

SOUTHERN LINKS 1
INDUSTRIAL DEVELOPMENT
STORMWATER ASSESSMENT REPORT

PROJECT INFORMATION

PROJECT	298002
---------	--------

DOCUMENT CONTROL

DATE OF ISSUE	07/09/2026
---------------	------------

REVISION	A
----------	---

AUTHOR	
--------	--

A handwritten signature in black ink, appearing to read 'Sean McDonald'.

Sean McDonald
Team Leader

REVIEWED BY	
-------------	--

A handwritten signature in black ink, appearing to read 'Min Shon'.

Min Shon
Team Leader

APPROVED BY	
-------------	--

A handwritten signature in blue ink, appearing to read 'Dean Morrison'.

Dean Morrison
Regional Director

© Maven Waikato Ltd
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
New Zealand
Phone 07 242 0601
www.maven.co.nz

Table of Contents

1.	Statement of Experience	4
2.	Executive summary	5
2.1.	Purpose and Context	5
2.2.	Design Philosophy and Statutory Framework	5
2.3.	Flood Modelling and Downstream Effects	5
2.4.	Conclusion	6
3.	Introduction	7
3.1.	Overview	7
3.2.	Site	7
3.3.	Catchment	8
3.4.	Objectives	8
4.	Industrial Development	10
5.	Statutory Context	11
5.1.	WAIKATO REGIONAL POLICY STATEMENT (RPS)	11
5.2.	WAIKATO REGIONAL PLAN	12
5.3.	COMPREHENSIVE CITY-WIDE DISCHARGE CONSENT	12
5.4.	WAITAWHIRIWHIRI & CITY CENTRE INTEGRATED CATCHMENT MANAGEMENT PLAN (DRAFT MARCH 2026)	13
5.5.	HAMILTON CITY COUNCIL CODE OF PRACTICE FOR SUBDIVISION AND LAND DEVELOPMENT	14
6.	Existing Catchment	16
7.	Design Approach	18
7.1.	DESIGN PARAMETERS	18
7.2.	HYDRAULIC CONNECTIVITY	19
8.	Stormwater Assessment	22
8.1.	RETENTION OF INITIAL ABSTRACTION	22
8.2.	TREATMENT TRAIN	24
8.3.	STORMWATER QUALITY AND QUANTITY	25
8.4.	ARTIFICIAL WETLANDS	25
8.5.	FOREBAY	28
8.6.	WETLAND OUTLET AND OVERFLOW STRATEGY	29
8.7.	STORMWATER CULVERTS	29
8.8.	WETLAND DISCHARGE SUMMARY	30
9.	Flooding	32
9.1.	MODELLING SUMMARY AND METHODOLOGY	32
9.2.	EXISTING/PRE DEVELOPMENT FLOODING WITHIN SL1	33
9.3.	POST DEVELOPMENT FLOODING	34
9.4.	DOWNSTREAM FLOOD MITIGATION SOLUTIONS	36
9.4.1.	MINIMUM FLOOR LEVELS	36
10.	Overland Flow paths	37
11.	Conclusions	39
	Appendix A – Stormwater Plans (Refer to Infrastructure Report Package)	40
	Appendix B – HEC-RAS Results (100year Assessment)	41

1. Statement of Experience

Author

My name is Sean McDonald. I am a Senior Engineer and Team Leader at Maven Waikato Ltd (“Maven”), a firm of consulting engineers and surveyors based in Hamilton. I have been employed by Maven since 2025. I hold a Bachelor of Engineering Technology (Highways) which I graduated from in 2006, hold a New Zealand Certificate of Engineering “Civil” (NZCE) and I am a member of Engineering New Zealand.

I have over 29 years of experience in the field of civil engineering including as a civil engineering technician, New Zealand army engineer, council engineer and consulting engineer, with over 20 years’ of experience post degree. Since obtaining my degree I have worked on a variety of civil projects including State Highway works, 3 Waters Infrastructure works, Residential Land Development, Commercial and Industrial Land Development and major Infrastructure projects such as the upgrade of the Port Boteny (Sydney) Naphtha Storage Facilities, the Transpower upgrade and extension of the Whakamuru Substation, the Central Government Rotorua Youth Justice Facility and Contact Energy’s new Tauhara Geothermal power station.

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 decision-maker 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.

Reviewer

I am Min Shon, a Senior Civil Engineer and Team Leader at Maven Waikato Ltd. I hold a Master of Civil Engineering from the University of Auckland and am a Chartered Professional Engineer (CPEng) registered with Engineering New Zealand. 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 decision-maker 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 Assessment Report (SAR) supports the resource consent application for the Southern Links 1 – Industrial Development, an approximately 60-hectare greenfield site located in the greater Southern Links 1 Growth Cell to the south of Hamilton City, located in the Waipā District, delivering approximately 22 industrial lots of varying industrial lot sizes. The SAR has been prepared in accordance with Waikato Regional Council (WRC) guidelines, the Regional Infrastructure Technical Specifications (RITS V2, 2025) and the Hamilton City Council Draft Waitawhiriwhiri Integrated Catchment Management Plan (ICMP) and accompanies the Substantive Application under the Fast-Track Approvals Act 2024.

The site sits within the Waitawhiriwhiri catchment and is interspersed with several straight artificial farm drains. The site overall geology consists of low-lying areas comprised of Holocene peat deposits, with the peat being underlain by interbedded Silts and Sands of the Late Pleistocene alluvial deposits of the Hinuera formation.

2.2. Design Philosophy and Statutory Framework

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

The core design targets are:

- Retention of the pre-development initial abstraction depth (10 mm) via on-lot retention and/or soakage;
- Water quality treatment through a treatment train achieving 75% TSS removal;
- Extended detention of the Water Quality Volume ($1.2 \times \text{WQV}$ over 24 hours);
- Attenuation of the 2-year and 10-year ARI events to pre-development discharge rates and
- Attenuation of the 100-year ARI climate change event to no more than 80% of pre-development discharge.

2.3. Flood Modelling and Downstream Effects

A comprehensive 2D flood model was developed using HEC-RAS, with hydrology generated in HEC-HMS using the SCS Curve Number method. The model extends from the upstream contributing catchments through the development site to the downstream Hamilton City Council drainage network, 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 all assessed sections under the 2-year, 10-year and 100-year climate change events.

Catchment	PRE Development Flows (m ³ /s)			POST Development Flows (m ³ /s)		
	2YR	10YR	100YR	2YR	10YR	100YR
A	0.140	0.2803	0.5339	0.061	0.081	0.3783
C	0.113	0.2265	0.4316	0.031	0.5428	0.8479
D	0.312	0.6274	1.1998	0.293	0.383	0.6975
E	0.695	1.3961	2.6704	0.691	0.98	1.6495
	1.2603	2.5303	4.8357	1.076	1.9868	3.5732

Table 1 – Pre & Post Development Flows

The results indicate that the proposed wetland systems are capable of achieving substantial attenuation of post-development runoff prior to discharge into the existing drainage network.

2.4. Conclusion

The SL1 – Industrial Development SAR provides a assessment of the regulatory requirements and objectives that form the basis of the integrated stormwater management framework philosophy for the proposed development, and to demonstrate the impact of the flood modelling both pre and post development for that integrated stormwater management framework.

Hydraulic modelling confirms that post-development peak discharges are reduced relative to pre-development conditions across all design events, and overland flow paths safely convey extreme events within road corridors.

Ongoing engagement with WRC, HCC, WDC and local Iwi will allow the final stormwater strategy to be refined further at detailed design if required. These ongoing engagements are not considered impediments to the feasibility of the stormwater strategy, rather an opportunity to ensure the final details of the implementation of the stormwater strategy serve the wider area stormwater management goals and culture values.

3. Introduction

3.1. Overview

This Stormwater Assessment Report (SAR) outlines the regulatory and technical requirements, the objectives that form the basis of the integrated stormwater management framework and also assesses the flooding impacts both pre and post development of that integrated stormwater management framework and the associated effects for the proposed development that supports the resource consent for the SL1 – Industrial Development.

This SAR is intended to be read in conjunction with the Stormwater Management Plan (SMP) that provides more detailed information on the technical aspects of the SAR stormwater management philosophy and demonstrates how the stormwater-related resource consent conditions will be implemented and complied with during the development of the site.

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

3.2. Site

The SL1 – Industrial area is a circa 60ha block of land within the Waipa District and it is contiguous with Hamilton City Council’s southwestern boundary. The current site access is through Higgins Road and Wickham Street in Hamilton. The site adjoins with the Frankton Industrial area to the north, KiwiRail Corridor to the east and the remainder of the site is surrounded by agricultural land. The site is utilised for pastoral grazing, with land cover comprising maintained grassland consistent with agricultural use, with some gravel “parking” and “storage” areas of Wickham Street and uncontrolled fill stockpile area in the northwest corner, adjacent to the KiwiRail Corridor.

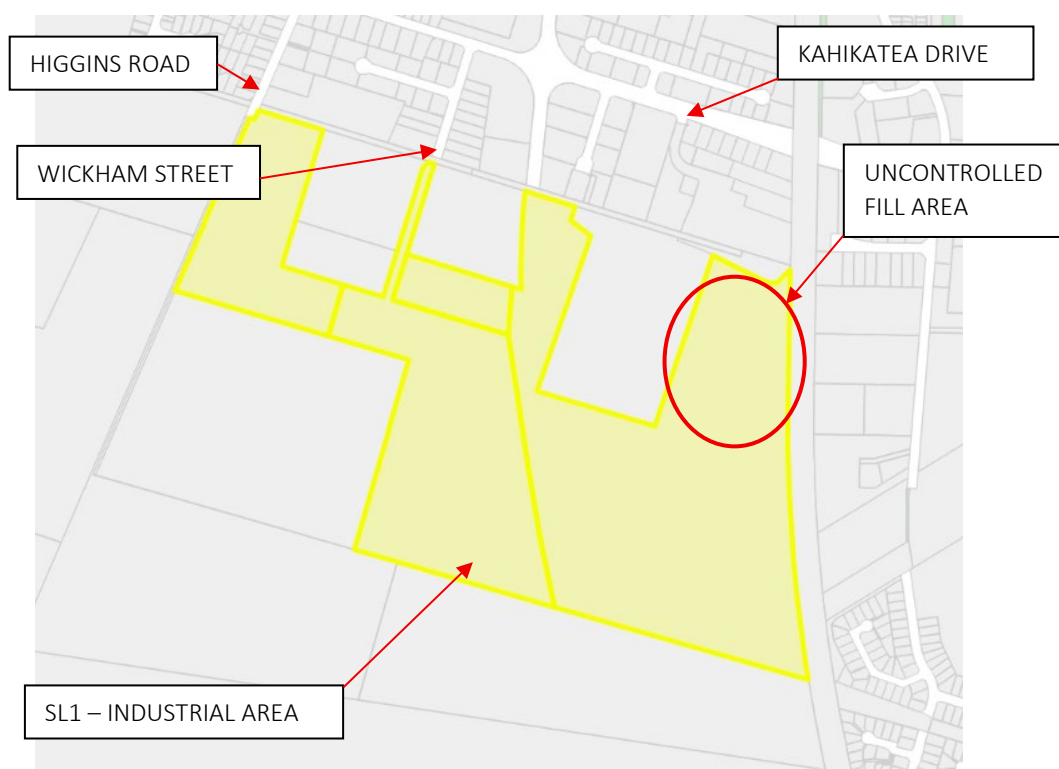


Figure 1: Site Locality

3.3. Catchment

The Project forms a part of wider SL1 area. The SL1 area is a circa 500ha block of land within Waipa District. The Industrial Development area has a northwest to southeast orientation from Higgins Road in the northwest to the KiwiRail Corridor to the southwest and borders the HCC boundary to the north and west. The SL1 – Industrial Development encompasses approx. 60ha of land. Most of the catchment is low-lying flat farmland, interspersed with straight artificial farm drains and connects to the HCC drainage network to the north which discharges into the Waitawhiriwhiri drainage network.

3.4. Objectives

As part of the structure plan process, an overarching SAR has been developed for SL1 – Industrial Development. The SAR prepared 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 SAR 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 SL1 – Industrial Development.

Proposed objectives of the SAR are outlined below:

- Consideration of future public networks required in support of SL1 – Industrial Development. The report confirms discharge location and provides a design methodology which will guide future development of the area.
- Existing waterways are identified and investigated. Parameters are set which will ensure protection of existing waterway environments in future development.
- Existing overland flow paths identified and investigated. Design parameters are set which will ensure existing overland flow paths 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 SAR provides an option-based assessment for water quality treatment in support of the future development of SL1 – Industrial 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 the future development of SL1-Industrial 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) for SL1 – Industrial Development.
- 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.
- The urbanisation of SL1 – Industrial Development presents an opportunity to provide significant ecological improvements through the protection and planting of riparian margins. Recommendations are made to guide future Change application(s) to ensure positive environmental outcomes are achieved.

- Groundwater recharge to areas thereby maintaining water tables and preventing dewatering.
- Information gaps which require further investigation and/or detailed design are identified.

The overall SAR creates a stormwater toolkit, which will guide future development of SL1 – Industrial Development. The toolkit will promote sustainable solutions including the integration of Water Sensitive Urban Design (WSUD') principles in future land use planning.

4. Industrial Development

The wider SL1 area comprises both residential and industrial development areas; however, this SAR relates solely to the Industrial area only. The Industrial Development area has been subdivided into several stormwater catchments and sub-catchments to support the assessment of stormwater quality, quantity, hydraulic connectivity, and flood management requirements.

This SAR provides further details of the proposed Industrial Development, and the stormwater strategies to meet regulatory requirements, RITS and ICMP.

Spanning approximately 60 ha, the SL1 – Industrial area includes circa 22 industrial lots of varying industrial lot sizes together with infrastructure devices including wetlands and roading.

The key feature of the development is integrated stormwater treatment train approach utilising wetland, forebays, roadside swales and piped infrastructure to convey and attenuate overflows from the road and lot areas releasing at 80% of pre-development flows into the Waitawhiriwhiri drainage network. Lot areas will be treated via a combination of “at source” and within artificial stormwater wetlands, while road impervious areas are to be treated via a combination of grass lined swales and artificial stormwater wetlands. Stages, Costs and Operation and Maintenance plan are further described in Stormwater Management Plan (SMP).

5. Statutory Context

Future stormwater discharge from SL1-Industrial Development 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. WAIKATO REGIONAL POLICY STATEMENT (RPS)

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

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

Central to the outcomes sought within the RPS is the protection and enhancement of freshwater ecosystems. The following lists key Waikato RPS high-level objectives relevant to this SAR and the future management of stormwater within SL1.

Relevant objectives include:

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

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

This SAR supports achievement of the above Waikato RPS objectives. It integrates land-use and three-waters planning within SL1 – Industrial Development. The SAR identifies the three-waters infrastructure necessary to accommodate urban growth, whilst giving effect to the relevant development principles, to ensure the freshwater ecosystem is protected and improved through urbanisation.

5.2. WAIKATO REGIONAL PLAN

The Waikato Regional Plan is the principal policy tool that enables Waikato Regional Council to conduct its functions to achieve the sustainable management of resources within the Region. With respect to this SAR, 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 of SL1-Industrial Development will need to be supported by resource consents from Waikato Regional Council under the Waikato Regional Plan. Such activities which would trigger consents are listed below:

1. Vegetation clearance and earthworks – including for management of sediment-laden runoff and dust.
2. Diversion and discharge of stormwater into water or onto or into land, including management of contaminants.

5.3. COMPREHENSIVE CITY-WIDE DISCHARGE CONSENT

Hamilton City Council holds a comprehensive city-wide stormwater consent ('CSDC') which allows for multiple discharges in multiple catchments. The CSDC authorises the diversion and discharge of stormwater from developed areas within Hamilton City existing at the commencement of the consent in 2012. This consent has stringent conditions relating to stormwater quality and quantity effects downstream of this proposal. It is anticipated that SL1- Industrial Development will be enveloped by the CSDC if brought into Hamilton City. As such, the development of a future ICMP/SMP based off this document will ensure compliance with the Council's CSDC.

The CSDC will authorise any new stormwater diversion and discharge activities established after 2012, if the Waikato Regional Council certifies they comply with the consent's conditions.

To achieve such certification, any new stormwater diversion and discharge activity in SL1 must meet these two tests:

- 1) It must be consistent with the conditions of the CSDC; and
- 2) Either:
 - a) Where it is in a greenfield area, it must be consistent with an ICMP; or
 - b) Where it is to be established in an existing urbanised area, it must not increase peak discharge rates or flow volumes in the receiving water body above those that would have occurred when the CSDC was granted in 2012, unless it is demonstrated that any such increases will have no adverse effects.

New stormwater diversion and discharge activities established in developing catchments that are not consistent with Catchment Management Plans will remain as single site resource consents. i.e., the CSDC will not authorise them.

This SAR has been prepared on the basis that the future discharge consents will be sought in compliance with the CSDC, and the consents will be transferred to Council, alongside the constructed stormwater infrastructure.

5.4. WAITAWHIRIWHIRI & CITY CENTRE INTEGRATED CATCHMENT MANAGEMENT PLAN (DRAFT MARCH 2026)

Hamilton City Council has prepared a draft ICMP for the Waitawhiriwhiri Stream Catchment, to which SL1-Industrial Development falls within. The Waitawhiriwhiri Stream Catchment is in the southwest of Hamilton, with the Waitawhiriwhiri hydrologic catchment headwaters originate in the Rukuhia Swamp which borders the HCC jurisdictional area to the west. Catchment delineation is somewhat arbitrary in this area due to the presence of the extensive farm drainage system which does not always align with hydrologic catchment boundaries. In the upper reaches, the Waitawhiriwhiri catchment is bounded to the north by a defined ridgeline which follows Tuhikaramea Road at the western extent of the catchment, and Wallace Road further east. The eastern boundary of the upper catchment is defined by higher areas within the Rukuhia Swamp.



Figure 3: ICMP Catchment Boundaries

The preparation of this SAR has been developed in accordance with the draft ICMP, as the future stormwater management within SL1 – Industrial Development will need to remain consistent with any approved ICMP. The primary outcomes envisaged within any approved ICMP are summarised below:

1. Water quality in a treatment train (two or more treatment devices in series).
2. The final treatment device is to be artificial stormwater wetlands which will also conduct 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. 100-year ARI peak flow attenuation (80% pre-development flow) to reduce erosion potential resulting from increased runoff from development
6. Retention of the first 10mm of stormwater, and/or the initial abstraction volume required for new Road surfaces.
7. Retention of On-lot predevelopment initial abstraction depth is required as per WRC stormwater Management Guidelines.
8. Utilisation of soakage for stormwater disposal where practical to replenish groundwater and minimise runoff volume.

5.5. HAMILTON CITY COUNCIL CODE OF PRACTICE FOR SUBDIVISION AND LAND DEVELOPMENT

The RITS sets 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 requires 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 ascribe the term “hierarchy” to this list of measures, it does not provide 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.

CRITERIA	DESIGN PARAMETER	WHEN REQUIRED
Water quality treatment ¹²	Refer to the stormwater management disposal hierarchy (section 4.2.3.1) and treatment devices hierarchy (section 4.2.16) 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 phosphorus and ammoniacal nitrogen) to achieve maximum practical removal rates.	Always.

Figure 4: Excerpts from RITS specifies Water Quality Standards.

In addition, stormwater quantity control standards specified in RITS table 4-3 are to be complied with which includes:

- Extended Detention for WQV (1/3 of 2-year ARI storm) – a 1.2 factor is to be applied to the WQV volume/Storage as per Table 48: Minimum device design summary in RITS.
- 2-year ARI storm – Attenuation back to pre-development flow is required.
- 10-year ARI storm – Attenuation back to pre-development flow is required.
- 100-year ARI storm – Attenuation back to 80% predevelopment flow is required.

6. Existing Catchment

Most of the catchment for the Industrial Development is low-lying flat farmland, interspersed with straight artificial farm drains and connects to the HCC drainage network to the north which discharges into the Waitawhiriwhiri drainage network.

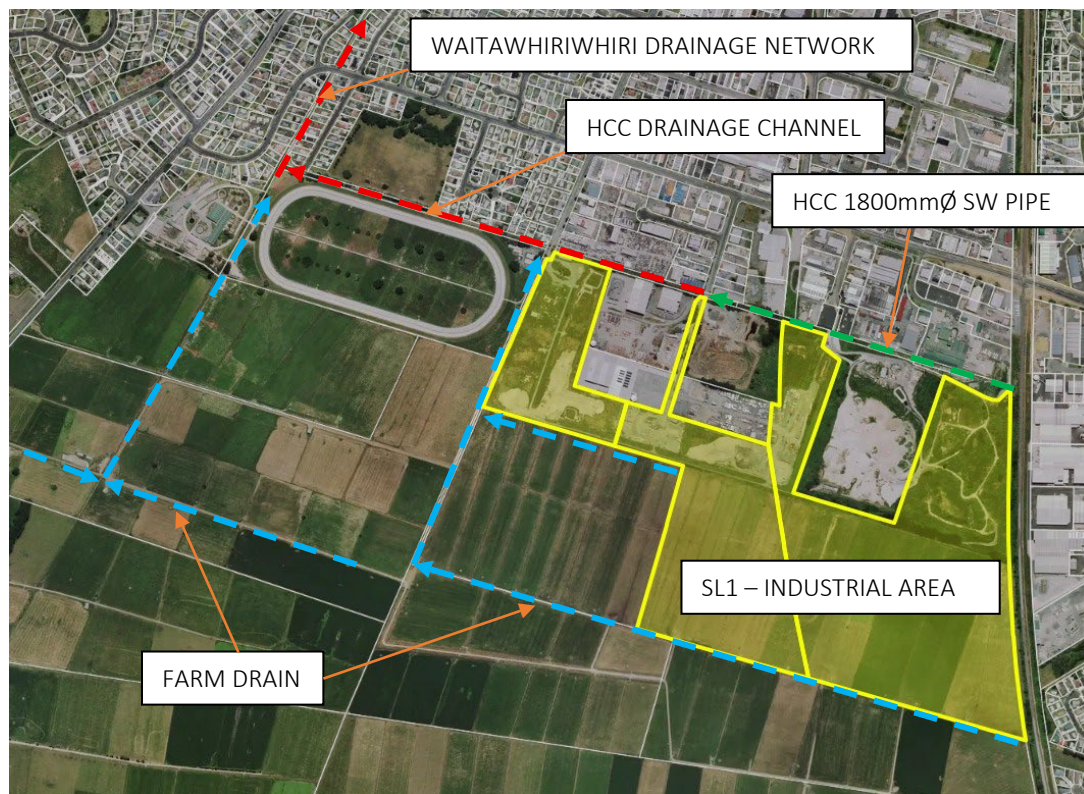


Figure 5: Existing Drainage Network

The catchment above has been delineated using HEC-HMS V3.12 based on a 1m grid from LINZ data as detailed below.

The existing catchment comprises a combination of local site runoff and significant upstream contributing catchments draining through the Waitawhiriwhiri Stream and associated drainage channels. Understanding these existing flow paths and discharge locations is critical to ensuring future development does not adversely affect upstream or downstream flooding. Accordingly, catchment delineation and hydrological modelling were undertaken to establish baseline flow conditions and inform the proposed stormwater management strategy.

Existing flows through HEC-HMS software were established with aid of TR20 Sheets, see below table that summarises it. these flows are directly discharging into the stream. Note external discharges into the surrounding area are ignored considering the proposing to discharge into the existing drain. Note also that discharge from upstream catchment is not included in the table 2 below.



Table 2 – Catchments Pre Development

Table 3 – Pre Development Flows

7. Design Approach

The project seeks to allow for the conveyance of stormwater through the site and discharge at target rate as summarized below.

- 10mm Initial abstraction – Retention tanks (Stage 1A Lots) and Soakage (via Roadside Swales and/or unlined Wetland Ponds) to provide the overall site retention.
- WQV for Treatment - Wetlands for Treatment refer to sections for table allows for treatment as per RITS
- ED – Wetlands to provided extended Detention refer to table as per RITS
- 2-year and 10-year - to be conveyed through pipe system and be attenuated within the proposed artificial wetlands.
- 100-years, to be conveyed through road corridors and discharged into the proposed artificial wetlands to undergo attenuation of flow to 80% Predevelopment.

7.1. DESIGN PARAMETERS

Rainfall information from the NIWA High Intensity Rainfall Design System V4 (HIRDS) has been used for the site location including an allowance for climate change.

The design shall be based on the following parameters.

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

Table 4 – HIRDS hydrology Data

Rainfall Event	Historical Rainfall Depth	RCP 8.5 Rainfall Depth	RCP8.5 Rainfall Intensity
2 Year ARI	65.6mm	84mm	-
WQV		28mm	-
10 Year ARI	99.2mm	131mm	137mm/hr
100 Year ARI	152mm	204mm	-

Table 5 – CN Values

Scenario	Impervious (CN)	Pervious (CN)
Pre Development	N/A	74
Post Development (Catchment A & C)	98	74
Post Development (Catchment B)	89.8	74

The proposed Industrial Area has assumed the following = 85% impervious and 15% pervious as per the Hamilton City Council District Plan and RITS standards for Industrial Areas.

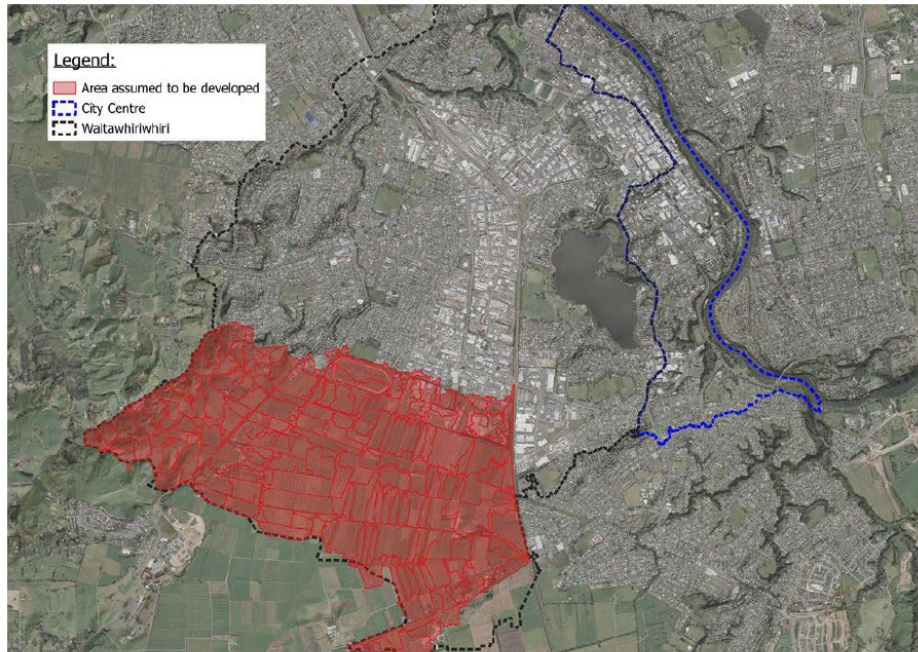


Figure 47 – Area of Upper Catchment Assumed to be Developed Under the Greenfield Development Scenario

Figure 9: ICMP Excerpt Showing Assumed Upper Catchment Development

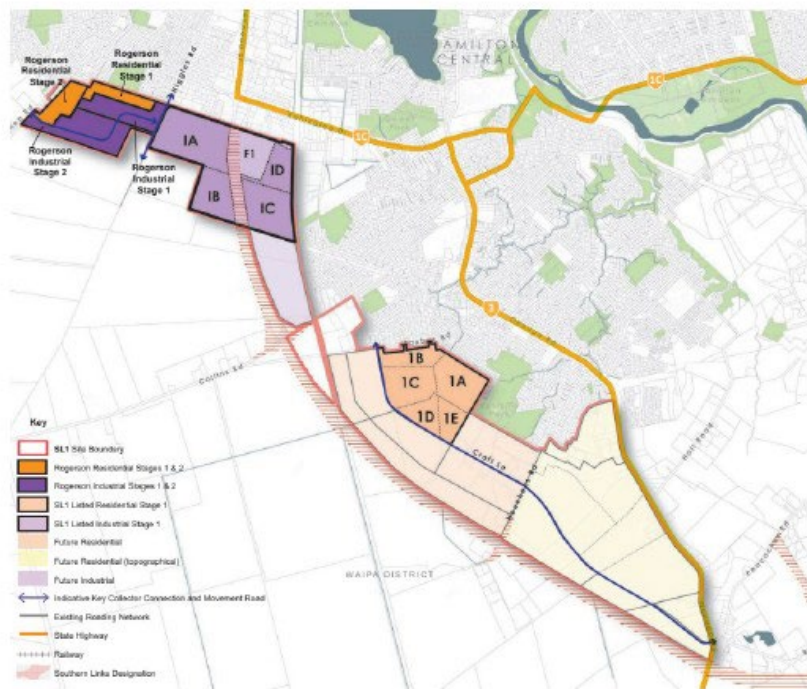


Figure 8 – SL1 Proposed Future Growth Area

Figure 10: ICMP Excerpt Showing Proposed SL1 Future Growth Area

7.2. HYDRAULIC CONNECTIVITY

Hydraulic connectivity across the site is maintained through construction of a new swale along the western side of the proposed Higgins Road extension that will maintain the connection for the farm

drain network to the south to the HCC drainage channel along the northern edge of the proposed development. It is noted that this will be included in the neighbouring proposed development and will require landowner approval to construct. Proposed artificial stormwater wetland systems will discharge into either the HCC drainage channel and/or SW Piped Infrastructure (wetland ponds 1 and 3) or to the existing farm drains to the south (wetland pond 2). The roadside swales, stormwater piped infrastructure and artificial wetland ponds have been integrated into the drainage network to ensure flood conveyance and stormwater attenuation objectives are achieved without adversely affecting upstream or downstream hydraulic conditions.

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

- Wetlands, Forebay and spillway
- On-lot stormwater Retention through tanks with overflow into the primary system.
- Planting of riparian areas if applicable

The Water Quality Volume (WQV) is treated at either at source for on Lot areas, or within the wetland ponds (refer to table 1, section 1.2 for more details). Overflows above the 2-year ARI cc event are directed to Wetlands. Existing runoff route is to be maintained with minimal impervious runoff being added. The proposed stormwater solution ensures stormwater is being treated before discharging into the receiving environment.

The General Layout and approach for stormwater design throughout the site is as shown below.

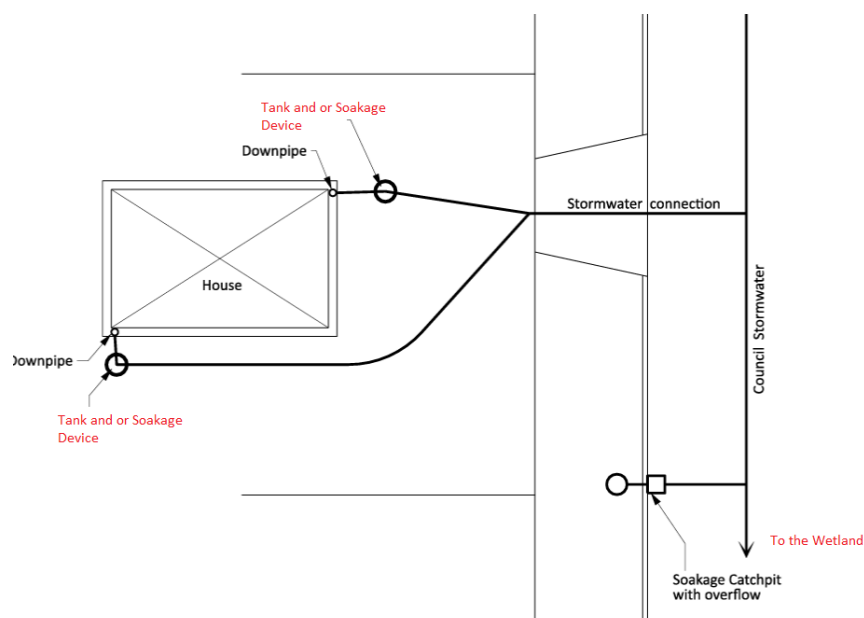


Figure 11: RITS excerpt. D4.5 Drawing with Added Mark up for Conceptual Purposes

On-lot stormwater soakage or rainwater harvesting tanks will be utilized to manage stormwater from roofs, accessways and parking areas for the Industrial Lots located within Stage 1A.

Retention of the first 10mm of stormwater, and/or the initial abstraction volume required for new Road surfaces will be provided through soakage (via Roadside Swales and/or unlined Wetland Ponds).

Artificial wetlands are proposed to provide treatment and attenuation/storage for the required flows as specified in the RTIS and ICMP prior to entering the Existing Council/Farm drain networks.

8. Stormwater Assessment

The proposed stormwater management system has been developed in accordance with the relevant objectives and recommendations of the Waitawhiriwhiri (Draft) Integrated Catchment Management Plan (ICMP). In particular, the ICMP identifies the need for new development to manage stormwater quality and quantity at source, retain initial runoff to reduce stream erosion, provide extended detention and attenuation for larger developments, incorporate stormwater treatment, and provide flood storage where required to avoid increasing downstream flood risk.

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 drainage channel culvert crossings, and provision of wetlands and stormwater storage areas throughout the development.

Initial abstraction requirements will be achieved through distributed on-lot retention tanks provided for each industrial lot located within Stage 1A or through soakage (via Roadside Swales and/or unlined Wetland Ponds). The proposed tank provision exceeds the required 10 mm retention volume and forms the first component of the overall stormwater treatment train.

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

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, while wetlands and associated storage areas provide attenuation and flood mitigation from the proposed site. 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.

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 of the Waitawhiriwhiri (Draft) ICMP.

8.1. RETENTION OF INITIAL ABSTRACTION

The Waitawhiriwhiri (Draft) ICMP and RITS requires retention of the initial abstraction volume generated by development. This may be achieved through retention of the first 10 mm of rainfall from impervious surfaces or by retaining a volume equivalent to the pre-development initial abstraction.

To ensure a conservative design approach, the 10 mm retention criterion has been applied throughout the development. Based on the contributing catchment areas for each development stage, the total required retention volume is estimated at approximately 5,077.71 m³. For comparison, the equivalent pre-development initial abstraction volume is estimated at 812.43m³. As the 10 mm retention requirement represents the more onerous criterion, it has been adopted as the design basis for the development.

Table 6 – Catchment Retention Volume

Catchment	Area - Catchment (m ²)	Retention Volume 10mm (m ³)	Retention Volume 1.6mm (m ³)
A (3)	207800	2078	332.48
B (2)	163100	1631	260.96
C (1)	36100	361	57.76
Stage 1 A (Lots)	100771	1007.71	161.23
		5,077.71	812.43

Retention of the required volume will be achieved by providing on-lot retention tanks for each industrial lot in Stage 1A. As per Hamilton City Council's Plan Change 12 (Three Waters Rules), retention tanks are proposed for each lot within Stage 1A, Table 6 and 7 summarises the required and proposed retention volumes for each development stage.

The proposed tank strategy provides approximately 102.29m³ of additional retention volume above the required 10 mm retention volume, demonstrating compliance with the ICMP retention requirements. By retaining runoff at the source, the tanks reduce the volume of stormwater entering the downstream conveyance network and support the overall treatment-train approach adopted for the development.

Overflow from the retention tanks will discharge to the downstream stormwater network once the available storage volume has been exceeded. Subsequent treatment, detention, and attenuation will be provided through the propose on-lot tanks, wetlands, diversion channels, and associated stormwater infrastructure located throughout the development.

Table 7 – Stage 1A Retention Volume Requirement

Lot	Area - Catchment (m ²)	Retention Volume 10mm (m ³)	Number 30m ³ Storage Tanks Required
1	7738	77.38	3
2	10699	106.99	4
3	13489	134.89	5
4	11563	115.63	4
5	6583	65.83	3
6	8961	89.61	3
9	19983	199.83	7
11	21755	217.55	8
		1,007.71	37

Alternatively, if and where soakage allows, a soakage device can be proposed to take in the overflow from the tanks. This could reduce the volume required from the tank, however additional soakage testing and tank sizing should be undertaken at building consent stage.

The final sizing, operation, and maintenance requirements for the retention tanks will be confirmed during each industrial lots building consent stage, to match the requirements for the proposed development overall stormwater management framework.

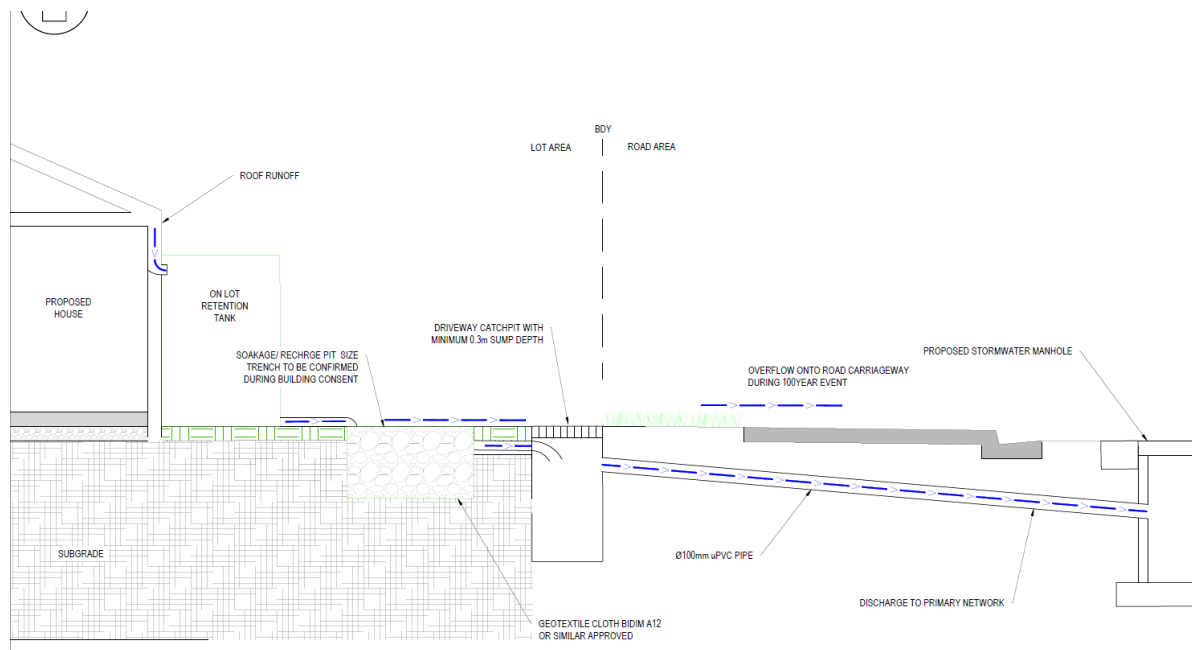


Figure 12: On-lot Stormwater Mitigation Concept

8.2. TREATMENT TRAIN

The first component of the treatment train for Stage 1A is the provision of on-lot retention tanks for the industrial lots. These tanks provide retention of the required initial abstraction volume and reduce the volume of runoff entering the downstream stormwater network.

The first component of the treatment train for Stage 1B, 2 and 3 is the provision of roadside swales (road run-off) and unlined artificial stormwater wetland ponds for industrial lots. These devices provide the loss via soakage of the required initial abstraction volume and reduce the volume of runoff entering the downstream stormwater network. It is noted that the Stage 1A road network adopts this principle as well.

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

The wetlands form the primary stormwater treatment and attenuation devices within the development. In addition to providing water quality treatment, the wetlands provide extended detention, attenuation, and flood storage functions.

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

Collectively, the treatment train provides an integrated stormwater management solution that addresses water quality, water quantity, flood management, and hydraulic connectivity objectives while supporting the staged development of the SL1 Industrial area.

8.3. 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 Waitawhiriwhiri (Draft) ICMP, RITS, and Waikato Stormwater Management Guideline TR20-07 Section 7. The overall strategy adopts a treatment train approach that combines source control, treatment, attenuation, flood storage, and conveyance measures throughout the development.

Water Quality Mitigation

Water quality mitigation is achieved through a combination of distributed source control measures and centralised wetland treatment systems. Initial abstraction is provided through on-lot retention tanks and/or grass lined roadside swales with check dams (as required) to achieve 9mins of resident time for each swale, reducing the volume of runoff entering the downstream stormwater network and providing retention and/or loss 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 objectives of the Waitawhiriwhiri (Draft) ICMP.

Water Volume Attenuation

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

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

The proposed wetland systems also provide flood storage and attenuation benefits during larger storm events. Collectively, these measures contribute to the achievement of the stormwater quantity objectives established within the ICMP while supporting the wider flood management strategy for the development.

8.4. ARTIFICIAL WETLANDS

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

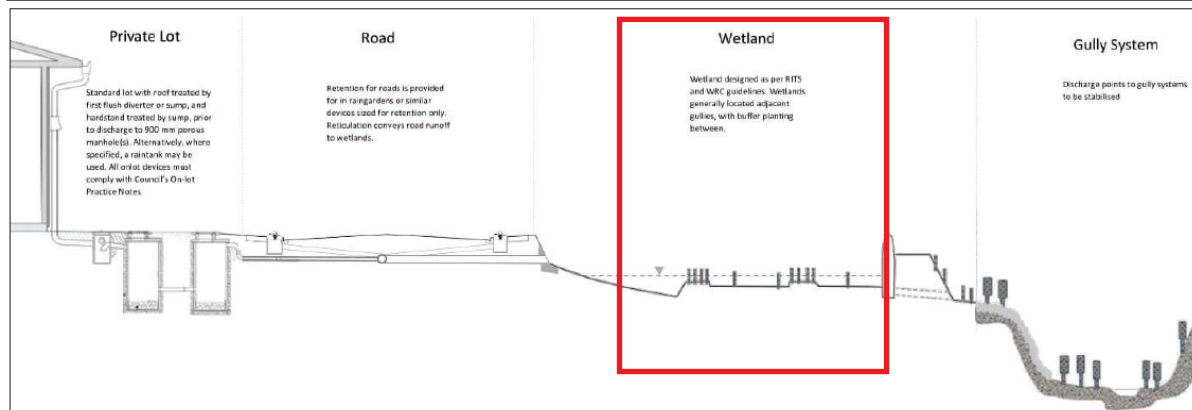


Figure 87: Standard Treatment Train

Figure 13: ICMP excerpt

Figure 13 above is an excerpt from the ICMP 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.

The Wetlands have been sized to also provide attenuation up to the 100-year ARI event prior to discharging into the Waitawhiriwhiri Stream catchment.

Wetland bathymetry will be banded and consist of a mix of deep and shallow pools to allow for dispersed flow through vegetated areas per RITS guidelines. The extended detention level or live storage zone (LSZ) will be set at a maximum depth of 0.35m above the permanent water level to support healthy plants per table 4-21 of the RITS document.

According to the TR20-07, when the impervious area for the contributing catchment is less than or equal to 70%, the wetland is to be sized at 3% of the catchment, anything above will require sizing to be 4% of the contributing catchment. For this industrial development, an 85% of the contributing catchment is assumed to be impervious there minimum of 4% has been adopted in the calculations and sizing. Refer Table 8 below provides conceptual wetland sizes for each catchment.

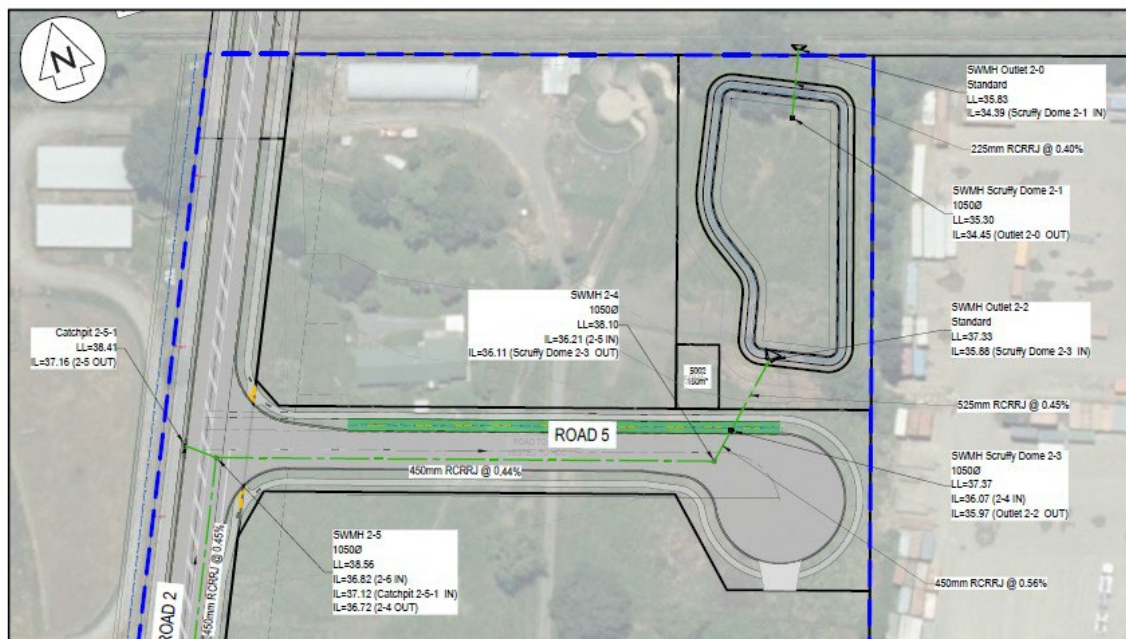


Figure 14: Wetland Details

Wetlands at the development have been split into 3 wetlands (Wetland 1 to Wetland 3), to allow it to be constructed in stages as each development occurs. Wetlands are proposed to treat and attenuate 100yr event including climate change.

Catchment	Area (Ha)	Wetland Pool Area	Percentage PWL Surface (%) - Catchment
1	3.61	0.135ha	4.87
2	16.31	0.906ha	5.55
3	20.78	1.0353ha	4.98

Table 8 – Wetland Pool Area

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

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

Detention/Attenuation

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

Treatment

- WQV treatment

TABLE 9 - STAGE 1 WETLAND CATCHMENT

Stage	Wetland	Catchment	Area (Ha)
1A	Wetland 1	A	3.61
1B	Wetland 2	B	16.31
3	Wetland 3	C	20.78

8.5. FOREBAY

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

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

Residential Artificial Wetland	Minimum Forebay Area m2
1	135
2	906
3	1035

Table 10 – Minimum forebay areas

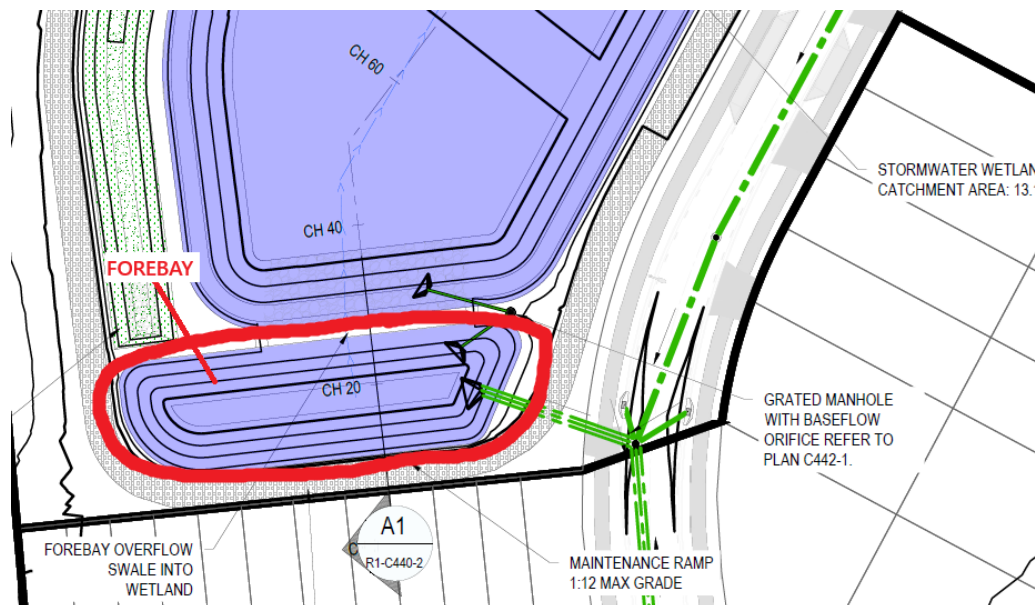


Figure 15: Typical layout forebay as part of the Treatment train.

8.6. WETLAND OUTLET AND OVERFLOW STRATEGY

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

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



Figure 16: 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.

8.7. STORMWATER CULVERTS

Two road crossings are proposed where the development road network intersects existing drainage channels traversing the site. The purpose of the culverts is to maintain the existing hydraulic connectivity of the council drainage channel while enabling the construction of the proposed Higgins Road and Wickham Street extensions and associated infrastructure.

The culvert crossings have been informed by hydraulic assessment and flood modelling undertaken as part of the stormwater and flood assessment. The sizing and configuration of the culverts will be

determined at detailed design stage and have been assumed to be 1800mmØ, as per the current council piped infrastructure, that currently discharges to the west of the end of Wickham Street crossing. The final design size and configuration will be selected to convey existing stream flows, maintain flood conveyance, and minimise adverse impacts on upstream and downstream water levels during design storm events.

8.8. WETLAND DISCHARGE SUMMARY

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

Table 11 – Pre vs Post Development Flows tables

2 Year Summary

	Pre Development	Post Development
Catchment	Discharge (m³/s)	Discharge (m³/s)
A	0.140	0.061
C	0.113	0.031
D	0.312	0.293
E	0.695	0.691

10 Year Summary

	Pre Development	Post Development
Catchment	Discharge (m³/s)	Discharge (m³/s)
A	0.2803	0.081
C	0.2265	0.5428
D	0.6274	0.383
E	1.3961	0.98

100 Year Summary

	Pre Development	Pre Development 80% - Target	Post Development
Catchment	Discharge (m³/s)	Discharge (m³/s)	Discharge (m³/s)
A	0.5339	0.42712	0.3783
C	0.4316	0.34528	0.8479
D	1.1998	0.95984	0.6975
E	2.6704	2.13632	1.6495

The results indicate that the proposed wetland systems are capable of achieving substantial attenuation of post-development runoff prior to discharge into the downstream environment or network. Post-

development discharge rates are below the adopted design targets, providing additional capacity and flexibility within the stormwater system if needed down the line.

This demonstrates that the proposed design not only satisfies the stormwater flow objectives of the development but also provides opportunities for further refinement during detailed design. Subject to detailed hydraulic assessment, there may be scope for value engineering of wetland storage volumes, outlet structures, and associated infrastructure while continuing to achieve the required stormwater management outcomes.

9. Flooding

Catchment modelling has been undertaken to provide input into the structure planning exercise. This modelling has confirmed the extent and location of flooding and overland flow within SL1 (Figure 14-15).

The following sections provides a summary on the flood modelling completed, investigates the known or assumed downstream constraints before outlining a high-level development framework which will enable the future development of the areas.

9.1. MODELLING SUMMARY AND METHODOLOGY

HEC-HMS was used for the hydrology and HEC-RAS was used to model flooding within SL1. The modelling confirms the extent, location, flow, and depth of flood waters. The Existing flood assessment was modelled by Golovan in 2021. Maven was provided with the raw data of the mentioned model and have conducted assessment based on this data.

Due to more recent survey data using drone topographic survey and with a more recent LINZ terrain made available that were not during the previous assessment, a new existing terrain has been created and used in the HEC RAS model. Results were consistent with the previous model.

A Post development Analysis was conducted only to confirm the impact of the proposed wetlands. The modelling involved creation of dummy channels utilised to divert flows within each sub catchment to respective wetlands. These channels will mimic what low volume; local roads will do once established and designed.

A hydraulic assessment of the SL1 Industrial development was undertaken using HEC-RAS 2D to assess existing and post-development flood behaviour across the site. The model was developed to understand the interaction between upstream catchment flows, existing drainage channels, proposed stormwater infrastructure, and downstream hydraulic controls.

The model incorporated detailed topographic information, proposed earthworks, existing drainage channels, stream corridors, proposed diversion channels, culvert crossings, wetlands, and downstream hydraulic constraints. The assessment focused on understanding flow conveyance, flood storage, overland flow paths, and flood extents under a range of storm events.

Existing condition simulations were initially undertaken to establish baseline flood behaviour across the site and identify key flood conveyance pathways, ponding areas, and hydraulic constraints. Project-specific catchment delineation was completed to refine the upstream contributing catchments identified within the Waitawhiriwhiri ICMP and ensure that external catchment flows entering the site were appropriately represented within the model.

Following completion of the existing condition assessment, the proposed development layout and stormwater infrastructure were incorporated into the model. This included the proposed diversion channels, stream culvert crossings, wetlands, flood storage areas, and associated stormwater management measures. The model was then used to assess the effectiveness of the proposed design in maintaining hydraulic connectivity, managing flood risk, and conveying both external catchment flows and development-generated runoff through the site.

The HEC-RAS model formed a key component of the overall stormwater assessment and was used in conjunction with 1D hydraulic assessments undertaken using Hydroflow to support the design of

culvert crossings, diversion channels, wetland systems, and flood mitigation measures. The modelling outcomes have informed the proposed stormwater management strategy and provided confidence that the development can be integrated within the wider catchment while maintaining flood conveyance and stormwater management objectives.

9.2. EXISTING/PRE DEVELOPMENT FLOODING WITHIN SL1

A 2D flood model has been developed for the site using HEC-RAS software Version 6.7. The model has been used to assess Pre Development and Post Development, using climate change for both scenarios.

The result demonstrates (refer to figure 18) that the site is currently subject to widespread shallow flooding and poorly defined flow paths. This has informed the proposed design approach, which focuses on conveyance through diversion channels, retaining drainage corridors, while incorporating wetlands and storage to mitigate stormwater events up to the 100YR ARI within the proposed site in line with RITS. This flood management and overall hydraulic performance across the site, is also consistent with the intent of the ICMP.

With Sensitivity assessment, it is assumed that all stormwater soakage attenuation devices have already reached their capacity. Even under this worst-case condition, the model demonstrates that the development maintains flood immunity, with only minor exceedances expected to be mitigated through detailed design refinements.

The figure below shows the contributing catchment of the site during the 100year event, delineated through QGIS/HEC-HMS based on a 10m grid externally. Data used is comprised of localised site survey and LINZ data capturing the wider extent of the catchment.

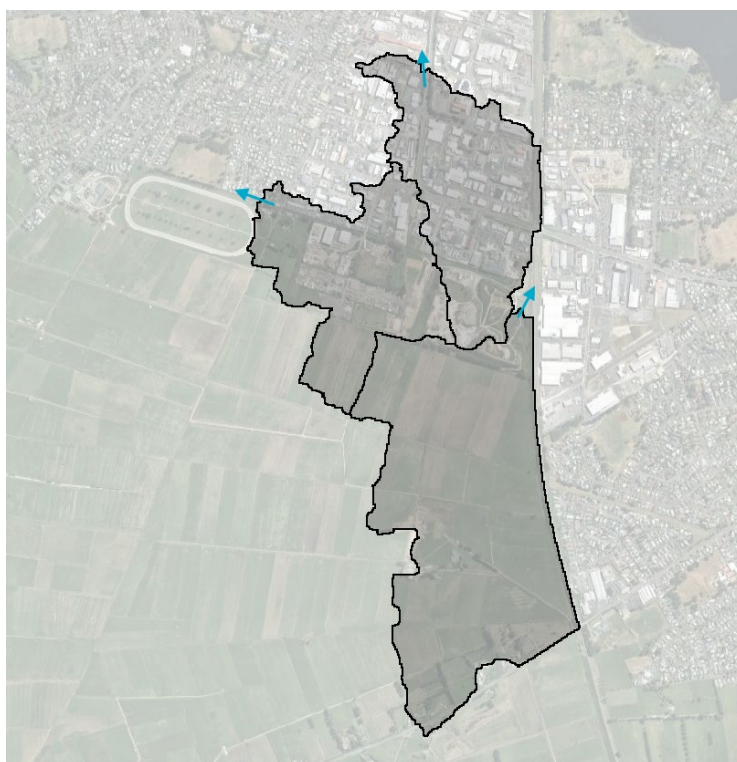


Figure 17 – Mapped Catchment Passing through the Industrial Area

The catchment extent is generally consistent with the ICMP catchment framework; however, project specific catchment delineation has been undertaken as part of this assessment to refine upstream contributing areas based on current information for data and modelling.

9.3. POST DEVELOPMENT FLOODING

A 2D flood model has been developed for the site using HEC-RAS. The model has been used to assess existing, design and sensitivity scenarios.

The figure below shows the contributing catchment of the site during the 100year event, delineated through QGIS/HEC HMS based on a 10m grid externally. Data used is comprised of localised site survey and LINZ data capturing the wider extent of the catchment.

The catchment extent is generally consistent with the ICMP catchment framework; however, project specific catchment delineation has been undertaken as part of this assessment to refine upstream contributing areas based on current information for data and modelling.



Figure 18: Existing Flood Extent in the 1% AEP Event (100mm)

HEC-RAS 2D modelling of the 100-year ARI climate change event (RCP 8.5) indicates that the site is influenced by a number of existing flow paths and receiving environments.

The western portion of the site generally drains via the existing farm drainage network before discharging into the artificial channel located along the northern boundary of the site, which conveys flows westward. The north-western portion of the site is also influenced by this channel and associated drainage network.

The area adjacent to the railway corridor is noticeably elevated compared to the remainder of the site and appears to have been previously modified through earthworks activities. As a result, runoff and floodwaters from this raised area generally shed down the embankment towards the lower-lying portions of the site.

The railway corridor located along the eastern boundary of the site acts as a raised embankment and generally contains floodwaters on the western side of the corridor. However, further north, ground levels either side of the railway become more comparable, allowing floodwaters to cross the railway corridor and discharge towards the eastern catchment during larger flood events.

Overall, the modelling indicates that the site forms part of a wider floodplain system with multiple flow paths and drainage outlets. These existing flood characteristics have been considered in the development of the proposed stormwater management strategy and the location of the proposed stormwater management devices.

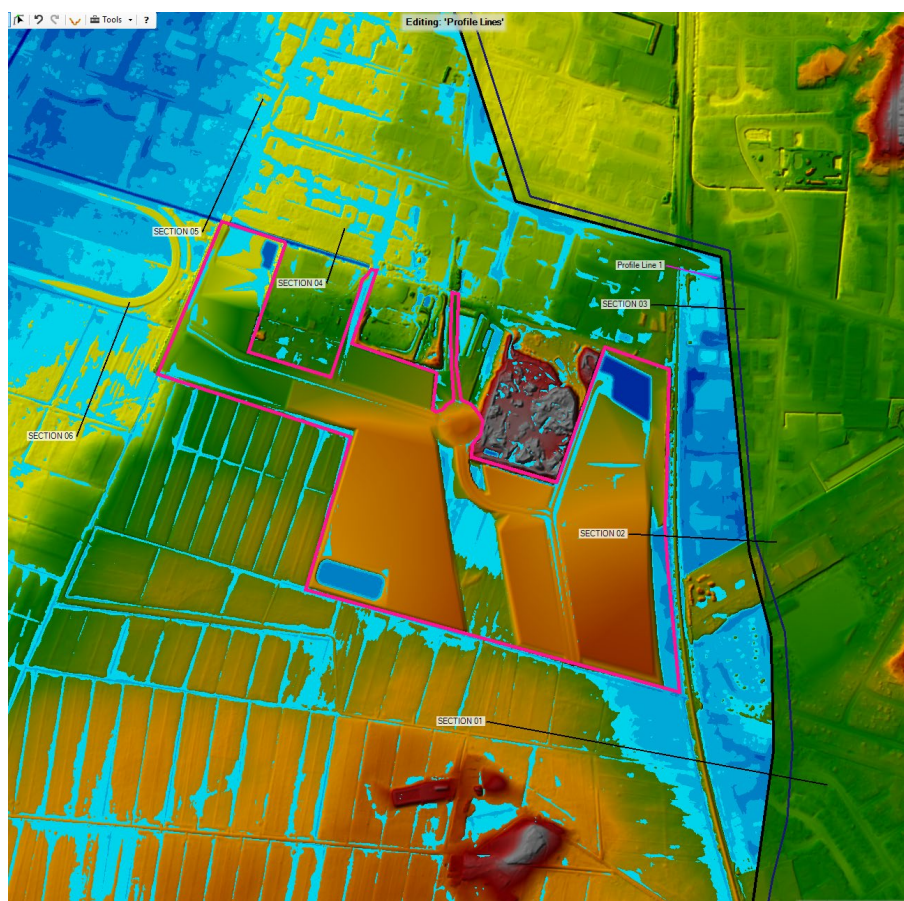


Figure 19: Post Flood Extent in the 1% AEP Event (100mm)

A comparison of the existing and post-development HEC-RAS model results indicates that flood behaviour across the wider area remains largely unchanged, with only localised changes observed adjacent to the proposed development.

- Section 1, peak flow rates are reduced under post-development conditions; however, flood depths increase by approximately 50 mm as a result of the proposed development partially obstructing overland flow paths.
- Section 2, flow rates on the eastern side of the railway remain largely unchanged. Within the development site, flow rates increase due to local changes in flow dynamics associated with the proposed earthworks in this area.
- Section 3, flood depths increase by approximately 30 mm and are accompanied by a corresponding increase in flow velocity.
- Section 4, flood depths remain generally unchanged, although an increase in flow velocity is predicted.
- Sections 5 and 6 show minimal change between the existing and post-development scenarios, indicating that the proposed development does not materially alter flood behaviour in these areas.

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 velocity identified in this assessment.

9.4. DOWNSTREAM FLOOD MITIGATION SOLUTIONS

To avoid any downstream flooding effects, flood mitigation will be required in support of the future STAGES development of SL1. Post development run-off from the development areas will require attenuation of peak flows from the site to 80% of the pre-development level for storm events up to 100-year ARI (average recurrence interval). Subject to this, there will be no downstream flooding effects.

As detailed in previous sections of this report, the 100year ARI flow rates are proposed to be attenuated within the proposed wetlands.

9.4.1. MINIMUM FLOOR LEVELS

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

TABLE 11 - 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.

10. Overland Flow paths

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.

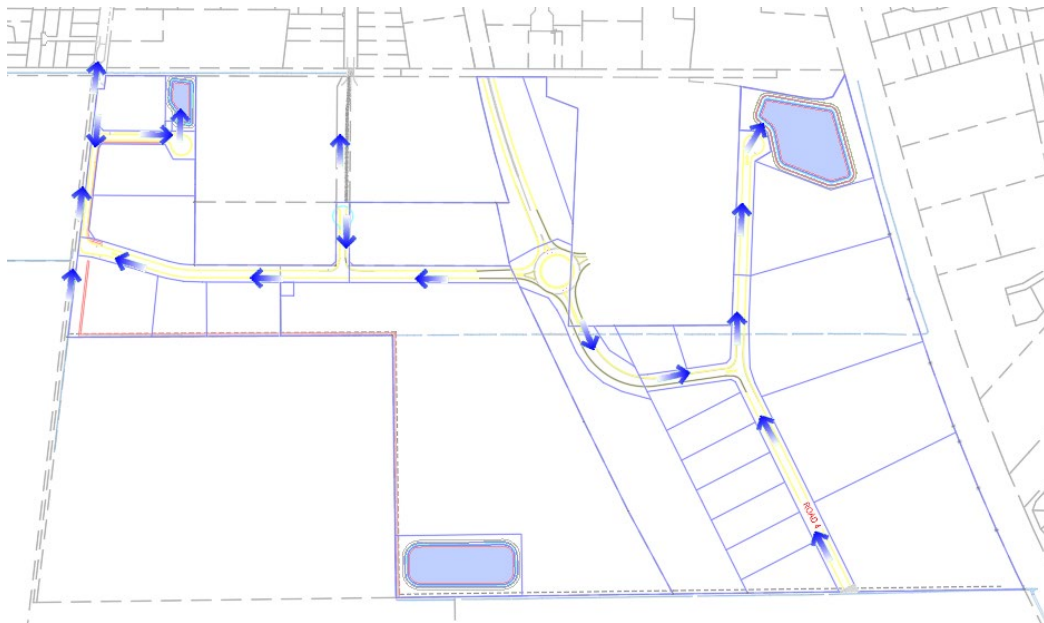


Figure 20: Proposed Overland Flow path.

- 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 HEC-RAS 2D. 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 showing results at the key locations.

More than 80% road areas comply with standard design thresholds.

However, the isolated catchment areas listed below have recorded maximum water depths above the 150mm guideline.

- Road 3: max depth = 200mm

- Road 4: max depth = 350mm
- Road 5: max depth = 200mm

Note these depths are likely to be reduced at further refined modelling at detailed design stage via applying the alternative measures listed below:

- Advance the flood model by including catchpits and roading stormwater network;
- Provide sensitivity analysis assuming catchpits are fully blocked;
- Provide proprietary Megapits if required to alleviate ponding;
- Increase vertical curvature length of the roading corridor to increase the spill weir and minimise ponding depth;
- Mono camber transition in the carriageway and/or footpath berms to reduce the depth of spilling headwaters;
- Or a combination of the solutions above

Highest velocity depth of $0.15 \text{ (m}^2/\text{s)}$ values remain below critical safety thresholds defined in Austroads 2012 Part 5, which specify:

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

The highest recorded value was $0.15 \text{ m}^2/\text{s}$ (Road 3) confirming safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads conveyed into roadside primary networks for the 10-year conveyance to the proposed wetlands.

11. Conclusions

This SAR has been prepared to support the Industrial Development within the Southern Links 1 (SL1) development area and provides the overarching framework for stormwater management throughout the site. The SAR has been developed in accordance with the objectives and requirements of the Waitawhiriwhiri (Draft) Integrated Catchment Management Plan (ICMP), Waikato Regional Council guidelines, and the Regional Infrastructure Technical Specifications (RITS).

The site is influenced by significant upstream contributing catchments, existing drainage channels, overland flow paths, and flood-prone areas. 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.

The proposed stormwater management system adopts a treatment train approach incorporating on-lot retention tanks, conveyance systems, wetlands, forebays, high-flow bypass systems, diversion channels, and flood storage areas. Together, these components provide stormwater treatment, detention, attenuation, and conveyance functions in accordance with the objectives of the ICMP and RITS requirements.

Initial abstraction requirements will be achieved through distributed on-lot retention tanks provided for each industrial lot located within Stage 1A or through soakage (via Roadside Swales and/or unlined Wetland Ponds). The proposed tank provision exceeds the required 10 mm retention volume and forms the first component of the overall stormwater treatment train.

Flood modelling indicates that the site is currently subject to widespread shallow flooding and diffuse flow paths resulting from the flat topography and interaction with upstream catchments. The proposed development seeks to formalise these flow paths through retained drainage corridors, diversion channels, culvert crossings, wetlands, and flood storage areas. Subject to detailed design and implementation of the proposed mitigation measures, stormwater runoff from the development will be managed to achieve the required attenuation targets, including discharge of the 100-year event at 80% of pre-development flow rates.

The proposed staging strategy enables each development stage to function independently while maintaining continuity of upstream flows and providing the required stormwater management outcomes. Interim stormwater management measures will be progressively replaced by permanent infrastructure as development proceeds.

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

Overall, the proposed stormwater management framework provides a practical and integrated solution that supports future urban development while maintaining catchment function, managing flood risk, protecting receiving environments, and aligning with the long-term objectives of the Waitawhiriwhiri (draft) ICMP. 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 – Stormwater Plans (Refer to Infrastructure Report Package)

Appendix B – HEC-RAS Results (100year Assessment)

HEC RAS RESULTS – PRE & POST

