5
64	Special Purpose - Tertiary Education Zone	70	-	NA	No max imperviousness defined in H30 but assumed to the same as school zone, as building coverage requirement is the same as 50%
68	Rural - Waitakere Foothills Zone[2]	12.5	-	min site size 4ha	Minimum lot sizes as per Table E39.4.5, (A31) Table H20.4.1, >25% non compliant. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
69	Rural - Waitakere Ranges Zone[2]	25	-	min net site area 2ha	Minimum net site area as per E39.6.5.3 (3), H21 (>15% non compliant). % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.

1 The % imperviousness numbers given in the above table are provided for consistency purposes for hydraulic modelling. The table should be used as a reference or "starting point" when determining what MPD % imperviousness is to be used for a specific study. The information given above is not a replacement for project specific analysis. Variations/deviations from the % imperviousness numbers given in the above table should be noted, rationale provided, with approval sought from Auckland Council.

2 Rural Zones: As max % imperviousness is not specified in AUP for rural zones, the above % imperviousness was worked out based on the minimum lot size requirement (E39) and the stormwater discharge and diversion rule E8 (A7). However, for some rural zones, the existing lots may be a smaller size than the current AUP subdivision requirements. It is therefore important to carry out project specific analysis and verify the above % imperviousness for rural zones before applying the number in subsequent hydraulic modelling activities.

3 Business Zones: Only Business Park Zone has a max % imperviousness specified in AUP. According to advises from planning, theoretically all other business zones could develop up to 100% impervious. However, practically with the riparian rules and existing green features, a likely % imperviousness is provided based on definitions and objectives for each individual zone.

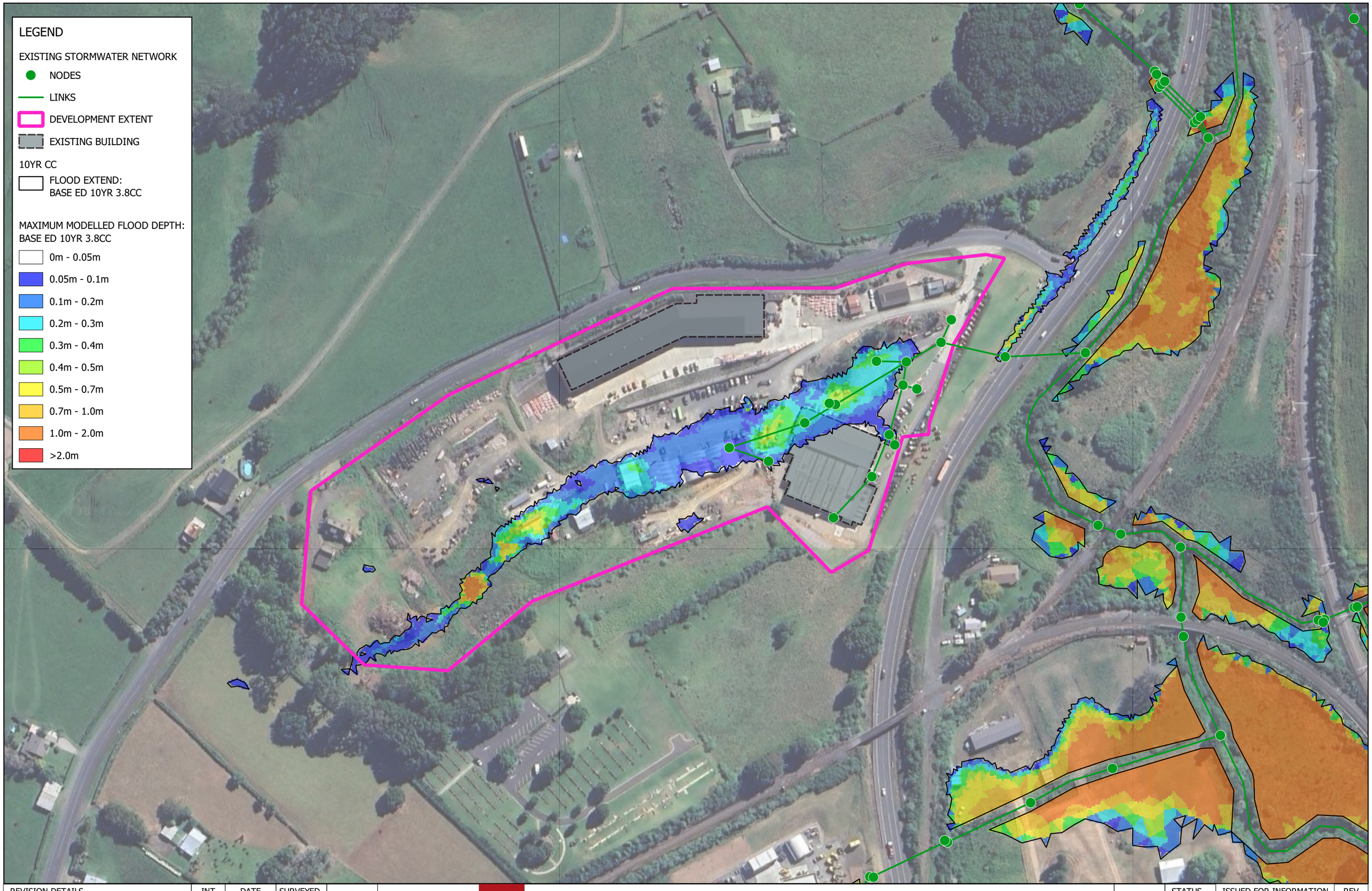
4 Special Purpose - Airports and Airfields Zone: the specified 80% imperviousness is based on a Planner's recommendation. It could be conservative for most of the airport/airfields zones, and site specific imperviousness analysis is recommended on a case by case basis. Precinct rules would apply for specific airport zones.

5 More detailed zoning is to be used for Future Urban Zones, when and if it becomes available through structure planning activities.

6 Sensitivity analysis is recommended to test impact of % imperviousness greater than allowed by AUP for Residential - Terrace Housing and Apartment Buildings Zone, Residential - Mixed Housing Urban Zone and Residential - Mixed Housing Suburban Zone.

Appendix F

Flood Depth and Afflux Plots



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1.0	FOR PC	-	25/07/2024	DESIGNED	SS
-	-	-	-	DRAWN	JM
-	-	-	-	CHECKED	
				APPROVED	-

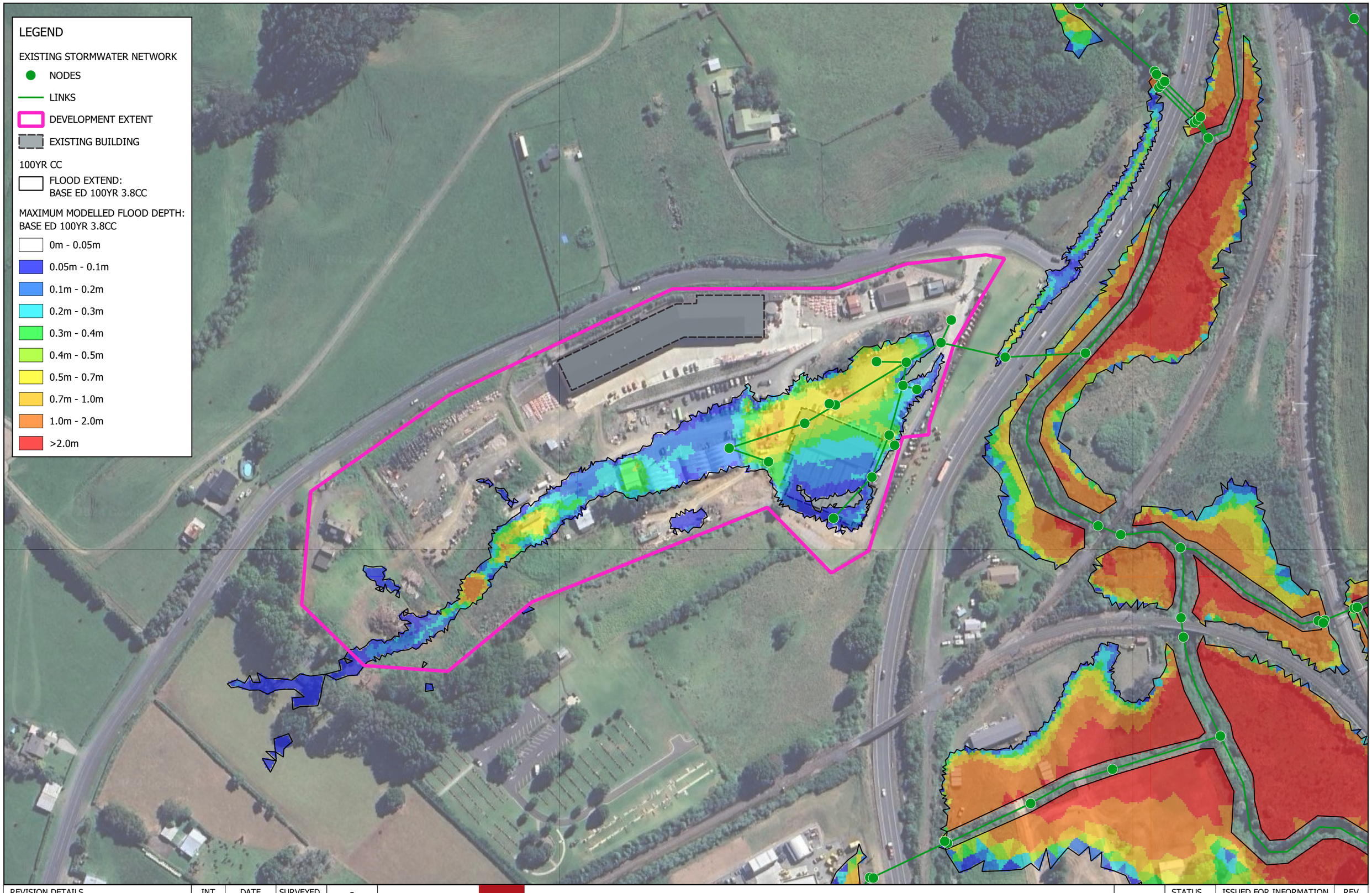
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
BASE ED 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



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-	-	-	-	DRAWN	JM
-	-	-	-	CHECKED	
				APPROVED	-

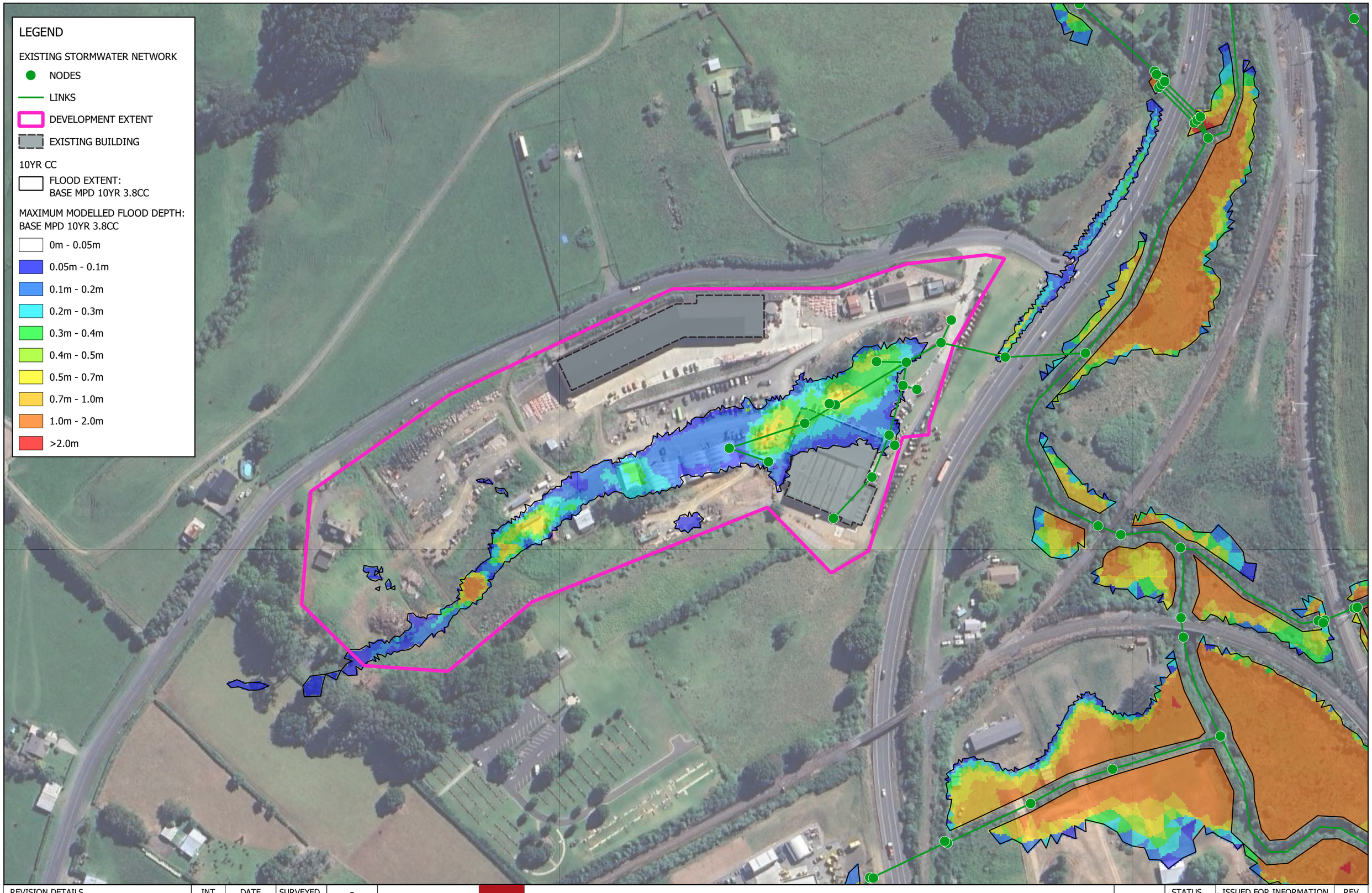
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
BASE ED 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



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-	-	-	-	CHECKED	
				APPROVED	-

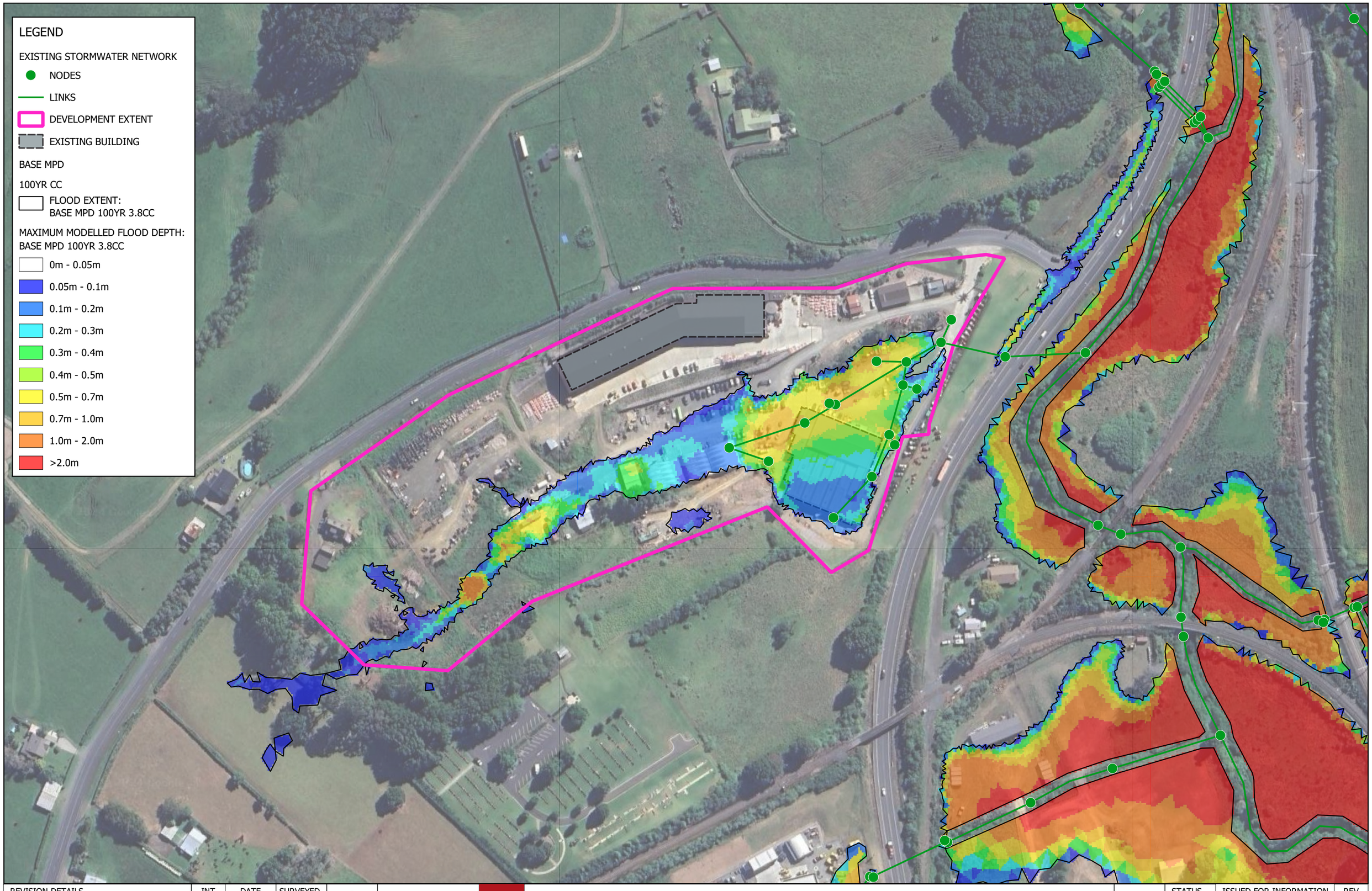
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
BASE MPD 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



REVISION DETAILS		INT	DATE	SURVEYED	-
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-	-	-	-	DRAWN	JM
-	-	-	-	CHECKED	
				APPROVED	-

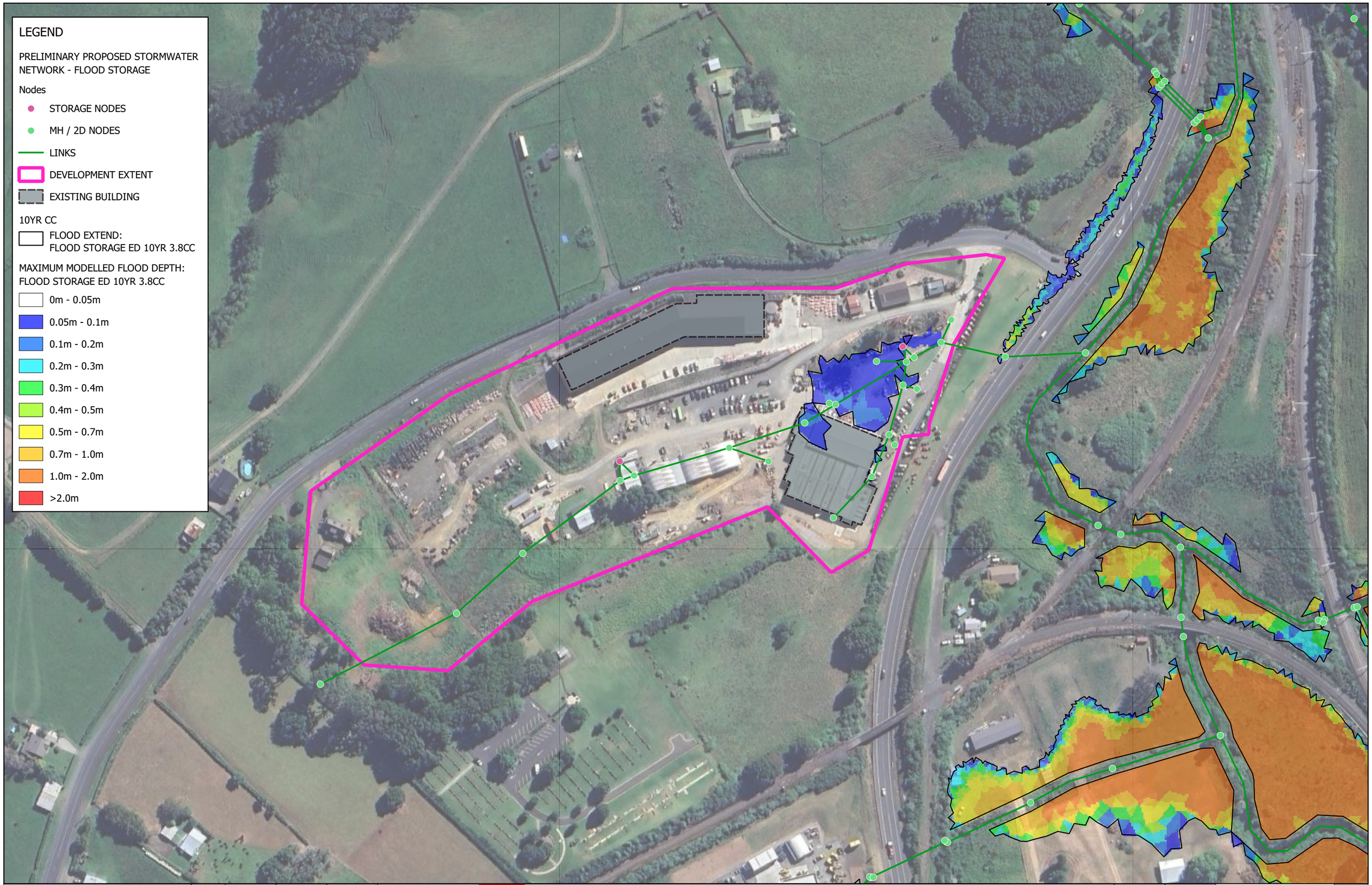
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
BASE MPD 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



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-	-	-	-	DRAWN	JM
-	-	-	-	CHECKED	
				APPROVED	-

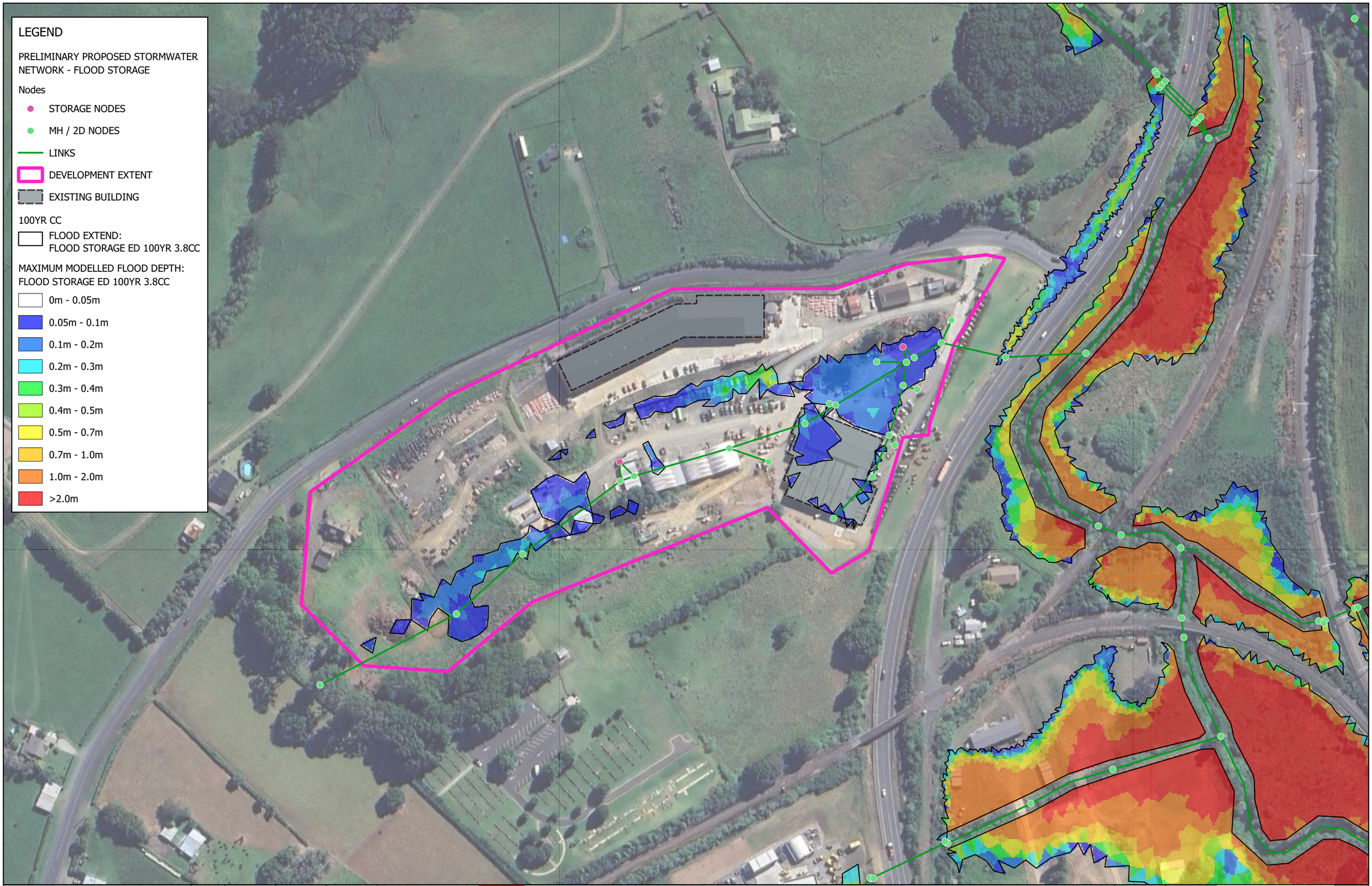
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
FLOOD STORAGE ED 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



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-	-	-	-	CHECKED	
				APPROVED	-

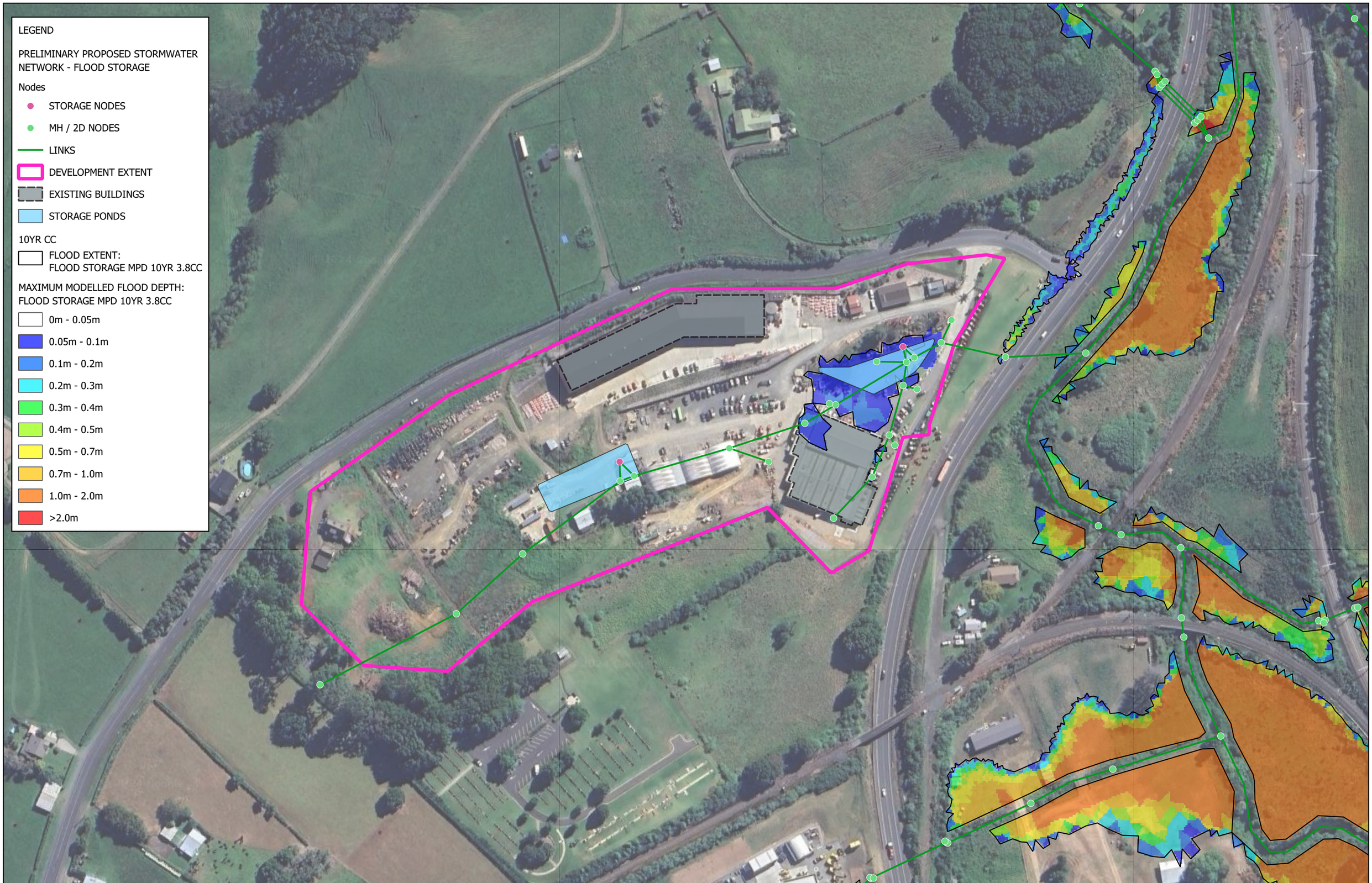
LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
FLOOD STORAGE ED 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	



REVISION DETAILS		INT	DATE	SURVEYED	-
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-	-	-	-	CHECKED	
				APPROVED	-

LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
FLOOD STORAGE MPD 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

LEGEND

PRELIMINARY PROPOSED STORMWATER NETWORK - FLOOD STORAGE

Nodes

- STORAGE NODES
- MH / 2D NODES
- LINKS
- DEVELOPMENT EXTENT
- EXISTING BUILDINGS
- STORAGE PONDS

100YR CC

FLOOD EXTENT:
FLOOD STORAGE MPD 100YR 3.8CC

MAXIMUM MODELLED FLOOD DEPTH:
FLOOD STORAGE MPD 100YR 3.8CC

- 0m - 0.05m
- 0.05m - 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

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR PC	-	06/09/2024	DESIGNED	SS
-	-	-	-	DRAWN	RK
-	-	-	-	CHECKED	
				APPROVED	-

LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH
FLOOD STORAGE MPD 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

REVISION DETAILS		INT	DATE	SURVEYED	-	LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD
1.0	FOR PC	-	26/07/2024	DESIGNED	SS	
-	-	-	-	DRAWN	JM	
-	-	-	-	CHECKED		
				APPROVED	-	WOODS.CO.NZ

WOODS Est.1970

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH DIFFERENCE
FLOOD STORAGE ED 10YR 3.8CC vs BASE ED 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR PC	-	26/07/2024	DESIGNED	SS
-	-	-	-	DRAWN	JM
-	-	-	-	CHECKED	
				APPROVED	-

LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH DIFFERENCE
FLOOD STORAGE ED 100YR 3.8CC vs BASE ED 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

LEGEND

PRELIMINARY PROPOSED STORMWATER NETWORK - FLOOD STORAGE

Nodes

- STORAGE NODES
- MH / 2D NODES
- LINKS
- DEVELOPMENT EXTENT
- EXISTING BUILDINGS
- STORAGE PONDS

10YR CC

- FLOOD EXTENT: BASE MPD 10YR 3.8CC

FLOOD STORAGE MPD 10YR 3.8CC VS BASE MPD 10YR 3.8CC

- < -300mm
- -300mm to -100mm
- -100mm to -50mm
- -50mm to 50mm
- 50mm to 100mm
- 100mm to 200mm
- 200mm to 300mm
- > 300mm

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR PC	-	06/09/2024	DESIGNED	SS
-	-	-	-	DRAWN	RK
-	-	-	-	CHECKED	
				APPROVED	-

LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH DIFFERENCE
FLOOD STORAGE MPD 10YR 3.8CC vs BASE MPD 10YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR PC	-	06/09/2024	DESIGNED	SS
-	-	-	-	DRAWN	RK
-	-	-	-	CHECKED	
				APPROVED	-

LEVEL 1, 8 NUGENT STREET, GRAFTON, 1061 AUCKLAND CBD

WOODS Est.1970

WOODS.CO.NZ

P18-088 9, 33 AND 39 HEIGHTS ROAD, PUKEKOHE, AUCKLAND
MAXIMUM MODELLED FLOOD DEPTH DIFFERENCE
FLOOD STORAGE MPD 100YR 3.8CC vs BASE MPD 100YR 3.8CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	

Appendix G
Flow Hydrographs

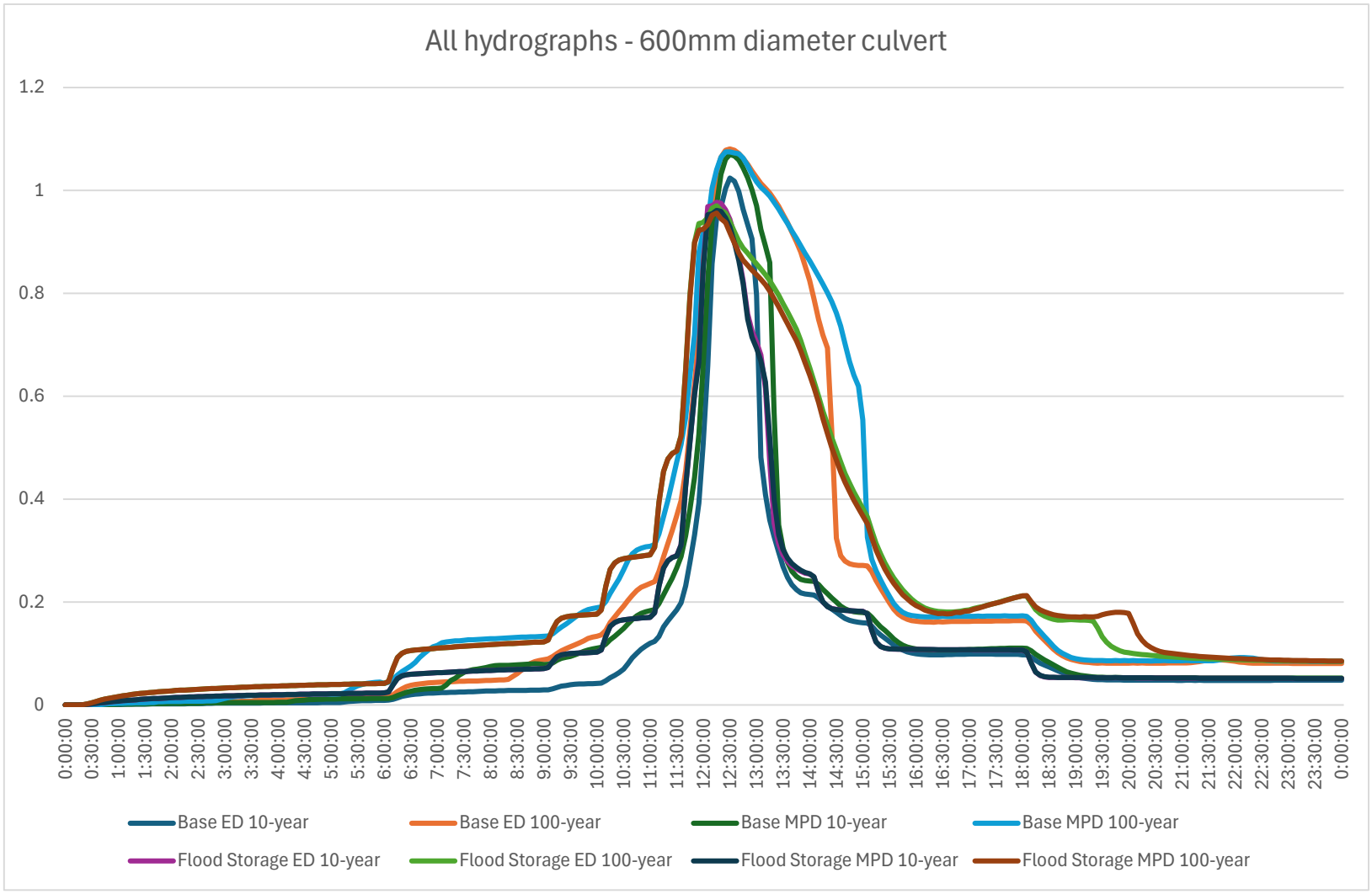
Time	Base ED 10-year	Base ED 100-year	Base MPD 10-year	Base MPD 100-year	Flood Storage ED 10-year	Flood Storage ED 100-year	Flood Storage MPD 10-year	Flood Storage MPD 100-year
0:00:00	0	0	0	0	0	0	0	0
0:05:00	0	0	0	0	0	0	0	0
0:10:00	0	0	0	0	0	0	0	0
0:15:00	0	0	0	0	0.000006	0.000014	0.000006	0.000014
0:20:00	0	0	0	0	0.000173	0.000429	0.000173	0.000429
0:25:00	0	0	0	0	0.000759	0.0019	0.000759	0.0019
0:30:00	0	0	0	0	0.001709	0.004259	0.001709	0.004259
0:35:00	0	0.000022	0	0.000044	0.002784	0.006778	0.002784	0.006778
0:40:00	0	0.000422	0	0.000438	0.003827	0.00909	0.003827	0.00909
0:45:00	0.000126	0.000601	0.000134	0.001285	0.004802	0.011159	0.004802	0.011159
0:50:00	0.000276	0.001482	0.000302	0.002203	0.005709	0.01302	0.005709	0.01302
0:55:00	0.000351	0.00199	0.000397	0.002574	0.006554	0.014703	0.006554	0.014703
1:00:00	0.000427	0.002241	0.001239	0.002884	0.007345	0.01623	0.007345	0.01623
1:05:00	0.000932	0.002494	0.001438	0.003171	0.008086	0.017622	0.008086	0.017622
1:10:00	0.001232	0.002699	0.00153	0.003402	0.008781	0.018895	0.008781	0.018895
1:15:00	0.00135	0.002868	0.001652	0.003629	0.009435	0.020058	0.009435	0.020058
1:20:00	0.001446	0.003063	0.001824	0.003838	0.01005	0.021132	0.01005	0.021132
1:25:00	0.001533	0.003195	0.00192	0.004051	0.010631	0.022122	0.010631	0.022122
1:30:00	0.001629	0.003345	0.001992	0.004224	0.011179	0.023037	0.011179	0.023037
1:35:00	0.001693	0.003497	0.00213	0.004424	0.011697	0.023884	0.011697	0.023884
1:40:00	0.001747	0.00363	0.002229	0.004774	0.012187	0.02467	0.012187	0.02467
1:45:00	0.001762	0.004387	0.002324	0.005887	0.012652	0.025401	0.012652	0.025401
1:50:00	0.001895	0.004996	0.002392	0.006197	0.013093	0.026082	0.013093	0.026082
1:55:00	0.00196	0.005256	0.002499	0.006399	0.013512	0.026716	0.013512	0.026716
2:00:00	0.002027	0.005418	0.002727	0.006651	0.01391	0.02731	0.01391	0.02731
2:05:00	0.002074	0.005518	0.00275	0.006692	0.014288	0.027865	0.014288	0.027865
2:10:00	0.002149	0.005622	0.00272	0.006825	0.014648	0.028385	0.014648	0.028385
2:15:00	0.002202	0.005726	0.002888	0.006931	0.014991	0.028874	0.014991	0.028874
2:20:00	0.002242	0.005824	0.002934	0.007033	0.015319	0.029333	0.015319	0.029333
2:25:00	0.002326	0.006006	0.003058	0.007183	0.015631	0.029765	0.015631	0.029765
2:30:00	0.002367	0.006113	0.003189	0.007273	0.015929	0.030188	0.015929	0.030188
2:35:00	0.00242	0.006174	0.003308	0.00738	0.016214	0.030639	0.016214	0.030639
2:40:00	0.00277	0.006285	0.003811	0.007515	0.016486	0.031105	0.016486	0.031105
2:45:00	0.003227	0.006354	0.004027	0.007693	0.016747	0.031562	0.016747	0.031562
2:50:00	0.003326	0.006453	0.004073	0.008073	0.016997	0.032003	0.016997	0.032003
2:55:00	0.003375	0.006502	0.004188	0.010519	0.017236	0.032427	0.017236	0.032427
3:00:00	0.003421	0.006675	0.004195	0.012605	0.017465	0.032834	0.017465	0.032834
3:05:00	0.003466	0.006663	0.004354	0.014368	0.017685	0.033226	0.017685	0.033226
3:10:00	0.003523	0.006817	0.004319	0.015595	0.017896	0.033603	0.017896	0.033603
3:15:00	0.00356	0.006855	0.004386	0.01636	0.018099	0.033967	0.018099	0.033967
3:20:00	0.003596	0.007024	0.004465	0.016992	0.018294	0.034317	0.018294	0.034317
3:25:00	0.003617	0.007216	0.00448	0.017536	0.018481	0.034656	0.018481	0.034656
3:30:00	0.003669	0.007413	0.004487	0.017947	0.018662	0.034983	0.018662	0.034983
3:35:00	0.003702	0.009171	0.004595	0.01829	0.018835	0.0353	0.018835	0.0353
3:40:00	0.003766	0.010421	0.004653	0.018492	0.019002	0.035607	0.019002	0.035607
3:45:00	0.003788	0.011422	0.004665	0.018693	0.01917	0.035904	0.01917	0.035904
3:50:00	0.003831	0.012221	0.00466	0.018947	0.019352	0.036192	0.019352	0.036192
3:55:00	0.003877	0.012793	0.004712	0.019145	0.019542	0.036472	0.019542	0.036472
4:00:00	0.003893	0.013406	0.004874	0.019476	0.019732	0.036743	0.019732	0.036743
4:05:00	0.003936	0.013691	0.004946	0.019459	0.019919	0.037007	0.019919	0.037007
4:10:00	0.003974	0.013946	0.005213	0.01964	0.0201	0.037264	0.0201	0.037264
4:15:00	0.004025	0.014204	0.006805	0.019786	0.020277	0.037514	0.020277	0.037514
4:20:00	0.004052	0.014491	0.008099	0.019912	0.02045	0.037757	0.02045	0.037757
4:25:00	0.004136	0.014478	0.008966	0.020018	0.020618	0.037994	0.020618	0.037994
4:30:00	0.004141	0.014665	0.009524	0.02014	0.020782	0.038225	0.020782	0.038225
4:35:00	0.004249	0.014814	0.01017	0.020234	0.020942	0.038451	0.020942	0.038451
4:40:00	0.004162	0.014909	0.010527	0.020743	0.021098	0.038671	0.021098	0.038671
4:45:00	0.004215	0.014977	0.010811	0.020727	0.02125	0.038887	0.02125	0.038887
4:50:00	0.004298	0.015112	0.01103	0.020821	0.021399	0.039097	0.021399	0.039097
4:55:00	0.004385	0.015028	0.011246	0.020888	0.021544	0.039302	0.021544	0.039302
5:00:00	0.004378	0.015176	0.011511	0.020947	0.021686	0.039504	0.021686	0.039504
5:05:00	0.004547	0.015346	0.011579	0.021003	0.021825	0.0397	0.021825	0.0397
5:10:00	0.004794	0.015363	0.011739	0.021246	0.021961	0.039893	0.021961	0.039893
5:15:00	0.005842	0.015428	0.011796	0.023659	0.022094	0.040082	0.022094	0.040082
5:20:00	0.006856	0.015529	0.011867	0.028248	0.022224	0.040267	0.022224	0.040267
5:25:00	0.007339	0.015743	0.011912	0.032997	0.022352	0.040449	0.022352	0.040449

5:30:00	0.007748	0.015743	0.011991	0.036821	0.022476	0.040627	0.022476	0.040627
5:35:00	0.008133	0.015789	0.012028	0.039512	0.022599	0.040801	0.022599	0.040801
5:40:00	0.008229	0.015935	0.012084	0.041494	0.022719	0.040973	0.022719	0.040973
5:45:00	0.008452	0.015937	0.012315	0.042937	0.022836	0.041141	0.022836	0.041141
5:50:00	0.008648	0.016138	0.012337	0.043955	0.022952	0.041306	0.022952	0.041306
5:55:00	0.008698	0.016155	0.01238	0.044601	0.023065	0.041469	0.023065	0.041469
6:00:00	0.008831	0.016154	0.012462	0.041713	0.023176	0.041629	0.023176	0.041629
6:05:00	0.009077	0.01637	0.012593	0.04361	0.025031	0.045249	0.025035	0.045249
6:10:00	0.010675	0.019993	0.014381	0.049557	0.038958	0.071321	0.038958	0.071321
6:15:00	0.013689	0.026145	0.01821	0.058165	0.051285	0.092226	0.051282	0.092226
6:20:00	0.016378	0.031306	0.021539	0.064865	0.056152	0.100354	0.056151	0.100354
6:25:00	0.018361	0.035206	0.024409	0.070244	0.058342	0.103913	0.058341	0.103913
6:30:00	0.019674	0.037859	0.026754	0.075582	0.059384	0.105537	0.059384	0.105537
6:35:00	0.020828	0.039631	0.028615	0.082435	0.060055	0.106546	0.060055	0.106546
6:40:00	0.021491	0.040927	0.029709	0.091854	0.060591	0.107334	0.060591	0.107334
6:45:00	0.02221	0.041986	0.030527	0.099856	0.061093	0.108075	0.061093	0.108075
6:50:00	0.022674	0.042861	0.031149	0.106791	0.061574	0.108787	0.061574	0.108787
6:55:00	0.023098	0.043439	0.031555	0.112937	0.06204	0.109478	0.06204	0.109478
7:00:00	0.02344	0.043949	0.031882	0.115692	0.062491	0.11015	0.062491	0.11015
7:05:00	0.023892	0.0444	0.033024	0.121011	0.062928	0.110804	0.062928	0.110804
7:10:00	0.024086	0.044759	0.038764	0.122309	0.063352	0.11144	0.063352	0.11144
7:15:00	0.024317	0.045094	0.047436	0.123143	0.063764	0.112061	0.063764	0.112061
7:20:00	0.024538	0.045392	0.051426	0.124267	0.064165	0.112666	0.064165	0.112666
7:25:00	0.024802	0.045672	0.058154	0.124473	0.064555	0.113257	0.064555	0.113257
7:30:00	0.024913	0.046037	0.063242	0.125503	0.064935	0.113833	0.064935	0.113833
7:35:00	0.025267	0.046328	0.066585	0.12648	0.065305	0.114397	0.065305	0.114397
7:40:00	0.025734	0.046309	0.068461	0.126721	0.065667	0.114948	0.065667	0.114948
7:45:00	0.026215	0.046648	0.06965	0.12691	0.066019	0.115487	0.066019	0.115487
7:50:00	0.026571	0.046958	0.070913	0.127532	0.066364	0.116014	0.066364	0.116014
7:55:00	0.026831	0.047239	0.072443	0.128172	0.0667	0.116531	0.0667	0.116531
8:00:00	0.026986	0.047651	0.074809	0.128616	0.067029	0.117037	0.067029	0.117037
8:05:00	0.027327	0.048175	0.076506	0.128878	0.067351	0.117533	0.067351	0.117533
8:10:00	0.02742	0.04834	0.077014	0.129237	0.067667	0.118019	0.067667	0.118019
8:15:00	0.027684	0.048666	0.076848	0.129843	0.067975	0.118496	0.067975	0.118496
8:20:00	0.027913	0.049758	0.076806	0.130327	0.068278	0.118964	0.068278	0.118964
8:25:00	0.028058	0.05546	0.077217	0.130764	0.068575	0.119423	0.068575	0.119423
8:30:00	0.028197	0.060502	0.078051	0.131423	0.068866	0.119874	0.068866	0.119874
8:35:00	0.028161	0.068152	0.078261	0.131604	0.069151	0.120317	0.069151	0.120317
8:40:00	0.028323	0.075267	0.079038	0.131898	0.069431	0.120751	0.069431	0.120751
8:45:00	0.028493	0.080646	0.079485	0.13238	0.069706	0.121179	0.069706	0.121179
8:50:00	0.028723	0.08411	0.079838	0.132518	0.069977	0.121599	0.069977	0.121599
8:55:00	0.028803	0.086262	0.079446	0.132966	0.070243	0.122012	0.070243	0.122012
9:00:00	0.028943	0.087876	0.078496	0.133263	0.070504	0.122418	0.070504	0.122418
9:05:00	0.029187	0.089252	0.078824	0.133967	0.072441	0.125998	0.072438	0.125996
9:10:00	0.031162	0.094301	0.081454	0.138315	0.084267	0.147092	0.084268	0.147092
9:15:00	0.033953	0.100055	0.086688	0.145008	0.093504	0.162361	0.093506	0.162362
9:20:00	0.036361	0.105081	0.090184	0.151237	0.097221	0.168472	0.097221	0.168473
9:25:00	0.037765	0.109164	0.092458	0.157007	0.098904	0.171194	0.098904	0.171194
9:30:00	0.038997	0.112915	0.093924	0.163137	0.099718	0.172486	0.099718	0.172486
9:35:00	0.040003	0.116402	0.097042	0.170104	0.100256	0.173327	0.100256	0.173327
9:40:00	0.040568	0.120392	0.100546	0.176078	0.100697	0.174009	0.100697	0.173937
9:45:00	0.040848	0.124387	0.103783	0.181297	0.101118	0.174662	0.101118	0.174581
9:50:00	0.041261	0.129309	0.106516	0.18495	0.101529	0.175296	0.101529	0.175212
9:55:00	0.041433	0.131547	0.10877	0.187363	0.101931	0.175918	0.101931	0.175826
10:00:00	0.041706	0.133212	0.110347	0.188782	0.102327	0.176527	0.102327	0.176429
10:05:00	0.0422	0.135859	0.11201	0.190567	0.106654	0.184496	0.106641	0.184347
10:10:00	0.046706	0.145005	0.118086	0.201134	0.133121	0.231256	0.133124	0.230884
10:15:00	0.052471	0.160165	0.126642	0.216323	0.152488	0.263323	0.152492	0.263008
10:20:00	0.05719	0.171278	0.133472	0.231022	0.160203	0.276084	0.160205	0.27579
10:25:00	0.062844	0.18131	0.140545	0.24497	0.163627	0.281639	0.163627	0.281364
10:30:00	0.069536	0.191749	0.148395	0.262679	0.165243	0.284039	0.165243	0.283895
10:35:00	0.079992	0.203008	0.157305	0.2806	0.166286	0.285566	0.166287	0.285458
10:40:00	0.091649	0.213058	0.16576	0.293403	0.167128	0.286874	0.167128	0.286714
10:45:00	0.100548	0.222288	0.173144	0.300714	0.167929	0.288054	0.167929	0.2879
10:50:00	0.108374	0.228376	0.177626	0.304674	0.168705	0.289213	0.168705	0.289054
10:55:00	0.114312	0.232531	0.180928	0.306968	0.169463	0.290332	0.169463	0.290173
11:00:00	0.119513	0.23579	0.183133	0.308378	0.170205	0.291406	0.170205	0.291269
11:05:00	0.123458	0.23983	0.185244	0.311338	0.179062	0.306811	0.179058	0.306297
11:10:00	0.1328	0.259457	0.196899	0.332364	0.230608	0.394116	0.23061	0.393289
11:15:00	0.151577	0.28775	0.213989	0.365882	0.265963	0.45345	0.265963	0.453652

11:20:00	0.163223	0.313632	0.230377	0.396953	0.280211	0.477823	0.280013	0.477798
11:25:00	0.173611	0.338375	0.24616	0.433189	0.286571	0.488693	0.286323	0.488532
11:30:00	0.184729	0.367721	0.266161	0.472784	0.289646	0.493614	0.289366	0.49354
11:35:00	0.198398	0.396418	0.288415	0.505899	0.311319	0.52353	0.310371	0.522311
11:40:00	0.231474	0.454806	0.328687	0.558216	0.425706	0.652552	0.424052	0.649433
11:45:00	0.277229	0.535599	0.380658	0.640215	0.512003	0.797657	0.511027	0.792016
11:50:00	0.329944	0.623526	0.442082	0.719854	0.606051	0.899091	0.603027	0.89798
11:55:00	0.391767	0.722204	0.525582	0.878761	0.675424	0.935438	0.666032	0.922147
12:00:00	0.506953	0.903058	0.66045	0.91831	0.85196	0.93738	0.846544	0.924181
12:05:00	0.658734	0.918284	0.826731	0.936693	0.968433	0.94669	0.952723	0.933533
12:10:00	0.857314	0.958375	0.939665	1.004036	0.97013	0.965273	0.95425	0.951679
12:15:00	0.947394	1.033826	0.972178	1.040224	0.97718	0.970152	0.961485	0.95603
12:20:00	0.96748	1.064079	1.030993	1.06404	0.974583	0.961228	0.958966	0.944599
12:25:00	1.003257	1.077582	1.060266	1.074403	0.962119	0.955894	0.946577	0.937428
12:30:00	1.023922	1.080868	1.069449	1.074619	0.943537	0.939202	0.928663	0.917677
12:35:00	1.017558	1.077729	1.06674	1.072356	0.912046	0.919391	0.898333	0.896996
12:40:00	0.997548	1.071343	1.058707	1.070935	0.871414	0.901499	0.86383	0.878069
12:45:00	0.963175	1.061962	1.043977	1.062387	0.824369	0.887601	0.819071	0.864
12:50:00	0.933101	1.050309	1.024385	1.047886	0.759577	0.877579	0.749339	0.854332
12:55:00	0.905644	1.037656	1.000574	1.031399	0.726863	0.867145	0.714496	0.844813
13:00:00	0.795924	1.025041	0.970074	1.016473	0.705092	0.857101	0.69308	0.835773
13:05:00	0.481014	1.013361	0.923986	1.006041	0.680081	0.847132	0.668338	0.826969
13:10:00	0.408773	1.003991	0.891418	0.997656	0.615127	0.835988	0.627345	0.816282
13:15:00	0.358932	0.994374	0.859508	0.988517	0.470865	0.824143	0.518455	0.803752
13:20:00	0.327299	0.982625	0.568597	0.976832	0.353456	0.810657	0.399274	0.789184
13:25:00	0.296839	0.968799	0.349784	0.963603	0.312684	0.795862	0.330492	0.77344
13:30:00	0.269145	0.953269	0.304797	0.94961	0.29147	0.780127	0.301784	0.757208
13:35:00	0.247486	0.936779	0.27658	0.935305	0.278642	0.763852	0.285326	0.740804
13:40:00	0.233267	0.918494	0.25937	0.920927	0.270143	0.747481	0.274694	0.724287
13:45:00	0.224109	0.899957	0.249428	0.90646	0.264075	0.729837	0.267308	0.707452
13:50:00	0.217574	0.879778	0.243939	0.891977	0.259349	0.707613	0.261725	0.687686
13:55:00	0.215359	0.85295	0.241693	0.877519	0.256103	0.681664	0.257582	0.66496
14:00:00	0.214272	0.824533	0.240723	0.862945	0.254224	0.655193	0.254933	0.640904
14:05:00	0.213429	0.788715	0.239899	0.848302	0.248388	0.628772	0.249047	0.616369
14:10:00	0.207867	0.748907	0.23389	0.832868	0.219696	0.599543	0.220369	0.587604
14:15:00	0.19964	0.718856	0.224461	0.817406	0.200028	0.571255	0.200163	0.556461
14:20:00	0.192487	0.693398	0.216071	0.801031	0.190939	0.544801	0.19093	0.527103
14:25:00	0.186172	0.531661	0.207558	0.783356	0.187178	0.519421	0.18699	0.499965
14:30:00	0.179766	0.324114	0.199576	0.761686	0.185437	0.495077	0.185194	0.475492
14:35:00	0.17366	0.290092	0.192219	0.735777	0.184431	0.471909	0.184152	0.452545
14:40:00	0.168053	0.27944	0.186598	0.701785	0.183727	0.449689	0.183454	0.432738
14:45:00	0.164181	0.27436	0.182999	0.666835	0.183141	0.430875	0.182862	0.41473
14:50:00	0.161901	0.272189	0.180942	0.640447	0.182641	0.413399	0.182374	0.397761
14:55:00	0.160369	0.27106	0.180073	0.619131	0.182215	0.39704	0.181956	0.38202
15:00:00	0.159717	0.270914	0.179408	0.553933	0.181838	0.381647	0.181605	0.367613
15:05:00	0.15909	0.269872	0.178311	0.32603	0.176573	0.365477	0.17664	0.352188
15:10:00	0.153147	0.259189	0.170692	0.283299	0.14504	0.339085	0.145375	0.325732
15:15:00	0.143635	0.241728	0.161088	0.260879	0.122356	0.313948	0.122394	0.301039
15:20:00	0.135897	0.226284	0.151584	0.242986	0.113611	0.293608	0.113619	0.281086
15:25:00	0.129523	0.212668	0.144827	0.226365	0.11013	0.275489	0.110166	0.263516
15:30:00	0.123011	0.19808	0.136426	0.210622	0.108942	0.260157	0.108995	0.24844
15:35:00	0.116047	0.185642	0.128355	0.1968	0.108474	0.246451	0.108558	0.235846
15:40:00	0.110622	0.176527	0.121355	0.18655	0.108265	0.234273	0.108376	0.224385
15:45:00	0.106392	0.170553	0.115856	0.179946	0.108103	0.223487	0.10824	0.214033
15:50:00	0.102952	0.166567	0.112502	0.175798	0.10796	0.213895	0.108117	0.205959
15:55:00	0.100681	0.163524	0.110101	0.173675	0.107841	0.205593	0.108001	0.199028
16:00:00	0.09913	0.162664	0.108589	0.172435	0.107726	0.198962	0.107879	0.193137
16:05:00	0.098056	0.161701	0.107551	0.171391	0.107626	0.192841	0.107758	0.188745
16:10:00	0.097571	0.161077	0.10704	0.171109	0.107533	0.188339	0.107648	0.184004
16:15:00	0.097197	0.161236	0.106652	0.171227	0.107446	0.185329	0.107551	0.181574
16:20:00	0.097233	0.160701	0.106472	0.171021	0.107366	0.1833	0.107462	0.179386
16:25:00	0.097263	0.16186	0.106434	0.170931	0.107291	0.181471	0.107388	0.177485
16:30:00	0.097395	0.16094	0.10656	0.171834	0.107227	0.180799	0.107326	0.178075
16:35:00	0.097517	0.161593	0.106554	0.171343	0.107168	0.180355	0.107277	0.176644
16:40:00	0.097735	0.161997	0.106637	0.171665	0.10712	0.180341	0.107244	0.17755
16:45:00	0.098023	0.162084	0.106818	0.171877	0.107078	0.180922	0.107221	0.179816
16:50:00	0.098195	0.16215	0.106953	0.171997	0.107036	0.181975	0.107207	0.179469
16:55:00	0.098509	0.162304	0.107185	0.172144	0.106992	0.183755	0.1072	0.182078
17:00:00	0.098769	0.162337	0.107467	0.172185	0.106953	0.184832	0.107193	0.182473
17:05:00	0.0988	0.162851	0.107628	0.172104	0.106905	0.187431	0.107179	0.185711

17:10:00	0.098788	0.162401	0.108014	0.172469	0.106858	0.189542	0.107156	0.187804
17:15:00	0.098762	0.162882	0.108332	0.172279	0.106817	0.191067	0.107144	0.190367
17:20:00	0.098721	0.162676	0.108593	0.17252	0.106784	0.193433	0.107121	0.193055
17:25:00	0.098633	0.162883	0.109117	0.172594	0.106705	0.195515	0.107097	0.195482
17:30:00	0.098485	0.163072	0.109318	0.172483	0.106672	0.197997	0.107073	0.197984
17:35:00	0.098304	0.163221	0.109671	0.172484	0.106617	0.200596	0.107034	0.200049
17:40:00	0.098173	0.163262	0.110014	0.17289	0.106577	0.20309	0.106983	0.202699
17:45:00	0.098041	0.163396	0.110187	0.172814	0.106527	0.205521	0.106928	0.20497
17:50:00	0.098026	0.163453	0.110403	0.172507	0.106474	0.20752	0.106873	0.207737
17:55:00	0.098055	0.163568	0.110518	0.172802	0.106429	0.209592	0.106821	0.209683
18:00:00	0.097387	0.163599	0.110483	0.172989	0.106379	0.212051	0.106773	0.212073
18:05:00	0.097028	0.163149	0.110026	0.172328	0.102918	0.211543	0.103189	0.212185
18:10:00	0.092568	0.155756	0.104872	0.164305	0.080752	0.197672	0.080869	0.200258
18:15:00	0.086534	0.143225	0.098143	0.152143	0.063837	0.185185	0.063927	0.190353
18:20:00	0.081177	0.133649	0.092359	0.141984	0.056991	0.177471	0.057297	0.184761
18:25:00	0.077178	0.125463	0.087334	0.13272	0.05435	0.172585	0.054717	0.180773
18:30:00	0.073714	0.116658	0.082529	0.123337	0.053504	0.169109	0.053885	0.177959
18:35:00	0.06992	0.108445	0.077802	0.113861	0.053247	0.166443	0.053586	0.175111
18:40:00	0.066109	0.101505	0.073083	0.106214	0.053177	0.164998	0.0535	0.173572
18:45:00	0.062551	0.095701	0.068668	0.100379	0.053136	0.164925	0.053418	0.172489
18:50:00	0.059336	0.09147	0.064474	0.096031	0.053068	0.165372	0.053345	0.17172
18:55:00	0.056709	0.088426	0.061578	0.092219	0.053017	0.165657	0.053278	0.171283
19:00:00	0.054482	0.08606	0.05929	0.089916	0.052965	0.165219	0.053195	0.170909
19:05:00	0.052878	0.084176	0.057494	0.088457	0.05293	0.16495	0.053132	0.170705
19:10:00	0.051413	0.082872	0.056195	0.087403	0.052866	0.164514	0.053091	0.171333
19:15:00	0.050451	0.082311	0.055112	0.086811	0.052846	0.164071	0.053056	0.171235
19:20:00	0.049751	0.081744	0.054485	0.086473	0.052824	0.16247	0.053015	0.171027
19:25:00	0.049188	0.081154	0.053922	0.086386	0.052786	0.149722	0.052942	0.172318
19:30:00	0.048868	0.081453	0.053515	0.086156	0.052743	0.132527	0.052889	0.175475
19:35:00	0.048657	0.080992	0.05331	0.085876	0.052715	0.121623	0.052835	0.177286
19:40:00	0.048399	0.081061	0.053247	0.08587	0.052639	0.114234	0.052799	0.178673
19:45:00	0.048396	0.081119	0.053218	0.08609	0.052606	0.109081	0.05305	0.17986
19:50:00	0.048339	0.081109	0.053047	0.085963	0.052565	0.105094	0.052743	0.180054
19:55:00	0.04826	0.081081	0.052953	0.085978	0.052539	0.10256	0.052692	0.179402
20:00:00	0.048168	0.081128	0.052896	0.085799	0.052498	0.101163	0.052685	0.1779
20:05:00	0.048083	0.081481	0.052896	0.086118	0.052462	0.099986	0.052657	0.158728
20:10:00	0.048059	0.081043	0.052791	0.085458	0.052412	0.098916	0.052589	0.138272
20:15:00	0.04812	0.081269	0.052818	0.085453	0.052376	0.097948	0.052556	0.12563
20:20:00	0.048067	0.081153	0.052867	0.085935	0.052305	0.097034	0.052514	0.117256
20:25:00	0.047972	0.080864	0.052804	0.085308	0.052269	0.096297	0.052476	0.11134
20:30:00	0.047925	0.081227	0.05278	0.085699	0.052218	0.095579	0.052438	0.107089
20:35:00	0.047857	0.081095	0.05277	0.085556	0.05216	0.094841	0.052389	0.103868
20:40:00	0.047752	0.080941	0.052755	0.086074	0.052087	0.094168	0.052364	0.102159
20:45:00	0.047842	0.081256	0.052735	0.085909	0.052023	0.093527	0.052313	0.100828
20:50:00	0.047802	0.081327	0.052647	0.085824	0.051996	0.092991	0.05229	0.0996
20:55:00	0.047682	0.081337	0.052586	0.085663	0.051949	0.092494	0.0522	0.098613
21:00:00	0.047681	0.081283	0.052551	0.085754	0.051882	0.092035	0.052145	0.097638
21:05:00	0.047771	0.08149	0.052528	0.08603	0.051865	0.091543	0.052068	0.096686
21:10:00	0.04776	0.082037	0.052473	0.085498	0.051806	0.091073	0.052045	0.095816
21:15:00	0.047722	0.083104	0.052484	0.085592	0.051765	0.0906	0.051973	0.094994
21:20:00	0.047763	0.084317	0.052426	0.085525	0.051748	0.09018	0.051936	0.094317
21:25:00	0.047745	0.085778	0.052325	0.085607	0.051694	0.089826	0.051877	0.093759
21:30:00	0.047745	0.08668	0.052351	0.085822	0.051666	0.089485	0.051842	0.093176
21:35:00	0.047708	0.087301	0.052379	0.085753	0.051645	0.089174	0.051809	0.092596
21:40:00	0.047639	0.087469	0.05228	0.086667	0.051588	0.088876	0.051744	0.092001
21:45:00	0.047616	0.087459	0.052288	0.088094	0.051523	0.088629	0.051702	0.091469
21:50:00	0.047582	0.086974	0.052198	0.089621	0.051513	0.088312	0.051669	0.090952
21:55:00	0.047631	0.085948	0.052203	0.090916	0.051504	0.088098	0.051648	0.090468
22:00:00	0.047598	0.084661	0.052088	0.091546	0.051496	0.087819	0.051653	0.090055
22:05:00	0.047618	0.083347	0.05224	0.091986	0.051487	0.087573	0.051595	0.089686
22:10:00	0.047662	0.082595	0.05222	0.09183	0.051479	0.087343	0.05158	0.089333
22:15:00	0.047696	0.081285	0.052104	0.091677	0.051472	0.087122	0.051478	0.089016
22:20:00	0.047719	0.081225	0.05208	0.090686	0.051464	0.086907	0.051471	0.088668
22:25:00	0.047731	0.081193	0.051977	0.089263	0.051459	0.086702	0.051463	0.088345
22:30:00	0.047734	0.08109	0.052226	0.087794	0.051451	0.086517	0.051456	0.088063
22:35:00	0.047672	0.081076	0.052178	0.086938	0.051443	0.086321	0.051449	0.087791
22:40:00	0.047724	0.080976	0.052171	0.085531	0.051437	0.086171	0.051442	0.087514
22:45:00	0.047764	0.080922	0.052177	0.085401	0.051431	0.086029	0.051436	0.08728
22:50:00	0.047784	0.080884	0.052206	0.085322	0.051425	0.085899	0.05143	0.087056
22:55:00	0.047773	0.080774	0.052136	0.085245	0.051419	0.085791	0.051424	0.086824

23:00:00	0.047831	0.080751	0.052211	0.085141	0.051414	0.085665	0.051419	0.086635
23:05:00	0.047785	0.080678	0.052225	0.085093	0.051408	0.085548	0.051414	0.086464
23:10:00	0.047788	0.080656	0.052106	0.08496	0.051404	0.085447	0.051408	0.086316
23:15:00	0.047864	0.080615	0.052256	0.08494	0.051399	0.085304	0.051404	0.086148
23:20:00	0.047886	0.080588	0.052346	0.084956	0.051394	0.085205	0.051399	0.086026
23:25:00	0.047943	0.08052	0.052331	0.084872	0.05139	0.085108	0.051395	0.085901
23:30:00	0.047879	0.080451	0.052156	0.084851	0.051386	0.085025	0.05139	0.085769
23:35:00	0.047928	0.080595	0.052164	0.084721	0.051382	0.084955	0.051386	0.085645
23:40:00	0.047893	0.080493	0.052263	0.084768	0.051378	0.084862	0.051382	0.08552
23:45:00	0.047874	0.080333	0.052168	0.084654	0.051374	0.084784	0.051379	0.085438
23:50:00	0.047983	0.080296	0.052305	0.084583	0.051371	0.084719	0.051375	0.085301
23:55:00	0.047948	0.080447	0.052164	0.08461	0.051367	0.084639	0.051371	0.085206
0:00:00	0.047922	0.080383	0.052156	0.084607	0.051364	0.08456	0.051368	0.085117


All hydrographs - 600mm diameter culvert
1.2
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Base ED 10-year
Base ED 100-year
Base MPD 10-year
Base MPD 100-year
Flood Storage ED 10-year
Flood Storage ED 100-year
Flood Storage MPD 10-year
Flood Storage MPD 100-year

Time	Base ED 100-year	Base ED 100-year Volume	Cum Base ED 100-year Volume	Flood Storage ED 100-year	Flood Storage ED 100-year volume	Cum Flood Storage ED 100-year
0:00:00	0	0	0	0	0	0
0:05:00	0	0	0	0	0	0
0:10:00	0	0	0	0	0	0
0:15:00	0	0	0	0.000014	0.0042	0.0042
0:20:00	0	0	0	0.000429	0.1287	0.1329
0:25:00	0	0	0	0.0019	0.57	0.7029
0:30:00	0	0	0	0.004259	1.2777	1.9806
0:35:00	0.000022	0.0066	0.0066	0.006778	2.0334	4.014
0:40:00	0.000422	0.1266	0.1332	0.00909	2.727	6.741
0:45:00	0.000601	0.1803	0.3135	0.011159	3.3477	10.0887
0:50:00	0.001482	0.4446	0.7581	0.01302	3.906	13.9947
0:55:00	0.00199	0.597	1.3551	0.014703	4.4109	18.4056
1:00:00	0.002241	0.6723	2.0274	0.01623	4.869	23.2746
1:05:00	0.002494	0.7482	2.7756	0.017622	5.2866	28.5612
1:10:00	0.002699	0.8097	3.5853	0.018895	5.6685	34.2297
1:15:00	0.002868	0.8604	4.4457	0.020058	6.0174	40.2471
1:20:00	0.003063	0.9189	5.3646	0.021132	6.3396	46.5867
1:25:00	0.003195	0.9585	6.3231	0.022122	6.6366	53.2233
1:30:00	0.003345	1.0035	7.3266	0.023037	6.9111	60.1344
1:35:00	0.003497	1.0491	8.3757	0.023884	7.1652	67.2996
1:40:00	0.00363	1.089	9.4647	0.02467	7.401	74.7006
1:45:00	0.004387	1.3161	10.7808	0.025401	7.6203	82.3209
1:50:00	0.004996	1.4988	12.2796	0.026082	7.8246	90.1455
1:55:00	0.005256	1.5768	13.8564	0.026716	8.0148	98.1603
2:00:00	0.005418	1.6254	15.4818	0.02731	8.193	106.3533
2:05:00	0.005518	1.6554	17.1372	0.027865	8.3595	114.7128
2:10:00	0.005622	1.6866	18.8238	0.028385	8.5155	123.2283
2:15:00	0.005726	1.7178	20.5416	0.028874	8.6622	131.8905
2:20:00	0.005824	1.7472	22.2888	0.029333	8.7999	140.6904
2:25:00	0.006006	1.8018	24.0906	0.029765	8.9295	149.6199
2:30:00	0.006113	1.8339	25.9245	0.030188	9.0564	158.6763
2:35:00	0.006174	1.8522	27.7767	0.030639	9.1917	167.868
2:40:00	0.006285	1.8855	29.6622	0.031105	9.3315	177.1995
2:45:00	0.006354	1.9062	31.5684	0.031562	9.4686	186.6681
2:50:00	0.006453	1.9359	33.5043	0.032003	9.6009	196.269
2:55:00	0.006502	1.9506	35.4549	0.032427	9.7281	205.9971
3:00:00	0.006675	2.0025	37.4574	0.032834	9.8502	215.8473
3:05:00	0.006663	1.9989	39.4563	0.033226	9.9678	225.8151
3:10:00	0.006817	2.0451	41.5014	0.033603	10.0809	235.896
3:15:00	0.006855	2.0565	43.5579	0.033967	10.1901	246.0861
3:20:00	0.007024	2.1072	45.6651	0.034317	10.2951	256.3812
3:25:00	0.007216	2.1648	47.8299	0.034656	10.3968	266.778
3:30:00	0.007413	2.2239	50.0538	0.034983	10.4949	277.2729
3:35:00	0.009171	2.7513	52.8051	0.0353	10.59	287.8629
3:40:00	0.010421	3.1263	55.9314	0.035607	10.6821	298.545
3:45:00	0.011422	3.4266	59.358	0.035904	10.7712	309.3162
3:50:00	0.012221	3.6663	63.0243	0.036192	10.8576	320.1738
3:55:00	0.012793	3.8379	66.8622	0.036472	10.9416	331.1154
4:00:00	0.013406	4.0218	70.884	0.036743	11.0229	342.1383
4:05:00	0.013691	4.1073	74.9913	0.037007	11.1021	353.2404
4:10:00	0.013946	4.1838	79.1751	0.037264	11.1792	364.4196
4:15:00	0.014204	4.2612	83.4363	0.037514	11.2542	375.6738
4:20:00	0.014491	4.3473	87.7836	0.037757	11.3271	387.0009
4:25:00	0.014478	4.3434	92.127	0.037994	11.3982	398.3991
4:30:00	0.014665	4.3995	96.5265	0.038225	11.4675	409.8666
4:35:00	0.014814	4.4442	100.9707	0.038451	11.5353	421.4019
4:40:00	0.014909	4.4727	105.4434	0.038671	11.6013	433.0032
4:45:00	0.014977	4.4931	109.9365	0.038887	11.6661	444.6693
4:50:00	0.015112	4.5336	114.4701	0.039097	11.7291	456.3984
4:55:00	0.015028	4.5084	118.9785	0.039302	11.7906	468.189
5:00:00	0.015176	4.5528	123.5313	0.039504	11.8512	480.0402
5:05:00	0.015346	4.6038	128.1351	0.0397	11.91	491.9502
5:10:00	0.015363	4.6089	132.744	0.039893	11.9679	503.9181
5:15:00	0.015428	4.6284	137.3724	0.040082	12.0246	515.9427
5:20:00	0.015529	4.6587	142.0311	0.040267	12.0801	528.0228
5:25:00	0.015743	4.7229	146.754	0.040449	12.1347	540.1575

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5:40:00	0.015935	4.7805	160.9941	0.040973	12.2919	576.8778
5:45:00	0.015937	4.7811	165.7752	0.041141	12.3423	589.2201
5:50:00	0.016138	4.8414	170.6166	0.041306	12.3918	601.6119
5:55:00	0.016155	4.8465	175.4631	0.041469	12.4407	614.0526
6:00:00	0.016154	4.8462	180.3093	0.041629	12.4887	626.5413
6:05:00	0.01637	4.911	185.2203	0.045249	13.5747	640.116
6:10:00	0.019993	5.9979	191.2182	0.071321	21.3963	661.5123
6:15:00	0.026145	7.8435	199.0617	0.092226	27.6678	689.1801
6:20:00	0.031306	9.3918	208.4535	0.100354	30.1062	719.2863
6:25:00	0.035206	10.5618	219.0153	0.103913	31.1739	750.4602
6:30:00	0.037859	11.3577	230.373	0.105537	31.6611	782.1213
6:35:00	0.039631	11.8893	242.2623	0.106546	31.9638	814.0851
6:40:00	0.040927	12.2781	254.5404	0.107334	32.2002	846.2853
6:45:00	0.041986	12.5958	267.1362	0.108075	32.4225	878.7078
6:50:00	0.042861	12.8583	279.9945	0.108787	32.6361	911.3439
6:55:00	0.043439	13.0317	293.0262	0.109478	32.8434	944.1873
7:00:00	0.043949	13.1847	306.2109	0.11015	33.045	977.2323
7:05:00	0.0444	13.32	319.5309	0.110804	33.2412	1010.474
7:10:00	0.044759	13.4277	332.9586	0.11144	33.432	1043.906
7:15:00	0.045094	13.5282	346.4868	0.112061	33.6183	1077.524
7:20:00	0.045392	13.6176	360.1044	0.112666	33.7998	1111.324
7:25:00	0.045672	13.7016	373.806	0.113257	33.9771	1145.301
7:30:00	0.046037	13.8111	387.6171	0.113833	34.1499	1179.451
7:35:00	0.046328	13.8984	401.5155	0.114397	34.3191	1213.77
7:40:00	0.046309	13.8927	415.4082	0.114948	34.4844	1248.254
7:45:00	0.046648	13.9944	429.4026	0.115487	34.6461	1282.9
7:50:00	0.046958	14.0874	443.49	0.116014	34.8042	1317.704
7:55:00	0.047239	14.1717	457.6617	0.116531	34.9593	1352.664
8:00:00	0.047651	14.2953	471.957	0.117037	35.1111	1387.775
8:05:00	0.048175	14.4525	486.4095	0.117533	35.2599	1423.035
8:10:00	0.04834	14.502	500.9115	0.118019	35.4057	1458.44
8:15:00	0.048666	14.5998	515.5113	0.118496	35.5488	1493.989
8:20:00	0.049758	14.9274	530.4387	0.118964	35.6892	1529.678
8:25:00	0.05546	16.638	547.0767	0.119423	35.8269	1565.505
8:30:00	0.060502	18.1506	565.2273	0.119874	35.9622	1601.468
8:35:00	0.068152	20.4456	585.6729	0.120317	36.0951	1637.563
8:40:00	0.075267	22.5801	608.253	0.120751	36.2253	1673.788
8:45:00	0.080646	24.1938	632.4468	0.121179	36.3537	1710.142
8:50:00	0.08411	25.233	657.6798	0.121599	36.4797	1746.621
8:55:00	0.086262	25.8786	683.5584	0.122012	36.6036	1783.225
9:00:00	0.087876	26.3628	709.9212	0.122418	36.7254	1819.95
9:05:00	0.089252	26.7756	736.6968	0.125998	37.7994	1857.75
9:10:00	0.094301	28.2903	764.9871	0.147092	44.1276	1901.877
9:15:00	0.100055	30.0165	795.0036	0.162361	48.7083	1950.586
9:20:00	0.105081	31.5243	826.5279	0.168472	50.5416	2001.127
9:25:00	0.109164	32.7492	859.2771	0.171194	51.3582	2052.485
9:30:00	0.112915	33.8745	893.1516	0.172486	51.7458	2104.231
9:35:00	0.116402	34.9206	928.0722	0.173327	51.9981	2156.229
9:40:00	0.120392	36.1176	964.1898	0.174009	52.2027	2208.432
9:45:00	0.124387	37.3161	1001.5059	0.174662	52.3986	2260.831
9:50:00	0.129309	38.7927	1040.2986	0.175296	52.5888	2313.419
9:55:00	0.131547	39.4641	1079.7627	0.175918	52.7754	2366.195
10:00:00	0.133212	39.9636	1119.7263	0.176527	52.9581	2419.153
10:05:00	0.135859	40.7577	1160.484	0.184496	55.3488	2474.502
10:10:00	0.145005	43.5015	1203.9855	0.231256	69.3768	2543.879
10:15:00	0.160165	48.0495	1252.035	0.263323	78.9969	2622.875
10:20:00	0.171278	51.3834	1303.4184	0.276084	82.8252	2705.701
10:25:00	0.18131	54.393	1357.8114	0.281639	84.4917	2790.192
10:30:00	0.191749	57.5247	1415.3361	0.284039	85.2117	2875.404
10:35:00	0.203008	60.9024	1476.2385	0.285566	85.6698	2961.074
10:40:00	0.213058	63.9174	1540.1559	0.286874	86.0622	3047.136
10:45:00	0.222288	66.6864	1606.8423	0.288054	86.4162	3133.552
10:50:00	0.228376	68.5128	1675.3551	0.289213	86.7639	3220.316
10:55:00	0.232531	69.7593	1745.1144	0.290332	87.0996	3307.416
11:00:00	0.23579	70.737	1815.8514	0.291406	87.4218	3394.838
11:05:00	0.23983	71.949	1887.8004	0.306811	92.0433	3486.881
11:10:00	0.259457	77.8371	1965.6375	0.394116	118.2348	3605.116
11:15:00	0.28775	86.325	2051.9625	0.45345	136.035	3741.151

11:20:00	0.313632	94.0896	2146.0521	0.477823	143.3469	3884.498
11:25:00	0.338375	101.5125	2247.5646	0.488693	146.6079	4031.105
11:30:00	0.367721	110.3163	2357.8809	0.493614	148.0842	4179.19
11:35:00	0.396418	118.9254	2476.8063	0.52353	157.059	4336.249
11:40:00	0.454806	136.4418	2613.2481	0.652552	195.7656	4532.014
11:45:00	0.535599	160.6797	2773.9278	0.797657	239.2971	4771.311
11:50:00	0.623526	187.0578	2960.9856	0.899091	269.7273	5041.039
11:55:00	0.722204	216.6612	3177.6468	0.935438	280.6314	5321.67
12:00:00	0.903058	270.9174	3448.5642	0.93738	281.214	5602.884
12:05:00	0.918284	275.4852	3724.0494	0.94669	284.007	5886.891
12:10:00	0.958375	287.5125	4011.5619	0.965273	289.5819	6176.473
12:15:00	1.033826	310.1478	4321.7097	0.970152	291.0456	6467.519
12:20:00	1.064079	319.2237	4640.9334	0.961228	288.3684	6755.887
12:25:00	1.077582	323.2746	4964.208	0.955894	286.7682	7042.655
12:30:00	1.080868	324.2604	5288.4684	0.939202	281.7606	7324.416
12:35:00	1.077729	323.3187	5611.7871	0.919391	275.8173	7600.233
12:40:00	1.071343	321.4029	5933.19	0.901499	270.4497	7870.683
12:45:00	1.061962	318.5886	6251.7786	0.887601	266.2803	8136.963
12:50:00	1.050309	315.0927	6566.8713	0.877579	263.2737	8400.237
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13:05:00	1.013361	304.0083	7489.6887	0.847132	254.1396	9171.65
13:10:00	1.003991	301.1973	7790.886	0.835988	250.7964	9422.447
13:15:00	0.994374	298.3122	8089.1982	0.824143	247.2429	9669.689
13:20:00	0.982625	294.7875	8383.9857	0.810657	243.1971	9912.887
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13:40:00	0.918494	275.5482	9517.188	0.747481	224.2443	10839.08
13:45:00	0.899957	269.9871	9787.1751	0.729837	218.9511	11058.03
13:50:00	0.879778	263.9334	10051.1085	0.707613	212.2839	11270.32
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14:15:00	0.718856	215.6568	11231.2968	0.571255	171.3765	12211.25
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14:25:00	0.531661	159.4983	11598.8145	0.519421	155.8263	12530.51
14:30:00	0.324114	97.2342	11696.0487	0.495077	148.5231	12679.04
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14:45:00	0.27436	82.308	11949.2163	0.430875	129.2625	13084.78
14:50:00	0.272189	81.6567	12030.873	0.413399	124.0197	13208.8
14:55:00	0.27106	81.318	12112.191	0.39704	119.112	13327.91
15:00:00	0.270914	81.2742	12193.4652	0.381647	114.4941	13442.4
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15:10:00	0.259189	77.7567	12352.1835	0.339085	101.7255	13653.77
15:15:00	0.241728	72.5184	12424.7019	0.313948	94.1844	13747.96
15:20:00	0.226284	67.8852	12492.5871	0.293608	88.0824	13836.04
15:25:00	0.212668	63.8004	12556.3875	0.275489	82.6467	13918.69
15:30:00	0.19808	59.424	12615.8115	0.260157	78.0471	13996.73
15:35:00	0.185642	55.6926	12671.5041	0.246451	73.9353	14070.67
15:40:00	0.176527	52.9581	12724.4622	0.234273	70.2819	14140.95
15:45:00	0.170553	51.1659	12775.6281	0.223487	67.0461	14208
15:50:00	0.166567	49.9701	12825.5982	0.213895	64.1685	14272.16
15:55:00	0.163524	49.0572	12874.6554	0.205593	61.6779	14333.84
16:00:00	0.162664	48.7992	12923.4546	0.198962	59.6886	14393.53
16:05:00	0.161701	48.5103	12971.9649	0.192841	57.8523	14451.38
16:10:00	0.161077	48.3231	13020.288	0.188339	56.5017	14507.89
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16:25:00	0.16186	48.558	13165.4271	0.181471	54.4413	14672.92
16:30:00	0.16094	48.282	13213.7091	0.180799	54.2397	14727.15
16:35:00	0.161593	48.4779	13262.187	0.180355	54.1065	14781.26
16:40:00	0.161997	48.5991	13310.7861	0.180341	54.1023	14835.36
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16:50:00	0.16215	48.645	13408.0563	0.181975	54.5925	14944.23
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17:10:00	0.162401	48.7203	13603.0242	0.189542	56.8626	15167.9
17:15:00	0.162882	48.8646	13651.8888	0.191067	57.3201	15225.22
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18:20:00	0.133649	40.0947	14271.3615	0.177471	53.2413	16004.38
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18:50:00	0.09147	27.441	14463.1341	0.165372	49.6116	16305.41
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19:00:00	0.08606	25.818	14515.4799	0.165219	49.5657	16404.67
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20:00:00	0.081128	24.3384	14809.5399	0.101163	30.3489	16882.27
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21:40:00	0.087469	26.2407	15305.2755	0.088876	26.6628	17442.24
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22:45:00	0.080922	24.2766	15628.9008	0.086029	25.8087	17782.31
22:50:00	0.080884	24.2652	15653.166	0.085899	25.7697	17808.08
22:55:00	0.080774	24.2322	15677.3982	0.085791	25.7373	17833.81

23:00:00	0.080751	24.2253	15701.6235	0.085665	25.6995	17859.51
23:05:00	0.080678	24.2034	15725.8269	0.085548	25.6644	17885.18
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23:30:00	0.080451	24.1353	15846.6759	0.085025	25.5075	18013
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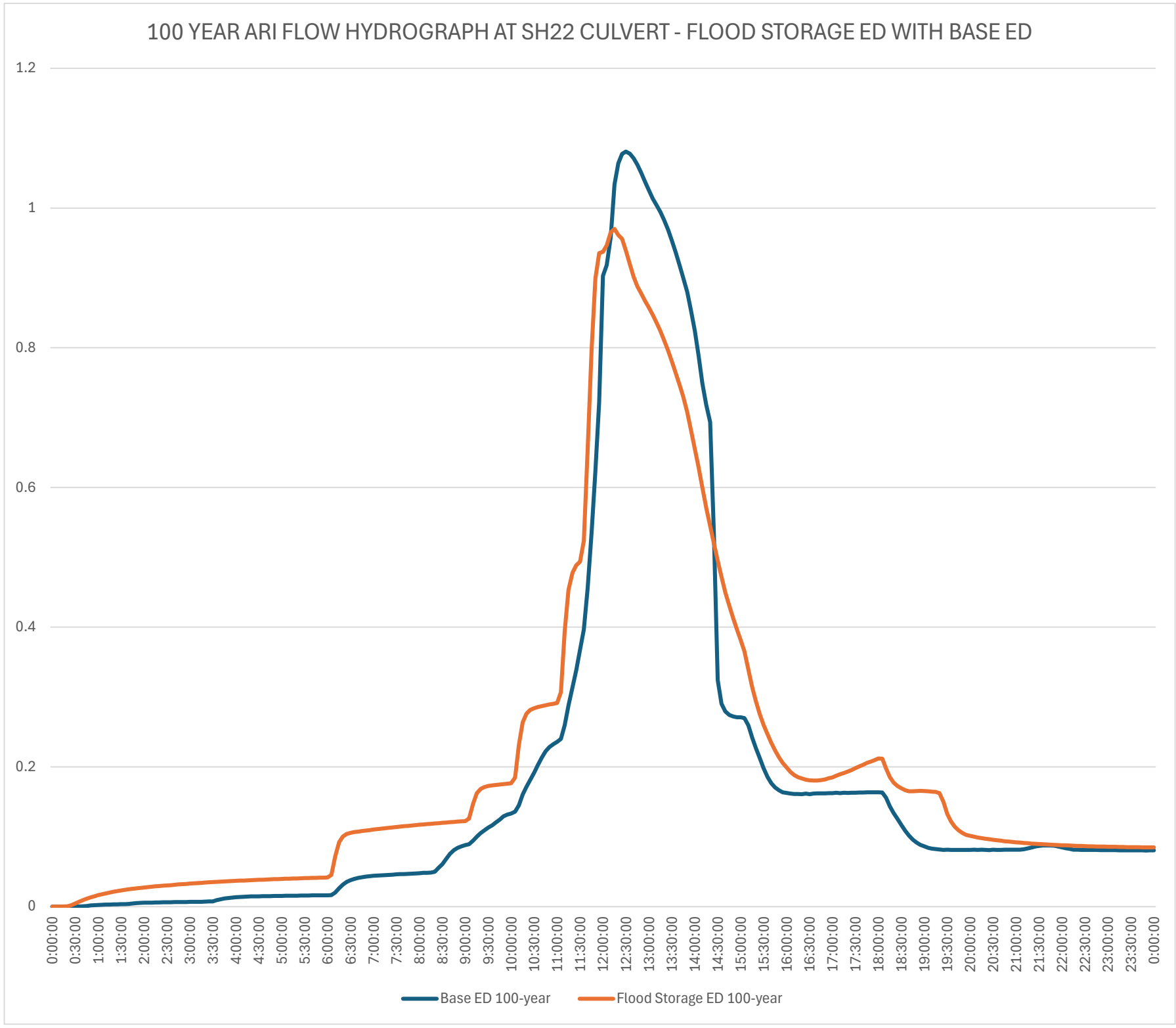
		15991.44			18165.5598	14%


100 YEAR ARI FLOW HYDROGRAPH AT SH22 CULVERT - FLOOD STORAGE ED WITH BASE ED
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Base ED 100-year
Flood Storage ED 100-year