`

STORMWATER MANAGEMENT PLAN

ASHBOURNE DEVELOPMENTS

CIVIL ENGINEERING ▾ SURVEYING ▾ LAND DEVELOPMENT

PROJECT INFORMATION

CLIENT:	Matamata Development Ltd
PROJECT:	289001

DOCUMENT CONTROL

DATE OF ISSUE:	30 MAY 2025
REVISION	Rev A
AUTHOR	Raatite Kanimako Engineer
REVIEWED BY	Mitchell Smith Associate
APPROVED BY	Dean Morris Regional Director

Level 1, 5 Owens Road
Epsom, 1023
Auckland
New Zealand
Phone 09 571 0050
www.maven.co.nz

TABLE OF CONTENTS

1 OVERVIEW

This stormwater management plan ('SMP') outlines the proposed management of stormwater for the Ashbourne developments, located west of the Matamata town centre.

The overall development is illustrated in Figure 1 below. The project spans approximately 100 hectares of land, encompassing areas both north and south of Station Road, as shown below. The southern areas extend westward toward the Waitoa River.

The SMP outlines the overarching stormwater management principles that will form the basis of stormwater design to support future development of the proposed sites.

Discharge consent is being sought to develop the system to enable future stormwater discharge from the proposed sites. This SMP is prepared to support this discharge consent application.

The project is split into 4 sites.

1. Residential Development
2. Northern Solar Farm Development
3. Southern Solar Farm Development
4. Retirement Village

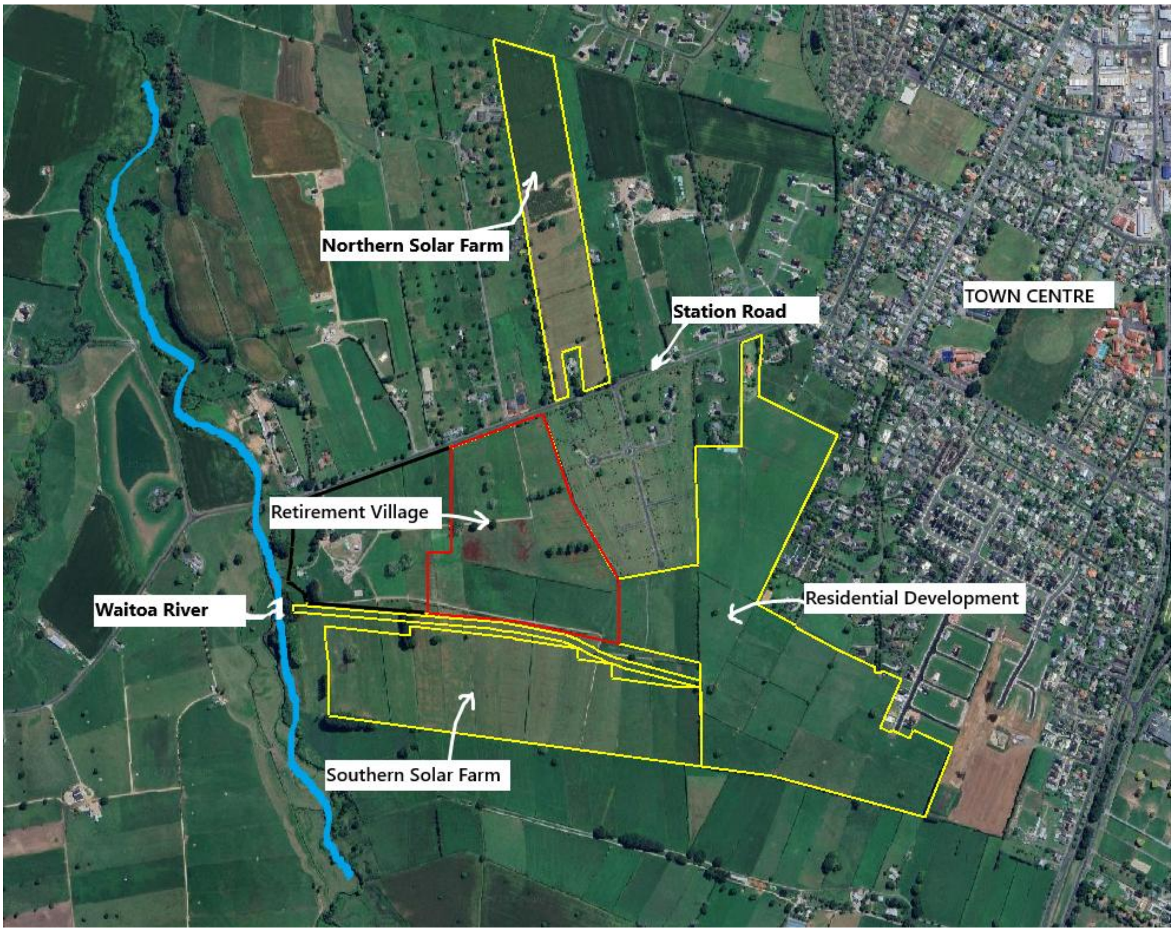


Figure 1: Site locality plan.

SITE	AREA (Ha)
Northern Solar Farm	13.00
Southern solar Farm	24.82
Retirement village	20.00
Residential	45.00

Table 1: Site Areas

There are total of 8 number of legal parcels distributed within the 4 project sites. List of these is provided is table 2 below.

PARCEL ID	AREA (ha)	OWNERS
Northern Solar Farm		
Lot 2 DP 567678	13.00	R.A Hemmings Limited
Southern Solar Farm and Retirement village		
Lot 1 DP 21055	33.23	R.A Hemmings Limited
Lot 2 DP 21055	27.38	R.A Hemmings Limited
Residential		
Lot 5 DP 365568	3.29	P & M Equipment Hire Limited
Lot 1 DPS 65481	4.20	CAT Limited, RM Craig, WJ Perry
Lot 5 DP 384886	8.10	Eldonwood Limited
Lot 3 DP 14362	13.71	R.A Hemmings Limited
Lot 204 DP 535395	24.14	Eldonwood Limited

Table 2: Legal Parcels, associated area, and Owners

The areas are currently zoned within rural, rural residential and future designated residential areas. The development has been master planned by the client in collaboration with Matamata-Piako District Council ('MPDC'), Waikato Regional Council ('WRC') and a design consultant specialists. As a result, this SMP is built upon previous discussions around stormwater management for the overall site with WRC and MPDC.

A discharge consent is required to enable the future stormwater discharge from these developments, which necessitate the importance of this SMP. The new discharge consent will be transferred to Council and ultimately form part of the Comprehensive Discharge Consent upon the vesting of the public network.

Stormwater is proposed to be discharged via the following methods:

- Soakage within the site using stormwater devices such as raingardens, soakage trenches and soakage basins.
- A proposed Greenway running east to west which discharges into Waitoa River at 80% of pre-development flows. The proposed greenway will also aid in diverting existing flows heading north from lands south of the project.
- Existing drains or overland flow paths leaving the project site at less than 80% of pre-development flows.

The overall Development area is divided into four distinct developments as listed and summarised below.

1.1 ASHBOURNE NORTHERN SOLAR FARM

This development spans approximately 13 Ha and will serve as the first solar farm constructed within the Ashbourne development. The site will feature 14,642 solar panels, generating required power to meet regional renewable energy requirements. The farm incorporates permeable ground coverage and minimal impervious surfaces to ensure effective stormwater infiltration and flow dispersion. A network of grass swales and drains will manage runoff from solar panels and ancillary infrastructure, maintaining water quality prior to discharging into the existing channel/farm drain along the northern boundary.

1.2 ASHBOURNE SOUTHERN SOLAR FARM

The Ashbourne southern solar farm spans approximately 24 ha and is the second solar farm planned for the Ashbourne development. The site will include 33,946 solar panels, generating required power to meet regional renewable energy requirements. The farm incorporates permeable ground coverage and minimal impervious surfaces to ensure effective stormwater infiltration and flow dispersion. A network of grass swales and drains will manage runoff from solar panels and ancillary infrastructure, maintaining water quality prior to discharging into the proposed greenway before discharging into Waitoa River.

1.3 RETIREMENT VILLAGE

The Retirement Village spans approximately 16 ha and is designed to accommodate 218 villas, one Aged Care Hospital, and other required facilities tailored to meet the needs of an aging population. The development aims to provide a high quality, connected environment for retirees, emphasizing on community living and accessibility.

Similar to the residential project, this development will require a stormwater basin to cater for overflows from upstream stormwater devices. Lot Areas and Road carriageways will be treated and discharged at source via the use of rain garden and soakage systems

1.4 RESIDENTIAL DEVELOPMENT

Spanning approximately 45 hectares, the residential development includes 518 Lots, designed with mix of housing typologies and densities to meet client and local authorities' requirements. Key feature of this development is the formation of the proposed greenway which serves as a stormwater management system for Catchment B of the residential areas. The Greenway conveys and attenuate overflows from the road and lot areas releasing at 80% of pre-development flows into the Waitoa River. Lot Areas and Road carriageways will be treated and discharged at source via the use of soakage systems.

1.5 STAGING, TIMING, RESPONSIBILITY AND FUNDING

The proposed development includes four distinct projects: the Residential Area, the Retirement Village, the northern solar farm, and the southern solar farm. Construction of these projects is not anticipated to occur simultaneously.

Key infrastructure elements, such as the greenway, provide shared downstream conveyance capacity; however, not all projects will depend on its availability. The Retirement Village will be proposing to install its own conveyance channel to discharge flows into the Waito River, and only Catchment B of the Residential area is set to discharge into the Greenway

The southern solar farms will utilise existing natural channels or, where necessary, create new discharge pathways to the Waitoa River prior to the establishment of the Greenway, while the northern solar farm will operate independently of the greenway system.

The Residential and Retirement Village developments will be carried out in staged phases, with each stage designed to comply with the principles and requirements outlined in this Stormwater Management Plan (SMP). Interim measures, such as swales and temporary conveyance routes, will be implemented to ensure ongoing mitigation throughout the construction period.

1.6 COSTS, FUNDING AND VESTING ASSETS

The construction of the proposed stormwater management devices will be undertaken by the consent holder. The proposed stormwater infrastructure includes a greenway swale, public piped networks, soakage trenches, detention basins, raingardens, and private propriety 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.

1.7 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 Resource Consent.

2 HYDRAULIC CONNECTIVITY

2.1 WATER SENSITIVE DESIGN

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

- Dry basins and a greenway with landscaping.
- Soakage Devices
- On-lot stormwater Retention through Soakage
- Protection of existing bush and covenant features.
- Planting of riparian areas if applicable.

The Water Quality Volume (WQV) is treated at source for both Road and Lot areas. Overflows above the 10-year ARI cc event are directed to Dry basins for both RV and Residential Developments. With both solar farms, existing runoff route is to be maintained with minimal impervious runoff being added. The proposed stormwater solution ensures stormwater is being treated before discharging into the receiving environment.

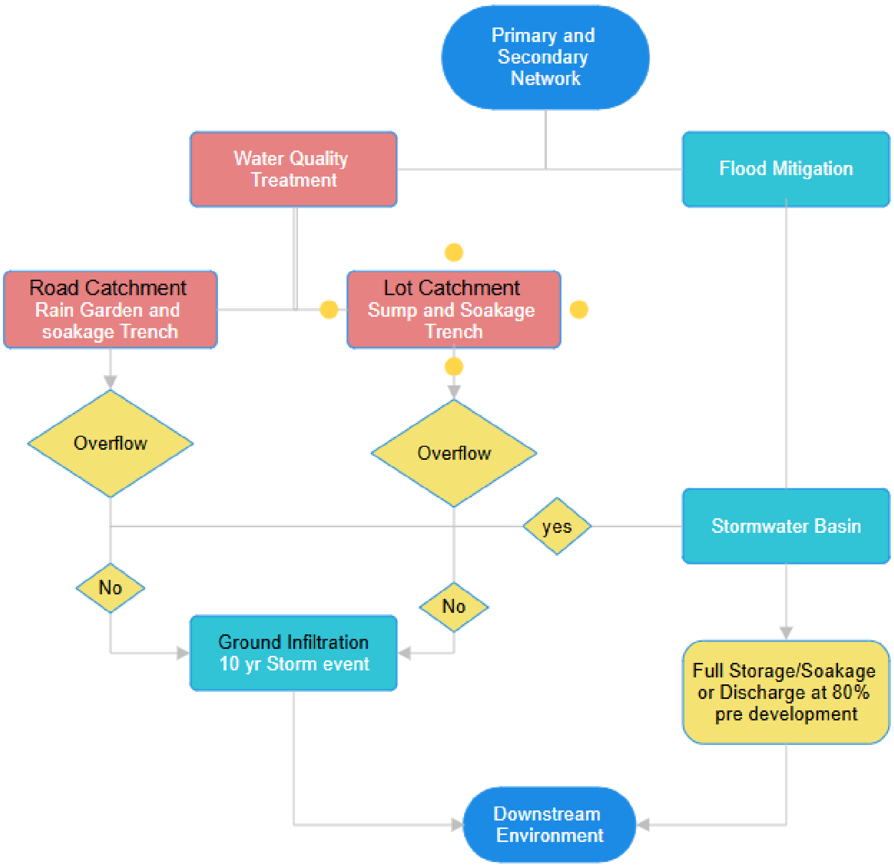


Figure 2: Hydraulics Connectivity Chart

3 EXISTING CATCHMENT CONTEXT

The Ashbourne development covers approximately 100 Ha, including areas, north and south of Station Road. The site features a flat to gently sloping topography shaped by its historical use as pastoral farmland. Gound elevations across the site range from RL 67m around the north area with RL 72m towards west and south, with the site generally draining in a northwest direction towards Waitoa River. The site is bounded to the west by Waitoa River, to the east by Existing Residential developments, and to the south by additional pastoral land, with Station Road dividing the northern and southern areas.

The existing land is predominantly grass covered, used for grazing livestock, characterised by grass covered paddocks, sporadic mature trees, and agricultural infrastructure such as farm buildings and swales. A network of farm drains across the site facilitates surface water conveyance, diverting water in line with the natural drainage pattern. Historical aerial photographs confirm the landform and drainage network have remained largely unchanged for the course of 50 years.

3.1 EXISTING CALCULATION PARAMETERS

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

Pre-Development CN	
Pervious	**Impervious**
61	98
Pre-Development 24hr Rainfall Depth (mm)	
10yr cc	**100 yr cc**
128	200

Table 3: Design Parameters

The RCP8.5 climate change adjustment has been applied to both scenarios (pre- and post-development) to enable comparison between the two events when assessing compliance. Refer to Table 4 below for catchment areas. Approximately 2-5% 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.

3.2 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.

Figure 3 Existing catchments & Flow direction (Refer to Plans 410 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 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 Flow	
SITE	**Catchment**	**Area (Ha)**	**10-year flow (m^3/s)**	**100-year flow (m^3/s)**
RESIDENTIAL	A1	2.39	0.18	0.37
	A2	8.78	0.47	0.96
	A3	0.52	0.04	0.09
	A4	3.33	0.21	0.43
	A5	0.47	0.04	0.08
	A6	9.33	0.52	1.06
	A7	28.51	1.64	2.97
	A8	0.54	0.05	0.1
SOUTH SOLAR	A9	121	4.22	8.63
RETIREMENT VILLAGE	A10	10.1	0.55	0.81
	A11	4.12	0.03	0.07
	A12	17	0.73	1.78
NORTH SOLAR	A13	0.26	0.05	0.11
	A14	2.33	0.15	0.28
	A15	17.89	0.83	1.71
	A16	0.66	0.05	0.11

Table 4: Overall Existing Catchment Flow table (refer to plan 410)

The above table shows pre development catchment areas and their respective flowrates, prior to development and serve as a baseline for checking overall flowrate pre vs post for the residential. This is linked to the 410 plans (Appendix A of infrastructure Report) and later referenced in tables 18 and 19.

3.3 WAITOA RIVER

The Waitoa River is one of the primary receiving environments for stormwater discharges from the Ashbourne development. It runs along the western boundary of the southern site and acts as the discharge point for both the residential and southern solar farm stormwater systems. The river plays a critical role in regional drainage and is known to experience periodic flood events, especially under prolonged rainfall conditions.

All stormwater outfalls from the development that discharge into the Waitoa River have been designed to include attenuation and treatment upstream, with flows directed either through dry basins, the greenway, or existing conveyance features. This discharge strategy ensures that post-development flows into the Waitoa River 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.

3.4 NORTHERN SOLAR FARM

The northern solar farm site, legally described as Lot 2 DP567678, encompasses an area of approximately 13hectares and is situated on the northern side of station road. The site comprises predominantly open pasture with sparse tree cover with no signs of existing dwellings. the topography shows a gradual slope across the site, generally falling from the southwest towards the northeast corner. The surrounding landscape features slightly elevated land to the west and south, contributing to the general eastward and northerly flow pattern across the site.

3.5 RETIREMENT VILLAGE

The southern Solar farm and the Retirement village comprise two adjoining rural land parcels located south of station road. Retirement Village site covers the northern portion of the two adjoining areas and Southern Solar farm to the South.

The area is predominantly open pastureland with generally flat typology with minimal existing infrastructures. A farm track currently crosses the site. The entrance is located on Station Road and provides access across the farmland, including the existing dwelling, which is situated to the west of the Retirement Village development boundary. Notably, the existing dwelling has its primary vehicle entrance located further west along Station Road.

The Retirement village is located adjacent to station road and occupies northern areas of the two adjoining parcel lands. General typology reveals majority of the site slopes towards east, with portion slopes south and westward towards the Waitoa river. This channel conveys flow to an existing culvert beneath station road, where it continues downstream.

Existing Inflows into the site are mainly from the southern solar farm areas and the residential area. Table 4 above summarises each sub catchment flows with plans 410 series (Appendix A) providing further details.

3.6 SOUTHERN SOLAR FARM

The southern Solar farm and the Retirement village comprise two adjoining rural land parcels located south of station road. Retirement Village site covers the northern portion of the two adjoining areas and Southern Solar farm to the South.

The area is predominantly open pastureland with generally flat typology with minimal existing infrastructures

The solar farm occupies the southern areas of the two parcel lands and receives additional inflows from the upstream catchment located to the south of the site. The general landform from the survey data reveals a general fall north until the flows splits, one drains down into Waitoa and rest discharges further north to the retirement village through the existing drain along the Eastern boundary, traverses over station Road, through further farmlands and finally will get discharge into the Waitoa River.

3.7 Existing Culvert – Station Road

Existing culverts and drains are located within and around the development sites, primarily to convey surface runoff, around the site, beneath station 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. these culverts remain in service; however, their capacity and condition vary across the site.

Figure 4: Existing Culvert with blockage Issue

One critical culvert is located along the eastern boundary corner of the retirement village area. This is where an open drain collects runoff and dischargers under station road through this culvert. This culvert serves as a key outlet for surface water from the Retirement village site and further upstream catchment.

Visual inspection indicates that this culvert is in bad 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.

3.8 RESIDENTIAL DEVELOPMENT

The Residential development site comprises of multiple existing land parcels, refer to overview section of the report. The land is currently used for rural and pastoral purposes with only one existing dwelling adjacent to station road.

The site lies to the south and west of established residential areas and is bounded by station road to the north, with rural properties including the solar farm site covering the western and southern areas. The site has a gentle and flat areas, sloping towards low lying areas in the central and northern parts of the site. Surface runoff generally conveyed through naturally formed low lying areas including existing farm drains etc.

The residential development existing catchment area has been subdivided into sub catchments, each draining towards the identified discharge points as outlined in the table below and stormwater plans 410 series.

3.9 ECOLOGICAL FEATURES

An Ecological assessment was conducted for the site covering the areas below. this assessment identified the western portion of the southern parcel, bordering the Waitoa River, as an area of heightened ecological sensitivity. This area contains a network of aquatic features, including oxbows, minor ponds, and a second order stream Channel, alongside existing riparian plantings of native species. While most of the site is highly modified and has low ecological value, this floodable corridor was recommended as a "no-development zone" due to its potential for ecological restoration and its contribution to habitat diversity and freshwater functions.

Figure 5: Existing Culvert with blockage Issue

While the proposed development areas do not fall within this "no development zone," the proposed greenway outlet does encroach into this area. As covered in section 6.2, the proposed greenway provides essential flood conveyance and will also enhance the ecological value of the site through planting and other measures; therefore, works within this area will further improve its ecological value.

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

3.10 GEOTECHNICAL REPORT

Two preliminary geotechnical investigations were undertaken to provide full coverage of the Ashbourne'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 two referenced Geotechnical report in this SMP are listed below (Appendix Of the Infrastructure Report).

1. HAM2023-0124AB Rev 1 (dated 12th December 2023)
2. HAM2023-0124AE Rev 0 (dated 5 July 2024)

The site is characterised by a predominantly, flat to gently sloping topography, underlain by Hinuera formation soils, 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.

<u>Ground Water Levels</u>

- Depths recorded between 1.5m and 4.2m across the sites.
- Seasonal Fluctuations of up to 1m observed.

<u>Soil Soakage Capacity</u>

- 2 x 10^-6m/s to 5x10^-6m/s for Silty Soils
- 7 x 10^-6m/s to 6x10^-6m/s for Sandier Soils

Soakage test Area	Results	Soakage rate adopted for Design purposes (mm/hr)	Soakage Rate factored by 0.5 as per RITS for conservatism (mm/hr)
Basin D Area (SOA24-15&16)	31-78 mm/hr	54.5	27.25
Basin C Area (SOA24-13&14)	2-51 mm/hr	26.5	13.25
Basin A Area (SOA24-23&24)	178-345 mm/hr	261.5	130.75
Northern Residential Catchment (SOA23-01) *	171mm/hr	171	171
Southern Residential Catchment (SOA23-02) *	613mm/hr	613	613
Retirement Village and South-Western residential catchment (SOA24-20,21 7 22)	480-4829 mm/hr	206.5	100

Table 5: Soakage tests Results

* *Note unit conversion, mm/hr to L/min/m² which has been used in design of road and lot areas.*

Infiltration testing across the site revealed significant variability in soakage performance, with notably low rates, such as 2 mm/hr, recorded within the North-Western Residential Catchment. According to the Geotech report, these low rates are attributed to perched groundwater, where infiltrating water is impeded by underlying less permeable layers, resulting in temporary saturation near the surface. 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 soakage through use of SW Devices such as raingarden/ basins 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.

Topsoil and Sub-surface profile

- Topsoil depth: 0.1m to 0.5m
- Subsurface Soilis: Hinuera Formation sands, silts, and gravels. Walton Subgroup soils at greater depths.

3.11 CN - VALUES

Soil Class Group B has been adopted for pre-development modelling based on the soil types encountered during geotechnical investigations (HAM2023-0124AE), which identified dense sands and stiff silts consistent with sandy loam and loam textures. These are typically associated with Group B under TP108 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**
61	98	74	98

Table 6: Design CN Values

For post-development conditions, a higher Curve Number of 74 has been used to account for reduced permeability due to compaction from earthworks, which may result in soil behaviour more consistent with Group C. This approach ensures a conservative assessment of stormwater runoff. The classification may be refined at the detailed design stage if additional testing is undertaken.

3.12 WGA MOUNDING ASSESSEMENT – SOAKAGE RATE

WGA conducted a mounding assessment to determine the long-term infiltration capacity of Basins A, C, and D within the Residential development. This assessment builds on the geotechnical soakage test data by incorporating additional site-specific factors such as aquifer thickness, existing groundwater levels, and the potential for mounding beneath each basin. While the geotechnical tests provide essential input on the soil's infiltration characteristics, the mounding assessment enhances this by evaluating how infiltration behaves over time, particularly under a sustained 24-hour storm event. As a result, the average 1-day hydraulic conductivity values derived from this assessment have been adopted for design based on table below:

	mm/hr Rate
Basin A	36.03
Basin C	20.69
Basin D	20.74

Table 7: Soakage tests Results

These values reflect a realistic and technically robust approach to stormwater management for the site.

3.13 CONTAMINATION

Contamination Investigation will be carried out. Once this is completed, we will incorporate the results and information into this SMP

3.14 ARCHAEOLOGICAL ASSESSMENT

Archaeological Assessment will be carried out. Once this is completed, we will incorporate the results and information into this SMP

3.15 IWI CONSULTATION

Iwi consultation is currently ongoing, and we will incorporate the applicable information into this SMP once completed.

4 EXISTING DEVELOPMENT FLOOD MODEL

4.1 EXISTING FLOODING, MODELLING & PARAMETERS

A catchment Analysis was undertaken to assess the runoff and flow conditions dynamically during the 100year event, within and around the four development sites. This undertaking establishes existing conditions within and around the sites, and support and informs the design proposal within these areas.

A predevelopment flood analysis was undertaken using a calibrated base model and geometry. The parameters used specific to the site are detailed below.

A 100-year (24-hour) rainfall event was analysed using various points along the catchment, as shown in the figure below. Rainfall depth values were obtained at multiple locations throughout the nominated 2D area and were then averaged to determine the representative depth to be used. HIRDS RCP8.5 rainfall data was applied for both Pre-Development and Post-Development scenarios

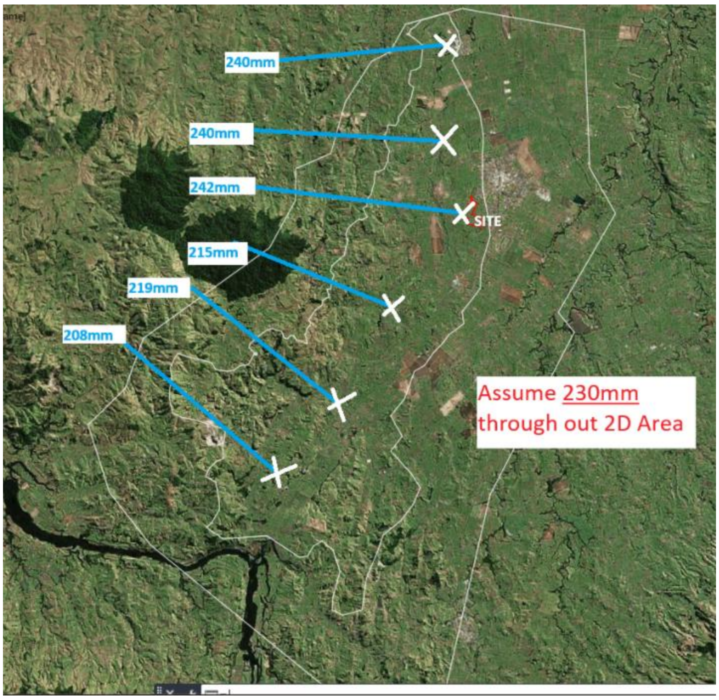


Figure 6 Rainfall depth across the 2D Area

Using HEC HMS software rainfall distribution within the shown 2D was created which has been inserted as a hyetograph onto the 2D area in HEC RAS.

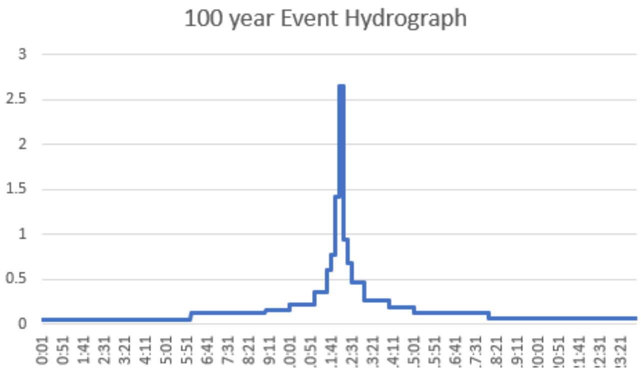


Figure 7 Hyetograph used in the Model (Data included in Appendix B)

CN Values used as shown below.

- CN numbers
  - Pre-development CN=61 for pervious Areas
  - Pre-development CN=98 for Impervious Areas
- Rainfall data from National Institute of Water and Atmospheric Research (NIWA) rainfall pattern and depth (Refer to Figure 6)

As part of the flood risk assessment for the site, an initial review was undertaken to identify any existing flood data from both the Waikato Regional Council (WRC) and the Matamata Piao District Council (MDPC). WRC confirmed that the wider area is within a flood hazard zone, however the available data was based on historical records dating back to 1996 and was not sufficiently detailed for direct use in assessing the site.

WRC did, however, provide access to gauge data from the Waitoa River at Sahara station and rainfall data from the Matamata Aerodrome Station. This formed the basis for the development and calibration of the hydraulic model, established as part of the overall flood Assessment.

The 2D flood model was built in HEC RAS version 6.6 and calibrated using observed flood events from the 2017 storm. The model simulates a 100year rainfall event (24hrs) duration and is simulated for over 3 days to ensure peak conditions are captured in the results. The calibration model/geometry was used therein to assess the existing and post development flows.

Additionally, this model will form base of the Sensitivity Analysis under section 7 of this report, the model assumes all primary system are 100% blocked.

4.2 FLOOD MODEL CALIBRATION

The Model was calibrated using observed rainfall data from the Tamhane (Matamata Aerodrome) rain gauge and river level data from the Waitoa River (Waharoa Control) Station, covering the period from April 4 to April 5, 2017. These stations are located within 6-9km downstream from the site. These data can be referred to in Appendix A of this memo.

The 2D area of the flood model was extended further downstream for calibration purposes to capture both data set available for this calibration exercise.

The datasets selected for calibration falls within the flood events that were caused by cyclone Debbie followed by Cyclone Cook in 2017. These two cyclones caused widespread of flooding across the Matamata region.

Figure 8 Calibration data Source Locations

Due to the 3km separation between the two stations, natural variability in flow response was anticipated in the model result.

The initial model result (Blue line as shown in graph below) indicated a quicker peak response than the observed data (Black Line as shown in graph below) with the modelled hydrograph rising more steeply and reaching its peak earlier than the observed data measurements.

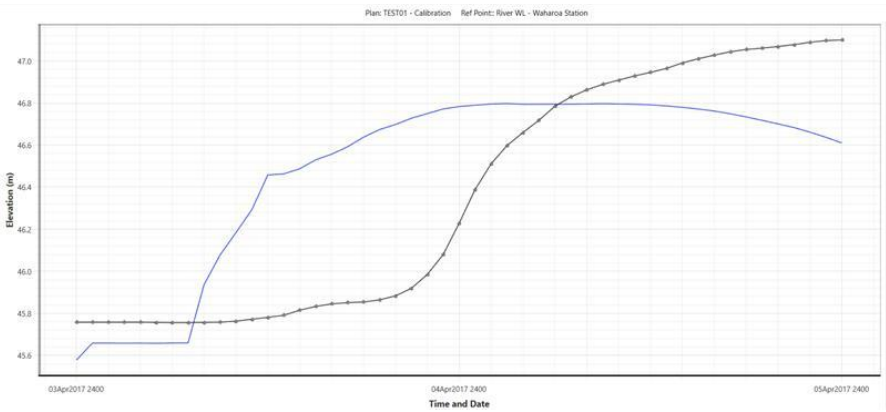


Figure 9 Elevation vs Time graph for both Model and Observed Data

Discrepancies in water levels at the beginning and end of simulation suggested differences in initial conditions, as model started with an empty channel while observed data included existing flow.

	Observed Data	Model Result	Difference
Initial Water RL	45.76	45.58	0.18
Max RL	47.1	46.8	0.3

Table 8 *First Run Results*

Area type	Road	Grass /farm	Stream Area	Rest of Area
Mannings n	0.02	0.045	0.05	0.04

Table 9 Mannings – Pre-Calibration of Model

The first calibration results presented above in first table, showing level differences between the observed data and the model. If we consider the model to have the same Water level as the observed data, the level difference is **120mm**. Mannings numbers used in the model is shown in the above second table.

Multiple runs were further undertaken of the calibration model to achieve a better alignment of the two sets. Mannings were adjusted including cell sizes. Final calibration results shown below table, including Manning's finalised values.

The second graph shows results of one of the adjustments which has improved the difference between the two sets, demonstrating a better representation of flood behaviour within the Waitoa River.

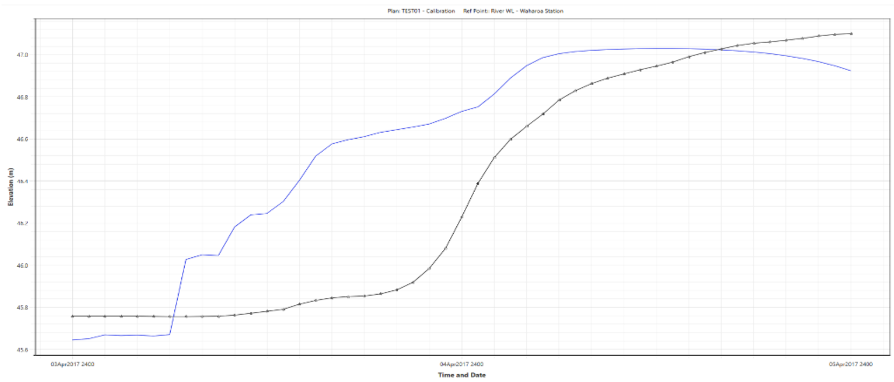


Figure 10 Elevation vs Time graph for both Model and Observed Data

	Observed Data	Model Result	Difference
Starting RL	45.76	45.58	0.18
Max RL	47.1	46.86	0.24

Table 10 Final Run Results

Area type	Road	Grass /farm	Stream Area	Rest of Area
Manning; s n	0.02	0.04	0.06	0.04

Table 11 Mannings – Final Run

If model is considered to have the same Water level as the observed data, the level difference is now **60mm**. Mannings numbers used in the model is shown in the above table. Further refinement of the model is not possible as adjusted parameters will be unrealistic.

Due to the nature of this model and data available it is not practical nor necessary to do further refinement until both models are the same. Theres is variances through rainfall distribution, land use, un modelled hydraulic devices. Instead, the focus was on ensuring that water level in the model is as realistically close as practically possible to the observed data, as this will establish a robust model base to use for flood analysis on the proposed site. Based on the above, this calibration achieves a good overall balance between real world conditions and modelling.

As mentioned in previous sections, The RCP8.5 climate change adjustment has been applied to both scenarios (pre- and post-development) to enable comparison between the two events when assessing compliance.

4.3 EXISTING MODEL RESULTS

The flood map results below display the extent of flooding with a tolerance of 50mm depth minimum. The results show the there are multiple interconnected overland flow paths traversing through sites. The general route for these flows is either a direct discharge into the Waitoa river or initially traversing ponding on land prior to discharging into the Waitoa River.

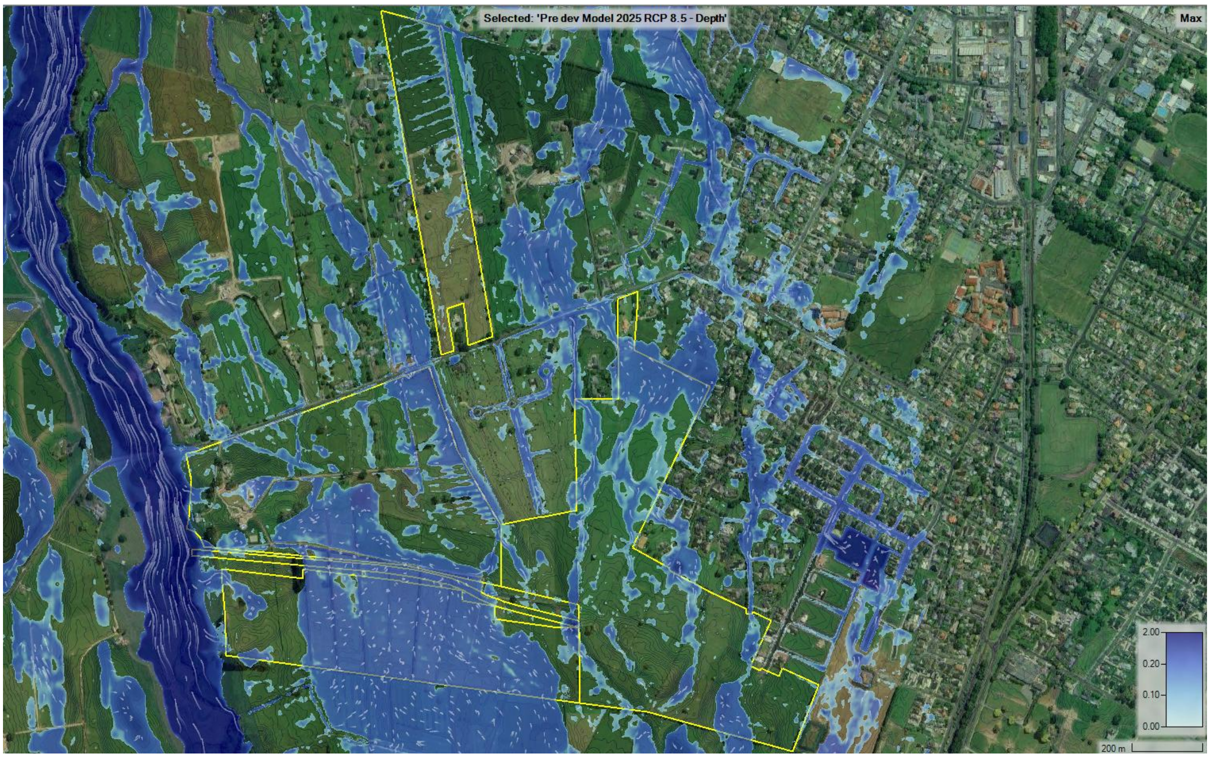


Figure 11: Overall Pre-Development Flood Map RCP 8.50

4.4 RESIDENTIAL AREA

As mentioned earlier in the report, there are several inflows into the residential area, originating from the upstream regions. These flows move northward into the site, following existing natural landforms and farm drains, before exiting along the lower northern boundary.

Notably, one of the discharge points from the residential catchment serves as an inflow into the retirement village catchment, as depicted in the screenshot, the flood model report, and the results below.

4.5 NORTHERN SOLAR FARM

inflow from the west enters the site and is conveyed through a network of existing farm drains. Most of the flows continues northward, with southern lower portion of the site discharges further east and west which is due to a crest line through the site within that portion of the site.

4.6 RETIREMENT VILLAGE

The retirement village catchment receives inflow from both southern solar farm and contributing portion (North-western Areas) of the residential catchments. There a few service tracks, farm drains and an existing conveyance channel running along the eastern boundary that leads to the existing culvert as mentioned in section 2 of this report

Due to blockage of the culvert beneath station road, as assumed in the flood model, floodwaters upstream of the culvert fills up the low land, flat areas of the RV site, flooded the area before it overtops station road.

4.7 SOUTHERN SOLAR FARM

This area receives upstream external catchment to the south. Runoff through the site is interfered by an existing farm track acting as a barrier, causing temporary ponding upstream of the farm track. The flow eventually overtops where the flow splits, north into the retirement village through the existing open channel while remainder continues westward, ponding within the localised depression before discharging into the Waitoa river. An isolated but much smaller area within the solar farm, northwest of the site, discharges directly into the Waitoa river

5 OPERATIVE CATCHMENT AND DEVELOPMENT PLANS

The development comprises both general residential and medium density residential zones as per the Operative Matamata-Piako District Plan (MPDP). This section provides a high-level summary of the planning and regulatory requirements.

5.1 REGULATORY AND DESIGN REQUIREMENTS

The relevant regulatory, technical and design requirements that the stormwater management for the development must meet are summarised in Table 12.

Table 12: Summary of regulatory and design requirements.

Requirements	Relevant regulatory/design to follow
Matama-Piako District Plan (MPDP) Section 5.9.1 Infrastructure and servicing performance standards	• The subdivision and development of land shall be carried out so as to provide for effective stormwater management, in compliance with the Development Manual. • Be adequate to meet the maximum potential demand on site arising from the development and use of the land as permitted under the District Plan and taking into account the actual and potential land uses up-gradient of the site. • In the first instance be managed and disposed of on-site. Only where onsite disposal is unable to be achieved will Council consider new connections to public drainage, where available. • The design capacity of any piped stormwater facilities should be sufficient to accommodate the surface water flows resulting from a 10-year storm event in the case of Residential, Industrial and Business zones, and to avoid flood damage to the existing or potential principal buildings on the site, resulting from a 100-year storm event . • Overland flow paths must be able to cater for a minimum of a 1 in 100 year return period storm. Flood paths within the subject site must be protected by an easement registered against the titles affected throughout their length. Where flood paths are not feasible, the piped system must cater for a minimum of a 1 in 100 year return period storm. Where disposal is to ground soakage with no flood path, the soakage must cater for a 1 in 100 year return period storm. • Secondary flows exiting the subject site following development must not exceed pre-development overland flows. • Stormwater proposals must take into account the requirements of the Council's current stormwater discharge consents from the WRC. All proposals must be consistent with the conditions of this consent including requirements for low impact design principles, stormwater management devices and best practicable options as set out in the consent. • Stormwater works should be provided in a manner which avoids excessive modification of natural drainage systems and minimises any detriment to the environment particularly through potential contamination of natural water.

	• The integrity of the stormwater system should be maintained, and its safe and efficient operation facilitated, while ensuring an adequate level of safety to the public and those operating and maintaining the facilities. • Any detriment to the enjoyment and development of individual allotments arising from the provision and operation of the stormwater system needs to be minimised. • The known or predicted effects of climate change on a proposal, based on best available scientific knowledge, shall be taken into account. • In terms of operation and maintenance, the stormwater system shall be in line with community expectations regarding anticipated performance. • The lifecycle and maintenance costs meet community expectations. • Any disposal or treatment areas located off-site, other than to Council owned systems, shall be protected by easements as appropriate. • Council may require a detailed stormwater plan to ensure that there are no adverse stormwater effects off-site. • Any necessary consents shall be obtained from the WRC.
Comprehensive Network Discharge Consent 105063	Condition 28 of the comprehensive stormwater discharge consent (#105063) states: "The consent holder shall prepare a Stormwater Management Plan for the Matamata-Piako District Township and municipal stormwater diversions and discharge activities, which shall be submitted to the Waikato Regional Council within 12 months of the commencement of this consent". The Plan shall be developed in consultation with interested parties and shall detail the procedures, initiatives and stormwater management systems that will be implemented to operate in accordance with the conditions of this resource consent. As a minimum the Stormwater Management Plan shall describe the following: a) The relationship and integration of the Stormwater Management Plan with other Matamata-Piako District Council planning instruments and regulatory systems, including existing and proposed planning and regulatory controls that will be utilised to assist the control of routine and non-routine contaminant discharges to the stormwater system. b) Contributing catchments and the existing land uses, catchment receiving waters (including physical and biological characteristics, riparian vegetation, existing uses and values) and the municipal stormwater system characteristics (a diagram showing locations of the reticulation system, designated overland flow paths, treatment and disposal systems should be included). c) Potential risks to stormwater quality in the Matamata-Piako urban areas (i.e., resulting from routine and non-routine contaminant discharges to the municipal stormwater system;

d) Stormwater management systems and implementation methods to avoid, remedy or mitigate routine contaminant discharges to the municipal stormwater system.
e) Contingency measures and reporting systems to be implemented in the event of non-routine contaminant discharges from the municipal stormwater system.
f) Methods which will be used to manage risks to stormwater quality, streambed scouring and erosion, and adverse flooding;
g) Methods to identify and provide for stormwater overland flow paths in urban areas;
h) Strategies for identifying municipal stormwater system structures that are impeding the upstream or downstream movement of fish, and system upgrades, implementation methods and timeframes to address these;
i) Initiatives and implementation methods for improving the aesthetic appearance of drainage structures and stormwater detention areas;
j) Street cleaning operations;
k) All stormwater management devices and methods for ensuring that stormwater management devices are constructed and maintained in accordance with the Auckland Regional Council Technical Publication No 10 "Stormwater Management Devices; Design Guidelines Manual" (ARC, 2003) or any other technical publication approved in advance by the Waikato Regional Council acting in a technical certification capacity;
l) Management and operational procedures to avoid contaminants discharging from the municipal stormwater system as a result of the various municipal operation and maintenance activities;
m) Investigations and remediation programmes to discontinue informal wastewater system connections to the municipal stormwater system;
n) Operation and maintenance programmes to minimise the discharge of any municipal wastewater system contaminants to the municipal stormwater system;
o) Methods which will be encouraged by the Matamata-Piako District Council to minimise the effects of stormwater discharges from new subdivisions;
p) Methods for ensuring consideration of Low Impact Design principles (as contained in the Auckland Regional Council Technical Publication No. 124 "Low Impact Design Manual for the Auckland Region" (ARC 2000)) for proposed greenfield development sites;
q) Methods for identifying and implementing Best Practicable Options to manage the municipal stormwater system and prevent or mitigate adverse effects on aquatic ecosystems;
r) Methods for implementing stormwater management education initiatives;
s) A prioritised schedule for implementing the procedures, initiatives and stormwater management systems that are identified in the Stormwater management plan".

6 PROPOSED DEVELOPMENT & STORMWATER MANAGMENT

The overall development comprises of four distinct projects, as summarised below

1. Residential Development
2. Northern Solar Farm Development
3. Southern Solar Farm Development
4. Retirement Village

The residential and retirement village project share a common approach to stormwater management. Both developments incorporate roadside raingarden for treatment for high contaminant generating areas within the road carriageway area. Roadside soakage integrated with raingarden combines to fully store and soak incoming flows for event up to the 10year cc storm event. Flows exceeding this are conveyed via overland flow paths within road carriageway to downstream basins for attenuation and/or soakage.

Following discussions with WRC for on-lot stormwater management, they accept in most cases it is not practical for on-lot stormwater systems to have multiple devices providing treatment. Therefore, a driveway catchpit or strip drain is proposed which discharges up to the 10-year cc event into a soakage trench/soak pit. A lot connection into the roadside soakage trench will also be provided for larger events and provides redundancy should on-lot soakage fail. Flows exceeding this are conveyed via overland flow paths within the road carriageway to downstream basins for attenuation and/or soakage.

The two solar farm projects, located north and south of Station Road, introduces minimal land disturbance. The solar panels are elevated on stilts and placed on existing pastoral land, with only limited earthworks required for the two developments. Stormwater management approach for the two solar farm sites, is utilising the existing farm swales for conveyance, treatment, and attenuation.

As mentioned in previous sections, The RCP8.5 climate change adjustment has been applied to both scenarios (pre- and post-development)

6.1 POST DEVELOPMENT CATCHMENTS

The post development catchment layout for both the residential and retirement village areas has been defined based on the proposed stormwater basins, which also serve as the primary discharge points for each sub catchment. the placement of these basins 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 two solar farm projects are not expected to alter the existing catchment flow patterns, as existing flow routes are not altered within the sites. As the solar panels will be mounted on steel frames with minimal ground disturbance with only access tracks introduced offsetting existing ones likely to be removed due to the development, most of the land will remain as it was. Therefore, post development flow paths in these areas closely follow existing conditions, retaining predevelopment conditions.

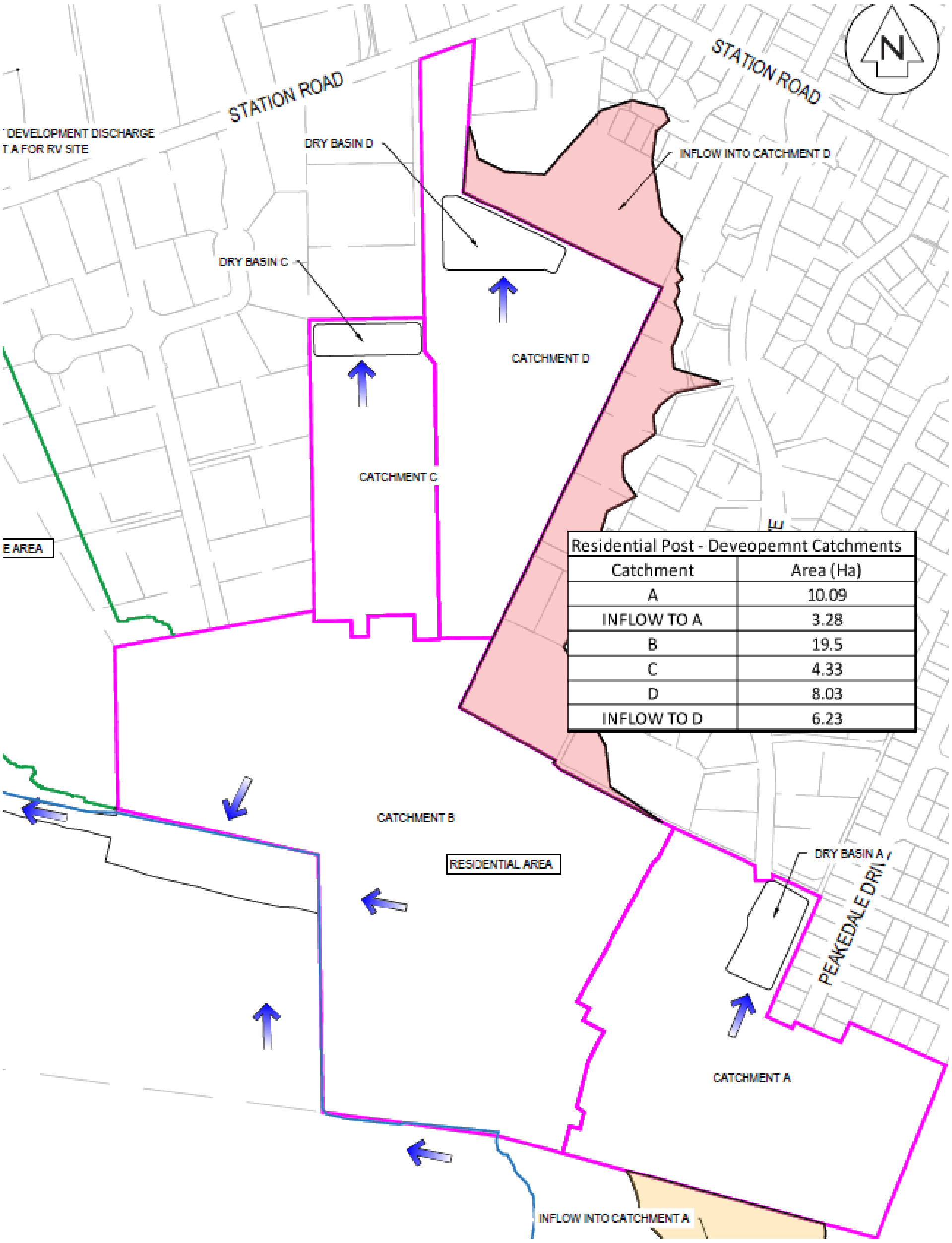
The post development model and calculations are built upon the following input and assumptions:

- CN numbers
    - Post-development CN=74 for Impervious 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**	
74	98	
Pre Development 24hr Rainfall Depth (mm)		
10yr RCP8.5	100 yr RCP8.5	100yr-10yr
167	265	98

Table 13 Design Parameters table

6.2 RESIDENTIAL DEVELOPMENT – CATCHMENT A-D



Residential Post - Deveopemnt Catchments	
Catchment	Area (Ha)
A	10.09
INFLOW TO A	3.28
B	19.5
C	4.33
D	8.03
INFLOW TO D	6.23

Figure 13: Overall Residential Development Catchment Plan

Catchment A is the south-eastern portion of the site. Soakage will be provided within the lots and the road to manage the stormwater flows for up to 10-year cc storm events. Storm events more than the 10-year cc storm events, will be conveyed as overland flows to a new designated stormwater basin downstream of each catchment to provide further mitigation up to the 100year cc event. upstream inflow into catchment A has been accounted for in the HEC HMS model. Refer to Appendix B.

Catchment B is the south-central portion of the site that connects to the proposed greenway. due to high ground water relative to the invert of the basin, soakage was not incorporated into the design for mitigation of flow within catchment B. in line with the overall strategy, the flow up to the 10-year ARI cc will be accommodated in roadside raingarden/soakage and private soakage for lot areas. flow above this event will be drained to a newly formed Basin + greenway. The greenway will start from the western boundary, and it will continue west to connect into the Waitoa River. At the end of the greenway an orifice of 1.25m ins dimeter is to be set at base of the greenway to allow for attenuation of the post-development 100year flow to 80 % predevelopment level.

Catchment C is the north-western portion of the site. Soakage will be provided within the lots and the road to manage the stormwater flows within the road corridor for up to 10-year cc storm events. Storm events in excess of the 10-year ARI cc storm events, will be conveyed as overland flows to a new designated stormwater dry basin in the northern portion of the catchment area.

Catchment D is the northern portion of the site. Soakage will be provided within the lots and the road to manage the stormwater flows for up to 10-year ARI cc storm events. Storm events in excess of the 10-year ARI cc storm events, will be conveyed as overland flows within the road corridor to a new designated stormwater dry basin in the northern portion of the catchment area.

Residential Staging

The residential portion of the development is intended to proceed in stages. As each stage progresses, interim swales will be implemented to ensure that stormwater mitigation measures remain consistent with the intent of this Stormwater Management Plan (SMP). During early stages, undeveloped areas will retain their natural flow patterns, and any new works will be designed to avoid adverse impacts on these areas. The strategic use of swales will provide effective flow management and treatment during construction and staging, ensuring that runoff is appropriately directed and controlled until full development and permanent infrastructure are completed.

6.3 RETIREMENT VILLAGE

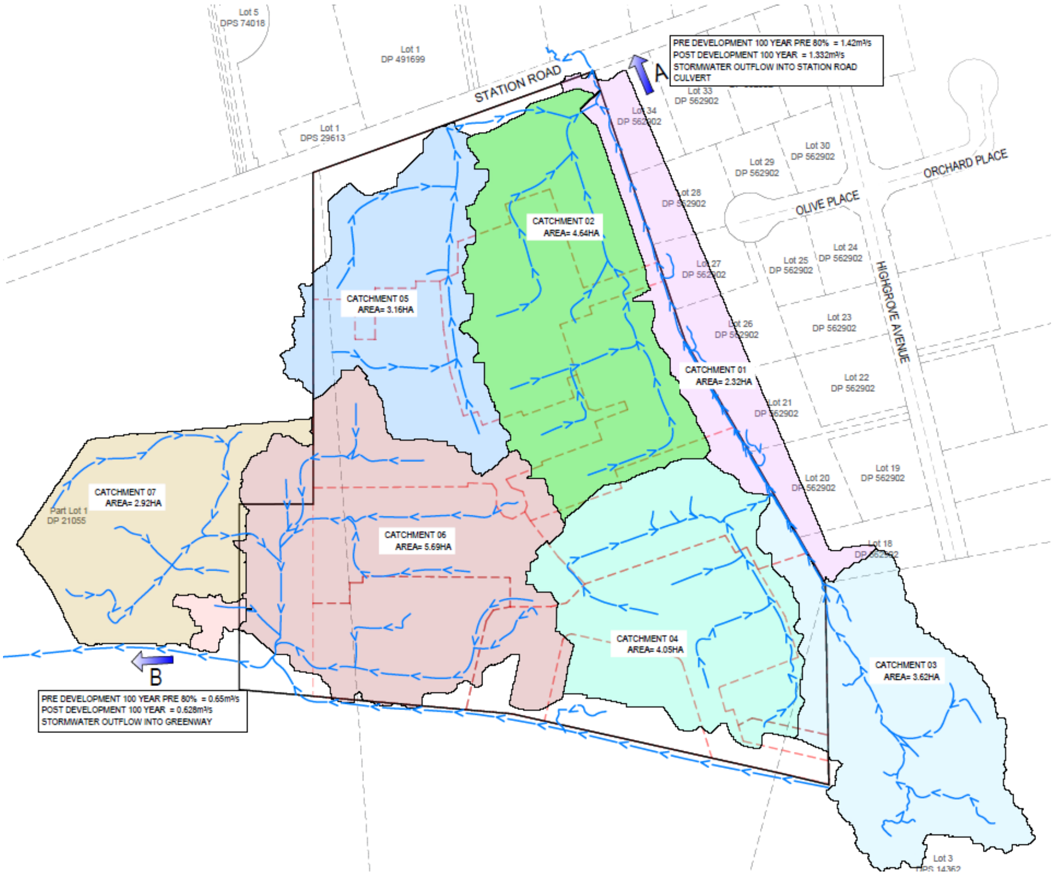


Figure 13: Overall Retirement Village Development Catchment Plan

The residential and retirement village project share a common approach to stormwater management. Both developments incorporate roadside raingarden for treatment for high contaminant generating areas within the road carriageway area. Roadside soakage integrated with raingarden combines to fully store and soak incoming flows for event up to the 10-year cc storm event. flows exceeding this are conveyed via overland flow paths within road carriageway to downstream two basins for attenuation and/or soakage, with slow release at, max 80% predevelopment.

6.4 SOLAR FARMS – NORTH AND SOUTH

As the solar panels themselves are built on steel frames, only approximately 5% of the solar farm will be changed to impervious surface. The remainder of the site remains in pasture suitable for sheep grazing. Therefore, assuming adherence to best practice stormwater management, the effects of increased stormwater runoff is considered to be 'Low'.

Southern solar will have combination of treatment methods where it will be initially treated using existing features such as drains etc, and eventually allow to flow to its natural flow path and existing streams. Farm site has 4m wide that runs from west to east centrally dividing the site. To manage stormwater flow from the southern side of the farm, open channels are proposed run in such a way that the flow is directed towards culverts. Culverts are placed at natural low points/existing streams allow discharge from southern side of the farm flow naturally to the other side discharging to proposed greenway and eventually flowing to Waitoa river. Culverts are designed to flow at 0.5% slope and average of 1m cover to comply with WRC standards. It will be sized to accommodate the discharge from receiving environment at detail design stages.

Northern solar farm site gently slopes from south to North. Existing farm drains will be incorporated around the site to facilitate pre-treatment of stormwater which will ultimately discharge into the Waitoa River.

6.5 CATCHMENT FLOW ANALYSIS

A hydrological model was created to assess the peak flows from the post development catchments. The model is based on the following input and assumptions:

- 10-year cc and 100-year cc rainfall from the post development catchments.
- Catchment extents as per C410 & 420 Series. refer to Appendix A
- Catchment characteristics as outlined in Appendix B (SW Calculations)
- Full soakage of up to the 10year cc event for Catchments for all lot and road catchments.
- Basin A, C and D full storage and Soakage for Excess flow from upstream up to 100year cc event. Attenuation to 80% predevelopment flow for Catchment B.
- For all Catchments: road corridors and accessways to convey secondary overland flow paths to the proposed Dry basins.
- For the Solar farm catchments: road corridors and accessways to convey secondary overland flow paths to the watercourses directly.

6.6 PRINCIPLES OF STORMWATER MANAGEMENT

The proposed stormwater management for the 4 developments 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 (Lockerbie Estate Subdivision AUTH141393.02.01) located in the same district of the proposed sites. The key components of the Ashbourne Developments 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 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 raingardens and soakage devices for the development.

6.7 GREENWAY AND BASIN B-Residential

Basin B is connected and located upstream of the proposed Greenway. Both forms part of the overall greenway/Basin B stormwater Mitigation device designed to cater for attenuation of flow from catchment B of the Residential development area and the diversion of the existing flows south and north of the Greenway.

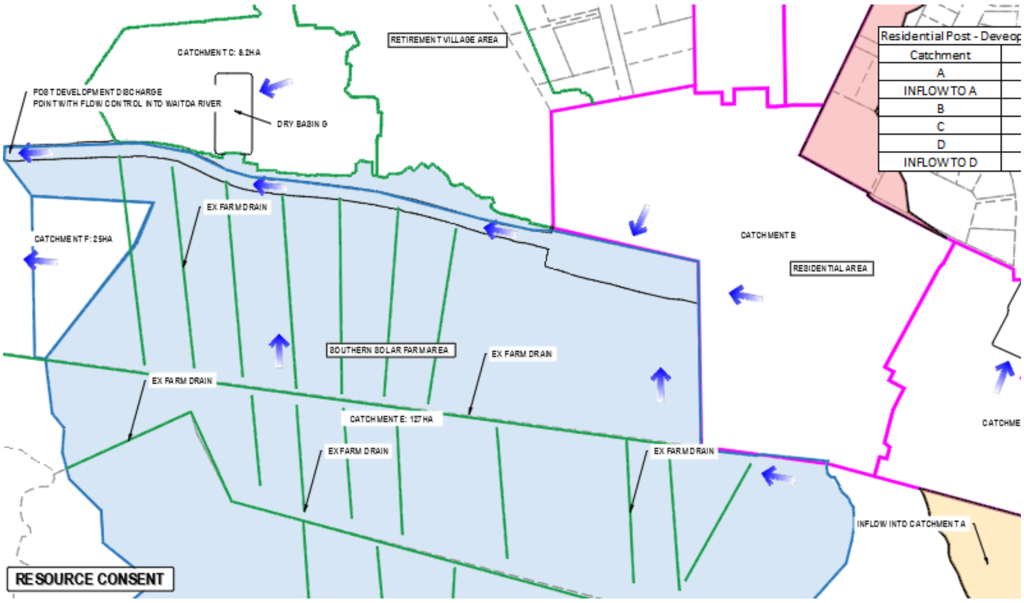


Figure 13A: Overall Greenway and Basin B Catchment Plan

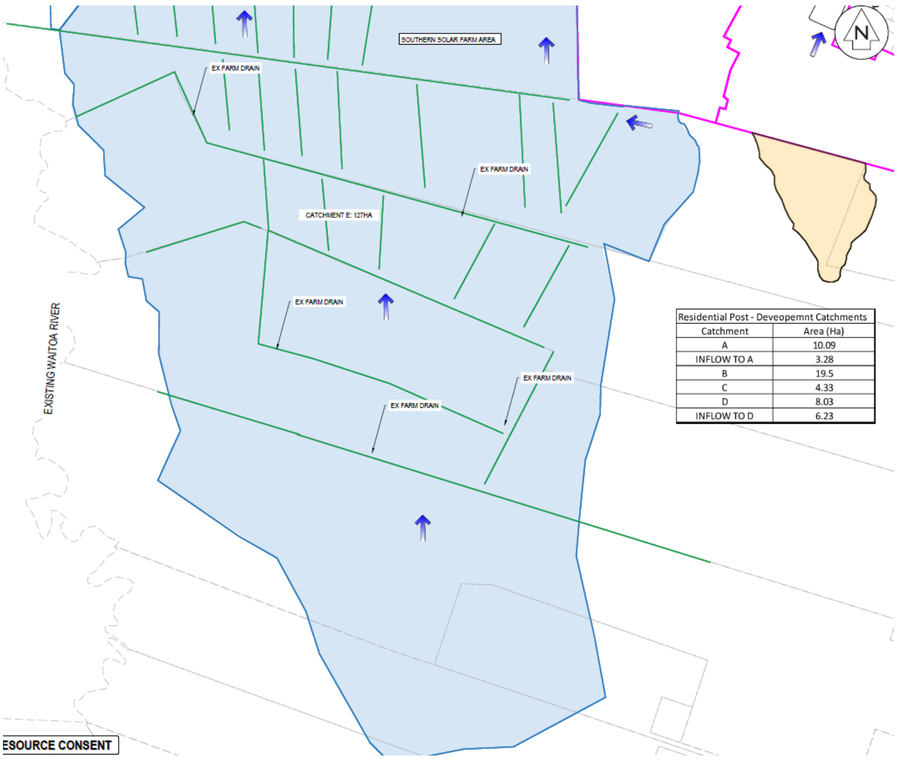


Figure 13B: Extent of Southern Catchment Plan for Greenway

Catchment	Area (Ha)
RES B	19.5
Inflow RV	8.2
Inflow South	127

Table 14 Greenway & Basin B Catchments

The 127-hectare inflow south catchment includes the neighbouring lands located south of the proposed solar farm and residential subdivision. A review of LiDAR data indicates that these lands generally slope gently from south to north.

There are a number of farm drains located throughout the area which appear to convey and direct flows into the Waitoa River. This is illustrated in the figures above. However, given the limited accuracy of the LiDAR data, and given these existing drains may become overwhelmed or blocked we have taken a conservative approach and designed the greenway to accommodate the full 127-hectare catchment, along with RES B and inflow RV, bringing the total to 155 hectares under an RCP8.5 1:100-year storm event.

The greenway will deliver significant benefits to this catchment as well as other surrounding catchments by acting as a large conveyance channel to the Waitoa River and helping to reduce localised flooding

The proposed Greenway corridor interconnects infrastructure, ecological wellbeing, connectivity, and amenity to support a place-based identity. Several uses are proposed along this corridor to encourage future residents to interact with the greenway, such as sheltered rest areas for relaxation and socialisation, active mode pathways, and play areas.

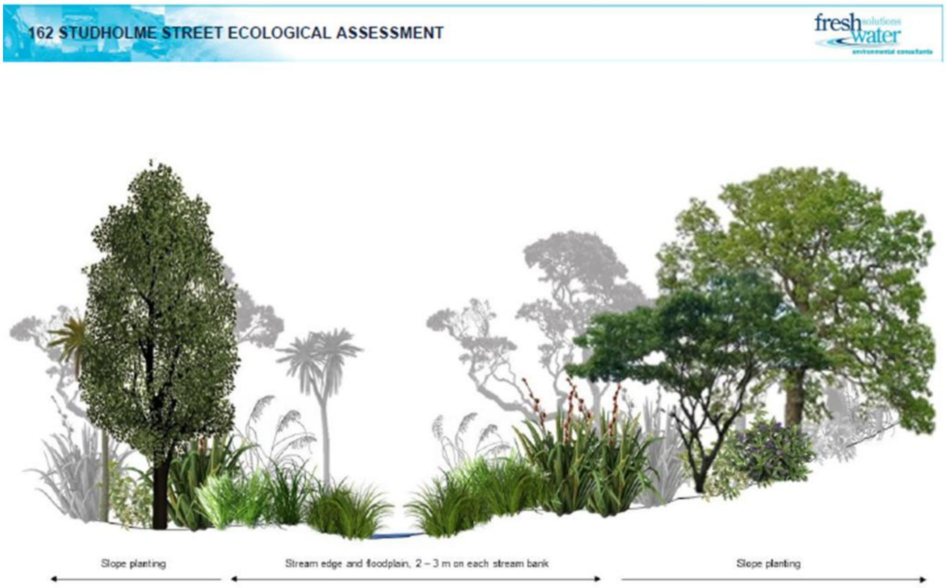


Figure 14: Greenway Cross Section (Plan 490-17)

The proposed greenway is sized to accommodate the 100-year ARI cc stormwater event flows less the 10-year ARI cc event from the Resident Area B. The 10 year cc ARI are proposed to be discharged via soakage in the road carriageway and the in the lot areas upstream of the proposed Greenway. Additionally, there is an inflow from the RV site through proposed South Easter RV Basin as shown in the above catchment diagram. This basin provides stormwater mitigation by capturing and discharging flows at 80% predevelopment flow into the greenway.

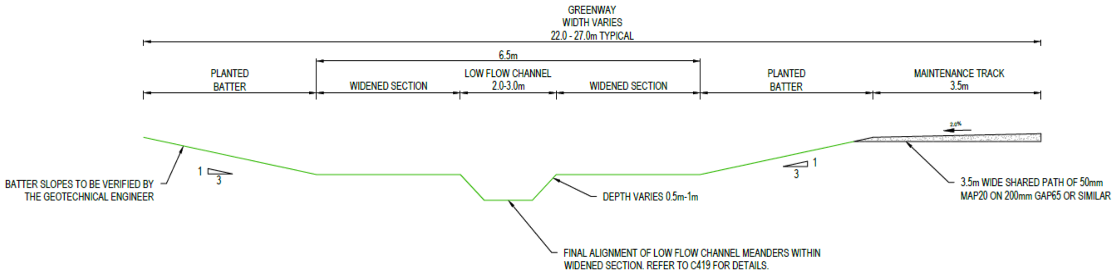


Figure 15: Greenway Cross Section (Plan 490-17)

A low-flow channel is incorporated at the base of the proposed greenway to replicate existing flow conditions and support continuous baseflows through the corridor. The channel is designed to have a width of approximately 2 to 3 meters and a depth of 0.5 to 1 meter, providing a defined conveyance path for low flows while maintaining ecological connectivity. This configuration ensures that hydraulic function is preserved during dry weather periods and provides controlled conveyance under baseflow conditions. The alignment and shape of the low-flow channel will follow the greenway’s finished levels, and an impermeable liner will be considered where required to retain flow and minimize infiltration losses.

To provide for future maintenance of the greenway a 3.5m wide maintenance track will be constructed along the northern side of the greenway. The maintenance track will also provide a shared access track for pedestrians and cyclists. The greenway will have widened sections to provide some additional flood storage and to enhance the aesthetics of the greenway. The typical greenway section is shown above (figure 15).

6.8 DRY BASINS

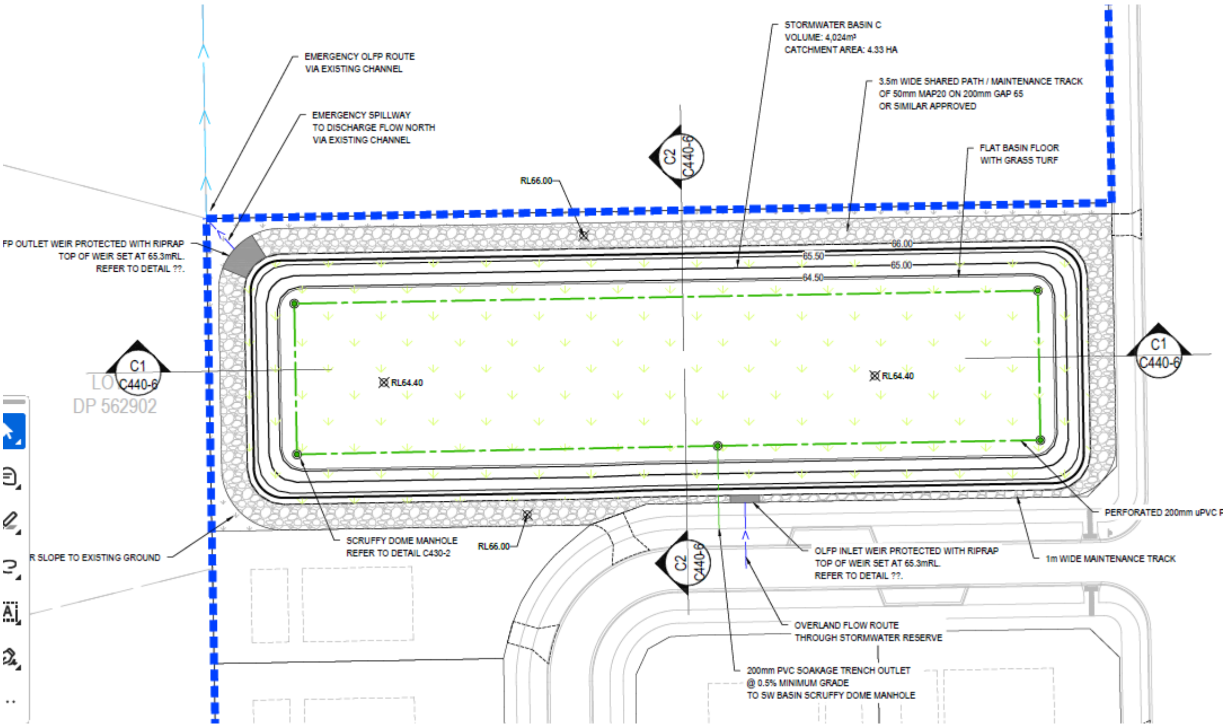


Figure 16: Dry Basin Typical

The proposed Dry basins captures excess runoff from upstream devices above the 10-year cc event. and up to the 100-year cc event. Attenuation, storage, and soakage is carried out within the dry basins with flow rate released no more than 80% Predevelopment rate.

Residential Dry basins for A, C and D, have been designed conservatively allowing full storage of the from upstream catchment. there is soakage element to them that has been applied in the HEC HMS model having a constant soakage throughout the 24hr period. Further calculations were carried out to determine time to drain from full condition (peak) with max allowable 48hrs.

The Retirement Village Dry Basins capture excess runoff from the upstream devices during event above the 10-year design event. Attenuation, storage, and soakage occur within the dry basins, and the flow rate is maintained at no more than 80% of the pre-development level rate.

Refer to calculation found in appendix B of this SMP.

For this resource consent application, stormwater dry basins have been designed to conservatively store the 100-year cc less 10-year cc event and to discharge via soakage without any release of flows into existing channels or via existing OLFPs. Therefore, there is potential for further refinement of dry basin sizing to utilise existing OLFP's up to a maximum release rate of 80% pre-development

6.9 SOAKAGE DEVICES

6.9.1.1 ON LOT SOAKAGE

The on-lot drainage system for the Ashbourne Residential area is proposed to consist of the following.

- Soakage Device
- Slot drain (if needed) connected to a Catchpit in the driveway
- Pipe system from the roof and catchpit (driveway) to the soakage Device
- Lot Connection pipe that connects Catchpit to the roadside soakage device.

Driveway/Impervious area runoff will flow to the slot drain directing flow to proposed catchpit with sump where settlement of courser suspended solids can occur. The flow then gets discharged into the soakage trench where it will be treated further and then soak to the ground. Pre-treatment for sediments is not required for typical residential roof loadings therefore the roof runoff with be discharged directly to Soakage trench.

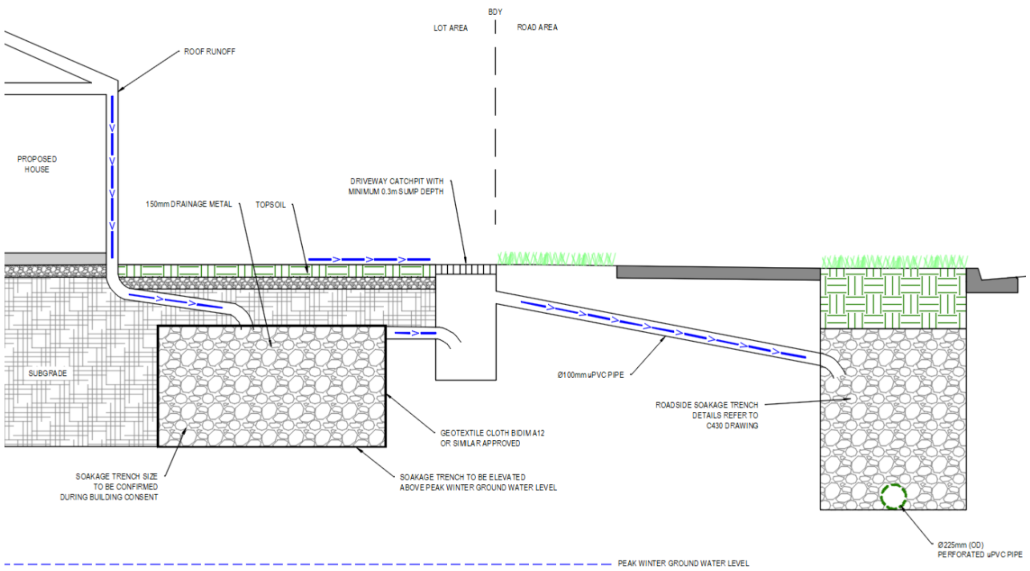


Figure 17: On Lot Drainage system/Soakage Typical Det

The proposed on lot systems have been designed to cater for up to the 10year cc rainfall event. Events above the 10year cc will be directed into the carriageway. This will be provided through a primary overflow mechanism, in the form of a connection from the proposed catchpit whin each lot to the stormwater soakage trench within the road reserve. This will form a lot connection for each of the lot areas within the Ashbourne Residential Area. Any flows above this, will be conveyed by overland flow into the road carriageway.

The sizing of soakage trenches for residential lots was based on the methodology outlined in E1/VM1. Stormwater catchment volumes were calculated for three typical impervious roof areas—150 m², 200 m², and 250 m². Corresponding soakage disposal volumes were determined using three representative soil infiltration rates (0.5, 1.5, and 3.0 L/min/m²).

The required trench storage volume for each scenario was derived by subtracting the volume of water disposed by soakage from the total catchment volume. In total, nine soakage trench volumes were calculated to represent different combinations of impervious area and soakage performance, allowing flexibility in design depending on lot-specific conditions. Refer to Appendix B for full calculation. Also refer to plans which states Soakage Device Sizing requirement table.

Additional site-specific geotechnical and/or infiltration testing will be undertaken prior to construction to confirm soakage values sizing of the proposed devices

6.10 On Lot RAIN SMART TANKS (RETIREMENT VILLAGE)

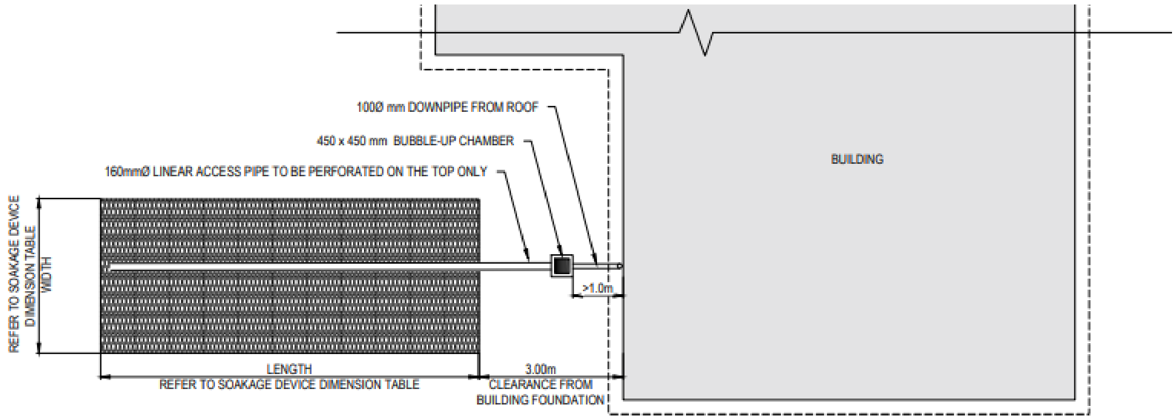


Figure 18: On Lot Soakage Typical Det

On-site stormwater management for the Retirement Village is achieved by using a modular Cirtex Rain smart Soakage system. This device is integrated within each unit's lot boundary to treat and dispose of roof runoff in accordance with regional requirements. Each device comprises modular tanks wrapped in AS410 geotextile, installed over a compacted sand base within a trench. The system includes a perforated 160mm diameter linear pipe to distribute flows evenly through the device, and a bubble-up chamber provides an overflow pathway. Refer to the RV infrastructure report containing the details of this product and design approach.

Additional site-specific geotechnical and/or infiltration testing will be undertaken prior to construction to confirm soakage values sizing of the proposed devices

6.11 Road Soakage & Raingarden – Residential

Combination of raingarden and soakage trench is used for managing impervious area flows of 10-year cc stormwater event. The raingardens will be connected via piped network to Stormwater basin.

Water from catchpits, roads and manhole will flow to raingarden where it will filter through the layers of raingarden thus removing contaminants and treating it initially. It will be placed at high point of soakage trench so it can flow naturally towards the soakage trench.

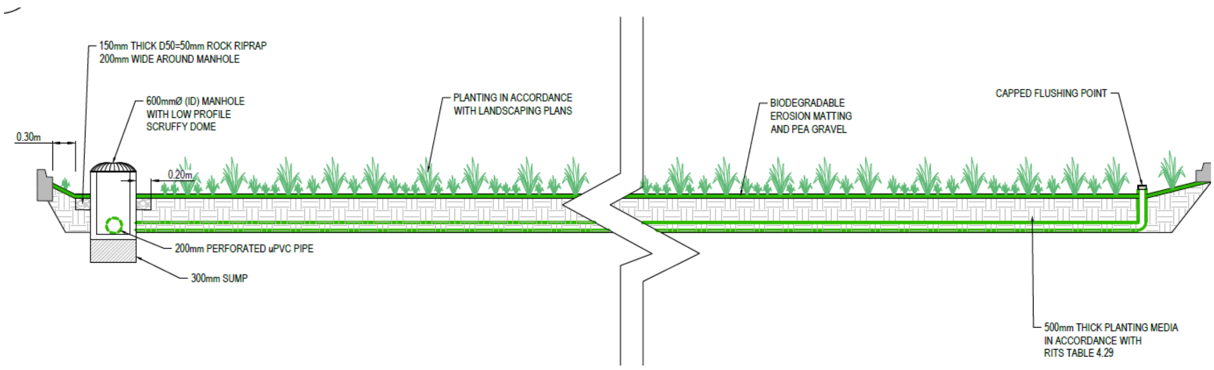


Figure 19: Typical RG (C430)

Raingardens were sized in accordance with RITS (Regional Infrastructure Technical Specification) requirements, using a volume equal to 2% of the contributing catchment area. To determine the required raingarden area, the total volume was divided by an assumed 1.0 m raingarden depth. This area was then divided by the road chainage within the relevant catchment to calculate the linear length of raingarden required per metre of road. This approach ensures adequate stormwater treatment and attenuation across road catchments, aligning with local council expectations for water quality management.

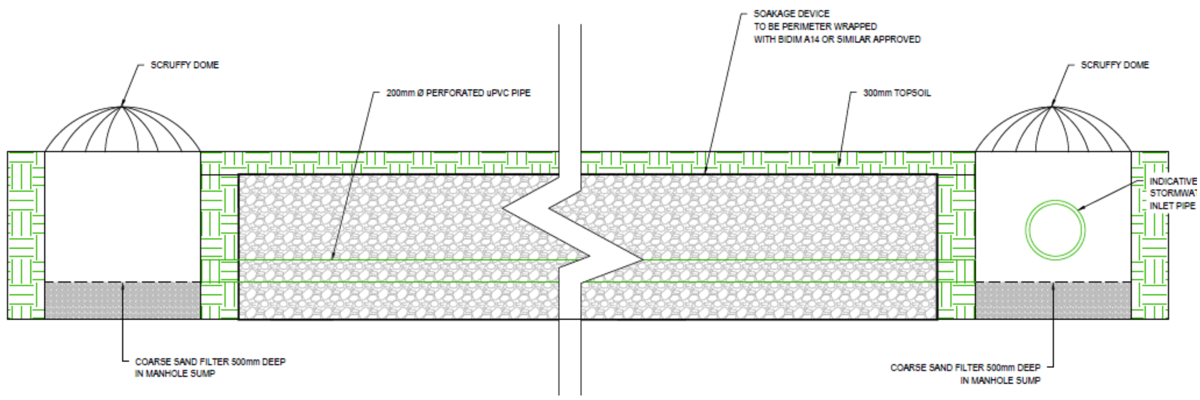


Figure 20: Typical Soakage Detail (C430-RES)

The soakage trench for the road carriageway area was designed in accordance with the Matamata-Piako District Council (MDPC) Soakage Manual, with the effective soakage area calculated using the methodology specified in the manual. The design objective is to ensure the trench can accommodate runoff up to a 10 year cc rainfall event.

Soakage rates were obtained from CMW Geotechnical testing,(allowing for 0.5 factor in accordance with the manual) using two representative rates, based on test pit results:

- 1.7 L/min/m²
- 5.7 L/min/m²

Due to the absence of a 10-year, 24-hour rainfall intensity graph in the MPDC Manual has been reasonably assumed/interpolated based on available information. Impervious area limits were estimated based on standard road widths.

For 18 m wide roads, with a trench dimension of 2.0 m wide x 1.5 m deep, the required trench length per meter of road was

- 0.55 m (0.28 m each side) for the 1.7 L/min/m² soakage rate.
- 0.27 m (0.135 m each side) for the 5.7 L/min/m² rate.

For 20-meter-wide roads, with a trench size of 1.2 m wide x 1.5 m deep, trench lengths of 1.1 m total (0.55 m per side) and 0.62 m total (0.31 m per side) were required for the lower and higher soakage rates, respectively.

- 1.1 m (0.55 m each side) for the 1.7 L/min/m² soakage rate.
- 0.62 m (0.31 m each side) for the 5.7 L/min/m² rate.

These trench sizing calculations above sets guidelines for sizing of soakage based on road typology and relevant soakage testing results onsite.

Additional site-specific geotechnical and/or infiltration testing will be undertaken prior to construction to confirm soakage values sizing of the proposed devices

6.12 Road Soakage & Raingarden – Retirement Village

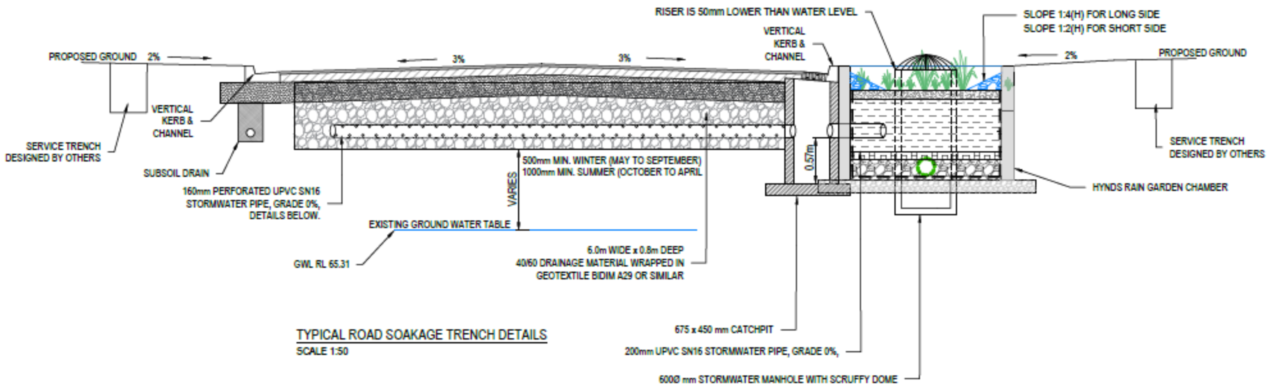


Figure 21: Typical Soakage Detail (C430-RES)

The soakage trench under road reserve is used for managing flows up to 10-year cc event for retirement village. Flows exceeding 10-year cc event will be redirected to road carriageway and discharged to the designated stormwater pond.

The retirement village reticulation system will allow stormwater to soak to the ground via roadside soakage trench for 10 yr cc event. Flows exceeding the 10-year cc soakage capacity are redirected back into the road carriageway and get discharged at the designated downstream Stormwater Pond.

Raingardens were sized in accordance with RITS (Regional Infrastructure Technical Specification) requirements, using a volume equal to 2% of the contributing catchment area. To determine the required raingarden area, the total volume was divided by an assumed 1.0 m raingarden depth. This area was then divided by the road chainage within the relevant catchment to calculate the linear length of raingarden required per metre of road. This approach ensures adequate stormwater treatment and attenuation across road catchments, aligning with local council expectations for water quality management.

6.13 INITIAL ABSTRACTION VOLUME

Initial abstraction volume of runoff from the proposed catchments will be retained by the proposed on-lot soakage Trenches and catchpit sumps. Initial abstraction volume of runoff from the proposed roads will be retained by the proposed raingardens/soakage devices. The preliminary design of these devices is summarised above and as provided in appendix B.

7 POST DEVELOPMENT FLOODING

7.1 OVERLAND FLOWPATHS (OLFPS) - CARRIAGEWAY

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.

- 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, Appendix B Detailed design of the OLFPs will be provided at future detail design stage following the approval of the resource consent.

A Preliminary assessment of the post development overland flow paths (OLPs) 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 cc 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 o the OLFP is viable through proposed carriageway.

See below table showing results at the key locations and is linked to plans 430 For Residential Development

Section	Peak Flow (m^3/s)	Max Depth (m)	Max Velocity (m/s)	V x D (m^2/s)
A1	0.6	0.137	0.77	0.105
A2	1.1	0.158	0.97	0.153
A3	0.6	0.131	0.82	0.107
B1	0.9	0.167	0.81	0.135
B2	0.3	0.116	0.59	0.068
B3	0.2	0.091	0.61	0.056
B4	1.5	0.216	0.79	0.171
B5	0.6	0.121	0.912	0.11
C1	0.5	0.125	0.81	0.101
D1	0.3	0.116	0.59	0.068
D2	0.3	0.109	0.59	0.064

Table 15: OLFP Assessment Results (Residential Area)

Section	Peak Flow (m^3/s)	Max Depth (m)	Max Velocity (m/s)	V x D (m^2/s)
A	0.17	0.09	0.75	0.07
B	0.26	0.1	0.77	0.08
C	0.29	0.11	0.8	0.09
D	0.34	0.12	0.82	0.1
E	0.44	0.13	0.85	0.11
F	0.45	0.13	0.87	0.11
G	0.55	0.14	0.89	0.12
H	0.67	0.15	0.91	0.14
I	0.7	0.16	0.94	0.15
J	0.73	0.16	0.96	0.15
K	0.85	0.17	0.98	0.17
L	0.96	0.18	1.01	0.18
M	1.07	0.19	1.03	0.2
N	1.24	0.21	1.05	0.22
O	0.58	0.14	0.9	0.13

Table 16: OLFP Assessment Results (Retirement Village)

Most OLFP sections comply with standard design thresholds. However, three sections in the residential development and six sections in the retirement village recorded maximum water depths above the 150mm guideline.

Residential

Catchment A – Section 2: Max Depth = 0.158

- Catchment B – Section 1: Max Depth = 0.167

Catchment B – Section 4: Max Depth = 0.216

Retirement Village

Sections I – N: Highest Max depth is 0.21m and Lowest Max Depth: 0.16m

Despite minor exceedances in depth, depth x velocity (m2/s) values remain well below 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 was $0.22m^2/s$ confirming safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads conveyed into roadside treatment and 10year cc event mitigation devices prior to spilling back (during event above the 10year cc) onto the road and get discharged into the proposed basins or Greenway.

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 this report, evaluates overland flow behaviour under worst case flooding conditions within and surrounding the site.

7.1 PROPOSED BASINS

The proposed basins located downstream of each catchment are primarily intended to capture rainfall runoff from events that exceed the 10 year cc event from the subject sites (RV and Residential). Please note that the table below presents the water levels for the 10-year cc event. This relates to upstream inflows, rather than those from the subject sites.

The table below displays the expected peak water levels for the basins during the critical duration 24-hour rainfall events for both the 10-year and 100-year periods.

SITE	BASIN	Water Level - HEC HMS		Min Platform Levels adjacent units
		10 years	100year	
RESIDENTIAL	A	64.10	66.20	66.70
	B	66.80	66.9	67.4
	C	-	65.45	65.95
	D	64.90	65.79	66.29
RETIREMENT VILLAGE	1	65.55	65.77	66.27
	2	66.41	66.82	67.32

Table 17: Stormwater Basin Water Levels

Note Min platforms levels for both the Residential and Retirement village complies with minimum freeboard requirements. This requirement is based on the 500mm freeboard referenced from both E1 Building Code and Matamata Piako district plan 11.4.

7.2 CONVEYANCE CHANNELS – EXTERNAL INFLOWS

The overall stormwater design accounts for all inflows from upstream catchments that flow through the site under pre-development conditions. As introduced in section 2.2 of this report, these inflows will require management to ensure conveyance while minimising impact to surrounding environment is maintained. To manage these flows, the proposal includes three conveyance channels positioned around the perimeter of the residential development. These channels aim to redirect upstream overland flows downstream, thereby minimizing flood risk and preventing adverse impacts on existing neighbouring properties.

The proposed channels vary in width from 3 to 4 meters. Preliminary sizing was conducted using HEC-RAS as part of the Flood RCP 8.5 sensitivity analysis. This process involved defining the channel alignments and iteratively adjusting their positions and widths to effectively accommodate flow during the design storm event while minimizing upstream impacts.

These inflows through the conveyance channel have been incorporated in the design of the greenway and the Stormwater Basins.

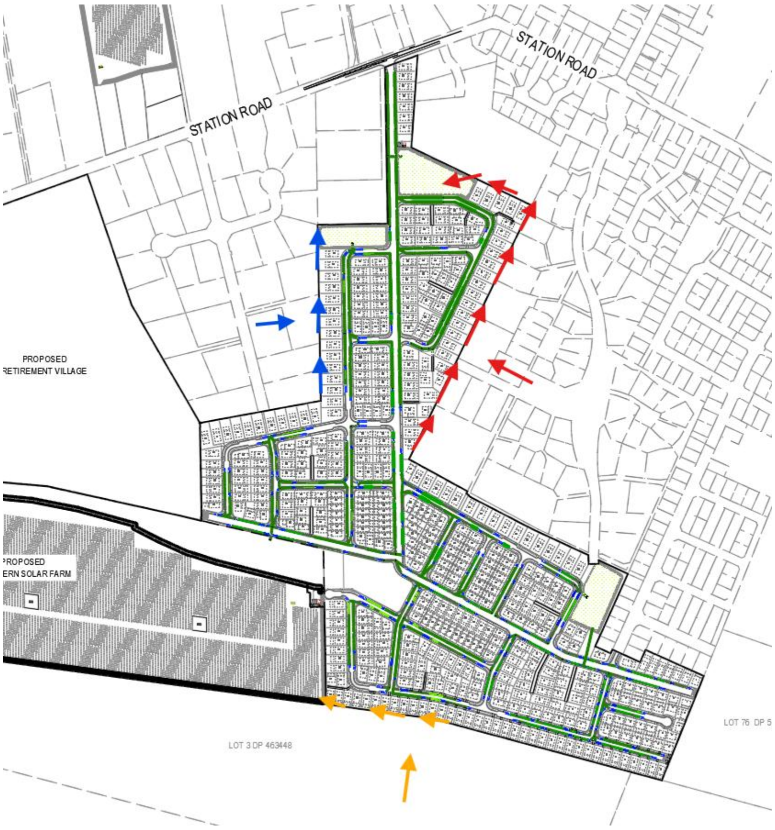


Figure 22: Greenway Cross Section (Plan 490-17)

Conveyance South of Residential Development - Orange

The proposed conveyance is required here for Runoff from the upstream portion of the post development Catchment B, located south of the residential development. This inflow will be redirected to the western edge of the residential area. From there, it will discharge into the southern solar farm zone. The redirected flow will ultimately be conveyed into the Waitoa River via the proposed greenway corridor.

Conveyance East of Residential Development – Red

Overland flow along the eastern boundary of Post Development Catchment D will be captured by this channel along the adjacent Eastern boundary. Under heavy rainfall, northern area of Basin D will pond within the neighbouring property, similar to existing pre-development conditions. Once ponding reaches elevation of RL 65.60, channel will overflow into Basin D. The basin also receives runoff from Catchment D (100-10yr cc event) and is designed with a soakage base, similar to Basins A and C, allowing for further storage for all inflows into Basin D.

Conveyance West of Residential Catchment C - Blue

A Conveyance channel is proposed along the western boundary of Post Development Catchment C to accommodate the natural overland flow from upstream areas. Under existing conditions, this flow would pass through the development area before entering the northern natural stream. The proposed channel will convey this existing flow downstream into the existing channel. This approach ensures that upstream flows are managed efficiently, preventing backwater effects due to infilling of the downstream areas.

7.3 DESIGN FLOW RESULTS – EXISTING DISCHARGE POINTS

SITE	Catchment (See Plan C-400 Series)	Pre-Development Flow: 10-year flow (m^3/s)	Pre-Development Flow: 100-year flow (m^3/s)	Post Development Flow: 10-year flow (m^3/s)	Post Development Flow: 100-year flow (m^3/s)
RESIDENTIAL	A1	0.18	0.37	0	0
	A2	0.47	0.96	0	0
	A3	0.04	0.09	0	0
	A4	0.21	0.43	0	0
	A5	0.04	0.08	0	0
	RES-CATCH B Discharge through Greenway			0.85	1.72
	A6	0.52	1.06	0	0
	A7	1.64	2.97	0	0
	A8	0.05	0.1	0	0
SOUTH SOLAR	A9	4.22	8.63	2.8	5.75
RETIREMENT VILLAGE	A10	0.55	0.81	0	0.63
	A11	0.03	0.07	0.03	0.07
	A12	0.73	1.78	0	1.33
NORTH SOLAR	A13	0.05	0.11	0.05	0.11
	A14	0.15	0.28	0.15	0.28
	A15	0.83	1.71	0.83	1.71
	A16	0.05	0.11	0.05	0.11

Table 18: HEC HMS discharge Table

The flow comparison table above presents the pre- and post-development peak flows across the various catchments within the Ashbourne development. Pre-development flows show a natural distribution of runoff across the site with majority discharging due north of the sites and into the Waitoa River.

In the post-development scenario, many of these flows are reduced to zero, particularly within the Residential and Retirement Village areas. This is due to the proposed use of basins with integrated soakage components, both within the basins themselves and in upstream areas, designed to retain stormwater on-site. Meanwhile, some catchments still show controlled discharge where infiltration is not feasible.

This pattern reflects a conservative design approach and highlights opportunities for further optimisation in the detailed design phase to improve land use efficiency while maintaining regulatory compliance.

8 POST DEVELOPMENT FLOODING – SENSITIVITY ANALYSIS

This section presents a sensitivity analysis carried out using HE RAS 2D for the 100year cc event which assumes all soakage and pond systems are fully blocked. This assessment builds on the Section 7 results but provides a more conservative view of surface flooding behaviour across the sites.

Objective of this analysis is to observe whether the overland flow paths can convey runoff when the mentioned key stormwater components are fully blocked, and how this will impact the development and the surrounding environment.

The map results shown below shows extent of the 100year cc flood event within and neighbouring site.

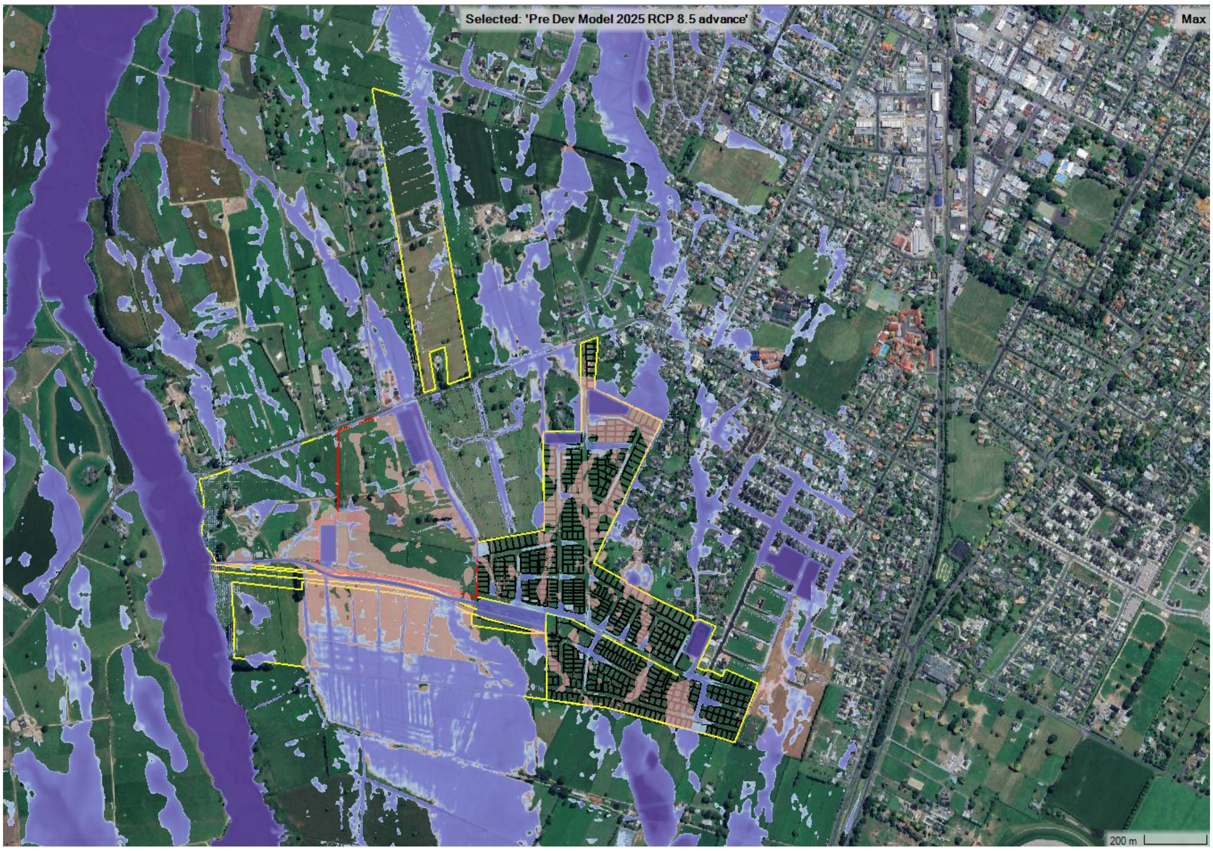


Figure 23: Overall Pre & Post Development Flood Map RCP 8.50 - Sensitivity

HEC RAS Catchment Flows (100 YEAR cc)m³/s				
SITE	**Catchment**	**Pre Development**	**HEC RAS Section**	**Post Development**
RESIDENTIAL	A1	0.85	RES SEC 11	0.2
	A2	0.96	RES SEC 10	0.96
	A3	2.05	RES SEC 09	0.05
	A4 & A5	0.85	RES SEC 03	0.08
	A6	2.3	RES SEC 06	0.3
	A7	2.6	RES SEC 04	1.2
	A8	0.13	RES SEC 12	0.05
SOUTH SOLAR	A9	1.7	GRNWAY SEC 01	9.8
RETIREMENT VILLAGE	A10		GRNWAY SEC 01	
	A11	0.84	RV SEC 01	0.9
	A12	2.99	RV SEC 02	1.25
NORTH SOLAR	A13	1.6	S.North SEC 01	1.5
	A14	0.9	S.North SEC 02	0.95
	A15		S.North SEC 01	
	A16	6.13	S.North SEC 03	6.1

Table 19: HEC RAS Sensitivity discharge Table

Referring to the table above, although the overall post-development scenario indicates reduced discharge at most locations, a few key areas require additional context.

For the Retirement Village, the increase in flow at the downstream section (RV Section 1) is attributed to preliminary surface levels, for small areas along the fringes of the RV development draining into the existing Road Swales on Station Road. These levels will be refined during the detailed design stage to ensure that all overland flows are directed appropriately into the proposed ponds, eliminating unintended bypass or overflow conditions.

8.1 Greenway and Waitoa River Interface.

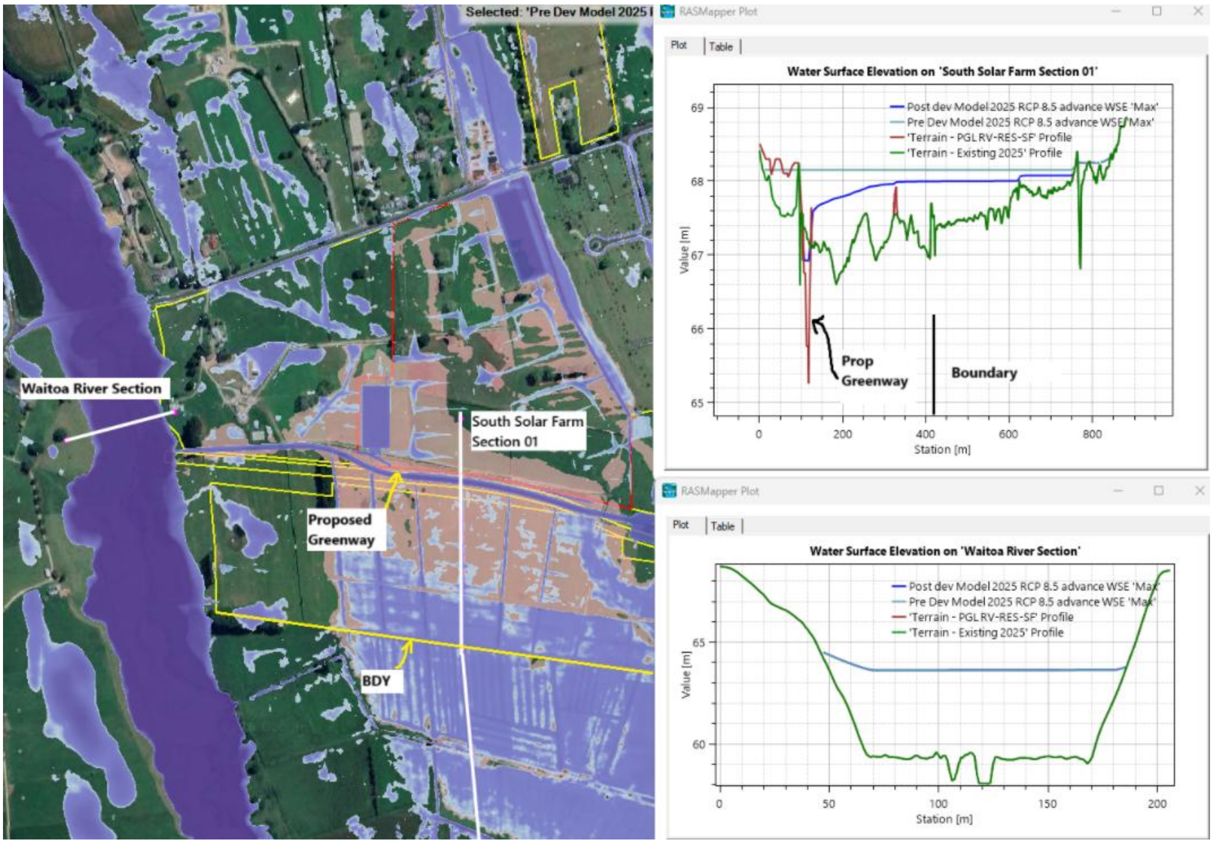


Figure 24: Overall Pre &Post Development Flood Map RCP 8.50 - Sensitivity

The proposed greenway plays a crucial role in the overall stormwater strategy for the development. One of its primary functions is to receive and attenuate flows from Catchment B of the residential area before discharging them into the Waitoa River. Another function is to convey flow from the south and north of the greenway. Refer to section 6.3, which provides more information the proposed greenway/Basin B and its function.

Under pre-development conditions, significant surface ponding was observed in the model within and upstream of the southern solar farm area, as seen in the results screenshot (blue—post dev & pink—pre dev). With the introduction of the greenway, this water is now conveyed more effectively downstream, resulting in an 80–90 mm reduction in flood depths in those upstream areas. This improvement supports the project's intent to alleviate localized flooding and enhance overland flow management.

However, the greenway's increased conveyance capability results in a higher runoff directed to the Waitoa River. This has led to a slight increase in the flood level, showing a 20 mm increase in water surface elevation observed in the flood sensitivity assessment. While this increase is acknowledged, it is considered minor and is outweighed by the substantial upstream benefits and overall reduction in localized flooding across the site.

8.2 North Of Basin D

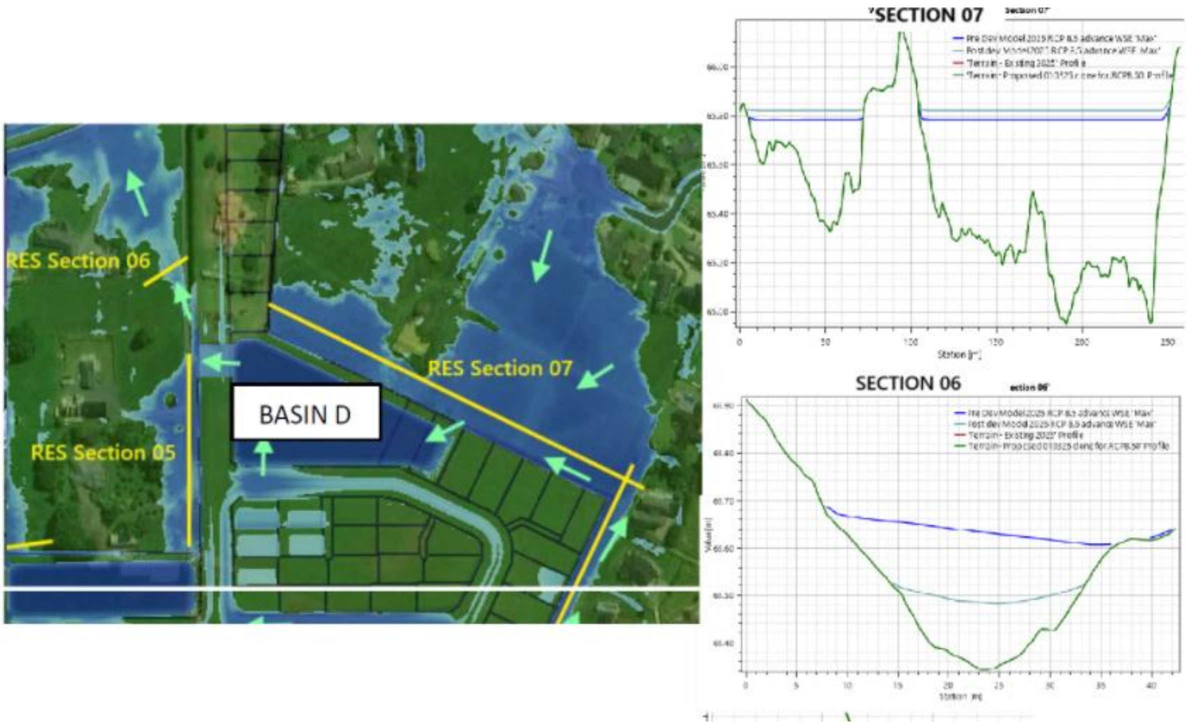


Figure 25: Basin D - RES Flood Map RCP 8.50 – Sensitivity

Basin D receives runoff from Catchment D and inflows from the northern and eastern areas upstream of Basin D, as referred to in the C410 catchment plan. As section 7.2 explains, this inflow is conveyed along the east boundary through the proposed convergence channel. Initially, the inflow will pond to the north of Basin D, similar to the pre-existing scenario. Over time, during the 24-hour event, it will eventually overtop and spill into Basin D. Once Basin D reaches its storage capacity, it will overflow westward onto the adjacent road corridor, before discharging into the neighbouring environment via the existing OLFP route.

The RES Section 07 has been placed to assess the development's impact on the neighbouring areas due to the rerouting of this inflow, as described above. The results indicate a slight increase in water depth ranging from 30 to 40 mm adjacent to the eastern boundary of Basin D, where it ponds before spilling into the Basin.

In contrast, RES Section 06 is located at the westward discharge point from the pond to assess the development's impact downstream. The results indicate a just over 100 mm reduction in post-development flood levels. This reduction underscores the effectiveness of the basin design in attenuating flows and, consequently, reducing flood risk in downstream areas.

9 SUMMARY OF PROPOSED STORMWATER MANAGEMENT

Stormwater management solutions for each post development sub-catchment is summarised in Table 20.

Table 20: Summary of stormwater management

Developments	Source	Water Quality	Flood management	Stream Protection	Water Sensitive Design
Residential Sub catchment-A, B, C &D	Lot Areas	Inert roof materials. Soakage Trench.	roadside raingardens and soakage trenches for 10yr ARI cc rainfall events. Catchment A, C & D; Overland flow paths for 100yr ARI cc events within road reserves, directed to detention basins. Catchment B: Overland flow paths for 100yr ARI cc events within road reserves, directed to detention basins and Greenway.	At source on lot soakage trench for: Full soakage/Mitigation of up to 10year cc event	**Stormwater detention basins 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 Raingardens, soakage trenches and stormwater basins 75% TSS as per requirements of GD01/ TR2018/01 for all impervious surfaces.		Raingardens, soakage trench and dry basins	
Retirement Village	Lot Areas	Inert roof materials. Soakage Trench.	Catchment wide dry Basin the 10yr cc and 100yr ARI cc. roadside raingardens and soakage trenches for 10yr ARI cc rainfall events. Use of rain smart (Cirtex) or similar to capture the 10year event cc.	At source on lot soakage trench for: Full soakage/Mitigation of up to 10year cc event	
	Public Roads	**At source Raingardens, soakage trenches and stormwater basins** 75% TSS as per requirements of GD01/ TR2018/01 for all impervious surfaces.		**Raingardens, soakage trench and dry basins**	

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 Ashbourne Development Areas*

10 DESIGN OPTIMISATION

As part of the ongoing refinement of the stormwater management system, two key optimization strategies can be explored during the next stage of the project. These aim to maximize land availability further, improve hydraulic performance, and reduce the infrastructure footprint where appropriate:

- Reduction of Stormwater Pond Size via Controlled Discharge: The current post-development model assumes zero discharge from several catchments, which is conservative and beneficial from a flood mitigation perspective. This means the sizes of the proposed basins can be further optimized. To achieve this, we will investigate discharging post-development flows at up to 80% of the pre-development flow rate, which aligns with council standards and requirements. This approach balances flood control with land efficiency and has the potential to reduce pond size, thereby creating more developable land for additional units where possible.

- Incorporation of Base Flow Discharge to Existing Streams: To better mimic the natural hydrological conditions, base flow discharge will be reintroduced where feasible. This can be achieved by quantifying the existing base flow and assigning selected units to discharge directly into the stream at this defined rate and quantity. This strategy improves ecological outcomes and further reduces onsite storage demand, particularly for minor and frequent rainfall events.

These optimization works will be further assessed through refined modelling and consultation with the council and external consultants during the further design stage to ensure compliance with council requirements while maximizing development potential.

11 DEPARTURES FROM STANDARD

A departure from standard stormwater design has been identified in a few Overland Flow Path (OLFP) sections where the flow depth exceeds the recommended threshold of 150 mm according to RITS. These exceedances are minor and occur in isolated sections of the residential OLFP network.

Sections exceeding the 150mm limit.

Residential

- Catchment A – Section 2: Max Depth = 0.158
- Catchment B – Section 1: Max Depth = 0.167

Catchment B – Section 4: Max Depth = 0.216
Retirement Village

- Sections I – N: Highest Max depth is 0.21m and Lowest Max Depth: 0.16m

These areas remain safely contained within their respective flow corridors and do not pose a risk to vehicles and pedestrians as VD values remain well below the threshold. Further refinement of levels, swale profiles, or berms at the detailed design stage is expected to reduce these values and bring all OLFP sections fully into compliance.

12 CONCLUSIONS

This Stormwater Management Plan (SMP) has been prepared to support a discharge consent application for the proposed Ashbourne development, which comprises four key projects:

- the Residential Development
- Northern and Southern Solar Farms
- the Retirement Village.

Each site has been considered in detail through hydrological and hydraulic modelling, including sensitivity scenarios under future climate conditions.

The proposed stormwater management system has been designed to Provide

- full soakage and treatment for up to the 10- year ARI cc storm event through a combination of on- lot soakage devices, raingardens, and road soakage systems.
- Conveyance of overflows above the 10- year cc event into dry detention basins and a central greenway corridor sized for up to the 100- year cc storm event. Limit post- development peak discharges to no more than 80% of pre- development flows, where applicable.
- Preserve existing flow paths and discharge locations to avoid introducing new hydrological impacts.
- Integrate water- sensitive design elements, including green corridors, baseflow retention, and modular soakage systems such as Cirtex Rain Smart
- Account for external inflows and upstream catchments to ensure downstream impacts are not worsened under post- development conditions
- Support future maintenance, accessibility, and ecological enhancement through features such as maintenance tracks and riparian planting zones.

A flood model has been developed and calibrated using the region's observed rainfall and river data. The model has been used to test a sensitivity scenario 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.

This SMP aligns with the requirements of both the Matamata- Piako District Council and Waikato Regional Council and has been developed in accordance with relevant planning instruments, including MPDC Section 5 Infrastructure Standards and the Waikato Comprehensive Network Discharge Consent (#105063).

Several design aspects of the proposed Stormwater will require further refinement during detailed design stage to ensure compliance and for further value engineering covered under design optimisation section of this SMP.

In conclusion, the proposed stormwater management approach is robust, resilient, and environmentally sensitive. It provides a strong foundation for the ongoing development of the Ashbourne site and offers a balanced integration of flood mitigation, water quality treatment, ecological protection, and long-term sustainability.

13 APPENDICES

APPENDIX A – ENGINEERING PLANS - BOUNDED WITH INFRASTRUCTURE REPORTS

APPENDIX B – STORMWATER CALCULATIONS AND RESULTS

Maven Associates Ltd.	Job Number 289001	Sheet 1	Rev A
Job Title: Station Road, Matamata Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
B	Open Space (Sandy Loam or Silty Loam)	61	10.10	616.10
* from Appendix B		Totals =	10.10	616.10

WQV

CN (weighted) = total product / total area = 616.10 / 10.10 = 61.0

Ia (weighted) = 5 x pervious area / total area = 5 x 10.10 / 10.10 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2) natural channels

Catchment length L = 0.39 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 61.0 / (200- 61.0) = 0.44

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

= 0 1 0.54 1.57 4.90 = 0.580 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.388 hrs

OK
use
0.39 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Maven Associates Ltd.	Job Number 289001	Sheet 2	Rev A
Job Title: Station Road, Matamata Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

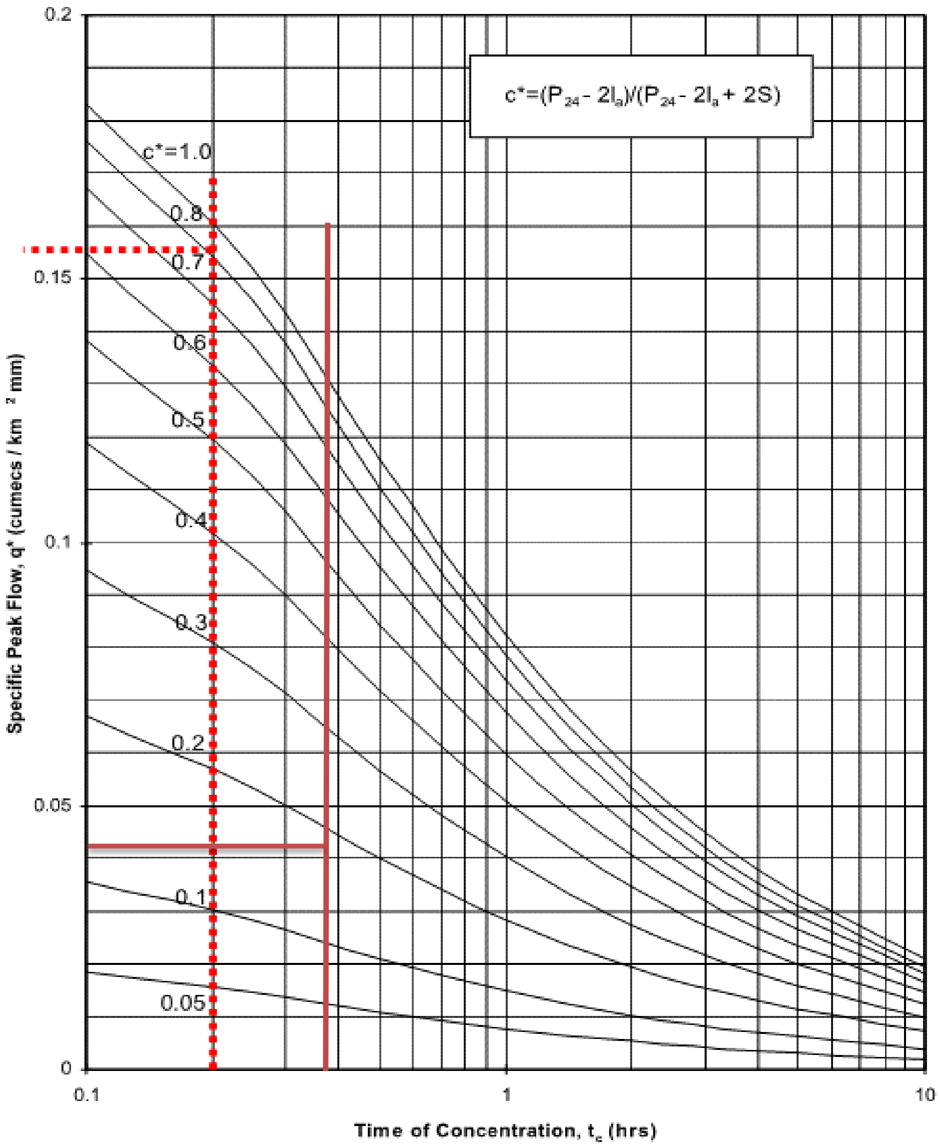
Catchment Area	A=	0.10100	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.39	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3.	Average recurrence interval, ARI	2	(yr)
4.	24 hour rainfall depth, P24	83	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.184	
6.	Specific peak flow rate q*	0.042	
7.	Peak flow rate, q_p=q*A*P_{24}	**0.352**	(m3/s)
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	25.3	
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	2556.16	(m3)

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)
0.2
0.15
0.1
0.05
0
0.1
1
10

Maven Associates Ltd.	Job Number 289001	Sheet 3	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

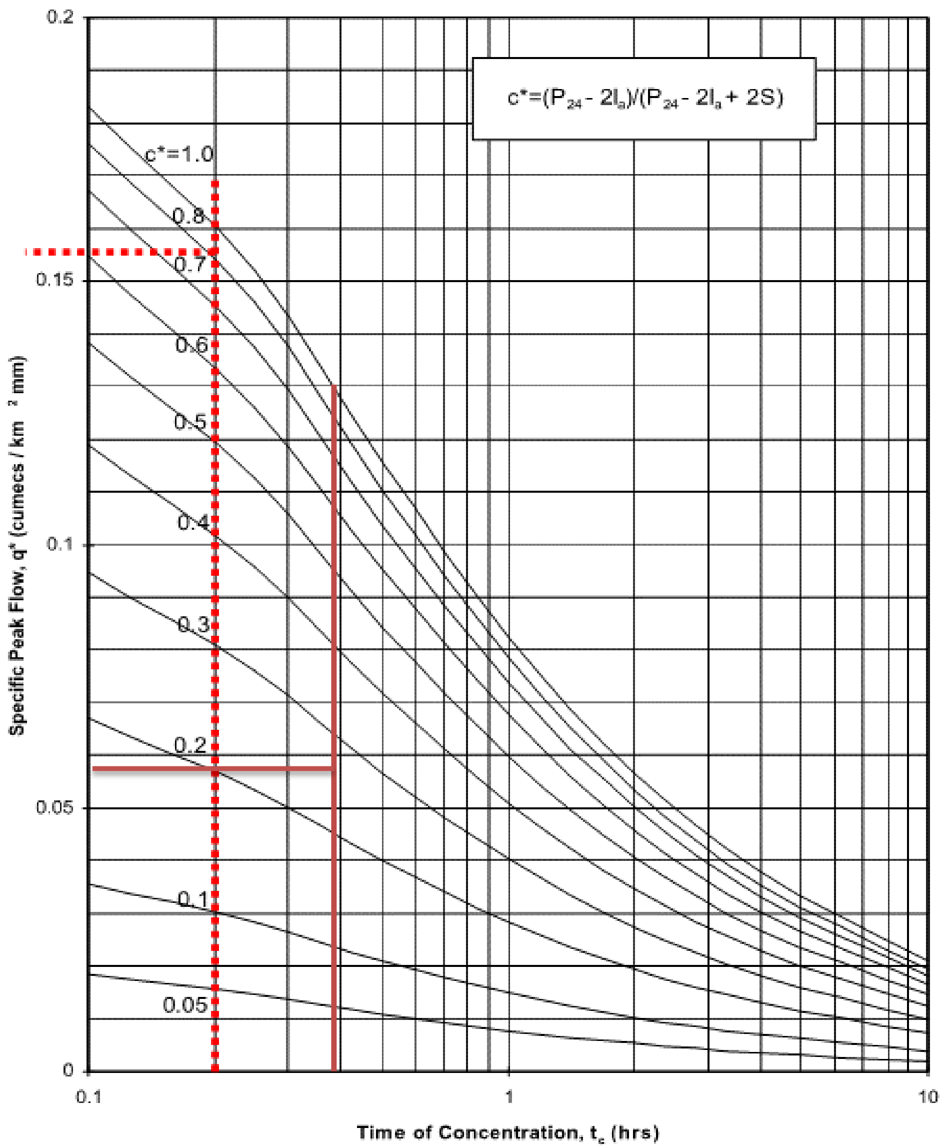
Catchment Area	A=	0.10100	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.39	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3. Average recurrence interval, ARI	10	(yr)
4. 24 hour rainfall depth, P24	128	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.266	
6. Specific peak flow rate q*	0.058	
7. Peak flow rate, q_p=q*A*P_{24}	**0.750**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})\text{+S}$	53.0	
9. Runoff volume, V_{24} = 1000xQ_{24}A	5354.11	(m3)

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.	Job Number 289001	Sheet 4	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

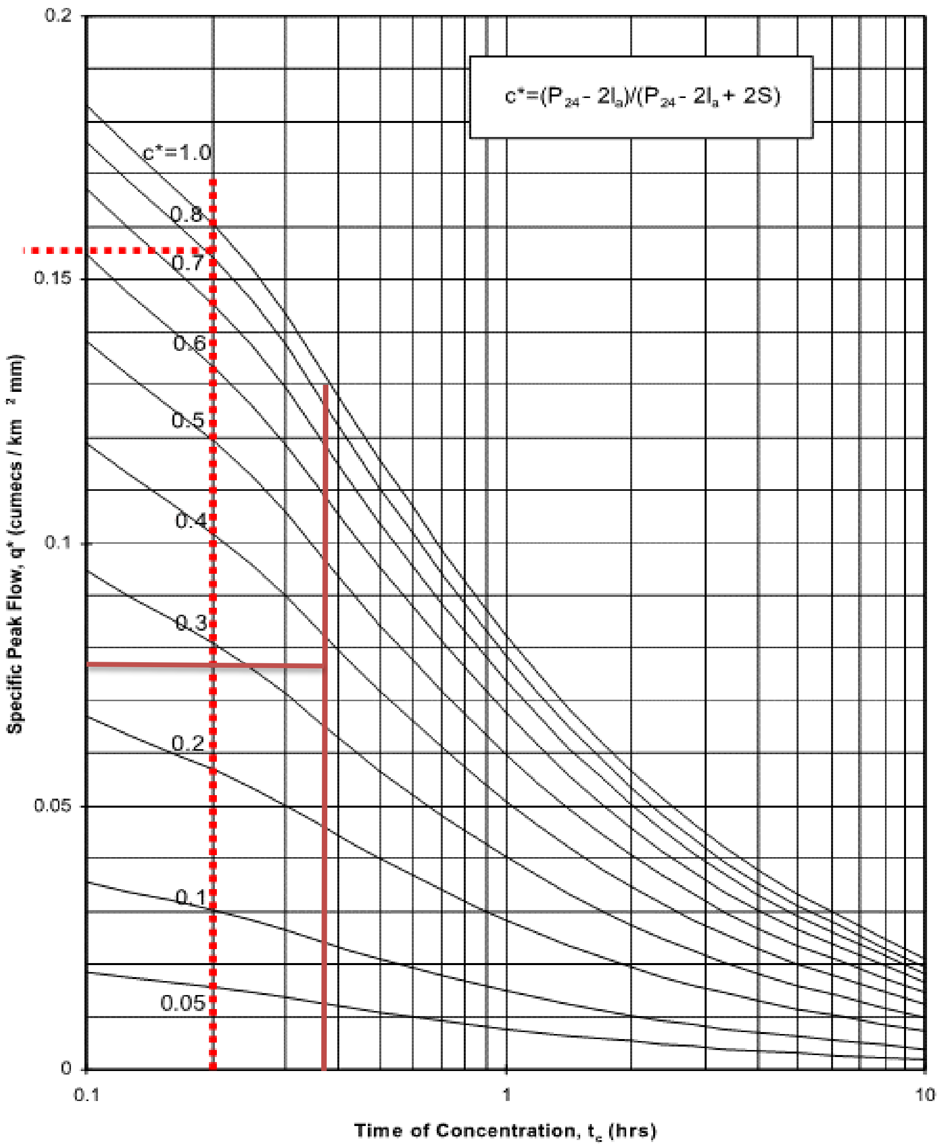
Catchment Area	A=	0.10100	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.39	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

3. Average recurrence interval, ARI	100	(yr)
4. 24 hour rainfall depth, P24	200	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.369	
6. Specific peak flow rate q*	0.078	
7. Peak flow rate, q_p=q*A*P_{24}	**1.576**	(m3/s)
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	106.4	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	10745.93	(m3)

NO CLIMATE CHANGE

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.		Job Number 289001	Sheet 5	Rev A
Job Title Calc Title	Eldonwood, Matamata Post-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
C	Road	98	2.76	270.5
C	Residential District (30% PERVIOUS)	74	2.2	163.5
C	Residential District (70% IMPERVIOUS)	90	5.13	461.7
* from Appendix B		Totals =	10.10	895.7

CN (weighted) = total product / total area = 895.72 / 10.100 = 88.7

Ia (weighted) = 5 x pervious area / total area = 5 x 2.21 / 10.10 = 1.1 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2) piped

Catchment length L = 0.39 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 88.7 / (200- 88.7) = 0.80

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

= 0.1 0.6 0.54 1.13 3.98 = 0.204 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.136 hrs

NO GOOD
use
0.170 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Maven Associates Ltd	Job Number 289001	Sheet 6	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.101	km2(100ha =1km2)
Runoff curve number	CN=	88.7	(from worksheet 1)
Initial abstraction	Ia=	1.1	mm (from worksheet 1)
Time of concentration	tc=	0.170	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 32 mm

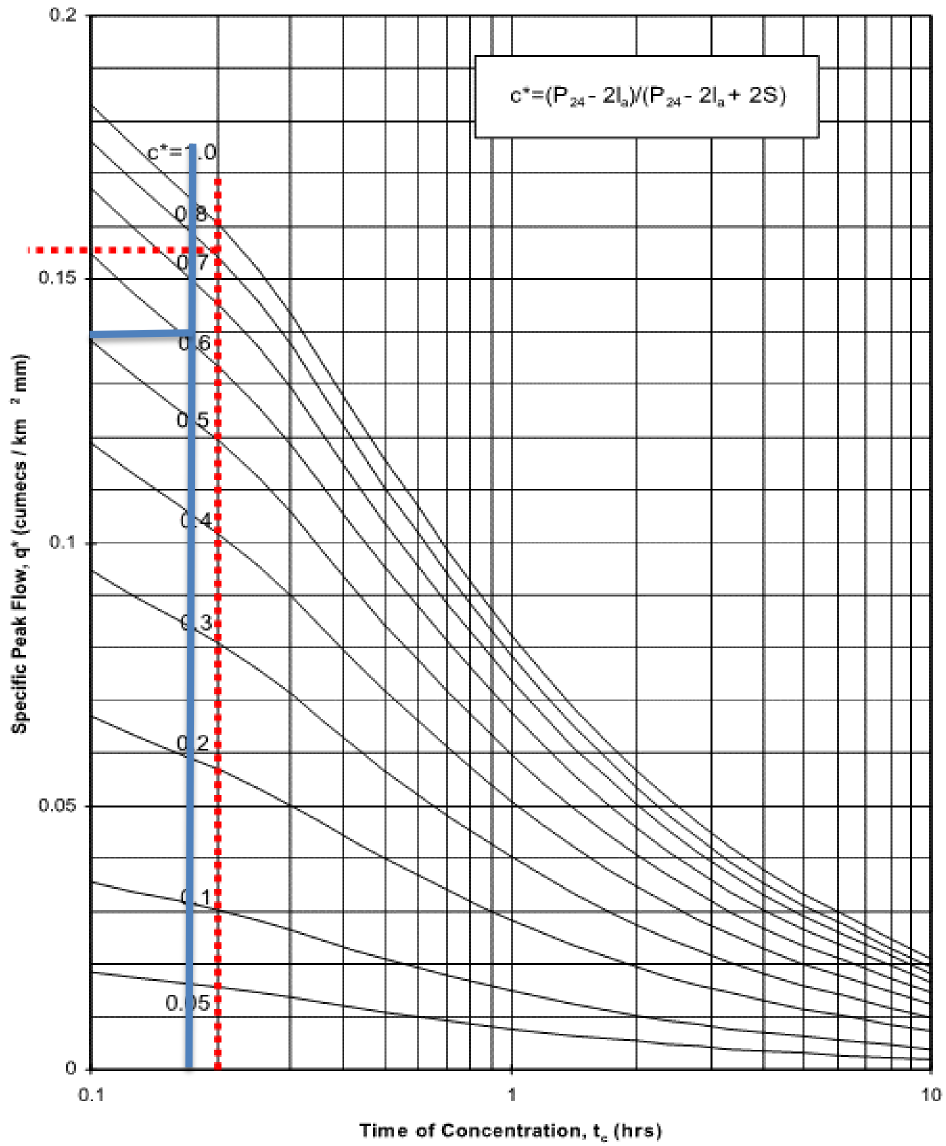
3.	Average recurrence interval, ARI	2	(yr)
4.	24 hour rainfall depth, P24	106	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.616	
6.	Specific peak flow rate q*	0.140	
7.	Peak flow rate, q_p=q*A*P_{24}	**1.499**	
8.	Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	80.1	
9.	Runoff volume, V_{24} = 1000xQ_{24}A	8094.91	(m3)

HEC-HMS Check

Pre-Dev

Pre development run off volume	**2556.16**	(m3)
Post development run off volume	**8094.91**	(m3)
Pre development flow rate	**0.35**	(m3/s)
Post development flow rate	**1.50**	(m3/s)

Worksheet 2: Graphical Peak Flow Rate

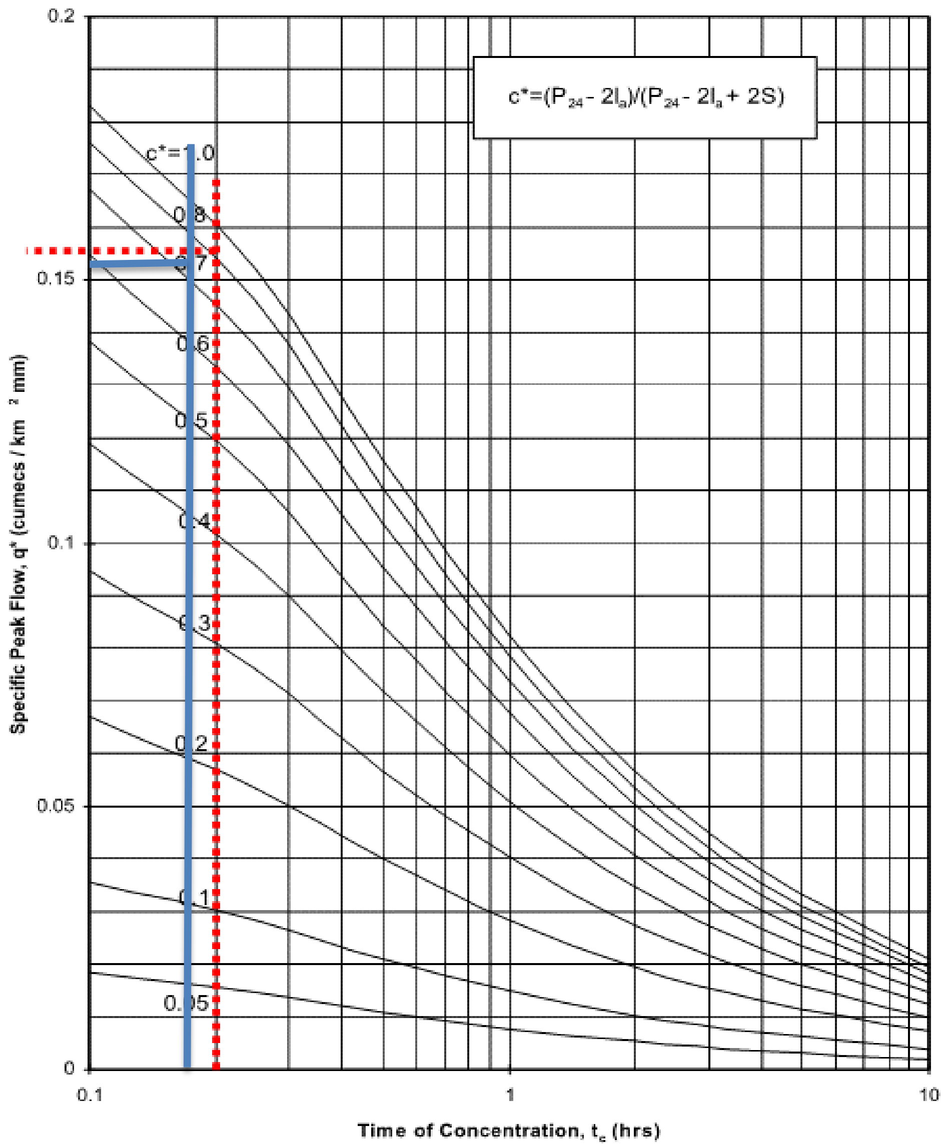

c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 7	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1.	Data			
	Catchment Area	A=	0.101	km2(100ha =1km2)
	Runoff curve number	CN=	88.7	(from worksheet 1)
	Initial abstraction	Ia=	1.1	mm (from worksheet 1)
	Time of concentration	tc=	0.170	hrs (from worksheet 1)
2.	Calculate storage, S =(1000/CN - 10)25.4	=	32	mm

3.	Average recurrence interval, ARI	10	(yr)		
4.	24 hour rainfall depth, P24	167	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.718			
6.	Specific peak flow rate q*	0.153		***HEC-HMS Check***	
7.	Peak flow rate, q_p=q*A*P_{24}	**2.581**			Pre-Dev
8.	Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})$+S	138.8			
9.	Runoff volume, V_{24} = 1000xQ_{24}A	14018.30	(m3)		
	Pre development run off volume	**5354.11**	(m3)		
	Post development run off volume	**14018.30**	(m3)		
	Pre development flow rate	**0.75**	(m3/s)		
	Post development flow rate	**2.58**	(m3/s)		

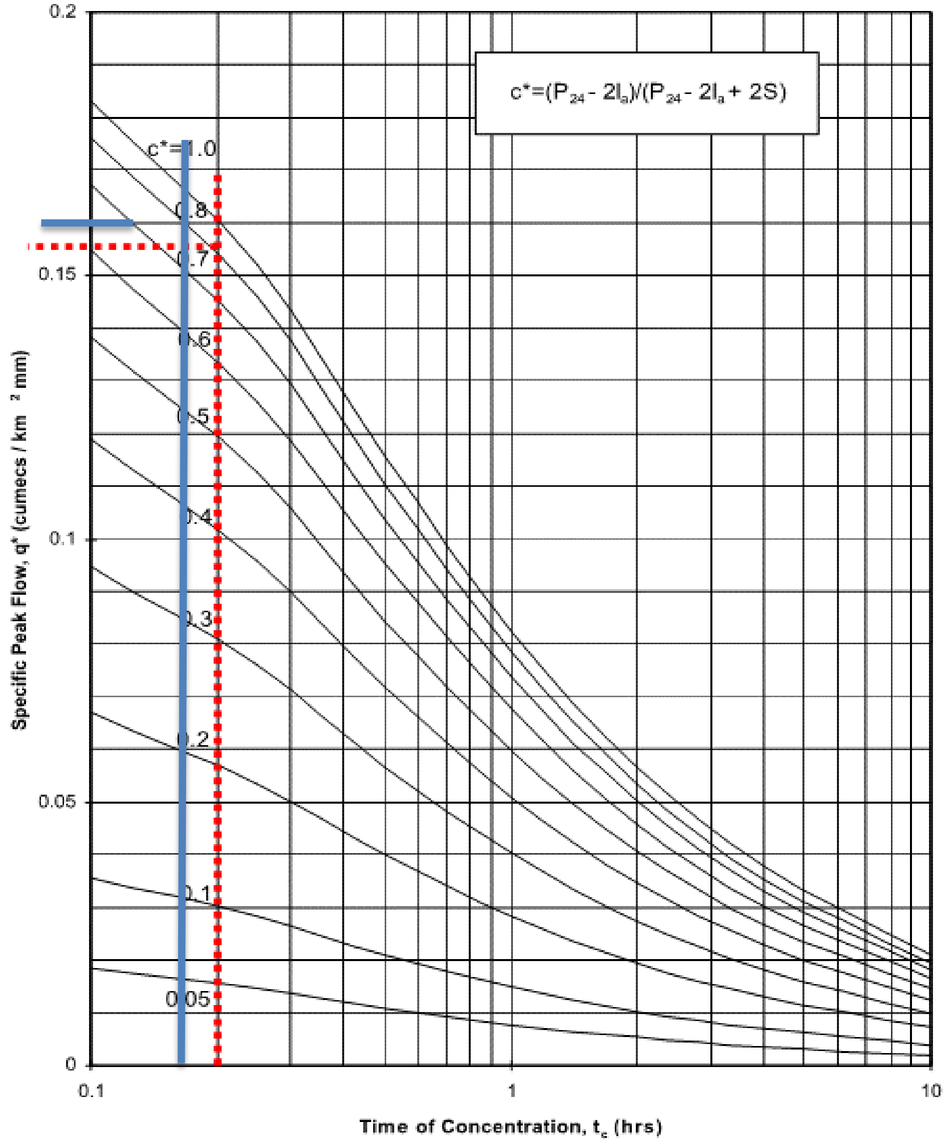
Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
0.2
0.15
0.1
0.05
0
0.1
1
10
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 8	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1.	Data					
	Catchment Area	A=	0.101	km2(100ha =1km2)		
	Runoff curve number	CN=	88.7	(from worksheet 1)		
	Initial abstraction	Ia=	1.1	mm (from worksheet 1)		
	Time of concentration	tc=	0.170	hrs (from worksheet 1)		
2.	Calculate storage, S =(1000/CN - 10)25.4		=	32 mm		
3.	Average recurrence interval, ARI		100	(yr)		
4.	24 hour rainfall depth, P24		265	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S		0.802			
6.	Specific peak flow rate q*		0.160		***HEC-HMS Check***	
7.	Peak flow rate, q_p=q*A*P_{24}		**4.282**		**1.260**	80% Pre
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$		235.0			
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$		23739.41	(m3)		
	Pre development run off volume		**10745.93**	(m3)		
	Post development run off volume		**23739.41**	(m3)		
	Pre development flow rate		**1.58**	(m3/s)		
	Post development flow rate		**4.28**	(m3/s)		
	100yr - 10yr post development		**9721.11**	(m3)		

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
0.2
0.15
0.1
0.05
0
0.1
1
10
Time of Concentration, tc (hrs)

Maven Associates Ltd.	Job Number 289001	Sheet 1	Rev A
Job Title: Station Road, Matamata Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
B	Open Space (Sandy Loam or Silty Loam)	61	19.50	1189.50
* from Appendix B		Totals =	19.50	1189.50

WQV

CN (weighted) = total product / total area = 1189.50 / 19.50 = 61.0

Ia (weighted) = 5 x pervious area / total area = 5 x 19.50 / 19.50 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2) natural channels

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 61.0 / (200- 61.0) = 0.44

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

= 0 1 0.71 1.57 4.90 = 0.770 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.516 hrs

OK
use
0.52 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

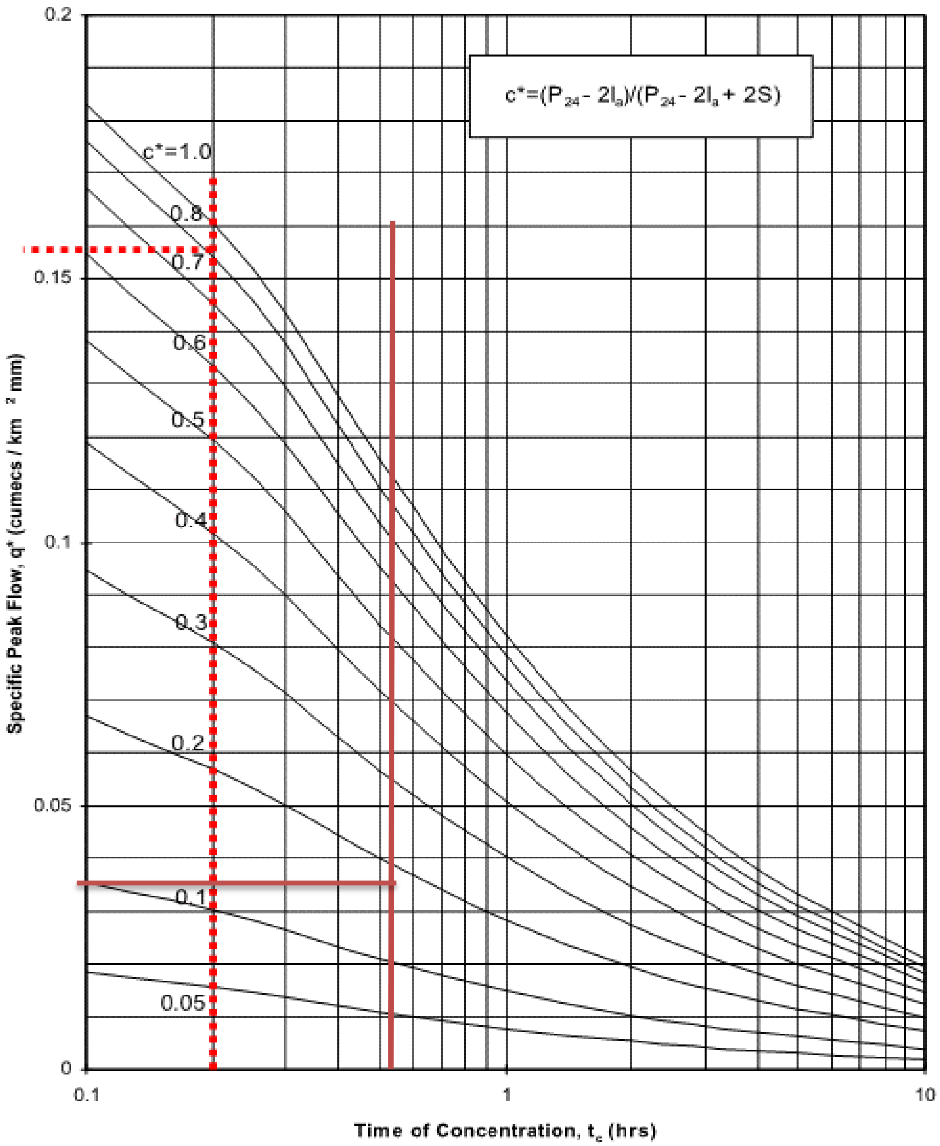
Maven Associates Ltd.	Job Number 289001	Sheet 2	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   - Catchment Area A= 0.19500 km2(100ha =1km2)
   - Runoff curve number CN= 61.0 (from worksheet 1)
   - Initial abstraction Ia= 5.0 mm (from worksheet 1)
   - Time of concentration tc= 0.52 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3.	Average recurrence interval, ARI	2	(yr)
4.	24 hour rainfall depth, P24	83	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.184	
6.	Specific peak flow rate q*	0.036	
7.	Peak flow rate, q_p=q*A*P_{24}	**0.583**	(m3/s)
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	25.3	
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	4935.16	(m3)

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)
0.2
0.15
0.1
0.05
0
0.1
1
10

Maven Associates Ltd.		Job Number 289001	Sheet 3	Rev A
Job Title Calc Title	Station Road, Matamata Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

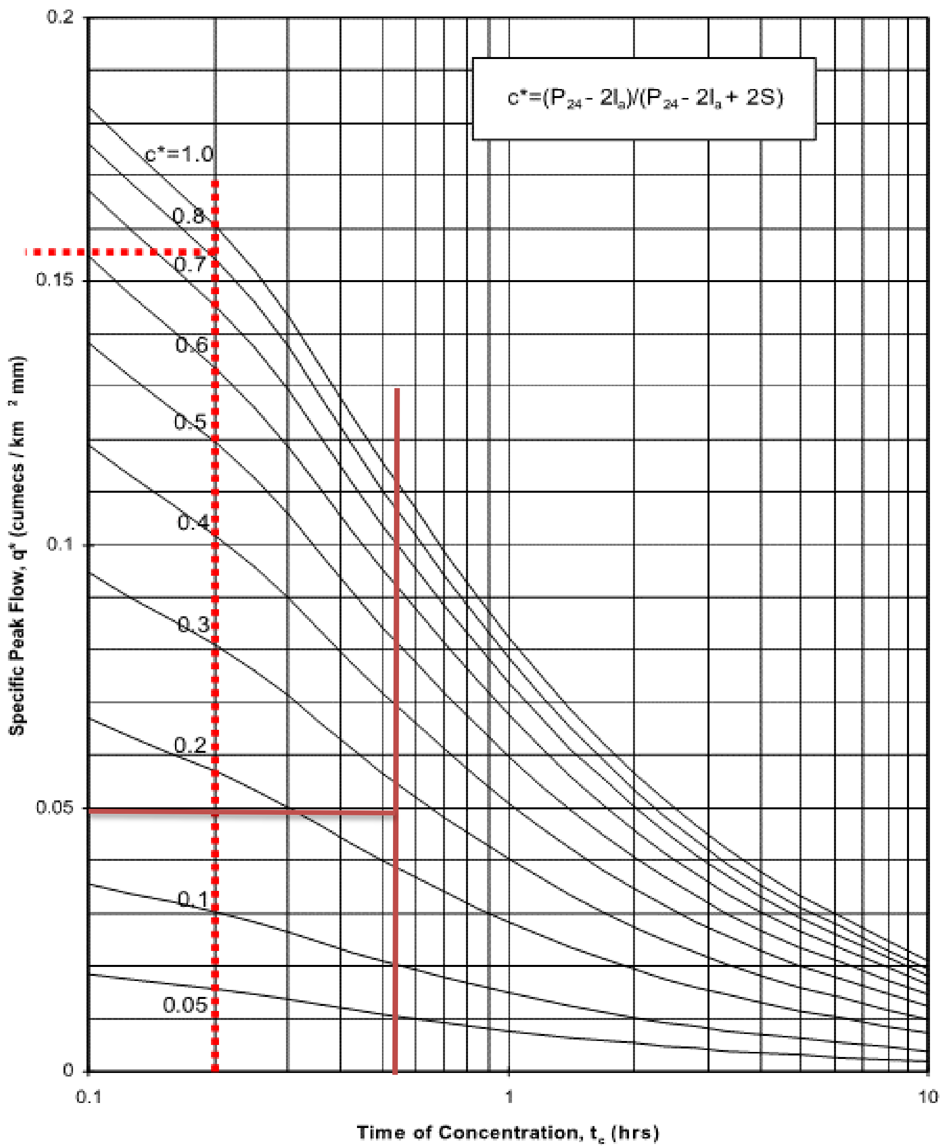
Catchment Area	A=	0.19500	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.52	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

3. Average recurrence interval, ARI	10	(yr)
4. 24 hour rainfall depth, P24	128	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.266	
6. Specific peak flow rate q*	0.049	
7. Peak flow rate, q_p=q*A*P_{24}	**1.223**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	53.0	
9. Runoff volume, V_{24} = 1000xQ_{24}A	10337.15	(m3)

NO CLIMATE CHANGE

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.		Job Number 289001	Sheet 4	Rev A
Job Title Calc Title	Station Road, Matamata Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   Catchment Area A= 0.19500 km2(100ha =1km2)

   Runoff curve number CN= 61.0 (from worksheet 1)

   Initial abstraction Ia= 5.0 mm (from worksheet 1)

   Time of concentration tc= 0.52 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

3. Average recurrence interval, ARI 100 (yr)

NO CLIMATE CHANGE

4. 24 hour rainfall depth, P24 200 (mm)

5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S 0.369

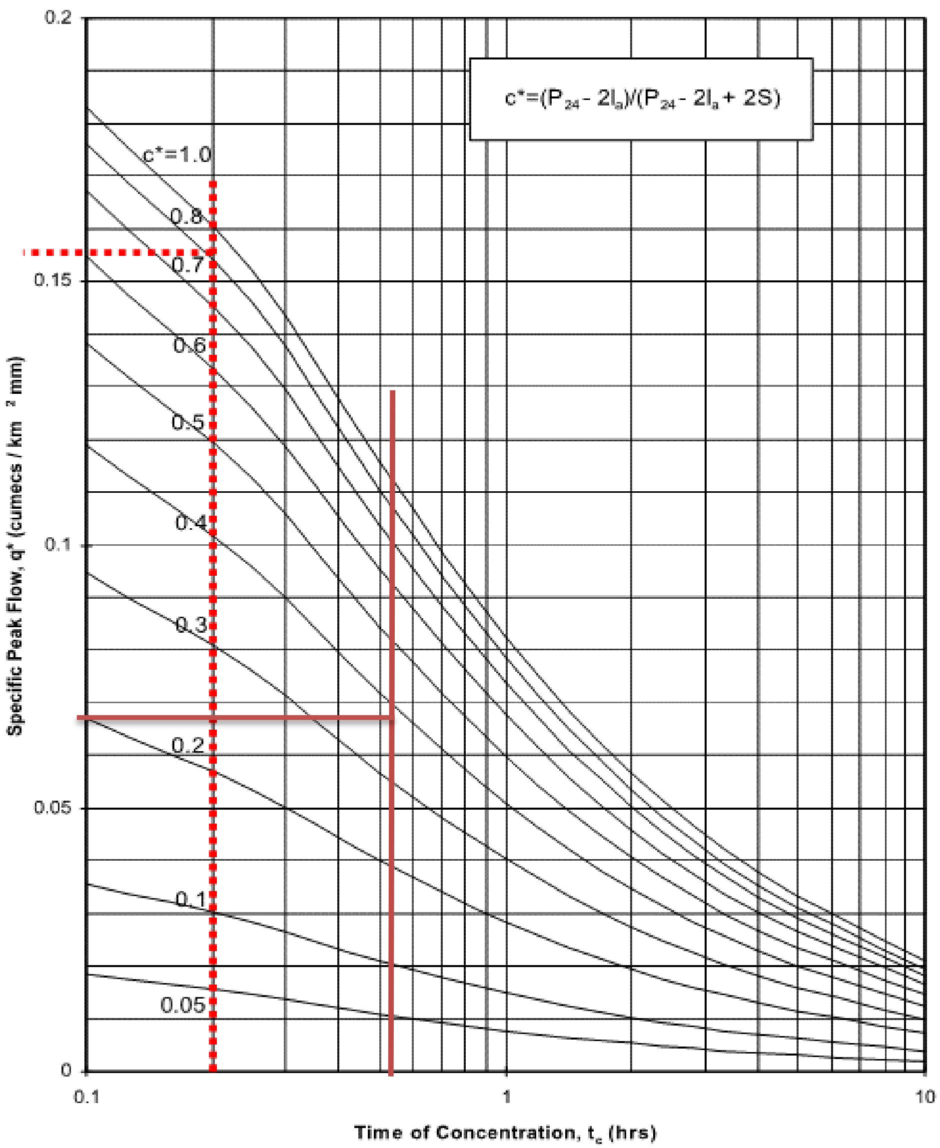
6. Specific peak flow rate q* 0.068

7. Peak flow rate, q_p=q*A*P_{24} **2.652** (m3/s)

8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ 106.4

9. Runoff volume, $V_{24} = 1000xQ_{24}A$ 20747.09 (m3)

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

	Maven Associates Ltd.	Job Number 289001	Sheet 5	Rev A
Job Title Calc Title	Eldonwood, Matamata Post-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
C	Road	98	5.96	583.6
C	Residential District (30% PERVIOUS)	74	4.1	300.8
C	Residential District (70% IMPERVIOUS)	90	9.48	853.6
* from Appendix B		Totals =	19.50	1738.0

CN (weighted) = total product / total area = 1738.02 / 19.505 = 89.1

Ia (weighted) = 5 x pervious area / total area = 5 x 4.06 / 19.50 = 1.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2) piped

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.1 / (200- 89.1) = 0.80

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

= 0.1 0.6 0.71 1.13 3.98 = 0.269 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.180 hrs

OK
use
0.180 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Maven Associates Ltd	Job Number 289001	Sheet 6	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1. Data

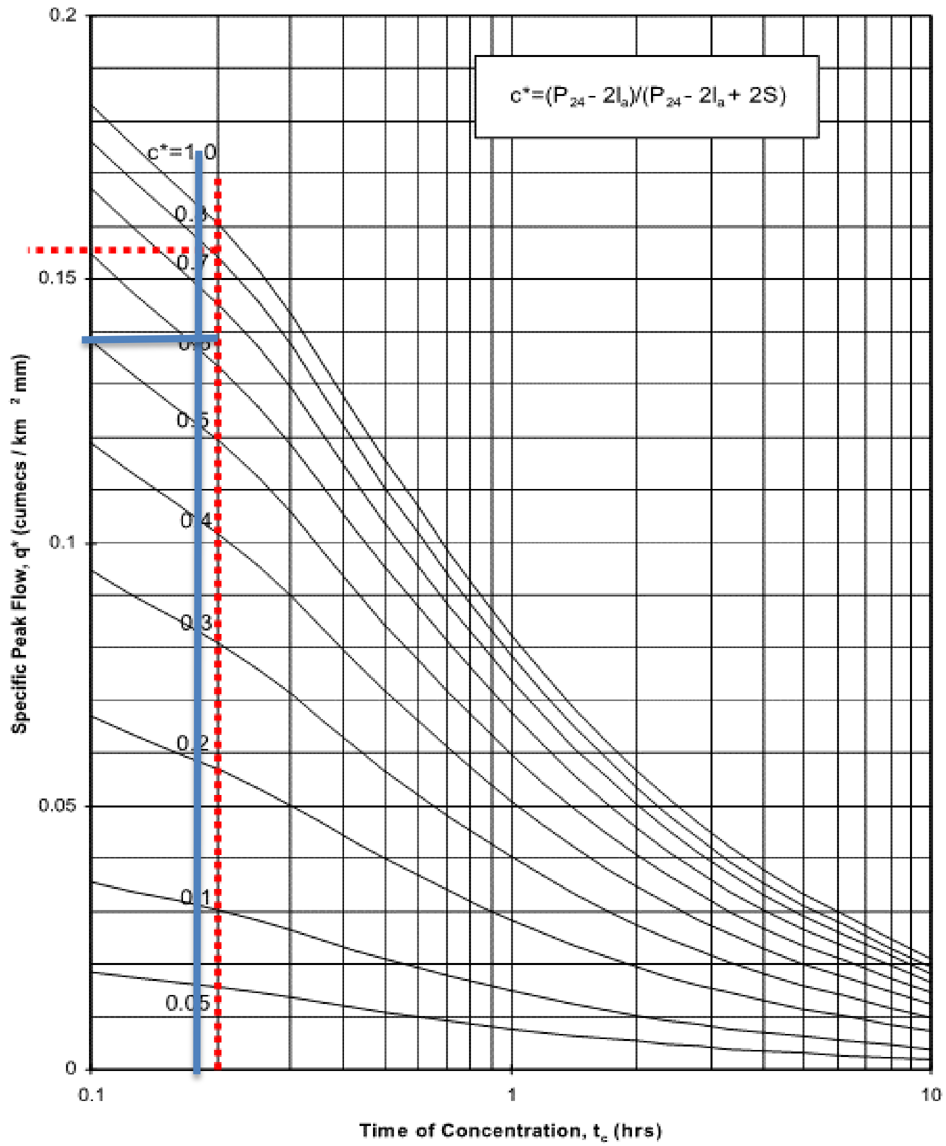
	Catchment Area	A=	0.195	km2(100ha =1km2)
	Runoff curve number	CN=	89.1	(from worksheet 1)
	Initial abstraction	Ia=	1.0	mm (from worksheet 1)
	Time of concentration	tc=	0.180	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 31 mm

3.	Average recurrence interval, ARI	2	(yr)	
4.	24 hour rainfall depth, P24	106	(mm)	
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.626		
6.	Specific peak flow rate q*	0.139		***HEC-HMS Check***
7.	Peak flow rate, q_p=q*A*P_{24}	**2.874**		Pre-Dev
8.	Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	81.0		
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	15798.35	(m3)	

Pre development run off volume	**4935.16**	(m3)
Post development run off volume	**15798.35**	(m3)
Pre development flow rate	**0.58**	(m3/s)
Post development flow rate	**2.87**	(m3/s)

Worksheet 2: Graphical Peak Flow Rate



F:\MAVEN HAMILTON\6. Projects\289001 - Station Road\6. Engineering\3. Calculations\C400\RESIDENTIAL\C400-ASHBOURNE - DRY BASIN - B

Maven Associates Ltd	Job Number 289001	Sheet 7	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

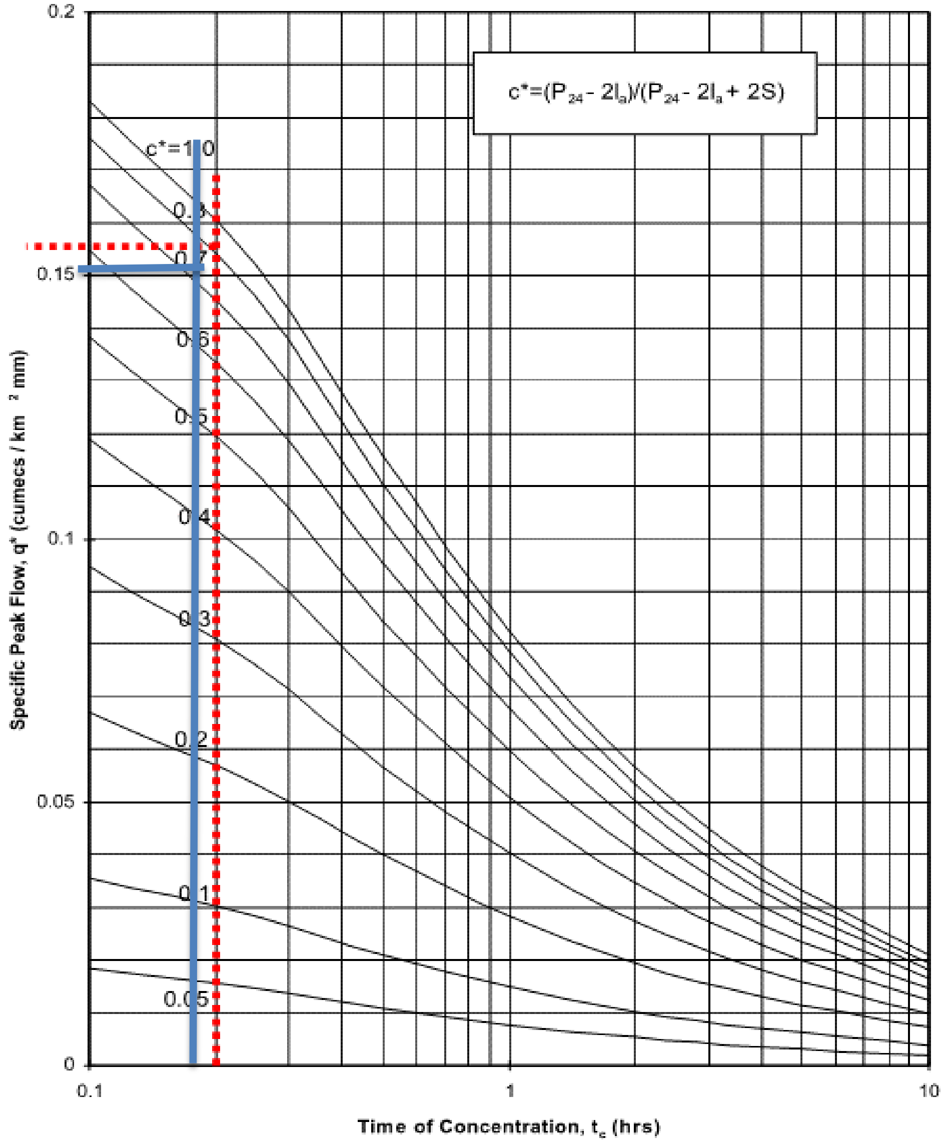
1. Data

Catchment Area	A=	0.195	km2(100ha =1km2)
Runoff curve number	CN=	89.1	(from worksheet 1)
Initial abstraction	Ia=	1.0	mm (from worksheet 1)
Time of concentration	tc=	0.180	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 31 mm

3.	Average recurrence interval, ARI	10	(yr)	
4.	24 hour rainfall depth, P24	167	(mm)	
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.726		
6.	Specific peak flow rate q*	0.151		***HEC-HMS Check***
7.	Peak flow rate, q_p=q*A*P_{24}	**4.918**		Pre-Dev
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	139.8		
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	27268.12	(m3)	
	Pre development run off volume	**10337.15**	(m3)	
	Post development run off volume	**27268.12**	(m3)	
	Pre development flow rate	**1.22**	(m3/s)	
	Post development flow rate	**4.92**	(m3/s)	

Worksheet 2: Graphical Peak Flow Rate

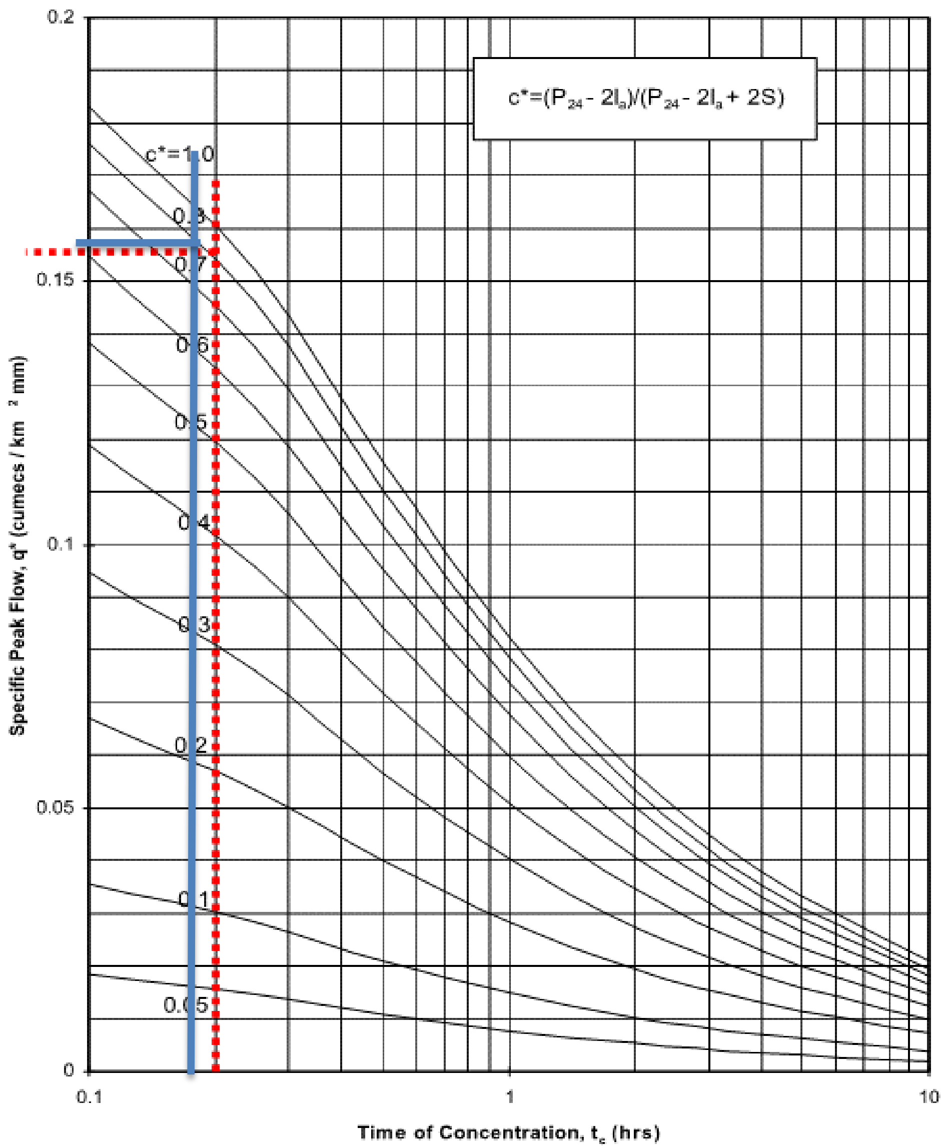


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km2 mm)
0.2
0.15
0.1
0.05
0
0.1
1
10
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 8	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1.	Data						
	Catchment Area	A=	0.195	km2(100ha =1km2)			
	Runoff curve number	CN=	89.1	(from worksheet 1)			
	Initial abstraction	Ia=	1.0	mm (from worksheet 1)			
	Time of concentration	tc=	0.180	hrs (from worksheet 1)			
2.	Calculate storage, S =(1000/CN - 10)25.4		=	31 mm			
3.	Average recurrence interval, ARI			100	(yr)		
4.	24 hour rainfall depth, P24			265	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S			0.809			
6.	Specific peak flow rate q*			0.158		***HEC-HMS Check***	
7.	Peak flow rate, q_p=q*A*P_{24}			**8.167**		**2.122**	80% Pre
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$			236.2			
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$			46065.59	(m3)		
	Pre development run off volume			**20747.09**	(m3)		
	Post development run off volume			**46065.59**	(m3)		
	Pre development flow rate			**2.65**	(m3/s)		
	Post development flow rate			**8.17**	(m3/s)		
	100yr - 10yr post development			**18797.47**	(m3)		

Worksheet 2: Graphical Peak Flow Rate



F:\MAVEN HAMILTON\6. Projects\289001 - Station Road\6. Engineering\3. Calculations\C400\RESIDENTIAL\C400-ASHBOURNE - DRY BASIN - B

Maven Associates Ltd.	Job Number 289001	Sheet 1	Rev A
Job Title: Station Road, Matamata Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
B	Open Space (Sandy Loam or Silty Loam)	61	4.33	264.41
* from Appendix B		Totals =	4.33	264.41

WQV

CN (weighted) = total product / total area = 264.41 / 4.33 = 61.0

Ia (weighted) = 5 x pervious area / total area = 5 x 4.33 / 4.33 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2) natural channels

Catchment length L = 0.34 km (along drainage path)

Catchment Slope Sc= 0.001 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 61.0 / (200- 61.0) = 0.44

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

= 0 1 0.49 1.57 7.94 = 0.858 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.575 hrs

OK
use
0.58 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

MAVEN	**Maven Associates Ltd.**	**Job Number** **289001**	**Sheet** **2**	**Rev** **A**
Job Title **Calc Title**	**Station Road, Matamata** **Pre-development**	**Author** **MKS**	**Date** **13/03/2025**	**Checked** **DJM**

1. Data

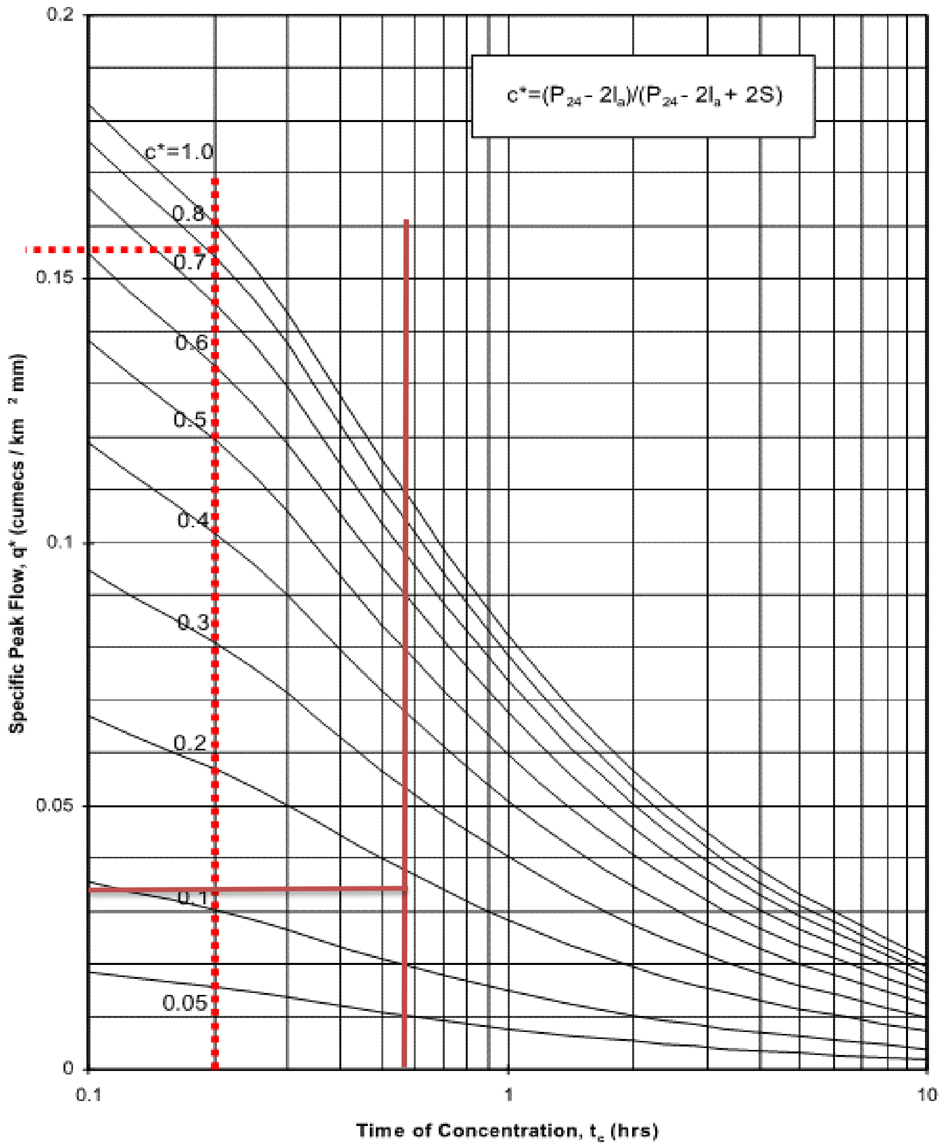
Catchment Area	A=	0.04335	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.58	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3. Average recurrence interval, ARI	2	(yr)
4. 24 hour rainfall depth, P24	83	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.184	
6. Specific peak flow rate q*	0.035	
7. Peak flow rate, q_p=q*A*P_{24}	**0.126**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}$-Ia$)^2$/(P_{24}-Ia)+S	25.3	
9. Runoff volume, V_{24} = 1000xQ_{24}A	1097.02	(m3)

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.	Job Number 289001	Sheet 3	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

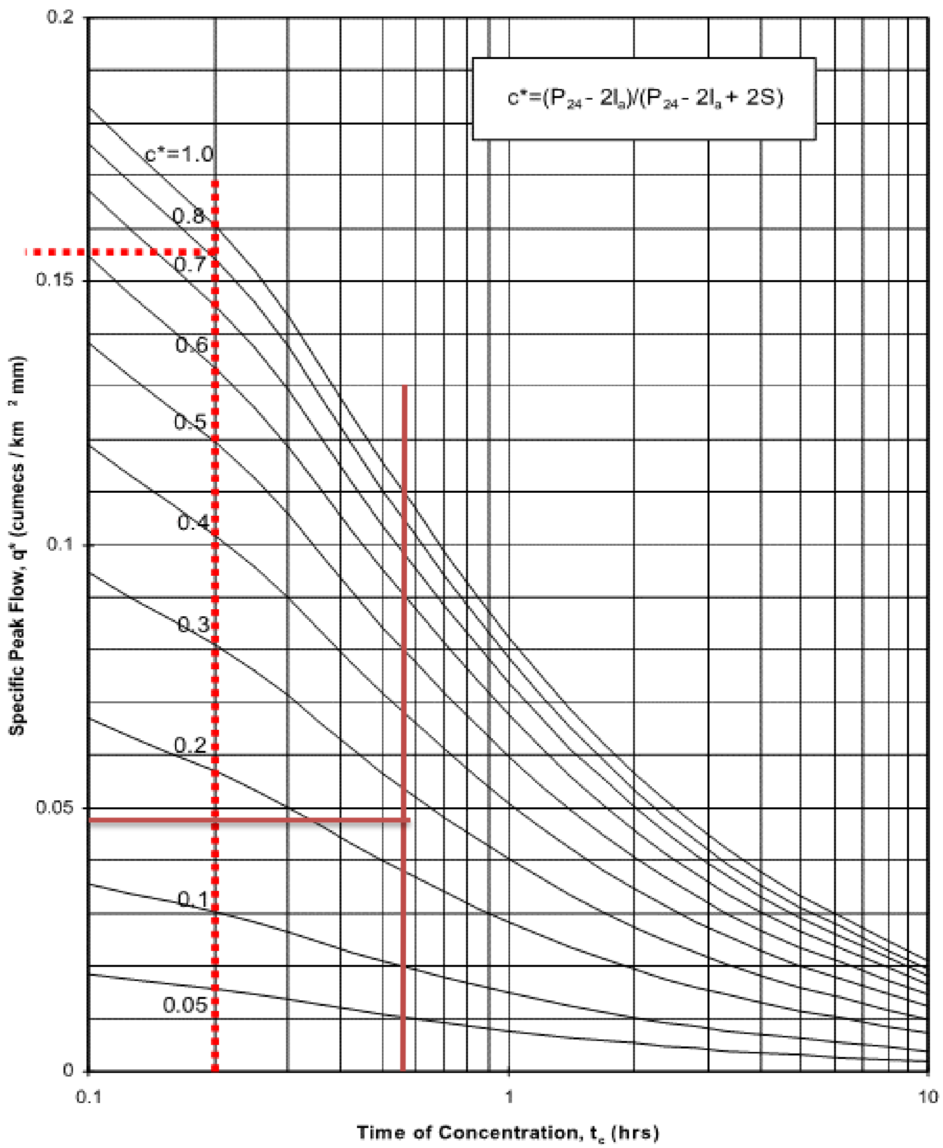
Catchment Area	A=	0.04335	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.58	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3. Average recurrence interval, ARI	10	(yr)
4. 24 hour rainfall depth, P24	128	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.266	
6. Specific peak flow rate q*	0.048	
7. Peak flow rate, q_p=q*A*P_{24}	**0.266**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	53.0	
9. Runoff volume, V_{24} = 1000xQ_{24}A	2297.82	(m3)

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)
0.2
0.15
0.1
0.05
0
0.1
1
10

Maven Associates Ltd.		Job Number 289001	Sheet 4	Rev A
Job Title Calc Title	Station Road, Matamata Pre-development	Author MKS	Date 13/03/2025	Checked DJM

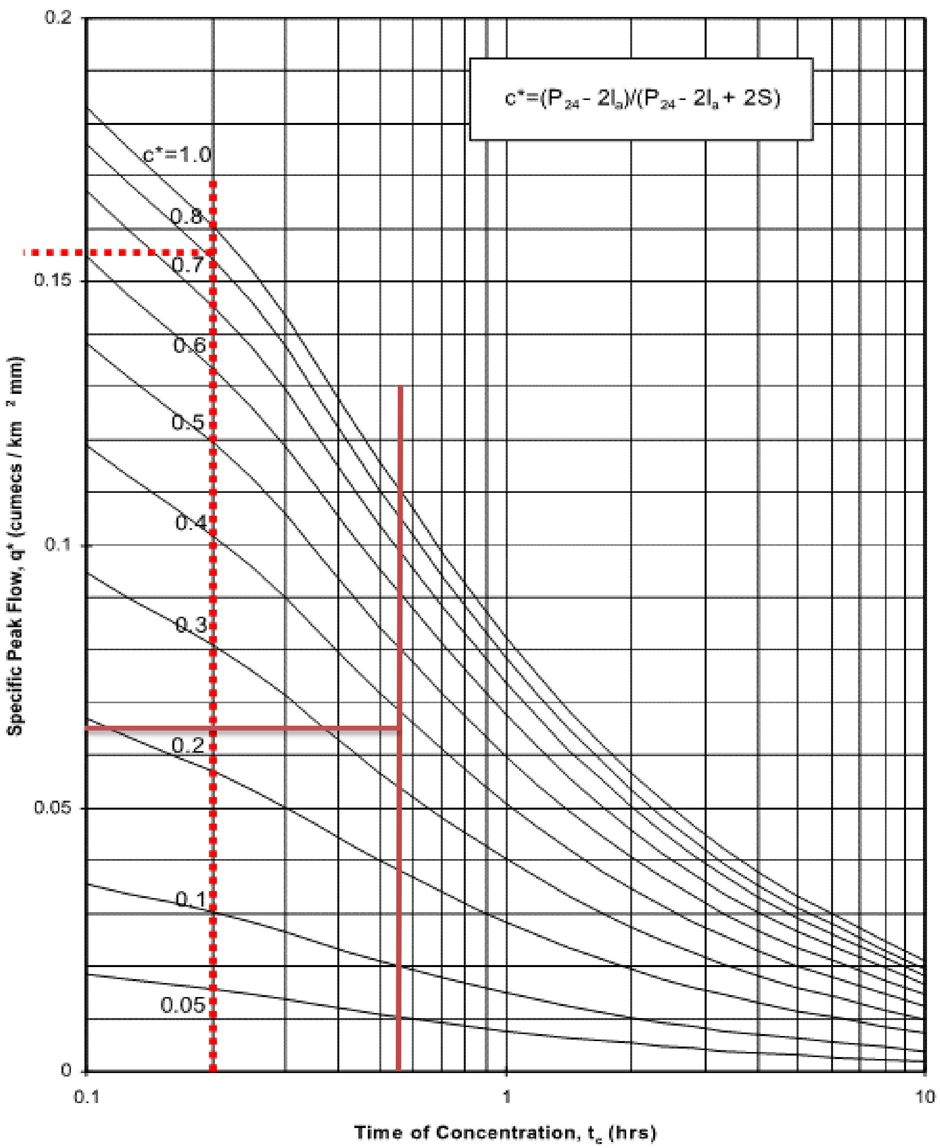
1. Data

Catchment Area	A=	0.04335	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.58	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

3. Average recurrence interval, ARI	100	(yr)	NO CLIMATE CHANGE
4. 24 hour rainfall depth, P24	200	(mm)	
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.369		
6. Specific peak flow rate q*	0.066		
7. Peak flow rate, q_p=q*A*P_{24}	**0.572**	(m3/s)	
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	106.4		
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	4611.81	(m3)	

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.		Job Number 289001	Sheet 5	Rev A
Job Title Calc Title	Eldonwood, Matamata Post-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
C	Road	98	1.07	105.3
C	Residential District (30% PERVIOUS)	74	0.98	72.4
C	Residential District (70% IMPERVIOUS)	90	2.28	205.4
* from Appendix B		Totals =	4.33	383.0

CN (weighted) = total product / total area = 383.05 / 4.335 = 88.4

Ia (weighted) = 5 x pervious area / total area = 5 x 0.98 / 4.33 = 1.1 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2) piped

Catchment length L = 0.34 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 88.4 / (200- 88.4) = 0.79

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

= 0.1 0.6 0.49 1.14 4.90 = 0.230 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.154 hrs

NO GOOD
use
0.170 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Maven Associates Ltd	Job Number 289001	Sheet 6	Rev A
Job Title Station Road, Matamata Calc Title Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

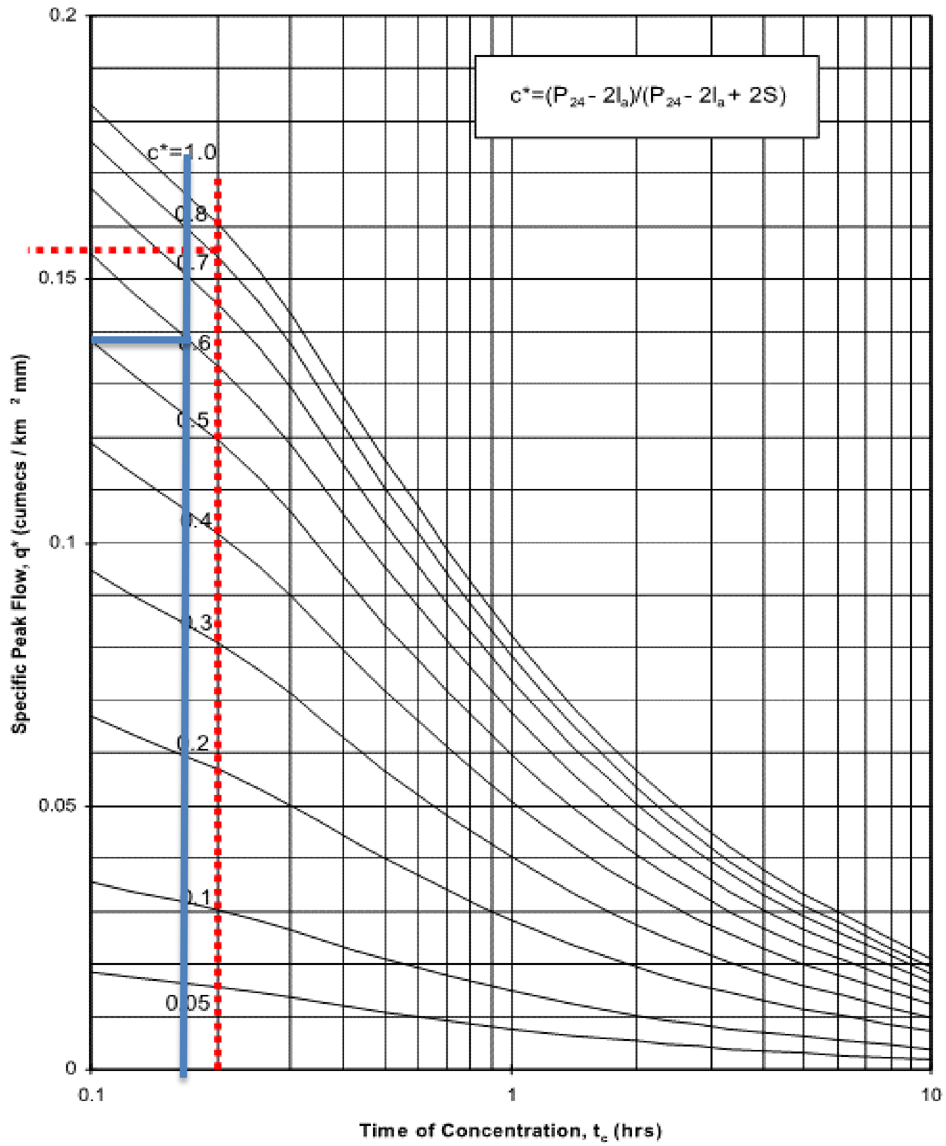
1. Data

Catchment Area	A=	0.043	km2(100ha =1km2)
Runoff curve number	CN=	88.4	(from worksheet 1)
Initial abstraction	Ia=	1.1	mm (from worksheet 1)
Time of concentration	tc=	0.170	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 33 mm

3.	Average recurrence interval, ARI	2	(yr)		
4.	24 hour rainfall depth, P24	106	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.608			
6.	Specific peak flow rate q*	0.139		***HEC-HMS Check***	
7.	Peak flow rate, q_p=q*A*P_{24}	**0.639**			Pre-Dev
8.	Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	79.5			
9.	Runoff volume, V_{24} = 1000xQ_{24}A	3447.06	(m3)		
	Pre development run off volume	**1097.02**	(m3)		
	Post development run off volume	**3447.06**	(m3)		
	Pre development flow rate	**0.13**	(m3/s)		
	Post development flow rate	**0.64**	(m3/s)		

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
0.2
0.15
0.1
0.05
0
0.1
1
10
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 7	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.043	km2(100ha =1km2)
Runoff curve number	CN=	88.4	(from worksheet 1)
Initial abstraction	Ia=	1.1	mm (from worksheet 1)
Time of concentration	tc=	0.170	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 33 mm

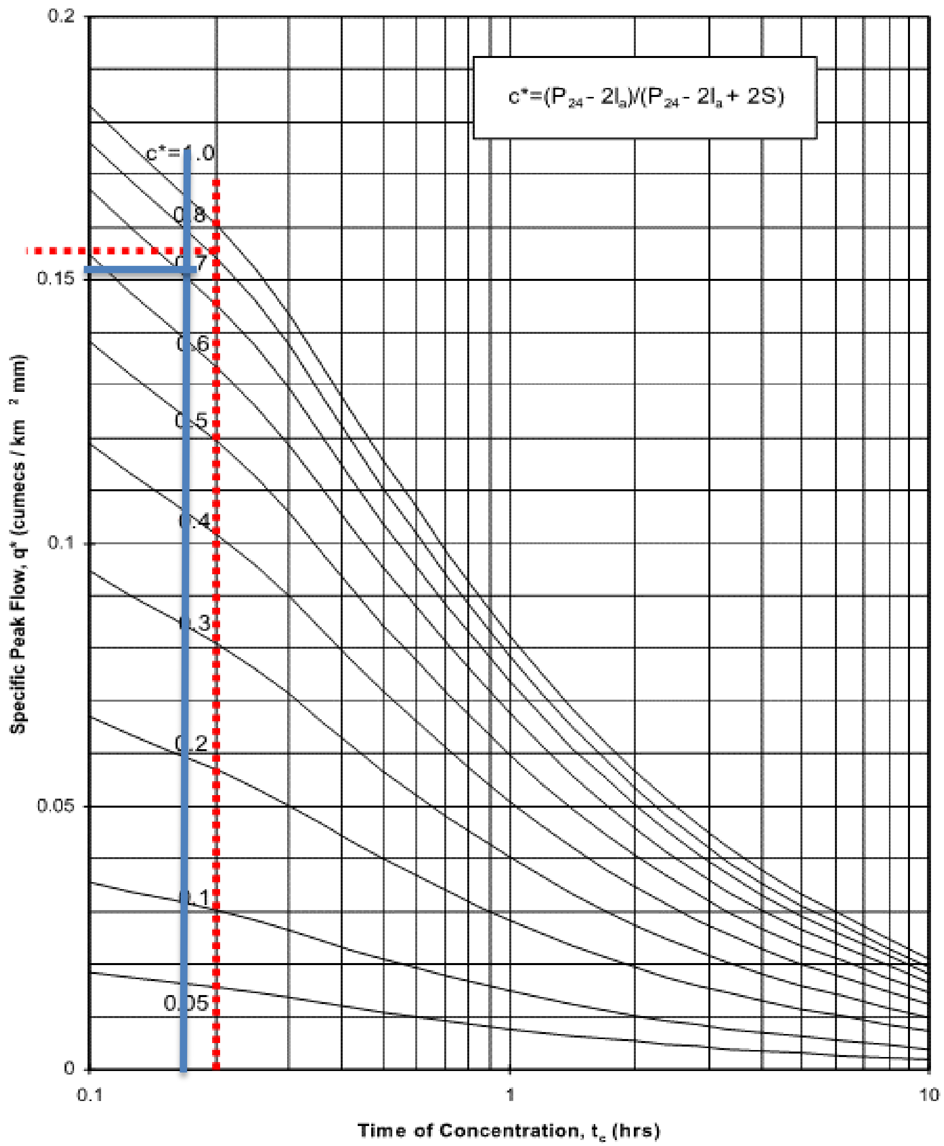
3.	Average recurrence interval, ARI	10	(yr)
4.	24 hour rainfall depth, P24	167	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.711	
6.	Specific peak flow rate q*	0.152	
7.	Peak flow rate, q_p=q*A*P_{24}	**1.100**	
8.	Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	138.1	
9.	Runoff volume, $V_{24} = 1000 \times Q_{24}A$	5983.93	(m3)

HEC-HMS Check

	Pre-Dev

Pre development run off volume	**2297.82**	(m3)
Post development run off volume	**5983.93**	(m3)
Pre development flow rate	**0.27**	(m3/s)
Post development flow rate	**1.10**	(m3/s)

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 8	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

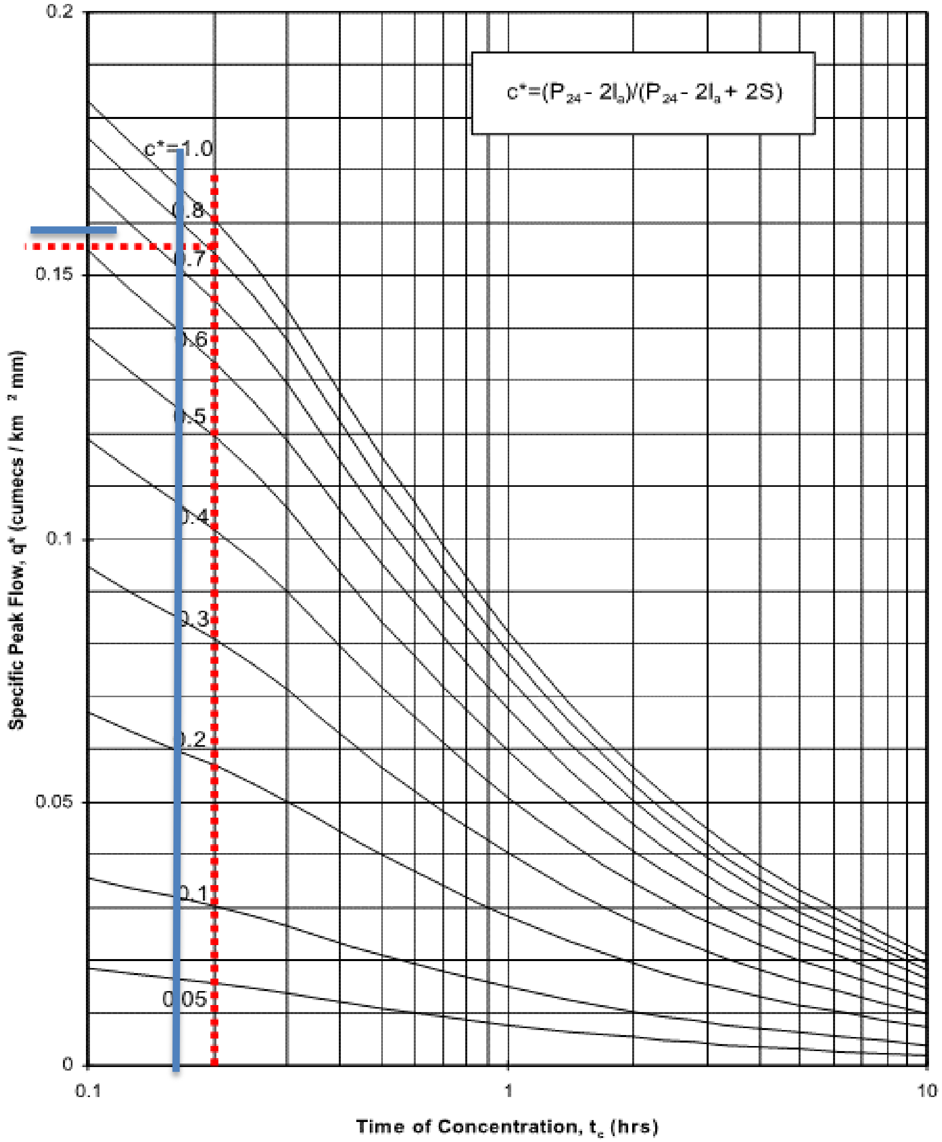
1. Data

Catchment Area	A=	0.043	km2(100ha =1km2)
Runoff curve number	CN=	88.4	(from worksheet 1)
Initial abstraction	Ia=	1.1	mm (from worksheet 1)
Time of concentration	tc=	0.170	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 33 mm

				HEC-HMS Check	
3.	Average recurrence interval, ARI	100	(yr)		
4.	24 hour rainfall depth, P24	265	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.797			
6.	Specific peak flow rate q*	0.159			
7.	Peak flow rate, q_p=q*A*P_{24}	**1.826**		**0.458**	80% Pre
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	234.2			
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	10151.65	(m3)		
	Pre development run off volume	**4611.81**	(m3)		
	Post development run off volume	**10151.65**	(m3)		
	Pre development flow rate	**0.57**	(m3/s)		
	Post development flow rate	**1.83**	(m3/s)		
	100yr - 10yr post development	**4167.72**	(m3)		

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km² mm)
Time of Concentration, tc (hrs)
0.2
0.15
0.1
0.05
0
0.1
1
10

Maven Associates Ltd.		Job Number 289001	Sheet 1	Rev A
Job Title Calc Title	Station Road, Matamata Pre-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
B	Open Space (Sandy Loam or Silty Loam)	61	8.03	489.83
* from Appendix B		Totals =	8.03	489.83

WQV

CN (weighted) = total product / total area = 489.83 / 8.03 = 61.0

Ia (weighted) = 5 x pervious area / total area = 5 x 8.03 / 8.03 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2) natural channels

Catchment length L = 0.62 km (along drainage path)

Catchment Slope Sc= 0.001 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 61.0 / 200- 61.0 = 0.44

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

= 0 1 0.73 1.57 7.94 = 1.276 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.855 hrs

OK
use
0.85 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

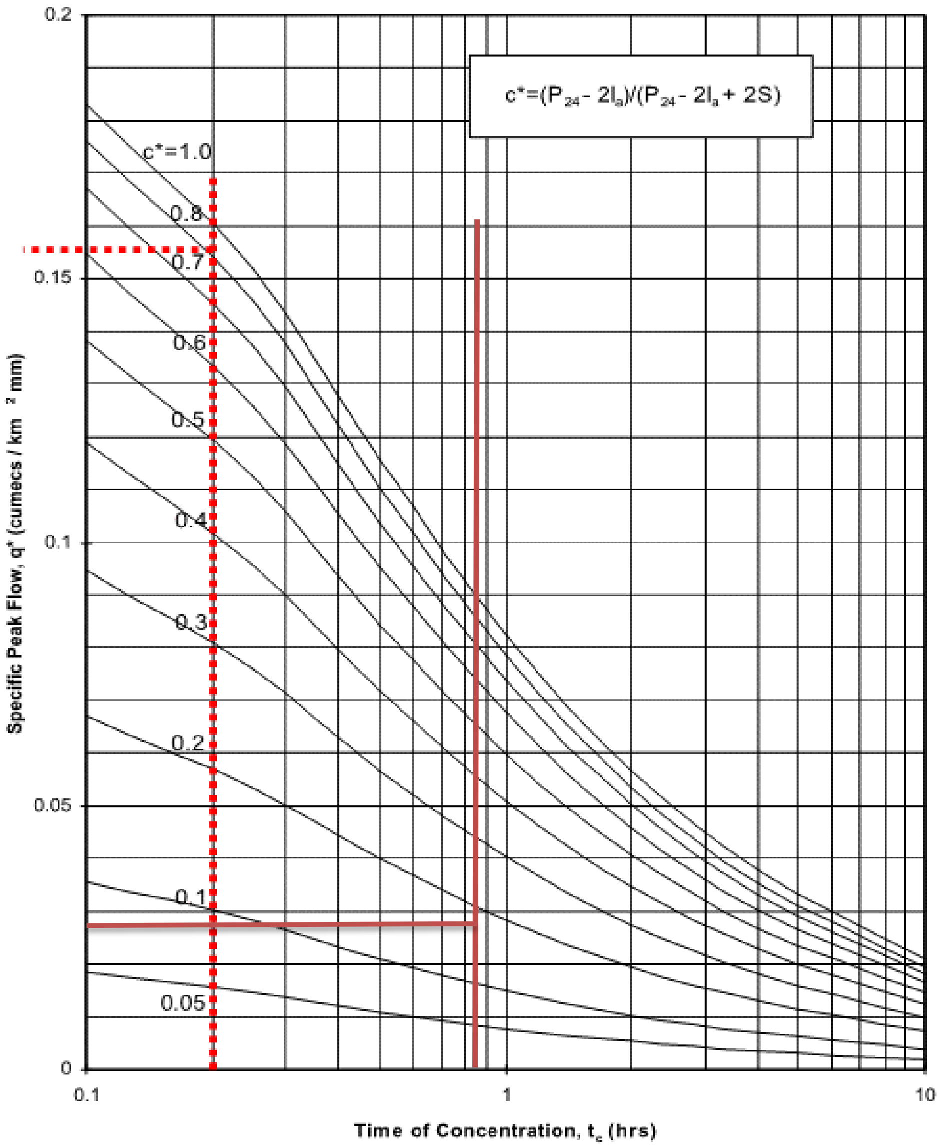
Maven Associates Ltd.	Job Number 289001	Sheet 2	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   - Catchment Area — A= 0.08030 km2(100ha =1km2)
   - Runoff curve number — CN= 61.0 (from worksheet 1)
   - Initial abstraction — Ia= 5.0 mm (from worksheet 1)
   - Time of concentration — tc= 0.85 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3. Average recurrence interval, ARI	2	(yr)
4. 24 hour rainfall depth, P24	83	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.184	
6. Specific peak flow rate q*	0.028	
7. Peak flow rate, q_p=q*A*P_{24}	**0.187**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	25.3	
9. Runoff volume, V_{24} = 1000xQ_{24}A	2032.27	(m3)

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)
0.2
0.15
0.1
0.05
0
0.1
1
10

Maven Associates Ltd.	Job Number 289001	Sheet 3	Rev A
Job Title / Calc Title — Station Road, Matamata / Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   Catchment Area A= 0.08030 km2(100ha =1km2)

   Runoff curve number CN= 61.0 (from worksheet 1)

   Initial abstraction Ia= 5.0 mm (from worksheet 1)

   Time of concentration tc= 0.85 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

3. Average recurrence interval, ARI 10 (yr)

NO CLIMATE CHANGE

4. 24 hour rainfall depth, P24 128 (mm)

5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S 0.266

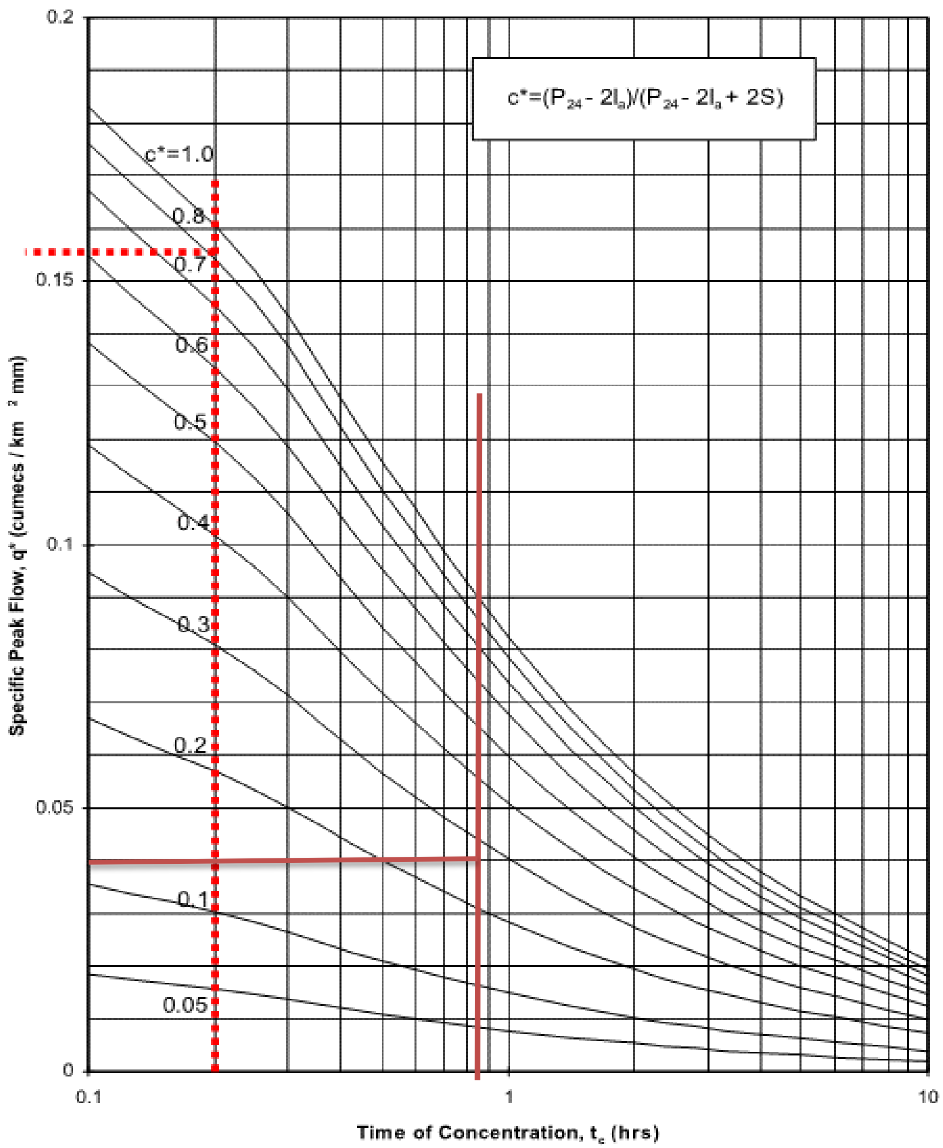
6. Specific peak flow rate q* 0.040

7. Peak flow rate, q_p=q*A*P_{24} **0.411** (m3/s)

8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ 53.0

9. Runoff volume, $V_{24} = 1000xQ_{24}A$ 4256.79 (m3)

Worksheet 2: Graphical Peak Flow Rate


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.	Job Number 289001	Sheet 4	Rev A
Job Title Station Road, Matamata Calc Title Pre-development	Author MKS	Date 13/03/2025	Checked DJM

1. Data

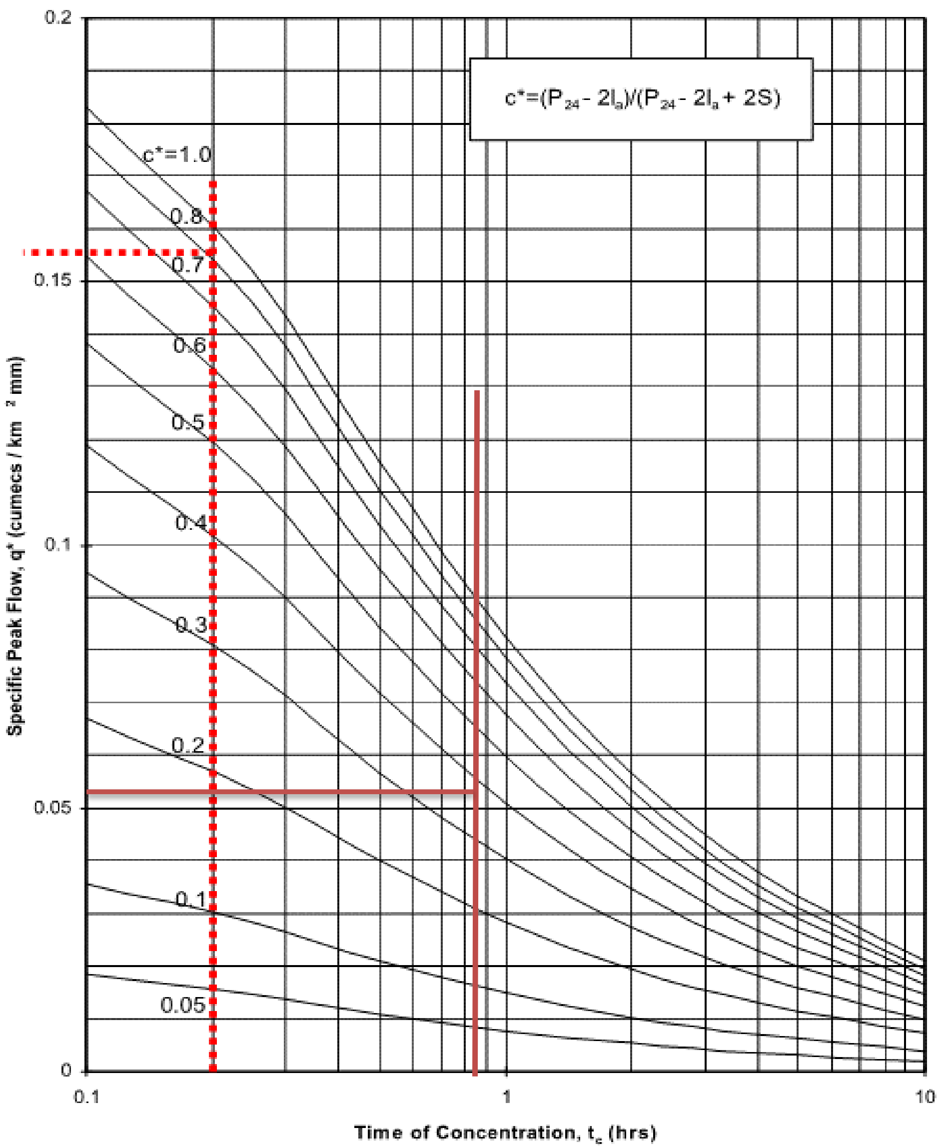
Catchment Area	A=	0.08030	km2(100ha =1km2)
Runoff curve number	CN=	61.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.85	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

NO CLIMATE CHANGE

3. Average recurrence interval, ARI	100	(yr)
4. 24 hour rainfall depth, P24	200	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.369	
6. Specific peak flow rate q*	0.053	
7. Peak flow rate, q_p=q*A*P_{24}	**0.851**	(m3/s)
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	106.4	
9. Runoff volume, V_{24} = 1000xQ_{24}A	8543.55	(m3)

Worksheet 2: Graphical Peak Flow Rate



c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd.		Job Number 289001	Sheet 5	Rev A
Job Title Calc Title	Eldonwood, Matamata Post-development	Author MKS	Date 13/03/2025	Checked DJM

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=1ha	Product of CN x area
C	Road	98	2.17	212.7
C	Residential District (30% PERVIOUS)	74	1.76	130.2
C	Residential District (70% IMPERVIOUS)	90	4.10	369.0
* from Appendix B		Totals =	8.03	711.9

CN (weighted) = total product / total area = 711.89 / 8.030 = 88.7

Ia (weighted) = 5 x pervious area / total area = 5 x 1.76 / 8.03 = 1.1 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2) piped

Catchment length L = 0.62 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 88.7 / (200- 88.7) = 0.80

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

= 0.1 0.6 0.73 1.13 4.90 = 0.340 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.228 hrs

OK
use
0.228 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Maven Associates Ltd	Job Number 289001	Sheet 6	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.080	km2(100ha =1km2)
Runoff curve number	CN=	88.7	(from worksheet 1)
Initial abstraction	Ia=	1.1	mm (from worksheet 1)
Time of concentration	tc=	0.228	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 33 mm

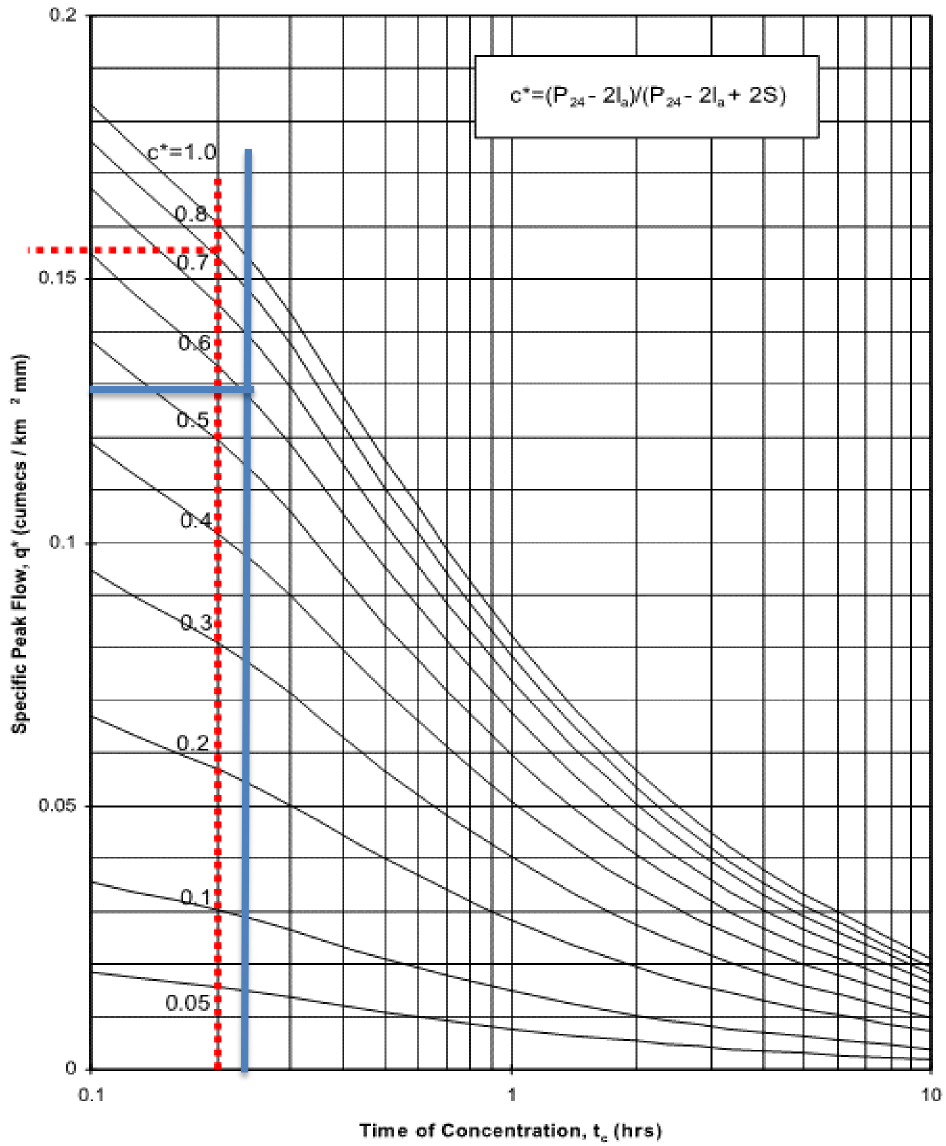
3.	Average recurrence interval, ARI	2	(yr)
4.	24 hour rainfall depth, P24	106	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.615	
6.	Specific peak flow rate q*	0.129	
7.	Peak flow rate, q_p=q*A*P_{24}	**1.098**	
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	80.1	
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	6431.06	(m3)

HEC-HMS Check

Pre-Dev

Pre development run off volume	**2032.27**	(m3)
Post development run off volume	**6431.06**	(m3)
Pre development flow rate	**0.19**	(m3/s)
Post development flow rate	**1.10**	(m3/s)

Worksheet 2: Graphical Peak Flow Rate



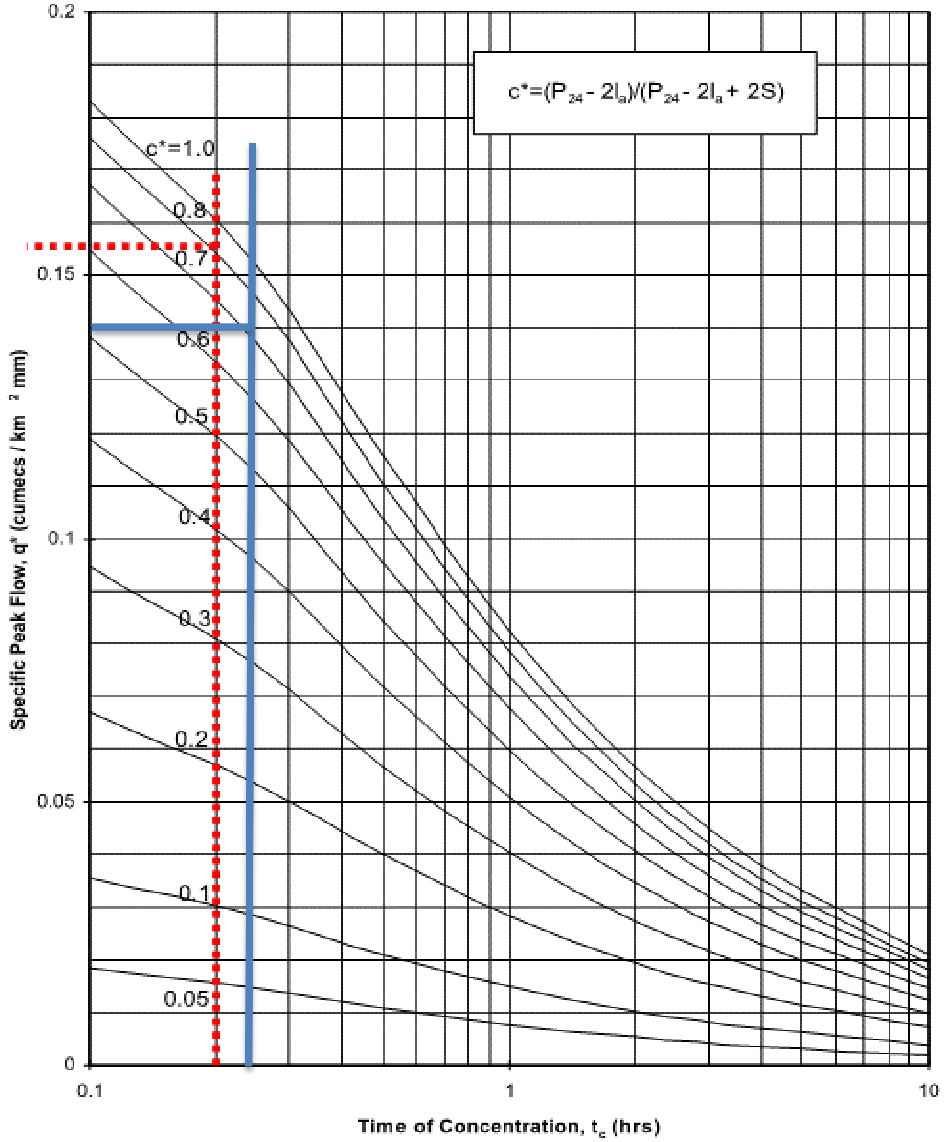
c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 7	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1.	Data			
	Catchment Area	A=	0.080	km2(100ha =1km2)
	Runoff curve number	CN=	88.7	(from worksheet 1)
	Initial abstraction	Ia=	1.1	mm (from worksheet 1)
	Time of concentration	tc=	0.228	hrs (from worksheet 1)
2.	Calculate storage, S =(1000/CN - 10)25.4	=	33	mm

				HEC-HMS Check
3.	Average recurrence interval, ARI	10	(yr)	
4.	24 hour rainfall depth, P24	167	(mm)	
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.717		
6.	Specific peak flow rate q*	0.140		
7.	Peak flow rate, q_p=q*A*P_{24}	**1.877**		Pre-Dev
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	138.7		
9.	Runoff volume, V_{24} = 1000xQ_{24}A	11139.43	(m3)	
	Pre development run off volume	**4256.79**	(m3)	
	Post development run off volume	**11139.43**	(m3)	
	Pre development flow rate	**0.41**	(m3/s)	
	Post development flow rate	**1.88**	(m3/s)	

Worksheet 2: Graphical Peak Flow Rate

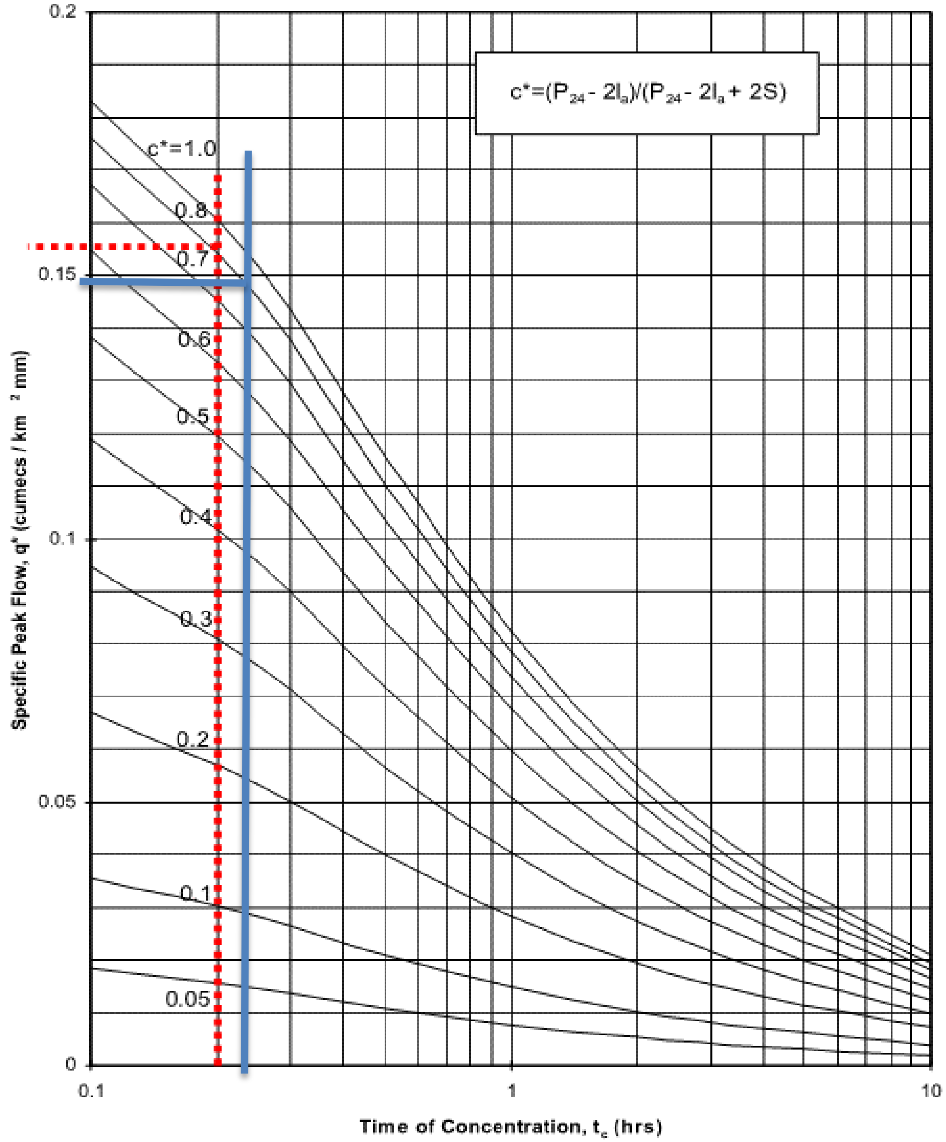

c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)

Maven Associates Ltd	Job Number 289001	Sheet 8	Rev A
Job Title: Station Road, Matamata Calc Title: Post-development SW Demand	Author MKS	Date 13/03/2025	Checked DJM

1.	Data			
	Catchment Area	A=	0.080	km2(100ha =1km2)
	Runoff curve number	CN=	88.7	(from worksheet 1)
	Initial abstraction	Ia=	1.1	mm (from worksheet 1)
	Time of concentration	tc=	0.228	hrs (from worksheet 1)
2.	Calculate storage, S =(1000/CN - 10)25.4	=	33	mm

3.	Average recurrence interval, ARI	100	(yr)		
4.	24 hour rainfall depth, P24	265	(mm)		
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.802			
6.	Specific peak flow rate q*	0.149		*HEC-HMS Check*	
7.	Peak flow rate, q_p=q*A*P_{24}	**3.171**		**0.681**	80% Pre
8.	Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	235.0			
9.	Runoff volume, V_{24} = $1000xQ_{24}A$	18867.28	(m3)		
	Pre development run off volume	**8543.55**	(m3)		
	Post development run off volume	**18867.28**	(m3)		
	Pre development flow rate	**0.85**	(m3/s)		
	Post development flow rate	**3.17**	(m3/s)		
	100yr - 10yr post development	**7727.85**	(m3)		

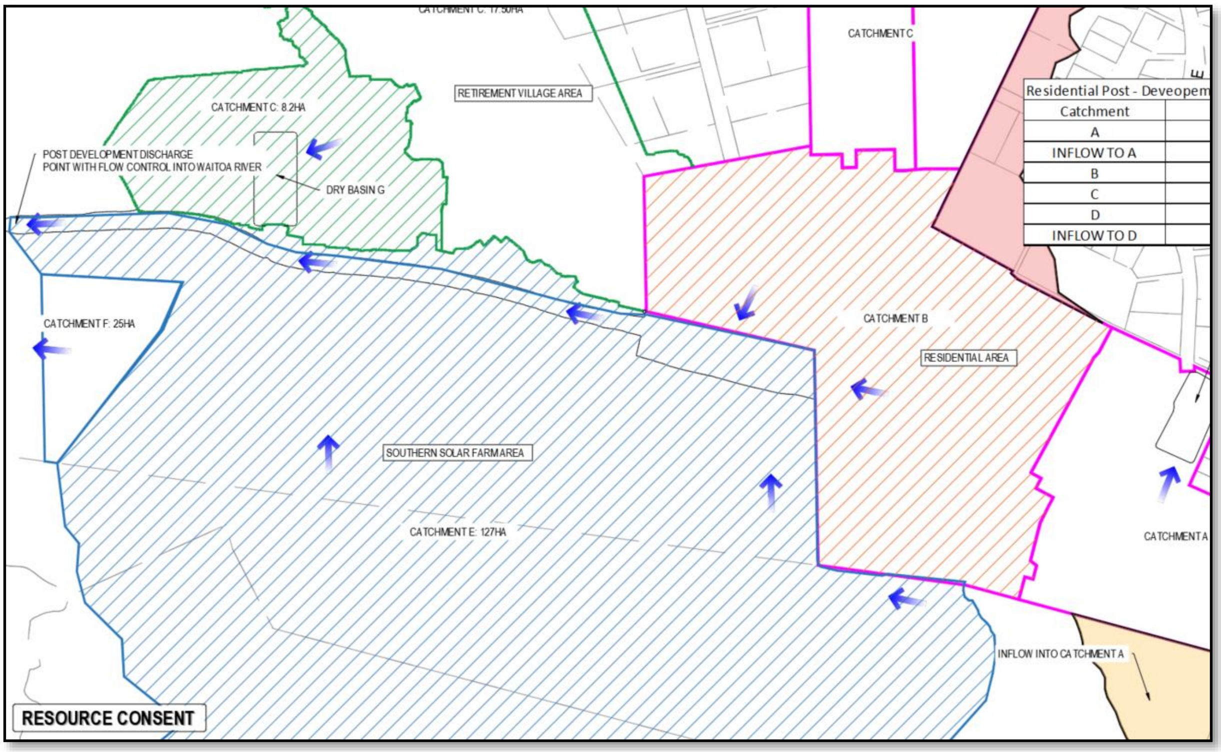
Worksheet 2: Graphical Peak Flow Rate


0.2
0.15
0.1
0.05
0
c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
Specific Peak Flow, q* (cumecs / km 2 mm)
0.1
1
10
Time of Concentration, tc (hrs)

GREENWAY DESIGN SUMMARY

Catchment Characteristics

The Greenway connects to Basin B and serves as an overall attenuation device for Basin B, as well as a diversion for the attenuated flow from RV and for inflow from the solar farm and upstream catchments. The catchment plan below, along with the tables further down, provides information regarding the catchment entering this stormwater device.Design



Catchment	Area (Ha)
RES B	19.5
Inflow RV	8.2
Inflow South	127

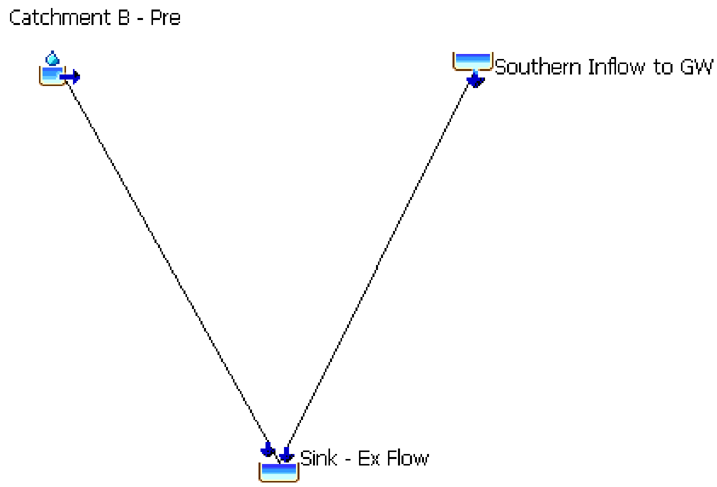
Pre-Development CN		Post Development CN	
Pervious	**Impervious**	**Pervious**	**Impervious**
61	98	74	98

	Pre Development		Post-Development (RCP 8.5)		
	10yr	100 yr	10yr	100yr	100yr-10yr
24 hour rainfall depth (mm)	128	200	167	265	98

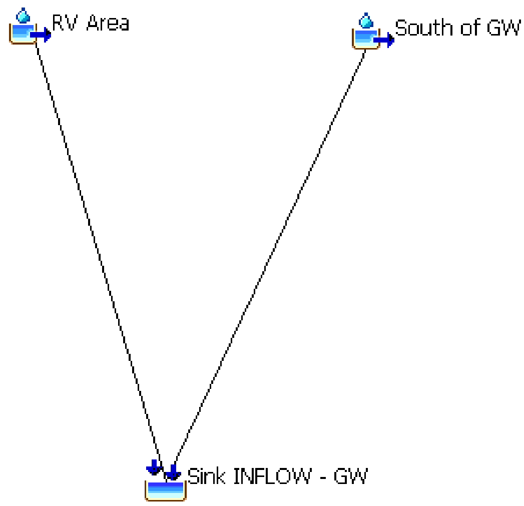
An HEC-HMS model has been prepared using the site design parameters mentioned above, along with the site hydrology data and TR20/07 data attached to this Design Summary.

Pre Development HEC HMS RESUTLS

Pre Development Basin Model



Southern Inflow to GW is separately modelled in the Basin Model shown below. Its hydrograph is inserted into the above main model representing the overall inflows outside of the Catchment B area. The same hydrograph is also incorporated into the post-development assessment of the Greenway + Basin model.



Pre Development Summary Results

Project: Basin A to D Simulation Run: Inflow 01 - GW
Sink: Sink INFLOW - GW

Start of Run:	04Apr2017, 00:00	Basin Model:	Inflow Basin Models
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge: 7.4724 (M3/S) Date/Time of Peak Discharge 04Apr2017, 13:58
Volume: 136.6029 (1000 M3)

Inflow Results

Project: Basin A to D Simulation Run: Catchment B 100year Pre

Start of Run:	04Apr2017, 00:00	Basin Model:	Pre Dev B
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Show Elements: All Elements Volume Units: ○ MM ◉ 1000 M3 Sorting: Watershed Explorer

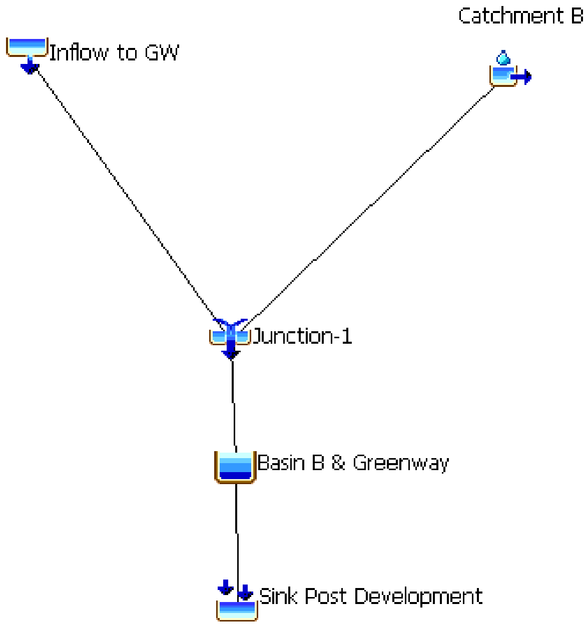
Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Catchment B - Pre	0.19500	2.1469	4 April 2017, 12:38	20.4084
Southern Inflow t...		7.4724	4 April 2017, 13:58	136.6028
Sink - Ex Flow		8.1179	4 April 2017, 13:55	157.0113

Combined Greenway + Catchment B Results

- Pre Development Peak Flow Rate Catchment B = 2.15m^3/s
- 80% Pre Development Peak Flow Rate Catchment B = **1.72m^3/s**
- Pre Development Peak Flow Rate Inflow Catchments = 7.47m^3/s
- Maximum Combined Flow Rate Required for Post Development = **9.19m^3/s**

Post Development HEC HMS RESUTLS

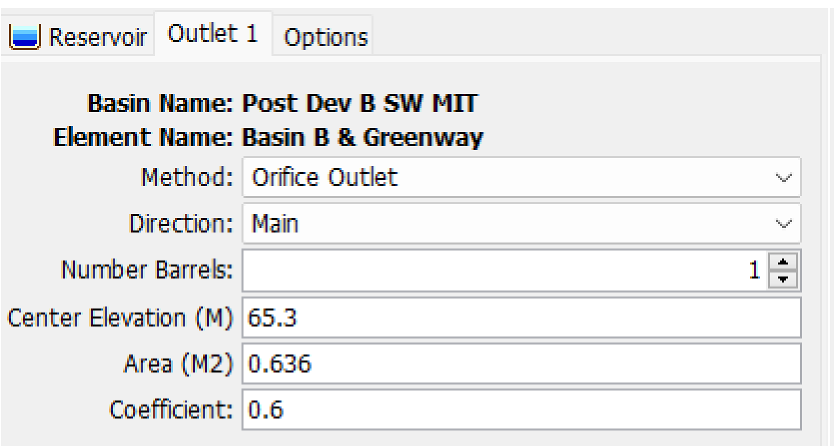
Post Development Basin Model



Basin B – Greenway – Set up

Outlet Assumptions;

- 1x Orifice 900mm @ Elevation 65.3m (note this is Center of Orifice)
- Spillway of 15m @ Elevation of 66.55m



Basin Name: Post Dev B SW MIT
Element Name: Basin B & Greenway

Method: Broad-Crested Spillway

Direction: Main

*Elevation (M) 66.55

*Length (M) 15

Coefficient (M^0.5/S) 1.6

Gates: 0

Greenway/Basin B Storage Function

Elevation	Volume (m^3)
67.00	19369.62
66.90	16927.66
66.80	14652.14
66.70	12520.01
66.60	10492.37
66.50	8536.09
66.40	6648.73
66.30	4832.60
66.20	3318.14
66.10	2359.96
66.00	1788.82
65.90	1338.32
65.80	997.34
65.70	757.29
65.60	580.37
65.50	432.76
65.40	310.75
65.30	212.29
65.20	135.32
65.10	77.79
65.00	37.66
64.90	12.88
64.80	1.41
64.75	0.03

Post Development Summary Results – Basin B

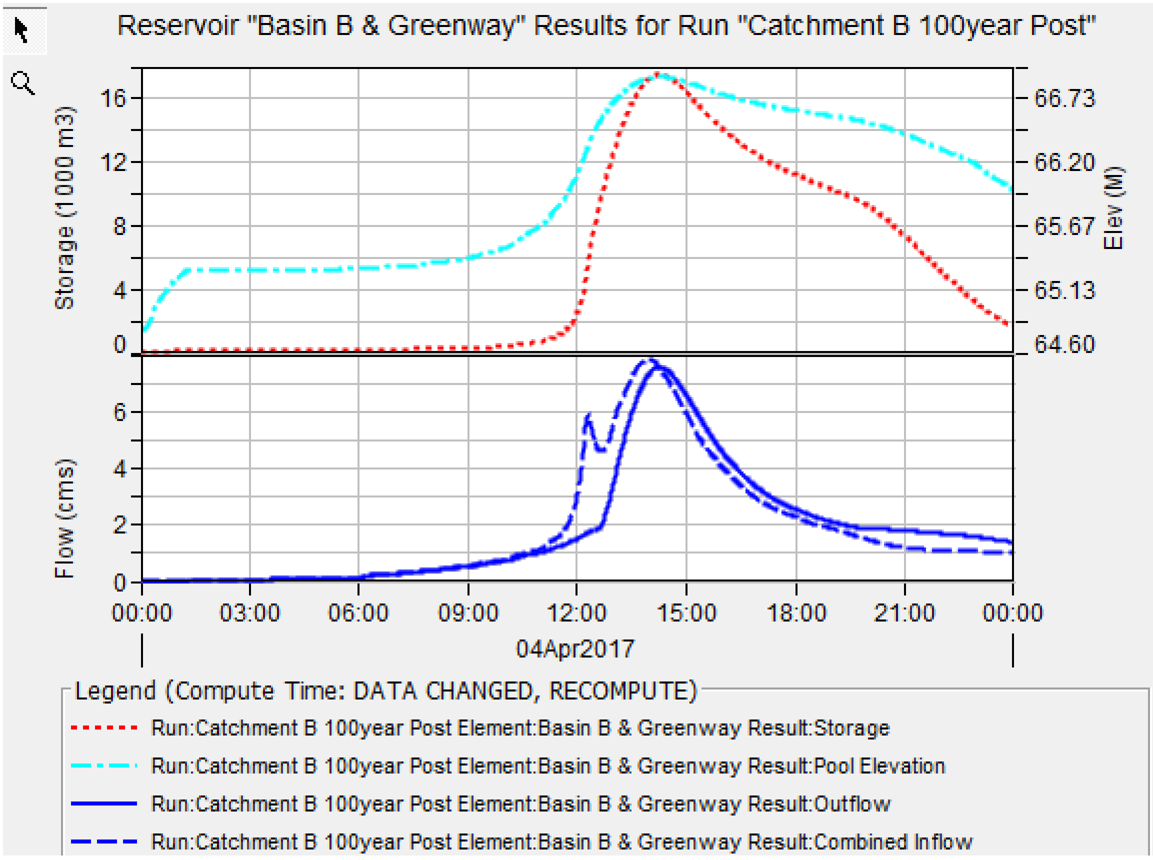
Project: Basin A to D   Simulation Run: Catchment B 100year Post
Reservoir: Basin B & Greenway

Start of Run:	04Apr2017, 00:00	Basin Model:	Post Dev B SW MIT
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100-10yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: (●) MM ( ) 1000 M3

Computed Results

Peak Inflow:	7.8421 (M3/S)	Date/Time of Peak Inflow:	04Apr2017, 13:58
Peak Discharge:	7.5728 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 14:15
Inflow Volume:	n/a	Peak Storage:	17.5033 (1000 M3)
Discharge Volume:	n/a	Peak Elevation:	66.9209 (M)



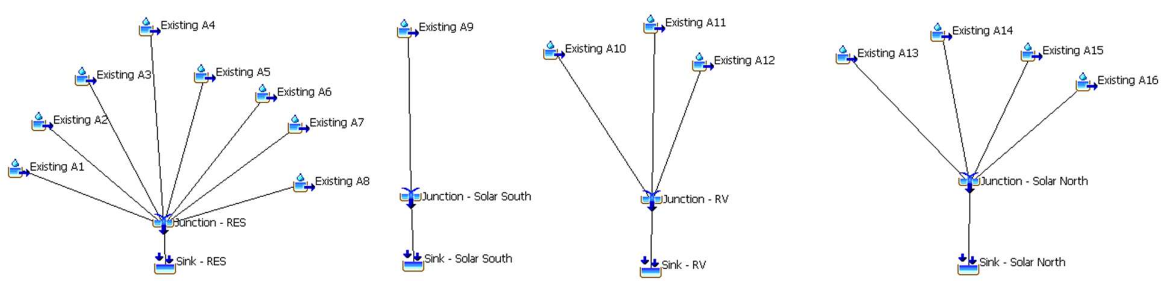
- Peak Water level @ RL: 66.92m
- Peak Discharge is 7.8m³/s
- Max Peak required is 9.19m³/s therefore OK

Matamata Developments Limited

Date: 30 May 2025

Ashbourne
HEC HMS Existing Inputs and Results

	AREA km2	CN	IMPERVIOUS %
A1	0.024	61	0
A2	0.0869	61	0
A3	0.0051	61	0
A4	0.033	61	0
A5	0.0047	61	0
A6	0.0927	61	0
A7	0.285	61	30
A8	0.0054	61	0
A9	1.21	61	0
A10	0.1	61	0
A11	0.00412	61	0
A12	0.17	61	0
A13	0.01	61	0
A14	0.0233	61	10
A15	0.179	61	0
A16	0.0066	61	0



Summary Results for Subbasin "Existing A1"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A1

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.083 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:22
Precipitation Volume:	2.0 (1000 M3)	Direct Runoff Volume:	0.6 (1000 M3)
Loss Volume:	1.4 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.6 (1000 M3)	Discharge Volume:	0.6 (1000 M3)

Summary Results for Subbasin "Existing A2"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A2

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.217 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:39
Precipitation Volume:	7.2 (1000 M3)	Direct Runoff Volume:	2.2 (1000 M3)
Loss Volume:	5.0 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	2.2 (1000 M3)	Discharge Volume:	2.2 (1000 M3)

Summary Results for Subbasin "Existing A3"

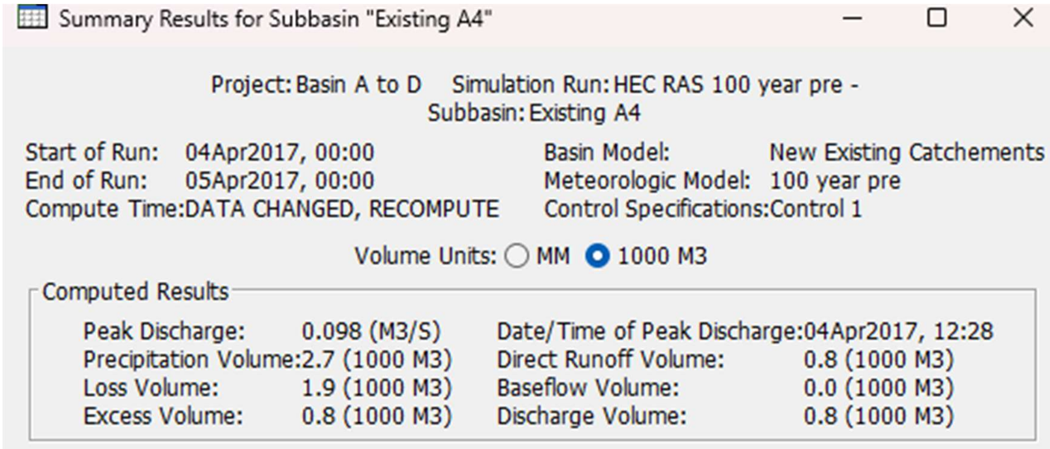
Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A3

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.021 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:16
Precipitation Volume:	0.4 (1000 M3)	Direct Runoff Volume:	0.1 (1000 M3)
Loss Volume:	0.3 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.1 (1000 M3)	Discharge Volume:	0.1 (1000 M3)



Summary Results for Subbasin "Existing A4"

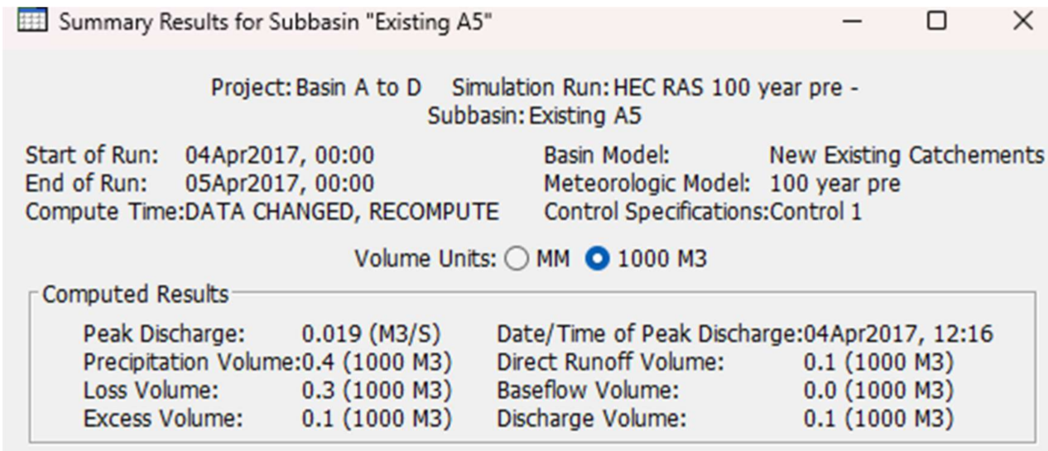
Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A4

Start of Run: 04Apr2017, 00:00 Basin Model: New Existing Catchements
End of Run: 05Apr2017, 00:00 Meteorologic Model: 100 year pre
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Discharge: 0.098 (M3/S) Date/Time of Peak Discharge: 04Apr2017, 12:28
Precipitation Volume: 2.7 (1000 M3) Direct Runoff Volume: 0.8 (1000 M3)
Loss Volume: 1.9 (1000 M3) Baseflow Volume: 0.0 (1000 M3)
Excess Volume: 0.8 (1000 M3) Discharge Volume: 0.8 (1000 M3)



Summary Results for Subbasin "Existing A5"

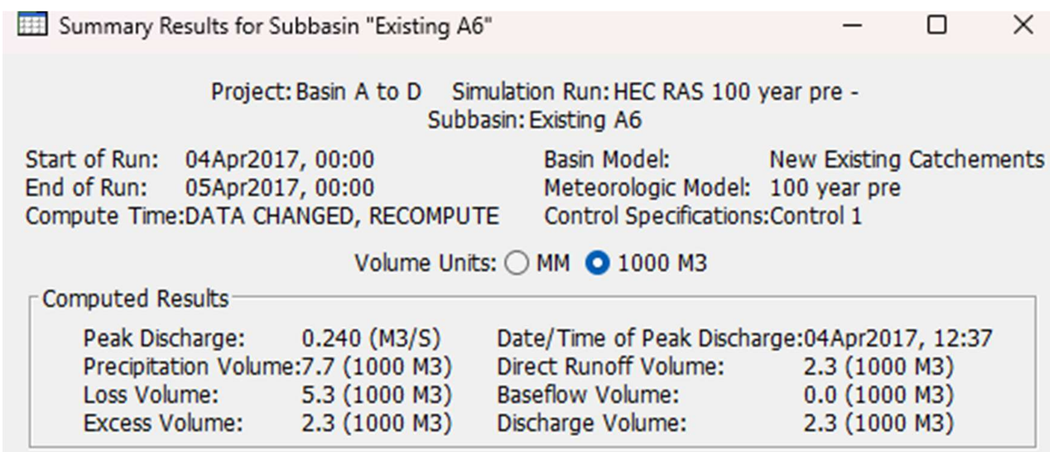
Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A5

Start of Run: 04Apr2017, 00:00 Basin Model: New Existing Catchements
End of Run: 05Apr2017, 00:00 Meteorologic Model: 100 year pre
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Discharge: 0.019 (M3/S) Date/Time of Peak Discharge: 04Apr2017, 12:16
Precipitation Volume: 0.4 (1000 M3) Direct Runoff Volume: 0.1 (1000 M3)
Loss Volume: 0.3 (1000 M3) Baseflow Volume: 0.0 (1000 M3)
Excess Volume: 0.1 (1000 M3) Discharge Volume: 0.1 (1000 M3)



Summary Results for Subbasin "Existing A6"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A6

Start of Run: 04Apr2017, 00:00 Basin Model: New Existing Catchements
End of Run: 05Apr2017, 00:00 Meteorologic Model: 100 year pre
Compute Time: DATA CHANGED, RECOMPUTE Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Discharge: 0.240 (M3/S) Date/Time of Peak Discharge: 04Apr2017, 12:37
Precipitation Volume: 7.7 (1000 M3) Direct Runoff Volume: 2.3 (1000 M3)
Loss Volume: 5.3 (1000 M3) Baseflow Volume: 0.0 (1000 M3)
Excess Volume: 2.3 (1000 M3) Discharge Volume: 2.3 (1000 M3)

Summary Results for Subbasin "Existing A7"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A7

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.910 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:58
Precipitation Volume:	23.7 (1000 M3)	Direct Runoff Volume:	11.9 (1000 M3)
Loss Volume:	11.5 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	12.1 (1000 M3)	Discharge Volume:	11.9 (1000 M3)

Summary Results for Subbasin "Existing A8"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A8

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.022 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:16
Precipitation Volume:	0.4 (1000 M3)	Direct Runoff Volume:	0.1 (1000 M3)
Loss Volume:	0.3 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.1 (1000 M3)	Discharge Volume:	0.1 (1000 M3)

Summary Results for Subbasin "Existing A9"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A9

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	1.968 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 13:24
Precipitation Volume:	100.4 (1000 M3)	Direct Runoff Volume:	29.3 (1000 M3)
Loss Volume:	69.8 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	30.6 (1000 M3)	Discharge Volume:	29.3 (1000 M3)

Summary Results for Subbasin "Existing A10"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A10

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.255 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:38
Precipitation Volume:	8.3 (1000 M3)	Direct Runoff Volume:	2.5 (1000 M3)
Loss Volume:	5.8 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	2.5 (1000 M3)	Discharge Volume:	2.5 (1000 M3)

Summary Results for Subbasin "Existing A11"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A11

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.015 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:20
Precipitation Volume:	0.3 (1000 M3)	Direct Runoff Volume:	0.1 (1000 M3)
Loss Volume:	0.2 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.1 (1000 M3)	Discharge Volume:	0.1 (1000 M3)

Summary Results for Subbasin "Existing A12"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A12

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.342 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:58
Precipitation Volume:	14.1 (1000 M3)	Direct Runoff Volume:	4.2 (1000 M3)
Loss Volume:	9.8 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	4.3 (1000 M3)	Discharge Volume:	4.2 (1000 M3)

Summary Results for Subbasin "Existing A13"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A13

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.025 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:38
Precipitation Volume:	0.8 (1000 M3)	Direct Runoff Volume:	0.2 (1000 M3)
Loss Volume:	0.6 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.3 (1000 M3)	Discharge Volume:	0.2 (1000 M3)

Summary Results for Subbasin "Existing A14"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A14

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.073 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:36
Precipitation Volume:	1.9 (1000 M3)	Direct Runoff Volume:	0.7 (1000 M3)
Loss Volume:	1.2 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.7 (1000 M3)	Discharge Volume:	0.7 (1000 M3)

Summary Results for Subbasin "Existing A15"

Project: Basin A to D Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A15

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Discharge:	0.388 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:50
Precipitation Volume:	14.9 (1000 M3)	Direct Runoff Volume:	4.4 (1000 M3)
Loss Volume:	10.3 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	4.5 (1000 M3)	Discharge Volume:	4.4 (1000 M3)

Summary Results for Subbasin "Existing A16"

Project: Basin A to D   Simulation Run: HEC RAS 100 year pre -
Subbasin: Existing A16

Start of Run:	04Apr2017, 00:00	Basin Model:	New Existing Catchements
End of Run:	05Apr2017, 00:00	Meteorologic Model:	100 year pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.024 (M3/S)	Date/Time of Peak Discharge:	04Apr2017, 12:20
Precipitation Volume:	0.5 (1000 M3)	Direct Runoff Volume:	0.2 (1000 M3)
Loss Volume:	0.4 (1000 M3)	Baseflow Volume:	0.0 (1000 M3)
Excess Volume:	0.2 (1000 M3)	Discharge Volume:	0.2 (1000 M3)

Maven Associates		Job Number 289001	Sheet 1	Rev: A
Job Title Ashbourne RG - A Calc Title Pre-development		Author MKS	Date 13/03/2025	Checked DJM

Eastern Rain Gardens
Total Catchment 27600

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=1ha	Product of CN x area
B		Open Space (Sandy Loam or Silty Loam)	61	2.76	168.36
			Totals =	2.76	168.36

CN (weighted) = total product / total area = 168.36 / 2.760 = **61.0**

S= (1000 / CN -10) * 25.4 (1000 / 61.0 - 10) *2 66 = **162.4** mm

Ia= 0.05*S 0.05x 162.4 = **8.1** mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)
$T=100nL^{0.33}/S^{0.2}$

L= m
S= %
n=
T= 0.000 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= 50
n= 0.04
s= 1%

(to be completed at detail design)
V= 1.201874642 m/s
T= 0.69 mins

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

= 0 + 0.00 + 0.69 = 0.693 mins
0.011556021 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.008 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	**Job Number** 289001	**Sheet** 2	**Rev: A**
Job Title Ashbourne RG - A **Calc Title** Pre-development	**Author** MKS	**Date** 13/03/2025	**Checked** DJM

Ea Data

Catchment Area A= 0.0276 km2(100ha =1km2)

Runoff curve number CN= 61.0 (from worksheet 1)

Initial abstraction Ia= 8.1 mm (from worksheet 1)

Catchment R1 (Impervious Area) 98

Time of con(Catchment R1 (pervious Area) 74

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP6.0 for the period 2081-2100	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.047		0.199	0.295	0.408	
6. Specific peak flow rate q*	0.015		0.059	0.083	0.108	
7. Peak flow rate, q_p=q*A*P_{24}	**0.014**	m^3/s				m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.1		31.4	67.6	136.4	
9. Runoff volume, V_{24} = 1000xQ_{24}A	87	m^3	**867.71**	**1865.53**	**3763.91**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 3	Rev: A
Job Title Calc Title — Ashbourne RG - A, Post development (Pervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 27600

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 (10%)	74	0.276	20.42
					0.00
			Totals =	0.276	20.42

CN (weighted) = total product / total area = 20.42 / 0.276 = **74.0**

S= (1000 / CN -10) * 25.4 (1000 - 10) *25.4 / 74.0 = **89.2** mm

Ia= 0.05*S 0.05x 89.2 = **4.5** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	**Job Number 289001**	**Sheet 4**	**Rev: A**
Job Title Ashbourne RG - A **Calc Title** Post development (Pervious)	**Author MKS**	**Date 13/03/2025**	**Checked DJM**

1. Data

Catchment Area	A=	0.00276	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	4.5	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

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

	WQV		2	10	100	
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	6.6		47.1	91.9	170.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	18	m^3	**130.02**	**253.73**	**471.45**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 5	Rev: A
Job Title: Ashbourne RG - A Calc Title: Post development (Impervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 27600

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		Impervious	98	2.48	243.43
					0.00
			Totals =	2.48	243.43

CN (weighted) = total product = / total area = 243.43 / 2.484 = **98.0**

S= (1000 / CN -10) * 25.4 = (1000 - 10) *25.4 / 98.0 = **5.2** mm

Ia= 0.05*S = 0.05x 5.2 = **0.3** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001.00	Sheet 6	Rev: A
Job Title: Ashbourne RG - A Calc Title: Post development (Impervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.0248	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.3	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	27.6		91.8	146.7	234.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	686	m^3	**2280.83**	**3644.73**	**5829.12**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 7	Rev: A
Job Title: Ashbourne RG - A Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 27600

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		Impervious (90%)	98	2.48	243.43
C		Pervious (10%)	74	0.28	20.42
			Totals =	2.76	263.86

CN (weighted) = total product / total area = 263.86 / 2.760 = **95.6**

S= (1000 / CN -10) * 25.4   (1000 / 95.6 - 10) *25.4 = **11.7** mm

Ia= 0.05*S   0.05x 11.7 = **0.6** 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= 5.00 %
n= 0.015
T= 9.117 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   n= 0.04
d= 1   s= 2%
l= 500

(to be completed at detail design)
V= 1.6997074 m/s
T= 4.90 mins

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

= 9.117 + 0.00 + 4.90 = 14.020 mins
0.2336634 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.157 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 8	Rev: A
Job Title: Ashbourne RG - A Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.0276	km2(100ha =1km2)
Runoff curve number	CN=	95.6	(from worksheet 1)
Initial abstraction	Ia=	0.6	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 12 mm

		WQV				
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	24.25	32.3	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.497	0.571	0.804	0.866	0.911	
6. Specific peak flow rate q*	0.124	0.135	0.160	0.163	0.165	
7. Peak flow rate, q_p=q*A*P_{24}	**0.083**	**0.121**	**0.428**	**0.685**	**1.092**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$						
9. Runoff volume, $V_{24} = 1000xQ_{24}A$						m^3

	2	10	100	
Pre development run off volume	867.71	1865.53	3763.91	m^3
Post development run off volume - Pervious	130.02	253.73	471.45	m^3
Post development run off volume - Impervious	2280.83	3644.73	5829.12	m^3
Post development run off volume - total	2410.84	3898.46	6300.58	m^3

	2	10	100	
Pre development flow rate	0.16	0.35	0.71	m^3/s
Post development flow rate	0.43	0.68	1.09	m^3/s

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 9	Rev: A
Job Title Ashbourne RG - A Calc Title WQV and ED	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Runoff volume (pervious)	V_p=	18	m^3	
Runoff volume (impervious)	V_{ip}=	686	m^3	
Combined volume	V=	704	m^3	
Pre-development initial abstration	I_{a1}=	8.1	mm	
Post-development compacted pervious area CN		74		Class C
Post-development initial abstration of	I_{a2}=	4.5	mm	
Post development Impervious area	A_{ip}=	2.48	ha.	
Post development compacted perviou	A_{pp}=	0.28	ha.	

2. Retention reduction

Impervious surface retention	Vrip=	201.7	m^3
Pervious surface retention	Vrp=	10.1	m^3

3. Water Quality Volume	WQV=	492	m^3
4. Extended Detention Volume	ED=	591	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 1	Rev: A
Job Title: Ashbourne RG - B Calc Title: Pre-development		Author MKS	Date 13/03/2025	Checked DJM

Eastern Rain Gardens
Total Catchment 59600

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=1ha	Product of CN x area
B		Open Space (Sandy Loam or Silty Loam)	61	5.96	363.56
			Totals =	5.96	363.56

CN (weighted) = total product / total area = 363.56 / 5.960 = **61.0**

S= (1000 / CN -10) * 25.4   (1000 - 10) *2 / 61.0   66 = **162.4** mm

Ia= 0.05*S   0.05x 162.4 = **8.1** mm

2. Time of Concentration

Sheet and Shallow Flow (to be completed at detail design)
$T=100nL^{0.33}/S^{0.2}$
L= m
S= %
n=
T= 0.000 mins

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

Open Channel Flow $V=R^{2/3}S^{1/2}/n$ w= 1   n= 0.04
R= A / Wp   0.33   d= 1   s= 1%
l= 50

(to be completed at detail design)
V= 1.201874642 m/s
T= 0.69 mins

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

= 0 + 0.00 + 0.69 = 0.693 mins
0.011556021 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.008 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 2	Rev: A
Job Title: Ashbourne RG - B Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

Ea Data

Catchment Area A= 0.0596 km2(100ha =1km2)

Runoff curve number CN= 61.0 (from worksheet 1)

Initial abstraction Ia= 8.1 mm (from worksheet 1)

Catchment R1 (Impervious Area) 98

Time of con Catchment R1 (pervious Area) 74

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP6.0 for the period 2081-2100	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.047		0.199	0.295	0.408	
6. Specific peak flow rate q*	0.015		0.059	0.083	0.108	
7. Peak flow rate, q_p=q*A*P_{24}	**0.029**	m^3/s				m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.1		31.4	67.6	136.4	
9. Runoff volume, $V_{24} = 1000 x Q_{24} A$	187	m^3	**1873.74**	**4028.46**	**8127.86**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		**Job Number** 289001	**Sheet** 3	**Rev: A**
Job Title **Calc Title**	**Ashbourne RG - B** **Post development (Pervious)**		**Author** MKS	**Date** 13/03/2025	**Checked** DJM

Wetland **0**
Total Catchmer 59600

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 (10%)	74	0.596	44.10
					0.00
			Totals =	0.596	44.10

CN (weighted) = total product / total area = 44.10 / 0.596 = **74.0**

S= ((1000 / CN) -10) * 25.4 (1000 / 74.0 - 10) *25.4 = **89.2** mm

Ia= 0.05*S 0.05x 89.2 = **4.5** mm

2. Time of Concentration
Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 4	Rev: A
Job Title: Ashbourne RG - B Calc Title: Post development (Pervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   - Catchment Area A= 0.00596 km2(100ha =1km2)
   - Runoff curve number CN= 74.0 (from worksheet 1)
   - Initial abstraction Ia= 4.5 mm (from worksheet 1)
   - Time of concentration tc= 0.00 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 89 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	6.6		47.1	91.9	170.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	40	m^3	**280.76**	**547.91**	**1018.07**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 5	Rev: A
Job Title / Calc Title — Ashbourne RG - B / Post development (Impervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 59600

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		Impervious	98	5.36	525.67
					0.00
			Totals =	5.36	525.67

CN (weighted) = total product = / total area = 525.67 / 5.364 = **98.0**

S= (1000 / CN -10) * 25.4 (1000 - 10) *25.4 / 98.0 = **5.2** mm

Ia= 0.05*S 0.05x 5.2 = **0.3** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 6	Rev: A
Job Title: Ashbourne RG - B Calc Title: Post development (Impervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.05364	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.3	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	27.6		91.8	146.7	234.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1481	m^3	**4925.27**	**7870.51**	**12587.53**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 7	Rev: A
Job Title: Ashbourne RG - B Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 59600

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		Impervious (90%)	98	5.36	525.67
C		Pervious (10%)	74	0.60	44.10
			Totals =	5.96	569.78

CN (weighted) = total product / total area = 569.78 / 5.960 = **95.6**

S= (1000 / CN -10) * 25.4 = (1000 / 95.6 - 10) *25.4 = **11.7** mm

Ia= 0.05*S = 0.05x 11.7 = **0.6** 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= 5.00 %
n= 0.015
T= 9.117 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= 2%

(to be completed at detail design)

V= 1.6997074 m/s
T= 4.90 mins

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

= 9.117 + 0.00 + 4.90 = 14.020 mins
0.2336634 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.157 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 8	Rev: A
Job Title: Ashbourne RG - B Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   - Catchment Area — A= 0.0596 km2(100ha =1km2)
   - Runoff curve number — CN= 95.6 (from worksheet 1)
   - Initial abstraction — Ia= 0.6 mm (from worksheet 1)
   - Time of concentration — tc= 0.17 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 12 mm

		WQV				
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	24.25	32.3	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.497	0.571	0.804	0.866	0.911	
6. Specific peak flow rate q*	0.124	0.135	0.160	0.163	0.165	
7. Peak flow rate, q_p=q*A*P_{24}	**0.179**	**0.261**	**0.923**	**1.478**	**2.359**	m^3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$						
9. Runoff volume, V_{24} = 1000xQ_{24}A						m^3

Pre development run off volume	1873.74	4028.46	8127.86	m^3
Post development run off volume - Pervious	280.76	547.91	1018.07	m^3
Post development run off volume - Impervious	4925.27	7870.51	12587.53	m^3
Post development run off volume - total	5206.03	8418.42	13605.60	m^3

Pre development flow rate	0.34	0.75	1.54	m^3/s
Post development flow rate	0.92	1.48	2.36	m^3/s

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 9	Rev: A
Job Title Ashbourne RG - B Calc Title WQV and ED	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Runoff volume (pervious)	V_p=	40	m^3	
Runoff volume (impervious)	V_{ip}=	1481	m^3	
Combined volume	V=	1521	m^3	
Pre-development initial abstration	I_{a1}=	8.1	mm	
Post-development compacted pervious area CN		74		Class C
Post-development initial abstration of	I_{a2}=	4.5	mm	
Post development Impervious area	A_{ip}=	5.36	ha.	
Post development compacted perviou	A_{pp}=	0.60	ha.	

2. Retention reduction

Impervious surface retention	Vrip=	435.5	m^3
Pervious surface retention	Vrp=	21.8	m^3

3. Water Quality Volume WQV= 1063 m^3

4. Extended Detention Volume ED= 1276 m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 1	Rev: A
Job Title: Ashbourne RG - C Calc Title: Pre-development		Author MKS	Date 13/03/2025	Checked DJM

Eastern Rain Gardens
Total Catchment 10700

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=1ha	Product of CN x area
B		Open Space (Sandy Loam or Silty Loam)	61	1.07	65.27
			Totals =	1.07	65.27

CN (weighted) = total product / total area = 65.27 / 1.070 = **61.0**

S= (1000 / CN -10) * 25.4   (1000 / 61.0 - 10) *2 66 = **162.4** mm

Ia= 0.05*S   0.05x 162.4 = **8.1** mm

2. Time of Concentration

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

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

L= m
S= %
n=
T= 0.000 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 n= 0.04
d= 1 s= 1%
l= 50

(to be completed at detail design)

V= 1.201874642 m/s
T= 0.69 mins

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

= 0 + 0.00 + 0.69 = 0.693 mins

0.011556021 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.008 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 2	Rev: A
Job Title: Ashbourne RG - C Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

Ea Data

Catchment Area A= 0.0107 km2(100ha =1km2)

Runoff curve number CN= 61.0 (from worksheet 1)

Initial abstraction Ia= 8.1 mm (from worksheet 1)

Catchment R1 (Impervious Area) 98

Time of conc Catchment R1 (pervious Area) 74

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP6.0 for the period 2081-2100	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.047		0.199	0.295	0.408	
6. Specific peak flow rate q*	0.015		0.059	0.083	0.108	
7. Peak flow rate, q_p=q*A*P_{24}	**0.005**	m^3/s				m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.1		31.4	67.6	136.4	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	34	m^3	**336.39**	**723.23**	**1459.20**	m^3

Worksheet 2: Graphical Peak Flow Rate

	Maven Associates		Job Number 289001	Sheet 3	Rev: A
Job Title Calc Title	Ashbourne RG - C Post development (Pervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 10700

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 (10%)	74	0.11	7.92
					0.00
			Totals =	0.11	7.92

CN (weighted) = total product = / total area = 7.92 / 0.107 = **74.0**

S= (1000 / CN -10) * 25.4 = (1000 - 10) *25.4 / 74.0 = **89.2** mm

Ia= 0.05*S = 0.05x 89.2 = **4.5** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 4	Rev: A
Job Title: Ashbourne RG - C Calc Title: Post development (Pervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.00107	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	4.5	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

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

	WQV		2	10	100	
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	6.6		47.1	91.9	170.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	7	m^3	**50.41**	**98.37**	**182.77**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 5	Rev: A
Job Title: Ashbourne RG - C Calc Title: Post development (Impervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 10700

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		Impervious	98	0.96	94.37
					0.00
			Totals =	0.96	94.37

CN (weighted) = total product / total area = 94.37 / 0.963 = **98.0**

S= (1000 / CN -10) * 25.4 = (1000 - 10) *25.4 / 98.0 = **5.2** mm

Ia= 0.05*S = 0.05x 5.2 = **0.3** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 6	Rev: A
Job Title: Ashbourne RG - C Calc Title: Post development (Impervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.00963	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.3	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5 mm

	WQV		2	10	100	
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	27.6		91.8	146.7	234.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	266	m^3	**884.23**	**1412.99**	**2259.84**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 7	Rev: A
Job Title: Ashbourne RG - C Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 10700

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		Impervious (90%)	98	0.96	94.37
C		Pervious (10%)	74	0.11	7.92
			Totals =	1.07	102.29

CN (weighted) = total product / total area = 102.29 / 1.070 = **95.6**

S= (1000/CN - 10) * 25.4 = (1000/95.6 - 10) *25.4 = **11.7** mm

Ia= 0.05*S = 0.05x 11.7 = **0.6** 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= 5.00 %
n= 0.015
T= 9.117 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 n= 0.04
d= 1 s= 2%
l= 500

(to be completed at detail design)

V= 1.6997074 m/s
T= 4.90 mins

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

= 9.117 + 0.00 + 4.90 = 14.020 mins

0.2336634 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.157 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 8	Rev: A
Job Title: Ashbourne RG - C Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   Catchment Area A= 0.0107 km2(100ha =1km2)

   Runoff curve number CN= 95.6 (from worksheet 1)

   Initial abstraction Ia= 0.6 mm (from worksheet 1)

   Time of concentration tc= 0.17 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 12 mm

		WQV				
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	24.25	32.3	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.497	0.571	0.804	0.866	0.911	
6. Specific peak flow rate q*	0.124	0.135	0.160	0.163	0.165	
7. Peak flow rate, q_p=q*A*P_{24}	**0.032**	**0.047**	**0.166**	**0.265**	**0.424**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$						
9. Runoff volume, $V_{24} = 1000xQ_{24}A$						m^3

	2	10	100	
Pre development run off volume	336.39	723.23	1459.20	m^3
Post development run off volume - Pervious	50.41	98.37	182.77	m^3
Post development run off volume - Impervious	884.23	1412.99	2259.84	m^3
Post development run off volume - total	934.64	1511.36	2442.62	m^3
Pre development flow rate	0.06	0.14	0.28	m^3/s
Post development flow rate	0.17	0.27	0.42	m^3/s

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 9	Rev: A
Job Title: Ashbourne RG - C Calc Title: WQV and ED	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Runoff volume (pervious)	V_p=	7	m^3
Runoff volume (impervious)	V_{ip}=	266	m^3
Combined volume	V=	273	m^3
Pre-development initial abstration	I_{a1}=	8.1	mm
Post-development compacted pervious area CN		74	Class C
Post-development initial abstration of	I_{a2}=	4.5	mm
Post development Impervious area	A_{ip}=	0.96	ha.
Post development compacted perviou	A_{pp}=	0.11	ha.

2. Retention reduction

Impervious surface retention	Vrip=	78.2	m^3
Pervious surface retention	Vrp=	3.9	m^3

3. Water Quality Volume	WQV=	191	m^3
4. Extended Detention Volume	ED=	229	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 1	Rev: A
Job Title / Calc Title — Ashbourne RG - D / Pre-development		Author MKS	Date 13/03/2025	Checked DJM

Eastern Rain Gardens
Total Catchment 21700

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=1ha	Product of CN x area
B		Open Space (Sandy Loam or Silty Loam)	61	2.17	132.37
			Totals =	2.17	132.37

CN (weighted) = total product = / total area — 132.37 / 2.170 = **61.0**

S= (1000 / CN -10) * 25.4 — (1000 / 61.0 - 10) *2 66 = **162.4** mm

Ia= 0.05*S — 0.05x 162.4 = **8.1** mm

2. Time of Concentration

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

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

L= m
S= %
n=
T= 0.000 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 n= 0.04
d= 1 s= 1%
l= 50

(to be completed at detail design)

V= 1.201874642 m/s
T= 0.69 mins

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

= 0 + 0.00 + 0.69 = 0.693 mins

0.011556021 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.008 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 2	Rev: A
Job Title: Ashbourne RG - D Calc Title: Pre-development	Author MKS	Date 13/03/2025	Checked DJM

Ea Data

Catchment Area A= 0.0217 km2(100ha =1km2)

Runoff curve number CN= 61.0 (from worksheet 1)

Initial abstraction Ia= 8.1 mm (from worksheet 1)

Catchment R1 (Impervious Area) 98

Time of con Catchment R1 (pervious Area) 74

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP6.0 for the period 2081-2100	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.047		0.199	0.295	0.408	
6. Specific peak flow rate q*	0.015		0.059	0.083	0.108	
7. Peak flow rate, q_p=q*A*P_{24}	**0.011**	m^3/s				m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.1		31.4	67.6	136.4	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	68	m^3	**682.22**	**1466.74**	**2959.30**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 3	Rev: A
Job Title Calc Title	Ashbourne RG - D Post development (Pervious)	Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 21700

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 (10%)	74	0.217	16.06
					0.00
			Totals =	0.217	16.06

CN (weighted) = total product / total area = 16.06 / 0.217 = **74.0**

S= (1000 / CN -10) * 25.4   (1000 - 10) *25.4 / 74.0   = **89.2** mm

Ia= 0.05*S   0.05x 89.2   = **4.5** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 4	Rev: A
Job Title: Ashbourne RG - D Calc Title: Post development (Pervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data
   Catchment Area A= 0.00217 km2(100ha =1km2)

   Runoff curve number CN= 74.0 (from worksheet 1)

   Initial abstraction Ia= 4.5 mm (from worksheet 1)

   Time of concentration tc= 0.00 hrs (from worksheet 1)

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

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	6.6		47.1	91.9	170.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	14	m^3	**102.22**	**199.49**	**370.67**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001	Sheet 5	Rev: A
Job Title: Ashbourne RG - D Calc Title: Post development (Impervious)		Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 21700

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		Impervious	98	1.95	191.39
					0.00
			Totals =	1.95	191.39

CN (weighted) = total product / total area = 191.39 / 1.953 = **98.0**

S= (1000 / CN -10) * 25.4 ; (1000 - 10) *25.4 / 98.0 = **5.2** mm

Ia= 0.05*S ; 0.05x 5.2 = **0.3** mm

2. Time of Concentration

Unnecessary for volume calculations

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 289001	Sheet 6	Rev: A
Job Title: Ashbourne RG - D Calc Title: Post development (Impervious)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.01953	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.3	mm (from worksheet 1)
Time of concentration	tc=	0.00	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5 mm

	WQV					
3. Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	32.3	(mm)	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			Unnecessary for volume calculations			
6. Specific peak flow rate q*			Unnecessary for volume calculations			
7. Peak flow rate, q_p=q*A*P_{24}		m^3/s	Unnecessary for volume calculations			m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	27.6		91.8	146.7	234.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	539	m^3	**1793.26**	**2865.61**	**4583.04**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 7	Rev: A
Job Title: Ashbourne RG - D Calc Title: Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

Wetland 0
Total Catchmer 21700

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		Impervious (90%)	98	1.95	191.39
C		Pervious (10%)	74	0.22	16.06
			Totals =	2.17	207.45

CN (weighted) = total product / total area = 207.45 / 2.170 = **95.6**

S= (1000 / CN -10) * 25.4 = (1000 / 95.6 - 10) *25.4 = **11.7** mm

Ia= 0.05*S 0.05x 11.7 = **0.6** 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= 5.00 %
n= 0.015
T= 9.117 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 n= 0.04
d= 1 s= 2%
l= 500

(to be completed at detail design)

V= 1.6997074 m/s
T= 4.90 mins

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

= 9.117 + 0.00 + 4.90 = 14.020 mins
0.2336634 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.157 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 289001	Sheet 8	Rev: A
Job Title Calc Title	Ashbourne RG - D Post development (whole site)	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Catchment Area	A=	0.0217	km2(100ha =1km2)
Runoff curve number	CN=	95.6	(from worksheet 1)
Initial abstraction	Ia=	0.6	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 12 mm

		WQV				
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	yr
4. 24 hour rainfall depth, P24 as per HIRDS RCP 6.0 2081-2100 data	24.25	32.3	97	152	240	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.497	0.571	0.804	0.866	0.911	
6. Specific peak flow rate q*	0.124	0.135	0.160	0.163	0.165	
7. Peak flow rate, q_p=q*A*P_{24}	**0.065**	**0.095**	**0.336**	**0.538**	**0.859**	m^3/s
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$						
9. Runoff volume, V_{24} = 1000xQ_{24}A						m^3

Pre development run off volume	682.22	1466.74	2959.30	m^3
Post development run off volume - Pervious	102.22	199.49	370.67	m^3
Post development run off volume - Impervious	1793.26	2865.61	4583.04	m^3
Post development run off volume - total	1895.48	3065.09	4953.72	m^3

Pre development flow rate	0.12	0.27	0.56	m^3/s
Post development flow rate	0.34	0.54	0.86	m^3/s

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 289001	Sheet 9	Rev: A
Job Title: Ashbourne RG - D Calc Title: WQV and ED	Author MKS	Date 13/03/2025	Checked DJM

1. Data

Runoff volume (pervious)	V_p=	14	m^3	
Runoff volume (impervious)	V_{ip}=	539	m^3	
Combined volume	V=	554	m^3	
Pre-development initial abstration	I_{a1}=	8.1	mm	
Post-development compacted pervious area CN		74		Class C
Post-development initial abstration of	I_{a2}=	4.5	mm	
Post development Impervious area	A_{ip}=	1.95	ha.	
Post development compacted perviou	A_{pp}=	0.22	ha.	

2. Retention reduction

Impervious surface retention	Vrip=	158.6	m^3
Pervious surface retention	Vrp=	7.9	m^3

3. Water Quality Volume WQV= 387 m^3

4. Extended Detention Volume ED= 465 m^3

Worksheet 2: Graphical Peak Flow Rate

289001 – Ashbourne Soakage Calculation

1. The total effective area (per metre length of road)

= **Impervious Area + (0.3 * Pervious Area)**

Based on MPDC definition, we can calculate 2 effective areas for our design.

a. 20m wide road = 16.3 + (0.3*3.7) = **17.41m^2**
b. 18m wide road = 14.6 + (0.3*3.4) = **15.62m^2**

2. Design Soakage Rate

DSR of 4 Soakage holes from CMW Geotech report were calculated which are:
SO-01: 1.7 litres/min/m^2
SO-02: 5.7 litres/min/m^2
SO-03: 0.5 litres/min/m^2
SO-04: 0.2 litres/min/m^2 -> But we go with 0.5 litres/min/m^2

->Considering Test Pit Results, only 1.7 and 5.7 litres/min/m^2 will be used.

3. Maximum Impervious Area per Soakage Trench

There is no graph available for 10y 24h soakage trench with 1.2m width and 2.0m width, so we need a fair assumption for Maximum Impervious Area per soakage trench.

For 1.7 Design Soakage Rate (litres/min/m^2)

0.4m wide	1m deep = 6m^2
	2m deep = 12m^2
0.8m wide	1m deep = 8m^2
	2m deep = 16m^2
1.2m wide	1m deep = 10.6m^2 (33.3% Increased per 0.4m)
	1.5m deep = 16m^2 (33.3% Increased per 0.4m)
	2m deep = 21.3m^2 (33.3% Increased per 0.4m)
2.0m wide	1m deep = 18.9m^2 (33.3% Increased per 0.4m)
	1.5m deep = 28.4m^2 (33.3% Increased per 0.4m)
	2m deep = 37.8m^2 (33.3% Increased per 0.4m)

For 5.7 Design Soakage Rate (litres/min/m²)

0.4m wide	1m deep = $9m^2$
	2m deep = $18m^2$
0.8m wide	1m deep = $13m^2$
	2m deep = $26m^2$
1.2m wide	1m deep = $18.7m^2$ (44.4% Increased per 0.4m)
	1.5m deep = $28.2m^2$ (44.4% Increased per 0.4m)
	2m deep = $37.5m^2$ (44.4% Increased per 0.4m)
2.0m wide	1m deep = $39m^2$ (44.4% Increased per 0.4m)
	1.5m deep = $58.7m^2$ (44.4% Increased per 0.4m)
	2m deep = $78.2m^2$ (44.4% Increased per 0.4m)

4. Comparison between Road and Soakage Trench

1.7 Design Soakage Rate (litres/min/m²) Zone:

2.0m wide and 1.5m deep soakage trench is recommended for 18m wide road, this will give us:

- 15.62 / 28.4 = 0.55 -> 1:0.55 ratio (18m wide road)

-> Every 1m long road construction, we need 0.55m long soakage trench to be constructed.

-> Every 1m long road construction, we need 0.28m long soakage trench in each side.

1.2m wide and 1.5m deep soakage trench is recommended for 20m wide road, this will give us:

- 17.41 / 16 = 1.1 -> 1:1.1 ratio (20m wide road)

-> Every 1m long road construction, we need 1.1m long soakage trench to be constructed.

-> Every 1m long road construction, we need 0.55m long soakage trench in each side.

5.7 Design Soakage Rate (litres/min/m²) Zone:

2.0m wide and 1.5m deep soakage trench is recommended for 18m wide road, this will give us:

- 15.62 / 58.7 = 0.27 -> 1:0.27 ratio (18m wide road)

-> Every 1m long road construction, we need 0.27m long soakage trench to be constructed.

-> Every 1m long road construction, we need 0.135m long soakage trench in each side.

1.2m wide and 1.5m deep soakage trench is recommended for 20m wide road, this will give us:

- 17.41 / 28.2 = 0.62 -> 1:0.62 ratio (20m wide road)

-> Every 1m long road construction, we need 0.62m long soakage trench to be constructed.

-> Every 1m long road construction, we need 0.31m long soakage trench in each side.

289001 – Ashbourne Soakage Calculation (E1/VM1)

1. Soakage Rate from the Percolation Test

- ➔ Soakage Rate 0.5l/min/m^2 -> 21mm/hr from CMW Geotech Report HAM2023-0124AB Rev1
- ➔ Soakage Rate 1.5l/min/m^2 -> 85mm/hr (half of 171mm/hr)
- ➔ Soakage Rate 3.0l/min/m^2 -> 171mm/hr from CMW Geotech Report HAM2023-0124AB Rev1

2. Stormwater Catchment Volume (Rc)

Formula: Rc = 10 * CIA

1. Assume: Impervious area: 150m^2
2. Assume: Impervious area: 200m^2
3. Assume: Impervious area: 250m

Run-off coefficient (C) = 0.9 from E1/VM1 Table 1 (Hard Surfaces)

Rain Intensity (I) = 48.8mm/hour (10-year, RCP 8.5)

1. Rc (10-year) = (10 * 0.9 * 48.8 * 0.015) = 6.588m^3
2. Rc (10-year) = (10 * 0.9 * 48.8 * 0.02) = 8.784m^3
3. Rc (10-year) = (10 * 0.9 * 48.8 * 0.025) = 10.98m^3

3. Volume of Water Disposed by Soakage: V(soak)

Formula: V(soak) = Soakage Trench Area * Soakage Rate / 1000

Impervious area (150m^2)

0.5 Soakage Rate (21mm/hr): Soakage Trench Size = 7m (L) * 2.44m (W) * 1m (H)

Soakage Trench Volume =

7 * 2.44 * 1.0 * 0.38 (void ratio) = 6.49m^3

This gives V(soak): 7 * 2.44 * 21 /1000 = 0.36m^3

1.5 Soakage Rate (85mm/hr): Soakage Trench Size = 6m (L) * 2.44m (W) * 1m (H)

Soakage Trench Volume =

6 * 2.44 * 1.0 * 0.38 (void ratio) = 5.56m^3

This gives V(soak): 6 * 2.44 * 85 /1000 = 1.24m^3

3.0 Soakage Rate (171mm/hr): Soakage Trench Size = 5m (L) * 2.44m (W) * 1m (H)

Soakage Trench Volume =

5 * 2.44 * 1.0 * 0.38 (void ratio) = 4.64m^3

This gives V(soak): 5 * 2.44 * 171 /1000 = 2.086m^3

Impervious area (200m^2)

0.5 Soakage Rate (21mm/hr): Soakage Trench Size = 13.5m (L) * 1.65m (W) * 1m (H)

Soakage Trench Volume =

13.5 * 1.65 * 1.0 * 0.38 (void ratio) = 8.46m^3

This gives V(soak): 13.5 * 1.65 * 21 /1000 = 0.47m^3

1.5 Soakage Rate (85mm/hr): Soakage Trench Size = 11.5m (L) * 1.65m (W) * 1m (H)

Soakage Trench Volume =

11.5 * 1.65 * 1.0 * 0.38 (void ratio) = 7.21m^3

This gives V(soak): 11.5 * 1.65 * 85 /1000 = 1.613m^3

3.0 Soakage Rate (171mm/hr): Soakage Trench Size = 10m (L) * 1.65m (W) * 1m (H)

Soakage Trench Volume =

10 * 1.65 * 1.0 * 0.38 (void ratio) = 6.27m^3

This gives V(soak): 10 * 1.65 * 171 /1000 = 2.82m^3

Impervious area (250m^2)

0.5 Soakage Rate (21mm/hr): Soakage Trench Size = 11.74m (L) * 1.6m (W) * 1.5m (H)

Soakage Trench Volume =

11.74 * 1.6 * 1.5 * 0.38 (void ratio) = 10.71m^3

This gives V(soak): 11.74 * 1.6 * 21 /1000 = 0.39m^3

1.5 Soakage Rate (85mm/hr): Soakage Trench Size = 11.74m (L) * 1.6m (W) * 1.4m (H)

Soakage Trench Volume =

11.74 * 1.6 * 1.4 * 0.38 (void ratio) = 9.99m³

This gives V(soak): 11.74 * 1.6 * 85 /1000 = 1.60m³

3.0 Soakage Rate (171mm/hr): Soakage Trench Size = 11.74m (L) * 1.6m (W) * 1.1m (H)

Soakage Trench Volume =

11.74 * 1.6 * 1.1 * 0.38 (void ratio) = 7.85m³

This gives V(soak): 11.74 * 1.6 * 171 /1000 = 3.21m³

4. Required Storage Volume: V(storage)

Formula: V(storage) = Rc – V(soak)

Impervious area (150m²)

1. 21mm/hr
- ➔ Required 10-year V(storage) = 6.588 – 0.36 = 6.23m³
- ➔ Proposed Soakage Trench Volume (6.49m³) is larger than Required Volume (6.23m³),
- ➔ Soakage trench sizing is OK

2. 85mm/hr
- ➔ Required 10-year V(storage) = 6.588 – 1.24 = 5.35m³
- ➔ Proposed Soakage Trench Volume (5.56m³) is larger than Required Volume (5.35m³)
- ➔ Soakage trench sizing is OK

3. 171mm/hr
- ➔ Required 10-year V(storage) = 6.588 – 2.086 = 4.5m³
- ➔ Proposed Soakage Trench Volume (4.64m³) is larger than Required Volume (4.5m³)
- ➔ Soakage trench sizing is OK

Impervious area (200m²)

4. 21mm/hr
- ➔ Required 10-year V(storage) = 8.78 – 0.47 = 8.31m³
- ➔ Proposed Soakage Trench Volume (8.46m³) is larger than Required Volume (8.31m³),
- ➔ Soakage trench sizing is OK

5. 85mm/hr
- ➔ Required 10-year V(storage) = 8.78 – 1.61 = 7.17m³

➔ Proposed Soakage Trench Volume (7.21m³) is larger than Required Volume (7.17m³)

➔ Soakage trench sizing is OK

6. 171mm/hr

➔ Required 10-year V(storage) = 8.78 – 2.82 = 5.96m³

➔ Proposed Soakage Trench Volume (6.27m³) is larger than Required Volume (5.96m³)

➔ Soakage trench sizing is OK

Impervious area (250m²)

7. 21mm/hr

➔ Required 10-year V(storage) = 10.98 – 0.39 = 10.59m³

➔ Proposed Soakage Trench Volume (10.71m³) is larger than Required Volume (10.59m³),

➔ Soakage trench sizing is OK

8. 85mm/hr

➔ Required 10-year V(storage) = 10.98 – 1.6 = 9.38m³

➔ Proposed Soakage Trench Volume (9.99m³) is larger than Required Volume (9.38m³)

➔ Soakage trench sizing is OK

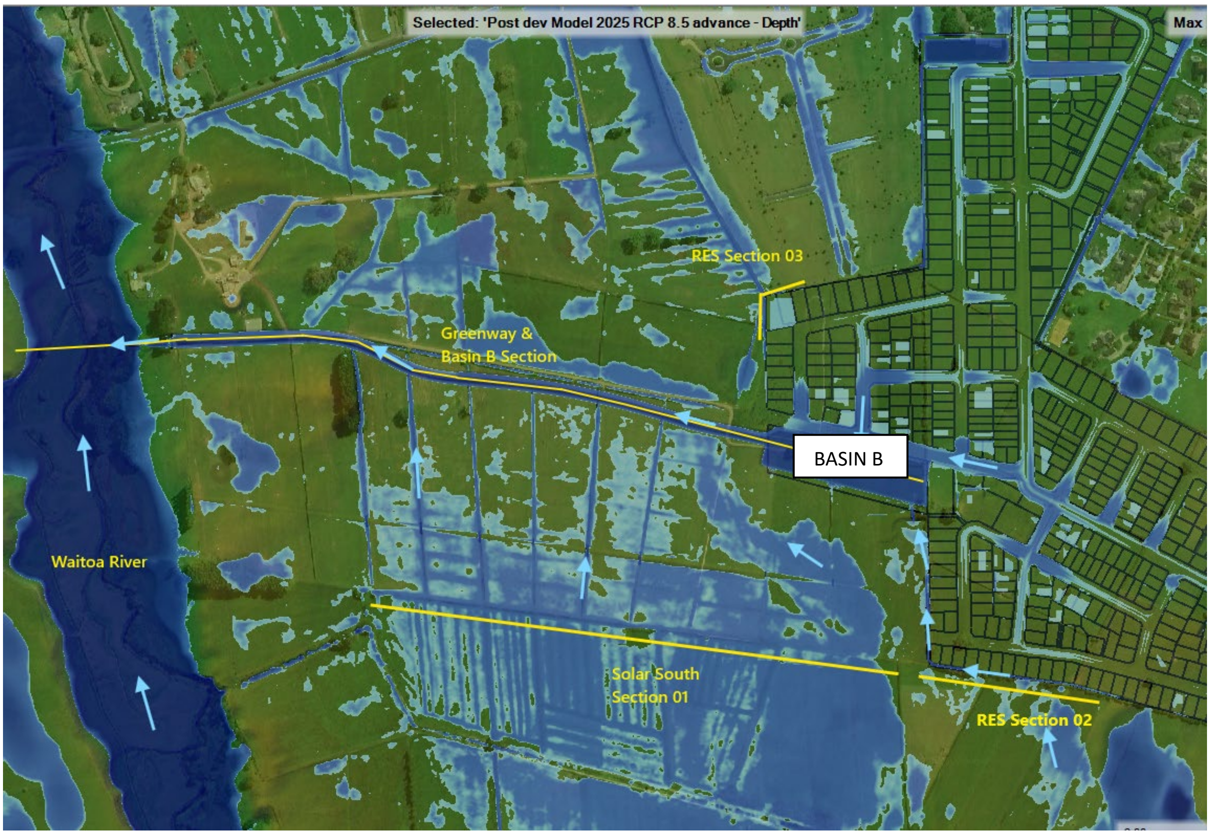
9. 171mm/hr

➔ Required 10-year V(storage) = 10.98 – 3.21 = 7.77m³

➔ Proposed Soakage Trench Volume (7.85m³) is larger than Required Volume (7.77m³)

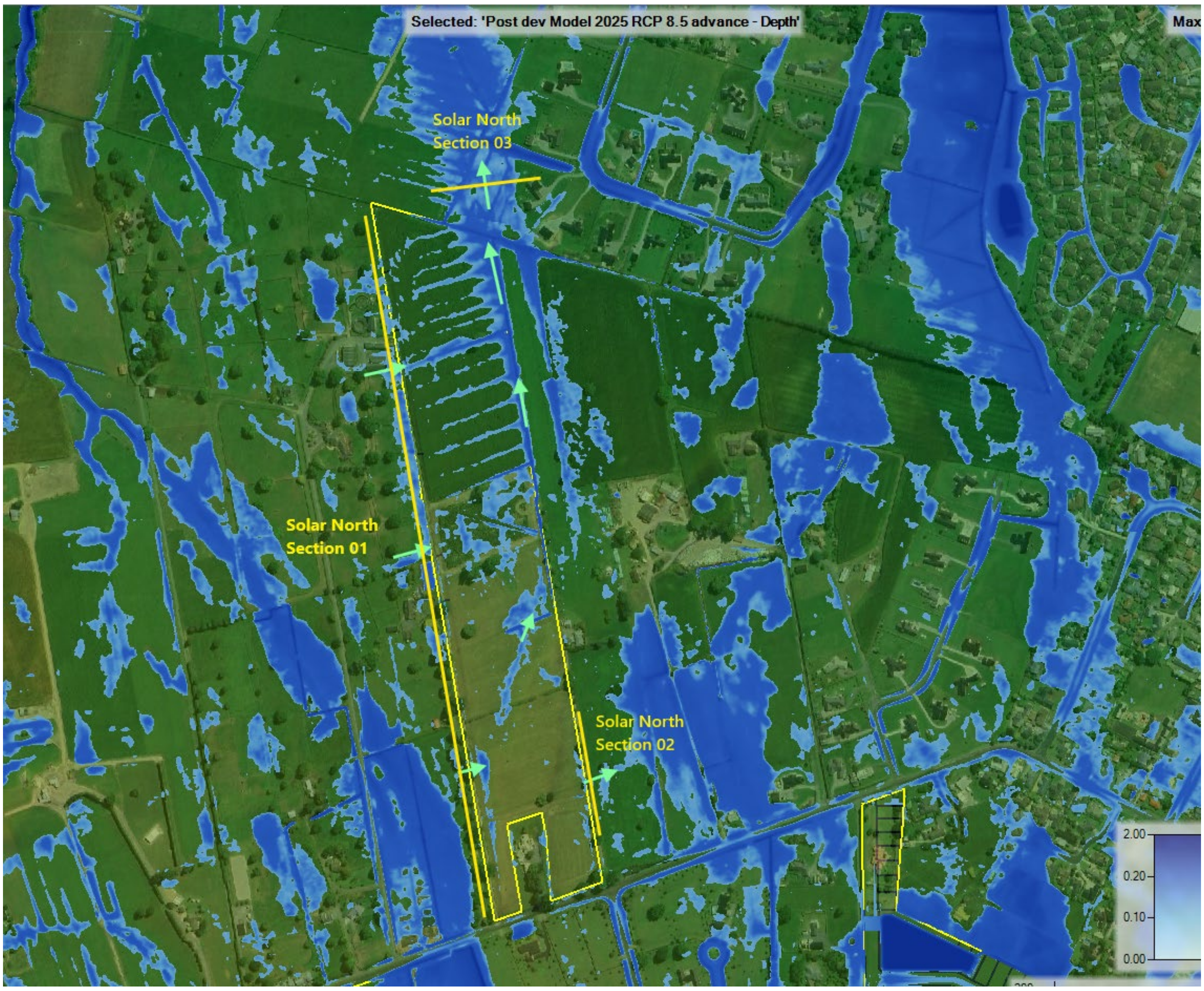
➔ Soakage trench sizing is OK

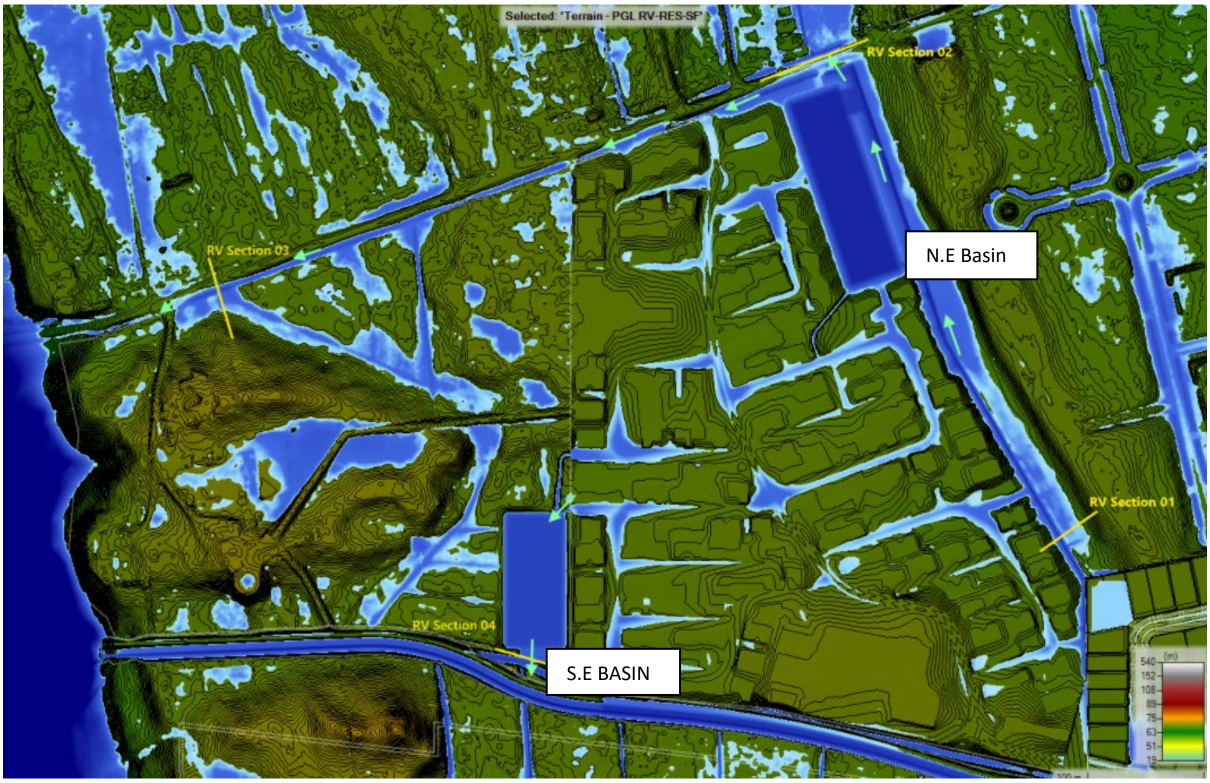
POST DEVELOMENT RESULTS RCP 8.5



Selected: 'Post dev Model 2025 RCP 8.5 advance - Depth'
Max
RES Section 03
Greenway &
Basin B Section
BASIN B
Waitoa River
Solar South
Section 01
RES Section 02

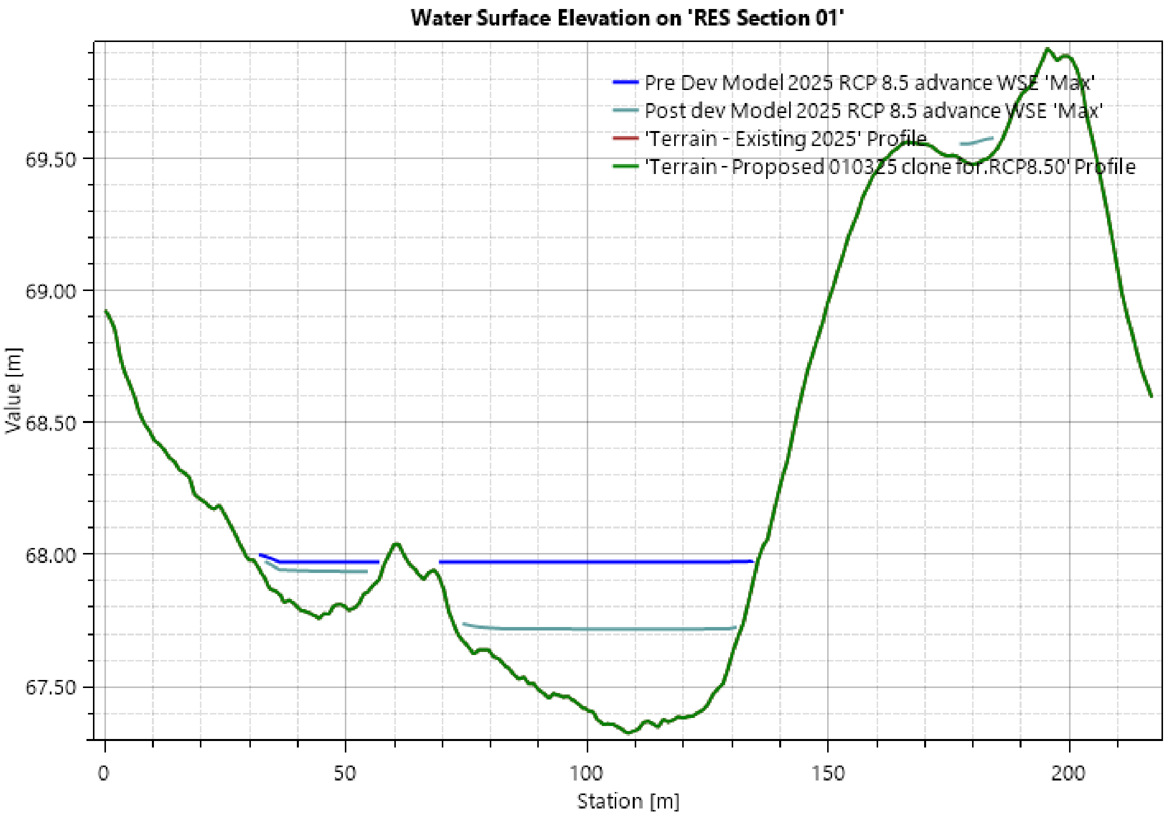

Selected: 'Post dev Model 2025 RCP 8.5 advance - Depth'
Max
RES Section 06
RES Section 07
BASIN D
RES Section 05
RES Section 04
BASIN C
RES Section 08
2.00

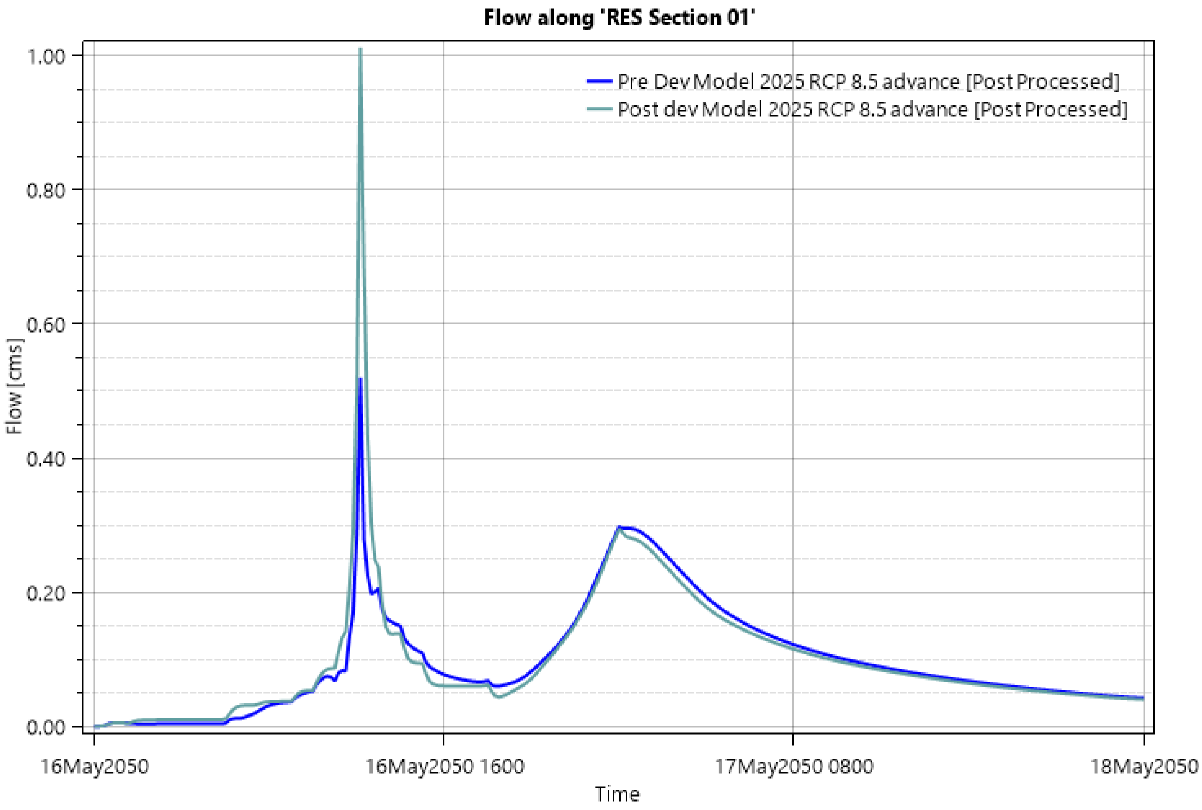

Selected: 'Post dev Model 2025 RCP 8.5 advance - Depth'
Max
Solar North
Section 03
Solar North
Section 01
Solar North
Section 02
2.00
0.20
0.10
0.00



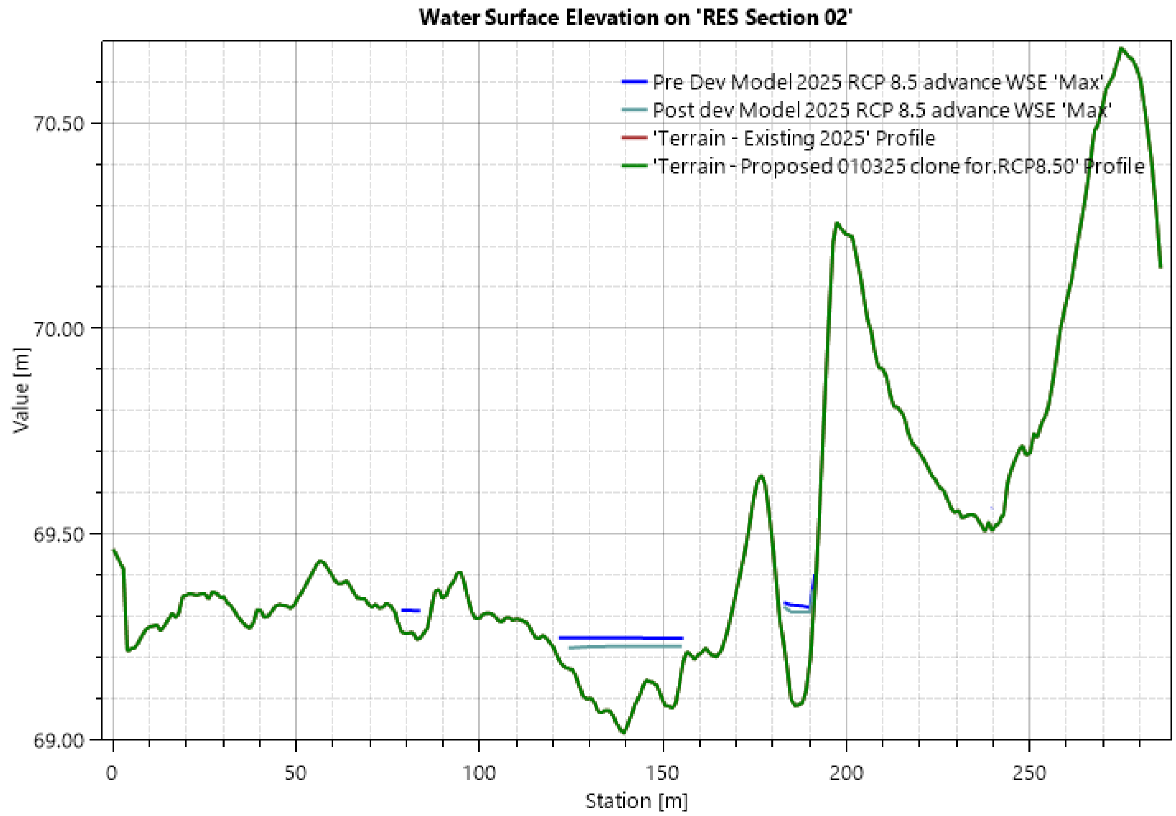
Selected: 'Terrain - PGL RV-RES-SF'
RV Section 02
N.E Basin
RV Section 03
RV Section 01
RV Section 04
S.E BASIN
(m)
540
152
108
89
75
63
51
19

HEC RAS RESULTS – SECTIONS PRE & POST

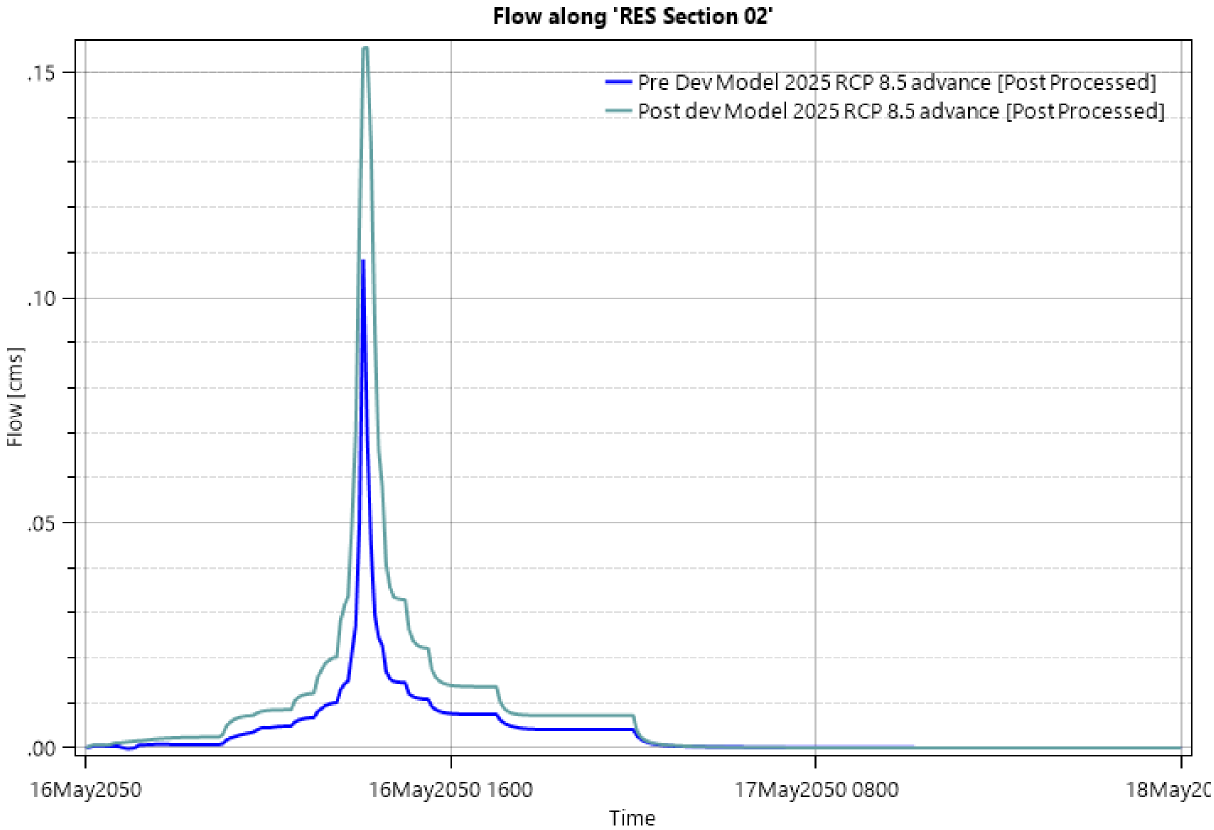




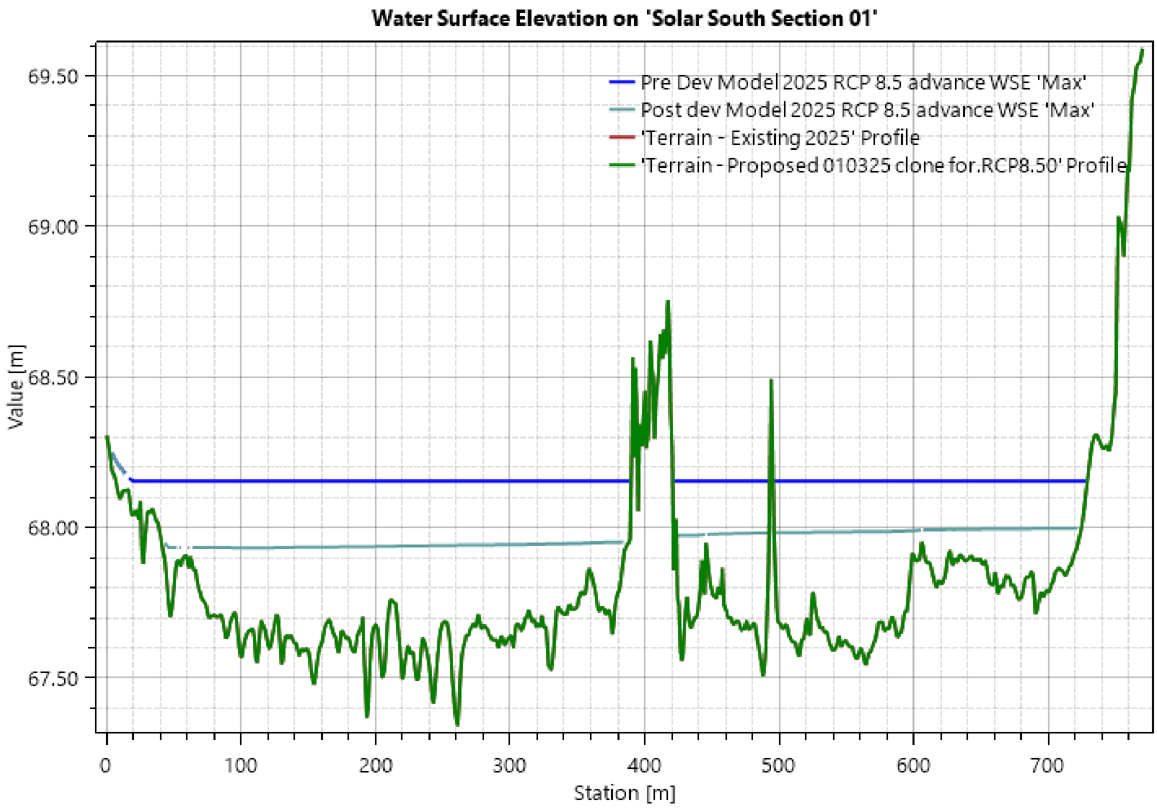
Flow along 'RES Section 01'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
1.00
0.80
0.60
0.40
0.20
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time



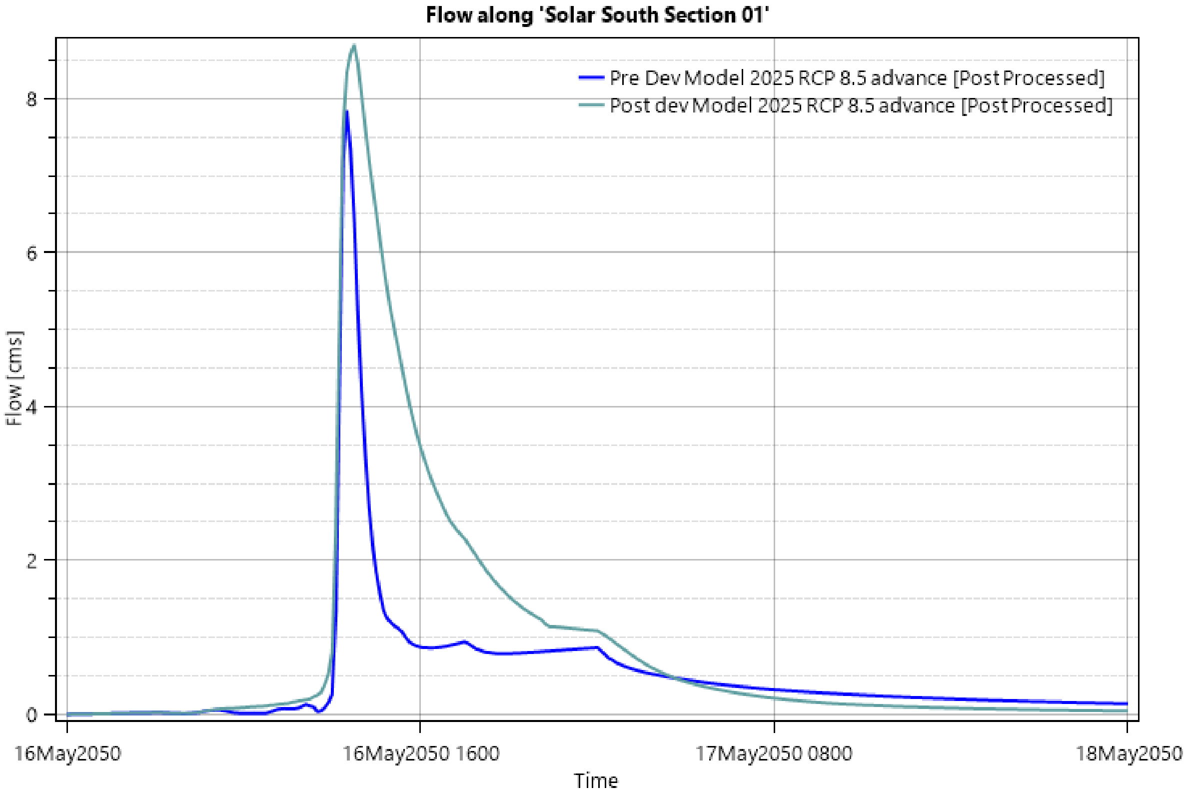
Water Surface Elevation on 'RES Section 02'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
70.50
70.00
69.50
69.00
0
50
100
150
200
250
Station [m]



Flow along 'RES Section 02'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
.15
.10
.05
.00
16May2050
16May2050 1600
17May2050 0800
18May20
Time

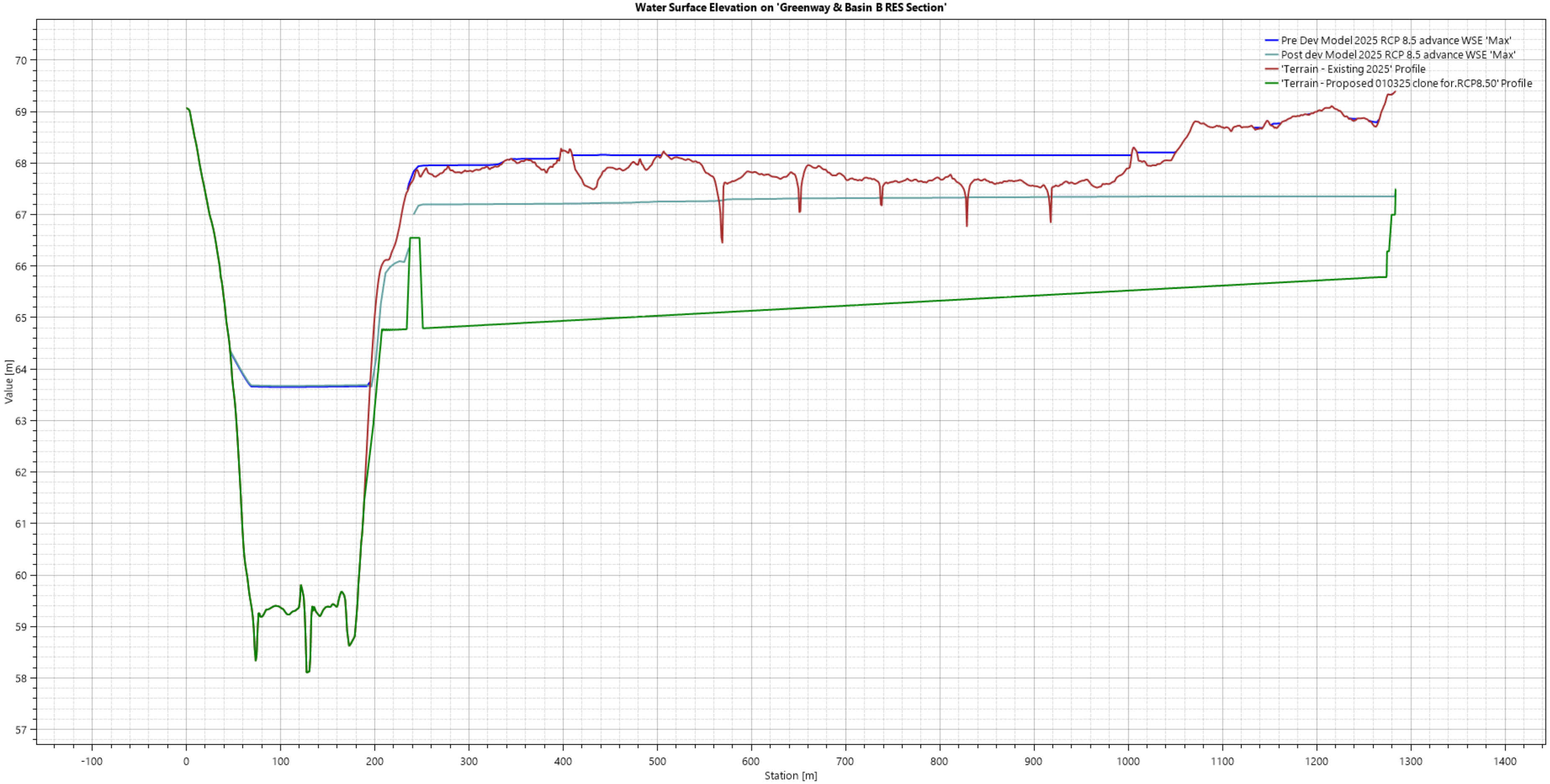


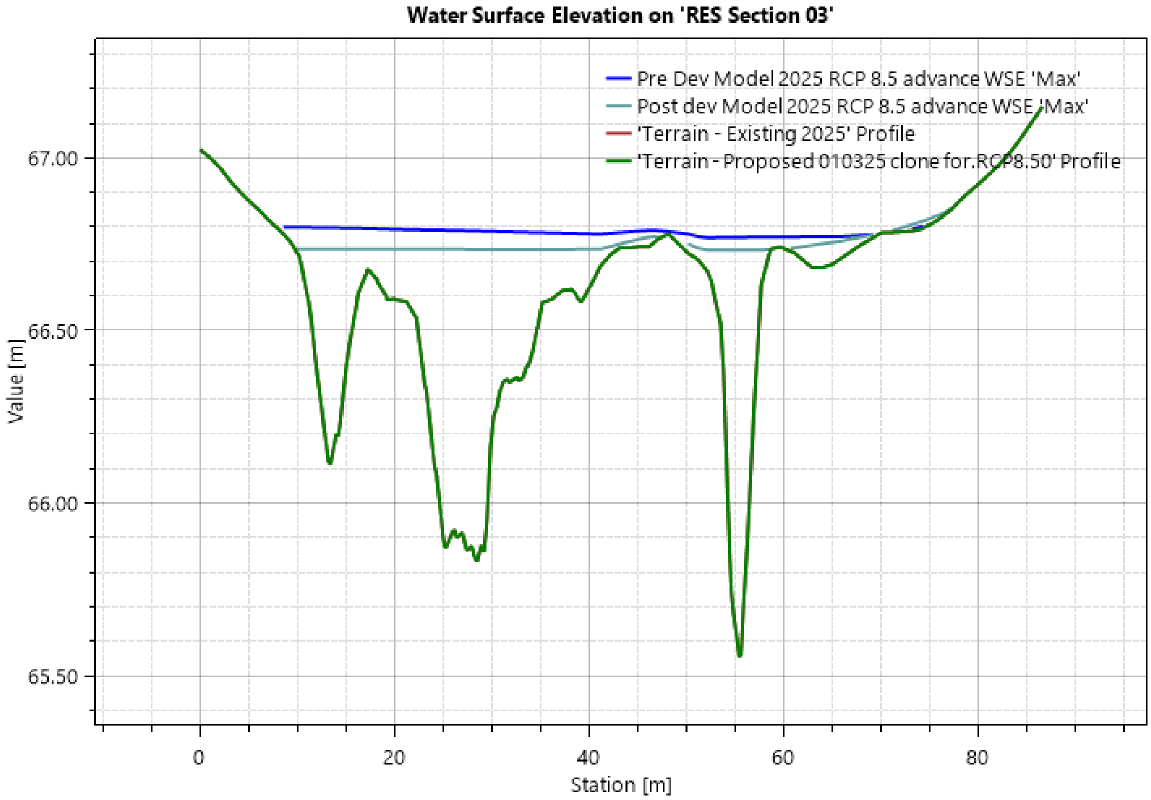
Water Surface Elevation on 'Solar South Section 01'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
69.50
69.00
68.50
68.00
67.50
0
100
200
300
400
500
600
700
Station [m]

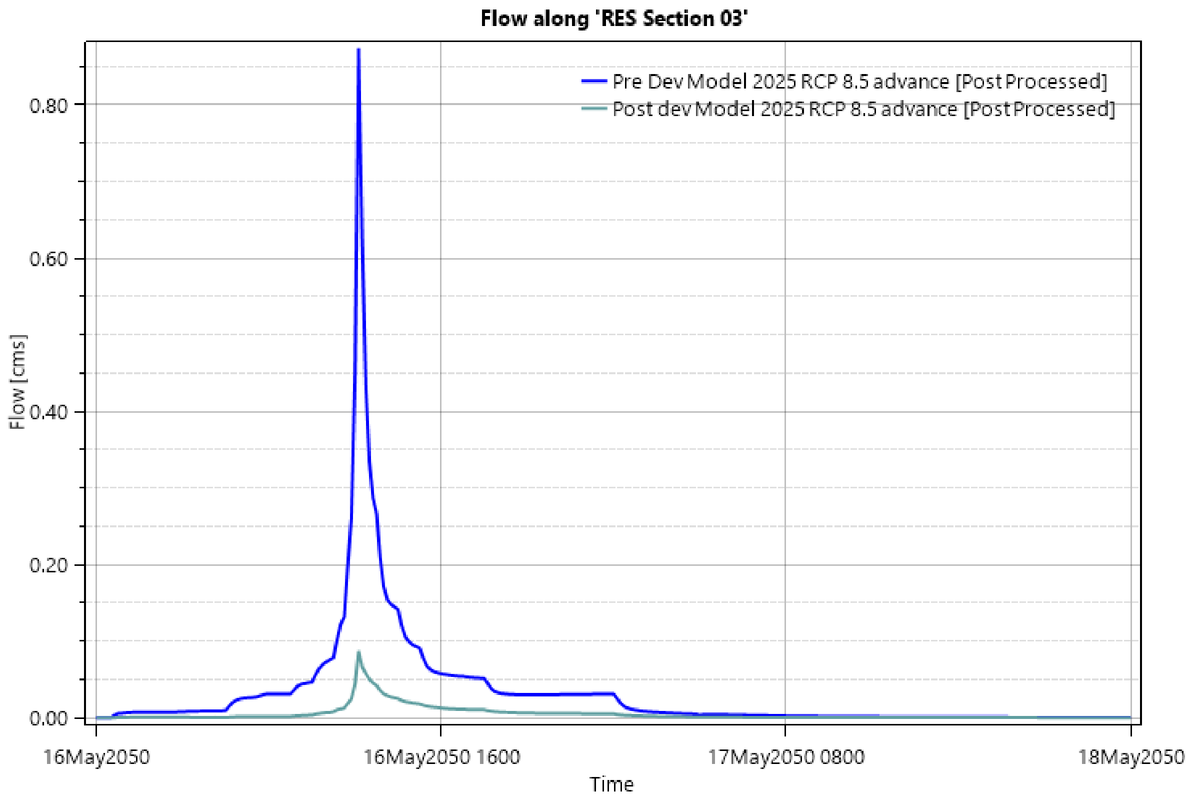


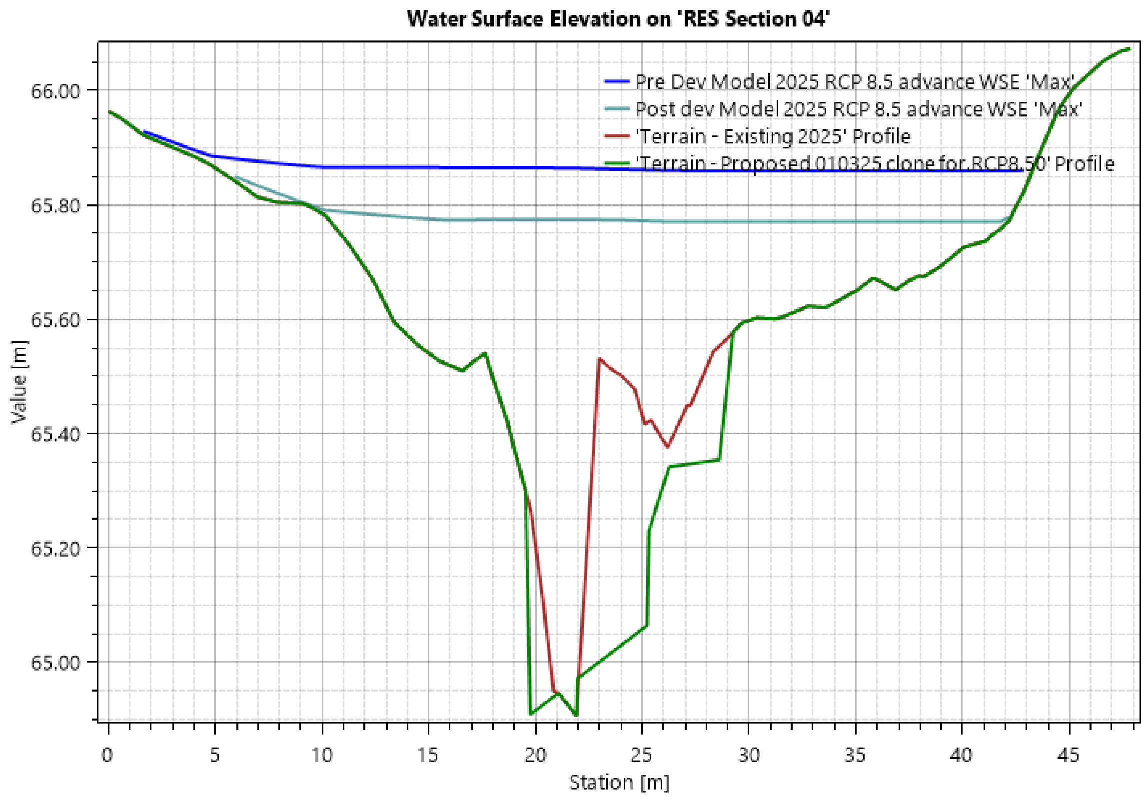
Flow along 'Solar South Section 01'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
0
2
4
6
8
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

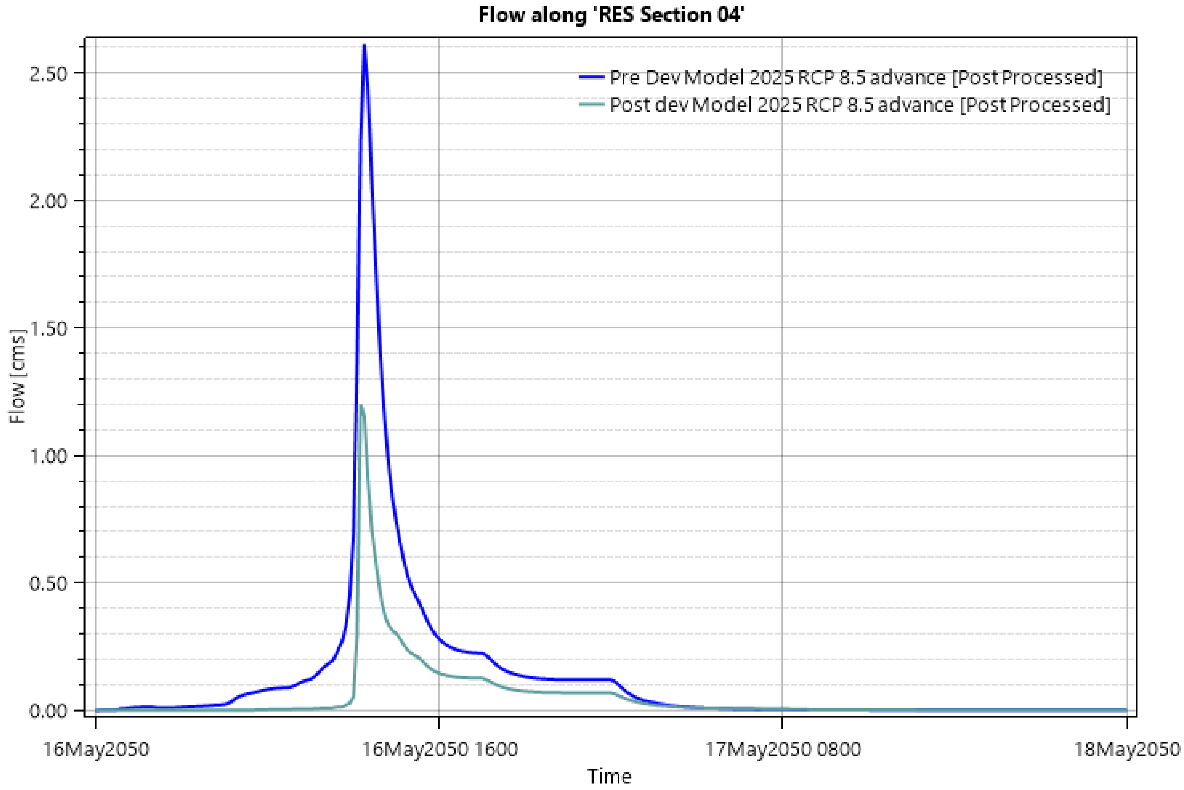
Water Surface Elevation on 'Greenway & Basin B RES Section'

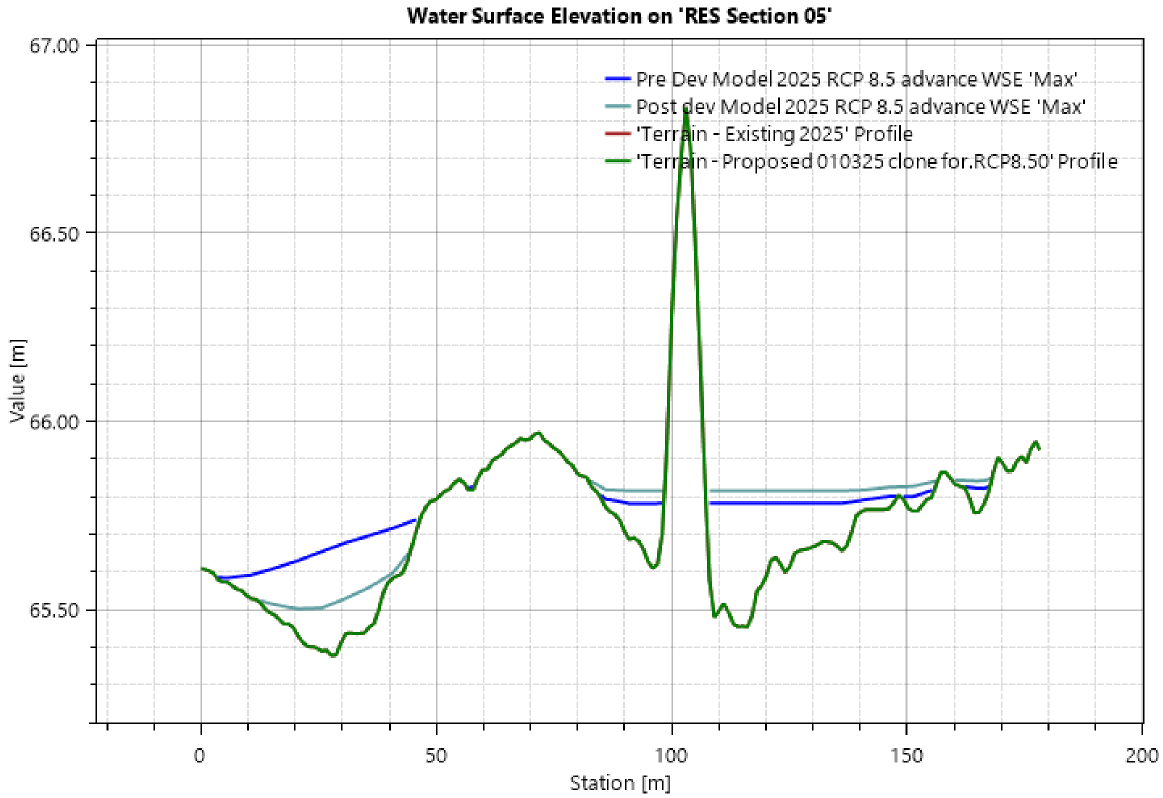


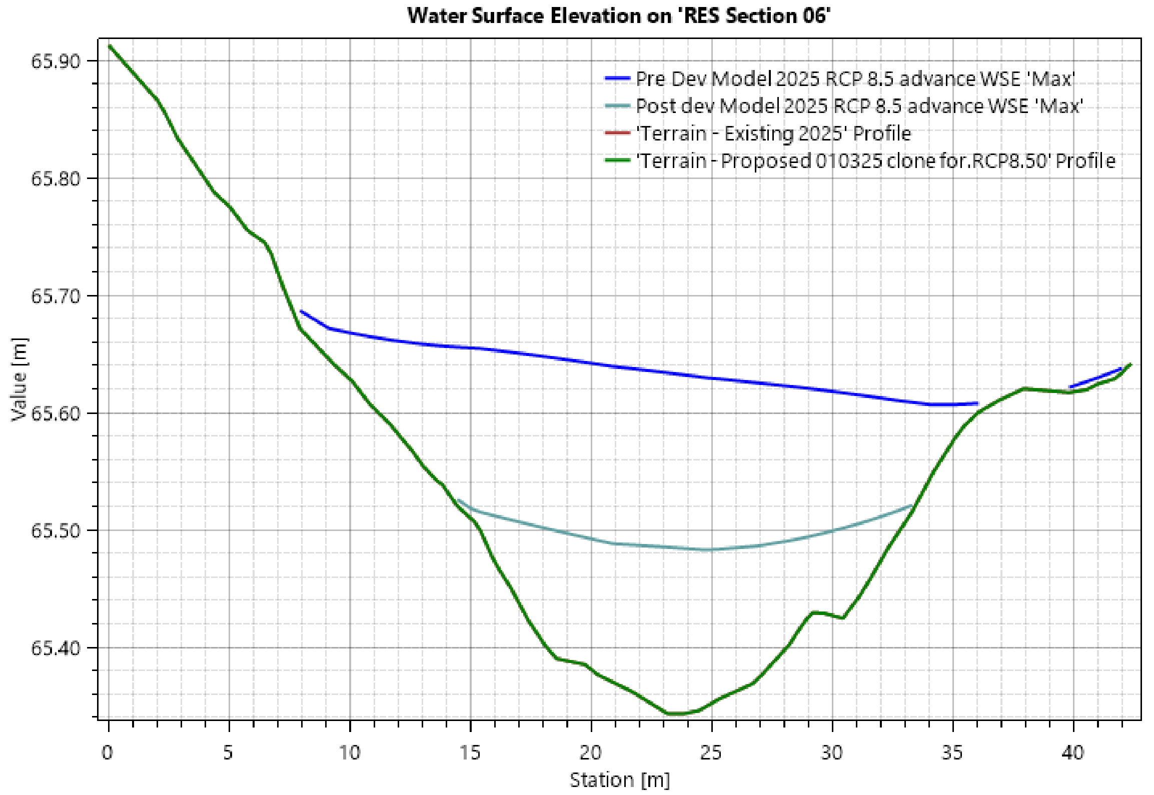

Water Surface Elevation on 'RES Section 03'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
67.00
66.50
66.00
65.50
0
20
40
60
80
Station [m]

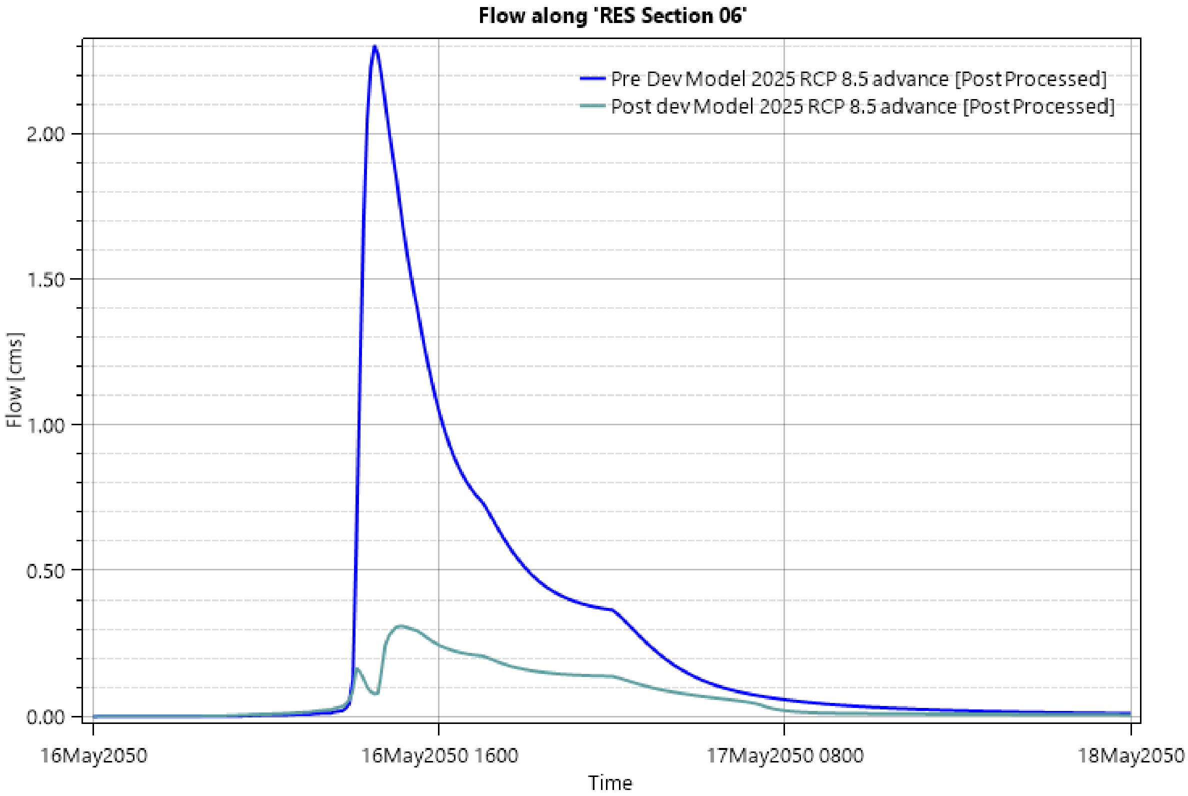

Flow along 'RES Section 03'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
0.80
0.60
0.40
0.20
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

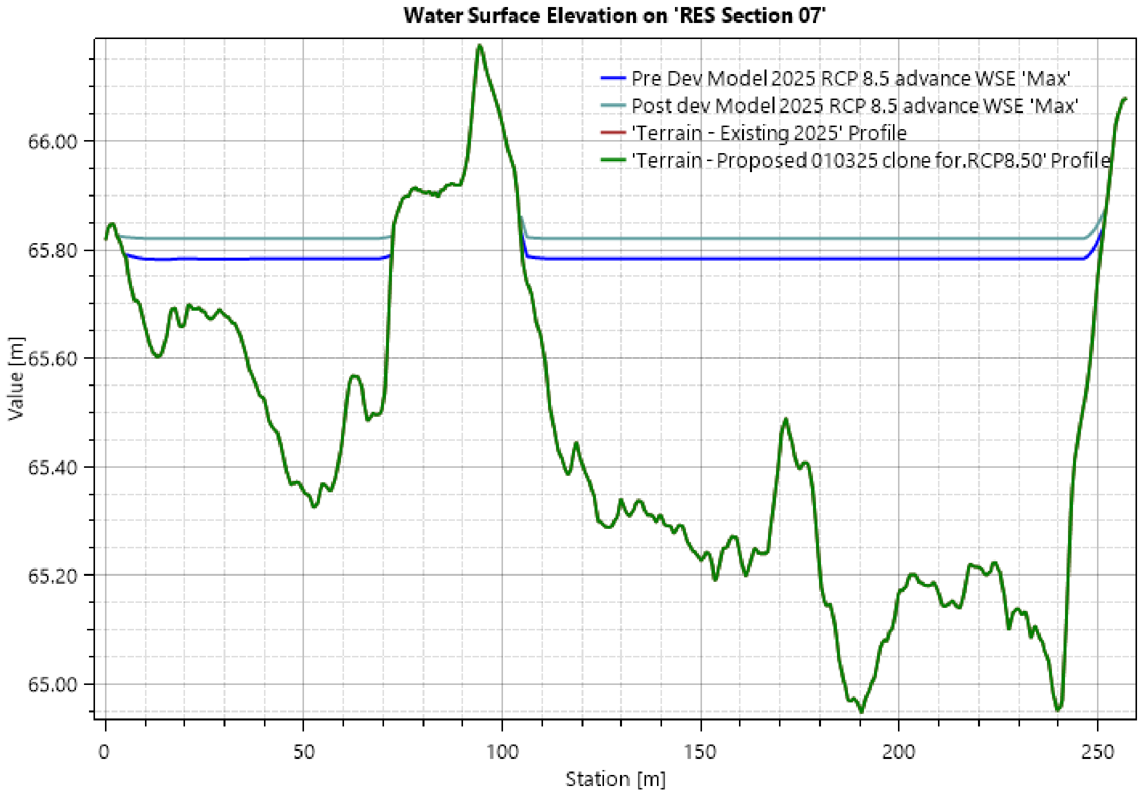

Water Surface Elevation on 'RES Section 04'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for RCP8.50' Profile
Value [m]
Station [m]
66.00
65.80
65.60
65.40
65.20
65.00
0
5
10
15
20
25
30
35
40
45

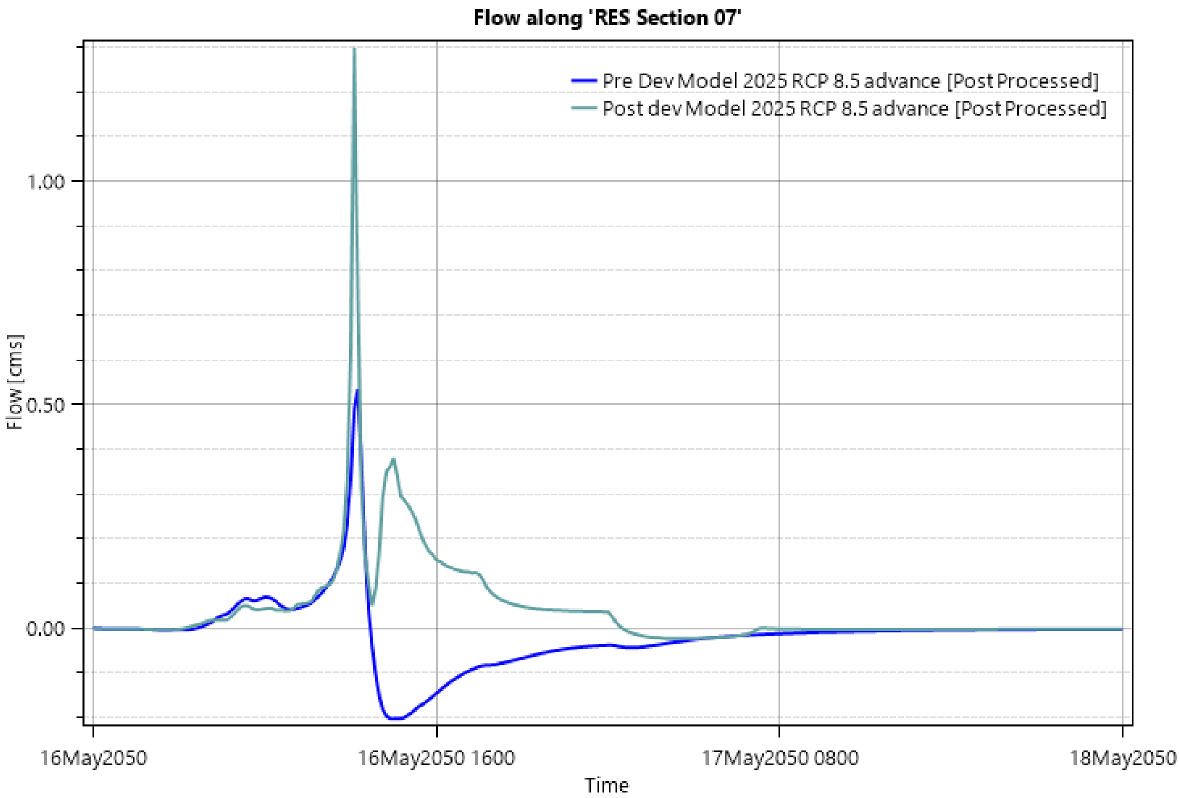

Flow along 'RES Section 04'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
Time
2.50
2.00
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050

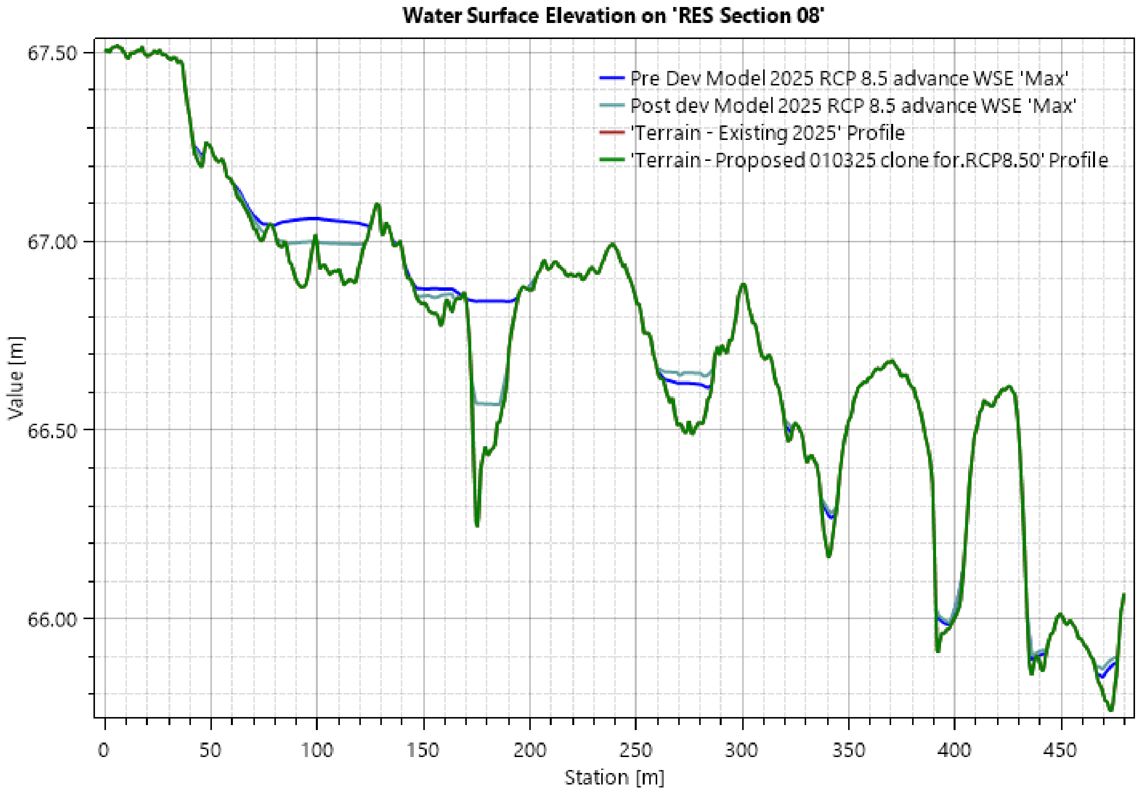

Water Surface Elevation on 'RES Section 05'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
67.00
66.50
66.00
65.50
0
50
100
150
200
Station [m]

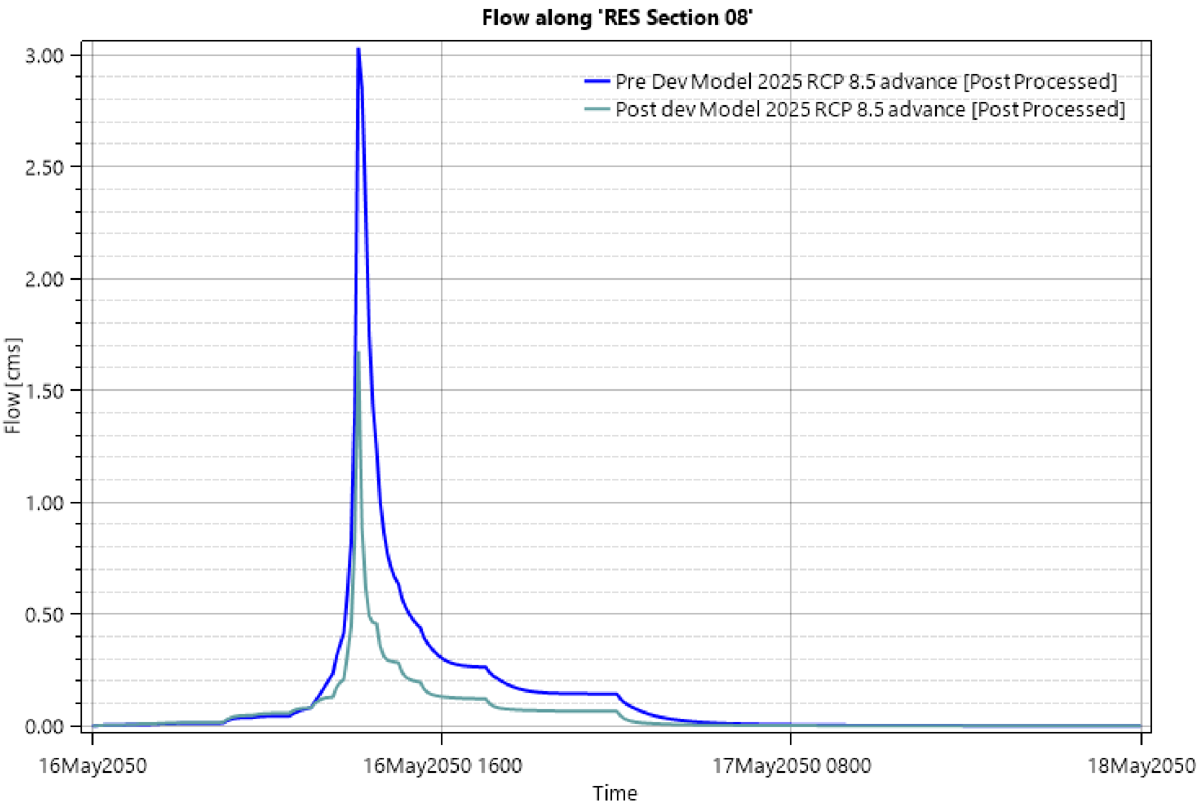

Water Surface Elevation on 'RES Section 06'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
65.90
65.80
65.70
65.60
65.50
65.40
0
5
10
15
20
25
30
35
40
Station [m]

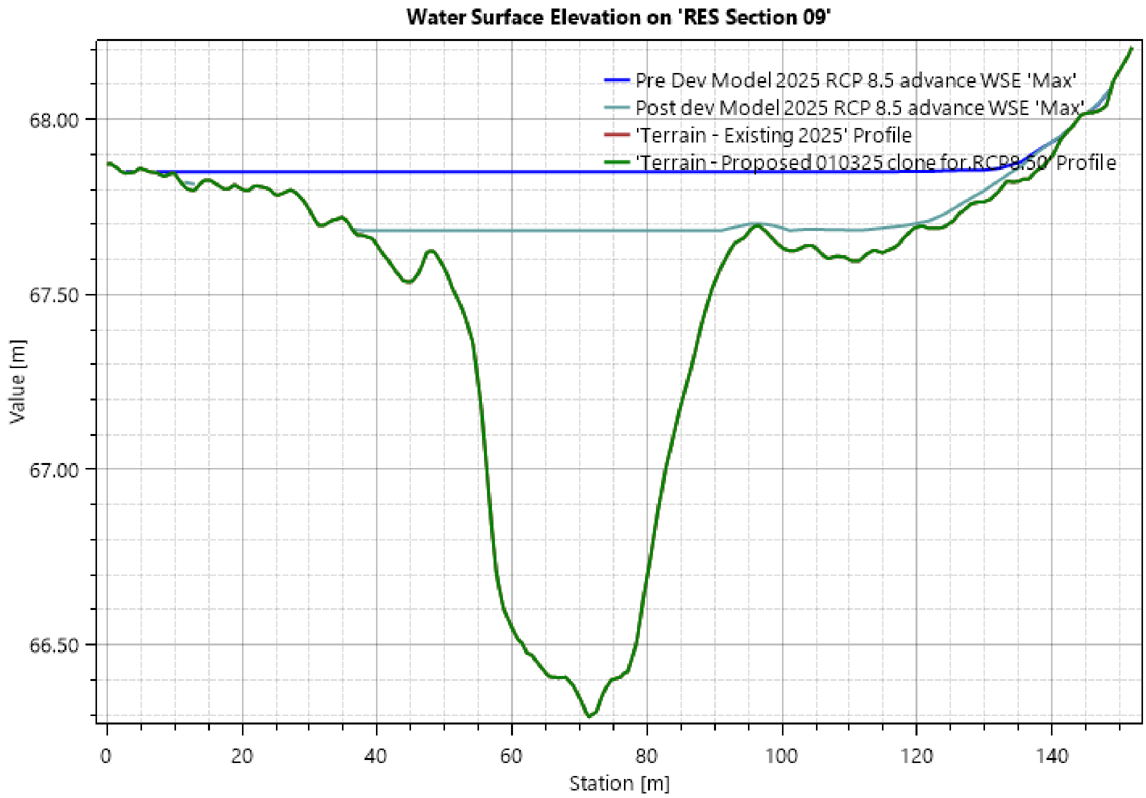

Flow along 'RES Section 06'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
2.00
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

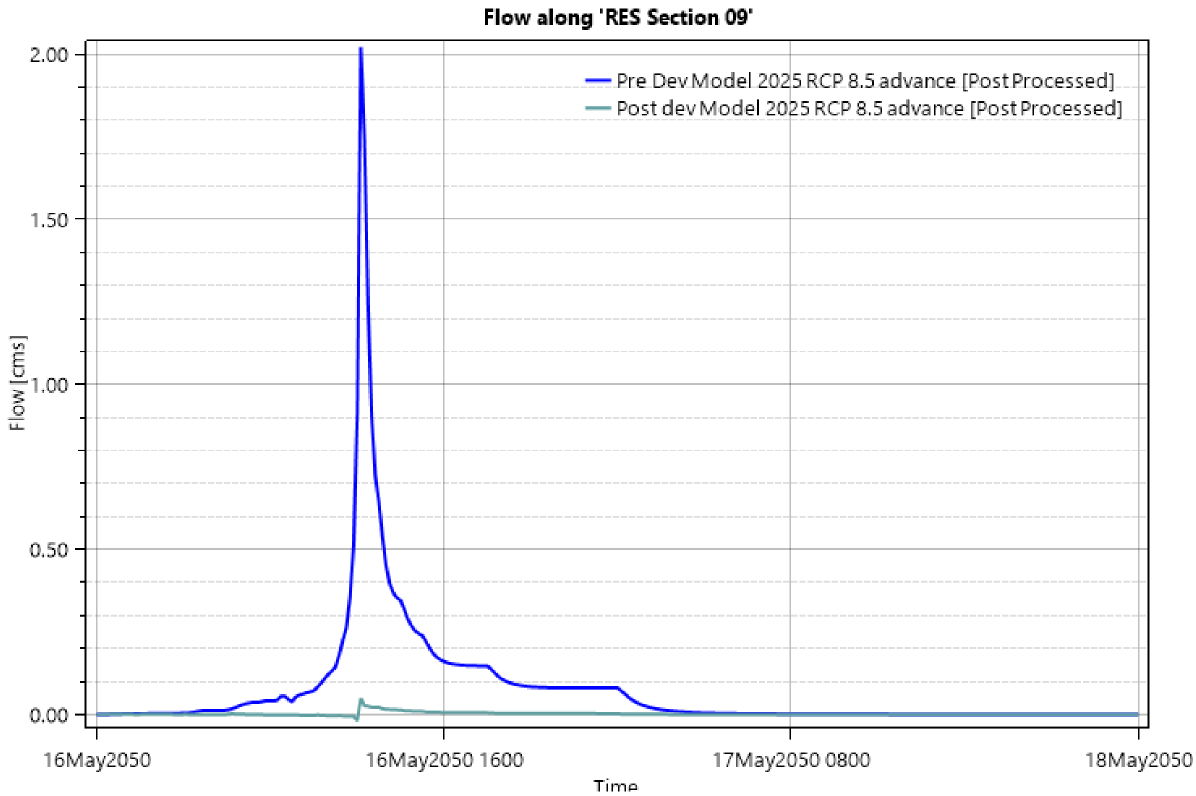

Water Surface Elevation on 'RES Section 07'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
66.00
65.80
65.60
65.40
65.20
65.00
0
50
100
150
200
250
Station [m]

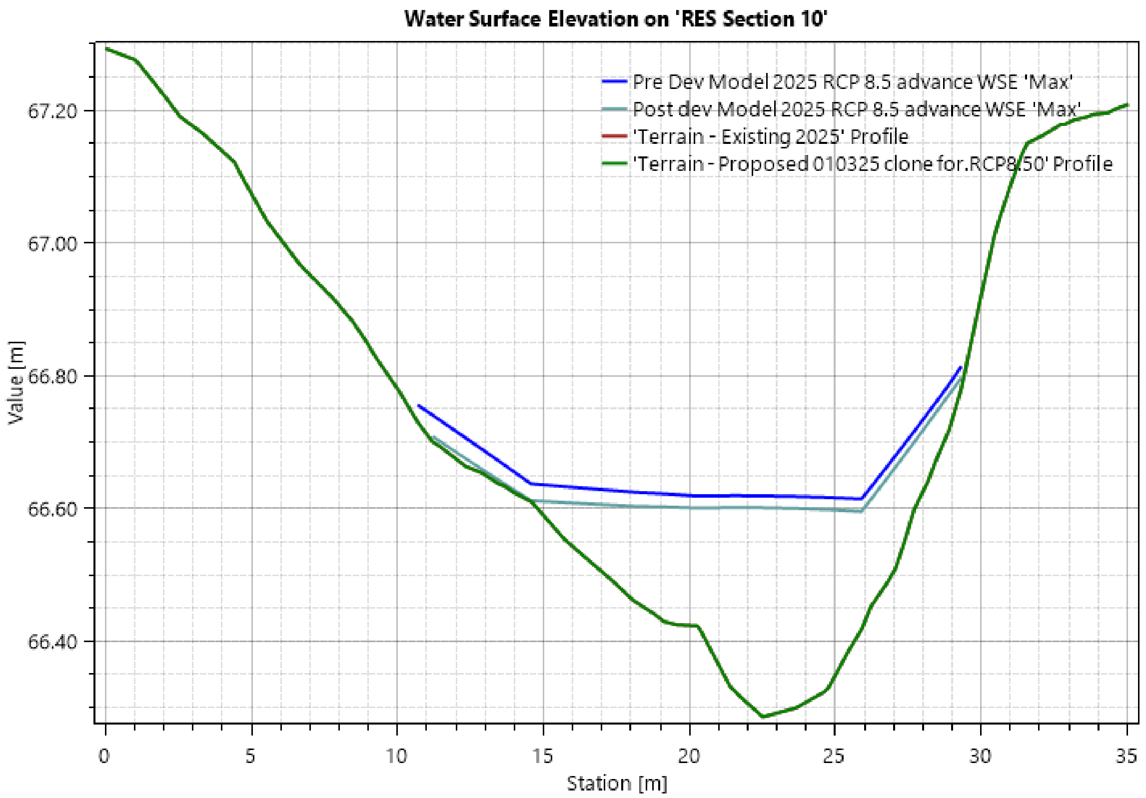

Flow along 'RES Section 07'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

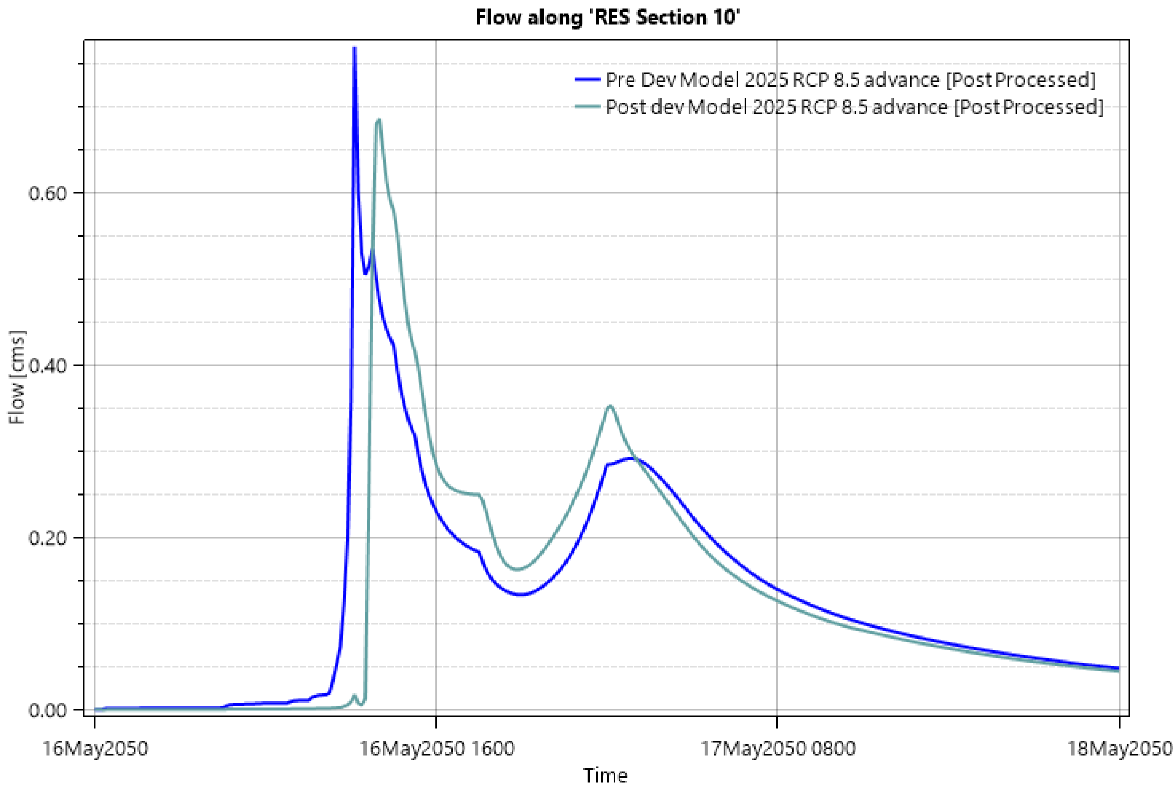

Water Surface Elevation on 'RES Section 08'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
67.50
67.00
66.50
66.00
0
50
100
150
200
250
300
350
400
450
Station [m]

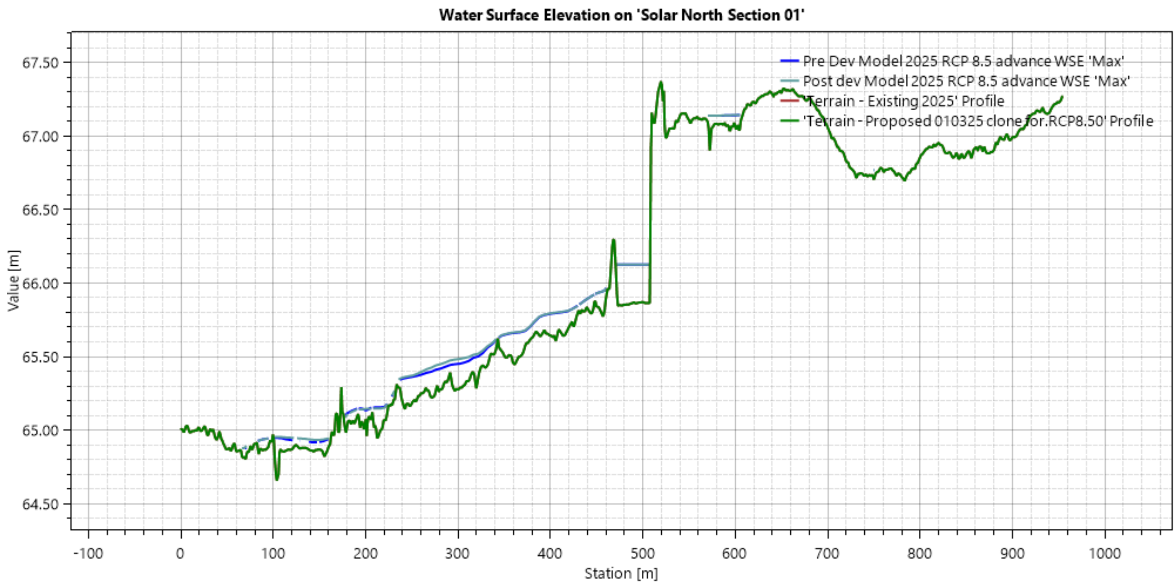

Flow along 'RES Section 08'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
3.00
2.50
2.00
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

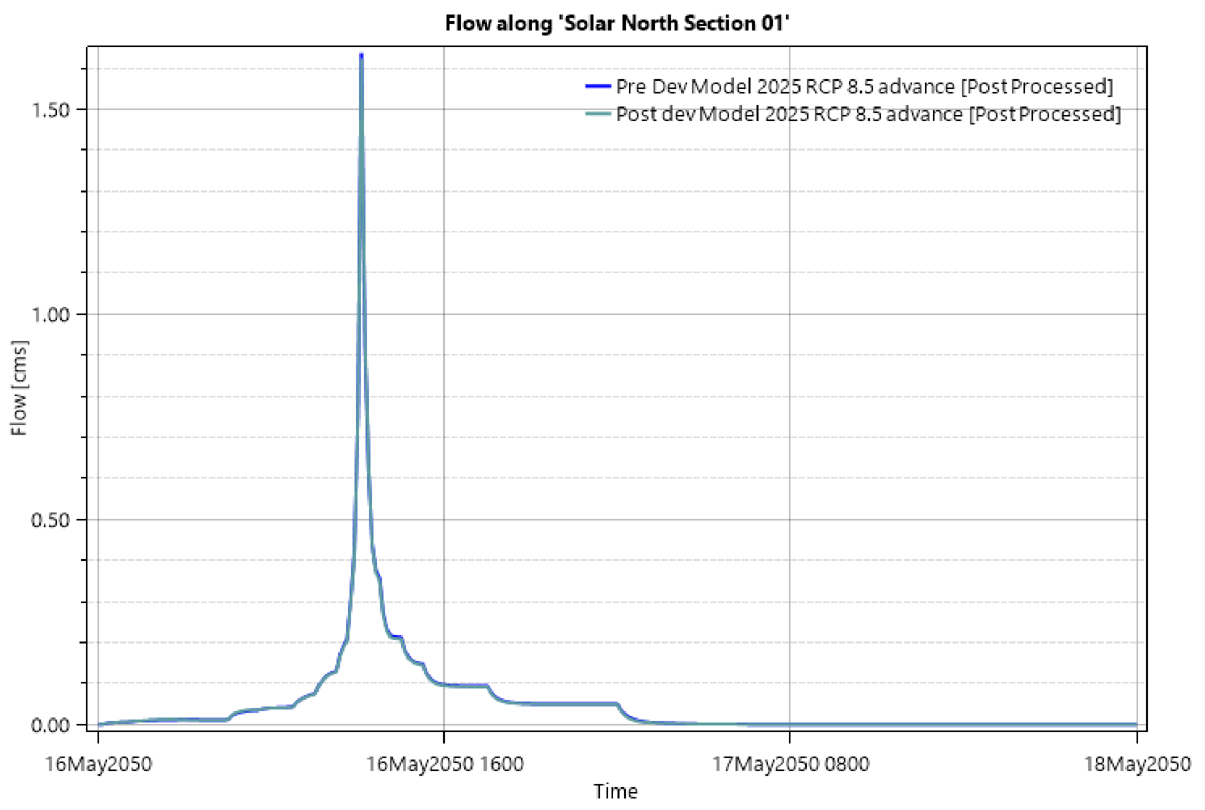

Water Surface Elevation on 'RES Section 09'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for RCP8.50' Profile
Value [m]
68.00
67.50
67.00
66.50
0
20
40
60
80
100
120
140
Station [m]

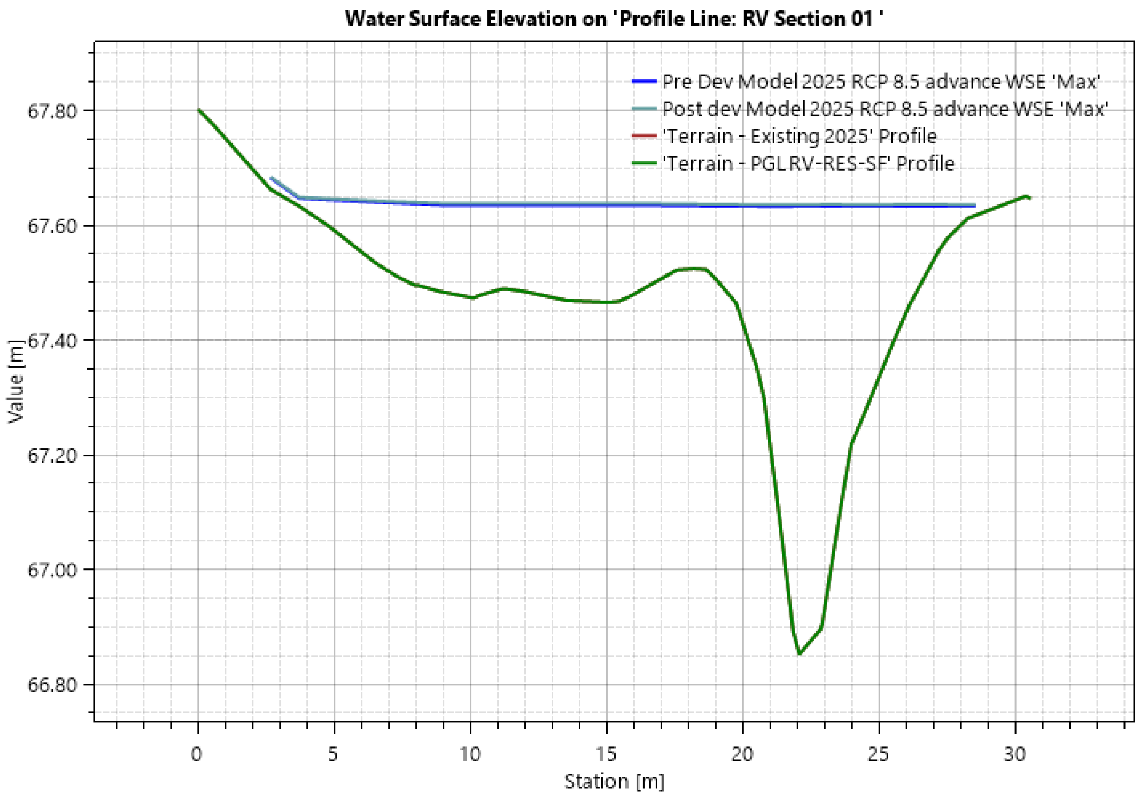

Flow along 'RES Section 09'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
2.00
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

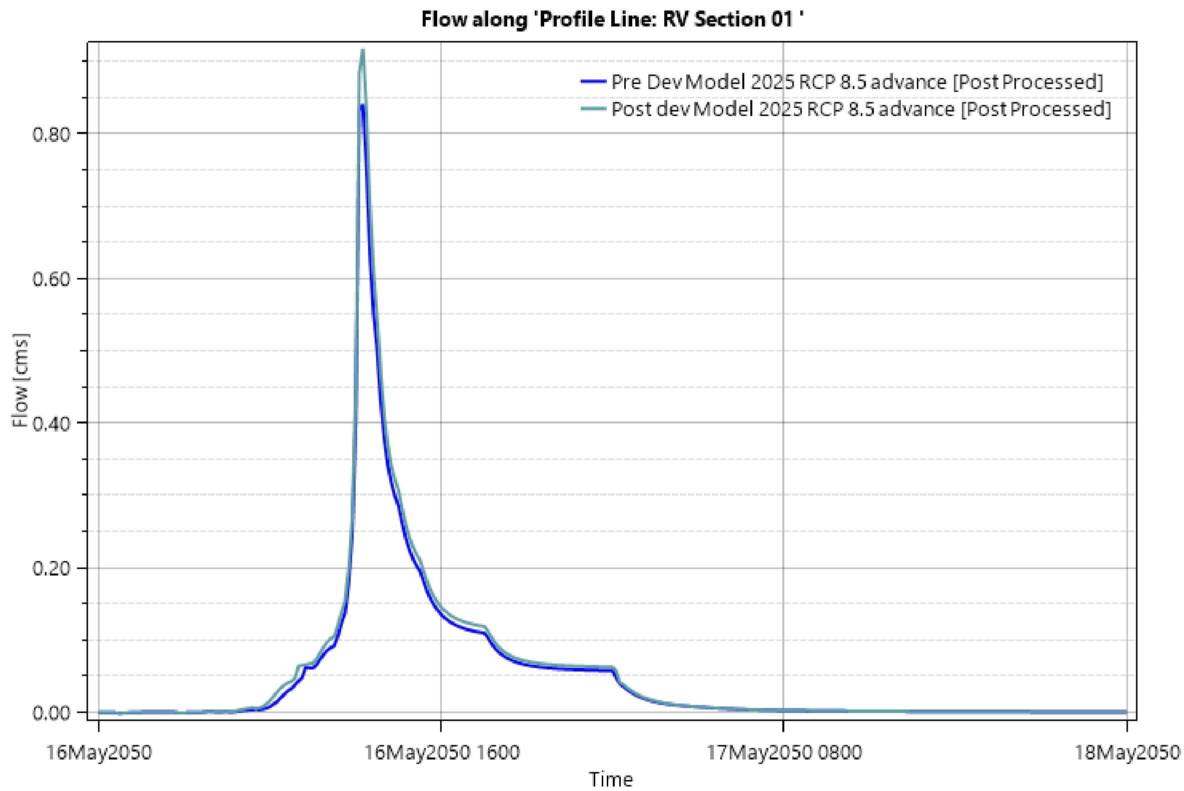

Water Surface Elevation on 'RES Section 10'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
67.20
67.00
66.80
66.60
66.40
0
5
10
15
20
25
30
35
Station [m]

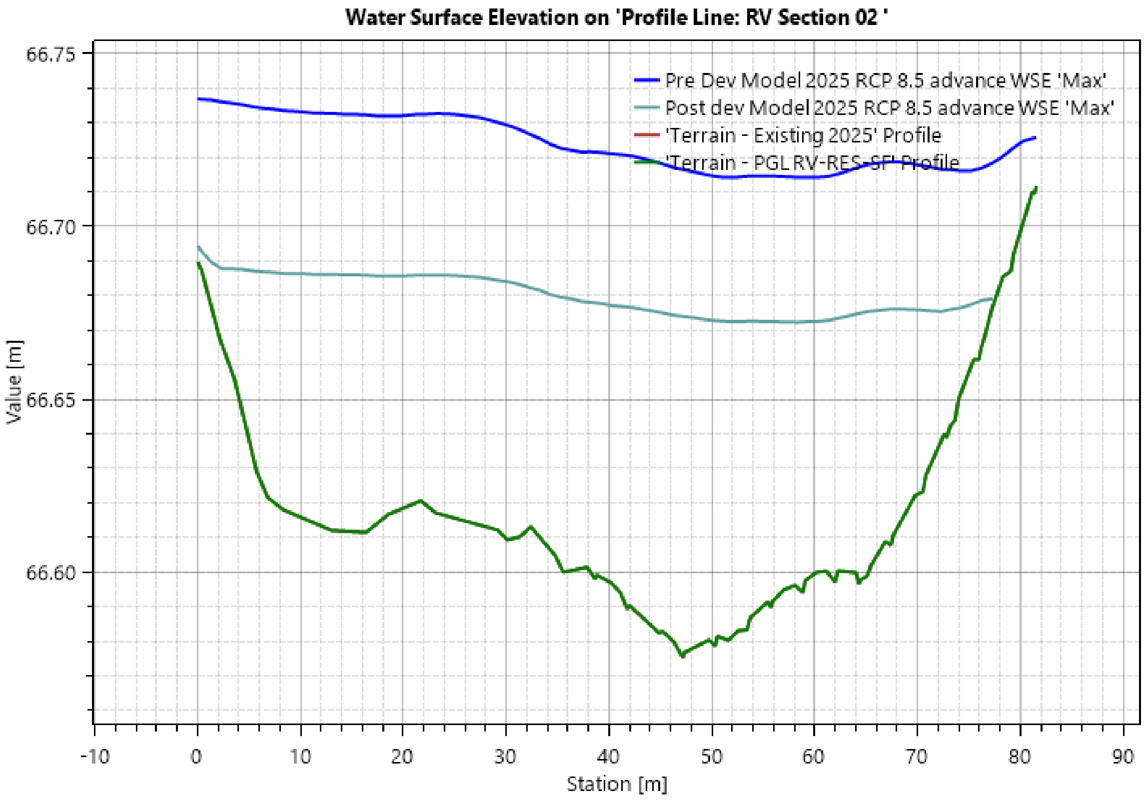

Flow along 'RES Section 10'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
0.60
0.40
0.20
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time


Water Surface Elevation on 'Solar North Section 01'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
Station [m]
67.50
67.00
66.50
66.00
65.50
65.00
64.50
-100
0
100
200
300
400
500
600
700
800
900
1000

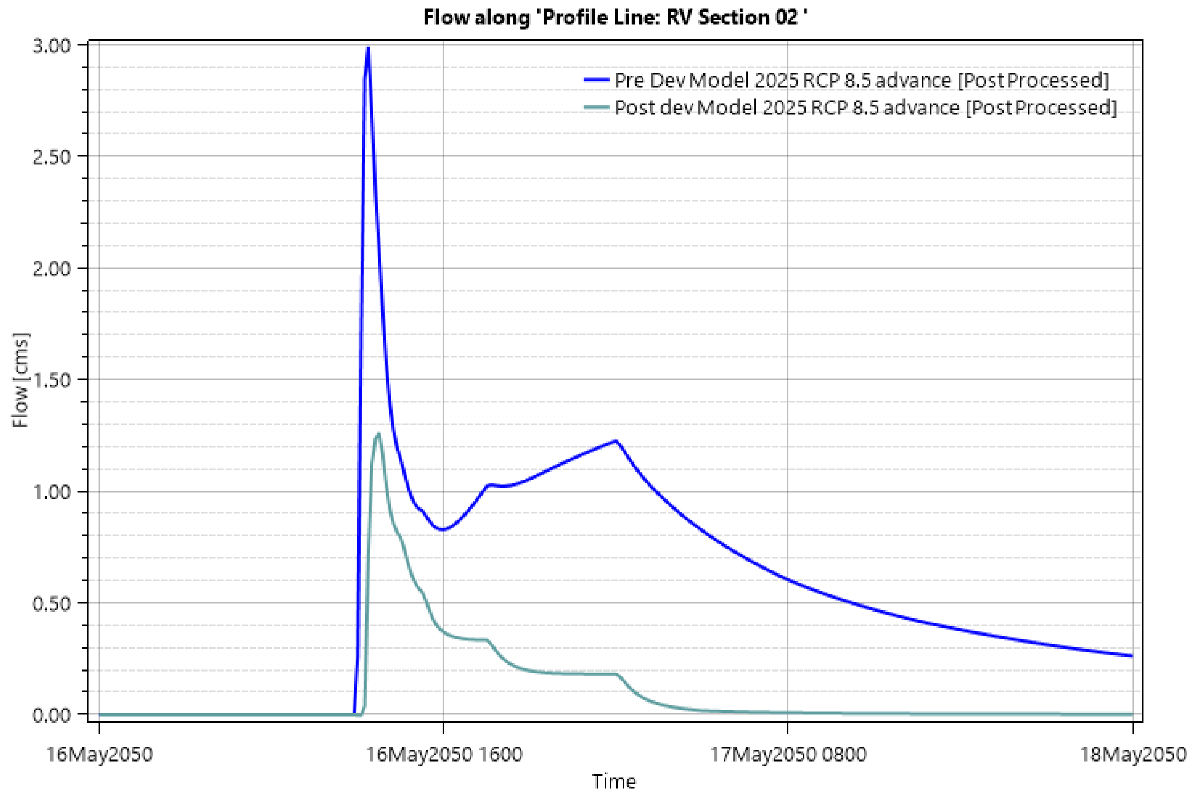

Flow along 'Solar North Section 01'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
Time
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050


Water Surface Elevation on 'Profile Line: RV Section 01 '
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - PGL RV-RES-SF' Profile
Value [m]
67.80
67.60
67.40
67.20
67.00
66.80
0
5
10
15
20
25
30
Station [m]

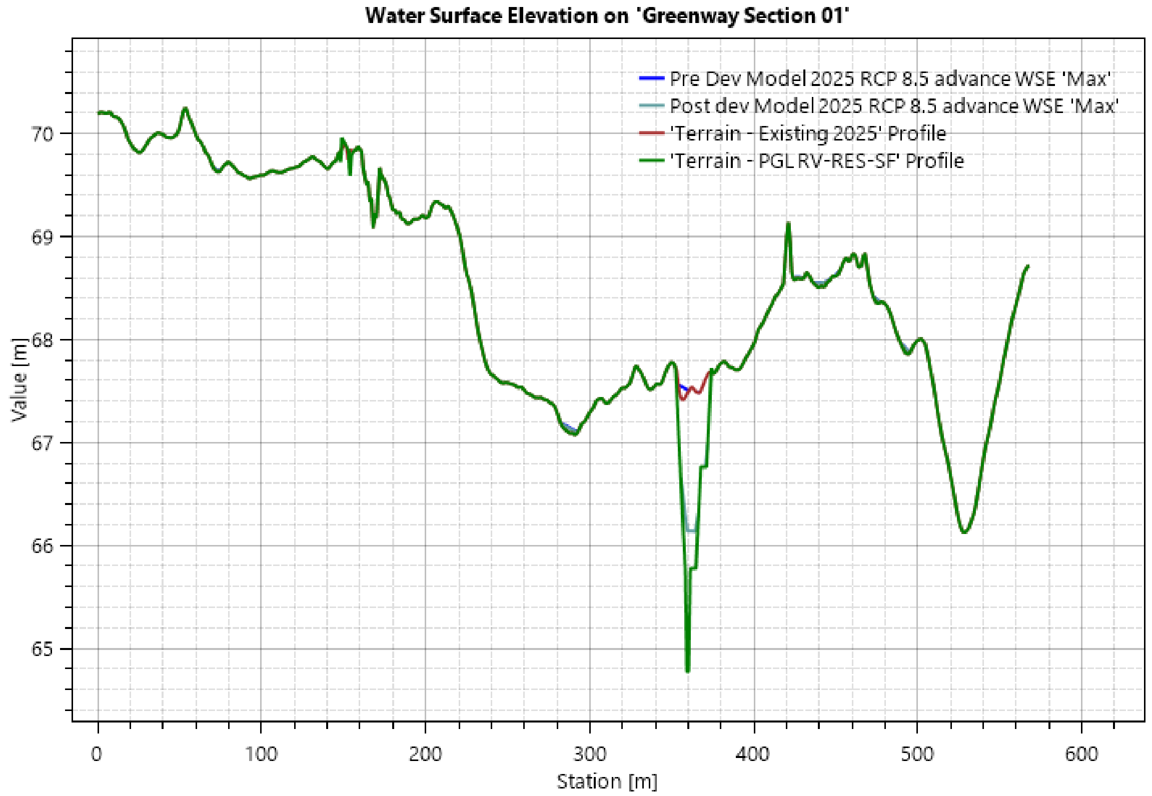

Flow along 'Profile Line: RV Section 01 '
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
0.80
0.60
0.40
0.20
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

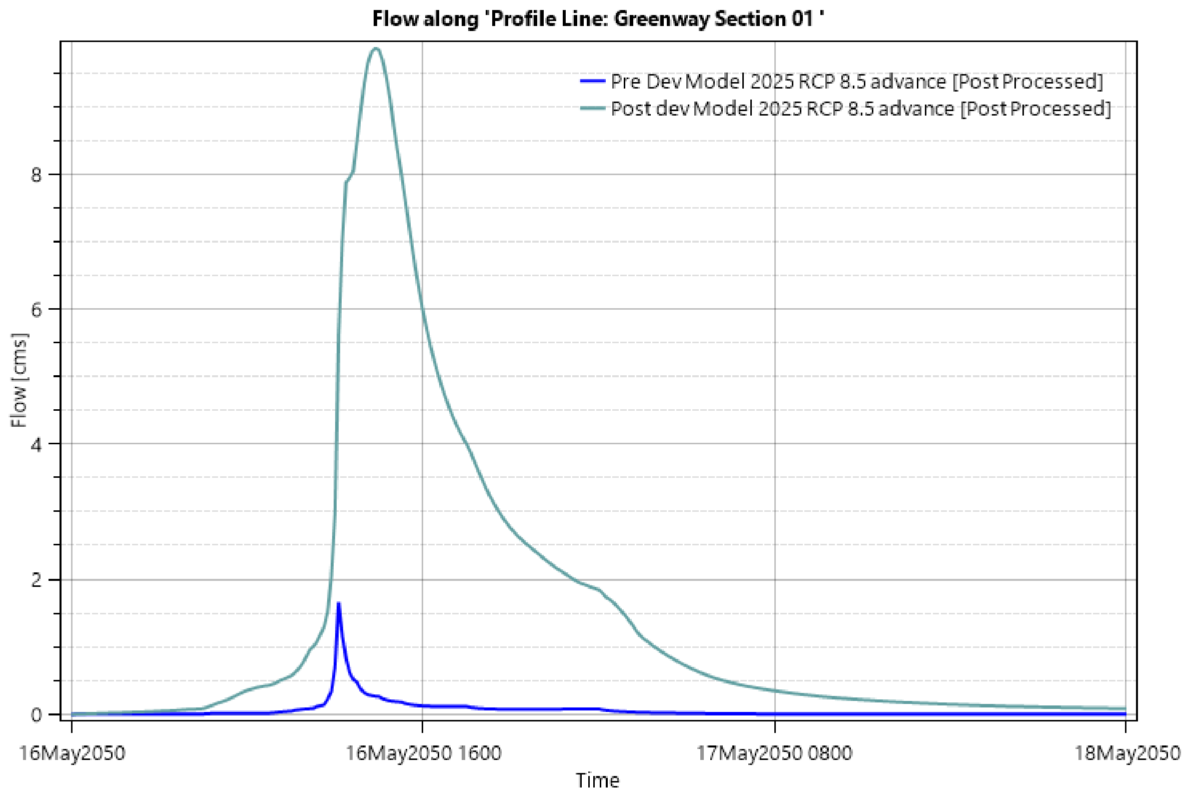


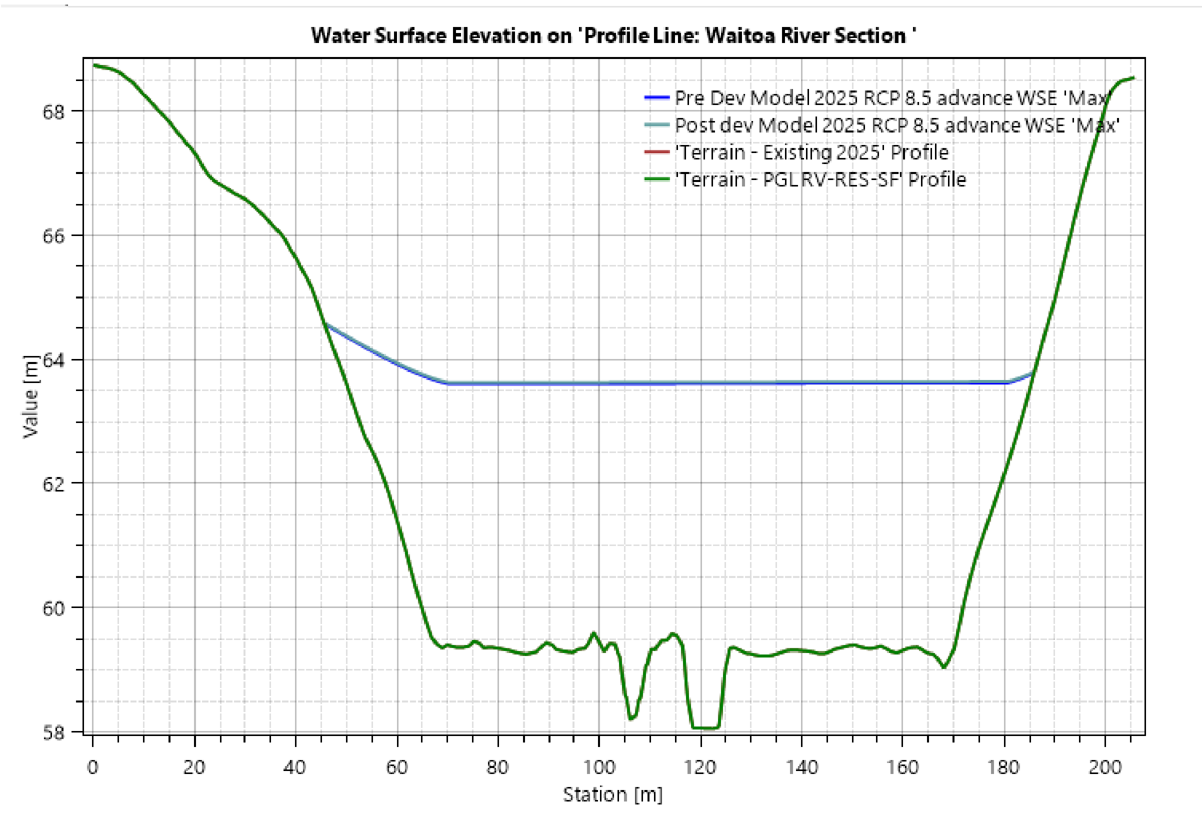
Water Surface Elevation on 'Profile Line: RV Section 02 '
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - PGL RV-RES-SF' Profile
Value [m]
66.75
66.70
66.65
66.60
-10
0
10
20
30
40
50
60
70
80
90
Station [m]

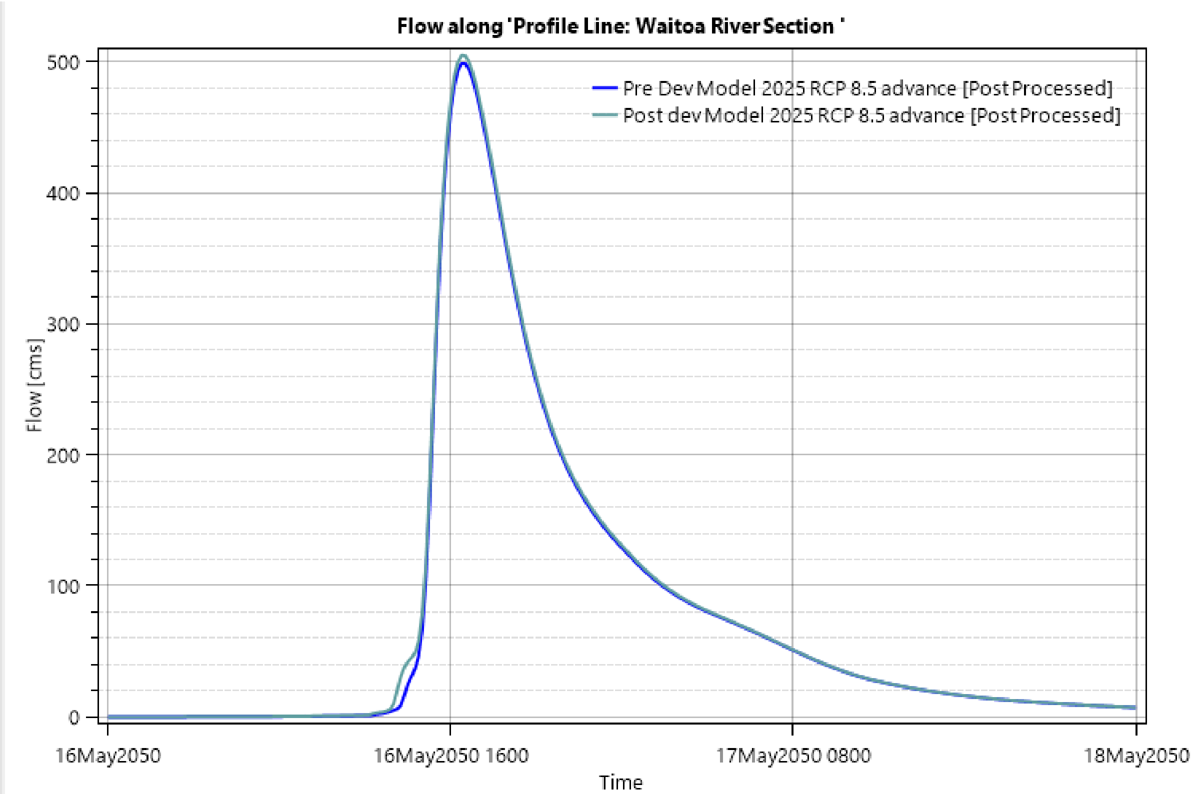


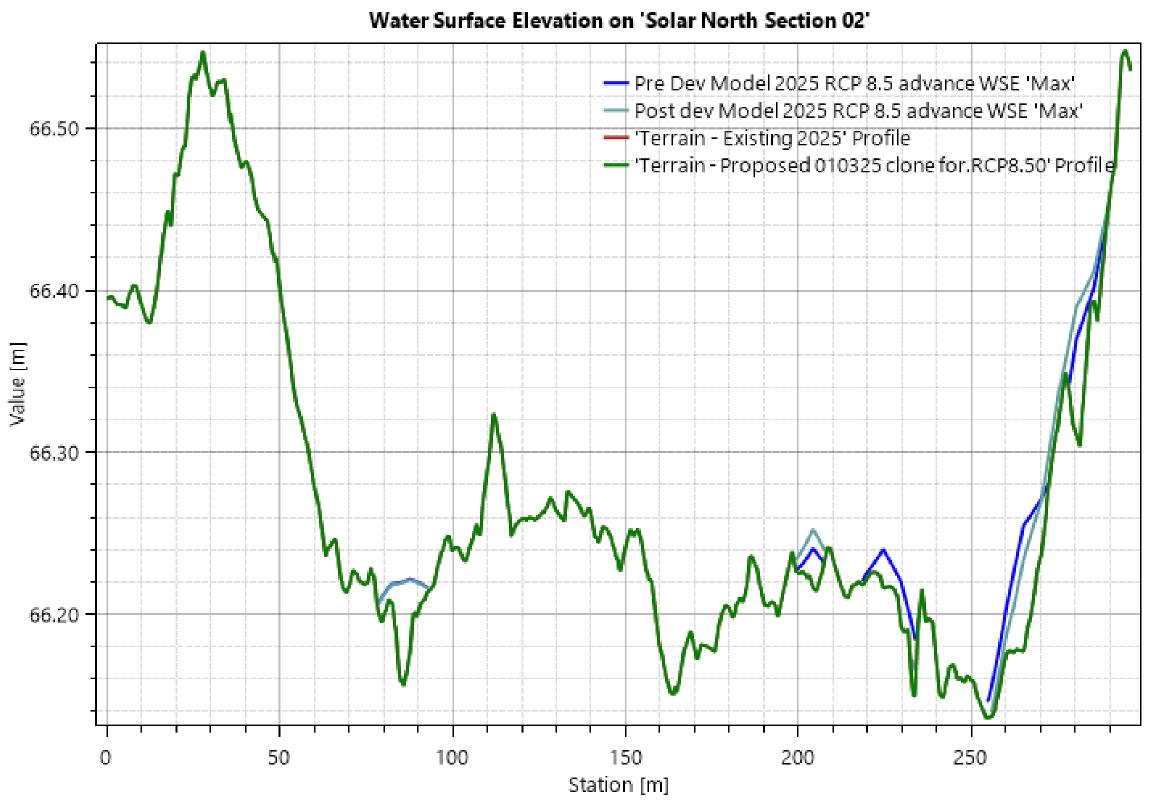
Flow along 'Profile Line: RV Section 02 '
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
3.00
2.50
2.00
1.50
1.00
0.50
0.00
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

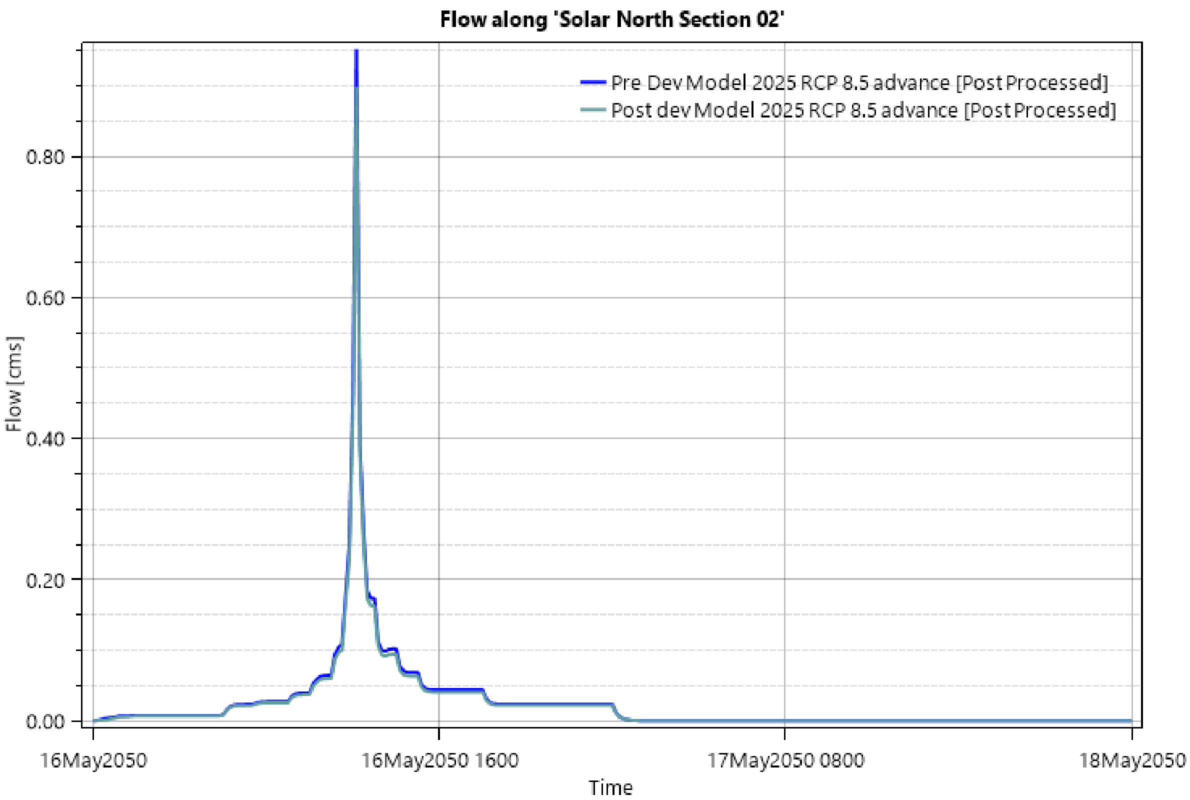

Water Surface Elevation on 'Greenway Section 01'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - PGL RV-RES-SF' Profile
Value [m]
70
69
68
67
66
65
0
100
200
300
400
500
600
Station [m]

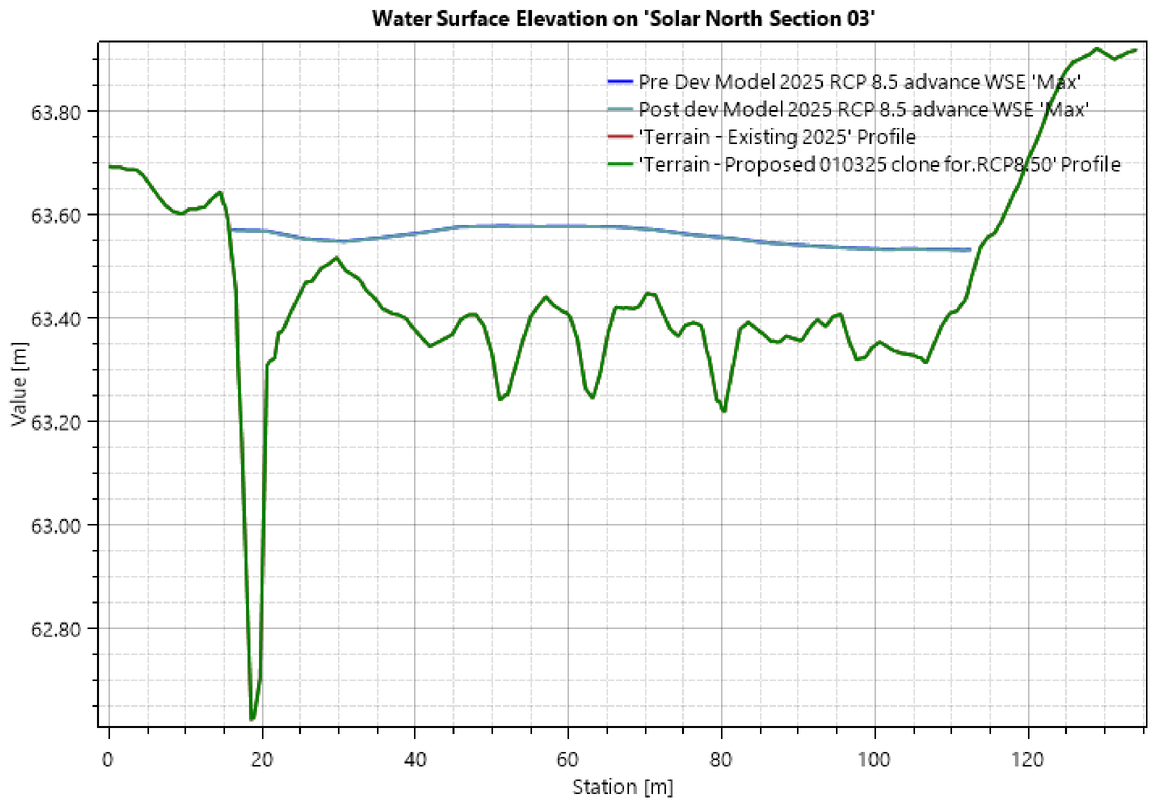

Flow along 'Profile Line: Greenway Section 01 '
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
8
6
4
2
0
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

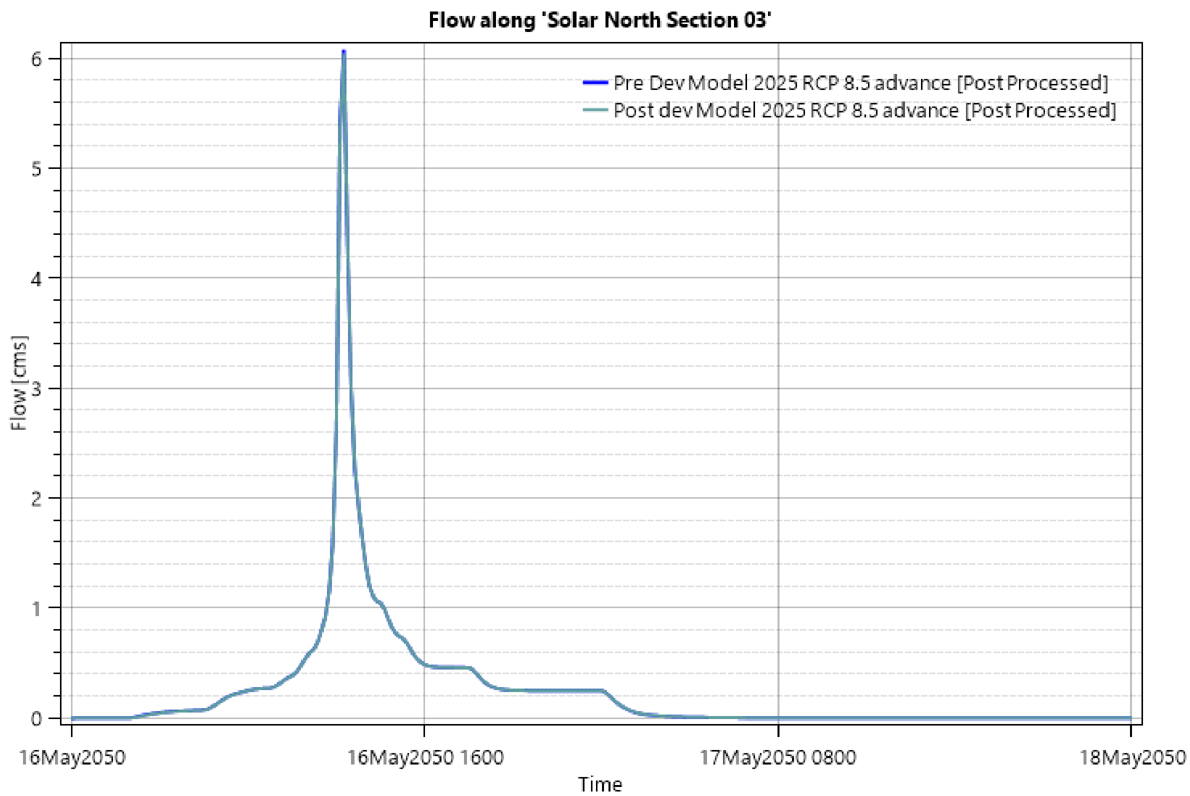

Water Surface Elevation on 'Profile Line: Waitoa River Section '
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - PGLRV-RES-SF' Profile
Value [m]
Station [m]
68
66
64
62
60
58
0
20
40
60
80
100
120
140
160
180
200


Flow along 'Profile Line: Waitoa River Section '
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
Time
500
400
300
200
100
0
16May2050
16May2050 1600
17May2050 0800
18May2050


Water Surface Elevation on 'Solar North Section 02'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
66.50
66.40
66.30
66.20
Value [m]
0
50
100
150
200
250
Station [m]


Flow along 'Solar North Section 02'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
0.80
0.60
0.40
0.20
0.00
Flow [cms]
16May2050
16May2050 1600
17May2050 0800
18May2050
Time


Water Surface Elevation on 'Solar North Section 03'
Pre Dev Model 2025 RCP 8.5 advance WSE 'Max'
Post dev Model 2025 RCP 8.5 advance WSE 'Max'
'Terrain - Existing 2025' Profile
'Terrain - Proposed 010325 clone for.RCP8.50' Profile
Value [m]
63.80
63.60
63.40
63.20
63.00
62.80
0
20
40
60
80
100
120
Station [m]


Flow along 'Solar North Section 03'
Pre Dev Model 2025 RCP 8.5 advance [Post Processed]
Post dev Model 2025 RCP 8.5 advance [Post Processed]
Flow [cms]
6
5
4
3
2
1
0
16May2050
16May2050 1600
17May2050 0800
18May2050
Time

Channel Report

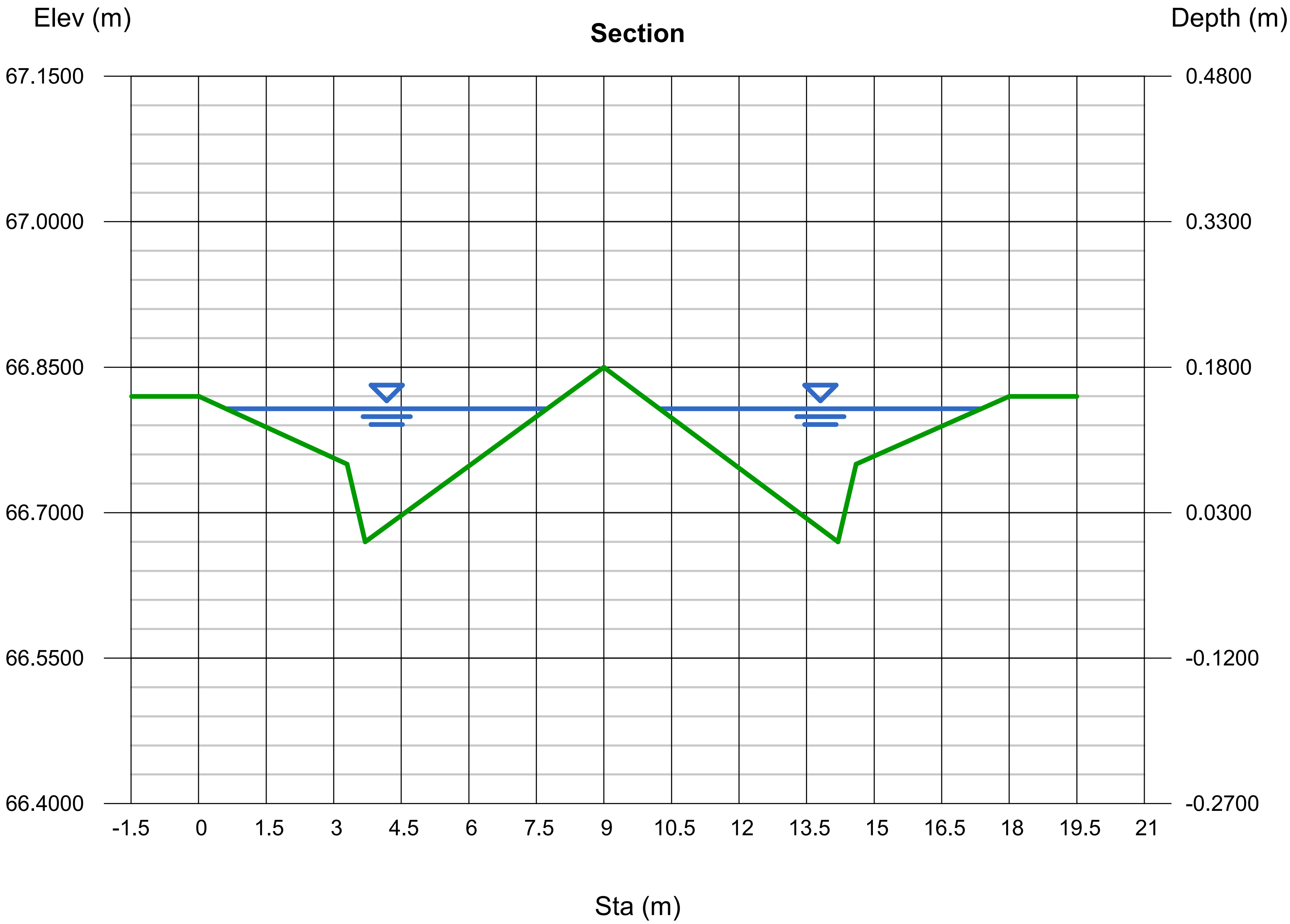
Catchemnt A Section 1

User-defined
Invert Elev (m) = 66.6700
Slope (%) = 0.7000
N-Value = 0.015

Calculations
Compute by: Known Q
Known Q (cms) = 0.6000

Highlighted
Depth (m) = 0.1372
Q (cms) = 0.6000
Area (sqm) = 0.7825
Velocity (m/s) = 0.7668
Wetted Perim (m) = 14.2849
Crit Depth, Yc (m) = 0.1402
Top Width (m) = 14.2631
EGL (m) = 0.1671

(Sta, El, n)-(Sta, El, n)...
(0.0100, 66.8200)-(3.3000, 66.7500, 0.015)-(3.7000, 66.6700, 0.015)-(9.0000, 66.8500, 0.015)-(14.2000, 66.6700, 0.015)-(14.6000, 66.7500, 0.015)-(18.0000, 66.82



Channel Report

Catchemnt A Section 2

User-defined

Invert Elev (m) = 66.5600
Slope (%) = 0.9000
N-Value = 0.015

Calculations

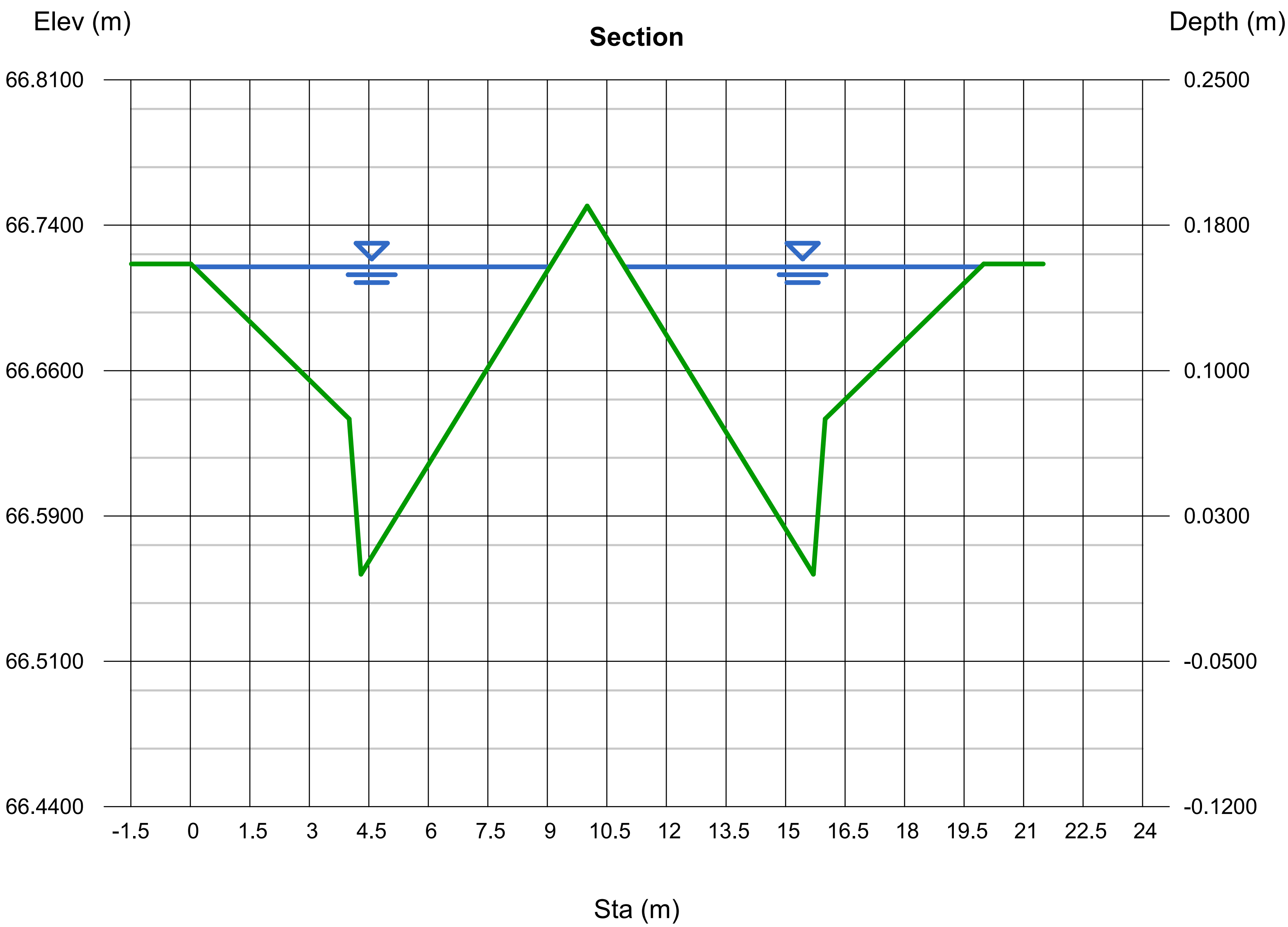
Compute by: Known Q
Known Q (cms) = 1.1000

Highlighted

Depth (m) = 0.1585
Q (cms) = 1.1000
Area (sqm) = 1.1324
Velocity (m/s) = 0.9714
Wetted Perim (m) = 17.9771
Crit Depth, Yc (m) = 0.1707
Top Width (m) = 17.9492
EGL (m) = 0.2066

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

(0.0100, 66.7200)-(4.0000, 66.6400, 0.015)-(4.3000, 66.5600, 0.015)-(10.0000, 66.7500, 0.015)-(15.7000, 66.5600, 0.015)-(16.0000, 66.6400, 0.015)-(20.0000, 66.7



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 17 2025

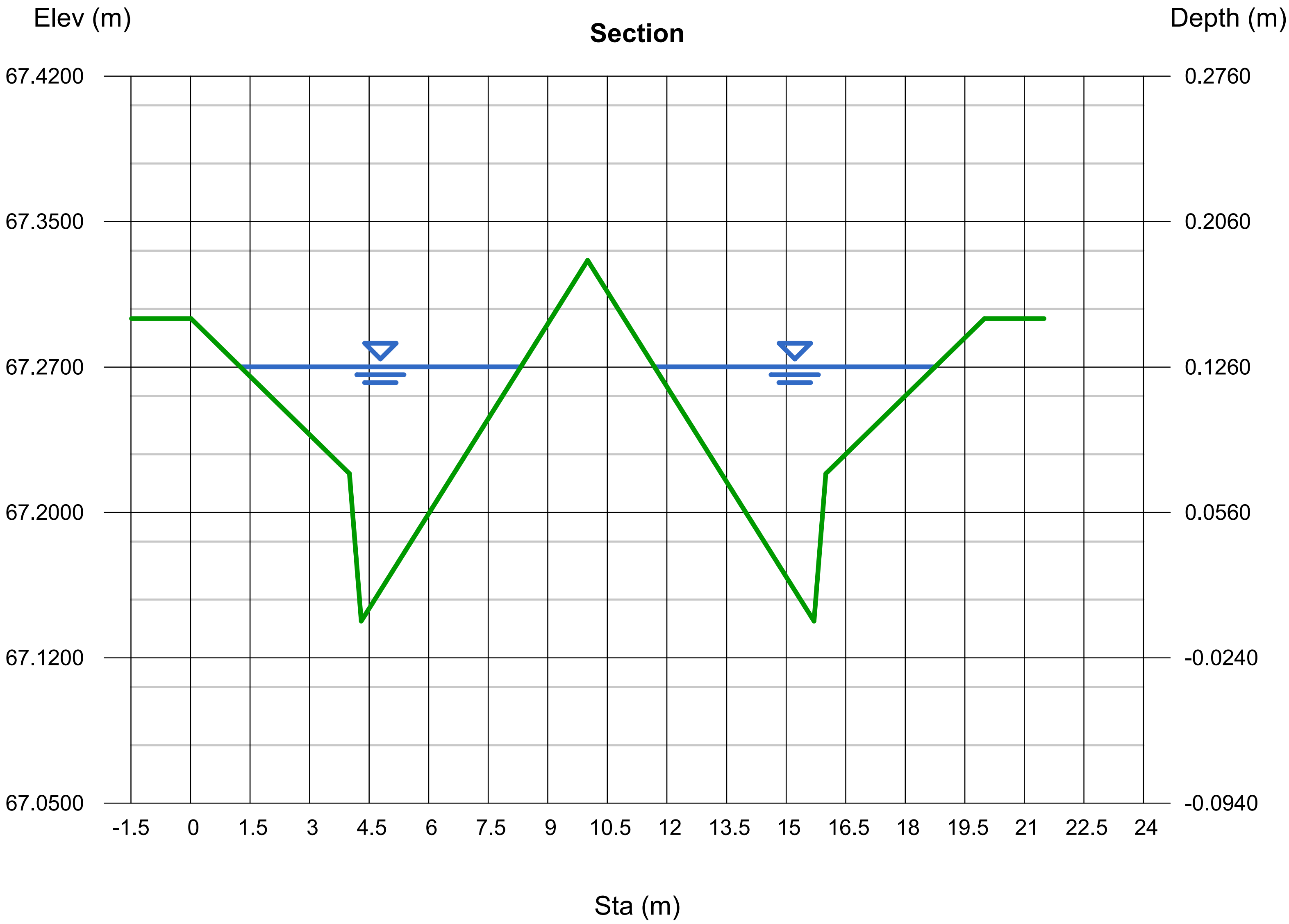
Catchemnt A Section 3

User-defined
Invert Elev (m) = 67.1440
Slope (%) = 0.9000
N-Value = 0.015

Calculations
Compute by: Known Q
Known Q (cms) = 0.6000

Highlighted
Depth (m) = 0.1311
Q (cms) = 0.6000
Area (sqm) = 0.7336
Velocity (m/s) = 0.8179
Wetted Perim (m) = 14.1554
Crit Depth, Yc (m) = 0.1372
Top Width (m) = 14.1310
EGL (m) = 0.1652

(Sta, El, n)-(Sta, El, n)...
(0.0100, 67.3000)-(4.0000, 67.2200, 0.015)-(4.3000, 67.1440, 0.015)-(10.0000, 67.3300, 0.015)-(15.7000, 67.1440, 0.015)-(16.0000, 67.2200, 0.015)-(20.0000, 67.3



Channel Report

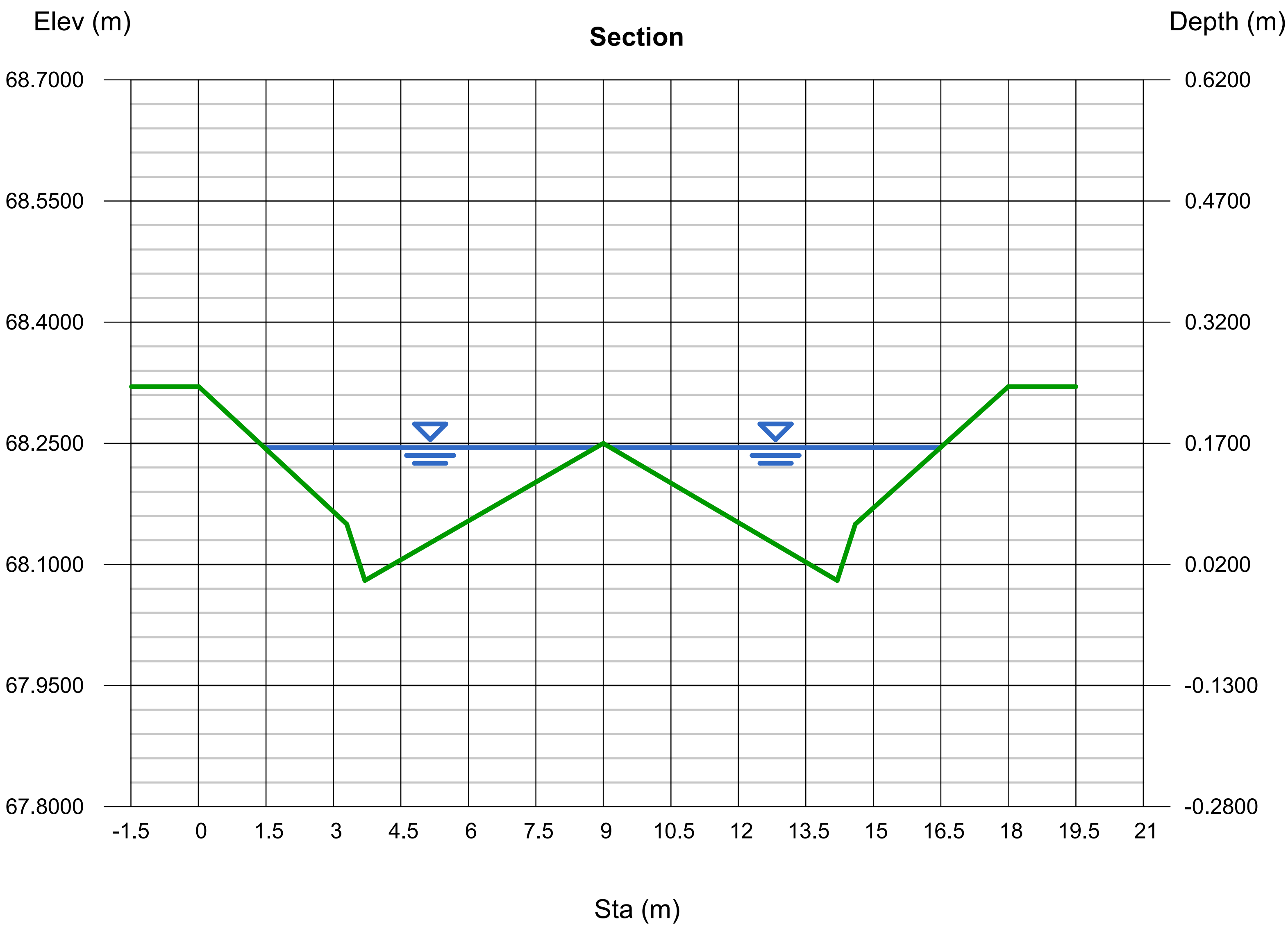
Catchemnt B Section 1

User-defined
Invert Elev (m) = 68.0800
Slope (%) = 0.5000
N-Value = 0.015

Calculations
Compute by: Known Q
Known Q (cms) = 0.9000

Highlighted
Depth (m) = 0.1646
Q (cms) = 0.9000
Area (sqm) = 1.1164
Velocity (m/s) = 0.8062
Wetted Perim (m) = 14.7110
Crit Depth, Yc (m) = 0.1615
Top Width (m) = 14.6887
EGL (m) = 0.1977

(Sta, El, n)-(Sta, El, n)...
(0.0100, 68.3200)-(3.3000, 68.1500, 0.015)-(3.7000, 68.0800, 0.015)-(9.0000, 68.2500, 0.015)-(14.2000, 68.0800, 0.015)-(14.6000, 68.1500, 0.015)-(18.0000, 68.32



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 17 2025

Catchemnt B Section 2

User-defined

Invert Elev (m)	=	67.8900
Slope (%)	=	0.5000
N-Value	=	0.015

Calculations

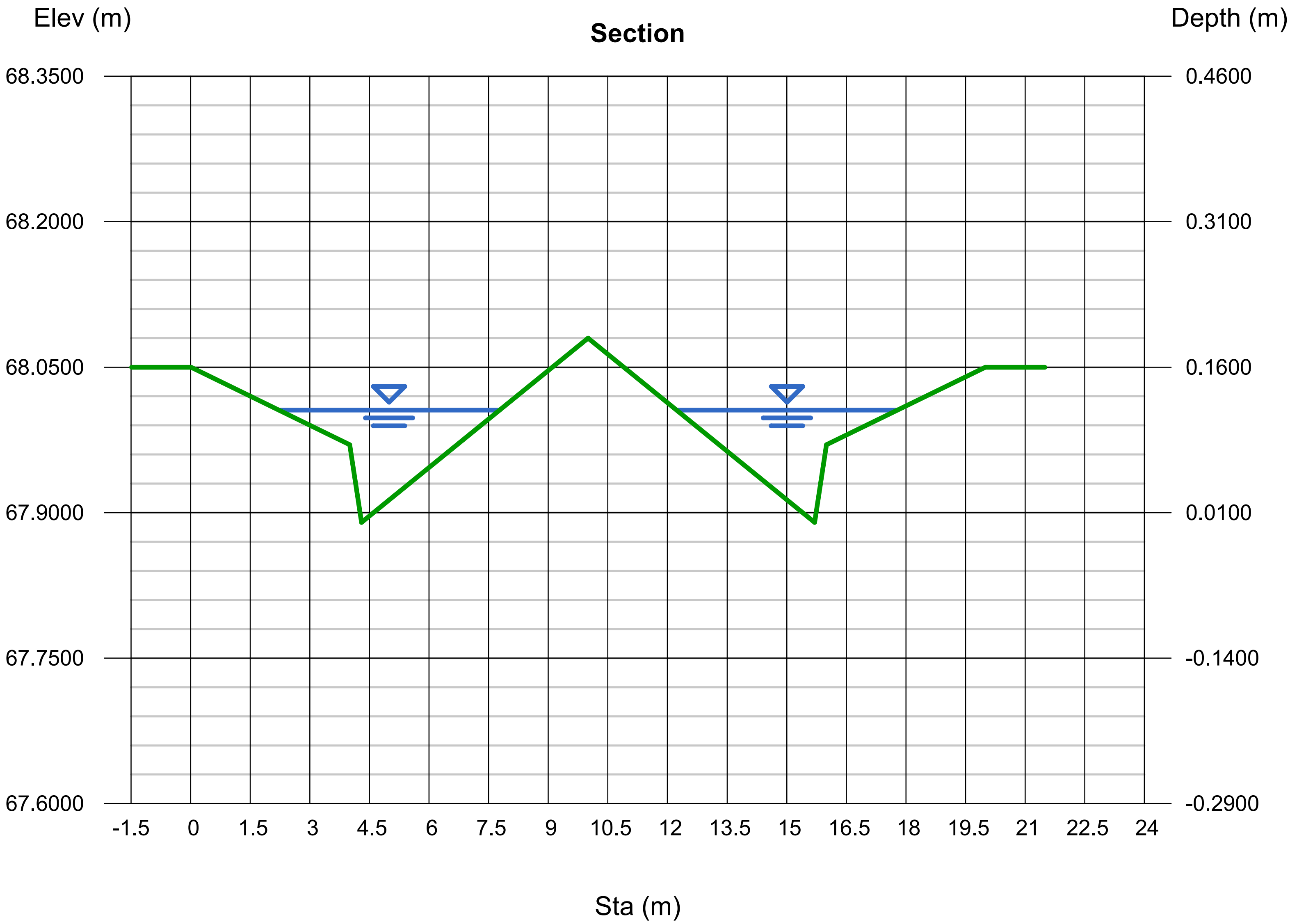
Compute by:		Known Q
Known Q (cms)	=	0.3000

Highlighted

Depth (m)	=	0.1158
Q (cms)	=	0.3000
Area (sqm)	=	0.5120
Velocity (m/s)	=	0.5859
Wetted Perim (m)	=	11.1529
Crit Depth, Yc (m)	=	0.1128
Top Width (m)	=	11.1273
EGL (m)	=	0.1333

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

(0.0100, 68.0500)-(4.0000, 67.9700, 0.015)-(4.3000, 67.8900, 0.015)-(10.0000, 68.0800, 0.015)-(15.7000, 67.8900, 0.015)-(16.0000, 67.9700, 0.015)-(20.0000, 68.0



Channel Report

Catchemnt B Section 3

User-defined

Invert Elev (m)	=	66.3200
Slope (%)	=	0.7000
N-Value	=	0.015

Calculations

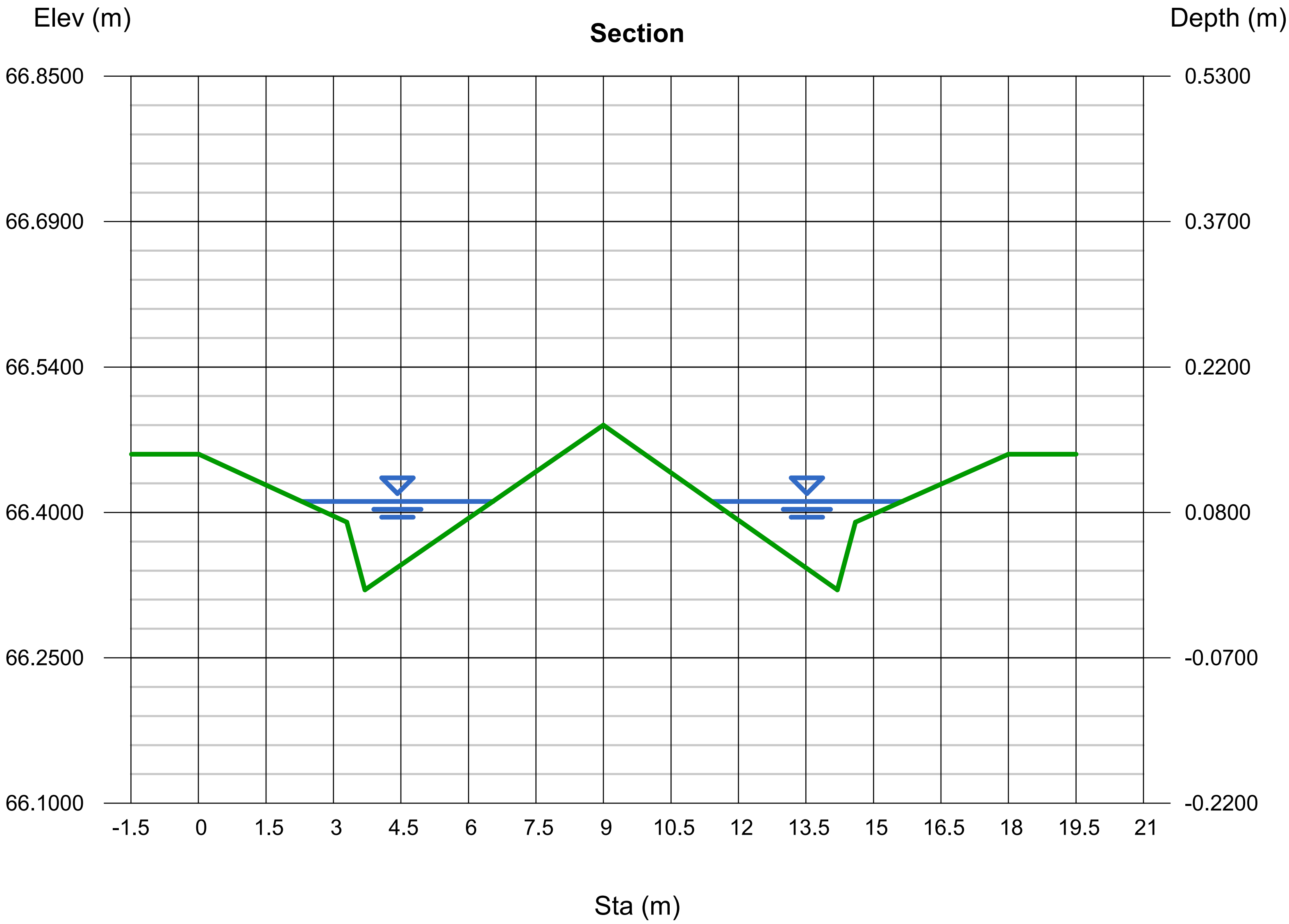
Compute by:		Known Q
Known Q (cms)	=	0.2000

Highlighted

Depth (m)	=	0.0914
Q (cms)	=	0.200
Area (sqm)	=	0.3253
Velocity (m/s)	=	0.6147
Wetted Perim (m)	=	8.5125
Crit Depth, Yc (m)	=	0.0945
Top Width (m)	=	8.4970
EGL (m)	=	0.1107

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

(0.0100, 66.4600)-(3.3000, 66.3900, 0.015)-(3.7000, 66.3200, 0.015)-(9.0000, 66.4900, 0.015)-(14.2000, 66.3200, 0.015)-(14.6000, 66.3900, 0.015)-(18.0000, 66.46



Channel Report

Catchemnt D Section 4

User-defined

Invert Elev (m)	=	67.1600
Slope (%)	=	0.3000
N-Value	=	0.015

Calculations

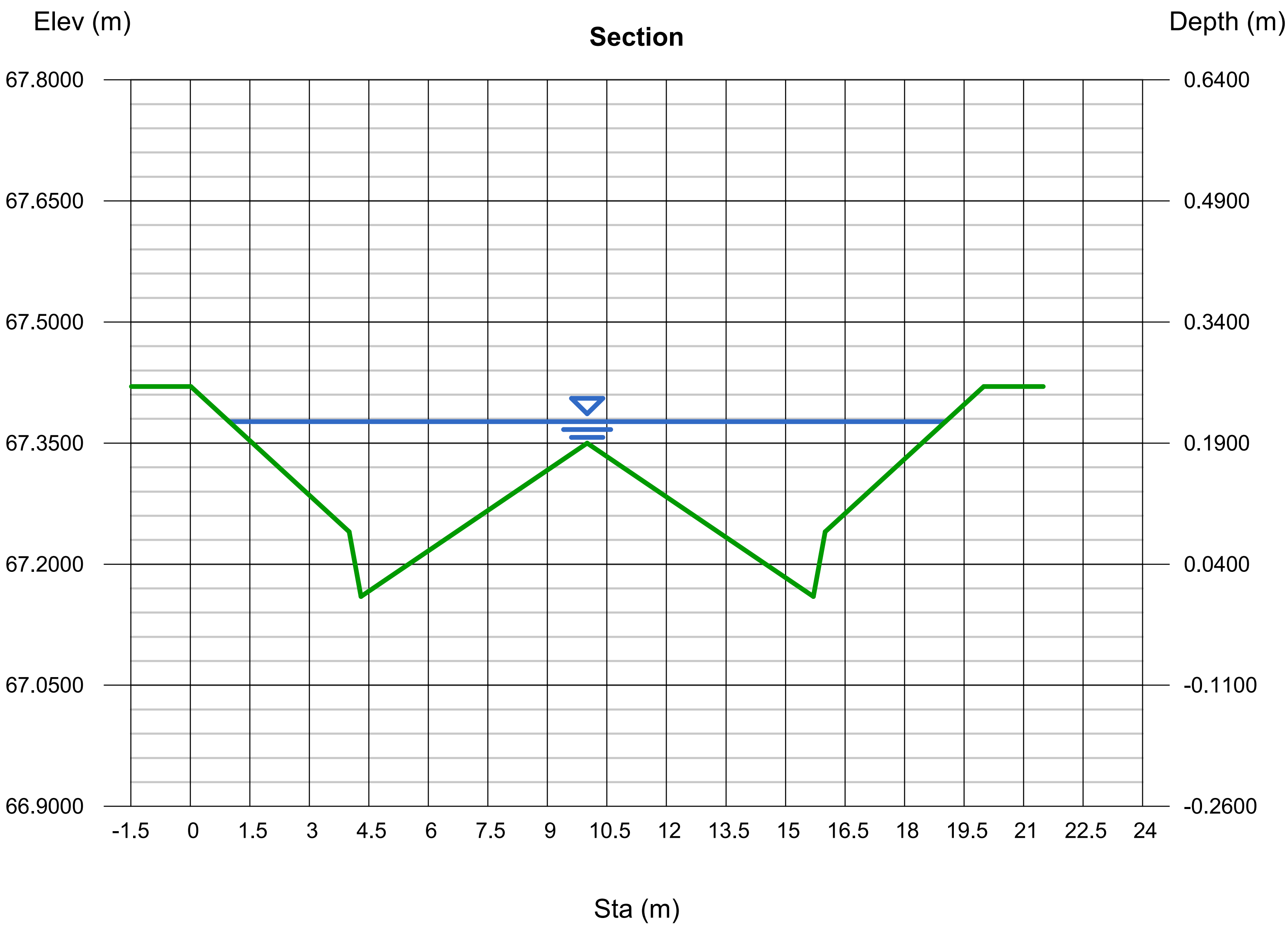
Compute by:		Known Q
Known Q (cms)	=	1.5000

Highlighted

Depth (m)	=	0.2164
Q (cms)	=	1.5000
Area (sqm)	=	1.9030
Velocity (m/s)	=	0.7882
Wetted Perim (m)	=	18.0888
Crit Depth, Yc (m)	=	0.2012
Top Width (m)	=	18.0554
EGL (m)	=	0.2481

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

(0.0100, 67.4200)-(4.0000, 67.2400, 0.015)-(4.3000, 67.1600, 0.015)-(10.0000, 67.3500, 0.015)-(15.7000, 67.1600, 0.015)-(16.0000, 67.2400, 0.015)-(20.0000, 67.4



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 17 2025

Catchemnt B Section 5

User-defined

Invert Elev (m)	=	66.5300
Slope (%)	=	1.1000
N-Value	=	0.015

Calculations

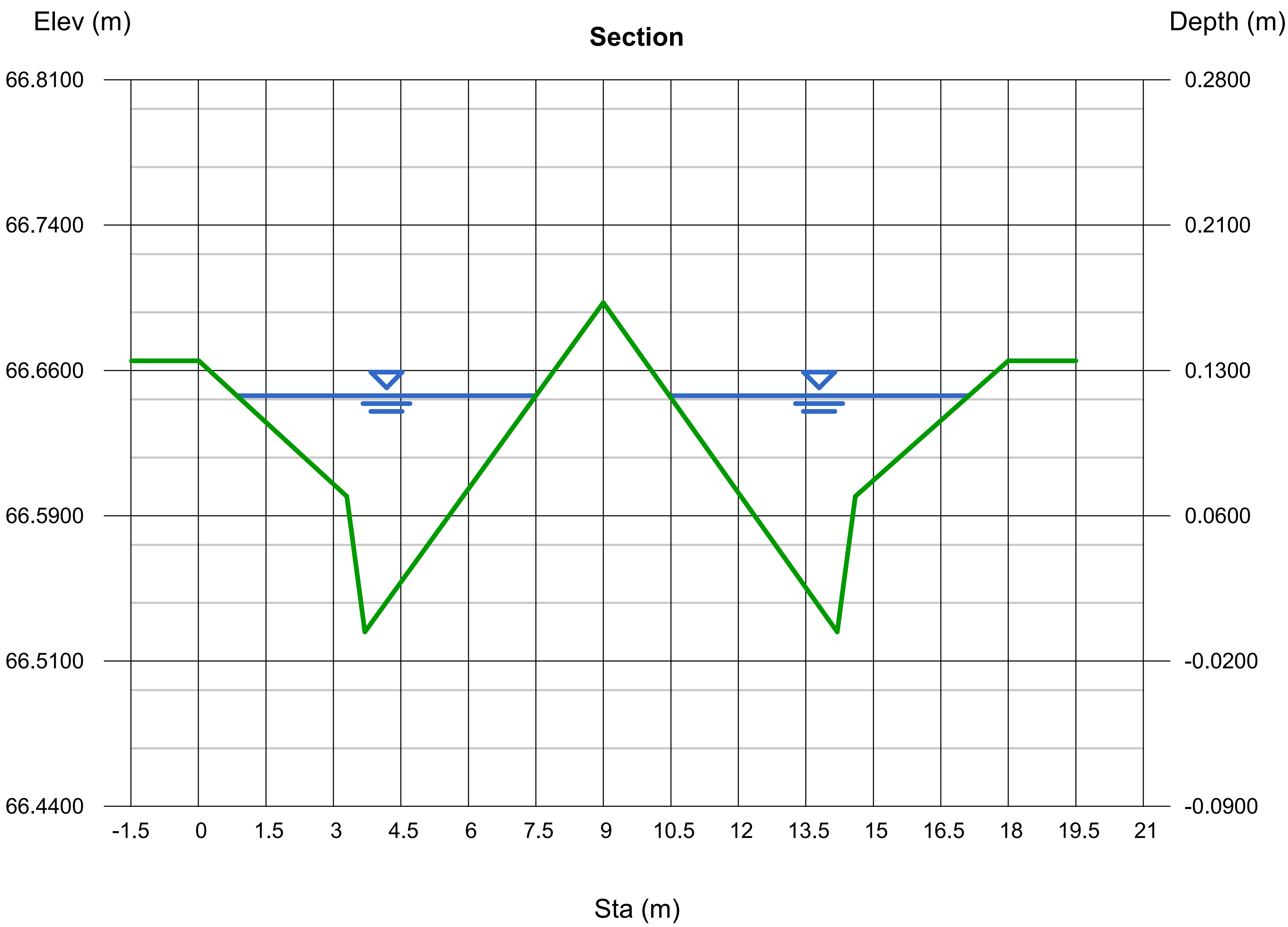
Compute by:		Known Q
Known Q (cms)	=	0.6000

Highlighted

Depth (m)	=	0.1219
Q (cms)	=	0.6000
Area (sqm)	=	0.6574
Velocity (m/s)	=	0.9127
Wetted Perim (m)	=	13.3098
Crit Depth, Yc (m)	=	0.1341
Top Width (m)	=	13.2927
EGL (m)	=	0.1644

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

(0.0100, 66.6700)-(3.3000, 66.6000, 0.015)-(3.7000, 66.5300, 0.015)-(9.0000, 66.7000, 0.015)-(14.2000, 66.5300, 0.015)-(14.6000, 66.6000, 0.015)-(18.0000, 66.67



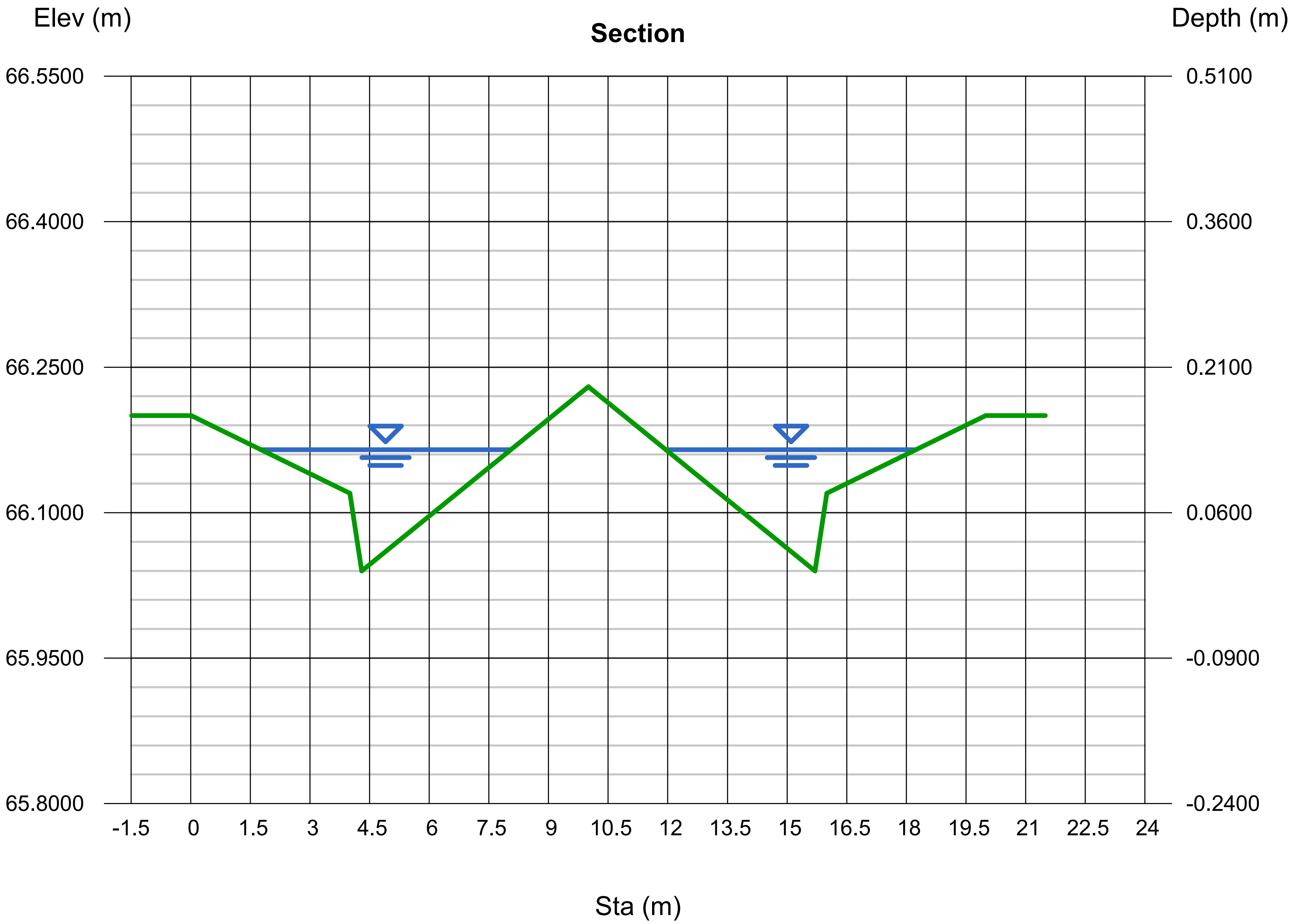
Channel Report

Catchemnt C Section 1

User-defined		**Highlighted**	
Invert Elev (m)	= 66.0400	Depth (m)	= 0.1250
Slope (%)	= 0.9000	Q (cms)	= 0.5000
N-Value	= 0.015	Area (sqm)	= 0.6205
		Velocity (m/s)	= 0.8058
Calculations		Wetted Perim (m)	= 12.6157
Compute by:	Known Q	Crit Depth, Yc (m)	= 0.1341
Known Q (cms)	= 0.5000	Top Width (m)	= 12.5896
		EGL (m)	= 0.1581

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

(0.0100, 66.2000)-(4.0000, 66.1200, 0.015)-(4.3000, 66.0400, 0.015)-(10.0000, 66.2300, 0.015)-(15.7000, 66.0400, 0.015)-(16.0000, 66.1200, 0.015)-(20.0000, 66.2



Channel Report

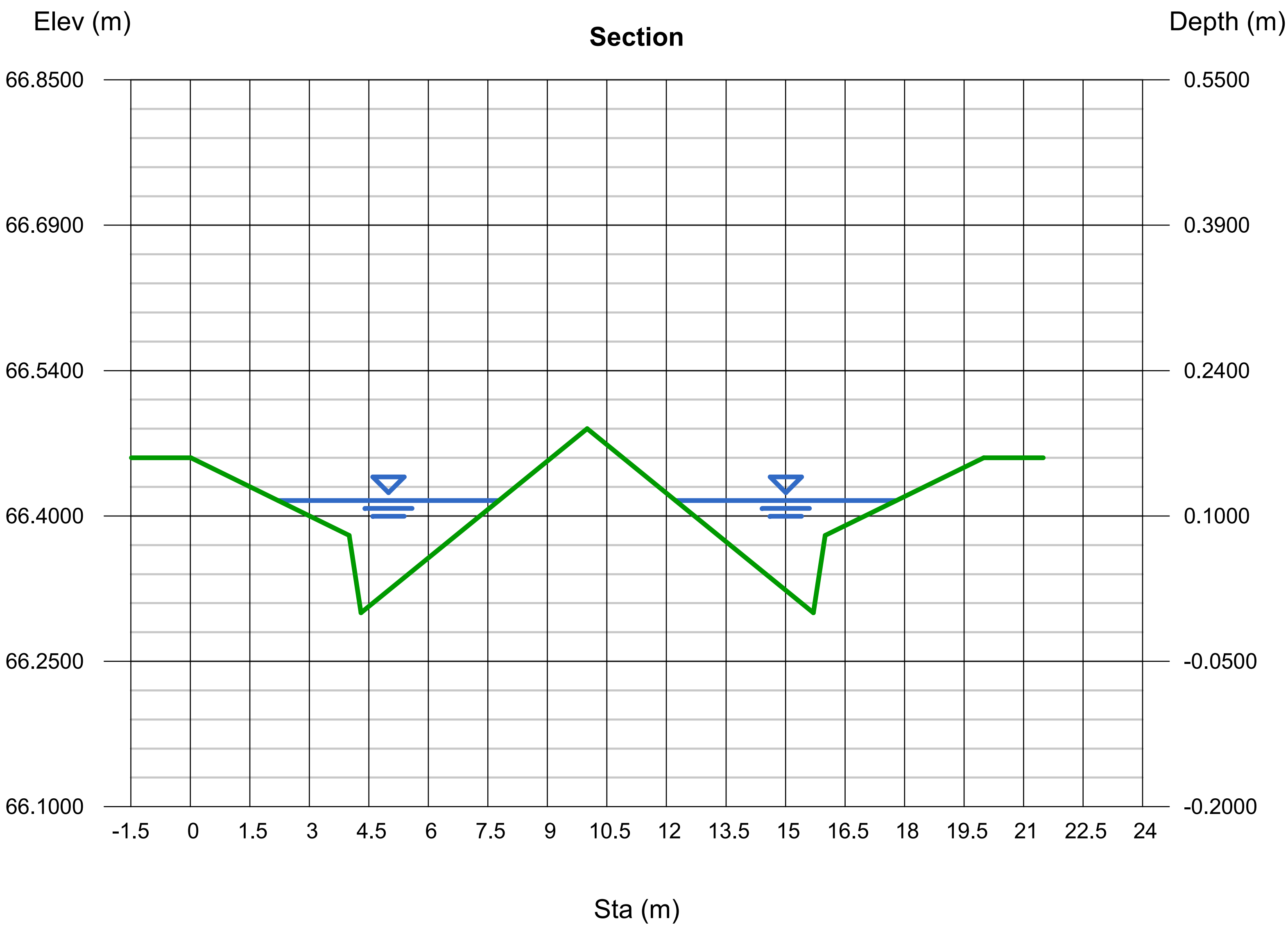
Catchemnt D Section 1

User-defined
Invert Elev (m) = 66.3000
Slope (%) = 0.5000
N-Value = 0.015

Calculations
Compute by: Known Q
Known Q (cms) = 0.3000

Highlighted
Depth (m) = 0.1158
Q (cms) = 0.3000
Area (sqm) = 0.5121
Velocity (m/s) = 0.5858
Wetted Perim (m) = 11.1542
Crit Depth, Yc (m) = 0.1128
Top Width (m) = 11.1286
EGL (m) = 0.1333

(Sta, El, n)-(Sta, El, n)...
(0.0100, 66.4600)-(4.0000, 66.3800, 0.015)-(4.3000, 66.3000, 0.015)-(10.0000, 66.4900, 0.015)-(15.7000, 66.3000, 0.015)-(16.0000, 66.3800, 0.015)-(20.0000, 66.4



Channel Report

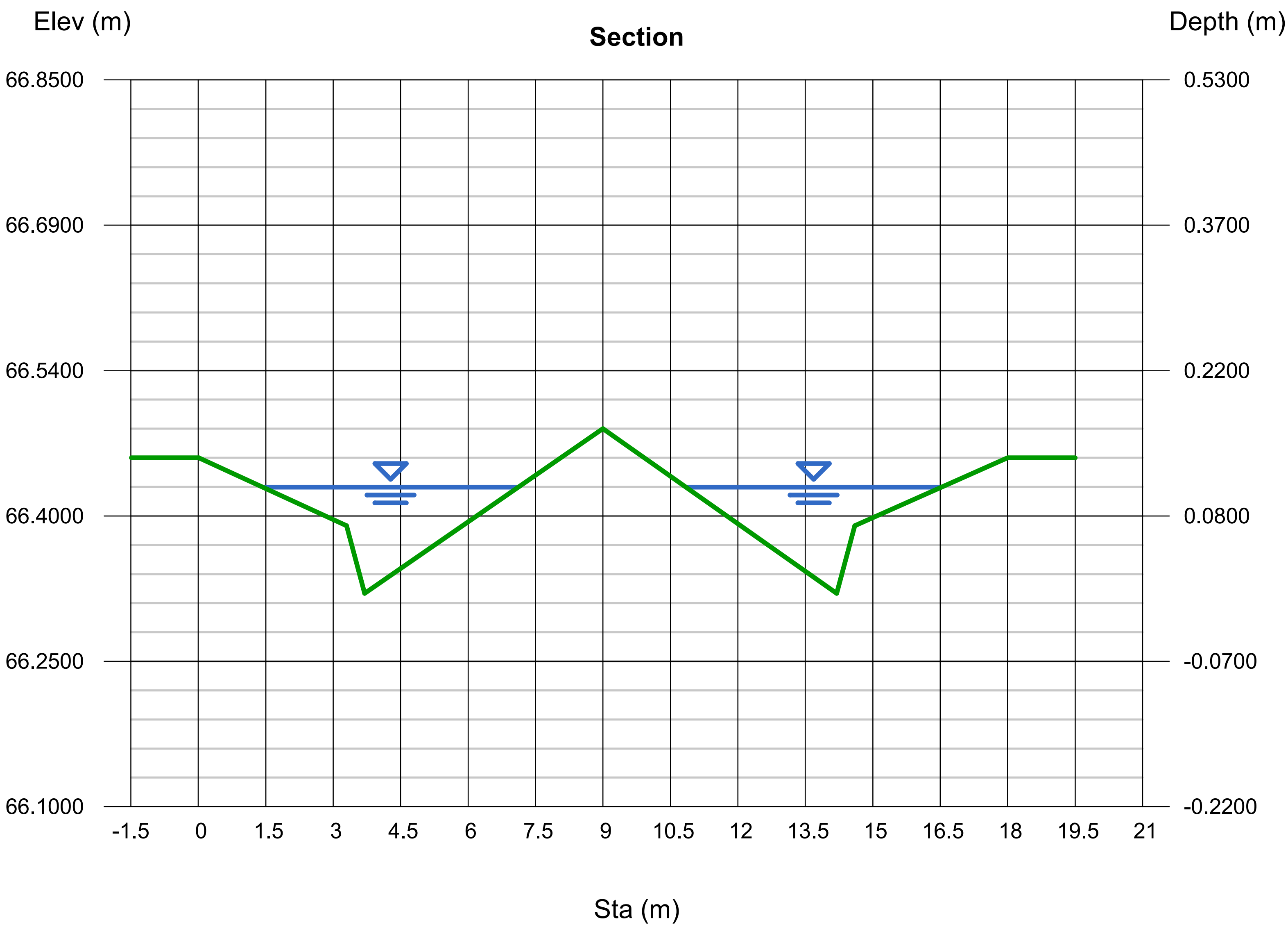
Catchemnt D Section 2

User-defined
Invert Elev (m) = 66.3200
Slope (%) = 0.5000
N-Value = 0.015

Calculations
Compute by: Known Q
Known Q (cms) = 0.3000

Highlighted
Depth (m) = 0.1097
Q (cms) = 0.3000
Area (sqm) = 0.5070
Velocity (m/s) = 0.5917
Wetted Perim (m) = 11.3907
Crit Depth, Yc (m) = 0.1067
Top Width (m) = 11.3742
EGL (m) = 0.1276

(Sta, El, n)-(Sta, El, n)...
(0.0100, 66.4600)-(3.3000, 66.3900, 0.015)-(3.7000, 66.3200, 0.015)-(9.0000, 66.4900, 0.015)-(14.2000, 66.3200, 0.015)-(14.6000, 66.3900, 0.015)-(18.0000, 66.46



APPENDIX C - CMW GEOTECH REPORT- BOUNDED WITH INFRASTRUCTURE REPORTS

APPENDIX D – STORMWATER DEVICE OPERATIONS MAINTENANCE PLAN

ASHBOURNE RESIDENTIAL DEVELOPMENT

STORMWATER OPERATIONS & MAINTENANCE PLAN

PROJECT INFORMATION

CLIENT	Matamata Developments Ltd
PROJECT	289001

DOCUMENT CONTROL

DATE OF ISSUE	30/05/2025
REVISION	A
AUTHOR	Min Shon Engineer
REVIEWED BY	Raatite Kanimako Engineer
APPROVED BY	Dean Morris Regional Director

Level 1, 286 Victoria Street, Hamilton Central, New Zealand
Phone 07 242 0601
www.maven.co.nz

Contents

1. Introduction

1.1. Background

Maven Waikato Ltd have been engaged by Matamata Developments Ltd to undertake Infrastructure Design in support of Ashbourne Residential Development at 127 Station Road, Matamata.

1.2. Purpose of this report

The purpose of this operation and maintenance report is to ensure the correct ongoing operation of the stormwater quality management devices of Ashbourne Residential development. The information provided herein outlines the methodology associated with the stormwater infrastructure onsite. This report is to be read in conjunction with the engineering drawings around stormwater management within the site held between WRC and Matamata-Piako District Council (MPDC).

It is the responsibility of the nominated maintenance contractor for MPDC to carry out maintenance of the stormwater system devices. The maintenance will be in generally accordance with this document, WRC Stormwater Guidelines and MPDC's SW Guidelines.

1.3. Stormwater Assets

The Public Assets constructed which will require operation and maintenance are:

- Stormwater discharge from Ashbourne Residential will be conveyed via roadside soakage trench and piped network (perforated), and road for OLFP to each Soakage Basin.
- Stormwater Basins with soakage devices in the base.
- Raingardens constructed within the road reserves providing quality for whole catchment. These devices are at-source rain gardens providing water quality, infiltration, and detention.
- Stormwater Greenway which carries stormwater runoff from Catchment B.

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.

Asset ID:		**Resource Consent Number:**	
Location:	127 Station Road, Matamata	Development Name / Legal Description:	
Asset Owner Details:			
Name:	Matamata-Piako	Postal Address: PO Box 266, Te Aroha 3342 Physical Address: Te Aroha Office - 35 Kenrick Street, Te Aroha Matamata-Piako Civic and Memorial Centre - 11 Tainui Street, Matamata Morrinsville Area Office - 56-62 Canada Street, Morrinsville	
Telephone Number:	0800 746 467		
Email:	Refer to Online Contact Form		
Maintenance Manager Emergency Contact Details			
Name:	MPDC call centre	Address: 56-62 Canada Street, Morrinsville	
Telephone Number: (Daytime)	0800 746 467		
Telephone Number: (Out-Of-Hours)	0800 746 467		
Email:	Relevant operational area inbox		

Designer Details:		
Name:	Dean Morris	Level 1, 286 Victoria Street, Hamilton Central, Hamilton 3204
Telephone Number:	09 242 2724	
Email:	deanm@maven.co.nz	
Applicant Details		
Name:	Matamata Developments Ltd	Address: 127 Station Road, Matamata
Telephone Number		
Email:		
Landowner Details:		
Name:	Matamata Developments Ltd	
Telephone Number		
Email:		
Notes / Restrictions / Access		

2. Stormwater System Description

2.1. Site Description

The Ashbourne Residential area is a circa 45.2ha block of land within the Matamata-Piako District. The current site access is through 127 Station Road in Matamata. The site adjoins with the new Highgrove Development to the north-west, and Peakedale and Pippins Development to the east, and the remainder of the site is surrounded by agricultural land.

There is an existing stormwater swale that follows the southern and western boundary. The Waitoa River which runs south to north is approximately 1km to the west of the subject site.

The site has an existing farmhouse located at 127 Station Road. Most of the site is low-lying flat farmland, that is interspersed with artificial farm drains.

2.2. Design Standards

The MPDC Development Manual sets out design and construction standards for stormwater and requires all land development projects to be provided with a mean of stormwater disposal.

Stormwater systems have been designed in accordance with RITS and other relevant standards including the MPDC Development Manual 2010 and caters for the primary pipe system up to the 10-year event as well as the secondary system and overland flow paths to manage excess runoff that cater for events exceeding the capacity of the primary piped system for events exceeding the 10-year event.

2.3. Stormwater Management Plan (SMP)

The planned development straddles the existing Network Discharge Consent ('NDC') boundary. As the development relates to undeveloped land stormwater discharge consents have been obtained from Waikato Regional Council.

The overarching stormwater strategy has been derived from the Maven Waikato SMP which sets out the high-level, best practice approach to stormwater management within the Ashbourne Residential development site. The SMP outlines the overarching stormwater management principles which will form the basis of stormwater design to support future development on the proposed sites.

Furthermore, the stormwater management strategy, as detailed within the SMP, establishes a robust long term stormwater solution, which integrates desired urban form outcomes, with the mitigation of flooding (flood plains and OLFPs) and consideration of best-practice design outcomes as detailed within relevant Waikato guidance documents.

The key components of the Ashbourne stormwater management strategy are as follows:

- Stormwater conveyance for 10yr cc ARI rainfall event
- Overland flow paths for (100yr – 10yr) cc ARI rainfall event to be accommodated within the site and conveyed to basins.
- Treatment of runoff prior to discharge into receiving environment in accordance with TP10 / GD01 / Waikato Stormwater Management Guidelines (WRC Technical Report 2018/01).
- Usage of soakage where possible

For further details please refer to the SMP prepared by Maven Waikato Ltd dated April 2025.

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 a private soakage device. Overflow is located in the catchpit system for flows surpassing the 10-year event within the lot areas. Excess flows will be diverted into the downstream basin via the road carriageway.

Stormwater Strategy for Road Carriageway

The initial runoff volume (WQV) is treated via proposed roadside raingardens. the proposed rain gardens are integrated with the roadside soakage trench combined to cater for the 10-year event. Flows exceeding the 10-year soakage capacity are redirected back into the road carriageway and get discharged at the downstream stormwater Basin.

Stormwater Strategy for SW Basin A, C, and D

These basins forms critical part of the overall stormwater Mitigation system. They have been sized to accommodate the 100-year event or excess flows from both the road carriageway and on lot flows exceeding the 10-year event. Additionally, the upstream inflows particularly in basins A and D has been accounted for as well in these basins. it is anticipated that through soakage and storage capacity of the proposed basins, no flows are expected to discharge into the downstream environment from these basins.

Stormwater Strategy for SW Basin B and Greenway

Stormwater Basin B is connected with the greenway and both serve a dual purpose; Attenuating flows from Catchment B flows (to at least 80% pre-development) and conveying flows from the southern solar farm and external inflow from the southern external catchment as depicted in plans.

2.4.1. Hydrogeological Assessment

Wallbridge Gilbert Aztec Ltd has been prepared the Hydrogeology – Assessment of Effects for the Ashbourne construction. Please consult the Hydrogeological Effects Assessment prepared by WGA Ltd which provides detailed guidance on hydrogeological measures.

2.5. Flooding

The WRC hazard portal has indicated there is potential flooding along the western side of Highgrove Development in the 100 years storm event, however there is no flooding indicated within the subject development.

A flood model has been developed and calibrated using the region's observed rainfall and river data. The model has been used to test a sensitivity scenario 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

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 flowpaths on the proposed development.

- 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 contained within Appendix A. summary of results provided below Detailed design of the OLFPs will be provided at future detail design stage following the approval of the resource consent.

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 Hydroflo 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 showing results at the key locations.

	SECTION	CATCHMENT AREA HA	FLOWRATE m3/s	MAX DEPTH m	VELOCITY m/s	DEPTH x VELOCITY
CATCHMENT A	1	3.1	0.6	0.137	0.77	0.105
	2	6.2	1.1	0.158	0.97	0.153
	3	2.9	0.6	0.131	0.82	0.107
CATCHMENT B	1	5.9	0.9	0.167	0.81	0.135
	2	2.3	0.3	0.116	0.59	0.068
	3	1.1	0.2	0.091	0.61	0.056
	4	12.5	1.5	0.216	0.79	0.171
	5	4.2	0.6	0.121	0.912	0.110
CATCHMENT C	1	2.3	0.5	0.125	0.81	0.101
CATCHMENT D	1	2.8	0.3	0.116	0.59	0.068
	2	2.7	0.3	0.109	0.59	0.064

Table 1: OLFP Results

Most OLFP sections comply with standard design thresholds. However, three sections recorded maximum water depths above the 150mm guideline.

- Catchment A – Section 2: Max Depth = 0.158
- Catchment B – Section 4: Max Depth = 0.216
- Catchment C – Section 1: Max Depth = 0.137m (just below threshold)

Despite minor exceedances in depth, depth x velocity (m2/s) values remain well below critical safety thresholds defined in Austroads 2012 Part 5, which specify;

- < 0.4m^2/s pedestrian Safety
- <0.6m^2/s for vehicle safety

The highest recorded value was 0.171m^2/s confirming safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads conveyed into roadside treatment and 10year mitigation devices prior to spilling back (during event above the 10year) onto the road and get discharged into the proposed basins or Greenway.
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. Raingardens

Raingardens are the primary stormwater treatment mechanism for Ashbourne Residential development. They have been designed to treat stormwater run-off from hardstand areas such as roads, footpaths, car parks etc. by filtering it through vegetation and then soaking vertically through an organic loam soil mix before draining into the piped stormwater network.

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 dewaters 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.

3.2. Soakage Basin

Soakage basins have been designed to restrict surface water flows from the site to predevelopment levels by retaining surface water on site within catchment areas.

The Ashbourne Residential development includes the construction of four (4) stormwater basins which will act primarily as dry ponds and will not have a permanent water level. These basins are primarily for stormwater attenuation. The design allows for infiltration within the base of stormwater basins. Each stormwater basin will have a maintenance access track around the perimeter, with sufficient widths for an excavator and cartage trucks.

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
- 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 rilling.
	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 form 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.

3.3. Temporary Swales

Temporary swales for stage 3 and 4 of Ashbourne Development will be constructed to capture surface water from rainfall events exceeding 100 year and discharge to stormwater basin B.
The temporary swales shall be inspected in line with the Waikato Stormwater Management Guideline 2020. This will include manual/mechanical prevention of undesired overgrowth from taking over the area (mowing/weeding) and manual debris and sediment removal from the outlets discharging into the temporary swales.

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 ne 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 MPDC will record operation and maintenance activities and report to Waikato Regional 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 & Maintanenence 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?

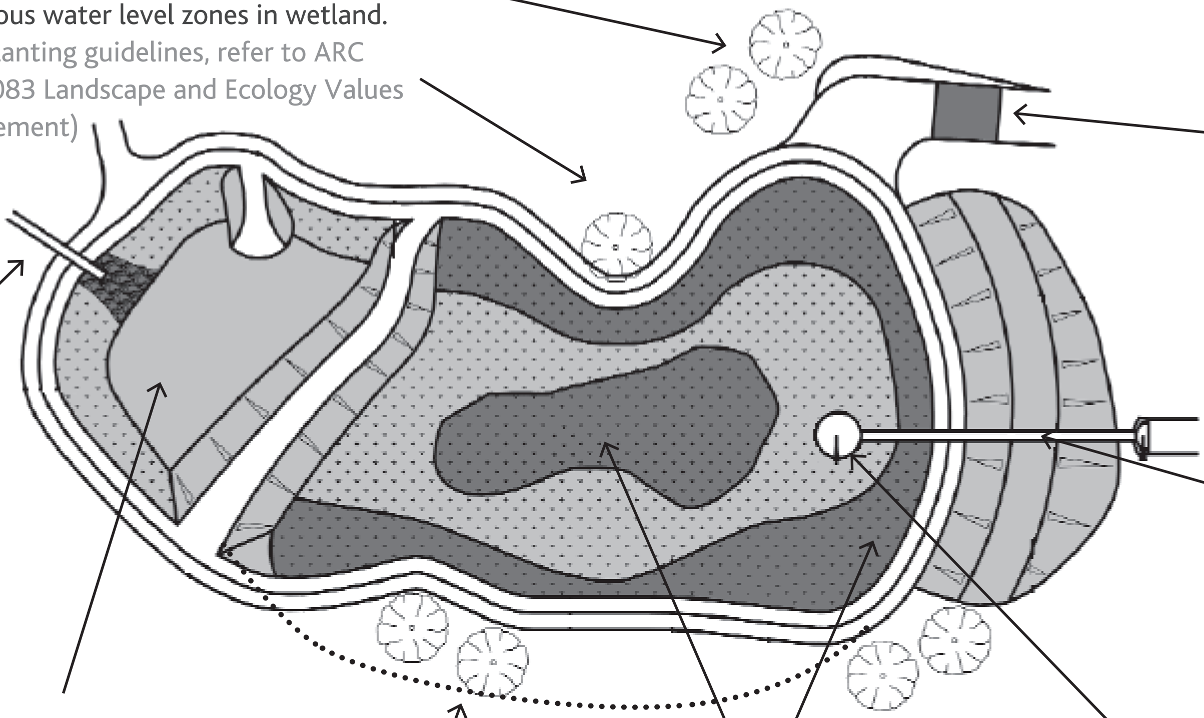
Constructed wetlands need to be maintained in two main ways. Firstly, so they continue to work as designed (filtering stormwater, slowing flows and controlling downstream flooding) and secondly, to look attractive. A full inspection of constructed wetlands should take place a year after construction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

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.

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

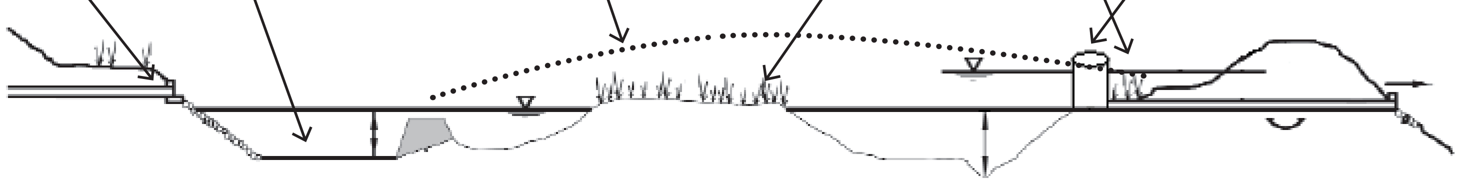
Shallow wide pond of variable depth to 1m, planted with aquatic species. Fine sediments settle to bottom and contaminants such as oil and grease break down.

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.

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

Timing	Component	Action
Following storms	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...

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
	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.
6 Monthly	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.
	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.
Anually	Valves and pumps	• Check pumps and valves, if present, are functioning properly. • Check moving parts for corrosion and lubricate if required.
2+ Years	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.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	• Remove plants by hand – do not use herbicides.
	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.
	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.
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.

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.	• 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 reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria Clostridium botulinum, 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.

Appendix B – Recommended Maintenance Event and Frequency Checklists

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato	**STORMWATER MAINTENANCE INSPECTION FORM**	Inspector: Date: Time: Weather: Rainfall over previous 2-3 days? Page 1 of 2 File No:

Site Name:		ID No:	
Location		Catchment:	
		Needs immediate attention	
		Not Applicable	

SWALE AND FILTER STRIP PRACTICE MAINTENANCE INSPECTION CHECKLIST	×	Required Y / N	✓	Okay	?	Clarification Required	

"As builts"	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**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

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: ____________________

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:

Date:

Time:

Weather: Rainfall over previous 2-3 days?

Site Name:		File No:	
Location:		Consent No:	
		Catchment:	

RAIN GARDEN MAINTENANCE INSPECTION CHECKLIST	✕	Needs immediate attention	✓	Okay	?	Clarification Required
	-	Not Applicable				

	"As builts"	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**	Y	N	Y	N	**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 dewaters 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**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

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: ______________________

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato	**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	✓	Okay	?	Clarification Required
	-	Not Applicable				

"As builts"	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	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 dewaters 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

INSPECTORS REMARKS:

OVERALL CONDITION OF DEVICE:

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: ______________________

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato	**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:	

STORMWATER POND/WETLAND MAINTENANCE INSPECTION CHECKLIST	×	Needs immediate attention	✓	Okay	?	Clarification Required
	-	Not Applicable				

"As builts"	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	

Pond/Wetland Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
EMBANKMENT & EMERGENCY SPILLWAY	Y	N	Y	N	**A,S**		Y	N	Y	N	
1. Is the spillway level?						20. Concrete/Masonry condition					
2. Adequate vegetation & ground cover?						Riser and barrels:					
3. Appropriate plants / weeds?						a) Cracks or displacement?					
4. Adequate freeboard?						b) Minor spalling (,0.25mm)?					
5. Embankment erosion evident?						c) Major spalling (rebars exposed)?					
6. Cracking, bulging or sliding of dam						d) Joint failures?					
a) Upstream embankment						e) Water tightness adequate?					
b) Downstream embankment						21. Pond drain valve:					
c) At or beyond toe upstream						a) Operational / exercised?					
d) At or beyond toe downstream						b) Chained and locked?					
e) Emergency spillway						22. Slope protection or rip-rap failures?					
7. Pond & toe drains clear & functioning?						23. Other?					
8. Evidence of animal burrows?						**PERMANENT POOL (WET POND)**					**3M**
9. Seeps/leaks on downstream face?						24. Undesirable vegetative growth?					
10. Vertical & horizontal alignment of top of						25. Removal of floating debris required?					
dam as per As-Built plans?						26. Visible pollution?					
11. Emergency spillway clear of obstructions						27. Evidence of 'edge' erosion?					
& debris						28. Other?					
12. Provision of access for maintenance?						**DRY POND**					**3M**
a) By hand?						29. Adequate vegetation cover?					
b) For machinery?						30. Presence of undesirable vegetation /					
13. Other?						woody growth?					
RISER & SERVICE SPILLWAY					**A**	31. Standing water or wet spots?					
Type: Reinforced concrete						32. Sediment and/or trash accumulation?					
Metal pipe						33. Low flow channels unobstructed?					
Masonry						34. Other?					
14. Low flow orifice obstructed?						**SEDIMENT FOREBAYS**					
15. Low flow trash rack:						35. Is sediment accumulation > 50%					
a) Is debris removal necessary?						(maintenance req'd immed. If Yes)					
b) Is corrosion evident?						36. Provision of access for maintenance:					
16. Weir trash rack maintenance						a) By hand?					
a) Is debris removal required?						b) For machinery?					
b) Is corrosion evident?						**OUTFALLS INTO PONDS**					**A,S**
17. Is there excessive sediment						37. Riprap failures?					
accumulation inside the riser?						38. Condition of endwalls / headwalls	Good		Fair		Poor
18. Metal pipe condition	Good		Fair		Poor	39. Evidence of slope erosion?					
19. Outfall channels functioning?						40. Condition of any inflow pipes.	Good		Fair		Poor
						41. Other?					

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
OTHER	Y	N	Y	N	**6M**	**CONSTRUCTED WETLAND AREAS**	Y	N	Y	N	**A**

1

41. Encroachments on pond or easement area?						45. Vegetation healthy and growing?					
42. Complaints from residents?						46. Evidence of invasive species?					
43. Aesthetics						47. Excessive sedimentation in wetland area?					
a) grass mowing required?											
b) graffiti removal needed?											
c) other (specify)?											
44. Any public hazards (specify)?											

Inspection Frequency Key **A = Annual, M = Monthly, S = after monthly storm**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

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: ______________________

Appendix C – Trouble Shooting 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 devices[175]

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 The underdrain clogged and water is not properly draining out of the garden	• Inspect rain garden after rain event to check garden drains within 12 – 24 hours (see solutions above for rain garden ponding)
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 of 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

Sediment forebay clogged with sediment and needing to be cleaned out

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.

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 wetland[177]

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 Clostridium botulinum, 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.