ENVELOPE ENGINEERING
LAND
STRUCTURE
MANAGE

STORMWATER MANAGEMENT PLAN

28, 30 and 66 Crestview Rise, Papakura

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EXECUTIVE SUMMARY

Envelope Engineering Ltd has been engaged to provide a Stormwater Management Plan (SMP) in support of a Private Plan Change (rezoning) application that will inform a future Resource Consent application for proposed residential development of land located at 28, 30 and 66 Crestview Rise, Papakura, Auckland hereafter known as the "site". This SMP has been developed to achieve consistency with the objectives and policies of the Auckland Unitary Plan, as well as Auckland Council's Guideline Documents and industry best practicable options (BPO).

This SMP sets out best management practices and identifies the mechanisms to be utilised to avoid or mitigate potential adverse effects on the receiving environment associated with stormwater discharge from the site.

The main outcomes of the SMP include:

- The provision of an integrated stormwater management approach.
- The confirmation of no adverse changes to the downstream overland flow paths and overall flood risk.
- The mitigation of any adverse effects from stormwater runoff on surface water quality by providing a treatment train approach.

The SMP will achieve the desired outcomes by adopting the following Water Sensitive Design principles:

- Applying inter-disciplinary planning and design.
- Protect and enhance the values and functions of natural ecosystems.
- Address stormwater effects as close to the source as possible.
- Mimic natural systems and processes for stormwater management.
- Using a treatment train approach which includes BPO options for filtering, conveyance and stormwater treatment.
- Enhancing the receiving environment.
- Respecting mana whenua values.

In order to achieve the outcomes, outlined above, the following methodologies are proposed:

- Provide for stormwater treatment for all trafficable surfaces through centralised bioretention devices such as raingardens
- Provide centralised stormwater attenuation pond(s) to cater for the 1% AEP (100-year ARI), and discharge stormwater at 80% pre-development flows.
- Adopt latest future climate change factors in hydrological calculation.
- The proposed pipe network will be sized to cater for the 10% AEP (10-year ARI) flows
- Overland flow from the 1% AEP (100-yr ARI) storm event will be contained within roadway areas or within designated engineered overland flowpaths.
- Inert building materials to be used to ensure no contaminant discharge from the structures.
- On lot rainwater tanks will be utilised to provide retention and possibly some detention of stormwater. The retention volume provided will be used for non-potable water uses. The primary purpose of the rainwater tanks is for rainwater re-use and retention.

1.0 EXISTING SITE APPRAISAL

1.1 SUMMARY OF DATA SOURCES

EXISTING SITE APPRAISAL ITEM	SOURCE OF DATA USED
Topography	• SurveyWorx – Drone Survey
Geotechnical / soil conditions	• ENGEO
Existing stormwater network	• Auckland Council GeoMaps
Stream, river, coastal erosion	• Auckland Council GeoMaps
Flooding and flowpaths	• Auckland Council GeoMaps
Coastal Inundation	• Auckland Council GeoMaps
Ecological / environmental areas	• Auckland Council GeoMaps
Cultural and heritage sites	• Auckland Council GeoMaps
Contaminated land	• Auckland Council GeoMaps

1.2 LOCATION AND GENERAL INFORMATION

EXISTING SITE ELEMENT	
Site address	• 28, 30 and 66 Crestview Rise, Papakura
Legal description	• LOT 123 DP 549093, LOT 124 DP 549093, LOT 127 DP 571188
Current Land Use/ Zone	• Rural – Countryside Living
Current building coverage	• Greenfield, grassed pasture
Historical Land Use	• Rural – Countryside Living

1.3 TOPOGRAPHY

The existing site topographic survey of the site was undertaken by SurveyWorx. This survey was completed in April 2023 and the existing contours are shown in the image in Figure 1 below.

From the existing survey, it can be seen that there are existing flowpath channels along the uphill boundaries of the site, diverting upstream flow away from the site. The site itself is evenly graded falling from southeast to northwest. The eastern half of the site generally falls towards upper Crestview Rise and the western half of the site generally falls towards Kotahitanga Street and the lower, southern part of Crestview Rise.

The majority of 28 Crestview Rise is sloping down towards Crestview Rise at grade range between 10 - 20% from a crest along the southern boundary. 30 Crestview Rise has a similar existing landscape to 30 Crestview Rise, however there is more angulating with some particularly steep areas. 66 Crestview Rise has slopes predominantly falling towards the west and northwest directions, with the average grade of around 20%.

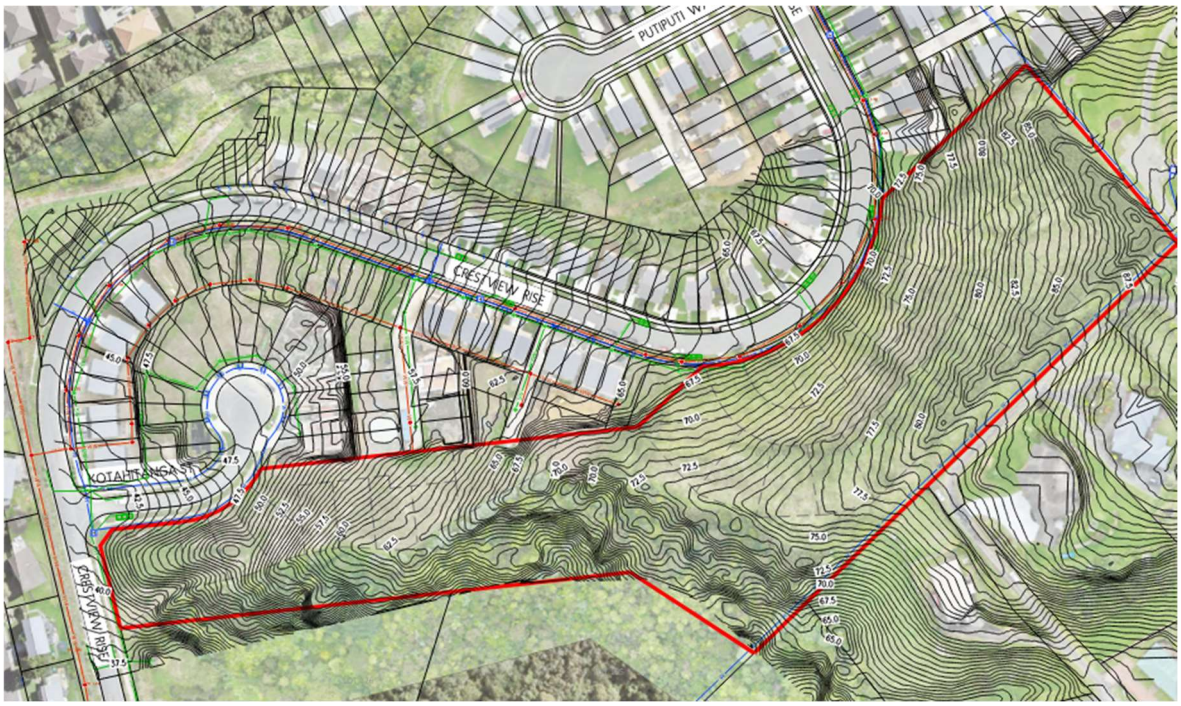

Figure 1: SurveyWorx Topographical Survey Contours

Figures 2-4 below are taken from Auckland Council's Geomaps. The figures include GIS (2016) contours as well as the 3-waters networks of wastewater and stormwater public drainage infrastructure. It is acknowledged the 2016 GIS contours are now out of date, but generally the current landform remains similar with respect to direction of fall, except for at the western most part of the site, adjacent to Crestview Rise. By interrogating the existing contours from Figure 1 and comparing this to GIS contours in Figure 4, it is possible to see that a plateau has been created at the western end of the site by cutting down existing ground and creating batters towards Crestview Rise and Kotahitanga Street. Section 1.4 below discusses the earthworks undertaken across the site in more detail.

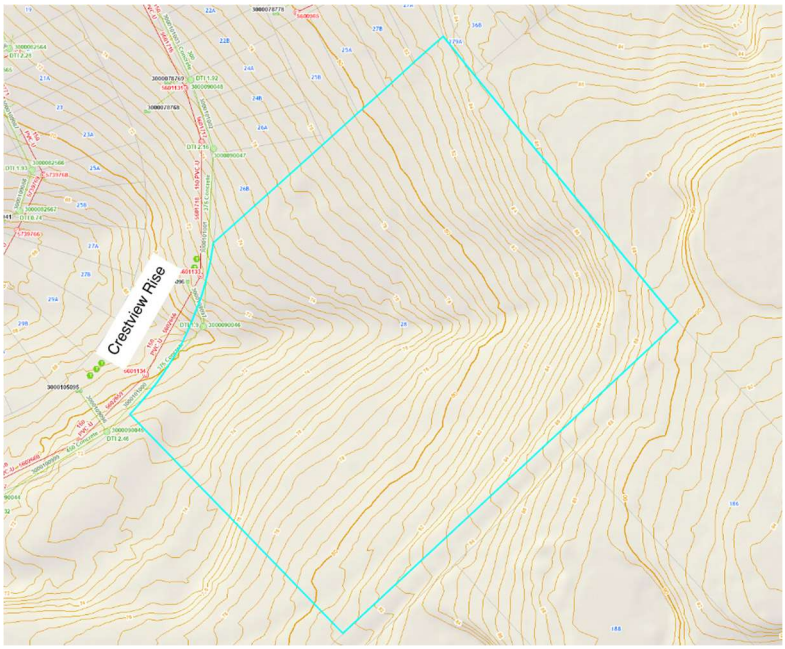

Figure 2: GIS MAP – 28 Crestview Rise

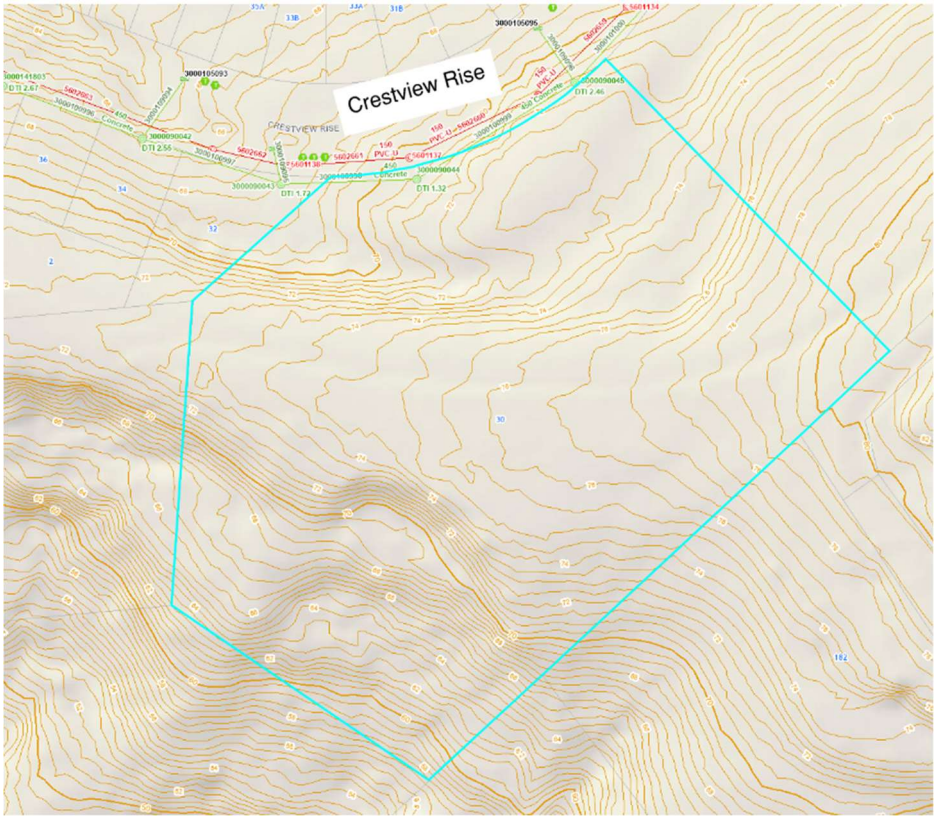

Figure 3: GIS MAP – 30 Crestview Rise

Figure 4: GIS MAP – 66 Crestview Rise

1.4 GEOTECHNICAL

The site has been created as three balance lots subdivided off the wider residential subdivision known as Stages 2 and 3 of 162-166 Settlement Road. As part of the subdivision works for that earlier residential development, earthworks were also carried out over the site and these earthworks were overseen by the appropriate geotechnical engineer.

The bulk earthworks for that earlier development were undertaken to create Crestview Rise and Kotahitanga Street along with the residential lots off those roads. This also included earthworks to 'smooth out' the site and to marry the levels from the site to the newly created roads.

As-built plans showing the earthworks carried out over the site are included in Appendix D.

A Geotechnical Completion Report of 28 – 30 Crestview Rise was completed in 2020 by ENGEO. This was completed as part of stage 2a of the 162 – 166 Settlement Road Subdivision Project. The completed report in 2020 determined the following:

- Topsoil depths over the site are likely to vary between 0 mm and 200mm.
- A Geotechnical ultimate bearing capacity of 300kPa is applicable for the site, for foundation design.
- A shallow gully feature was mucked out within Lot 123 (28 Crestview Rise). Underfill drains were installed and was backfilled 2017. (Refer to Fig 5 which shows as-built info of the subsoil drains)

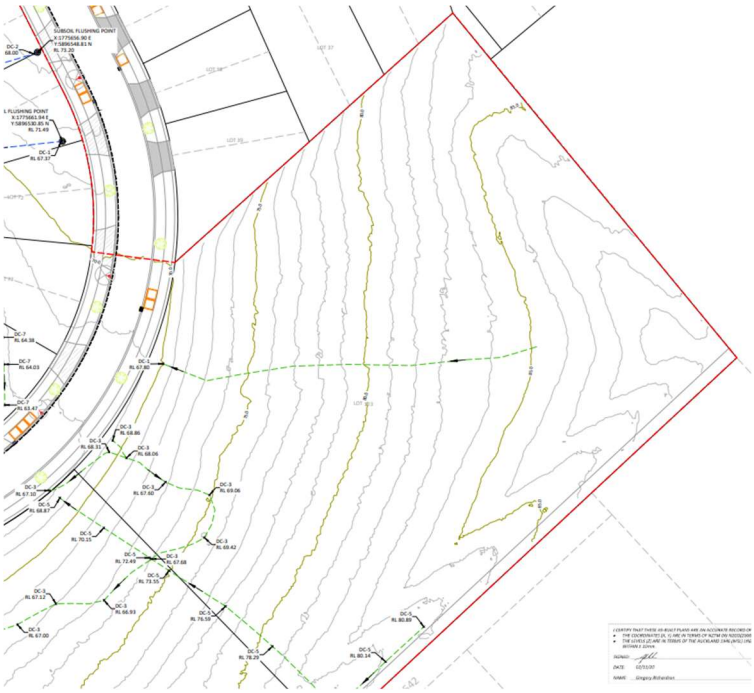

Figure 5. Image from Subsoil As-built plan showing historical subsoil drains across 28 Crestview Rise

A Geotechnical Completion Report of 66 Crestview Rise was completed in 2022 by ENGEO. This was completed as part of Stage 2B, 2C and 3 of the 162-166 Settlement Rise Subdivision Project.

- Topsoil depths over the site are likely to vary between 0 mm and 400 mm.
- A Geotechnical ultimate bearing capacity of 300 KPa is applicable for the site for foundation design.

The Geotechnical Completion Reports, which cover earthworks previously carried out over the site confirm that the earthworks were carried out appropriately under the required supervision. Earthworks over the site has been to 'engineered' standards and the site is geotechnical stable.

Where a historic minor gully existed over the site, this has been correctly filled with appropriate subsoil drainage beneath the fill to control groundwater and seepage.

ENGEO have now produced a geotechnical investigation report that informs the plan change and the geotechnical suitability of the site for the likely development as provided in the attached civil engineering plans in Appendix A to this report.

1.5 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

Auckland Council Geomaps shows a newly constructed gravity stormwater pipe network. This new stormwater network passes through the berm of Crestview Rise and was installed to service the existing development.

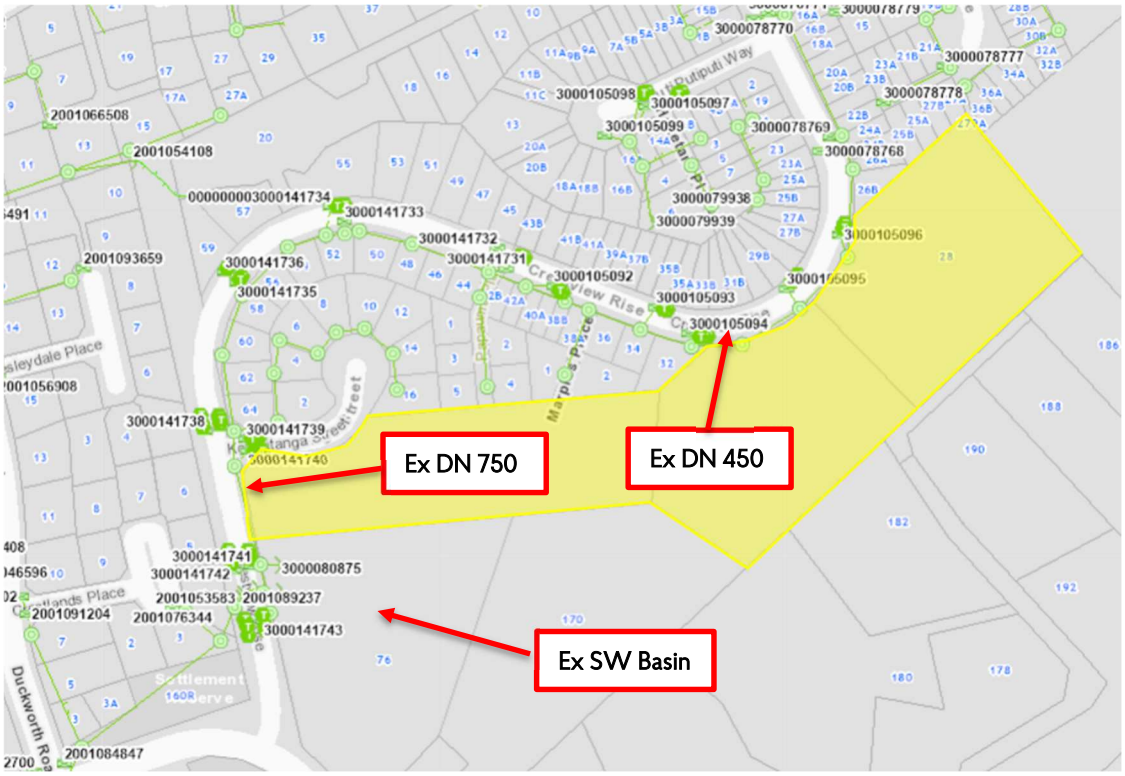

Figure 4: GIS MAP – AC GEOMAPS STORMWATER

This newly constructed stormwater network was installed as part of subdivision of 162 – 166 Settlement Road. Upon review of the infrastructure report prepared by Crang Civil Consulting Engineers dated June 2016, it is noted that the subject site forms part of rural lots and these lots are the natural/ existing upstream catchment to the aforementioned public stormwater line/ network.

The report states that "*The rural lots will capture rain from the roof and store this on site for re-use. Overflows from the tanks will discharge to the ground and flow overland.*" The overland flow from the grassed rural lots (the site) has been allowed for within the piped network, however no future additional development flow from the site was allowed for.

Given this, the post-development discharge from the proposed site must be controlled to match the pre-development discharge which would naturally runoff from the rural lot. Our stormwater strategy, detailed within this report, ensures that stormwater is managed to less than pre-development flows.

1.6 RECEIVING ENVIRONMENT

1.6.1 COASTAL

The site is not immediately adjacent to the coast hence the coast is not considered a direct receiving environment.

1.6.2 PUBLIC RETICULATION

The primary stormwater disposal system for the site will be to collect stormwater runoff via a new public stormwater pipe network. This network will discharge through rain garden devices (for stormwater quality treatment) and through stormwater ponds (for attenuation) and then will connect to the existing public stormwater drainage immediately downstream of the site. The existing public stormwater drainage was installed as part of the 162-166 Settlement Road development and discharges

to an existing gully on No: 76 Crestview Rise. Stormwater flow from this gully is collected via a 1050mm dia public line and piped a significant distance downstream.

1.7 EXISTING HYDROLOGICAL FEATURES

The site is **not** situated within a Stormwater Management Area Control. However, the site is currently within the AUP Subdivision Variation Control area.

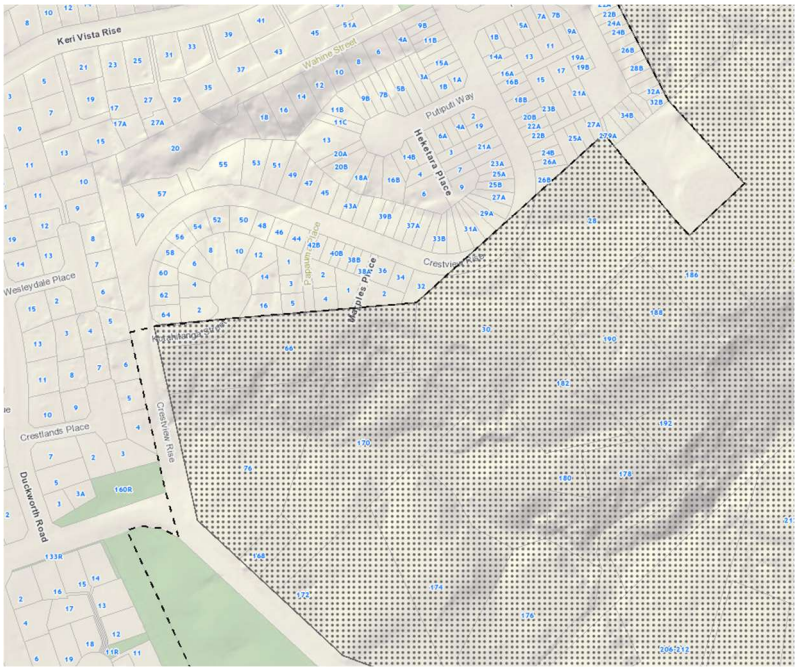

Figure 5: GIS MAP – Subdivision Variation Control Area

1.8 FLOODING AND FLOWPATHS

Auckland Council's Geomaps shows that there were minor overland flowpaths that passed through the site. These overland flowpaths originated from on-site and passed across the site from the east and flowed towards the north of the site. The flowpaths would have comprised a very minor depression. Since the earthworks occurred on site (as described within Section 1.4 above), the minor flowpaths have been modified/ filled in. Overland flow from the site now passes as sheet flow across the site and ultimately discharges to Crestview Rise as it would have originally.

The site is not located within a flood prone area, flood sensitive area or a floodplain and is well elevated above surrounding roadways which would comprise Council's network of secondary overland flowpaths.

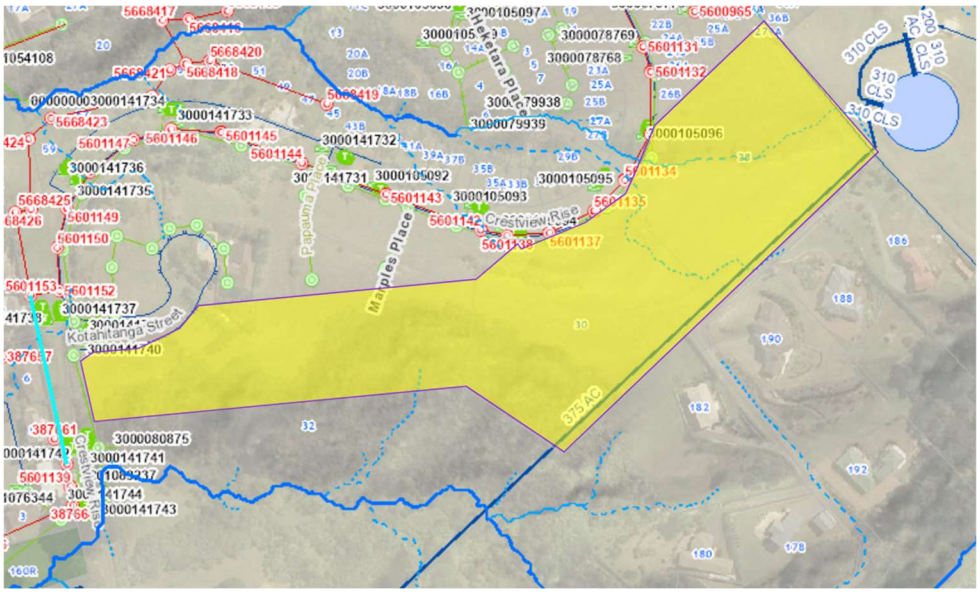

Figure 6: GIS MAP – Historical overland flowpaths (from Council Geomaps)

1.9 COASTAL INUNDATION

The site lies beyond the extent of coastal inundation as set out in E36 of the Auckland Unitary Plan and is also high and far enough away from the coast. Therefore, coastal inundation is not deemed a constraint moving forward.

1.10 BIODIVERSITY

The site is situated within the AUP Macroinvertebrate Community Index Control Area.

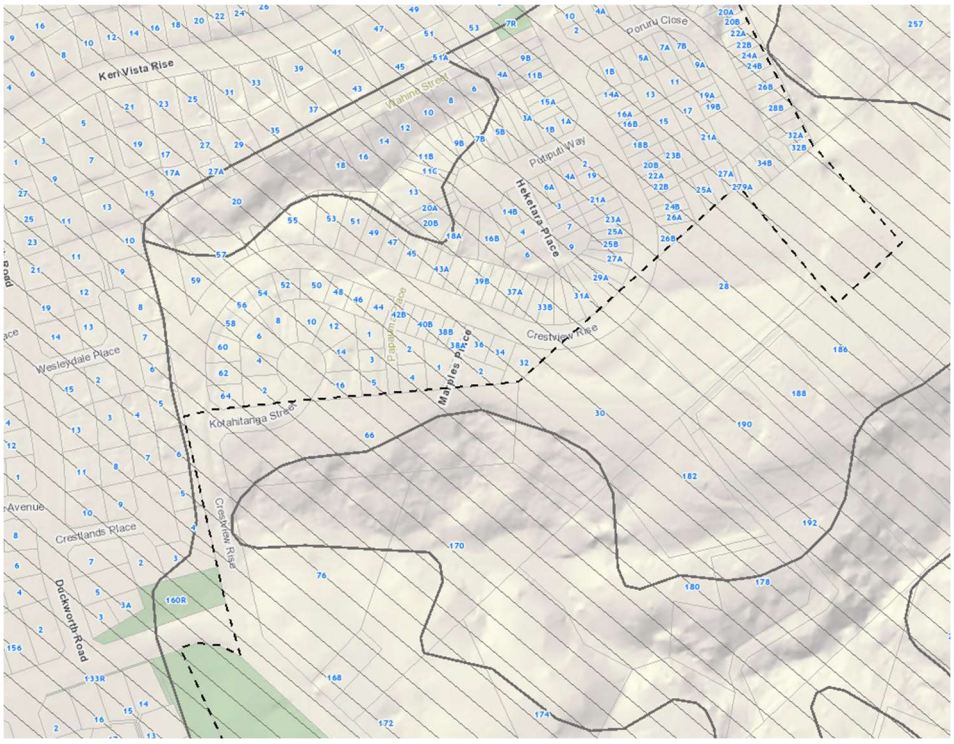

Figure 7: GIS MAP – Macroinvertebrate Community Index.

1.11 CONTAMINATED LAND

The site is not known to be contaminated with the site already having undergone previous bulk earthworks as part of the earlier subdivision approvals. ENGEO have provided a PSI report dated 19 December 2023 confirming this and the report forms part of the Plan Change application.

2.0 DEVELOPMENT SUMMARY AND PLANNING CONTEXT

2.1 REGULATORY AND DESIGN REQUIREMENTS

Based on review of Auckland Council's regulatory and stormwater guidelines, the site-specific stormwater management requirements have been identified. The relevant regulatory guidelines are listed in the Table below, and a summary of the requirements that are applied is presented in the sections following.

REQUIREMENT	RELEVANT REGULATORY / DESIGN TO FOLLOW
Unitary Plan – SMAF hydrology mitigation	Not within a SMAF zone
High Contaminant Generating Areas	AUP Chapter E9
Natural Hazards	AUP Chapter E36
Auckland Council Regionwide Network Discharge Consent	Greenfields – Future Urban Development (schedule 4)
Stormwater Management Devices Design	GD01
Application of Principles of Water Sensitive Design	GD01
Hydrology in the Auckland Region	Guidelines for Stormwater Runoff Modelling in the Auckland Region – Technical Publication 108 (1999).
Stormwater Management Approach	Auckland Unitary Plan Stormwater Management provisions: Technical basis of contaminant and volume management requirements – Technical Report 2013/035 (2013), Auckland Council.
Design and Construction of Stormwater Systems	Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 – Stormwater) – v3, January 2022

3.0 MANA WHENUA: TE AO MAORI AND MATAURANGA

3.1 IDENTIFICATION AND INCORPORATION OF MANA WHENUA VALUES

It is important that all stormwater management considers Mana Whenua values and potential issues of significance to iwi. It is not expected those values will be compromised as a result of the implementation of the proposed development concept design and stormwater management approach enabled by the plan change. Typical areas of acknowledgement, design or iwi participation include:

- Maintaining and enhancing the mauri of water by passing all roading and/or carpark runoff through a treatment device.
- Water conservation by re-use tanks.
- Detention of peak stormwater discharge to below pre-development levels to ensure no off-site effects on the wider stream catchment.
- Input of iwi in design of the centralised stormwater management devices (treatment and attenuation reserve area)

3.2 IWI ENGAGEMENT

On the 27th of July 2023, a Hui was undertaken on site with representatives of Te Akitai Waiohua, Ngati Te Ata Waiohua and Ngati Tamaoho. The Kaupapa was discussed, with key topics including the shifting of Rural Urban Boundary (RUB) and the stream that runs through the bush. It was discussed the importance of not extending the RUB to the southern slopes, and only extending to the ridgeline so the northern slopes are included within the boundary. This ensures that the disturbance to the natural bush is reduced and that the stream is maintained and undisturbed. Also during the Hui, it was acknowledged that the site does not have any Outstanding Natural Features (ONF), Mana Whenua or SEA overlays as well not having any recorded archaeological sites nearby.

Cultural value assessment reports were produced subsequently by Te Akitai Waiohua, Ngati Te Ata Waiohua and have informed an understanding of mana whenua values, matters of significance and the nature of the proposed stormwater management design measures for the land in avoiding adverse effects on the receiving environment.

Subsequent hui with iwi also took place on 1 February 2024 to inform iwi of progress on the plan change and how the plan change and related technical reports had considered the cultural value assessment reports including matters identified at the initial hui.

From a stormwater management perspective, the proposed precinct has objectives and policies which includes further participation by mana whenua during the design stages. The envisaged stormwater management philosophy being applied and its various measures, suitably recognizes and provides for mana whenua values and kaitiakitanga during the development stages to ensure environmental protection and enhancement.

4.0 STAKEHOLDER ENGAGEMENT AND CONSULTATION

STAKEHOLDERS	WHAT IS THE REASON FOR INTEREST?	WHAT ENGAGEMENT HAS BEEN COMPLETED?	FEEDBACK AND RESPONSE
Te Akitai Waiohua, Ngati Te Ata Waiohua and Ngati Tamaoho	Sustainable resource management, the protection of environment and mana whenua value recognition.	Hui on site on 27th of July 2023. Hui on site on 1 February 2024.	
Auckland Council and Auckland Transport	Requirements around design parameters for new public road.	To be handled at RC stage with assessment provided by client's Traffic Engineer. Stormwater management to be centralised rather than on-road rain gardens.	-
Auckland Council – Healthy Waters	New stormwater infrastructure being installed and increase in impervious area requiring management and connections to the existing public network	HW engagement to determine the stormwater discharge methodology and requirements around attenuation. This amended SMP responds to Clause 23 RFI matters and discussions held 27 July 2024.	

5.0 PROPOSED DEVELOPMENT

5.1 GENERAL DEVELOPMENT INFORMATION

The Site is Rural – Countryside Living Zone as defined by the Auckland Unitary Plan – Operative in Part (AUP). The site is bordered by Crestview Rise to the north and west, a recent subdivision completed by the present owner Harbour View Heights LP.

To assist with understanding the form of development which might occur following a rezoning, a conceptual development plan and associated engineering plans showing earthworks, roading layout and 3-waters servicing has been prepared for the site.

The proposed rezoning to Mixed Housing Urban and potential subsequent development could consist of the following:

- The construction of 31 residential Lots providing up to 90 dwellings
- Bulk Earthworks of the site to establish the proposed roading and stormwater management devices
- Proposed formation of a Public Road (to vest) and a Jointly Owned Access Lot
- Proposed formation of stormwater management reserve lot(s)
- Associated 3-waters infrastructure and utility services provision

5.2 SITE LAYOUT AND URBAN FORM

Refer to drawings in Appendix A showing the potential development layout and associated infrastructure works for the conceptual development proposal.

5.3 EARTHWORKS

A separate Bulk Earthworks Resource Consent will be required. Refer to the Bulk Earthworks plans: Proposed Contours and Proposed Cut and Fill plans.

As per the Bulk Earthworks plans, earthworks are proposed for the development to provide suitable contour primarily for road access and services. An existing stockpile area of surplus fill adjacent to Kotahitanga Street will also be removed. The stockpile has been seeded and currently resembles a natural earth formation. An earthworks area of approximately 0.85 ha is required for the formation of road reserves and the levelling within the site. It is anticipated that there will be approximately 13,500m^3 of cut and 1,100m^3 of fill for the entire site.

Based on the existing site topography, there is no potential development plan that would lend itself to requiring filling of any significant volume. In fact, potential development will require excavation, to form the roadways and the stormwater management device. Overall, there will be an excess of cut material and this will be removed off-site to an appropriate tip-site. An earthworks resource consent may be required to establish individual site building platforms.

6.0 STORMWATER MANAGEMENT

6.1 PRINCIPLES OF STORMWATER MANAGEMENT

This section sets out the stormwater management approach for the post-development operation of the site. This approach is intended for the sustainable stormwater management and land development within the site. It is also geared towards the protection, restoration, and enhancement of the receiving environment.

6.1.1 ORIGINAL PRINCIPLES

Guidelines and principles for Water Sensitive Design (WSD) are described as follows:

- Protect and enhance the values and functions of natural ecosystems.
- Address stormwater effects as close to the source as possible.
- Mimic natural systems and process for stormwater management, as much as practicable
- Filtering, Conveyance and Bioretention. This will be incorporated into the design through the provision of raingarden treatment devices, attenuation ponds and at source/on-lot rainwater collection tanks.
- Respecting the receiving environment.

WSD Objectives

The objectives for WSD for stormwater aim to deliver the priorities identified in the Auckland Unitary Plan. These objectives include:

- Valuing our natural heritage.
- Sustainably managing natural resources.
- Treasuring our coastline, harbours, islands, and marine areas.
- Realising quality, compact developments.
- Demanding good design in all development.
- Optimising, integrating, and aligning network provision and planning.
- Protecting, enabling, aligning, integrating, and providing social and community infrastructure for present and future generations.

6.1.2 UPDATED PRINCIPLES

This section will continue to be updated as the design process continues, and new data becomes available.

6.2 PROPOSED STORMWATER MANAGEMENT

6.2.1 GENERAL

A Stormwater Management Plan (SMP) is required as the site is classified as greenfield. The proposed development enabled by the rezoning will result in a net increase to the impervious coverage which will generate stormwater runoff that will need to be controlled and managed with appropriate mitigation measures. A stormwater management network consisting of underground pipes, rainwater collection and reuse systems, centralised attenuation devices, and centralised bioretention devices will be used to collect, treat, attenuate, and convey runoff from the proposed buildings and road infrastructure, following a treatment train approach.

A summary of the treatment train approach is:

1. The selection of building materials on house sites will be controlled through application of the use of land covenants/ consent notices at time of subdivision or development consent to ensure that contaminant generating materials (eg copper or zinc) are prohibited.

2. Each house site will include rainwater collection and re-use tanks. The tanks will have a retention function (plumbed into the house water supply providing for non-potable water use) and may have

detention function although this isn't required if all attenuation for the development is provided through centralised detention ponds (as currently proposed).

3. Each house site will connect stormwater from the rainwater tank overflow and from driveway catchpits, into the proposed stormwater reticulation which will pass through a centralised treatment and attenuation device, comprising a large raingarden and a detention pond.

4. All runoff from the proposed public road and the private accessways located within the JOAL will collect road runoff via standard street catchpits or superpits with a sediment trap. The catchpits will connect to the proposed public stormwater reticulation system which passes through a centralised rain garden and detention pond device.

5. The combination of on-lot rainwater collection and the proposed centralised detention pond will be sized to ensure that peak discharge control is achieved, so that post development runoff is less than 80% of pre-development runoff.

The treatment train approach described above is detailed on the Drainage Plans Nos: 400-402 in Appendix A.

6.2.2 WATER QUALITY

The contemplated stormwater management provision requirements are as follows:

- Avoid as far as practicable, or otherwise minimise or mitigate, adverse effects of stormwater runoff from the development on freshwater systems by minimising or mitigating changes in hydrology.
- Minimise or mitigate adverse effects of stormwater runoff by reducing the discharge of gross stormwater pollutants from high contamination generating activities and encouraging the restoration of natural freshwater systems where possible.

To protect water quality, treatment will be provided for the Water Quality Flow of 10mm/hr. A treatment train approach enables the capture of a range of predicted contaminants by directing stormwater runoff through a complementary sequence of stormwater management devices. The Water Sensitive Design principles adopted promote the direction of stormwater runoff to enhanced natural systems or practices that incorporate natural processes such as discharge to the proposed raingarden and stormwater pond.

It is not anticipated that the proposed public road, carparking or accessway will be deemed to be a High Use Road with more than 5000 vehicular movements per day however, it is proposed to provide treatment of all trafficked roadways, carparks and driveways. If left untreated, the receiving environment will be susceptible to high levels of sediments and contaminants, ultimately leading to a damaged ecosystem, loss in biodiversity and eutrophication.

The method to treat runoff from the accessways, carparks and driveways are as follows:

- Provide for stormwater treatment for all trafficable surfaces through a centralised bioretention device in the form of a rain garden. This will be sized in accordance with GD01 for contributing trafficable surfaces including access ways, roads and driveways. Our plans have assumed the sizing at 5% at this stage.
- There are effectively two main catchments from the development. Each catchment will be served by its own raingarden and detention pond device. Catchment areas are detailed in Appendix B.

The NDC requires the treatment of all impervious surfaces including building roof catchment. It is proposed to use inert building materials to prevent the generation of contaminant-laden runoff from the proposed buildings.

All runoff from the development will pass through raingardens. In addition, it should be noted that roof runoff will be collected through a rainwater re-use tank. This system will effectively ensure that the first flush of rainwater, carrying the majority of suspended sediments will be contained within the rain tank. While a specific treatment device for roof runoff is not proposed, the removal of suspended sediments through a rainwater tank is considered a Best Practical Option (BPO).

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6.2.3 WATER QUANTITY

This site is not located within a SMAF zone; however, we propose to provide retention on site.

Based on the geotechnical report produced, the site is underlain by expansive clay soils. Due to this, re-use within the accessway via soakage was considered impractical and due to steeper road grades pervious pavement solutions are not feasible.

Therefore, individual rainwater tanks are proposed for each dwelling and compliance with this requirement can be controlled through future consent notices registered against each title. The actual volume, sizing and tank shape will be finalised during consenting stages. The retention volume is to be re-used for non-potable water use such as laundry, toilet flushing and for landscaping.

A centralized stormwater detention pond is proposed at the lower end of each catchment. All stormwater from the development will be directed to one of two ponds proposed. Before entering the pond, a proposed low/high flow manhole will route smaller storm events (the first flush) to a proposed raingarden, while larger events will bypass the raingarden and discharge directly to the detention pond. These ponds will be designed to provide detention to ensure that peak discharge (for all storms up to the 1% AEP event) will be no greater than 80% of pre-development peak flows. A tiered orifice outlet will discharge into the existing stormwater reticulation network along Crestview Rise in two separate locations as shown on our Drainage Plans (Refer Appendix A).

Appendix A includes Dwg No 470 which shows the stormwater catchments for the site.

Catchment 1: Western Catchment – Discharging to the proposed SW pond 1.

The existing western catchment (66 Crestview Rise) conveys runoff towards the southwest corner of the site. A new stormwater pond is proposed at the west corner of the site to match. Nine proposed lots along with a proposed JOAL are within this catchment area and will discharge to the centralised treatment and detention device.

1. Retention - Water re-use for non-potable water uses such as laundry, toilet flushing and for landscaping will be provided within on-lot/dwelling rainwater tanks.

2. Detention – Runoff from the roofed areas, from private on-lot driveway areas and from the JOAL will be collected via piped drainage and directed to the centralised stormwater detention pond serving this catchment.

3. Management of the Primary Stormwater Network (10-year ARI storm) – The proposed pipe network will be designed to ensure capacity. Stormwater will be directed into the proposed stormwater pond, where it will be attenuated to 80% of pre-development levels and discharged back into the existing stormwater network.

4. Management of the Secondary Stormwater Network (1% AEP event) – Secondary overland flow from this catchment will be directed into the proposed stormwater pond, where they will be attenuated and released at 80% of pre-development flow rates to the downstream overland flow path network. The existing network includes a low and high flow manhole that directs 10-year flows directly into the system, while 100-year flows are routed into the existing basin along the east side of Crestview Rise and within Road 01. A raised pedestrian crossing, or similar will be constructed at the road entrance to ensure flow paths are directed to the proposed pond.

   As it is proposed to attenuate all stormwater flows to 80% of pre-development flow rates, the existing network is designed and able to accommodate discharge from the site.

Catchment 2: Eastern Catchment – Discharging to the proposed SW pond 2.

The existing eastern catchment (28 & 30 Crestview Rise) discharge to the existing Crestview Rise network and secondary overland flowpath within Crestview Rise. All proposed lots developed as well as the proposed new public road will discharge to a new piped stormwater network and conveyed to an additional stormwater pond proposed specifically for this catchment.

1. Retention - Water re-use for non-potable water uses such as laundry, toilet flushing and for landscaping will be provided within on-lot rainwater tanks.

2. Detention - The roof areas from each lot, the accessway areas and the proposed public Road will be detained within the proposed centralised stormwater pond.

3. Management of the Primary Stormwater Network (10-year ARI storm) – The proposed pipe network will be designed to ensure it has capacity to cater for the primary flows from the 10% ARI event. Stormwater will be directed into the proposed stormwater pond, where it will be attenuated to 80% of pre-development levels and discharged back into the existing stormwater network.

4. Management of the Secondary Stormwater Network (1% AEP event) – Secondary overland flow from this catchment will be passed through the detention pond to ensure that flows are attenuated to 80% of pre-development flow. Overflow from the detention pond will be onto the existing public roadway of upper Crestview Rise, where it currently passes.

   As it is proposed to attenuate all stormwater flows to 80% of pre-development flow rates, the existing public network is designed and able to accommodate overland flow discharge from the site.

6.2.4 STREAM HYDROLOGY

On the southern neighbouring site (76 Crestview Rise), there is an existing stream (a tributary of the Otuwairoa stream) running east to west. This is shown on Figure 8 below. The proposed development will only occur over the northern portion of the site due to a ridgeline in the existing topography. This natural ridgeline in the existing topography will ensure no flow from the new development will eventuate in the stream.

All post-development stormwater will be discharged into the existing public piped stormwater network with no direct stream discharges.

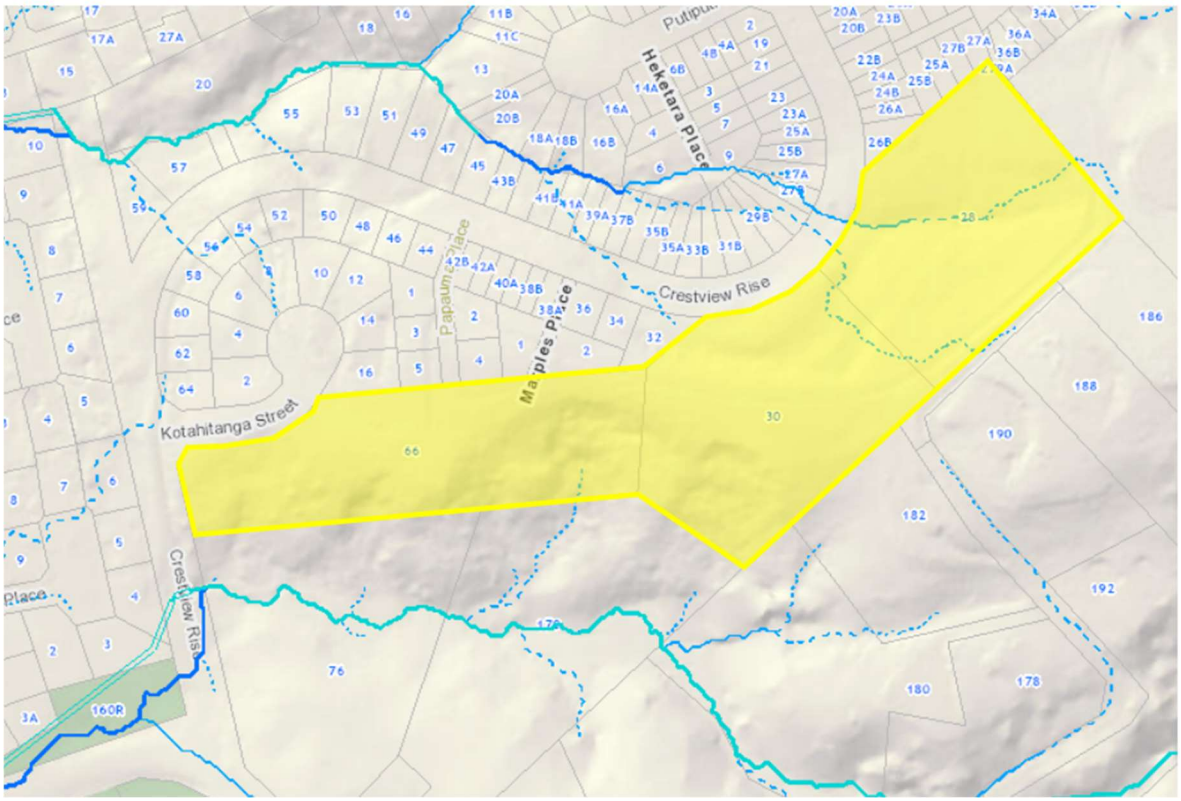


Figure 8: GIS MAP – Stream and OLFP.

6.2.5 FLOODING 10 PERCENT AEP EVENT (NETWORK CAPACITY)

In accordance with Auckland Council's Stormwater Code of Practice and TP108, the stormwater system has been designed and sized to convey flows from the 10-year ARI rainfall event adjusted for a 17% increase due to climate change.

The proposed primary stormwater network is described below:

1. The network will collect all stormwater from the proposed lots , the JOAL and Road 1 and connect into proposed public stormwater reticulation through laterals or catchpit leads (from roadways). The main lines will convey all stormwater to the stormwater ponds proposed and discharge into the existing public stormwater piped network adjacent to each respective pond.

2. The pond serving catchment 1 will discharge into the existing 750mm dia public network at lower Crestview Rise on the western end of the site. The pond serving catchment 2 will discharge into the existing 450mm dia public network at upper Crestview Rise on the eastern end of the site. These connection points and proposed drainage layout is detailed on our Dwg. Nos. 401 and 402. The stormwater pond will discharge at 80% of pre-development flows.

Overall combined peak flow from the developed site for the 10% AEP (1 in 10-year storm) is calculated and have been included in Appendix B. Our calculations confirm that the existing public stormwater network within Crestview rise has adequate capacity to serve the proposed development.

6.2.6 FLOODING 1 PERCENT AEP EVENT (NETWORK CAPACITY)

Due to existing downstream flood constraints, the proposed development is designed to limit discharge to no more than 80% of pre-development peak flows during a 100-year storm event. To achieve this, all new stormwater discharge, will be routed through the proposed piped network (for 10% AEP flows) and via overland flowpaths (for 1% AEP flows) to one of two planned stormwater ponds. The overland flowpath network will be designed to accommodate a 100-year event, ensuring that flows are directed to the pond wherever possible.

6.2.7 FLOODING 1 PERCENT AEP EVENT (HABITABLE FLOORS)

Overland flowpaths for the site have been designed to be conveyed and contained within the proposed roadways. Flowpaths across the site are minor with the contributing catchment being limited to from the site only. Upstream overland flow, from the south and the east are currently diverted away from the site and do not contribute to any flood risk on the site. Therefore, flooding in the 1% AEP (1 in 100 year) scenario is not anticipated to be an issue. No special arrangements need to be made with respect to setting of freeboards for building platforms within the proposed development. Instead, the standard freeboard requirements set out in the Building Code can be followed.

Further to this, the stormwater tanks on each dwelling and the stormwater retention pond has been sized to attenuate and reduce stormwater flows so that there is no increase in flow rates in a 1% AEP event.

6.2.8 OVERLAND FLOWPATH AND FLOODPLAIN MANAGEMENT

There are multiple minor OLFP's that pass through the site. These overland flowpaths pass through the site from the east and flow towards Crestview Rise based on GIS. These overland flow paths are minor and form within the proposed development, with no stormwater being conveyed from outside the development boundary due to the ridgeline.

The existing OLFP within Crestview Rise will be preserved, with both the proposed JOAL and public road discharging into this OLFP in the event of blockage and subsequently into the existing stormwater attenuation basin forming part of the Council stormwater easement area within the stream environment.

6.2.9 DEVELOPMENT STAGING

It is expected that all public stormwater infrastructure will be installed with the roading infrastructure and before the construction of buildings and accessways. The communal devices and other public network systems will be built as part of the subdivision civil works, alongside the other proposed infrastructure. The centralized treatment and attenuation devices will be operational before any dwellings are constructed, regardless of the staging approach.

6.3 ASSET OWNERSHIP

It is proposed that the final stormwater management devices, not otherwise located within individual residential lots, and including the proposed underground network, detention ponds and raingardens will be vested as public stormwater assets. Any on lot rainwater tanks and treatment devices will be private assets, owned and maintained by the individual dwelling owner.

6.3.1 RAIN TANKS (NON-POTABLE RE-USE)

Periodically the property's plumbing and drainage system should be checked for leaks and faults. Only fully certified practitioners for confined space entry should enter the tanks for inspections and maintenance. These maintenance check requirements range from quarterly for the outlet pipe to every few years for pump inspections.

It is essential that appropriate access is provided to all components of the rainwater tank system to enable regular inspection and maintenance (at least annually) to be carried out with minimal effort and inconvenience. Roofs and collections areas must be kept free of overhanging trees to reduce organic litter and prevent access by rodents, cats, possums, and other wildlife. Inlets and overflows should be screened, and access hatches kept closed.

Sizing of the proposed on-lot tanks will be undertaken at future Building Consent stage in conjunction with house design.

6.4 IMPLEMENTATION OF STORMWATER NETWORK

The stormwater network has been conceptually designed to manage the stormwater run-off from the proposed rezoned area and contemplated development. All private stormwater conveyance and treatment devices will be finalised as part of the Building Consent stage. Once approved, the works will be installed and monitored in coordination with Auckland Council inspectors for signoff.

As the development progresses, it is expected that staged stabilisation of completed bulk earth worked areas will occur to avoid sedimentation of the stormwater network. This would be a condition expected at the initial subdivision and earthworks consenting stage.

Operations, maintenance and monitoring of the proposed stormwater system will be critical in ensuring that the short and long-term performance of the system is maintained with the key focus being the prevention of sedimentation.

Monitoring will be carried out during the construction stages, on completion and will continue throughout the life cycle of the system.

6.5 RISKS

WHAT IS THE RISK TO THE PROPOSED STORMWATER MANAGEMENT?	HOW CAN THIS BE MITIGATED / MANAGED?	WHAT OTHER MANAGEMENT / MITIGATION COULD BE USED?	WHEN DOES THIS RISK NEED TO BE ADDRESSED?	WHAT IS THE RESULTANT LEVEL OF RISK?
Flooding due to insufficient capacity during a 1% AEP event	Design infrastructure to accommodate the 1% AEP event, with safety margins for higher intensity storms	Implement additional detention basins or emergency overflow paths	Preliminary Design	Medium
Climate Change Risk	Design for future climate scenarios, with increased capacity in retention/detention systems	Over attenuation of pre-development flows.	Preliminary Design	Medium
Inaccurate GIS floodplain and OLFP information	Undertake recent site-specific survey for designs	Site visit to visually confirm	Preliminary Design	Low
Blockages	Regular inspection and maintenance of inlets, outlets, and culverts	Design system redundancy and suitable overland flow paths	Ongoing	Medium
Ownership of assets	Early coordination with stakeholders during the RC process to be undertaken		During the Resource Consent phase	Low

7.0 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

7.1 CONCLUSIONS

This Stormwater Management Plan has been developed to support the Proposed Plan Change to rezone land for residential purposes potentially up to 90 dwellings. A concept subdivision/development plan for the site has been prepared to inform, evaluate and apply the best practicable stormwater management measures for the site. An integrated stormwater management approach will be adopted across the site and has been developed based on the policies set out in the Auckland Unitary Plan along with stormwater specific guidelines from Auckland Council's Code of Practice, GD01 and the New Zealand Building Code. The main outcomes of the SMP include:

- The provision of an integrated stormwater management approach.
- The assurance of no adverse changes to the downstream overland flowpaths and overall flood risk.
- The mitigation of any adverse effects from stormwater runoff on surface water quality by providing a treatment train approach.

In order to achieve the desired outcomes, the following Water Sensitive Design principles will be adopted:

- Promoting inter-disciplinary planning and design
- Protecting and enhance the values and functions of the natural ecosystems
- Addressing stormwater effects as close to the source as possible through the provision of proprietary treatment devices for all contaminant generating impervious surfaces.
- Mimicking natural systems and process for stormwater management by retention/detention
- Enhancing the receiving environment by providing Stormwater treatment.

Detailed Design of the proposed stormwater management approach, including device selection, sizing and location will be addressed and finalised at Detailed Design stage of the development and approved through the subdivision/Engineering Plan Approval and/or Building Consent processes.

7.2 FUTURE WORK

This Stormwater Management Plan is a live document and may be updated in response to feedback from iwi consultation, the Proposed Plan Change decision making, and future consenting processes.

8.0 LIMITATIONS

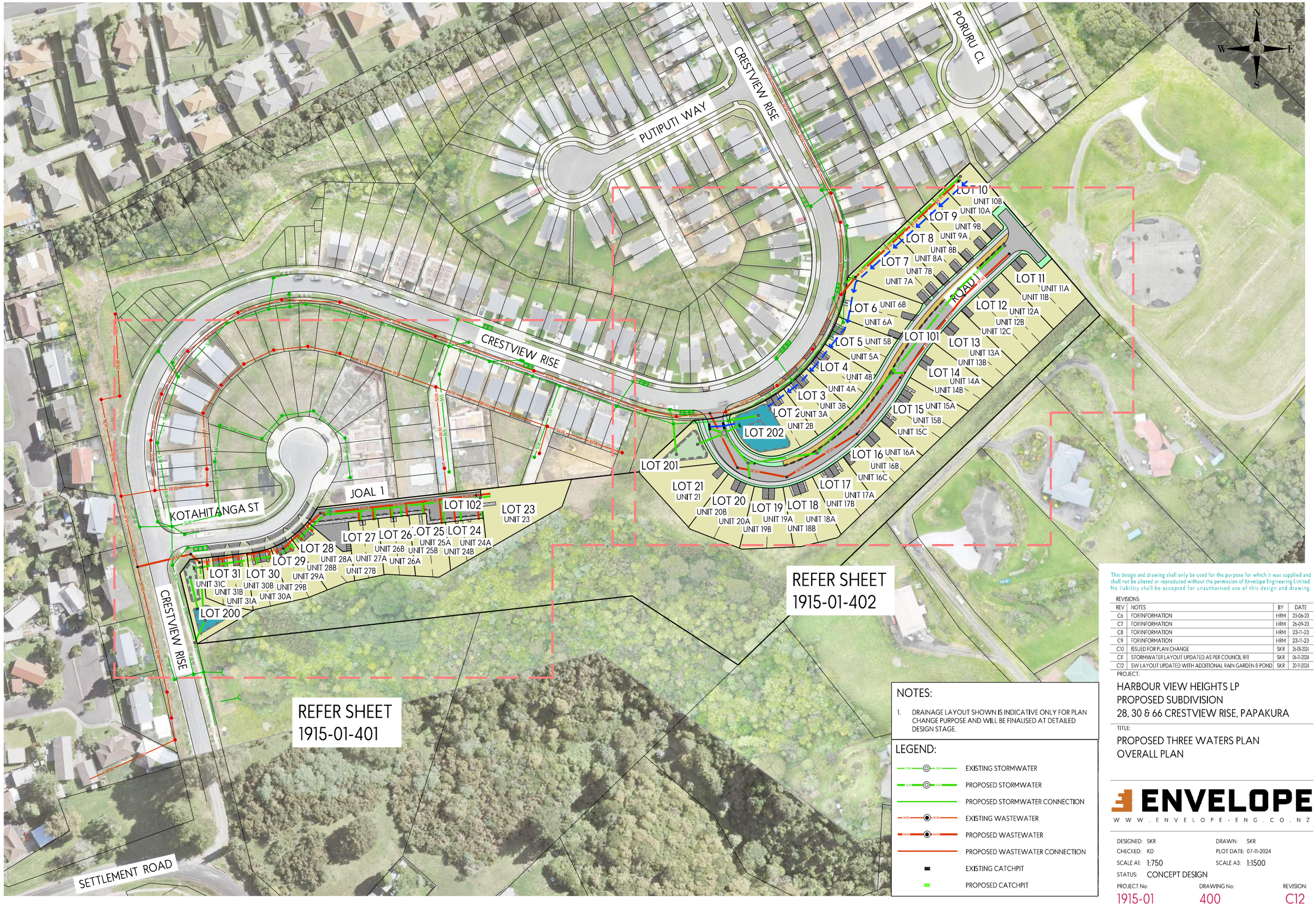
8.1 GENERAL

This report is for the use by Harbourview Heights LP only and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Envelope Engineering Limited. No responsibility is accepted by Envelope Engineering Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

APPENDICES

APPENDIX A
PROPOSED CIVIL ENGINEERING PLANS



REVISIONS:

REV	NOTES	BY	DATE
C6	FOR INFORMATION	HRM	23-06-23
C7	FOR INFORMATION	HRM	26-09-23
C8	FOR INFORMATION	HRM	23-11-23
C9	FOR INFORMATION	HRM	23-11-23
C10	ISSUED FOR PLAN CHANGE	SKR	26-08-2024
C11	STORMWATER LAYOUT UPDATED AS PER COUNCIL RFI	SKR	06-11-2024
C12	SW LAYOUT UPDATED WITH ADDITIONAL RAIN GARDEN & POND	SKR	20-11-2024

PROJECT:

HARBOUR VIEW HEIGHTS LP
PROPOSED SUBDIVISION
28, 30 & 66 CRESTVIEW RISE, PAPAKURA

TITLE:

PROPOSED THREE WATERS PLAN
OVERALL PLAN

NOTES:

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE ONLY FOR PLAN CHANGE PURPOSE AND WILL BE FINALISED AT DETAILED DESIGN STAGE.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- PROPOSED STORMWATER CONNECTION
- EXISTING WASTEWATER
- PROPOSED WASTEWATER
- PROPOSED WASTEWATER CONNECTION
- EXISTING CATCHPIT
- PROPOSED CATCHPIT

ENVELOPE
WWW.ENVELOPE-ENG.CO.NZ

DESIGNED:	SKR	DRAWN:	SKR
CHECKED:	KD	PLOT DATE:	07-11-2024
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STATUS:	CONCEPT DESIGN		

PROJECT No:	DRAWING No:	REVISION:
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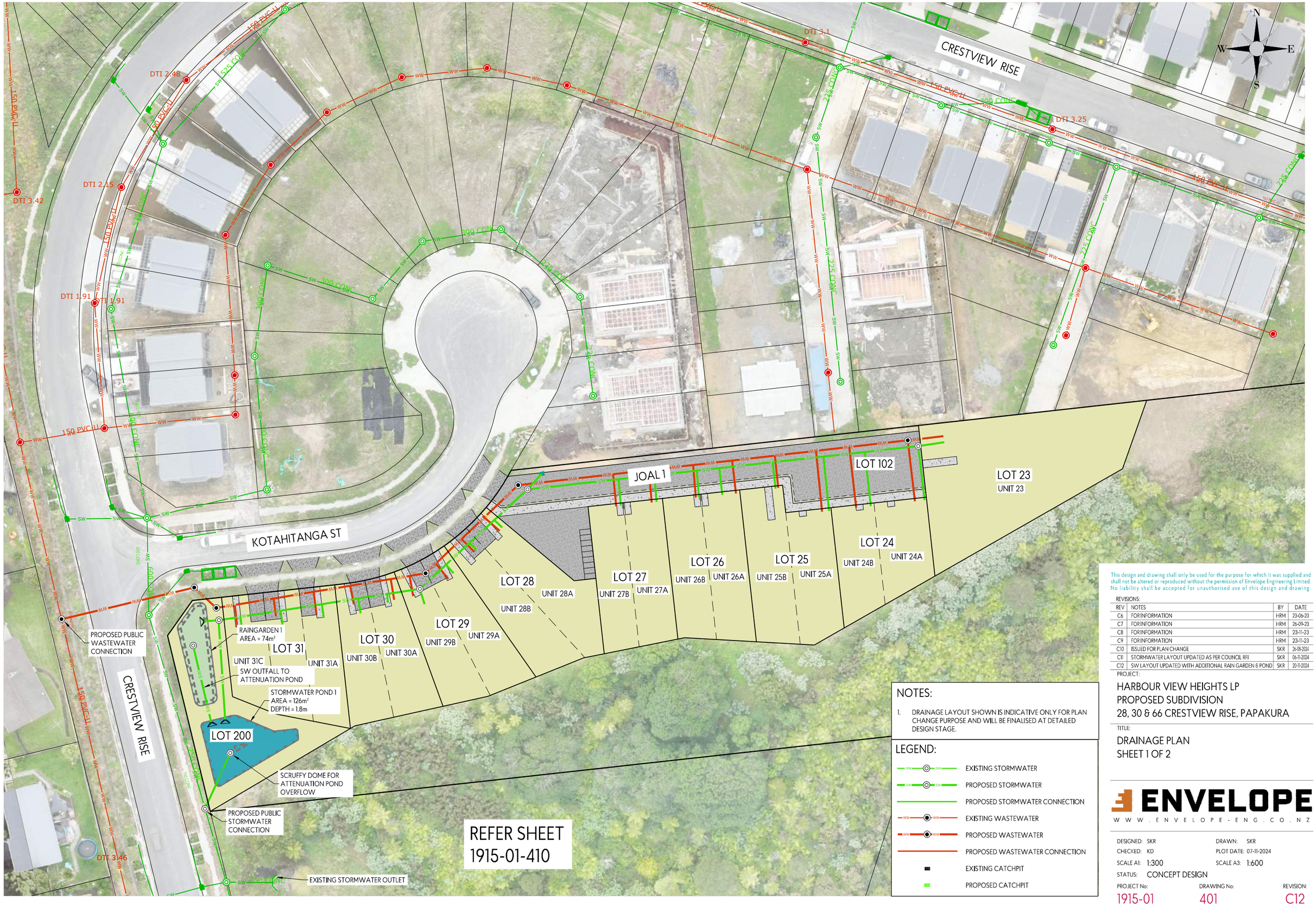

REFER SHEET
1915-01-410

NOTES:

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE ONLY FOR PLAN CHANGE PURPOSE AND WILL BE FINALISED AT DETAILED DESIGN STAGE.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- PROPOSED STORMWATER CONNECTION
- EXISTING WASTEWATER
- PROPOSED WASTEWATER
- PROPOSED WASTEWATER CONNECTION
- EXISTING CATCHPIT
- PROPOSED CATCHPIT

REVISIONS:

REV	NOTES	BY	DATE
C6	FOR INFORMATION	HRM	23-06-23
C7	FOR INFORMATION	HRM	26-09-23
C8	FOR INFORMATION	HRM	23-11-23
C9	FOR INFORMATION	HRM	23-11-23
C10	ISSUED FOR PLAN CHANGE	SKR	26-08-2024
C11	STORMWATER LAYOUT UPDATED AS PER COUNCIL RFI	SKR	06-11-2024
C12	SW LAYOUT UPDATED WITH ADDITIONAL RAIN GARDEN & POND	SKR	20-11-2024

PROJECT:

HARBOUR VIEW HEIGHTS LP
PROPOSED SUBDIVISION
28, 30 & 66 CRESTVIEW RISE, PAPAKURA

TITLE:

DRAINAGE PLAN
SHEET 1 OF 2

ENVELOPE
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DESIGNED:	SKR	DRAWN:	SKR
CHECKED:	KD	PLOT DATE:	07-11-2024
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STATUS:	CONCEPT DESIGN		

PROJECT No:	DRAWING No:	REVISION:
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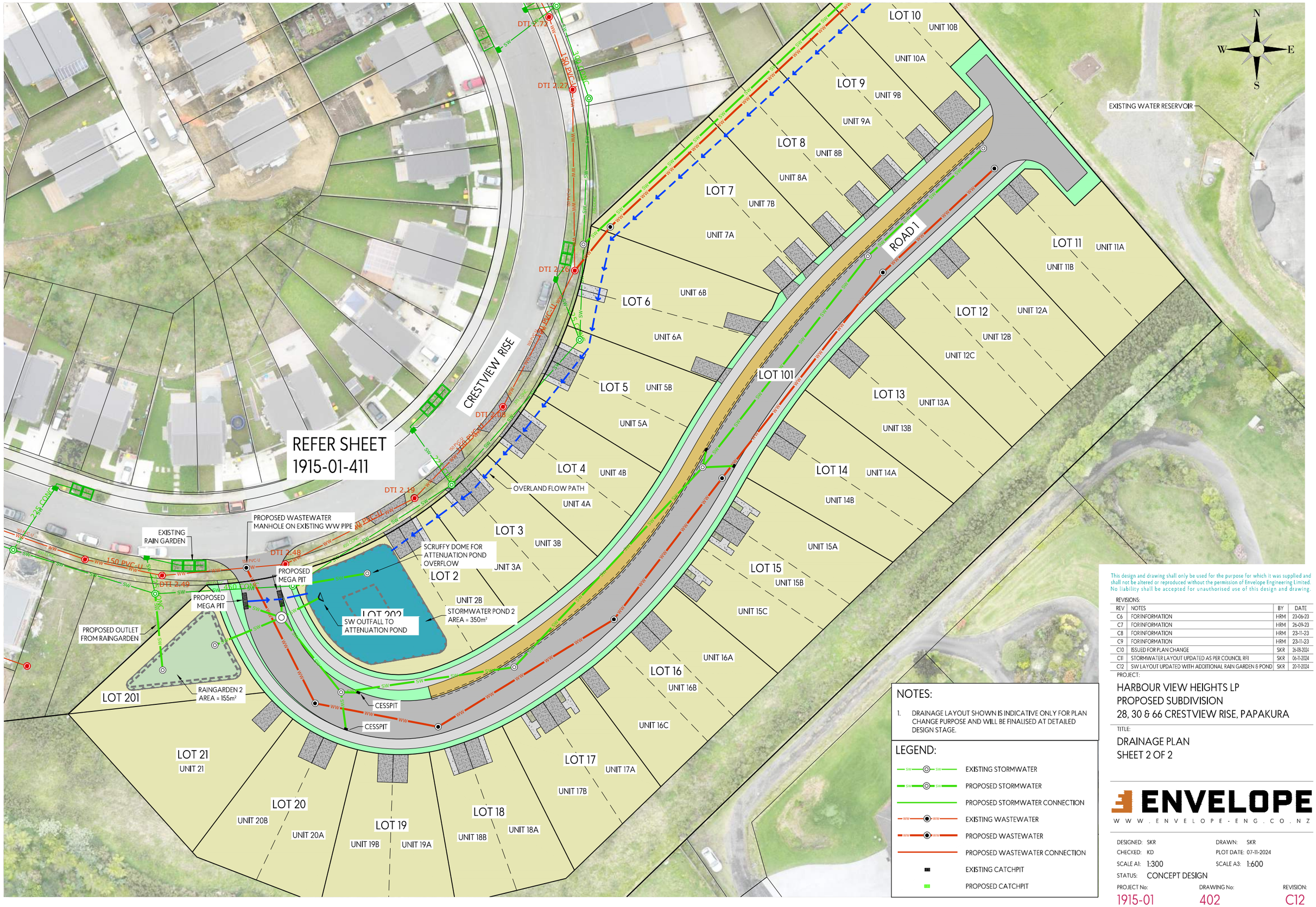

NOTES:

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE ONLY FOR PLAN CHANGE PURPOSE AND WILL BE FINALISED AT DETAILED DESIGN STAGE.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- PROPOSED STORMWATER CONNECTION
- EXISTING WASTEWATER
- PROPOSED WASTEWATER
- PROPOSED WASTEWATER CONNECTION
- EXISTING CATCHPIT
- PROPOSED CATCHPIT

REVISIONS:

REV	NOTES	BY	DATE
C6	FOR INFORMATION	HRM	23-06-23
C7	FOR INFORMATION	HRM	26-09-23
C8	FOR INFORMATION	HRM	23-11-23
C9	FOR INFORMATION	HRM	23-11-23
C10	ISSUED FOR PLAN CHANGE	SKR	28-08-2024
C11	STORMWATER LAYOUT UPDATED AS PER COUNCIL RFI	SKR	06-11-2024
C12	SW LAYOUT UPDATED WITH ADDITIONAL RAIN GARDEN & POND	SKR	20-11-2024

PROJECT:

HARBOUR VIEW HEIGHTS LP
PROPOSED SUBDIVISION
28, 30 & 66 CRESTVIEW RISE, PAPAKURA

TITLE:

DRAINAGE PLAN
SHEET 2 OF 2

ENVELOPE
WWW.ENVELOPE-ENG.CO.NZ

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DRAWN: SKR
CHECKED: KD
PLOT DATE: 07-11-2024
SCALE A1: 1:300
SCALE A3: 1:600
STATUS: CONCEPT DESIGN

PROJECT No: 1915-01
DRAWING No: 402
REVISION: C12

LOT 200

CRESTVIEW RISE

EXISTING DN 750
STORMWATER PIPE

PROPOSED
STORMWATER PIPE

SITE BOUNDARY

EXISTING DN 750
STORMWATER PIPE

EXISTING
STORMWATER
MANHOLE

EXISTING DN 750
STORMWATER PIPE

EXISTING STORMWATER
OUTLET. REFER PHOTO
ON RIGHT.

STORMWATER OUTLET - PHOTO 1

STORMWATER OUTLET - PHOTO 2

NOTES:

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE ONLY FOR PLAN CHANGE PURPOSE AND WILL BE FINALISED AT DETAILED DESIGN STAGE.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- PROPOSED STORMWATER CONNECTION
- EXISTING WASTEWATER
- PROPOSED WASTEWATER
- PROPOSED WASTEWATER CONNECTION
- EXISTING CATCHPIT
- PROPOSED CATCHPIT

REVISIONS:

REV	NOTES	BY	DATE
C11	STORMWATER LAYOUT UPDATED AS PER COUNCIL RFI	SKR	06-11-2024

PROJECT:

HARBOUR VIEW HEIGHTS LP
PROPOSED SUBDIVISION
28, 30 & 66 CRESTVIEW RISE, PAPAKURA

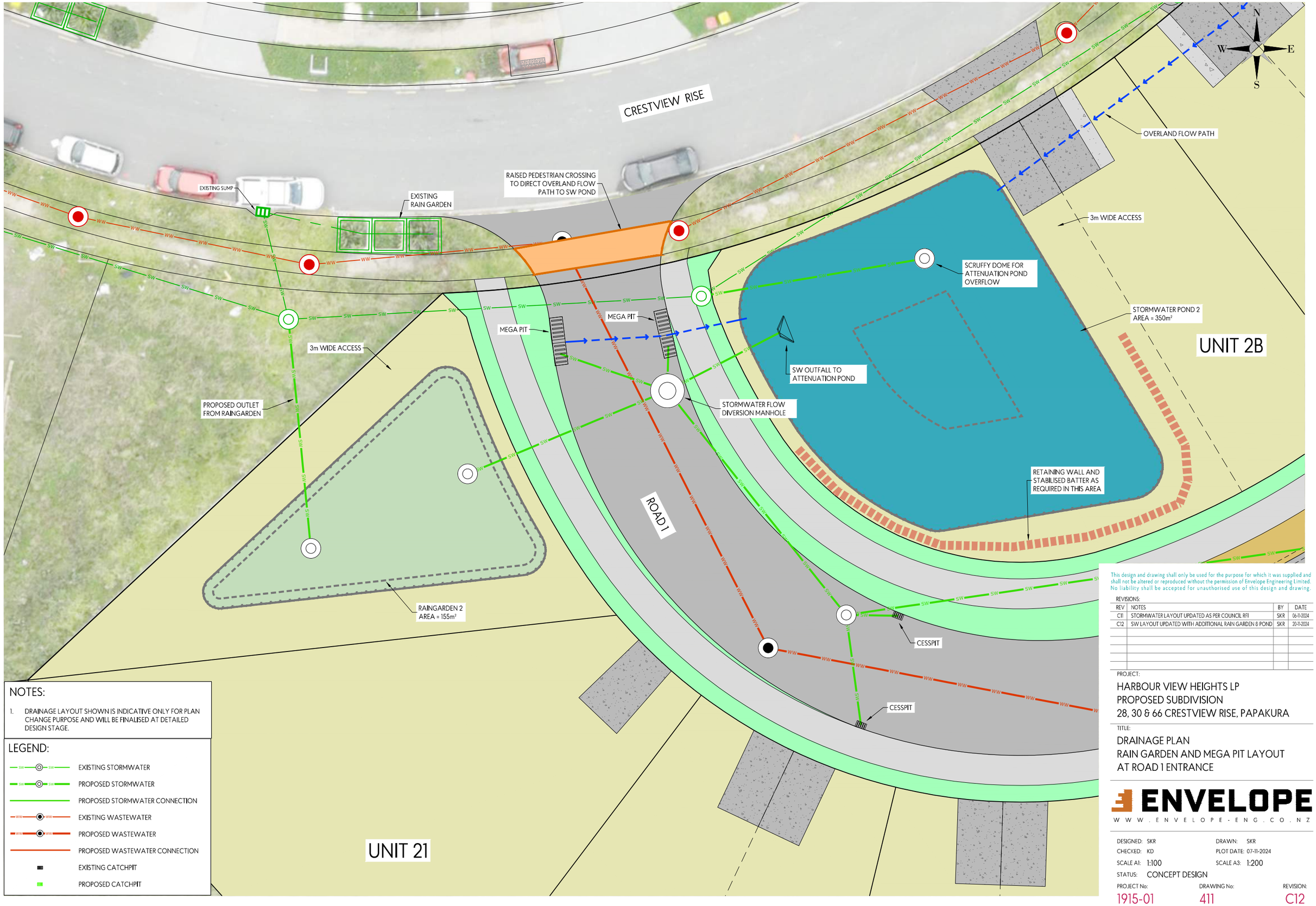
TITLE:

DRAINAGE PLAN
EXISTING STORMWATER OUTLET

ENVELOPE
WWW.ENVELOPE-ENG.CO.NZ

DESIGNED: SKR
DRAWN: SKR
CHECKED: KD
PLOT DATE: 07-11-2024
SCALE A1: 1:75
SCALE A3: 1:150
STATUS: CONCEPT DESIGN

PROJECT No: 1915-01
DRAWING No: 410
REVISION: C11



NOTES:

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE ONLY FOR PLAN CHANGE PURPOSE AND WILL BE FINALISED AT DETAILED DESIGN STAGE.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- PROPOSED STORMWATER CONNECTION
- EXISTING WASTEWATER
- PROPOSED WASTEWATER
- PROPOSED WASTEWATER CONNECTION
- EXISTING CATCHPIT
- PROPOSED CATCHPIT

REVISIONS:

REV	NOTES	BY	DATE
C11	STORMWATER LAYOUT UPDATED AS PER COUNCIL RFI	SKR	06-11-2024
C12	SW LAYOUT UPDATED WITH ADDITIONAL RAIN GARDEN & POND	SKR	20-11-2024

PROJECT:

HARBOUR VIEW HEIGHTS LP
PROPOSED SUBDIVISION
28, 30 & 66 CRESTVIEW RISE, PAPAKURA

TITLE:

DRAINAGE PLAN
RAIN GARDEN AND MEGA PIT LAYOUT AT ROAD 1 ENTRANCE

ENVELOPE
WWW.ENVELOPE-ENG.CO.NZ

DESIGNED: SKR
DRAWN: SKR
CHECKED: KD
PLOT DATE: 07-11-2024
SCALE A1: 1:100
SCALE A3: 1:200
STATUS: CONCEPT DESIGN

PROJECT No: 1915-01
DRAWING No: 411
REVISION: C12

APPENDIX B
STORMWATER DESIGN CALCULATIONS

Client	Harbourview Heights LP
Project Site	Settlement Road
Envelope Ref	1915-01
Version	1
Date	20/11/2024

ENVELOPE

STORMWATER - RAINFALL

TP108 Rainfall Method				
Event	**Depth**			
Figure A.1 - 2 yr ARI - 50% AEP	75	mm		
Figure A.2 - 5 yr ARI - 20% AEP		mm		
Figure A.3 - 10 yr ARI - 10% AEP	135	mm		
Figure A.4 - 20 yr ARI - 5% AEP		mm		
Figure A.5 - 50 yr ARI - 2% AEP		mm		
Figure A.6 - 100 yr ARI - 1% AEP	215	mm		

Climate Change Adjusted				
Annual Exceedence Probability (AEP)	**% increase in 24-Hour Design Rainfall Depth FCC - 2.1 degree**	**% increase in 24-Hour Design Rainfall Depth FCC - 3.8 degree**	**Climate adjusted rainfall depth (mm) - 2.1 degree cc**	**Climate adjusted rainfall depth (mm) - 3.8 degree cc**
50%	15%	27%	86.325	**95.55**
20%	16%	30%	0	0
10%	17%	31%	157.95	**176.58**
5%	17%	31%	0	0
2%	18%	32%	0	0
1%	18%	33%	253.915	**285.305**

Client	Harbourview Heights LP
Project Site	Settlement Road
Envelope Ref	1915-01
Version	2
Date	20/11/2024

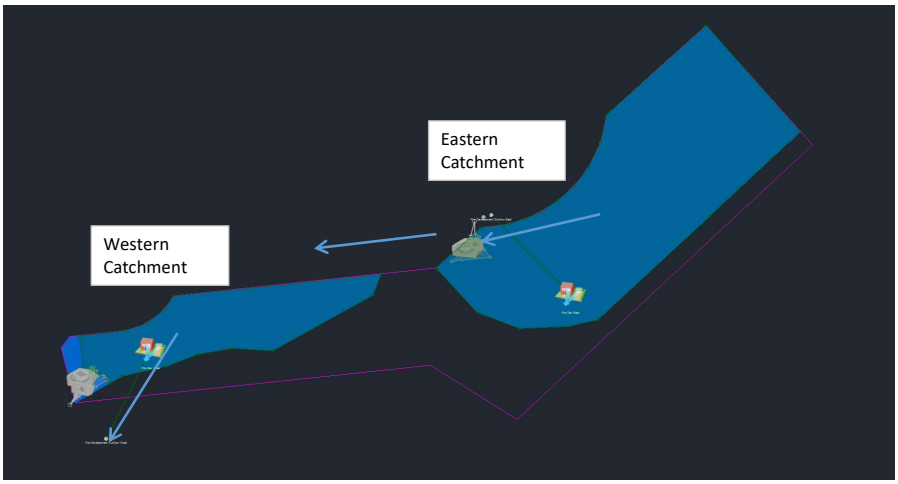
ENVELOPE

STORMWATER - PRE DEVELOPMENT

Catchment Areas			
Catchment Pre Development	**100 yr - (3.8 degrees cc)**		
Eastern Area	1.465	ha	

Catchment Areas			
Catchment Pre Development	**100 yr - (3.8 degrees cc)**		
Catchment number	EAST	→	
Impervious Area	0	ha	
Pervious Area	1.465	ha	
Total area	1.5	ha	
% Impervious	0.0		
Catchment Slope (Sc)	0.1	m/m	
Catchment Length (l)	0.1	km	
Channelisation Factor (C)	0.6		
Hydrological Soil Group	Group_C		
SCS Curve Number (CN)	74		
24-Hour Rainfall Depth (P24)	258.8	mm	
Weighted Curve Number	74.0		
Initial Abstraction (Ia) weighted	5.0	mm	
tc	0.2	hours	
tp	0.1	hours	
Storage (S)	89.2	mm	
c*=(P24-2Ia)/(P24-2Ia+2S)	0.6		
q* (from Fig. 6.1)	0.1	Approx!!	
Peak Flowrate (qp)	0.5	m3/s	
Peak Flowrate (qp)	497.6	L/s	
24 hour rainfall depth (Q 24)	187.8	mm	
24 hour runoff volume (V24)	2750.9	m3	
80% Peak Flowrate (qp)	398.1	L/s	

Catchment Map



Eastern Catchment Results

Summary Results for Pre Development Outflow East

Storm Event	Max. Inflow (L/s)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	118.3	118.3	610.197	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	215.2	215.2	1102.481	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	281.7	281.7	1442.935	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	360.7	360.8	1851.498	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	451.4	451.4	2324.667	OK
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	514.0	514.0	2654.389	OK

Client	Harbourview Heights LP
Project Site	Settlement Road
Envelope Ref	1915-01
Version	2
Date	20/11/2024

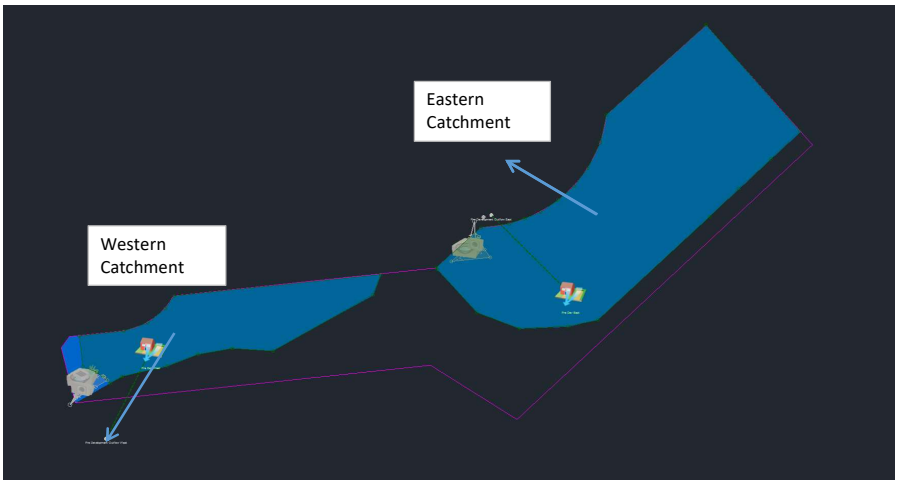
ENVELOPE

STORMWATER - PRE DEVELOPMENT

Catchment Areas			
Catchment Pre Development	**100 yr - (3.8 degrees cc)**		
Western Area	0.469	ha	

Catchment Areas			
Catchment Pre Development	**100 yr - (3.8 degrees cc)**		
Catchment number	WEST	→	
Impervious Area	0	ha	
Pervious Area	0.469	ha	
Total area	0.5	ha	
% Impervious	0.0		
Catchment Slope (Sc)	0.1	m/m	
Catchment Length (l)	0.1	km	
Channelisation Factor (C)	0.6		
Hydrological Soil Group	Group_C		
SCS Curve Number (CN)	74		
24-Hour Rainfall Depth (P24)	258.8	mm	
Weighted Curve Number	74.0		
Initial Abstraction (Ia) weighted	5.0	mm	
tc	0.2	hours	
tp	0.1	hours	
Storage (S)	89.2	mm	
c*=(P24-2Ia)/(P24-2Ia+2S)	0.6		
q* (from Fig. 6.1)	0.1	Approx!!	
Peak Flowrate (qp)	0.2	m3/s	
Peak Flowrate (qp)	159.3	L/s	
24 hour rainfall depth (Q 24)	187.8	mm	
24 hour runoff volume (V24)	880.7	m3	
80% Peak Flowrate (qp)	127.4	L/s	

Catchment Map



Western Catchment Results

Summary Results for Pre Development Outflow West

Storm Event	Max. Inflow (L/s)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	37.9	37.9	195.427	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	68.9	68.9	353.070	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	90.2	90.2	462.114	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	115.5	115.5	592.930	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	144.6	144.6	744.502	OK
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	164.6	164.6	850.074	OK

Client	Harbourview Heights LP
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ENVELOPE

STORMWATER - POST DEVELOPMENT

Catchment Areas			
Catchment Post Development	**100 yr - (3.8 degrees cc)**		
Eastern Area	1.465	ha	

Catchment Areas			
Catchment Post Development	**100 yr - (3.8 degrees cc)**		
Catchment number	EAST	→	
Impervious Area	1.26	ha	
Pervious Area	0.205	ha	
Total area	1.465	ha	
% Impervious	0.86		
Catchment Slope (Sc)	0.1	m/m	
Catchment Length (l)	0.1	km	
Channelisation Factor (C)	0.6		
Hydrological Soil Group	Group_C		
SCS Curve Number (CN)	74		
24-Hour Rainfall Depth (P24)	258.8	mm	
Weighted Curve Number	94.6		
Initial Abstraction (Ia) weighted	0.7	mm	
tc	0.2	hours	
tp	0.1	hours	
Storage (S)	14.4	mm	
c*=(P24-2Ia)/(P24-2Ia+2S)	0.9		
q* (from Fig. 6.1)	0.2	Approx!!	
Peak Flowrate (qp)	0.6	m3/s	
Peak Flowrate (qp)	612.0	L/s	
24 hour rainfall depth (Q 24)	244.5	mm	
24 hour runoff volume (V24)	3581.6	m3	
80% Peak Flowrate (qp) (Pre Development)	398.1	L/s	
Peak Flowrate (qp) (Post Development)	612.0	L/s	
Additonal peak flows	213.9	L/s	

Catchment Map - Post

Eastern Catchment Results

Summary Results for Pre Development Outflow East

Storm Event	Max. Inflow (L/s)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	118.3	118.3	610.197	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	215.2	215.2	1102.481	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	281.7	281.7	1442.935	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	360.7	360.8	1851.498	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	451.4	451.4	2324.667	OK
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	514.0	514.0	2654.389	OK

Client	Harbourview Heights LP
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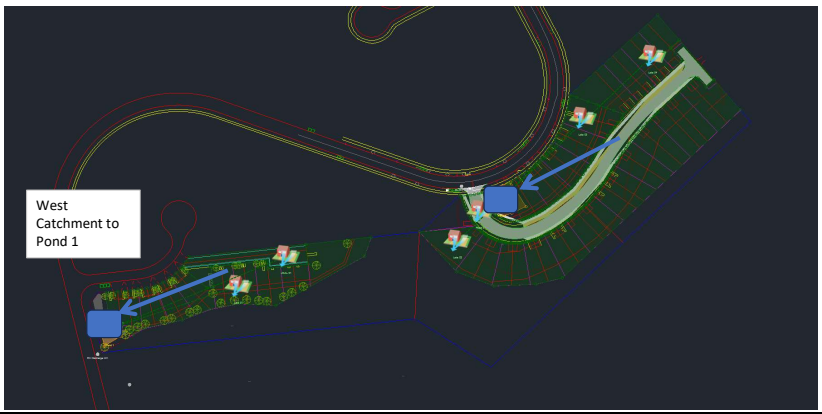
ENVELOPE

STORMWATER - POST DEVELOPMENT

Catchment Areas			
Catchment Post Development	**100 yr - (3.8 degrees cc)**		
Western Area	0.469	ha	

Catchment Areas			
Catchment Post Development	**100 yr - (3.8 degrees cc)**		
Catchment number	EAST	→	
Impervious Area	0.403	ha	
Pervious Area	0.0657	ha	
Total area	0.469	ha	
% Impervious	0.86		
Catchment Slope (Sc)	0.1	m/m	
Catchment Length (l)	0.1	km	
Channelisation Factor (C)	0.6		
Hydrological Soil Group	Group_C		
SCS Curve Number (CN)	74		
24-Hour Rainfall Depth (P24)	258.8	mm	
Weighted Curve Number	94.6		
Initial Abstraction (Ia) weighted	0.7	mm	
tc	0.2	hours	
tp	0.1	hours	
Storage (S)	14.4	mm	
c*=(P24-2Ia)/(P24-2Ia+2S)	0.9		
q* (from Fig. 6.1)	0.2	Approx!!	
Peak Flowrate (qp)	0.2	m3/s	
Peak Flowrate (qp)	195.8	L/s	
24 hour rainfall depth (Q 24)	244.5	mm	
24 hour runoff volume (V24)	1145.8	m3	
80% Peak Flowrate (qp) (Pre Development)	127.4	L/s	
Peak Flowrate (qp) (Post Development)	195.8	L/s	
Additonal peak flows	68.4	L/s	

Catchment Map - Post



Western Catchment Results

Summary Results for Pre Development Outflow West

Storm Event	Max. Inflow (L/s)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	37.9	37.9	195.427	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	68.9	68.9	353.070	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	90.2	90.2	462.114	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	115.5	115.5	592.930	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	144.6	144.6	744.502	OK
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	164.6	164.6	850.074	OK

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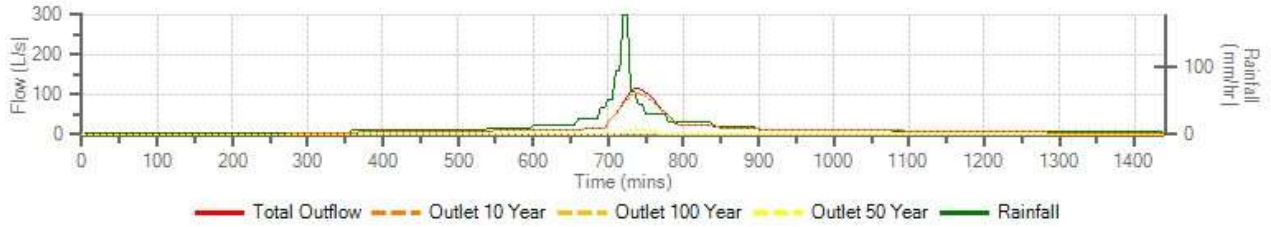
ENVELOPE

STORMWATER - PROPOSED POND 1

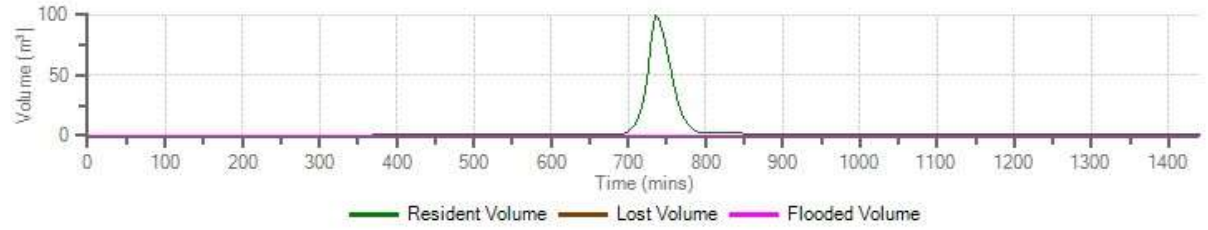
Outlet Design

Depth	2.5	m	
Freeboard	500	mm	
Volume	165	m^3	
Orifice 1 Size	190	mm	diameter
Orifice 1 Invert Elevation	0	mm	
Orifice 2 Size	75	mm	diameter
Orifice 2 Invert Elevation	0.8	m	
Orifice 3 Size	200	mm	diameter
Orifice 3 Invert Elevation	2	m	
Peak Flowrate (qp) 100 yr	128.7	litres/second	OK

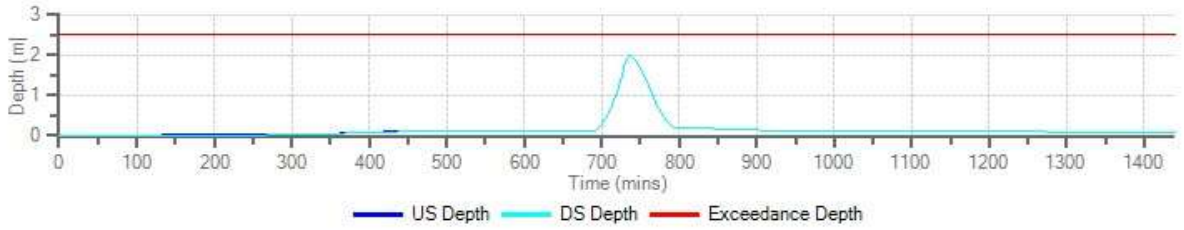
Flow Graph - Pond 1



Volume Graph - Pond 1



Depth Graph - Pond 2



Scenarios - Pond 1

Summary Results for Pond 1

Storm Event	Max. Avg. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m^3)	Max. Flooded Volume (m^3)	Total Lost Volume (m^3)	Max. Outflow (L/s)	Total Discharge Volume (m^3)	Percentage Available (%)	Status
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	1.984	224.0	99.419	0.000	0.000	128.7	1083.114	2	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	1.535	169.5	58.375	0.000	0.000	110.1	803.497	42	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	1.226	140.6	37.679	0.000	0.000	94.8	656.329	63	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	0.892	114.9	21.185	0.000	0.000	72.8	529.440	79	OK
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	0.190	23.8	2.340	0.000	0.000	23.1	332.997	98	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	1.819	201.9	82.647	0.000	0.000	122.2	969.532	18	OK
First Flush - Rainfall Depth (mm): 10.0, Run Time (mins): 2880	0.004	0.0	0.036	0.000	0.000	0.0	5.507	100	OK

Client	Harbourview Heights LP
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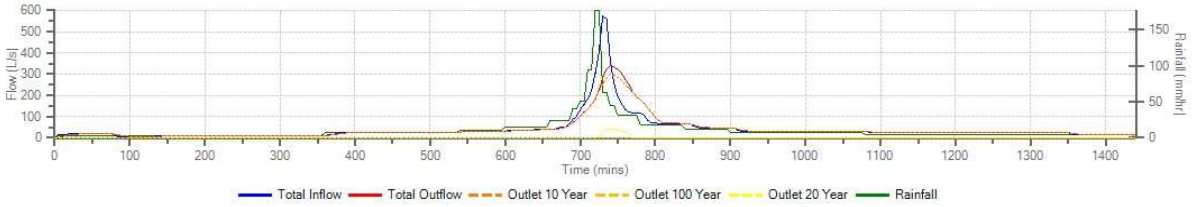
ENVELOPE

STORMWATER - PROPOSED POND 2

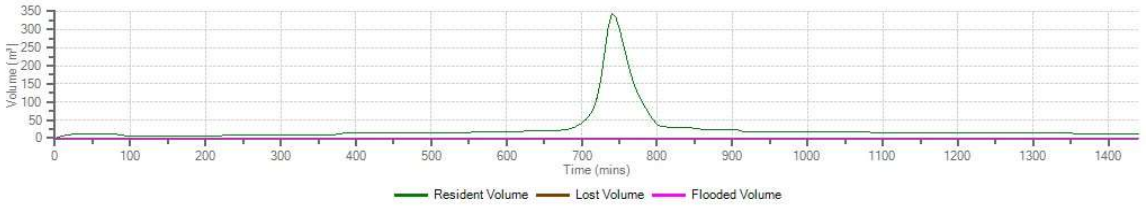
Outlet Design

Depth	2.5	m	
Freeboard	500	mm	
Volume	540	m^3	
Orifice 1 Size	325	mm	diameter
Orifice 1 Invert Elevation	0	mm	
Orifice 2 Size	150	mm	diameter
Orifice 2 Invert Elevation	0.6	m	
Orifice 3 Size	150	mm	diameter
Orifice 3 Invert Elevation	2	m	
Peak Flowrate (qp) 100 yr	382.4	litres/second	OK

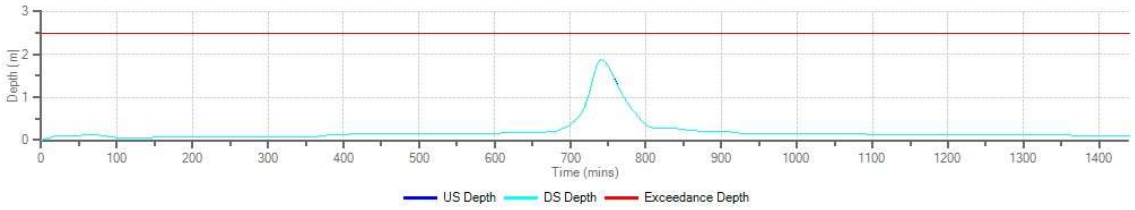
Flow Graph - Pond 2



Volume Graph - Pond 2



Depth Graph - Pond 2



Scenarios - Pond 2

Summary Results for Pond 2

Storm Event	Max. Avg. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Percentage Available (%)	Status
ARC - 100yr ARI - FCC: +18.1 %: ARC - 100yr ARI - FCC1440	1.882	575.8	343.923	0.000	0.000	382.4	3362.428	9	OK
ARC - 20yr ARI - FCC: +17.2 %: ARC - 20yr ARI - FCC1440	1.424	435.3	227.570	0.000	0.000	310.6	2535.220	40	OK
ARC - 10yr ARI - FCC: +17 %: ARC - 10yr ARI - FCC1440	1.153	360.9	169.535	0.000	0.000	252.1	2100.180	55	OK
ARC - 5yr ARI - FCC: +16.4 %: ARC - 5yr ARI - FCC1440	0.869	291.2	116.919	0.000	0.000	190.9	1724.502	69	OK
ARC - 2yr ARI - FCC: +15.1 %: ARC - 2yr ARI - FCC1440	0.353	118.6	39.974	0.000	0.000	98.6	1144.084	89	OK
ARC - 50yr ARI - FCC: +17.6 %: ARC - 50yr ARI - FCC1440	1.703	518.8	295.676	0.000	0.000	356.5	3026.150	22	OK
First Flush - Rainfall Depth (mm): 10.0, Run Time (mins): 2880	0.107	17.0	11.101	0.000	0.000	17.0	112.074	97	OK

APPENDIX C
DRAFT OPERATION AND MAINTENANCE

Table 3

Typical stormwater pond maintenance schedule.

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm events
Functional maintenance recommendations						
Inlet pipes and structures	Inspect for clogging and build up of debris and rubbish. Debris should not block or threaten to obstruct any stormwater inflow points.	✓				✓
	The area around inlet and energy dissipation (e.g. rip rap) structures should also be inspected for erosion and cracks in the structure. Remove debris and litter and fix cracks and erosion as necessary.		✓			✓
Trash racks and debris screens	If the pond is equipped with trash racks, inspect for build up of gross pollutants including leaves, sticks, branches, litter and other debris. Remove accumulated debris that can hinder stormwater flows into the pond and cause localised flooding. Remove and properly dispose of debris and litter. Check the trash rack for corrosion. Replace excessively corroded racks.	✓				✓
Sediment forebay	Accumulated sediments need to be removed from the forebay more frequently than from the main pond. Dredging needs to occur if sediment build-up threatens operation or if storage volume of the forebay is reduced to about 50% of its design volume (i.e. the depth of the sediment is half of the total depth of the water, check using a stick or survey staff gauge). Sediments should be tested for contaminants (e.g. heavy metals, PAHs) prior to dredging to determine the most appropriate mechanism (e.g. landfill) for disposal of the sediments (contaminated sediment has concentrations higher than natural background levels, refer TP153).				✓	✓

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm e vents
Bund	The bund separates the forebay from the main pond and also provides an important access point for maintenance (if designed for to bear equipment). The bund should also be checked for erosion and stability (see Erosion and Bank Stability section below). Any problems with erosion should be quickly repaired.		✓			✓
Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockages could be caused by heavy sedimentation, floating debris, trash, etc. or if maintenance has been neglected, control structures could be overgrown with vegetation. If left uncorrected, blockages can cause both local and widespread flooding. Trash and other floating debris should be regularly removed from the pond and disposed of properly. The areas around the control structure should be free of blockages and dense vegetation to maintain an unobstructed flow path for stormwater. A boat may be needed to access the outlet.	✓				✓
	Inspect for evidence of leaky joints or soil piping around outflow pipes. Erosion (washout, scouring) around outflow pipes can be caused by water flowing from the pond and out along the outside of pipe, which can lead to bank failure. In this case, the anti-seep collar around the outflow pipe may need to be repaired or replaced.		✓			✓
	Inspect outfall and water discharge areas for erosion. Restore eroded areas and stabilise as necessary. Check to make sure energy dissipaters are adequate.		✓			✓

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm e vents
Emergency overflow or spillway	Inspect and verify that the emergency overflow path is clear of debris and has not been blocked or altered in any way. Correct blockages and alterations as necessary. Check the flow path for erosion and fix as necessary. If problems with the emergency flow path are left unattended, significant flooding and even pond bank failure can occur. Structural repairs must be done promptly to avoid catastrophic failure.	✓				✓
Erosion and bank stability	Check banks for settlement, erosion, scouring, cracking, sloughing, seepage, and rilling etc. Unless specified in the pond's landscape plans, woody vegetation should generally be removed as its root systems can compromise bank strength if the plant should die. They can also impede access of maintenance equipment. If woody plants are present, the plant and root system needs to be removed, replaced with the proper material and compacted to the original bank design specifications (usually 95% of the soil maximum density). Pedestrian and bicycle traffic can compact soils and kill off vegetation cover, thus leading to erosion. Therefore, pedestrian traffic should either be restricted and affected areas closed off and restored, or the affected areas provided with a more erosion resistant ground cover.	✓				✓
Valves and pumps	Inspect for properly functioning valves and pumps, if installed. Mechanical features on ponds should be run through their full range of motion and their proper operation confirmed. Moving parts should be inspected for corrosion and properly lubricated.		✓			

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm e vents
Main pond	The main pond will also require the removal of accumulated sediments, but not as frequently as the sediment forebay. A permanent silt marker (either a mark on the riser or permanent post) will assist in determining when the main pond will require removal of built up sediment. Dredging of sediment should occur when the build-up reduces the storage volume of the main pond to about 50% of its design volume (i.e. the depth of the sediment is half of the total depth of the water, check using a stick or survey staff gauge). Consideration needs to be given to the noise and costs of pumps for de-watering. Gravity methods of de-watering are often preferred.				✓	
	For dry ponds check vegetation cover. Vegetation must have shallow root systems and not impede flow when the pond is inundated. Remove woody species and dense clumps of vegetation.		✓			
Aesthetic maintenance recommendations						
Landscaping	Banks and surrounding areas need to be regularly cleared of weeds, plants pruned and replaced 3 monthly. Grass areas around the pond need to be mown monthly. Schedules may vary with growth rates and seasons.	✓				
Shallow pond areas (which support wetland type vegetation, also known as littoral zone)	Inspect littoral zones for exotic and invasive/nuisance aquatic vegetation and remove accordingly. Control of invasive vegetation may be done manually or with appropriate herbicide. (Application of herbicides may need to be done by a properly-licensed and registered professional). Inspection frequency may need to be increased during the growing season.		✓			

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm e vents
Water body	Rubbish and other floating debris need to be removed from the pond's surface and in areas where it collects. Inspect the pond for algal blooms or fish kills, which may signal eutrophication (a condition characterised by a combination of super-dense aquatic vegetation or algae growth and low dissolved oxygen levels in pond water), high nutrient or high pollutant levels in the stormwater run-off. Water quality testing may be needed to help identify causes of algal blooms.	✓				✓
	Check the water body for invasive aquatic weed species which can clog the flow of water through the pond. Species include common cattail, arrowhead, marshwort, hornwort, fringed water lily, and water poppy (refer Regional Pest Management Strategy). Removal of weeds should be carried out through biological control or manual removal (refer Landscape and Ecology Values within Stormwater Management, Boffa Miskell 2009).		✓			
Wildlife	Once established, many stormwater ponds become habitats for birds and aquatic life. Regular inspection is required to ensure that desirable species are not threatened and that pest species are controlled. Open areas for mosquito control should be maintained, avoid stagnant, still water which may require chemical treatment for mosquito control. A visual inspection of the pond area to check for dead or sick birds or the presence of any introduced fish (e.g. carp, catfish, rudd, tench etc) should be carried out in conjunction with other monthly maintenance tasks.	✓				✓

Component	Recommended action	Frequency				
		Monthly	6 monthly	Yearly	Two or more y ears	After storm e vents
Soil	Soil can be eroded from pond banks particularly after heavy rainfall and where vegetation cover is poor. Also, depending on the quality of the soil, fertilisers may be needed to aid plant growth (refer Landscape and Ecology Values within Stormwater Management, Boffa Miskell, 2009). **NB: Fertilisers, herbicides and pesticides should only be used after careful consideration due to proximity to the waterway and because the pond water will ultimately discharge into the stormwater system.**	✓				✓
	When planting is being established or new planting has recently gone in, the soil should be protected with an organic matting such as coconut fibre to prevent erosion.			✓		

Note: A storm event is any heavy rain event or prolonged rainfall period where by flooding can occur or debris can be blown into the pond area (e.g. falling trees, or branches). Typically a storm event is >2-year event.

4.4.2 Unplanned or emergency maintenance

Unplanned or emergency works can result from storm events, uncontrolled activities within the catchment, or contaminant spills. Depending on the location of the pond there may be some time between the incident occurring, reporting, and remediation. It is important that after storm events the pond is visually inspected promptly so that any damage can be rectified.

Typical issues after storm events include floatables, blockages of outlets or inlets, flooding and erosion of banks. The procedures listed above should be used for any corrective maintenance. Details for refurbishment or re-build will be found in the technical information section of the operation and maintenance manual.

Uncontrolled catchment activities relate mainly to earthworks without effective erosion and sediment control measures in place. The increased sediment load in run-off could inundate the pond and cause problems for aquatic life.

A spill response plan should also be included in the operation and maintenance manual (or referenced if located in another document). The primary response will be preventing

MAINTENANCE SCHEDULE

TIMING	COMPONENT	ACTION
Following storms	Grass filter strip (if included), kerbing, paved area	• Remove rubbish, leaves and other debris from the grass filter strip and surrounding drainage area.
	Ponding area	• Clear inflow points of sediment, rubbish and leaves. • Check for erosion or gouging and repair. • Test drainage of ponding area - check garden 24 hours after rain to ensure no water is ponding. • Top up soil and mulch as necessary (ensuring level is below surrounding hard surface and overflow).
	Mulch	• Mulch may need to be redistributed or added around inflow points.
3 monthly	Grass filter strip, kerbing, paved area	• If grass strip is present, mowing frequency depends on growth rates and seasons. • Mow no shorter than 50mm (approximately 3 finger widths). Do not mow grass shorter or the filter strip will not work properly. • Re-sow grass as necessary. • Remove rubbish, leaves and other debris. • Check soil and mulch level is below surrounding hard surface areas and overflow. • Remove excess mulch/soil if required.
	Ponding area	• Clear inflow points of built up sediment, rubbish and leaves. Check for erosion or gouging – repair if necessary.
	Mulch layer (bark, pebbles, etc)	• Remove rubbish, leaves and other debris. • After storm events mulch may need to be redistributed or added around inflow points.
	Plants	• Water establishing plants monthly during extended dry periods. • Check plant health and replace dead plants as necessary. • Use native species to suit garden conditions (e.g. full sun or shaded). - See ARC TP10 for partial list of suitable species. • Remove weeds – do not use herbicides, pesticides and fertilisers as these chemicals will pollute the stormwater runoff.

MAINTENANCE SCHEDULE CONT...

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

TROUBLESHOOTING

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Stormwater run off is bypassing the rain garden.	Local earthworks increasing sediment load to rain garden, blocking rain garden outlets or raising the surface level of garden.	• Check surface of the rain garden is below the surrounding area. • Remove any sediments and debris from inflow areas and from the surface of the rain garden. • Protect rain garden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the rain garden.	• Regularly remove rubbish, leaves and any other debris from inflow points.
Rain garden is ponding for longer than 24 hours. Stormwater and/or mulch flowing off the rain garden.	Incorrect blend of soil mix.	• Replace soil mix with the correct rain garden soil mix. Do Ribbon test or Percolation test to test soil mix is free-draining.
	The soil within the garden compacted during construction or other activities.	• Loosen the top 500mm soil by tilling or forking. Discourage vehicle, pedestrian and bicycle access to the rain garden.
	Layer of fine sediment settled on the garden surface.	• Remove fine sediment layer and turn over the top layer of rain garden soil mix. Protect rain garden from surrounding sediment run off.
	Rain garden filled with too much mulch or soil.	• Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow.
	Overflows or discharge pipes clogged with sediments or debris.	• Clear overflow and discharge pipes.
	Planting or rain garden soil mix clogged.	• It may be necessary to remove some of the rain garden soil mix and replace with fresh rain garden soil mix.
Sulphur smell coming from the rain garden.	Plants and soils lacking oxygen (anaerobic conditions). Organic material rotting within the garden. The underdrain clogged and water is not properly draining out of the garden.	• Inspect rain garden after rain event to check garden drains within 12 to 24 hours. *(See solutions, above for rain garden ponding.)*

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Erosion and gouging occurring within the rain garden	Kerbs and other hard structures channelling stormwater flow. (Rain gardens require an even sheet flow of water to operate effectively.)	• Create openings in the kerb to increase number and width of run off points, or replace kerbing with a different design (e.g. kerbing slightly raised off the ground).
	Inflow points are too concentrated.	• Increase kerb opening size by cutting kerbs or replacing with different design. If this is not possible install rip-rap (i.e. stones set into concrete) at the inflow point to spread flow and reduce erosion.
Plants are stressed or dying. Symptoms may include yellowing of leaves, unseasonal leaf fall, wilting..	Plant varieties selected for rain garden are unsuitable for the location and/or extreme wet/dry conditions.	• Select plants appropriate for the location (e.g. full shade, partial shade, full sun, etc.). • Due to their hardy nature, native plants are recommended *(see ARC TP10 for suggested plant list).*
	Ponding or excessively long periods of flooding cause plants to become stressed and die.	• Inspect rain garden after rain event to check garden drains within 12 to 24 hours. See above solutions for rain garden ponding.
	The plants poisoned by run-off from a hazardous spill (fuel, paint, oil, etc) Pollutants accumulated in the rain garden reached a toxic level for plants	• Check soil and mulch for evidence of heavily polluted run off (e.g. rainbow slick, coloured mulch, etc). • If contamination is extensive, clean out rain garden soil mix and replace fresh soil and new plants. *See construction guide for instructions.*
	The plants dehydrated from extended dry conditions.	• Newly established plants need watering. • Check soil moisture content and water plants if dry. • Establishing plants need watering in dry weather conditions.
	Plants stressed due to attack by plant pests or diseases. Pests may include insects or animals.	• Check for leaf damage or pests and consult gardening manuals or a garden centre for the best treatment. • Stressed plants need replacing with healthy variety or pest-resistant species.
	Rain garden soil mix compacted.	• Loosen the top 500mm of soil by tilling or forking. Do not allow vehicle, pedestrian and bicycle access to the rain garden.

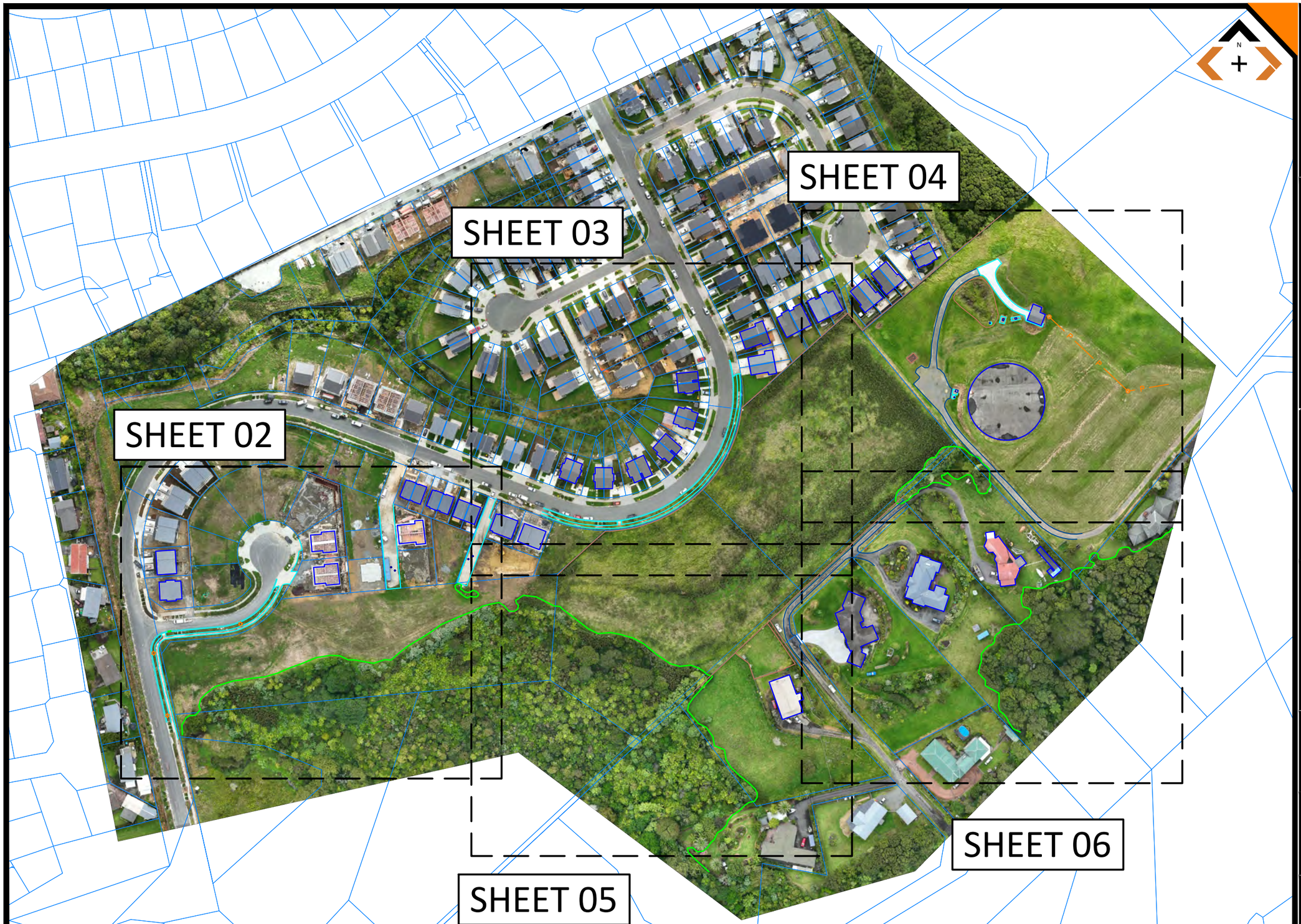
Quick maintenance checks

- ✓ Regularly remove rubbish, leaves, debris and weeds from inflows and ponding area.
- ✓ Use native plants when replanting is required.
- ✓ Replace soil mix with a mix of sandy loam, sand or loam compost. Ready-made rain garden soil mix is available from some garden centres and horticultural suppliers.

Avoid

- ✗ Do not use sprays to kill weeds/vegetation or algae as this will contaminate the downstream waterways.
- ✗ Do not compact the rain garden soil mix – use drainage test as described above to check.
- ✗ Do not add clay or silt in the rain garden soil mix as this will restrict water draining through the soil

APPENDIX D
AS-BUILT TOPOGRAPHICAL SURVY PLANS (PROVIDE BY SURVEY WORX)



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0	ORIGINAL ISSUE	MWC	19.04.23
1	SYSTEM/DATUM SHIFTED	RRR	11.09.23

NOTES:

BEARING AND COORDINATE DATUM IS NZGD2000
NEW ZEALAND TRANSVERSE MERCATOR PROJECTION

LEVELS ARE IN TERMS OF LANDS AND SURVEY DATUM (MSL)
AUCKLAND 1946

ORIGIN OF SURVEY: CLLQ RM X DP 80473
5895891.033mN
1775447.737mE
RL 28.048m

1. CONTOURS ARE SHOWN AT 1.0M INTERVALS
2. DTM TRIANGLES ARE FROZEN ON LAYER (300-SF-TRIANGLES-SWX)
3. BOUNDARY INFORMATION FROM LINZ LAND ONLINE EXTRACT AND SUBJECT TO SURVEY
4. CONTOURS ARE TOP OF VEGETATION
5. PHOTOGRAMMETRY &/OR LIDAR PRINCIPLES APPLY

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SURVEY EQUIPMENT USED:
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GPS: TRIMBLE R6/R8 SYSTEMS / LEICA GPS08 PLUS
PRECISE LEVELLING: TRIMBLE DINI Series 0.3mm DIGITAL
VERTICAL PLUMMING: FOIF DZJ2 LASER PLUMMIT
LASER SCANNER: LEICA RTC360 / LEICA P30

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PROJECT
LOTS 123, 124 & 127, 166 SETTLEMENT RD, PAPAKURA

TITLE
UAV TOPOGRAPHICAL SURVEY PLAN
SHEET LAYOUT

SCALE	(A1)	(A3)	DRAWING No	SHEET	REVISION
1:1000	1:2000		7077-705-001	1 of 6	1

PLOT DATE: 9/11/2023 4:10 pm

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TITLE
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7077-705-001	6 of 6	1	