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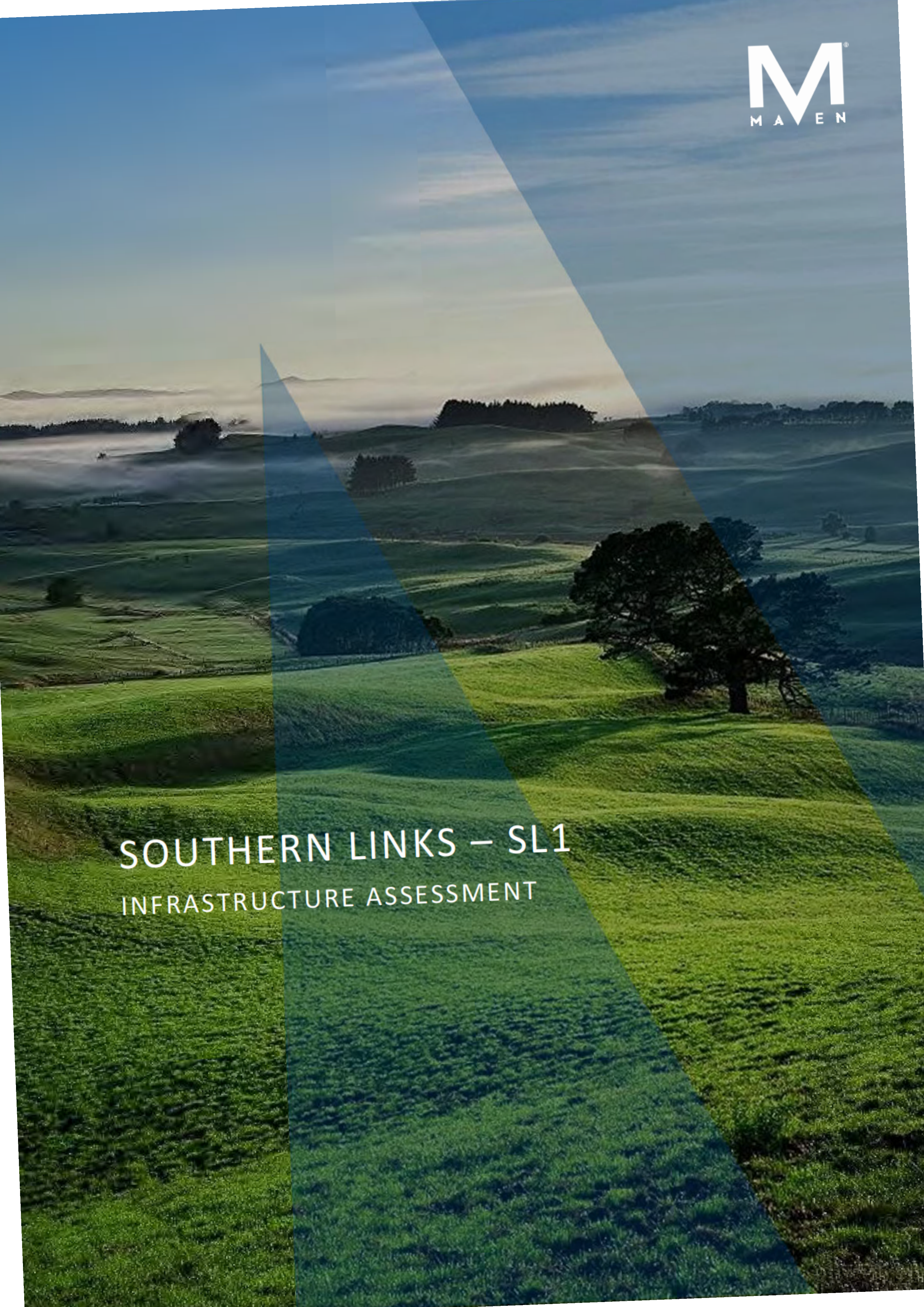

SOUTHERN LINKS – SL1

INFRASTRUCTURE ASSESSMENT

PROJECT INFORMATION

CLIENT	Colliers Project Leaders
PROJECT	298001

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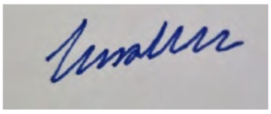
AUTHOR	 Tim Hawke Senior Engineer
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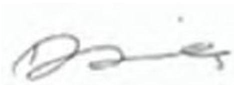
APPROVED BY	 Dean Morris Regional Director

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1. Introduction

1.1. Background

Maven Waikato Ltd have been engaged by a Colliers Project Leaders to assist a group of developers within the boundaries of designated Southern Links area (SL1) to explore the feasibility and concept of land development for residential and industrial use. SL1 is an emerging area identified by HCC for future housing and industrial.

1.2. Purpose of this report

The purpose of this report is to provide developers an initial assessment of infrastructure servicing that supports the intended rezoning of the SL1 area.

The design and layout of the SL1 structure plan (Figure 1 Structure Plan concept prepared by Barker & Associates, overpage) has been developed through ongoing consultation and collaboration with developers.

Revision A of this report was issued to the client on the 15*th* of March 2024. Maven have since been asked to provide an updated Infrastructure report and Stormwater Management Plan with a specific focus on the Stage 1 Development. Section 8 has been added to this report under revision B, which includes further discussion on the water supply and wastewater strategy covering Stage 1.

The SL1 area is a circa 440ha block of land within Waipa District. The area has a northwest to southeast orientation from Dinsdale in the north to Rukuhia in the south. Most of the site is low-lying flat farmland, once a peat bog in pre-European times, interspersed with straight artificial farm drains.

To the southeast of the site, within the Saxbys and Houchens Road area bordering the HCC boundary, rolling hill topography and isolated elevated terraces feature with two main tributaries dividing the surrounding pastoral farmland.

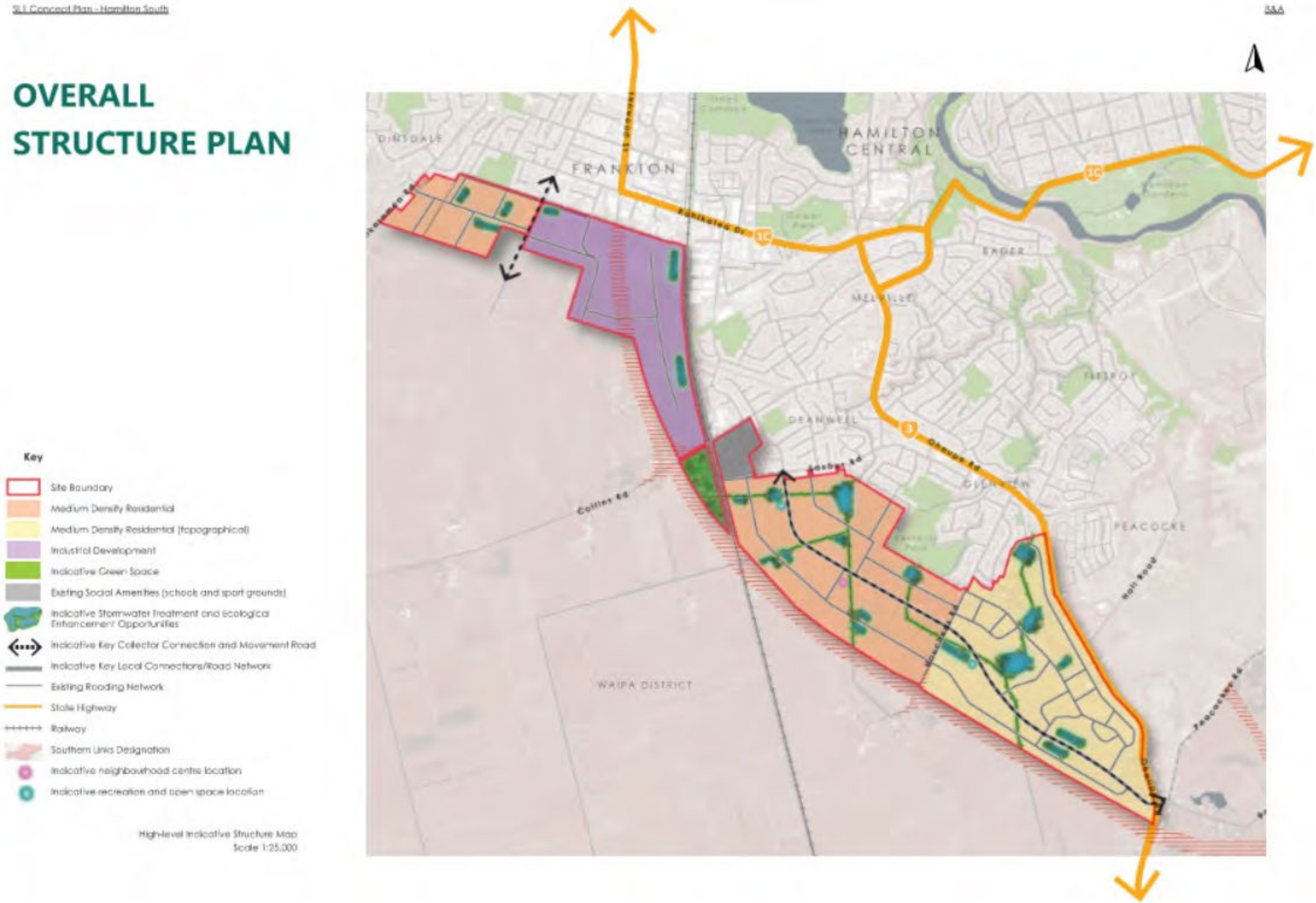


Figure 1 – Structure plan

2. Earthworks

A geotechnical desktop review for the proposed SL1 development area was undertaken by CMW in March 2024 refer to (Appendix F) for the CMW report.

The report identifies the approximate distribution of prevailing landforms and geologies for the local area (Figure 2), typical geotechnical challenges associated with subdivision development on those landforms and presents strategies to mitigate hazards by further geotechnical investigation and design.

Within SL1 the extent of earthworks will vary considerably depending on demand and yield driving design considerations such as developable lots, transport corridors, and protection and mitigation from flooding and overland flow.

Based on the results of previous geotechnical investigations at SL1 and surrounding sites, SL1 should be suitable for the intended development. The area will however present challenges, therefore development should be supported by detailed geotechnical investigation and earthworks management.

2.1. Low Lying Peatland

Future land suitable for development consists of low-lying peat. The peat is a characteristic deposit of the Waikato Basin and is described as normally to near normally consolidated and therefore is susceptible to significant settlement when subjected to loading or drainage. As peat areas are low-lying, they can be susceptible to flooding as well.

Please see in appendix F – CMW -“Peat Contour Plan” for underground mapping that was created to show depths of indicative Peat soils using surrounding ground investigation results.

2.1.1. Development in Peatland

Where development in peat is proposed, developers will need to comply with the requirements of the draft ICMP for the Mangakotukutuku Catchment (Consultation revision November 2020):

- Identify if peat is to be removed and advise if it is to be replaced.
- Confirm that this does not change groundwater flows sufficiently to cause any adverse effects.

The ICMP for Mangakotukutuku catchment is currently being revised and it is currently not available on the Waikato Regional Council website.

2.1.2. Earthworks

Where peat is present, drainage of the peat which could lead to shrinkage shall be carefully considered and mitigated against (see 4.3 Groundwater Recharge).

Peat and any existing over-lying fill material may require undercut and replacement with engineered fill where peat depths are up to 2m (above the water table) to minimise differential settlement issues.

Preload fill material may be suitable in areas where depths of peat are greater than 2m. Specific, underfill drainage, temporary pre-loading, and settlement monitoring, under the direction of a geotechnical engineer, will be required to limit post construction ground settlements.

2.1.3. Building Foundations

Where development in peat is proposed, pile foundations beyond base of peat or preload to induce ground settlements may be practical. Preload depths of approx. 2m with settlement hold periods of three to six months are expected based on historical works.

Lightweight buildings may require raft foundations that are designed to accommodate ground settlements. Where development in peat results in high foundation loads (i.e., heavy Industrial buildings exceeding preloading weight), piled foundations beyond the base of the peat will likely be required. Foundations for larger structures resulting in high foundation loads typical to the zone it would require specific design from a geotechnical Engineer. Specific design (often requiring piling) is typically required in any case even if building foundations were in clay.

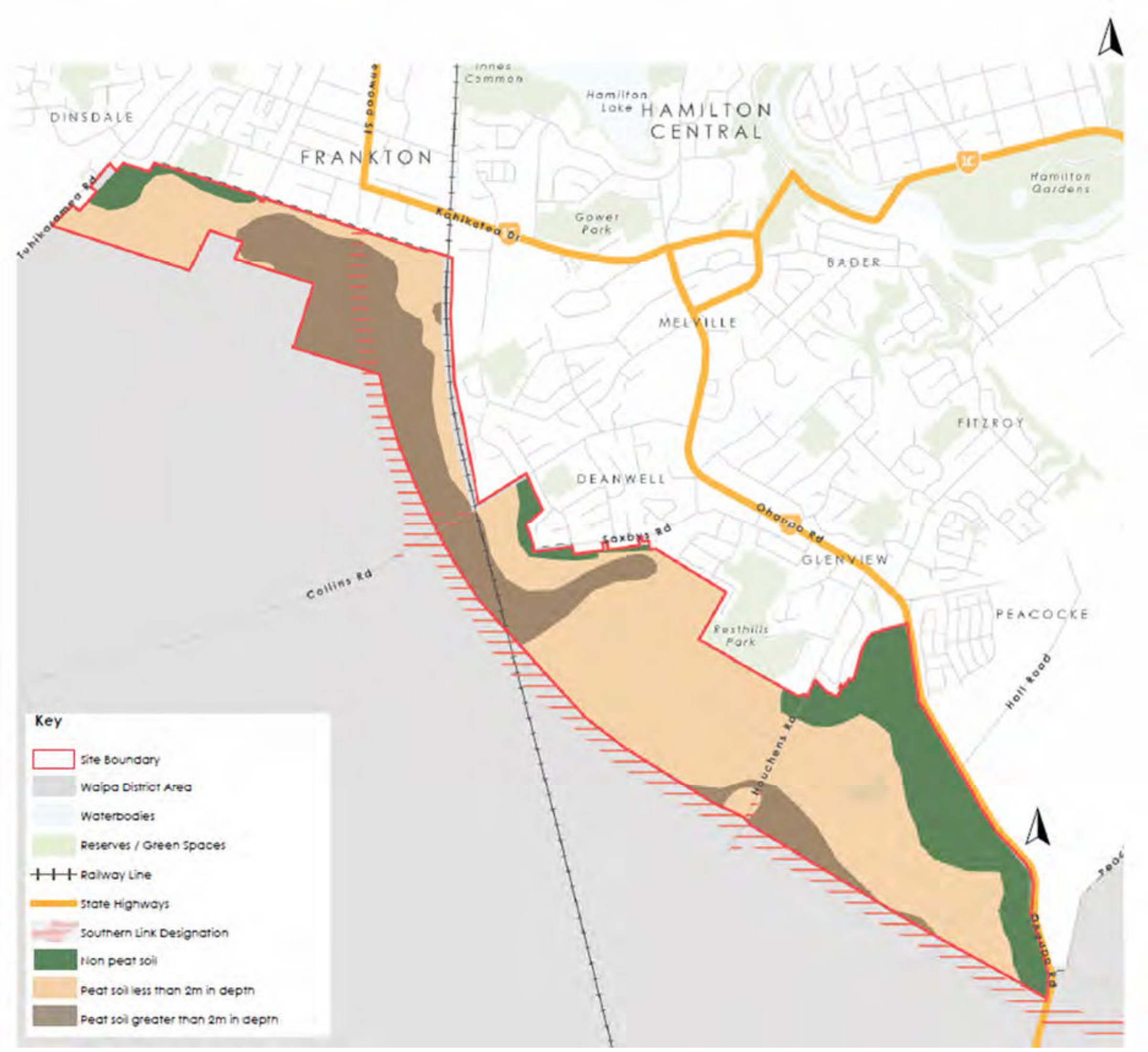


Figure 2 – Soils

2.2. Roading Construction

For construction of any new roads, HCC will not accept new roads being built directly over existing peat soils. Where the peat is less than 2m the peat will likely be undercut and removed, and approved engineered fill placed. For peat soils greater than 2m in depth, the peat will likely be preloaded to induce ground settlement and the settlement monitored. The expected settlement time is 3 to 6 months based on historical results for surrounding areas.

2.3. Sediment and Erosion Control

Sediment and erosion control measures are to be established in accordance with Waikato Regional Council's (WRC) Erosion and sediment control Guidelines for soil disturbing Activities. Erosion and sediment controls should be in place before earthworks commences and checked onsite by the Engineer. Sediment and erosion control drawings will be provided prior to construction.

2.4. Preliminary Earthworks

A preliminary earthworks assessment has been undertaken for the proposed development. The design terrain was developed based on the structure plan layout for the roading and stormwater. An earthworks balance was achieved.

Earthworks Volumes	
Total Cut =	3,737,523m^3
Total Fill =	3,319,585m^3
Balance (Cut) =	417,938m^3

Volumes indicated are solid measure in place, no bulking or compaction factors have been applied and topsoil stripping has not been included.

3. Roading

The preliminary roading layout for SL1 includes constructing a new 6.7km collector road and 10.4km of local roads. The local low volume roads have been excluded from the preliminary roading layout and they will be further developed in the detailed design stages. BBO have been engaged as the Transport Engineering leads for the development. BBO are working with the local stakeholders to determine the proposed roading network for the development. The design criteria considered for the local and collector roads is shown in figure 3 below.

							Berm requirements[5]				
Transport corridor type[1]	Land use environment [2]	Design speed environment (max desirable)	Legal width (min desirable)[4, 5, 14]	Carriageway width[3]	Movement lane width[15]	Berm requirements[5]	On street parking requirements (min desirable)	Passenger transport requirements (min desirable)[11]	Footpath requirements (min desirable)[12]	Cyclepath requirements (min desirable)	Service corridor (min desirable)[6]
Residential Land Use Environment											
Local (low volume)	Residential (serving 10-20 units via fee simple tenure)	40km/h	16m	6m	2 way flow, not marked	5m both sides	Recessed parallel parking bays (2m) on both sides	None	1.5m wide footpath, both sides	Cycling on road shared in movement lane	1.5m both sides
Local	Residential	40km/h	20m	6m	2 way flow, not marked	7m both sides	Recessed parallel parking bays (2m) on both sides	None	1.5m wide footpath, both sides	Cycling on road shared in movement lane	1.5m both sides
Collector	Residential	40 to 50km/h	23m	9m	2 @ 3m, marked	7m both sides	Recessed parallel parking bays (2m) on both sides	All bus stops to be kerbside[11]	2m wide footpath, both sides	1.5m on road marked cycle lane, both sides	2m both sides

Figure 3 – Road Hierarchy

Refer to (Appendix B) for the roading layout drawing.

3.1. Spine road

A new spine road is proposed for SL1 that will run from the southern end of the site to the north with an anticipated connection to State Highway 1C at the intersection of Greenwood Street and Kahikatea Drive in Frankton. BBO are in discussions with stakeholders to determine what type of road the spine road will take. The options put forward by BBO include a 36m wide minor Arterial Road and a 30m wide main collector road, the two options are shown below.

Figure 4 – Minor Arterial Road (36m Width)

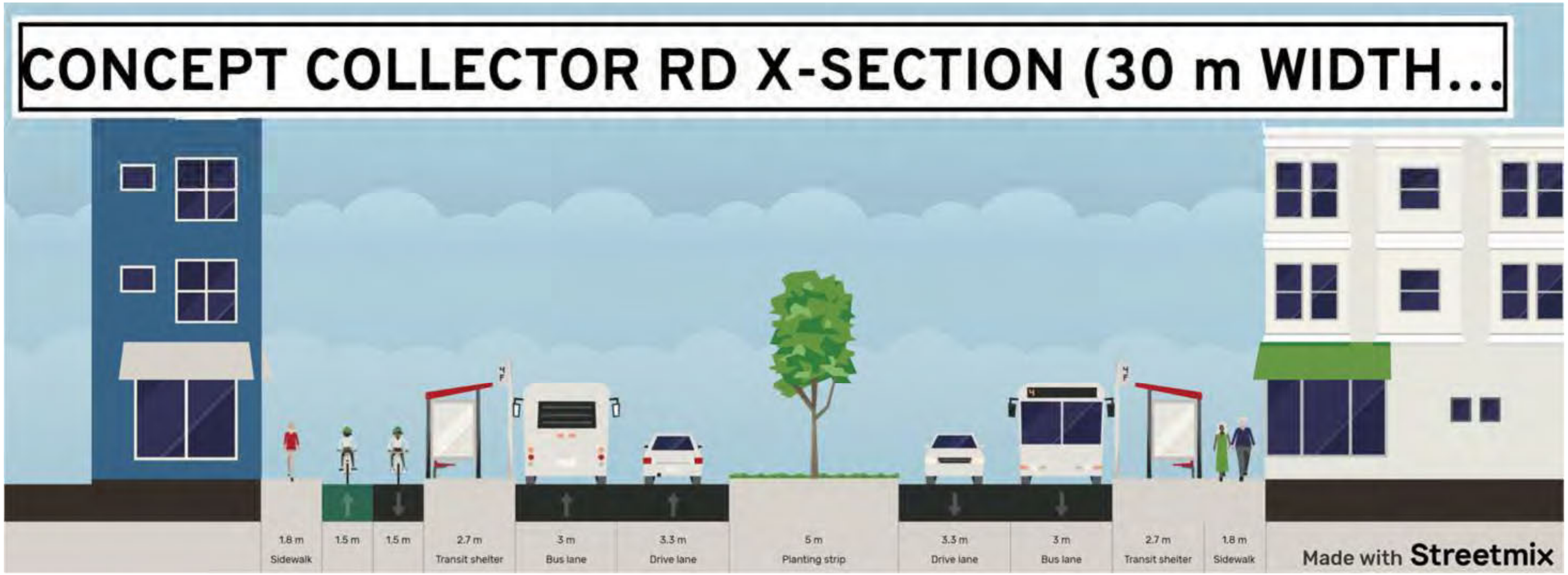


Figure 5 – Main Collector Road (30m Width)

4. Stormwater

A preliminary Stormwater Management Plan (SMP) has been developed for SL1 to set out the best practice framework for stormwater management. The stormwater is currently managed by the existing wetlands, farm drains and culverts to convey the surface runoff through the site. The draft consultation document for stormwater treatment for the Mangakotukutuku integrated catchment management plan (ICMP) provides draft stormwater treatment guidelines. Refer to (Appendix I) for the draft stormwater ICMP. Refer to (Appendix A) for the Stormwater Management Plan and (Appendix B) for the stormwater layout drawing. A high-level summary of the SMP is provided below.

4.1. Suggested Outcomes

Proposed objectives of the stormwater strategy are:

- Consideration of future public networks required in support of the Study Areas.
- Identify existing overland flowpaths.
- Identify existing flood hazards.
- Provide an option-based assessment for water quality treatment in support of the future development of the Study Areas.
- Consideration and requirement for extended detention in support of the future development of the Study Areas to avoid any downstream flooding, erosion and scouring.
- Confirming the need for attenuation of peak flow during storm events up to the 100-yr events.
- On-site retention (volume reduction) to ensure pre-development runoff rates and volumes are maintained within catchments and streams.
- Recommendations to guide future Plan Change application(s) to ensure positive environmental outcomes are achieved.

4.2. Reticulation

Existing stormwater infrastructure within SL1 is limited to farm/roadside drains and streams. Development of SL1 will be supported by new public stormwater networks that will discharge into groundwater recharge pits and into the existing and proposed wetlands for primary and secondary water quality treatment. The future public networks would be developed by the developers. The stormwater infrastructure will need to comply with the conditions for Resource Consent and Engineering Approval before being vested with Hamilton City Council (HCC). Where possible, the stormwater network will be designed and constructed within the roads.

4.3. Stormwater Quality and Quantity

An assessment has been undertaken to establish the best practical design options for the stormwater quality and quantity design in support of SL1. These options include:

- At source stormwater quality control through the following controls:
- Inert roofing materials for all future buildings.
- Reduction of impervious areas using permeable paving (where possible).
- Lot development supported by approved propriety devices such as raingardens, treepits, stormwater filters etc.
- Treatment of public roads and right of ways via approved propriety devices (raingardens, swales, stormwater filters etc) as per GD01 design guidelines.
- Sub-catchment wide stormwater quality provision through detention basins and wetlands.

- Planting of riparian areas and protection of any existing bush features within SL1.
- Use of the treatment train devices (Swales and/or Amalgamated Raingardens and Artificial Wetlands) to provide storage and attenuation for the required storm events from WQV, ED, 2year, 10year and 100year ARI.
- Second option is to provide storage and attenuation within the existing (rehabilitated) streams in addition to wetlands. This is detailed further in the SMP.

A Treatment train solution is proposed solution which would be in the form of an integrated forebay, amalgamated raingarden and wetland for each catchment. This provides two step treatment and reduces the amount of maintenance required by creating one location per catchment to attend to.

HCC have noted their current preference is for the consolidated/amalgamated raingarden approach above. However, roadside raingardens or swales could be used in place of amalgamated raingardens before discharging into wetlands if required.

Proposed wetlands would be sized at 4% of their respective catchments, and discharge into the existing/enhanced streams. Refer to Appendix B for the concept stormwater plan which provides preliminary catchments and wetland locations.

4.4. Groundwater Recharge

Soakage and recharge of stormwater into peat will be required to maintain hydrology to prevent dewatering of downstream wetland and streams and to mitigate ground shrinkage. For areas of deep peat, the preference would be to construct wetlands through these areas. Recharge pits should be designed at regular intervals throughout the development to encourage even distribution of groundwater recharge.

Detailed investigations by a suitable qualified geotechnical engineer, to determine the suitable recharge treatment measure to be implemented for each area. Recharge treatment measures will need to consider the future infrastructure and buildings in the decision-making process.

4.5. Rainwater Harvesting/Reuse

Reusing rainwater can significantly reduce the amount of water supply demand by household units by up to 50%. Decreasing demand on water supply has multiple benefits including meeting Water-sensitive urban design (WSUD) criteria and decreasing household water use. Allowance for water metering is suggested for any future changes to Hamilton Water Supply requiring a meter box at the boundary.

Rainwater can be harvested and used for a range of different applications; for watering the garden or washing the car, for use in the laundry and toilet. Rainwater is harvested directly off the roof and travels through down pipes to a water tank which sits either above ground or below.

Rainwater harvesting requires a building consent and would be enforced by a condition of Resource Consent and consent notice on each title. The use of rainwater reuse and their effects on water supply demand will need to be investigated and confirmed with council. Rainwater reuse options will be further investigated as part of future Resource Consent applications.

Rainwater harvesting can significantly reduce the amount of water supply demand from household units. Rainwater harvesting will be incorporated where possible into the proposed development during house construction.

4.6. Existing Stream Enhancement

The proposed wetlands are located adjacent and upstream of a few key existing conveyance channels/streams within the development. This will allow conveyance of flow from the development area into the existing environment. We have investigated the existing stream depths and levels based on available survey data and it appears most existing streams are very shallow. In their current state, this will restrict attenuation and flood storage ability for the adjacent catchment.

Based on the above, enhancement of existing streams is recommended which would include deepening and possibly widening to accommodate conveyance and possibly storage and attenuation for the SL1 development. Altering the streams provides the opportunity to rehabilitate the streams enhancing ecological habitat by providing a more natural meander, wetland areas and planting. This will require further inputs from an Ecologist during future design. Proposed enhanced stream locations can be found on the stormwater plan in appendix B.

4.7. Flooding

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 has updated the HEC RAS model using more recent survey data.

Existing Modelling confirms that flooding within SL1 occurs during the 100-year flood event. Depths vary and are concentrated within the existing watercourses. Outside of the watercourses the bulk of the lower lying areas are subject to sheet flows only, with depths ranging from 100-300mm. This is illustrated in figure 6 below.

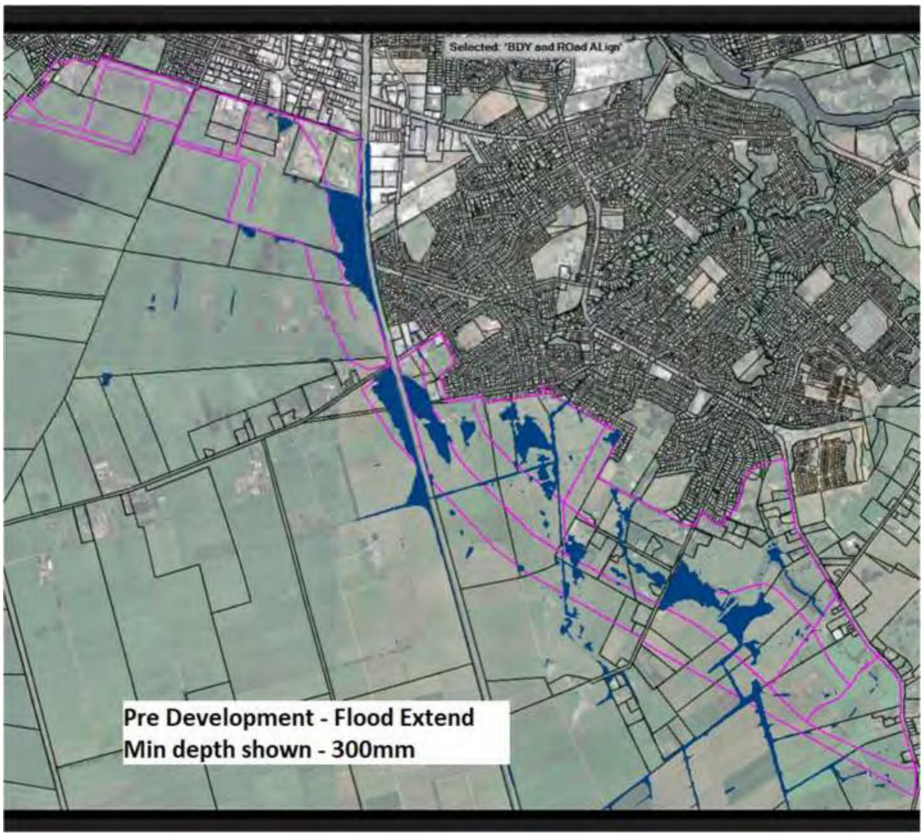


Figure 6 – Existing site flood map

As mentioned in section 4.3, flood volumes and flows are proposed to be stored and attenuated within wetlands for each catchment. The wetlands would provide attenuation by means of a discharge control device installed within the wetland high-flow bypass. Alternatively, the enhanced existing streams could also be used to provide attenuation and storage. The discharge to catchments downstream of SL1 would need to be controlled to ensure attenuation targets can be met. This is discussed in further detail in the SMP (appendix A)

Subject to the future development complying with the above, there will be no adverse downstream effects from the development of SL1. Additional investigation and detailed design are required to refine the preferred solution as part of any future resource consent or plan change approval.

4.8. Feedback from Hamilton City Council

In principle HCC agree with the general stormwater design approach. To maintain the existing wetlands and the existing primary natural overland flow paths through SL1. We propose to create new consolidated wetlands for primary or secondary treatment however, HCC still need to come to an agreement with Waikato Regional Council for the proposal. Roadside raingardens or swales may be proposed as an alternative option.

5. Wastewater

Maven have undertaken a desktop study to identify the most suitable option for wastewater disposal for the SL1 area. Reticulated, decentralised, and at source solutions have been considered. The site is in a rural location and there is no pre-existing infrastructure within the site to service the proposed development. A staged approach in developing the proposed infrastructure will likely be adopted, with a preference to connect into the existing wastewater infrastructure where possible. Refer to (Appendix B) for the concept wastewater layout drawing.

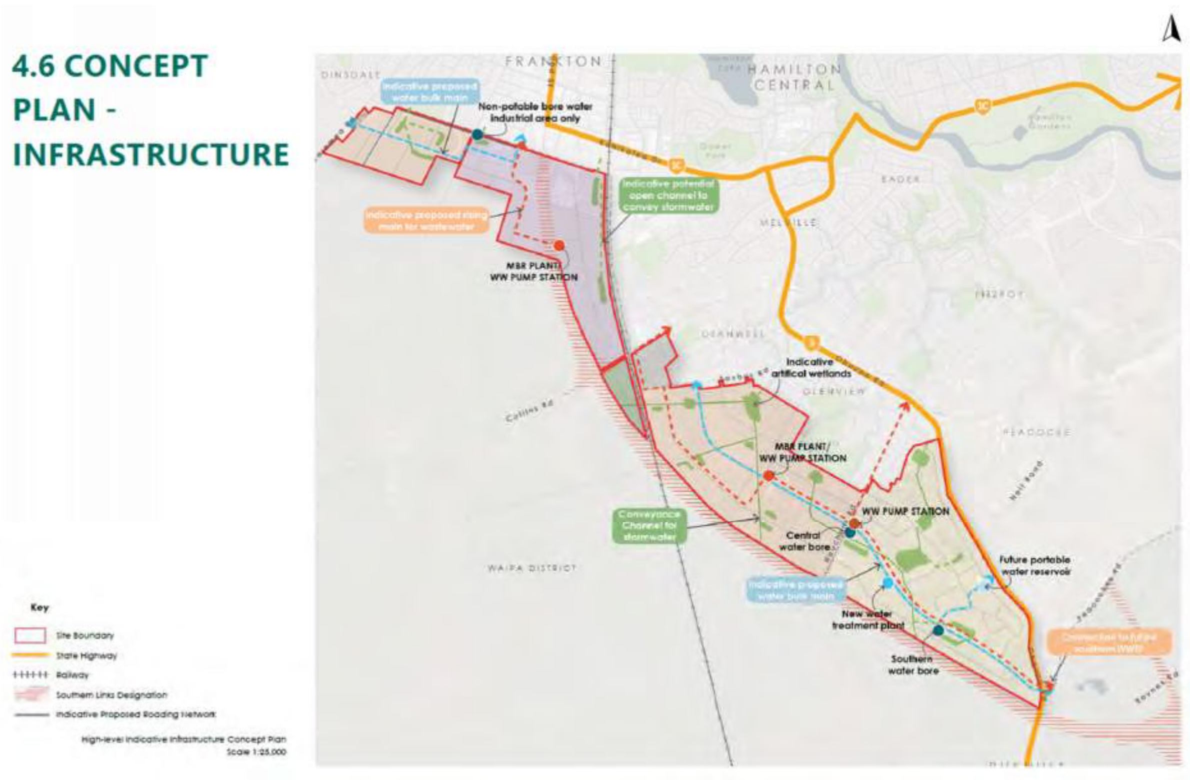


Figure 7 – Concept Infrastructure Plan

5.1. Existing Public Infrastructure

Hamilton has one centralised wastewater treatment plant in Pukete, that currently treats the wastewater for the entire city. HCC will be spending $56 Million to upgrade the existing plant, to provide additional capacity and to upgrade the secondary treatment process at the plant. The upgrade works to the existing plant started in 2018 and are due to be completed by the end of 2024. The upgraded plant will provide for the quality, capacity and security of Hamilton's wastewater treatment plant for the next 30 years.

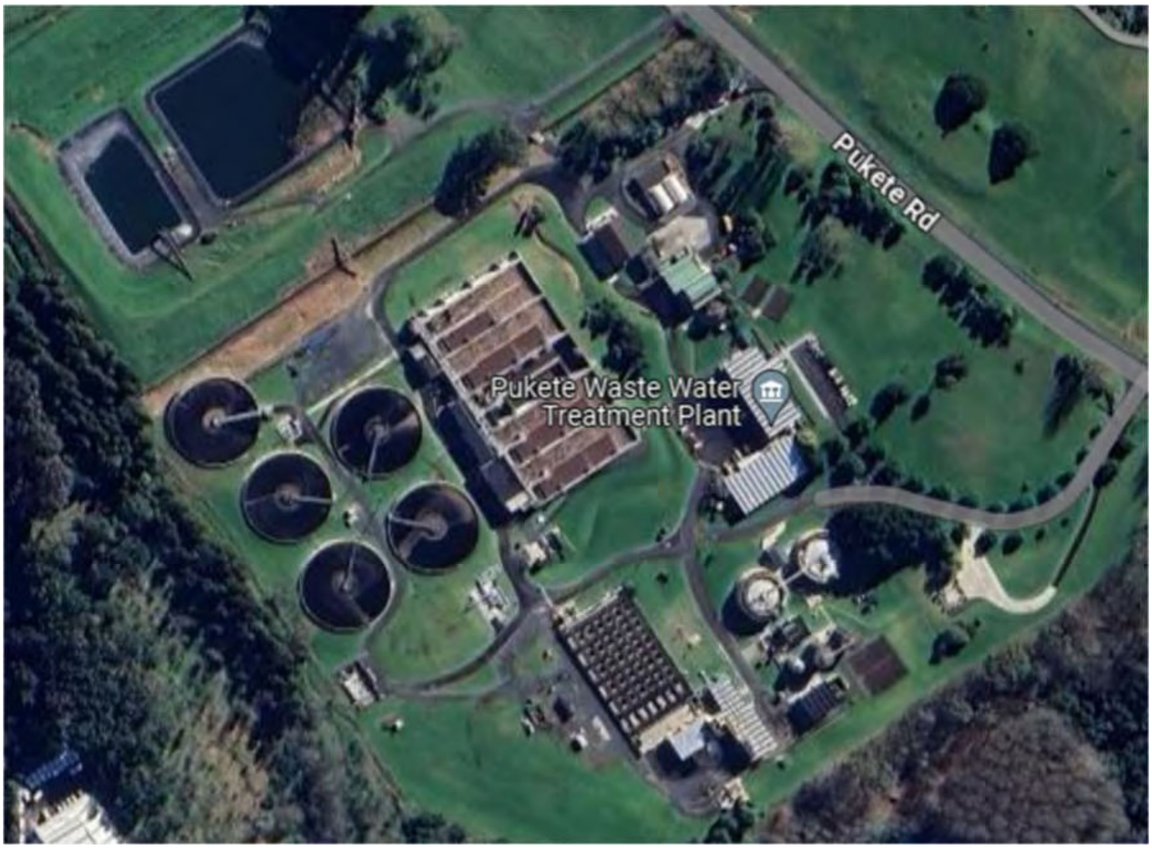


Figure 8 Pukete Wastewater Treatment Plant (Google Map)

5.2. Proposed Public Infrastructure

A new Peacocke wastewater transfer station is currently being built and is due to be completed by the end of 2024. The new wastewater transfer station is located opposite the existing the Hamilton water treatment plant.

The wastewater transfer station will hold up to 1.8 million litres of wastewater. The wastewater will be pumped over the new bridge across the Waikato River, through to the eastern wastewater interceptor. 7.1km of new wastewater pipeline will be constructed to make the connection to the eastern wastewater interceptor. The infrastructure will provide for the wastewater needs of the 21,000 future residents of the new Peacockes suburb. The screen shot shown below is an aerial photo taken of the Peacocke wastewater transfer station during construction.

Figure 9 Peacocke Wastewater Transfer Station (HCC GIS)

New bulk underground wastewater storage tanks are currently being installed in the reserve area between Collins Road and Katherine Place. The new bulk underground wastewater storage tanks will provide an extra 2 million litres of wastewater storage to the existing network. Installing these tanks will provide further resilience to the existing wastewater network for the area and it will reduce the risk of overflows after heavy rainfall events.

Figure 10 Collins Road underground wastewater storage tanks (HCC)

5.3. Reticulation

The site topography is generally flat, SL1 would be predominantly serviced by gravity mains, that would drain to intermediary pump stations located in the low points throughout the development. The intermediary pump stations will transfer wastewater through the site for discharge to the existing HCC wastewater network.

We have not undertaken an in-depth review of the existing network capacity, however connection into the existing reticulation will be challenging, as the network bordering SL1 has overflow and capacity issues identified by previous analysis undertaken by HCC.

To address these issues HCC have been upgrading the existing wastewater treatment plant in Pukete to provide more treatment capacity and they are, also introducing new large underground wastewater storage tanks in 8 new locations around the city. The underground tanks will provide additional wastewater holding capacity for the wet weather flows and the tanks that will release the wastewater back to the treatment plant at off peak times. The first location selected is in Collins Road, near the SL1 development. A new assessment of the existing network capacity should be considered post the public network upgrades covered above.

Given the volume of additional flows forecast by the 438ha development, discharge of additional wastewater to the HCC network will compound these issues, so strategic capacity upgrades (covered below) are likely before significant development can progress. Connection to the existing network will likely need to be split into separate sub catchments and development will be limited to the capacity of the existing downstream network, where connections are made into the existing network.

5.4. Strategic Wastewater Connections

HCC has prepared a draft ICMP for the Mangakotukutuku Catchment (Consultation revision November 2020). The ICMP summarises infrastructure planned for zoned growth and options for hypothetical growth. SL1 falls within the Hahawaru Sub-catchment of this ICMP and as such will need to comply with the requirements of the ICMP (if adopted) and RITS unless agreed otherwise by Council. The ICMP has identified options for wastewater infrastructure needed to service the Hahawaru Sub-catchment.

5.5. Discharge to existing local HCC infrastructure

Connection into the existing HCC infrastructure would be the preferred option, the wastewater options are discussed further in section 5.7.

5.6. Discharge via Peacockes strategic infrastructure

Connection to the Peacockes strategic infrastructure, could provide some wastewater capacity to support a portion of the SL1 development and for the wider Hahawaru Sub-Catchment, in the short term or long term.

The Peacocke wastewater transfer station has been designed to solely service the Peacocke development and given it is a considerable distance from SL1 this option will no longer be further investigated.

5.7. Discharge to a new wastewater treatment plant

The Mangakotukutuku ICMP references The Metro Spatial Plan investigations into strategies for wastewater servicing for Hamilton and the surrounding settlements. As Hamilton City grows, the Pukete Wastewater Treatment Plant will be limited by the population equivalent that it can realistically treat, so resilience will be required within the network to support growth.

HCC have included constructing a new wastewater treatment plant in their long-term plan with an estimated start date of 2030. The exact timing is still to be confirmed by council, however some funding towards the treatment plant may shift the start date. This option should be further investigated and discussed with council.

HCC have suggested providing funding towards the wastewater treatment, they also said they would not provide for conveyance to the plant. There may be an opportunity to negotiate with HCC to construct the pipeline to the wastewater treatment plant, which would provide for SL1 development and for the surrounding areas, as a contribution towards the plant infrastructure.

5.8. Alternative Treatment Options

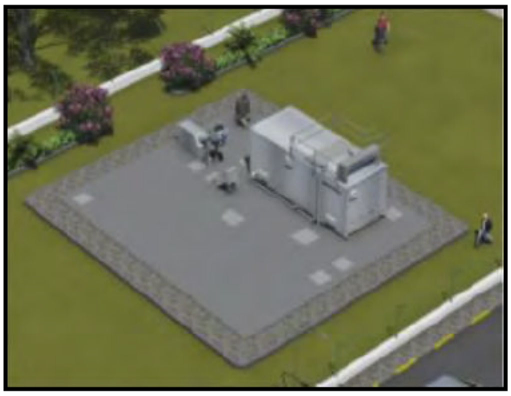
Recognising the issues and constraints around traditional centralised solutions identified above, Maven have considered “at source” and “decentralised” wastewater treatment solutions.

5.9. At Source treatment

At source wastewater treatment solutions were considered, but discounted, as treatment devices will significantly reduce the available yield that can be achieved due to the need for large lot sizes to provide for sufficient secondary treatment area rendering development in the area unfeasible.

5.10. Decentralised Treatment

Centralised approaches identified in the Mangakotukutuku ICMP will offer long term viability for development of SL1, however, prohibitive costs and programme to implement capital infrastructure for surrounding areas and downstream capacity upgrades could unnecessarily delay or prolong initial development of the SL1 area. If early release of initial stages is desired, then MBR package plant technology could be a viable and affordable medium-term alternative.



Recent advances in MBR technology have enabled package plants to be implemented to land development projects elsewhere in New Zealand (case studies presented in Appendix H). The benefits of doing so would avoid capacity constraints on existing infrastructure and enable early release of developable areas. Whilst treated liquid waste is "clean" and can be discharged to a stream environment, consideration would need to be given to the effects of such discharge into the environment for water quality, soakage (especially in low lying peat areas), and subsequent water table mounding and flooding. Due to these constraints, it is likely that package plants would only be suitable interim stages of development, in good ground away from peat, and when strategic infrastructure is likely to be considerably delayed. Refer to (Appendix H) for the MBR/Aeration wastewater case study. Treated wastewater flows will discharge into an artificial wetland.

Model Number	Capacity (m3/day)	People (ep)	Foot Print (ca.) L X W (m)
MW-M25	25	166	7 x 2
MW-M75	75	500	13 x 3
MW-M150	150	1000	14 x 4
MW-M300	300	2000	16 x 5

Figure 11 Mena Water MBR/Aeration Treatment sizes

5.11. Feedback from Hamilton City Council

HCC said they would not support decentralised wastewater treatment and therefore the MBR/Aeration plants would need to remain under private ownership. The developers were happy with this arrangement if it is for the short to medium term. HCC had concerns with discharging the treated wastewater from the MBR/Aeration plants, directly to the wetlands and Maven clarified this would be to offline artificial stormwater wetlands, discharge from MBR/Aeration plants would only be proposed at acceptable water quality levels, alternatively there is the option to discharge to land instead. HCC said they currently have no existing capacity for SL1 to connect into the existing wastewater network. Further consultation with HCC will be required to consider options.

HCC said they are working on a design of a new Southern Wastewater treatment plant (WWTP) and the programmed construction would start in 2027. HCC said their preference would be to invest into the southern WWTP for the SL1 instead of implementing decentralised wastewater treatment. HCC said they would not provide any funding towards the conveyance to the Southern WWTP for SL1.

5.12. Option One – Develop the proposed wastewater network to service SL1

5.12.1. Northern Catchment

The northern catchment is the block of land to the west of the existing railway line, that has a total catchment area of 149Ha. The northern catchment will include new medium density residential and industrial development. To service the northern catchment area, the wastewater could be pumped to make a connection into the western interceptor at the intersection of Greenwood Street and Kahikatea Drive.

If there are capacity issues within the network, underground storage tanks could be used to provide wastewater detention and the wastewater would discharge back network at the off-peak times.

5.12.2. Central Catchment

The central catchment is the block of land to the east of the railway and between Collins Road and Houchens Road and it has a total catchment area of 169Ha. The central catchment will include new medium to high density housing and some commercial development. To service the central catchment area, the wastewater could be pumped to connect into the existing trunk wastewater lines at the intersection of Collins Road and Prisk street. When the southern wastewater treatment plant is operational, most of the wastewater could be redirected to the southern wastewater treatment plant.

If there are capacity issues within the network, underground storage tanks could be used to provide wastewater detention and the wastewater would discharge back network at the off-peak times.

To address capacity issues, portable MBR/Aeration wastewater treatment plants will be considered to treat the wastewater onsite as a short to mid-term solution. The number of MBR/Aeration units required onsite will increase over time, as the site is further developed to meet the new demand requirements.

5.12.3. Southern Catchment

The southern catchment is the block of land east of Houchens Road, that has a total catchment area of 176Ha. The southern catchment will include new medium density residential development and some commercial development.

To service the southern catchment the wastewater, a new pumpstation is proposed at the intersection of the new collector and Houchens Road. The wastewater would be pumped up Houchens Road and then it would continue along Ohaupo Road to tie in with the existing 225 dia. trunk main, located near the intersection of Ohaupo Road and Dixon Road. If the Peacocke development can provide for some wastewater servicing near SL1 it will be considered. When the southern wastewater treatment plant is operational, most of the wastewater could be redirected to the southern wastewater treatment plant. If

5.13. Option two – Develop the proposed network and use decentralised wastewater treatment

Preference would be to connect into the existing network where possible as covered above. For the areas through the development that cannot be serviced by the existing network, MBR/Aeration plants would be installed to provide wastewater treatment for final discharge to offline artificial wetlands or land. The MBR/Aeration plants would be used for the short to mid-term to service these areas.

If there are areas identified that cannot be serviced by existing infrastructure, portable MBR/Aeration wastewater treatment plants will be considered. They will provide wastewater treatment onsite for the short to mid-term. Treated wastewater from the MBR/Aeration plants would be discharged to artificial wetlands or land and not directly into existing waterways. The number of portable MBR/Aeration units required onsite will increase over time, as the site is further developed to meet the new demand requirements. When the existing network has been upgraded and can now service the development, the wastewater will be redirected to the existing network and the MBR/Aeration plants decommissioned.

HCC have said they will not support decentralised wastewater options and therefore these MBR/Aeration plants would need to be privately owned and managed for the duration of their operations. Conditions on the property titles should include maintenance costs for running the MBR/Aeration plants will be covered by the new property owners, until the wastewater is connected into the public network.

5.14. Recommendation

Option one to connect into the existing wastewater network would be the recommended option, as this would be a long-term solution and maintenance would then be transferred over to HCC from the developers. We recommend further consultation with HCC to confirm details of the proposed southern wastewater treatment plant; and to confirm what servicing they will be able to provide in the short to long term for SL1.

6. Water

Maven have undertaken a desktop study to identify the most suitable option for potable water for the SL1 area. Reticulated and decentralised solutions have been considered. Refer to (Appendix B) for the proposed water layout drawing.

6.1. Existing Public Infrastructure

Hamilton has one centralised water treatment plant located at 1A Waiora Terrace, Fitzroy, Hamilton, that currently treats the water from the Waikato River that provides water supply for the vast majority of Hamilton city.

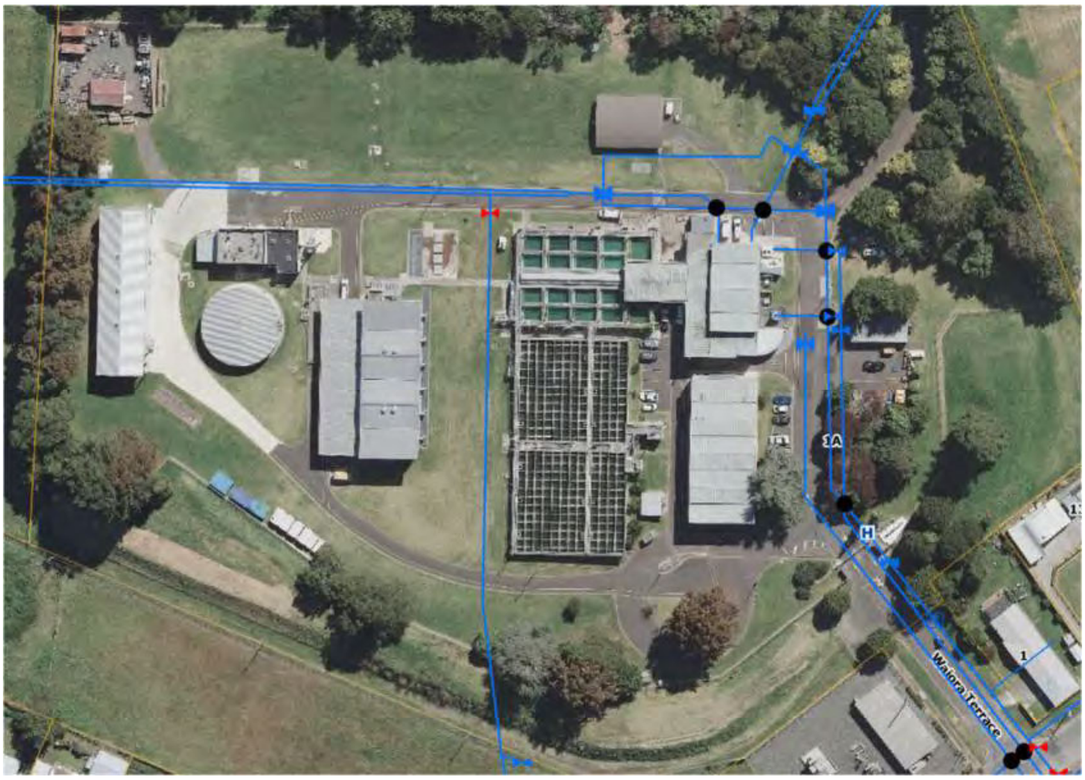


Figure 12 Hamilton Water treatment Plant

The existing Hamilton south reservoir which is located at 3122 Ohaupo Road, and it is located within the SL1 designation area. The reservoir currently services the surrounding areas, and it will provide some water supply to the Peacockes development.

Figure 13 Hamilton South Reservoir

The original 750 DICL water supply trunk main to the reservoir was installed in 2005. A new 560OD HDPE bulk water main was installed from the reservoir to the Hamilton water treatment station located at 1A Waiora Terrace in 2017. The bulk water main was to provide resilience for the existing water supply for the reservoir and to provide for the future demands of a proposed second water reservoir.

6.2. Proposed Public

A new reservoir is proposed to be built next to the existing reservoir to provide water supply for the Peacocke Development this could potentially provide for the SL1 development through further consultation with HCC.

6.3. Reticulation and Capacity

Reticulation will be designed to provide SL1 with a suitable means of potable and firefighting supply.

We have not undertaken an in-depth review of the existing network; however, Mott MacDonald was commissioned by Golden Valley Farms to assess the system performance in terms of Level of Service (LOS) and firefighting capacity within the eastern residential area of SL1.

Mott MacDonald assessed system performance for the 2013, 2021, 2041 and 2061 peak day scenario of the existing network considering demand resulting from the proposed Golden Valley Farm development which equates to around 25% of the SL1 area. Without any network upgrades, Mott MacDonald concluded that residential fire flow requirements could not be met for any scenario.

Mott MacDonald identified that connecting to the Hamilton South reservoir supply main and likely upgrades to the Water Treatment Plant delivery pump(s) and the Hamilton South Reservoir filling main would allow levels of service to be met both in the development and in the remainder of the network.

In addition to upgrades required to meet minimum levels of service, it can be assumed that localised capacity upgrades of pipelines and / or new infrastructure is required to provide reticulation to SL1, and this covered further in the options section 6.7.

6.4. Strategic Upgrades

HCC has prepared a draft ICMP for the Mangakotukutuku Catchment (Consultation revision November 2020). The ICMP summarises infrastructure planned for zoned growth and options for hypothetical growth. SL1 falls within the Hahawaru Sub-catchment of this ICMP and as such will need to comply with the requirements of the ICMP (if adopted) and RITS unless agreed otherwise by Council. The ICMP has identified options for water infrastructure needed to service the Hahawaru Sub-catchment.

Hamilton water infrastructure bordering SL1 is fed by the Hamilton South Reservoir. This reservoir is filled by a dedicated filling line from the Water Treatment Plant to the north of Peacockes.

No allowance is made within the HCC Water Master Plan to supply water to SL1. The Mangakotukutuku ICMP does, however, propose a second reservoir located in the south-eastern portion of SL1 adjacent to the existing Reservoir. This reservoir would need to be filled by a second dedicated filling line from the Water Treatment Plant to the north of Peacockes and whilst the intent of such infrastructure is to service Peacockes, recognition in the HCC Water Master Plan would enable engagement around futureproofing of strategic pipelines and associated infrastructure for SL1.

6.5. Alternative Supply Options

In addition to the centralised solutions identified above, a hydrogeological desktop review of SL1 was undertaken by WGA (May 2021) to consider groundwater as a potable water solution. Refer to (Appendix G) for the WGA report for further details.

Whilst centralised approaches offer long term viability for development of SL1, prohibitive costs and programme to implement capital infrastructure for surrounding areas could delay initial development. If early release of initial stages is desired, then using ground water could provide a transition period for development to occur. In addition to a transition period, groundwater could also provide increased security for water supply to the Hamilton South Reservoir, against seismic events that could disrupt water supply to the reservoir.

Further information is contained within the desktop review by WGA May 2021 in (Appendix G).

6.6. Feedback from Hamilton City Council

HCC said there are potential licensing issues and supply issues for using water bores within, however this is managed by WRC, and they would need to confirm the suitability to use water bores for SL1.

Maven asked if the existing reservoir or the proposed water reservoir could service SL1, and they said the new reservoir was reserved for servicing the Peacocke development. Maven asked if the water reservoir could be upsized to also provide water supply for SL1 and they said SL1 would have different pressure requirements and therefore not suitable.

HCC suggested contacting Waipa district council to see if they had extra capacity in their network that could provide water supply for SL1.

6.7. Option One – Develop the proposed water network to service SL1

6.7.1. Northern Catchment

The northern catchment is the block of land to the west of the existing railway line. The northern catchment will be split into medium density residential and industrial. The medium density residential area to the west has a total catchment area of 44.2Ha and the industrial area has a total catchment area of 104.3Ha.

To service the whole northern catchment, we would look to install a new 355OD HDPE portable water bulk main. The new bulk main would connect to the existing 250 AC trunk water main in Tuhikaramea Road and it will run through the site before it would terminate at the existing 620 SSCL water bulk main, located at the intersection of Greenwood Street and Kahikatea Drive.

6.7.2. Central Catchment

The central catchment is the block of land from Collins Road through to Houchens Road and it has a total catchment area of 177.5Ha. The central catchment will include new medium density residential, high density residential and some commercial development.

To service the central catchment a new 450OD HDPE trunk water line would be installed, along the central collector that would start at Houchens Road, and it would terminate at Saxbys Road.

6.7.3. Southern Catchment

The southern catchment is the block of land to the east of Houchens Road, and it has a total catchment area of 175.5Ha.

A new water reservoir would be constructed next to the existing southern water reservoir that would provide water supply for SL1. To provide water supply to the new reservoir, a new 560OD HDPE water bulk main would be installed between the new reservoir to the existing 560OD HDPE water bulk main, located on Ohaupo Road.

A new 450OD HDPE water trunk main would be installed between the new water reservoir through to the new collector road. The new water trunk main would also run along the full length of the new collector road.

Proposed sizing for water trunk/bulk mains are preliminary only and will need to be confirmed during future design in consultation with HCC.

6.8. Option two - Develop the proposed network and use ground water bores

Preference would be to connect into the existing network where possible as covered above. If there are areas identified that will not be able to be serviced by the existing water infrastructure, then water bores would be considered.

WGA have completed water bore testing in a few test locations around the site, and they have confirmed there are underground aquifers that would be suitable for water supply. Three potential water bore locations have been identified in the three main catchment areas.

For the central and southern catchment water bores, they would pump raw ground water to a water treatment plant mid-way between the two water bores for water treatment. The treated water would then feed into the 450OD PE trunk water mains for water supply to the southern and central catchment areas. For the northern water bore it would not pass through any water treatment and the raw water would only provide water supply to the industrial areas.

The number of MBR units required onsite will increase over time, as the site is further developed to meet the new demand requirements. Containerised water treatment plants would be required to treat the water supplied from each bore, for it to be suitable for portable water supply. HCC said WRC manage consents to use groundwater bores and we would need to confirm with WRC if they would support it.

6.9. Recommendations

Option one to connect into the existing wastewater network would be the recommended option, as this would be a long-term solution and maintenance would then be transferred over to HCC from the developers.

We recommend arranging a meeting with WRC to confirm if they will allow for new water bores to be established within SL1. We should also discuss the feasible options with HCC for a new water reservoir to service SL1.

7. Services

We have received service provisions from the service providers for power, gas and fibre for servicing SL1, refer to Appendix J.

8. Development Stages

8.1. Residential Stage 1

8.1.1. Site Description

The SL1 Stage 1 residential area is a circa 46ha block of land within Dinsdale South. Most of the site is low-lying flat farmland and the Mangakootukutuku stream passes through the middle of the site. From the CMW report it has indicated that the site has predominantly peat subsoils at depths generally under 2m.

8.1.2. Proposed Development

The proposed development is to provide medium to high density housing and to develop the infrastructure to support this development and to provide recreational facilities. The site will be split into 5 separate substages that will be split by the mainstream tributaries. The design and layout of the Stage 1 Residential Sub-Staging Plan (Figure 14 Staging Plan concept prepared by Barker & Associates, shown below) has been developed through ongoing consultation and collaboration with developers.

Figure 14 – Stage 1 Residential Sub-Staging Plan

8.1.3. Stormwater

A preliminary Stormwater Management Plan (SMP) has been developed for SL1 to set out the best practice framework for stormwater management. The stormwater is currently managed by the existing wetlands, farm drains and culverts to convey the surface runoff through the site.

The SMP has been further developed to provide the stormwater strategy details specific to the residential stage 1. Please refer to (Appendix A) for the Stormwater Management Plan and (Appendix K) for the stormwater layout drawings.

8.1.4. Wastewater

Maven have undertaken a desktop study to identify the most suitable option for wastewater disposal for the SL1 residential stage 1 area. Reticulated, decentralised, and at source solutions have been considered.

The site is in a rural location and there is no pre-existing infrastructure within the site to service the proposed development. A staged approach in developing the proposed infrastructure will likely be adopted, with a preference to connect into the existing wastewater infrastructure where possible. Further discussions will be held with HCC to see if they would be any provision to make a minor wastewater connection to the existing network to manage a portion of this development stage. Please Refer to (Appendix K) for the Wastewater Drainage option drawings. For the wastewater calculations refer to (Appendix L).

The wastewater calculations are summarised in the table below.

SL1 Stage 1 Residential Wastewater			
Stage	Area (Ha)	Population	Peak Flow (l/s)
1A	8.0	933	8.22
1B	3.1	350	3.67
1C	6.9	991	8.38
1D	2.6	282	9.70
1E	3.6	538	4.89
1	24	3093	24.58

The SL1 stage 1 residential substages will be serviced by a wastewater gravity reticulation network through stage 1. The wastewater will be directed to a new wastewater pumpstation that will be located within the reserve area, which will be connected to underground storage tanks. The underground wastewater storage tanks will provide wastewater attenuation storage and emergency storage.

The wastewater from the storage tanks will be pumped during the off-peak times via a new wastewater rising main, through to the existing trunk wastewater manhole WWX23125 that is located within Ohaupo road. The emergency option will involve utilising sucker trucks to remove the stored wastewater from the storage tanks.

A new wastewater rising main will need to be constructed from the new pumpstation to the existing trunk manhole WWX23125. The new wastewater rising main route options that are been considered are as follows:

- Option 1 - The rising main would start from the wastewater pumpstation and it would head east along the new collector road, before passing through the Waikato Softball Association carpark area heading north towards John Webb Drive. The rising main would follow John Webb Drive heading east towards Houchens Road and then follow Houchens Road north through to Ohaupo Road and then it would terminate at the public trunk wastewater manhole WWX231235 in Ohaupo Road. Refer to drawing WD510 in Appendix K.
- Option 2 – the rising main would start from the wastewater pumpstation and it would head east along the new collector road through to Houchens Road. The rising main would then head north along Houchens Road through to Ohaupo Road and then it would terminate at the public trunk wastewater manhole WWX2231235 in Ohaupo Road. Refer to drawing WD511 in Appendix K.

8.1.5. Recommendations

Option 1 would require landowners' approval to bring the wastewater rising main through carpark area and a service easement would be required for the rising main and Route Option 2 would remain within the public road area. Option 2 would be the recommended option and it is generally in line with the long-term solution, to redirect the wastewater from SL1 to the new Southern Wastewater treatment plant via new trunk wastewater rising main.

8.1.6. Water

Maven have undertaken a desktop study to identify the most suitable option for potable water for the SL1 stage 1 residential area. Reticulated and decentralised solutions have been considered. Please Refer to (Appendix K) for the Water supply option drawings. For the water supply calculations refer to (Appendix M).

There is an existing water reservoir located approximately 2km east of the stage 1 development. From earlier consultation with HCC, they said the existing reservoir is already at full capacity and a new water reservoir will be constructed next to the existing reservoir, to provide water supply for the new Peacocke's Development.

Further discussions will be held with HCC to see if they would be any provision to make a minor water supply connection to the existing network to manage a portion of this development stage.

The water supply calculations are summarised in the table below.

SL1 Stage 1 Residential Water			
Stage	Area (Ha)	Population	Peak Flow (l/s)
1A	8.0	933	14.04
1B	3.1	351	5.28
1C	6.9	990	14.9
1D	2.6	282	4.24
1E	3.6	537	8.08
1	24.2	3093	46.54

The SL1 stage 1 residential substages will be serviced by a water reticulation network through stage 1 development area. A new trunk water main will be constructed from stage 1 to connect into the existing trunk water network to provide water supply. The following two options are being considered:

- Option 1 – The trunk water main would follow the new collector road east through to Houchens Road and then head north along Houchens Road to Ohaupo road. The trunk water main would then head east along Ohaupo road to connect into the 450mm HDPE trunk water main before the intersection of Ohaupo and Dixon Road. Refer to drawing WD610 in Appendix K.
- Option 2 - The trunk water main would follow the collector road east to Houchens Road and then it would continue east along the collector road before heading north to connect into the new water reservoir. Refer to drawing WD611 in Appendix K.

8.1.7. Recommendations

Option 1 can provide water supply for stage 1 from an existing trunk water main which is closer than the proposed reservoir. Option 2 would require large capital costs for constructing the new water reservoir and it could also delay the development if the new water reservoir is not built within the agreed timeframes. Option 1 would be our recommended option to service stage 1. When the future stages get developed near the water reservoir, that would be a more suitable time to construct the new trunk line to the new water reservoir.

8.2. Industrial Stage 1

8.2.1. Site Description

The SL1 Stage 1 industrial area is a circa 80ha block of land within Frankton South. Half of the site is currently industrial, and the remainder of the site is low-lying flat farmland. From the CMW report it has indicated that the site has predominantly peat subsoils at depths generally over 2m.

8.2.2. Proposed Development

The proposed development is for proposed Industrial and for developing the infrastructure to support the development. The site will be split into 4 separate substages. The design and layout of the Stage 1 Industrial Sub-Staging Plan (Figure 15 Staging Plan concept prepared by Barker & Associates, shown below) has been developed through ongoing consultation and collaboration with developers.

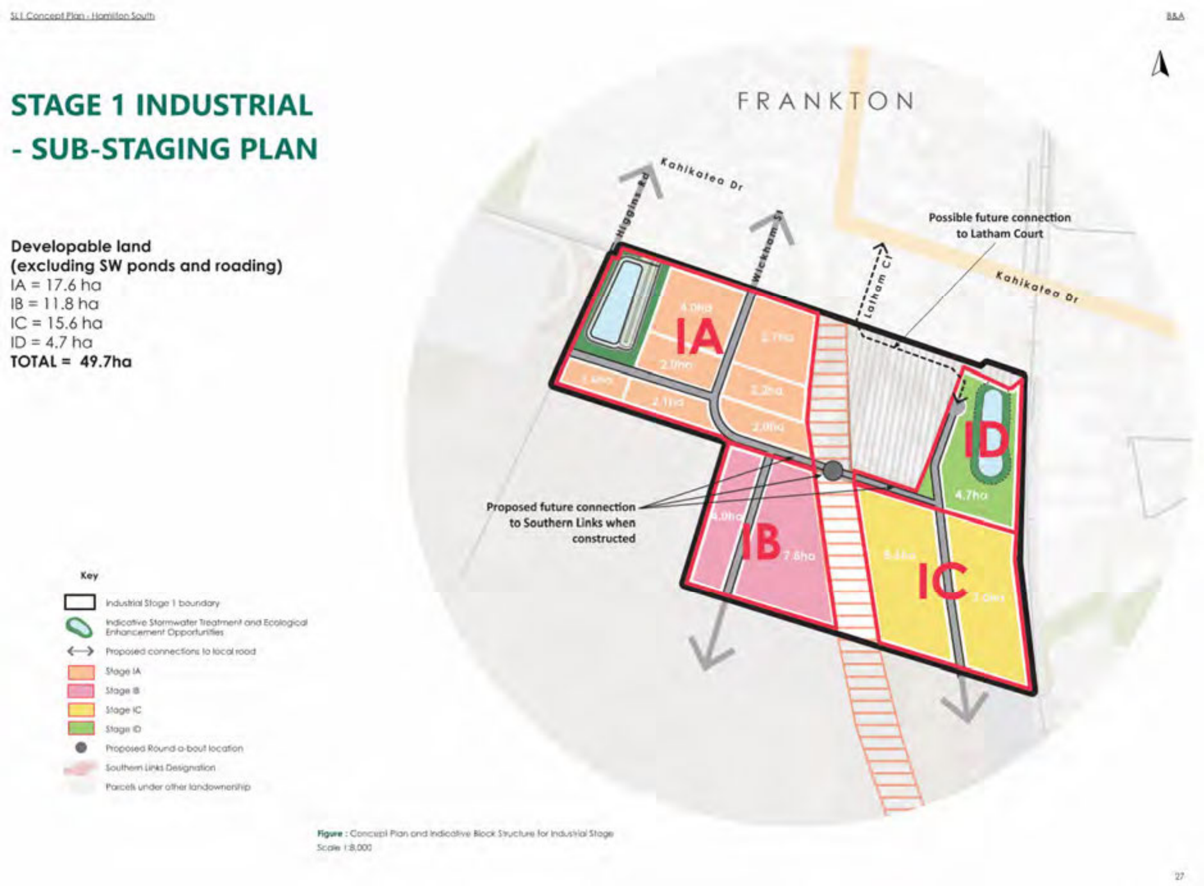


Figure 15 – Stage 1 Industrial Sub-Staging Plan

8.2.3. Stormwater

A preliminary Stormwater Management Plan (SMP) has been developed for SL1 to set out the best practice framework for stormwater management. The stormwater is currently managed by the existing wetlands, farm drains, stormwater channel, piped reticulation to convey the surface runoff through the site.

The SMP has been further developed to provide the stormwater strategy details specific to the industrial stage 1. Please refer to (Appendix A) for the Stormwater Management Plan and (Appendix K) for the stormwater layout drawings.

8.2.4. Wastewater

Maven have undertaken a desktop study to identify the most suitable option for wastewater disposal for the SL1 industrial stage 1 area. Reticulated, decentralised, and at source solutions have been considered.

The site is in a rural location and there is no pre-existing infrastructure within the site to service the proposed development. A staged approach in developing the proposed infrastructure will likely be adopted, with a preference to connect into the existing wastewater infrastructure where possible. Please Refer to (Appendix K) for the Wastewater Drainage option drawings. For the wastewater calculations refer to (Appendix L).

The wastewater calculations are summarised in the table below.

SL1 Stage 1 Industrial Wastewater			
Stage	Area (Ha)	Population	Peak Flow (l/s)
1A	17.6	792	8.59
1B	11.8	531	6.00
1C	15.6	702	7.61
1D	4.7	212	2.83
1	49.7	2237	21.66

The SL1 stage 1 industrial substages will be serviced by a wastewater gravity reticulation network through stage 1. The wastewater will be directed to a new wastewater pumpstation that will be located within 1A in the southeastern corner, which will be connected to underground storage tanks. The underground wastewater storage tanks will provide wastewater attenuation storage and emergency storage.

The wastewater from the storage tanks will be pumped during the off-peak times via a new wastewater rising main, to connect into the existing public wastewater network. The emergency option will involve utilising sucker trucks to remove the stored wastewater from the storage tanks.

The new wastewater rising main route options that been considered:

- Option 1 – Construct the rising main from the pumpstation and it will head east following the new roads through to Higgins Road extension. The rising main would then head north following Higgins Road extension, before heading west following the stormwater channel before connecting into the wastewater pumpstation SPS119, which is located within the reserve area near the end of Karen Crescent. Refer to drawing WD512 in Appendix K.
- Option 2 - Construct the rising main from the pumpstation and it will head east following the new roads through to Higgins Road extension. The rising main would then head north following Higgins Road extension and then connect into the existing wastewater manhole WWU16003 at the intersection of Higgins Road and Kahikatea Drive. Refer to drawing WD513 in Appendix K.

8.2.5. Recommendations

Option 1 would be our recommended option it can provide a long-term solution by connecting into the trunk rising main and it will put less stress on the existing wastewater upstream networks, which may already be at capacity.

8.2.6. Water

Maven have undertaken a desktop study to identify the most suitable option for potable water for the SL1 stage 1 Industrial area. Reticulated and decentralised solutions have been considered. Please Refer to (Appendix K) for the Water supply option drawings. For the water supply calculations refer to (Appendix M).

There is an existing 620mm SSCL water bulk main located within the SH1 road corridor along Greenwood Street and Kahikatea Drive. HCC have said there is insufficient water supply to service SH1. If there is insufficient water supply to fully service stage 1, the water reticulation may only be extended for firefighting supply. Water supply would be provided through rainwater harvesting from roof water collection as a non-portable water source and onsite water treatment could be used to provide portable water.

The water supply calculations are summarised in the table below.

SL1 Stage 1 Industrial Water			
Stage	Area (Ha)	Population	Peak Flow (l/s)
1A	17.6	834	12.54
1B	11.8	559	8.41
1C	15.6	739	11.12
1D	4.7	223	3.35
1	49.7	2354	35.42

The SL1 stage 1 industrial substages will be serviced by a water reticulation network through stage 1 development area. A new trunk water main will be constructed from stage 1 to connect into the existing trunk water network to provide water supply. The following two options are being considered:

- Option 1 – The trunk water main would follow Wickham Street and then connect into the existing 250OD HDPE trunk water main on Kahikatea drive. Refer to drawing WD612 in Appendix K.
- Option 2 - The trunk water main would connect into the existing 200mm OPVC water main at the end of Higgins Road. Refer to drawing WD613 in Appendix K.

8.2.7. Recommendations

Option 1 can provide water supply for stage 1 from an existing trunk water main which is closer than the proposed reservoir. Option 2 would require large capital costs for constructing the new water reservoir and it could also delay the development if the new water reservoir is not built within the agreed timeframes. Option 1 would be our recommended option to service stage 1. When the future stages get developed near the water reservoir, that would be a more suitable time to construct the water reservoir.

9. Conclusions

Stormwater drainage can be provided for SL1 through wetlands, ground water recharge and piped stormwater networks. Overland flow paths will be managed through the development, and it will reduce any potential flooding risks. An overarching stormwater strategy has been developed, and this sets out the high-level, best practice approach for stormwater management within the catchment.

Wastewater drainage can be provided for SL1 though piped networks to intermediary pump stations that will transfer wastewater through the site for discharge into the existing HCC wastewater network. If the existing network cannot provide sufficient capacity for stages of the development decentralised portable onsite wastewater treatment will be implemented, until the downstream public network can support them.

Potable water can be provided for SL1 though water supply networks through the development and connection into the existing network. A potential new water reservoir may be constructed next to the existing southern water supply reservoir, to provide water supply to SL1. If the existing network cannot provide sufficient capacity for stages of the development, new water bores will be established a strategic locations and onsite portable water treatment devices will treat the water before entering the public water supply network.

Additional investigation work and detailed reporting for three waters and earthworks will be required to support future Structure Plans.

10. Limitations

The calculations and assessments included in this report are a 'desktop' analysis and are preliminary in nature based on information available at time of issue. To the best of our knowledge, it represents a reasonable interpretation of available information including the outcomes of the Mangakotukutuku ICMP which status is Draft for consultation at the time of this issue.

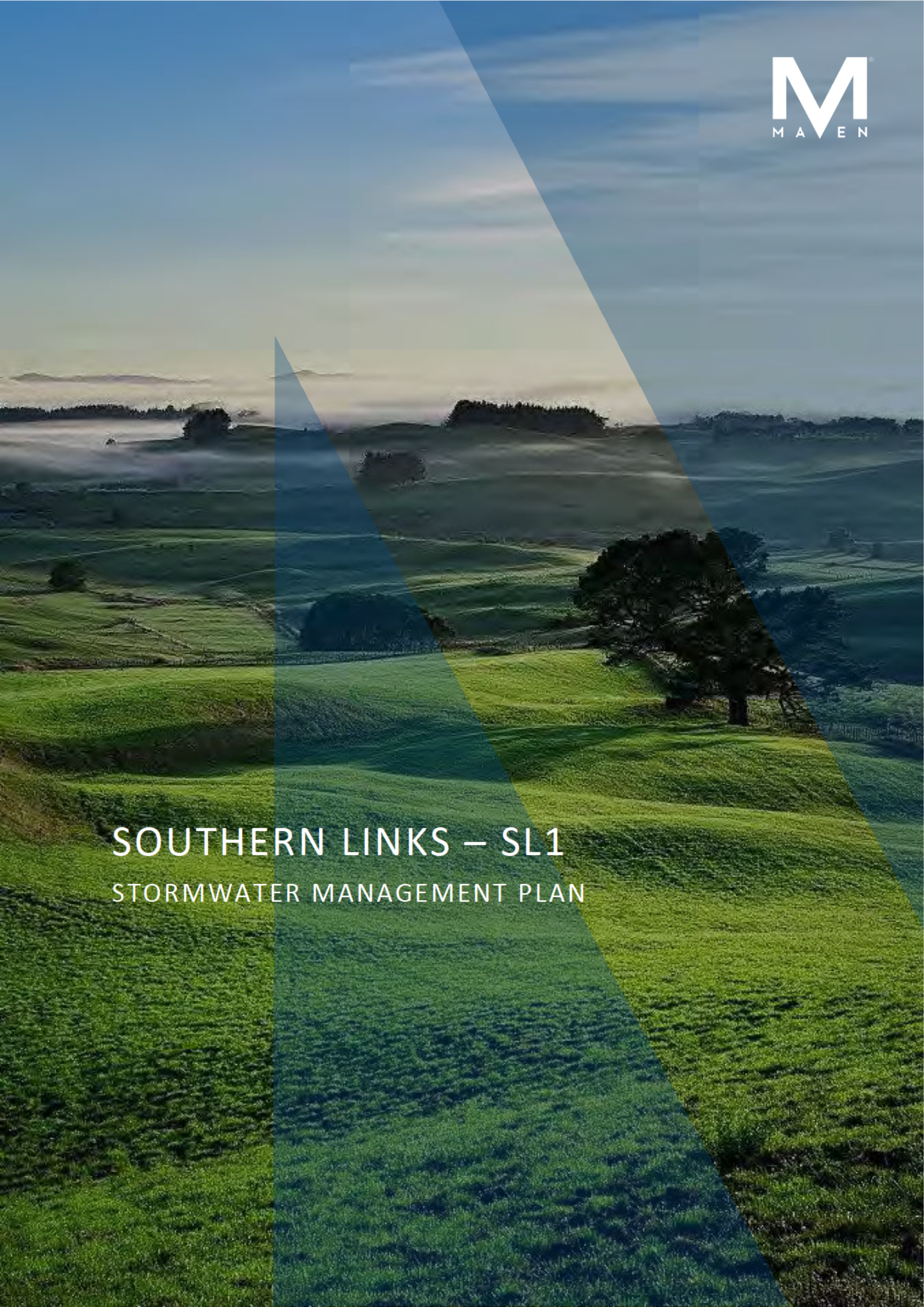
Depending on the outcome of the high-level Structure Plan, further community; stakeholder engagement; and feasibility investigations, including engineering design and calculations, will be required to determine the suitability of the areas proposed for industrial and residential development.

This report is solely for our client's use for the purpose for which it is intended in accordance with the agreed scope of work. It may not be disclosed to any person other than the Client and any use or reliance by any person contrary to the above, to which Maven has not given its prior written consent, is prohibited.

This report must be read in its entirety and no portion of it should be relied on without regard to the limitations and disclaimers set out.

Maven makes no assurances with respect to the accuracy of assumptions and exclusions listed within this report and some may vary significantly due to ongoing stakeholder engagement.

Appendix A – Stormwater Management Report



SOUTHERN LINKS – SL1

STORMWATER MANAGEMENT PLAN

PROJECT INFORMATION

CLIENT	Colliers NZ Ltd
PROJECT	298001

DOCUMENT CONTROL

DATE OF ISSUE	03/05/2024
REVISION	C
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Table of Contents

1. Introduction

1.1. Background

Maven Associates (Maven) have been engaged by developers within the boundaries of designated Southern Links area (SL1) to explore the feasibility of land development for residential and industrial use. This feasibility assessment is in support of a high-level Structure Plan for the SL1 area and an approach to the Future Proof to have the area recognised within the Future Proof Settlement Pattern.

Revision A of this report was issued to the client on the 15th of March, 2024. Maven have since been asked to provide an updated stormwater management report with a specific focus on the Stage 1 Development. Section 9 has been added to this report under revision B which includes further discussion on the stormwater strategy including proposed artificial wetlands and retention devices within the Stage 1 Development.

1.2. Purpose of this Report

The purpose of this report is to provide a high-level overarching Stormwater Management Plan (SMP) that supports the intended rezoning of the SL1 area and to provide the framework for future stormwater management plans.

The design and layout of the SL1 structure plan (concept plan prepared by Barker & Associates) has been developed through on-going consultation and collaboration with developers.

The calculations and assessments included in this report are a 'desktop' analysis and are preliminary in nature based on information available at time of issue. Depending on the outcome of the high-level Structure Plan, further community; stakeholder engagement; and feasibility investigations, including engineering design and calculations, will be required to determine the suitability of the areas proposed for industrial and residential development.

1.3. Catchment

The SL1 area is a circa 500ha block of land within Waipa District. The area has a northwest to southeast orientation from Dinsdale in the north to Rukuhia in the south. Most of the catchment is low-lying flat farmland, once a peat bog in pre-European times, interspersed with straight artificial farm drains.

To the southeast of the catchment, within the Saxbys and Houchens Road area bordering the HCC boundary, rolling hill topography and isolated elevated terraces feature with two main tributaries dividing the surrounding pastoral farmland.

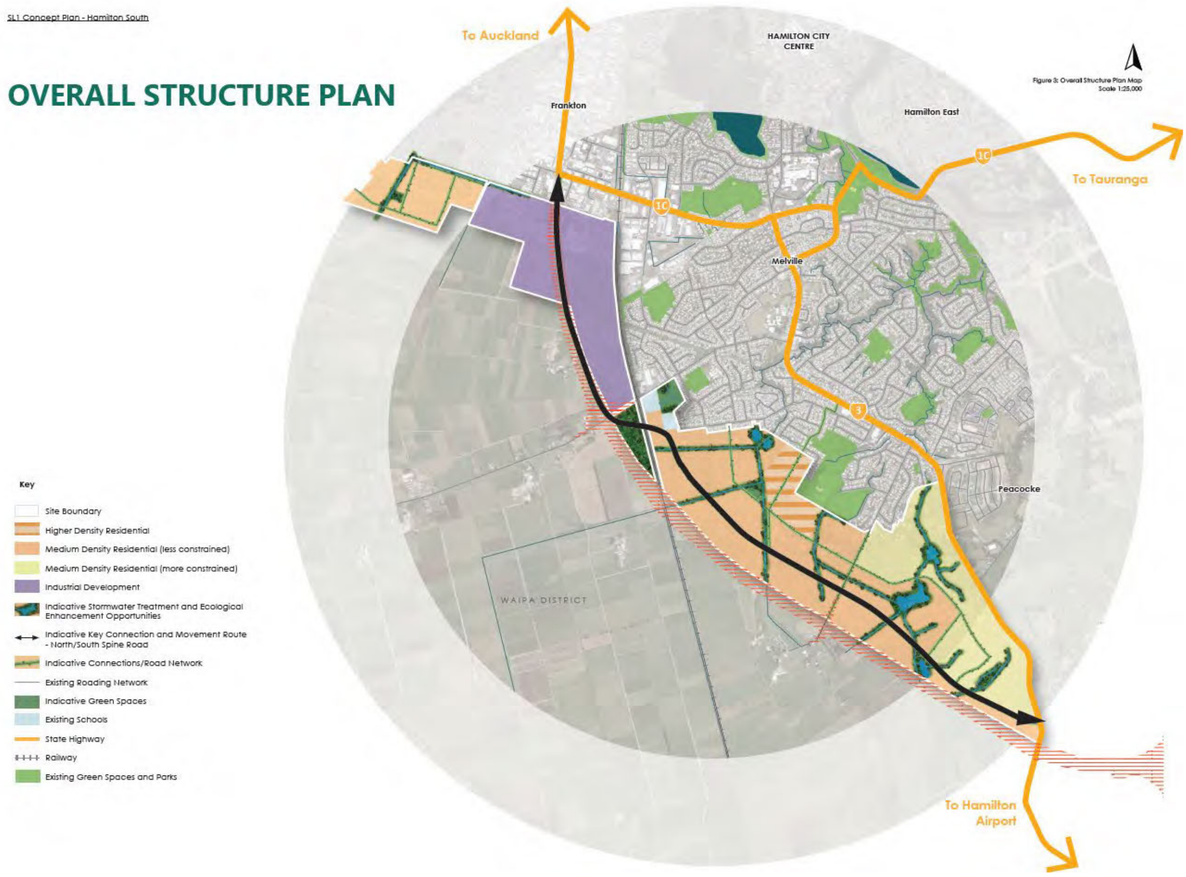


Figure 1 - Structure Plan

1.4. Objectives

As part of the structure plan process, an overarching SMP has been developed for SL1. The SMP sets out the high-level, best practice approach to stormwater management within the receiving catchment.

The strategy for the future stormwater management is outcome focused. The SMP provides a solution-based approach for the receiving environment. Consideration and emphasis is given to the inclusion of Water Sensitive Urban Design principles, with the overall goal of developing environmentally conscious outcomes which help address and mitigate known and future constraints of SL1.

Proposed objectives of the SMP are outlined below:

- Consideration of future public networks required in support of SL1. 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 SMP provides an option-based assessment for water quality treatment in support of the future development of SL1. 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 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.
- 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 SL1 and it is important to maintain underlying base flows of water into the streams to avoid any effects on stream biodiversity.
- The urbanisation of SL1 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 SMP creates a stormwater toolkit, which will guide future development of SL1. The toolkit will promote sustainable solutions including the integration of Water Sensitive Urban Design ('WSUD') principles in future land use planning.

2. Stormwater Reticulation

Existing stormwater infrastructure within SL1 is limited to farm/roadside drains and streams. Development of SL1 will be supported by new public stormwater networks. The future public networks would be constructed by developers, will be subject to Resource Consent and Engineering Approval before being vested to Hamilton City Council, post construction. Where possible, the network will be designed and constructed within public roads.

2.1. Stormwater Capacity

The primary reticulated network will be sized to convey the peak discharge for rainfall events up to and including 10-year $_{(cc)}$ ARI to the identified point of discharge. Calculations would need to be provided to Hamilton City Council in support of the detailed design of the new public network at Resource Consent and Engineering Approval stages. The future networks will need to demonstrate compliance with the Hamilton City Council standards for Subdivision and Land Development.

There is no overland flow predicted for the 10-year $_{(cc)}$ ARI event. During the 100-year $_{(cc)}$ event the stormwater runoff will be conveyed by overland flow paths within the proposed development, which will follow the road reserves (where possible) which in turn discharge into the existing watercourses and/or catchment detention solutions contained within SL1.

3. Stormwater Quality and Quantity

3.1. Statutory Context

Future stormwater discharge from SL1 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 is summarised below:

3.1.1. Waikato Regional Policy Statement (RPS)

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

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

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

Relevant objectives include:

1. Integrated management of natural and physical resources;
2. Restoration and protection of the health and wellbeing of the Waikato River;
3. Avoiding the potential adverse effects of climate change;
4. The relationship of tangata whenua with the environment is 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 fresh water bodies;
8. Maintain or enhance riparian areas and wetlands;
9. Historic or cultural heritage sites, areas or landscapes are protected or maintained;
10. Healthy, functioning ecosystems and indigenous biodiversity;
11. Maintenance and enhancement of amenity;
12. Protection of the natural character of wetlands and rivers and their margins;
13. Maintenance and enhancement of public access along rivers; and
14. The effects of natural hazards are managed.

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

This SMP supports achievement of the above Waikato RPS objectives. It integrates land-use and three-waters planning within SL1. The SMP 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.

3.1.2. Waikato Regional Plan

The Waikato Regional Plan is the principal policy tool that enables Waikato Regional Council to carry out its functions to achieve the sustainable management of resources within the Region. With respect to this SMP, the following modules of the Waikato Regional Plan are relevant: matters of significance to 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 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. Works in a stream bed – such as for culvert, bridge, pipeline or stormwater pipeline outfall construction or any stream diversion; and
2. Vegetation clearance and earthworks – including for management of sediment-laden runoff and dust;
3. Diversion and discharge of stormwater into water or onto or into land, including management of contaminants.

3.1.3. 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 will be enveloped by the CSDC if brought into Hamilton City via Future Proof. 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 Council's CSDC will not authorise them.

This SMP has been derived 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.

3.1.4. Mangakootukutuku Integrated Catchment Management Plan (Consultation revision November 2020)

Hamilton City Council has prepared a draft ICMP for the Mangakootukutuku Catchment, to which SL1 falls within. The Mangakootukutuku Catchment is in the southwest of Hamilton, with some headwater tributaries extending south across the boundary into Waipa District. The Mangakootukutuku stream flows into the Waikato River directly northeast of the intersection of Peacocke Rd and Norrie St. The SL1 area is wholly located within the Hahawaru sub-catchment.

The preparation of this SMP has been developed in accordance with the draft ICMP, as the future stormwater management within SL1 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 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. 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.

3.1.5. National Environmental Standards for Freshwater

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

The standards are designed to:

- protect existing inland and coastal wetlands.
- protect urban and rural streams from in-filling.
- ensure connectivity of fish habitat (fish passage).
- set minimum requirements for feedlots and other stockholding areas.
- improve poor practice intensive winter grazing of forage crops.
- restrict further agricultural intensification until the end of 2024.

- limit the discharge of synthetic nitrogen fertiliser to land and require reporting of fertiliser use.

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

3.1.6. Hamilton City Council Code of Practice for Subdivision and Land Development

The Regional Infrastructure Technical Specification (RITS) (Waikato Local Authority Shared Services, 2018) 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 and Hamilton District Plan 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 3.3.2.

SECTION 4 – STORMWATER UPDATED MAY 2018

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 2 – 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:

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% pre-development flow is required

3.2. 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 RITS does not currently provide guidance on which HIRDS climate change RCP to use. However, RITS section 4.2.4.4, notes the post-development design storm shall account for 2.1C climate change adjustment. This corresponds closest to an RCP 6.0 (2081-2100) which has been used to determine the 24-hour rainfall depth for each design storm. We note that HCC is currently reviewing the RCP assumptions within the RITS and the expectation is stormwater modelling will require sensitivity checks using a climate scenario of RCP 8.5 for resource consent and engineering plan approval.

Therefore, stormwater design shall be based on the following parameters.

Table 1 – HIRDS hydrology Data

Rainfall Event	RCP 6.0 Rainfall Depth	RCP6.0 Rainfall Intensity
2 Year ARI	73mm	-
WQV	25mm	-
10 Year ARI	103mm	111mm/hr
100 Year ARI	171mm	-

Table 2 – CN Values

Scenario	Impervious (CN)	Pervious (CN)
Pre-development		61
Post-development	98	74

Maximum probable development (MPD) = 70% impervious and 30% pervious as per the draft ICMP, refer to image below.

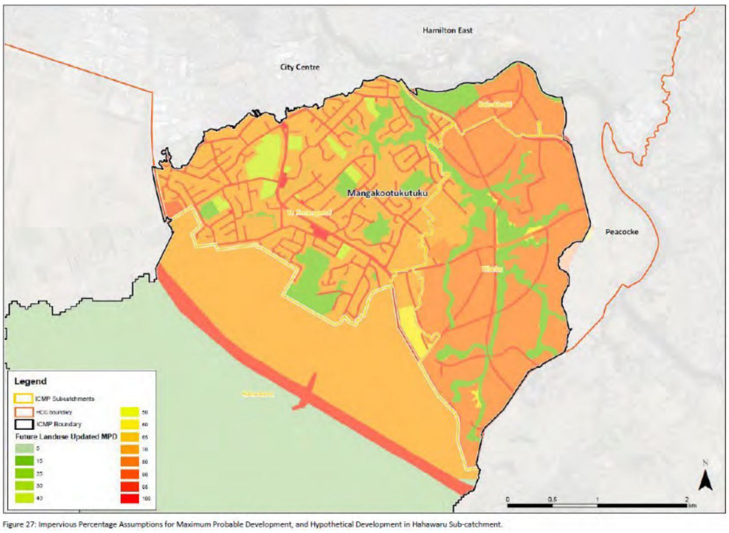


Figure 3 – ICMP excerpts showing MPD for the proposed site

3.3. Stormwater Quality and Quantity - Mitigation Options Assessment

An assessment has been undertaken to establish the best practical design options for the stormwater quality and quantity design in support of SL1. These options include:

- At source stormwater quality control through the following controls:
    - Inert roofing materials for all future buildings.
    - Reduction of impervious areas using permeable paving (where possible).
    - Lot development supported by approved propriety devices such as raingardens, tree pits, stormwater filters etc.

- Treatment of public roads and right of ways via approved propriety devices (raingardens, swales, stormwater filters etc) as per GD01 design guidelines.
- Sub-catchment wide stormwater quality provision through detention basins and wetlands.
- Planting of riparian areas and protection of any existing bush features within SL1.
- Use of the treatment train devices (Swales and/or Amalgamated Raingardens and Artificial Wetlands) to provide storage and attenuation for the required storm events from WQV, ED, 2year, 10year and 100year ARI.
- Option to provide storage and attenuation within the existing (rehabilitated) streams (refer to section 4) in addition to wetlands.

3.4. Best Practical Options

The overall preference is for stormwater to be managed as close to source as possible. This requires careful consideration of the wider use of smaller devices (such as inert materials, pervious paving, swales, and rain gardens) in preference to larger devices such as wetlands. These at-source devices are most efficient at improving water quality from frequent short and medium duration events.

The best practical options to mitigate the stormwater quality and quantity risk is detailed in the following sections.

3.4.1. On-Lot Stormwater Soakage

Low-lying plains of the SL1 Catchment are formed by the Rukuhia swamp, a peat bog that has been drained over time and converted to agriculture and horticultural use. Careful consideration of stormwater management is required on peat soils.

Soakage and recharge of stormwater into peat is likely required to maintain hydrology to prevent dewatering of downstream wetlands and streams and to mitigate shrinkage. Recharge or soak pits should be designed at regular intervals throughout the development to encourage even distribution of groundwater recharge.

A soakage system is a stormwater device supported by both the RITS and the ICMP for on lot primary system to manage stormwater from roofs, accessways, parking areas and occasionally roads.

Depending on the soakage rate available on site, this stormwater device can provide full compliance with the draft ICMP for both quality and quantity mitigation requirements as listed below.

Retention

- Pre-development Initial abstraction depth is required, referencing WRC stormwater Management Guidelines.

Detention/Attenuation

- Extended detention of 1.2 x WQV
- 2 and 10-year attenuation to pre-development flow.

See Figure 4 below for a typical soakage pit detail from WRC's stormwater management guidelines.

Soakage pit

Soakage pits function in a similar fashion with the excavated subgrade being filled with stone and relying upon the void spaces to provide for stormwater storage until the runoff infiltrates into the soil as shown in Figure 8-18.

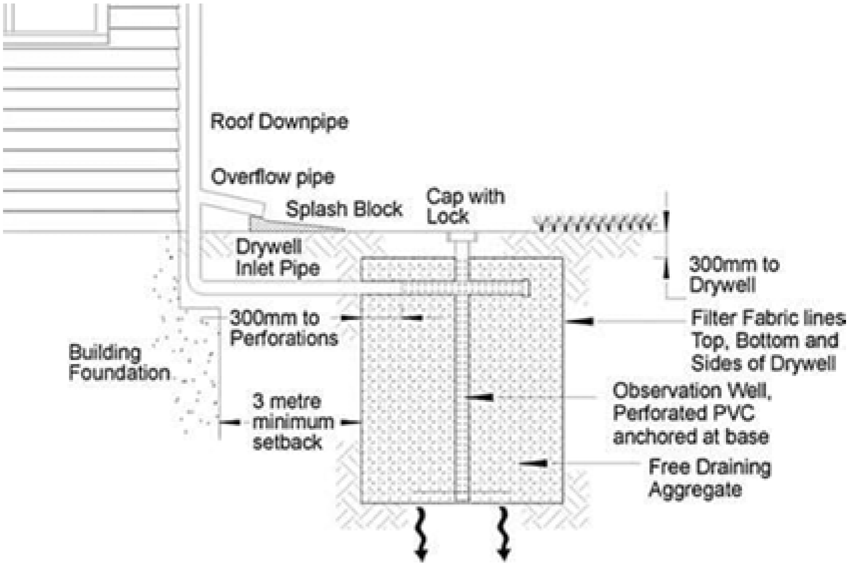


Figure 8-18: Schematic of a soakage pit[115]

Figure 4 – Excerpt from Waikato Stormwater Management Guideline of a soakage pit device.

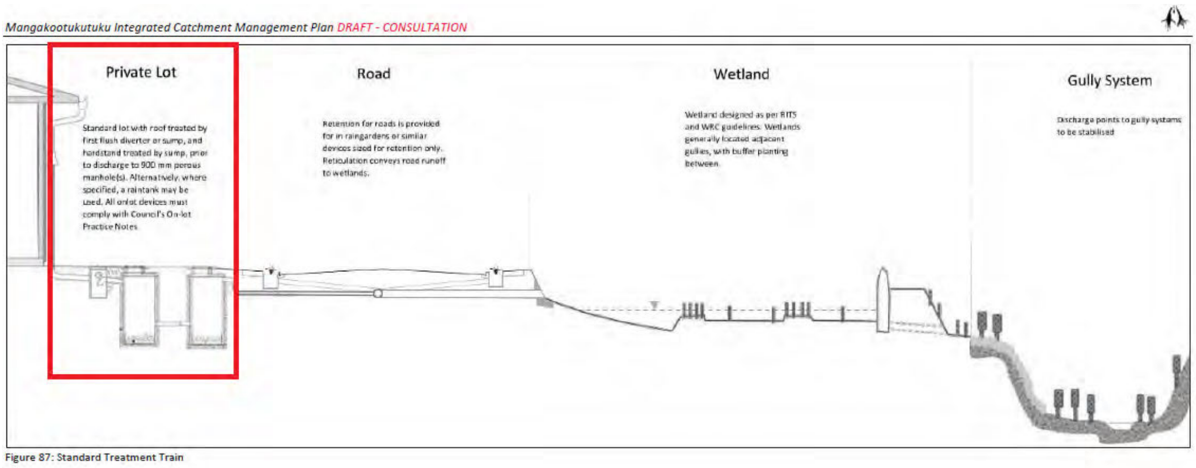


Figure 5 – ICMP excerpt.

Figure 5 above is an excerpt from the ICMP depicting the overall treatment system, the on-lot requirements highlighted as being relevant to this section.

It is recommended that a percolation testing is carried out at least once for each soakage device. Detailed investigations for each area will be required by a suitable qualified geotechnical engineer to determine the correct requirements for recharge and to provide development controls for infrastructure and buildings throughout the various catchment areas.

For areas that do not meet the required soakage rate, a bubble up system can be used whereby a stormwater line for each lot will discharge into a sump with a grated lid that allows water to bubble up into the carriageway during events exceeding the sump volume and the 3000L tank as proposed under Plan Change 12.

3.4.2. Rainwater Harvesting/Reuse

Reusing rainwater can significantly reduce the amount of water supply demand by household units by up to 50%. Decreasing demand on water supply has multiple benefits including meeting Water-sensitive urban design (WSUD) criteria and decreasing household water use. Allowance for water metering is suggested for any future changes to Hamilton Water Supply requiring a meter box at the boundary.

Rainwater can be harvested and used for a range of different applications; for watering the garden or washing the car, for use in the laundry and toilet. Rainwater is harvested directly off the roof and travels through down pipes to a water tank which sits either above ground or below.

Rainwater harvesting requires a building consent and would be enforced by a condition of Resource Consent and consent notice on each title. The use of rainwater reuse and their effects on water supply demand will need to be investigated and confirmed with council. Rainwater reuse options will be further investigated as part of future Resource Consent applications.

Rainwater harvesting can significantly reduce the amount of water supply demand from household units. Rainwater harvesting will be incorporated where possible into the proposed development during house construction.

3.4.3. Treatment Train

Section 6.12.3 of the draft ICMP provides a concept stormwater treatment train approach for greenfield developments. Whereby stormwater discharge from public roads is directed to raingardens or similar devices sized for retention only, before discharging into artificial wetlands prior to discharge into streams.

The treatment train solution proposed would be in the form of an integrated forebay, amalgamated raingarden and wetland for each catchment. This provides two step treatment and reduces the amount of maintenance required by creating one location per catchment to attend to.

This was the approach taken for the Rotokauri Greenway Project located within Hamilton City Council (currently lodged under Covid-19 Fast Track consent). Device engagement targets were as follows:

- Baseflow enters the forebay and bypasses the raingarden to the wetland.
- Small storms equivalent to approximately a quarter of the 2-year flow (suitable to engage the infiltration and freeboard storage of the undersized raingarden (sized for 25% of normal) flow through the raingarden media and discharge to the wetland.
- Medium sized storms between one quarter of the 2-year flow and the 2-year peak flow bypass the raingarden and enter the wetland.
- Large storms greater than 2-year ARI peak flow bypass all treatment to the high-flow channel.

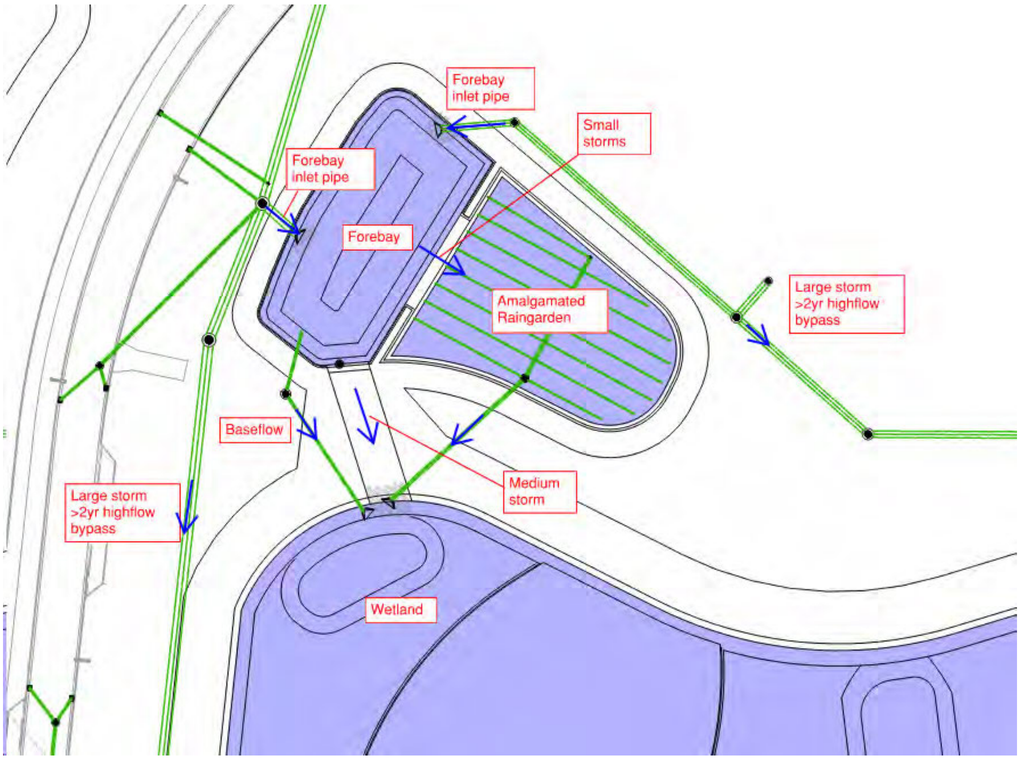


Figure 6 – Typical layout of amalgamated Raingarden in relation to the wetland and forebay as part of the Treatment train.

HCC have noted their current preference is for the consolidated/amalgamated raingarden approach above. However, roadside raingardens or swales could be used in place of amalgamated raingardens before discharging into wetlands if required.

Further information on proposed raingardens, forebays and wetlands is provided in the following sections.

3.4.4. Raingardens

As mentioned, the draft ICMP requires retention for roads provided in raingardens or similar. The raingardens or bioretention device will be sized to retain the initial abstraction depth for its catchment.

Raingardens and/or swales will also be required to provide pre-treatment when required for high contaminant load surfaces, defined in RITS as "Roads or intersections with VPD > 10,000 VPD1, zinc or copper roofs, all industrial zones and uncovered carparks over 750 m2."

We are proposing amalgamated raingardens integrated into the artificial wetlands along with the forebay. HCC have noted their current preference is for the consolidated/amalgamated raingarden approach above. However, roadside raingardens or swales could be used in place of amalgamated raingardens before discharging into wetlands if required.

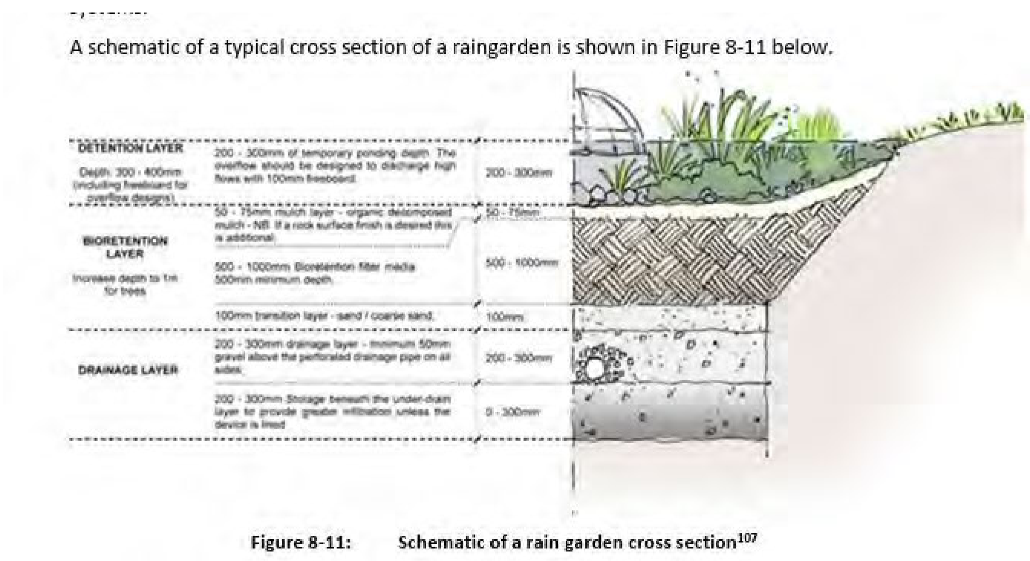

A schematic of a typical cross section of a raingarden is shown in Figure 8-11 below.

Figure 8-11: Schematic of a rain garden cross section[107]

Figure 7 Excerpt from Waikato Stormwater Management Guideline, typical section of Raingarden.

The raingarden shall be designed to comply with the below requirements:

Retention

- 10mm retention of proposed road surfaces

Treatment

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

3.4.5. 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.

Table 3 – Minimum forebay areas

Residential Artificial Wetland	Minimum Forebay Area m2
1A	1980
1B	550
1C	1410
1D	890
2A-1	620
2A-2	1400
2B	1070
2C	3290
F1	N/A
F2-1	650
F2-2	1100
F2-3	1400
F3-1	1260
F3-2	1600
F3-3	1200
F4-1	940
F4-2	1480
F5	2000
F6-1	1100
F6-2	900
F7-1	1800
F7-2	2400
F8	3260
F9	1840

Industrial Artificial Wetland	Minimum Forebay Area m2
1A	4310
1B	3500
1C	2800
3A	1200
3B	1200
3C	2100

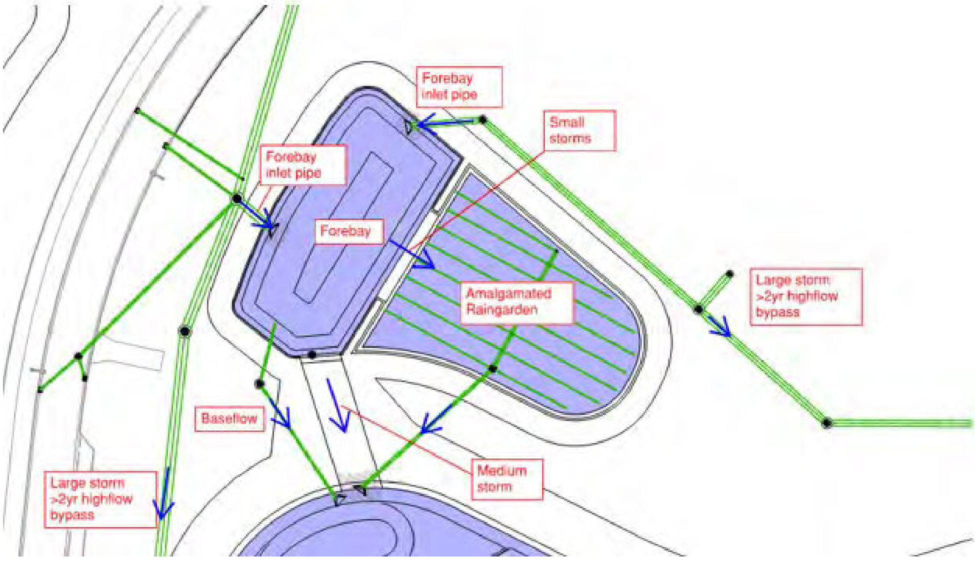


Figure 8 Typical layout forebay as part of the Treatment train.

3.4.6. Artificial Wetlands

Wetlands will be designed in accordance with Waikato's Reginal 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 raingardens 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.

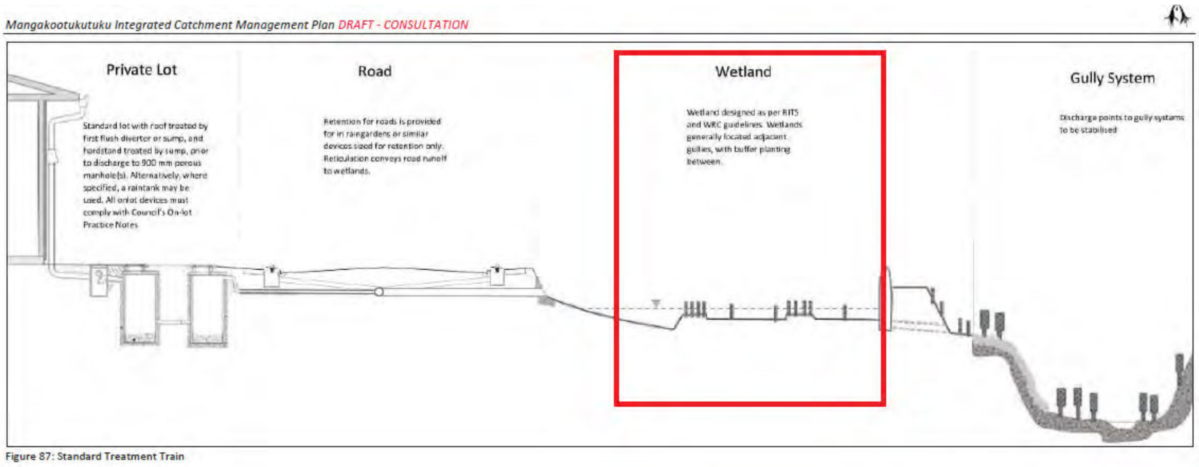


Figure 9 – ICMP excerpt.

Figure 9 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.

Any rainfall event larger than the WQV ED will bypass the wetland and be directed via a high-flow bypass to the existing stream.

Wetland bathymetry will be banded and consist of a mix of deep and shallow pools to allow for dispersed flow through vegetated areas per RITS guidelines. The extended detention level or live storage zone (LSZ) will be set at a maximum depth of 0.35m above the permanent water level to support healthy plants per table 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. The wetland is to be sized at 4% of the catchment once imperviousness exceeds 70%. According to the ICMP, the site is placed within a 70% impervious MPD zone (refer to section 3.2). This would suggest a 3% sizing factor may be satisfactory for the proposed wetlands. However, due to the high-level nature of this assessment, conceptual wetlands have been sized at 4% of their respective catchment. Refer to Maven stormwater drawings for preliminary proposed catchments and wetland locations. Table 4 below provides conceptual wetland sizes for each catchment.

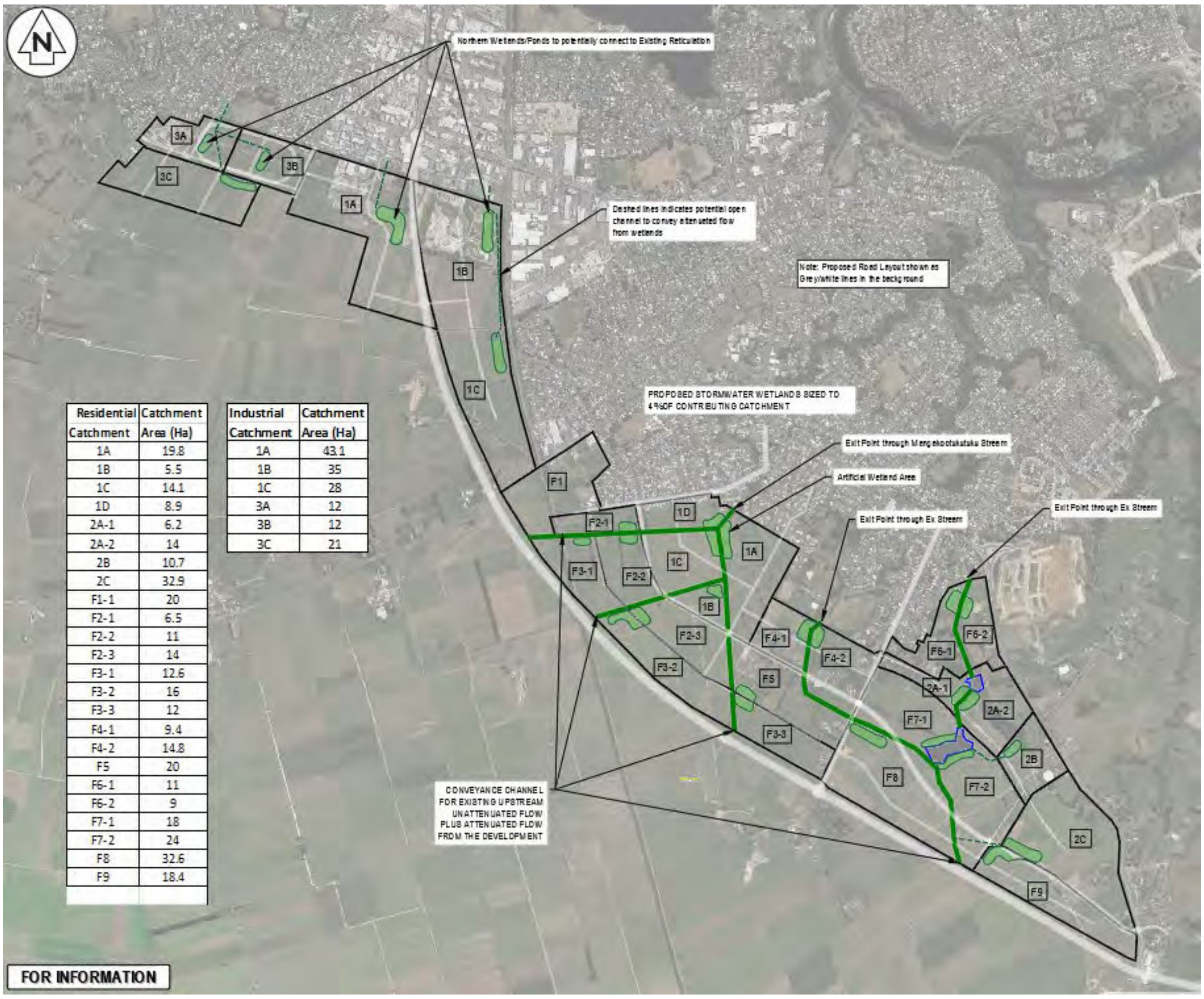
Table 4 – Conceptual Wetland sizes

Residential Catchment	Catchment Area (Ha)	Artificial Wetland Area (m2) 4% of Catchment
1A	19.8	7920
1B	5.5	2200
1C	14.1	5640
1D	8.9	3560
2A-1	6.2	2480

2A-2	14	5600
2B	10.7	4280
2C	32.9	13160
F1	N/A	N/A
F2-1	6.5	2600
F2-2	11	4400
F2-3	14	5600
F3-1	12.6	5040
F3-2	16	6400
F3-3	12	4800
F4-1	9.4	3760
F4-2	14.8	5920
F5	20	8000
F6-1	11	4400
F6-2	9	3600
F7-1	18	7200
F7-2	24	9600
F8	32.6	13040
F9	18.4	7360

Industrial Catchment	**Catchment**	**Artificial Wetland Area (m2)**
	Area (Ha)	**4% of Catchment**
1A	43.1	17240
1B	35	14000
1C	28	11200
3A	12	4800
3B	12	4800
3C	21	8400

Figure 10 below illustrates the proposed wetlands, enhanced streams and their associated catchments. This can also be found in Appendix A.



Residential Catchment	Catchment Area (Ha)
1A	19.8
1B	5.5
1C	14.1
1D	8.9
2A-1	6.2
2A-2	14
2B	10.7
2C	32.9
F1-1	20
F2-1	6.5
F2-2	11
F2-3	14
F3-1	12.6
F3-2	16
F3-3	12
F4-1	9.4
F4-2	14.8
F5	20
F6-1	11
F6-2	9
F7-1	18
F7-2	24
F8	32.6
F9	18.4

Industrial Catchment	Catchment Area (Ha)
1A	43.1
1B	35
1C	28
3A	12
3B	12
3C	21

*Figure 10 Preliminary Wetlands, Enhance Streams and Catchments (*note that catchment numbering have been altered as part of development works under Section 9 of this report)*

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 high-flow bypass is detailed under 3.3.7 below.

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

<u>Detention/Attenuation</u>

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

<u>Treatment</u>

- WQV treatment

3.4.7. High-flow bypass (HBP)

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

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

High-flow bypass swales connect to the Existing Stream with wingwalls and riprap. Open channels are HCC's preference for high-flow bypasses/secondary systems. In most cases open channels are proposed, however a few specific locations may require piping.

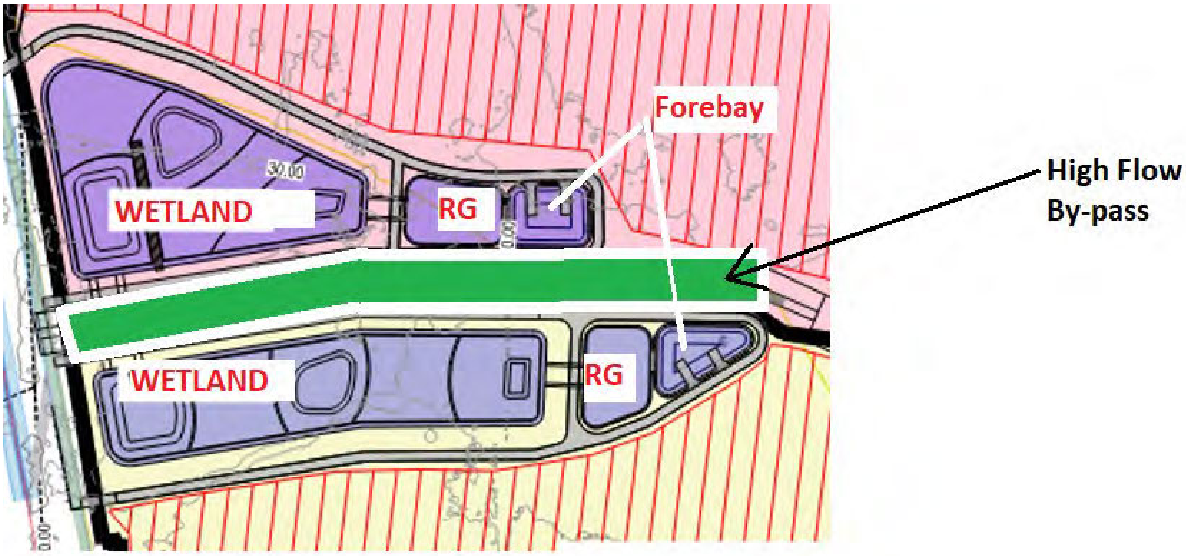


Figure 11 – High-flow By-pass as shown in Green area above.

The high-flow bypass (HBP) is proposed to include a discharge device consisting of a 2-10yr ARI orifice and weir or similar to attenuate the 2,10 and 100year flow prior to entering the stream as set out under section 3.1. During the 2,10 and 100yr rainfall events, the high-flow bypass discharge device will then enable flows to backup and enter into the wetland, utilizing the wetland for storage. This is in line with RITS guidance.

Alternatively the channel downstream could be rehabilitated and used for storage and attenuation within the SL1 development. This is detailed further in section 6.5.2.

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

Detention/Attenuation.

- 2, 10 and 100year ARI attenuation as detailed in section 3.1

3.4.8. Other means of stormwater quality treatment

In addition to the methods described above, other means of stormwater quality treatment would include:

- Restrictions around building materials (via consent notices) to ensure roofing materials are non-contaminant yielding.
- Minimisation of impervious areas within the residential lots through the promotion of permeable paving and use of propriety devices prior to discharge into the public network.
- Planting of riparian margins, wetlands, and detention basins. Protection of existing areas of vegetation where practical and possible.

These options would be expanded on further as part of any Plan Change application and would be administered through a comprehensive SMP and/or rules in the District Plan.

Subject to the inclusion of the above controls, all stormwater from SL1 can satisfy the requirements of the relevant statutory documents outlined above.

4. Existing Stream Enhancement

The proposed wetlands are located adjacent and upstream of a few key existing conveyance channels/streams within the development. This will allow conveyance of flow from the development area into the existing environment. We have investigated the existing stream depths and levels based on available survey data and it appears most existing streams are very shallow. In their current state, this will restrict attenuation and flood storage ability for the adjacent catchment.

See below table showing depths available for each catchment based on the existing survey data of the area.

Table 5 –Existing Stream vs Wetland Levels

Residential Catchment	Catchment Area (Ha)	Ex Stream IL	Wetland Top Level	Elevation Difference
1A	19.8	37.73	40.7	2.97
1B	5.5	38	40	2
1C	14.1	37.73	42	4.27
1D	8.9	37.73	42	4.27
2A-1	6.2	42.5	52	9.5
2A-2	14	42.5	52	9.5
2B	10.7	Ex WL/Pond	N/A	-
2C	32.9	48.5	51	2.5
F1	20	40.5	41	0.5
F2-1	6.5	40	41	1
F2-2	11	40	40.5	0.5
F2-3	14	Ex WL/Pond	N/A	-
F3-1	12.6	41.5	42	0.5
F3-2	16	40.5	42.3	1.8
F3-3	12	40.5	41.5	1
F4-1	9.4	39.5	41.5	2
F4-2	14.8	39.5	41.5	2
F5	20	40.5	41.5	1
F6-1	11	39.5	41.5	2
F6-2	9	39.5	41.5	2
F7-1	18	Ex WL/Pond	N/A	-
F7-2	24	Ex WL/Pond	N/A	-
F8	32.6	44.5	45	0.5
F9	18.4	48.5	51	2.5

Industrial Catchment	Catchment Area (Ha)	Ex Stream IL	Wetland Top Level	Elevation Difference
1A	43.1	unknown	unknown	N/A
1B	35	unknown	unknown	N/A
1C	28	unknown	unknown	N/A
3A	12	unknown	unknown	N/A
3B	12	unknown	unknown	N/A
3C	21	unknown	unknown	N/A

The integrated forebay, raingarden and wetland require approximately 4m level difference between the stream invert and top of wetland. According to the above data, only four sub-catchments are considered to have enough depth, with the majority failing to meet the minimum depth required.

Based on the investigation above, to allow treatment, storage and attenuation within the proposed wetlands and high-flow bypass areas, an option to resolve this would be to deepen the existing streams. Another option would be to infill lands adjacent the streams to achieve the grade required or there is the potential to undertake a combination of both.

Achieving the required height, depth or head from top of proposed wetlands to the IL of stream would allow wetlands to be sized based on 4% of the catchment. However, if the existing streams were to remain unaltered, the use of very large and shallow flood storage wetlands/basins or tanks would be required to provide the required attenuation and storage.

If existing streams were to be altered to deepen them, further investigation is recommended to whether the streams should also be widened. The existing streams could be replaced by “greenway swale(s)” which has been proposed for the Rotokauri South development. A greenway swale allows for conveyance as well as storage and attenuation of the 100-year event and can be used to minimize the storage requirements on wetlands. This is discussed further in section 6.5.

Altering the streams provides the opportunity to rehabilitate the streams enhancing ecological habitat by providing a more natural meander, wetland areas and planting. This would require further inputs from an Ecologist during future design.

Stream rehabilitation or establishment works could be staged per catchment relevant to the development area it will be servicing. Working from downstream will be a logical approach as the project moves through stages of Design, consenting and construction.

LiDAR or drone survey of existing streams can often be inaccurate given its inability to penetrate overgrown vegetation or water. Therefore, it is recommended to undertake survey of the existing streams to confirm the existing stream inverts and cross sections to verify the above assessment during future design stages.

For the Northern portion of the site, within the industrial designated area, an existing drain runs east to west and discharges into Waitawhiriwhiri West stream. Further investigation will be required to confirm the existing scenario.

5. Catchments

The overall SL1 development has been split into 18 preliminary Catchments as detailed in the table below. Existing streams, topography of the land/design formation, overland flow paths and staging plans dictates the extents of these catchments. HCC has also noted their preference to consolidate catchments and wetland areas as much as possible which we have taken into consideration to define these catchments.

Table 6 –Catchment Areas

Residential Catchment	Catchment Area (Ha)
1A	19.8
1B	5.5
1C	14.1
1D	8.9
2A-1	6.2
2A-2	14
2B	10.7
2C	32.9
F1-1	20
F2-1	6.5
F2-2	11
F2-3	14
F3-1	12.6
F3-2	16
F3-3	12
F4-1	9.4
F4-2	14.8
F5	20
F6-1	11
F6-2	9
F7-1	18
F7-2	24
F8	32.6
F9	18.4

Industrial Catchment	Catchment Area (Ha)
1A	43.1
1B	35
1C	28
3A	12
3B	12
3C	21

The proposed catchments are preliminary in nature only and based on the available information to date including the current proposed staging of the project. The catchments can be adjusted to suit future development layouts and grading as detailed design commences.

The majority of catchments sit within a low lying flat farmland ranging from 0.05 to 0.5% in gradient. It is recommended these flat areas be filled as needed to provide sufficient gradient to allow stormwater and wastewater gravity systems to service the site and remove or reduce the need for pumping.

6. 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 12 and 13).

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.

6.1. 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 carried out 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.

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.

6.2. Existing Flooding within SL1

Existing Modelling confirms that flooding within SL1 occurs during the 100-year flood event. Depths vary and are concentrated within the existing watercourses. Outside of the watercourses the bulk of the lower lying areas are subject to sheet flows only, with depths ranging from 100-300mm. The extent of the existing flooding is shown below within Figure 12 and 13.

6.3. Downstream Flooding

Downstream of SL1, HCC flood mapping in the Mangakotukutuku Catchment shows that there is existing flooding within tributary gullies. Downstream flooding effects was reviewed as part of the draft Mangakootukutuku ICMP with modelling carried out by AECOM using the Mike Flood modelling suite.

A range of pre- and post-development scenarios were modelled for various rainfall events. The development scenarios included existing development, maximum probable development within the city boundary with climate change, and a sensitivity check of the effects of maximum probable development resulting from urbanisation of Waipa North with climate change. Mitigation scenarios were also run where flood control requirements were considered likely to apply.

The modelled results indicated that there would be increased flooding within the downstream catchment without mitigation.

Further survey and assessment within and downstream of the development is required to fully understand downstream conditions and location of any constraints.

Further assessment is also required North of the development area. This includes identifying downstream exit points and establishing existing overland flow downstream from the northern area.

Sensitivity analysis of the overall flooding analysis would be required once detailed plans and levels have been established.

6.4. Downstream Flood Mitigation Solutions

To avoid any downstream flooding effects, flood mitigation will be required in support of the future 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 section 3 of this report, the 100year ARI flow rates is proposed to be attenuated within the proposed wetlands and high-flow bypass areas. Alternatively, the attenuation could be provided within the wetlands and rehabilitated stream as detailed in section 6.5.2.

There is also the option to deepen the existing stream downstream or infill lands adjacent existing streams in order to minimise the size of the wetlands and/or storage basins when allowing for attenuation of the 100yr event which will also maximise land-use for private properties.

6.5. Flood Mitigation within SL1

Existing flood hazards will need to be mapped and detailed as part of any future Plan Change process. This will require Resource Consents to be obtained for any earthworks or change of land use within the flood plain/flood prone areas. Applicants will need to demonstrate that the development allows for the existing flood plain volume and that there will be no adverse upstream or downstream effects.

6.5.1. 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 7: MINIMUM FREEBOARD REQUIREMENTS

Freeboard	Minimum Height
Vulnerable Activities	500mm
Les 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.

6.5.2. Retention of Storage Volume

Flood volumes and flows are proposed to be managed either within each wetland or by using both wetland and the enhanced existing streams if this proves more efficient in terms of use of space and wetland sizing. These two options have been described in more detail below.

Option 1 – Within artificial wetlands only

This option utilizes the wetland footprint and high-flow bypass to provide flood storage and attenuation. The high-flow bypass would include a discharge device to limit flows entering the downstream channel. During a flood event, water backs up into the high-flow bypass and wetland and provides the overall storage required. Attenuation and flood storage will be isolated to each catchment and discharge to the existing streams running through the development, will be limited to 80% of the 1:100-year pre-development flow.

As mentioned in section 4, the existing stream is subject to further investigation at further detailed design and may require to be deepened or lands raised either side of existing streams to allow for attenuation.

Option 2 – Within artificial wetlands and enhanced streams

The second option is the use of enhanced or rehabilitated streams/channels. The existing stream would be both widened and deepened to allow attenuation and flood storage within both the stream and adjacent artificial wetlands. In this option, the rehabilitated stream would become a greenway swale similar to what has been proposed at the Rotokauri South development. This will provide attenuation by way of using both wetlands and the swale/stream as storage with an attenuation orifice located at the downstream end of the development to ensure discharge leaving the development is limited to 80% of the 1:100 year pre-development flow. This option provides attenuation and flood storage for the whole site rather than per each catchment as per option 1.

Northern catchments

The northern area which we understand to be mainly industrial development area will be required to discharge into an existing primary reticulation system for all flows up to the 10-year ARI. Design levels within these areas will have to allow for the conveying of overland flow paths into existing flow paths in the adjacent areas.

6.6. Flooding Summary

Subject to the future development complying with the above, there will be no adverse downstream effects from the development of SL1. Additional investigation and detailed design is required to refine the preferred solution as part of any future resource consent or plan change approval.

Figures 12 and 13 below illustrate the pre and post-development model outputs during the 100 year ARI storm. As mentioned in section 6.1, further assessment will be required once confirmation of local roads, development layout and grading has been established to allow for actual conveyance in the model.

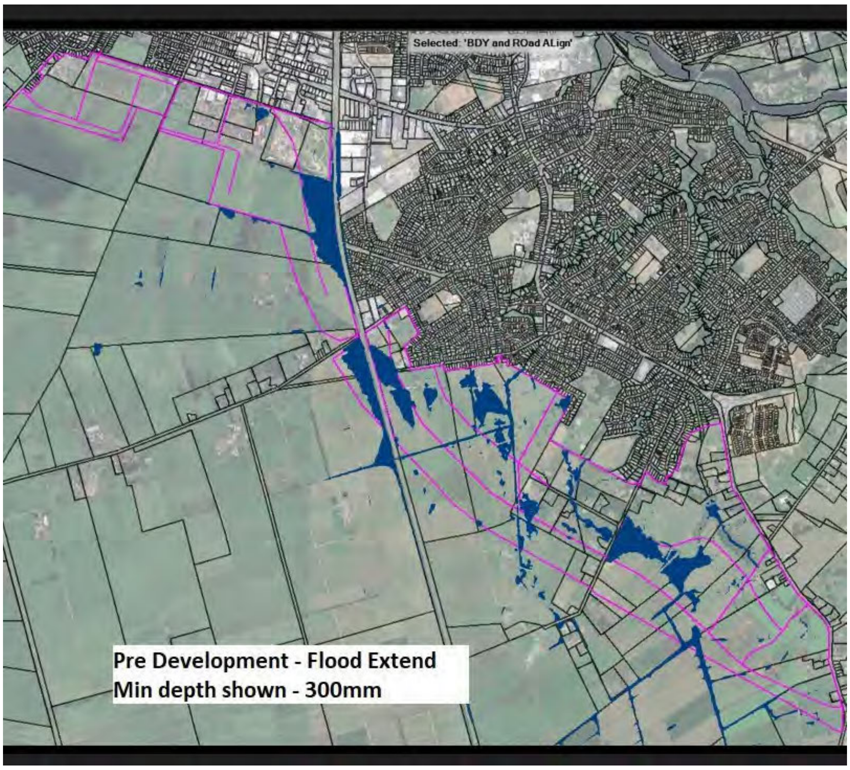


Figure 12 – Pre-Development Flood Modelling

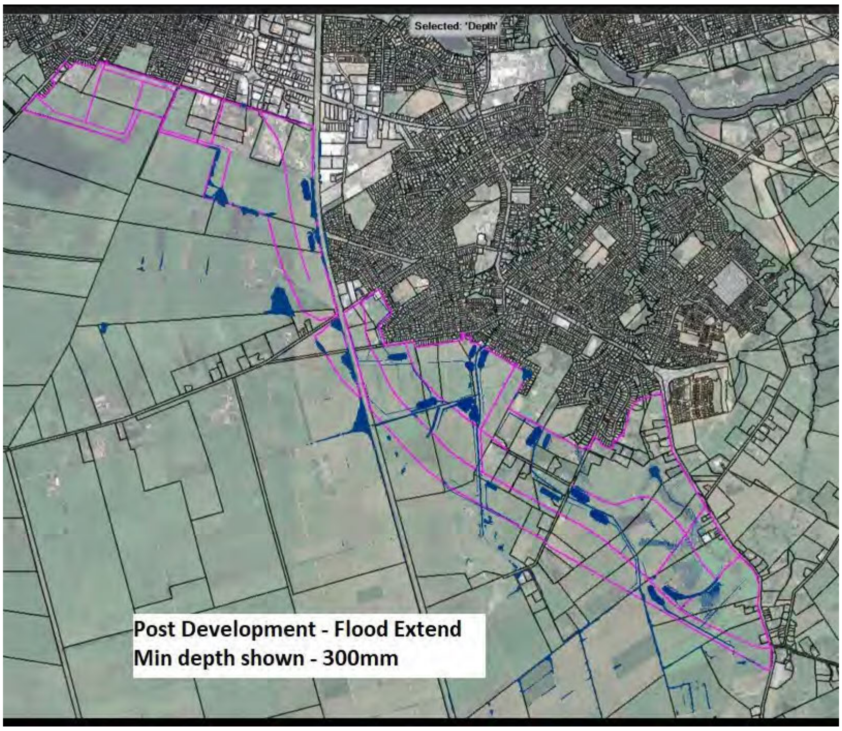


Figure 13 – Post-Development Flood Modelling (Dummy)

7. Overland Flow paths

Future development of SL1 will need to consider and allow for the modelled overland flow paths up to and for the 100-yr cc event.

7.1. Overland Flow paths – Options Assessment

An options assessment has been undertaken to establish the best practical design criteria for the overland flow path design in support of SL1. These options include:

- Retention and protection of existing overland flow paths through the development area, ideally within green corridors where the overland flow doubles as watercourse.
- Maintaining the flow of OLFPs up to the 100yr cc ARI rainfall event under the maximum probable development scenario.
- Directing all internal OFLPs within the proposed roading network, where possible.
- Piping of upstream OLFPs through the development site.

7.2. Overland Flow paths – Best Practical Option

The best practical option to mitigate OLFP effects is as follows:

- Retention of natural OLFPs where possible (and practical). Emphasis is provided on the OLFPs which correlate to intermittent or permeant streams within SL1.
- Maintaining the flow of OLFPs up to and for the 100yr cc ARI rainfall event under the maximum probable development scenario.
- OLFPs are to be designed where possible within the roading network and discharge into the stormwater devices or existing watercourses (green corridors).
- Minimum freeboards for habitable buildings to be provided as per below:
  - 500mm freeboard for OLFP flow rates above 2m3/s.
  - 500mm freeboard for OLFP less than 2m3/s with average flow depths of 100mm when inundation is against the building.
  - 150mm freeboard for OLFP less 2m3/s
- Resource Consents will require the provision of a depth-velocity assessment to indicate that the hazards associated with OLFPs within the road reserves are minor, with safe passage of vehicles and pedestrians within the road reserve in accordance with best practice guidelines.

8. Green Corridors

Green corridors should be provided within SL1. The green corridors would follow the primary tributaries identified within SL1 and would support the existing and/or proposed wetlands and detention basins. These green corridors could also assist in providing the required flood storage volume, attenuation, and conveyance of overland flows.

The green corridors would be protected from development and would be planted to provide ecological and water quality benefits. The watercourses would be mapped as part of the future consent application and controls would be required to retain these areas and mandate applicants to undertake riparian planting.

9. Stage 1 Development

The Stage 1 development proposal has been developed in consultation with the client, Hamilton City Council and associated consultants. Stage 1 consists of two areas, one being residential and the other, industrial. The two areas have been further split into sub-catchments, as shown in Figures 14 and 15 below.

This section of the report provides further details of the proposed stage 1 development, its stormwater strategies, and options to meet regulatory requirements, RITS and the ICMP as specified earlier in section 3 of this report.

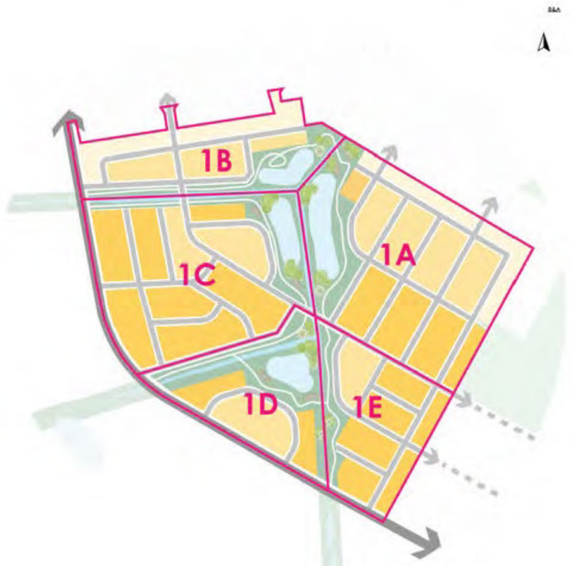


Figure 14 – Developed Structural Plan STAGE 1 - Residential

Figure 15 – Developed Structural Plan STAGE 1 – Industrial

The proposed stage 1 industrial area falls just outside the draft Mangakootukutuku ICMP with a discharge into Waitawhiriwhiri West Stream. From Maven's understanding an ICMP for this area has yet to be developed, and given the close proximity to the Mangakootukutuku ICMP area, a stormwater management approach in line with this ICMP has been assumed in this feasibility assessment. This will require further investigation and discussions with HCC to determine whether there are any specific stormwater management requirements for this area.

9.1. Stormwater Strategy

The stormwater strategy for the Stage 1 development is in line with the Best Practical Options described in section 3.4 of this report. The general layout and approach for stormwater design throughout Stage 1 is illustrated in Figure 16 and described below.

- On-lot stormwater soakage or rainwater harvesting tanks will be utilized to manage stormwater from roofs, accessways, parking areas and occasionally roads.
- Retention of the first 10mm of stormwater, and/or the initial abstraction volume required for new road surfaces will be provided in soakage trenches, raingardens, swales or similar.
- 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 stream/drain.
- Discharge into existing stream/drain will be at 80% of the pre-development flow.

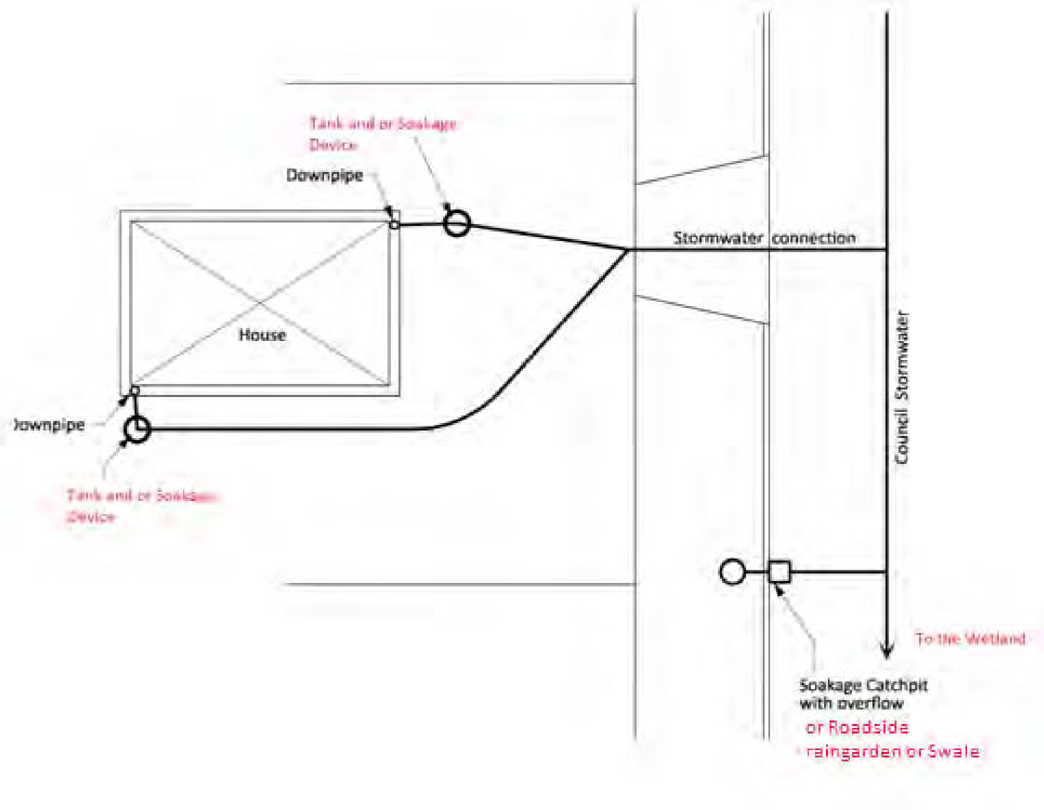


Figure 16 – RITS excerpt. D4.5 Drawing with Added Mark up for Conceptual Purposes

The stage 1 wetland catchments are split into two areas, road areas and lot areas. Stormwater within Stage 1 lot areas is proposed to be managed via soakage or rainwater harvesting as described in section 3.4.2 and 3.4.3 of this report. Section 3.43 proposed the treatment train method whereby an amalgamated raingarden sized to provide retention and/or initial abstraction of the first 10mm for road areas is integrated into the wetland, centralizing the stormwater treatment device in one location. However, an option to substitute the amalgamated raingarden with soakage trenches, roadside raingardens or swales has been explored further. This is described in section 9.3 below. Artificial wetlands providing stormwater treatment and flow mitigation for the road and Lot areas have been detailed in section 9.4. Discharge locations into existing drains/streams for stage 1 are described in section 9.5.

A desktop study by CMW confirms 75% of the development area is covered with Peat. Refer to the infrastructure report appendix F for more details. To avoid consolidation and ground water settlement due to dewatered peat, ground water recharge is required consistently throughout the development area. The same will apply for the stage 1 development areas.

9.2. Flooding and Overland Flow paths

As depicted in figure 12 of this report and the ICMP and the HCC flood viewer, there is an existing overland flow path through the site. During the 100 year event, the flow is conveyed through the existing streams. Minor and shallow overland flow paths exist throughout the site conveying flows within the site and into the adjacent existing drains/streams. The proposal seeks to provide attenuation of the 100 year flow event back to 80% pre-development primarily by use of the artificial wetlands and it's high-flow bypass. Stage 1 overland flow paths and extent of flooding during the existing 100yr events are shown in Figure 17 below.

Figure 17 – HEC RAS result excerpt. Existing Flood Result RCP6.0 with 100mm min. extent

9.3. Retention of Initial Abstraction

The ICMP requires retention of the first 10mm of stormwater, and/or the initial abstraction volume required for new Road surfaces. Given the expectation of peat throughout the catchment, soakage and recharge of stormwater into peat will also maintain hydrology to prevent dewatering of downstream wetlands and streams and mitigate shrinkage.

Options to achieve the initial abstraction requirements laid out in the draft ICMP have been explored further for the Stage 1 Development. The amalgamated raingarden solution integrated into the wetlands as conceptually proposed in section 3.4.3, is recommended to be substituted in favor of a roadside stormwater solution. The rationale for this recommendation is provided below.

To achieve the required retention would result in a very large centralized amalgamated raingarden solution (approx. 6-7% of the road catchment at an assumed depth of 0.5m). By centralizing the retention device, we would also be concentrating the soakage and water recharge in one location rather than spreading it out over the site. A roadside soakage trench or swale solution has the advantage of utilizing the berm area in order to achieve the required retention storage volume whilst also spreading out the water recharge locations and rehydrating peat throughout the catchment.

Therefore, the following options are proposed to achieve retention of initial abstraction.

Runoff from the road areas, are to be captured by roadside catchpits or similar. The flow will then enter a stormwater device capable of SW mitigation and more importantly soakage for water recharge purposes. An overflow will then direct stormwater flows into downstream artificial wetlands.

One of the options to consider is shown in Figure 18 below.

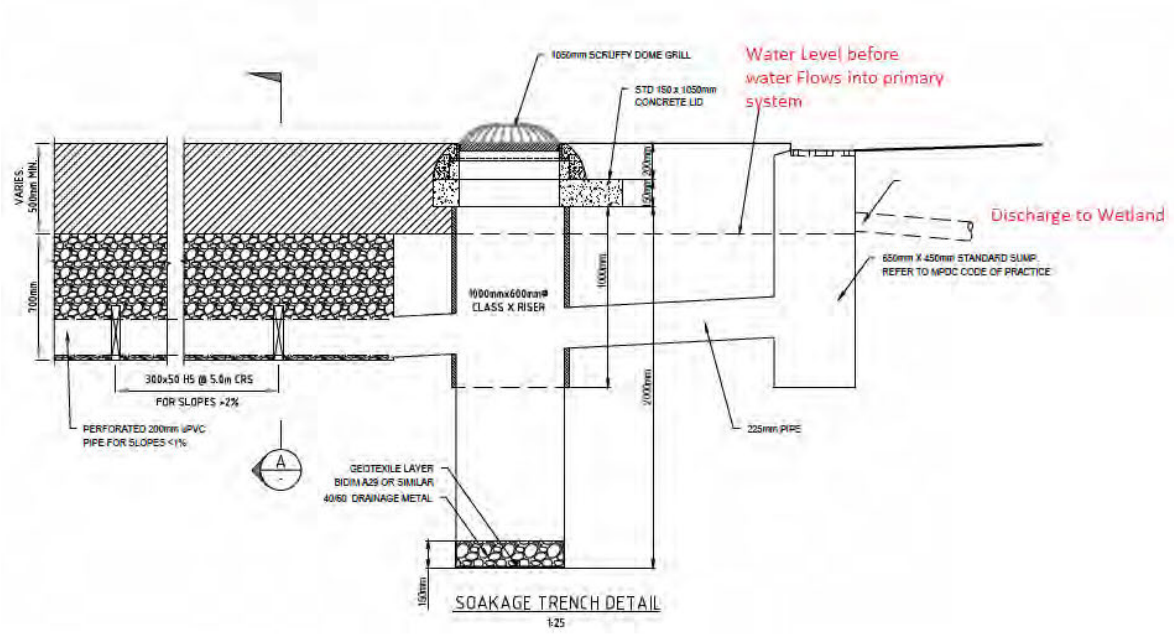


Figure 18 – Subsurface Soakage/Storage Device

The above device is a subsurface Soakage/Storage device proposed for one of our projects in the Matamata region. This contains the three functions (Treatment, Attenuation and Soakage) we look for in our road catchment system. This configuration allows stormwater to flow into this device via a catchpit providing pre-treatment by capturing sediment. Stormwater is then stored within the soakage trench and infiltrated into the ground beneath the trench and manhole. Higher flows above the capacity of this system will discharge via the outlet pipe located above the top of the storage devices within the catchpit, out into the pipe network and eventually into the artificial wetlands for secondary treatment.

Use of roadside swales depending on road width available or roadside raingardens can also carry out the above three functions. Soakage testing will be required during future designs to determine expected infiltration rates and inform soakage trench size requirements.

When designing/choosing a stormwater mitigation and treatment device, it is essential to consider the stormwater base flow into the proposed wetlands. This is to maintain the biodiversity of the wetland and its treatment function. One way this could be achieved would be to enable a bypass of the soakage device for baseflows. This could be in the form of allocating one (or more) catchpits with a direct outlet into the artificial wetland. Alternatively, the use of orifice plates within catchpits sized for baseflow could also enable baseflows to be directed to the wetland.

9.4. Artificial Wetlands

A high-level concept design has been undertaken for the artificial wetlands within stage 1 and are included on the proposed Engineering Plans WD400 series. Figure 19 below shows the proposed artificial wetlands located within stage 1.

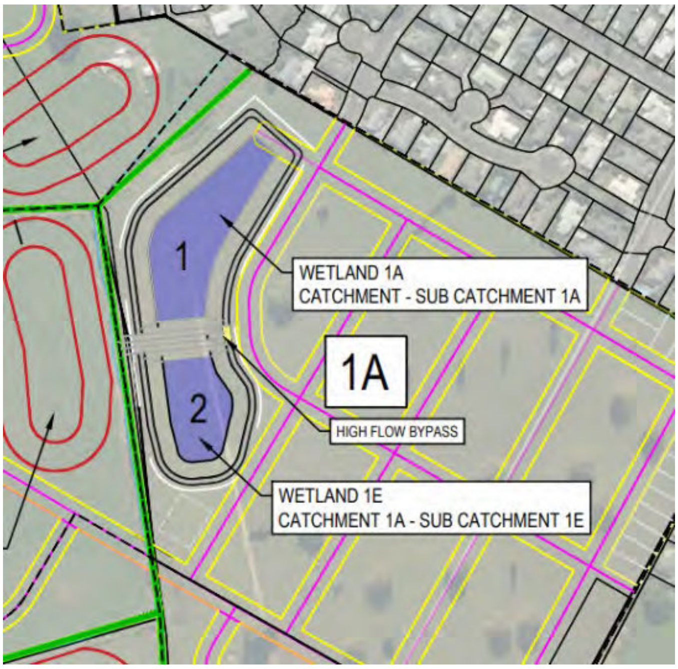


Figure 19 – Wetland 1A and 1E Residential

Wetland 1A has been split into two wetlands (Wetland 1A and Wetland 1E), to allow it to be constructed in stages as each development occurs. Both wetlands are separated by a high-flow bypass, and are proposed to treat and mitigate two separate stormwater catchments as shown in the below table and Engineering plans. It is proposed that the high-flow bypass and wetland 1A is to be built as part of substage 1A development. The second wetland is proposed to be built as part of Sub Catchment 1E development.

TABLE 7: RESIDENTIAL STAGE 1A WETLAND CATCHMENT

Residential Area		Associated Wetland
Catchment	Area (Ha)	
1A	13.4	Wetland R-1A
1B	8.9	Wetland R-1B
1C	14.1	Wetland R-1C
1D	5.5	Wetland R-1D
1E	6.6	Wetland R-1E

Table 8: Industrial STAGE 1A Wetland catchment

Industrial Area		Associated Wetland
Catchment	Area (Ha)	
1A	9.0	Wetland I-1A
1B	11.8	Wetland I-1B
1C	15.8	Wetland I-1C
1D	16.1	Wetland I-1D

The stage 1 wetlands have been further developed to establish the anticipated area required to construct the wetlands including important wetland features to enable the ongoing function and maintenance of the wetlands. These include its general shape, batter slopes, buffer areas, footpath areas and a high-flow bypass. Detailed modelling and analysis to determine the final wetland footprint will be required in future designs.

Upstream of the wetland, a stormwater flow splitter device is proposed. This will direct the WQV ED flow into the wetland area for treatment and slow release of the extended detention volume. Higher flows greater than the WQV ED flows are to be diverted into the high-flow bypass to undergo attenuation before discharging into the existing stream. The stormwater flow splitter device could be in the form of a stormwater flow splitter manhole, or a weir device located within the high-flow bypass channel upstream of the wetland forebay.

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

9.5. Discharge into Existing Stream/Drains

As described in section 4 of this report, the proposed wetlands are located adjacent and upstream of a few key existing conveyance channels/streams within the development. This will allow conveyance of flow from the development area into the existing environment following treatment and attenuation. Attenuation devices located within the high-flow bypasses will release at 80% of the pre-development flow in accordance with the draft ICMP.

Stage 1 residential sub catchment 1A discharges into an existing stream with an approximate depth of 3.56m. As described in section 4, the integrated raingarden and wetland solution requires approximately 4m level difference between the stream invert and top of wetland. For stage 1 we are recommending roadside soakage trenches, swales or raingardens which will reduce the approximate level difference. There is also the opportunity to place fill to achieve the level differences required. Based on this, deepening of the stream may not be required for stage 1. Further investigation including survey of the existing stream and detailed modelling of the wetland and high-flow bypass is recommended to confirm whether or not enhancement/deepening of the existing stream is required and to determine the level of fill required for stormwater drainage. An existing typical cross section of the stream is shown in Figure 21 below.

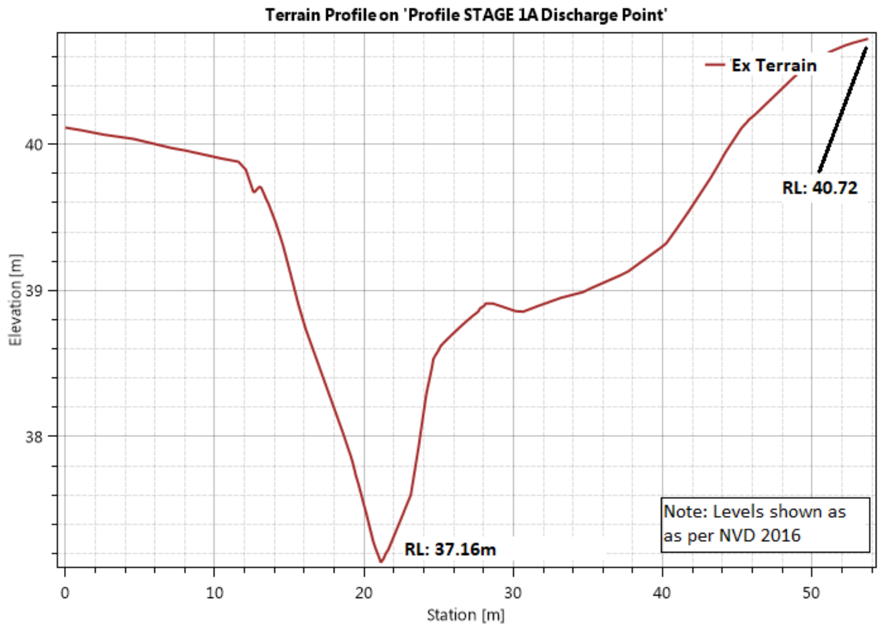


Figure 21 – Section of Stream Adjacent to Wetland R-1A & 1B

Stage 1 industrial sub catchment 1A discharges into an existing shallow stream/drain with an approximate depth of 2.47m. As above, the stormwater solution will require level differences in the order of 4m, possibly less if adopting roadside soakage trenches, swales or raingardens. The existing drain discharges through a culvert approximately 1km downstream. Referring to Google view and 3 Waters GIS viewer, this drain continues downhill and discharges into the Waikato River approximately 6.5km downstream from the site. Depending on the IL of the downstream Culvert, this may limit the ability to enhance/deepen the existing channel. Therefore, it is expected this area will require the lands to be infilled to achieve gravity drainage of the development. As above, further investigation including survey of the existing stream and downstream culvert as well as detailed modelling of the artificial wetland and high-flow bypass is recommended to confirm whether or not enhancement/deepening of the existing stream is required and to determine the level of fill require for stormwater drainage. An existing typical cross section of the stream is shown in Figure 22 below.

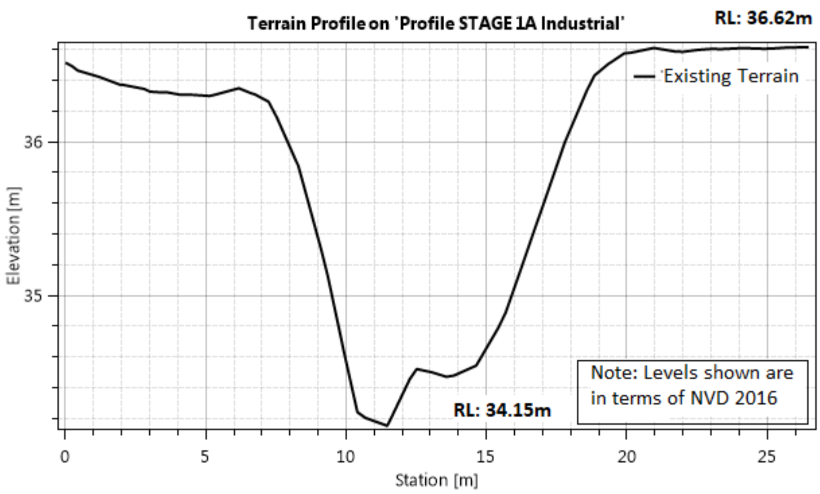


Figure 22 – Section of Stream Adjacent to Wetland I-1A

10. Conclusions

This high-level SMP sets the framework that will enable the future development of SL1. The Plan has considered the relevant statutory documents and will ensure future stormwater discharge from SL1 complies with the Waikato Regional Council policies.

New public networks will need to be constructed. The network will need to convey the 10-yr ARI event and be designed in accordance with the Hamilton City Council Code of Practice for Subdivision and Land Development.

Stormwater recharge will need to be designed and constructed at regular intervals throughout the development in low lying plains to maintain groundwater neutrality.

A treatment train approach is proposed with an integrated forebay, raingarden and wetland for each catchment. Alternatively, roadside raingardens or swales could be used to provide initial treatment and retention prior to the wetlands. Artificial wetlands have been sized to 4% of their catchment and will also provide flood storage and attenuation.

Existing streams in the area generally appear shallow and therefore, enhancement including deepening and potentially widening is an option proposed to enable servicing of the SL1 development. Flat areas are also proposed to be filled as needed to provide sufficient gradient to allow stormwater and wastewater gravity systems to service the site and remove or reduce the need for pumping.

Overland flow paths will need to be mapped in any future consent application. Future development of SL1 will need to allow for and retain existing overland Flow paths up to the 100-yr cc ARI event.

To ensure there is no downstream flooding effects, stormwater attenuation and flood storage is required to limit discharge to 80% of the pre-development flow up to the 100-yr ARI event. This is proposed to be addressed by artificial wetlands with discharge restriction devices. Alternatively, the enhanced streams could also provide flood storage and attenuation with discharge restriction devices at the downstream ends of the development prior to leaving the development. A concept catchment plan has been developed including proposed wetland locations as well as flood model to illustrate the above requirements can be met.

HEC HMS and HEC RAS modelling to confirm attenuation and downstream impact has been quantified and mitigated, these will require further development once scheme plans are finalised for each individual stage.

Modelled flood plains will need to be incorporated into any future consent process. Future development applications located within the flood plains will need to maintain the existing storage volume if applicable and provide suitable freeboard for all habitable buildings. This will limit the extent of developable land within each catchment unless downstream flood mitigation works are achieved.

This stormwater management report has been updated with the addition of section 9 focusing on the Stage 1 development. The stage 1 development proposal is consistent with the best practical options for stormwater addressed in this report. Methods to achieve retention of the first 10mm of road areas is proposed utilizing soakage trenches, roadside raingardens or swales. A high-level concept layout for stage 1 artificial wetlands has been provided. Discharge locations within existing streams/drains have been identified. Further design and detailing will be undertaken during future consent applications.

Appendix A – Stormwater Plans