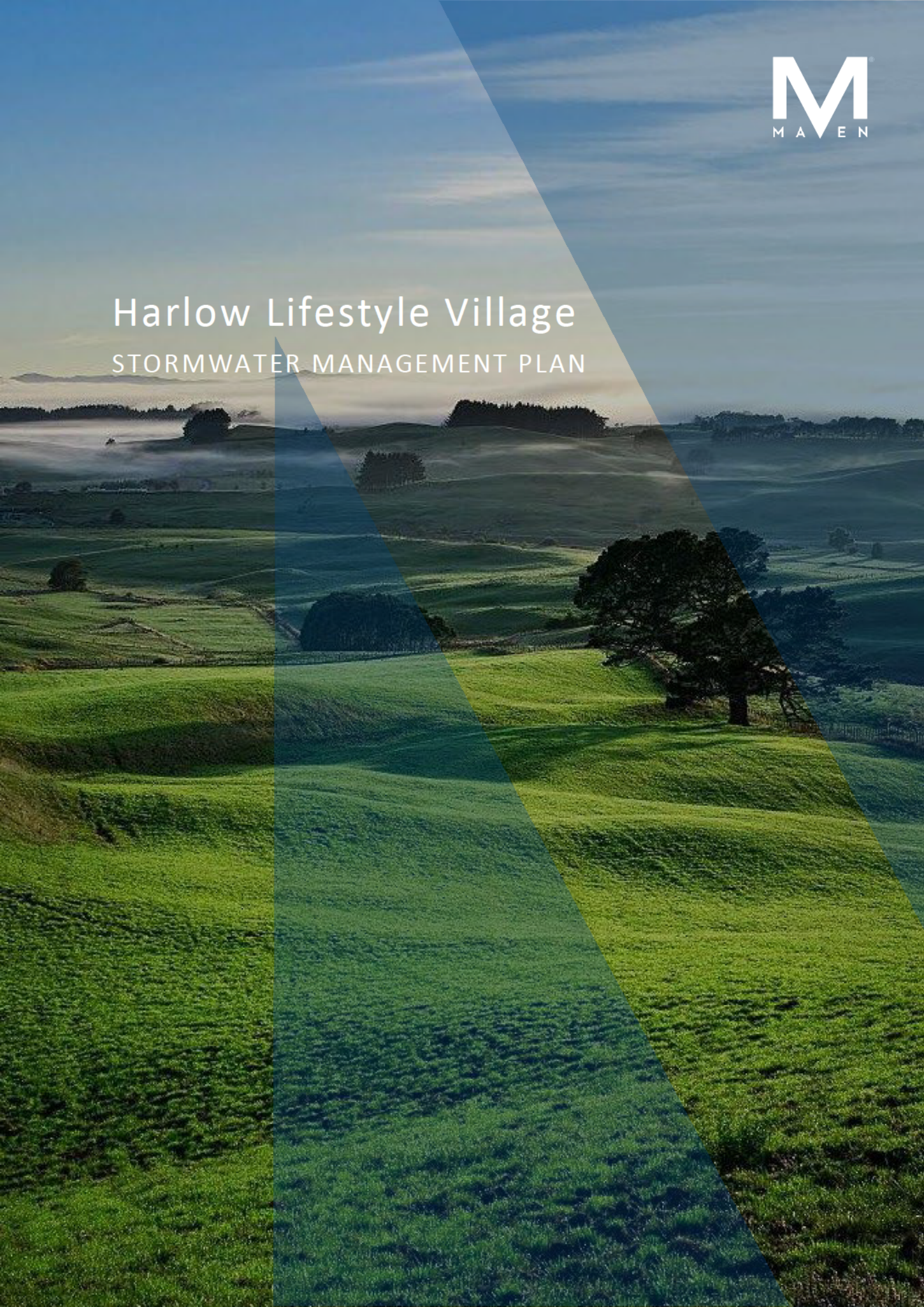
Appendix 19a – Stormwater Management Plan



Harlow Lifestyle Village

STORMWATER MANAGEMENT PLAN

PROJECT INFORMATION

CLIENT	Harlow Lifestyle Village Ltd
PROJECT	411001

DOCUMENT CONTROL

DATE OF ISSUE	28/10/2026
REVISION	REV A1
AUTHOR	[redacted] Navdeep Kaur Civil engineering Technician
REVIEWED BY	[redacted] Min Shon Team Leader
APPROVED BY	[redacted] Dean Morris Regional Director

© Maven Waikato Ltd 2023
This document is and shall remain the property of Maven Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

19 Kaimiro Street,
Pukete, Hamilton 3200
New Zealand
Phone 09 571 0050
www.maven.co.nz

Table of Contents

1. STATEMENT OF EXPERIENCE 5
2. EXECUTIVE SUMMARY 6
   - 2.1. Purpose and Context 6
   - 2.2. Objectives 6
   - 2.3. Design Philosophy and Statutory Framework 6
   - 2.4. The Treatment Train 7
   - 2.5. Flood Modelling and Overland Flow 8
   - 2.6. Conclusion 9
3. Introduction 10
   - 3.1. OVERVIEW 10
4. PROPOSED DEVELOPMENT 11
   - 4.1. OVERALL DEVELOPMENT AREA 11
   - 4.2. LEGAL DESCRIPTION 12
   - 4.3. STAGING & TIMING 13
   - 4.4. COSTS AND VESTING ASSETS 13
5. POLICY CONTEXT 14
6. EXISTING CATCHMENT CONTEXT 19
   - 6.1. EXISTING CALCULATION PARAMETERS 19
   - 6.2. EXISTING OVERALL CATCHMENT 19
   - 6.3. MANGAPIKO STREAM 21
   - 6.4. ECOLOGICAL FEATURES 21
   - 6.5. GEOTECHNICAL REPORT 22
   - 6.6. CN - VALUES 22
   - 6.7. ASSESSEMENT – SOAKAGE RATE 23
   - 6.8. OPERATION MAINTENANCE AND MONITORING PLAN 24
   - 6.9. EROSION MANAGEMENT PLAN 24
7. DESIGN APPROACH 25
   - 7.1. POST DEVELOPMENT CATCHMENTS 25
   - 7.2. PRINCIPLES OF STORMWATER MANAGEMENT 25
   - 7.3. HYDRAULIC CONNECTIVITY 26
   - 7.4. OBJECTIVES 27
8. PROPOSED DEVELOPMENT & STORMWATER MANAGEMENT 28
   - 8.2. TREATMENT TRAIN (Catchment A to E) 30
   - 8.3. RETENTION OF INITIAL ABSTRACTION AND RAINGARDENS 31
   - 8.4. ARTIFICIAL WETLANDS (Catchment A to E) 32
   - 8.5. FOREBAY 35
   - 8.6. HIGH FLOW BYPASS (HFB) 36
   - 8.7. WETLAND OUTLET AND OVERFLOW STRATEGY 36
   - 8.8. LIVE WETLAND (Catchment B) 37
   - 8.9. CATCHMENT F AND G 37
   - 8.10. STORMWATER CULVERTS 38
   - 8.11. FISH PASSAGE AND CULVERT INTERACTION 39
9. FLOOD MODELLING 41
   - 9.1. EXISTING FLOODING, MODELLING AND PARAMETERS 41
   - 9.2. EXISTING MODEL RESULTS 42
   - 9.3. POST DEVELOPMENT FLOODING ASSESSMENT 44
10. OVERLAND FLOWPATHS 48

10.1. DEPARTURES FROM STANDARD 50
11. SUMMARY OF PROPOSED STORMWATER MANAGEMENT 52
12. CONCLUSION 53
Appendix A – Engineering Calculations 54
Appendix B – Operation and Maintenance Plan 55
Appendix C – Erosion Management Plan 56
Appendix D – HEC-RAS Summary 57

1. STATEMENT OF EXPERIENCE

Author

I am Navdeep Kaur, a Civil Engineering Technician with Maven Waikato. I hold a New Zealand Diploma in Engineering (Civil) from Waikato Institute of Technology (Wintec) and have 5 years' experience, with experience in large and medium scale land development projects, including earthwork, roading and three waters design.

I confirm that I have read and understood the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023, and I agree to comply with it.

I acknowledge that, as an expert, I have an overriding duty to assist the decision maker impartially on matters within my area of expertise. In preparing this report, I have exercised my independent professional judgement, and the opinions I express are my own. I understand that my duty as an expert is not to advocate for the interests of the applicant or any other party.

In preparing this report I have relied on the following documents: Ecological Assessment – Phoenix Ecology; Geotechnical Report – Titus/BTW; Groundwater Assessment – WGA; Infrastructure Report- Maven.

I confirm that the matters addressed in this report are within my area of expertise, except where I expressly state that I am relying on information or opinions provided by another person. I have not omitted to consider any material facts known to me that might alter or detract from the opinions expressed in this report.

Reviewer

I am Min Shon, a team leader at Maven Waikato Ltd. I hold a Master of Civil Engineering from the University of Auckland and am a Chartered Professional Engineer registered with Engineering New Zealand (CPEng Reg no- 1168074). I have over six (6) years of professional experience in civil engineering, with particular experience in land development, including earthworks, roading, and three waters infrastructure design.

I confirm that I have read and understood the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023 and agree to comply with its requirements.

I acknowledge that, as an expert, I have an overriding duty to assist the decisionmaker impartially on matters within my area of expertise. In preparing this report, I have exercised my independent professional judgement, and the opinions expressed in this report are my own. I understand that my duty as an expert is not to advocate for the interests of the applicant or any other party.

I confirm that the matters addressed in this report are within my area of expertise, except where I expressly identify that I have relied upon information, assessments or opinions provided by others. I have made all reasonable enquiries and have not knowingly omitted any material facts known to me that might alter or detract from the opinions expressed in this report.

2. EXECUTIVE SUMMARY

2.1. Purpose and Context

This Stormwater Management Plan (SMP) has been prepared to support the resource consent application for Harlow Lifestyle Village development at 2025 Ōhaupo Road, Te Awamutu. The development comprises approximately 25.78 hectares and is proposed to accommodate approximately 414 residential units, located in Waipā District Council. The SMP is prepared in accordance with Waikato Regional Council (WRC) guidelines, the Regional Infrastructure Technical Specifications (RITS V2 (2025) and accompanies the Substantive Application under the Fast-Track Approvals Act 2024.

The site generally drains towards the central portion of the property, with flows conveyed westward towards the Mangapiko Stream and ultimately the Waipā River. The site contains areas of natural vegetation, existing wetlands, watercourses and areas identified as Significant Natural Areas (SNAs). These features form important components of the existing receiving environment and have been considered in developing the proposed stormwater management approach

2.2. Objectives

The SMP sets out the best practice approach to stormwater management within the receiving catchment.

Proposed objectives of the SMP are outlined below:

- Manage stormwater runoff in a manner that maintains or improves the hydraulic and environmental performance of the receiving environment.
- Minimise adverse effects of the development on downstream properties, infrastructure, and receiving waters through appropriate stormwater quantity and quality management.
- Incorporate Water Sensitive Urban Design (WSUD) principles, where practicable, to promote sustainable stormwater management and enhance environmental outcomes.
- Provide a stormwater management system that complies with the WRC Stormwater Guidelines, RITS, and resource consent conditions.
- Deliver an integrated stormwater network that supports the development of Harlow village while achieving the assessed stormwater management outcomes.

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

2.3. Design Philosophy and Statutory Framework

The SMP adopts an integrated treatment-train approach that addresses stormwater quality, quantity, flood management and hydraulic connectivity across the development. The design is outcome-focused and incorporates Water Sensitive Urban Design (WSUD) principles. Key statutory drivers include the Waikato Regional Policy Statement, the Waikato Regional Plan, the Resource Management (National Environmental Standards for Freshwater) Regulations 2025, RITS V2 (2025) and the WRC Stormwater Management Guidelines (TR2020/07).

2.4. The Treatment Train

Stage 1- Primary Conveyance

The primary piped stormwater network is designed to convey the adopted 10-year climate-change event, with larger events accommodated through designated overland flow paths, road corridors, wetlands, high-flow bypasses and existing drainage features.

The proposed Primary piped stormwater network will be sized for up to the 10-year ARI climate change RCP 6 event and have been sensitivity checked for RCP 8.5.

Flows beyond the piped system capacity are conveyed as overland flow within road corridors, designed to safely pass the 100-year ARI climate change event with maximum depths at or below 150 mm (Refer to section 10.1 of this report for details on exceedance) and "Depth" x "Velocity" products well within Austroads safety thresholds (< 0.4 m^2/s for pedestrians).

Stage 2 —Retention of initial abstraction volumes

The proposed development is divided into 7 catchments; each catchment except (F & G) has a designated centralised raingarden and is sized to meet the initial abstraction requirements with additional retention measures provided where required. Piped Network have been sized to capture flows from the catchment and outlet to the raingarden.

Runoff exceeding the available raingarden storage is conveyed and directed towards the proposed wetland and/or high-flow bypass systems.

Catchment F will be managed separately, with runoff directed to a proposed vegetated dry basin to provide stormwater treatment and support the overall water quality objectives.

Catchment G will remain untreated, with runoff continuing to discharge to the existing roadside drainage network. As the development does not increase the impervious area within this catchment, no additional treatment or attenuation measures are proposed.

Stage 3 — Treatment and Attenuation

The Five (5) artificial wetlands (Wetlands A through E) form the primary treatment and attenuation devices. Each wetland incorporates the following:

• A forebay (minimum 10% of wetland area per RITS, 15% of WQV per TR2020/07) for sediment capture, • 2.0m safety bench (1V:8H slope as per RITS)

• Internal bathymetry in accordance with RITS Table 69.

  - Shallow Marsh area approx. 40% of Permanent Storage Zone (PSZ) (+/- 5%)
  - Deep marsh area approx. 40% of PSZ (+/- 5%)
  - Intermediate deep pools approx. 10% of PSZ (+/- 2%)
  - An extended detention zone (1.2 × WQV),

- Controlled Outlet manhole structure with extended detention orifice and Spillway. A flow splitter manhole upstream of each wetland directs flows above the extended detention volume through the treatment system, the piped High-flow bypasses (HFB) are proposed within the relevant sub-catchments to provide a secondary conveyance route for flows that exceed the capacity of the proposed wetland treatment and extended detention system. The HFB system is intended to protect the wetland treatment areas from excessive hydraulic loading during larger rainfall events while maintaining safe conveyance of major stormwater flows through the development.

Stage 4 — Controlled Discharge

Stormwater will be attenuated on-site through designated wetlands, stormwater management devices and enhancement of the existing flood basin, with culverts ensuring controlled discharge to receiving environment. Outflows will be restricted to 80% of pre-development discharge rates where practicable, contributing to the overall site flood mitigation strategy.

The existing Waipā District Significant Natural Area (SNA WP312), comprising predominantly kahikatea and other wetland-associated vegetation, will be incorporated into the site flood mitigation plan. Enhancement of the existing flood basin within the SNA will provide additional flood storage while supporting the wetland environment, while creating an opportunity to provide enhances planting within the SNA. This is consistent with the protection requirements of the NES-FW and the recommendations of the Ecological Assessment.

2.5. Flood Modelling and Overland Flow

A comprehensive 2D flood model was developed using HEC-RAS, with hydrology generated in HEC-HMS using the SCS Curve Number method. The model extends from the upstream contributing catchments through the development site to the downstream Mangapiko Stream, capturing the full hydraulic system that influences flood behaviour on site. The existing-condition modelling confirms that the site is currently subject to widespread shallow flooding and poorly defined flow paths.

Post-development modelling demonstrates that the proposed stormwater measures effectively mitigate flood impacts. Peak flow rates are reduced at Sections 1, 2, 3 4, 5, 6 and 8 under the 100-year climate change event, with localised increases at Sections 7 reflecting temporary flood storage and the head required to convey flow through the attenuation culverts. Flows immediately downstream of the development (Sections 1–2) are reduced.

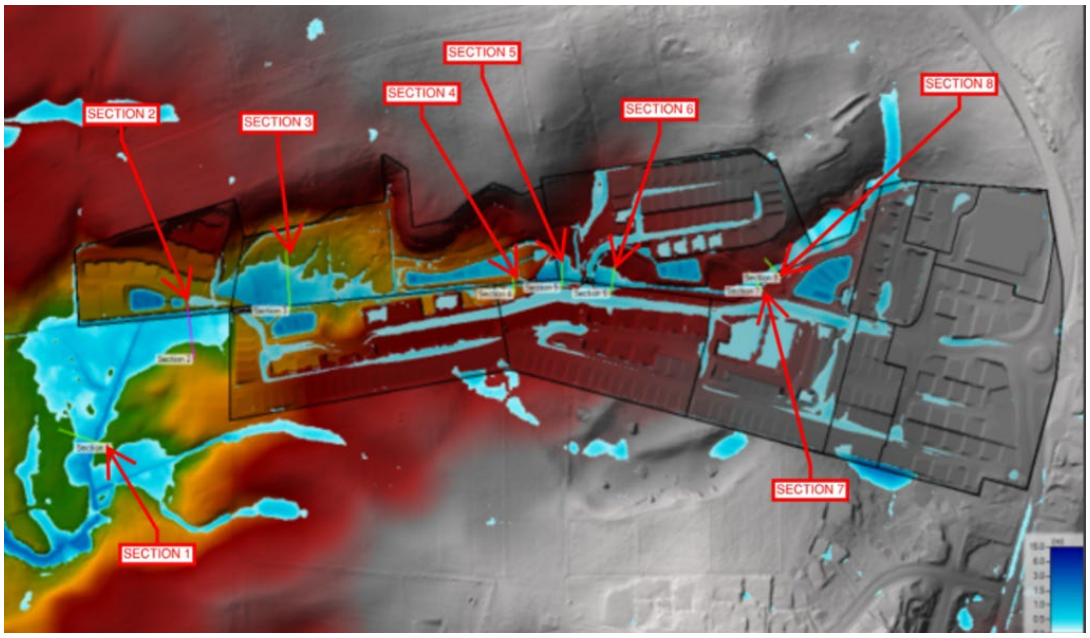


Figure 1: *Post Development 100year cc Flood Map*

Table 1 Pre vs Post Development WSE and Flow Rate Values

Sections	Pre Development		Post Development	
	Q (m^3/s)	WSE (m)	Q (m^3/s)	WSE (m)
1	11.14	46.6	7.35	46.5
2	12.05	46.64	7.23	46.53
3	11.66	47.42	7.28	48.04
4	7.72	51.31	2.48	51.29
5	8.33	53.36	5.08	53.76
6	6.9	54.97	2.57	54.7
7	2.64	59.28	3.1	59.57
8	2.57	61.09	2.3	61

The results indicate that the Stormwater will be attenuated on-site through designated artificial wetlands, stormwater management devices and enhanced existing flood basin and SNA, with controlled discharge via culverts to minimise downstream impacts. Outflows will be restricted to 80% of pre-development discharge rates for the 100-year ARI event, and to pre-development rates for the 2-year and 10-year ARI events.

The existing Waipā District Significant Natural Area (SNA WP312), comprising predominantly kahikatea and other wetland-associated vegetation, forms part of the site flood mitigation plan. Enhancement of the existing flood basin within the SNA will provide additional flood storage while supporting the wetland environment, while creating an opportunity to provide enhances planting within the SNA. This is consistent with the protection requirements of the NES-FW and the recommendations of the Ecological Assessment.

2.6. Conclusion

Overall, the proposed stormwater management framework provides an integrated approach to stormwater quality, quantity and flood management for the Harlow Lifestyle Village. The combination of raingardens, wetlands, forebays, extended detention, high-flow bypasses, controlled outlets, existing drainage channels and SNA/Flood basin and overland flow paths is intended to maintain catchment function and minimise potential downstream effects. The SMP provides the overarching framework for the staged development, with detailed stormwater infrastructure, hydraulic modelling, wetland design and flood mitigation measures to be refined through detailed design and engineering approval.

3. Introduction

3.1. OVERVIEW

This Stormwater Management Plan ('SMP') outlines the proposed management of stormwater that supports the Substantive Application under the Fast-track Approvals Act 2024 for the Harlow Lifestyle Village located at 2025 Ōhaupō Road, Te Awamutu.

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

The overall development is illustrated in Figure 2 below. The project encompasses approximately 25.78 hectares of land located to the west of Ōhaupō Road (SH3). The site generally drains towards the central portion of the property, with flows conveyed westward towards the Mangapiko Stream and ultimately the Waipā River. The site contains areas of natural vegetation, existing wetlands, watercourses and areas identified as Significant Natural Areas (SNAs). These features form important components of the existing receiving environment and have been considered in developing the proposed stormwater management approach.

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

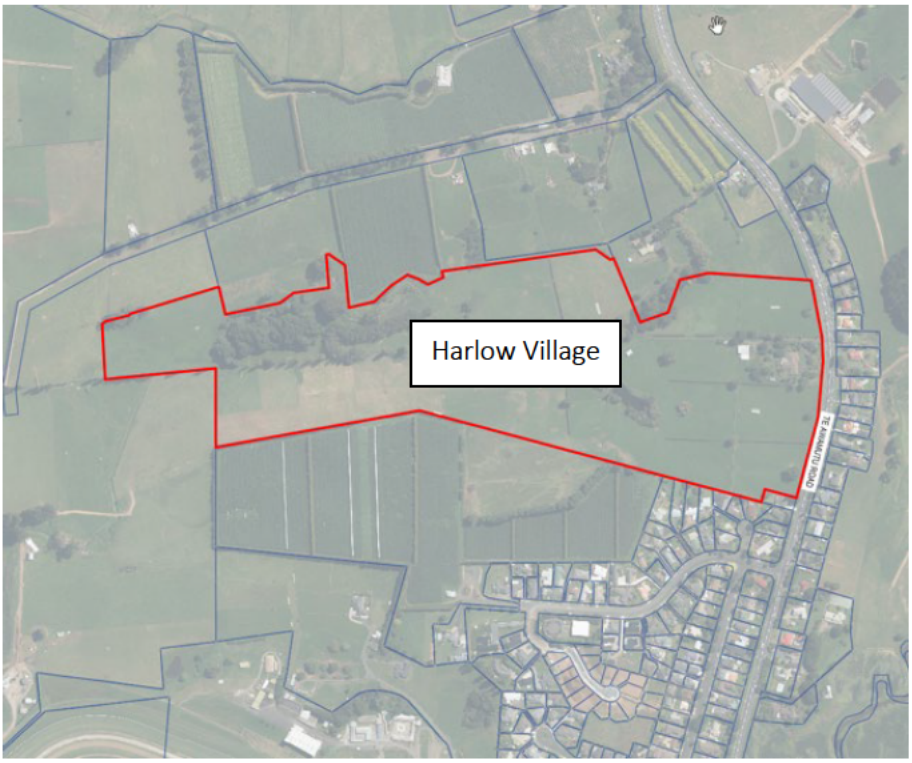


Figure 2: Site Locality

4. PROPOSED DEVELOPMENT

4.1. OVERALL DEVELOPMENT AREA

The Harlow Village Development is a circa 25.78 ha block of land within the Waipā District. The area is located in northern most part of Te Awamutu and west of Ōhaupō Road. The site topography comprises a low-lying central drainage corridor with gently rolling land extending from east to west. The site has predominantly been used for pastoral grazing, with land cover generally comprising maintained grassland.

The site contains existing wetlands, open watercourses and a kahikatea remnant identified as a Waipā District Significant Natural Area (SNA WP312). The kahikatea remnant is fenced from stock and supports a regenerating indigenous understorey, with some exotic weed species (gorse and Kiwi vine) present around its margins. These natural features form part of the existing receiving environment and have been considered in developing the proposed stormwater management approach.

The site is bounded by kiwifruit orchards to the north and south, with residential development also present to the south-east. Agricultural land extends to the north and west, while SH3, Ōhaupō Road and residential development are located to the east. A network of closely spaced open drains runs through the central low-lying area of the site from east to west, ultimately connecting to downstream drainage features associated with the Mangapiko Stream.

The overall Development area is medium density residential as shown on the overview plan below.

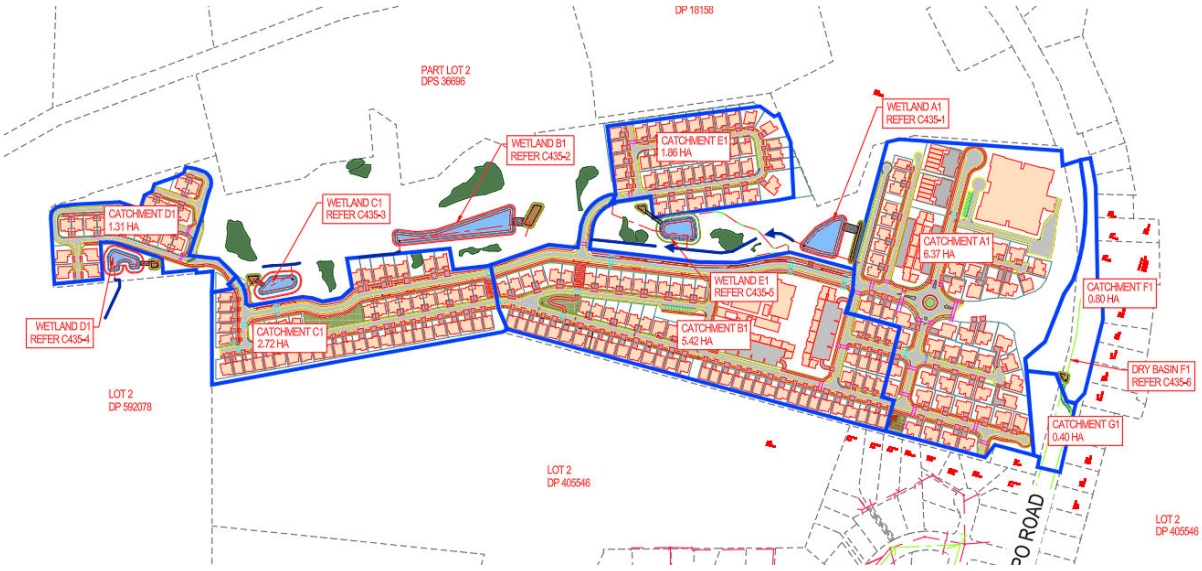


Figure 3: Catchments Overview Plan (Refer to Maven Drawing C430)

4.1.1. RESIDENTIAL DEVELOPMENT

The Harlow Village is a multi-staged residential development, with circa approximately 414 proposed residential units. The development units will have varying housing typologies with detached, duplexes, terraces, apartment units, a managed care facility along with a supporting mixed-use residential and lifestyle recreational facilities and areas, open spaces, and infrastructure. The Harlow Masterplan is shown in figure 4 below.



Figure 4: Masterplan (provided by Pacific Environment Architects 2026)

The proposed residential lifestyle village community is underpinned by design principles that seek to create a well-connected, liveable and diverse lifestyle and retirement community. The development is structured around an east–west spine road, supported by a network of local and private roads, rights-of-way and accessibility connections. With appropriate accessibility access, including accessible routes and connections to the wider shared path and pedestrian network, to facilitate safe and convenient movement for residents, visitors and care providers. Shared paths and pedestrian networks provide convenient and accessible connections throughout the development, with provision for walking and mobility scooters reflecting the needs of the retirement community. Cycling connectivity is also provided where appropriate.

A range of housing typologies and densities, including terraces, duplexes, standalone dwellings and apartments, are proposed to respond to the site opportunities and constraints and integrate with the adjoining urban area. A dedicated recreational facility will provide amenity and services for residents and the wider community, while a separate managed care facility will provide dedicated care and support services for residents requiring additional assistance.

A network of well-distributed open spaces is integrated throughout the development to provide amenity and recreational opportunities, while supporting ecological outcomes through the retention and enhancement of existing wetlands and riparian areas, including through revegetation.

4.2. LEGAL DESCRIPTION

The Development Area comprises the following parcels:

Address	Lot Description	Area (Ha)
2025 Ōhaupō Road, Te Awamutu 3800	PT LOT 1 DP 35654 LOT 1 DPS 36696 BKL II PUNIU SD	25.7824
Made up Off		
Parcel ID 4352868	Part Lot 1 DP 35654	16.6614
Parcel ID 4538250	Lot 1 DPS 36696	9.121
	Total Area (Ha)	**25.7824**

Table 2: Legal Descriptions

The areas are currently farmlands/rural areas and is located on the outskirts of Te Awamutu. The development masterplan was prepared by Pacific Environment Architects in collaboration with other specialist consultants.

Stormwater discharge from the subject property will require a resource consent from Waikato Regional Council. This SMP supports the application for that discharge consent and the substantive application under the Fast-track Approvals Act 2024.

Stormwater is proposed to be discharged via the following methods:

- Initial abstraction retention within the site using raingardens.
- WQV and EDV provided within Wetlands.
- Anything above EDV will bypass the wetland to existing channel.
- Existing/Modified Farm drains within the site running east to west which eventually discharges into the Mangapiko Stream (approximately 1.5km to the southwest).
    - The modified drains will also aid in diverting Proposed and existing flows through proposed site.
- Existing drains or overland flow paths leaving the project site at less than 80% of pre-development flows in 100yr cc event.

4.3. STAGING & TIMING

Key stormwater infrastructure elements, including raingardens, wetlands, high flow bypass systems, forebays and primary conveyance systems (pipe or overland), form the stormwater management system proposed. The proposed infrastructure provides both treatment (quality), conveyance and flow control in line with standards and WRC requirements.

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

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

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

Interim stormwater management measures, such as temporary swales, bunds and conveyance routes for flows, will be implemented during construction to maintain existing drain and direct flows through and around the site during earthworks in accordance with Erosion and Sediment Control Plan (refer to Maven drawing C230. These measures will be progressively replaced by permanent infrastructure as development proceeds.

4.4. COSTS AND VESTING ASSETS

The construction of the proposed stormwater management devices will be undertaken by the consent holder. The proposed stormwater infrastructure includes public and private piped networks and private wetlands, and raingardens.

The public assets will be vested to Waipā District Council at the appropriate time as the development progresses.

Private assets will be managed by the lifestyle village body corporate where appropriate legal instruments will be set up by body corporate to manage the private infrastructure and pond and ensure ongoing operation and maintenance.

Final layout and design of the infrastructure will be confirmed with the appropriate council(s) at detailed design and subject to engineering approval process.

Any public stormwater assets, such as primary pipe networks will be vested to council at subject to compliance with and approval process.

5. POLICY CONTEXT

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

5.1.1. WAIKATO REGIONAL PLAN

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

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

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

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

5.1.2. NATIONAL ENVIRONMENTAL STANDARDS FOR FRESHWATER

The Resource Management (National Environmental Standards for Freshwater) Regulations 2025 set requirements for activities that pose risks to freshwater and freshwater ecosystems, replacing the 2020 NES-FW. The applicant also has regard to the National Policy Statement for Freshwater Management.

The standards are designed to:

- protect existing inland and coastal wetlands.
- protect urban and rural streams from in-filling.
- ensure connectivity of fish habitat (fish passage).
- set minimum requirements for feedlots and other stockholding areas.

- improve poor practice intensive winter grazing of forage crops.
- limit the discharge of synthetic nitrogen fertilizer to land and require reporting of fertilizer use.

Whilst most of the above standards set out to restrict rural use, specific emphasis has been placed on the protection of all natural wetlands. Earthworks or land disturbance activities within 10m of natural wetlands are prohibited, and consent is also required for the change in natural drainage patterns within 100m of any natural wetland. Thirteen natural wetlands have been identified across the site by Phoenix Ecology (refer to the Ecological Assessment). Natural wetlands are to be avoided in accordance with the NES-FW; the proposed works involve the loss of a 33 m² wetland, which is addressed through the proposed 10,000 m² of wetland restoration and enhancement. This is made up of current wetlands (4,886m²) with additional areas of 6,468m². See Table 4; *Wetland loss, restoration and replacement* in Ecologists Report.

5.1.3. WAIKATO REGIONAL COUNCIL STORMWATER GUIDELINES

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

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

5.1.4. REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATION (RITS V2 (2025)

The Regional Infrastructure Technical Specification (RITS V2 2025) (Waikato Local Authority Shared Services, 2025) set standards for design and construction of earthworks, transportation, water, wastewater and stormwater infrastructure, landscapes, and accepted materials. Resource consents for subdivisions and developments in the Catchment will require developers to comply with RITS when constructing such infrastructure.

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

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

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

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

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

Figure 5: *Excerpts from RITS specifies Water Quality Standards.*

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

a. Extended Detention for WQV (1/3 of 2-year ARI storm) – a 1.2 factor is to be applied to the WQV volume/Storage.

b. 2-year ARI storm – Attenuation back to pre-development flow is required

c. 10-year ARI storm – Attenuation back to pre-development flow is required

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

Table 3: Design Requirements and how it is achieved.

	Design Criteria / Requirement	Application to Proposed Development	Related Report Sections / Supporting Documents
WRC / RITS – Water Quality Treatment	Stormwater is to be treated prior to discharge to receiving environments. A treatment train approach is adopted where appropriate.	A treatment train comprising Raingarden, forebays, wetlands, and high-flow bypass piped network will be used where applicable. Raingardens will also be provided upstream of receiving environments where required. Treatment measures will be selected based on the characteristics of each catchment and receiving environment.	Refer to section 8.
WRC / RITS – Extended Detention	Provide extended detention (1.2 of the WQV) to reduce downstream erosion potential and manage discharge to receiving streams. A 24-hour detention period is adopted where practicable.	Wetlands and attenuation systems will provide extended detention (1.2 of the WQV), with a target detention period of 24 hours.	Refer to table 12 and section 8.4. Refer to Tr20 calcs in Appendix A.
WRC/RITS – Peak Flow Control	Post-development peak discharge for the 2-year and 10-year ARI events is to be limited to the applicable pre-development discharge.	Flow above EDV will High flow bypass to existing farm drain (bypassing the proposed wetland), Culverts will act as controlled outlets to provide flood attenuation within Existing Farm drain which will be designed to limit post-development peak discharge to the applicable pre-development discharge rates.	Refer to section 7 and further section 8 for summary on proposed stormwater management.
	Post-development peak discharge for the **100-year ARI event** is to be limited to 80% of the pre-development discharge, where applicable.	Culverts will act as controlled outlets to provide flood attenuation within Existing channel and significant natural area/flood basin which will be used to limit the 100-year ARI discharge to **80% of the pre-development discharge**, where required.	Refer to section 7 and further section 8 for summary on proposed stormwater management.
WRC – Initial Abstraction	Retain the site-specific pre-development initial abstraction from impervious areas.	Initial runoff will be retained through **Raingardens**, with additional retention measures provided where required.	Refer to section 8.3.

WRC – Volume control	Post-development peak volumes for the 100-year ARI event is to be limited to the pre-development volumes.	The existing channel, significant natural area/flood basin and wetlands will provide flood attenuation and help mitigate the increase in runoff volumes resulting from the proposed increase in impervious surfaces across the site.	Refer to section 9.3. Refer to WGA and CMW report attached in appendix of infrastructure report.
RITS – Hydraulic Capacity	The stormwater conveyance network is to provide sufficient capacity for the adopted design event.	The proposed Primary piped stormwater network will be sized for up to the 10-year ARI climate change RCP 6 event and have been sensitivity checked for RCP 8.5.	Refer to Maven drawings C400.
RITS – Climate Change	Climate change rainfall allowances are to be incorporated in accordance with RITS Section 4.2.4.4, based on NIWA downscaled end-century SSP5-8.5 projections.	Climate change rainfall allowances have been incorporated into the hydrological and hydraulic assessment for the 2-year, 10-year and 100-year ARI events.	Refer to climate change excel attached in appendix A
RITS/WRC- Erosion Control	Erosion Protection- Stormwater discharge is to be managed to minimise increases in flow and erosion potential within receiving waterways.	Peak flow attenuation and extended detention will be provided where required, with controlled discharge to receiving wetlands and drainage channels.	Refer to Erosion management plan attached in appendix C
RITS/WRC	Operation and Maintenance		Refer to Operation and maintain report in appendix B.
National environmental standards for fresh water	Maintain the existing hydrological regime of receiving wetlands and avoid adverse changes to wetland inflows.	Catchment boundaries, discharge locations, attenuation and outlet controls have been developed to maintain the required flow contribution to existing wetlands.	Refer to Phoenix ecology report attached in the appendix of infrastructure report.

6. EXISTING CATCHMENT CONTEXT

6.1. EXISTING CALCULATION PARAMETERS

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

Pre-Development CN	
Pervious	**Impervious**
74	98
Pre-Development 24hr Rainfall Depth (mm)	
10yr	**100 yr**
118	181
Climate change (4deg) RCP 8.5 24hr Rainfall Depth (mm)	
10yr CC	**100 yr CC**
132	203

Table 4: Design Parameters

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

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

6.2. 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 Maven drawings C410 series. Refer to Table 5 below for catchment areas. Approximately 1-2% of existing impervious coverage is likely present within the existing catchment; however, it is assumed to be zero. This is conservative for peak flow estimation but not for runoff volume and is acknowledged as such in the 100-year volume control assessment.

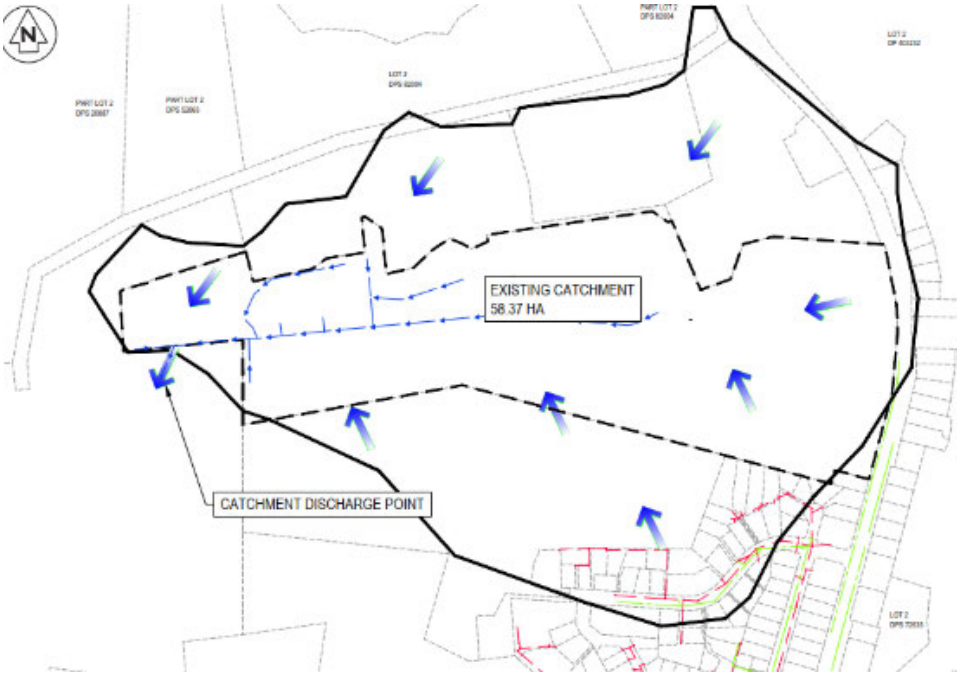


Figure 6: Existing catchments & Flow direction (Refer to Plans C420 Series)

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

		Pre-Development (historical no cc) Flow	
Catchment	**Area (Ha)**	**10-year flow (m^3/s)**	**100-year flow (m^3/s)**
1	58.37	7.69	12.85

Table 5: Overall Existing Catchment Flow table (Refer to Maven drawings C410)

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

6.3. MANGAPIKO STREAM

Mangapiko Stream is one of primary receiving environments for stormwater runoff from Harlow Lifestyle Village development that eventually connects to lower reaches of Waipā River. The Stream catchment comprises the area of approximate 221 km^2 and is located approximately 1.5km to the southwest (as the crow flies). Within the Catchment, the drainage network includes culverts, drains along the stream, which have been installed because of the low-lying landscape and underlying alluvial soils that make the area prone to flooding.

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

Future assessments of the Stream 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.

6.4. ECOLOGICAL FEATURES

An Ecological assessment was conducted by Phoenix ecology ltd covering the development site. The site contains a significant kahikatea forest remnant (Waipā District SNA WP312), several wetlands, a watercourse and constructed ponds. Long-tailed bats, classified as Nationally Critical, were detected across the site, while shortfin eels were confirmed in the watercourse. Although no threatened or at-risk bird species or lizards were detected during the surveys, suitable habitat for copper skinks may be present. The overall ecological value of the site was assessed as high, primarily due to the kahikatea remnant, wetlands and habitat supporting long-tailed bats.

Vegetation around the tree stand and ponds comprises a mixture of exotic and indigenous species. Exotic vegetation includes willows, oaks, alders, blackwoods and Lombardy poplars, while indigenous species include tree ferns, harakeke, cabbage trees, lemonwood and kawakawa. The watercourse downstream of the pond system has sparse riparian vegetation, predominantly comprising exotic species such as Chinese privet, climbing ivy, barberry and pin oak, with scattered indigenous tree ferns also present. Several exotic weed species are present across the site, including gorse, kiwifruit vine, woolly nightshade, black nightshade and arum lily, particularly along the edges of the tree stand and within existing vegetation.

The proposed development has the potential to adversely affect ecological values through vegetation clearance, earthworks, wetland loss, in-stream works and lighting. However, the assessment concluded that, with the recommended mitigation measures fully implemented, the overall ecological effects would be low and no more than minor. Key measures include wildlife management protocols, lighting controls around retained bat habitats, sediment and erosion controls, restoration planting, and the preparation of an Ecological Management and Restoration Plan. The proposal also includes approximately 10,000 m^2 of wetland restoration, along with fencing, enhancement and infill planting within the kahikatea remnant. These measures are intended to compensate for the loss of a small 33 m^2 wetland and potential bat foraging habitat while improving the quality and extent of available habitats. Overall, the assessment anticipates a positive outcome for the site's ecological values, provided all recommended management and restoration measures are implemented.

6.5. GEOTECHNICAL REPORT

A Geotechnical Suitability Report has been prepared by Titus Consulting Engineers (Ref No: C3102) and BTW Company (Ref No: Rev A – 24/11/2022) for the Harlow Lifestyle Village. The site is characterised by rolling hill with Walton Subgroup (Hamilton Ash) and the low-lying areas consisting of Holocene swamp deposits (Alluvium) and saturated clay. The investigations confirm that compressible ground conditions are present across the low-lying portions of the site.

The geotechnical assessment showed that fill-induced settlement within the low-lying areas could be significant with preliminary predicted settlements of approximately up to 40mm without mitigation or preloading. Ground Improvement of up to 4m of backfill is recommended for the low-lying areas of the site to avoid any surface expression of liquefaction. No ground improvement is necessary for the rolling hills.

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

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

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

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

6.6. CN - VALUES

Soil Class Group D has been adopted for pre-development modelling based on the soil types encountered during geotechnical investigations, which identified dense organic soil and clay. These are typically associated with Group D under TR2020/07 and USDA-NRCS classification systems. Additionally, the observed infiltration performance during site testing supports this classification.

Pre Development CN		**Post Development CN**	
Pervious	**Impervious**	**Pervious**	**Impervious**
74	98	79	98

Table 6: Design CN Values

For post-development conditions, a higher Curve Number of 79 has been adopted following the geotechnical assessment of compaction effects (refer to the Geotechnical Report); this is a conservative

assumption pending confirmation at detailed design. This approach ensures a conservative assessment of stormwater runoff. The classification may be refined at the detailed design stage if additional testing is undertaken.

6.7. ASSESSEMENT – SOAKAGE RATE

The preliminary geotechnical investigations were undertaken to provide full coverage of the Harlow Village development area. The investigations cover assessed ground water levels, soil soakage capacity, liquefaction potential, and lateral spreading risks, ensuring comprehensive data for stormwater management, earthworks, Roading and foundation design. The referenced Geotechnical report in this SMP is listed below (Appendix of the Infrastructure Report).

1. 211365 Rev A (dated 24/11/2022)

The site is characterised as rolling low hills bisected east-to-west by a central gully that feeds two existing ponds, wetlands, and a small stream, which ultimately flows into the surrounding alluvial plains. Overall, underlain by Walton Subgroup along the low hills and the gullies, low-lying areas are underlain by the Hinuera Formation, flanked by rolling hills to the north and south, comprised of Hamilton ashes, with ground water levels varying seasonally and across different areas.

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

Ground Water Levels

- Depths recorded 0.2m below existing ground level in low lying areas
- Groundwater was not encountered within 2m of the surface across the elevated low hills of the site.

The BTW company LTD conducted field tests to determine the soakage rates at site: Falling Head tests. The results are as detailed in below.

Soakage Test Unit	Site Location	Results (mm/hr)	Soakage Rate factored by 0.5 as per RITS for conservatism (mm/hr)
CPT 1	Stage 1B	16	8
CPT 2	Stage 1A	120	60
CPT 3	Stage 2A	156	78
CPT 5	Stage 3	480	240
CPT 7	Stage 3	1,200	600
CPT 10	Stage 4	96	48

Table 7: Soakage tests Results from Falling Head

2. WGA260929-RP-HG-0010_A (dated August 2026)

The site is characterised as irregular shaped rectangle with rolling and undulating hills, with a gully running east to west which form a dendritic valley pattern. Overall, underlain by Walton Subgroup along the hills, while the stream valley is underlain by Hinuera Formation.

WGA conducted field hydraulic testing and produced hydraulic conductivity at varied locations across the site, which have been interpolated to soakage rate for a better understanding of the site.

Piezometer ID	Site Location	Hydraulic Conductivity (m/sec)	Results (mm/hr)
PZ26-01	Stage 1A	4.74×10^{-8} to 2.94×10^{-7}	0.17 to 1.06
PZ26-02	Stage 1E	2.75×10^{-7} to 1.05×10^{-6}	0.99 to 3.78
PZ26-03	Stage 3	5.76×10^{-7} to 1.34×10^{-6}	2.07 to 4.82

Table 8: Interpolated Soakage Results from Hydraulic Conductivity data

The testing results from both investigations indicate varied soakage performance across the site, with notably low rates, such as 8 mm/hr, recorded closer to the eastern boundary. Observations from soakage testing and variable groundwater depths indicate that perched layers are likely present in parts of the site. As such, the adopted soakage rates for design have incorporated conservative assumptions, and further investigation at the detailed design stage is recommended to confirm underlying groundwater conditions beyond any perched layers.

The results in the Geotechnical report, shows soils at this site are generally suitable to provide use of SW Devices such as raingarden etc. The falling head tests and the WGA hydraulic conductivity results differ by up to two orders of magnitude, reflecting the presence of perched layers. On this basis soakage is not relied upon for the raingardens or wetlands (all lined except Wetland B), which function as filtration and detention devices; the WGA results are adopted as the conservative basis for assessing groundwater interaction. This soakage rate has been derived from double ring infiltration test and falling head 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.

6.8. OPERATION MAINTENANCE AND MONITORING PLAN

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

6.9. EROSION MANAGEMENT PLAN

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

7. DESIGN APPROACH

7.1. POST DEVELOPMENT CATCHMENTS

The post development catchment layout areas has been defined based on the proposed stormwater wetland's location, which also serve as the primary discharge points for each sub catchment the placement of these wetlands has been carefully considered to align with existing discharge locations and existing wetland locations, ensuring that no new discharge points are introduced as part of the development.

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

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

- CN numbers
    - Post-development CN=79 for pervious Areas
    - Post-development CN=98 for Impervious Areas
- Rainfall data from National Institute of Water and Atmospheric Research (NIWA) rainfall pattern and depth:

Post Development CN	
Pervious	**Impervious**
79	98
Post Development 24hr Rainfall Depth (mm)	
10yr RCP8.5	**100 yr** RCP8.5
132	203

Table 9: Design Parameters table

7.2. PRINCIPLES OF STORMWATER MANAGEMENT

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

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

The principles set out in this SMP aligns with stormwater management plans previously approved by Waikato Regional Council for comparable developments in the district.

. The key components of the 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, swale and existing channels.
- 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, with the post-development discharge limited to the applicable pre-development discharge.
- 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 for all impervious catchment of this development.

7.3. HYDRAULIC CONNECTIVITY

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

- Modern Building Materials
- Master Plan Layout and landscaping design.
- Stormwater Retention via Raingarden
- Artificial Wetland
- High flow Bypass
- Soakage Devices where viable
- Protection of existing bush, wetlands and covenant features.
- Planting of riparian areas if applicable.

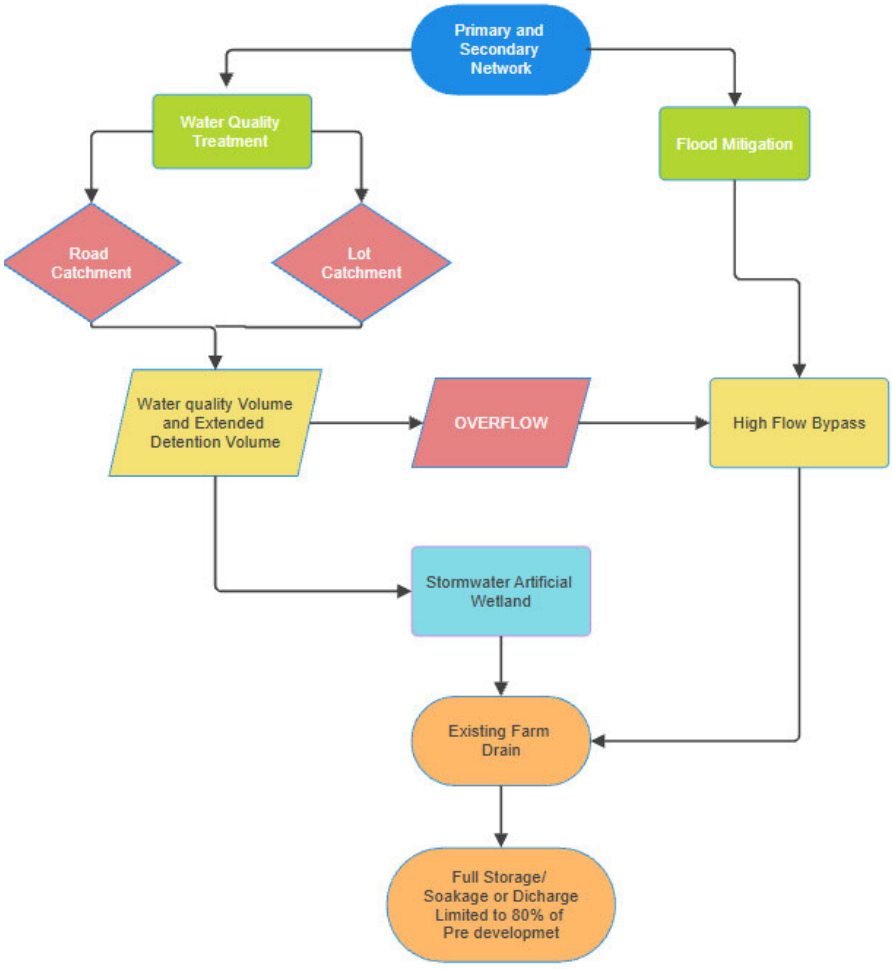


Figure 7: Hydraulics Connectivity Chart

7.4. OBJECTIVES

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

The strategy for the future stormwater management is outcome focused. The SMP provides a solution-based approach for the receiving environment. Consideration and emphasis are given to the inclusion of Water Sensitive Urban Design principles, with the overall goal of developing environmentally conscious outcomes which help address and mitigate known and future constraints of the Development Area.

Proposed objectives of the SMP are outlined below:

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

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

8. PROPOSED DEVELOPMENT & STORMWATER MANAGEMENT

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

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

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

Initial abstraction requirements will be achieved amalgamated raingarden for each Catchment.

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

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

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

8.1.1. STORMWATER QUALITY AND QUANTITY

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

Water Quality Mitigation

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

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

Water Quantity Mitigation

Water quantity mitigation is achieved through a combination of source control, flood storage, attenuation, and controlled discharge. Water quality volume and extended detention volume requirements are met through the provision of the proposed wetland system, while additional storage and attenuation are provided within the existing farm drain, SNA/Flood basin and associated stormwater culverts act as controlled outlet.

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

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

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

8.2. TREATMENT TRAIN (Catchment A to E)

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

The first component of the treatment train is the provision of centralised raingarden for retention of the required initial abstraction volume and reduces the volume of runoff entering the downstream stormwater network.

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

The wetlands form the primary stormwater treatment and provide extended detention volumes within the development. High-flow bypass structures are incorporated into the wetland design to safely convey/bypass high velocity flows from storm events while maintaining treatment performance for more frequent rainfall events.

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

8.3. RETENTION OF INITIAL ABSTRACTION AND RAINGARDENS

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

The initial abstraction requirement has been assessed using site-specific information in accordance with the TR2020/07 WRC guideline. The required initial abstraction retention depth is 4.5 mm, calculated in accordance with TR2020/07 (refer to Appendix A). The retention requirement have been achieved by Amalgamated raingarden. The raingardens or bioretention device will be sized to retain the initial abstraction depth for its catchment.

Table 10: Retention Volume Requirement

Catchment	Impervious Catchment (70% of total catchment) (m^2)	Required Retention Volume 4.5 mm (m^3)	Proposed raingarden area (m^2) (Based on TR2020/07)	Ponding depth of raingarden (mm)	Volumes achieved within Raingarden (m^3)
A	44,590.00	200.655	73.2	850	222.95
B	37,940.00	170.73	96.9	850	189.7
C	19,040.00	85.68	49.3	850	95.2
D	9,170.00	41.265	24.1	1600	45.85
E	13,064.20	58.7889	36.4	750	65.321
F	5,636.85	25.365825	*		
G	2,731.94	12.29373	*		
Total		594.8	279.9		648.9
**Initial abstraction is not provided within Catchments F and G; the required retention is delivered by over-provision in Catchments A–E. This is a departure from the catchment-by-catchment basis of TR2020/07 and is addressed under Section 10.*					

Based on the proposed catchment the total retention volume provided is approximately 600.5 m^3. The proposed strategy provides approximately 65 m^3 of additional retention volume above the required 4.5 mm retention volume, demonstrating compliance with the retention requirements. Wetland B is unlined and groundwater-connected; its contribution to retention has been excluded to keep the assessment conservative.

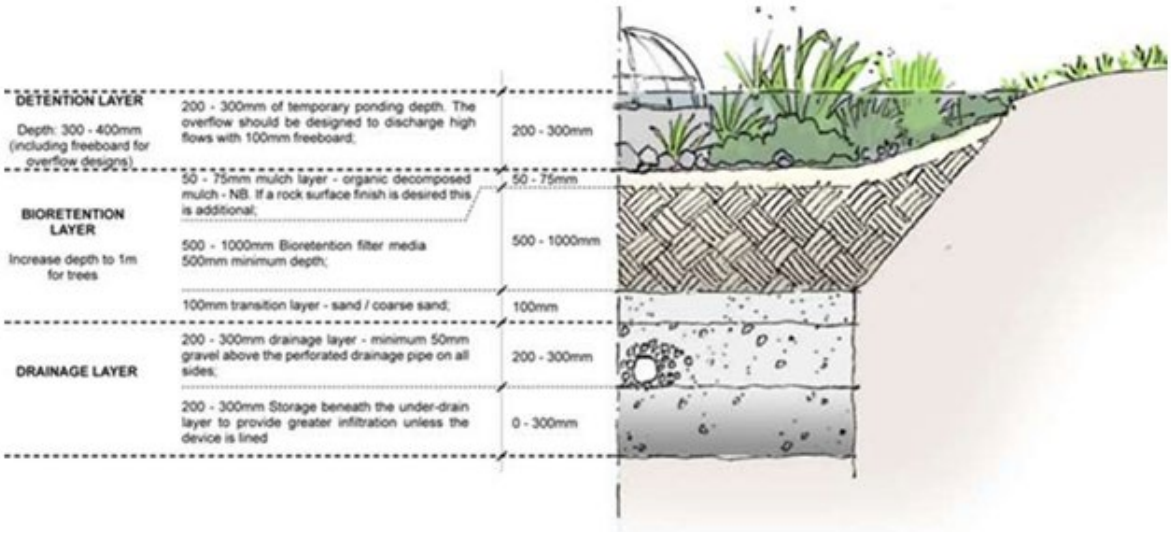


Figure 8: Excerpt from Waikato Stormwater Management Guideline, typical section of Raingarden.

The raingarden designed to comply with the below requirements:

Retention

- Initial Abstract retention of proposed imprervious surfaces.

Treatment

- Treatment of incoming flows from the roadways and potentially lot areas (including roof areas) where soakage cannot be achieved.

8.4. ARTIFICIAL WETLANDS (Catchment A to E)

Wetlands will be designed in accordance with Waikato's Regional Infrastructure Technical Specifications (RITS V2 (2025)) and other relevant standards including Waikato Stormwater Runoff Modelling Guideline (TR2020-06) and Waikato Stormwater management Guideline (TR2020/07). Wetlands will provide secondary treatment (following forebay) and extended detention prior to discharging to the existing/enhanced stream or primary network. Wetlands will be located offline to the existing/enhanced stream, to allow upstream flows to bypass the wetland.

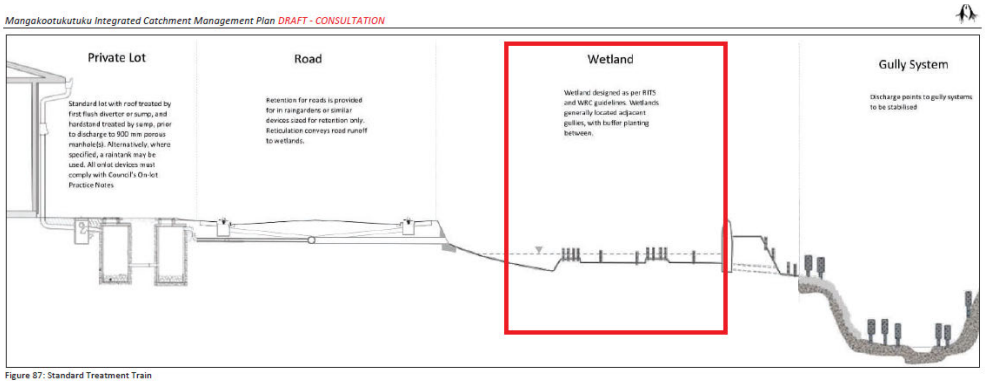


Figure 9: WRC excerpt

Figure 9 above is an excerpt from the guidelines depicting the overall treatment system, the wetland requirements highlighted as being relevant to this section.

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

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

Wetland bathymetry will be banded and consist of a mix of deep and shallow pools to allow for dispersed flow through vegetated areas per RITS guidelines. Internal bathymetry in accordance with RITS Table 69.

- Shallow Marsh area approx. 40% of Permanent Storage Zone (PSZ) (+/- 5%)
- Deep marsh area approx. 40% of PSZ (+/- 5%) o Intermediate deep pools approx. 10% of PSZ (+/- 2%) • An extended detention zone (1.2 × WQV),
- The remaining balance comprises the forebay and permanent deep pool zone as per RITS

According to TR2020/07, a conservative approach to wetland design is recommended. Where the contributing catchment has an imperviousness of less than or equal to 70%, the permanent water surface area of the wetland is be sized at 3% of the contributing catchment area. This sizing can be refined during the detailed design stage once the catchment characteristics, hydrology, and treatment objectives are confirmed.

Based on the anticipated imperviousness of the proposed development, the adopted 3% sizing factor applies where contributing imperviousness is ≤ 70% (TR2020/07). The design imperviousness for each catchment is 70% (refer to Appendix A). The contributing catchments and wetland locations are shown on the Maven stormwater drawings. Table 11 presents the conceptual wetland surface area requirements for each contributing catchment.

A design has been undertaken for the artificial wetlands within each catchment and is included on proposed Engineering Plans. Figure 10 below shows the proposed artificial wetlands located within Catchment C.

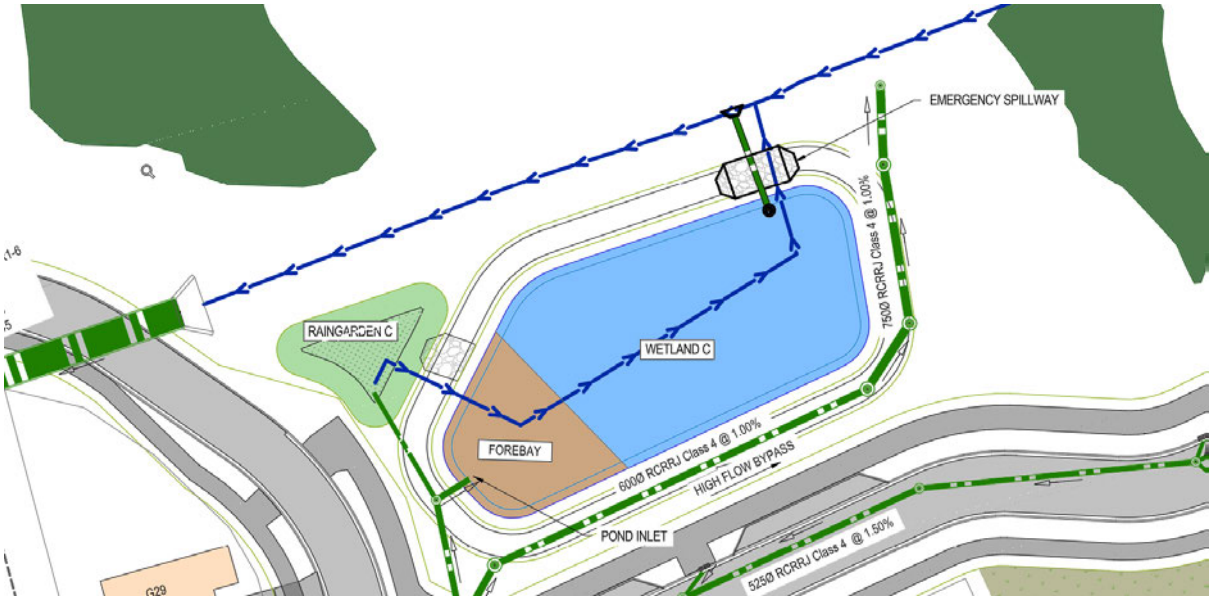


Figure 10: Wetland Details Catchment C

Wetlands at the development have been split into 5 wetlands (Wetland A to Wetland E), to allow it to be constructed in stages as each development occurs. Wetlands are separated by a high-flow bypass and are proposed to treat and attenuate up to EDV including climate change.

Table 11: Wetland Pool Area and achieved treatment area.

CATCH-MENT	AREA (HA)	REQUIRED WETLAND POND AREA (m2)	PROPOSED WETLAND POND AREA (m2)	Wetland Lined or unlined
A	5.88	1764	1770	Lined
B	5.45	1635	1640	Unlined
C	2.72	816	816	Lined
D	1.42	426	447.3	Lined
E	1.83	549	761.1	Lined
TOTAL	17.68	5304	5434.4	

As shown in the table above, all wetlands will be lined to maintain base flows and permanent water levels, except Wetland B, which is an unlined, groundwater-connected constructed habitat pond (refer to Section 8.8). Lined wetlands will use a low-permeability clay liner or a synthetic geomembrane (HDPE or LLDPE), confirmed at detailed design with the geotechnical engineer. Implications for groundwater interaction and settlement are addressed in drawings in the WGA groundwater assessment and the Titus/BTW geotechnical reports.

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

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

Detention/Attenuation

- EDV Storage and slow discharge over 24hrs

Treatment

- WQV treatment

Table 12: STAGE 1 Wetland EDV and WQV requirements

CATCHMENT	WETLAND	DEAD STORAGE VOLUME (m^3) REQUIRED - 50% of WQV	EDV (m^3) REQUIRED - 1.2 x WQV	DEAD STORAGE VOLUME (m^3) PROPOSED - 50% of WQV	LIVE POND STORAGE VOLUME - AVAILABLE
A	A	415.7	1305.88	415.8	1489.2
B	B	85	641.17	303.1	1264.4
C	C	186.29	592.22	186.3	796

D	D	174.72	885.28	175.0	1133.3
E	E	185.2	385.2	185.2	891.4
	TOTAL	1046.91	3809.75	1218.9	5574.3

Wetland B is an unlined habitat pond; the larger dead storage reflects its open-water habitat function.

A stormwater splitter device is proposed upstream of the wetland. This will direct the EDV into the wetland area for treatment and storage. Higher flows are to be diverted into the high flow bypass to undergo attenuation. This device is currently represented as a stormwater flow splitter manhole, within the piped high-flow outlet.

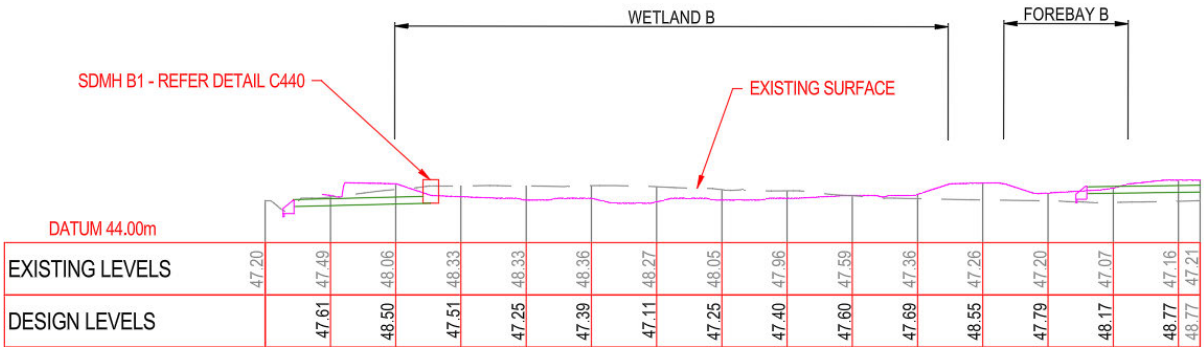


Figure 11: *Wetland Section*

8.5. FOREBAY

Forebays will be sized to meet a minimum area of 10% of the artificial wetland as per RITS. WRC TR2020/07 requires a forebay sized to minimum 15% of the WQV. Both RITS and WRC requirements will be achieved for each wetland. Rainfall events up to EDV event will be directed to the forebays. The forebay will provide energy dissipation of incoming flow and minimizes erosion and scour within the wetlands.

Conceptual minimum forebay sizes based on the current catchment and wetland sizes are provided in the table 13 below. Forebay areas will need to be reviewed and refined as required during the Engineering Plan Approval stage in accordance with RITS and WRC TR2020/07.

Table 13: Minimum forebay areas

Residential	**Required**	**Actual/ Proposed**
Artificial	**Forebay Area**	**Forebay Area**
Wetland	**m²**	**m²**
A	190	242
B	209	235.5
C	111	111
D	84	84
E	93	116.6

8.6. HIGH FLOW BYPASS (HFB)

High-flow bypasses are proposed within the relevant sub-catchments to provide a secondary conveyance route for flows that exceed the capacity of the proposed wetland treatment and extended detention system. The HFB system is intended to protect the wetland treatment areas from excessive hydraulic loading during larger rainfall events while maintaining safe conveyance of major stormwater flows through the development.

Under normal and frequent rainfall conditions, runoff will be directed through the proposed treatment train comprising the raingarden, forebay and artificial wetland. The wetland will provide the required water quality treatment and extended detention, with the stored volume released through the controlled wetland outlet structure.

When inflows exceed the adopted extended detention capacity of the wetland system, the flow splitter arrangement will progressively divert the excess flow into the HFB. The piped bypass will convey these larger flows around the wetland treatment area and discharge to the retained existing drainage channel or other approved downstream conveyance system.

The HFB forms part of the secondary conveyance system for larger events, with peak-flow attenuation achieved through the combination of the wetland/outlet system, retained drainage corridors, flood storage and controlled downstream hydraulic structures, as applicable to each catchment.

8.7. WETLAND OUTLET AND OVERFLOW STRATEGY

The proposed wetland systems have been designed to provide extended detention for 24hours, anything above extended detention will bypass the treatment and outflows to existing environment. During extreme events, where downstream water levels exceed the wetland outlet level, discharge through the primary outlet structure may be temporarily restricted due to backwater effects.

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



Figure 12: Backflow Device installed on Outlet Pipe.

Once water levels within the receiving stream recede, stored stormwater within the wetlands will progressively discharge through the primary outlet structure, comprising a low-flow orifice and spillway arrangement. A backflow prevention device will be incorporated within the outlet structure to prevent reverse flow from the receiving stream entering the wetland system during periods of elevated downstream water levels.

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

8.8. LIVE WETLAND (Catchment B)

Wetland B is a constructed stormwater treatment pond rather than a natural wetland. Its function is to replace the open water and pond habitat lost through removal of the site's two artificial farm ponds, in particular to recreate lost habitat for shortfin eel. The habitat accounting for the removal of the two farm ponds and the 33 m² of natural wetland loss is set out in the Ecological Assessment (Phoenix Ecology). The pond (approximately 2,500 m² including habitat/chamber areas) is connected to both groundwater and the retained watercourse, with fish passage provided via a V-type cutout past the forebay. Flow is managed through a mainstream 300 mm culvert maintaining natural flows up to Extended detention volumes, with a high-flow bypass culvert directing larger flows to a splitter manhole (1,500 mm culvert); a small outlet from this manhole directs baseline flows to the wetland, with high bypass flows returned to the existing watercourse.

The pond is unlined and incorporates various artificial habitat features (logs, snags and rocks) within its Deep Marsh and Intermediate Deep Pond zones, placed in suitable locations across roughly half of the pond area. The system cascades through six chambers (forebay through alternating deep marsh, shallow marsh and intermediate pond zones to outlet), each stepped down approximately 100 mm, allowing it to fulfil its function as a conventional stormwater treatment train while also providing open water habitat replacement.

8.9. CATCHMENT F AND G

Catchment F is managed via a Stormwater basin. Runoff from Catchment F is directed to a proposed stormwater dry basin, which will be planted with suitable vegetation to provide stormwater treatment and support the overall water quality objectives for the catchment. The basin has been size to accommodate WQV volume and anything above WQV will be directed to roadside drain. This will be further detailed on detail design stage.

Table 14. Catchment F WQV achieved.

Catchment F Area in m²	**Treatment area required m²**	**Treatment area achieved m²**	**WQV required based on TR20/07 m³**	**WQV Achieved based on TR20/07 m³**
8400	252	277	131	136.79

Catchment G is not included in the proposed treatment train. The catchment is currently untreated and discharges to the existing roadside drainage network. As there is no increase in impervious area within Catchment G as part of the proposed development, the existing runoff characteristics and drainage

arrangement remain unchanged. Accordingly, no additional stormwater treatment or attenuation measures are proposed for this catchment.

Collectively, the proposed stormwater management measures provide an integrated approach to water quality, water quantity, flood management, and hydraulic connectivity across the development. Catchment F is managed via the proposed vegetated dry basin, and Catchment G remains consistent with the existing drainage arrangement, with no increase in impervious area or associated change in runoff characteristics.

8.10. STORMWATER CULVERTS

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

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

Three road main crossings (Culvert 1, 2 and 3) and one footpath crossing (Culvert 4) are proposed where the development road/ footpath network intersects existing drainage channels traversing the site. The purpose of the culverts is to maintain the existing hydraulic connectivity of the stream system while enabling the construction of the proposed collector roads and associated infrastructure.

There are 1 Box culvert, and 3 circular culverts proposed mainly to allow conveyance of the rerouted stream and the discharge from proposed wetlands. Refer to drawing C400 for location of the culvert crossing locations.

All culvert crossings have been designed with a longitudinal grade of the existing ground condition and incorporate embedment below the existing stream bed to maintain stream continuity through the structures. Refer to Table 15 for the culvert details.

Table 15. Culvert details

Culvert	Dimension	Gradient	Flow through the barrel (m^3/s) (Hec Ras)
Culvert 1	3m span x 1m rise	0.9%	2.34
Culvert 2	1.5 m Dia	3.7%	0.75
Culvert 3	1.5 m Dia	0.8%	0.46
Culvert 4	1.2 m Dia	8.5%	0.42

8.11. FISH PASSAGE AND CULVERT INTERACTION

To support ecological connectivity, the culverts have been carefully designed to allow for fish passage and maintain connectivity of existing waterways and drainage features. Where required, appropriate fish passage measures, such as fish/eel ropes or low-flow pathways, will be incorporated to facilitate movement through culverts and minimise barriers to aquatic passage.

- Culverts 1 is a 3.0 m wide by 1.0 m high open-bottom box culvert. The open-bottom configuration retains the natural streambed through the culvert, maintaining the existing channel substrate and flow characteristics. This provides a continuous natural bed for aquatic fauna and supports fish passage without requiring a separate artificial passage structure. The arrangement also maintains continuity between the upstream and downstream channel and provides the required hydraulic conveyance capacity without overtopping during the design event.
- Culverts 2 and 3 are 1,500 mm diameter circular culverts, each embedded approximately 25% into the existing streambed. Embedding the culverts allows the natural channel bed material to be maintained through the barrel, providing a more continuous aquatic pathway and supporting fish passage. Low-flow channels are incorporated within each culvert to maintain a defined flow path during lower flow conditions and assist aquatic fauna in moving through the culverts.

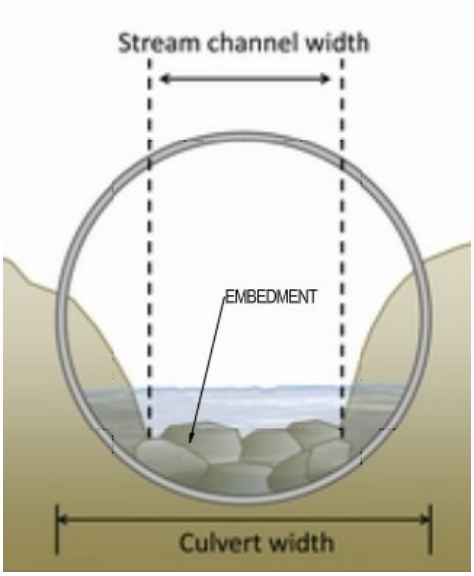


Figure 13: Embedment of the culvert

- Culvert 4, A 1,200 mm diameter circular culvert is proposed beneath the footpath, with approximately 25% of the culvert diameter embedded below the channel bed to maintain a naturalised bed and facilitate fish passage. The culvert will be installed at a gradient of approximately 8.5%, following the existing channel bed gradient to maintain continuity with the upstream and downstream watercourse.
  Fish passage ropes will also be provided within the culvert to assist fish and eel movement through the structure, particularly during low-flow conditions. The minimum proposed footpath level at the culvert crossing is to be maintained at RL 61.12 m to prevent overtopping of the proposed footpath in the 1 in 100 yr event. The proposed arrangement provides sufficient hydraulic conveyance capacity to safely convey the design flows without overtopping, while maintaining watercourse connectivity and facilitating fish passage.



Figure 14: Fish Rope Passage

This approach promotes the retention of natural stream processes and facilitates aquatic organism passage through the crossings. Riprap protection is proposed at the inlet and outlet structures to minimise erosion and protect the receiving environment. Wingwalls will be confirmed during detailed design to provide a stable transition between the stream channel and culvert structures

Riprap protection and energy dissipation measures are proposed at the inlet and outlet structures to minimise erosion and protect the receiving environment. Refer to erosion protection plan for the riprap details in appendix C.

9. FLOOD MODELLING

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

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

Consultation was undertaken with Waikato Regional Council (WRC) and Waipā District Council (WDC) to establish the available flood and hydrological information for the downstream catchment. WRC confirmed that there is limited site-specific flood-level information available for the Mangapiko Stream in the vicinity of the development, with the nearest available information relating to the Puniu River at Bartons Corner Road Bridge and the Waipā River at Pirongia which is distant from the subject site.

As a check on the adopted hydraulic representation, the available Waikato Regional Council 100-year RCP6.0 flood information in the vicinity of the development was reviewed and compared with a corresponding 100-year RCP6.0 HEC-RAS results. The WRC flood mapping indicates flooding extending through the low-lying area in the order of 1m to 1.2m immediately downstream of the development, while the HEC-RAS model predicts a maximum flood depth of approximately 1.2 m at the immediate downstream end of the subject site. The two assessments are of the same order of magnitude, providing a reasonable cross-check on the modelled flood behaviour and downstream hydraulic response (Refer to HEC RAS summary for the model check with RCP 6.0 and correspondence note in Appendix D).

The comparison indicates that the downstream flood behaviour represented in the HEC-RAS model is broadly consistent with the available regional flood information. The HEC-RAS model therefore represents the local drainage network and downstream floodplain hydraulics, with the downstream boundary condition applied at the downstream extent of the model.

The desktop assessment and modelling confirmed that the immediate downstream low-lying area from the subject site acts as a basin during extreme events, with runoff conveyed from upstream catchments through the Development Area before discharging downstream to the environment. The Development Area is located immediately upstream of this existing overall catchment, with farm drainage channels providing the primary conveyance route through the site feeding runoff to the main existing drain.

9.1. EXISTING FLOODING, MODELLING AND PARAMETERS

Modelling parameters

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

- Rainfall Data – NIWA cc adjusted using RITS RCP8.5 2100-2120 (climate change 4 degrees)

- Rainfall data distribution – using normalised 24hr temporal rainfall intensity (climate change allowance of 3.8 °C)
- Runoff Method: SCS CN – CN used as advised by geotechnical Engineer and noted in the geotechnical report.
- Design Events assessed: 2, 10 and 100year existing/historical and RCP8.5 2100-2120
- Design Check: 100yr RCP6.0 2081-2100

Hydrology - HEC HMS

- For Catchment Delineation and generating inflow hydrographs, TR2020/07 Sheets for Tc.
- Used for Wetland and Pond attenuation/routing design and soakage

Hydraulics – HEC RAS 2D Modelling

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

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

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

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

The assessment extent includes the upstream catchments that discharges through the development area and the downstream areas extending towards Mangapiko Stream. This extent ensures that flood behaviour is assessed within the context of the wider catchment, and potential increase in the levels of stream.

Figure 15 and 16 below – Hydraulic Assessment Extent showing the upstream contributing catchment (reference from the site), development Area and extending towards Mangapiko Stream.

9.2. EXISTING MODEL RESULTS

The modelling confirms the extent of existing flooding, ponding, and overland flow paths under the predevelopment 100year cc event. The results indicate that the downstream low-lying areas just downstream from the property is flooded and act as a basin, storing significant flood volume during major storm events.

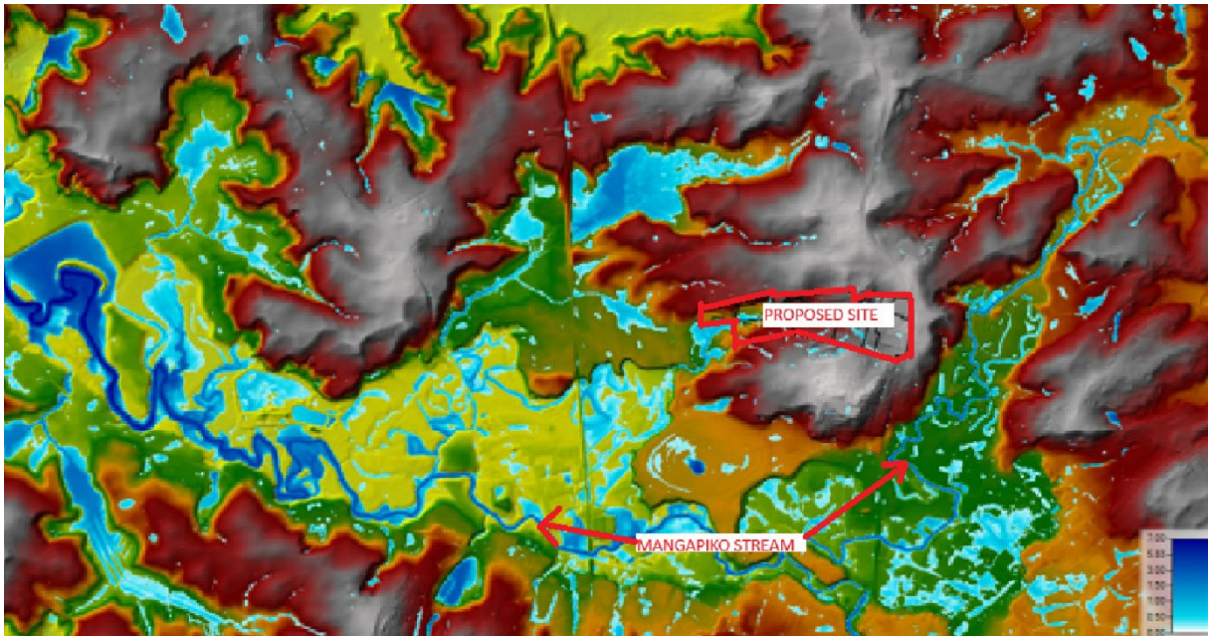


Figure 15*: Pre Development 100year cc Flood Map.*

Runoff from the wider catchment, including upstream residential and rural areas, is conveyed through the development area via the existing farm drains and streams before discharging into the Mangapiko Stream.

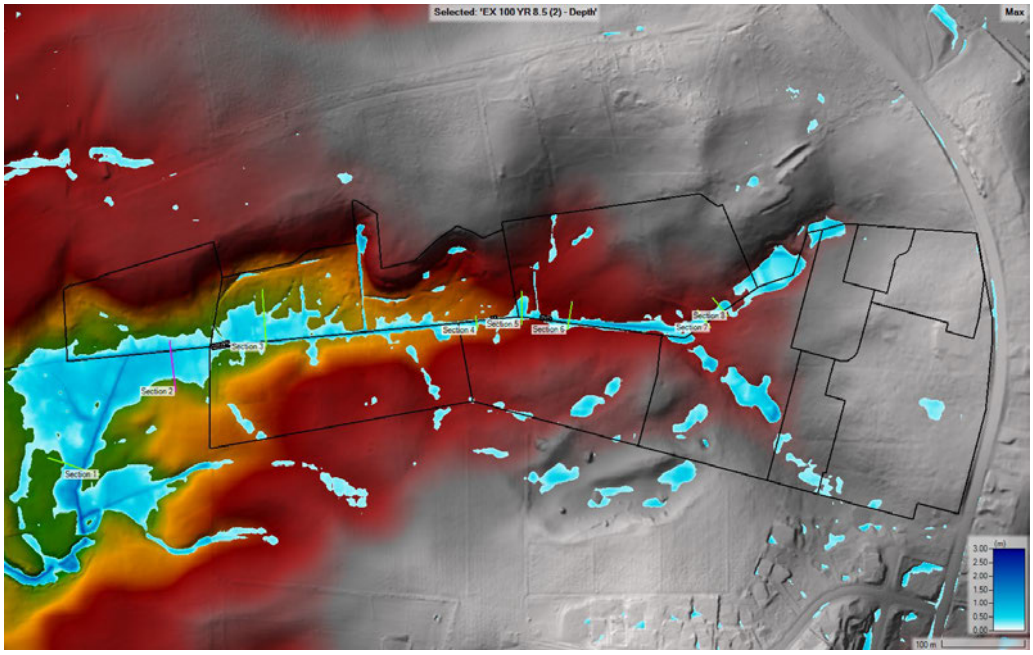


Figure 16: *Pre Development 100year cc Flood Map zoomed into the Site.*

The full hydraulic model outputs are provided in Appendix D, with a summary of results provided in table 16 below.

9.3. POST DEVELOPMENT FLOODING ASSESSMENT

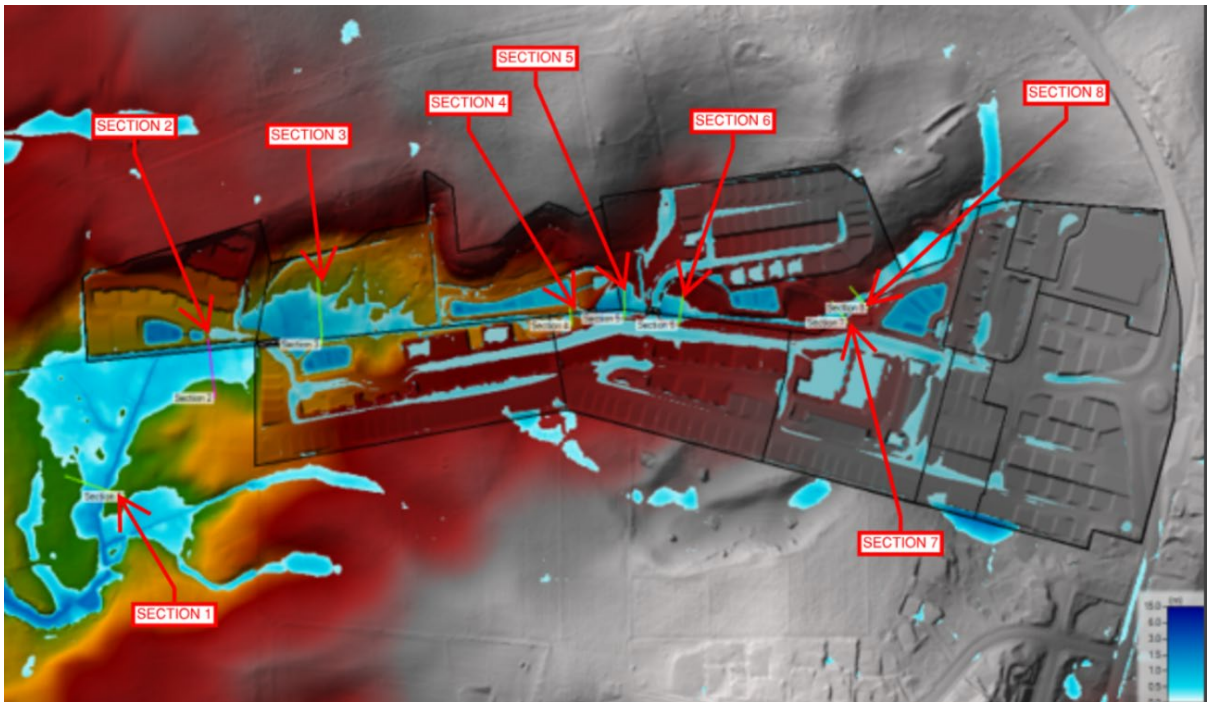


Figure 17: *Post Development 100year cc Flood Map*

Table 16: *Pre vs Post Development WSE and Flow Rate Values*

Sections	Pre Development		Post Development	
	Q (m^3/s)	WSE (m)	Q (m^3/s)	WSE (m)
1	11.14	46.6	7.35	46.5
2	12.05	46.64	7.23	46.53
3	11.66	47.42	7.28	48.04
4	7.72	51.31	2.48	51.29
5	8.33	53.36	5.08	53.76
6	6.9	54.97	2.57	54.7
7	2.64	59.28	3.1	59.57
8	2.57	61.09	2.3	61

A comparison of the existing and post-development HEC-RAS model results indicates that flood behaviour across the wider area has improved.

- Section 1-2 is located outside the property downstream of the development. Post-development peak flows and WSEs are lower than pre-development, indicating no adverse downstream flood level increase at these locations.
- Section 3 is located within the wider low-lying portion of the channel that provides the main flood storage and attenuation area. Culvert 1 (3 m × 1 m) provides the downstream outlet from this basin, with the increased post-development WSE reflecting utilisation of the available storage rather than an increase in downstream discharge.

- Sections 4-6 pass through the central portion of the attenuation channel, where flows are temporarily stored and conveyed through Culverts 2 and 3 (1.5 m diameter). Peak flows reduce progressively through this system, while the local WSE increases reflect the hydraulic storage and associated head required to convey flow through the culverts.
- Sections 7-8 represent the upstream end of the attenuation system, with Culvert 4 (1.2m diameter) providing the upstream flow connection into the channel.

The Existing drainage corridor provides distributed flood storage and attenuation, with the Section 3 low-lying area forming the primary attenuation basin and the downstream culverts controlling discharge, resulting in reduced peak flows to the downstream receiving environment compared with the pre-development scenario.

9.3.1. DOWNSTREAM FLOOD EFFECTS ASSESSMENT AND RESULTS

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

- Runoff volume: Within the channel running through the development, the post-development runoff volume increases by approximately 5,600 m³ compared with the pre-development scenario. This increase is primarily attributable to the additional impervious area and the attenuation associated with the proposed development and the resulting increase in runoff generation. At the downstream end of Culvert 1, the post-development runoff volume is approximately 10,000 m³, compared with 11,900 m³ under the pre-development scenario. This represents a reduction of approximately 1,900 m³ (16%), in the post-development runoff volume at this location. The reduction demonstrates that the additional runoff generated within the development is effectively attenuated by the proposed stormwater management measures before exiting the site boundary through Culvert 1. Refer to Hec Ras Summary in Appendix D for the area of study and graph of pre and post volumes.
- The total runoff volume under the post-development scenario for the channel running middle of the development is approximately 4,300 m³ higher than under the pre-development scenario. This increase is primarily attributable to the increase in impervious area associated with the proposed development, resulting in greater runoff generation. However, comparison of the pre- and post-development scenarios immediately downstream of the development, at the downstream end of Culvert 1, demonstrates that the increase in runoff has been effectively attenuated within the catchment. The post-development runoff volume at this location is approximately 10,000 m³, compared with 11,930 m³ under the pre-development scenario, representing a reduction of approximately 1,930m³ in the peak event runoff volume. This indicates that the proposed stormwater management measures effectively attenuate the increased runoff generated by the development. Refer to Hec Ras Summary in Appendix D for the area of study and graph of pre and post volumes.
- Peak discharge: Despite the increase in total runoff volume, the post-development peak discharge is reduced relative to the pre-development condition. This reduction is achieved through the proposed stormwater management measures, including extended detention, attenuation storage via wetland systems, existing channels and proposed stormwater culverts within the channel, which collectively provide flow attenuation and controlled discharge.

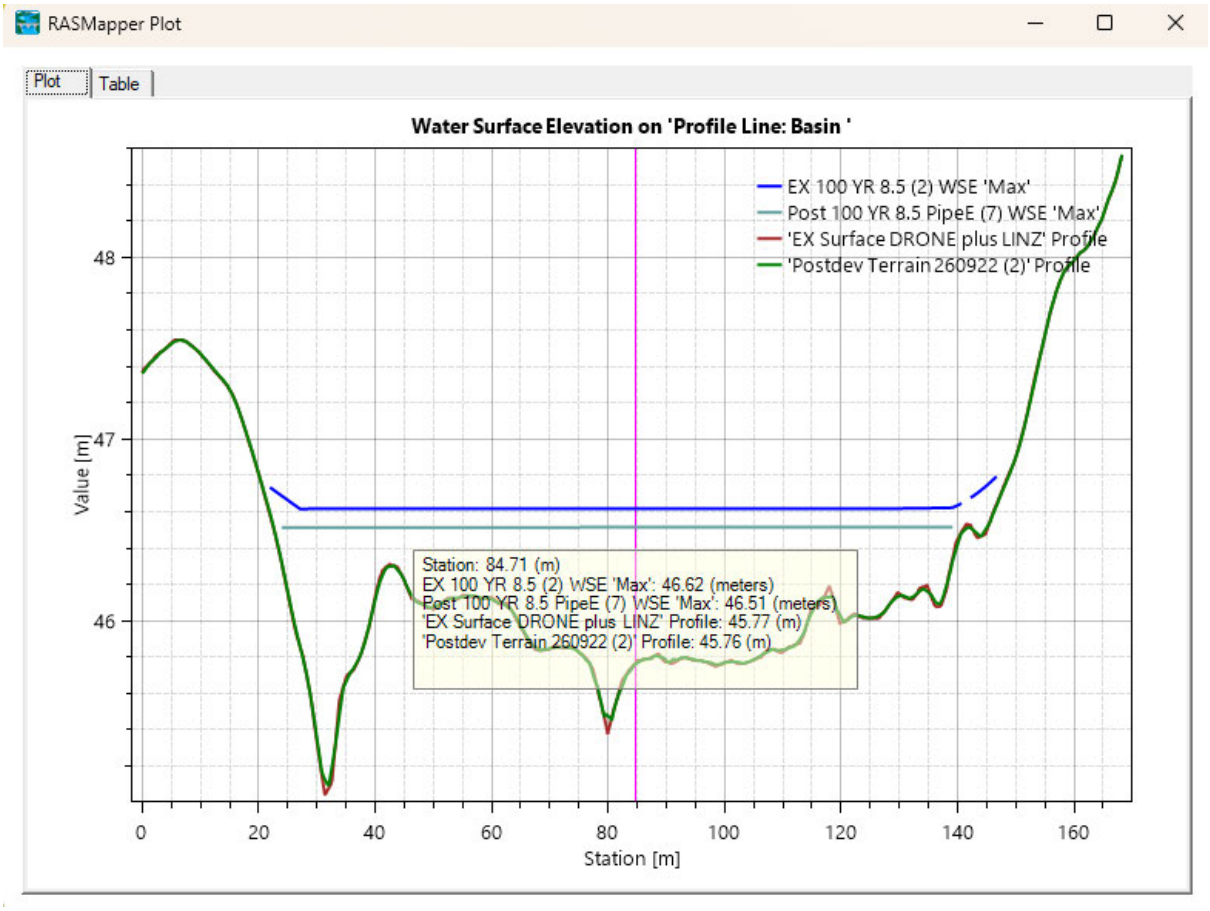


Figure 18: Pre vs Post Basin water elevation level

- **Downstream water level:** Overall, the HEC-RAS modelling demonstrates that the proposed stormwater management measures effectively attenuate the post-development peak discharge. The post-development WSE at the basin downstream is 46.51 m, approximately 110 mm lower than the pre-development WSE of 46.62 m, indicating that the proposed attenuation and controlled outlet arrangement does not increase flood levels downstream. Accordingly, the proposed development is not expected to increase the risk of flooding to downstream properties, and the overall effect on the downstream receiving environment is considered minor to negligible. It is anticipated that further refinement of the proposed earthworks, stormwater infrastructure, and hydraulic modelling during the detailed design phase will optimise site drainage and may reduce the localised increases in flood depth and velocities identified in this assessment.

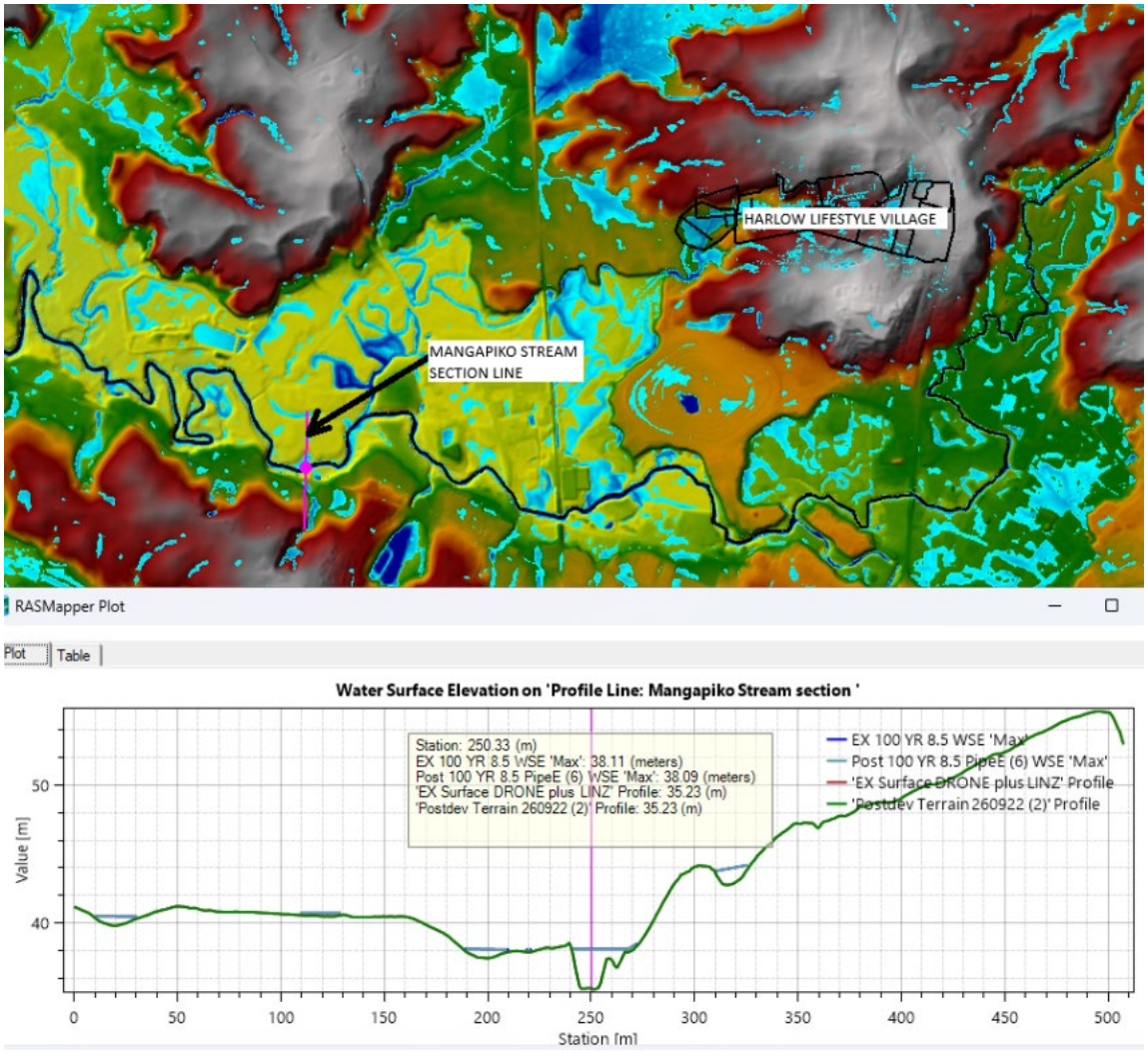


Figure 19: Pre vs Post water elevation level of Mangapiko Stream

- Mangapiko stream: The water surface elevation (WSE) for the pre-development scenario is 39.11 m, compared with 39.09 m for the post-development scenario, representing a negligible decrease of 0.02 m. The differences in results are attributable to the proposed development and are considered negligible; therefore, no significant impacts on the Mangapiko Stream are anticipated.

9.3.2. DOWNSTREAM FLOOD MITIGATION

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

- Raising and filling the development site to reduce flooding effects. The site levels have been elevated through appropriate fillings to reduce the risk and extent of flooding. Through raising these low lying lots it will provide greater flood immunity for the proposed lots.
- Attenuation of flows within the site. Stormwater will be attenuated on-site through designated wetlands, stormwater management devices and enhanced existing flood basin and SNA, with controlled discharge via culverts to minimise downstream impacts. Outflows will be restricted to 80% of pre-development discharge rates where practicable, contributing to the overall site flood mitigation strategy.

- The existing Waipā District Significant Natural Area (SNA WP312), comprising predominantly kahikatea and other wetland-associated vegetation, will be incorporated into the site flood mitigation plan. Enhancement of the existing flood basin within the SNA will provide additional flood storage while supporting the wetland environment, while creating an opportunity to provide enhances planting within the SNA. This is consistent with the protection requirements of the NES-FW and the recommendations of the Ecological Assessment.
- Erosion and scour protection: Appropriate erosion and scour protection measures have been incorporated into the stormwater management approach to minimise the potential for increased erosion resulting from concentrated stormwater discharges. The proposed erosion protection measures, including outlet protection and management of discharge velocities, are detailed in the Erosion and Sediment Control / Erosion Management Plan provided in Appendix C. These measures will assist in protecting downstream channels and receiving environments from potential erosion and scour effects.

9.3.3. MINIMUM FLOOR LEVELS

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

Table 17: Minimum Freeboard Requirements

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

** Vulnerable activities defined as residential activities*

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

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

9.3.4. PROPOSED LEVELS

It is noted that the proposed development lifts the habitable portion of the site between 1 to 2m (as a minimum) above the existing flood areas, and as such these minimum floor levels will be met via onsite earthworks of the proposed development further reducing any risk of flooding to the building platform

10. OVERLAND FLOWPATHS

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



Figure 20: Proposed Overland Flow path.

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

The preliminary OLFP design is summarised below.

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

Flow depths and velocities were assessed at key locations throughout the development covering all the various road/accessway typologies ensuring and confirming conveyance of the OLFP is viable through proposed carriageway. See below table 18 showing results at the key locations.

Table 18: OLFP section details

CATCHMENT	SECTION	FLOW RATE FROM HEC-RAS MODEL (m^3/s)	MAX DEPTH (m)	VELOCITY (m/s)	DEPTH x VELOCITY (m^2/s)
A1	1	0.39	0.11	1.96	0.22
A1	2	0.71	0.10	2.30	0.23
B1	3	0.66	0.14	2.12	0.29
B1	4	0.96	0.17	1.00	0.17
C1	5	1.2	0.18	1.46	0.26
D1	6	0.2	0.09	1.06	0.09
E1	7	1.06	0.11	2.26	0.24

All modelled sections except Section 4 and Section 5 are within the 150mm design guideline. Depth x velocity values remain well below the critical safety thresholds defined in Austroads 2012 Part 5, which specify:

- < 0.4 m^2/s for pedestrian safety
- < 0.6 m^2/s for vehicle safety

The highest recorded value, 0.29 m^2/s is at Catchment B1 (Section 3), but confirms safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads and conveyed into roadside primary networks for the 10-year cc conveyance, with surcharge above this directed to the designated wetlands and/or existing channel via the OLFP.

10.1. DEPARTURES FROM STANDARD

A departure from standard stormwater design has been identified in Overland Flow Path (OLFP) sections 5 and 4 where the flow depth exceeds the recommended threshold of 150 mm according to RITS V2 2025 Clause 3.3.14.10. These two locations are proposed as departures and these exceedances are minor and occur in isolated sections of the residential OLFP network.

Sections exceeding the 150mm limit are:

- Catchment B1 – Section 4: Max Depth = 0.17m
- Catchment C1 – Section 5: Max Depth = 0.18m

These areas remain safely contained within their respective flow corridors and do not pose a risk to vehicles and pedestrians as Depth x Velocity (D x V) values remain well below the threshold. Further refinement of the earthworks model in conjunction with the Architectural and Landscape design will allow these maximum depths to be addressed and resolved at detailed design.

11. SUMMARY OF PROPOSED STORMWATER MANAGEMENT

Stormwater management solutions for each post development sub-catchment summarised below

Table 19: Summary of stormwater management

Developments	Source	Water Quality	Flood management	Stream Protection	Water Sensitive Design
Residential	Lot Areas	In the adopted treatment train approach raingarden and wetlands will provide the required treatment.	Stormwater pipe network for 10yr ARI cc rainfall events. Artificial Wetlands and raingarden designed to cater for up to EDV event rainfall events. Catchment A to E; Overland flow paths for 100yr ARI cc events within road reserves, directed to SNA/flood-basin and existing Channel. Catchment F will be treated via a SW dry basin planted with suitable vegetation. Catchment G - goes to existing roadside drains - no treatment or attenuation for this catchment since no change in imperviousness and as the existing channel, SNA/flood basin provides sufficient flood storage and over-attenuation to offset the effects of the proposed development.	At source Raingardens Extended detention within artificial wetlands. Controlled release of 2 year, 10-year and 100-year cc events at 80% pre-development flows.	Stormwater wetlands with planting. 75% TSS as per requirements of TR2020/07 for all impervious surfaces. Protection of streams and riparian planting.
	Public Roads	At source Artificial Wetlands and amalgamated raingardens. 75% TSS as per requirements of TR2020/07 for all impervious surfaces.		Artificial Wetlands, forebay and high flow bypass. OR Treatment devices like raingardens wherever required and discharge limited to flows from existing wetland in 2year event.	

Notes: On site refers to a source, e.g., adjacent to the road carriageway or within the catchment boundary.

12. CONCLUSION

This Stormwater Management Plan (SMP) has been prepared to support the Harlow Lifestyle Village Development and provides the overarching framework for stormwater management throughout the site. The SMP has been developed in accordance with the objectives and requirements of the Waikato Regional Council guidelines, and the Regional Infrastructure Technical Specifications (RITS V2 (2025)) and other relevant Scheme Plans.

The site is influenced by localised and residential upstream contributing catchments, existing drainage channels, overland flow paths, and flood-prone areas downstream. These extents further into the Mangapiko Stream. Detailed catchment delineation and hydraulic modelling have been undertaken to refine the understanding of existing stormwater behaviour and to inform the proposed stormwater management strategy. The assessment confirms that maintaining hydraulic connectivity and accommodating external catchment flows are critical components of the overall design approach.

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

Initial abstraction requirements will be achieved through amalgamated raingardens for each catchment provided which forms the first component of the overall stormwater treatment train.

The modelling confirms the extent of existing flooding, ponding, and overland flow paths under the pre- and post-development 100-year climate change (CC) event. The results indicate that the existing channel within the site provides significant flood storage during major storm events, while the culverts act as flow controls within the channel, regulating the downstream conveyance of flows.

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

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

Appendix A – Engineering Calculations

Maven Associates		Job Number 411001	Sheet 1	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Catchment Areas	RK	9/09/2026	

Wetland A Catchment	ha	Area (m2)	% impervious
Residential catchment	5.88	58800	70.0%

Maven Associates		Job Number 411011	Sheet 2	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Pre-development		Author: RK	Date: 9/09/2026	Checked

Wetland C
Total Catchment 58800

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

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	5.88	435.12
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	5.88	435.12

CN (weighted) = total product / total area = 435.12 / 5.880 = **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

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

Top Contour Level	84.6	L=	240	m
Bottom Contour Level	62.6	S=	0.092	%
Catchment Length	240	n=	0.035	
		T=		34.443 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 34.44 + 0.00 + 0.00 = 34.443 mins
0.5740427 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.385 hrs

OK use **0.38** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 3	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Pre-development	Author: RK	Date: 9/09/2026	Checked

1. Data

Catchment Area	A=	0.0588	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=	0.38	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	yr
4. 24 hour rainfall depth, P24	21.6	(mm)	64.7	96.6	146	(mm)
*as per HIRDS Historical data						
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.066		0.238	0.329	0.434	
6. Specific peak flow rate q*	0.021		0.069	0.091	0.113	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.027**	m^3/s	**0.264**	**0.518**	**0.968**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	2.8		24.3	46.8	86.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	162	m^3	**1427.35**	**2752.08**	**5104.14**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 4	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment A Post development (Pervious)		Author RK	Date 9/09/2026	Checked

Wetland C
Total Catchmer 58800

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	30.0%	74	1.76	130.54
C		Impervious	70.0%	98		0.00
						0.00
				Totals =	1.76	130.54

CN (weighted) = total product / total area = 130.54 / 1.764 = **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 411001	Sheet 5	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Post development (Pervious)	RK	9/09/2026	

1. Data

Catchment Area	A=	0.01764	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=	0.17	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 RITS 6.0 2081-2100	24.1 (mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S		0.262	0.359	0.470	
6. Specific peak flow rate q*		0.075	0.098	0.119	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	m^3/s	**0.096**	**0.188**	**0.351**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.5	29.2	56.4	104.9	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	62 m^3	**515.60**	**994.80**	**1850.91**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 6	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment A Post development (Impervious)		Author RK	Date 9/09/2026	Checked

Wetland C
Total Catchmer 58800

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	30.0%	74		0.00
C		Impervious	70.0%	98	4.12	403.37
						0.00
				Totals =	4.12	403.37

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{403.37}{4.116} =$ **98.0**

S= $\frac{(1000}{CN}$ -10) * 25.4 $\frac{(1000}{98.0}$ - 10) *25.4 = **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 411001.00	Sheet 7	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Post development (Impervious)	RK	9/09/2026	

1. Data

Catchment Area	A=	0.04116	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=	0.17	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	24.1	(mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.694		0.874	0.913	0.941	
6. Specific peak flow rate q*	0.150		0.164	0.165	0.166	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.149**	m^3/s	**0.486**	**0.740**	**1.139**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	19.6		67.1	103.8	161.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	805	m^3	**2762.06**	**4272.12**	**6656.12**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 411001	Sheet 8	Rev: A
Job Title / Calc Title: HARLOW LIFESTYLE VILLAGE - Catchment A / Post development (whole site)	Author RK	Date 9/09/2026	Checked MHS

Wetland C
Total Catchmer 58800

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	30.0%	74	1.76	130.54
C		Impervious	70.0%	98	4.12	403.37
						0.00
				Totals =	5.88	533.90

CN (weighted) = total product / total area = 533.90 / 5.880 = **90.8**

S= (1000/CN - 10) * 25.4 = (1000/90.8 - 10) *25.4 = **25.7** mm

Ia= 0.05*S = 0.05x 25.7 = **1.3** mm

2. Time of Concentration

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

Top Contour Level	80.6	L=	350 m
Bottom Contour Level	67.4	S=	0.038 %
Catchment Length	350	n=	0.015
		T=	19.968 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design) V= 0.8498537 m/s

T= 0.00 mins

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

= 19.97 + 0.00 + 0.00 = 19.968 mins

0.3327984 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 9		Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Post development (whole site)	Author: RK	Date: 9/09/2026		Checked

1. Data

Catchment Area	A=	0.0588	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.3	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 26 mm

	WQV						
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP 6.0 2081-2100 data	18.05	24.1	72.2	109	167	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.231	0.295	0.575	0.674	0.762	0.762	
6. Specific peak flow rate q*	0.068	0.083	0.136	0.148	0.157	0.157	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.072**	**0.118**	**0.577**	**0.951**	**1.538**	**1.538**	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	1427.35	2752.08	5104.14	5104.14	m^3
Post development run off volume - Pervious	515.60	994.80	1850.91	1850.91	m^3
Post development run off volume - Impervious	2762.06	4272.12	6656.12	6656.12	m^3
Post development run off volume - total	3277.67	5266.92	8507.03	8507.03	m^3
			Volume	3402.90	m^3
Pre development flow rate	0.26	0.52	0.97	0.97	m^3/s
Post development flow rate	0.58	0.95	1.54	1.54	m^3/s
Target Flow Rates (80% Pre development)	0.21	0.41	0.77	0.77	m^3/s

Design Orifice that allows discharge out of your p

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 10	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment A WQV and ED	Author RK	Date 9/09/2026	Checked

1. Data

Runoff volume (pervious)	V_p=	62	m^3	
Runoff volume (impervious)	V_{ip}=	805	m^3	
Combined volume	V=	867.0	m^3	
Pre-development initial abstration	I_{a1}=	4.5	mm	
Post-development compacted pervious area CN		74		Class C
Post-development initial abstration of pervious area	I_{a2}=	4.5	mm	
Post development Impervious area	A_{ip}=	4.12	ha.	
Post development compacted pervious areas	A_{pp}=	1.76	ha.	

2. Retention reduction

Impervious surface retention	Vrip=	183.7	m^3	
Pervious surface retention	Vrp=	0.0	m^3	

3. Water Quality Volume	WQV=	683.3	m^3	Minimum
4. Extended Detention Volume	ED=	820	m^3	Minimum
5. Pond/Wetland Volume		3402.90	m^3	Minimum

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 11	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Wetland Pond		Author RK	Date 9/09/2026	Checked

Catchment Area		Area	58800	m²			
WQV Volume		Vol	683.3	m^3			
Extended Detention Volume		Vol	820	m^3			
2yr 24hr Volume		Vol	1850.3	m^3			
10yr 24hr Volume		Vol	2514.8	m^3			
100yr 24hr Volume		Vol	3402.90	m^3	0.00	Check	
Pond Volume Check (3d EW volumes)		PWL	415.8	m^3			
		WQV	844.094	m^3			
		EDV	1305.883	m^3			
	(assume 100mm spillway depth)	TOP POND	1905.0	m^3			
						Check	
	WQV Volume	Dead	415.77	m^3		74.101	N/A
		Live	428.3	m^3		86.665	OK
		Total	844.09	m^3		160.765	N/A
	EDV Volume		890.1	m^3		70.124	OK
	Total Pond Voolume		1489.2	m^3		1.000	80% of
						0.805	2yr
Pond Permanent Suface Area						Check	
	WRC Recommended	%	3%				
		Area	1764	m²			
	TR2020-06 Calculated	Live Depth	0.20	m			
		Dead Depth	0.20	m			
		Total Depth	0.40	m			
		Area	1708	m²		2.91%	
Design	Wetland Permant Surface Area	Area	1575.17	m²		-133.15	
	Raingarden Permenant Surface Area	Area	73.18	m²		19.40	
	Total Treatment Area	Area	1648.35	m²		-59.98	

Worksheet 2: Graphical Peak Flow Rate

Catchment			A	Check
Runoff Depth	Q	mm	2.26	
Rainfall Depth	P	mm	5	
Storage	S	mm	5.18	5.18
Initial abstraction	Ia	mm	0.26	0.26
Curve Number	CN		98	98

Water Quality Volume	WQV	m3	53.77
Runoff Depth	Q	mm	2.26
Area	A	m2	23745

Raingarden Plan area	As	m2	**53.77**	
Water Quality Volume	WQV	m3	53.77	
Planting Soil Depth	d	m	0.6	standard from WRC TR 2020
Coefficient of permeability	k	m/day	0.75	standard from WRC TR 2020
Average height of water	h	m	0.2	standard from WRC TR 2020
Time to pass through soil	t	day	1	standard from WRC TR 2020

Design Rain Gardens			
Width	Type 1	m	6
Length		m	10
Number		ea	1
Width	Type 2	m	1.5
Length		m	3
Number		ea	0
Area		m^2	**60**

Storage calculations to tin "Fast Track Surface 09 09 2026" - (with plan polygon "CTRL/PONDS/POND A->TOB POND A1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta Vol	Plan Area	Delta Area	Slope Area	Delta Area
66.070		1904.979		2080.274		2123.669	
	0.010		20.775		5.642		5.948
66.060		1884.205		2074.632		2117.721	
	0.010		20.718		5.633		5.938
66.050		1863.487		2069.000		2111.783	
	0.010		20.662		5.623		5.929
66.040		1842.825		2063.376		2105.854	
	0.010		20.606		5.614		5.920
66.030		1822.219		2057.763		2099.934	
	0.010		20.550		5.604		5.910
66.020		1801.669		2052.158		2094.024	
	0.010		20.494		5.595		5.901
66.010		1781.176		2046.563		2088.124	
	0.010		20.438		5.585		5.891
66.000		1760.738		2040.978		2082.233	
	0.010		20.382		5.576		5.882
65.990		1740.356		2035.402		2076.351	
	0.010		20.326		5.567		5.872
65.980		1720.030		2029.835		2070.479	
	0.010		20.271		5.557		5.863
65.970		1699.759		2024.278		2064.616	
	0.010		20.215		5.548		5.853
65.960		1679.544		2018.730		2058.763	
	0.010		20.160		5.538		5.844
65.950		1659.385		2013.192		2052.919	
	0.010		20.104		5.529		5.834
65.940		1639.281		2007.663		2047.085	
	0.010		20.049		5.519		5.825
65.930		1619.232		2002.144		2041.260	
	0.010		19.994		5.510		5.815
65.920		1599.238		1996.634		2035.445	
	0.010		19.939		5.501		5.806
65.910		1579.299		1991.133		2029.639	
	0.010		19.884		5.491		5.796
65.900		1559.415		1985.642		2023.843	
	0.010		19.829		5.482		5.787
65.890		1539.586		1980.160		2018.056	
	0.010		19.774		5.472		5.777
65.880		1519.812		1974.688		2012.279	
	0.010		19.720		5.463		5.768

65.870		1500.092		1969.225	2006.511
	0.010		19.665	5.453	5.758
65.860		1480.427		1963.772	2000.753
	0.010		19.610	5.444	5.749
65.850		1460.817		1958.328	1995.004
	0.010		19.556	5.435	5.739
65.840		1441.261		1952.893	1989.265
	0.010		19.502	5.425	5.730
65.830		1421.759		1947.468	1983.535
	0.010		19.448	5.416	5.720
65.820		1402.311		1942.052	1977.814
	0.010		19.393	5.406	5.711
65.810		1382.918		1936.646	1972.103
	0.010		19.339	5.397	5.701
65.800		1363.578		1931.249	1966.402
	0.010		19.286	5.387	5.692
65.790		1344.293		1925.862	1960.710
	0.010		19.232	5.378	5.683
65.780		1325.061		1920.484	1955.027
	0.010		19.178	5.369	5.673
65.770		1305.883		1915.115	1949.354
	0.010		19.124	5.481	5.778
65.760		1286.759		1909.634	1943.576
	0.010		19.069	5.475	5.772
65.750		1267.690		1904.159	1937.805
	0.010		19.014	5.470	5.766
65.740		1248.676		1898.689	1932.039
	0.010		18.960	5.464	5.760
65.730		1229.717		1893.225	1926.279
	0.010		18.905	5.458	5.754
65.720		1210.812		1887.766	1920.525
	0.010		18.850	5.453	5.748
65.710		1191.961		1882.313	1914.778
	0.010		18.796	5.447	5.742
65.700		1173.165		1876.866	1909.036
	0.010		18.741	5.442	5.736
65.690		1154.424		1871.425	1903.300
	0.010		18.687	5.436	5.730
65.680		1135.737		1865.989	1897.570
	0.010		18.633	5.430	5.724
65.670		1117.104		1860.559	1891.846
	0.010		18.578	5.425	5.718
65.660		1098.526		1855.134	1886.128
	0.010		18.524	5.419	5.712
65.650		1080.001		1849.715	1880.415
	0.010		18.470	5.413	5.706
65.640		1061.531		1844.302	1874.709
	0.010		18.416	5.408	5.700
65.630		1043.115		1838.894	1869.009
	0.010		18.362	5.402	5.694
65.620		1024.753		1833.492	1863.315
	0.010		18.308	5.396	5.688

65.610		1006.445		1828.096	1857.626
	0.010		18.254	5.391	5.682
65.600		988.191		1822.705	1851.944
	0.010		18.200	5.385	5.676
65.590		969.991		1817.320	1846.267
	0.010		18.146	5.379	5.670
65.580		951.845		1811.941	1840.597
	0.010		18.093	5.374	5.665
65.570		933.752		1806.567	1834.932
	0.010		18.039	5.368	5.659
65.560		915.714		1801.199	1829.274
	0.010		17.985	5.362	5.653
65.550		897.728		1795.836	1823.621
	0.010		17.932	5.357	5.647
65.540		879.797		1790.480	1817.974
	0.010		17.878	5.351	5.641
65.530		861.919		1785.128	1812.334
	0.010		17.825	5.346	5.635
65.520		844.094		1779.783	1806.699
	0.010		17.771	5.355	5.643
65.510		826.323		1774.428	1801.056
	0.010		17.718	5.350	5.638
65.500		808.606		1769.078	1795.418
	0.010		17.664	5.345	5.633
65.490		790.942		1763.733	1789.786
	0.010		17.611	5.340	5.627
65.480		773.331		1758.393	1784.158
	0.010		17.557	5.336	5.622
65.470		755.774		1753.058	1778.536
	0.010		17.504	5.331	5.617
65.460		738.270		1747.727	1772.919
	0.010		17.451	5.326	5.612
65.450		720.819		1742.401	1767.307
	0.010		17.397	5.321	5.607
65.440		703.422		1737.080	1761.700
	0.010		17.344	5.316	5.602
65.430		686.078		1731.763	1756.098
	0.010		17.291	5.312	5.597
65.420		668.787		1726.452	1750.501
	0.010		17.238	5.307	5.591
65.410		651.549		1721.145	1744.910
	0.010		17.185	5.302	5.586
65.400		634.364		1715.843	1739.324
	0.010		17.132	5.297	5.581
65.390		617.232		1710.546	1733.743
	0.010		17.079	5.292	5.576
65.380		600.153		1705.253	1728.167
	0.010		17.026	5.288	5.571
65.370		583.127		1699.966	1722.596
	0.010		16.973	5.283	5.566
65.360		566.153		1694.683	1717.030
	0.010		16.920	5.278	5.561

65.350		549.233		1689.405	1711.469
	0.010		16.868	5.273	5.555
65.340		532.365		1684.132	1705.914
	0.010		16.815	5.268	5.550
65.330		515.550		1678.863	1700.364
	0.010		16.762	5.264	5.545
65.320		498.788		1673.599	1694.818
	0.010		16.710	5.259	5.540
65.310		482.078		1668.341	1689.278
	0.010		16.657	5.254	5.535
65.300		465.421		1663.086	1683.744
	0.010		16.605	5.249	5.530
65.290		448.817		1657.837	1678.214
	0.010		16.552	5.245	5.525
65.280		432.264		1652.593	1672.689
	0.010		16.500	77.425	77.705
65.270		415.765		1575.167	1594.984
	0.010		15.616	27.304	27.536
65.260		400.149		1547.864	1567.449
	0.010		15.340	27.833	28.074
65.250		384.809		1520.031	1539.374
	0.010		15.059	28.362	28.613
65.240		369.750		1491.668	1510.761
	0.010		14.773	28.892	29.152
65.230		354.978		1462.777	1481.609
	0.010		14.481	29.421	29.691
65.220		340.496		1433.356	1451.917
	0.010		14.184	29.950	30.230
65.210		326.312		1403.406	1421.687
	0.010		13.882	30.479	30.769
65.200		312.430		1372.927	1390.918
	0.010		13.575	31.009	31.308
65.190		298.855		1341.918	1359.610
	0.010		13.262	31.538	31.847
65.180		285.594		1310.380	1327.763
	0.010		12.944	32.067	32.386
65.170		272.650		1278.313	1295.377
	0.010		12.621	32.596	32.925
65.160		260.029		1245.717	1262.452
	0.010		12.292	33.126	33.464
65.150		247.737		1212.591	1228.989
	0.010		11.958	33.655	34.003
65.140		235.779		1178.936	1194.986
	0.010		11.619	34.184	34.542
65.130		224.160		1144.752	1160.444
	0.010		11.274	34.713	35.081
65.120		212.886		1110.039	1125.364
	0.010		10.925	35.243	35.619
65.110		201.961		1074.796	1089.744
	0.010		10.570	35.772	36.158
65.100		191.392		1039.024	1053.586
	0.010		10.209	36.301	36.697

65.090		181.182		1002.723	1016.889
	0.010		9.844	36.830	37.236
65.080		171.339		965.893	979.652
	0.010		9.473	336.281	336.697
65.070		161.866		629.611	642.956
	0.010		6.249	9.357	9.759
65.060		155.617		620.254	633.196
	0.010		6.156	9.267	9.669
65.050		149.461		610.988	623.527
	0.010		6.064	9.176	9.579
65.040		143.397		601.812	613.948
	0.010		5.973	9.086	9.488
65.030		137.424		592.726	604.460
	0.010		5.882	8.995	9.398
65.020		131.542		583.730	595.062
	0.010		5.793	8.905	9.308
65.010		125.749		574.826	585.754
	0.010		5.704	8.814	9.217
65.000		120.045		566.011	576.537
	0.010		5.616	8.724	9.127
64.990		114.429		557.287	567.410
	0.010		5.530	8.634	9.037
64.980		108.899		548.654	558.373
	0.010		5.444	8.543	8.946
64.970		103.456		540.110	549.427
	0.010		5.359	8.453	8.856
64.960		98.097		531.658	540.571
	0.010		5.275	8.362	8.766
64.950		92.822		523.295	531.805
	0.010		5.192	8.272	8.675
64.940		87.631		515.023	523.130
	0.010		5.109	8.181	8.585
64.930		82.521		506.842	514.545
	0.010		5.028	227.972	228.375
64.920		77.493		278.870	286.170
	0.010		2.765	4.638	4.841
64.910		74.728		274.232	281.330
	0.010		2.719	4.595	4.797
64.900		72.009		269.637	276.533
	0.010		2.674	4.552	4.753
64.890		69.335		265.085	271.780
	0.010		2.628	4.509	4.709
64.880		66.707		260.576	267.070
	0.010		2.583	4.466	4.665
64.870		64.123		256.110	262.405
	0.010		2.539	4.423	4.622
64.860		61.584		251.687	257.783
	0.010		2.495	4.380	4.578
64.850		59.090		247.306	253.205
	0.010		2.451	4.338	4.534
64.840		56.638		242.969	248.671
	0.010		2.408	4.295	4.490

64.830		54.230		238.674	244.181
	0.010		2.365	4.252	4.447
64.820		51.865		234.422	239.734
	0.010		2.323	4.209	4.403
64.810		49.541		230.214	235.331
	0.010		2.281	4.166	4.359
64.800		47.260		226.048	230.972
	0.010		2.240	4.123	4.315
64.790		45.020		221.925	226.657
	0.010		2.199	4.080	4.272
64.780		42.822		217.845	222.385
	0.010		2.158	4.037	4.228
64.770		40.663		213.807	218.157
	0.010		2.118	3.994	4.184
64.760		38.545		209.813	213.973
	0.010		2.078	3.951	4.140
64.750		36.467		205.862	209.833
	0.010		2.039	3.908	4.096
64.740		34.428		201.953	205.737
	0.010		2.000	3.866	4.053
64.730		32.428		198.088	201.684
	0.010		1.962	3.823	4.009
64.720		30.466		194.265	197.675
	0.010		1.924	3.780	3.965
64.710		28.542		190.486	193.710
	0.010		1.886	3.737	3.921
64.700		26.656		186.749	189.788
	0.010		1.849	3.694	3.878
64.690		24.807		183.055	185.911
	0.010		1.812	3.651	3.834
64.680		22.995		179.404	182.077
	0.010		1.776	102.281	102.463
64.670		21.219		77.123	79.614
	0.010		0.765	1.298	1.368
64.660		20.454		75.825	78.246
	0.010		0.752	1.290	1.360
64.650		19.702		74.535	76.886
	0.010		0.739	1.283	1.352
64.640		18.963		73.251	75.534
	0.010		0.726	1.276	1.344
64.630		18.237		71.976	74.190
	0.010		0.713	1.268	1.337
64.620		17.524		70.707	72.853
	0.010		0.701	1.261	1.329
64.610		16.823		69.446	71.524
	0.010		0.688	1.254	1.321
64.600		16.135		68.192	70.203
	0.010		0.676	1.246	1.314
64.590		15.459		66.946	68.889
	0.010		0.663	1.239	1.306
64.580		14.796		65.707	67.583
	0.010		0.651	1.232	1.298

64.570		14.145		64.475	66.285
	0.010		0.639	1.225	1.290
64.560		13.506		63.250	64.995
	0.010		0.626	1.217	1.283
64.550		12.880		62.033	63.712
	0.010		0.614	1.210	1.275
64.540		12.266		60.823	62.437
	0.010		0.602	1.203	1.267
64.530		11.664		59.621	61.170
	0.010		0.590	1.195	1.260
64.520		11.073		58.426	59.910
	0.010		0.578	1.188	1.252
64.510		10.495		57.238	58.658
	0.010		0.566	1.181	1.244
64.500		9.929		56.057	57.414
	0.010		0.555	1.173	1.237
64.490		9.374		54.884	56.177
	0.010		0.543	1.166	1.229
64.480		8.831		53.718	54.949
	0.010		0.531	1.159	1.221
64.470		8.300		52.559	53.727
	0.010		0.520	1.151	1.213
64.460		7.780		51.408	52.514
	0.010		0.508	1.144	1.206
64.450		7.271		50.264	51.308
	0.010		0.497	1.137	1.198
64.440		6.774		49.127	50.110
	0.010		0.486	1.129	1.190
64.430		6.289		47.998	48.920
	0.010		0.474	1.122	1.183
64.420		5.814		46.876	47.738
	0.010		0.463	1.115	1.175
64.410		5.351		45.761	46.563
	0.010		0.452	1.107	1.167
64.400		4.899		44.654	45.396
	0.010		0.441	1.100	1.159
64.390		4.458		43.554	44.236
	0.010		0.430	1.093	1.152
64.380		4.028		42.461	43.084
	0.010		0.419	1.085	1.144
64.370		3.609		41.376	41.940
	0.010		0.408	1.078	1.136
64.360		3.201		40.297	40.804
	0.010		0.398	1.071	1.129
64.350		2.803		39.227	39.675
	0.010		0.387	1.063	1.121
64.340		2.416		38.163	38.555
	0.010		0.376	1.056	1.113
64.330		2.040		37.107	37.441
	0.010		0.366	1.049	1.105
64.320		1.674		36.058	36.336
	0.010		0.355	1.042	1.098

64.310		1.318	35.017	35.238	
	0.010	0.345	1.034		1.090
64.300		0.973	33.983	34.148	
	0.010	0.335	1.027		1.082
64.290		0.639	32.956	33.066	
	0.010	0.324	1.020		1.075
64.280		0.314	31.936	31.991	
	0.010	0.314	31.936		31.991
64.270		0.000	0.000	0.000	
	19.770	0.000	0.000		0.000
44.500		0.000	0.000	0.000	

Polygon plan area = 2080.662

MAVEN	**Maven Associates**	**Job Number** 411001	**Sheet** 1	**Rev: A**
Job Title	**HARLOW LIFESTYLE VILLAGE - Catchment B**	**Author**	**Date**	**Checked**
Calc Title	**Catchment Areas**	**RK, SPAM**	**9/10/2026**	

Wetland A Catchment	ha	Area (m2)	% impervious
Residential catchment	5.45	54500	70.0%

.

Maven Associates		Job Number 411011	Sheet 2	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Pre-development		Author: RK	Date: 9/10/2026	Checked

Wetland C
Total Catchment 54500

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

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	5.45	403.30
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	5.45	403.30

CN (weighted) = total product / total area = 403.30 / 5.450 = **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

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

Top Contour Level	84.6	L=	240	m
Bottom Contour Level	62.6	S=	0.092	%
Catchment Length	240	n=	0.035	
		T=		34.443 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 34.44 + 0.00 + 0.00 = 34.443 mins
0.5740427 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.385 hrs

OK use **0.38** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 3	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment A Calc Title: Pre-development	Author: RK	Date: 9/10/2026	Checked

1. Data

Catchment Area	A=	0.0545	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=	0.38	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	yr
4. 24 hour rainfall depth, P24	21.6	(mm)	64.7	96.6	146	(mm)
*as per HIRDS Historical data						
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.066		0.238	0.329	0.434	
6. Specific peak flow rate q*	0.021		0.069	0.091	0.113	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.025**	m^3/s	**0.245**	**0.480**	**0.897**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	2.8		24.3	46.8	86.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	150	m^3	**1322.97**	**2550.82**	**4730.87**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 4	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment A Post development (Pervious)		Author RK	Date 9/10/2026	Checked

Wetland C
Total Catchmer 54500

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	30.0%	74	1.64	120.99
C		Impervious	70.0%	98		0.00
						0.00
				Totals =	1.64	120.99

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{120.99}{1.635}$ = **74.0**

S= $\left(\frac{1000}{CN} - 10\right) * 25.4$ $\frac{(1000 - 10) * 25.4}{74.0}$ = **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 411001	Sheet 5	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Post development (Pervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.01635	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=	0.17	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 RITS 6.0 2081-2100	24.1 (mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S		0.262	0.359	0.470	
6. Specific peak flow rate q*		0.075	0.098	0.119	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	m^3/s	**0.089**	**0.174**	**0.325**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.5	29.2	56.4	104.9	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	58 m^3	**477.90**	**922.05**	**1715.55**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 6	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A		Author	Date	Checked
Calc Title	Post development (Impervious)		RK	9/10/2026	

Wetland C
Total Catchmer 54500

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	30.0%	74		0.00
C		Impervious	70.0%	98	3.82	373.87
						0.00
				Totals =	3.82	373.87

CN (weighted) = total product / total area = 373.87 / 3.815 = **98.0**

S= (1000 / CN -10) * 25.4 = (1000 / 98.0 - 10) *25.4 = **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 411001.00	Sheet 7	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Post development (Impervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.03815	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=	0.17	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	24.1	(mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.694		0.874	0.913	0.941	
6. Specific peak flow rate q*	0.150		0.164	0.165	0.166	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.138**	m^3/s	**0.450**	**0.686**	**1.056**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	19.6		67.1	103.8	161.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	746	m^3	**2560.08**	**3959.70**	**6169.37**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 411001	Sheet 8	Rev: A
Job Title / Calc Title: HARLOW LIFESTYLE VILLAGE - Catchment A / Post development (whole site)	Author RK	Date 9/10/2026	Checked MHS

Wetland C
Total Catchmer 54500

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	30.0%	74	1.64	120.99
C		Impervious	70.0%	98	3.82	373.87
						0.00
				Totals =	5.45	494.86

CN (weighted) = total product / total area = 494.86 / 5.450 = **90.8**

S= (1000/CN - 10) * 25.4 = (1000/90.8 - 10) *25.4 = **25.7** mm

Ia= 0.05*S = 0.05x 25.7 = **1.3** mm

2. Time of Concentration

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

Top Contour Level	80.6	L=	350	m
Bottom Contour Level	67.4	S=	0.038	%
Catchment Length	350	n=	0.015	
		T=	19.968	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=	500		

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 19.97 + 0.00 + 0.00 = 19.968 mins
0.3327984 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 411001.00	Sheet 9		Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date		Checked
Calc Title	Post development (whole site)	RK	9/10/2026		

1. Data

Catchment Area	A=	0.0545	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.3	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 26 mm

		WQV					
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP 6.0 2081-2100 data	18.05	24.1	72.2	109	167	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.231	0.295	0.575	0.674	0.762	0.762	
6. Specific peak flow rate q*	0.068	0.083	0.136	0.148	0.157	0.157	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.067**	**0.109**	**0.535**	**0.881**	**1.425**	**1.425**	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	1322.97	2550.82	4730.87	4730.87	m^3
Post development run off volume - Pervious	477.90	922.05	1715.55	1715.55	m^3
Post development run off volume - Impervious	2560.08	3959.70	6169.37	6169.37	m^3
Post development run off volume - total	3037.97	4881.75	7884.92	7884.92	m^3
			Volume	**3154.04**	m^3
Pre development flow rate	0.24	0.48	0.90	0.90	m^3/s
Post development flow rate	0.53	0.88	1.43	1.43	m^3/s
Target Flow Rates (80% Pre development)	0.20	0.38	0.72	0.72	m^3/s

Design Orifice that allows discharge out of your p

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 10	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	WQV and ED	RK	9/10/2026	

1. Data					
Runoff volume (pervious)	V_p=	58	m^3		
Runoff volume (impervious)	V_{ip}=	746	m^3		
Combined volume	V=	803.6	m^3		
Pre-development initial abstration	I_{a1}=	4.5	mm		
Post-development compacted pervious area CN		74		Class C	
Post-development initial abstration of pervious area	I_{a2}=	4.5	mm		
Post development Impervious area	A_{ip}=	3.82	ha.		
Post development compacted pervious areas	A_{pp}=	1.64	ha.		
2. Retention reduction					
Impervious surface retention	Vrip=	170.2	m^3		
Pervious surface retention	Vrp=	0.0	m^3		
3. Water Quality Volume	WQV=	633.4	m^3	Minimum	Use this to Design RG
4. Extended Detention Volume	ED=	760	m^3	Minimum	Actual Volume of this within yo
5. Pond/Wetland Volume		3154.04	m^3	Minimum	

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 11	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment A	Author	Date	Checked
Calc Title	Wetland Pond	RK	9/10/2026	

Catchment Area		Area	54500	m²			
WQV Volume		Vol	633.4	m^3			
Extended Detention Volume		Vol	760	m^3			
2yr 24hr Volume		Vol	1715.0	m^3			
10yr 24hr Volume		Vol	2330.9	m^3			
100yr 24hr Volume		Vol	3154.04	m^3	0.00	Check	
Pond Volume Check (3d EW volumes)		PWL	292.7	m^3			
		WQV	377.656	m^3			
		EDV	1093.63	m^3			
	(assume 100mm spillway depth)	TOP POND	1289.5	m^3			
						Check	
	WQV Volume	Dead	292.69	m^3		-23.990	N/A
		Live	85.0	m^3		-231.712	N/A
		Total	377.66	m^3		-255.701	N/A
	EDV Volume		800.9	m^3		40.912	OK
	Total Pond Voolume		996.8	m^3		-718.236	58% of
						0.581	2yr
Pond Permanent Suface Area						Check	
	WRC Recommended	%	3%				
		Area	1635	m²			
	TR2020-06 Calculated	Live Depth	0.20	m			
		Dead Depth	0.20	m			
		Total Depth	0.40	m			
		Area	1583	m²		2.91%	
Design	Wetland Permant Surface Area	Area	1515.00	m²		-68.39	
	Raingarden Permenant Surface Area	Area	96.80	m²		10.40	
	Total Treatment Area	Area	1611.80	m²		28.41	

NOTE: STEPPED POND AREAS NOT STEPPED
NOTE: DEAD VOL NOT STEPPED

Worksheet 2: Graphical Peak Flow Rate

Catchment			A	Check
Runoff Depth	Q	mm	2.26	
Rainfall Depth	P	mm	5	
Storage	S	mm	5.18	5.18
Initial abstraction	Ia	mm	0.26	0.26
Curve Number	CN		98	98

Water Quality Volume	WQV	m3	86.40
Runoff Depth	Q	mm	2.26
Area	A	m2	38150

Raingarden Plan area	As	m2	**86.40**	
Water Quality Volume	WQV	m3	86.40	
Planting Soil Depth	d	m	0.6	standard from WRC TR 2020
Coefficient of permeability	k	m/day	0.75	standard from WRC TR 2020
Average height of water	h	m	0.2	standard from WRC TR 2020
Time to pass through soil	t	day	1	standard from WRC TR 2020

Design Rain Gardens			
Width	Type 1	m	6
Length		m	15
Number		ea	1
Width	Type 2	m	1.5
Length		m	3
Number		ea	0
Area		m^2	**90**

Storage calculations to tin "Fast Track Surface 09 09 2026" - (with plan polygon "CTRL/PONDS/POND A->TOB POND B1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta Vol	Plan Area	Delta Area	Slope Area	Delta Area
50.550		1289.458		2006.063		2050.462	
	0.010		20.018		8.448		8.915
50.540		1269.440		1997.615		2041.547	
	0.010		19.934		8.439		8.906
50.530		1249.506		1989.176		2032.642	
	0.010		19.850		8.429		8.896
50.520		1229.657		1980.747		2023.745	
	0.010		19.765		8.420		8.887
50.510		1209.891		1972.327		2014.859	
	0.010		19.681		8.408		8.875
50.500		1190.210		1963.919		2005.984	
	0.010		19.597		8.396		8.862
50.490		1170.613		1955.524		1997.122	
	0.010		19.513		8.387		8.853
50.480		1151.099		1947.137		1988.268	
	0.010		19.429		8.376		8.843
50.470		1131.670		1938.761		1979.425	
	0.010		19.346		8.366		8.833
50.460		1112.324		1930.394		1970.592	
	0.010		19.262		8.356		8.823
50.450		1093.062		1922.038		1961.769	
	0.010		19.179		8.346		8.813
50.440		1073.883		1913.692		1952.956	
	0.010		19.095		8.336		8.803
50.430		1054.788		1905.356		1944.154	
	0.010		19.012		8.326		8.793
50.420		1035.776		1897.030		1935.361	
	0.010		18.929		8.316		8.782
50.410		1016.848		1888.714		1926.579	
	0.010		18.846		8.303		8.770
50.400		998.002		1880.411		1917.809	
	0.010		18.763		8.291		8.757
50.390		979.239		1872.120		1909.052	
	0.010		18.680		8.269		8.738
50.380		960.559		1863.850		1900.314	
	0.010		18.597		8.252		8.722
50.370		941.962		1855.598		1891.592	
	0.010		18.515		8.240		8.710
50.360		923.447		1847.358		1882.882	
	0.010		18.432		8.228		8.698

50.350		905.015		1839.130		1874.184	
	0.010		18.350		8.216		8.686
50.340		886.665		1830.913		1865.498	
	0.010		18.268		8.204		8.674
50.330		868.397		1822.709		1856.824	
	0.010		18.186		8.192		8.662
50.320		850.211		1814.517		1848.162	
	0.010		18.104		8.180		8.650
50.310		832.106		1806.337		1839.513	
	0.010		18.023		8.165		8.635
50.300		814.084		1798.172		1830.878	
	0.010		17.941		8.149		8.620
50.290		796.143		1790.023		1822.258	
	0.010		17.860		8.130		8.601
50.280		778.283		1781.893		1813.658	
	0.010		17.778		8.106		8.578
50.270		760.505		1773.788		1805.080	
	0.010		17.697		8.086		8.559
50.260		742.807		1765.702		1796.521	
	0.010		17.617		40.946		41.418
50.250		725.191		1724.756		1755.103	
	0.010		17.158		17.943		18.421
50.240		708.033		1706.814		1736.682	
	0.010		16.979		17.782		18.259
50.230		691.054		1689.032		1718.423	
	0.010		16.802		17.621		18.098
50.220		674.252		1671.411		1700.325	
	0.010		16.627		17.461		17.936
50.210		657.625		1653.950		1682.389	
	0.010		16.453		17.294		17.769
50.200		641.172		1636.656		1664.620	
	0.010		16.281		17.160		17.633
50.190		624.892		1619.496		1646.987	
	0.010		16.110		16.999		17.471
50.180		608.782		1602.497		1629.516	
	0.010		15.941		16.838		17.309
50.170		592.841		1585.658		1612.207	
	0.010		15.773		16.677		17.147
50.160		577.068		1568.981		1595.060	
	0.010		15.607		16.516		16.985
50.150		561.461		1552.464		1578.074	
	0.010		15.413		22.224		22.664
50.140		546.048		1530.240		1555.410	
	0.010		15.192		21.983		22.422
50.130		530.855		1508.257		1532.988	
	0.010		14.974		21.741		22.179
50.120		515.882		1486.516		1510.809	
	0.010		14.757		21.500		21.936
50.110		501.124		1465.016		1488.873	
	0.010		14.544		21.259		21.694
50.100		486.581		1443.757		1467.179	
	0.010		14.332		21.017		21.451

50.090		472.248		1422.740	1445.728
	0.010		14.123	20.776	21.208
50.080		458.125		1401.964	1424.519
	0.010		13.917	20.534	20.966
50.070		444.208		1381.430	1403.553
	0.010		13.713	20.293	20.723
50.060		430.496		1361.137	1382.830
	0.010		13.511	20.052	20.481
50.050		416.985		1341.085	1362.350
	0.010		13.310	20.170	20.632
50.040		403.675		1320.915	1341.717
	0.010		13.109	19.978	20.438
50.030		390.566		1300.937	1321.279
	0.010		12.910	19.786	20.244
50.020		377.656		1281.151	1301.036
	0.010		12.713	19.593	20.050
50.010		364.942		1261.558	1280.986
	0.010		12.518	19.401	19.855
50.000		352.424		1242.157	1261.131
	0.010		12.325	19.208	19.661
49.990		340.098		1222.949	1241.469
	0.010		12.134	19.016	19.467
49.980		327.964		1203.932	1222.003
	0.010		11.945	18.824	19.273
49.970		316.019		1185.109	1202.730
	0.010		11.758	18.631	19.078
49.960		304.261		1166.478	1183.652
	0.010		11.572	201.420	201.865
49.950		292.689		965.058	981.786
	0.010		9.565	17.061	17.441
49.940		283.124		947.997	964.345
	0.010		9.395	16.869	17.247
49.930		273.728		931.128	947.098
	0.010		9.228	16.676	17.053
49.920		264.501		914.452	930.045
	0.010		9.062	16.484	16.859
49.910		255.439		897.967	913.186
	0.010		8.898	52.690	53.063
49.900		246.541		845.278	860.123
	0.010		8.379	14.655	14.982
49.890		238.161		830.623	845.141
	0.010		8.234	14.476	14.801
49.880		229.928		816.147	830.341
	0.010		8.090	14.296	14.620
49.870		221.838		801.851	815.721
	0.010		7.948	14.117	14.439
49.860		213.890		787.734	801.281
	0.010		7.807	13.938	14.259
49.850		206.082		773.796	787.023
	0.010		7.662	15.107	15.417
49.840		198.420		758.689	771.606
	0.010		7.512	14.918	15.226

49.830		190.908		743.771	756.380
	0.010		7.364	14.728	15.034
49.820		183.544		729.043	741.346
	0.010		7.218	14.539	14.843
49.810		176.327		714.504	726.504
	0.010		7.073	14.349	14.651
49.800		169.253		700.155	711.852
	0.010		6.931	14.160	14.460
49.790		162.323		685.996	697.393
	0.010		6.790	13.970	14.268
49.780		155.533		672.026	683.125
	0.010		6.651	13.780	14.077
49.770		148.882		658.245	669.048
	0.010		6.514	13.591	13.885
49.760		142.367		644.654	655.163
	0.010		6.379	13.401	13.694
49.750		135.988		631.253	641.469
	0.010		6.236	15.255	15.541
49.740		129.752		615.997	625.928
	0.010		6.085	15.052	15.335
49.730		123.667		600.945	610.593
	0.010		5.935	14.849	15.130
49.720		117.732		586.096	595.463
	0.010		5.788	14.646	14.925
49.710		111.945		571.450	580.538
	0.010		5.642	115.758	116.034
49.700		106.303		455.691	464.504
	0.010		4.494	12.604	12.828
49.690		101.809		443.087	451.676
	0.010		4.369	12.414	12.635
49.680		97.440		430.673	439.041
	0.010		4.245	12.224	12.443
49.670		93.195		418.449	426.598
	0.010		4.124	12.034	12.251
49.660		89.071		406.416	414.346
	0.010		4.005	55.470	55.685
49.650		85.066		350.946	358.661
	0.010		3.454	11.097	11.251
49.640		81.612		339.849	347.410
	0.010		3.344	10.924	11.077
49.630		78.268		328.925	336.334
	0.010		3.235	10.751	10.902
49.620		75.033		318.174	325.431
	0.010		3.129	10.578	10.728
49.610		71.904		307.596	314.703
	0.010		3.024	10.406	10.554
49.600		68.880		297.190	304.150
	0.010		2.921	10.233	10.379
49.590		65.960		286.957	293.770
	0.010		2.819	10.060	10.205
49.580		63.141		276.897	283.565
	0.010		2.719	9.887	10.031

49.570		60.421		267.010	273.535
	0.010		2.621	9.715	9.857
49.560		57.800		257.295	263.678
	0.010		2.525	9.542	9.682
49.550		55.275		247.753	253.996
	0.010		2.441	7.288	7.452
49.540		52.834		240.466	246.544
	0.010		2.369	7.184	7.347
49.530		50.465		233.282	239.197
	0.010		2.297	7.080	7.241
49.520		48.168		226.202	231.955
	0.010		2.227	6.976	7.136
49.510		45.941		219.226	224.819
	0.010		2.158	6.872	7.030
49.500		43.783		212.354	217.789
	0.010		2.090	6.768	6.925
49.490		41.693		205.586	210.864
	0.010		2.022	6.664	6.820
49.480		39.671		198.922	204.044
	0.010		1.956	6.560	6.714
49.470		37.715		192.362	197.330
	0.010		1.891	6.456	6.609
49.460		35.823		185.906	190.721
	0.010		1.827	6.352	6.503
49.450		33.996		179.553	184.218
	0.010		1.774	4.227	4.416
49.440		32.222		175.326	179.802
	0.010		1.732	4.189	4.376
49.430		30.489		171.137	175.427
	0.010		1.691	4.151	4.336
49.420		28.799		166.987	171.090
	0.010		1.649	4.113	4.297
49.410		27.150		162.874	166.794
	0.010		1.608	35.744	35.926
49.400		25.541		127.130	130.868
	0.010		1.257	2.829	2.973
49.390		24.284		124.301	127.895
	0.010		1.229	2.804	2.947
49.380		23.055		121.496	124.949
	0.010		1.201	2.779	2.920
49.370		21.854		118.717	122.028
	0.010		1.173	2.754	2.894
49.360		20.681		115.963	119.134
	0.010		1.146	25.493	25.632
49.350		19.535		90.470	93.502
	0.010		0.896	1.716	1.824
49.340		18.639		88.753	91.678
	0.010		0.879	1.704	1.811
49.330		17.760		87.049	89.867
	0.010		0.862	1.692	1.798
49.320		16.898		85.357	88.070
	0.010		0.845	1.680	1.785

49.310		16.052		83.677	86.285
	0.010		0.828	1.668	1.772
49.300		15.224		82.009	84.513
	0.010		0.812	1.656	1.759
49.290		14.412		80.354	82.754
	0.010		0.795	1.644	1.746
49.280		13.617		78.710	81.007
	0.010		0.779	1.631	1.733
49.270		12.838		77.079	79.274
	0.010		0.763	1.619	1.720
49.260		12.075		75.459	77.554
	0.010		0.747	42.116	42.217
49.250		11.329		33.343	35.337
	0.010		0.331	0.581	0.626
49.240		10.998		32.762	34.711
	0.010		0.325	0.576	0.620
49.230		10.674		32.186	34.091
	0.010		0.319	0.571	0.615
49.220		10.355		31.616	33.476
	0.010		0.313	0.566	0.609
49.210		10.041		31.050	32.867
	0.010		0.308	0.561	0.604
49.200		9.734		30.489	32.263
	0.010		0.302	0.556	0.598
49.190		9.431		29.934	31.665
	0.010		0.297	0.550	0.593
49.180		9.135		29.383	31.072
	0.010		0.291	0.545	0.587
49.170		8.844		28.838	30.485
	0.010		0.286	0.540	0.582
49.160		8.558		28.298	29.903
	0.010		0.280	0.535	0.577
49.150		8.278		27.762	29.326
	0.010		0.275	0.530	0.571
49.140		8.003		27.232	28.755
	0.010		0.270	0.525	0.566
49.130		7.733		26.707	28.190
	0.010		0.264	0.520	0.560
49.120		7.469		26.187	27.630
	0.010		0.259	0.515	0.555
49.110		7.209		25.672	27.075
	0.010		0.254	0.510	0.549
49.100		6.955		25.162	26.526
	0.010		0.249	0.505	0.544
49.090		6.706		24.657	25.982
	0.010		0.244	0.500	0.538
49.080		6.462		24.157	25.444
	0.010		0.239	0.495	0.533
49.070		6.223		23.663	24.911
	0.010		0.234	0.490	0.527
49.060		5.989		23.173	24.383
	0.010		0.229	0.485	0.522

49.050		5.759		22.688	23.861
	0.010		0.224	0.480	0.516
49.040		5.535		22.209	23.345
	0.010		0.220	0.474	0.511
49.030		5.315		21.734	22.834
	0.010		0.215	0.469	0.506
49.020		5.100		21.265	22.328
	0.010		0.210	0.464	0.500
49.010		4.890		20.801	21.828
	0.010		0.206	0.459	0.495
49.000		4.684		20.341	21.334
	0.010		0.201	0.454	0.489
48.990		4.483		19.887	20.845
	0.010		0.197	0.449	0.484
48.980		4.286		19.438	20.361
	0.010		0.192	0.444	0.478
48.970		4.094		18.994	19.883
	0.010		0.188	0.439	0.473
48.960		3.907		18.555	19.410
	0.010		0.183	0.434	0.467
48.950		3.723		18.121	18.942
	0.010		0.179	0.429	0.462
48.940		3.544		17.692	18.481
	0.010		0.175	0.424	0.456
48.930		3.369		17.269	18.024
	0.010		0.171	0.419	0.451
48.920		3.199		16.850	17.573
	0.010		0.166	0.414	0.446
48.910		3.032		16.436	17.128
	0.010		0.162	0.409	0.440
48.900		2.870		16.028	16.688
	0.010		0.158	0.404	0.435
48.890		2.712		15.624	16.253
	0.010		0.154	0.398	0.429
48.880		2.557		15.226	15.824
	0.010		0.150	0.393	0.424
48.870		2.407		14.832	15.400
	0.010		0.146	0.388	0.418
48.860		2.261		14.444	14.982
	0.010		0.143	0.383	0.413
48.850		2.118		14.061	14.569
	0.010		0.139	0.378	0.407
48.840		1.980		13.683	14.162
	0.010		0.135	0.373	0.402
48.830		1.845		13.309	13.760
	0.010		0.131	0.368	0.396
48.820		1.713		12.941	13.364
	0.010		0.128	0.363	0.391
48.810		1.586		12.578	12.973
	0.010		0.124	0.358	0.385
48.800		1.462		12.221	12.587
	0.010		0.120	0.353	0.380

48.790		1.341		11.868	12.207
	0.010		0.117	0.348	0.375
48.780		1.224		11.520	11.833
	0.010		0.113	0.343	0.369
48.770		1.111		11.177	11.464
	0.010		0.110	0.338	0.364
48.760		1.001		10.840	11.100
	0.010		0.107	0.333	0.358
48.750		0.894		10.507	10.742
	0.010		0.103	0.327	0.353
48.740		0.791		10.180	10.389
	0.010		0.100	0.322	0.347
48.730		0.691		9.857	10.042
	0.010		0.097	0.317	0.342
48.720		0.594		9.540	9.700
	0.010		0.094	0.312	0.336
48.710		0.500		9.227	9.364
	0.010		0.091	0.307	0.331
48.700		0.409		8.920	9.033
	0.010		0.088	0.302	0.325
48.690		0.321		8.618	8.707
	0.010		0.085	0.297	0.320
48.680		0.237		8.321	8.387
	0.010		0.082	0.292	0.315
48.670		0.155		8.029	8.073
	0.010		0.079	0.287	0.309
48.660		0.076		7.742	7.764
	0.010		0.076	7.742	7.764
48.650		0.000		0.000	0.000
	4.150		0.000	0.000	0.000
44.500		0.000		0.000	0.000

Polygon plan area = 2255.460

	Maven Associates	Job Number 411001	Sheet 1	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C	Author	Date	Checked
Calc Title	Catchment Areas	RK	9/10/2026	

Wetland A Catchment	ha	Area (m2)	% impervious
Residential catchment	2.72	27200	65.0%

Maven Associates		Job Number 411011	Sheet 2	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment C Calc Title: Pre-development		Author: RK	Date: 9/10/2026	Checked

Wetland C
Total Catchment 27200

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

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	2.72	201.28
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	2.72	201.28

CN (weighted) = total product / total area = 201.28 / 2.720 = **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

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

Top Contour Level	84.6	L=	240 m
Bottom Contour Level	62.6	S=	0.092 %
Catchment Length	240	n=	0.035
		T=	34.443 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 34.44 + 0.00 + 0.00 = 34.443 mins
0.5740427 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.385 hrs

OK use **0.38** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 3	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment C Calc Title: Pre-development	Author: RK	Date: 9/10/2026	Checked

1. Data

Catchment Area	A=	0.0272	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=	0.38	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	yr
4. 24 hour rainfall depth, P24 *as per HIRDS Historical data	21.6	(mm)	64.7	96.6	146	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.066		0.238	0.329	0.434	
6. Specific peak flow rate q*	0.021		0.069	0.091	0.113	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.012**	m^3/s	**0.122**	**0.240**	**0.448**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	2.8		24.3	46.8	86.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	75	m^3	**660.27**	**1273.07**	**2361.10**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 4	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C		Author	Date	Checked
Calc Title	Post development (Pervious)		RK	9/10/2026	

Wetland C
Total Catchmer 27200

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	35.0%	74	0.95	70.45
C		Impervious	65.0%	98		0.00
						0.00
				Totals =	0.95	70.45

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{70.45}{0.952}$ = **74.0**

S= $\left(\frac{1000}{CN} - 10\right) * 25.4$ $\frac{(1000 - 10) * 25.4}{74.0}$ = **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 411001	Sheet 5	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C	Author	Date	Checked
Calc Title	Post development (Pervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.00952	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=	0.17	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 RITS 6.0 2081-2100	24.1 (mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S		0.262	0.359	0.470	
6. Specific peak flow rate q*		0.075	0.098	0.119	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	m^3/s	**0.052**	**0.101**	**0.189**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.5	29.2	56.4	104.9	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	34 m^3	**278.26**	**536.87**	**998.90**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 6	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment C Post development (Impervious)		Author RK	Date 9/10/2026	Checked

Wetland C
Total Catchmer 27200

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	35.0%	74		0.00
C		Impervious	65.0%	98	1.77	173.26
						0.00
				Totals =	1.77	173.26

CN (weighted) = total product / total area = 173.26 / 1.768 = **98.0**

S= (1000/CN -10) * 25.4 = (1000/98.0 - 10) *25.4 = **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 411001.00	Sheet 7	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C	Author	Date	Checked
Calc Title	Post development (Impervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.01768	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=	0.17	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	24.1 (mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.694	0.874	0.913	0.941	
6. Specific peak flow rate q*	0.150	0.164	0.165	0.166	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.064** m^3/s	**0.209**	**0.318**	**0.489**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	19.6	67.1	103.8	161.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	346 m^3	**1186.43**	**1835.06**	**2859.09**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 411001	Sheet 8	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment C Calc Title: Post development (whole site)	Author RK	Date 9/10/2026	Checked MHS

Wetland C
Total Catchmer 27200

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	35.0%	74	0.95	70.45
C		Impervious	65.0%	98	1.77	173.26
						0.00
				Totals =	2.72	243.71

CN (weighted) = total product / total area = 243.71 / 2.720 = **89.6**

S= (1000/CN - 10) * 25.4 = (1000/89.6 - 10) *25.4 = **29.5** mm

Ia= 0.05*S = 0.05x 29.5 = **1.5** mm

2. Time of Concentration

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

Top Contour Level	80.6	L=	350	m
Bottom Contour Level	67.4	S=	0.038	%
Catchment Length	350	n=	0.015	
		T=	19.968	mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design) V= 0.8498537 m/s

T= 0.00 mins

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

= 19.97 + 0.00 + 0.00 = 19.968 mins

0.3327984 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

	Maven Associates	Job Number 411001.00	Sheet 9		Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C	Author	Date		Checked
Calc Title	Post development (whole site)	RK	9/10/2026		

1. Data

Catchment Area	A=	0.0272	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29 mm

	WQV					
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	100 yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP 6.0 2081-2100 data	18.05	24.1	72.2	109	167	167 (mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.204	0.264	0.540	0.643	0.736	0.736
6. Specific peak flow rate q*	0.061	0.076	0.131	0.145	0.154	0.154
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.030**	**0.050**	**0.257**	**0.429**	**0.701**	**0.701** 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	660.27	1273.07	2361.10	2361.10	m^3
Post development run off volume - Pervious	278.26	536.87	998.90	998.90	m^3
Post development run off volume - Impervious	1186.43	1835.06	2859.09	2859.09	m^3
Post development run off volume - total	1464.69	2371.93	3858.00	3858.00	m^3
			Volume	1496.90	m^3
Pre development flow rate	0.12	0.24	0.45	0.45	m^3/s
Post development flow rate	0.26	0.43	0.70	0.70	m^3/s
Target Flow Rates (80% Pre development)	0.10	0.19	0.36	0.36	m^3/s

Design Orifice that allows discharge out of your p

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 10	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment C WQV and ED	Author RK	Date 9/10/2026	Checked

1. Data					
Runoff volume (pervious)	V_p=	34	m^3		
Runoff volume (impervious)	V_{ip}=	346	m^3		
Combined volume	V=	379.3	m^3		
Pre-development initial abstration	I_{a1}=	4.5	mm		
Post-development compacted pervious area CN		74		Class C	
Post-development initial abstration of pervious area	I_{a2}=	4.5	mm		
Post development Impervious area	A_{ip}=	1.77	ha.		
Post development compacted pervious areas	A_{pp}=	0.95	ha.		
2. Retention reduction					
Impervious surface retention	Vrip=	78.9	m^3		
Pervious surface retention	Vrp=	0.0	m^3		
3. Water Quality Volume	WQV=	300.4	m^3	Minimum	Use this to Design RG
4. Extended Detention Volume	ED=	360	m^3	Minimum	Actual Volume of this within yo
5. Pond/Wetland Volume		1496.90	m^3	Minimum	

Worksheet 2: Graphical Peak Flow Rate

Maven Associates			Job Number 289001.00	Sheet 11	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment C		Author	Date	Checked
Calc Title	Wetland Pond		RK	9/10/2026	

Catchment Area		Area	27200	m²			
WQV Volume		Vol	300.4	m^3			
Extended Detention Volume		Vol	360	m^3			
2yr 24hr Volume		Vol	804.4	m^3			
10yr 24hr Volume		Vol	1098.9	m^3			
100yr 24hr Volume		Vol	1496.90	m^3	0.00	Check	
Pond Volume Check (3d EW volumes)		PWL	186.3	m^3			
		WQV	338.083	m^3			
		EDV	592.224	m^3			
	(assume 100mm spillway depth)	TOP POND	982.3	m^3			
						Check	
	WQV Volume	Dead	186.29	m^3		36.104	N/A
		Live	151.8	m^3		1.599	OK
		Total	338.08	m^3		37.704	N/A
	EDV Volume		405.9	m^3		45.475	OK
	Total Pond Voolume		796.0	m^3		-302.893	99% of
						0.989	2yr
Pond Permanent Suface Area						Check	
	WRC Recommended	%	3%				
		Area	816	m²			
	TR2020-06 Calculated	Live Depth	0.20	m			
		Dead Depth	0.20	m			
		Total Depth	0.40	m			
		Area	751	m²		2.76%	
Design	Wetland Permant Surface Area	Area	694.34	m²		-56.61	
	Raingarden Permenant Surface Area	Area	49.30	m²		9.26	
	Total Treatment Area	Area	743.64	m²		-7.31	

Worksheet 2: Graphical Peak Flow Rate

Catchment			A	Check
Runoff Depth	Q	mm	2.26	
Rainfall Depth	P	mm	5	
Storage	S	mm	5.18	5.18
Initial abstraction	Ia	mm	0.26	0.26
Curve Number	CN		98	98

Water Quality Volume	WQV	m3	40.04
Runoff Depth	Q	mm	2.26
Area	A	m2	17680

Raingarden Plan area	As	m2	**40.04**	
Water Quality Volume	WQV	m3	40.04	
Planting Soil Depth	d	m	0.6	standard from WRC TR 2020
Coefficient of permeability	k	m/day	0.75	standard from WRC TR 2020
Average height of water	h	m	0.2	standard from WRC TR 2020
Time to pass through soil	t	day	1	standard from WRC TR 2020

Design Rain Gardens			
Width		m	4
Length		m	10
Number	Type 1	ea	1
Width		m	1.5
Length		m	3
Number	Type 2	ea	0
Area		m^2	**40**

Storage calculations to tin "Fast Track Surface 09 09 2026" - (with plan polygon "CTRL/PONDS/POND A->TOB POND C1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta Vol	Plan Area	Delta Area	Slope Area	Delta Area
48.500		982.264		1050.407		1076.653	
	0.010		10.485		3.835		4.048
48.490		971.779		1046.572		1072.605	
	0.010		10.447		3.830		4.042
48.480		961.333		1042.743		1068.563	
	0.010		10.408		3.824		4.036
48.470		950.924		1038.919		1064.527	
	0.010		10.370		3.819		4.030
48.460		940.554		1035.100		1060.497	
	0.010		10.332		3.813		4.025
48.450		930.222		1031.287		1056.472	
	0.010		10.294		3.808		4.019
48.440		919.929		1027.479		1052.453	
	0.010		10.256		3.802		4.013
48.430		909.673		1023.676		1048.440	
	0.010		10.218		3.797		4.008
48.420		899.455		1019.879		1044.432	
	0.010		10.180		3.792		4.002
48.410		889.275		1016.088		1040.430	
	0.010		10.142		3.786		3.996
48.400		879.133		1012.302		1036.434	
	0.010		10.104		3.781		3.990
48.390		869.029		1008.521		1032.444	
	0.010		10.066		3.775		3.985
48.380		858.963		1004.746		1028.459	
	0.010		10.029		3.770		3.979
48.370		848.934		1000.976		1024.481	
	0.010		9.991		3.764		3.973
48.360		838.943		997.212		1020.507	
	0.010		9.953		3.759		3.967
48.350		828.990		993.453		1016.540	
	0.010		9.916		3.754		3.962
48.340		819.074		989.699		1012.578	
	0.010		9.878		3.748		3.956
48.330		809.196		985.951		1008.622	
	0.010		9.841		3.743		3.950
48.320		799.355		982.208		1004.672	
	0.010		9.803		3.737		3.944
48.310		789.552		978.471		1000.728	
	0.010		9.766		3.732		3.939

48.300		779.786		974.739	996.789
	0.010		9.729	3.726	3.933
48.290		770.057		971.013	992.856
	0.010		9.692	3.721	3.927
48.280		760.365		967.292	988.929
	0.010		9.654	3.716	3.922
48.270		750.711		963.577	985.007
	0.010		9.617	3.710	3.916
48.260		741.094		959.867	981.091
	0.010		9.580	3.705	3.910
48.250		731.514		956.162	977.181
	0.010		9.543	3.699	3.904
48.240		721.971		952.463	973.277
	0.010		9.506	3.694	3.899
48.230		712.464		948.769	969.378
	0.010		9.469	3.688	3.893
48.220		702.995		945.081	965.486
	0.010		9.432	3.683	3.887
48.210		693.563		941.398	961.598
	0.010		9.396	3.677	3.881
48.200		684.167		937.720	957.717
	0.010		9.359	3.672	3.876
48.190		674.808		934.048	953.841
	0.010		9.322	3.667	3.870
48.180		665.486		930.381	949.971
	0.010		9.286	3.661	3.864
48.170		656.201		926.720	946.107
	0.010		9.249	3.656	3.858
48.160		646.952		923.064	942.249
	0.010		9.212	3.650	3.853
48.150		637.739		919.414	938.396
	0.010		9.176	3.645	3.847
48.140		628.564		915.769	934.549
	0.010		9.139	3.639	3.841
48.130		619.424		912.130	930.708
	0.010		9.103	3.634	3.836
48.120		610.321		908.496	926.872
	0.010		9.067	3.629	3.830
48.110		601.254		904.867	923.042
	0.010		9.031	3.623	3.824
48.100		592.224		901.244	919.218
	0.010		8.994	3.661	3.859
48.090		583.229		897.583	915.359
	0.010		8.958	3.655	3.853
48.080		574.272		893.928	911.506
	0.010		8.921	3.650	3.847
48.070		565.351		890.278	907.659
	0.010		8.885	3.644	3.841
48.060		556.466		886.634	903.818
	0.010		8.848	3.638	3.835
48.050		547.618		882.996	899.982
	0.010		8.812	3.633	3.829

48.040		538.806		879.363	896.153
	0.010		8.775	3.627	3.823
48.030		530.031		875.736	892.330
	0.010		8.739	3.621	3.817
48.020		521.292		872.114	888.512
	0.010		8.703	3.616	3.811
48.010		512.589		868.498	884.701
	0.010		8.667	3.610	3.805
48.000		503.922		864.888	880.895
	0.010		8.631	3.604	3.800
47.990		495.291		861.284	877.096
	0.010		8.595	3.599	3.794
47.980		486.696		857.685	873.302
	0.010		8.559	3.593	3.788
47.970		478.137		854.092	869.515
	0.010		8.523	3.588	3.782
47.960		469.614		850.504	865.733
	0.010		8.487	3.582	3.776
47.950		461.127		846.922	861.957
	0.010		8.451	3.576	3.770
47.940		452.676		843.346	858.188
	0.010		8.416	3.571	3.764
47.930		444.260		839.776	854.424
	0.010		8.380	3.565	3.758
47.920		435.880		836.211	850.666
	0.010		8.344	3.559	3.752
47.910		427.536		832.651	846.914
	0.010		8.309	3.554	3.746
47.900		419.227		829.098	843.168
	0.010		8.273	3.548	3.740
47.890		410.954		825.550	839.428
	0.010		8.238	3.542	3.734
47.880		402.716		822.007	835.694
	0.010		8.202	3.537	3.728
47.870		394.514		818.471	831.966
	0.010		8.167	3.531	3.722
47.860		386.347		814.940	828.244
	0.010		8.132	3.525	3.716
47.850		378.215		811.414	824.528
	0.010		8.097	3.520	3.710
47.840		370.118		807.894	820.818
	0.010		8.061	3.514	3.704
47.830		362.057		804.380	817.113
	0.010		8.026	3.508	3.698
47.820		354.031		800.872	813.415
	0.010		7.991	3.503	3.692
47.810		346.039		797.369	809.723
	0.010		7.956	3.497	3.686
47.800		338.083		793.872	806.036
	0.010		7.921	3.516	3.704
47.790		330.162		790.356	802.332
	0.010		7.886	3.513	3.700

47.780		322.276		786.843	798.632
	0.010		7.851	3.509	3.696
47.770		314.425		783.334	794.937
	0.010		7.816	3.505	3.691
47.760		306.609		779.830	791.246
	0.010		7.781	3.501	3.687
47.750		298.829		776.329	787.559
	0.010		7.746	3.497	3.683
47.740		291.083		772.832	783.876
	0.010		7.711	3.493	3.678
47.730		283.372		769.338	780.197
	0.010		7.676	3.489	3.674
47.720		275.696		765.849	776.523
	0.010		7.641	3.485	3.670
47.710		268.055		762.364	772.853
	0.010		7.606	3.482	3.666
47.700		260.449		758.882	769.187
	0.010		7.571	3.478	3.661
47.690		252.877		755.404	765.526
	0.010		7.537	3.474	3.657
47.680		245.341		751.930	761.869
	0.010		7.502	3.470	3.653
47.670		237.839		748.460	758.216
	0.010		7.467	3.466	3.649
47.660		230.371		744.994	754.567
	0.010		7.433	3.462	3.644
47.650		222.939		741.532	750.923
	0.010		7.398	3.458	3.640
47.640		215.541		738.073	747.283
	0.010		7.363	3.455	3.636
47.630		208.177		734.619	743.647
	0.010		7.329	3.451	3.632
47.620		200.848		731.168	740.016
	0.010		7.294	3.447	3.627
47.610		193.554		727.721	736.388
	0.010		7.260	33.386	33.566
47.600		186.294		694.336	702.823
	0.010		6.882	12.345	12.439
47.590		179.412		681.990	690.384
	0.010		6.759	12.251	12.344
47.580		172.654		669.739	678.039
	0.010		6.637	12.158	12.250
47.570		166.017		657.581	665.790
	0.010		6.515	12.064	12.155
47.560		159.502		645.517	653.635
	0.010		6.395	11.970	12.060
47.550		153.107		633.547	641.575
	0.010		6.276	11.877	11.965
47.540		146.831		621.670	629.609
	0.010		6.158	11.783	11.871
47.530		140.673		609.888	617.739
	0.010		6.040	11.689	11.776

47.520		134.633		598.198		605.963	
	0.010		5.924		11.595		11.681
47.510		128.709		586.603		594.282	
	0.010		5.808		11.502		11.586
47.500		122.900		575.101		582.696	
	0.010		5.694		11.408		11.492
47.490		117.206		563.694		571.204	
	0.010		5.580		11.314		11.397
47.480		111.626		552.379		559.807	
	0.010		5.468		11.220		11.302
47.470		106.158		541.159		548.505	
	0.010		5.356		11.127		11.207
47.460		100.803		530.032		537.298	
	0.010		5.245		11.033		11.113
47.450		95.558		518.999		526.186	
	0.010		5.135		10.939		11.018
47.440		90.422		508.060		515.168	
	0.010		5.026		10.846		10.923
47.430		85.396		497.214		504.245	
	0.010		4.918		10.752		10.828
47.420		80.478		486.463		493.417	
	0.010		4.811		10.658		10.733
47.410		75.666		475.804		482.683	
	0.010		4.705		153.569		153.644
47.400		70.961		322.235		329.039	
	0.010		3.189		6.631		6.861
47.390		67.772		315.604		322.178	
	0.010		3.123		6.570		6.798
47.380		64.649		309.033		315.381	
	0.010		3.058		6.509		6.735
47.370		61.591		302.524		308.646	
	0.010		2.993		6.448		6.672
47.360		58.598		296.075		301.974	
	0.010		2.929		6.388		6.609
47.350		55.670		289.688		295.366	
	0.010		2.865		6.327		6.546
47.340		52.804		283.361		288.820	
	0.010		2.802		6.266		6.482
47.330		50.002		277.096		282.338	
	0.010		2.740		6.205		6.419
47.320		47.262		270.891		275.918	
	0.010		2.678		6.144		6.356
47.310		44.584		264.747		269.562	
	0.010		2.617		6.083		6.293
47.300		41.967		258.665		263.269	
	0.010		2.556		6.022		6.230
47.290		39.411		252.643		257.038	
	0.010		2.497		5.961		6.167
47.280		36.914		246.682		250.871	
	0.010		2.437		5.900		6.104
47.270		34.477		240.782		244.767	
	0.010		2.379		5.839		6.041

47.260	32.098	234.944	238.726	
0.010	2.320	109.987	110.187	
47.250	29.778	124.956	128.539	
0.010	1.235	2.954	3.067	
47.240	28.543	122.003	125.472	
0.010	1.205	2.918	3.029	
47.230	27.338	119.085	122.443	
0.010	1.176	2.881	2.992	
47.220	26.161	116.204	119.451	
0.010	1.148	2.845	2.954	
47.210	25.013	113.358	116.497	
0.010	1.120	2.809	2.917	
47.200	23.894	110.549	113.580	
0.010	1.092	2.773	2.880	
47.190	22.802	107.776	110.700	
0.010	1.064	2.737	2.842	
47.180	21.738	105.039	107.858	
0.010	1.037	2.701	2.805	
47.170	20.701	102.338	105.053	
0.010	1.010	2.665	2.767	
47.160	19.691	99.674	102.286	
0.010	0.984	2.629	2.730	
47.150	18.708	97.045	99.556	
0.010	0.957	2.592	2.693	
47.140	17.750	94.453	96.863	
0.010	0.932	2.556	2.655	
47.130	16.819	91.896	94.208	
0.010	0.906	2.520	2.618	
47.120	15.912	89.376	91.590	
0.010	0.881	2.484	2.580	
47.110	15.031	86.892	89.010	
0.010	0.857	2.448	2.543	
47.100	14.174	84.444	86.467	
0.010	0.832	2.412	2.506	
47.090	13.342	82.033	83.961	
0.010	0.808	2.376	2.468	
47.080	12.533	79.657	81.493	
0.010	0.785	2.340	2.431	
47.070	11.749	77.317	79.063	
0.010	0.762	2.303	2.393	
47.060	10.987	75.014	76.669	
0.010	0.739	2.267	2.356	
47.050	10.248	72.747	74.313	
0.010	0.716	2.231	2.318	
47.040	9.532	70.515	71.995	
0.010	0.694	2.195	2.281	
47.030	8.838	68.320	69.714	
0.010	0.672	2.159	2.244	
47.020	8.165	66.161	67.470	
0.010	0.651	2.123	2.206	
47.010	7.514	64.039	65.264	
0.010	0.630	36.736	36.818	

47.000		6.885		27.303	28.446
	0.010		0.270	0.583	0.619
46.990		6.614		26.720	27.827
	0.010		0.264	0.577	0.612
46.980		6.350		26.142	27.214
	0.010		0.259	0.571	0.606
46.970		6.092		25.571	26.608
	0.010		0.253	0.565	0.599
46.960		5.839		25.006	26.009
	0.010		0.247	0.559	0.593
46.950		5.591		24.448	25.416
	0.010		0.242	0.553	0.586
46.940		5.350		23.895	24.829
	0.010		0.236	0.546	0.580
46.930		5.114		23.349	24.249
	0.010		0.231	0.540	0.574
46.920		4.883		22.808	23.676
	0.010		0.225	0.534	0.567
46.910		4.657		22.274	23.109
	0.010		0.220	0.528	0.561
46.900		4.437		21.746	22.548
	0.010		0.215	0.522	0.554
46.890		4.222		21.224	21.994
	0.010		0.210	0.516	0.548
46.880		4.013		20.708	21.447
	0.010		0.205	0.510	0.541
46.870		3.808		20.198	20.906
	0.010		0.199	0.504	0.535
46.860		3.609		19.695	20.371
	0.010		0.194	0.497	0.528
46.850		3.414		19.198	19.843
	0.010		0.190	0.491	0.522
46.840		3.225		18.706	19.322
	0.010		0.185	0.485	0.515
46.830		3.040		18.221	18.807
	0.010		0.180	0.479	0.509
46.820		2.860		17.742	18.298
	0.010		0.175	0.473	0.502
46.810		2.685		17.269	17.796
	0.010		0.170	0.467	0.496
46.800		2.515		16.802	17.301
	0.010		0.166	0.461	0.489
46.790		2.349		16.342	16.812
	0.010		0.161	0.454	0.483
46.780		2.188		15.887	16.329
	0.010		0.157	0.448	0.476
46.770		2.031		15.439	15.853
	0.010		0.152	0.442	0.470
46.760		1.879		14.997	15.384
	0.010		0.148	0.436	0.463
46.750		1.731		14.561	14.921
	0.010		0.143	0.430	0.457

46.740		1.588		14.131	14.464
	0.010		0.139	0.424	0.450
46.730		1.449		13.707	14.014
	0.010		0.135	0.418	0.444
46.720		1.314		13.289	13.571
	0.010		0.131	0.412	0.437
46.710		1.183		12.878	13.134
	0.010		0.127	0.405	0.431
46.700		1.056		12.472	12.703
	0.010		0.123	0.399	0.424
46.690		0.934		12.073	12.279
	0.010		0.119	0.393	0.418
46.680		0.815		11.680	11.862
	0.010		0.115	0.387	0.411
46.670		0.700		11.293	11.451
	0.010		0.111	0.381	0.405
46.660		0.589		10.912	11.046
	0.010		0.107	0.375	0.398
46.650		0.482		10.537	10.648
	0.010		0.104	0.369	0.392
46.640		0.378		10.169	10.257
	0.010		0.100	0.362	0.385
46.630		0.278		9.806	9.872
	0.010		0.096	0.356	0.379
46.620		0.182		9.450	9.493
	0.010		0.093	0.350	0.372
46.610		0.089		9.100	9.121
	0.010		0.089	9.100	9.121
46.600		0.000		0.000	0.000
	2.100		0.000	0.000	0.000
44.500		0.000		0.000	0.000

==========

Polygon plan area = 1050.407

	Maven Associates	Job Number 411001	Sheet 1	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date	Checked
Calc Title	Catchment Areas	RK	9/10/2026	

Wetland A Catchment	ha	Area (m2)	% impervious
Residential catchment	1.31	13100	65.0%

Maven Associates		Job Number 411011	Sheet 2	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment D Calc Title: Pre-development		Author: RK	Date: 9/10/2026	Checked

Wetland C
Total Catchment 13100

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

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	1.31	96.94
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	1.31	96.94

CN (weighted) = total product / total area = 96.94 / 1.310 = **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

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

Top Contour Level	84.6	L=	240	m
Bottom Contour Level	62.6	S=	0.092	%
Catchment Length	240	n=	0.035	
		T=		34.443 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 34.44 + 0.00 + 0.00 = 34.443 mins
0.5740427 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.385 hrs

OK use **0.38** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 3	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment D Calc Title: Pre-development	Author: R	Date: 9/10/2026	Checked

1. Data

Catchment Area	A=	0.0131	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=	0.38	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	yr
4. 24 hour rainfall depth, P24	21.6	(mm)	64.7	96.6	146	(mm)
*as per HIRDS Historical data						
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.066		0.238	0.329	0.434	
6. Specific peak flow rate q*	0.021		0.069	0.091	0.113	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.006**	m^3/s	**0.059**	**0.115**	**0.216**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	2.8		24.3	46.8	86.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	36	m^3	**318.00**	**613.13**	**1137.15**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 4	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D		Author	Date	Checked
Calc Title	Post development (Pervious)		RK	9/10/2026	

Wetland C
Total Catchmer 13100

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	35.0%	74	0.46	33.93
C		Impervious	65.0%	98		0.00
						0.00
				Totals =	0.46	33.93

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{33.93}{0.459} =$ **74.0**

$S = \frac{(1000}{CN} - 10) * 25.4 = \frac{(1000}{74.0} - 10) * 25.4 =$ **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 411001	Sheet 5	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date	Checked
Calc Title	Post development (Pervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.004585	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=	0.17	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 RITS 6.0 2081-2100	24.1 (mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S		0.262	0.359	0.470	
6. Specific peak flow rate q*		0.075	0.098	0.119	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	m^3/s	**0.025**	**0.049**	**0.091**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.5	29.2	56.4	104.9	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	16 m^3	**134.02**	**258.57**	**481.09**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 6	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment D Post development (Impervious)	Author RK	Date 9/10/2026	Checked

Wetland C
Total Catchmer 13100

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	35.0%	74		0.00
C		Impervious	65.0%	98	0.85	83.45
						0.00
				Totals =	0.85	83.45

CN (weighted) = total product / total area = 83.45 / 0.852 = **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 411001.00	Sheet 7	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date	Checked
Calc Title	Post development (Impervious)	RK	9/10/2026	

1. Data

Catchment Area	A=	0.008515	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=	0.17	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	24.1	(mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.694		0.874	0.913	0.941	
6. Specific peak flow rate q*	0.150		0.164	0.165	0.166	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.031**	m^3/s	**0.101**	**0.153**	**0.236**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	19.6		67.1	103.8	161.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	166	m^3	**571.40**	**883.80**	**1376.99**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 411001	Sheet 8	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment D Calc Title: Post development (whole site)	Author RK	Date 9/10/2026	Checked MHS

Wetland C
Total Catchmer 13100

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	35.0%	74	0.46	33.93
C		Impervious	65.0%	98	0.85	83.45
						0.00
				Totals =	1.31	117.38

CN (weighted) = total product / total area = 117.38 / 1.310 = **89.6**

S= (1000/CN - 10) * 25.4 = (1000/89.6 - 10) *25.4 = **29.5** mm

Ia= 0.05*S = 0.05x 29.5 = **1.5** mm

2. Time of Concentration

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

Top Contour Level	80.6	L=	350	m
Bottom Contour Level	67.4	S=	0.038	%
Catchment Length	350	n=	0.015	
		T=		19.968 mins

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

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

w= 1 d= 1 l= 500 **n=** 0.04 **s=** 1%

(to be completed at detail design) V= 0.8498537 m/s

T= 0.00 mins

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

= 19.97 + 0.00 + 0.00 = 19.968 mins

0.3327984 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 411001.00	Sheet 9		Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date		Checked
Calc Title	Post development (whole site)	RK	9/10/2026		

1. Data

Catchment Area	A=	0.0131	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29 mm

		WQV					
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP 6.0 2081-2100 data	18.05	24.1	72.2	109	167	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.204	0.264	0.540	0.643	0.736	0.736	
6. Specific peak flow rate q*	0.061	0.076	0.131	0.145	0.154	0.154	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.014**	**0.024**	**0.124**	**0.207**	**0.338**	**0.338**	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	318.00	613.13	1137.15	1137.15	m^3
Post development run off volume - Pervious	134.02	258.57	481.09	481.09	m^3
Post development run off volume - Impervious	571.40	883.80	1376.99	1376.99	m^3
Post development run off volume - total	705.42	1142.37	1858.08	1858.08	m^3
			Volume	**720.93**	m^3
Pre development flow rate	0.06	0.12	0.22	0.22	m^3/s
Post development flow rate	0.12	0.21	0.34	0.34	m^3/s
Target Flow Rates (80% Pre development)	0.05	0.09	0.17	0.17	m^3/s

Design Orifice that allows discharge out of your p

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 10	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date	Checked
Calc Title	WQV and ED	RK	9/10/2026	

1. Data					
Runoff volume (pervious)	V_p=	16	m^3		
Runoff volume (impervious)	V_{ip}=	166	m^3		
Combined volume	V=	182.7	m^3		
Pre-development initial abstration	I_{a1}=	4.5	mm		
Post-development compacted pervious area CN		74		Class C	
Post-development initial abstration of pervious area	I_{a2}=	4.5	mm		
Post development Impervious area	A_{ip}=	0.85	ha.		
Post development compacted pervious areas	A_{pp}=	0.46	ha.		
2. Retention reduction					
Impervious surface retention	Vrip=	38.0	m^3		
Pervious surface retention	Vrp=	0.0	m^3		
3. Water Quality Volume	WQV=	144.7	m^3	Minimum	Use this to Design RG
4. Extended Detention Volume	ED=	174	m^3	Minimum	Actual Volume of this within yo
5. Pond/Wetland Volume		720.93	m^3	Minimum	

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 289001.00	Sheet 11	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment D	Author	Date	Checked
Calc Title	Wetland Pond	RK	9/10/2026	

Catchment Area		Area	13100	m²			
WQV Volume		Vol	144.7	m^3			
Extended Detention Volume		Vol	174	m^3			
2yr 24hr Volume		Vol	387.4	m^3			
10yr 24hr Volume		Vol	529.2	m^3			
100yr 24hr Volume		Vol	720.93	m^3	0.00	Check	
Pond Volume Check (3d EW volumes)		PWL	151.4	m^3			
		WQV	274.877	m^3			
		EDV	477.327	m^3			
	(assume 100mm spillway depth)	TOP POND	1263.0	m^3			
						Check	
	WQV Volume	Dead	151.40	m^3		79.068	N/A
		Live	123.5	m^3		51.141	OK
		Total	274.88	m^3		130.209	N/A
	EDV Volume		325.9	m^3		152.323	OK
	Total Pond Voolume		1111.6	m^3		390.652	154% of
						1.542	100yr
Pond Permanent Suface Area						Check	
	WRC Recommended	%	3%				
		Area	393	m²			
	TR2020-06 Calculated	Live Depth	0.20	m			
		Dead Depth	0.20	m			
		Total Depth	0.40	m			
		Area	362	m²		2.76%	
Design	Wetland Permant Surface Area	Area	459.72	m²		98.05	
	Raingarden Permenant Surface Area	Area	24.15	m²		4.87	
	Total Treatment Area	Area	483.87	m²		122.20	

Worksheet 2: Graphical Peak Flow Rate

Catchment			A	Check
Runoff Depth	Q	mm	2.26	
Rainfall Depth	P	mm	5	
Storage	S	mm	5.18	5.18
Initial abstraction	Ia	mm	0.26	0.26
Curve Number	CN		98	98

Water Quality Volume	WQV	m3	19.28
Runoff Depth	Q	mm	2.26
Area	A	m2	8515

Raingarden Plan area	As	m2	**19.28**	
Water Quality Volume	WQV	m3	19.28	
Planting Soil Depth	d	m	0.6	standard from WRC TR 2020
Coefficient of permeability	k	m/day	0.75	standard from WRC TR 2020
Average height of water	h	m	0.2	standard from WRC TR 2020
Time to pass through soil	t	day	1	standard from WRC TR 2020

Design Rain Gardens			
Width	Type 1	m	4
Length		m	10
Number		ea	1
Width	Type 2	m	1.5
Length		m	3
Number		ea	0
Area		m^2	**40**

Storage calculations to tin "Fast Track Surface 09 09 2026" - (with plan polygon "CTRL/PONDS/POND A->TOB POND D1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta Vol	Plan Area	Delta Area	Slope Area	Delta Area
48.150		1262.987		953.156		990.397	
	0.010		9.514		3.535		3.724
48.140		1253.473		949.621		986.673	
	0.010		9.478		3.566		3.756
48.130		1243.995		946.055		982.917	
	0.010		9.443		3.560		3.749
48.120		1234.552		942.495		979.168	
	0.010		9.407		3.553		3.742
48.110		1225.145		938.943		975.426	
	0.010		9.372		3.546		3.735
48.100		1215.773		935.397		971.691	
	0.010		9.336		3.539		3.728
48.090		1206.437		931.857		967.963	
	0.010		9.301		3.532		3.721
48.080		1197.136		928.325		964.242	
	0.010		9.266		3.526		3.714
48.070		1187.871		924.799		960.529	
	0.010		9.230		3.519		3.707
48.060		1178.640		921.280		956.822	
	0.010		9.195		3.512		3.700
48.050		1169.445		917.768		953.122	
	0.010		9.160		3.505		3.693
48.040		1160.285		914.263		949.429	
	0.010		9.125		3.499		3.686
48.030		1151.160		910.764		945.743	
	0.010		9.090		3.492		3.679
48.020		1142.070		907.273		942.064	
	0.010		9.055		3.485		3.672
48.010		1133.014		903.788		938.392	
	0.010		9.020		3.478		3.665
48.000		1123.994		900.309		934.728	
	0.010		8.986		3.471		3.658
47.990		1115.008		896.838		931.070	
	0.010		8.951		3.465		3.651
47.980		1106.057		893.373		927.419	
	0.010		8.916		3.458		3.644
47.970		1097.141		889.915		923.775	
	0.010		8.882		3.451		3.637
47.960		1088.259		886.464		920.138	
	0.010		8.847		3.444		3.630

47.950		1079.411		883.020	916.508
	0.010		8.813	3.438	3.623
47.940		1070.598		879.582	912.886
	0.010		8.779	3.431	3.616
47.930		1061.820		876.151	909.270
	0.010		8.744	3.424	3.609
47.920		1053.075		872.727	905.661
	0.010		8.710	3.417	3.602
47.910		1044.365		869.310	902.059
	0.010		8.676	3.411	3.595
47.900		1035.689		865.899	898.465
	0.010		8.642	3.404	3.588
47.890		1027.047		862.496	894.877
	0.010		8.608	3.397	3.581
47.880		1018.439		859.099	891.296
	0.010		8.574	3.390	3.574
47.870		1009.865		855.709	887.723
	0.010		8.540	3.383	3.567
47.860		1001.325		852.325	884.156
	0.010		8.506	3.377	3.560
47.850		992.819		848.949	880.596
	0.010		8.473	3.370	3.553
47.840		984.346		845.579	877.043
	0.010		8.439	3.363	3.546
47.830		975.907		842.216	873.498
	0.010		8.405	3.356	3.539
47.820		967.502		838.859	869.959
	0.010		8.372	3.350	3.532
47.810		959.130		835.510	866.427
	0.010		8.338	3.343	3.525
47.800		950.791		832.167	862.903
	0.010		8.305	3.336	3.518
47.790		942.486		828.831	859.385
	0.010		8.272	3.329	3.511
47.780		934.215		825.502	855.875
	0.010		8.238	3.322	3.504
47.770		925.976		822.179	852.371
	0.010		8.205	3.316	3.497
47.760		917.771		818.864	848.874
	0.010		8.172	3.309	3.490
47.750		909.599		815.555	845.385
	0.010		8.139	3.302	3.483
47.740		901.460		812.253	841.902
	0.010		8.106	3.295	3.476
47.730		893.354		808.957	838.427
	0.010		8.073	3.289	3.469
47.720		885.281		805.669	834.958
	0.010		8.040	3.282	3.462
47.710		877.241		802.387	831.496
	0.010		8.007	3.275	3.455
47.700		869.233		799.112	828.042
	0.010		7.975	3.268	3.448

47.690		861.258		795.844	824.594
	0.010		7.942	3.261	3.441
47.680		853.316		792.582	821.154
	0.010		7.910	3.255	3.434
47.670		845.407		789.327	817.720
	0.010		7.877	3.248	3.427
47.660		837.530		786.080	814.294
	0.010		7.845	3.241	3.420
47.650		829.685		782.838	810.874
	0.010		7.812	3.234	3.413
47.640		821.873		779.604	807.462
	0.010		7.780	3.228	3.405
47.630		814.093		776.376	804.056
	0.010		7.748	3.221	3.398
47.620		806.345		773.156	800.658
	0.010		7.715	3.214	3.391
47.610		798.630		769.942	797.266
	0.010		7.683	3.207	3.384
47.600		790.946		766.734	793.882
	0.010		7.651	3.201	3.377
47.590		783.295		763.534	790.504
	0.010		7.619	3.194	3.370
47.580		775.676		760.340	787.134
	0.010		7.587	3.187	3.363
47.570		768.088		757.153	783.770
	0.010		7.556	3.180	3.356
47.560		760.533		753.973	780.414
	0.010		7.524	3.173	3.349
47.550		753.009		750.799	777.065
	0.010		7.492	3.167	3.342
47.540		745.517		747.633	773.722
	0.010		7.461	3.160	3.335
47.530		738.056		744.473	770.387
	0.010		7.429	3.153	3.328
47.520		730.627		741.320	767.058
	0.010		7.397	3.146	3.321
47.510		723.230		738.173	763.737
	0.010		7.366	3.140	3.314
47.500		715.864		735.034	760.423
	0.010		7.335	3.133	3.307
47.490		708.529		731.901	757.115
	0.010		7.303	3.126	3.300
47.480		701.226		728.775	753.815
	0.010		7.272	3.119	3.293
47.470		693.953		725.656	750.522
	0.010		7.241	3.112	3.286
47.460		686.712		722.543	747.235
	0.010		7.210	3.106	3.279
47.450		679.503		719.438	743.956
	0.010		7.179	3.099	3.272
47.440		672.324		716.339	740.684
	0.010		7.148	3.092	3.265

47.430		665.176		713.247	737.418
	0.010		7.117	3.085	3.258
47.420		658.059		710.161	734.160
	0.010		7.086	3.079	3.251
47.410		650.972		707.083	730.909
	0.010		7.055	3.072	3.244
47.400		643.917		704.011	727.664
	0.010		7.025	3.065	3.237
47.390		636.892		700.946	724.427
	0.010		6.994	3.058	3.230
47.380		629.898		697.888	721.197
	0.010		6.964	3.051	3.223
47.370		622.934		694.836	717.974
	0.010		6.933	3.045	3.216
47.360		616.001		691.792	714.757
	0.010		6.903	3.038	3.209
47.350		609.099		688.754	711.548
	0.010		6.872	3.031	3.202
47.340		602.226		685.722	708.346
	0.010		6.842	3.024	3.195
47.330		595.384		682.698	705.151
	0.010		6.812	3.018	3.188
47.320		588.572		679.680	701.962
	0.010		6.782	3.011	3.181
47.310		581.791		676.670	698.781
	0.010		6.752	3.004	3.174
47.300		575.039		673.665	695.607
	0.010		6.722	2.997	3.167
47.290		568.317		670.668	692.440
	0.010		6.692	2.991	3.160
47.280		561.625		667.678	689.280
	0.010		6.662	2.984	3.153
47.270		554.964		664.694	686.127
	0.010		6.632	2.977	3.146
47.260		548.332		661.717	682.980
	0.010		6.602	2.970	3.139
47.250		541.729		658.747	679.841
	0.010		6.573	2.963	3.132
47.240		535.157		655.783	676.709
	0.010		6.543	2.957	3.125
47.230		528.614		652.827	673.584
	0.010		6.514	2.950	3.118
47.220		522.100		649.877	670.466
	0.010		6.484	2.943	3.111
47.210		515.616		646.934	667.355
	0.010		6.455	2.936	3.104
47.200		509.161		643.997	664.251
	0.010		6.425	2.930	3.097
47.190		502.736		641.068	661.154
	0.010		6.396	2.923	3.090
47.180		496.340		638.145	658.064
	0.010		6.367	2.916	3.083

47.170		489.973		635.229	654.980
	0.010		6.338	2.909	3.076
47.160		483.635		632.320	651.904
	0.010		6.309	2.902	3.069
47.150		477.327		629.417	648.835
	0.010		6.279	2.977	3.138
47.140		471.047		626.441	645.698
	0.010		6.250	2.971	3.132
47.130		464.798		623.469	642.566
	0.010		6.220	2.965	3.126
47.120		458.578		620.504	639.440
	0.010		6.190	2.960	3.120
47.110		452.388		617.544	636.320
	0.010		6.161	2.954	3.114
47.100		446.227		614.590	633.206
	0.010		6.131	2.948	3.108
47.090		440.096		611.642	630.098
	0.010		6.102	2.943	3.102
47.080		433.994		608.699	626.996
	0.010		6.072	2.937	3.096
47.070		427.922		605.762	623.900
	0.010		6.043	2.932	3.090
47.060		421.879		602.830	620.810
	0.010		6.014	2.926	3.084
47.050		415.865		599.904	617.725
	0.010		5.984	2.920	3.078
47.040		409.881		596.984	614.647
	0.010		5.955	2.915	3.072
47.030		403.926		594.069	611.575
	0.010		5.926	2.909	3.066
47.020		397.999		591.160	608.508
	0.010		5.897	2.903	3.060
47.010		392.102		588.257	605.448
	0.010		5.868	2.898	3.054
47.000		386.234		585.359	602.394
	0.010		5.839	2.892	3.048
46.990		380.395		582.468	599.345
	0.010		5.810	2.886	3.042
46.980		374.585		579.581	596.303
	0.010		5.781	2.881	3.037
46.970		368.804		576.701	593.266
	0.010		5.753	2.875	3.031
46.960		363.051		573.825	590.236
	0.010		5.724	2.869	3.025
46.950		357.327		570.956	587.211
	0.010		5.695	2.864	3.019
46.940		351.632		568.092	584.192
	0.010		5.667	2.858	3.013
46.930		345.965		565.234	581.180
	0.010		5.638	2.852	3.007
46.920		340.327		562.382	578.173
	0.010		5.610	2.847	3.001

46.910		334.717		559.535	575.172
	0.010		5.581	2.841	2.995
46.900		329.136		556.694	572.177
	0.010		5.553	2.835	2.989
46.890		323.584		553.859	569.188
	0.010		5.524	2.830	2.983
46.880		318.059		551.029	566.205
	0.010		5.496	2.824	2.977
46.870		312.563		548.205	563.229
	0.010		5.468	2.819	2.971
46.860		307.095		545.386	560.257
	0.010		5.440	2.813	2.965
46.850		301.655		542.573	557.292
	0.010		5.412	2.807	2.959
46.840		296.244		539.766	554.333
	0.010		5.384	2.802	2.953
46.830		290.860		536.964	551.380
	0.010		5.356	2.796	2.947
46.820		285.504		534.169	548.433
	0.010		5.328	2.790	2.941
46.810		280.177		531.378	545.492
	0.010		5.300	2.785	2.935
46.800		274.877		528.594	542.557
	0.010		5.272	2.814	2.963
46.790		269.605		525.779	539.594
	0.010		5.244	2.809	2.958
46.780		264.361		522.970	536.636
	0.010		5.216	2.804	2.952
46.770		259.145		520.166	533.684
	0.010		5.188	2.799	2.947
46.760		253.958		517.366	530.737
	0.010		5.160	2.795	2.942
46.750		248.798		514.572	527.795
	0.010		5.132	2.790	2.936
46.740		243.666		511.782	524.859
	0.010		5.104	2.785	2.931
46.730		238.562		508.998	521.928
	0.010		5.076	2.780	2.926
46.720		233.486		506.218	519.002
	0.010		5.048	2.775	2.921
46.710		228.438		503.443	516.081
	0.010		5.021	2.770	2.915
46.700		223.417		500.673	513.166
	0.010		4.993	2.765	2.910
46.690		218.425		497.908	510.256
	0.010		4.965	2.760	2.905
46.680		213.459		495.148	507.351
	0.010		4.938	2.755	2.899
46.670		208.522		492.393	504.452
	0.010		4.910	2.750	2.894
46.660		203.611		489.643	501.558
	0.010		4.883	2.745	2.889

46.650		198.729		486.898	498.669
	0.010		4.855	2.740	2.884
46.640		193.873		484.157	495.785
	0.010		4.828	2.735	2.878
46.630		189.046		481.422	492.907
	0.010		4.801	2.730	2.873
46.620		184.245		478.692	490.034
	0.010		4.773	2.725	2.868
46.610		179.472		475.966	487.167
	0.010		4.746	2.721	2.862
46.600		174.726		473.246	484.304
	0.010		4.719	2.716	2.857
46.590		170.007		470.530	481.447
	0.010		4.692	2.711	2.852
46.580		165.315		467.819	478.595
	0.010		4.665	2.706	2.846
46.570		160.650		465.113	475.749
	0.010		4.638	2.701	2.841
46.560		156.013		462.413	472.908
	0.010		4.611	2.696	2.836
46.550		151.402		459.717	470.072
	0.010		4.584	2.691	2.831
46.540		146.818		457.026	467.241
	0.010		4.557	2.686	2.825
46.530		142.262		454.340	464.416
	0.010		4.530	2.681	2.820
46.520		137.732		451.659	461.596
	0.010		4.503	2.676	2.815
46.510		133.228		448.982	458.781
	0.010		4.476	14.579	14.717
46.500		128.752		434.403	444.064
	0.010		4.300	8.877	9.029
46.490		124.452		425.526	435.035
	0.010		4.211	8.793	8.943
46.480		120.241		416.734	426.091
	0.010		4.124	8.708	8.858
46.470		116.117		408.026	417.234
	0.010		4.037	8.624	8.772
46.460		112.080		399.402	408.462
	0.010		3.951	8.539	8.686
46.450		108.129		390.863	399.776
	0.010		3.866	8.454	8.600
46.440		104.263		382.409	391.175
	0.010		3.782	8.370	8.514
46.430		100.481		374.039	382.661
	0.010		3.699	8.285	8.429
46.420		96.782		365.753	374.232
	0.010		3.616	8.201	8.343
46.410		93.165		357.553	365.889
	0.010		3.535	8.116	8.257
46.400		89.630		349.436	357.632
	0.010		3.454	8.032	8.171

46.390		86.176		341.405	349.461
	0.010		3.374	7.947	8.085
46.380		82.802		333.457	341.375
	0.010		3.295	7.863	8.000
46.370		79.507		325.595	333.376
	0.010		3.217	7.778	7.914
46.360		76.290		317.816	325.462
	0.010		3.140	7.694	7.828
46.350		73.150		310.123	317.634
	0.010		3.063	7.609	7.742
46.340		70.087		302.514	309.892
	0.010		2.987	7.525	7.656
46.330		67.100		294.989	302.235
	0.010		2.913	7.440	7.571
46.320		64.187		287.549	294.664
	0.010		2.839	7.355	7.485
46.310		61.348		280.194	287.179
	0.010		2.766	72.408	72.537
46.300		58.583		207.785	214.643
	0.010		2.057	4.125	4.311
46.290		56.526		203.660	210.332
	0.010		2.016	4.086	4.270
46.280		54.510		199.574	206.063
	0.010		1.975	4.047	4.229
46.270		52.534		195.527	201.834
	0.010		1.935	4.009	4.188
46.260		50.599		191.518	197.646
	0.010		1.895	3.970	4.147
46.250		48.704		187.548	193.498
	0.010		1.856	3.931	4.107
46.240		46.848		183.618	189.392
	0.010		1.817	3.892	4.066
46.230		45.031		179.725	185.326
	0.010		1.778	3.853	4.025
46.220		43.253		175.872	181.301
	0.010		1.740	3.815	3.984
46.210		41.513		172.058	177.316
	0.010		1.702	3.776	3.944
46.200		39.812		168.282	173.373
	0.010		1.664	3.737	3.903
46.190		38.148		164.545	169.470
	0.010		1.627	3.698	3.862
46.180		36.521		160.847	165.608
	0.010		1.590	3.659	3.821
46.170		34.931		157.187	161.787
	0.010		1.554	3.621	3.780
46.160		33.377		153.567	158.006
	0.010		1.518	32.495	32.653
46.150		31.859		121.072	125.353
	0.010		1.198	2.602	2.729
46.140		30.662		118.470	122.624
	0.010		1.172	2.578	2.704

46.130		29.490		115.891	119.920
	0.010		1.146	2.554	2.678
46.120		28.344		113.337	117.242
	0.010		1.121	2.530	2.653
46.110		27.223		110.807	114.589
	0.010		1.096	2.507	2.627
46.100		26.127		108.300	111.962
	0.010		1.071	2.483	2.602
46.090		25.057		105.818	109.360
	0.010		1.046	2.459	2.577
46.080		24.011		103.359	106.783
	0.010		1.021	2.435	2.551
46.070		22.990		100.924	104.232
	0.010		0.997	2.411	2.526
46.060		21.992		98.513	101.706
	0.010		0.973	2.387	2.500
46.050		21.019		96.126	99.206
	0.010		0.949	2.363	2.475
46.040		20.070		93.763	96.731
	0.010		0.926	2.339	2.450
46.030		19.144		91.424	94.281
	0.010		0.903	2.315	2.424
46.020		18.241		89.109	91.857
	0.010		0.880	2.291	2.399
46.010		17.362		86.817	89.458
	0.010		0.857	2.267	2.373
46.000		16.505		84.550	87.085
	0.010		0.834	2.244	2.348
45.990		15.671		82.306	84.737
	0.010		0.812	2.220	2.322
45.980		14.859		80.086	82.415
	0.010		0.790	2.196	2.297
45.970		14.069		77.891	80.118
	0.010		0.768	2.172	2.272
45.960		13.301		75.719	77.846
	0.010		0.746	2.148	2.246
45.950		12.554		73.571	75.600
	0.010		0.725	2.124	2.221
45.940		11.829		71.447	73.379
	0.010		0.704	2.100	2.195
45.930		11.125		69.347	71.184
	0.010		0.683	2.076	2.170
45.920		10.442		67.270	69.014
	0.010		0.662	2.052	2.144
45.910		9.780		65.218	66.870
	0.010		0.642	21.626	21.716
45.900		9.138		43.592	45.153
	0.010		0.430	1.174	1.238
45.890		8.708		42.419	43.916
	0.010		0.418	1.157	1.220
45.880		8.289		41.262	42.696
	0.010		0.407	1.140	1.202

45.870		7.882		40.121	41.494
	0.010		0.396	1.123	1.184
45.860		7.487		38.998	40.309
	0.010		0.384	1.107	1.167
45.850		7.102		37.891	39.143
	0.010		0.373	1.090	1.149
45.840		6.729		36.801	37.994
	0.010		0.363	1.073	1.131
45.830		6.366		35.728	36.862
	0.010		0.352	1.056	1.114
45.820		6.014		34.672	35.749
	0.010		0.342	1.040	1.096
45.810		5.673		33.632	34.653
	0.010		0.331	1.023	1.078
45.800		5.342		32.609	33.574
	0.010		0.321	1.006	1.060
45.790		5.021		31.604	32.514
	0.010		0.311	0.989	1.043
45.780		4.710		30.614	31.471
	0.010		0.301	0.972	1.025
45.770		4.408		29.642	30.446
	0.010		0.292	0.956	1.007
45.760		4.117		28.687	29.439
	0.010		0.282	0.939	0.990
45.750		3.834		27.748	28.449
	0.010		0.273	0.922	0.972
45.740		3.562		26.826	27.477
	0.010		0.264	0.905	0.954
45.730		3.298		25.921	26.523
	0.010		0.255	0.888	0.937
45.720		3.043		25.032	25.586
	0.010		0.246	0.872	0.919
45.710		2.797		24.161	24.668
	0.010		0.237	6.881	6.927
45.700		2.560		17.280	17.741
	0.010		0.170	0.491	0.517
45.690		2.390		16.790	17.223
	0.010		0.165	0.484	0.510
45.680		2.224		16.306	16.714
	0.010		0.161	0.477	0.503
45.670		2.063		15.829	16.211
	0.010		0.156	0.470	0.495
45.660		1.907		15.359	15.716
	0.010		0.151	0.463	0.488
45.650		1.756		14.896	15.227
	0.010		0.147	0.456	0.481
45.640		1.610		14.440	14.747
	0.010		0.142	0.449	0.474
45.630		1.467		13.991	14.273
	0.010		0.138	0.442	0.466
45.620		1.330		13.549	13.807
	0.010		0.133	0.435	0.459

45.610		1.196	13.113	13.348	
	0.010	0.129	0.429		0.452
45.600		1.067	12.685	12.896	
	0.010	0.125	0.422		0.444
45.590		0.943	12.263	12.451	
	0.010	0.121	0.415		0.437
45.580		0.822	11.848	12.014	
	0.010	0.116	0.408		0.430
45.570		0.706	11.440	11.584	
	0.010	0.112	0.401		0.423
45.560		0.593	11.039	11.162	
	0.010	0.108	0.394		0.415
45.550		0.485	10.645	10.746	
	0.010	0.105	0.387		0.408
45.540		0.380	10.258	10.338	
	0.010	0.101	0.380		0.401
45.530		0.280	9.878	9.937	
	0.010	0.097	0.373		0.394
45.520		0.183	9.504	9.543	
	0.010	0.093	0.367		0.386
45.510		0.090	9.138	9.157	
	0.010	0.090	9.138		9.157
45.500		0.000	0.000	0.000	
	1.000	0.000	0.000		0.000
44.500		0.000	0.000	0.000	

Polygon plan area = 953.237

	Maven Associates	Job Number 411001	Sheet 1	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment E	Author	Date	Checked
Calc Title	Catchment Areas	RK, SPAM	9/10/2026	

Wetland A Catchment	ha	Area (m2)	% impervious
Residential catchment	1.86	18600	65.0%

Maven Associates		Job Number 411001	Sheet 2	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment E Calc Title: Pre-development		Author: RK, SPAM	Date: 9/10/2026	Checked

Wetland C
Total Catchment 18600

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

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	1.86	137.64
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	1.86	137.64

CN (weighted) = total product / total area = 137.64 / 1.860 = **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

Sheet and Shallow Flow $T=100nL^{0.33}/S^{0.2}$ (to be completed at detail design)
Top Contour Level 84.6
Bottom Contour Level 62.6
Catchment Length 240
L= 240 m
S= 0.092 %
n= 0.035
T= 34.443 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
I= 500
n= 0.04
s= 1%
(to be completed at detail design)
V= 0.8498537 m/s
T= 0.00 mins

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

= 34.44 + 0.00 + 0.00 = 34.443 mins
0.5740427 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.385 hrs

OK use **0.38** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates	Job Number 411001.00	Sheet 3	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment E Calc Title: Pre-development	Author: RK SPAM	Date: 9/10/2026	Checked

1. Data

Catchment Area	A=	0.0186	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=	0.38	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	yr
4. 24 hour rainfall depth, P24	21.6	(mm)	64.7	96.6	146	(mm)
*as per HIRDS Historical data						
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.066		0.238	0.329	0.434	
6. Specific peak flow rate q*	0.021		0.069	0.091	0.113	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.008**	m^3/s	**0.084**	**0.164**	**0.306**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	2.8		24.3	46.8	86.8	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	51	m^3	**451.51**	**870.56**	**1614.57**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 4	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment E Post development (Pervious)		Author RK SPAM	Date 9/10/2026	Checked

Wetland C
Total Catchmer 18600

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	35.0%	74	0.65	48.17
C		Impervious	65.0%	98		0.00
						0.00
				Totals =	0.65	48.17

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{48.17}{0.651}$ = **74.0**

$S = \frac{1000}{CN} - 10) * 25.4$ $\frac{(1000 - 10) * 25.4}{74.0}$ = **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 411001	Sheet 5	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment E	Author	Date	Checked
Calc Title	Post development (Pervious)	RK SPAM	9/10/2026	

1. Data

Catchment Area	A=	0.00651	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=	0.17	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 RITS 6.0 2081-2100	24.1	(mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S			0.262	0.359	0.470	
6. Specific peak flow rate q*			0.075	0.098	0.119	
7. Peak flow rate, $q_p=q^*A^*P_{24}$		m^3/s	**0.035**	**0.069**	**0.130**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.5		29.2	56.4	104.9	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	23	m^3	**190.28**	**367.13**	**683.07**	m^3

Worksheet 2: Graphical Peak Flow Rate

	Maven Associates		Job Number 411001	Sheet 6	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment E Post development (Impervious)		Author RK SPAM	Date 9/10/2026	Checked

Wetland C
Total Catchmer 18600

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	35.0%	74		0.00
C		Impervious	65.0%	98	1.21	118.48
						0.00
				Totals =	1.21	118.48

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{118.48}{1.209}$ = **98.0**

S= $\left(\frac{1000}{CN} - 10\right) * 25.4$ $\frac{(1000 - 10) * 25.4}{98.0}$ = **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 411001.00	Sheet 7	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment E	Author RK SPAM	Date 9/10/2026	Checked
Calc Title	Post development (Impervious)			

1. Data

Catchment Area	A=	0.01209	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=	0.17	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	24.1	(mm)	72.2	109	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.694		0.874	0.913	0.941	
6. Specific peak flow rate q*	0.150		0.164	0.165	0.166	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.044**	m^3/s	**0.143**	**0.217**	**0.335**	m^3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	19.6		67.1	103.8	161.7	
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	236	m^3	**811.31**	**1254.86**	**1955.12**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates	Job Number 411001	Sheet 8	Rev: A
Job Title: HARLOW LIFESTYLE VILLAGE - Catchment E Calc Title: Post development (whole site)	Author RK	Date 9/10/2026	Checked MHS

Wetland C
Total Catchmer 18600

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	35.0%	74	0.65	48.17
C		Impervious	65.0%	98	1.21	118.48
						0.00
				Totals =	1.86	166.66

CN (weighted) = total product / total area = 166.66 / 1.860 = **89.6**

S= (1000/CN - 10) * 25.4 = (1000/89.6 - 10) *25.4 = **29.5** mm

Ia= 0.05*S = 0.05x 29.5 = **1.5** mm

2. Time of Concentration

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

Top Contour Level	80.6	L=	350	m
Bottom Contour Level	67.4	S=	0.038	%
Catchment Length	350	n=	0.015	
		T=	19.968	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=	500		

(to be completed at detail design)

V= 0.8498537 m/s
T= 0.00 mins

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

= 19.97 + 0.00 + 0.00 = 19.968 mins
0.3327984 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 411001.00	Sheet 9		Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment E	Author	Date		Checked
Calc Title	Post development (whole site)	RK	9/10/2026		

1. Data

Catchment Area	A=	0.0186	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29 mm

		WQV					
3. Average recurrence interval, ARI	1/4 of 2yr	1/3 of 2yr	2	10	100	100	yr
4. 24 hour rainfall depth, P24 *as per HIRDS RCP 6.0 2081-2100 data	18.05	24.1	72.2	109	167	167	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.204	0.264	0.540	0.643	0.736	0.736	
6. Specific peak flow rate q*	0.061	0.076	0.131	0.145	0.154	0.154	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.020**	**0.034**	**0.176**	**0.293**	**0.480**	**0.480**	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	451.51	870.56	1614.57	1614.57	m^3
Post development run off volume - Pervious	190.28	367.13	683.07	683.07	m^3
Post development run off volume - Impervious	811.31	1254.86	1955.12	1955.12	m^3
Post development run off volume - total	1001.59	1621.98	2638.19	2638.19	m^3
			Volume	**1023.61**	m^3
Pre development flow rate	0.08	0.16	0.31	0.31	m^3/s
Post development flow rate	0.18	0.29	0.48	0.48	m^3/s
Target Flow Rates (80% Pre development)	0.07	0.13	0.24	0.24	m^3/s

Design Orifice that allows discharge out of your p

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001.00	Sheet 10	Rev: A
Job Title Calc Title	HARLOW LIFESTYLE VILLAGE - Catchment E WQV and ED	Author RK	Date 9/10/2026	Checked

1. Data					
Runoff volume (pervious)	V_p=	23	m^3		
Runoff volume (impervious)	V_{ip}=	236	m^3		
Combined volume	V=	259.4	m^3		
Pre-development initial abstration	I_{a1}=	4.5	mm		
Post-development compacted pervious area CN		74		Class C	
Post-development initial abstration of pervious area	I_{a2}=	4.5	mm		
Post development Impervious area	A_{ip}=	1.21	ha.		
Post development compacted pervious areas	A_{pp}=	0.65	ha.		
2. Retention reduction					
Impervious surface retention	Vrip=	53.9	m^3		
Pervious surface retention	Vrp=	0.0	m^3		
3. Water Quality Volume	WQV=	205.4	m^3	Minimum	Use this to Design RG
4. Extended Detention Volume	ED=	246	m^3	Minimum	Actual Volume of this within yo
5. Pond/Wetland Volume		1023.61	m^3	Minimum	

Worksheet 2: Graphical Peak Flow Rate

Maven Associates			Job Number 411001.00	Sheet 11	Rev: A
Job Title	HARLOW LIFESTYLE VILLAGE - Catchment E		Author	Date	Checked
Calc Title	Wetland Pond		RK	9/10/2026	

Catchment Area		Area	18600	m²			
WQV Volume		Vol	205.4	m^3			
Extended Detention Volume		Vol	246	m^3			
2yr 24hr Volume		Vol	550.1	m^3			
10yr 24hr Volume		Vol	751.4	m^3			
100yr 24hr Volume		Vol	1023.61	m^3	0.00	Check	
Pond Volume Check (3d EW volumes)		PWL	185.2	m^3			
		WQV	385.97	m^3			
		EDV	707.398	m^3			
	(assume 100mm spillway depth)	TOP POND	1076.4	m^3			
						Check	
	WQV Volume	Dead	185.20	m^3		82.501	N/A
		Live	200.8	m^3		98.063	OK
		Total	385.97	m^3		180.564	N/A
	EDV Volume		522.2	m^3		275.706	OK
	Total Pond Voolume		891.2	m^3		341.126	162% of 2yr
						1.620	
Pond Permanent Suface Area						Check	
	WRC Recommended	%	3%				
		Area	558	m²			
	TR2020-06 Calculated	Live Depth	0.20	m			
		Dead Depth	0.20	m			
		Total Depth	0.40	m			
		Area	514	m²		2.76%	OK
Design	Wetland Permant Surface Area	Area	721.35	m²		207.83	OK
	Raingarden Permenant Surface Area	Area	36.40	m²		-0.08	OK
	Total Treatment Area	Area	757.75	m²		244.23	OK

Worksheet 2: Graphical Peak Flow Rate

Catchment			A	Check
Runoff Depth	Q	mm	2.26	
Rainfall Depth	P	mm	5	
Storage	S	mm	5.18	5.18
Initial abstraction	Ia	mm	0.26	0.26
Curve Number	CN		98	98

Water Quality Volume	WQV	m3	27.38
Runoff Depth	Q	mm	2.26
Area	A	m2	12090

Raingarden Plan area	As	m2	**36.48**	
Water Quality Volume	WQV	m3	27.38	
Planting Soil Depth	d	m	258	standard from WRC TR 2020
Coefficient of permeability	k	m/day	0.75	standard from WRC TR 2020
Average height of water	h	m	0.2	standard from WRC TR 2020
Time to pass through soil	t	day	1	standard from WRC TR 2020

Design Rain Gardens			
Width		m	3
Length		m	10
Number	Type 1	ea	1
Width		m	1.5
Length		m	3
Number	Type 2	ea	0
Area		m^2	**30**

Storage calculations to tin "Fast Track Surface 09 09 2026" - (with plan polygon "CTRL/PONDS/POND A->TOB POND E1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta Vol	Plan Area	Delta Area	Slope Area	Delta Area
59.420		1076.409		1124.310		1152.579	
	0.010		11.223		4.074		4.297
59.410		1065.187		1120.237		1148.282	
	0.010		11.182		4.067		4.291
59.400		1054.005		1116.169		1143.991	
	0.010		11.141		4.061		4.284
59.390		1042.863		1112.109		1139.708	
	0.010		11.101		4.054		4.277
59.380		1031.762		1108.055		1135.431	
	0.010		11.060		4.047		4.270
59.370		1020.702		1104.008		1131.161	
	0.010		11.020		4.041		4.263
59.360		1009.682		1099.967		1126.898	
	0.010		10.979		4.034		4.256
59.350		998.703		1095.933		1122.642	
	0.010		10.939		4.027		4.249
59.340		987.764		1091.906		1118.392	
	0.010		10.899		4.021		4.242
59.330		976.865		1087.885		1114.150	
	0.010		10.859		4.014		4.236
59.320		966.006		1083.872		1109.914	
	0.010		10.819		4.007		4.229
59.310		955.187		1079.864		1105.686	
	0.010		10.779		4.001		4.222
59.300		944.409		1075.864		1101.464	
	0.010		10.739		3.994		4.215
59.290		933.670		1071.869		1097.249	
	0.010		10.699		3.987		4.208
59.280		922.971		1067.882		1093.041	
	0.010		10.659		3.981		4.201
59.270		912.312		1063.901		1088.840	
	0.010		10.619		3.974		4.194
59.260		901.693		1059.927		1084.645	
	0.010		10.579		3.967		4.187
59.250		891.114		1055.960		1080.458	
	0.010		10.540		3.961		4.181
59.240		880.574		1051.999		1076.277	
	0.010		10.500		3.954		4.174
59.230		870.074		1048.045		1072.104	
	0.010		10.461		3.947		4.167

59.220		859.613		1044.098	1067.937
	0.010		10.421	3.941	4.160
59.210		849.192		1040.157	1063.777
	0.010		10.382	3.934	4.153
59.200		838.810		1036.223	1059.624
	0.010		10.343	3.928	4.146
59.190		828.467		1032.295	1055.477
	0.010		10.303	3.921	4.139
59.180		818.164		1028.374	1051.338
	0.010		10.264	3.914	4.132
59.170		807.900		1024.460	1047.206
	0.010		10.225	3.908	4.126
59.160		797.675		1020.552	1043.080
	0.010		10.186	3.901	4.119
59.150		787.489		1016.651	1038.961
	0.010		10.147	3.894	4.112
59.140		777.342		1012.757	1034.849
	0.010		10.108	3.888	4.105
59.130		767.233		1008.870	1030.744
	0.010		10.069	3.881	4.098
59.120		757.164		1004.989	1026.646
	0.010		10.031	3.874	4.091
59.110		747.134		1001.114	1022.555
	0.010		9.992	3.868	4.084
59.100		737.142		997.247	1018.471
	0.010		9.953	3.861	4.078
59.090		727.189		993.385	1014.393
	0.010		9.915	3.854	4.071
59.080		717.274		989.531	1010.322
	0.010		9.876	3.848	4.064
59.070		707.398		985.683	1006.259
	0.010		9.837	3.910	4.121
59.060		697.561		981.774	1002.137
	0.010		9.798	3.904	4.115
59.050		687.763		977.869	998.022
	0.010		9.759	3.898	4.109
59.040		678.003		973.971	993.912
	0.010		9.720	3.893	4.104
59.030		668.283		970.078	989.809
	0.010		9.681	3.887	4.098
59.020		658.602		966.191	985.711
	0.010		9.642	3.882	4.092
59.010		648.959		962.309	981.620
	0.010		9.604	3.876	4.086
59.000		639.356		958.433	977.534
	0.010		9.565	3.870	4.080
58.990		629.791		954.563	973.454
	0.010		9.526	3.865	4.074
58.980		620.264		950.699	969.381
	0.010		9.488	3.859	4.068
58.970		610.777		946.840	965.313
	0.010		9.449	3.853	4.062

58.960		601.327		942.986	961.251
	0.010		9.411	3.848	4.056
58.950		591.917		939.139	957.195
	0.010		9.372	3.842	4.050
58.940		582.545		935.297	953.145
	0.010		9.334	3.836	4.044
58.930		573.211		931.460	949.101
	0.010		9.295	3.831	4.038
58.920		563.915		927.629	945.063
	0.010		9.257	3.825	4.032
58.910		554.658		923.804	941.031
	0.010		9.219	3.819	4.026
58.900		545.439		919.985	937.005
	0.010		9.181	3.814	4.020
58.890		536.259		916.171	932.985
	0.010		9.143	3.808	4.014
58.880		527.116		912.363	928.971
	0.010		9.105	3.802	4.008
58.870		518.011		908.561	924.962
	0.010		9.067	3.797	4.002
58.860		508.945		904.764	920.960
	0.010		9.029	3.791	3.996
58.850		499.916		900.972	916.964
	0.010		8.991	3.786	3.990
58.840		490.925		897.187	912.973
	0.010		8.953	3.780	3.984
58.830		481.972		893.407	908.989
	0.010		8.915	3.774	3.978
58.820		473.057		889.633	905.010
	0.010		8.877	3.769	3.973
58.810		464.180		885.864	901.038
	0.010		8.840	3.763	3.967
58.800		455.340		882.101	897.071
	0.010		8.802	3.757	3.961
58.790		446.538		878.344	893.111
	0.010		8.765	3.752	3.955
58.780		437.773		874.592	889.156
	0.010		8.727	3.746	3.949
58.770		429.046		870.846	885.207
	0.010		8.690	3.740	3.943
58.760		420.356		867.106	881.265
	0.010		8.652	3.735	3.937
58.750		411.704		863.371	877.328
	0.010		8.615	3.729	3.931
58.740		403.088		859.642	873.397
	0.010		8.578	3.723	3.925
58.730		394.511		855.919	869.472
	0.010		8.541	3.718	3.919
58.720		385.970		852.201	865.553
	0.010		8.503	3.749	3.948
58.710		377.467		848.452	861.605
	0.010		8.466	3.772	3.971

58.700		369.001		844.680	857.634
	0.010		8.428	3.795	3.993
58.690		360.573		840.884	853.642
	0.010		8.390	3.819	4.015
58.680		352.184		837.066	849.627
	0.010		8.351	3.842	4.037
58.670		343.832		833.224	845.590
	0.010		8.313	3.865	4.059
58.660		335.519		829.359	841.530
	0.010		8.274	3.888	4.081
58.650		327.245		825.471	837.449
	0.010		8.235	3.912	4.104
58.640		319.010		821.559	833.345
	0.010		8.196	3.935	4.126
58.630		310.814		817.624	829.219
	0.010		8.156	3.958	4.148
58.620		302.657		813.666	825.071
	0.010		8.117	3.981	4.170
58.610		294.541		809.685	820.901
	0.010		8.077	4.004	4.192
58.600		286.464		805.681	816.709
	0.010		8.037	4.028	4.215
58.590		278.427		801.653	812.494
	0.010		7.996	4.051	4.237
58.580		270.431		797.602	808.258
	0.010		7.956	4.074	4.259
58.570		262.475		793.528	803.999
	0.010		7.915	4.097	4.281
58.560		254.560		789.430	799.718
	0.010		7.874	4.121	4.303
58.550		246.687		785.310	795.414
	0.010		7.832	4.144	4.325
58.540		238.854		781.166	791.089
	0.010		7.791	4.167	4.348
58.530		231.063		776.999	786.741
	0.010		7.749	4.190	4.370
58.520		223.314		772.809	782.371
	0.010		7.707	4.214	4.392
58.510		215.607		768.595	777.979
	0.010		7.665	4.237	4.414
58.500		207.942		764.358	773.565
	0.010		7.622	4.260	4.436
58.490		200.320		760.098	769.129
	0.010		7.580	4.283	4.459
58.480		192.741		755.815	764.670
	0.010		7.537	34.466	34.640
58.470		185.204		721.349	730.030
	0.010		7.141	14.431	14.554
58.460		178.063		706.918	715.476
	0.010		6.998	14.295	14.417
58.450		171.065		692.623	701.059
	0.010		6.855	14.160	14.280

58.440		164.210		678.463		686.779	
	0.010		6.714		14.025		14.143
58.430		157.495		664.438		672.636	
	0.010		6.575		13.889		14.006
58.420		150.921		650.549		658.630	
	0.010		6.437		13.754		13.869
58.410		144.484		636.795		644.762	
	0.010		6.300		13.619		13.732
58.400		138.184		623.176		631.030	
	0.010		6.164		13.483		13.594
58.390		132.020		609.693		617.436	
	0.010		6.030		13.348		13.457
58.380		125.990		596.345		603.978	
	0.010		5.897		13.213		13.320
58.370		120.093		583.133		590.658	
	0.010		5.766		13.077		13.183
58.360		114.327		570.055		577.475	
	0.010		5.636		12.942		13.046
58.350		108.691		557.113		564.429	
	0.010		5.507		12.807		12.909
58.340		103.184		544.307		551.520	
	0.010		5.380		12.671		12.772
58.330		97.804		531.635		538.748	
	0.010		5.254		12.536		12.635
58.320		92.551		519.100		526.113	
	0.010		5.129		12.401		12.498
58.310		87.422		506.699		513.615	
	0.010		5.006		12.265		12.361
58.300		82.416		494.434		501.255	
	0.010		4.884		12.130		12.224
58.290		77.533		482.304		489.031	
	0.010		4.763		11.995		12.086
58.280		72.770		470.309		476.945	
	0.010		4.644		154.590		154.680
58.270		68.126		315.719		322.264	
	0.010		3.125		6.490		6.712
58.260		65.002		309.229		315.553	
	0.010		3.060		6.433		6.652
58.250		61.942		302.796		308.901	
	0.010		2.996		6.375		6.593
58.240		58.945		296.421		302.308	
	0.010		2.933		6.318		6.533
58.230		56.013		290.103		295.775	
	0.010		2.870		6.260		6.474
58.220		53.143		283.843		289.301	
	0.010		2.807		6.203		6.415
58.210		50.336		277.640		282.886	
	0.010		2.746		6.145		6.355
58.200		47.590		271.495		276.531	
	0.010		2.684		6.088		6.296
58.190		44.906		265.407		270.235	
	0.010		2.624		6.031		6.237

58.180		42.282		259.376	263.998
	0.010		2.564	5.973	6.177
58.170		39.718		253.403	257.821
	0.010		2.504	5.916	6.118
58.160		37.214		247.487	251.703
	0.010		2.446	5.858	6.058
58.150		34.768		241.629	245.645
	0.010		2.387	5.801	5.999
58.140		32.381		235.829	239.646
	0.010		2.330	5.743	5.940
58.130		30.051		230.085	233.706
	0.010		2.272	111.383	111.577
58.120		27.779		118.702	122.129
	0.010		1.173	2.883	2.991
58.110		26.606		115.819	119.138
	0.010		1.144	2.850	2.957
58.100		25.462		112.970	116.181
	0.010		1.116	2.817	2.922
58.090		24.347		110.153	113.258
	0.010		1.088	2.784	2.888
58.080		23.259		107.369	110.370
	0.010		1.060	2.750	2.854
58.070		22.199		104.619	107.516
	0.010		1.033	2.717	2.820
58.060		21.167		101.901	104.697
	0.010		1.006	2.684	2.785
58.050		20.161		99.217	101.911
	0.010		0.979	2.651	2.751
58.040		19.182		96.566	99.160
	0.010		0.953	2.618	2.717
58.030		18.230		93.948	96.443
	0.010		0.927	2.585	2.683
58.020		17.303		91.363	93.761
	0.010		0.901	2.552	2.648
58.010		16.402		88.811	91.113
	0.010		0.875	2.519	2.614
58.000		15.527		86.292	88.499
	0.010		0.850	2.486	2.580
57.990		14.676		83.807	85.919
	0.010		0.826	2.453	2.545
57.980		13.851		81.354	83.373
	0.010		0.801	2.419	2.511
57.970		13.049		78.935	80.862
	0.010		0.777	2.386	2.477
57.960		12.272		76.549	78.385
	0.010		0.754	2.353	2.443
57.950		11.518		74.195	75.943
	0.010		0.730	2.320	2.408
57.940		10.788		71.875	73.534
	0.010		0.707	2.287	2.374
57.930		10.081		69.588	71.160
	0.010		0.685	2.254	2.340

57.920		9.396		67.334	68.820
	0.010		0.662	2.221	2.306
57.910		8.734		65.114	66.515
	0.010		0.640	2.188	2.271
57.900		8.094		62.926	64.244
	0.010		0.618	2.155	2.237
57.890		7.475		60.771	62.007
	0.010		0.597	2.121	2.203
57.880		6.878		58.650	59.804
	0.010		0.576	31.827	31.907
57.870		6.302		26.823	27.896
	0.010		0.265	0.644	0.678
57.860		6.037		26.178	27.218
	0.010		0.259	0.637	0.671
57.850		5.778		25.541	26.547
	0.010		0.252	0.630	0.663
57.840		5.526		24.911	25.884
	0.010		0.246	0.623	0.656
57.830		5.280		24.287	25.228
	0.010		0.240	0.616	0.648
57.820		5.040		23.671	24.580
	0.010		0.234	0.609	0.641
57.810		4.807		23.062	23.939
	0.010		0.228	0.602	0.634
57.800		4.579		22.460	23.305
	0.010		0.222	0.595	0.626
57.790		4.358		21.866	22.679
	0.010		0.216	0.588	0.619
57.780		4.142		21.278	22.060
	0.010		0.210	0.581	0.611
57.770		3.932		20.697	21.449
	0.010		0.204	0.573	0.604
57.760		3.728		20.124	20.845
	0.010		0.198	0.566	0.596
57.750		3.529		19.558	20.249
	0.010		0.193	0.559	0.589
57.740		3.337		18.998	19.660
	0.010		0.187	0.552	0.581
57.730		3.149		18.446	19.079
	0.010		0.182	0.545	0.574
57.720		2.968		17.901	18.505
	0.010		0.176	0.538	0.566
57.710		2.791		17.363	17.939
	0.010		0.171	0.531	0.559
57.700		2.620		16.832	17.380
	0.010		0.166	0.524	0.552
57.690		2.455		16.308	16.828
	0.010		0.160	0.517	0.544
57.680		2.294		15.792	16.284
	0.010		0.155	0.510	0.537
57.670		2.139		15.282	15.747
	0.010		0.150	0.503	0.529

57.660	1.989	14.779	15.218	
0.010	0.145	0.495		0.522
57.650	1.843	14.284	14.696	
0.010	0.140	0.488		0.514
57.640	1.703	13.796	14.182	
0.010	0.136	0.481		0.507
57.630	1.567	13.314	13.675	
0.010	0.131	0.474		0.499
57.620	1.437	12.840	13.176	
0.010	0.126	0.467		0.492
57.610	1.311	12.373	12.684	
0.010	0.121	0.460		0.484
57.600	1.189	11.913	12.200	
0.010	0.117	0.453		0.477
57.590	1.072	11.461	11.723	
0.010	0.112	0.446		0.470
57.580	0.960	11.015	11.253	
0.010	0.108	0.439		0.462
57.570	0.852	10.576	10.791	
0.010	0.104	0.432		0.455
57.560	0.748	10.145	10.336	
0.010	0.099	0.424		0.447
57.550	0.649	9.720	9.889	
0.010	0.095	0.417		0.440
57.540	0.554	9.303	9.450	
0.010	0.091	0.410		0.432
57.530	0.463	8.893	9.017	
0.010	0.087	0.403		0.425
57.520	0.376	8.490	8.592	
0.010	0.083	0.396		0.417
57.510	0.293	8.093	8.175	
0.010	0.079	0.389		0.410
57.500	0.214	7.705	7.765	
0.010	0.075	0.382		0.402
57.490	0.139	7.323	7.363	
0.010	0.071	0.375		0.395
57.480	0.068	6.948	6.968	
0.010	0.068	6.948		6.968
57.470	0.000	0.000	0.000	
12.970	0.000	0.000		0.000
44.500	0.000	0.000	0.000	

Polygon plan area = 1124.310

Maven Associates		Job Number 411001	Sheet 1	Rev: A A
Job Title: Harlow Lifestyle Village Calc Title: Pre-development - Catchment F1		Author AP	Date 18/09/2026	Checked

Discharg SW Basin F **Previous Ratio** 100%
Total Cat 8400 m² **Imprevious Ratio** 0%

1. Runoff Curve Number (CN) and initial Abstrac 74.0 CALCS to WRC TR2020/06

Soil name and classification	ID	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C		Pervious (100%)	74	0.84	62.16
C		Impervious (0%)	98	0.00	0.00
					0.00
			Totals =	0.84	62.16

CN (weighted) = total product / total area = 62.16 / 0.840 = **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

Sheet and Shallow Flow
$T=100nL^{0.33}/S^{0.2}$
L= 264 m
S= 5.890 %
n= 0.035
T= 15.459 mins

Concentrated Network Flow: 0

Open Channel Flow $V=R^{2/3}S^{1/2}/n$
R= A / Wp 0.33
w= 1 n= 0.035
d= 1 s= 2%
l= 175
V= 1.893337 m/s
T= 1.54 mins

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

= 15.46 + 0.00 + 1.54 = 16.999 mins
0.2833191 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.190 hrs

OK use **0.19** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 411001	Sheet 2	Rev: A A
Job Title Calc Title	Harlow Lifestyle Village Pre-development- Catchment F1	Author AP	Date 18/09/2026	Checked

Discharg SW Basin F

	Catchment Area	A=	0.0084	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=	0.28	hrs (from worksheet 1)

P

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	yr
4.	24 hour rainfall depth, P24 *as per HIRDS Historical data	28.7	(mm)	86	132	203	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.100		0.302	0.408	0.521	
6.	Specific peak flow rate q*	0.031		0.085	0.108	0.128	
7.	Peak flow rate, $q_p=q*A*P_{24}$	**0.008**	m^3/s	**0.061**	**0.119**	**0.218**	m^3/s
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	5.2		38.9	75.0	137.0	
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	43	m^3	**327.01**	**630.28**	**1150.55**	m^3

Worksheet 2: Graphical Peak Flow Rate

Maven Associates		Job Number 411001	Sheet 3	Rev: A A
Job Title: Harlow Lifestyle Village Calc Title: POST-development - Catchment F1		Author AP	Date 18/09/2026	Checked

Discharg SW Basin F **Previous Ratio** 30%
Total Cat 8400 m² **Imprevious Ratio** 70%

1. Runoff Curve Number (CN) and initial Abstrac 74 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 (30%)	79	0.25	19.91
C		Impervious (70%)	98	0.59	57.62
					0.00
			Totals =	0.84	77.53

CN (weighted) = total product / total area = 77.53 / 0.840 = **92.3**

S= (1000/CN - 10) * 25.4 = (1000/92.3 - 10) *25.4 = **21.2** mm

Ia= 0.05*S = 0.05x 21.2 = **1.1** mm

2. Time of Concentration

Sheet and Shallow Flow $T=100nL^{0.33}/S^{0.2}$
L= 234 m
S= 1.360 %
n= 0.015
T= 8.535 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= 500
(to be completed at detail design)
V= 0.8498537 m/s
T= 0.00 mins

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

= 8.535 + 0.00 + 0.00 = 8.535 mins
0.1422569 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.000 hrs

NO GOOD use **0.17** hrs

Worksheet 1: Runoff Parameters and Time of Concentration

Maven Associates		Job Number 411001.00	Sheet 4	Rev: A A
Job Title Calc Title	Harlow Lifestyle Village Post-development	Author AP	Date 18/09/2026	Checked

Discharg SW Basin F

	Catchment Area	A=	0.0084	km2(100ha =1km2)	
	Runoff curve number	CN=	74.0	(from worksheet 1)	
	Initial abstraction	Ia=	1.1	mm (from worksheet 1)	
	Time of concentration	tc=	0.14	hrs (from worksheet 1)	
2.	Calculate storage, S =(1000/CN - 10)25.4		=	89 mm	

P

		WQV					
3.	Average recurrence interval, ARI	1/3 of 2yr	(yr)	2	10	100	yr
4.	24 hour rainfall depth, P24 *as per HIRDS Historical data	28.7	(mm)	86	132	203	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.129		0.320	0.421	0.530	
6.	Specific peak flow rate q*	0.040		0.089	0.110	0.129	
7.	Peak flow rate, $q_p=q*A*P_{24}$	**0.010**	m^3/s	**0.064**	**0.122**	**0.220**	m^3/s
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	6.5		41.4	77.9	140.0	
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	55	m^3	**347.94**	**654.10**	**1176.41**	m^3

Worksheet 2: Graphical Peak Flow Rate