

BRYMER FARMS LIMITED

STORMWATER MANAGEMENT PLAN

PROJECT INFORMATION

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EXECUTIVE SUMMARY

1. Purpose and Context

This Stormwater Management Plan (SMP) supports the resource consent application for the Brymer Farms development — an approximately 81-hectare greenfield site in northern Temple View, Waikato District, delivering approximately 1,048 residential units and two mixed-use commercial hubs. The SMP has been prepared in accordance with Waikato Regional Council (WRC) guidelines, the Regional Infrastructure Technical Specifications (RITS V2, 2025) and the Waikato Regional Council Land Drainage Management Plan and accompanies the Substantive Application under the Fast-Track Approvals Act 2024. The site sits within the Ohote Basin catchment, forming part of the WRC-administered land drainage scheme. It is bisected by low-lying terrain underlain by Holocene peat deposits, flanked by rolling hills to the north and south. A network of closely spaced open farm drains runs east to west through the centre of the site, ultimately discharging via the Ohote Stream to the Waipā River. These ground conditions particularly the peat and the site's position immediately upstream of a known flood-prone basin at Laxon Road are the defining constraints that have shaped the stormwater strategy.

2. Design Philosophy and Statutory Framework

The SMP adopts an integrated treatment-train approach that addresses stormwater quality, quantity, flood management and hydraulic connectivity across the development. The design is outcome-focused and incorporates Water Sensitive Urban Design (WSUD) principles. Key statutory drivers include the Waikato Regional Policy Statement, the Waikato Regional Plan, the National Environmental Standards for Freshwater, RITS, and the WRC Stormwater Management Guidelines (TR20-07).

The core design targets are: retention of the pre-development initial abstraction depth (3.2 mm) via on-lot soakage; water quality treatment through a treatment train achieving 75% TSS removal; extended detention of the Water Quality Volume ($1.2 \times \text{WQV}$ over 24 hours); attenuation of the 2-year and 10-year ARI events to pre-development discharge rates and attenuation of the 100-year ARI climate change event to no more than 80% of pre-development discharge. Climate change allowances use NIWA downscaled end-century SSP5-8.5 (RCP 8.5) projections.

3. The Treatment Train

Stage 1 — On-Lot Retention

Each residential lot is provided with a DN900 $\times$ 2.7 m deep soakhole (or retention tank where soakage is not viable), retaining the 3.2 mm initial abstraction volume. Across approximately 832 residential lots, this provides roughly 1,509 m³ of distributed retention. The soakholes serve a dual function: retaining the first flush of runoff and providing groundwater recharge to maintain peat moisture content, mitigating the risk of peat shrinkage and settlement.

Stage 2 — Primary Conveyance

Runoff exceeding the on-lot retention capacity is conveyed via a piped stormwater network sized for the 10-year ARI climate change event. Flows beyond the piped system capacity are conveyed as overland flow within road corridors, designed to safely pass the 100-year ARI climate change event with maximum depths at or below 130 mm and depth $\times$ velocity products well within Austroads safety thresholds ($< 0.4 \text{ m}^2/\text{s}$ for pedestrians).

Stage 3 — Treatment and Attenuation

Seven artificial wetlands (Wetlands A1 through F) form the primary treatment and attenuation devices. Each wetland incorporates a forebay (minimum 10% of wetland area per RITS, 15% of WQV per TR20-07) for sediment capture, a permanent pool for water quality treatment, an extended detention zone ($1.2 \times \text{WQV}$), and a controlled outlet structure with a low-flow orifice and spillway. A flow splitter upstream of each wetland directs flows up to the 2-year event through the treatment system, while higher flows bypass to a high-flow bypass (HFB) channel. During larger events, the HFB outlet control causes flows to back up and engage the wetland's flood storage volume, providing attenuation for events up to the 100-year ARI.

Stage 4 — Controlled Discharge

Treated and attenuated flows discharge via controlled outlets to modified drains and existing channels, ultimately reaching the Ohote Stream. Backflow prevention devices are incorporated to prevent reverse flow from the receiving drainage network during elevated downstream water levels. The wetlands are designed to fully drain within 48 hours following the design storm event.

4. Catchment-Specific Strategies

Residential Development (Catchments A–F)

The main residential area (Stages 1–12) is served by the full treatment train described above. Catchment A3 is a topographic exception it drains away from Wetland A2 and is instead directed to a treatment swale, with compensatory over-attenuation provided in Wetlands A1 and A2. Catchment F, in the northern portion of the site, is surrounded by existing natural wetlands. Here, several sub-catchments discharge directly to existing wetlands (with at-source treatment) to maintain the existing hydrological regime and baseflows, while Catchments F1 and F5 use a proposed wetland and an Aquafort attenuation system respectively, with discharge limited to 80% of pre-development flows.

Large Lots-Residential (Catchment G)

Stage 1A, comprising approximately nine large rural-residential lots (around 2,500 m² each) at the higher northern point of the site, is serviced by on-lot retention tanks and/or soakholes providing initial abstraction and attenuation. Road runoff is treated via a raingarden and attenuated through a Cirtex Aquafort system before controlled discharge to the existing wetland. The 2-year ARI discharge is aligned with the existing-condition flow to maintain wetland baseflows, while the 100-year discharge is limited to 80% of pre-development levels.

5. Flood Modelling and Downstream Effects

A comprehensive 2D flood model was developed using HEC-RAS, with hydrology generated in HEC-HMS using the SCS Curve Number method. The model extends from the upstream contributing catchments through the development site to the downstream Ohote Basin, Laxon Road floodgate, and Waipā River confluence — capturing the full hydraulic system that influences flood behaviour on site.

The existing-condition modelling confirms that the low-lying area immediately upstream of the Laxon Road crossing functions as a flood storage basin during major events. Flooding in this area is governed by two mechanisms: initial runoff accumulation from local and upstream catchments (peaking at approximately 24 hours), followed by backwater overtopping from the Waipā River via the Laxon Road crossing (peaking at 5–6 days). The Laxon Road floodgate closes when downstream water levels exceed upstream levels, preventing backwater ingress but causing upstream ponding.

Post-development modelling demonstrates that the proposed stormwater measures effectively mitigate flood impacts. Peak flow rates are reduced at all assessed sections under the 100-year

climate change event. The total runoff volume increases by approximately 13,200 m³ under the 10-year event (from 48,900 m³ to 62,310 m³), reflecting increased impervious area; however, peak discharge reduces from 6.54 m³/s to 2.76 m³/s due to attenuation. The resulting downstream water level increase in the Ohote Basin is approximately 10 mm, considered minor to negligible. Flood depths and flow rates downstream of the proposed bridge and within the large lots-residential area are unchanged or improved relative to pre-development conditions.

6. Peat Management and Groundwater Recharge

The low-lying central portion of the site is underlain by peat deposits that are susceptible to shrinkage and settlement if dewatered. The stormwater strategy directly supports the geotechnical peat management approach by maintaining groundwater recharge through distributed on-lot soakage and wetland systems. Wetland base levels and permanent water levels have been set above the peat layer to avoid excavation into peat, minimising disturbance to existing subsurface conditions. Preloading is excluded from proposed wetland footprints. Groundwater and settlement monitoring will be undertaken through construction and post-construction, with results relayed to Council.

7. Infrastructure, Staging, and Financial Sustainability

Key stormwater infrastructure includes seven artificial wetlands with forebays, approximately 1,600 m of high-flow bypass channels and treatment swales, nine culvert crossings (six box, three circular), one 12 m span bridge, approximately 3,880 m of piped primary network, and two Cirtex Aquafort systems. The system operates entirely by gravity with no pump stations or mechanical plant, reducing long-term operational risk. Total concept-level (Class 5) capital cost is estimated at approximately \$8.3 million, with annual depreciation of \$170,000 and maintenance OPEX of \$56,600.

A financial sustainability assessment based on the Waikato District Council 2026/27 urban stormwater targeted rate of \$364.68 per property projects annual rating revenue of approximately \$382,200 against total annual costs of \$226,600, yielding a surplus of approximately \$155,600 per year (revenue-to-cost ratio of ~1.69). The development will be staged, with each stage designed to operate independently while maintaining consistency with the overall SMP. Interim measures (temporary swales, bunds, conveyance routes) will manage stormwater during construction. Public assets will be vested to Council; private assets (on-lot devices) will remain in private ownership with appropriate legal instruments for ongoing maintenance.

8. Conclusion

The Brymer Farms SMP provides a robust, integrated stormwater management framework that addresses the full spectrum of challenges posed by this site: peat soils requiring groundwater recharge, significant upstream catchment inflows, existing flood-prone downstream basins, ecologically sensitive receiving wetlands, and the need to service a large-scale staged urban development. The treatment-train approach achieves compliance with WRC and RITS requirements for both water quality and quantity.

Hydraulic modelling confirms that post-development peak discharges are reduced relative to pre-development conditions across all design events, downstream flood level increases are negligible (~10 mm), and overland flow paths safely convey extreme events within road corridors. The system is financially sustainable, operates entirely by gravity and is structured to be delivered incrementally alongside the staged development programme. Residual matters for detailed design include refinement of wetland bathymetry, confirmation of soakage rates beyond perched layers, finalisation of culvert and bridge designs and ongoing engagement with WRC, HCC, and Ngaati Maahanga. None of these are considered impediments to the feasibility of the stormwater strategy.

1. INTRODUCTION

1.1. OVERVIEW

This Stormwater Management Plan ('SMP') outlines the proposed management of stormwater that supports the resource consent for the Brymer farms development located at 584 Whatawhata Road (SH23), Hamilton.

The SMP outlines the overarching stormwater management principles that will form the basis of stormwater design to support future development of the proposed site. The WRC guidelines, Regional infrastructure technical specification (RITS) and the land drainage plan have been used to inform and align the SMP with established stormwater management principles.

The overall development is illustrated in Figure 1 below. The project spans approximately 81 hectares of land, encompassing areas to south of Bagust Road and north of Whatawhata road, as shown in the image below. The Low-lying areas in the centre extend westward toward the Ohote Stream and eventually to Waipa River.

This report is to be read in conjunction with the engineering drawings and calculations and is to accompany the Substantive Application under the Fast-Track Approvals Act 2024.



Figure 1: Site Locality

2. SITE

2.1. OVERALL DEVELOPMENT AREA

The Brymer Farms Development is a circa 81ha block of land within the Waikato District. The area is located in northern Temple View and west of Grandview Heights.

The site topography is split with low lying terrain through the centre of the site and rolling hills to the north and south, with elevations ranging between 38m and 50m. The site adjoins with the existing residential housing to the east, and the remainder of the site is surrounded by agricultural land. The site has been predominantly utilised for pastoral grazing, with land cover comprising maintained grassland consistent with agricultural use.

A network of closely spaced open drains run through the centre of the site from east to west, that discharge to the central drains, that form part of the Waikato drainage scheme. The central drain flows from east to west through this development.

The overall Development area is divided into two distinct developments summarised below.

Residential Development - Catchment A to F

Large Lots- Residential Development- Catchment G

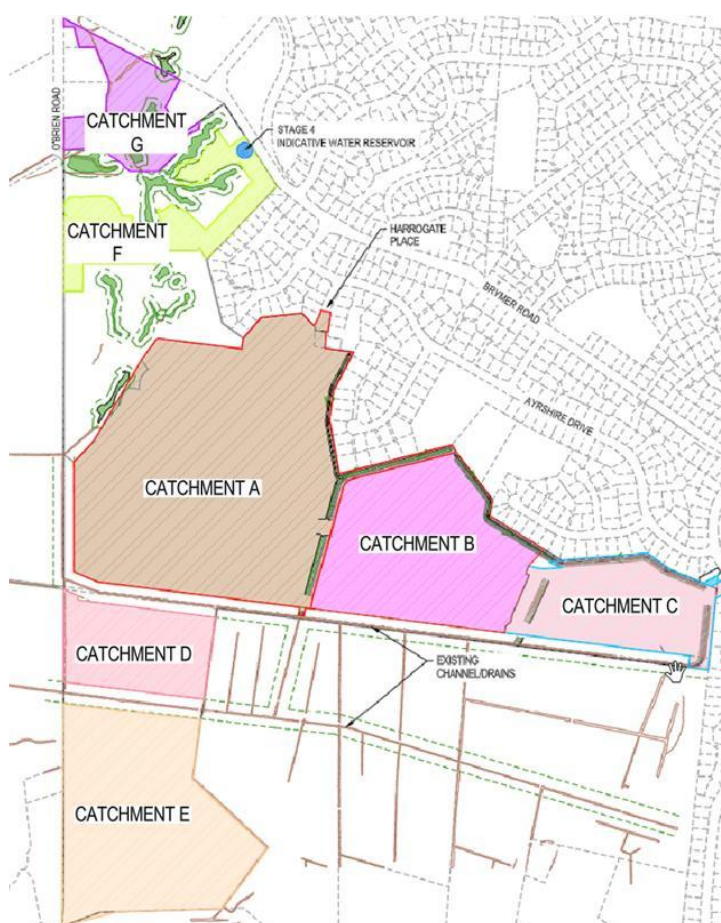


Figure 2: Stages Overview Plan

2.1.1. RESIDENTIAL DEVELOPMENT

The Brymer Farms is a multi-staged residential development, with circa 1100 proposed residential units. The development units will have varying housing typologies with detached, duplexes, terraces, apartment units, along with a supporting mixed-use neighbourhood centres, open spaces, and infrastructure. The Brymer Farms Masterplan is shown in figure 3 below.



Figure 3: Masterplan (provided by Barkers and Associates 2026)

The proposed residential community is underpinned by design principles that seek to create a well-connected, liveable and diverse neighbourhood on Hamilton City's urban fringe. The development is structured around a north-south spine road supported by a network of local roads, cycling connections and pedestrian pathways, providing an accessible and legible transport network. A range of housing typologies and densities, including terraces, duplexes, standalone dwellings and apartments, are proposed to respond to the changing housing market, site opportunities and constraints, and integrate with the adjoining urban footprint. Two mixed-use neighbourhood centres are proposed at the heart of the Brymer Farms development, providing a range of local amenities and services for residents and

the wider community, including potential cafés, local retail and superette facilities, with apartments located above. The scale and location of the commercial component have been designed to complement the proposed residential density, particularly the surrounding apartment typologies. A network of well-distributed open spaces is integrated throughout the development to provide amenity and recreational opportunities, while supporting ecological outcomes through the retention and enhancement of existing wetlands and riparian areas through revegetation.

2.1.2. LARGE LOTS- RESIDENTIAL DEVELOPMENT

Stage 1A comprises both residential development and large lots- residential development. This section outlines the stormwater management strategy for the residential development, while the following section describes the strategy for the large lots- residential development

Sitting at the higher, northern point of the site is a large lots- residential, that comprises approximately 3.6 hectares and provide lots that are around 2500 m² each. This development area has multiple existing wetlands, within and around the catchment and ecology of existing wetland will be protected by managing its base flows.

The development will be appropriately serviced via a robust infrastructure strategy, which includes stormwater ponds, wetlands and treatment devices.

2.2. LEGAL DESCRIPTION

The Development Area comprises the following parcels:

Table 1: Legal Descriptions

Lot Description	Area (m ²)
Allot 365 Pukete PSH	1,444
Part Lot 2 DP 18355	183,753
Lot 1 DPS 87291	579,170
Lot 22 DPS 79526	677
Lot 3 DP 385271	44,890
Lot 44 DPS 59874	622
Lot 9 DPS 67823	887

The areas are currently farmlands/rural areas and falls outside of HCC boundary; it is future designated as medium to high density residential and residential areas. The development masterplan was prepared by Barker and Associates in collaboration with other specialist consultants.

A discharge consent is required to enable the future stormwater discharge from the development, which necessitate the importance of this SMP.

Stormwater is proposed to be discharged via the following methods:

- Peat recharge and initial abstraction retention within the site using stormwater devices such as soak holes, Wetlands etc.
- Modified drains within the site running east to west which discharges into Ohote Stream. The modified drains will also aid in diverting existing flows through proposed site.
- Existing drains or overland flow paths leaving the project site at less than 80% of pre-development flows in 100yr cc event.

2.3. STAGING TIMING, RESPONSIBILITY AND FUNDING

Key stormwater infrastructure elements, including on-lot soakholes or tanks, wetland, high flow bypass systems, forebay and primary conveyance system (pipe or overland), form the stormwater management system proposed. The proposed infrastructure provides both treatment (quality), conveyance and flow control in line with standards and WRC requirements.

The development will be undertaken in stage phases, with each stage designed to operate independently while maintaining consistency with the overall stormwater management strategy outlined in this SMP.

Each stage will incorporate the required/necessary proposed infrastructure to manage its runoff generate within that stage without reliance on future stages (Refer to Infrastructure report section 1.7), while also maintaining continuity of flow from upstream catchment runoff conveyed through the site and existing drains.

Where practicable, key elements of the primary stormwater network, including diversion channels and downstream wetlands, will be constructed early to support both interim and eventual main stormwater management.

Interim stormwater management measures, such as temporary swales, bunds conveyance routes for flows, will be implemented during construction to maintain existing drain and direct flows through and around the site during earthworks. These measures will be progressively replaced by permanent infrastructure as development proceeds.

2.4. COSTS AND VESTING ASSETS

The construction of the proposed stormwater management devices will be undertaken by the consent holder. The proposed stormwater infrastructure includes a lot of retention soakholes tanks, public piped networks, wetlands, and private property devices.

The public assets will be vested to council at the appropriate time as the development progresses.

Private assets will remain in private ownership where appropriate legal instruments will be set up to ensure ongoing operation and maintenance responsibilities are with the owners.

Discussions will be undertaken with council(s) as to the design of the infrastructure, location, and purpose, with all public infrastructure subject to the relevant Engineering Approval process.

Public stormwater assets, including primary pipe networks, wetland will be vested to council at subject to compliance with and approval process.

Private stormwater infrastructure, such as on lot retentions will remain in private ownership with ongoing operation and maintenance to be made available for eventual property owners.

The design, location and function of all stormwater infrastructure will be confirmed post consultation with council during detailed design stage and subject to engineering approval process.

2.5. OPERATION MAINTENANCE AND MONITORING PLAN

Operation and maintenance plans will be provided for all stormwater management devices that will be vested to Council(s), which will be required as a condition of any approved Fast Track Application. Refer to Operation and Maintenance plan attached in Appendix B.

2.6. OPERATION EXPENDITURE (OPEX) AND CAPITAL COST ESTIMATE

The Estimates in this section are Class 5 (concept-level). The Wetland figures use Christchurch City Council's published 2020/21 stormwater device cost-curve formulas ([Christchurch City Council Cost/Benefit Analysis for CSNDC Schedule 4D, July 2021](#)) the most detailed NZ-published dataset

available applied to Brymer's actual wetland areas and escalated ~30% to 2026 Waikato costs. For device categories not covered by a published NZ cost curve (culverts, piped network, HFB/swale, Aquafort), typical NZ unit rates have been applied to the estimated quantities, since detailed lengths/volumes are not yet finalised from a detailed design. All figures must be verified after detailed design stage.

Table 2: Estimated capital cost, depreciation and Opex

Device	Capital cost estimate	Useful life	Annual depreciation	Annual Opex estimate
Artificial wetlands (7 no., incl. forebays)	\$3,300,000	35 yrs	\$94,400	\$33,100
HFB channels / treatment swale (~1,600m)- \$350/m	\$660,000	25 yrs	\$22,400	\$6,095
Culverts (6 box + 3 circular)	\$2,190,000	80 yrs	\$27,375	\$9,000
Piped primary network (3,879.64m) -\$550/m	\$2,133,802	90 yrs	\$23,709	\$3,298
Cirtex Aquafort (2 systems)	\$110,000	50 yrs	\$2,200	\$5,000
Total	\$8,294,000		\$170,084 / yr	\$56,550 / yr

Total annual cost to Council (depreciation + Opex): approximately \$226,584 /year.

The network operates entirely by gravity with no pump stations or mechanical plant. This removes power, mechanical/electrical maintenance and reduces failure modes/asset risk relative to a mechanically conveyed scheme. The two Cirtex Aquafort systems require periodic jetting/desilting but operate under gravity.

2.6.1. STORMWATER FINANCIAL SUSTAINABILITY ASSESSMENT

WDC tests financial sustainability by comparing projected targeted rating revenue against annual maintenance Opex plus depreciation over a 30-to-50-year lifecycle window. The development is considered financially sustainable where projected revenue is sufficient to cover annual Opex and depreciation.

The projected stormwater revenue has been based on the Waikato District Council 2026/27 urban stormwater fixed targeted rate of \$364.68 per property per year. Based on the proposed development comprising 1,048 lots, the estimated annual stormwater rating revenue is therefore approximately \$382,185 per year. This revenue has been used as the funding allowance against the ongoing stormwater operational expenditure and depreciation costs to assess the long-term financial sustainability of the vested stormwater assets.

Table 3: Financial sustainability calculation

Item	Basis	Annual value
Total depreciation (all SW devices)	Table 2	\$170,084
Total maintenance Opex (all SW devices)	Table 2	\$56,550
Total annual cost to Council	Sum of above	\$226,584
Rating revenue	1,048 lots x \$364.68 WDC urban SW targeted rate (2026/27)	\$382,185
Net position	Revenue - Cost	+\$155,601 surplus

The projected rating revenue of approximately \$382,200/year exceeds the estimated annual depreciation plus maintenance Opex of approximately \$226,584/year, giving a surplus of approximately \$155,601 /year (revenue-to-cost ratio of ~1.69x). The result remains concept-level and should be confirmed against the final detailed design asset schedule.

2.7. EROSION MANAGEMENT PLAN

Stormwater discharges will be managed to minimise increases in flow velocities and erosion potential within downstream receiving waterways. Appropriate erosion and scour protection measures have been incorporated into the stormwater management design to minimise potential adverse effects on downstream channels and receiving environments and to ensure compliance with the applicable erosion protection requirements. Details of the proposed erosion protection measures are provided in the Erosion Protection Plan, included in Appendix C.

3. STATUTORY CONTEXT

Future stormwater discharge is required to comply with the Regional Policy Statement and the Regional Resource Management Plan both administered by Waikato Regional Council. The relevant policy criteria are summarised below:

3.1.1. WAIKATO REGIONAL POLICY STATEMENT (RPS)

The Waikato Regional Policy Statement (Te Tauākī Kaupapa here ā-Rohe), or RPS, is a mandatory document that provides an overview of the resource management issues in the Waikato region, and the ways in which integrated management of the region's natural and physical resources will be achieved.

The RPS identifies the significant resource management issues of the region and sets out the objectives, policies, and methods to address these issues. The RPS informs the regional and district plans and consideration of resource consents.

Central to the outcomes sought within the RPS is the protection and enhancement of freshwater ecosystems. The following lists key Waikato RPS high-level objectives relevant to this SMP and the future management of stormwater within the Development Area.

Relevant objectives include:

- 1. Integrated management of natural and physical resources;*
- 2. Restoration and protection of the health and wellbeing of the Waikato River;*
- 3. Avoiding the potential adverse effects of climate change;*
- 4. The relationship of tangata whenua with the environment is recognized and provided for;*
- 5. Sustainable and efficient use of resources;*
- 6. Development of the built environment in an integrated, sustainable and planned manner;*
- 7. Maintain or enhance the mauri and identified values of freshwater bodies;*
- 8. Maintain or enhance riparian areas and wetlands;*
- 9. Historic or cultural heritage sites, areas or landscapes are protected or maintained;*
- 10. Healthy, functioning ecosystems and indigenous biodiversity;*
- 11. Maintenance and enhancement of amenity;*

12. Protection of the natural character of wetlands and rivers and their margins;

13. Maintenance and enhancement of public access along rivers; and

14. The effects of natural hazards are managed.

The Waikato RPS states territorial authorities should consider promoting best practice stormwater management for urban areas and preparing stormwater catchment plans for greenfield urban developments.

This SMP supports achievement of the above Waikato RPS objectives. It integrates land-use and three-water planning within the Development Area. The SMP identifies the SW infrastructure necessary to accommodate urban growth, whilst giving effect to the relevant development principles, to ensure the freshwater ecosystem is protected and improved through urbanization.

3.1.2. WAIKATO REGIONAL PLAN

The Waikato Regional Plan is the principal policy tool that enables Waikato Regional Council to carry out its functions to achieve the sustainable management of resources within the Region. With respect to this SMP, the following modules of the Waikato Regional Plan are relevant: matters of significance to Maori, water, river and lake beds, land and soil, and air.

Each module provides an overview of the environmental problems the Regional Council seeks to manage, the objectives to be achieved, policies (actions to be taken) to achieve them, and methods and rules to implement the objectives and policies. Each module also describes the environmental results anticipated and how they will be monitored. Resource consent will be required for any activity that will not comply with permitted activity standards listed under the plan.

Future development will need to be supported by resource consents from Waikato Regional Council under the Waikato Regional Plan. Such activities which would trigger consent are listed below:

- 1. Works in a stream bed – such as for culvert, bridge, pipeline or stormwater pipeline outfall construction or any stream diversion; and*
- 2. Vegetation clearance and earthworks – including for management of sediment-laden runoff and dust;*
- 3. Diversion and discharge of stormwater into water or onto or into land, including management of contaminants.*

3.1.3. NATIONAL ENVIRONMENTAL STANDARDS FOR FRESHWATER

The National Policy Statement for Freshwater 2020 provides local authorities with updated directions on how they should manage freshwater under the Resource Management Act 1991. The Freshwater NES set requirements for carrying out certain activities that pose risks to freshwater and freshwater ecosystems. Anyone carrying out these activities will need to comply with the standards.

The standards are designed to:

- protect existing inland and coastal wetlands.*
- protect urban and rural streams from in-filling.*
- ensure connectivity of fish habitat (fish passage).*
- set minimum requirements for feedlots and other stockholding areas.*
- improve poor practice intensive winter grazing of forage crops.*

- restrict further agricultural intensification until the end of 2024.
- limit the discharge of synthetic nitrogen fertilizer to land and require reporting of fertilizer use.

Whilst most of the above standards set out to restrict rural use, specific emphasis has been placed on the protection of all natural wetlands. Earthworks or land disturbance activities within 10m of natural wetlands are prohibited, and consent is also required for the change in natural drainage patterns within 100m of any natural wetland. The mapping of all existing wetlands is currently underway by Fresh Water Solutions, and any identified areas will need to be avoided and suitably protected by the future development and associated management of stormwater.

3.1.4. WAIKATO REGIONAL COUNCIL STORMWATER GUIDELINES

The preparation of this SMP has been developed in accordance with Waikato regional council stormwater guidelines, as the future stormwater management within Brymer farms development will need to remain consistent with any approved WRC guidelines. The primary outcomes envisaged within WRC guidelines are summarized below:

1. Water quality in a treatment train (two or more treatment devices in series).
2. The final treatment device is likely to be artificial wetlands which will also carry out attenuation functions.
3. 24 hour extended detention (ED) to reduce erosion potential and manage stream base flows for the Water Quality Volume (WQV) runoff event.
4. 2 year and 10-year peak flow attenuation to reduce erosion potential resulting from increased runoff from development.
5. Extended detention provided in 10yr 24hr event.
6. 100-year ARI peak flow attenuation (discharge limited to 80% pre-development flow) to reduce erosion potential resulting from increased runoff from development
7. Retention of On-lot predevelopment initial abstraction depth is required as per WRC stormwater Management Guidelines.

Utilization of soakage for stormwater disposal where practical to replenish groundwater and minimize runoff volume.

3.1.5. REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATION (RITS V2 2025)

The Regional Infrastructure Technical Specification (RITS) (Waikato Local Authority Shared Services, 2025) set standards for design and construction of earthworks, transportation, water, wastewater and stormwater infrastructure, landscapes, and accepted materials. Resource consents for subdivisions and developments in the Catchment will require developers to comply with RITS when constructing such infrastructure.

The RITS require stormwater to be managed according to a hierarchy, which is based on sustainability and efficiency principles. Preference is given to disposing of stormwater by a method that is higher in the following hierarchy – “a” is higher than “b”, which is higher than “c”, which is higher than “d”:

- a) Retention of rainwater/stormwater for reuse on site.
- b) Soakage techniques.
- c) Treatment and detention and gradual release to a watercourse.
- d) Treatment and detention and gradual release to a piped stormwater system.

Although both the RITS and the Hamilton City District Plan ascribe the term “hierarchy” to this list of measures, neither document provides criteria for determining when adoption of a lower hierarchy measure is justified.

Below specifies Water Quality Standards required to be achieved via use of Treatment Train system as detailed in section 1.7.9.

CRITERIA	DESIGN PARAMETER	WHEN REQUIRED
Water treatment ⁶⁴	quality Refer to: • Clause 4.2.3.1 Stormwater management disposal hierarchy on page 182 • Treatment devices hierarchy (Clause 4.2.16 Soakage devices) for disposal and treatment preferences. Water quality requirements include: • Total suspended solids (TSS) (75% removal of post-development loads taken as measured at the discharge point from site). • Total metals (copper, zinc) to achieve maximum practical removal possible. • Temperature (<25°C). • Nutrients (total nitrogen, total phosphorous and ammoniacal nitrogen) to achieve maximum practical removal rates. • Hydrocarbons to achieve maximum practical removal rates.	Always

Figure 4 – Excerpts from RITS specifies Water Quality Standards.

In addition, stormwater quantity control standards specified in RITS table 48 are to be complied with which includes:

- Extended Detention for WQV (1/3 of 2-year ARI storm) – a 1.2 factor is to be applied to the WQV volume/Storage.
- 2-year ARI storm – Attenuation back to pre-development flow is required
- 10-year ARI storm – Attenuation back to pre-development flow is required

100-year ARI storm – Attenuation back to 80% predevelopment flow is required.

3.1.6. DRAINAGE SCHEME PLAN

The site forms part of the Waikato Regional Council (WRC) land drainage network, which is managed under the Waikato Regional Council Land Drainage Management Plan (2019). The purpose of the regional drainage scheme is to provide and maintain a primary rural drainage network that manages groundwater levels and removes surface ponding from low-lying rural land, enabling productive agricultural use while conveying runoff to the receiving river systems.

The drainage scheme differs from an urban stormwater system in that Waikato Regional Council is responsible for maintaining the primary drainage network, while individual landowners are responsible for collecting and conveying runoff from within their properties to the Council-maintained drains. The scheme therefore provides the downstream drainage outlet rather than managing internal site drainage.

The Land Drainage Management Plan adopts a performance objective of clearing ponded water generated by rainfall events up to the 10-year Annual Exceedance Probability (AEP) event within approximately three days, where gravity drainage and downstream receiving water levels allow. This objective reflects the operational nature of the drainage scheme, recognising that temporary ponding during significant rainfall events is an expected component of the system's function.

Source/Design Driver	Design Criteria / Requirement	Application to Proposed Development	Related Report Sections / Supporting Documents
WRC / RITS – Water Quality Treatment	Stormwater is to be treated prior to discharge to receiving environments. A treatment train approach is adopted where appropriate.	A treatment train comprising forebays, wetlands, and high-flow swale will be used where applicable. Raingardens and swales will also be provided upstream of receiving environments where required. Treatment measures will be selected based on the characteristics of each catchment and receiving environment.	Refer to section 6.6, 6.7 and 6.8
WRC / RITS – Extended Detention	Provide extended detention (1.2 of the WQV) to reduce downstream erosion potential and manage discharge to receiving streams. A 24-hour detention period is adopted where practicable.	Wetlands and attenuation systems will provide extended detention (1.2 of the WQV), with a target detention period of 24 hours.	Refer to table 13 and section 6.6.
WRC/RITS – Peak Flow Control	Post-development peak discharge for the 2-year and 10-year ARI events is to be limited to the applicable pre-development discharge.	Wetlands, attenuation devices and controlled outlets will be designed to limit post-development peak discharge to the applicable pre-development discharge rates.	Refer to section 6.11 of this report and TR20 calcs in Appendix A.
	Post-development peak discharge for the 100-year ARI event is to be limited to 80% of the pre-development discharge, where applicable.	Attenuation storage and controlled outlet structures will be used to limit the 100-year ARI discharge to 80% of the pre-development discharge , where required.	Refer to section 6.11 of this report and TR20 calcs in Appendix A.
WRC – Initial Abstraction	Retain the site-specific pre-development initial abstraction from impervious areas.	Initial runoff will be retained through on-lot soakage systems and/or retention tanks , with additional retention measures provided where required.	Refer to section 6.3.
WRC / RITS – Peat Recharge	Maintain recharge to peat areas and minimise changes to the existing hydrological regime.	Soakage systems and/or retention tanks will be provided within impervious catchments to retain and infiltrate runoff. Proposed wetlands and drainage features will also contribute to maintaining local recharge where appropriate.	Refer to section 6.12, further refer to 6.3 for strategy. Refer to WGA and CMW report attached in appendix of infrastructure report.

WRC – Administered Drainage Areas	Total post-development runoff volume for the 10-year ARI event is not to exceed the pre-development runoff volume.	Assessment of effects will be undertaken to demonstrate that no adverse effects will result.	Refer to section 7.3
	The released runoff volume for the 10-year ARI event is to be discharged over an extended detention period of 72 hours to avoid overloading the receiving drainage network. Where the criterion cannot be achieved, an assessment of effects will be undertaken to demonstrate that no adverse effects will result.	Assessment of effects will be undertaken to demonstrate that no adverse effects will result.	Refer to section 7.4
RITS – Hydraulic Capacity	The stormwater conveyance network is to provide sufficient capacity for the adopted design event.	The proposed piped stormwater network will be sized for up to the 10-year ARI climate change (CC) event , with larger flows managed through designated overland flow paths.	Refer to Maven drawings C400.
RITS – Climate Change	Climate change rainfall allowances are to be incorporated in accordance with RITS Section 4.2.4.4 , based on NIWA downscaled end-century SSP5-8.5 projections.	Climate change rainfall allowances have been incorporated into the hydrological and hydraulic assessment for the 2-year, 10-year and 100-year ARI events .	Refer to climate change excel attached in appendix A
RITS/WRC- Erosion Control	Erosion Protection- Stormwater discharge is to be managed to minimise increases in flow and erosion potential within receiving waterways.	Peak flow attenuation and extended detention will be provided where required, with controlled discharge to receiving wetlands and drainage channels.	Refer to Erosion management plan attached in appendix C
RITS/WRC	Operation and Maintenance		Refer to Operation and maintain report in appendix B.
National environmental standards for fresh water	Maintain the existing hydrological regime of receiving wetlands and avoid adverse changes to wetland inflows.	Catchment boundaries, discharge locations, attenuation and outlet controls have been developed to maintain the required flow contribution to existing wetlands.	Refer to WGA report attached in the appendix of infrastructure report.

4. EXISTING CATCHMENT CONTEXT

4.1. EXISTING CALCULATION PARAMETERS

The design and calculation assumptions used for pre-development are outlined in the table 4 below. These values were established using the available GIS/aerial view, topographical site survey, geotechnical report, and NIWA-HIRDS.

<u>Pre-Development CN</u>	
Pervious	Impervious
74	98
<u>Pre-Development 24hr Rainfall Depth (mm)</u>	
10yr	100 yr
94.8	145
<u>Climate change RCP 8.5 24hr Rainfall Depth (mm)</u>	
10yr CC	100 yr CC
126	195

Table 4: Design Parameters

Rainfall data. Two predevelopment scenarios have been adopted in this stormwater Management Plan, depending on the purpose of the assessment;

1. **Design and sizing of stormwater mitigation devices** (Section 6). Pre-development data used when designing and sizing of proposed devices uses historical rainfall event data without climate change. Refer to table 4 above.
2. **Flood sensitivity Analysis** (Section 7) for assessing impact of the surrounding environment adopts RCP8.5 for Existing scenarios consistent with the proposed scenario. This would allow assessment of impacts using same events to quantify its relative impacts.

4.2. EXISTING OVERALL CATCHMENT

A catchment analysis was undertaken to establish the extent of the Existing catchment within the proposed development areas. TR20/07 and HEC HMS were used for this analysis, with results shown below and further detailed in plans 410 series. Refer to Table 5 below for catchment areas. Approximately 1-2% of existing impervious coverage is likely present within the existing catchment; however, it is assumed in our calculation that there is none. This assumption is conservative.

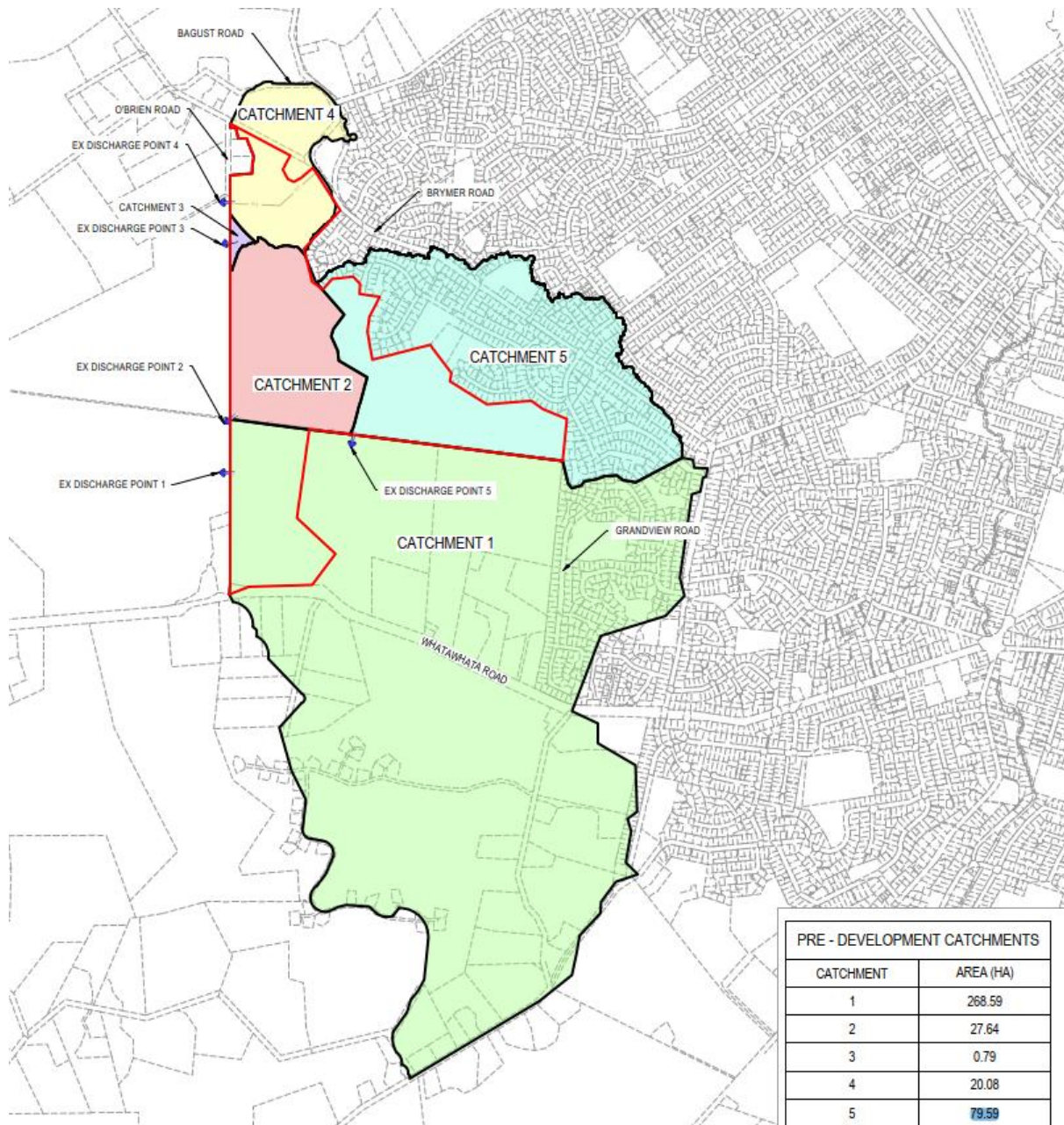


Figure 5: Existing catchments & Flow direction (Refer to Plans 400 Series)

The peak flow rates for both the 10- and 100-year events were calculated using HEC HMS, using the catchment analysis findings in addition to calculation parameters provided under section 3.1 and are provided in the table 5 below. A few inflows from upstream areas were established from this catchment analysis. Either diversion away from development or accommodating it/them within catchment design for post development will be required (Proposal regarding these inflows are provided under Post development Section of this SMP).

		Pre-Development (historical no cc) Flow	
Catchment	Area (Ha)	10-year flow (m ³ /s)	100-year flow (m ³ /s)
1	268.5143	16.982	33.522
2	26.6691	1.603	3.249
3	0.7868	0.047	0.096
4	20.0847	1.207	2.447
5	80.5533	4.842	9.815

Table 5: Overall Existing Catchment Flow table (refer to plan 410)

The above table 5 shows pre-development catchment areas and their respective flowrates (using HEC HMS), prior to development and serve as a baseline for checking overall flowrate pre vs post for the residential. This is linked to the C410 -Maven drawings.

4.3. OHOTE STREAM

Ohote Stream is one of primary receiving environments for stormwater runoff from Brymer farms development that eventually connects to lower reaches of Waipa River. The Ohote Stream catchment comprises two main sub-catchments. The first includes land draining from the Lake Rotokauri catchment, and the second encompasses the area of the Ohote Basin which is upstream of Laxon Road. This upstream catchment extends from the Western Heights area of Hamilton City to Laxon Road and it includes the proposed development site. Within the basin, the drainage network includes culverts, drains, stop banks along the stream and floodgates, which have been installed because of the low-lying landscape and underlying peat soils that make the area prone to flooding.

All stormwater outfalls from the development that discharge into the Ohote stream have been designed to include attenuation and treatment upstream, with flows directed either through artificial Wetlands or existing conveyance features. This discharge strategy ensures that post-development flows into the stream are maintained at or reduced from pre-development conditions, and energy dissipation structures are proposed to minimize erosion risk at outfall locations.

Future assessments of the river's bank stability, riparian condition, and erosion susceptibility near discharge points will be conducted during the detailed design stage to ensure the integration of ecological and hydraulic objectives. Monitoring may also be proposed as a consent condition to assess any long-term impacts on the river system.

4.4. EXISTING CULVERT- LAXON ROAD

Existing culverts, drains, and stop banks are located within and around the development sites, primarily to convey surface runoff, around the site, beneath Laxon road and through ex accessways or farm tracks. The culverts form part of the existing drainage network conveying stormwater within the site and from upstream catchment to downstream environment. These culverts remain in service; however, their capacity and condition vary across the site.

One critical culvert is located under the Laxon road. This culvert has a large floodgate structure on outlet side of the culvert to cope with increased runoff from urban development in the Western areas of Hamilton City. This serves as a key outlet point for surface water from downstream of Ohote basin and the development site.

Visual inspection indicates that this culvert is in fair condition, with vegetation overgrowth and sediment accumulation presents at both the inlet and outlet locations. These conditions will restrict flow, capacity, particularly during higher rainfall events, and poses risk of upstream ponding.



Figure 6: Laxon road culvert



Figure 7: Culvert outlet with flood gates beneath Laxon road

4.5. ECOLOGICAL FEATURES

An Ecological assessment was conducted by ecological solution for the site covering the development site. This assessment identified Natural wetland and multiple existing channels/drains within the site. This site contains a network of highly modified watercourses (farm drains) which are likely to contain a variety of aquatic life-forms including native species such as gaint and banded kokopu, black mudfish

and longfin eels etc. The ecological report notes that there is opportunity to enhance the ecological values within the Site and in the wider Ohote Stream catchment.

Further value engineering and design at detailed design stage will be undertaken to ensure full compliance with the ecological report recommendations and referenced standards.

4.5.1. EXISTING NATURAL WETLANDS AND PROPOSED ECOLOGICAL WETLANDS

In accordance with the effects management hierarchy, the proposed stormwater management approach incorporates measures to avoid, minimise and remedy potential effects on existing wetland and aquatic habitats. Where residual effects cannot be practicably avoided or remedied, additional wetland creation, restoration and enhancement measures are proposed to achieve an overall net positive ecological outcome. The ecological assessment identifies the residual effects associated with the development, including the loss of approximately 0.5 ha of highly modified wetland habitat. To address this loss, approximately 0.76 ha of new wetland habitat is proposed within the Site, together with restoration and enhancement of existing wetland areas. The proposed wetland creation areas are located within the Site and have been selected to provide a close ecological match to the affected wetland habitats, while integrating with the wider stormwater treatment and existing native vegetation network. Hydrogeological assessments have confirmed the suitability of the proposed wetland creation areas. The wetland areas will provide additional habitat extent and ecological values while also contributing to the treatment and attenuation of stormwater runoff. The proposed measures have been assessed using the Biodiversity Compensation Model (BCM) as a decision-support tool to quantify the adequacy of the proposed compensation measures and provide confidence that the residual ecological effects are appropriately addressed. Refer to ecological report by Ecological solutions for more details.

4.5.2. EXISTING AND MODIFIED CHANNELS/DRAIN

As part of the proposed stormwater management and ecological enhancement measures, approximately 749 m of existing artificial drain, which is connected to watercourses and is proposed to be enhanced through indigenous riparian planting along one bank. While the drain enhancement is not relied upon as part of the quantified ecological compensation assessment, the proposed planting will provide additional riparian cover, improve bank stability, reduce potential erosion, and support improved water quality and aquatic habitat values. The enhancement will also strengthen ecological connectivity between the existing drainage network, proposed stream and wetland areas, and stormwater management devices, thereby providing an integrated approach to stormwater management and ecological enhancement across the Site. Refer to ecological report by Ecological solutions for more details

4.6. GEOTECHNICAL REPORT

A Geotechnical Investigation Report (GIR) has been prepared by CMW Geosciences for the Brymer Farms development. The site is characterised by low-lying swamp deposits comprising of peat and underlying compressible soils with more clay and silt materials generally associated with the elevated areas. The investigations confirm that compressible ground conditions are present across the low-lying portions of the site.

The geotechnical assessment showed that fill-induced settlement within the low-lying areas could be significant with preliminary predicted settlements of approximately 300-800mm without mitigation or preloading. Ground improvement through temporary preloading has therefore been adopted as the

preferred approach/philosophy to accelerate consolidation and reduce post-development settlement. Preliminary assessments indicate preload thicknesses in the order of 1-4m with most areas anticipated to require approximately 9 to 12 months of surcharge with confirmation through detailed design and field monitoring.

Preloading will be undertaken progressively within the identified peat and soft-ground areas. Settlement monitoring will be established prior to loading and maintained throughout the preload periods with preload heights, duration and removal subject to geotechnical review and agreed hold points. The observational approach allows the surcharge programme to be refined in response to measured settlement behaviour and ground conditions meaning throughout the phase a refined approach of preload will be incorporated into the phasing of earthworks.

From a stormwater point of view, the interaction between peat consolidation, groundwater and the proposed drainage infrastructure is an important to consider and adapt as needed. Preload areas will be coordinated with the stormwater and wetland design with preloading excluded from proposed stormwater wetland areas to create Peat wetlands. Any interaction between surcharge areas, drainage infrastructure, wetland excavation or changes to existing drainage shall be reviewed by the Professional Geotechnical Engineer and confirmed with Contractor prior to moving to next phase.

The stormwater design will therefore be incorporated in conjunction with the geotechnical staging and peat management strategy, with groundwater and settlement monitoring relaying the timing and progression of earthworks, drainage infrastructure and final development platforms for Brymer Farms.

Regular monitoring through construction and post construction of water levels within the wetlands is recommended and can be incorporated into post construction consent conditions and relayed to council's representatives.

4.7. CN - VALUES

Soil Class Group D has been adopted for pre-development modelling based on the soil types encountered during geotechnical investigations, which identified dense organic soil and clay and peat in low lying areas. These are typically associated with Group D under TR20-07 and USDA-NRCS classification systems. Additionally, the observed infiltration performance during site testing supports this classification.

Pre Development CN		Post Development CN	
Pervious	Impervious	Pervious	Impervious
80	98	84	98

Table 6: Design CN Values

For post-development conditions, a higher Curve Number of 84 has been used based to account for reduced permeability due to compaction from earthworks. This approach ensures a conservative assessment of stormwater runoff. The classification may be refined at the detailed design stage if additional testing is undertaken.

4.8. ASSESSEMENT – SOAKAGE RATE

The preliminary geotechnical investigations were undertaken to provide full coverage of the Brymer's development area. The investigations cover assessed ground water levels, soil soakage capacity, liquefaction potential, and lateral spreading risks, ensuring comprehensive data for stormwater

management, earthworks, Roading and foundation design. The referenced Geotechnical report in this SMP is listed below (Appendix of the Infrastructure Report).

1. HAM2025-0084 Rev 1 (dated 7th August 2026)

The site is characterised by a predominantly, flat low-lying topography in the centre and rolling hills to North, predominantly underlain by Holocene Swamp deposits in the valleys, flanked by rolling hills to the north and south, comprised of Pleistocene aged silts and clays, with ground water levels varying seasonally and across different areas.

The findings provide crucial insights into the site's Geotechnical behaviour, have informed the design completed to date and will inform future design considerations. The key findings are summarised below.

Ground Water Levels

- Depths recorded 0m to 4m below existing ground level in low lying areas
- Depths recorded 0.5 m to 3.7m below existing ground level in elevated ridges.

Soakage test Area	Results	Soakage Rate factored by 0.5 as per RITS for conservatism (mm/hr)
Wetland F Area (SO25-01)	25.5 mm/hr	12.75
Wetland A Area (SOA25-03)	40.42 mm/hr	20.1
Wetland B Area (SOA25-04)	25.83 mm/hr	12.915
Catchment D (SOA235-04) *	23.3mm/hr	11.65
Catchment E-South-(SOA25-06)	2.08mm/hr	1.04

Table 7: Soakage tests Results

Infiltration testing across the site revealed significant variability in soakage performance, with notably low rates, such as 2 mm/hr, recorded within the Southern Residential Catchment. Observations from soakage testing and variable groundwater depths indicate that perched layers are likely present in parts of the site. As such, the adopted soakage rates for design have incorporated conservative assumptions, and further investigation at the detailed design stage is recommended to confirm underlying groundwater conditions beyond any perched layers.

The results in the Geotechnical report, shows soils at this site are generally suitable to provide use of SW Devices such as raingarden, Aquafort device etc. This soakage rate has been derived from permeability test results, the results are averaged to adopt it for design purposes and factored by 0.5 to reflect long term reduction in soakage over time.

4.9. ARCHAEOLOGICAL ASSESSMENT

An Archaeological Assessment of Effects has been prepared by Redox Cultural Heritage Services for the proposed Brymer Farms development. The assessment included a review of historic plans, aerials, archaeological records and a site inspection.

The assessment identified one archaeological site within the development area, being S14/509 Drain, which a pre-1900 historic drainage reserve constructed between approximately 1865 and 1883. The drainage feature remains visible and continues to function as a field drain through the site.

The proposed development and associated earthworks including stormwater infrastructure and drainage work have the potential to modify or destroy portions of the identified archaeological feature. Accordingly, an Archaeological Authority from Heritage New Zealand Pouhere Taonga (HNZPT) is required prior to undertaking works that may modify or destroy the archaeological site.

The archaeological assessment recommends that any modification or removal of archaeological material is appropriately managed through archaeological fieldwork, sampling, recording and reporting, with the works controlled by an Archaeological Site Management Plan (ASMP). Early consultation with Mana Whenua is also recommended.

Accordingly, the detailed design and construction of stormwater infrastructure will have regard to the archaeological requirements and any conditions associated with the Archaeological Authority and ASMP.

4.10. IWI CONSULTATION

A Cultural Impact Assessment (CIA) has been prepared by Ngaati Maahanga in relation to the proposed Brymer Farms development. Ngaati Maahanga hold mana whenua over the development area which forms part of the upper Ohote Stream catchment and is hydrologically connected to the Waipa/Waikato River. The site contains peat soils, wetlands, groundwater systems and modified drainage networks that are identified as having ongoing cultural and environmental significance.

The CIA identifies the management of wai, wetlands, groundwater, stormwater and whenua as key cultural considerations. Stormwater management should maintain hydrological integrity, avoid adverse effects on wetland function, prevent contaminant transfer to receiving environments and consider cumulative effects within the wider catchment.

Ngaati Maahanga supports the proposed mitigation measures in principle, subject to appropriate design, monitoring and adaptive management. Specific recommendations relevant to the SWMP include maintaining pre-development discharge rates and volumes, achieving appropriate stormwater discharge quality, avoiding discharge structures within natural wetlands where practicable and maintaining groundwater levels necessary to support wetland health and ecological function.

The CIA also recommends that final stormwater design is provided to Ngaati Maahanga for review prior to construction, with ongoing engagement through the detailed design, construction and operational phases. Monitoring information relating to groundwater, water quality and wetland health is also to be provided to Ngaati Maahanga at agreed intervals.

Furthermore, the detailed design and implementation of the stormwater management system will have regard to the cultural requirements identified in the CIA, with ongoing engagement and consultation undertaken with Ngaati Maahanga as the project progresses.

5. DESIGN APPROACH

5.1. POST DEVELOPMENT CATCHMENTS

The post development catchment layout for both the residential and large lots- residential areas has been defined based on the proposed stormwater wetland's location, which also serve as the primary

discharge points for each sub catchment the placement of these wetlands has been carefully considered to align with existing discharge locations ensuring that no new discharge points are introduced as part of the development.

Each post development catchment incorporates not only the development catchment but also includes upstream inflows that have been identified and considered in the design. These inflow areas have been accounted for in the post-development analysis to ensure ongoing conveyance and to avoid any adverse effects both upstream and downstream resulting from the proposed development.

The post development model and calculations are built upon the following input and assumptions:

- CN numbers
 - Post-development CN=84 for pervious Areas
 - Post-development CN=98 for Impervious Areas
- Rainfall data from National Institute of Water and Atmospheric Research (NIWA) rainfall pattern and depth:

Post Development CN	
Pervious	Impervious
84	98
Pre Development 24hr Rainfall Depth (mm)	
10yr RCP8.5	100 yr RCP8.5
126	195

Table 8: Design Parameters table

5.2. PRINCIPLES OF STORMWATER MANAGEMENT

The proposed stormwater management for the development incorporates a number of stormwater management principles, which are focused on:

- Enhancing ecological value of the wider catchment.
- Preserving existing and waterways within the development sites.
- Mitigating flooding impacts.
- Treating stormwater runoff from the proposed impervious areas.

The principles set out in this SMP aligns with the previous projects SMP approved by WRC located in the same district of the proposed sites. The key components of the Brymer Farm SMP are as follows:

- Stormwater conveyance for up to 10year cc ARI rainfall event.
- Overland flow paths for 100-year cc ARI rainfall event to be accommodated within the site and conveyed by the road and green corridors.
- Downstream mitigation through attenuation of 100-year cc ARI rainfall event within the site:
 - Discharge limited to 80% pre-development levels (Maximum).
- Downstream mitigation through detention of 10-year cc ARI rainfall event within the site:
 - Discharge limited to 80 % pre-development levels (Maximum).
- Treatment of runoff prior to discharge into receiving environment in accordance with TP10 / GD01 / Waikato Stormwater Management Guidelines (WRC Technical Report 2020/07).
- Retention of initial abstraction runoff volume using on-lot soakage trench or wetlands for road catchments for the development.

5.3. HYDRAULIC CONNECTIVITY

Stormwater management for the developments will include several devices which are considered as water sensitive design elements. These include the following:

- Modified drains/channels with landscaping.
- Artificial Wetlands
- High flow Bypass
- Soakage Devices where viable
- On-lot stormwater Retention via soakage and/or retention tanks
- Protection of existing bush, wetlands and covenant features.
- Planting of riparian areas if applicable.

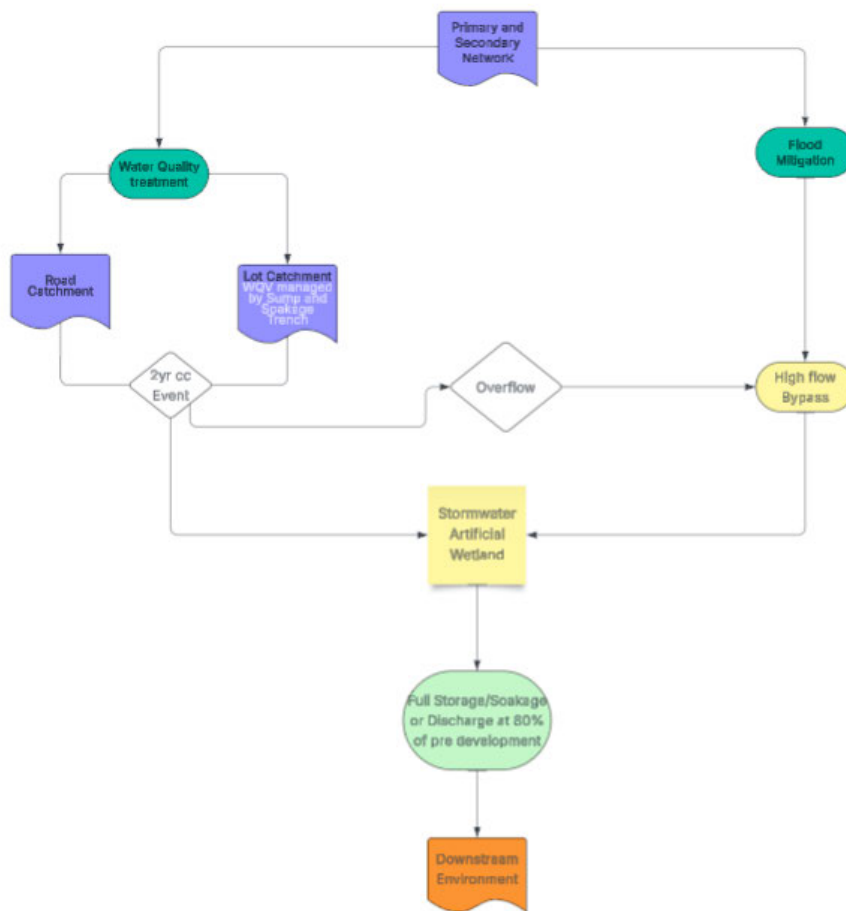


Figure 8: Hydraulics Connectivity Chart

5.4. OBJECTIVES

An overarching SMP has been developed for the Development Area. The SMP sets out the high-level, best practice approach to stormwater management within the receiving catchment.

The strategy for the future stormwater management is outcome focused. The SMP provides a solution-based approach for the receiving environment. Consideration and emphasis is given to the inclusion of

Water Sensitive Urban Design principles, with the overall goal of developing environmentally conscious outcomes which help address and mitigate known and future constraints of the Development Area.

Proposed objectives of the SMP are outlined below:

- Consideration of future public networks required. The report confirms discharge location and provides a design methodology which will guide future development of the area.
- Existing waterways and wetlands are identified and investigated. Parameters are set which will ensure protection of existing waterway and wetland environments in future development.
- Existing overland flowpaths identified and investigated. Design parameters are set which will ensure existing overland flowpaths are allowed for in future development up to and for the 100-yr event.
- Existing flood hazards investigated, mapped, and summarised. Flood mitigation strategies are developed for each of the catchments. This framework will enable the development of the structure plan areas and will guide future development controls.
- The requirement for water quality treatment in support of future development. A review of the relevant statutory framework is undertaken before a high-level strategy is provided for the catchments.
- The consideration and requirement for extended detention in support of future development to avoid any downstream flooding, erosion and scouring. Indicative flood mitigation options are developed for the catchments and receiving environments.
- Confirming the need for the attenuation of peak flow, decreasing stream bed erosion during storm events up to and including the 100-yr events. Attenuation forms part of the overall stormwater management toolbox and solutions are considered (both at-source and catchment wide).
- On-site retention (volume reduction) to ensure pre-development runoff rates and volumes are maintained to provide catchments with hydraulic neutrality.
- On-site retention (volume reduction) to ensure pre-development runoff rates and volumes are maintained within catchments and streams. Existing streams are located within the Development Area, and it is important to maintain underlying base flows of water into the streams to avoid any effects on stream biodiversity.
- The urbanisation of the Development Area presents an opportunity to provide significant ecological improvements through the protection and planting of riparian margins. Recommendations to guide a future Plan Change application to ensure positive environmental outcomes are achieved.
- Groundwater recharge to areas thereby maintaining water tables, preventing dewatering and recharging peat.
- Information gaps which require further investigation and/or detailed design are identified.

The overall SMP creates a stormwater toolkit, which will guide future development. The toolkit will promote sustainable solutions including the integration of Water Sensitive Urban Design (WSUD') principles in future land use planning.

6. PROPOSED DEVELOPMENT & STORMWATER MANAGMENT

Overall, the proposed stormwater management framework provides an integrated solution that balances urban development, flood management, water quality treatment, and environmental protection while aligning with the long-term objectives.

The overall development comprises of 2 distinct projects, as summarised below:

1. Residential Development

2. Large Lots- Residential Development

The proposed stormwater management system has been developed in accordance with the objectives of the Waikato Regional Council and adopts an integrated treatment train approach that addresses stormwater quality, quantity, flood management, and hydraulic connectivity across the development.

The site is influenced by significant upstream catchments, existing drainage channels, and flood-prone areas. Accordingly, the proposed design seeks to maintain and improve existing hydraulic connectivity through the retention of primary drainage corridors, implementation of diversion channels, construction of stream culvert crossings, and provision of wetlands and stormwater storage areas throughout the development.

Initial abstraction requirements will be achieved through distributed on-lot retention soakholes or tanks provided for each residential lot.

Runoff generated from roads and developed areas will be conveyed through the primary stormwater network and directed to the proposed artificial wetland, forebays, and high-flow bypass systems. These devices provide water quality treatment, extended detention, attenuation, and flood storage functions while supporting the staged development of the site.

One major enhanced channel crossing and three minor enhanced channel crossing are proposed to support the collector road network. These crossings have been designed using both 1D Hydraflow and 2D HEC-RAS hydraulic modelling to ensure that existing stream conveyance is maintained while minimising flood impacts and preserving ecological connectivity.

Flood management forms a key component of the overall strategy. Existing external catchment flows will be maintained through the site via retained drainage corridors and diversion channels. The proposed stormwater system has been developed to manage both development-generated runoff and existing upstream flows, ensuring the site can function within the wider catchment system.

6.1.RESIDENTIAL DEVELOPMENT (CATCHMENT A-F)

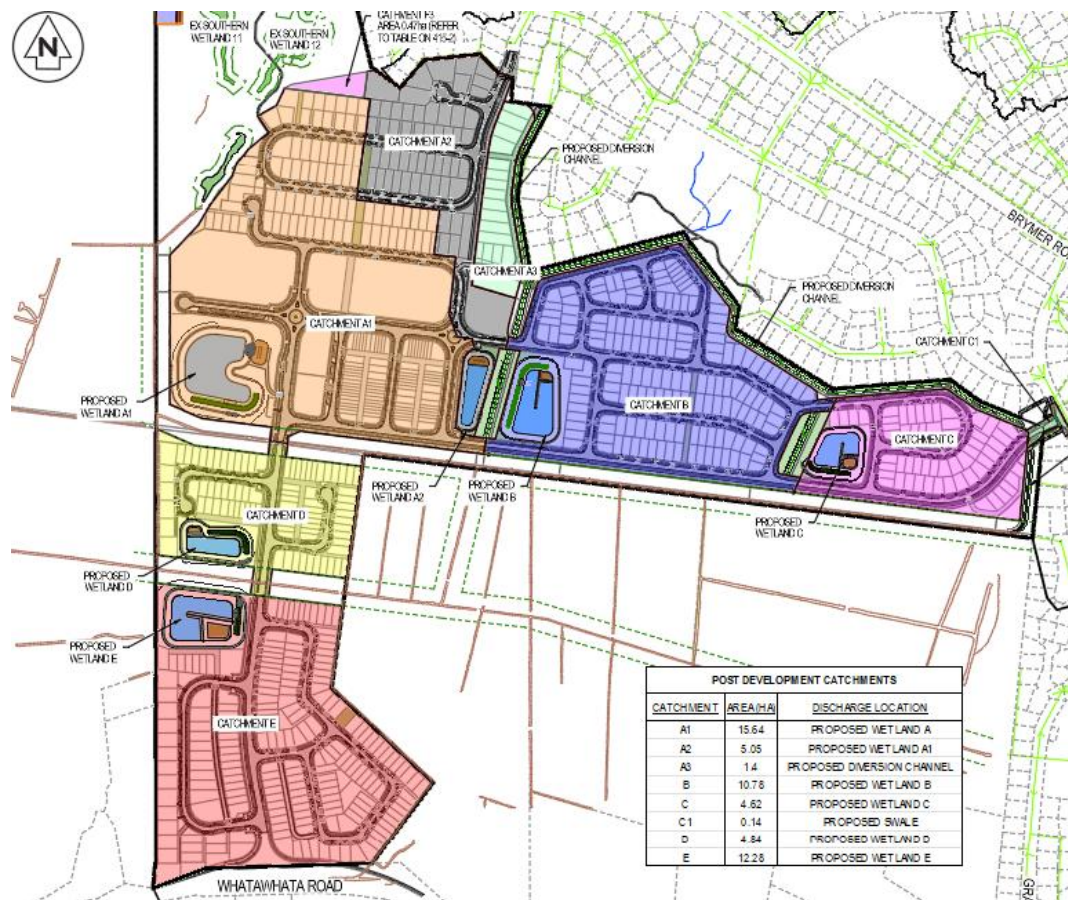


Figure 9: Residential development stage 1-5

6.1.1. STRATEGY FOR LOT AREAS

Roof runoff is captured and managed using on-lot retention via soakholes or retention tanks. Driveway runoff is collected via a catch pit or slot drain incorporating a sump to provide pre-treatment before discharging to the on-lot stormwater soakhole, where the initial abstraction volume is retained.

The on-lot stormwater management system is designed to achieve both initial abstraction and groundwater recharge objectives where required. Retention tanks or soakholes provide the required initial abstraction storage, this is to allow for peat recharge where require with discharge above capacity of the soakage device will then overflow into the primary network system.

Flows exceeding initial abstraction volume are conveyed via the piped stormwater network to the designated stormwater wetland.

6.1.2. STRATEGY FOR ROAD CARRIAGEWAY

Runoff from the road carriageway will be collected by the proposed primary pipe network, designed to cater up to the 10yr cc event. Flows Exceeding the primary system capacity will be conveyed via overland flow path to the Artificial wetlands (Refer to Section 6.6)

The Road Carriageway forms the secondary stormwater conveyance (OLFP) system for the development. Surcharge flows from the network, together with runoff generated from the road carriageway and overflow from the lot stormwater system, are conveyed via the road designated overland flow paths to the proposed wetlands

6.1.3. EXCEPTIONS TO THE RESIDENTIAL DEVELOPMENT STRATEGY

Strategy for catchment A3

Catchment A comprises three sub-catchments: A1, A2 and A3, as shown on Maven Drawing C415. Catchments A1 and A2 will discharge to the proposed wetlands for water quality treatment and flow attenuation. Due to the topography and site constraints, Catchment A3 will instead discharge to a proposed treatment swale prior to discharge to the receiving environment.

Catchment A3 drains away from the A2 wetland catchment, making diversion to Wetland A2 impractical. Such diversion would require significant changes to the proposed wetland configuration, steep pipe gradients and additional earthworks, and is therefore not considered practicable. The proposed treatment swale provides a suitable alternative discharge pathway while maintaining the natural drainage direction of the catchment.

To account for the direct discharge from Catchment A3, additional attenuation storage has been incorporated within the proposed Stage 1 wetlands A1 and A2. The wetlands are designed to provide additional storage and over-attenuation of post-development flows during the 2-year, 10-year and 100-year ARI climate change (CC) events. This additional storage offsets the higher discharge from Catchment A3 and ensures that the overall Catchment A post-development discharge remains limited to 80% of the pre-development discharge in 100yr cc event, thereby reducing potential downstream hydraulic impacts.

Strategy for Catchment F

Northern most portion of Brymer farms comprises both residential development and large lots-residential development. This section outlines the stormwater management strategy for the residential development catchment F, while the following section describes the strategy for the large lots-residential development (refer to section 6.2 for large lots- residential development).

This catchment is surrounded by a number of natural wetlands, with wetland baseflows being maintained through discharges from developed lots and road catchments within the contributing catchment area.

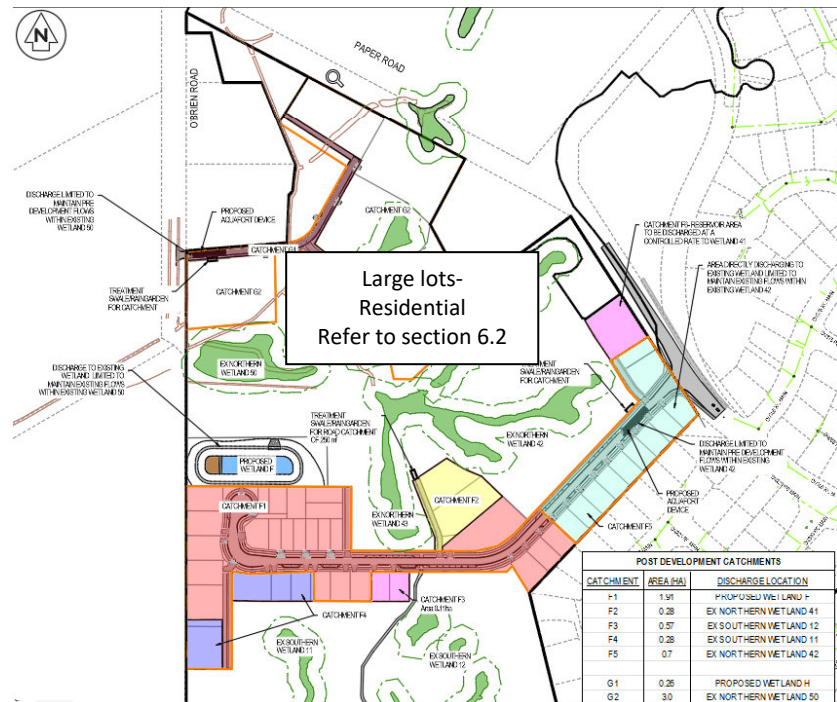


Figure 10: Stage 6 Residential development

Stormwater from the proposed catchments will be managed through either direct/ treated or controlled discharge to the existing wetlands. The catchments have been delineated to maintain the existing hydrological regime of the wetlands and minimise changes to existing wetland flows. The proposed stormwater management approach is as follows:

1. Catchments F1 and F5 will use controlled discharge systems. Stormwater will be conveyed through the proposed piped stormwater network and directed to the proposed attenuation systems. For events up to the 10-year ARI event, flows will be managed through the proposed attenuation systems. During larger events, including the 100-year ARI event, flows will overland flow to attenuation systems (wetland and aquafort respectively) which will then be discharged to the wetland at 80% of predevelopment flows.

The proposed wetland will provide both water quality treatment and flow attenuation before discharging to the existing natural wetland at a controlled rate.

The Aquafort system will provide flow attenuation for the relevant catchment. A separate water quality treatment device, such as a swale or raingarden, will be connected to the Aquafort system to provide treatment prior to discharge to the receiving wetland. Refer to Drawing C400 for the proposed discharge locations and stormwater management arrangements.

2. The remaining catchments will discharge directly to the adjacent existing wetlands. This approach will help maintain the existing baseflows and hydrological regime of the wetlands. At-source water quality treatment measures will be provided within these catchments before stormwater is discharged to the receiving wetland. Refer to Table 9 for the discharge location and treatment arrangement for each catchment, to be read in conjunction with Maven Drawing C415.

On-lot retention will be provided using soakage systems and/or retention tanks to retain the initial runoff generated from each lot. During larger rainfall events, including the 2-year, 10-year and 100-

year ARI critical-duration events, flows exceeding the available on-lot storage will overflow to the existing receiving wetland through the proposed stormwater network and/or designated overland flow paths.

Overall, the proposed approach combines on-lot retention, water quality treatment, flow attenuation and controlled discharge to manage stormwater while maintaining the existing wetland hydrology.

Table 9: Discharge locations

POST DEVELOPMENT CATCHMENTS		
<u>CATCHMENT</u>	<u>AREA (HA)</u>	<u>DISCHARGE LOCATION</u>
F1	1.91	PROPOSED WETLAND F
F2	0.28	EX NORTHERN WETLAND 41
F3	0.08	EX SOUTHERN WETLAND 12
F4	0.28	EX SOUTHERN WETLAND 11
F5	0.9	EX NORTHERN WETLAND 42

Overall, the allowable discharge to the existing wetland under the developed scenario was established using HEC-HMS and TR-20 modelling. A trial-and-error process was undertaken to determine the contributing catchment area that generated a discharge rate equivalent to the target existing-condition flow from a low flow event, ensuring hydraulic neutrality. The developed 2yr event climate change (CC) event was assessed against the existing 2-year (cc) to identify the corresponding discharge rates to ensure hydrological regime is maintained in the low flow events. Table 10 summarises the discharge comparison and the contributing catchment areas required to maintain hydraulic neutrality.

Table 10: Existing Wetland Pre and post discharge Flowrate and volumes

	HEC HMS RESULTS- Pre Wetland Deficit						HEC HMS RESULTS- Post Wetland Deficit						
Catchment	Volume (m ³)			Flow rate (m ³ /s)			Volume (m ³)			Flow rate (m ³ /s)			Notes
	2yr	10yr	100yr	2yr	10yr	100yr	2yr	10yr	100yr	2yr	10yr	100yr	Catchment
F6	200.42	334.75	601.44	0.03	0.07	0.18	203.62	334.08	535.54	0.03	0.05	0.08	Post- NORTHERN 41
F5	500.27	932.29	1619.00	0.10	0.19	0.31	394.78	647.71	1038.29	0.06	0.10	0.16	Post- NORTHERN 42
F2	304.53	567.52	985.81	0.06	0.11	0.19	238.62	416.6	697.9	0.04	0.07	0.11	Post- NORTHERN 43
G1, G2	285.67	532.37	924.76	0.06	0.11	0.18	236.87	388.63	622.98	0.04	0.06	0.10	Post- NORTHERN 50
F4	245.19	456.93	793.72	0.05	0.091	0.152	199.47	327.26	524.61	0.03	0.05	0.08	Post- SOUTHERN 11
F3	284.06	529.36	919.54	0.06	0.105	0.176	266.65	437.49	701.3	0.04	0.07	0.11	Post- SOUTHERN 12

6.2. LARGE LOTS- RESIDENTIAL DEVELOPMENT (CATCHMENT G)

Catchment G comprises for 2 sub catchment that is Road Catchment G1 and Lot catchment G2, refer to drawing 415 for details. The strategy would be to maintain pre-existing discharge volume in 2yr event to maintain its base flows. While 100 yr flows will overland flow to the existing wetland.



Figure 11: Stage 6 large lots- residential

6.2.1. STRATEGY FOR LOT AREAS

Roof and driveway runoff will be managed at source using a combination of on-lot retention tanks and/or soakholes. The systems will provide initial abstraction and attenuation of post-development runoff for the 2-year, 10-year and 100-year ARI CC events. For the 100-year ARI CC event, the controlled discharge from the lots will be limited to 80% of the pre-development flow rate. The final sizing and configuration of the on-lot systems will be confirmed during detailed design.

6.2.2. STRATEGY FOR ROAD CARRIAGEWAY

Road runoff will be collected by catchpits and conveyed through the proposed piped network to a treatment device like raingarden (refer to Appendix A for raingarden sizing) which is then connected to the Aquafort attenuation system. A connected raingarden or swale will provide water quality treatment prior to discharge to the receiving wetland. The Aquafort will be designed to accommodate flows up to the 100-year ARI CC event, with discharge controlled through appropriately sized orifices and outlet controls that will allow for discharge to the existing wetland. Refer to the Drawing C475 for the Aquafort and outlet arrangement.

The allowable discharge rate has been established to maintain the existing wetland flow regime, with the 2-year ARI CC discharge aligned with the existing-condition flow. Discharges for the 100-year ARI CC events are limited to 80% of predevelopment flows. The design discharge rates are summarised in Table 16 and appendix B of this report

6.3. RETENTION OF INITIAL ABSTRACTION

The Waikato Regional Council (WRC) requirements and RITS require the initial abstraction volume generated by the proposed development to be retained. This can be achieved through retention of rainfall runoff from impervious surfaces and/or by providing a volume equivalent to the pre-development initial abstraction requirement.

Given the presence of peat soils throughout the low-lying residential catchment, the proposed stormwater management approach also seeks to maintain infiltration and recharge to the underlying peat. Retaining and infiltrating stormwater at source will assist in maintaining the existing hydrological regime, reducing the potential for dewatering of downstream wetlands and streams, and mitigating potential peat shrinkage associated with changes in soil moisture and groundwater conditions.

The initial abstraction requirement has been assessed using site-specific rainfall information in accordance with the TR20-07 WRC guideline. A 3.2 mm retention criterion has been adopted for the development. The required retention volume has been calculated based on the contributing impervious catchment area and residential yield for each development stage.

Table 11: Retention Volume Requirement

TABLE: INITIAL ABSTRACTION				
Catchment	Impervious Catchment (80% of Catchment) (m2)	Unit Total	Retention Volume 3.2mm as per WRC guidelines (m3)	Minimum Retention Volume Per Lot (m3)
Residential				
A	175200	175	560.64	3.20
B	86240	207	275.96	1.33
C	36160	85	115.71	1.36
D	38720	100	123.90	1.24
E	98240	192	314.36	1.64
F	28800	64	92.16	1.44
	Total		1482.72	
Large Lots- Residential				
G	8490	9	27.168	3.02
	Total		27.168	

Retention of the required volume will be achieved by providing on-lot soak hole or retention tank for each residential unit. The standard Dn900mm x 2.7 deep is proposed for each lot, providing a distributed retention system across the development. While preliminary assessments identified varying storage requirements across individual stages, a consistent 1.7m³ volume has been adopted throughout the development to simplify construction, operation, and long-term maintenance. This approach also provides flexibility during future subdivision and building consent stages while maintaining compliance with the development's stormwater management objectives.

Based on the proposed staging layout and residential yield of approximately 832 lots, the total retention volume provided is approximately 1509m³ out of which 27.2 m³ is the total volume from large lots-residential that have yield of 9 lots.

Table 11 and 12 summarises the required and proposed retention volumes for each development stage.

The proposed strategy provides approximately 23m³ (for residential and large lots- residential) of additional retention volume above the required 3.2 mm retention volume, demonstrating compliance with the retention requirements. By retaining runoff at the source, the soakholes reduce the volume of stormwater entering the downstream conveyance network and support the overall treatment-train approach adopted for the development.

Alternatively, if and where soakage is not possible, on lot tank can be proposed and the overflow from system will be directed to soakage trench or the soak holes. This could allow the tank up to 1m³ and a single soak-hole of 0.7m³ as an example depending on what volume is available in the soakage system.

Furthermore, overflow from the soak hole or a retention tank will discharge to the downstream stormwater network once the available storage volume has been exceeded. Subsequent treatment, detention, and attenuation will be provided through the proposed-on lot system, wetlands, diversion channels, and associated stormwater infrastructure located throughout the development.

Table 12: Proposed On-lot Soakholes

Catchment	Unit Total	Retention Volume 3.2mm (m3)	Retention Volume Per Lot (m3)	Proposed Retention Volume Per Lot (m3)	Soakage specification
Residential					
A	175	454.1	2.6	1.7	Single soakhole 2.7m deep - (3 x Ø900mm x 900mm H permeable concrete rings)
B	207	276.0	1.3	1.7	
C	85	115.7	1.4	1.7	
D	100	123.9	1.2	1.7	
E	192	314.4	1.6	1.7	
F	64	92.2	1.4	1.7	
Total	823	1376.1		1399.1	
Large Lots- Residential					
F	9	27.2	3.0	3	two soakhole 2.7m deep - (3 x Ø900mm x 900mm H permeable concrete rings)

The soakholes have been designed to not consider soakage at this stage. The final sizing, operation, and maintenance requirements for the retention will be confirmed during detailed design and incorporated into the overall stormwater management framework.

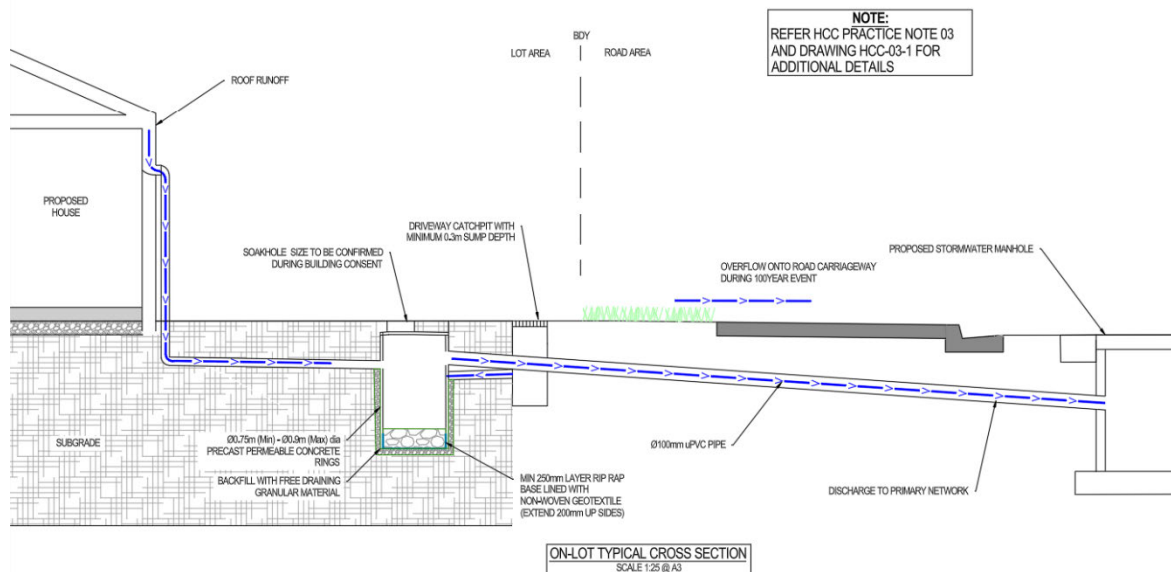


Figure 12: On-lot Stormwater Mitigation Concept

6.4. TREATMENT TRAIN

The proposed stormwater management system adopts a treatment train approach that manages stormwater at multiple stages before discharge to the receiving environment. The treatment train has been developed in accordance with the objectives of the WRC and integrates source control, treatment, attenuation, and flood management measures throughout the development.

The first component of the treatment train is the provision of on-lot retention for each residential unit. These soakholes provide retention of the required initial abstraction volume and reduce the volume of runoff entering the downstream stormwater network.

Runoff exceeding the available soak hole storage is conveyed through the primary stormwater network and directed towards the proposed wetland systems. Prior to entering the wetlands, stormwater passes through forebays which provide sediment capture and assist in reducing maintenance requirements within the primary treatment areas.

The wetlands form the primary stormwater treatment and attenuation devices within the development. In addition to providing water quality treatment, the wetlands provide extended detention, attenuation, and flood storage functions. High-flow bypass structures are incorporated into the wetland design to safely convey high velocity flows from storm events while maintaining treatment performance for more frequent rainfall events.

Following treatment and attenuation, stormwater is discharged via controlled outlet structures incorporating low-flow orifices, spillways, and backflow prevention devices. These outlet structures regulate discharge rates, provide attenuation of post-development flows, and prevent reverse flow from the receiving drainage network during periods of elevated downstream water levels.

Collectively, the treatment train provides an integrated stormwater management solution that addresses water quality, water quantity, flood management, and hydraulic connectivity objectives while supporting the staged development of the Brymer farms.

6.5. STORMWATER QUALITY AND QUANTITY

The proposed stormwater management system has been developed to address both water quality and water quantity requirements in accordance with the RITS, and relevant Waikato Regional Council guidance. The overall strategy adopts a treatment train approach that combines source control, treatment, attenuation, flood storage, and conveyance measures throughout the development.

Water Quality Mitigation

Water quality mitigation is achieved through a combination of distributed source control measures and centralised wetland treatment systems. Initial abstraction is provided through on-lot retention located throughout the development, reducing the volume of runoff entering the downstream stormwater network and providing retention of the first flush of stormwater.

Stormwater generated from roads and developed areas is conveyed through the primary stormwater network and directed toward a series of constructed wetlands. The wetlands incorporate forebays and treatment zones designed to capture sediment and improve stormwater quality prior to discharge to the receiving environment. The proposed wetland system forms the primary water quality treatment mechanism for the development and has been configured in accordance with the objective.

Water Quantity Mitigation

Water quantity mitigation is achieved through a combination of source control, flood storage, attenuation, and controlled discharge. Initial abstraction requirements are met through the provision of distributed on-lot retention system, while additional storage and attenuation are provided within the proposed wetland systems and associated stormwater infrastructure.

The site is influenced by significant upstream catchments and existing drainage channels traversing the development area. Accordingly, the stormwater strategy has been designed to manage both development-generated runoff and external catchment flows while maintaining hydraulic connectivity through the site.

Existing drainage corridors are retained and supplemented by diversion channels, stream culvert crossings, wetlands, and associated storage areas. These elements work together to maintain conveyance of external flows, reduce flood risk within the development, and provide attenuation of post-development runoff prior to discharge.

The proposed wetland systems also provide flood storage and attenuation benefits during larger storm events. High-flow bypass structures incorporated within the wetland design allow high velocity flows to be conveyed safely through the system while preserving treatment performance for more frequent events. Collectively, these measures contribute to the achievement of the stormwater quantity objectives established within the WRC guidelines while supporting the wider flood management strategy for the development.

6.6. ARTIFICIAL WETLANDS

Wetlands will be designed in accordance with Waikato's Regional Infrastructure Technical Specifications (RITS) and other relevant standards including TR20-06 Waikato Stormwater Runoff Modelling Guideline (TR20-06) and TR20-07 Waikato Stormwater management Guideline (TR20-07). Wetlands will provide secondary treatment (following forebay and/or swales) and extended detention prior to discharging to the existing/enhanced stream or primary network. Wetlands will be located offline to the existing/enhanced stream, to allow upstream flows to bypass the wetland.

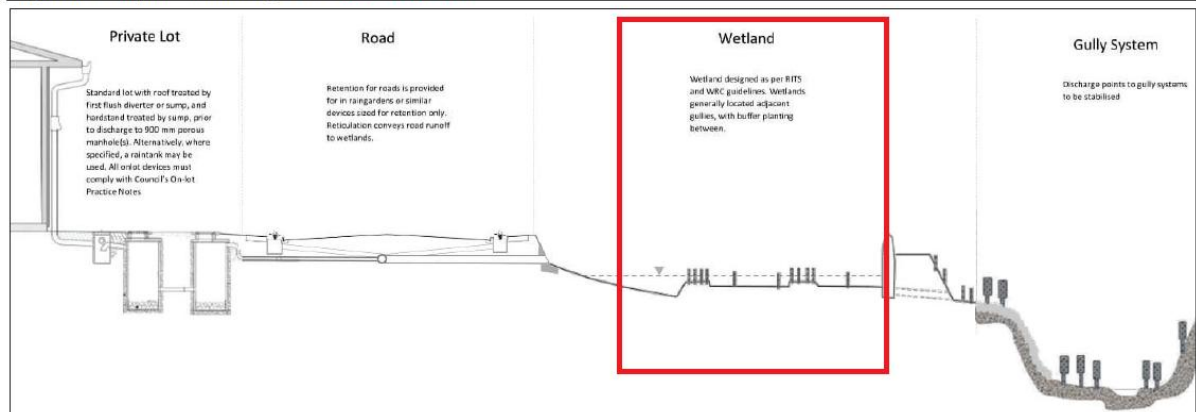


Figure 87: Standard Treatment Train

Figure 13: WRC excerpt

Figure 13 above is an excerpt from the guidelines depicting the overall treatment system, the wetland requirements highlighted as being relevant to this section.

Each wetland will be sized to treat the full water quality volume (WQV) including storage and slow release of the extended detention to protect the downstream natural receiving environment.

Any event that generated high velocity flows will bypass the wetland and be directed via a high-flow bypass to the existing stream.

Wetland bathymetry will be banded and consist of a mix of deep and shallow pools to allow for dispersed flow through vegetated areas per RITS guidelines. The extended detention level or live storage zone (LSZ) will be set at a maximum depth of 0.35m above the permanent water level to support healthy plants per table 68 of the RITS document.

According to TR20-07, a conservative approach to wetland design is recommended. Where the contributing catchment has an imperviousness of greater than 70%, the permanent water surface area of the wetland is be sized at 4% of the contributing catchment area. This sizing can be refined during the detailed design stage once the catchment characteristics, hydrology, and treatment objectives are confirmed.

Based on the anticipated imperviousness of the proposed development, a 4% sizing factor has been adopted for the conceptual design of the proposed wetlands. Preliminary contributing catchments and wetland locations are shown on the Maven stormwater drawings. Table 13 presents the conceptual wetland surface area requirements for each contributing catchment.

A design has been undertaken for the artificial wetlands within stage 1 and is included on proposed Engineering Plans. Figure 14 below shows the proposed artificial wetlands located within stage 1.

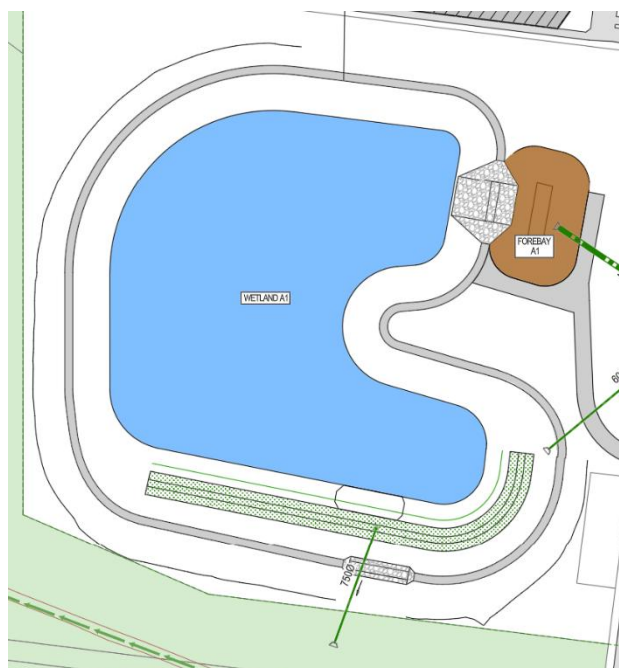


Figure 14: Wetland Details

Wetlands at the development have been split into 6 wetlands (Wetland A1 to Wetland G), to allow it to be constructed in stages as each development occurs. Wetlands are separated by a high-flow bypass and are proposed to treat and attenuate 100yr event including climate change.

Table 13: Wetland Pool Area

Catchment	Area (Ha)	Wetland Pool Area
1A	15.5	0.65ha
2A	5.01	0.16ha
1B	10.78	0.49ha
1C	4.62	0.18ha
1D	7.84	0.17ha
1E	12.28	0.35ha
1F	1.73	0.08ha

To achieve extended detention, an Orifice is to be designed and placed at the permanent water level within the wetland zone to allow slow release of WQV ED storage within 24hrs into the High flow bypass. An overflow in the form of a weir or similar will be located above the WQV ED Storage level for higher flow events into the high flow bypass.

The Wetlands shall be designed to comply with the below requirements.

Detention/Attenuation

- 2, 10 and 100 year ARI attenuation
- EDV Storage and slow discharge over 24hrs

- ED Orifice less than 110mm is considered blocked for conservatism.

Treatment

- WQV treatment

Table 14: STAGE 1 Wetland catchment

Catchment	Wetland	WQV (m³) (50% of WQV where extended detention in provided as per RITS)	EDV (m³) = 1.2x WQV
A	Wetland A1	1387	3329
A	Wetland A2	448	1075
B	Wetland B	956	2294
C	Wetland C	523	1255
D	Wetland D	430	1031
E	Wetland E	1089	2614
F	Wetland F	153	367

A stormwater splitter device is proposed upstream of the wetland. This will direct the WQV and 2year cc flow into the wetland area for treatment and storage. Higher flows are to be diverted into the high flow bypass to undergo attenuation. This device is currently represented as a stormwater flow splitter manhole, however, could also be a weir device located within the high-flow bypass channel.

When designing/choosing a stormwater mitigation and treatment device upstream from the wetland, it is essential to consider the stormwater base flow into the proposed wetlands. This is to maintain the biodiversity of the wetland and its treatment function.

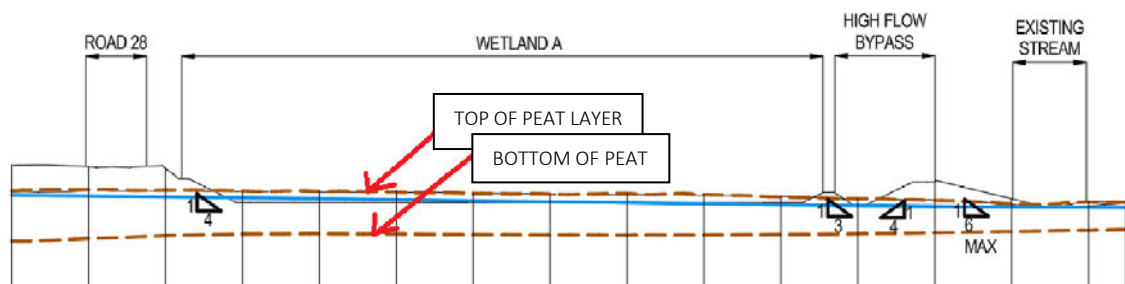


Figure 15: Wetland Section with Peat Layer

An existing peat layer has been identified across central portion of the development area, including within the footprint of several proposed wetland systems. To avoid disturbance of the peat and maintain the existing subsurface conditions, the permanent water level (PWL) and wetland base levels have been established above the peat layer. This approach avoids excavation without entering in peat layer, minimises potential impacts on groundwater behaviour, and assists in maintaining the long-term hydraulic performance and stability of the proposed wetland systems

6.7. FOREBAY

Forebays will be sized to meet a minimum area of 10% of the artificial wetland as per RITS. WRC TR20-07 requires a forebay sized to minimum 15% of the WQV. Both RITS and WRC requirements will be achieved for each wetland. Rainfall events less than the 2year event will be directed to the forebays. The forebay will provide energy dissipation of incoming flow and minimizes erosion and scour within the wetlands.

Conceptual minimum forebay sizes based on the current catchment and wetland sizes are provided in the table 15 below. Forebay areas will need to be reviewed and refined as required during Resource Consent and Engineering Plan Approval in accordance with RITS and WRC TR20-07

Table 15: Minimum forebay areas

Residential Artificial Wetland	Minimum Forebay Area m2
1A	650
2A	315
1B	690
1C	352
1D	120
1E	595
1F	155

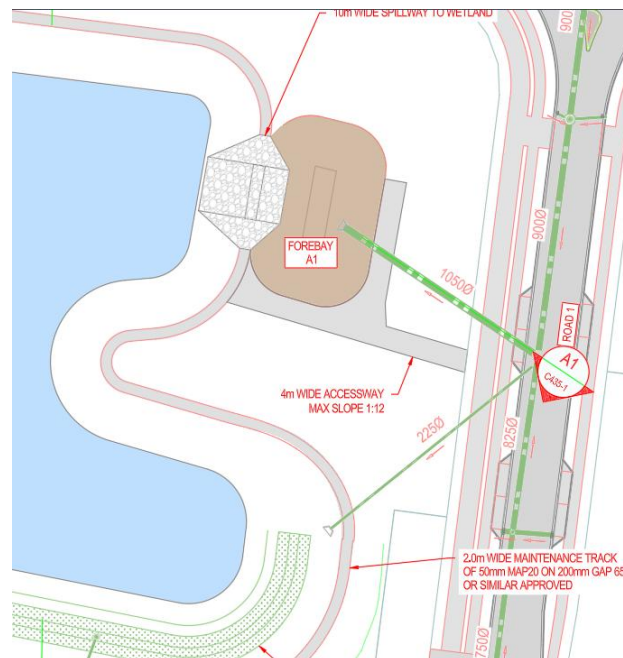


Figure 16: Typical layout forebay as part of the Treatment train.

6.8. HIGH FLOW BYPASS (HBP)

High-flow bypasses are proposed for each sub-catchment which diverts high-flows greater than the 2-year flow, up to the 100-year event around the treatment train (forebay and wetlands) to the downstream channel/stream in accordance with RITS secondary system design section 4.2.3.4.

Each high-flow bypass includes flow splitters to divert high and low flows. Flow splitters will consist of either a manhole with a weir, or a weir structure installed within the high-flow swale. The weir height will overtop during flows larger than the WQV ED storage.

High-flow bypass swales connect to the existing stream with wingwalls and riprap. Open channels for high-flow bypasses/secondary systems where possible as per RITS. In most cases open channels are proposed, however a few specific locations may require piping.

The high flow bypass (HBP) is proposed to include a discharge device consisting of a 2-10yr ARI orifice and weir or similar to attenuate the 2,10 and 100year flow prior to entering the existing drain. During the 2,10 and 100yr rainfall events, the High flow bypass discharge device will then enable flows to backup and enter the wetland, utilizing the wetland for storage. This is in line with the RITS guidance.

6.9. WETLAND OUTLET AND OVERFLOW STRATEGY

The proposed wetland systems have been designed to account for elevated water levels within the receiving stream during larger storm events. During extreme events, where downstream water levels exceed the wetland outlet level, discharge through the primary outlet structure may be temporarily restricted due to backwater effects.

To accommodate these conditions, the wetland systems incorporate primary spillways that provide emergency overflow capacity and ensure floodwaters can be safely conveyed through the system during extreme events. These spillways are intended to operate only during larger storm events when water levels within the receiving stream are elevated.



Figure 17: Backflow Device installed on Outlet Pipe.

Once water levels within the receiving stream recede, stored stormwater within the wetlands will progressively discharge through the primary outlet structure, comprising a low-flow orifice and spillway

arrangement. A backflow prevention device will be incorporated within the outlet structure to prevent reverse flow from the receiving stream entering the wetland system during periods of elevated downstream water levels.

The outlet structures have been configured to achieve the required attenuation and drawdown performance, with the wetlands designed to fully drain within 48 hours following the design storm event, subject to receiving water levels returning to normal operating conditions.

6.10. STORMWATER CULVERTS

Two road main crossings are proposed where the development road network intersects existing drainage channels traversing the site. The purpose of the culverts is to maintain the existing hydraulic connectivity of the stream system while enabling the construction of the proposed collector roads and associated infrastructure.

There are 6 Box culverts, and 3 circular culverts proposed mainly to allow conveyance of the rerouted stream and the discharge from proposed wetlands. The culvert crossings have been informed by 2D hydraulic modelling undertaken using HEC-RAS as part of the wider stormwater and flood assessment and further analyzed in Hydraflow Software. Refer to drawing C400 for location of the culvert crossing. There is 1 proposed bridge crossing that spans across 12m and is an important component of the overall stormwater and flood management strategy by maintaining conveyance of channel/drain flows through the site while supporting the proposed transport network.

All culvert crossings have been designed with a longitudinal grade of 0.5% and incorporate embedment below the existing stream bed to maintain stream continuity through the structures.

To support ecological connectivity, the culverts have been embedded approximately 25% into the stream bed and incorporate low-flow channels within each barrel. This approach promotes the retention of natural stream processes and facilitates aquatic organism passage through the crossings. Riprap protection and energy dissipation measures are proposed at the inlet and outlet structures to minimise erosion and protect the receiving environment. Wingwalls will be confirmed during detailed design to provide a stable transition between the stream channel and culvert structures.

The proposed culvert crossings form an important component of the overall stormwater and flood management strategy by maintaining conveyance of channel/drain flows through the site while supporting the proposed transport network. The hydraulic assessment confirms that the crossings can accommodate the required design flows while maintaining the function of the existing drainage system and supporting the broader objectives of the WRC.

The culvert crossings have been informed by both 1D hydraulic modelling undertaken using Hydraflow and 2D hydraulic modelling undertaken using HEC-RAS as part of the wider stormwater and flood assessment. These assessments were used to determine the required culvert capacity, assess upstream and downstream water level effects, and confirm that the proposed crossings maintain conveyance of both frequent and extreme storm events. The sizing and configuration of the culverts have therefore been selected to convey existing stream flows, maintain flood conveyance, and minimise adverse impacts on the surrounding floodplain.

6.11. WETLAND AND CATCHMENT DISCHARGE SUMMARY

The following table 16 summarises the modelled peak discharge rates from the proposed wetland catchments and compares these against the corresponding pre-development flows. The assessment has been undertaken using the proposed stormwater management strategy, incorporating on-lot retention, diversion channels, wetland storage, attenuation volumes, and controlled outlet structures. The results provide an indication of the discharge rates expected to enter the existing drainage network under post-development conditions and demonstrate the effectiveness of the proposed mitigation measures.

Table 16: Wetland Pre vs Post Development Flows table

Wetland	Pre Development (historical rainfall)			Post Development (Climate change)		
	2 Year - 24Hr	10 Year - 24Hr	100 Year - 24Hr	2 Year - 24Hr	10 Year - 24Hr	100 Year - 24Hr
	Q (m ³ /S)	Q (m ³ /S)	Q (m ³ /S)	Q (m ³ /S)	Q (m ³ /S)	Q (m ³ /S)
Catchment A1	0.7	1.2	1.7	0.3	0.7	1.4
Catchment A2	0.2	0.4	0.5	0.2	0.2	0.4
Catchment B	0.4	0.8	1.1	0.2	0.6	1.2
Catchment C	0.2	0.3	0.5	0.1	0.2	0.4
Catchment D	0.2	0.3	0.5	0.1	0.2	0.4
Catchment E	0.5	1	1.4	0.1	0.2	0.5
Catchment F	0.1	0.1	0.2	0.1	0.1	0.2
Total	2.3	4.1	5.9	1.1	2.2	4.5

The results indicate that the proposed wetland systems can achieve substantial attenuation of post-development runoff prior to discharge into the existing drainage network. Post-development discharge rates are below the adopted design targets, providing additional capacity and flexibility within the stormwater system if needed down the line. This demonstrates that the proposed design not only satisfies the stormwater quantity objectives of the development but also provides opportunities for further refinement during detailed design. Subject to detailed hydraulic assessment, there may be scope for value engineering of wetland storage volumes, outlet structures, and associated infrastructure while continuing to achieve the required stormwater management outcomes.

Table 17: Overall site Pre and Post Development volumes

Catchments	Predevelopment scenario with climate change		Post development scenario with climate change		
	10 Year - 24Hr		10 Year - 24Hr		
	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	
Catchment A1	2.64	20.17	0.7	16.2	Wetland A1
Catchment A2			0.2	4.9	Wetland A2
Catchment A3			0.20	1.60	No attenuation provided for this catchment, over attenuation provided in wetland A1 and A2 to offset the effects
Catchment B	1.45	10.82	0.6	11.4	Wetland B
Catchment C	1.22	8.74	0.2	4.9	Wetland C
Catchment C2			0.02	0.18	
Catchment D	0.52	3.92	0.2	6.4	Wetland C
Catchment E	0.50	3.85	0.2	12.8	Wetland D
Catchment F	0.20	1.40	0.1	1.8	Wetland E
Catchment F2			0.05	0.33	Wetland F
Catchment F3			0.07	0.44	Direct discharge to recharge existing wetland
Catchment F4			0.05	0.33	Direct discharge to recharge existing wetland
Catchment F5			0.10	0.65	Direct discharge to recharge existing wetland
Catchment G1, G2			0.06	0.39	Controlled discharge to existing wetland
Total	6.54	48.90	2.76	62.31	Controlled discharge to existing wetland 1. Road catchment dealt using an aquafort device, discharge limited to discharge from natural wetland 2. lot catchment discharge limited to pre-existing discharge rate
Post- Pre with climate change			-3.77	13.41	

As presented in Table 17, the post-development runoff volume increases from 48900 m³ to 62,310 m³ under the 10-year 24-hour climate change event, while the peak discharge reduces from 6.54 m³/s to

2.76 m³/s. The increase in volume is managed through the proposed wetland attenuation, controlled discharge and wetland recharge measures. Consequently, the increased runoff volume is not expected to result in a material increase in downstream flooding or erosion effects, with the overall effects considered negligible. Furthermore, for 2yr and 10yr event peak discharge and volume comparison for overall site, refer to Appendix E (of this report) and for the assessment of the potential effects of the proposed development on the downstream receiving environment using HEC RAS is provided in Section 7.3.1 of this report.

6.12. GROUNDWATER RECHARGE

The low-lying areas of the Development Area are underlain by peat deposits that have historically been drained and converted for agricultural and horticultural use. To minimise peat dewatering and the associated risk of peat shrinkage and settlement, stormwater soakage and groundwater recharge will be maintained throughout the development.

Groundwater recharge is proposed to route through the proposed treatment train within the units. Each on lot device will be connected to a soakhole system, this allows for recharge promoting an even distribution of recharge across the peat deposits. In addition, stormwater wetlands within each catchment will allow to support groundwater recharge while also providing stormwater treatment and flow attenuation.

Detailed geotechnical investigations will be required for each stage of development and undertaken by a suitably qualified geotechnical engineer at detailed design. These investigations will determine the site-specific groundwater recharge requirements and establish appropriate development controls for infrastructure and building foundations within the various catchment area.

7. FLOOD MODELLING

The Development Area is situated within the Ohote Basin catchment and forms part of the wider Waikato Regional Council land drainage scheme. Existing farm drainage channels traverse the site, conveying runoff from upstream residential and rural catchments to downstream floodplain areas before ultimately discharging to the Waipā River. Consequently, flood behaviour across the site is influenced by both upstream inflows and downstream hydraulic controls associated with the wider drainage scheme.

Desktop Study and Consultation

A desktop assessment was undertaken to develop an understanding of the existing flood behaviour, catchment characteristics, drainage network, and downstream hydraulic controls associated with the development area. The assessment included a review of the Waikato Regional Council Flood Hazard Portal, LiDAR topographic data, aerial imagery, available drainage scheme information, existing watercourses, and catchment drainage patterns to identify overland flow paths, flood-prone areas, and existing primary drainage network.

Consultation was undertaken with Waikato Regional Council to obtain information on the downstream Ohote Basin Drainage Scheme and the operation of the Laxon Road floodgates and the potential influence of Waipa River backwater effects on the downstream drainage network. Council confirmed that the development area ultimately drains through the Ohote Basin Drainage Scheme, which comprises the upgraded Ohote Stream, associated drainage channels, stop banks, and floodgates constructed to manage runoff from the wider catchment. Whilst detailed operational information for the Laxon Road floodgates was unavailable, representative operating assumptions were developed through discussions with Council and incorporated into the HEC-RAS hydraulic model. (Refer to Correspondence Note, under Appendix D)

Waikato Regional Council provided a predicted 100year cc water levels from its one-dimensional (1D) Waipā River hydraulic model at a cross-section near the confluence of the Ohote Stream. These levels were converted from MVD53 to NZVD2016 and compared against the corresponding HEC-RAS model outputs to verify that the adopted downstream boundary conditions and hydraulic representation of the wider drainage scheme were appropriate.

The desktop assessment and modelling confirmed that the downstream low-lying areas upstream of the Laxon Road crossing, form part of the existing flood-prone environment within the Ohote Basin Drainage Scheme, with runoff conveyed from upstream catchments through the Development Area before discharging downstream to the basin.

The Development Area is located immediately upstream of this existing floodplain, with farm drainage channels providing the primary conveyance route through the site feeding runoff to the main existing drain.

7.1. EXISTING FLOODING, MODELLING AND PARAMETERS

Modelling parameters

The pre-development modelling parameters and design assumptions are outlined below. Stormwater management requirements have been based on WRC guidelines and RITS, as there is currently no ICMP dedicated for this area. The adopted parameters were retrieved from available GIS information, Aerial Imagery Online, Topographical Survey, NIWA and external consultants reports.

- Rainfall Data – NIWA cc adjusted using RITS RCP8.5 2100-2120 (climate change 4 degrees)
- Rainfall data distribution – using normalised 24hr temporal rainfall intensity (Climate change 3.8degrees)
- Runoff Method: SCS CN – CN used as advised by geotechnical Engineer and noted in the geotechnical report.
- Design Events assessed: 2, 10 and 100year existing/historical and RCP8.5 2100-2120

Hydrology - HEC HMS

- For Catchment Delineation and generating inflow hydrographs, TR20 Sheets for Tc.
- Used for Wetland and Pond attenuation/routing design and soakage

Hydraulics – HEC RAS 2D Modelling

- Flood modelling of Existing pre-development
- Flood modelling of Design post-development
- Flood modelling for sensitivity checks

Hydraulics – Hydraflow software & Hydraulic toolbox (these are more for checks against modelled values)

- OLFP Checks
- Manning's calculations
- Rip Rap Design
- Energy dissipation device design
- Hydraflow Culvert design (100year cc)

Existing Surface data: used in our HEC RAS model comprises of the following: Drone survey, survey stormwater existing features on proposed development area like culverts, existing channels, drains, natural wetland etc. and LINZ DEM surface for the extended area. The standard vertical datum and Coordinate system for the existing surface is NZVD 2016 and Mount Eden 2000, respectively.

The assessment extent includes the upstream catchments that discharges through the development area and the downstream drainage Basin areas extending through Laxon Road crossing towards the Waipa River. This extent ensures that flood behaviour is assessed within the context of the wider catchment, including influence of the Ohote Basin Drainage Scheme, the Laxon Road Floodgate, and potential backwater effects from the Waipa River.

Figure 18 and 19 below – Hydraulic Assessment Extent showing the upstream contributing catchment (reference from the site), Development Area, Ohote Stream, Laxon Road Crossing/Gate and Waipa catchment extending south Towards Te Kuiti.



Figure 18: Flood Model 2D Area Extent.

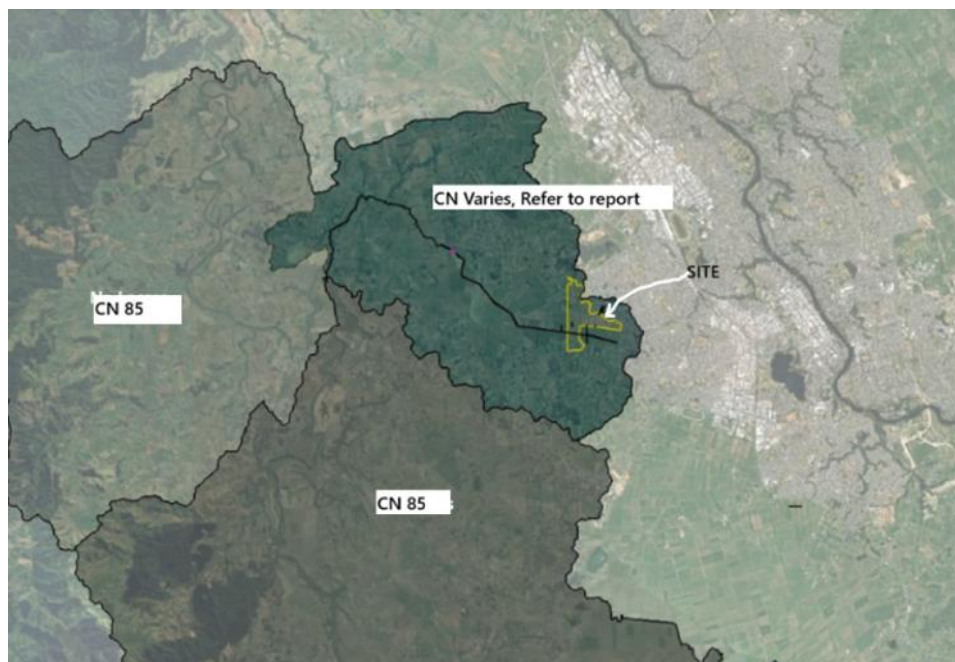


Figure 19: Flood Model 2D Area Extent with CN Values.



Figure 20: Existing Gate under Laxon Road.

The Flood gate applied in the model represents the information found onsite, that is the current water level at time of survey, dimensions of the gate and levels. the conditions applied that represents its operational assumptions and is provided below;

1. The gate valve is assumed to remain open while the downstream water level remains lower than the upstream water level.
2. When water downstream rises above the upstream water level due to backwater from the Waipa catchment Gate is closed.
3. Gate opens again when water level downstream resides to allow flushing of the flooded water upstream of Luxon Road.

7.2. EXISTING MODEL RESULTS

The modelling confirms the extent of existing flooding, ponding, and overland flow paths under the predevelopment 100year cc event. The results indicate that the downstream low-lying areas just upstream of the Laxon Road crossing is flooded and act as a basin, storing significant flood volume during major storm events. Flooding in these areas are influenced by the operation of the Laxon Road floodgates and backwater effects from the Waipa River.



Figure 20: Pre Development 100year cc Flood Map.

Runoff from the wider catchment, including upstream residential and rural areas, is conveyed through the development area via the existing farm drains and streams before discharging into the downstream flood prone area as mentioned in the above paragraph. As water levels within the Waipa River rises, the gate under Laxon Road is closed to avoid backwater into the flood prone area. Due to the closure of this gate, the area is flooded further. The second stage during a much more intense rainfall (100year ARI cc) is when the Waipa River rises further, backwater overtops the Laxon road crossing, and as a result further floods these areas.

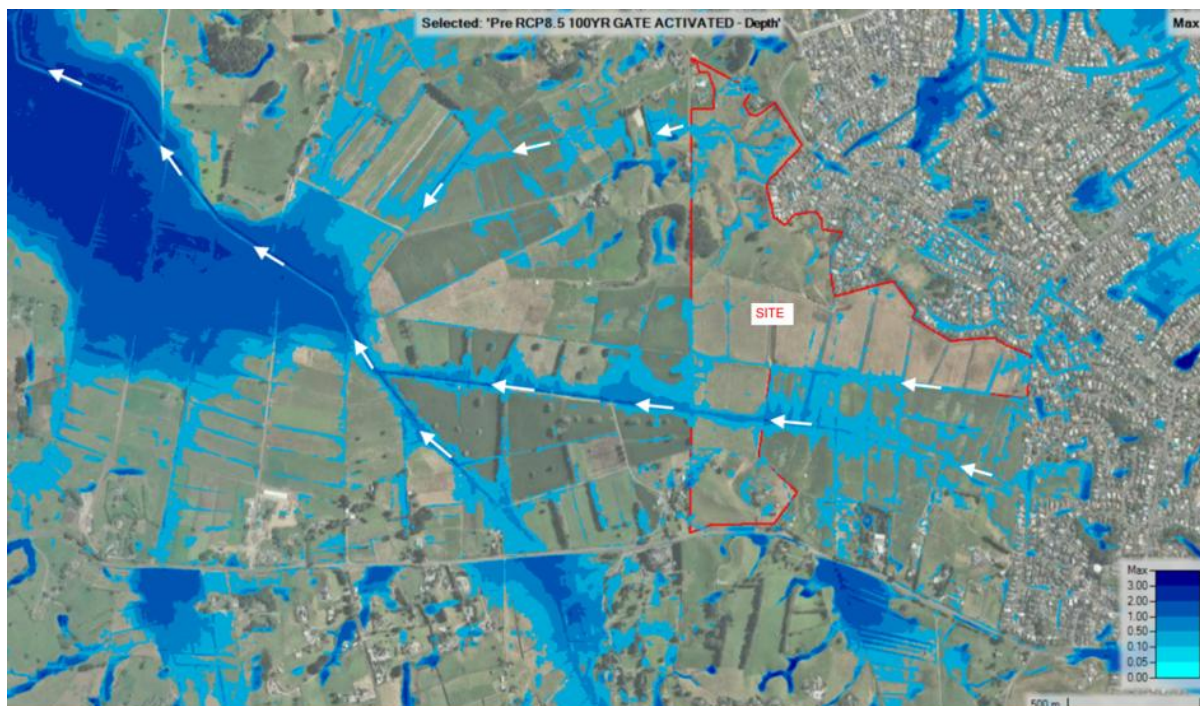


Figure 21: Pre Development 100year cc Flood Map zoomed into the Site.

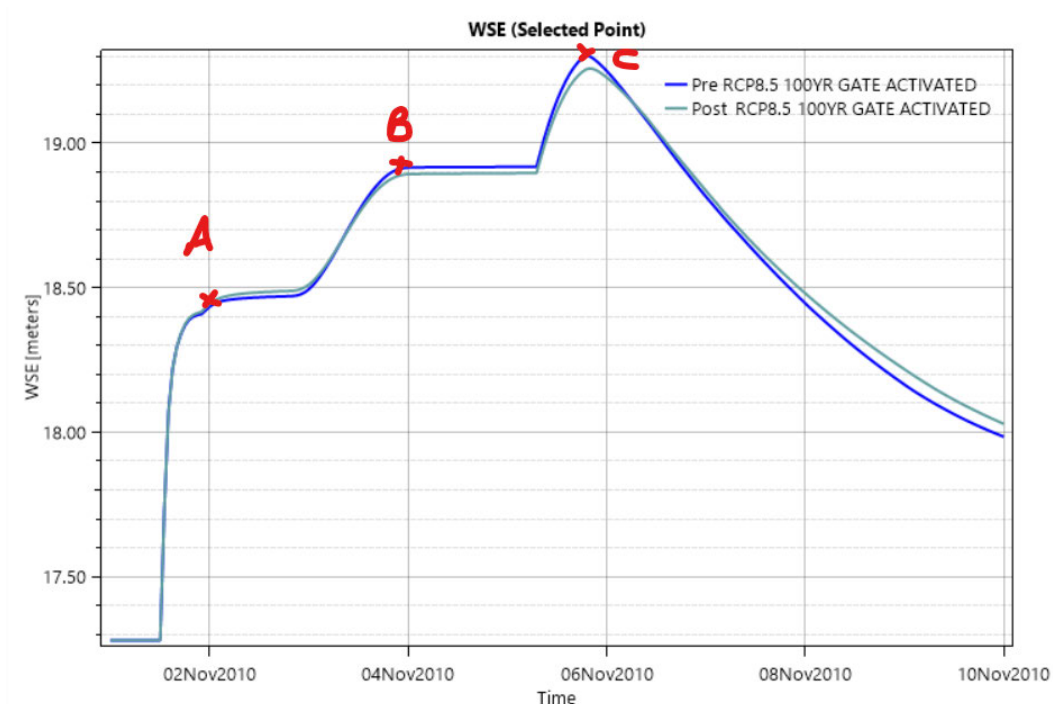


Figure 22: Section 10 WSE vs Time Graph

A WSE vs Time graph is provided above at point along Section 10 (Refer to the result folder) located within the flood prone area upstream of Laxon Road crossing. This provides further clarity on how the Laxon Road gate and the Waipa River backwater impact water levels in this area during the simulation or flood event (100year cc ARI).

Peak at point A represents the initial response to runoff generated from the local and upstream catchments including the proposed development. During this period the Laxon road flood gate is open initially and then closes as water from downstream of the gate rises further rapidly to due Waipa back water. This Peaks around 24hrs of the model.

Peak B and C represents further increase in water surface level in this area due to overtopping at the Laxon road crossing from the Waipa River backwater onto the Ohote Basin. This peaks between 5-6days of the model.

Properties affected by flooding upstream of the Laxon Road crossing have been identified and are summarised in Appendix D.

The full hydraulic model outputs are provided in Appendix D, with a summary of results provided in table 18 below.

7.3. POST DEVELOPMENT FLOODING ASSESSMENT



Figure 23: Post Development 100year cc Flood Map

Table 18: Pre vs Post Development WSE and Flow Rate Values

Sections	Pre Development		Post Development	
	Q (m ³ /s)	WSE (m)	Q (m ³ /s)	WSE (m)
1	5.02	25.27	4.85	25.24
2	9.69	23.84	9.3	23.82
3	15.12	23.7	13.66	23.7
4	17.49	22.46	15.77	22.4
5	20.09	22.26	17	22.2
6	2.15	28.77	1.41	28.75
7	1.64	25.66	1.52	25.64
8	32.42	19.3	31.09	19.26

A comparison of the existing and post-development HEC-RAS model results indicates that flood behaviour across the wider area remains unchanged or improved, with only localised ponding within proposed roads exceeding 150mm (section 8) covering less than 10% of the site.

- Section 1-3, peak flow rates and flood depths are reduced under post-development conditions; this is largely due to farm drains being rediverted around the site thus allowing attenuation impact on the flows and peak flows.
- Section 4-5, flow rates downstream of the proposed Bridge has improved in comparison to predevelopment. This is largely due to provided storage within proposed wetlands and

rerouting of stream flows allowing more to reach this point in comparison to predevelopment condition.

- Flood depths and flowrates remain unchanged or have improved for Section 6 and 7, downstream of the large lots- residential, similar with the other results.

7.3.1. DOWNSTREAM FLOOD EFFECTS ASSESSMENT AND RESULTS

Further, to assess the potential effects of the proposed development on the downstream receiving environment, a HEC-RAS model has been developed to assess the downstream basin and the proposed development area only.

The modelling has considered the 1% AEP (100-year) design event with the applicable climate change allowance under both pre-development and post-development scenarios. The modelling results indicate the following:

- **Runoff volume:** The total runoff volume under the post-development scenario is higher than under the pre-development scenario. This increase is primarily attributable to the increase in impervious area associated with the proposed development, resulting in increased runoff generation. Comparison of the pre- and post-development scenarios indicates an increase of approximately 13,200 m³ in total runoff volume.
- **Peak discharge:** Despite the increase in total runoff volume, the post-development peak discharge is reduced relative to the pre-development condition. This reduction is achieved through the proposed stormwater management measures, including extended detention, attenuation storage and the incorporation of ecological wetlands, which collectively provide flow attenuation and controlled discharge.
- **Downstream water level:** The increase in total runoff volume results in an approximately **10 mm increase in the water level** within the downstream basin. This increase is considered minor and is not expected to result in adverse effects on downstream properties or a material increase in downstream flood risk.

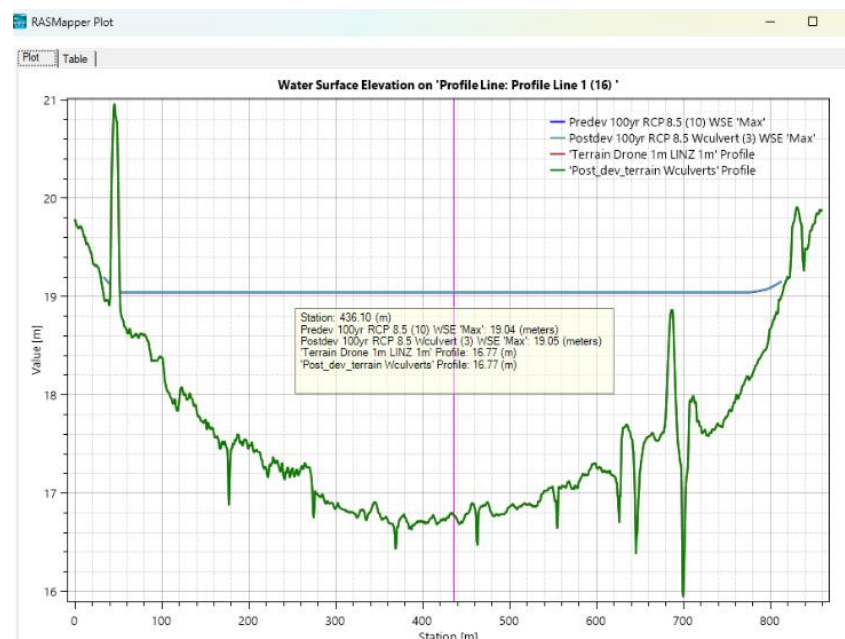


Figure 24: Pre vs Post Basin water elevation level

Overall, the HEC-RAS modelling demonstrates that the proposed stormwater management measures effectively attenuate the post-development peak discharge despite the increase in runoff volume associated with the development. The resulting change in downstream water level is minor, with an approximately 10 mm increase predicted for the 1% AEP (100-year) event with climate change allowance. Accordingly, the proposed development is not expected to materially alter downstream flood levels or increase the risk of flooding to downstream properties, and the overall effect on the downstream receiving environment is considered minor to negligible.

It is anticipated that further refinement of the proposed earthworks, stormwater infrastructure, and hydraulic modelling during the detailed design phase will optimise site drainage and may reduce the localised increases in flood depth and velocities identified in this assessment.

7.3.2. DOWNSTREAM FLOOD MITIGATION

Following are the measures taken to eliminate/ minimize impact downstream flooding:

- Raising and filling the development site to reduce flooding effects. The site levels have been elevated through appropriate fillings to reduce the risk and extent of flooding. Through raising these lower lying lots it will provide greater flood immunity for the proposed lots.
- Increasing storage capacity through open channels and drains within our site. Stormwater stored by utilizing existing open channels and drainage corridors. The lifting of the site surface resulted in deeper bases for the existing streams/channels. These channel bases have been maintained at their current levels to preserve natural flow paths and avoid altering downstream hydraulics.
- Attenuation of flows within the site. Stormwater will be attenuated on-site via designated wetland and stormwater devices, ensuring controlled discharge rates. Outflows from the development will be restricted to 80% of pre-development discharge rates where possible, thereby reducing peak flows and mitigating potential downstream impacts.
- Erosion and scour protection: Appropriate erosion and scour protection measures have been incorporated into the stormwater management approach to minimise the potential for increased erosion resulting from concentrated stormwater discharges. The proposed erosion protection measures, including outlet protection and management of discharge velocities, are detailed in the Erosion and Sediment Control / Erosion Management Plan provided in Appendix C. These measures will assist in protecting downstream channels and receiving environments from potential erosion and scour effects.

7.3.3. MINIMUM FLOOR LEVELS

Floor level requirements in relation to floodplains will be set through rules in the future District Plan. Minimum floor levels freeboard over the 100-yr flood level will be required for all habitable buildings in accordance with the recommendations provided below:

Table 19: Minimum Freeboard Requirements

Freeboard	Minimum Height
Vulnerable Activities	500mm
Less Vulnerable Activities	300mm

* *Vulnerable activities defined as residential activities*

* *Less vulnerable activities defined as commerce, industry, and rural activities*

All future freeboard clearances shall be in accordance with the criteria stipulated above and would need to demonstrate compliance with Building Code E1 – Surface Water as required.

8. OVERLAND FLOWPATHS

Additional branches of OLFPs will be created as roading corridors are formed. The following measures will be adopted to mitigate their effects of these overland flow paths on the proposed development.



Figure 25: Proposed Overland Flow path.

- Identify and maintain natural overland flow/watercourse locations to convey concentrated stormwater from the site. Utilise existing culverts (where possible) to maintain the same discharge locations, post development.
- Identify and retain any upstream OLFPs and/or watercourses to avoid any upstream flooding.
- Ensure OLFPs are to be designed where possible within the roading network and discharge into watercourses.

The preliminary OLFP design is summarised below.

An assessment of the post development overland flow paths (OLFPs) has been carried out to evaluate the behaviour of surface runoff in the road carriageway under the proposed stormwater management system. The design scenario is based on the 2081-2100 RCP8.5 climate change scenario, incorporating all proposed devices and the assessment is done through HEC-RAS 2D modelling. The OLFPs represents the conveyance of surface runoff because of the proposed system during the 100-year storm event.

Flow depths and velocities were assessed at key locations throughout the development covering all the various road/accessway typologies ensuring and confirming conveyance of the OLFP is viable through proposed carriageway. See below table 20 showing results at the key locations.

Table 20: OLFP section details

CATCHMENT	SECTION	FLOW RATE FROM HEC-RAS MODEL (cms)	MAX DEPTH (m)	VELOCITY (m/s)	DEPTH x VELOCITY(m ² /s)
A1	1	0.49	0.09	1.59	0.14
A2	2	0.12	0.07	1.2	0.08
A3	3	0.1	0.05	1.41	0.07
B	4	0.25	0.07	1.09	0.08
C	5	0.15	0.09	1.42	0.13
D	6	0.03	0.10	1.52	0.15
E	7	1.00	0.07	1.31	0.10
F1	8	0.11	0.06	0.54	0.03
F5	9	0.11	0.13	2.19	0.28
G1	10	0.26	0.06	1.05	0.06

All modelled sections report a maximum flow depth at or below 0.13m (Catchment F5, Section 9), which is within the 150mm design guideline for all catchments assessed. Depth x velocity values remain well below the critical safety thresholds defined in Austroads 2012 Part 5, which specify:

- $< 0.4\text{m}^2/\text{s}$ for pedestrian safety
- $< 0.6\text{m}^2/\text{s}$ for vehicle safety

The highest recorded value, $0.28\text{ m}^2/\text{s}$ at Catchment F5 (Section 9), reflects the highest velocity in the assessed sections (2.19 m/s) but confirms safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads and conveyed into roadside primary networks for the 10-year cc conveyance, with surcharge above this directed to the designated wetlands and/or the treatment swale via the OLFP.

9. SUMMARY OF PROPOSED STORMWATER MANAGEMENT

Stormwater management solutions for each post development sub-catchment is summarised in table 21.

Table 21: Summary of stormwater management

Developments	Source	Water Quality	Flood management	Stream Protection	Water Sensitive Design
Residential	Lot Areas	Inert roof materials. Soakholes or retention tanks, to recharge peat where required.	Stormwater pipe network for 10yr ARI cc rainfall events. Artificial Wetlands and soakholes for up to 100yr ARI cc rainfall events where soakage is viable. Catchment A to E; Overland flow paths for 100yr ARI cc events within road reserves, directed to High flow bypass and Wetlands.	At source on lot soakage where soakage is viable. Full soakage/Mitigation of up to 10year cc event Extended detention within artificial wetlands. Controlled release of 10-year and 100-year cc events at 80% pre-development flows.	Stormwater wetlands with planting. 75% TSS as per requirements of GD01/TR2018/01 for all impervious surfaces. Protection of streams and riparian planting.
	Public Roads	At source Artificial Wetlands 75% TSS as per requirements of GD01/ TR2018/01 for all impervious surfaces.	Some areas will be treated at source and discharged to existing Wetland to maintain hydrology of wetland in low flow event that is 2year event. 100 yr discharge limited to 80% of predevelopment flows.	Artificial Wetlands, forebay and high flow bypass. OR Treatment devices wherever required and discharge limited to flows from existing wetland in 2year event.	
Large Lots-Residential	Lot Areas	Inert roof materials. At source Stormwater tanks or soakholes for treatment and attenuation.	Stormwater tanks and soakage devices for initial abstraction.	Extended detention within artificial wetlands. Controlled release of 10-year and 100-year	

			<i>Overland flow paths for 100yr ARI cc events within road reserves, directed to existing Wetlands.</i> <i>Attenuation and flood storage up to 100yr ARI cc.</i>	cc events discharge limited to flows from existing wetland.	
	Public Roads	Aquafort device and raingarden for attenuation. and treatment, respectively.	<i>Discharge of 2-year, 10 and 100yr, at pre-development flows of existing wetlands.</i>		

Notes:

1. On site refers to at source, e.g., adjacent to the road carriageway or within the lot boundary.
2. Catchment wide refers to outside of the road carriageway or lot boundary however within the Brymer Development Areas

10. CONCLUSION

This Stormwater Management Plan (SMP) has been prepared to support the Brymer Farms Development and provides the overarching framework for stormwater management throughout the site. The SMP has been developed in accordance with the objectives and requirements of the Waikato Regional Council guidelines, and the Regional Infrastructure Technical Specifications (RITS) and other relevant Scheme Plans.

The site is influenced by localised and residential upstream contributing catchments, existing drainage channels, overland flow paths, and flood-prone areas downstream. Downstream constraints exist therefore the assessment is well extended towards the downstream areas where there are flood gates and flood prone areas. These extents further into the Waipa River as suggested through consultation with council to assess impact it has on the development site and vice versa.

Detailed catchment delineation and hydraulic modelling have been undertaken to refine the understanding of existing stormwater behaviour and to inform the proposed stormwater management strategy. The assessment confirms that maintaining hydraulic connectivity and accommodating external catchment flows are critical components of the overall design approach.

To ensure the development impact is minimised towards downstream areas and existing wetlands, the proposed stormwater management system adopts a treatment train approach incorporating on-lot retention, conveyance systems, wetlands, forebays, high-flow bypass systems, diversion channels, and flood storage areas. Together, these components provide stormwater treatment, detention, attenuation, and conveyance functions in accordance with the objectives set out by council and relevant standards. This also includes allocating areas directly discharging into the existing wetlands to maintain neutrality.

Initial abstraction requirements will be achieved through distributed on-lot soakholes or tanks provided for each lot (via Roadside Swales and/or unlined wetland ponds). The proposed soakhole or retention provides retention volume and forms the first component of the overall stormwater treatment train.

The modelling confirms the extent of existing flooding, ponding, and overland flow paths under the pre and post development 100year cc event. The results indicate that the downstream low-lying areas just upstream of the Laxon Road crossing is flooded and act as a basin, storing significant flood volume during major storm events. Flooding in these areas are influenced by the operation of the Laxon Road floodgates and backwater effects from the Waipa River.

Modelling demonstrates that the proposed stormwater systems are capable of achieving discharge rates below the adopted design targets, providing confidence in the proposed stormwater strategy while allowing opportunities for further optimisation during detailed design.

Overall, the proposed stormwater management framework provides a practical and integrated solution that supports future urban development while maintaining catchment function, managing flood risk, protecting receiving environments, and aligning with the long-term objectives of Waikato administered land drainage plan. Further refinement of stormwater infrastructure, hydraulic modelling, wetland design, and flood mitigation measures will be undertaken during detailed design and engineering approval stages.

Appendix A – Calculations



Maven Waikato

Job Number
119014

Sheet
1

Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland A-F

Author
NK

Date
13/08/2026

Checked
DJM

<u>Catchment Post Development</u>	Ha	Area (m2)
A	15.64	156391
A2	5.05	50508
B	10.78	107800
C	4.62	46200
D	4.84	48400
E	12.28	122800
F	1.73	17250

Key:
input



Maven Waikato

Job Title	Brymer Farms Limited			Author	NK	Date	13/08/2026	Checked	DJM
Calc Title	Wetland Sizing and dimensions								
Catchment	Catchment and Wetland A								
				References:					Key:
				WRC 2020/07 8.5.6 Stormwater pond					input
				WRC 2020/07 8.5.7 Wetlands					
Wetland / Pond Sizing and dimensions				RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands					
Catchment Area		15.64	ha						
Imperviousness <70%?		no							
Percentage of catchment area		4%							
Wetland surface area		6256	m2	per WRC 2020/06 8.5.7		Govened by EDV volume			
Info Table									
		PostDev							
Q2		0.30	m ³ /s	See Tab "HEC HMS Results "					
V2		9400.00	m ³						
Q10		0.70	m ³ /s						
V10		16200.00	m ³						
Q100 (RCP8.5)		1.40	m ³ /s						
V100 (RCP8.5)		26900.00	m ³						
Min. WQV		2774.00	m ³	1/3 of the 2-year storm 24hr ARI rainfall event.					
SUMMARY TABLE									
Min. wetland area (catchment)		6256	m2						
Designed pwl wetland area		6584	m2	From Cad					
Min. WQV		2774	m3						
Min. ED		3329	m ³	1.2WQV					
Designed V (50% OF WQV when ED is provided		1387	m3	OK					
Fore Bay Volume	(15% of WQV)		=	416.10	m ³	Per WRC	2357.90		
Min Fore Bay Area	(10% of Wetland Area)		=	658.40	m ²	per RITS			
Designed ForeBay Area				1200	m ²	from CAD			



Maven Waikato

Job Number
119014

Sheet
1

Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland A

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:

input

Wetland / Pond Sizing and dimensions

Catchment Area 5.05 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 2020 m2 per WRC 2020/06 8.5.7 Governed by EDV volume
Info Table

PostDev

Q2 0.20 m³/s See Tab "HEC HMS Results "
V2 2700.00 m³
Q10 0.20 m³/s
V10 4900.00 m³
Q100 (RCP8.5) 0.40 m³/s
V100 (RCP8.5) 8400.00 m³
Min. WQV 896.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (catchment) 2020 m2
Designed pwl wetland area 2184 m2 From Cad
WQV 896 m3
Min. ED 1075 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 448 m3 OK

Fore Bay Volume (15% of WQV) = 134.40 m³ Per WRC
Min Fore Bay Area (10% of Wetland Area) = 218.40 m² per RITS
Designed ForeBay Area 1200 m² from CAD



Maven Waikato

Job Number
119014

Sheet
1

Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland B

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:

input

Wetland / Pond Sizing and dimensions

Catchment Area 10.78 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 4312 m2 per WRC 2020/06 8.5.7 Govened by EDV volume
Info Table

PostDev

Q2 0.20 m³/s See Tab "HEC HMS Results "
V2 6800.00 m³
Q10 0.60 m³/s
V10 11400.00 m³
Q100 (RC8.5) 1.20 m³/s
V100 (RCP8.5) 18800.00 m³
Min. WQV 1912.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (3% catchment) 4312 m2
Designed wetland area 5625 m2 From CAD
WQV 1912 m3 Maximum of calculated WQV vs water depth x wetland area
Min. ED 2294 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 956 m³ OK

Fore Bay Volume (15% of WQV) = 286.80 m³ Per WRC
Fore Bay Area (10% of Wetland Area) = 562.50 m² per RITS
Designed ForeBay Area = 1500 m² From CAD



Maven Waikato

Job Number
119014

Sheet
1

Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland C

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:
input

Wetland / Pond Sizing and dimensions

Catchment Area 4.62 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 1848 m² per WRC 2020/06 8.5.7 Governed by EDV volume
Info Table

PostDev

Q2 0.10 m³/s See Tab "HEC HMS Results "
V2 2900.00 m³
Q10 0.20 m³/s
V10 4900.00 m³
Q100 (RC6.0) 0.40 m³/s
V100 (RCP6.0) 8000.00 m³
Min. WQV 1046.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (catchment) 1848 m²
Designed wetland area 7300 m² From CAD
WQV 1046 m³ Maximum of calculated WQV vs water depth x wetland area
Min. ED 1255 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 523 m³ OK

Fore Bay Volume (15% of WQV) = 156.90 m³ Per WRC
Fore Bay Area (10% of Wetland Area) = 730.00 m² per RITS
Designed ForeBay Area = 1300 m² From CAD



Maven Waikato

Job Number
119014

Sheet
1

Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland D

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:
input

Wetland / Pond Sizing and dimensions

Catchment Area 4.84 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 1936 m² per WRC 2020/06 8.5.7 Governed by EDV volume
Info Table

PostDev

Q2 0.10 m³/s See Tab "HEC HMS Results "
V2 4300.00 m³
Q10 0.20 m³/s
V10 6400.00 m³
Q100 (RC6.0) 0.40 m³/s
V100 (RCP6.0) 9700.00 m³
Min. WQV 859.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (3% catchment) 1936 m²
Designed wetland area 5395 m² From CAD
WQV 859 m³ Maximum of calculated WQV vs water depth x wetland area
Min. ED 1031 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 430 m³ OK

Fore Bay Volume Min (15% of WQV) = 128.85 m³ Per WRC
Fore Bay Area Min (10% of Wetland Area) = 539.50 m² per RITS
Designed ForeBay Area = 937 m² From CAD



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Job Number
119014

Sheet
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Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland E

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:
input

Wetland / Pond Sizing and dimensions

Catchment Area 12.28 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 4912 m² per WRC 2020/06 8.5.7 Governed by EDV volume
Info Table

PostDev

Q2 0.10 m³/s See Tab "HEC HMS Results "
V2 7800.00 m³
Q10 0.20 m³/s
V10 12800.00 m³
Q100 (RC6.0) 0.50 m³/s
V100 (RCP6.0) 20800.00 m³
Min. WQV 2178.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (3% catchment) 4912 m²
Designed wetland area 3900 m² From CAD
WQV 2178 m³ Maximum of calculated WQV vs water depth x wetland area
Min. ED 2614 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 1089 m³ OK

Fore Bay Volume (15% of WQV) = 326.70 m³ Per WRC
Fore Bay Area (10% of Wetland Area) = 390.00 m² per RITS
Designed ForeBay Area = 630 m² From CAD



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119014

Sheet
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Rev: A

Job Title
Calc Title
Catchment

Brymer Farms Limited
Wetland Sizing and dimensions
Catchment and Wetland F

Author
NK

Date
13/08/2026

Checked
DJM

References:

WRC 2020/07 8.5.6 Stormwater pond
WRC 2020/07 8.5.7 Wetlands
RITS V2.5 October 2024 - 4.2.18 Constructed Wetlands

Key:
input

Wetland / Pond Sizing and dimensions

Catchment Area 1.73 ha
Imperviousness <70%? no
Percentage of catchment area 4%
Wetland surface area 690 m² per WRC 2020/06 8.5.7 Governed by EDV volume
Info Table

PostDev

Q2 0.10 m³/s See Tab "HEC HMS Results "
V2 1000.00 m³
Q10 0.10 m³/s
V10 1800.00 m³
Q100 (RC6.0) 0.20 m³/s
V100 (RCP6.0) 3000.00 m³
Min. WQV 306.00 m³ 1/3 of the 2-year storm 24hr ARI rainfall event.

SUMMARY TABLE

Min. wetland area (3% catchment) 690 m²
Designed wetland area 2800 m² From CAD
WQV 306 m³ Maximum of calculated WQV vs water depth x wetland area
Min. ED 367 m³ 1.2WQV
Designed V (50% OF WQV when ED is provided) 153 m³ OK

Fore Bay Volume (15% of WQV) = 45.90 m³ Per WRC
Fore Bay Area (10% of Wetland Area) = 280.00 m² per RITS
Designed ForeBay Area = 239 m² From CAD

	WQV
A	2774
A2	896
B	1912
C	1046
D	859
E	2178
F	306
G	222

2 YEAR - 24Hr	Pre Development		Post Development	
	Q (m³/s)	V (m³)*1000	Q (m³/s)	V (m³)*1000
A	0.7	5.1	0.3	9.4
A2	0.2	1.5	0.2	2.7
B	0.4	3.1	0.2	6.8
C	0.2	1.3	0.1	2.9
D	0.2	1.4	0.1	4.3
E	0.5	4	0.1	7.8
F	0.1	0.5	0.1	1
	2.3	16.9	1.1	34.9

10 YEAR - 24Hr	Pre Development		Post Development	
	Q (m³/s)	V (m³)*1000	Q (m³/s)	V (m³)*1000
A	1.2	9.4	0.7	16.2
A2	0.4	2.7	0.2	4.9
B	0.8	5.8	0.6	11.4
C	0.3	2.5	0.2	4.9
D	0.3	2.6	0.2	6.4
E	1	7.4	0.2	12.8
F	0.1	0.9	0.1	1.8
	4.1	31.3	2.2	58.4

100Yr - 24hr	Pre Development (80%)		Post Development	
	Q (m³/s)	V (m³)*1000	Q (m³/s)	V (m³)*1000
A	1.7	23.9	1.4	26.9
A2	0.5	7.3	0.4	8.4
B	1.1	15.6	1.2	18.8
C	0.5	6.7	0.4	8
D	0.5	7	0.4	9.7
E	1.4	18.8	0.5	20.8
F	0.2	2.5	0.2	3
	5.9	81.8	4.5	95.6

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 1

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Span =	4 m	
Pipe Dia. (D _o) =	2 m	From 12d
Slope =	0.5 %	From 12d
Flow (Q) =	4.000 m ³ /s	From Hec Ras
Velocity (V) =	1 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d _p) =	2 m	
Downstream channel material:	Sandy loam, noncolloidal ▼	
Max velocity for erosion control (V _{max}):	0.5 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F _o) = V / (g × d _p) ^{0.5}	= 0.2258	
Riprap Diameter (d _s) = 0.25 × D _o × F _o	= 0.11	m
Thickness of Riprap (D _A) = 2 × d _s	= 0.23	m
Length of Riprap (L _A) = D _o × (8 + 17 × LogF _o)	= -5.98	m
Head Width of Riprap (W _A) = 3 × D _o	= 6.00	m
Tail Width of Riprap (W _T) = L _A × 2/3 + W _A	= 2.02	m
Height of Riprap (H) = crown of pipe + 300 mm	= 2.30	m

HEC14 V3, 2006

Tail Water Depth (TW) = 0.4 × D _o	= 0.80	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D ₅₀) = 0.2 × D (Q/g ^{0.5} D ^{2.5}) ^{4/3} (D/TW)	= 0.137	m	
Thickness of Riprap (D _A) = 3.5 × D ₅₀	= 0.48	m	
Length of Riprap (L) = 4 × D	= 8.00	m	
Head Width of Riprap (W _H) = 3 × D _o	= 6.00	m	
Tail Width of Riprap (W _T) = L × 2/3 + W _H	= 11.33	m	

Wingwall Dimensions

Tail Width of Wingwall (W _w) =	m
Height of Wingwall (H _w) =	m

Riprap Dimensions

Design Method (TP10 or HEC14) =	HEC14 ▼	
Riprap Diameter (d _s) =	0.14 m	use 0.15
Thickness of Riprap (D _A) =	0.48 m	use 0.5
Length of Riprap (L _A) =	8.00 m	
Head Width of Riprap (W _H) =	6.00 m	
Tail Width of Riprap (W _T) =	11.33 m	
Height of Riprap (H) =	- m	

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 2

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Span =	2 m	
Pipe Dia. (D _o) =	2 m	From 12d
Slope =	0.5 %	From 12d
Flow (Q) =	3.000 m ³ /s	From Hec Ras
Velocity (V) =	1 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d _p) =	2 m	
Downstream channel material:	Sandy loam, noncolloidal	
Max velocity for erosion control (V _{max}):	0.5 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F _o) = V / (g × d _p) ^{0.5}	= 0.2258	
Riprap Diameter (d _s) = 0.25 × D _o × F _o	= 0.11	m
Thickness of Riprap (D _A) = 2 × d _s	= 0.23	m
Length of Riprap (L _A) = D _o × (8 + 17 × LogF _o)	= -5.98	m
Head Width of Riprap (W _A) = 3 × D _o	= 6.00	m
Tail Width of Riprap (W _T) = L _A × 2/3 + W _A	= 2.02	m
Height of Riprap (H) = crown of pipe + 300 mm	= 2.30	m

HEC14 V3, 2006

Tail Water Depth (TW) = 0.4 × D _o	= 0.80	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D ₅₀) = 0.2 × D (Q/g ^{0.5} D ^{2.5}) ^{4/3} (D/TW)	= 0.094	m	
Thickness of Riprap (D _A) = 3.5 × D ₅₀	= 0.33	m	
Length of Riprap (L) = 4 × D	= 8.00	m	
Head Width of Riprap (W _H) = 3 × D _o	= 6.00	m	
Tail Width of Riprap (W _T) = L × 2/3 + W _H	= 11.33	m	

Wingwall Dimensions

Tail Width of Wingwall (W _w) =	m
Height of Wingwall (H _w) =	m

Riprap Dimensions

Design Method (TP10 or HEC14) =	HEC14	
Riprap Diameter (d _s) =	0.09 m	use 0.15
Thickness of Riprap (D _A) =	0.33 m	use 0.3
Length of Riprap (L _A) =	8.00 m	
Head Width of Riprap (W _H) =	6.00 m	
Tail Width of Riprap (W _T) =	11.33 m	
Height of Riprap (H) =	- m	

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 3

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Span =	3 m	
Pipe Dia. (D _o) =	2 m	From 12d
Slope =	0.5 %	From 12d
Flow (Q) =	3.000 m ³ /s	From Hec Ras
Velocity (V) =	1.5 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d _p) =	1.5 m	
Downstream channel material:	Kikuyu grass - low	
Max velocity for erosion control (V _{max}):	1.9 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F _o) = V/(g × d _p) ^{0.5}	= 0.3910	
Riprap Diameter (d _s) = 0.25 × D _o × F _o	= 0.20	m
Thickness of Riprap (D _A) = 2 × d _s	= 0.39	m
Length of Riprap (L _A) = D _o × (8 + 17 × LogF _o)	= 2.14	m
Head Width of Riprap (W _A) = 3 × D _o	= 6.00	m
Tail Width of Riprap (W _T) = L _A × 2/3 + W _A	= 7.42	m
Height of Riprap (H) = crown of pipe + 300 mm	= 2.30	m

HEC14 V3, 2006

Tail Water Depth (TW) = 0.4 × D _o	= 0.80	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D ₅₀) = 0.2 × D (Q/g ^{0.5} D ^{2.5}) ^{4/3} (D/TW)	= 0.094	m	
Thickness of Riprap (D _A) = 3.5 × D ₅₀	= 0.33	m	
Length of Riprap (L) = 4 × D	= 8.00	m	
Head Width of Riprap (W _H) = 3 × D _o	= 6.00	m	
Tail Width of Riprap (W _T) = L × 2/3 + W _H	= 11.33	m	

Wingwall Dimensions

Tail Width of Wingwall (W _w) =	m
Height of Wingwall (H _w) =	m

Riprap Dimensions

V < V_{max}, No Riprap required, use wingwall with apron

Design Method (TP10 or HEC14) =	HEC14	
Riprap Diameter (d _s) =	0.09 m	use 0.3
Thickness of Riprap (D _A) =	0.33 m	use 0.35
Length of Riprap (L _A) =	8.00 m	
Head Width of Riprap (W _H) =	6.00 m	
Tail Width of Riprap (W _T) =	11.33 m	
Height of Riprap (H) =	- m	

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 4,6

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Span =	4 m	
Pipe Dia. (D _o) =	1 m	From 12d
Slope =	0.5 %	From 12d
Flow (Q) =	1.500 m ³ /s	From Hec Ras
Velocity (V) =	1.5 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d _p) =	1 m	
Downstream channel material:	Kikuyu grass - low	
Max velocity for erosion control (V _{max}):	1.9 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F _o) = V / (g × d _p) ^{0.5}	= 0.4789	
Riprap Diameter (d _s) = 0.25 × D _o × F _o	= 0.12	m
Thickness of Riprap (D _A) = 2 × d _s	= 0.24	m
Length of Riprap (L _A) = D _o × (8 + 17 × LogF _o)	= 2.56	m
Head Width of Riprap (W _A) = 3 × D _o	= 3.00	m
Tail Width of Riprap (W _T) = L _A × 2/3 + W _A	= 4.71	m
Height of Riprap (H) = crown of pipe + 300 mm	= 1.30	m

HEC14 V3, 2006

Tail Water Depth (TW) = 0.4 × D _o	= 0.40	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D ₅₀) = 0.2 × D (Q/g ^{0.5} D ^{2.5}) ^{4/3} (D/TW)	= 0.187	m	
Thickness of Riprap (D _A) = 3.3 × D ₅₀	= 0.62	m	
Length of Riprap (L) = 4 × D	= 4.00	m	
Head Width of Riprap (W _H) = 3 × D _o	= 3.00	m	
Tail Width of Riprap (W _T) = L × 2/3 + W _H	= 5.67	m	

Wingwall Dimensions

Tail Width of Wingwall (W _w) =	m
Height of Wingwall (H _w) =	m

Riprap Dimensions

V < V_{max}, No Riprap required, use wingwall with apron

Design Method (TP10 or HEC14) =	HEC14	
Riprap Diameter (d _s) =	0.19 m	use 0.3
Thickness of Riprap (D _A) =	0.62 m	use 0.65
Length of Riprap (L _A) =	4.00 m	
Head Width of Riprap (W _H) =	3.00 m	
Tail Width of Riprap (W _T) =	5.67 m	
Height of Riprap (H) =	- m	

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 7 and 8

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Pipe Dia. (D_o) =	0.6 m x2	From 12d
Slope =	3 %	From 12d
Flow (Q) =	0.800 m ³ /s	From Hec Ras
Velocity (V) =	1 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d_p) =	0.6 m	
Downstream channel material:	Kikuyu grass - low	
Design velocity for erosion control (V_{max}):	1.9 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) = $V / (g \times d_p)^{0.5}$	= 0.4122	
Riprap Diameter (d_s) = $0.25 \times D_o \times F_o$	= 0.06	m
Thickness of Riprap (D_A) = $2 \times d_s$	= 0.12	m
Length of Riprap (L_A) = $D_o \times (8 + 17 \times \log F_o)$	= 0.87	m
Head Width of Riprap (W_A) = $3 \times D_o$	= 1.80	m
Tail Width of Riprap (W_T) = $L_A \times 2/3 + W_A$	= 2.38	m
Height of Riprap (H) = crown of pipe + 300 mm	= 0.90	m

HEC14 V3, 2006

Tail Water Depth (TW) = $0.4 \times D_o$	= 0.24	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D_{50}) = $0.2 \times D \left(\frac{Q}{g^{0.5} D^{2.5}} \right)^{4/3} (D/TW)$	= 0.267	m	
Thickness of Riprap (D_A) = $2.4 \times D_{50}$	= 0.64	m	
Length of Riprap (L) = $5 \times D$	= 3.00	m	
Head Width of Riprap (W_H) = $3 \times D_o$	= 1.80	m	
Tail Width of Riprap (W_T) = $L \times 2/3 + W_H$	= 3.80	m	

Wingwall Dimensions

Tail Width of Wingwall (W_w) =	m
Height of Wingwall (H_w) =	m

Riprap Dimensions

$V < V_{max}$, No Riprap required, use wingwall with apron

Design Method (TP10 or HEC14) =	HEC14	
Riprap Diameter (d_s) =	0.27	m
Thickness of Riprap (D_A) =	0.64	m
Length of Riprap (L_A) =	3.00	m
Head Width of Riprap (W_H) =	1.80	m
Tail Width of Riprap (W_T) =	3.80	m
Height of Riprap (H) =	-	m

use 0.3
use 0.65

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 9

DATE: 01 August 2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Pipe Dia. (D_o) =	0.2 m	From 12d
Slope =	6 %	From 12d
Flow (Q) =	0.030 m ³ /s	From Hec Ras
Velocity (V) =	0.03 m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d_p) =	0.2 m	
Downstream channel material:	Kikuyu grass - low	
Max velocity for erosion control (V_{max}):	1.9 m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) = $V / (g \times d_p)^{0.5}$	= 0.0214	
Riprap Diameter (d_s) = $0.25 \times D_o \times F_o$	= 0.00	m
Thickness of Riprap (D_A) = $2 \times d_s$	= 0.00	m
Length of Riprap (L_A) = $D_o \times (8 + 17 \times \log F_o)$	= -4.08	m
Head Width of Riprap (W_A) = $3 \times D_o$	= 0.60	m
Tail Width of Riprap (W_T) = $L_A \times 2/3 + W_A$	= -2.12	m
Height of Riprap (H) = crown of pipe + 300 mm	= 0.50	m

HEC14 V3, 2006

Tail Water Depth (TW) = $0.4 \times D_o$	= 0.08	m	Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Riprap Size (D_{50}) = $0.2 \times D \times (Q/g^{0.5} D^{2.5})^{4/3} (D/TW)$	= 0.043	m	
Thickness of Riprap (D_A) = $3.5 \times D_{50}$	= 0.15	m	
Length of Riprap (L) = $4 \times D$	= 0.80	m	
Head Width of Riprap (W_H) = $3 \times D_o$	= 0.60	m	
Tail Width of Riprap (W_T) = $L \times 2/3 + W_H$	= 1.13	m	

Wingwall Dimensions

Tail Width of Wingwall (W_w) =	m
Height of Wingwall (H_w) =	m

Riprap Dimensions

$V < V_{max}$, No Riprap required, use wingwall with apron

Design Method (TP10 or HEC14) =	HEC14	
Riprap Diameter (d_s) =	0.04 m	use 0.15
Thickness of Riprap (D_A) =	0.15 m	use 0.15
Length of Riprap (L_A) =	0.80 m	
Head Width of Riprap (W_H) =	0.60 m	
Tail Width of Riprap (W_T) =	1.13 m	
Height of Riprap (H) =	- m	

Channel Report

Section 01

User-defined

Invert Elev (m)

= 25.9340

Slope (%)

= 3.1000

N-Value

= 0.012

Highlighted

Depth (m)

= 0.0884

Q (cms)

= 0.4900

Area (sqm)

= 0.3082

Velocity (m/s)

= 1.5900

Wetted Perim (m)

= 7.9599

Crit Depth, Yc (m)

= 0.1250

Top Width (m)

= 7.9108

EGL (m)

= 0.2173

Calculations

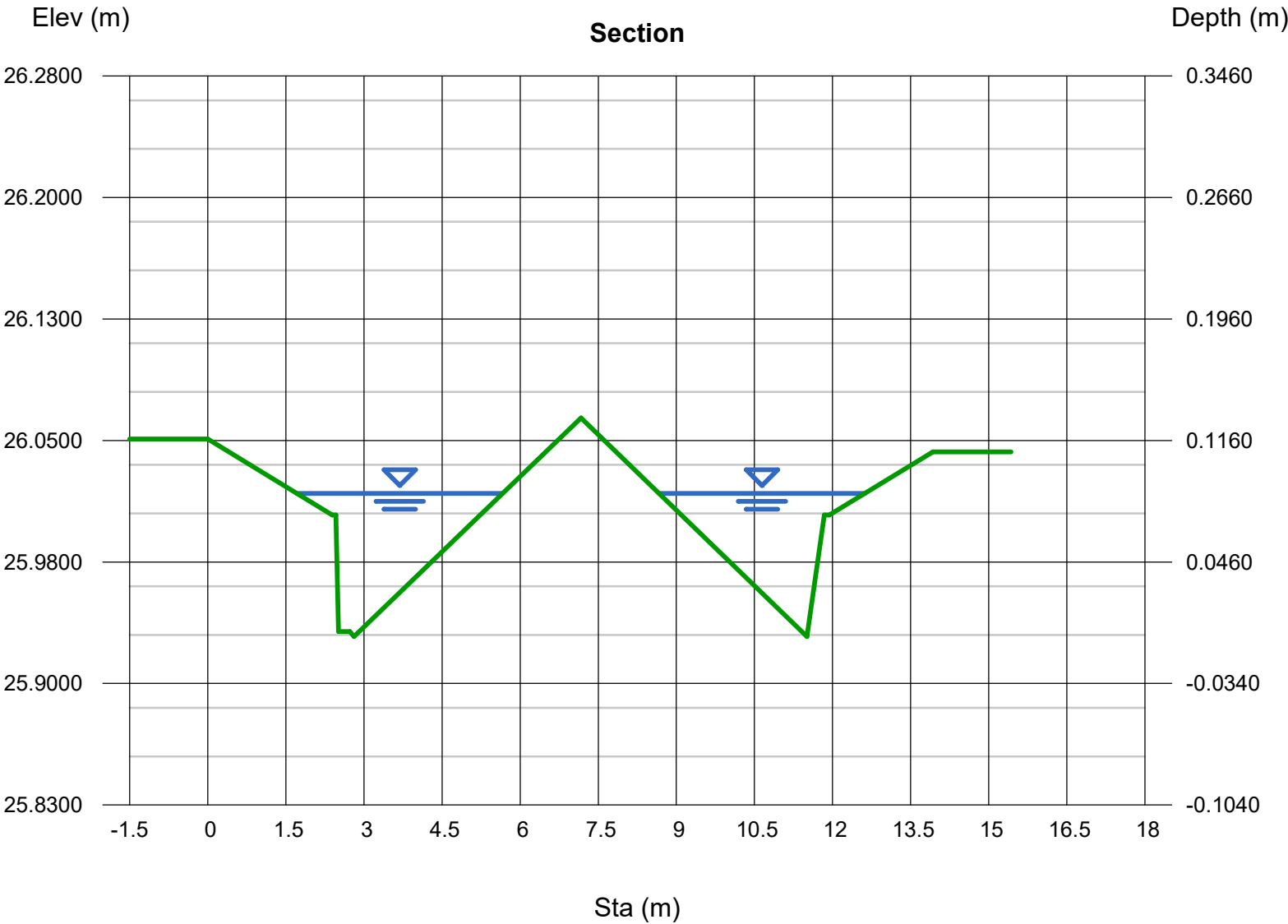
Compute by:Known Q

Known Q (cms)

= 0.4900

(Sta, El, n)-(Sta, El, n)...

(0.0000, 26.0560)-(2.3900, 26.0090, 0.012)-(2.4600, 26.0090, 0.012)-(2.5100, 25.9370, 0.012)-(2.7300, 25.9370, 0.012)-(2.8100, 25.9340, 0.012)-(7.1700, 26.0690, 0.012)-(11.5100, 25.9340, 0.012)-(11.8400, 26.0090, 0.012)-(11.9400, 26.0090, 0.012)-(13.9300, 26.0480, 0.012)

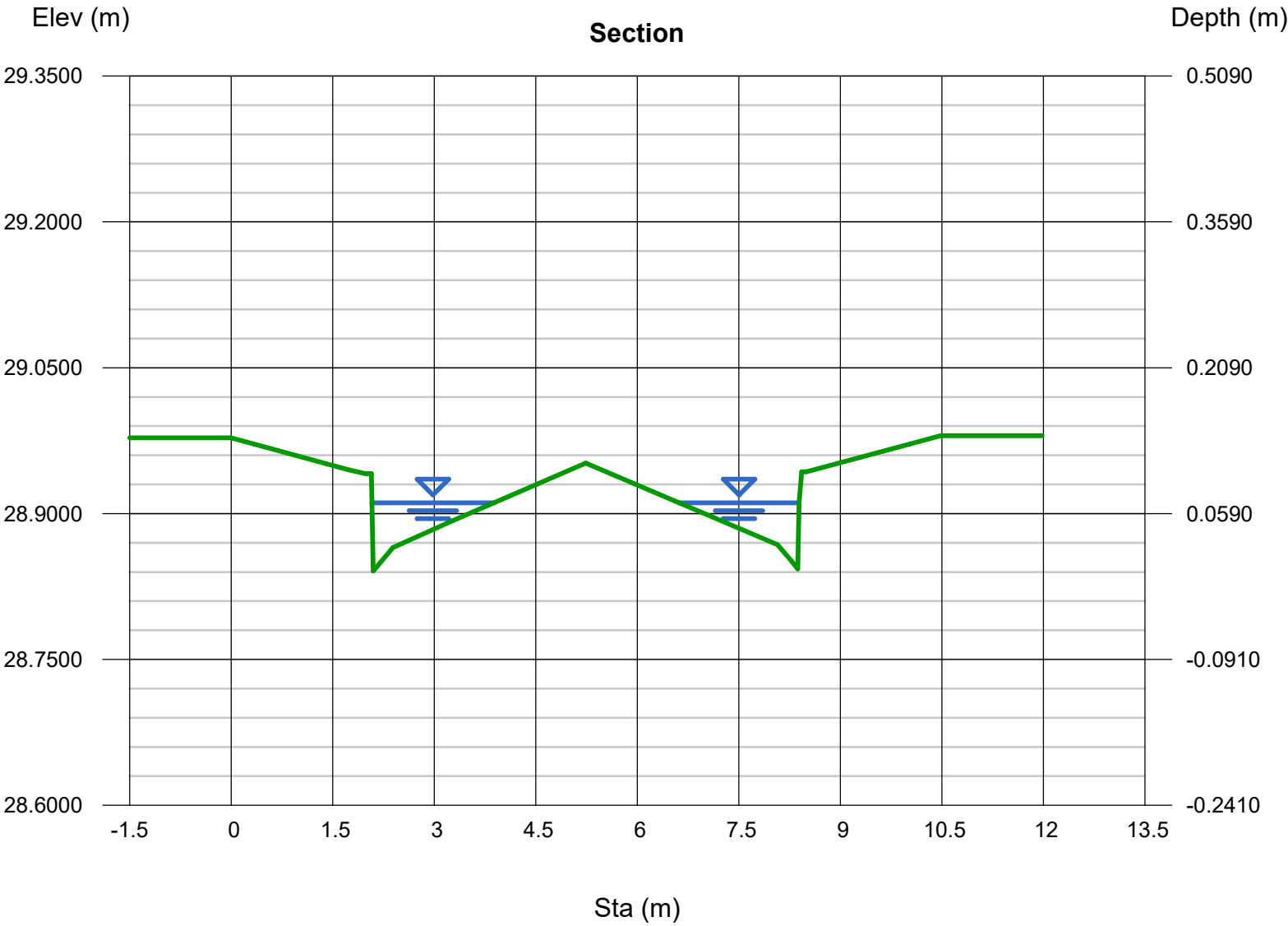


Channel Report

Section 02

User-defined		Highlighted	
Invert Elev (m)	= 28.8410	Depth (m)	= 0.0701
Slope (%)	= 3.1000	Q (cms)	= 0.120
N-Value	= 0.012	Area (sqm)	= 0.1002
Calculations		Velocity (m/s)	= 1.1977
Compute by:	Known Q	Wetted Perim (m)	= 3.6813
Known Q (cms)	= 0.1200	Crit Depth, Yc (m)	= 0.0945
		Top Width (m)	= 3.5749
		EGL (m)	= 0.1433

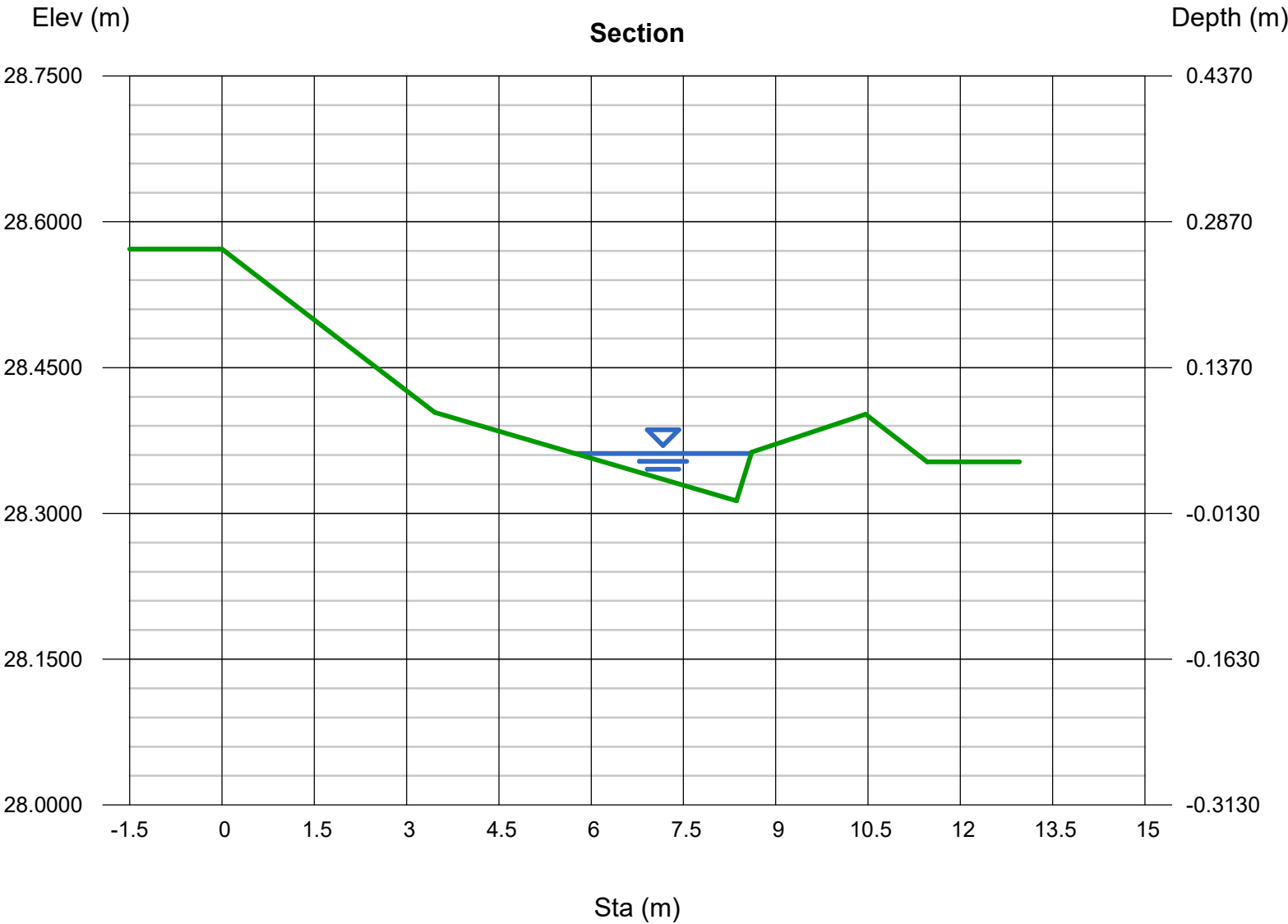
(Sta, El, n)-(Sta, El, n)...
(0.0000, 28.9780)-(1.7400, 28.9450, 0.012)-(1.9800, 28.9410, 0.012)-(2.0700, 28.9410, 0.012)-(2.1000, 28.8410, 0.012)-(2.3900, 28.8650, 0.012)-(3.2800, 28.8930, 0.012)-(5.2400, 28.9520, 0.012)-(8.0700, 28.8680, 0.012)-(8.2800, 28.8510, 0.012)-(8.3700, 28.8430, 0.012)-(8.3900, 28.9110, 0.012)-(8.4300, 28.9430, 0.012)-(8.5000, 28.9520, 0.012)-(9.6300, 28.9640, 0.012)-(10.4800, 28.9800, 0.012)



Channel Report

Section 03

User-defined		Highlighted	
Invert Elev (m)	= 28.3130	Depth (m)	= 0.0488
Slope (%)	= 5.3000	Q (cms)	= 0.100
N-Value	= 0.012	Area (sqm)	= 0.0708
Calculations Compute by: Known Q Known Q (cms) = 0.1000		Velocity (m/s)	= 1.4131
		Wetted Perim (m)	= 3.0544
		Crit Depth, Yc (m)	= 0.0762
		Top Width (m)	= 3.0489
		EGL (m)	= 0.1506
(Sta, El, n)-(Sta, El, n)... (0.0000, 28.5720)-(3.4600, 28.4040, 0.012)-(8.3600, 28.3130, 0.012)-(8.6100, 28.3630, 0.012)-(10.4600, 28.4020, 0.012)-(11.4600, 28.3530, 0.012)			



Channel Report

Section 04

User-defined

Invert Elev (m) = 25.3810
Slope (%) = 3.0000
N-Value = 0.012

Highlighted

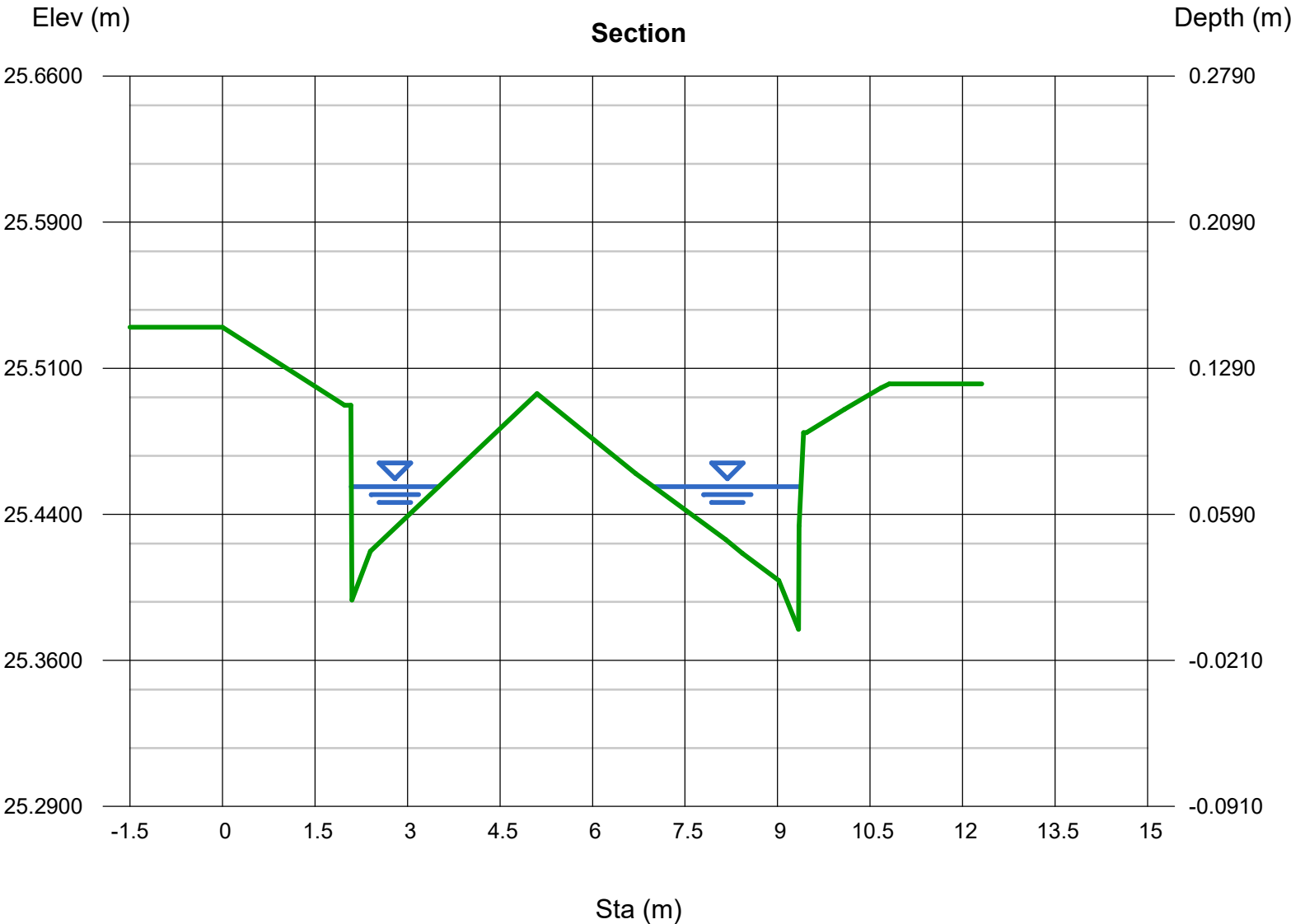
Depth (m) = 0.0732
Q (cms) = 0.110
Area (sqm) = 0.1009
Velocity (m/s) = 1.0901
Wetted Perim (m) = 3.9029
Crit Depth, Yc (m) = 0.0945
Top Width (m) = 3.8020
EGL (m) = 0.1338

Calculations

Compute by: Known Q
Known Q (cms) = 0.1100

(Sta, El, n)-(Sta, El, n)...

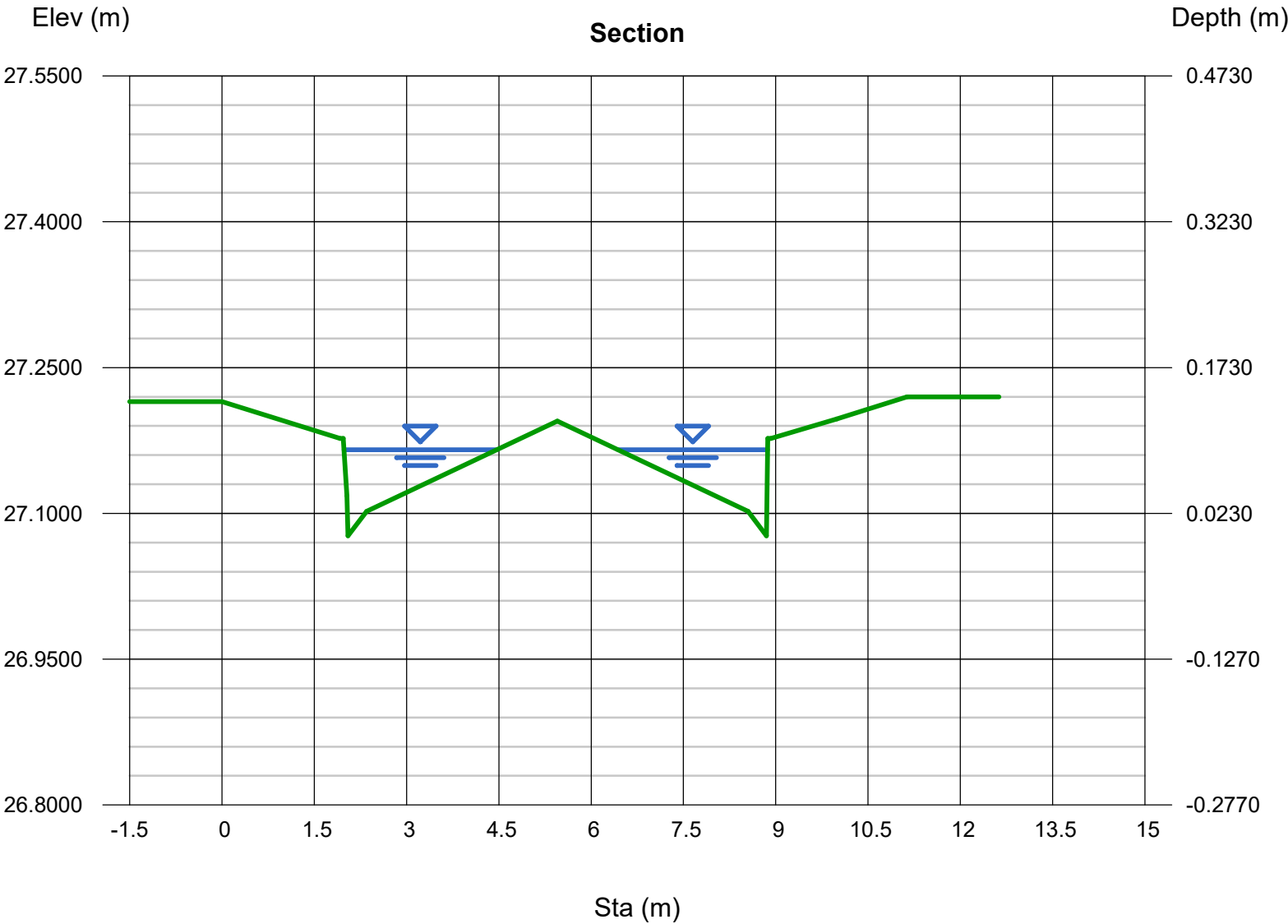
(0.0000, 25.5360)-(1.9800, 25.4960, 0.012)-(2.0800, 25.4960, 0.012)-(2.1000, 25.3960, 0.012)-(2.4000, 25.4210, 0.012)-(5.1000, 25.5020, 0.012)-(6.7000, 25.4610, 0.012)-(8.1600, 25.4270, 0.012)-(8.4300, 25.4200, 0.012)-(9.0200, 25.4060, 0.012)-(9.3400, 25.3810, 0.012)-(9.3500, 25.4340, 0.012)-(9.4200, 25.4820, 0.012)-(9.4700, 25.4820, 0.012)-(10.0900, 25.4940, 0.012)-(10.6800, 25.5050, 0.012)-(10.8100, 25.5070, 0.012)



Channel Report

Section 05

User-defined		Highlighted	
Invert Elev (m)	= 27.0770	Depth (m)	= 0.0884
Slope (%)	= 3.0000	Q (cms)	= 0.260
N-Value	= 0.012	Area (sqm)	= 0.1828
Calculations Compute by: Known Q Known Q (cms) = 0.2600		Velocity (m/s)	= 1.4226
		Wetted Perim (m)	= 5.0334
		Crit Depth, Yc (m)	= 0.1219
		Top Width (m)	= 4.9119
		EGL (m)	= 0.1916
(Sta, El, n)-(Sta, El, n)... (0.0000, 27.2150)-(1.9200, 27.1770, 0.012)-(1.9700, 27.1770, 0.012)-(2.0300, 27.1180, 0.012)-(2.0500, 27.0770, 0.012)-(2.3500, 27.1020, 0.012)-(5.4500, 27.1950, 0.012)-(8.5500, 27.1020, 0.012)-(8.8500, 27.0770, 0.012)-(8.8700, 27.1770, 0.012)-(8.9200, 27.1770, 0.012)-(9.9900, 27.1970, 0.012)-(11.1300, 27.2200, 0.012)			



Channel Report

Section 06

User-defined

Invert Elev (m)

= 24.4770

Slope (%)

= 3.1000

N-Value

= 0.012

Highlighted

Depth (m)

= 0.1006

Q (cms)

= 0.250

Area (sqm)

= 0.1648

Velocity (m/s)

= 1.5172

Wetted Perim (m)

= 4.6764

Crit Depth, Yc (m)

= 0.1341

Top Width (m)

= 4.5453

EGL (m)

= 0.2180

Calculations

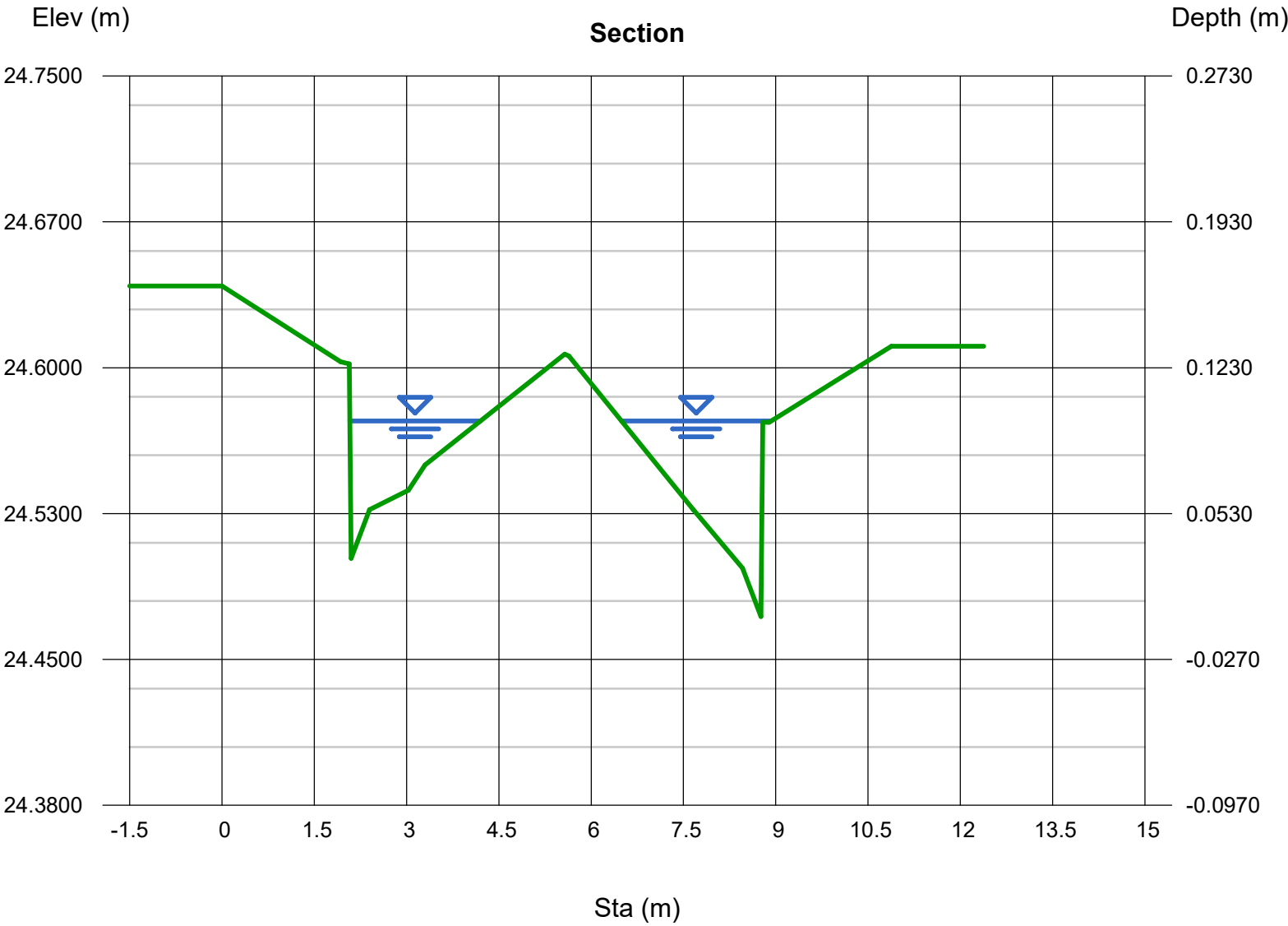
Compute by:Known Q

Known Q (cms)

= 0.2500

(Sta, El, n)-(Sta, El, n)...

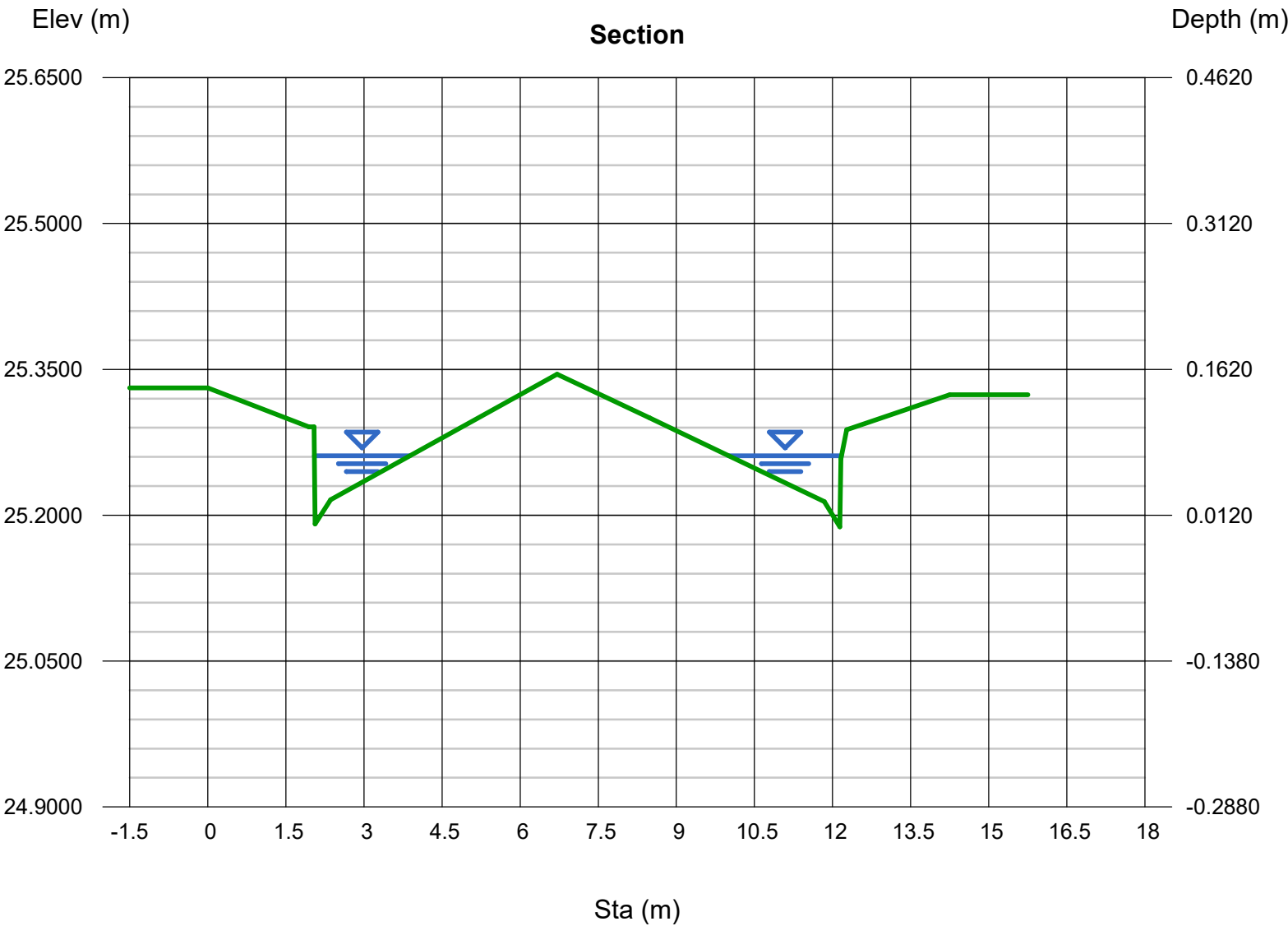
(0.0000, 24.6470)-(1.9300, 24.6080, 0.012)-(2.0700, 24.6070, 0.012)-(2.1000, 24.5070, 0.012)-(2.4000, 24.5320, 0.012)-(3.0300, 24.5420, 0.012)-(3.3000, 24.5550, 0.012)-(5.5700, 24.6120, 0.012)-(5.6400, 24.6110, 0.012)-(5.8200, 24.6040, 0.012)-(7.6600, 24.5320, 0.012)-(8.4600, 24.5020, 0.012)-(8.7600, 24.4770, 0.012)-(8.7900, 24.5550, 0.012)-(8.8900, 24.5770, 0.012)-(10.8800, 24.6160, 0.012)



Channel Report

Section 07

User-defined		Highlighted	
Invert Elev (m)	= 25.1880	Depth (m)	= 0.0732
Slope (%)	= 3.4000	Q (cms)	= 0.150
N-Value	= 0.012	Area (sqm)	= 0.1143
Calculations		Velocity (m/s)	= 1.3125
Compute by:	Known Q	Wetted Perim (m)	= 4.1190
Known Q (cms)	= 0.1500	Crit Depth, Yc (m)	= 0.1006
		Top Width (m)	= 4.0048
		EGL (m)	= 0.1610
(Sta, El, n)-(Sta, El, n)...			
(0.0000, 25.3310)-(1.9400, 25.2910, 0.012)-(2.0400, 25.2910, 0.012)-(2.0600, 25.1910, 0.012)-(2.3600, 25.2160, 0.012)-(6.7100, 25.3450, 0.012)-(8.4900, 25.3000, 0.012)-(11.8400, 25.2140, 0.012)-(12.1400, 25.1880, 0.012)-(12.1600, 25.2580, 0.012)-(12.2700, 25.2880, 0.012)-(14.2500, 25.3240, 0.012)			



Channel Report

Section 08

User-defined

Invert Elev (m) = 45.6320
Slope (%) = 1.0000
N-Value = 0.012

Calculations

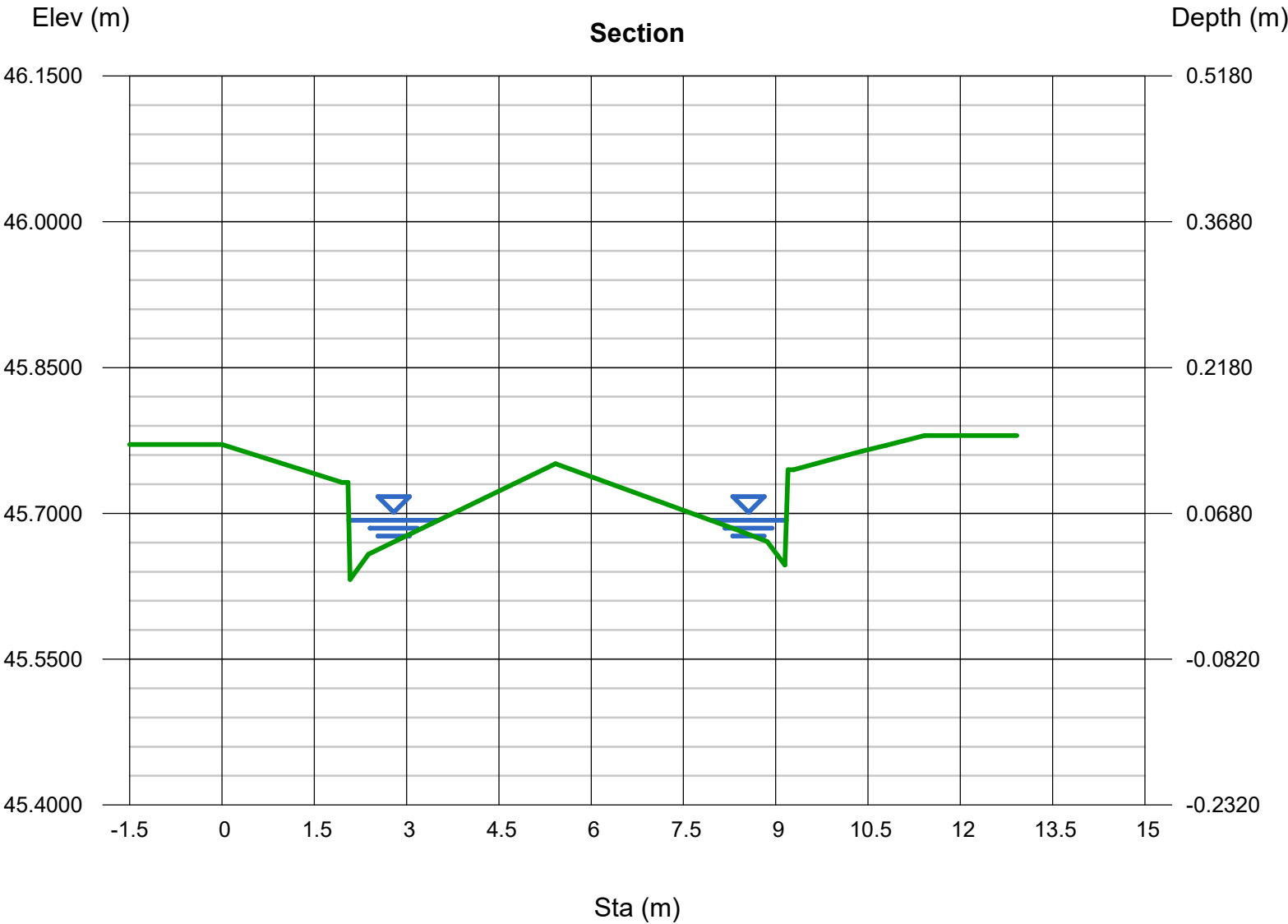
Compute by: Known Q
Known Q (cms) = 0.0300

Highlighted

Depth (m) = 0.0610
Q (cms) = 0.030
Area (sqm) = 0.0552
Velocity (m/s) = 0.5431
Wetted Perim (m) = 2.7702
Crit Depth, Yc (m) = 0.0671
Top Width (m) = 2.6938
EGL (m) = 0.0760

(Sta, El, n)-(Sta, El, n)...

(0.0000, 45.7710)-(1.9500, 45.7320, 0.012)-(2.0500, 45.7320, 0.012)-(2.0800, 45.6320, 0.012)-(2.3800, 45.6580, 0.012)-(5.4200, 45.7510, 0.012)-(8.3300, 45.6840, 0.012)-(8.8600, 45.6710, 0.012)-(9.0300, 45.6570, 0.012)-(9.1500, 45.6470, 0.012)-(9.2000, 45.7450, 0.012)-(9.2900, 45.7450, 0.012)-(10.0400, 45.7580, 0.012)-(10.4100, 45.7700, 0.012)-(11.4200, 45.7800, 0.012)



Channel Report

Section 09

User-defined

Invert Elev (m)

= 51.0020

Slope (%)

= 4.2000

N-Value

= 0.012

Highlighted

Depth (m)

= 0.1280

Q (cms)

= 1.0000

Area (sqm)

= 0.4564

Velocity (m/s)

= 2.1909

Wetted Perim (m)

= 9.2325

Crit Depth, Yc (m)

= 0.1390

Top Width (m)

= 9.0873

EGL (m)

= 0.3729

Calculations

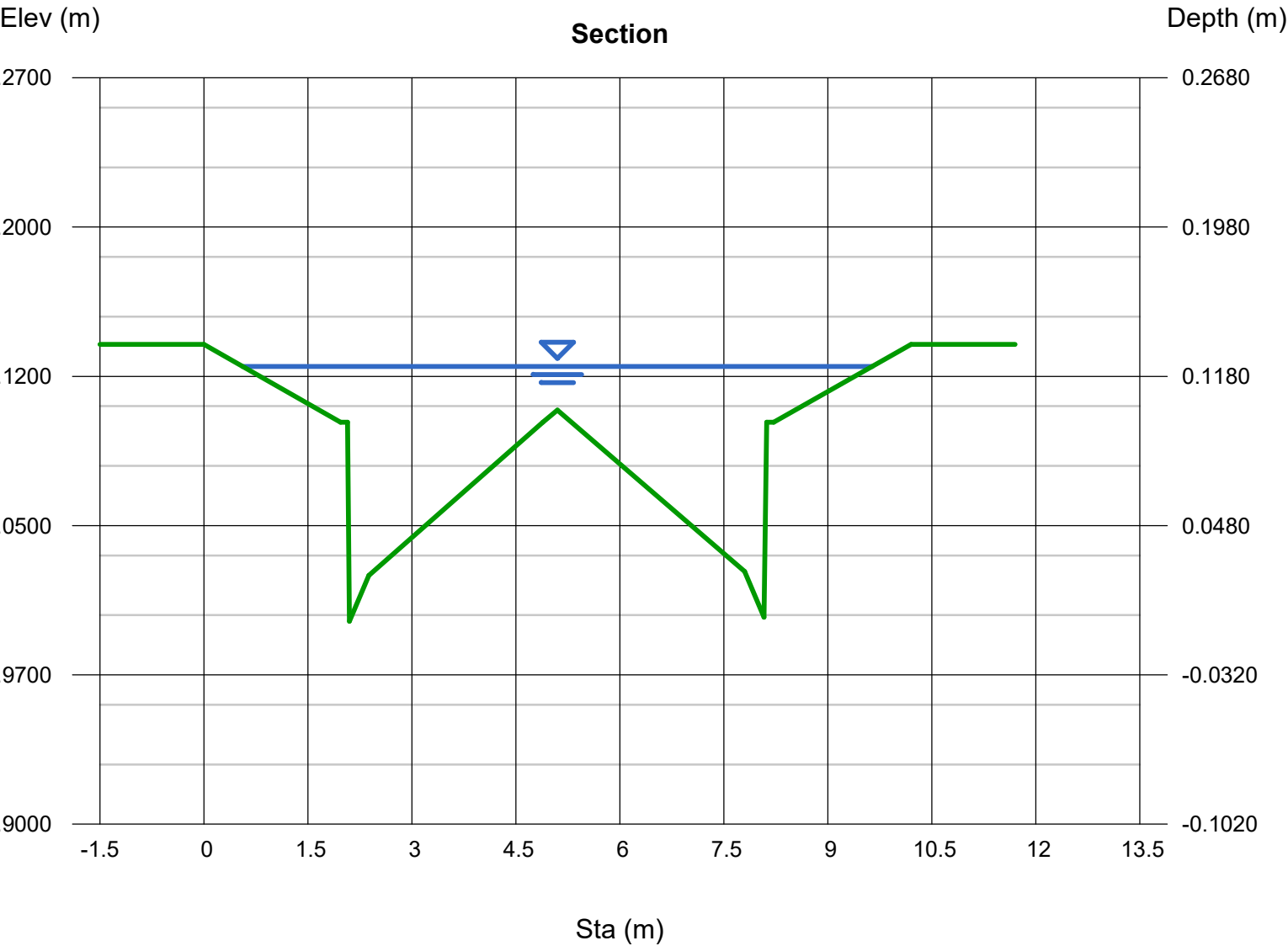
Compute by:Known Q

Known Q (cms)

= 1.0000

(Sta, El, n)-(Sta, El, n)...

(0.0000, 51.1410)-(1.9700, 51.1020, 0.012)-(2.0700, 51.1020, 0.012)-(2.1000, 51.0020, 0.012)-(2.3800, 51.0250, 0.012)-(4.8900, 51.1020, 0.012)-(5.1000, 51.1080, 0.012)-(7.8000, 51.0270, 0.012)-(8.0800, 51.0040, 0.012)-(8.1200, 51.1020, 0.012)-(8.2200, 51.1020, 0.012)-(10.2000, 51.1410, 0.012)



Channel Report

Section 10

User-defined

Invert Elev (m) = 29.6160
Slope (%) = 2.5000
N-Value = 0.012

Calculations

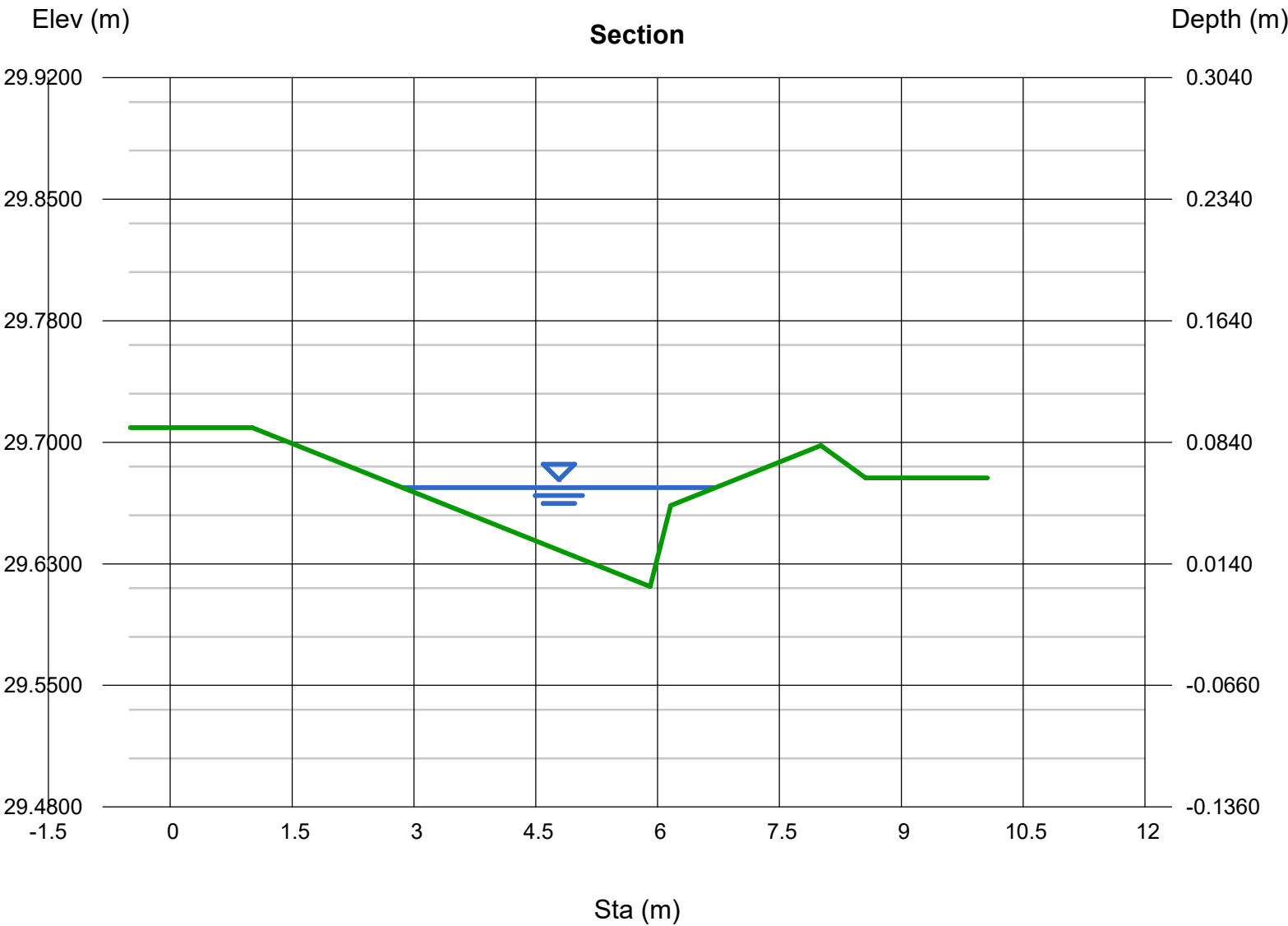
Compute by: Known Q
Known Q (cms) = 0.1100

Highlighted

Depth (m) = 0.0610
Q (cms) = 0.110
Area (sqm) = 0.1049
Velocity (m/s) = 1.0487
Wetted Perim (m) = 3.8515
Crit Depth, Yc (m) = 0.0823
Top Width (m) = 3.8458
EGL (m) = 0.1171

(Sta, El, n)-(Sta, El, n)...

(1.0100, 29.7140)-(5.9100, 29.6160, 0.012)-(6.1600, 29.6660, 0.012)-(8.0100, 29.7030, 0.012)-(8.5600, 29.6830, 0.012)



Sitename: Custom Location
Coordinate system: WGS84
Longitude: 175.1999
Latitude: -37.7835
DDF Model Parameters c d e f g h i
Values: -0.00215 0.401549 -0.02037 0 0.249692 -0.0089 2.980058
Example: Duration (h ARI (yrs) x y Rainfall Depth (mm)
24 100 3.178054 4.600149 145.3728

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.98	12.4	14.8	19.7	25.7	37.8	47.1	57.4	68.6	75.5	80.5	84.4
2	0.5	9.84	13.5	16.2	21.6	28.2	41.4	51.4	62.7	74.9	82.4	87.8	92 2yr
5	0.2	12.9	17.7	21.1	28.1	36.6	53.7	66.6	81	96.7	106	113	118
10	0.1	15.2	20.8	24.8	33	43	62.9	78	94.8	113	124	132	138 10yr
20	0.05	17.6	24.2	28.8	38.2	49.8	72.7	90	109	130	143	152	159
30	0.033	19.1	26.2	31.2	41.4	53.9	78.6	97.2	118	140	154	164	171
40	0.025	20.2	27.7	33	43.7	56.9	82.9	103	124	148	162	172	180
50	0.02	21.1	28.9	34.3	45.6	59.2	86.3	107	129	154	169	179	188
60	0.017	21.8	29.8	35.5	47.1	61.2	89.1	110	134	159	174	185	193
80	0.013	23	31.4	37.4	49.5	64.3	93.6	116	140	167	182	194	203
100	0.01	23.9	32.6	38.8	51.4	66.8	97.2	120	145	173	189	201	210 100yr
250	0.004	27.8	37.9	45	59.6	77.3	112	138	167	198	217	231	241

Per RITS Amendments for Design Rainfall 2020

RCP 6.0 2.3deg (mm)	RCP 8.5 4deg (mm)
24h	24h
	81
	126
	195

Depth standard error (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	0.68	0.85	1	1.5	1.9	3	3.7	4.5	5.3	5.6	6.1	6.6
2	0.5	0.74	0.92	1.1	1.6	2	3.3	4	4.9	5.8	6	6.6	7.1
5	0.2	1.2	1.5	1.8	2.4	3	4.6	5.7	6.6	8	8.2	9.1	9.8
10	0.1	1.7	2.2	2.7	3.3	4.2	6.2	7.6	8.3	10	10	11	12
20	0.05	2.4	3.1	4	4.6	5.8	8.5	10	11	13	13	15	16
30	0.033	2.9	3.8	4.9	5.6	7	10	12	12	15	15	17	19
40	0.025	3.3	4.3	5.6	6.4	8	12	14	13	16	17	19	21
50	0.02	3.7	4.8	6.3	7	8.8	13	15	14	18	19	20	22
60	0.017	4	5.2	6.8	7.6	9.6	14	16	15	19	20	22	24
80	0.013	4.5	5.9	7.8	8.7	11	16	19	17	21	22	24	27
100	0.01	5	6.5	8.7	9.6	12	17	20	18	22	24	26	29
250	0.004	7.2	9.4	13	14	18	26	30	25	31	33	36	40

 Maven Associates			Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Catchment Areas		Author NAK	Date 10.09.25	Checked

Discharge point	Catchment Area (m2)	Ha
Dp 1	2685143	268.5143
Dp 2	266691	26.6691
Dp 3	7868	0.7868
Dp 4	200847	20.0847
Dp 5	805533	80.5533

	Maven Associates	Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Pre-development	Author NAK	Date 10.09.25	Checked

Discharge point Dp 1
 Total Catchment 2685143

1. Runoff Curve Number (CN) and initial Abstraction (Ia) CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 1000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	268.51	19870.06
C		Impervious (0%)	98	0.00	0.00
Totals =				268.51	19870.06

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{19870.06}{268.514} = \boxed{74.0}$

S = $\frac{(1000 - \text{CN})}{\text{CN}} \times 25.4 = \frac{(1000 - 74)}{74.0} \times 25.4 = \boxed{89.2} \text{ mm}$

Ia = $0.05 \times S = 0.05 \times 89.2 = \boxed{4.5} \text{ mm}$

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)

$T = 100nL^{0.33}/S^{0.2}$

L = 629 m

S = 0.50 %

n = 0.015

T = 14.449 mins

Concentrated Network Flow (to be completed at detail design)

0

Open Channel Flow

$V = R^{2/3} S^{1/2} / n$

R = A / Wp 0.33

w = 1

d = 1

l = 500

n = 0.04

s = 1%

(to be completed at detail design)

V = 0.8498537 m/s

T = 9.81 mins

$T_c = T_{\text{sheet flow}} + T_{\text{concentrated flow}} + T_{\text{open channel flow}}$

= 14.45 + 0.00 + 9.81

= 24.255 mins

0.4042513 hrs

= 0.271 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c$

OK use

0.27 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN HAMILTON\6. Projects\119014 - Brymer Farms\6. Engineering\3. Calculations\C400 SW\TR202006 Existing Discharge points

	Maven Associates		Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Pre-development		Author NAK	Date 10.09.25	Checked

Discharge point Dp 2
 Total Catchment 266691

1. Runoff Curve Number (CN) and initial Abstraction (Ia) CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	26.67	1973.51
C		Impervious (0%)	98	0.00	0.00
					0.00
Totals =				26.67	1973.51

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1973.51}{26.669} =$ 74.0

S= $\frac{(1000}{CN} - 10) * 25.4}{74.0} = 91.2$ 145.0 mm

Ia= $0.05 * S = 0.05 * 145.0 =$ 7.3 mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)

$T = 100nL^{0.33}/S^{0.2}$

L= 629 m
 S= 1.10 %
 n= 0.015
 T= 12.341 mins

Concentrated Network Flow (to be completed at detail design) 0

Open Channel Flow (to be completed at detail design)

$V = R^{2/3} S^{1/2} / n$
 $R = A / Wp$

w= 1
 d= 1
 l= 500

n= 0.04
 s= 1%

V= 1.2605368 m/s
 T= 6.61 mins

$T_c = T_{\text{sheet flow}} + T_{\text{concentrated flow}} + T_{\text{open channel flow}}$

= 12.34 + 0.00 + 6.61

= 18.952 mins
 = 0.3158738 hrs

SCS Lag for HEC-HMS... $t_p = 2/3 t_c$ 0.21 hrs

OK

use

0.21 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

	Maven Associates		Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Pre-development		Author NAK	Date 10.09.25	Checked

Discharge point Dp 3
 Total Catchment 7868

1. Runoff Curve Number (CN) and initial Abstraction (Ia) CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	0.79	58.22
C		Impervious (0%)	98	0.00	0.00
Totals =					0.79 58.22

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{58.22}{0.787} =$ 74.0

S= $\frac{(1000}{\text{CN}} - 10) * 25.4 = \frac{(1000}{74.0} - 10) * 25.4 = 91.2$ 145.0 mm

Ia= $0.05 * S = 0.05 * 145.0 =$ 7.3 mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)

$T = 100nL^{0.33}/S^{0.2}$

L= 629 m
 S= 0.50 %
 n= 0.015
 T= 14.449 mins

Concentrated Network Flow (to be completed at detail design) 0

Open Channel Flow $V = R^{2/3} S^{1/2} / n$
 $R = A / Wp = 0.33$

(to be completed at detail design)

w= 1
 d= 1
 l= 500
 n= 0.04
 s= 1%
 V= 0.8498537 m/s
 T= 9.81 mins

$T_c = T_{\text{sheet flow}} + T_{\text{concentrated flow}} + T_{\text{open channel flow}}$

= 14.45 + 0.00 + 9.81 = 24.255 mins
 $\frac{24.255}{60} = 0.4042513$ hrs

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c =$ 0.271 hrs

OK use 0.27 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

	Job Title	Calc Title
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**Brymer Farms
Pre-development**

Author
NAK

Date
10.09.25

Checked

Dis Data

Catchment Area A= 0.007868 km²(100ha =1km²)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction la= 7.3 mm (from worksheet 1)

Time of concentration $t_c =$ 0.40 hrs (from worksheet 1)

2. Calculate storage, $S = (1000/CN - 10)25.4$ = 89 mm

3. Average recurrence interval, ARI

4. 24 hour rainfall depth, P24

*as per HIRDS Historical data

5. Compute $c^* = P_{24} - 2I_a / P_{24} - 2I_a + 2S$

6. Specific peak flow rate q^*

7. Peak flow rate, $q_p = q^* A P_{24}$

8. Runoff depth, $Q_{24} = (P_{24} - I_a)^2 / (P_{24} - I_a) + S$

9. Runoff volume, $V_{24} = 1000 \times Q_{24} \times A$

WQV			
1/3 of 2yr (yr)	2	10	100 yr
17.3 (mm)	52	78.9	121 (mm)
0.016	0.174	0.265	0.374
0.005	0.052	0.076	0.101
0.001 m ³ /s	0.021	0.047	0.096 m ³ /s
1.0	14.9	31.9	63.7
8 m ³	117.59	251.05	501.52 m ³

Worksheet 2: Graphical Peak Flow Rate

	Maven Associates		Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Pre-development		Author NAK	Date 10.09.25	Checked

Discharge point Dp 4
 Total Catchment 200847

1. Runoff Curve Number (CN) and initial Abstraction (Ia) CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	20.08	1486.27
C		Impervious (0%)	98	0.00	0.00
					0.00
Totals =				20.08	1486.27

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1486.27}{20.085} =$ 74.0

S= $\frac{(1000}{CN} - 10) * 25.4}{74.0} = 91.2$ 145.0 mm

Ia= $0.05 * S = 0.05 * 145.0 =$ 7.3 mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)

$T = 100nL^{0.33}/S^{0.2}$

L= 629 m

S= 0.40 %

n= 0.015

T= 15.109 mins

Concentrated Network Flow (to be completed at detail design) 0

Open Channel Flow

$V = R^{2/3} S^{1/2} / n$
 $R = A / Wp$

0.33

w= 1

d= 1

l= 500

n= 0.04

s= 1%

(to be completed at detail design)

V= 1.2018746 m/s

T= 6.93 mins

$T_c = T_{\text{sheet flow}} + T_{\text{concentrated flow}} + T_{\text{open channel flow}}$

= 15.11 + 0.00 + 6.93 = 22.043 mins

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c$ = 0.3673759 hrs

= 0.246 hrs

OK use 0.25 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN HAMILTON\6. Projects\119014 - Brymer Farms\6. Engineering\3. Calculations\C400 SW\TR202006 Existing Discharge points

[illegible]

**Brymer Farms
Pre-development**

Author
NAK

Date
10.09.25

Checked

Dis Data

Catchment Area $A = 0.200847 \text{ km}^2$ (100ha = 1km²)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction la= 7.3 mm (from worksheet 1)

Time of concentration $t_c =$ 0.37 hrs (from worksheet 1)

2. Calculate storage, $S = (1000/CN - 10)25.4$ = 89 mm

3. Average recurrence interval, ARI

4. 24 hour rainfall depth, P24

*as per HIRDS Historical data

5. Compute $c^* = P_{24} - 2I_a / P_{24} - 2I_a + 2S$

6. Specific peak flow rate q^*

7. Peak flow rate, $q_p = q \cdot A \cdot P_{24}$

8. Runoff depth, $Q_{24} = (P_{24} - I_a)^2 / (P_{24} - I_a) + S$

9. Runoff volume, $V_{24} = 1000 \times Q_{24} \times A$

WQV			
1/3 of 2yr (yr)	2	10	100 yr
17.3 (mm)	52	78.9	121 (mm)
0.016	0.174	0.265	0.374
0.005	0.052	0.076	0.101
0.018 m³/s	0.548	1.207	2.447 m³/s
1.0	14.9	31.9	63.7
206 m³	3001.71	6408.55	12802.26 m³

Worksheet 2: Graphical Peak Flow Rate

	Maven Associates		Job Number 119014	Sheet 1	Rev: A
Job Title Calc Title	Brymer Farms Pre-development		Author NAK	Date 10.09.25	Checked

Discharge point Dp 5
 Total Catchment 805533

1. Runoff Curve Number (CN) and initial Abstraction (Ia) CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	80.55	5960.94
C		Impervious (0%)	98	0.00	0.00
					0.00
Totals =				80.55	5960.94

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{5960.94}{80.553} =$ 74.0

S = $\frac{(1000}{\text{CN}} - 10) * 25.4 = \frac{(1000}{74.0} - 10) * 25.4 = 91.2$ 145.0 mm

Ia = $0.05 * S = 0.05 * 145.0 =$ 7.3 mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)

$T = 100nL^{0.33}/S^{0.2}$

L = 629 m

S = 0.40 %

n = 0.015

T = 15.109 mins

Concentrated Network Flow (to be completed at detail design) 0

Open Channel Flow

$V = R^{2/3} S^{1/2} / n$
 $R = A / Wp$

0.33

w = 1

d = 1

l = 500

n = 0.04

s = 1%

(to be completed at detail design)

V = 1.2018746 m/s

T = 6.93 mins

$T_c = T_{\text{sheet flow}} + T_{\text{concentrated flow}} + T_{\text{open channel flow}}$

= 15.11 + 0.00 + 6.93 = 22.043 mins

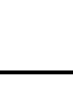
SCS Lag for HEC-HMS... $t_p = 2/3 t_c$ = 0.3673759 hrs

= 0.246 hrs

OK use 0.25 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN HAMILTON\6. Projects\119014 - Brymer Farms\6. Engineering\3. Calculations\C400 SW\TR202006 Existing Discharge points

 Maven Associates	Job Number 119014.00	Sheet 2	Rev: A
Job Title Calc Title	Author NAK	Date 10.09.25	Checked
Brymer Farms Pre-development			

Dis Data

Catchment Area A= 0.805533 km2(100ha =1km2)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction la= 7.3 mm (from worksheet 1)

Time of concentration tc= 0.37 hrs (from worksheet 1)

2. Calculate storage, $S = (1000/CN - 10)25.4$ = 89 mm

WQV	2	10	100
1/3 of 2yr (yr)			
17.3 (mm)	52	78.9	121
0.016	0.174	0.265	0.374
0.005	0.052	0.076	0.101
0.072 m ³ /s	2.199	4.842	9.815
1.0	14.9	31.9	63.7
825 m ³	12038.89	25702.65	51345.76

3. Average recurrence interval, ARI

4. 24 hour rainfall depth, P₂₄
 *as per HIRDS Historical data

5. Compute $c^* = P_{24} - 2la/P_{24} - 2la + 2S$

6. Specific peak flow rate q^*

7. Peak flow rate, $q_p = q^*A \cdot P_{24}$

8. Runoff depth, $Q_{24} = (P_{24} - la)^2 / (P_{24} - la) + S$

9. Runoff volume, $V_{24} = 1000 \times Q_{24} \cdot A$

WQV	2	10	100
1/3 of 2yr (yr)			
17.3 (mm)	52	78.9	121
0.016	0.174	0.265	0.374
0.005	0.052	0.076	0.101
0.072 m ³ /s	2.199	4.842	9.815
1.0	14.9	31.9	63.7
825 m ³	12038.89	25702.65	51345.76

Worksheet 2: Graphical Peak Flow Rate

 MAVEN ASSOCIATES	Job Number	Sheet 1	Rev A
Job Title Calc Title	Author	Date	Checked GB

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m ² =1 ha	Product of CN x area
C	CATCHMENT A - PAVEMENT	98	0.35	34.30
C	CATCHMENT A - PERVIOUS AREAS	80		0.00
				0.00
				0.00
				0.00
				0.00
Totals =			0.350	34.30

* from Appendix B

WQV
25.43

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{34.30}{0.35} = 98.0$

Ia (weighted) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 0.0}{0.35} = 0.0 \text{ mm}$

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.02 km (along drainage path)

Catchment Slope Sc = 0.5 m/m (by equal area method)

Runoff factor, $\frac{\text{CN}}{200 - \text{CN}} = \frac{98.0}{200 - 98.0} = 0.96$

$t_c = 0.14 C L^{0.66} (\text{CN}/200 - \text{CN})^{-0.55} S_c^{-0.30}$

= 0.14 0.6 0.08 1.02 1.23 = 0.009 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c$ = 0.006 hrs

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

 MAVEN ASSOCIATES		Job Number	Sheet	Rev A
Job Title Calc Title	Raingarden Sizing-Catchment G1 (ROAD)	Author	Date	Checked
1.	Data			
	Catchment Area A=	0.0035 km ² (100ha =1km ²)		
	Runoff curve number CN=	98.0 (from worksheet 1)		
	Initial abstraction Ia=	0.0 mm (from worksheet 1)		
	Time of concentration tc=	0.17 hrs (from worksheet 1)		
	2yr 24hr event	126 mm (from Niwa hirs RCP 8.5)		
2.	Calculate storage, $S = (1000/CN - 10)25.4$	=	5 mm	
3.	Average recurrence interval, ARI			
		WQV		
4.	WQV 24 hour rainfall depth, P ₂₄	30.00 (mm)		If greater than 30mm, use 30mm
5.	Compute $c^* = P_{24} - 2I_a/P_{24} - 2I_a + 2S$	0.743		
6.	Specific peak flow rate q^*	0.155		
7.	Peak flow rate, $q_p = q^* A P_{24}$	16.2824 (m ³ /s)		
8.	Runoff depth, $Q_{24} = (P_{24} - I_a)^2 / (P_{24} - I_a) + S$	25.6		
9.	Runoff volume, $V_{24} = 1000 \times Q_{24} A$	56.99 (m ³)		
<u>Area of Rain Garden Required (from WRC)</u>				
	Maximum Ponding Depth=	0.3 m		
	WQV = treatment Volume	56.99 (m ³)		
	Required Live $\epsilon = 0.4 \times WQV$	22.80 (m ³)		
	As	64.59 (m ²)		
	Live storage available	19.38 (m ³)		
	Is the "Required" live storage volume achieved use "As", if not move continue to next step?	NO,continue		
	Design surface area= live storage/ total ponding depth	75.98 (m ²)		
	$A_f =$ surface area	76.0 (m ²)		
	Pit Width	5 (m)		(Try to achieve 1:3 or 1:5 ratio)
	Pit Length	16.00 (m)		
		80.0 (m ²)	OK	Make sure it is closer to Af

Worksheet 2: Graphical Peak Flow Rate

	MAVEN ASSOCIATES	Job Number	Sheet 1	Rev A
Job Title Calc Title	Raingarden Sizing-Catchment F2 (ROAD)	Author	Date	Checked GB

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m ² =1 ha	Product of CN x area
C	CATCHMENT A - PAVEMENT	98	0.04	3.92
C	CATCHMENT A - PERVIOUS AREAS	80		0.00
				0.00
				0.00
				0.00
				0.00
* from Appendix B			Totals =	0.040 3.92

WQV
25.43

CN (weighted) = $\frac{\text{total product} = 3.92}{\text{total area} = 0.04} = 98.0$

Ia (weighted) = $\frac{5 \times \text{pervious area} = 0.0}{\text{total area} = 0.04} = 0.0 \text{ mm}$

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.022 km (along drainage path)

Catchment Slope Sc= 0.5 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{98.0}{200 - 98.0} = 0.96$

$t_c = 0.14 C L^{0.66} (CN/200-CN)^{-0.55} Sc^{-0.30}$

= 0.14 0.6 0.08 1.02 1.23 = 0.009 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c$ = 0.006 hrs

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration



MAVEN ASSOCIATES

Job Number

Sheet

Rev
A

Job Title
Calc Title

Raingarden Sizing-Catchment F2 (ROAD)

Author

Date

Checked

1. Data
Catchment Area $A = 0.0004 \text{ km}^2$ (100ha =1km²)
Runoff curve number $CN = 98.0$ (from worksheet 1)
Initial abstraction $I_a = 0.0 \text{ mm}$ (from worksheet 1)
Time of concentration $t_c = 0.17 \text{ hrs}$ (from worksheet 1)
2yr 24hr event **126 mm** (from Niwa hards RCP 8.5)

2. Calculate storage, $S = (1000/CN - 10)25.4 = 5 \text{ mm}$

3. Average recurrence interval, ARI

WQV

4. WQV 24 hour rainfall depth, P₂₄

30.00 (mm)

If greater
than 30mm,
use 30mm

5. Compute $c^* = P_{24} - 2I_a/P_{24} - 2I_a + 2S$

0.743

6. Specific peak flow rate q^*

0.155

7. Peak flow rate, $q_p = q^* A P_{24}$

1.8609 (m³/s)

8. Runoff depth, $Q_{24} = (P_{24} - I_a)^2 / (P_{24} - I_a) + S$

25.6

9. Runoff volume, $V_{24} = 1000 \times Q_{24} A$

0.74 (m³)

Area of Rain Garden Required (from WRC)

Maximum Ponding Depth= 0.3 m
WQV = treatment Volume 0.74 (m³)
Required Live $\epsilon = 0.4 \times WQV$ 0.30 (m³)
As 0.84 (m²)
Live storage available 0.25 (m³)

Is the "Required" live storage volume achieved use "As", NO, continue
if not move continue to next step?

Design surface area= live storage/ total ponding depth 0.99 (m²)

$A_f =$ surface area **1.0** (m²)

Pit Width **1** (m)

Pit Length **2.00** (m)

(Try to
achieve 1:3
or 1:5 ratio)

2.0 (m²)

OK

Make sure
it is closer
to A_f

Worksheet 2: Graphical Peak Flow Rate

 MAVEN ASSOCIATES	Job Number	Sheet 1	Rev A
Job Title Calc Title	Author	Date	Checked GB
Raingarden Sizing-Catchment F5			

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	CATCHMENT A - PAVEMENT	98	0.608	59.58
C	CATCHMENT A - PERVIOUS AREAS	80	0.152	12.16
				0.00
				0.00
				0.00
				0.00
* from Appendix B			Totals =	71.74

WQV
25.43

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{71.74}{0.76} = 94.4$

Ia (weighted) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 0.0}{0.76} = 0.0 \text{ mm}$

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.02 km (along drainage path)

Catchment Slope Sc = 0.5 m/m (by equal area method)

Runoff factor, $\frac{\text{CN}}{200 - \text{CN}} = \frac{94.4}{200 - 94.4} = 0.89$

$t_c = 0.14 C L^{0.66} (\text{CN}/200 - \text{CN})^{-0.55} S_c^{-0.30}$

= 0.14 0.6 0.08 1.06 1.23 = 0.009 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3 t_c$ = 0.006 hrs

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration



MAVEN ASSOCIATES

Job Number

Sheet

Rev
A

Job Title
Calc Title

Raingarden Sizing-Catchment F5

Author

Date

Checked

1. Data
Catchment Area $A = 0.0076 \text{ km}^2$ (100ha =1km²)
Runoff curve number $CN = 94.4$ (from worksheet 1)
Initial abstraction $I_a = 0.0 \text{ mm}$ (from worksheet 1)
Time of concentration $t_c = 0.17 \text{ hrs}$ (from worksheet 1)
2yr 24hr event **126 mm** (from Niwa hards RCP 8.5)

2. Calculate storage, $S = (1000/CN - 10)25.4 = 15 \text{ mm}$

3. Average recurrence interval, ARI

WQV

4. WQV 24 hour rainfall depth, P₂₄

30.00 (mm)

If greater
than 30mm,
use 30mm

5. Compute $c^* = P_{24} - 2I_a/P_{24} - 2I_a + 2S$

0.499

6. Specific peak flow rate q^*

0.124

7. Peak flow rate, $q_p = q^* A P_{24}$

28.3067 (m³/s)

8. Runoff depth, $Q_{24} = (P_{24} - I_a)^2 / (P_{24} - I_a) + S$

20.0

9. Runoff volume, $V_{24} = 1000 \times Q_{24} A$

215.13 (m³)

Area of Rain Garden Required (from WRC)

Maximum Ponding Depth= 0.3 m
WQV = treatment Volume 215.13 (m³)
Required Live $\epsilon = 0.4 \times \text{WQV}$ 86.05 (m³)
As 243.82 (m²)
Live storage available 73.14 (m³)

Is the "Required" live storage volume achieved use "As", NO, continue
if not move continue to next step?

Design surface area= live storage/ total ponding depth 286.84 (m²)

$A_f =$ surface area **286.8** (m²)

Pit Width **5** (m)

Pit Length **60.00** (m)

(Try to
achieve 1:3
or 1:5 ratio)

300.0 (m²)

OK

Make sure
it is closer
to A_f

Worksheet 2: Graphical Peak Flow Rate

Appendix B – Operation and maintenance Plan

BRYMER FARMS LTD

STORMWATER OPERATIONS & MAINTENANCE PLAN

PROJECT INFORMATION

CLIENT	Brymer Farms LTD
PROJECT	119014

DOCUMENT CONTROL

DATE OF ISSUE	19/08/2026
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REVISION	A
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1. Introduction

1.1. Background

Maven Waikato Limited have been engaged by Brymer Farms Ltd to undertake the infrastructure design in support of the Brymer Farms residential development at 584 Whatawhata Road (SH23), Temple View, Hamilton.

1.2. Purpose of this report

The purpose of this operation and maintenance report is to ensure the correct ongoing operation of the stormwater quantity and quality management devices proposed for the Brymer Farms development. The information provided herein outlines the methodology associated with the stormwater infrastructure onsite. This report is to be read in conjunction with the stormwater engineering drawings, design calculations, proprietary device manuals and Stormwater management Plan (SMP and is to accompany the Substantive Application under the Fast-Track Approvals Act 2024.

It is the responsibility of the nominated maintenance contractor (pre-vesting: the developer's appointed contractor; post-vesting: Waikato District council's contractor) to carry out maintenance of the stormwater system devices. Maintenance will be undertaken generally in accordance with this document, the Waikato Regional Council (WRC) Waikato Stormwater Management Guideline (TR2020/07).

1.3. Stormwater Assets

The Assets to be constructed which will require operation and maintenance are:

- Stormwater discharge from lot areas is conveyed via on-lot soakage pits and/or retention tanks, road soakage trenches and piped network (perforated and non-perforated), and road corridors for OLFP conveyance to the designated Artificial Wetlands.
- Seven artificial wetlands (Wetlands A1, A2, B, C, D, E and F), each with an associated forebay, providing water quality treatment, extended detention and attenuation.
- High flow bypass for the associated wetlands
- Treatment Swales and temporary swales.
- Road corridor catchpits, sumps, kerb and channel providing primary conveyance to the piped network.
- Cirtex Aquafort attenuation systems serving Catchments F1, F5, F6 and G, with an upstream raingarden for treatment.

Private assets, being on-lot Soakage pits and/or retention tanks servicing individual residential lots and large lots- residential, remain the responsibility of the individual lot owner. Public assets will be vested to Waikato Regional Council progressively as each stage is completed, subject to the Engineering Approval process.

1.4. Contact Information

A summary of the contact information relating to the ownership, maintenance manager, and designer for the stormwater system is included below.

Table 1: Contact information summary

Asset ID:		Resource Consent Number:	
Location:	584 Whatawhata Road (SH23), Temple View, Hamilton	Development Name / Legal Description:	Allot 365 Pukete PSH, Part Lot 2 DP 18355, Lot 1 DPS 87291, Lot 22 DPS 79526, Lot 3 DP 385271, Lot 44 DPS 59874, Lot 9 DPS 67823
Asset Owner Details:			
Name:		Postal Address:	
Telephone Number:			
Email:			
Maintenance Manager Emergency Contact Details			
Name:		Address:	
Telephone Number: (Daytime)			
Telephone Number: (Out-Of-Hours)			
Email:			
Designer Details:			

Name:	Dean Morris	19 Kaimiro Street, Pukete, Hamilton 3200
Telephone Number:	[REDACTED]	
Email:	[REDACTED]	
Applicant Details		
Name:		Address:
Telephone Number		
Email:		
Landowner Details:		
Name:		
Telephone Number		
Email:		
Notes / Restrictions / Access		

2. Stormwater System Description

2.1. Site Description

The Brymer Farms Development is a circa 81ha block of land within the Waikato District, located in northern Temple View and west of Grandview Heights. The site topography is split with low-lying terrain through the centre of the site and rolling hills to the north and south, with elevations ranging between 38m and 50m. A network of closely spaced open drains runs through the centre of the site from east to west, discharging to the central drains that form part of the Ohote drainage scheme. The site is partially underlain by Holocene swamp deposits (peat) in the low-lying valleys, which has a direct bearing on groundwater recharge and the ongoing maintenance of soakage-based devices.

2.2. Design Standards

Stormwater systems have been designed in accordance with the Regional Infrastructure Technical Specifications (RITS V2, 2025) and the Waikato Regional Council Waikato Stormwater Management Guideline (TR2020/07), which caters for the primary pipe system up to the 10-year cc ARI event, and the secondary system and overland flow paths for events up to and including the 100-year cc ARI event.

2.3. Stormwater Management Plan (SMP)

Discharge consent for the site has been sought from Waikato Regional Council. The overarching stormwater strategy is derived from the Brymer Farms SMP (119014, Rev A), which sets out the high-level, best-practice approach to stormwater management for the site, in accordance with WRC's stormwater guidelines and RITS.

The key components of the Brymer Farms stormwater management strategy are:

- Retention of the on-lot pre-development initial abstraction depth (3.2mm) via soakage pits and/or retention tanks.
- Stormwater conveyance for up to the 10-year cc ARI rainfall event via the piped network to the designated artificial wetlands.
- Conveyance of flows up to the 100-year ARI storm event as overland flow within road corridors, directed to the designated wetlands.
- Peak discharge for the 2-year and 10-year ARI events attenuated to pre-development levels; the 100-year ARI event attenuated to no more than 80% of pre-development peak flow.
- Preservation of existing flow paths and discharge locations, and accounting for external/upstream inflows so downstream impacts are not worsened.
- Groundwater recharge to the underlying peat, maintained through on-lot and wetland soakage.

For further detail, refer to the SMP prepared by Maven Waikato Ltd (119014, Rev A).

2.4. Capacity and Quality

Stormwater Strategy for Lot Areas

Roof runoff is managed using inert roofing materials, while driveway runoff is directed through a catch pit with a sump for pre-treatment before disposal into an on-lot soakage pit and/or retention tank. Overflow above the on-lot storage capacity is directed to the piped network, ultimately discharging to the designated wetland.

Stormwater Strategy for Road Carriageway

Road runoff is collected by the proposed primary pipe network, sized for the 10-year cc ARI event. Flows exceeding the primary network capacity are conveyed via the road-designated overland flow path to the proposed artificial wetlands, together with any surcharge from the lot stormwater system.

Stormwater Strategy for Catchment A (Wetlands A1 and A2)

Catchment A comprises sub-catchments A1, A2 and A3. A1 and A2 discharge via the piped network and OLFP to Wetlands A1 and A2 respectively, providing water quality treatment, extended detention and attenuation. Due to topography and site constraints, A3 instead discharges directly to a proposed treatment swale, with additional attenuation storage incorporated into Wetlands A1 and A2 to offset this direct discharge, so the overall Stage 1 post-development discharge remains limited to 80% of the pre-development discharge.

Stormwater Strategy for Catchments B, C, D and E (Wetland B, C, D and E)

Catchments B, C, D and E discharges via the piped stormwater network and road-carriageway OLFP to Wetlands B, C, D and E respectively, providing water quality treatment, extended detention and attenuation.

Stormwater Strategy for Catchment F (Wetland F and Existing Wetlands)

Stage 6 comprises both residential and large lots- residential development and is surrounded by a number of natural wetlands whose baseflows are maintained by discharge from developed lots and road catchments within the contributing area. Sub-catchments F1, F5 and F6 use controlled discharge: stormwater is conveyed via the piped network to a Cirtex Aquafort attenuation system and Wetland F, which provide water quality treatment and flow attenuation ahead of controlled discharge to the existing natural wetland. Sub-catchments F2, F3 and F4 discharge directly to the adjacent existing wetlands (identified in the SMP as Northern Wetland 41/42 and Southern Wetland 11/12) to maintain existing baseflows and hydrological regime, with at-source water quality treatment provided within these catchments.

Stormwater Strategy for Catchment G (Large Lots- Residential)

Catchment G comprises Road Catchment G1 and Lot Catchment G2. Road runoff is collected by catchpits and conveyed via the piped network to a Cirtex Aquafort attenuation system, with a connected raingarden or swale providing water quality treatment ahead of controlled discharge to the receiving wetland, maintaining the existing 2-year ARI baseflow. Lot runoff is managed via on-lot retention tanks and/or soakage pits, providing initial abstraction and attenuation of the 2, 10 and 100-year ARI CC events, with the 100-year ARI CC discharge limited to 80% of the pre-development flow rate.

2.5. Flooding

A 2D flood model (HEC-RAS) has been developed for the site and used to assess existing, design and sensitivity scenarios in which all primary stormwater devices are blocked. Even under this worst-case condition, the model demonstrates that the development maintains flood immunity, with only minor exceedances expected to be mitigated through detailed design refinements.

2.6. Overland Flow

Overland flow paths (OLFPs) are provided within road corridors to convey flows exceeding the primary piped network's capacity, up to the 100-year cc ARI event, to the designated wetlands.

- Identify and maintain natural overland flow/watercourse locations to convey concentrated stormwater from the site. Utilise existing culverts (where possible) to maintain the same discharge locations, post development.
- Identify and retain any upstream OLFPs and/or watercourses to avoid any upstream flooding.
- Ensure OLFPs are to be designed where possible within the roading network and discharge into watercourses and 100-year detention devices.

The preliminary OLFP design is shown in Maven Associates drawings C460.

An assessment of the post development overland flow paths (OLFPs) has been carried out to evaluate the behaviour of surface runoff in the road carriageway under the proposed stormwater management system. The design scenario is based on the RCP8.5 climate change scenario, incorporating all proposed soakage and treatment devices and the assessment is done through Autodesk Hydraflow software. The OLFPs represents the conveyance of surface runoff as a result of the proposed system during the 100-year storm event.

Flow depths and velocities were assessed at key locations throughout the development covering all the various road/Accessway typologies ensuring and confirming conveyance of the OLFP is viable through proposed carriageway. See below table 1 showing results at the key locations.

Table 2: OLFP Results

Catchment	Section	Catchment Area (ha)	Flow Rate HEC-RAS (m ³ /s)	Max Depth (m)	Velocity (m/s)	Depth x Velocity (m ² /s)
A1	1	13.5	0.49	0.09	1.59	0.14
A2	2	4.9	0.12	0.07	1.2	0.08
A3	3	1.46	0.1	0.05	1.41	0.07
B	4	9.7	0.11	0.07	1.09	0.08
C	5	3.9	0.26	0.09	1.42	0.13
D	6	4.1	0.25	0.10	1.52	0.15
E	7	11.1	0.15	0.07	1.31	0.10
F1	8	1.91	0.03	0.06	0.54	0.03
F5	9	0.7	1.00	0.13	2.19	0.28
G1	10	0.26	0.11	0.06	1.05	0.06

All modelled sections report a maximum flow depth at or below 0.13m (Catchment F5, Section 9), which is within the 150mm design guideline for all catchments assessed. Depth x velocity values remain well below the critical safety thresholds defined in Austroads 2012 Part 5, which specify:

- < 0.4m²/s pedestrian Safety
- < 0.6m²/s for vehicle safety

The highest recorded value, 0.28 m²/s at Catchment F5 (Section 9), reflects the highest velocity in the assessed sections (2.19 m/s) but confirms safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads and conveyed into roadside primary networks for the 10-year cc conveyance, with surcharge above this directed to the designated wetlands and/or the treatment swale via the OLFP.

It is noted that a separate flood sensitivity analysis has been completed using HEC-RAS 2D modelling assuming all stormwater devices are fully blocked. The assessment detailed in section 7 of SMP, evaluates overland flow behaviour under worst case flooding conditions within and surrounding the site.

3. Stormwater System Devices

3.1. On-Lot Soakage pits and/or retention tanks

On-lot soakage pit and/or retention tanks (standard Dn900mm x 2.7 deep is proposed for each lot) provide the initial abstraction storage (3.2mm) for each residential and large lots- residential, and support ongoing groundwater recharge to the underlying peat. These are private devices, maintained by the individual lot owner.

Inspection requirements

- Inlet sump and pre-treatment catch pit clear of debris
- No evidence of surface ponding beyond the expected drain-down period
- Overflow connection to the road/piped network unobstructed
- Where an observation well is fitted, no evidence of reduced infiltration performance against the 7mm/hour design rate

Table 3: OLFP Results

Timing	Component	Action
Following storms	Inlet sump / catch pit	Remove debris, leaves and sediment from the pre-treatment sump.
Annually (owner), or if ponding observed	Soakage pit / tank / observation well	Check drain-down time; where performance is suspected impaired, test infiltration rate (TR2020/07 impairment threshold: <1mm/hour).
As required	Overflow path	Confirm overflow connection to the road/piped network is unobstructed.

3.2. Raingardens with Aquafort modular attenuation system

A Cirtex Aquafort modular attenuation system is proposed for road catchment areas within Catchments F1, F5, F6 and G (large lots- residential), providing flow attenuation ahead of discharge to the receiving wetland or existing natural wetland. A separate water quality treatment-raingarden is connected upstream of the Aquafort to provide treatment prior to attenuation. The Aquafort is designed to accommodate flows up to the 100-year ARI cc event, with discharge controlled through appropriately sized orifices and outlet controls.

The Aquafort structure is a proprietary modular plastic crate system, so its operation and maintenance requirements are governed by the manufacturer's specification (refer to Appendix D).

Vegetation

Vegetation enhances raingarden performance for stormwater treatment and therefore requires close attention.

Maintenance includes fertilising plants, removing noxious plants or weeds, re-establishing plants that die and maintaining mulch cover.

Regular inspections by the responsible entity must be done to ensure that the desired vegetation remains and is not overtaken by invasive undesirable plants.

In some situations, the replacement of the planted vegetation by a volunteer species may be beneficial, but only if the invasive species provides equal or increased water quality benefits and is accepted by the owners of the site.

Plants

Use native plants as per the approved landscaping plans to replace plants if this is required.

Sediment

Sediments accumulate in raingardens. Removal should occur when surface ponding lasts significantly longer than the one day drain time, which indicates surface clogging. When sediments are to be removed, it is essential to restore the vegetation and soil conditions to the originally constructed condition.

Sediment removal will necessitate disturbance of the vegetation, so steps will have to be taken to re-establish the vegetation upon completion of sediment removal.

Erosion control in the contributing drainage area also will be necessary to prevent scour and excessive sedimentation in the rain garden until there is once again a dense stand of vegetation.

Sediment may also impede effective performance of a rain garden by clogging the soil surface and preventing design storms from being treated. If stormwater backs up into the upstream drainage area, overflow may occur and bypass the treatment area.

Debris

Similar to other types of practices, debris removal is an ongoing maintenance function at all rain garden systems.

Debris, if not removed, can block inlets or outlets, and can be unsightly if located in a visible location.

Soil

Only use approved raingarden soil (usually a sandy loam compost) which is readily available at some horticultural centres.

Drainage Testing

If water is not observed freely draining from the rain garden outlet it may be blocked. Back wash through the outlet and/or maintenance access port until the rain garden is freely draining. If this does not help then the soil may be blocked and need to be removed, pipes inspected/cleared.

Avoid

- The use of sprays to kill weeds or algae as this will contaminate the downstream waterways.
- Do not compact the rain garden soil mix.
- Do not add clay or silt in the rain garden soil mix as this will restrict infiltration.

Inspection requirements

- Debris cleanout
 - Removal of debris
 - No dumping of wastes into raingarden
 - Litter has been removed
- Vegetation
 - Plant height not less than design water depth
 - Fertilised per specifications
 - No evidence of erosion
 - Is planting composition still according to approved plans
 - No placement of inappropriate plants
- Dewatering and sedimentation
 - Raingarden dewaterers between storms

- No evidence of standing water
- No evidence of surface clogging
- Sediments should not be > than 20% raingarden design depth
- Outlets / Overflow Spillway
 - No evidence of erosion
 - No evidence of any blockages
- Integrity of Biofilter
 - Raingarden has not been blocked or filled inappropriately
 - Mulch layer still in place
 - Noxious plants or weeds removed

Maintenance procedures

Timing	Component	Action
Following storms	Grass filter strip, kerbing, and paved area	Remove rubbish, leaves, and other debris from the grass filter strip and surrounding drainage area
	Ponding area	Clear inflow points of sediments, rubbish, and leaves Check for erosion or gouging and repair Test drainage of ponding area
	Mulch	Mulch may need to be redistributed or added around inflow points.
3 monthly	Grass filter strip, kerbing, and paved area	Mow no shorter than 50mm. Re-sow grass as necessary. Remove rubbish, leaves, and other debris. Remove excess mulch/soil if required.
	Ponding area	Clear inflow points of built-up sediment, rubbish, and leaves. Check for erosion or gouging.
	Mulch layer	Remove rubbish, leaves, and other debris. After storm events, mulch may need to be redistributed or added around inflow points.
	Plants	Water establishing plants monthly during extended dry periods. Check plant health and replace dead plants. Use native species to suit garden conditions. Remove weeds – do not use herbicides, pesticides, and fertilisers.
Annually	Ponding area	Clear inflow points of sediment, rubbish, and leaves. Check for erosion or gouging and repair. Check all water has drained 24 hours after heavy rain.
	Raingarden soil mix	Check soil level is below surrounding hard surface level and overflow grate.
	Mulch layer	Check surface of mulch for build-up of sediment, remove and replace.
	Underdrain system	Use inspection well to check underdrain is working properly.

Troubleshooting

Symptom	Possible problems	Solutions
Stormwater runoff is bypassing the raingarden	Local earthworks increasing sediment load to raingarden, blocking raingarden outlets, or raising surface level of the raingarden	Check surface of the raingarden is below the surrounding areas. Remove any sediments and debris from inflow areas and from the surface of the raingarden. Protect raingarden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the raingarden	Regularly remove rubbish leaves, and any other debris from inflow points.
Raingarden is ponding for longer than 24 hours	Incorrect blend of soil mix	Replace soil mix with the correct raingarden soil mix.
Stormwater and/or mulch flowing off the raingarden	The soil within the garden compacted during construction or other activities	Loosen the top 500mm of soil by tiling or forking.
	Raingarden filled with too much mulch or soil	Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow
Sulphur smell coming from the raingarden	Plants and soils lacking oxygen.	Inspect raingarden after rain event to check garden drains within 12 to 24hours.
Erosion and gouging occurring within the raingarden	Kerbs and other hard structures channelling stormwater flow.	Create openings in the kerb to increase number and width of run off points or replace kerbing with a different design.

3.3. Artificial Wetlands

Seven artificial wetlands (A1, A2, B, C, D, E, F) form the primary treatment and attenuation devices for the development, providing WQV treatment, extended detention and attenuation of the 2, 10 and 100-year ARI cc events, discharging at up to 80% of pre-development peak flow.

Inspection requirements

- Embankment & Emergency Spillway
 - Level of spillway
 - Vegetation and ground cover
 - Freeboard
 - No evidence of embankment erosion
 - Removal of debris on emergency spillway
- Riser & Service Spillway
 - No low flow orifice obstructed
 - No excessive sediment accumulation inside the riser
 - Function of outfall channels
 - Slope protection
 - No rip-rap failures

- Wetland
 - No undesirable vegetation growth
 - Removal of floating debris
 - No visible pollution
 - No evidence of edge erosion
- Dry Pond
 - Vegetation cover
 - No presence of undesirable vegetation
 - No standing water of wet spots
 - Sediment and/or trash not accumulated
 - Low flow channels not observed
- Sediment Forebays
 - Sediment is not accumulated more than 50%
 - Provision of access of maintenance

Maintenance procedures

Timing	Component	Action
Following storms / Monthly	Inlet	Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens	Inspect and clear all litter, including leaves, rubbish, branches, and any other materials.
	Sediment forebay	Check the forebay for accumulated sediment. Test sediments for contaminants prior to dredging and dispose of sediment to landfill or similar, suitable for contaminant levels.
	Risers, control structures, grates, outlet pipes, skimmers, weirs, and orifices	Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Clear and remove all blockages to avoid local flooding. Inspect outflow pipes for leaky joints or soil piping erosion. Check if anti-seep collars need repair or replacement. Check outfall and water discharge areas for erosion and restore and stabilise erosion.
	Emergency overflow or spillway	Check emergency overflow path remains clear of debris and blockages and remove any blockages. Check flow paths for erosion and repair as necessary.
	Erosion and bank stability	Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rolling.
	Water body	Remove rubbish and other floating debris from wetland pond.
	Wildlife	Remove dead animals to prevent disease spread.

	Soil	Inspect for loss of soil on wetland banks from erosion.
Annually	Valves and pumps	Check pumps and valves. Check moving parts for corrosion and lubricate.
2+ years	Wetland liners	Inspect liner for leaks and fix as per manufacturers or design specifications.
	Sediment forebay	Check the forebay for accumulated sediment. Test sediment for contaminants prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

Troubleshooting

Symptom	Possible problems	Solutions
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary.
	Outlets structures are clogged	Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants	Remove plants by hand. (no herbicide)
	A maintenance valve is open	Check drain valves and shut if open
	Water leaking from cracks in outlet structure	Inspect for cracks and repair as necessary. Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels	Pond will remain dry as long as groundwater levels are low. Design for pond should have taken this into account, so this may be normal for this wetland.
Stormwater discharging from the wetland looks dirty, muddy, or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	Check catchment for erosion areas, including construction works. Check erosion controls are in place.
	Forebay full of sediment	Forebay usually needs more frequent clearing of sediment than wetland pond.
	Local works disturbing soils, with rain washing these into wetland	Check erosion and sediment controls in place on local construction sites.
Pond banks are eroding	Water flowing down pond banks is eroding soils	Minor erosion can be repaired by replacing soil and stabilising with planting or other methods.
	Stormwater outlet pipes direct flow at banks	Cause of erosion from direct discharge may be required, for example, by extending pipes down into pond. Extensive erosion due to continuing discharge may require erosion protection.

Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly.	Qualified contractors should make immediate repairs. It usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks.
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3.4. Treatment Swales, Temporary Swales and High Flow Bypass channel

Catchment A3 discharges directly to a proposed treatment swale rather than being diverted to the Wetland A2 catchment, due to topography and site constraints. The swale provides water quality treatment by filtering runoff through vegetation ahead of discharge to the receiving environment, with additional attenuation storage provided in Wetlands A1 and A2 to offset this direct discharge.

Temporary swales will be constructed as part of interim stormwater management measures during construction to maintain existing drainage and direct flows through and around the site during earthworks.

Each wetland catchment includes a high-flow bypass (HFB) channel diverting flows above the 2-year event around the treatment train to the receiving drain, via a flow-splitter device and a discharge control device (2-10-year orifice/weir). As an open, generally grassed/vegetated conveyance channel, the High flow bypass is treated here consistently with TR2020/07's swale and filter strip guidance (Table 18-1).

Inspection requirements

- Debris cleanout
 - Removal of debris
 - No dumping of wastes into swales
 - Litter has been removed
- Vegetation
 - Plant height not less than design water depth
 - Fertilised per specifications
 - No evidence of erosion
 - Grass height not greater than 250mm
 - No placement of inappropriate plants
- Dewatering
 - Swales dewater between storms
 - No evidence of standing water

Maintenance procedures

Timing	Component	Action
Following storms	Inflow points	Check for scouring, channelling, and erosion and repair as necessary.
	Side slopes	Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Channel base	Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Plants and soil	Check stormwater is filtering through soil following stormwater runoff. Remove weeds.
Monthly	Outlet	Check for scouring or erosion and repair to suit.

	Inflow points	Remove rubbish and debris.
	Channel base	If grassed, mow channel no shorter than 150mm Re-seed bare patches of grass.
	Plants and soil	Replant gaps and water new plants in dry conditions until established.
Two yearly	Outlet	Remove rubbish and debris from outlet grate or catchpit.
	Channel base	Check for boggy patches and ponding water. Check soil is not compacted and aerate surface or tip up dips to repair.
	Grass, plants, and soil	Remove weeds, rubbish, and debris. Re-plant gaps and re-seed bare patches, and water if required to establish. Aerate soil to prevent natural compaction. Check Stormwater is filtering through soil.

Troubleshooting

Symptom	Possible problems	Solutions
Water not draining	Soil compacted	Aerate soil with rotating aerator or core.
	Soil clogged with fine sediments	Remove top layer of soil and replace, turning soil.
	Underdrain, if present, may be blocked	Re-build underdrain.
Water flowing straight to outlet	Soil not free draining	Aerate soil, replace top layer of soil, replace soil with free draining mix.
	Swale slope is too steep	If slope is over 5%, construct check dams to slow flows.
	Plants or grass is not dense enough	Leave grass longer, and re-seed to increase density.
Scouring / Channels appearing	Inflow is concentrated at inlets	Remove blockages including rubbish, debris, and sediment build up.

4. Reporting and Scheduling

Recording and Reporting of Operation and Maintenance activities to the WRC

Recording of information and device tracking are important components of the maintenance of stormwater system devices. It is important that site operator and/or owners track maintenance by use of database. This helps inspectors to understand what devices need to be inspected, when they need to be inspected, and when was the last maintenance. Contractors nominated by Waikato District Council will record operation and maintenance activities and report to Waikato District Council by use of a database. Established checklists will be used during the inspection and maintenance activities, and the activities will never rely on the memory of any one individual.



Appendix A – Auckland Council’s Wetlands Operation and Maintenance Guide



WETLANDS

Operation & Maintenance Guide

STORMWATER DEVICE INFORMATION SERIES

**Auckland
Council**
Te Kaunihera o Tāmaki Makaurau



What are constructed wetlands?

Constructed wetlands are large shallow planted ponds that filter stormwater runoff, slow flows and help control flooding downstream. Similar to natural wetlands, they look attractive and provide home and shelter to wildlife. Constructed wetlands help remove sediments, nutrients and contaminants from incoming stormwater before discharging to downstream stormwater system or waterways.

This guide offers a general description of constructed wetlands. Each constructed wetland is specifically designed to suit a particular site, so construction details will be on design and site construction plans. Correct construction levels are crucial for supplying suitable drainage for wetland plants.

How and when should maintenance be carried out?

Constructed wetlands need to be maintained in two main ways. Firstly, so they continue to work as designed (filtering stormwater, slowing flows and controlling downstream flooding) and secondly, to look attractive. A full inspection of constructed wetlands should take place a year after construction is completed.

This may be carried out by the construction contractor to coincide with the end of the defects liability period. The tables below give only typical timelines and actions for maintaining constructed wetlands. This is a general guide - each wetland should have its own detailed maintenance plan to suit the particular catchment size, pollutant loads and inflows.

WARNING - CONTAMINATED SOIL

Constructed wetlands treat stormwater run-off, so will collect contaminants in the sediments of the pond and forebay. All material removed from these sites should be tested for contaminants before being disposed of at a suitable secure landfill.



Eight key components of a constructed wetland

5. Plants

Usually native plants, in the pond and on littoral shelf.
Species chosen to suit various water level zones in wetland.
(For suitable species and planting guidelines, refer to ARC Technical Report TR2009/083 Landscape and Ecology Values within Stormwater Management)

1. Inlet

Inlet pipe, receiving runoff.
Erosion controls at inlet (rip rap, energy dissipaters) slow flows. Debris screens or trash racks capture rubbish.

2. Sedimentation forebay (if included)

Forebay helps slow runoff and sediment drops to the bottom. Separated from main pond by a bund or low dam.

3. Main wetland

Shallow wide pond of variable depth to 1m, planted with aquatic species. Fine sediments settle to bottom and contaminants such as oil and grease break down.

4. Shallow wetland area (Littoral shelf)

Shoreline of the pond, planted with swamp species submerged at times. Plants take up nutrients (nitrogen and phosphorous) as well as slow flows and trap sediment.

7. Emergency overflow

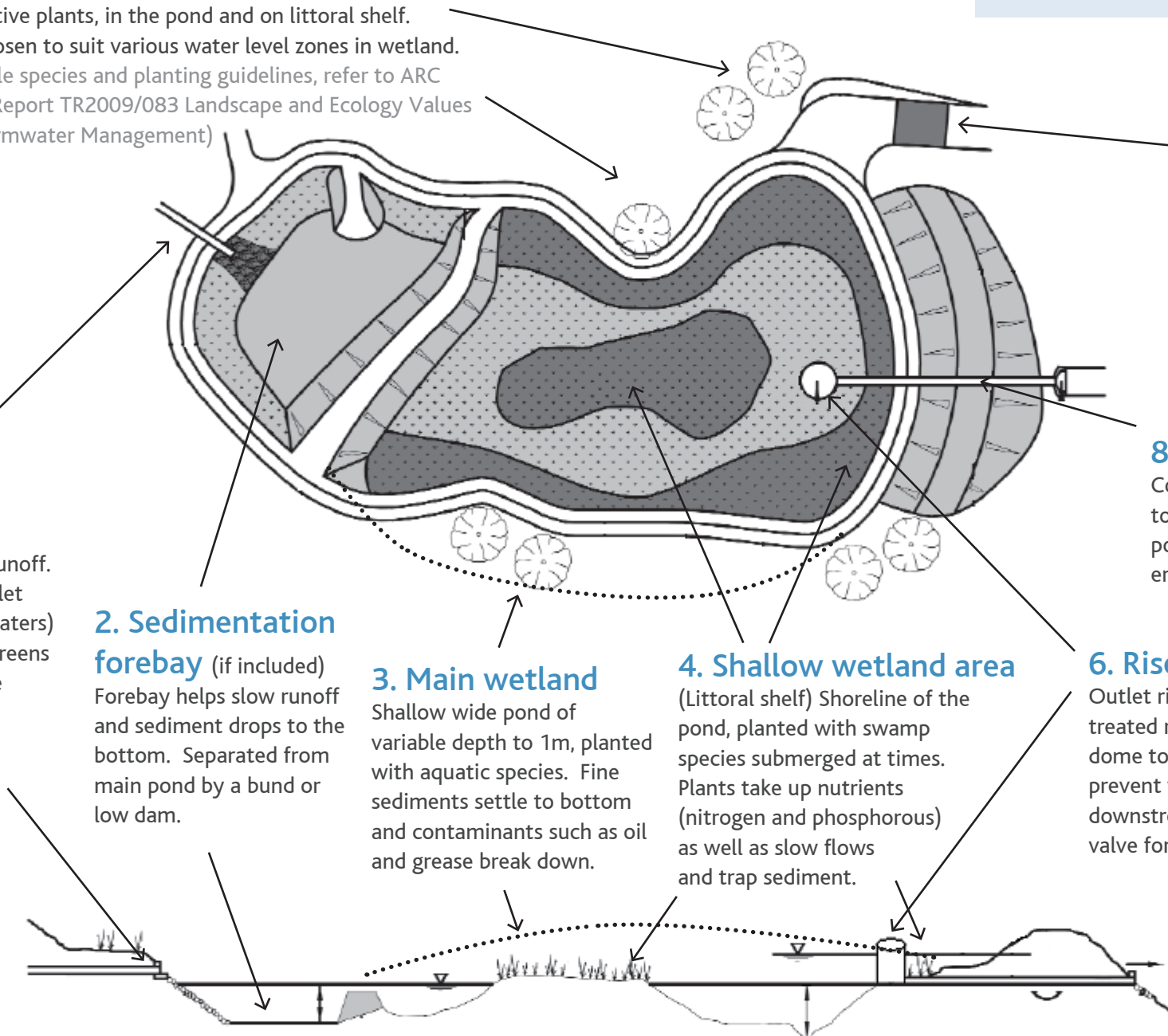
Structure to allow extreme heavy rain flows to bypass wetland and drain downstream, to prevent overtopping of wetland banks. May be in outlet riser or separate.

8. Anti-seep collars

Collars are fitted to all pipework to prevent pond leakage and potential bank collapse from erosion.

6. Risers/outlets

Outlet riser pipe or weir for discharge of treated runoff. Risers may have scruffy dome to trap debris, or baffles/skimmer to prevent water life and debris from flowing downstream. Some risers have drain-down valve for maintenance.



MAINTENANCE SCHEDULE

Following storms

Timing	Component	Action
	Inlet	• Inspect and remove rubbish and debris from inlets. • Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. Check racks for corrosion and replace if necessary.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. • Control structures could be overgrown with vegetation. • Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. A boat may be required to access the outlet. • Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. • Check energy dissipaters are adequate.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages, and remove any blockages. Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
Following storms	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. • Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification of maximum 90% dry soil density. • Inspect for pedestrian and cycle traffic or pathways on banks. • Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Water body	• Remove rubbish and other floating debris from wetland pond. • Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. • Test water quality if these problems suspected.
	Wildlife	• Control pest species so they do not threaten birds and aquatic life of the wetland. • Remove dead animals, especially water birds, to prevent disease spread. Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	• Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
Monthly	Inlet	• Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. • Check racks for corrosion and replace if necessary.

MAINTENANCE SCHEDULE cont...

Monthly

TIMING	COMPONENT	ACTION
Monthly	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	- Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. Control structures could be overgrown with vegetation. - Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. - Boat may be required to access outlet.
	Emergency overflow or spillway	- Check emergency overflow path remains clear of debris and blockages, and remove any blockages. - Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.
	Erosion and bank stability	- Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. - Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification (of maximum 90% dry soil density). - Inspect for pedestrian and cycle traffic or pathways on banks. - Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Landscaping	Clear wetland plants of weeds and prune and replace three-monthly. Mow split grass around pond monthly. Schedules may vary depending on seasonal growth.
	Water body	Remove rubbish and other floating debris from wetland pond. Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. Test water quality if these problems suspected.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
6 Monthly	Wildlife	- Control pest species so they do not threaten birds and aquatic life of the wetland. Remove dead animals, especially water birds, to prevent disease spread. - Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
	Inlet	Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Bund	Check for erosion or instability and repair if required.
Anually	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	- Inspect outflow pipes for leaky joints or soil piping erosion. - Check if anti-seep collars need repair or replacement. - Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	- Inspect wetland plants for exotic or invasive/nuisance water species and remove. - Control may be done manually, or with appropriate herbicide by properly licensed and registered professional. Follow up inspections may be needed during growing season.
2+ Years	Valves and pumps	- Check pumps and valves, if present, are functioning properly. - Check moving parts for corrosion and lubricate if required.
	Wetland liner	Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	- Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. - Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

TROUBLESHOOTING

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
	Invasive plants (such as raupo) clogging pond area	Remove plants by hand – do not use herbicides.
Wetland is dry	A maintenance valve is open.	Check drain valves and shut if open.
	Water leaking from cracks in outlet structure.	- Inspect for cracks and repair as necessary. - Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels.	- Pond will remain dry as long as groundwater levels are low. - Design for pond should have taken this into account, so this may be normal for this wetland.
Stormwater discharging from the wetland looks dirty, muddy or dark	Ground water levels have dropped due to drought conditions	Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area.	- Check catchment for erosion areas, including construction works. - Check erosion controls are in place. Add or repair erosion control as required.
	Forebay full of sediment.	Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland.	- Check erosion and sediment controls in place on local construction sites. - Repair if necessary and stabilise areas of exposed soil where erosion occurring.
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge.	Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond.	Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils. Stormwater outlet pipes direct flow at banks.	- Minor erosion can be repaired by replacing soil and stabilising with planting or other methods. - Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. - Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria <i>Clostridium botulinum</i>, either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	- Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). - Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Algal blooms (Yellow, green, red or blue-green coloured scum on the surface of the water.)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather.	• Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. • Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species.	• Thin out vegetation where possible. • Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	• Choose plant varieties suitable to local conditions. • New plants need watering until established. • Replace unsuitable varieties.

Quick maintenance checks

- ✓ Check for leaks and erosion on and around banks, especially at leak collars.
- ✓ Regularly clear rubbish and dead vegetation around outlet structures, trash racks and forebay.
- ✓ Remove dead birds in case of botulism, especially in hot, humid conditions
- ✓ Keep new plants watered and control weed species.

Avoid

- ✗ Do not let erosion go unchecked. Repair, and replace erosion controls if necessary.
- ✗ Do not let forebay volume reach over half-full of sediment. Dredge and dispose of to suitable landfill.
- ✗ Prevent fertilizers, pesticides and herbicides entering the pond to avoid algal blooms and polluting downstream waterways.
- ✗ Do not ignore algal blooms and unusually dirty or dark pond water. These can affect the health of the wetland and downstream waterways.

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Appendix B – Recommended Maintenance Event and Frequency Checklists

		STORMWATER MAINTENANCE INSPECTION FORM		Inspector:			
				Date:			
				Time:			
				Weather: Rainfall over previous 2-3 days?			
				Page 1 of 2			
Site Name:		ID No:		File No:			
Location		Catchment:		Needs immediate attention			
				Not Applicable			
SWALE AND FILTER STRIP PRACTICE MAINTENANCE INSPECTION CHECKLIST		☒	Required Y / N	☒	Okay ? Clarification Required		
"As built"		Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N		
"Operation & Maintenance Plan"		Required Y / N	Available Y / N	Adequate Y / N			
"Planting Plan"		Required Y / N	Available Y / N	Adequate Y / N			
Swale And Filter Strip Components:							
Items Inspected	Checked	Maintenance Needed	Inspection Frequency		Checked	Maintenance Needed	Inspection Frequency
DEBRIS CLEANOUT	Y	Y N	M	CHECK DAMS / ENERGY DISSIPATORS / SUMPS	Y N	Y N	A
1. Swales and filter strips and contributing areas clean of debris							
2. No dumping of wastes into swales or filter strips							
3. Litter (branches, etc) have been removed							
VEGETATION			M				
4. Plant height not less than design water depth							
5. Fertilised per specifications							
6. No evidence of erosion							
7. Grass height not greater than 250mm							
8. Is plant composition according to design plans							
9. No placement of inappropriate plants							
DEWATERING			M				
10. Swales and filter strips dewater between storms							
11. No evidence of standing water							

Inspection Frequency Key A = Annual, M = Monthly

[illegible]

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

 STORMWATER MAINTENANCE INSPECTION FORM		Inspector:						
		Date:						
		Time:						
		Weather: Rainfall over previous 2-3 days?						
		Page 1 of 2						
Site Name:		File No:						
Location:		Consent No:						
		Catchment:						
RAIN GARDEN MAINTENANCE INSPECTION CHECKLIST		☒ Needs immediate attention ☐ Not Applicable	☒ Okay ☐ ? Clarification Required					
"As built"		Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N			
"Operation & Maintenance Plan"		Required Y / N	Available Y / N	Adequate Y / N				
"Planting Plan"		Required Y / N	Available Y / N	Adequate Y / N				
Rain Garden Components:								
Items Inspected	Checked		Maintenance Needed	Inspection Frequency		Checked	Maintenance Needed	Inspection Frequency
DEBRIS CLEANOUT	Y	N	Y	N	M	OUTLETS/OVERFLOW SPILLWAY		A, AMS
1. Rain gardens and contributing areas clean of debris						13. Good condition, no need for repair		
2. No dumping of yard wastes into rain garden						14. No evidence of erosion		
3. Litter (branches, etc) have been removed						15. No evidence of any blockages		
VEGETATION					3M	INTEGRITY OF BIOFILTER		A
4. Planting height not less than design water depth						16. Rain garden has not been blocked or filled inappropriately		
5. Fertilised per specifications						17. Mulch layer still in place		
6. No evidence of erosion						18. Noxious plants or weeds removed		
7. Is plant composition still according to approved plans								
8. No placement of inappropriate plants								
DEWATERING AND SEDIMENTATION								
9. Rain garden dewater between storms					3M			
10. No evidence of standing water								
11. No evidence of surface clogging								
12. Sediments should not be > than 20% of rain garden design depth								

Inspection Frequency Key A = Annual, M = Monthly, AMS = After Major Storm

[illegible]

Inspector's signature: _____

		STORMWATER MAINTENANCE INSPECTION FORM		Inspector:							
				Date:							
				Time:							
				Weather: Rainfall over previous 2-3 days?							
Page 1 of 2											
Site Name:				File No:							
Location				Consent No:							
				Catchment:							
INFILTRATION TRENCH MAINTENANCE INSPECTION CHECKLIST		☒ Needs immediate attention ☐ Not Applicable		☒ Okay ☐ ? ☐ Clarification Required							
"As built"		Required Y / N		Available Y / N		Adequate Y / N		Approx. check to verify vol(s). Y / N			
"Operation & Maintenance Plan"		Required Y / N		Available Y / N		Adequate Y / N					
"Planting Plan"		Required Y / N		Available Y / N		Adequate Y / N					
Infiltration Trench Components:											
Items Inspected	Checked		Maintenance Needed		Inspection Frequency	Checked		Maintenance Needed		Inspection Frequency	
DEBRIS CLEANOUT	Y	N	Y	N	M	INLETS		Y	N	A	
1. Trench surface clear of debris						13. Good condition					
2. Inlet areas clear of debris						14. No evidence of erosion					
3. Inflow pipes clear of debris						OUTLETS/OVERFLOW SPILLWAY				A	
4. Overflow spillway clear of debris						15. Good condition, no need for repair					
SEDIMENT TRAPS, FOREBAYS, OR PRETREATMENT SWALES					A	16. No evidence of erosion					
5. Obviously trapping sediment						AGGREGATE REPAIRS				A	
6. Greater than 50% of storage volume remaining						17. Surface of aggregate clean					
VEGETATION					M	18. Top layer of stone does not need replacement					
7. Mowing done when needed						19. Trench does not need rehabilitation					
8. Fertilized per specifications						VEGETATED SURFACE				M	
9. No evidence of erosion						20. No evidence of erosion					
DEWATERING					3M	21. Perforated inlet functioning adequately					
10. Trench dewater between storms						22. Water does not stand on vegetative surface					
SEDIMENT CLEANOUT OF TRENCH					A	23. Good vegetative cover exists					
11. No evidence of sedimentation in trench											
12. Sediment accumulation does not yet require cleanout											

Inspection Frequency Key

A = Annual, M = Monthly

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Comments: _____

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Appendix C – Troubleshooting Guide

Timing	Component	Action
		Remove weeds – do not use herbicides, pesticides and fertilisers as these chemicals will pollute the stormwater runoff.
Annually	Ponding area	- Clear inflow points of sediment, rubbish and leaves. - Check for erosion or gouging and repair. - Check all water has drained 24 hours after heavy rain. - Alternatively test drainage of ponding area. Dig a hole 200mm wide x 200mm deep. Pour in 10 litres of water in hole. Check drainage rate over 1 hour period – minimum 25mm/hour. - If crust of fine sediment present on surface of soil mix, remove with spade and rework using rake. Top up soil and mulch as necessary (ensuring level is below surrounding hard surface and overflow). Dispose of contaminated crusted topsoil in a secure landfill (unless soil testing shows no contamination).
	Rain garden soil mix	- Check soil level is below surrounding hard surface level and overflow grate. Use drainage test described above to check soil is free draining.
	Mulch layer (bark, pebbles, etc.)	Check surface of mulch for build-up of sediment, remove and replace as required.
	Underdrain system	- Use inspection well (if present) to check underdrain is working properly. - Check rain garden draining freely using the drainage test described above. If rain garden is not free-draining, the underdrain may be blocked. Try back-washing under drain from the outlet. If still blocked, the rain garden may need plants and rain garden soil mix removed and replaced.

Table 18-5: Troubleshooting for bioretention devices¹⁷⁵

Symptom	Possible problems	Solution
Stormwater runoff is bypassing the rain garden	Local earthworks increasing sediment load to rain garden, blocking rain garden outlets or raising surface level of the rain garden	- Check surface of the rain garden is below the surrounding areas. - Remove any sediments and debris from inflow areas and from the surface of the rain garden. - Protect rain garden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the rain garden	Regularly remove rubbish, leaves and any other debris from inflow points.
Rain garden is ponding for longer than 24 hours	Incorrect blend of soil mix	Replace soil mix with the correct rain garden soil mix. Do Ribbon test or Percolation test to test soil mix is free-draining.

¹⁷⁵ Auckland Council Rain Garden Operation and Maintenance Guide

Symptom	Possible problems	Solution
Stormwater and/or mulch flowing off the rain garden	The soil within the garden compacted during construction or other activities.	Loosen the top 500mm of soil by tilling or forking. Discourage vehicle, pedestrian and bicycle access to the rain garden.
	Layer of fine sediment settled on the garden surface	Remove fine sediment layer and turn over the top layer of rain garden soil mix. Protect rain garden from surrounding sediment run off.
	Rain garden filled with too much mulch or soil	Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow.
	Overflows or discharge pipes clogged with sediments or debris	Clear overflow and discharge pipes.
	Planting or rain garden soil mix clogged	It may be necessary to remove some of the rain garden soil mix and replace with fresh rain garden soil mix.
Sulphur smell coming from the rain garden	Plants and soils lacking oxygen (anaerobic conditions). Organic material rotting within the garden	Inspect rain garden after rain event to check garden drains within 12 – 24 hours (see solutions above for rain garden ponding)
	The underdrain clogged and water is not properly draining out of the garden	
Erosion and gouging occurring within the rain garden	Kerbs and other hard structures channelling stormwater flow (rain gardens require an event sheet of flow of water to operate effectively)	Create openings in the kerb to increase number and width of run off points, or replace kerbing with a different design (eg. kerbing slightly raised off the ground)
	Inflow points are too concentrated	Increase kerb opening size by cutting kerbs or replacing with different design. If this is not possible install rip-rap (i.e. stones set into concrete) at the inflow point to spread flow and reduce erosion.
Plants are stressed or dying. Symptoms may include yellowing of leaves, unseasonal leaf fall, wilting.	Plant varieties selected for rain garden are unsuitable for the location and/or extreme wet/dry conditions.	- Select plants appropriate for the location (eg. full shade, partial shade, full sun, etc.) - Due to their hardy nature, native plants are recommended.
	Ponding or excessively long periods of flooding cause plants to become stressed or die.	Inspect rain garden after rain event to check garden drains within 12 – 24 hour. If not, see above solutions for rain garden ponding.
	The plants poisoned by runoff from a hazards spill (fuel, paint, oil, etc).	Check soil and mulch for evidence of heavily polluted runoff (eg. rainbow slick, coloured mulch, etc.)
	Pollutants accumulated in the rain garden reached a toxic level for plants.	If contamination is extensive, clean out raingarden soil mix and replace fresh soil and new plants.
	The plants dehydrated from extended dry conditions	- Newly established plants need watering. - Check soil moisture content and water plants if dry.

Symptom	Possible problems	Solution
		Establishing plants need watering in dry weather.
	Plants stressed due to attack by plant pests or diseases. Pests may include insects or animals.	- Check for leaf damage or pests and consult gardening manuals or a garden centre for the best treatment. - Stressed plants need replacing with healthy variety or pest-resistance species.
	Rain garden soil mix compacted	Loosen the top 500mm of soil by tilling or forking. Do not allow vehicle, pedestrian and bicycle access to the rain garden.

18.2.1.4 Infiltration devices

Infiltration devices are very sensitive to impaired performance if excessive amounts of sediments or oils and greases are introduced into them. The greatest problem is clogging of soils in the sides and bottom or in the case of permeable paving surface clogging. This can occur fairly rapidly if inflow sediment loads are not reduced by pre-treatment devices.

Other contaminants, which are attached to sediments, are not considered a clogging concern.

Another problem is poor drainage as a result of high water table, groundwater mounding or a confining soil layer. Prolonged wetness encourages micro-organism growths that tend to clog soils.

18.2.1.5 Ponds and wetlands

One of the greatest benefits of stormwater management ponds and wetlands is their resilient performance even when excessive contaminant loads enter them. However, performance will suffer if sediment is introduced in large amounts over a lengthy time frame. Sediments reduce the volume of storage and reduce extended detention times, which ultimately reduce the pond or wetland's contaminant reduction potential.

This impaired function is not something that tends to occur dramatically in a short time period but rather occurs cumulatively over a longer time period if the incoming sediment load is consistently elevated.

Another problem that ponds and wetlands have that other devices do not have to such an extent is maintenance problems associated with debris clogging inlets and outlet areas. While other devices can have visual issues related to debris, pond outlets can become blocked, especially the extended detention orifices. Clogging of these outfall orifices can cause significant adverse effects by elevating water in the pond or wetland and potentially killing the vegetation, increasing safety concerns and increasing the zone of saturation in the pond or wetland embankment.

Sediment forebay clogged with sediment and needing to be cleaned out



A recommended maintenance schedule for wetlands is provided below:

Timing	Component	Action
	Bund	Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	- Inspect outflow pipes for leaky joints or soil piping erosion. - Check if anti-seep collars need repair or replacement. - Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	- Inspect wetland plants for exotic or invasive/nuisance water species and remove. - Control may be done manually, or with appropriate herbicide by properly licensed and registered professionals. Follow up inspections may be needed during growing season.
Annually	Valves and pumps	- Check pumps and valves, if present, are functioning properly. - Check moving parts for corrosion and lubricate if required.
2+ years	Wetland liners	Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	- Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. - Test sediment for contaminants (eg. heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

Table 18-7: Trouble shooting for wetland¹⁷⁷

Symptom	Possible problems	Solution
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	Remove plants by hand, do not use herbicide.
	A maintenance valve is open	Check drain valves and shut if open
	Water leaking from cracks in outlet structure	- Inspect for cracks and repair as necessary - Inspect for leaky joints at outlet pipes and repair

¹⁷⁷ Auckland Council Wetlands Operation and Maintenance Guide

Symptom	Possible problems	Solution
	Wetland in area of changing groundwater levels	- Pond will remain dry as long as groundwater levels are low. - Design for pond should have taken this into account, so this may be normal for this wetland.
	Groundwater levels have dropped due to drought conditions	Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
Stormwater discharging from the wetland looks dirty, muddy or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	- Check catchment for erosion areas, including construction works. - Check erosion controls are in place. Add or repair erosion control as required
	Forebay full of sediment	Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland	- Check erosion and sediment controls in place on local construction sites - Repair if necessary and stabilise areas of exposed soil where erosion occurring
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge	Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond	Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils	Minor erosion can be repaired by replacing soil and stabilising with planting or other methods
	Stormwater outlet pipes direct flow at banks	- Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. - Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks

Symptom	Possible problems	Solution
		reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria <i>Clostridium botulinum</i> , either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	- Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). - Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.
Algal blooms (yellow, green, red or blue-green coloured scum on the surface of the water)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather	- Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. - Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species	- Thin out vegetation where possible. - Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	- Choose plant varieties suitable to local conditions. - New plants need watering until established. - Replace unsuitable varieties.

18.2.1.6 Green roofs

Principal reasons why this device performance can deteriorate are the following:

- Impermeable membrane failure due to leakage, puncture or UV deterioration
- Excessive weed growth outcompeting planted growth
- Ponding of water on flat roofs
- Concentration of flows across the green roof causing scour and discharge at locations not designed for
- Clogging of substrate, and
- Plugged outlets.

18.2.1.7 Water tanks

Water tank function can be compromised mainly due to two reasons:

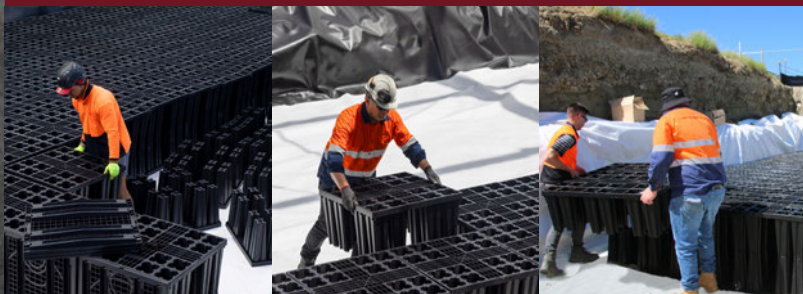
1. Inadequate water supply where demand exceeds supply, and
2. The tank outlets or downspouts become clogged due to excessive vegetative entry into the tank from roof spouting.

Appendix D – Aquafort O&M Manual

AQUAFORT

O&M MANUAL

ISO: 139 002 | JULY 2026 | VERSION 3



CIRTEX®
GAIN MORE GROUND™



OVERVIEW

Cirtex Industries Ltd distributes the AquaFort modular stormwater system for effective management of soakage, recharge, detention, and attenuation systems. The systems modules can be configured in many ways to suit site specific requirements and constraints. The system is capable of withstanding traffic loads when installed according to the Cirtex specifications, allowing the system to be used under trafficked areas such as carparks and driveways. The system has a high void ratio, compared with 30 – 40% in traditional gravel pits and includes access through the entire system to allow for easy maintenance and inspections.

BACKGROUND

A number of areas of New Zealand use stormwater recharge pits and retention/attenuation systems to allow for a predetermined amount of each rainfall event to flow directly back into the ground or to manage storm flows on site. Traditionally this has been done with rock filled pits sized according to the impervious area being treated. These rock filled trenches have typically been accepted by local authorities, despite being difficult to maintain.





AQUAFORT SYSTEM

THE OPTIONS

There are 2 primary pre-treatment for the AquaFort system, each having specific requirements for maintenance.

1. AQUAFORT WITHOUT LINEAR CHANNEL WATER ENTRY SYSTEM

The AquaFort System is installed as a freestanding soakage/storage device. Any pre-treatment is external to the system. The access tracks between every bank of legs allows for inspection camera and jetting access throughout the system.

2. AQUAFORT WITH LINEAR CHANNEL WATER ENTRY SYSTEM

The AquaFort system can also be installed with the patented Linear Channel water entry system (See section 2). This unique system provides a sediment-containment channel, which reduces the velocity of the incoming water and allows sediment to settle out, prior to entering the module zone. Sediments confined in the channel will be washed through to the outlet sump in the ensuing storm event or can be manually blasted through with a jetting hose.

IMPORTANT

During construction, ensure that sediment and gross pollutants are not able to enter the system. The best way is to ensure that the system is offline until all construction works are completed, surfaces stabilised and the drains are cleaned at the completion of the project. If this is not possible, it is imperative that the pretreatment system is maintained to ensure pollutants do not reach the tank.

SECTION 1

MAINTENANCE OF AQUAFORT SYSTEM WITHOUT LINEAR ACCESS CHANNELS

The inlets to an AquaFort system should be protected by a manhole with sump depth $\geq 300\text{mm}$. In some cases, local consent requirements will stipulate that a pre-treatment device should also be installed. Additionally, it is recommended to have catchpit filters to capture gross pollutants. It is recommended that catchpit protection should be installed prior to stormwater entering the AquaFort system. The amount of sediment being collected needs to be ascertained by the design engineer and will vary for each site. The following data is given as an indication.

On a typical hardstand site which is well maintained, it is reasonable to expect that only 0.1 cubic metres

of sediment per year will enter a tank system per 1000 m² of hardstand area serviced, which is protected by upstream manhole and catchpits. An AquaFort System servicing this area will typically be about 17 cubic meters. Therefore the volume of sediment accumulation over a 10 year cycle would be in the order of 1 cubic meter, or 6% of module volume.

NB: These figures are typical figures only and will vary from site to site. A suitably qualified stormwater engineer must ascertain the values for each application.

SUGGESTED PROCEDURE FOR INSPECTION AND MAINTENANCE

Inspection: After a period of time ascertained by the engineer, but not more than one year from initial installation, the system should be inspected to check sediment levels or performance. This can either be done with a CCTV camera through the access tracks throughout the system or by monitoring the time taken for the system to empty after a storm event and comparing with design criteria. From this, an indication can be gained as to the rate of sedimentation and further inspections can be scheduled.

Further inspections will be as deemed necessary by the engineer, but will be at least annually, and after every heavy rainfall event.

Flushing: When sediment build up in the sump is $>200\text{mm}$, the sediment should be removed and the AquaFort system can be flushed out using jetting and vacuum via the access tracks running throughout the system. This would be done via the inlet/outlet pipes as this is the area where the largest sediment build up will take place. Inspection of the AquaFort access tracks should be undertaken at least every 3 years.



SECTION 2

MAINTENANCE OF AQUAFORT SYSTEM WITH THE LINEAR ACCESS CHANNEL SYSTEM

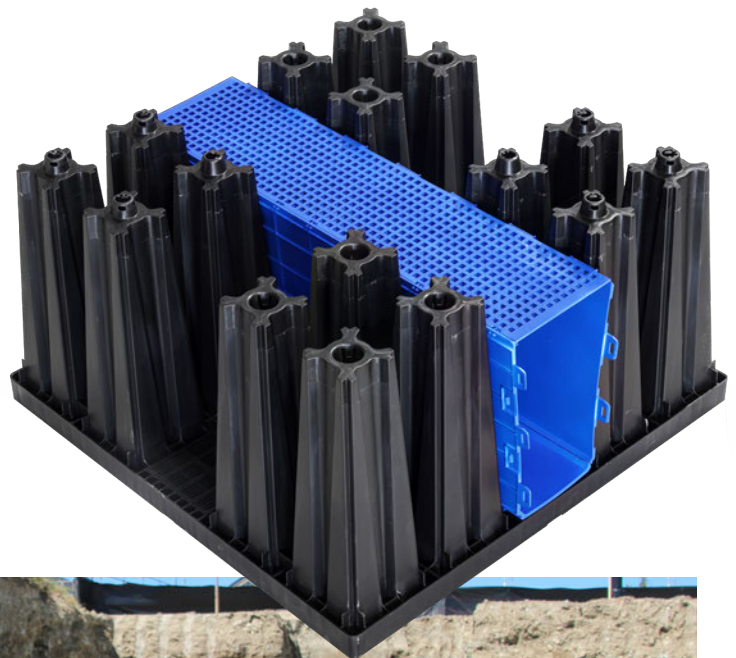
The AquaFort Linear Channel water entry system is designed to capture any sediment that evades the pre-treatment train, confining it for easy removal prior to entering the AquaFort module zone. First flush stormwater enters the inlet sump and flows through the Linear Channel at high velocity and into the exit sump. The water level continues rising in both sumps, eventually reaching the top of the Linear Channel. At this point, it overflows into the AquaFort modules at a slow velocity. Solids are left in the Channel and will wash through to the outlet sump at the start of the ensuing storm event.

Maintenance requirements are simplified as the Linear Channel is self cleaning, due to the flushing effect of the water entry. All that is required is regular cleaning of the sump screen filter and to check and vacuum the exit sump, as required.

Additional pipe entry with removable caps can be installed to provide access into the wider system. It is suggested to check the sumps for sedimentation every 3 months for the first year, and then

annually thereafter. It may be necessary to increase the frequency of inspection if the first year checks show a larger than anticipated rate of sediment build up.

Sediment can then be either vacuumed out from the sump or simply cleaned out with a shovel.



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Appendix C – Erosion Management Plan

BRYMER FARMS LTD

STORMWATER EROSION PROTECTION PLAN

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1. INTRODUCTION

This Erosion Protection Plan supports the Brymer Farms Stormwater Management Plan (119007 SMP) and sets out the measures adopted to manage flow velocities and erosion potential across the proposed stormwater network. It covers the permanent (post-construction) stormwater devices.

Erosion protection has been applied at each point in the treatment train where concentrated flow or a change in flow velocity could otherwise cause scour: on-lot and road discharge points, wetland/pond inlets and outlets, swales and high-flow bypass channels, culvert crossings, overland flow paths, and the receiving environment (Ohote Stream and existing natural wetlands).

2. GENERAL PRINCIPLES

- Velocity appropriate protection: energy dissipation (riprap, level spreaders, splash pads) is provided wherever a device outlet or pipe discharge would otherwise generate a velocity capable of scouring the receiving surface.
- Avoid steep grades: channels, swales and culvert inverts have been kept to low longitudinal grades where practicable (culvert crossings are set at a 0.5% grade) to limit velocity build-up; check dams are used where a steeper grade cannot be avoided.
- Stable batter slopes: vegetated embankments and pond/wetland side slopes are to be no steeper than 1V:2.5H (interior) and 1V:3H (exterior, where space allows), consistent with RITS and standard NZ stormwater pond design practice. Slopes steeper than this increase both erosion risk and the difficulty of establishing stabilising vegetation.
- Vegetate early, protect until established: temporary erosion protection (matting, riprap) is used to protect bare surfaces until permanent vegetation cover is established, particularly on the peat-affected low-lying areas of the site where surface stability is more sensitive to disturbance.
- Preserve natural flow paths: existing drainage corridors and discharge locations are retained rather than redirected, to avoid introducing new erosion risk at previously stable locations.

3. OUTLET/ DISCHARGE PROTECTION

All piped stormwater discharges (on-lot overflow, road corridor laterals, and the primary network) are directed to energy dissipation structures before entering open channels, swales or receiving wetlands. Outlet protection generally comprises a riprap apron sized to the design discharge velocity, with the apron footprint set to dissipate flow to a non-erosive velocity before it reaches unprotected ground or vegetation in accordance with Section 4 of RITS V2 2025.

4. WETLAND OUTLET PROTECTION

Each artificial wetland outlet comprises a low-flow orifice (extended detention), an overflow weir/spillway for events above the extended detention storage, and a backflow prevention device to prevent reverse flow from the receiving drain during elevated downstream water levels. Riprap protection and energy dissipation are provided at the wetland/HFB discharge point to the receiving

drain or stream. Emergency spillways are designed to safely convey extreme events without structural erosion of the embankment.

5. INLET PROTECTION

Wetland and forebay inlets are protected with riprap pads or level spreaders to dissipate the energy of incoming piped/channel flow before it enters the treatment device, preventing scour of the forebay base and short-circuiting of settled sediment. Where flow enters directly from a road corridor overland flow path, the inlet is graded and protected to accept sheet flow without concentrating it into an erosive point discharge.

6. SWALE AND CHANNEL PROTECTION

The treatment swale and the high-flow bypass (HFB) channels serving each wetland are vegetated conveyance features, designed for distributed (sheet) flow rather than concentrated flow. Protection measures include: dense, uniform vegetation cover across the full channel width; longitudinal grades kept as low as practicable; and riprap or check-dam protection at any grade break, bend, or point where flow could concentrate. Channel base and side slopes are stabilised prior to flows being directed through the swale/channel.

7. CULVERT INLET/ OUTLET PROTECTION

Nine culvert crossings (6 box culverts, 3 circular culverts) convey the rerouted stream and wetland discharges beneath the collector road network. Culverts are precast concrete units (modular length per manufacturer's standard unit), embedded approximately 25% into the streambed to support fish passage, with wingwalls to be confirmed at detailed design. Riprap protection has been sized for the inlet and outlet apron of each culvert based on the design discharge velocity, culvert geometry and outfall length, as set out in Table 1.

Table 1: Riprap sizing

Culvert	Type	Barrel length (m)	Span x Height or dia. (m)	Riprap D50 (m)	Riprap thickness (m)	Outfall length (m)	Head width (m)	Tail width (m)	Apron area (m ²)
1	Box	50.65	4.0 x 2.0	0.15	0.5	8	6	12	144
2	Box	39.55	2.0 x 2.0	0.15	0.3	8	6	12	144
3	Box	47.97	3.0 x 2.0	0.15	0.35	8	6	12	144
4	Box	36.49	4.0 x 1.0	0.25	0.65	5	6	6.5	47.5
5	Box	38.00	4.0 x 1.0	0.15	0.3	5	6	12	144
6	Box	35.00	4.0 x 1.0	0.25	0.65	5	6	6.5	47.5
7	Circular	12.7	0.6 dia (twin)	0.3	0.65	6	3.6	7.6	67.2
8	Circular	16.7	0.6 dia (twin)	0.3	0.65	6	3.6	7.6	67.2
9	Circular	14.0	0.2 dia	0.15	0.15	0.8	0.6	1.13	1.4

Riprap median rock diameter (D50) and apron dimensions have been sized to the design discharge velocities and geometry of each culvert, with the larger box culverts (1, 2, 3, 5) and smaller box culverts (4, 6) requiring proportionately different D50 and apron footprints, and the smallest circular culvert (9) requiring only a minimal apron given its low design flow. Riprap thickness is generally set at approximately twice the D50 rock size, consistent with standard outlet protection practice. The D50

values are based on design velocities from HEC RAS modelling (Refer to Section 7- Flood Modelling of the SMP report). These dimensions are to be confirmed against final culvert sizing and discharge velocities at the detailed design.

8. OVERLAND FLOW PATHS

Road corridor overland flow paths (OLFPs) convey flows above the piped network's capacity, up to the 100-year cc ARI event. Erosion protection along OLFPs relies primarily on maintaining sealed road/kerb surfaces and directing flow to designated discharge points (wetlands or existing watercourses) rather than allowing it to leave the formed corridor. Modelled OLFP depths and velocities (refer to section 8- Overland Flowpaths of SMP report) have been checked against the Austroads 2012 Part 5 safety and scour thresholds (0.4 m²/s pedestrian, 0.6 m²/s vehicle), with all assessed sections remaining within these limits, indicating a low erosion risk within the road corridor itself. R.

9. RECEIVING ENVIRONMENT PROTECTION

Discharge to the Ohote Stream and to existing natural wetlands (Catchments F and G) has been designed to maintain pre-development flow rates and hydrological regime, limiting the potential for erosion of these receiving environments. Energy dissipation is provided at each discharge point into the Stream or an existing wetland, and riparian planting is proposed along modified drains and stream margins to stabilise banks and provide long-term erosion resistance as vegetation establishes. Discharge locations have been preserved at existing points wherever practicable, avoiding the introduction of new erosion risk at previously unaffected locations on the receiving watercourse.

10. CONSTRUCTION-PHASE EROSION AND SEDIMENT CONTROL

Temporary ESC measures are shown on the Proposed Year 1- 4 ESC Plan (Drawing 119014-C216-4) and will be maintained throughout each earthworks sub-stage. The key measures are:

- Sediment Retention Ponds (SRPs): SRPs are provided for each active earthworks sub-stage (e.g. SRP 1A-1, 1B-1, 1C-1/2, 2B-1, 3A-1/2/3 and E4A-1/2). Each SRP is sized for a 5-year ARI design storm event and incorporates the required pond volume, dead storage and multiple decant points. The SRPs have been sized in accordance with the principles outlined in Waikato Regional Council Technical Report No. 2009/02- *Guidelines for Soil-Disturbing Activities*, considering the contributing disturbed catchment area.
- Clean/dirty water diversion: upstream clean water is diverted around active earthworks areas and directed to the SRPs, separating undisturbed catchment runoff from sediment-laden site runoff.
- Stabilised construction entrances: provided at the site access points (e.g. the existing farm entrance off Whatawhata Road) to limit sediment tracking onto public roads.
- Staged topsoil and cut-to-fill stockpile management: Dedicated stockpile areas (e.g. Stockpile E1, Topsoil Stockpile E2) are located and managed to minimise erosion risk and re-use material efficiently within the earthworks balance.

- Pre-construction methodology for works near streams: As per Drawing 119014- C216-4 general Note 7, any works within or adjacent to existing stream areas require a site-specific construction methodology, agreed with Waikato Regional Council prior to commencement.
- Sediment and erosion control must be installed and operational before earthworks start on site, in accordance with WRC standards, with a pre-construction meeting held with the WRC monitoring team (Infrastructure Report Section 2.6).

11. CONCLUSION

This Erosion Protection Plan sets out the measures adopted across the Brymer Farms stormwater network to manage flow velocities and protect against erosion, from the point of discharge at each lot and road corridor through to the receiving environment. Protection has been applied consistently at every point in the treatment train where a change in flow velocity or concentration of flow could otherwise cause scour, including wetland and forebay inlets and outlets, the Catchment A3 treatment swale and high-flow bypass channels, and the nine culvert crossings beneath the collector road network.

Culvert protection has been designed on a structure-by-structure basis, with riprap median rock diameter, thickness and apron dimensions sized to the discharge velocity and geometry of each of the six box and three circular culverts (Table 1). Batter slopes, channel grades and vegetation establishment have been addressed through the general principles set out in Section 2, with particular regard to the peat-affected low-lying areas of the site where surface stability is more sensitive to disturbance.

Together with the flow attenuation and hydraulic neutrality measures set out in the SMP, these erosion protection measures are considered sufficient to protect downstream channels, existing natural wetlands and the Ohote Stream from adverse erosion effects arising from the development. Final riprap sizing, wingwall details and planting specifications are to be confirmed at detailed design stage.

Appendix D – HEC-RAS Summary

LIST OF PROPERTIES AFFECTED DOWNSTREAM DURING 100YR CC RCP 8.5 FLOOD EVENT

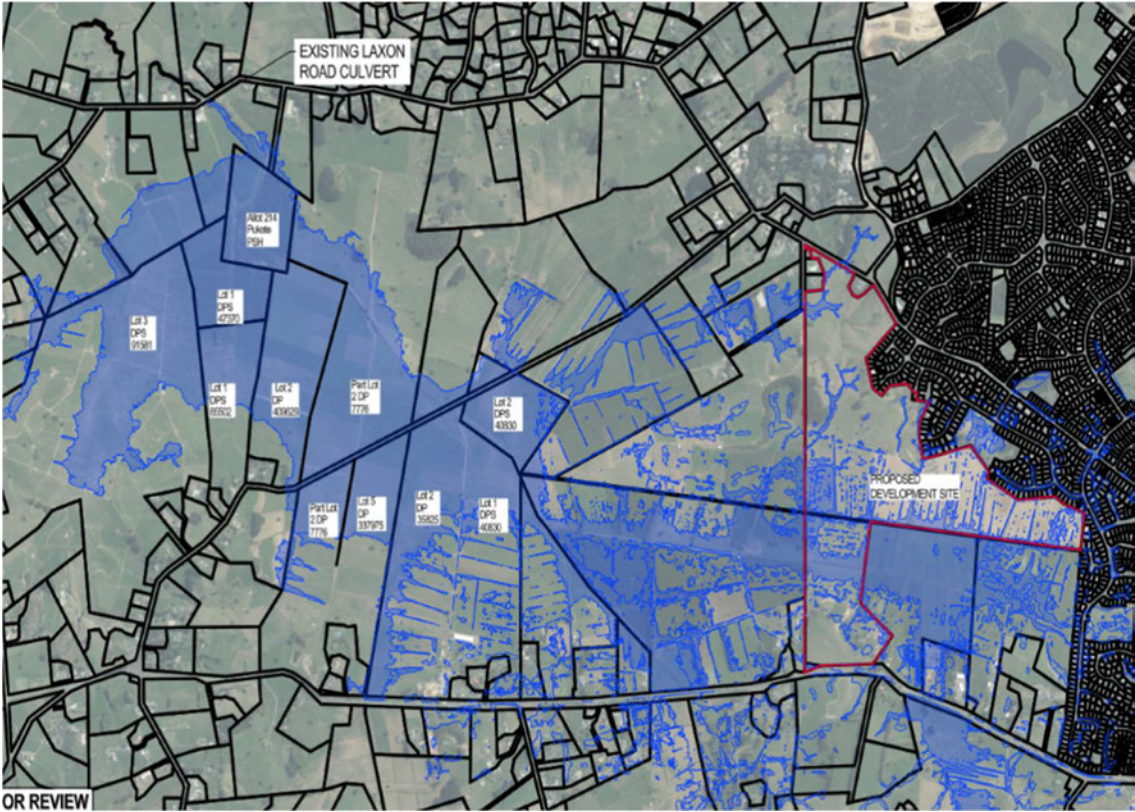


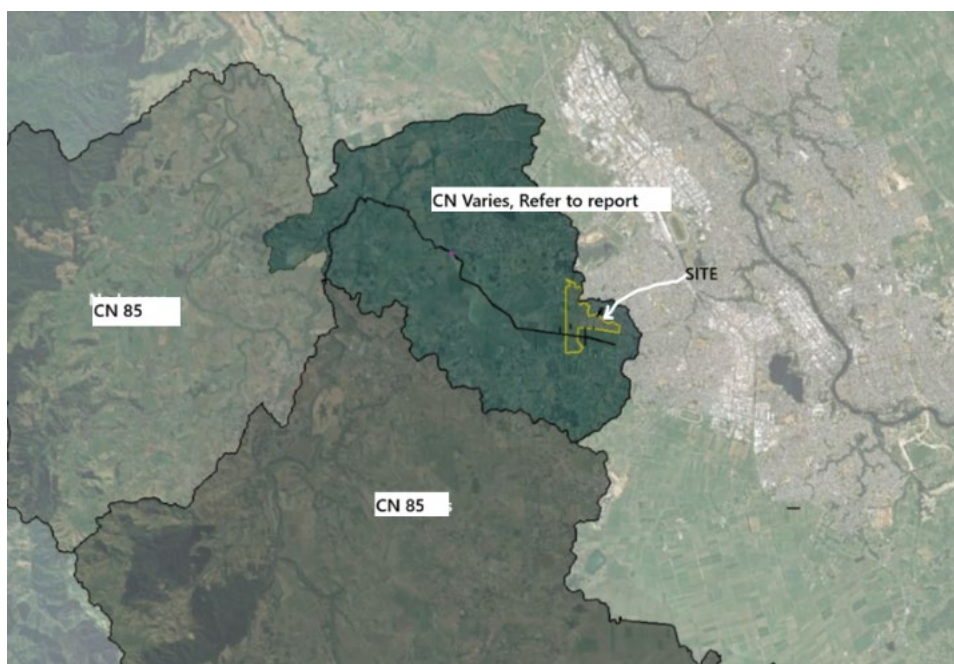
Figure 6: Hec Ras existing scenario Flood Model, rainfall event 100yr with Climate change

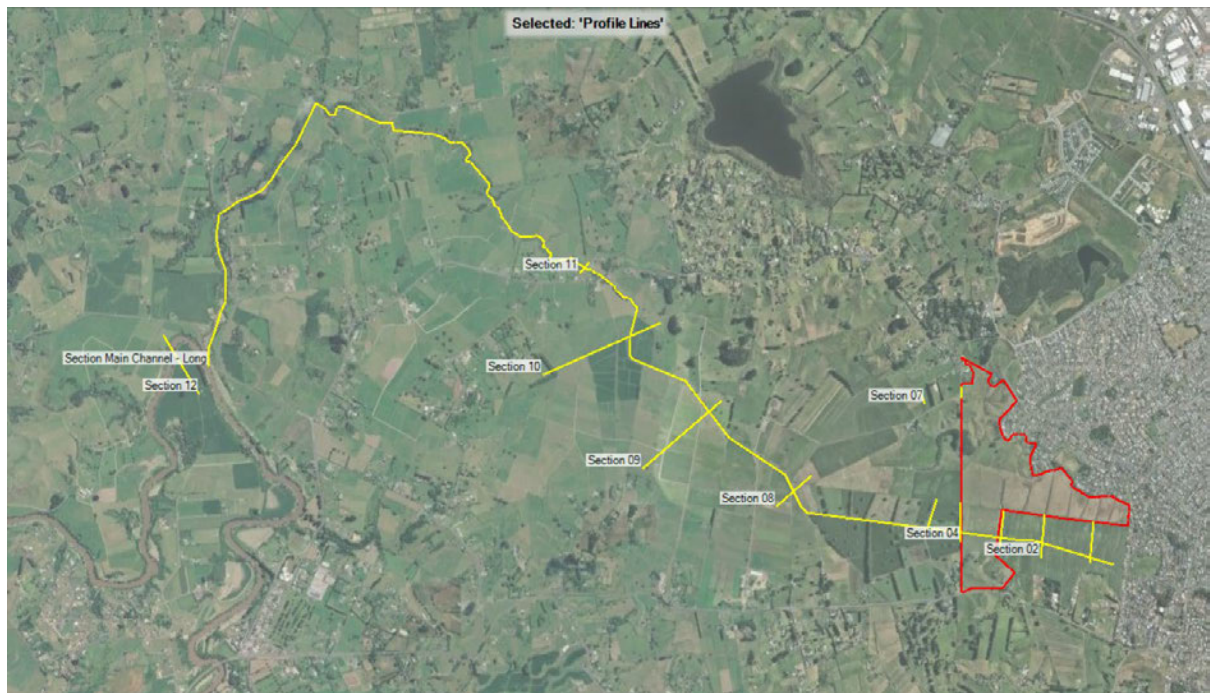
Lot Appellation	Owned by	Address
Lot 3 DPS 91581	Clevedon Cattle Corporation	44 Lindsay Road, Whatawhata, Hamilton
Lot 2 DP 409629	Waikato dairy limited	South Auckland
Part Lot 2 DP 7776	Waikato dairy limited	850 Whatawhata road, Whatawhata
Lot 1 and lot 2 DP 35825	FMS Trustees Limited, Graeme Reevely Preest, Jocelyn Marie Preest	South Auckland

Lot 5 DP 337975	Waikato dairy limited	South Auckland
Lot 1 DPS 85502	89 Robertson Road, Whatawhata, Hamilton	Bronwin Mead, Robin Bernard Mead
Lot 1 DPS 47370	Murphy's Estate Limited	South Auckland
Allot 214 Pukete PSH	Murphy's Estate Limited	South Auckland

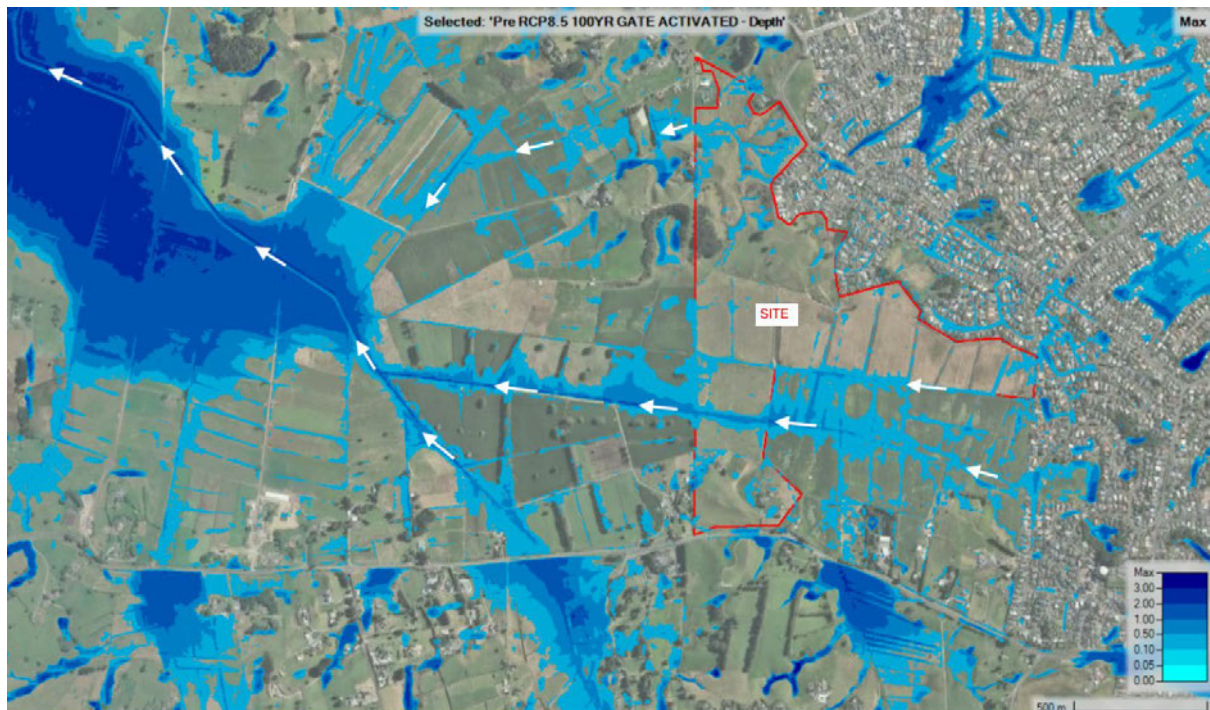
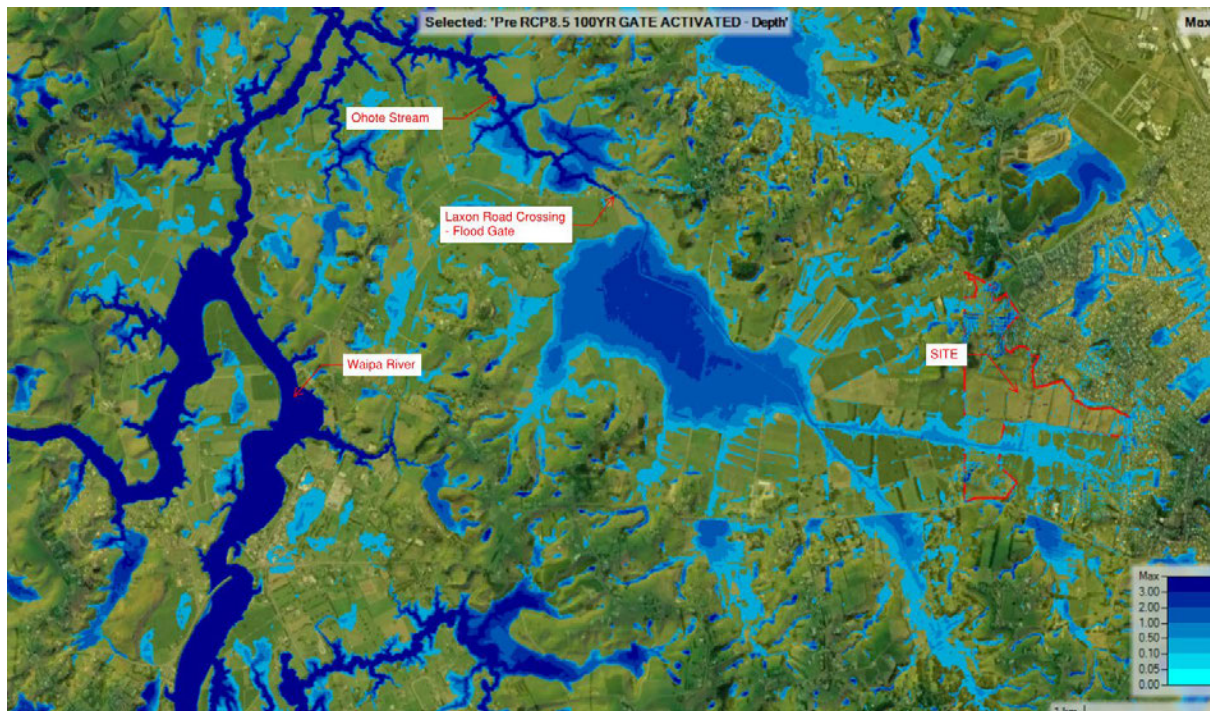
APPENDIX B

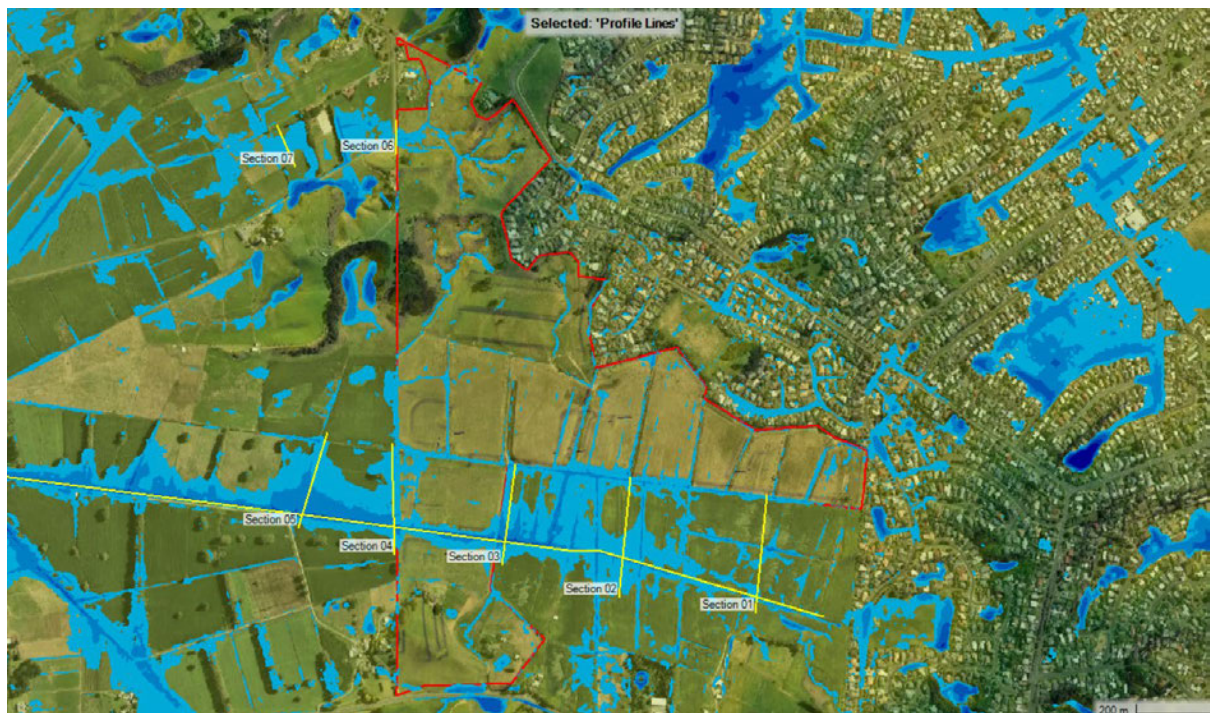
HEC RAS RESULT – BRYMER FARMS PROJECT



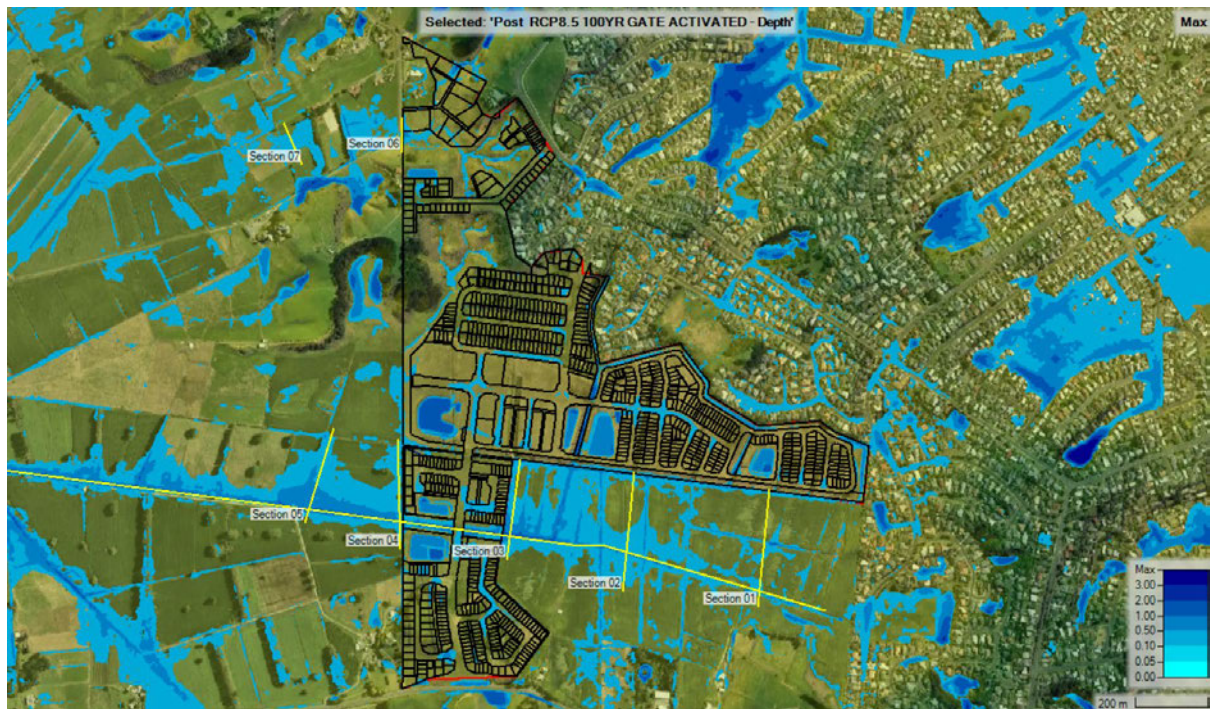


Pre Development 100 year CC Map

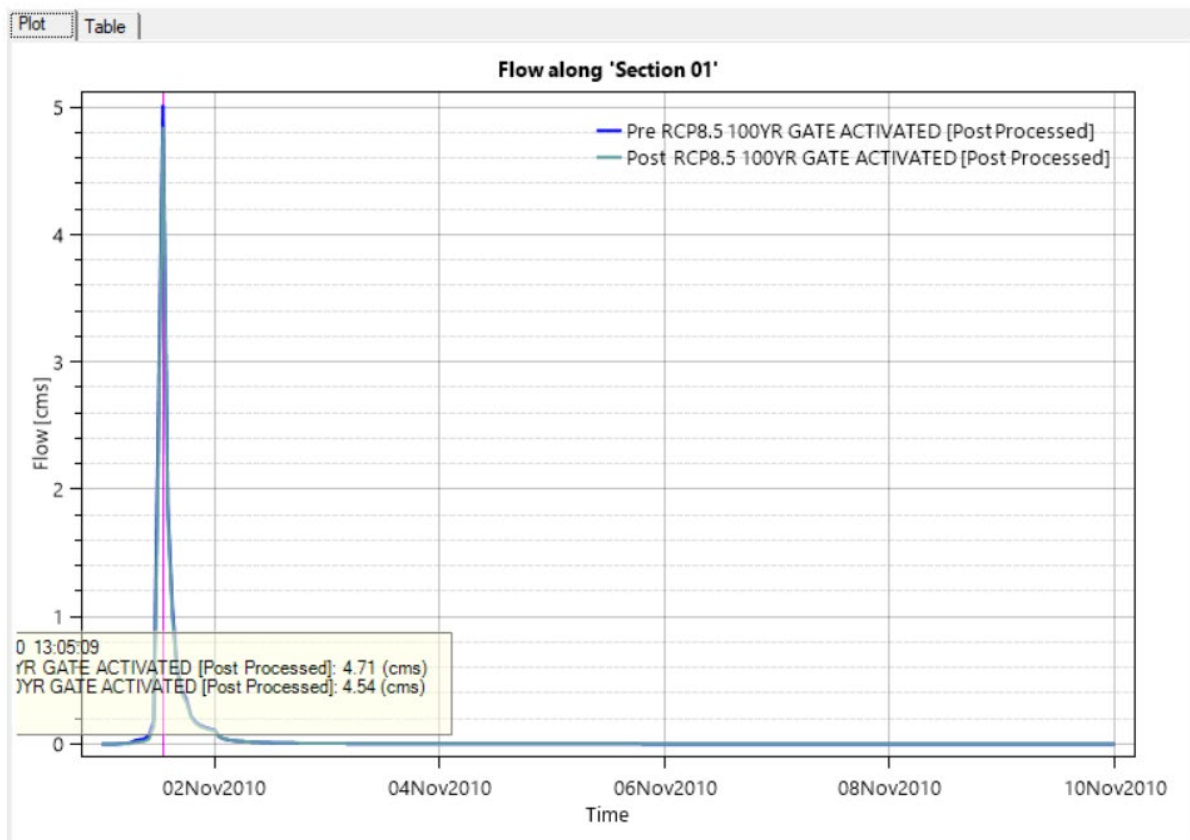
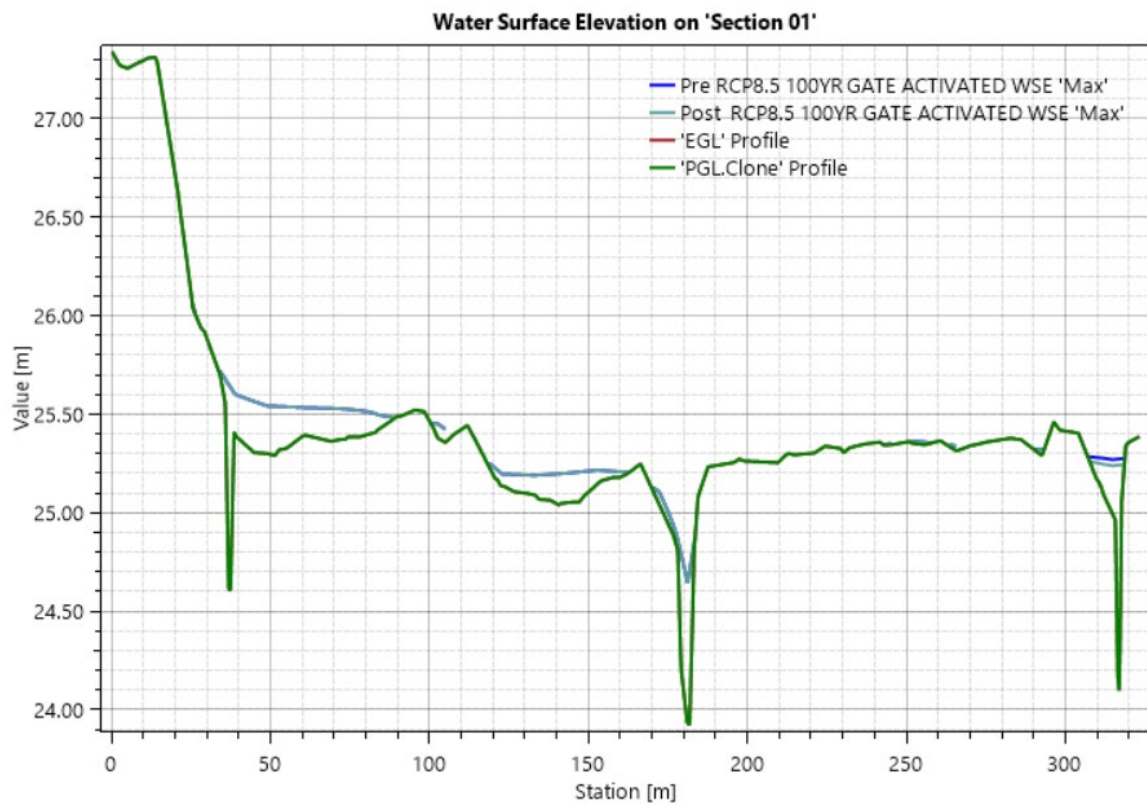


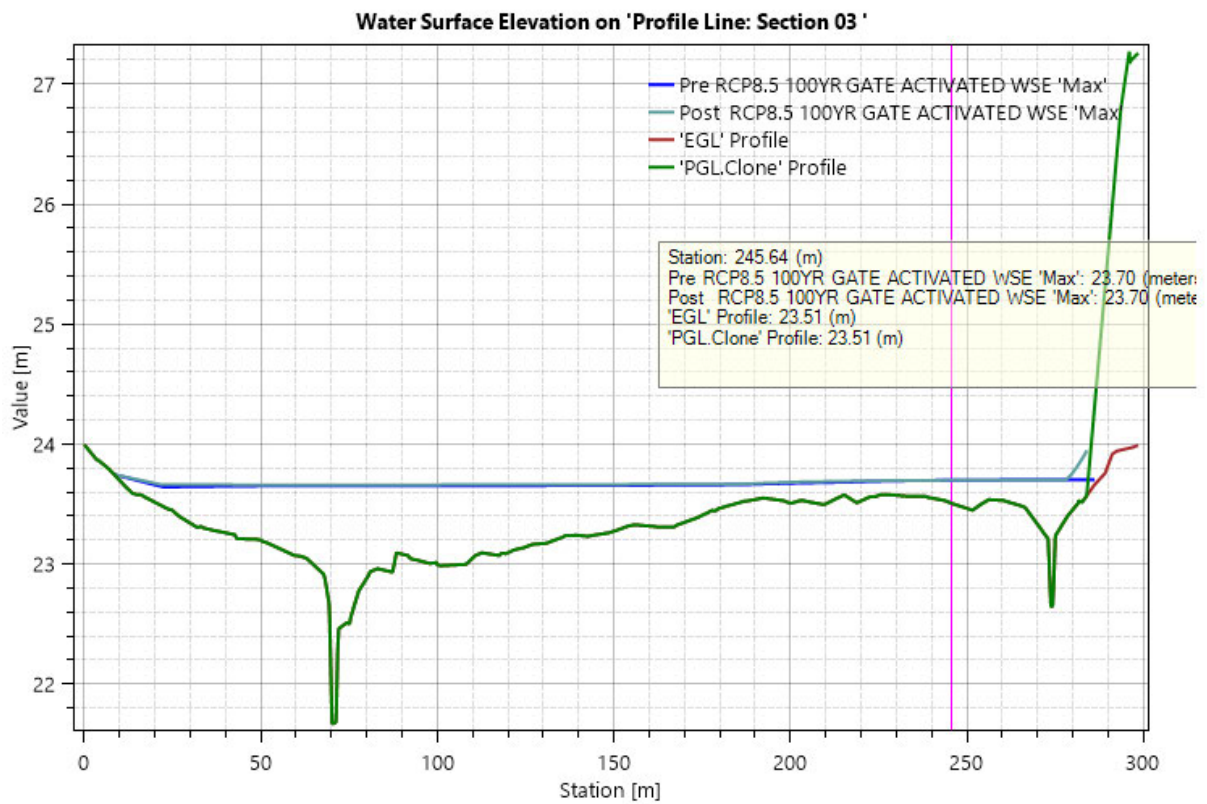
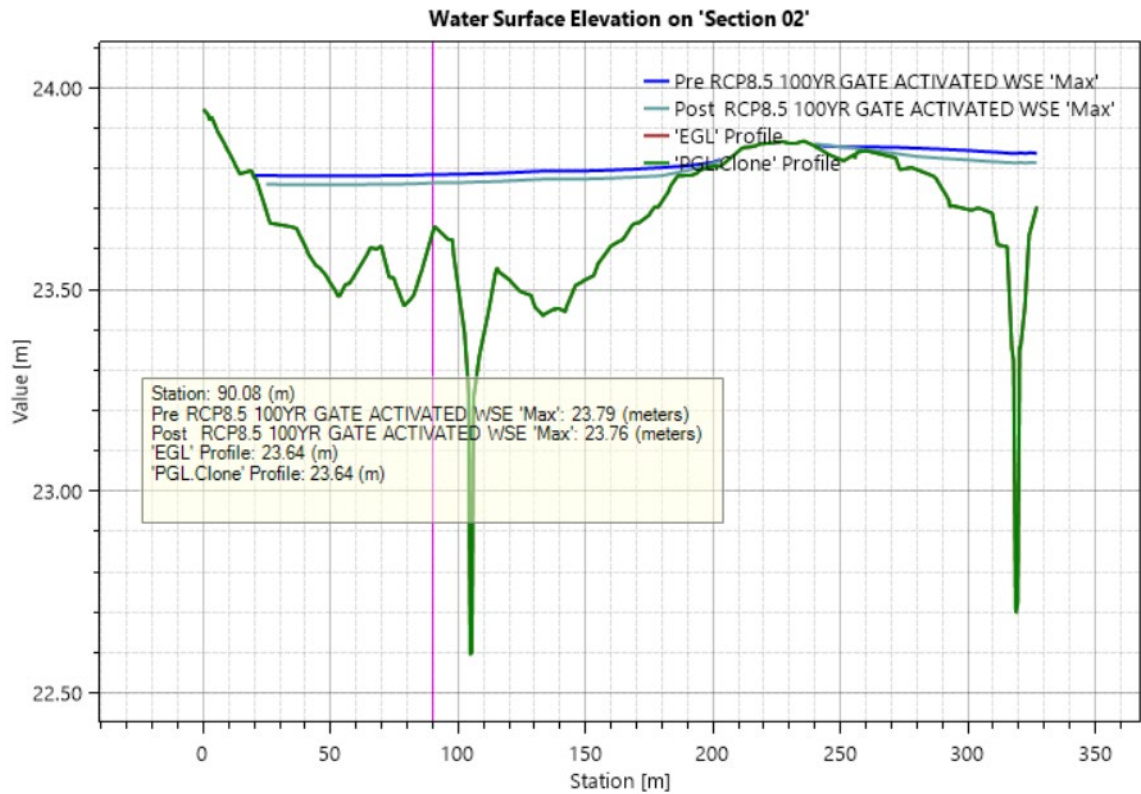


Post Development 100 year CC Map

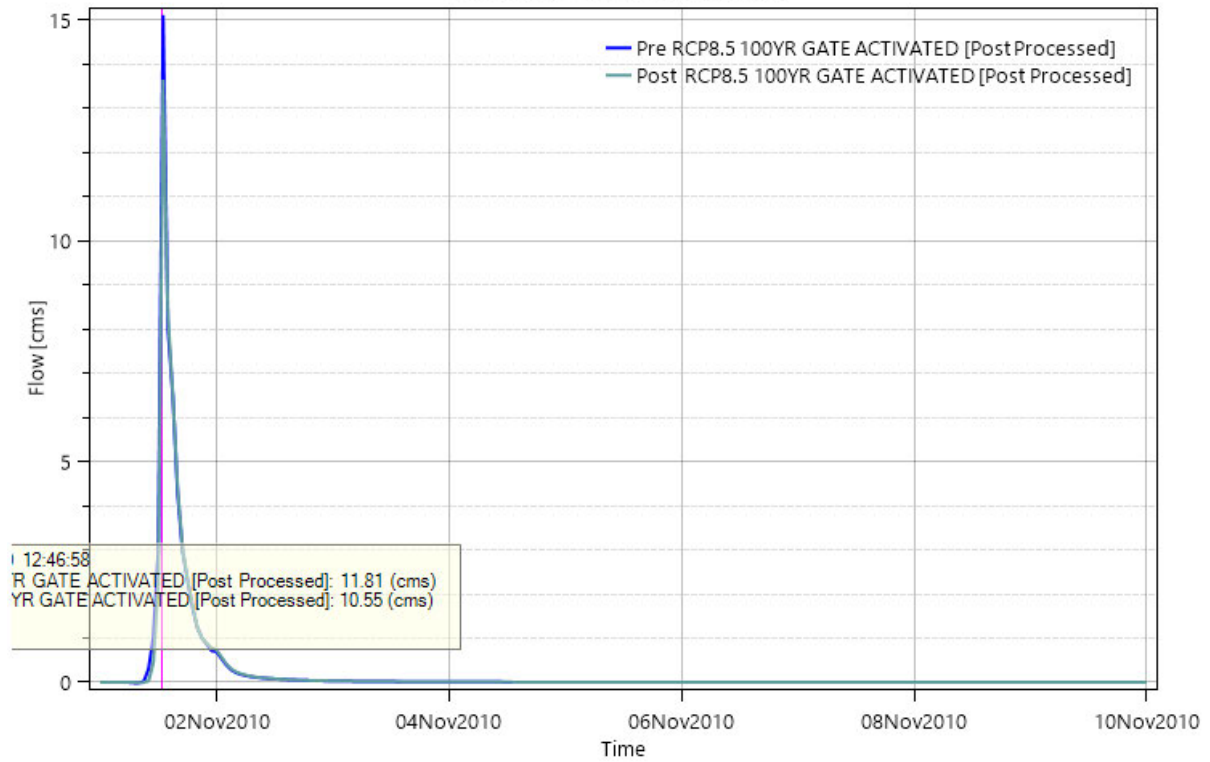


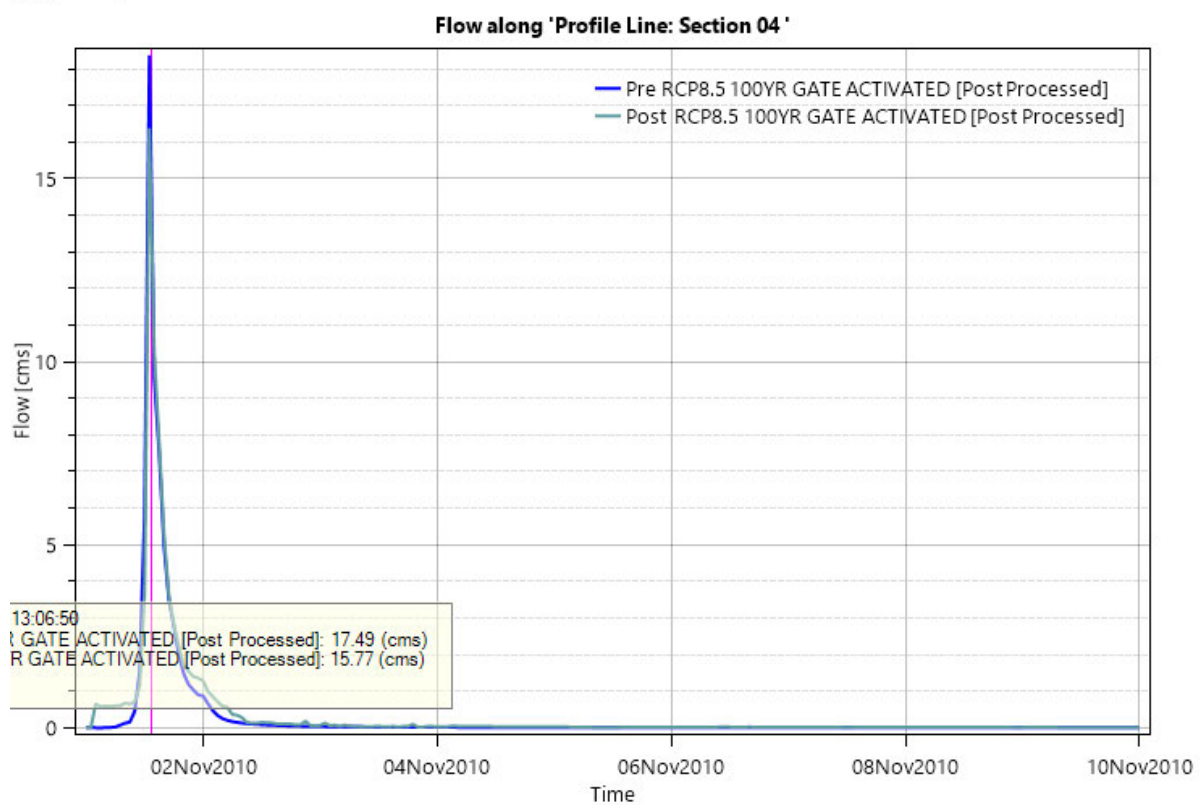
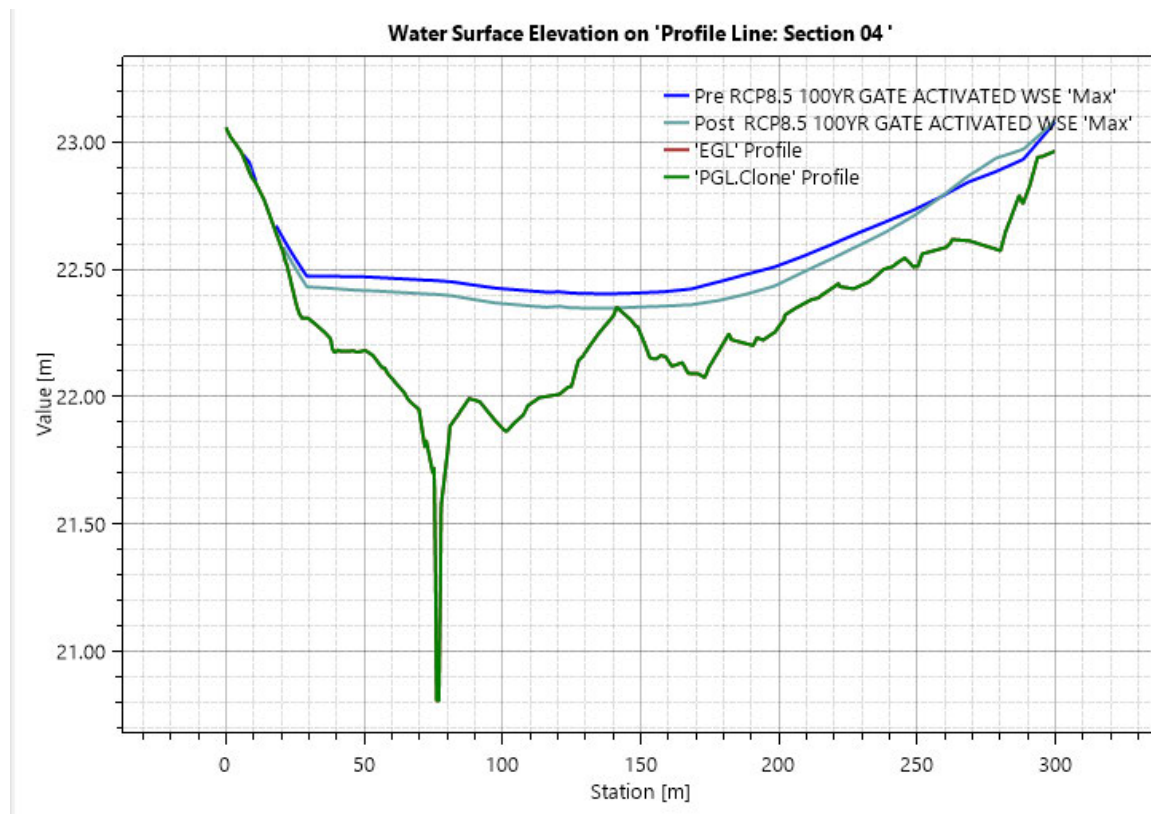
Sections Results – WSE & Flow Rate

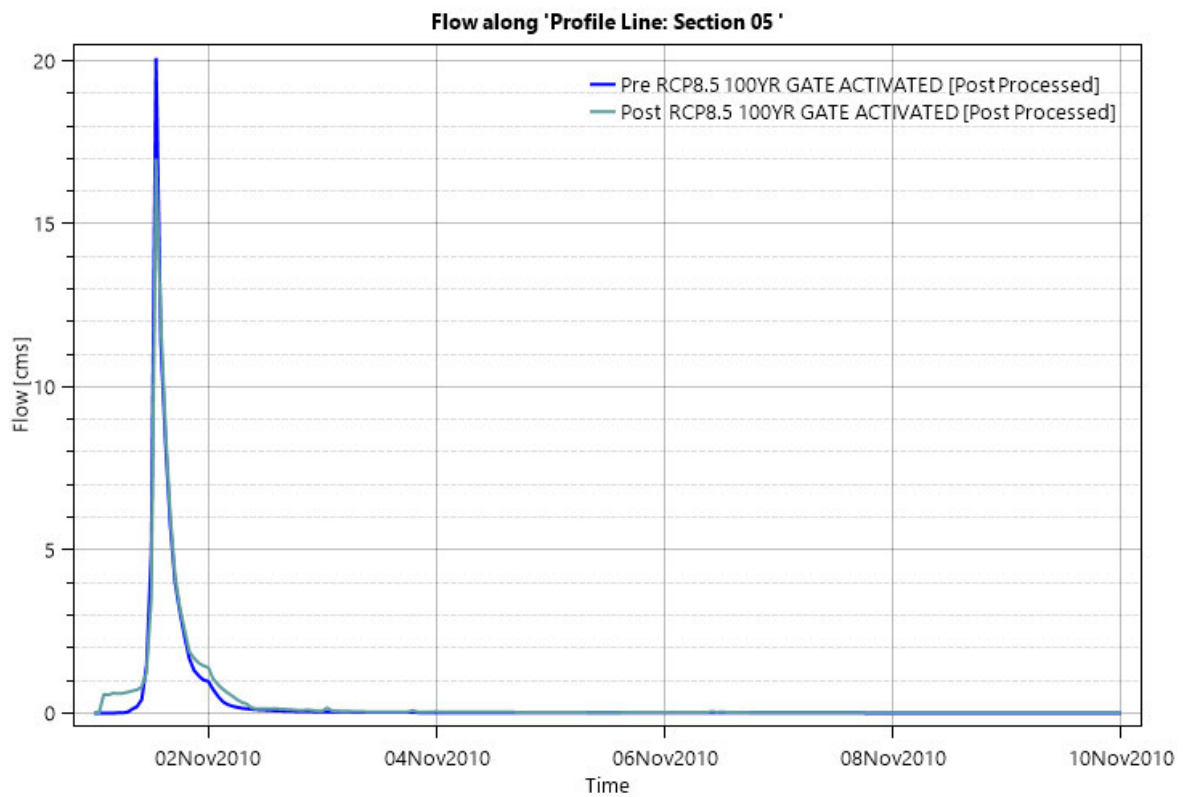
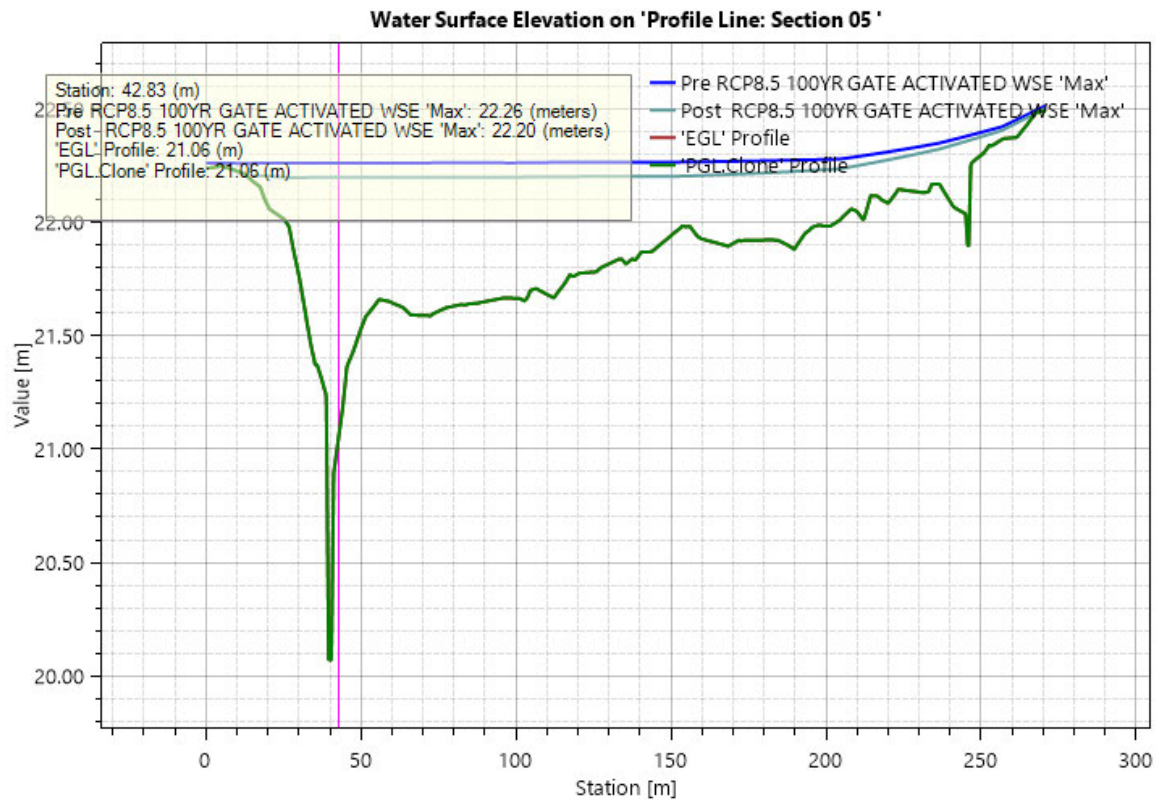


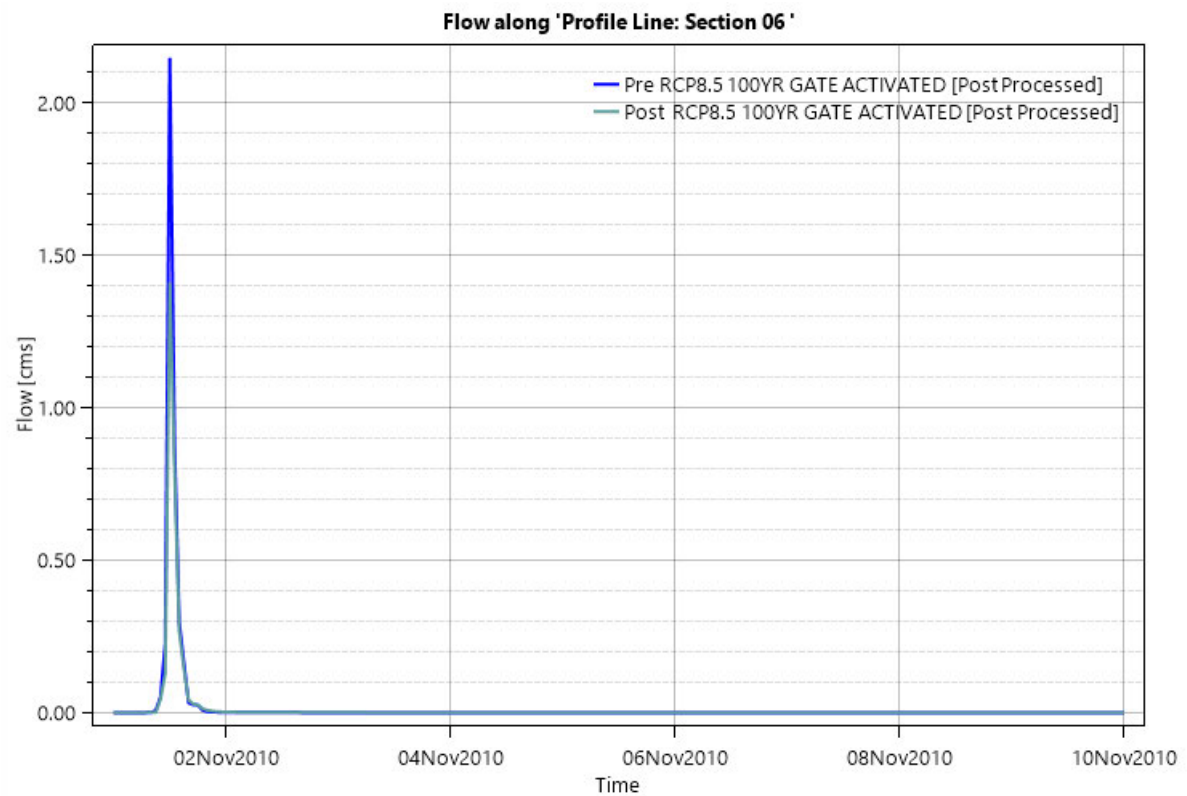
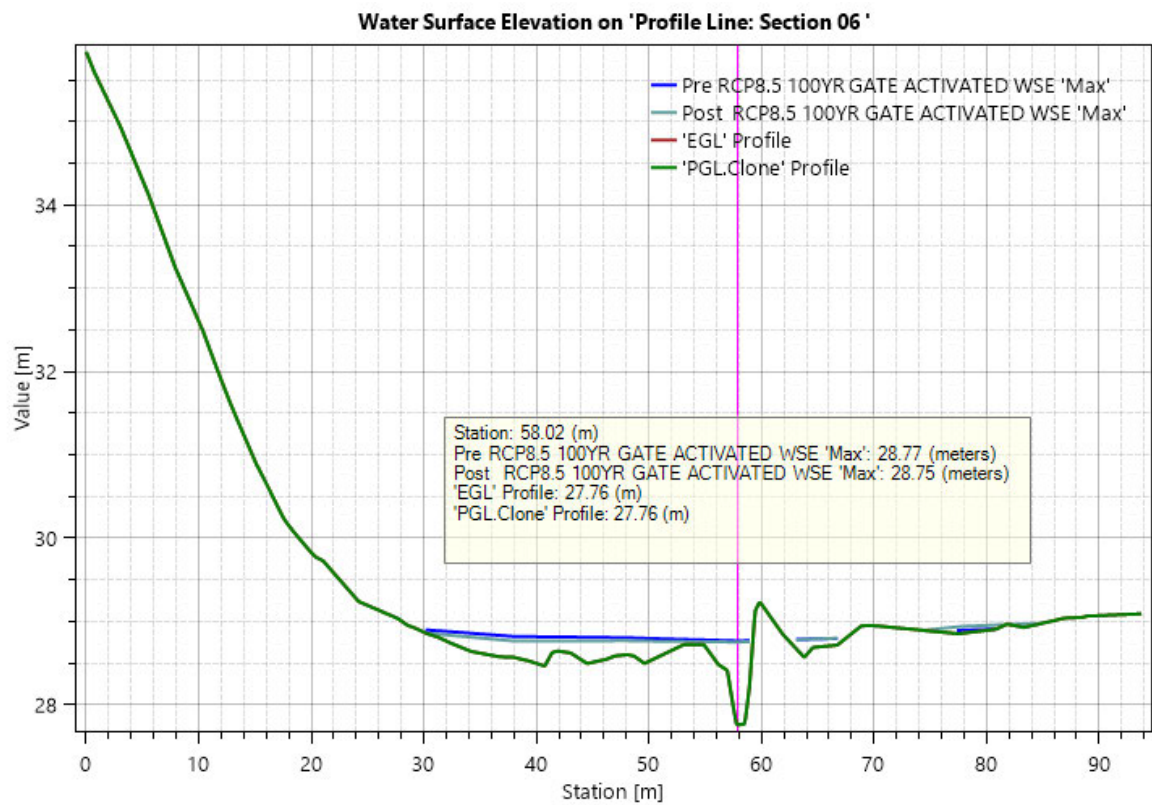


Flow along 'Profile Line: Section 03 '

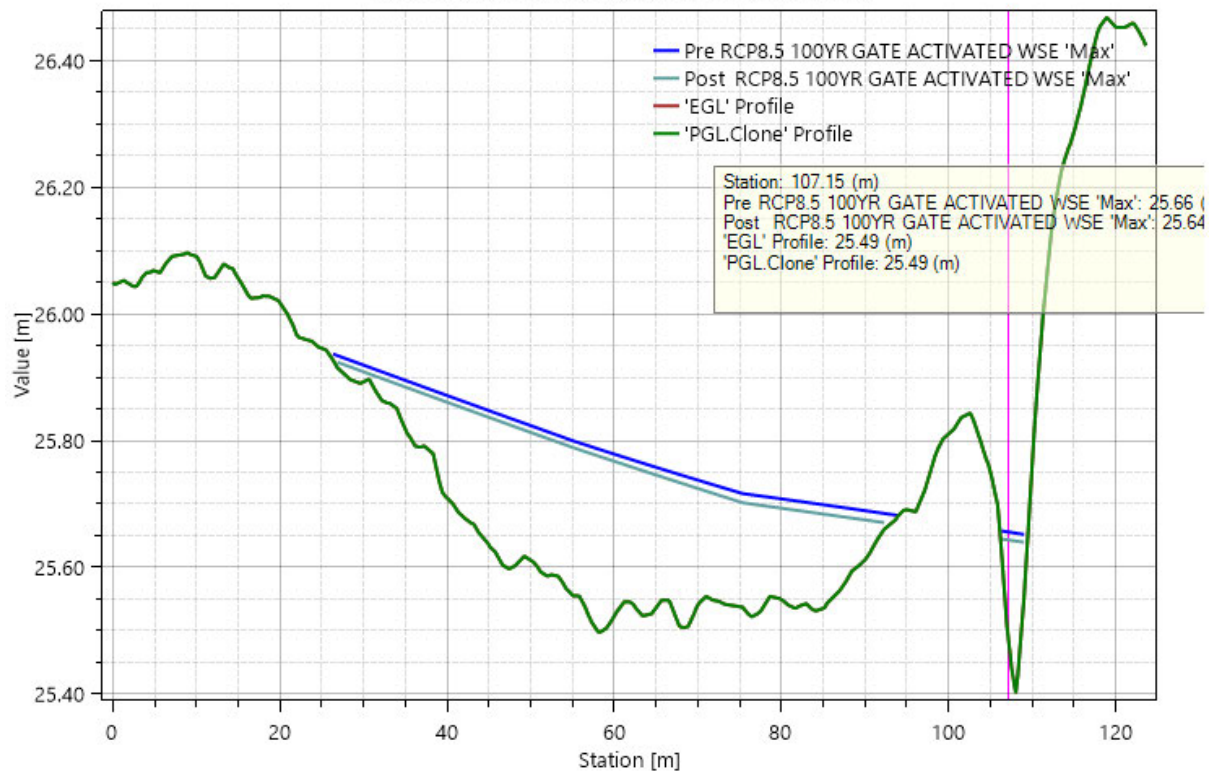




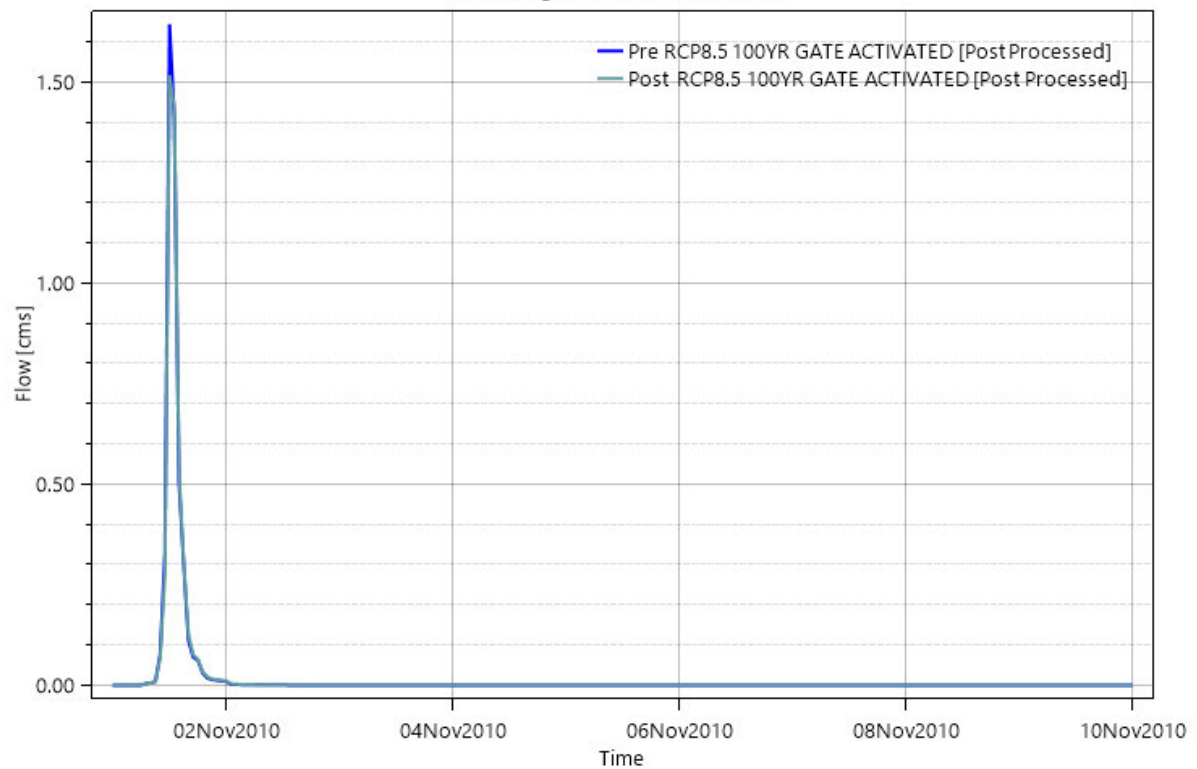


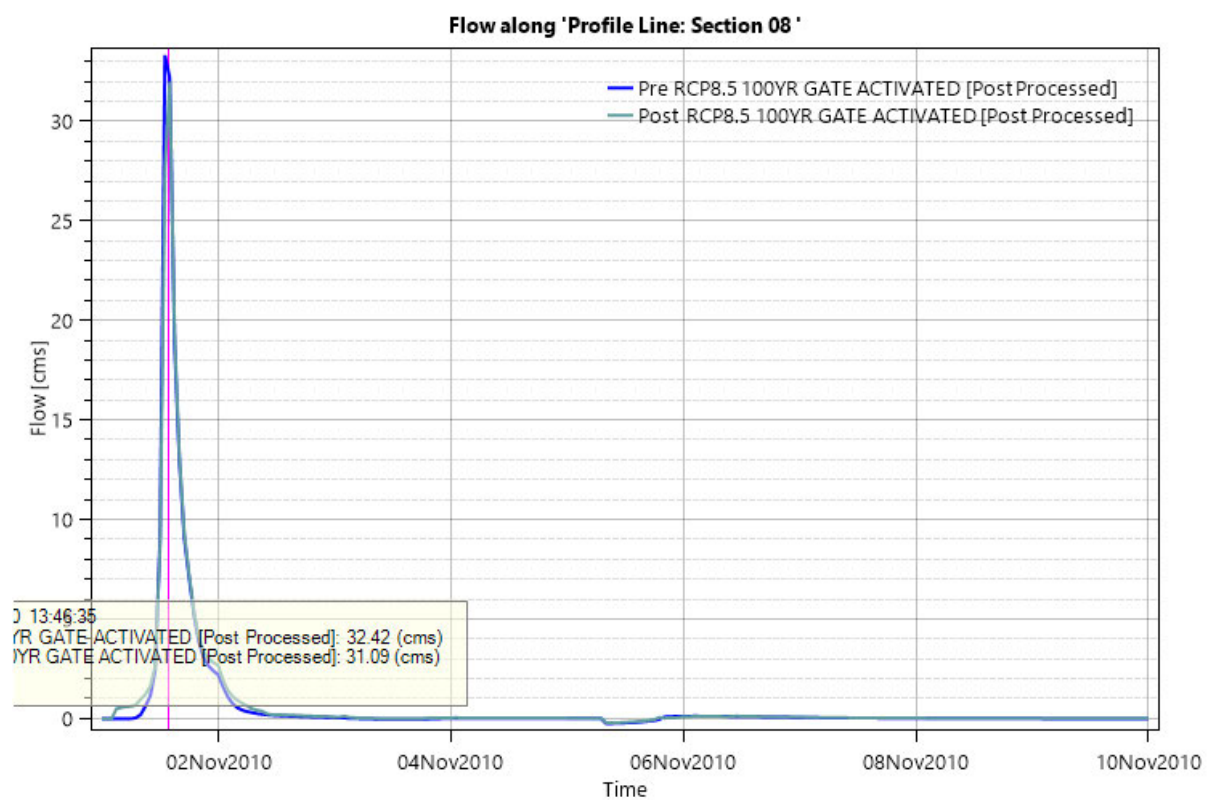
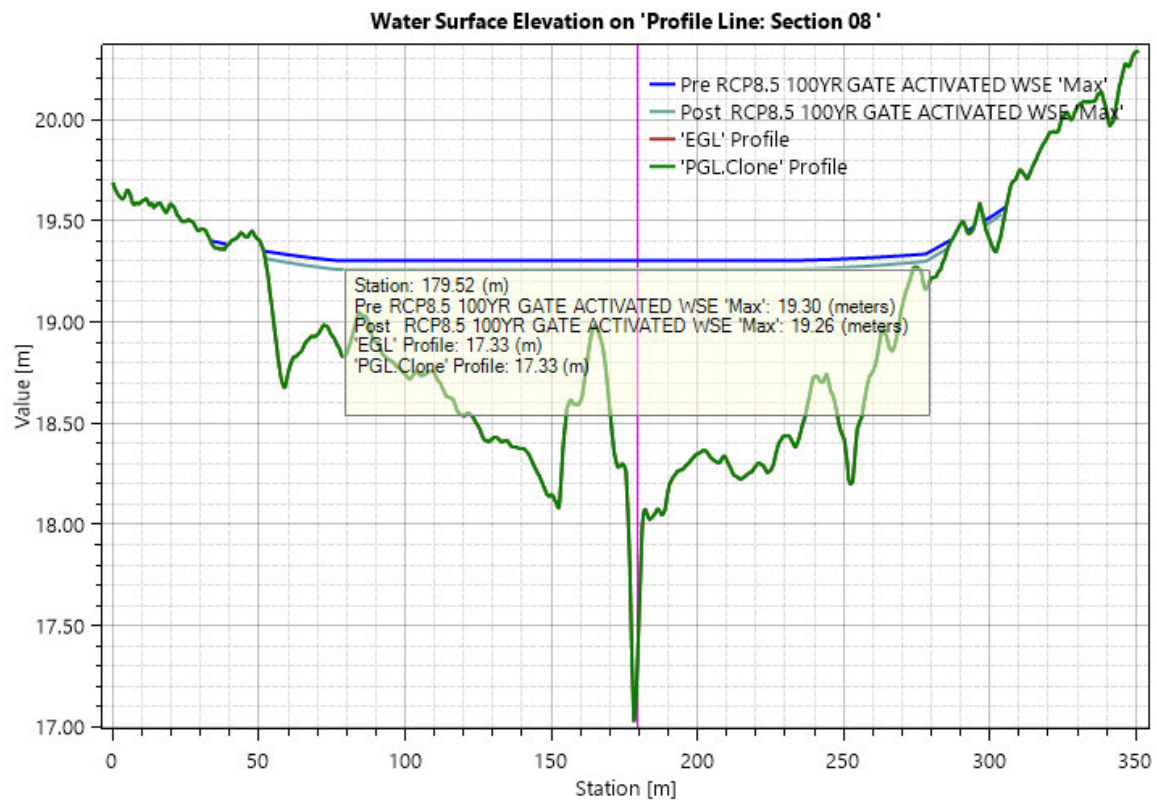


Water Surface Elevation on 'Profile Line: Section 07 '



Flow along 'Profile Line: Section 07 '





Navdeep Kaur

From: Kathy Walter [REDACTED]
Sent: Friday, 26 September 2025 2:12 pm
To: Navdeep Kaur
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton
Attachments: Ohote at Westlands daily rainfall.xlsx

Hi Navdeep

I am unfamiliar with the area but if the co-ords I gave you are correct. Please find requested Ohote data attached.

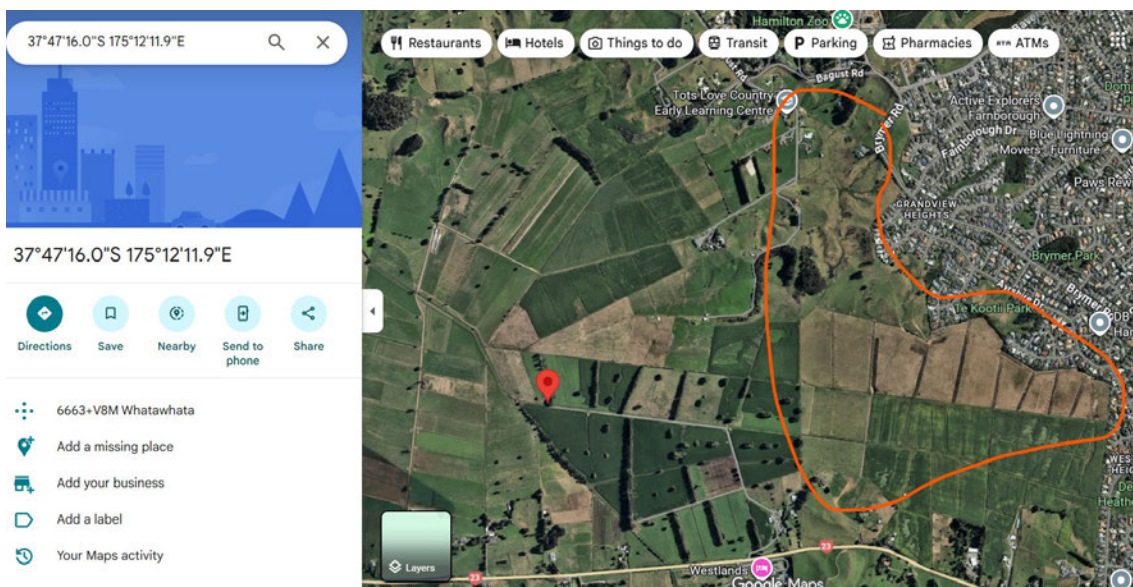
Bye, Kathy

From: Navdeep Kaur [REDACTED]
Sent: Friday, 26 September 2025 1:15 pm
To: Kathy Walter [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Kathy,

Yes, the coordinates look closer to our site, could you please send us this data will be helpful in calibrating out model?

Just want to confirm that rainfall site you have mentioned is same as below. Orange circle refers to our site location and red mark is the site location for rainfall data.



Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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From: Kathy Walter [REDACTED]
Sent: Friday, 26 September 2025 9:25 am
To: Navdeep Kaur [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Good morning Navdeep

Thank you for your email.

Site 1143428 is a closed flow site, and I understand you are after a rainfall site. We did operate a rainfall site Ohote at Westlands from 1969 to 1991. Location is Latitude: -37.78778622, Longitude: 175.20329673. Would this data be of interest to you?

You can also search on our DataHub <https://data.niwa.co.nz/> for further sites.

Thank you
Kind regards, Kathy

From: Navdeep Kaur [REDACTED]
Sent: Friday, 26 September 2025 8:33 am
To: Michael Bargh [REDACTED]; Kathy Walter [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Morning Mike and Kathy,

I hope you're doing well.

Just following up on my previous email regarding any available data or information related to the Ohote Stream (Rotokauri) site – specifically in reference to TIDEDA Site Number **1143428** – to assist with our flood model calibration.

Please let me know if there's any update or if you require any further details from my end.

Looking forward to hearing from you.

Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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From: Navdeep Kaur

Sent: Wednesday, 24 September 2025 9:42 am

To: [REDACTED]

Cc: [REDACTED]; Raatite Kanimako [REDACTED]

Subject: FW: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Mike,

Kathy's email directed to your email.

We are doing a flood model for site highlighted in the image below. We were given some information on Ohote stream Rotokauri rain gauge by WRC and they further suggested to get in touch with you if you have any other information that could be used to calibrate our flood model as the site is outside the WRC domain. Please refer to emails below that quoted **TIDEDA Site Number 1143428** for the **Ohote stream Rotokauri** site and close to the circle area.



Thanks and let me know if you can provide information about ohote stream rain gauge or have any further queries,

Regards

From: Doug Stewart [REDACTED]
Sent: Wednesday, 24 September 2025 8:33 am
To: Navdeep Kaur [REDACTED]
Cc: Debbie Eastwood [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,
Low Flows are 5 yr 7 day low flow estimates in m³/s (so 0.004 m³/s or 4 l/s)

Ohote at Rotokauri is not a WRC site – you would be best to contact Kathy Walter at Earth Science [REDACTED] for the data.
She will use TIDEDA Site Number 1143428 for the site

Cheers, Doug

Doug Stewart | SENIOR ENVIRONMENTAL MONITORING SCIENTIST - HYDROLOGY | Hydrology and Air, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [REDACTED]
M: [REDACTED]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 16:27
To: Doug Stewart [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

CAUTION: This email originated from outside of Waikato Regional Council. Do not follow guidance, click links, or open attachments unless you recognise the sender and know the content is safe.

Hi Doug,

Thankyou for sending that through.

Regarding flow guage 624_6 Ohote at Rotokauri, just want to confirm if it refers to flow of 5 year event and flow is in terms of cubic meters per second?

Regarding flow guage 624_6 Ohote at Rotokauri , do you have any other information that could be helpful in calibrating model like 10 yr or 100yr flow gauge data?

O	P	C
Low Flows	Q5 estimate	
624_1 Ohote at Blackett Rd	0.009	
624_2 Ohote at Fullerton Rd		
624_3 Ohote at Laxon Rd		
624_4 Ohote at Duck Rd-McCracken Rd Bridge	0.004	
624_5 Ohote at Whatawhata-Horotiu Rd		
624_6 Ohote at Rotokauri (NIWA)	0.004	

Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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From: Doug Stewart [REDACTED]
Sent: Tuesday, 23 September 2025 4:06 pm
To: Navdeep Kaur [REDACTED]; Debbie Eastwood [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,
Attached file has flow gaugings from Ohote Stream from our database.

Ministry of Works and Development (now Earth Sciences NZ) operated a site from 1968 to 1991.

Cheers, Doug

Doug Stewart | SENIOR ENVIRONMENTAL MONITORING SCIENTIST - HYDROLOGY | Hydrology and Air, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato

P: [REDACTED]
M: [REDACTED]

F: facebook.com/waikatoregion

Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

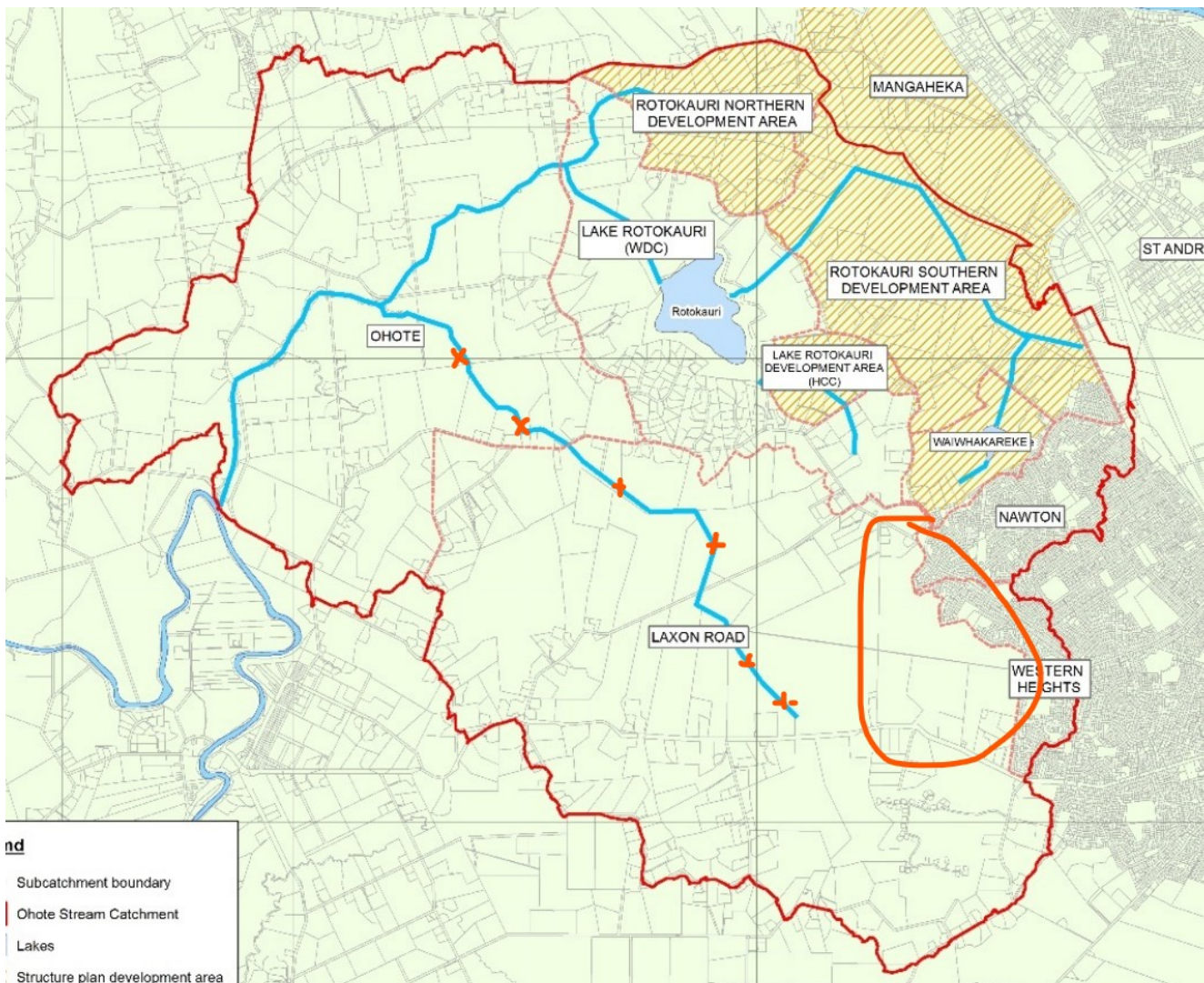
From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 14:36
To: Debbie Eastwood [REDACTED]
Cc: Doug Stewart [REDACTED]; Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

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Hi Debbie,

Thank you for your swift reply.

Is there any information at Ohote stream, as highlighted below with crosses?



Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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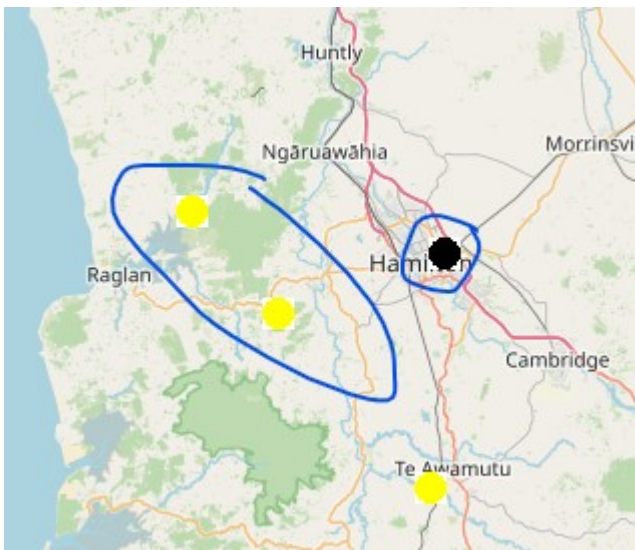
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From: Debbie Eastwood [REDACTED]
Sent: Tuesday, 23 September 2025 12:52 pm
To: Navdeep Kaur [REDACTED]
Cc: Doug Stewart [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,

As far as I'm aware the only station we have in Hamilton is Ruakura (NIWA station).
Doug, do we have any others I'm not aware of in Hamilton area?

The only other ones on the west are Karamu Walkway and Waingaro, which will be too far away I imagine.



Cheers

Debbie

Debbie Eastwood | ENVIRONMENTAL DATA ADVISOR | Environmental Data, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [REDACTED]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 11:34 am

To: Debbie Eastwood [REDACTED]
Subject: Flood Model- for 584 Whatawhata Road, Hamilton

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Hi Debbie,

We are doing flood modelling in the Waikato Region, this time closer to Rotokauri area in Hamilton City, North as per image below.



Do we have any rainfall data around this region preferably downstream and close to the circle area. something we can use for calibration.

Thanks and let me know if you have any further queries,

Regards

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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Kathy Walter

Principal Technician - Environmental Information
Manager – National Hydrometric Database



10 Kyle Street Riccarton, Christchurch, New Zealand
Earth Sciences New Zealand



The Institute of Geological and Nuclear Sciences Limited and the National Institute of Water and Atmospheric Research Limited joined to become the New Zealand Institute for Earth Science Limited. We are known as Earth Sciences New Zealand. For more information on the Earth Sciences transition [click here](#).

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Navdeep Kaur

From: Doug Stewart [REDACTED]
Sent: Wednesday, 24 September 2025 8:33 am
To: Navdeep Kaur
Cc: Debbie Eastwood
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,
Low Flows are 5 yr 7 day low flow estimates in m³/s (so 0.004 m³/s or 4 l/s)

Ohote at Rotokauri is not a WRC site – you would be best to contact Kathy Walter at Earth Science [REDACTED] for the data.
She will use TIDEDA Site Number 1143428 for the site

Cheers, Doug

Doug Stewart | SENIOR ENVIRONMENTAL MONITORING SCIENTIST - HYDROLOGY | Hydrology and Air, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [REDACTED]
M: [REDACTED]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 16:27
To: Doug Stewart [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

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Hi Doug,

Thankyou for sending that through.

Regarding flow guage 624_6 Ohote at Rotokauri, just want to confirm if it refers to flow of 5 year event and flow is in terms of cubic meters per second?

Regarding flow guage 624_6 Ohote at Rotokauri , do you have any other information that could be helpful in calibrating model like 10 yr or 100yr flow gauge data?

O	P	C
Low Flows	Q5 estimate	
624_1 Ohote at Blackett Rd	0.009	
624_2 Ohote at Fullerton Rd		
624_3 Ohote at Laxon Rd		
624_4 Ohote at Duck Rd-McCracken Rd Bridge	0.004	
624_5 Ohote at Whatawhata-Horotiu Rd		
624_6 Ohote at Rotokauri (NIWA)	0.004	

Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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From: Doug Stewart [REDACTED]
Sent: Tuesday, 23 September 2025 4:06 pm
To: Navdeep Kaur [REDACTED]; Debbie Eastwood [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,
Attached file has flow gaugings from Ohote Stream from our database.

Ministry of Works and Development (now Earth Sciences NZ) operated a site from 1968 to 1991.

Cheers, Doug

Doug Stewart | SENIOR ENVIRONMENTAL MONITORING SCIENTIST - HYDROLOGY | Hydrology and Air, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato

P: [REDACTED]
M: [REDACTED]

F: facebook.com/waikatoregion

Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

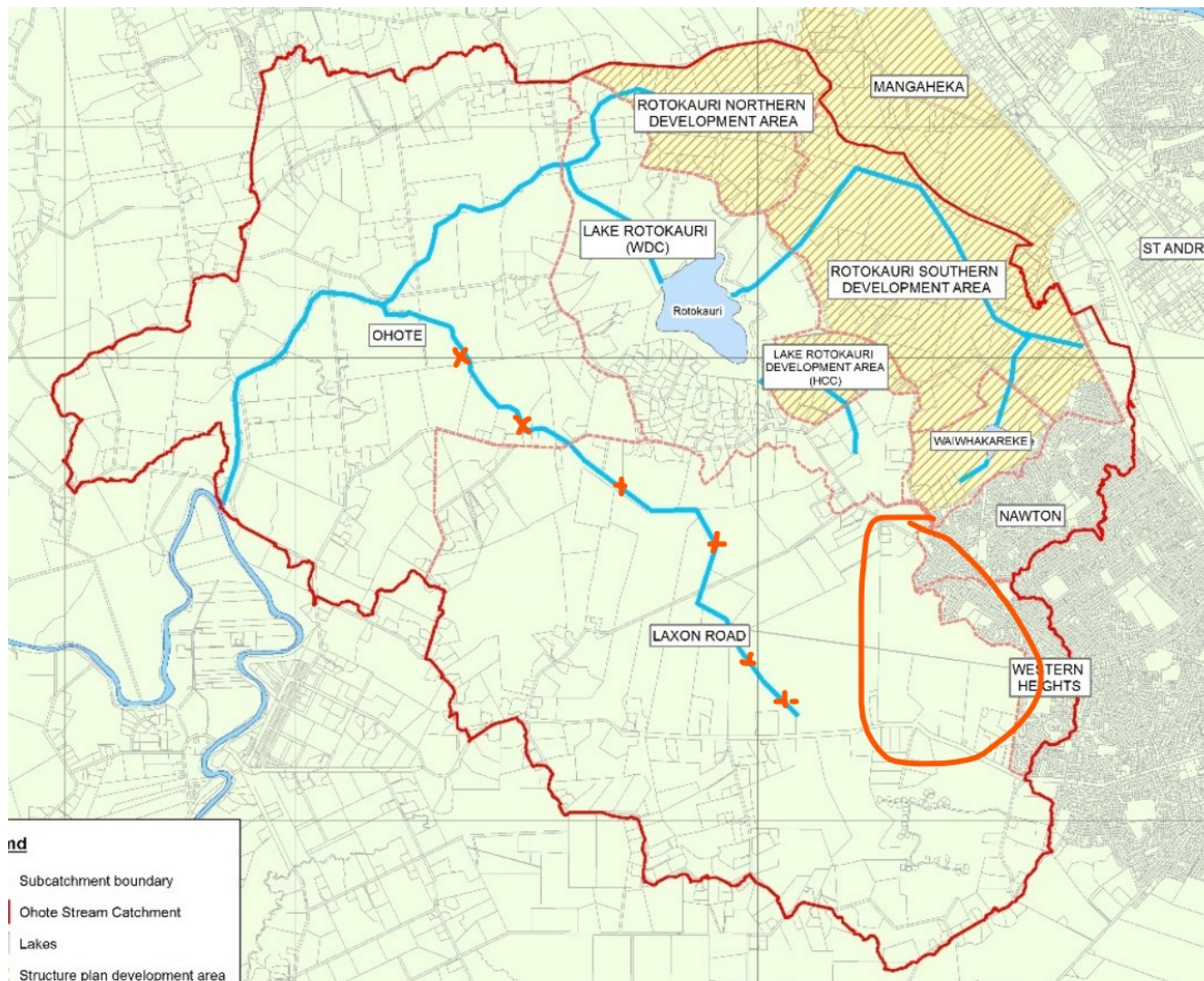
From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 14:36
To: Debbie Eastwood [REDACTED]
Cc: Doug Stewart [REDACTED]; Raatite Kanimako [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

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Hi Debbie,

Thank you for your swift reply.

Is there any information at Ohote stream, as highlighted below with crosses?



Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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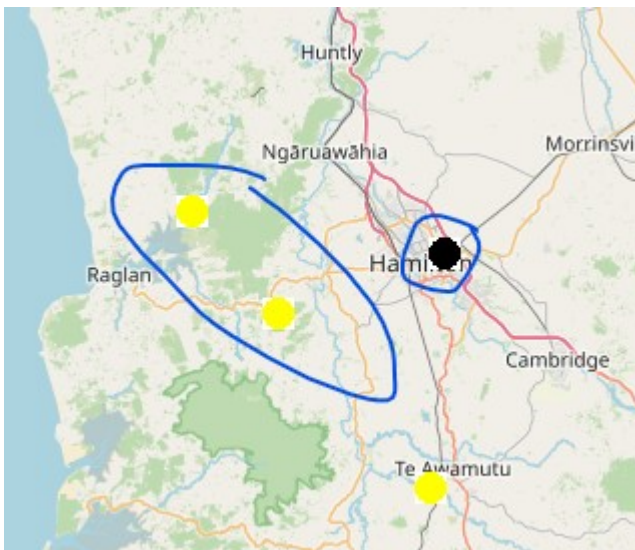
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From: Debbie Eastwood [REDACTED]
Sent: Tuesday, 23 September 2025 12:52 pm
To: Navdeep Kaur [REDACTED]
Cc: Doug Stewart [REDACTED]
Subject: RE: Flood Model- for 584 Whatawhata Road, Hamilton

Hi Navdeep,

As far as I'm aware the only station we have in Hamilton is Ruakura (NIWA station).
Doug, do we have any others I'm not aware of in Hamilton area?

The only other ones on the west are Karamu Walkway and Waingaro, which will be too far away I imagine.



Cheers

Debbie

Debbie Eastwood | ENVIRONMENTAL DATA ADVISOR | Environmental Data, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [REDACTED]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 23 September 2025 11:34 am

To: Debbie Eastwood [REDACTED]
Subject: Flood Model- for 584 Whatawhata Road, Hamilton

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Hi Debbie,

We are doing flood modelling in the Waikato Region, this time closer to Rotokauri area in Hamilton City, North as per image below.



Do we have any rainfall data around this region preferably downstream and close to the circle area. something we can use for calibration.

Thanks and let me know if you have any further queries,

Regards

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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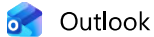


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RE: Flood Model - Waikato Hamilton area

From Steven Cornelius [REDACTED]
Date Fri 10/17/2025 1:53 PM
To Navdeep Kaur [REDACTED]

Hi Navdeep.

Sorry for the slow reply, it has been a busy week with flooding around Waitomo/Otorohonga and flows moving through the Waipa River system.

I think that screen shot was taken from a 1 % AEP current climate run. Though as the model is not calibrated this shouldn't relied upon.

Regards

Steven

Steven Cornelius | SENIOR ENGINEER | Regional Resilience, Integrated Catchment Management
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [REDACTED]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]
Sent: Tuesday, 14 October 2025 10:08 am
To: Steven Cornelius [REDACTED]
Cc: Raatite Kanimako [REDACTED]
Subject: RE: Flood Model - Waikato Hamilton area

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Hi Steven,

Thankyou for your email.

I understand that the flood model images you have sent is not fully developed. Just want to check if you could please send us the boundary condition data used in the model so we can compare to our flood model? Could you also confirm the design parameters used in the model? Is the rainfall event 100 yr RCP 8.5 2081-2100?

Thanks,

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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19 Kaimiro Street, Pukete, Hamilton 3200

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From: Steven Cornelius [REDACTED]
Sent: Tuesday, 7 October 2025 9:35 am
To: Navdeep Kaur [REDACTED]
Subject: RE: Flood Model - Waikato Hamilton area

You don't often get email from [REDACTED] [Learn why this is important](#)

Hi Nadeep

Sorry for the slow reply, I have been on leave. In future I suggest you submit requests for information using the on line form ([Request for service](#) | [Puka tono ratonga: Request - Waikato Regional Council](#)). This will ensure that your request is responded too in a timely manner.

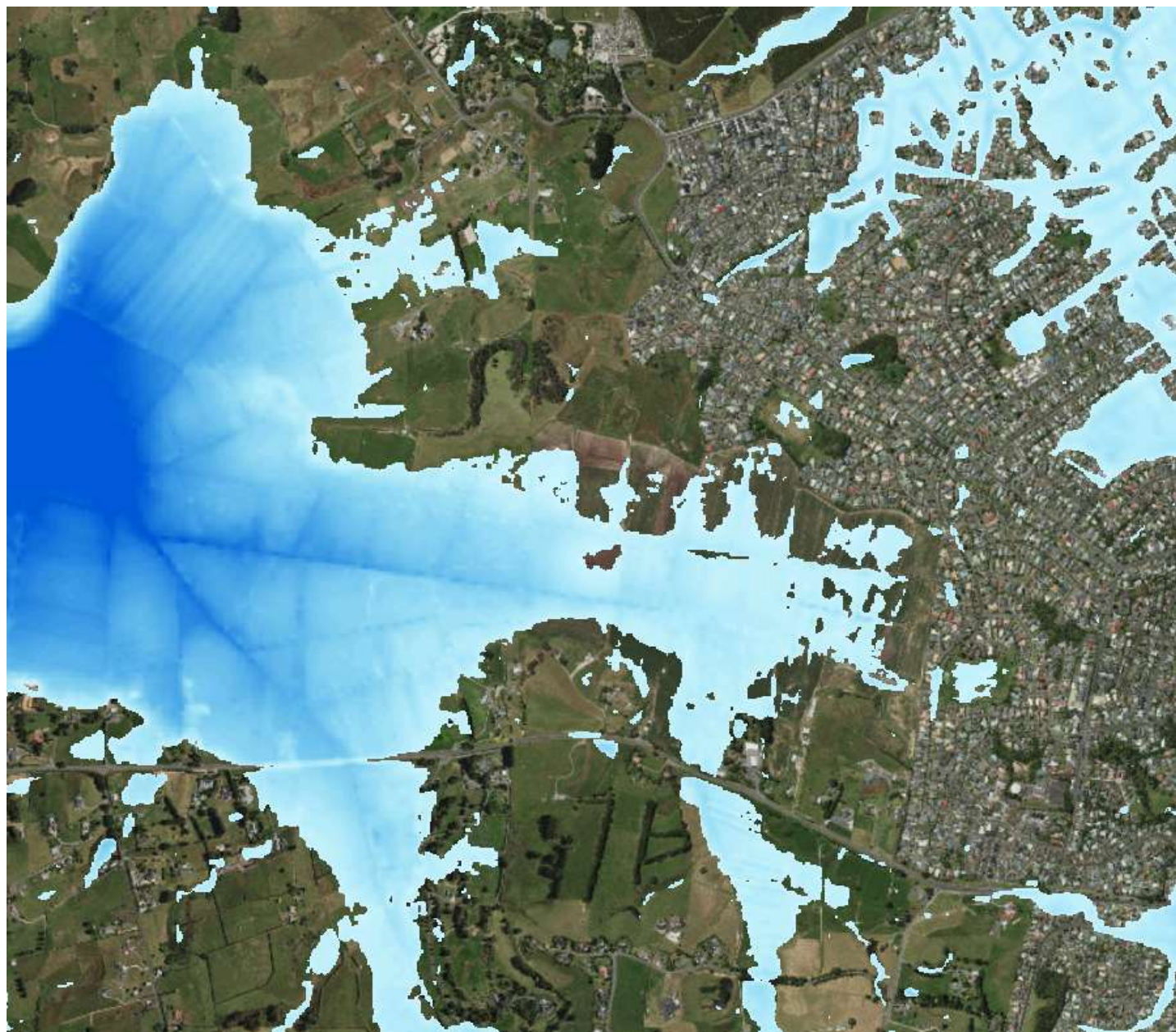
We are currently working on a model that includes this area. The model is an early draft and is not suitable for use in development planning or setting building floor levels. The screen shot below is taken from this model and suggests that the area is a flood plain. The second screen shot suggests that there is a constriction downstream at Laxon Road. The area is also within the flood plain of the Waipa River.

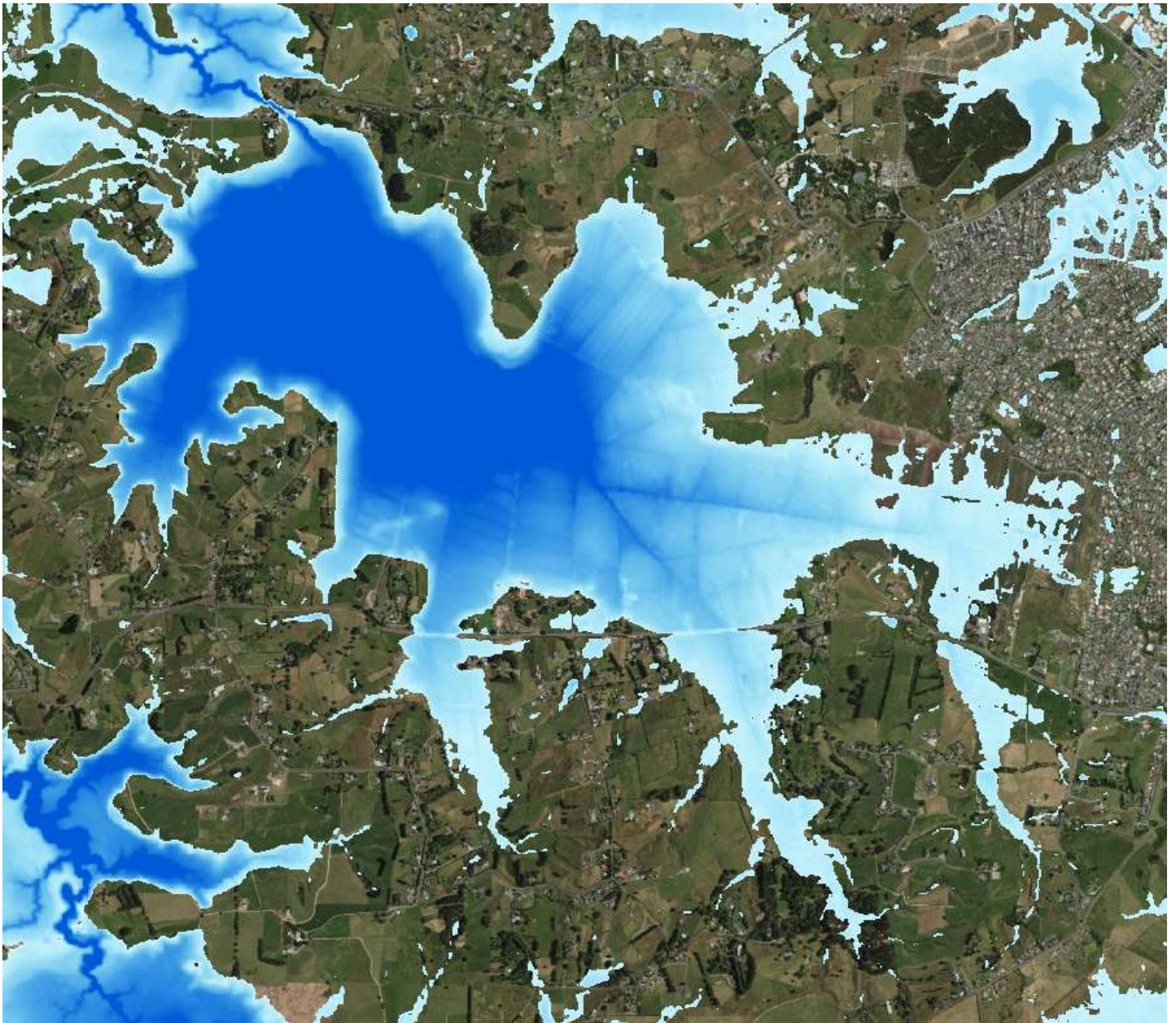
The site is probably best described as low-lying swampy land that isn't suitable for development. The site is within the Ohoto Basin drainage scheme, see the third screenshot below which is from [Waikato Regional Hazards Portal](#), and would have been wetland prior to the establishment of the scheme. I suspect there are still areas of wetland within the site. The drainage scheme is designed to prevent pasture die off, surface ponding resulting from a 10-year ARI 24 hour storm should be cleared within 3 days. This level of service is not intended to protect urban development.

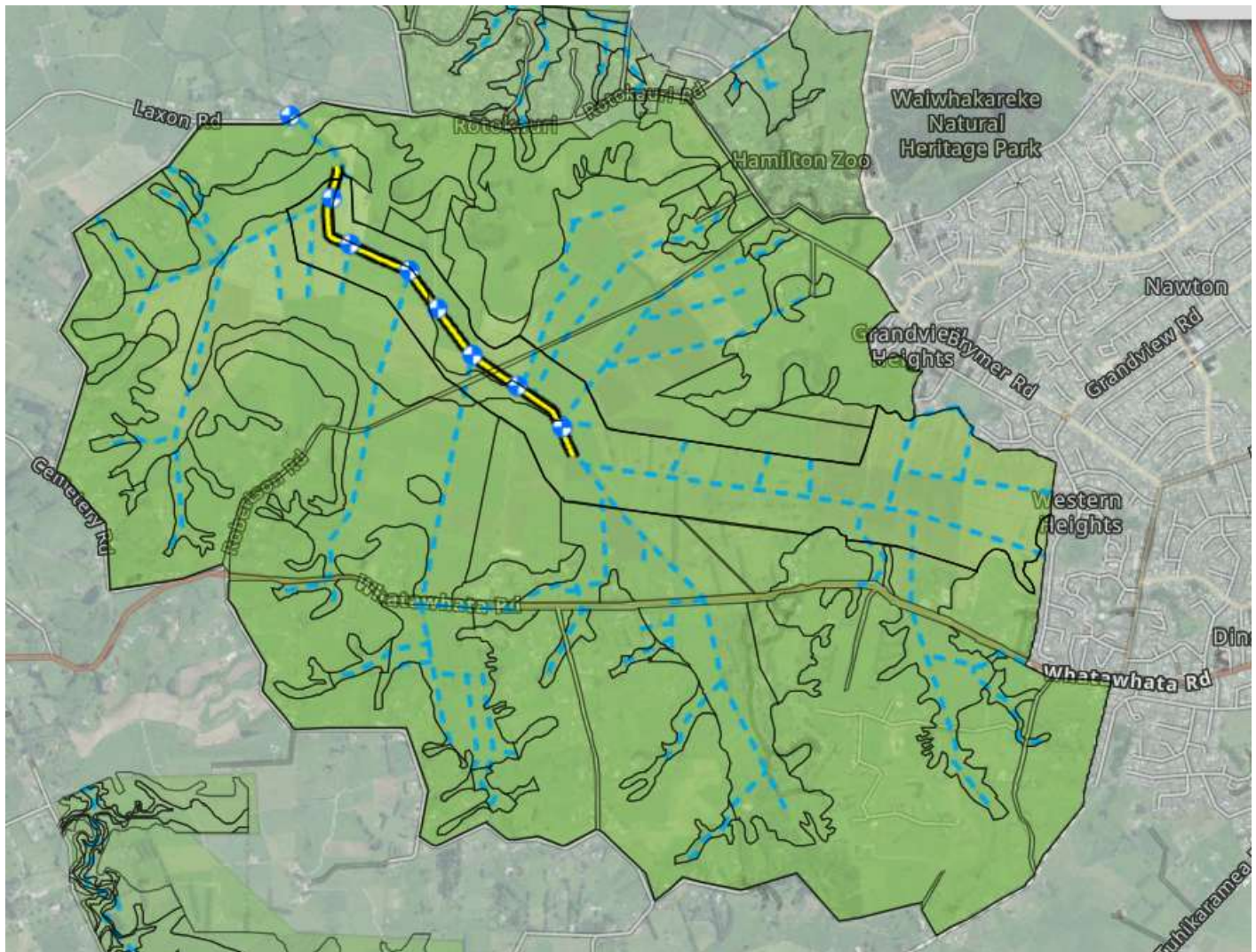
I trust this helps.

Regards

Steven







Steven Cornelius | SENIOR ENGINEER | Regional Resilience, Integrated Catchment Management

WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato

P: [REDACTED]

F: facebook.com/waikatoregion

Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [REDACTED]

Sent: Tuesday, 23 September 2025 11:40 am

To: Steven Cornelius [REDACTED]

Subject: Flood Model - Waikato Hamilton area

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Hi Steven,

We are doing a preliminary flood analysis through the area just Northwest of Hamilton as shown in screenshot below.



Would you happen to have or know of any current/past flood modelling information or known events data in this area that we could use to calibrate our model with?

Thanks and I look forward to hearing from you.

Regards

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN



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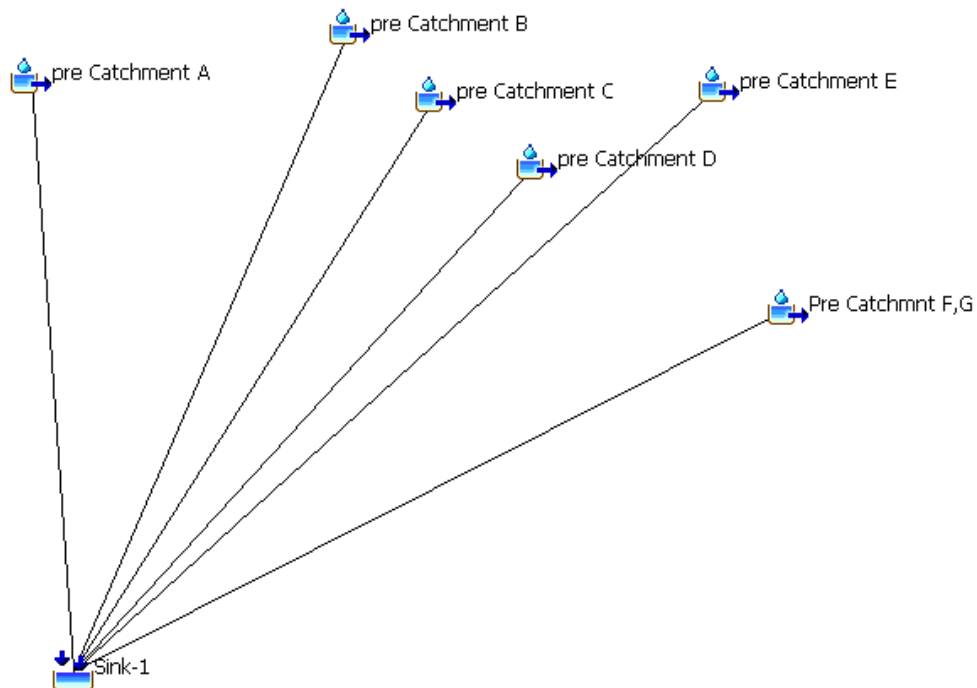
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Appendix E – HEC-HMS Results (100year Assessment) (Below)

Results for overall site

I. Pre-development 100-yr CC event



Global Summary Results for Run "Overall PRE Catchment CC 100y"

Project: Project 1 Simulation Run: Overall PRE Catchment CC 100y

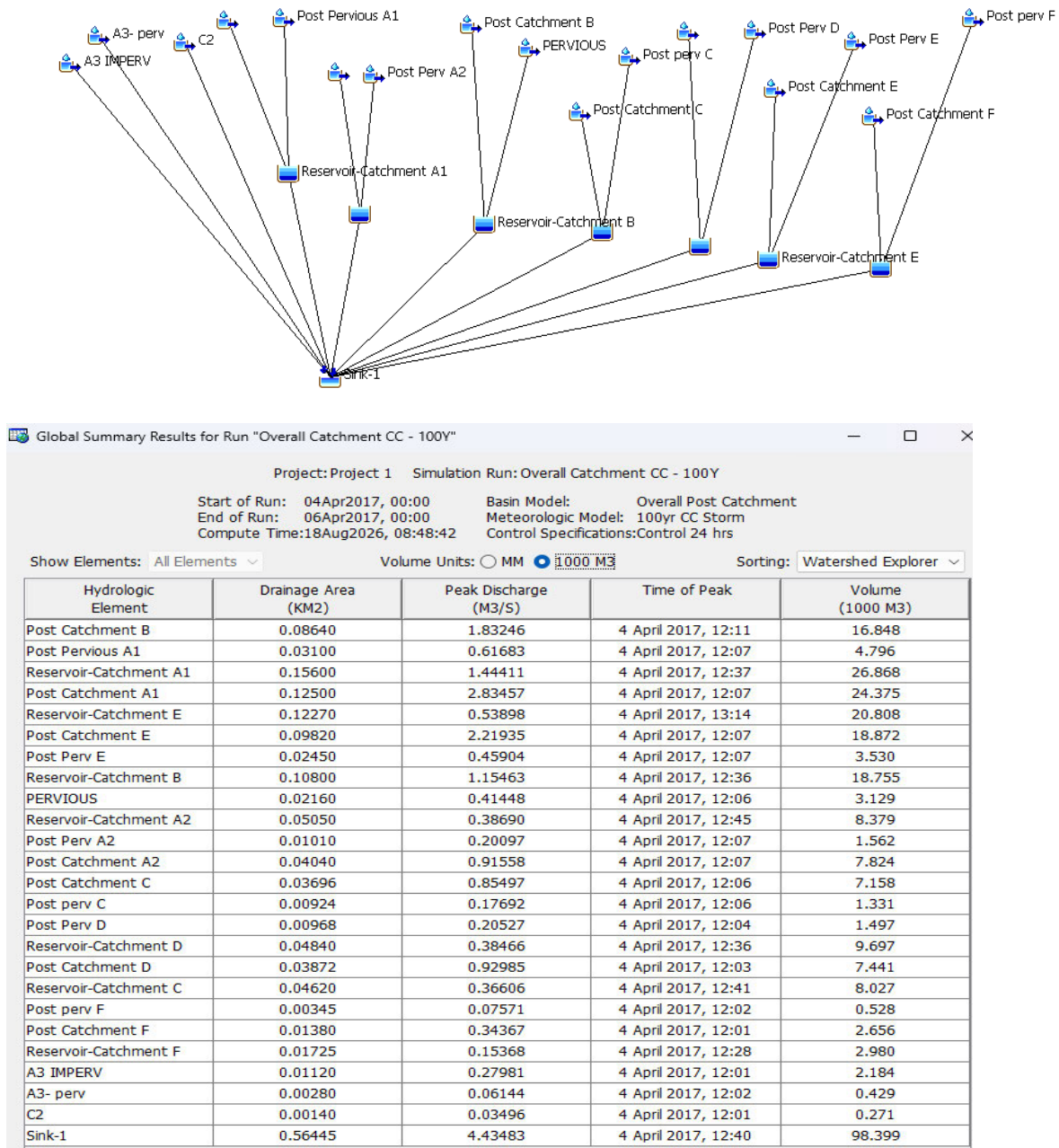
Start of Run: 04Apr2017, 00:00 Basin Model: Overall Pre catchment
End of Run: 06Apr2017, 00:00 Meteorologic Model: 100yr CC Storm
Compute Time: 13Aug2026, 09:55:22 Control Specifications: Control 24 hrs

Show Elements: All Elements Volume Units: ☐ MM ☒ 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
pre Catchment A	0.22900	4.54588	4 April 2017, 12:07	35.075
pre Catchment E	0.12280	2.50351	4 April 2017, 12:06	18.809
pre Catchment B	0.10800	2.15666	4 April 2017, 12:04	15.562
pre Catchment D	0.04840	0.93180	4 April 2017, 12:06	6.974
pre Catchment C	0.04760	0.89184	4 April 2017, 12:07	6.859
Pre Catchmnt F,G	0.01730	0.35987	4 April 2017, 12:02	2.493
Sink-1	0.57310	11.33432	4 April 2017, 12:06	85.771

2. Post Development results - catchment A to F1 (excludes catchment for wetland recharge that is F3, F4, F5, G1 and G2)

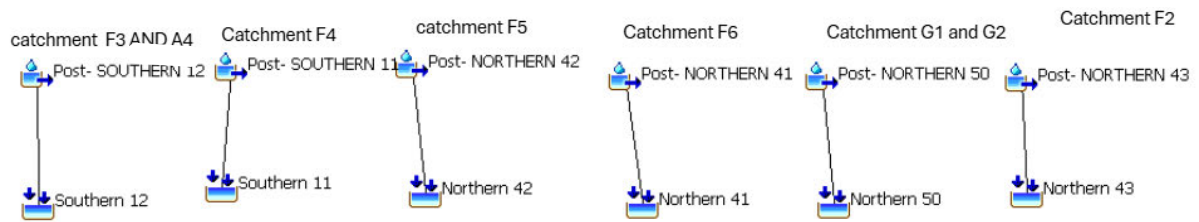
100-yr CC event



Catchments discharging to recharge existing wetland

1.) *Setting up a controlled discharge target in 2yr event*

2.) *10-yr and 100-yr will be automatically limited to pre-existing flows and are shown below*



2-year event with CC

Global Summary Results for Run "Post- Deficit 2yr+cc"

Project: Brymer Farms-1 Simulation Run: Post- Deficit 2yr+cc

Start of Run: 04Apr2017, 00:00 Basin Model: Postdev-Wetland deficit
End of Run: 05Apr2017, 00:00 Meteorologic Model: 2yr CC Storm
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 24 hrs

Show Elements: All Elements Volume Units: ☐ MM ☒ 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Post- SOUTHERN 12	0.00385	0.04371	4 April 2017, 12:05	0.267
Post- NORTHERN 42	0.00570	0.06471	4 April 2017, 12:05	0.395
Post- NORTHERN 43	0.00420	0.04023	4 April 2017, 12:05	0.239
Northern 43	0.00420	0.04023	4 April 2017, 12:05	0.239
Northern 42	0.00570	0.06471	4 April 2017, 12:05	0.395
Post- NORTHERN 50	0.00342	0.03883	4 April 2017, 12:05	0.237
Northern 50	0.00342	0.03883	4 April 2017, 12:05	0.237
Southern 12	0.00385	0.04371	4 April 2017, 12:05	0.267
Post- SOUTHERN 11	0.00288	0.03270	4 April 2017, 12:05	0.199
Southern 11	0.00288	0.03270	4 April 2017, 12:05	0.199
Post- NORTHERN 41	0.00294	0.03338	4 April 2017, 12:05	0.204
Northern 41	0.00294	0.03338	4 April 2017, 12:05	0.204

10-year event with CC

Global Summary Results for Run "Post- Deficit 10yr+cc"

Project: Brymer Farms-1 Simulation Run: Post- Deficit 10yr+cc

Start of Run: 04Apr2017, 00:00 Basin Model: Postdev-Wetland deficit
End of Run: 05Apr2017, 00:00 Meteorologic Model: 10yr CC Storm
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 24 hrs

Show Elements: All Elements Volume Units: ☐ MM ☒ 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Post- SOUTHERN 12	0.00385	0.07032	4 April 2017, 12:05	0.437
Post- NORTHERN 42	0.00570	0.10411	4 April 2017, 12:05	0.648
Post- NORTHERN 43	0.00420	0.06956	4 April 2017, 12:05	0.417
Northern 43	0.00420	0.06956	4 April 2017, 12:05	0.417
Northern 42	0.00570	0.10411	4 April 2017, 12:05	0.648
Post- NORTHERN 50	0.00342	0.06247	4 April 2017, 12:05	0.389
Northern 50	0.00342	0.06247	4 April 2017, 12:05	0.389
Southern 12	0.00385	0.07032	4 April 2017, 12:05	0.437
Post- SOUTHERN 11	0.00288	0.05260	4 April 2017, 12:05	0.327
Southern 11	0.00288	0.05260	4 April 2017, 12:05	0.327
Post- NORTHERN 41	0.00294	0.05370	4 April 2017, 12:05	0.334
Northern 41	0.00294	0.05370	4 April 2017, 12:05	0.334

100yr with CC

Global Summary Results for Run "Post- Deficit 100yr+cc"				
Project: Brymer Farms-1 Simulation Run: Post- Deficit 100yr+cc				
Start of Run: 04Apr2017, 00:00		Basin Model: Postdev-Wetland deficit		
End of Run: 05Apr2017, 00:00		Meteorologic Model: 100yr CC Storm		
Compute Time: DATA CHANGED, RECOMPUTE		Control Specifications: Control 24 hrs		
Show Elements:	All Elements	Volume Units:	☐ MM ☒ 1000 M3	Sorting: Alphabetic
Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Northern 41	0.00294	0.08453	4 April 2017, 12:05	0.536
Northern 42	0.00570	0.16388	4 April 2017, 12:05	1.038
Northern 43	0.00420	0.11456	4 April 2017, 12:05	0.698
Northern 50	0.00342	0.09833	4 April 2017, 12:05	0.623
Post- NORTHERN 41	0.00294	0.08453	4 April 2017, 12:05	0.536
Post- NORTHERN 42	0.00570	0.16388	4 April 2017, 12:05	1.038
Post- NORTHERN 43	0.00420	0.11456	4 April 2017, 12:05	0.698
Post- NORTHERN 50	0.00342	0.09833	4 April 2017, 12:05	0.623
Post- SOUTHERN 11	0.00288	0.08280	4 April 2017, 12:05	0.525
Post- SOUTHERN 12	0.00385	0.11069	4 April 2017, 12:05	0.701
Southern 11	0.00288	0.08280	4 April 2017, 12:05	0.525
Southern 12	0.00385	0.11069	4 April 2017, 12:05	0.701

Table on the next sheet shows the compilation of the result for overall development.

Catchment	Pre Development with Climate change						Post Development with Climate change						Attenuation summary
	2 Year - 24Hr		10 Year - 24Hr		100 Year - 24Hr		2 Year - 24Hr		10 Year - 24Hr		100 Year - 24Hr		
	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	Q (m³/S)	V (m³)*1000	
Catchment A1	1.44	10.99	2.64	20.17	4.55	35.08	0.30	9.4	0.7	16.2	1.4	26.9	Wetland A1
Catchment A2							0.20	2.7	0.2	4.9	0.4	8.4	Wetland A2
Catchment A3							0.10	1.00	0.20	1.60	0.40	2.60	No attenuation provided for this catchment, over attenuation provided in wetland A1 and A2 to offset the effects
Catchment B	0.79	5.89	1.45	10.82	2.50	18.81	0.20	6.8	0.6	11.4	1.2	18.8	Wetland B
Catchment C	0.64	4.63	1.22	8.74	2.16	15.56	0.10	2.9	0.2	4.9	0.4	8	Wetland C
Catchment C2							0.01	0.11	0.02	0.18	0.03	0.27	No attenuation provided for this catchment, over attenuation provided in wetland C to offset the effects
Catchment D							0.28	2.07	0.52	3.92	0.93	6.97	0.10
Catchment E	0.26	2.04	0.50	3.85	0.89	6.86	0.10	7.8	0.2	12.8	0.5	20.8	Wetland E
Catchment F	0.11	0.74	0.20	1.40	0.02	2.49	0.10	1	0.1	1.8	0.2	3	Wetland F
Catchment F2							0.03	0.20	0.05	0.33	0.08	0.54	Direct discharge to recharge existing wetland
Catchment F3							0.04	0.27	0.07	0.44	0.11	0.70	Controlled discharge to existing natural wetland discharge to recharge existing wetland
Catchment F4							0.03	0.20	0.05	0.33	0.08	0.52	Direct discharge to recharge existing wetland
Catchment F5							0.06	0.39	0.10	0.65	0.16	1.04	Direct discharge to recharge existing wetland
Catchment G1,G2							0.04	0.24	0.06	0.39	0.10	0.62	Controlled discharge to existing wetland 1. Road catchment dealt using an aquafort device, discharge limited to discharge from natural wetland 2. lot catchment discharge limited to pre existing discharge rate
Total	3.51	26.36	6.54	48.90	11.05	85.77	1.43	37.31	2.76	62.31	5.47	101.89	
Post- Pre with climate change							-2.09	10.96	-3.77	13.41	-5.57	16.12	

