Appendix 8

Three Waters Design Report

PROPOSED RESIDENTIAL DEVELOPMENT
AT 131 & 189 THREE MILE BUSH ROAD, WHANGAREI
HURUPAKI SUBDIVISION

THREE WATERS DESIGN REPORT

Project Number: 18733

Date: 24 August 2021

Revision: 0

1 Introduction 3
2 Water 4
3 Wastewater 5
4 Hydrological Assessment 7
4.1 Pre-Development 7
4.2 Post-Development 7
4.3 Soil Classification 9
5 Council Requirements 9
5.1 Northland Regional Council SW requirements 9
5.2 Proposed Northland Regional Plan July 2021 11
5.3 Whangarei District Council Three Water Management ..... - 16 -
6 Proposed Stormwater Mitigation Methodology ..... - 23 -
6.1 Proposed Devices ..... - 23 -
6.2 Modelling Inputs ..... - 23 -
6.3 Results ..... - 24 -
6.4 Stormwater Device Design ..... - 25 -
6.4.1 Front Pond ..... - 25 -
6.4.2 Middle Pond ..... - 26 -
6.4.3 Rear Pond ..... - 27 -
7 Stream road crossing ..... - 29 -
8 Other Considerations ..... - 29 -

1 INTRODUCTION

LDE Ltd was engaged by Hurupaki Holdings Limited to provide a report covering the three waters management for the proposed residential development on 131 & 189 Three Mile Bush Road, Whangarei.

Figure 1 - Site location plan with reference to Whangarei CBD. From Whangarei District Council IntraMaps.

As with any new development water, wastewater and stormwater servicing and management is required.

The water supplies additional demand can be serviced either on the public network or with an onsite water supply which can consist of either an extension of the public system or the use of water tanks or water bores. As this development is to be smaller urban sized lots, an extension of the water network is proposed with wastewater disposal connection to a public system is proposed due to the smaller lot sizes. Smaller lot areas below about 2000m² are not generally suitable for OSW disposal systems as there is generally insufficient land area available to install suitable disposal fields.

With stormwater new impervious areas are created, and these areas require stormwater management devices to be utilised to minimise their impact on the environment. To attenuate runoff for new impervious areas within the proposed site, the pre-development and post-development scenarios were modelled in HEC-HMS software. Additionally, the quality of stormwater runoff from high contaminant generating surfaces such as roads and carparks must be treated before discharge to minimise their impact on the health of the receiving ecosystem.

The design presented in this report is in accordance with Whangarei District Council's and Northland Regional Council's requirements in terms of mitigating stormwater runoff from impervious areas, with the three ponds providing water quality, extended detention, and stormwater attenuation to predevelopment levels for the 2, 10 and 100yr storms, including an allowance for 20% climate change.

2 WATER

Water supply will be an extension of the public water mains into the development. This will provide both water supply to the new dwellings and firefighting water supply for the new dwelling.

The 78 new lots will require the following additional water supply capacity assuming 300ltrs/day/person with 4 people per dwelling.

Peak day demand = 2.0 x PF

- 2.0 x 300(l/day) x 4(people) x 78(lots) = 187,200ltrs/day

Peak hourly demand = 5 x PF/24hrs

- 5 x 300(l/day) x 4(people) x 78(lots)/24(hrs)= 19,500ltrs/hour

Council have advised that until the new reservoir is constructed further along Three Mile Bush Road the water pressure is likely to be less than desirable with some of the lots. The reservoir is located at an elevation of RL220m, with the sections at the rear of the property elevated at RL210m. For the adjacent site (being 115 Three Mile Bush Road) council modelling indicated the water pressure at node 46560 would be approximately 450kPa(46m) head with the development elevation being up to RL190m at its highest point, this modelling indicates that the pressure that could be expected at the proposed developments rear site could drop as low as 250-300kPa, which is a similar elevation level to the properties at the start of Lake Ora Road.

Therefore it is proposed that should council not have upgraded the reservoir (currently expected to be at least 2 years away) then the following could be implemented if necessary for those

dwellings that do not have sufficient water pressure because of the elevation between the reservoir and the new dwellings.

Figure 2

Install a small 5000 litre water tank for each dwelling which is trickle fed off the public water main. The water supply for those affected dwellings would then use this tank in conjunction with a water pump providing the boosted water pressure that most modern desire being unaffected by the low pressure available on the sites.

Alternatively, the dwellings could install larger rain water tanks with a pump and suitable filtration system. (We would recommend at least two 25,000 litre tanks unless there is a low pressure connection to the public system to refill tanks during drier summers and that every lot have a water connection to enable a future connection)

3 WASTEWATER

The wastewater servicing the development will be an extension of the existing public reticulation. The network will connect through the recent adjacent development which has installed a 150 gravity pipeline across the boundary into the proposed development.

As the lots on the northern side of the stream are isolated from the gravity pipe network, it is intended to require individual on site pump stations, likely to be necessary on Lots 65-78, with 24 hours storage to be installed on each lot. These will pump wastewater in individual private lines up to the top of the development into a central manhole serving as the collection point for the individual discharges, which will then drain via gravity into a manhole within the proposed public gravity system.

This will enable both sides of the stream to be serviced and extend the public network as far as practical without the complication of crossing the stream with a pipe bridge for the wastewater. The network will extend across to the cul-de-sac on the proposed plans.

The additional wastewater flows that will be generated by the development are as follows

Dry weather peak daily flow = 2.5 x ADWF

- 2.5 x 200(l/day) x 4(people) x 78(lots) = 156,000ltrs/day

Peak wet weather flow (PWWF) = 5 x ADWF

- 5 x 200(l/day) x 4(people) x 78(lots) = 312,000ltrs/day

Council have confirmed that the waste water network has sufficient capacity for this additional level of development.

4 HYDROLOGICAL ASSESSMENT

4.1 Pre-Development

The subject site, shown in the aerial photo in Figure 3, has an area of approximately 11ha which is currently covered in grass with some trees and is used for grazing. The site comprises of a central gully with moderate side slopes either side (11-16 degrees). The southern end of the site is relatively flat. The northern side of the site has steep scoria cone slopes (approximately 27 degrees).

Figure 3 - Aerial photo of sites (red) with the adjacent flow paths indicated in blue. Sourced WDC GIS.

4.2 Post-Development

It is proposed to subdivide the site into residential lots with majority of the areas between 550m^2 and 1000m^2. A loop road with foot paths will provide access to and around the subdivision. The proposed scheme plan can be seen in Figure 4 below.

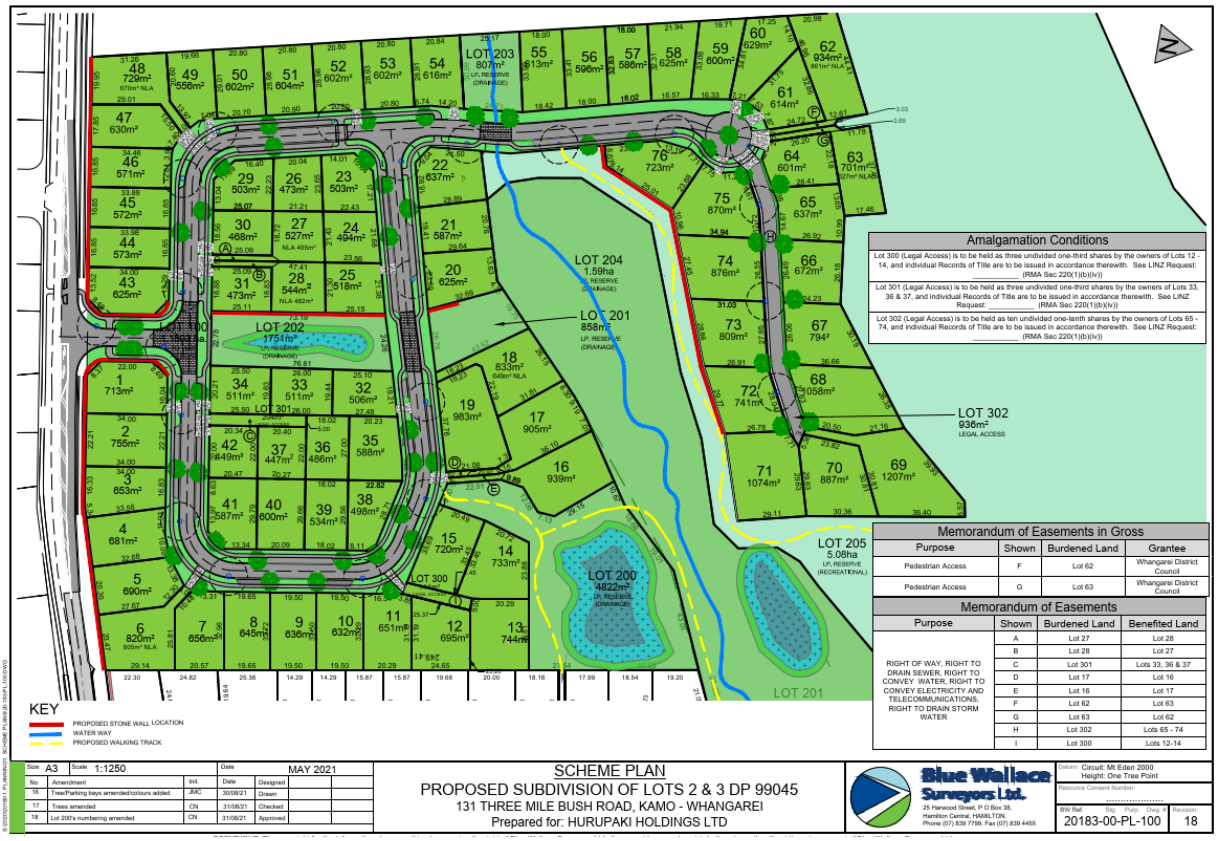


Figure 4 - Proposed scheme plan.

It is proposed to construct 3 stormwater ponds within the subdivision to provide attenuation and water quality treatment for runoff from the development. To achieve this, the ponds have been designed to meet the requirements of Auckland Council's GD01. Additionally approximately 9060m2 of catchment area will be treated in the front pond, reducing the flows through the neighbouring stormwater pond providing additional stormwater benefits which have not been modelled.

The proposed lots have been divided into impervious and pervious components with 60% of the lot area being nominated as impervious and the remaining 40% pervious. The road reserve area has used 85% impervious and 15% pervious. The steep cone area on the northern side of the site will be revegetated providing a small reduction in the total runoff from the site which has been considered within the design and managing flows to below predevelopment levels. Refer to Figure 4 below for catchment areas and pond locations.

Table 1 –Pre and Post Development catchment areas and curve numbers.

Pre-Development		
Description	Curve Number (CN)	Area (m^2)
Grassed areas - pervious	70	69, 875

Post Development		
Description	Curve Number (CN)	Area (m^2)
Residential Lots - Impervious	98	33,484
Residential Lots - Pervious	70	22,323
Road Reserve (Road, Footpaths, Berms)	98	69,875
Revegetated hillside	64	40,093

Catchments C and D are assumed to be connected into the pond via the reticulated networks but not all flows, specifically being those from the sites pervious areas would be captured and flow into the ponds, so for the purpose of the modelling these areas are considered unmitigated even though some of these flows would be routed through the stormwater ponds.

4.3 Soil Classification

From the LDE geotechnical investigation of the site, the site is underlain by Pleistocene basalt lava flows from the Kerikeri Volcanic Group which is described as clay and silt. For the purpose of stormwater modelling, we have assessed these soils beneath the site as being between Soil Class C and B soils as defined in the Whangarei Environmental Engineering Standards. The site is underlain by pockets of very high soakage areas, and others with slow draining soils, so a number of CN70 was chosen for the site in its predevelopment state as grazed pasture.

5 Council Requirements

5.1 Northland Regional Council SW requirements

Water and Soil Plan

8.3.5 Stormwater

During dry weather, contaminants such as dirt, oil, grease, and heavy metals tend to accumulate on the streets, footpaths, carparks, roofs and similar hard surfaces within urban areas. When it rains, the stormwater carries the accumulated contaminants with it into the stormwater drainage systems which in turn flow directly into nearby streams, rivers or estuaries. Such urban stormwater runoff receives little or no treatment before being discharged into natural water bodies. Heavy metals have been found in the Upper Whangarei Harbour sediments that exceed the standards recommended for aquatic life.

These contaminants will remain in the receiving environment and will accumulate over time as stormwater discharges continue. Stormwater discharges are generally authorised by discharge permits based on a stormwater management plan. Stormwater management plans are widely

used in terms of the design of the stormwater system. However, these have focused on the capacity of the stormwater system to accept runoff, with little or no attention given to stormwater quality. The plans, however, provide a useful basis upon which to institute quality controls which are available and used both in New Zealand and overseas.

8.5.6 Issues Relating to Stormwater Discharges

1. The levels of heavy metals, sediments and other contaminants, which are potentially harmful to aquatic life, in stormwater runoff.
2. The lack of attention to quality controls in stormwater system design.
3. The contribution of runoff from industrial sites to contaminant loadings in urban stormwater, including those from ancient spills.
4. The deliberate or careless disposal of oil and other household and commercial wastes to stormwater systems.

8.17 Specific Policies for Stormwater Diversions and Discharges

1. To manage the diversion and discharge of stormwater in a way that provides safeguards against flooding and maintains or enhances water quality.
2. To require the inclusion of water quality controls as far as practicable in existing stormwater management systems that are known to be causing concentrations of contaminants within the receiving environment that are in excess of applicable water quality and/or sediment quality guidelines.
3. To manage the diversion and discharge or stormwater in urban areas through long duration resource consents that are supported by comprehensive stormwater management plans.
4. To promote best practice for stormwater management design, including low impact options.
5. To promote stormwater management practices that avoid or minimise the discharge of contaminants from industrial and trade premises into stormwater drainage systems.
6. To encourage activities to operate in accordance with industry standards and/or environmental guidelines where these are intended to avoid, remedy or mitigate the adverse effects of stormwater contamination.
7. To permit the discharge of stormwater from hazardous substance storage areas and industrial or trade premises if sufficient safeguards are adopted to avoid, remedy or mitigate the potential adverse effects associated with stormwater contamination.
8. To promote public awareness of the adverse effects of stormwater discharges on natural waters, including awareness of the adverse effects of household waste introduced into stormwater systems.

5.2 Proposed Northland Regional Plan July 2021

C.4.1 Land drainage and flood control

The proposed development is considered a permitted activity based on the following rules, with the intention to mitigate the 100yr storm to avoid any adverse effects downstream.

C.4.1.1 Land drainage – permitted activity

The damming, diversion and discharge of water associated with land drainage are permitted activities, provided:

1) the activity complies with all relevant conditions of Rule C.4.1.9 Land drainage and flood control general conditions, and

2) any resulting land subsidence or slumping does not cause adverse effects on structures or infrastructure on other property, and

3) the discharge is in or from the same catchment in which the water would naturally flow, and

4) a new drain is not constructed within 15 metres of an existing wastewater disposal area.

C.4.1.9 Land drainage and flood control general conditions

General conditions apply to activities when referred to in the rules of Section C.4.1.

1) There is no adverse flooding, erosion or over-drainage effects on other property.

2) The activity does not alter the course of a lake or continually or intermittently flowing river.

3) New land drainage does not occur within 50 metres of any natural wetland.

4) Drainage does not cause any change to the seasonal or annual range in water level of a natural wetland to an extent that may adversely affect the wetland's natural ecosystem.

5) No vegetation, soil or other debris generated from the activity is placed in a position where it may be carried into a river or natural wetland, lake or the coastal marine area.

6) There is no damage to a flood defence or any other authorised structure.

7) Fish passage is maintained, unless an existing authorisation provides otherwise, or temporary works to enable repair and replacement works are being carried out.

8) Eels, fish (other than pest fish), kōura (freshwater crayfish) and kākahi (freshwater mussels) unintentionally removed during mechanical clearing of drainage channels are returned to the drainage channel as soon as practicable, but no later than one hour after their removal.

9) Refuelling of machinery does not take place in the bed of a river or lake.

10) Where a discharge from land drainage enters an outstanding freshwater body or coastal water beyond the zone of reasonable mixing, the discharge does not:

a) result in any conspicuous oil or grease films, scums or foams, or floatable or suspended material except where caused by natural events in the receiving water, and

b) cause the pH of the receiving water to fall outside the range of 6.5 to 9.0 (except where

caused by natural events, or when natural background levels fall outside that range), and

c) cause any emission of objectionable odour in the receiving water, and

d) cause any conspicuous change in colour or visual clarity of the receiving water, and

e) cause the natural temperature of the receiving water body to be changed by more than three degrees Celsius.

11) Any discharge of sediment associated with repair and maintenance activities does not occur for more than five consecutive days and must not occur for more than 12 hours on any one day.

C.6.4 Stormwater discharges

The proposed development is considered a permitted activity based on the following rules

C.6.4.1 Stormwater discharges from a public stormwater network – permitted activity

The diversion and discharge of stormwater from a public stormwater network into water or onto or into land where it may enter water is a permitted activity, provided:

1) the discharge is not from a public stormwater network servicing an urban area listed in *Table 10: Urban areas*, and

2) the diversion and discharge does not cause permanent scouring or erosion of the bed of a water body at the point of discharge, and

3) the discharge is not within 100 metres of a geothermal surface feature, and

4) the discharge does not contain contaminants used, stored or generated in trade or industrial premises, and

5) the discharge does not contain more than 15 milligrams per litre of total petroleum hydrocarbons, and

6) the discharge does not cause any of the following effects in the receiving waters beyond the zone of reasonable mixing:

a) the production of conspicuous oil or grease films, scums or foams, of floatable or suspended materials, or

b) a conspicuous change in the colour or visual clarity, or

c) an emission of objectionable odour, or

d) the rendering of fresh water unsuitable for consumption by farm animals, or

e) the rendering of freshwater taken from a mapped priority drinking water abstraction point (refer I Maps | Ngā mahere matawhenua) unsuitable for human consumption after existing treatment.

C.6.4.2 Other stormwater discharges – permitted activity

The diversion and discharge of stormwater into water or onto or into land where it may enter water from an impervious area or by way of a stormwater collection system, is a permitted activity, provided:

1) the discharge or diversion is not from:
    a) a public stormwater network, or
    b) a high-risk industrial or trade premises, and
2) the diversion and discharge does not cause or increase flooding of land on another property in a storm event of up to and including a 10 percent annual exceedance probability, or flooding of buildings on another property in a storm event of up to and including a one percent annual exceedance probability, and
3) where the diversion or discharge is from a hazardous substance storage or handling area:
    a) the stormwater collection system is designed and operated to prevent hazardous substances stored or used on the site from entering the stormwater system, or
    b) there is a secondary containment system in place to intercept any spillage of hazardous substances and either discharges that spillage to a trade waste system or stores it for removal and treatment, or
    c) if the stormwater contains oil contaminants, the stormwater is passed through a stormwater treatment system designed in accordance with the *Environmental Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand (Ministry for the Environment, 1998)* prior to discharge, and
4) where the diversion or discharge is from an industrial or trade premises:
    a) the stormwater collection system is designed and operated to prevent any contaminants stored or used on the site, other than those already controlled by condition 3) above, from entering stormwater unless the stormwater is discharged through a stormwater treatment system, and
    b) any process water or liquid waste stream on the site is bunded, or otherwise contained, within an area of sufficient capacity to provide secondary containment equivalent to 100 percent of the quantity of any process water or liquid waste that has the potential to spill into a stormwater collection system, in order to prevent trade waste entering the stormwater collection system, and
5) the diversion or discharge is not into potentially contaminated land, or onto potentially contaminated land that is not covered by an impervious area, and
6) the diversion and discharge does not cause permanent scouring or erosion of the bed of a water body at the point of discharge, and
7) the discharge does not contain more than 15 milligrams per litre of total petroleum hydrocarbons, and

8) the discharge does not cause any of the following effects in the receiving waters beyond the zone of reasonable mixing:

a) the production of conspicuous oil or grease films, scums or foams, of floatable or suspended materials, or

b) a conspicuous change in the colour or visual clarity, or

c) an emission of objectionable odour, or

d) the rendering of fresh water unsuitable for consumption by farm animals, or

e) the rendering of fresh water taken from a mapped priority drinking water abstraction point (refer I Maps | Ngā mahere matawhenua) unsuitable for human consumption after existing treatment.

C.8.3 Earthworks

Earthworks to construct the stormwater ponds (damming), proposed subdivision and road network are considered a controlled activity based on the following rules and will be managed in accordance with GD005 current guidelines.

C.8.3.1 Earthworks – permitted activity

Earthworks outside the bed of a river, lake, wetland and the coastal marine area, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, are permitted activities provided:

1) the area and volume of earthworks at a particular location or associated with a project complies with the thresholds in Table 13:

Table 13: Permitted activity earthworks thresholds

Table 13: Permitted activity earthworks thresholds

Location	Earthworks thresholds
Within 10m of a natural wetland, the bed of a continually or intermittently flowing river or lake	200 square metres of exposed earth at any time, and 50 cubic metres of moved or placed earth in any 12-month period.
Catchment of an outstanding lake	2500 square metres of exposed earth at any time.
Erosion-prone land	2500 square metres of exposed earth at any time.
High-risk flood hazard area	50 cubic metres of moved or placed earth in any 12-month period.
Coastal riparian and foredune management area	Excluding for coastal dune restoration, 200 square metres of exposed earth at any time.
Flood hazard area	100 cubic metres of moved or placed earth in any 12-month period.
Other areas	5000 square metres of exposed earth at any time.

2) the discharge is not within 20 metres of a geothermal surface feature, and

3) except for coastal dune restoration activities, good management practice erosion and sediment control measures equivalent to those set out in the *Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region 2016 (Auckland Council Guideline Document GD2016/005),* are implemented for the duration of the activity, and

4) batters and side castings are stabilised to prevent slumping, and

5) exposed earth is stabilised upon completion of the earthworks to minimise erosion and avoid slope failure, and

6) earth and debris are not deposited into, or in a position where they can enter, a natural wetland, a continually or intermittently flowing river, a lake, an artificial watercourse, or the coastal marine, and

7) the earthworks activity does not:

a) reduce the height of a dune crest in a coastal riparian and foredune management area, except where dunes are recontoured to remove introduced materials or to remediate dune blow-outs as part of coastal dune restoration work, or

b) exacerbate flood or coastal hazard risk on any other property, or

c) create or contribute to the instability or subsidence of land on other property, or

d) divert flood flow onto other property, and

8) any associated damming, diversion and discharge of stormwater does not give rise to any of the following effects in the receiving waters beyond the zone of reasonable mixing:

a) any conspicuous change in colour or visual clarity, or

b) the rendering of fresh water unsuitable for consumption by farm animals, or

c) contamination which may render freshwater taken from a mapped priority drinking water abstraction point (refer I Maps | Ngā mahere matawhenua) unsuitable for human consumption after existing treatment, and

9) information on the source and composition of any clean fill material and its location within the disposal site are recorded and provided to the Regional Council on request, and

10) the Regional Council's Compliance Manager is given at least five working days' notice (in writing or by email) of any earthworks activity being undertaken within a high-risk flood hazard area, flood hazard area, where contaminated land will be exposed, or in sand dunes within a coastal riparian and foredune management area.

C.8.3.2 Earthworks – controlled activity

Earthworks outside the bed of a river or lake, wetland and the coastal marine area that exceed 5000 square metres of exposed earth at any time at a particular location or associated with a project area, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, are controlled activities, provided the earthworks are not located:

1) within 10 metres of a natural wetland, the bed of a continually or intermittently flowing river or lake, or

2) within 10m of an īnanga spawning site, or

3) in a catchment of an outstanding lake, or

4) on erosion-prone land, or

5) in a flood hazard or high-risk flood hazard area, or

6) in the coastal riparian and foredune management area.

C.8.3.3 Earthworks in a flood hazard area – controlled activity

Earthworks in a flood hazard area that involve more than 50 cubic metres, but not more than 1000 cubic metres, of earth being moved or placed in any 12-month period, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, are controlled activities.

C.8.3.4 Earthworks – discretionary activity

Earthworks outside the bed of a river or lake, a wetland, or the coastal marine area, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, that are not a permitted or controlled activity under another rule in section C.8.3 of this Plan.

5.3 Whangarei District Council Three Water Management

Three Waters Management implements provisions to manage the impact of land use and subdivision on water resources, namely stormwater, wastewater and water supply:

- Stormwater systems manage the quality and quantity of stormwater runoff to minimise flood damage and to protect people, land, infrastructure and the receiving environment from adverse effects.
- Wastewater systems collect and convey wastewater for subsequent treatment and disposal. This will normally consist of either connection to the reticulated wastewater network, or on-site treatment and disposal (either individual or communal in nature).
- A water supply is necessary to ensure that a sufficient quality and quantity of water is available to all properties.

Whangarei district council three waters policy objectives are as follows:

1. TMW-01 Connections - Ensure that connection to reticulated three waters networks is provided for within a reticulated area.

2. TWM-O2 – Reticulated Networks - Maintain the effectiveness, efficiency and sustainability of reticulated three waters networks.
3. TWM-O3 – Integrated Infrastructure - Plan and provide for three waters infrastructure in an integrated and comprehensive manner.
4. TWM-O4 – Private Systems - Ensure that private three waters systems are provided where connections are not provided to reticulated networks
5. TWM-O5 – Adverse Effects - Minimise adverse effects from stormwater and wastewater on people, property, infrastructure, the receiving environment and cultural values.

TWM-REQ1

All Zones Any consent application where connection will be provided to reticulated three waters network(s) shall include an assessment detailing (where relevant):

a. Provision made for connections to reticulated three waters networks.
    - See Table 2
b. Confirmation that sufficient capacity exists within reticulated three waters networks to service the proposed development.
    - See Table 2, noting that water supply may require on site tanks on some of the more elevated lots to enable sufficient pressure until the new proposed reservoir is constructed.
c. Any upgrades and/or extensions to existing reticulated three waters infrastructure that are proposed or necessary.
    - See Table 2
d. Consideration of the elevation of each proposed lot to establish a service envelope where that lot is able to be serviced without the need for on-site pumping. Reference shall be made to any part of the lot that is outside the service envelope.
    - See Table 2, noting that individual on site sewer pump stations will be required for some of the lots on the northern side of the stream, expected to be Lots 65-76.
e. Land and infrastructure to be vested in the Council.
    - See Table 2

TWM-REQ3

Any application under rules TWM-R6 – R7 shall include an Integrated Three Waters Assessment which details:

a. How the proposal is consistent with the recommendations, measures and targets of any relevant Council approved Catchment Management Plan
    - The proposed stormwater network and three ponds provide water quality treatment and stream/peak flow protection which is consistent with the wider catchment management plan. See section 6 and plans for further details.
b. An assessment of any potential effects (including cumulative effects) of the development in relation to the site, any adjoining sites, the wider catchment and cultural values.
    - The proposed stormwater network and three ponds provide water quality treatment and stream/peak flow protection which mitigates the effects of the development. See section 6 and plans for further details.
c. Information on how wastewater (including trade waste) will be managed to minimise any impacts on the reticulated network or from on-site discharges.
    - A public wastewater network extension is proposed, with each lot connecting to the public network through this mitigating any effects. The wastewater network has sufficient capacity for this extension. See Table 2 and plans for further details.
d. The provision of water supply, wastewater disposal and/or stormwater disposal reticulation through the proposed development or subdivision to a standard necessary to provide adequate reticulation to adjacent land zoned for reticulated development.
    - A public stormwater, waste water and water supply is proposed.
e. Any low impact design, green infrastructure or water sensitive design solutions that are proposed, what benefits these will provide, and how they will be operated and maintained to ensure ongoing water efficiency benefits.
    - Three stormwater ponds are proposed which will provide the necessary stormwater mitigation, additionally these will also provide amenity value being incorporated into a series of walkways, recreational areas.
f. Consideration of opportunities to integrate three waters infrastructure and informal or passive recreation opportunities.
    - Three stormwater ponds are proposed which will provide the necessary stormwater mitigation, additionally these will also provide amenity value being incorporated into a series of walkways, recreational areas.
g. Any proposed conditions.
    - Lots 65-76 will require individual private sewer pump stations to be installed on each lot discharging into the proposed public network extension.

Whangarei district council policies are as follows

Table 2

Policies	Explanation	Development Assessment
TWM-P1 – Three waters Infrastructure	To ensure that three waters resources are appropriately managed by requiring subdivision and development to provide three waters infrastructure that: • Is coordinated, integrated and compatible with the existing infrastructure and capacities. • Enables the existing network to be expanded or extended to adjacent land where that land is suitable for future reticulated development.	The proposed stormwater ponds will limit peak flows to predevelopment level for the 2, 10 and 100yr storm events, with a 20% allowance for climate change. They will include an extended detention volume to address erosion effects on the stream network that they discharge into and provide water quality treatment for the roads within the development, based on 1/3rd of the 2yr storm.
TWM-P2 – Reticulated Areas	To sustainably and efficiently manage three waters resources by avoiding private three waters systems where connection to the reticulated network is practicable or where failure to connect may compromise the future extension of the reticulated network.	The development will provide stormwater, water and wastewater connections for each lot. Water and wastewater will connect to the existing public systems, with additional public network extensions undertaken as part of the development. Stormwater will discharge into a new public SW network that discharges into the stream. There will be three outlet points one from each of the three ponds, which drain to similar locations as they presently do.
TWM-P3 – Capacity	To manage the scale and design of subdivision and development where connection is provided to reticulated three waters networks	The water and wastewater networks will be extended to service the development. The new public stormwater system including the

	to ensure that there is sufficient capacity in the reticulated networks, and where necessary require upgrades and/or extensions to the reticulated networks.	proposed three SW ponds, will mitigate effects for up to a 1% AEP. This will minimise additional effects on downstream areas which have flooding issues within the stream wider catchment.
TWM-P4 – Future Development	To ensure that reticulated three waters infrastructure is designed to accommodate planned and future development.	The development is on the boundary of the urban development area. It is currently proposed to provide a Ø150 wastewater connection to the neighbouring lot upstream of the property which is zoned for urban development. The water network already extends past the boundary of the proposed development so it is not considered necessary to extend this network other than to service the proposed development. The stream extends into the upstream property and as such no extension of the proposed stormwater network is considered necessary.
TWM-P5 – Vested Assets	To require vested assets, and connections to vested assets, to be designed and constructed in a manner that protects the ongoing operation, maintenance and upgrading of that asset.	All three waters infrastructure will be designed in accordance with relevant councils and NZ engineering standards and will be vested to council as part of the development.
TWM-P6 – Private Systems	To ensure that where connection to a reticulated three waters network is not available or	The lots to the rear of the properties will require individual on-site wastewater pump stations with 24hrs storage. These will each have their

	practicable that provision can be made for: 1. A water supply. 2. The treatment, disposal, and where appropriate attenuation, of stormwater in a way that does not lead to significant adverse effects on or off site. 3. Management of wastewater via: a. An on-site wastewater treatment system; or b. Approval to connect to a private wastewater system.	own 25mm rising main which extends up the right of way and discharges into a manhole which collects all the discharges and gravity feeds into the proposed public wastewater system. The water, stormwater and gravity wastewater systems will be vested to council.
TWM-P7 – Flooding	To reduce the risk of flood hazards or increased upstream and downstream flood levels resulting from stormwater discharges.	Flows from the development will be reduced to below predevelopment levels for up to a 1% AEP, and will include a 20% rainfall increase for climate change. Stormwater flows within the development will include both a piped reticulation system and secondary flow paths to manage stormwater flows up to a 1% AEP.
TWM-P8 – Integrated Three Waters Assessments	To require Integrated Three Waters Assessments for large scale developments to: 1. Manage three waters in an integrated and comprehensive manner. 2. Enable and recognise the benefits of green infrastructure and low	Three stormwater ponds will be installed as part of the development which will protect the receiving environment and also become part of the developments walkways and park areas creating a great amenity in the area. The water and wastewater will be connected to the public systems to mitigate the effects of more intensive urban

	impact and water sensitive design.	development. As part of the development it is planned to plant the steeper areas of the hillside, creating a bush reserve with walking tracks which will also reduce runoff from this steeper hillside area.
TWM-P9 – Infrastructure	To require subdividers and developers to meet the costs of any upgrades or extensions of reticulated three waters infrastructure which are attributed to the impacts of the subdivision or development.	The subdivision will install the infrastructure necessary to service the proposed development as part of its construction. With the exception of the councils planned water reservoir, no network upgrades are required as part of the development. A solution for those properties that are affected by the lower water has been proposed within this report, which can be either a short term option or a long term one.

With reference to Whangarei District Council's engineering standards, ponds should be designed generally in accordance with TP10/GD01, which are Auckland Council's standards for stormwater design for development and are considered a suitable set of guidelines for Northland with similar catchments and geology.

The design the stormwater ponds generally requires the following:

- An extended detention volume of 34.5mm for the site to be released over a 24hr period, This slow release volume is to minimise stream erosion and increase water quality in the pond. In accordance with the technical guidance on pond design that GD01 is based upon (TR2013-024) a 70mm (to minimise blockage risks) or larger orifice has been used to manage these flows.
- The ponds are designed with capacity to mitigate post development flows to equal or less than the pre-development 24 hour 2, 10 and 100 year storm events to prevent the development increasing the flooding risks downstream.
- The Whangarei District Council's engineering standards also require new developments to apply a 20% increase to the design storm runoff figures to address

future increases resulting from climate change effects this has been incorporated into the post development model.

6 PROPOSED STORMWATER MITIGATION METHODOLOGY

6.1 Proposed Devices

Due to the constraints of the site, it is proposed to mitigate the effects of the development using the following devices:

- Three stormwater ponds have been designed to collect the stormwater runoff from impervious and pervious areas of each lot and the road reserve. The ponds have been designed with the necessary outlet configuration to mitigate the 2yr, 10yr and 100yr storm events to equal or less than pre-development rates, which ensures that it does not affect downstream areas with any increases in flow rates. The water will discharge from these ponds into the Waitaua stream catchment into the headwaters of the catchment.
- Additional to the 2,10 and 100yr storm event mitigation an extended detention volume has been allowed for in the pond with a 24hr drain down period designed in accordance with Auckland Council's GD01. The extended detention reduces the stream erosion and increases water quality in the pond for the runoff from all the individual lots and road reserve areas and will help improve the overall quality of the stream the pond discharges to.
- Approximately 4 hectares of hillside planting is proposed as part of the development on the steeper slopes. This will improve water quality, and reduce runoff from the steeper hillside area. This also provides a slight improvement for the overall flows from the site which has been added into the model.
- The full water quality treatment volume for all areas of the development is provided within each of the ponds. A forebay is included in the pond designs aid maintenance of each pond. The ponds are also likely to drain completely through soakage during the drier periods, as the stream only flows during heavier rainfall events, remaining dry for a lot of the drier summer period.

6.2 Modelling Inputs

A HEC-HMS model was developed based on a SCS Type 1A storm profile determined from HIRDS V4 rainfall data for the site, and the hydrological parameters outlined in Table 1 above.

A nested storm was also run through the ponds as a check which contains all the storm durations from a 10min storm through to the 24hr storm event.

A time of concentration of 10 minutes was used due to the small catchment lengths, with the stream located in the centre of the development.

The rainfall data was increased by 20% in the post development scenario to account for the increases in storm intensity and frequency as a result of climate change.

6.3 Results

Table 3 below shows the pre-development and post-development peak flow rates produced by the proposed design. The full output tables from the HEC-HMS modelling are appended to this report.

Table 3 - Pre and Post Development peak flow rates from the development.

Storm Event (ARI)	Pre Development (m^3/s)	Bush planting improvements (m^3/s)	Allowable Post Development (m^3/s)	Post Development (m^3/s)
2yr	0.282	0.026	0.308	0.308
10yr	0.510	0.039	0.549	0.549
100yr	1.022	0.057	1.079	0.952
100yr check (All Nested storms)	1.464			1.281

The results show that the proposed design attenuates post-development peak flows to equal or less than the pre-development peak flows including the overall improvements from the hillside planting.

If impermeable areas greater than those analysed in this design are proposed, then a revision of the design presented in this report will be required.

6.4 Stormwater Device Design

6.4.1 Front Pond

- The footprint of the permanent pond water level covers an area of approximately 2260m^2 at RL173.6m, with the depth being approximately 4.8m. The base of the pond will be at RL168.7m.
- The volumes and elevations for the various storm event storage are summarised in Table 4 below.

Table 4 - Pond volumes and respective elevations for storm event storage.

Storage Event	Elevation (RL)	Cumulative Pond Volume (m^3)
Dead Storage	171.2	740
Extended Detention	172	1420
2 year Live Storage	172.5	2260
10 year Live Storage	172.7	2530
100 year Live Storage	173.2	3140
Total Pond Capacity	173.6	3600

- The pond will incorporate a 1m wide bench as a safety precaution to allow anyone to exit the water should anyone inadvertently enter the pond at the permanent water level.
- The dead storage volume (740 m^3) will provide water quality treatment most of which will slowly drain through soakage in the drier months.
- A low flow outlet will control the permanent pond levels around RL171.2m, with the extended detention volume being above this level.
- The top of the pond bank is a 3m width to allow for maintenance access at RL173.5m, this allows 0.3m freeboard from the 100yr storm event level. Additionally, the pond has a 3m wide emergency spillway into the stream installed at 173.25m. This is capable of discharging events in the unlikely event that the ponds emergency spillway is blocked.
- The outfall structure of the pond will have outlets as shown in Table 5 below. A drawing of the outlet structure and pond dimensions is appended to this report.

Table 5 - Pond outlet structure summary.

Outlet	Elevation (RL)	Description
Outlet 1	171.18	Ø70mm orifice outlet
Outlet 2	172	Ø300mm orifice outlet
Emergency Spillway	173.25	Manhole overflow

- A forebay with a minimum volume of 110 m^3 shall be provided at the inlet to the pond to capture coarse sediments entering the pond. Access shall be provided to the forebay such that sediments can be cleaned out.
- A 3m wide access track shall be formed around the top of the pond down with access onto this track via a shared concreted accessway at a maximum grade of 1:4 which will also serve as the overland flow path into the pond.
- A capped 150mm PVC outlet will be installed at the base of the pond discharging into the outlet manhole, this outlet is to be only used if de-watering the pond is required for maintenance purposes.
- The pond will be grassed upon completion and the grass will provide additional water quality treatment as the lower water levels in the pond soak away, which we expect to happen over drier periods as testing indicates that soakage rates where the scoria pockets are exposed are in excess of 200mm/hr, reducing to mod/slow draining in soils where these pockets are not exposed.

6.4.2 **Middle Pond**

- The footprint of the permanent pond water level covers an area of approximately 675m^2 at RL196.5m, with the depth being approximately 2.0m. The base of the pond will be at RL194.5m.
- The volumes and elevations for the various storm event storage are summarised in Table 6 below.

Table 6 - Pond volumes and respective elevations for storm event storage.

Storage Event	Elevation (RL)	Cumulative Pond Volume (m^3)
Dead Storage	195.5	120
Extended Detention	195.7	220
2 year Live Storage	195.75	230
10 year Live Storage	195.8	270
100 year Live Storage	196.2	450
Total Pond Capacity	196.5	615

- As the pond is only pond being only 10-12m in width, has a normal water depth of 1m or less and side slopes 1:3, a safety bench is not proposed as the surrounding land above pond crest is gently sloping in most locations.
- The dead storage volume (120 m^3) will provide water quality treatment most of which will drain completely through soakage in the drier months.

- A low flow outlet will control the permanent pond levels around RL195.5m, with the extended detention volume being above this level.
- The top of the pond bank is a at RL196.5m, this allows 0.3m freeboard from the 100yr storm event level with the surrounding areas gently sloping towards the pond along most of the embankment. Additionally, the pond will have a 2m wide emergency spillway into adjacent installed at 196.25m. This is capable of discharging events in the unlikely event that the ponds outlets are blocked.
- The outfall structure of the pond will have outlets as shown in Table 7 below. A drawing of the outlet structure and pond dimensions is appended to this report.

Table 7 - Pond outlet structure summary.

Outlet	Elevation (RL)	Description
Outlet 1	195.5	Ø70mm orifice outlet
Outlet 2	195.7	Ø200mm orifice outlet
Emergency Spillway	196.25	Manhole overflow

- A forebay with a minimum volume of 20 m^3 shall be provided at the inlet to the pond to capture coarse sediments entering the pond. Access shall be provided to the forebay such that sediments can be cleaned out.
- A 3m wide access track shall be formed around the top of the pond down with access onto this track via a shared concreted accessway at a maximum grade of 1:4 which will also serve as the overland flow path into the pond.
- A capped 150mm PVC outlet will be installed at the base of the pond discharging into the outlet manhole, this outlet is to be only used if de-watering the pond is required for maintenance purposes.
- The pond will be grassed upon completion and the grass will provide additional water quality treatment as the lower water levels in the pond soak away, which we expect to happen over drier periods as testing indicates that soakage rates where the scoria pockets are exposed are in excess of 200mm/hr, reducing to mod/slow draining in soils where these pockets are not exposed.

6.4.3 **Rear Pond**

- The footprint of the permanent pond water level covers an area of approximately 1400m^2 at RL168.5m, with the depth being approximately 3.7m. The base of the pond will be at RL164.8m.

- The volumes and elevations for the various storm event storage are summarised in Table 8 below.

Table 8 - Pond volumes and respective elevations for storm event storage.

Storage Event	Elevation (RL)	Cumulative Pond Volume (m^3)
Dead Storage	166.8	390
Extended Detention	167.4	680
2 year Live Storage	167.7	960
10 year Live Storage	167.9	1140
100 year Live Storage	168.2	1370
Total Pond Capacity	168.5	1620

- The pond will incorporate a 1m wide bench as a safety precaution to allow anyone to exit the water should anyone inadvertently enter the pond at the permanent water level.
- The dead storage volume (390 m^3) will provide water quality treatment most of which will slowly drain through soakage in the drier months.
- A low flow outlet will control the permanent pond levels around RL166.8m, with the extended detention volume being above this level.
- The top of the pond bank is a 3m width to allow for maintenance access at RL168.5m, this allows 0.3m freeboard from the 100yr storm event level. Additionally, the pond has a 3m wide emergency spillway into the stream installed at 168.25m. This is capable of discharging events in the unlikely event that the ponds emergency spillway is blocked.
- The outfall structure of the pond will have outlets as shown in Table 9 below. A drawing of the outlet structure and pond dimensions is appended to this report.

Table 9 - Pond outlet structure summary.

Outlet	Elevation (RL)	Description
Outlet 1	166.8	Ø70mm orifice outlet
Outlet 2	167.4	Ø250mm orifice outlet
Outlet 3	167.9	Ø300mm orifice outlet
Emergency Spillway	168.2	Manhole overflow

- A forebay with a minimum volume of 60 m^3 shall be provided at the inlet to the pond to capture coarse sediments entering the pond. Access shall be provided to the forebay such that sediments can be cleaned out.
- A 3m wide access track shall be formed around the top of the pond.

- A capped 150mm PVC outlet will be installed at the base of the pond discharging into the outlet manhole, this outlet is to be only used if de-watering the pond is required for maintenance purposes.
- The pond will be grassed upon completion and the grass will provide additional water quality treatment as the lower water levels in the pond soak away, which we expect to happen over drier periods as testing indicates that soakage rates where the scoria pockets are exposed are in excess of 200mm/hr, reducing to mod/slow draining in soils where these pockets are not exposed.

7 STREAM ROAD CROSSING

The subdivisions proposed road crosses the stream at the upper end of the development where the current driveway crossing culvert is installed. A new box culvert will be installed that accommodates the 10yr flows (2m3/s) with the 100yr flows (4.1m3/s) overtopping the road. The box culvert will be partially buried beneath the stream bed to allow the base of the culvert to mimic natural stream bed conditions and allow the passage of fish etc (even though there is a waterfall about 10m further down stream. It is expected the box culvert will be about 1m high with about 300-400mm of the base submerged to achieve this.

8 OTHER CONSIDERATIONS

This report has been prepared exclusively for Hurupaki Holdings Limited with respect to the particular brief given to us. Information, opinions and recommendations contained in it cannot be used for any other purpose or by any other entity without our review and written consent. LDE Ltd accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report by any third party. This report should be read in its entirety and in conjunction with the construction drawings for the development.

For and on behalf of LDE Ltd

Aaron Holland
CPEng
Civil Engineer
Civil/Structural/Geotechnical Engineer

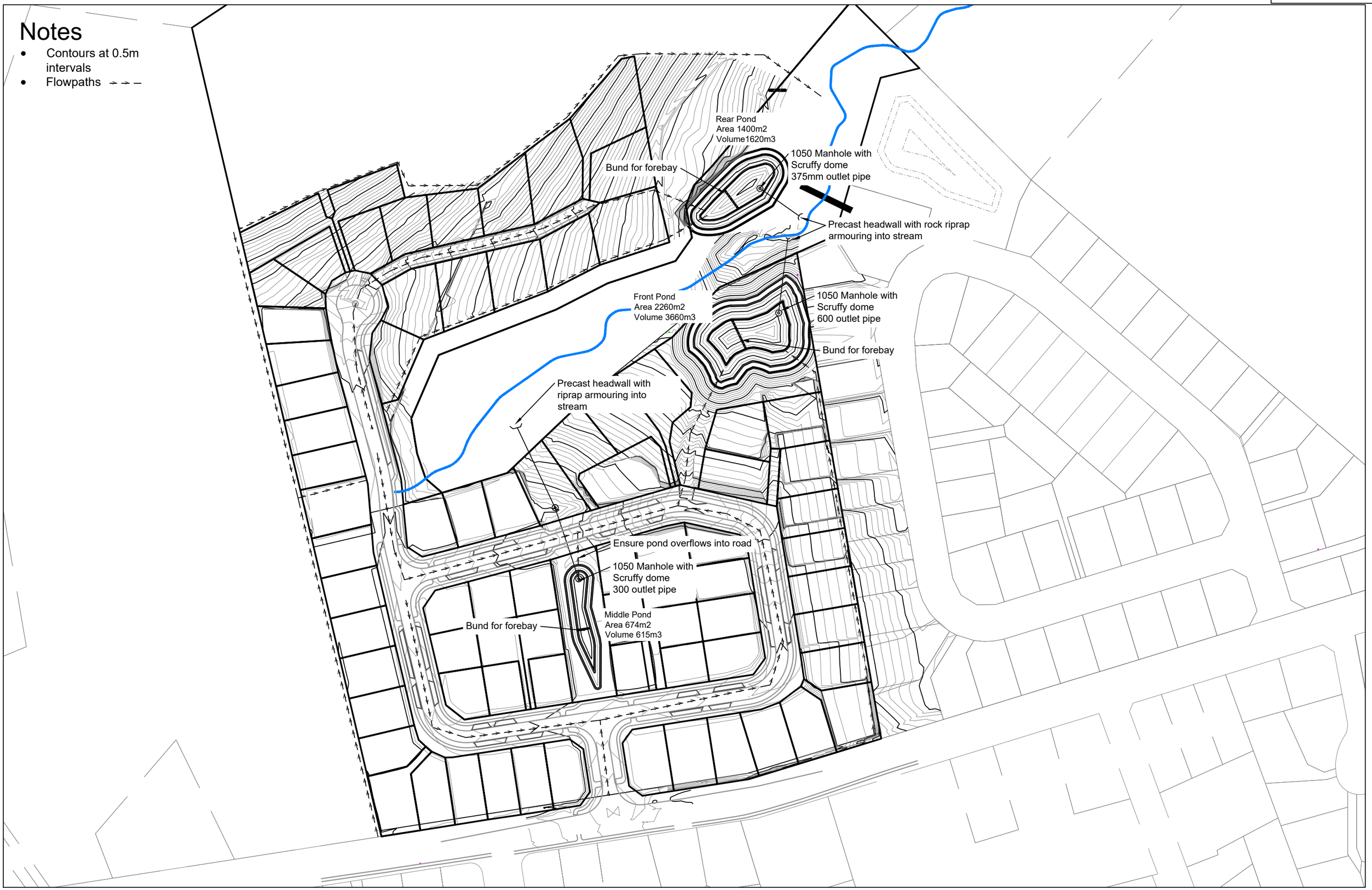
APPENDIX A

STORMWATER MITIGATION DESIGN DRAWING

Contractor shall check all dimensions on site prior to work commencing

Notes

- Contours at 0.5m intervals
- Flowpaths



CLIENT

Hurupaki Holdings Limited

PROJECT

Stormwater Ponds
189 &131 Three Mile Bush Road
Whangarei

DRAWING TITLE

Stormwater Ponds

LAND DEVELOPMENT & ENGINEERING LTD.

No.	REVISION	BY	DATE
3	Updated lot layout	AH	01/09/21
2	For consent	AH	19/08/21

DESIGN:	AH
DRAWN:	AH
DATE:	19/06/21
CHECKED:	
SCALE A3:	1:1750@A3

PROJECT STATUS: Consent

PROJECT: 18733

SHEET: 01 of 03

DRAWING No: P01

REV: 03

Contractor shall check all dimensions on site prior to work commencing

Notes

- Contours at 0.5m intervals
- Flowpaths

CLIENT	PROJECT	DRAWING TITLE	
Hurupaki Holdings Limited	Stormwater Ponds 189 &131 Three Mile Bush Road Whangarei	Pond Catchments	LDE LAND DEVELOPMENT & ENGINEERING LTD.

No.	REVISION	BY	DATE
3	Updated catchment areas	AH	01/09/21
2	For consent	AH	19/08/21

DESIGN:	AH
DRAWN:	AH
DATE:	19/06/21
CHECKED:	
SCALE A3:	1:1750@A3

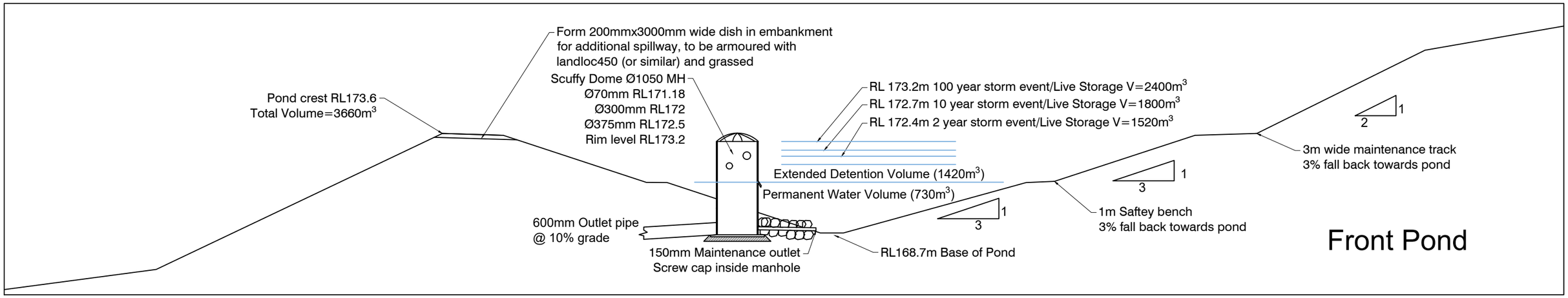
PROJECT STATUS: Consent

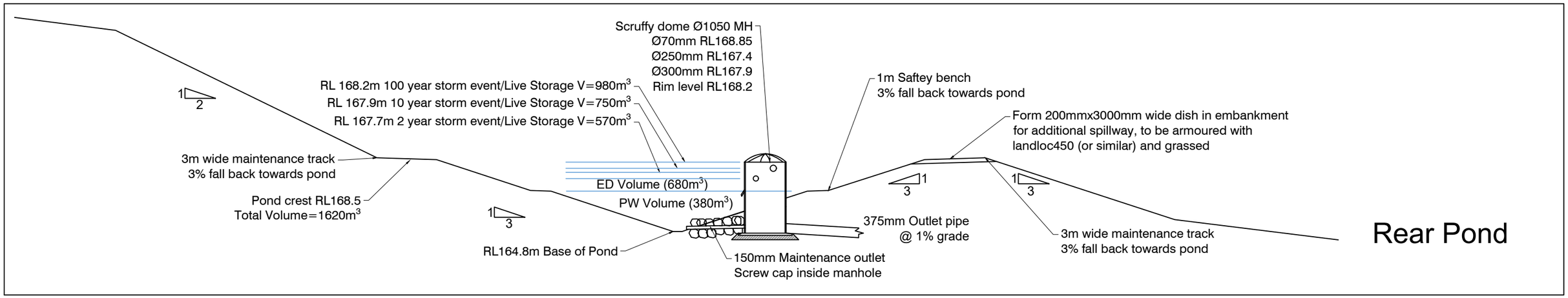
PROJECT: 18733

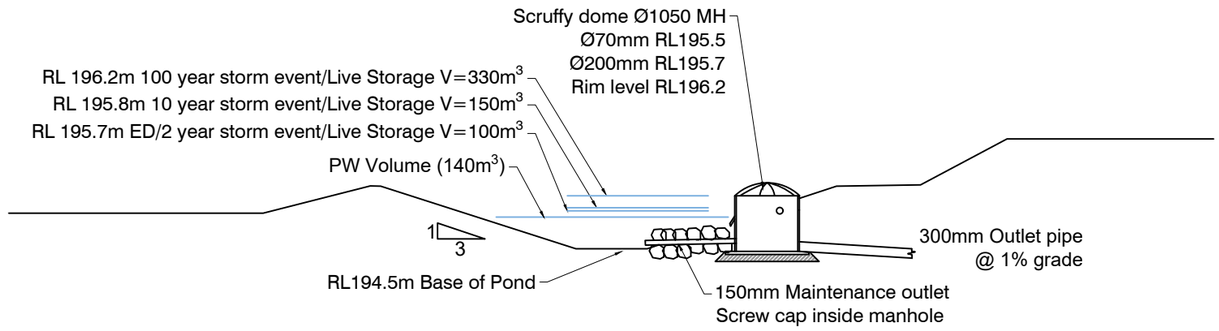
SHEET: 02 of 03

DRAWING No: P02

REV: 03







CLIENT: Hurupaki Holdings Limited	PROJECT: Stormwater Ponds 189 &131 Three Mile Bush Road Whangarei	DRAWING TITLE: Typical Pond sections	LAND DEVELOPMENT & ENGINEERING LTD.		DESIGN: AH DRAWN: AH DATE: 23/08/21 CHECKED: SCALE A3: 1:200@A3	PROJECT STATUS: Consent PROJECT: 18733 SHEET: 03 of 03 DRAWING No: P03 REV: 2

No.	REVISION	BY	DATE
2	Consent	AH	23/08/21

APPENDIX B

HEC-HMS OVERALL DEVELOPMENT MODEL OUTPUTS

Global Summary Results for Run "2yr pre"

Project: 18733 Stormwater design Simulation Run: 2yr pre

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time:16Aug2021, 13:31:59

Basin Model: Pre development
Meteorologic Model: 2yr pre
Control Specifications:24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Front areas	0.043585	0.176	01Jan2000, 08:00	2.88
Rear	0.018297	0.074	01Jan2000, 08:00	1.21
Middle areas	0.007289	0.029	01Jan2000, 08:00	0.48
Unmitigate areas	0.000704	0.003	01Jan2000, 08:00	0.05
Hillside post planted	0.040093	0.136	01Jan2000, 08:00	2.31
Hillside area	0.040093	0.162	01Jan2000, 08:00	2.65
Runoff reduction	0.080186	0.298	01Jan2000, 08:00	4.97
Stream	0.069875	0.282	01Jan2000, 08:00	4.62

2yr Pre- Development (Add bush planting improvements)

Global Summary Results for Run "2yr post"

Project: 18733 Stormwater design Simulation Run: 2yr post

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time:DATA CHANGED, RECOMPUTE

Basin Model: Post development
Meteorologic Model: 2yr post
Control Specifications:24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Impervious	0.0138636	0.136	01Jan2000, 08:00	2.08
Front road	0.0097954	0.096	01Jan2000, 08:00	1.47
A Pervious	0.0092424	0.050	01Jan2000, 08:00	0.80
C Impervious	0.0028392	0.028	01Jan2000, 08:00	0.43
D Impervious	0.0024864	0.024	01Jan2000, 08:00	0.37
Front road pervious	0.0017286	0.009	01Jan2000, 08:00	0.15
Front Pond A	0.0399556	0.163	01Jan2000, 08:30	4.33
F, G Impervious	0.009348	0.092	01Jan2000, 08:00	1.40
F, G pervious	0.006232	0.034	01Jan2000, 08:00	0.54
Rear Road	0.0022967	0.023	01Jan2000, 08:00	0.34
E Impervious	0.0004338	0.004	01Jan2000, 08:00	0.07
Rear Road pervious	0.0004053	0.002	01Jan2000, 08:00	0.04
E Pervious	0.0002892	0.002	01Jan2000, 08:00	0.03
Rear Pond	0.0190050	0.089	01Jan2000, 08:25	2.04
B Impervious	0.0043734	0.043	01Jan2000, 08:00	0.66
B Pervious	0.0029156	0.016	01Jan2000, 08:00	0.25
Middle pond B	0.0072890	0.039	01Jan2000, 08:20	0.82
C Pervious	0.0018928	0.010	01Jan2000, 08:00	0.16
D Pervious	0.0016576	0.009	01Jan2000, 08:00	0.14
Stream	0.0698000	0.301	01Jan2000, 08:25	7.49

2yr Post- Development

Global Summary Results for Run "10yr pre"

Project: 18733 Stormwater design Simulation Run: 10yr pre

Start of Run: 01Jan2000, 00:00 Basin Model: Pre development
End of Run: 02Jan2000, 00:00 Meteorologic Model: 10yr pre
Compute Time:16Aug2021, 13:34:12 Control Specifications:24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Front areas	0.043585	0.318	01Jan2000, 08:00	4.99
Rear	0.018297	0.134	01Jan2000, 08:00	2.09
Middle areas	0.007289	0.053	01Jan2000, 08:00	0.83
Unmitigate areas	0.000704	0.005	01Jan2000, 08:00	0.08
Hillside post planted	0.040093	0.254	01Jan2000, 08:00	4.11
Hillside area	0.040093	0.293	01Jan2000, 08:00	4.59
Runoff reduction	0.080186	0.547	01Jan2000, 08:00	8.69
Stream	0.069875	0.510	01Jan2000, 08:00	7.99

10yr Pre- Development (Add bush planting improvements)

Global Summary Results for Run "Post 10yr piped"

Project: 18733 Stormwater design Simulation Run: Post 10yr piped

Start of Run: 01Jan2000, 00:00 Basin Model: Post development
End of Run: 02Jan2000, 00:00 Meteorologic Model: 10yr post
Compute Time:DATA CHANGED, RECOMPUTE Control Specifications:24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Impervious	0.0138636	0.198	01Jan2000, 08:00	3.05
Front road	0.0097954	0.140	01Jan2000, 08:00	2.16
A Pervious	0.0092424	0.088	01Jan2000, 08:00	1.36
C Impervious	0.0028392	0.041	01Jan2000, 08:00	0.62
D Impervious	0.0024864	0.036	01Jan2000, 08:00	0.55
Front road pervious	0.0017286	0.017	01Jan2000, 08:00	0.25
Front Pond A	0.0399556	0.348	01Jan2000, 08:20	7.01
F, G Impervious	0.009348	0.134	01Jan2000, 08:00	2.06
F, G pervious	0.006232	0.060	01Jan2000, 08:00	0.92
Rear Road	0.0022967	0.033	01Jan2000, 08:00	0.51
E Impervious	0.0004338	0.006	01Jan2000, 08:00	0.10
Rear Road pervious	0.0004053	0.004	01Jan2000, 08:00	0.06
E Pervious	0.0002892	0.003	01Jan2000, 08:00	0.04
Rear Pond	0.0190050	0.132	01Jan2000, 08:25	3.30
B Impervious	0.0043734	0.063	01Jan2000, 08:00	0.96
B Pervious	0.0029156	0.028	01Jan2000, 08:00	0.43
Middle pond B	0.0072890	0.054	01Jan2000, 08:20	1.30
C Pervious	0.0018928	0.018	01Jan2000, 08:00	0.28
D Pervious	0.0016576	0.016	01Jan2000, 08:00	0.24
Stream	0.0698000	0.549	01Jan2000, 08:25	12.13

10yr Post- Development

Global Summary Results for Run "100yr pre A"

Project: 18733 Stormwater design Simulation Run: 100yr pre A

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 16Aug2021, 13:34:24

Basin Model: Pre development
Meteorologic Model: 100yr pre A
Control Specifications: 24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Front areas	0.043585	0.638	01Jan2000, 08:00	9.60
Rear	0.018297	0.268	01Jan2000, 08:00	4.03
Middle areas	0.007289	0.107	01Jan2000, 08:00	1.61
Unmitigate areas	0.000704	0.010	01Jan2000, 08:00	0.16
Hillside post planted	0.040093	0.530	01Jan2000, 08:00	8.15
Hillside area	0.040093	0.587	01Jan2000, 08:00	8.83
Runoff reduction	0.080186	1.117	01Jan2000, 08:00	16.98
Stream	0.069875	1.022	01Jan2000, 08:00	15.39

100yr Pre- Development (Add bush planting improvements)

Global Summary Results for Run "100yr post"

Project: 18733 Stormwater design Simulation Run: 100yr post

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Post development
Meteorologic Model: 100yr Post A
Control Specifications: 24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Impervious	0.0138636	0.323	01Jan2000, 08:00	5.01
Front road	0.0097954	0.228	01Jan2000, 08:00	3.54
A Pervious	0.0092424	0.172	01Jan2000, 08:00	2.57
C Impervious	0.0028392	0.066	01Jan2000, 08:00	1.03
D Impervious	0.0024864	0.058	01Jan2000, 08:00	0.90
Front road pervious	0.0017286	0.032	01Jan2000, 08:00	0.48
Front Pond A	0.0399556	0.549	01Jan2000, 08:20	12.43
F, G Impervious	0.009348	0.218	01Jan2000, 08:00	3.38
F, G pervious	0.006232	0.116	01Jan2000, 08:00	1.73
Rear Road	0.0022967	0.054	01Jan2000, 08:00	0.83
E Impervious	0.0004338	0.010	01Jan2000, 08:00	0.16
Rear Road pervious	0.0004053	0.008	01Jan2000, 08:00	0.11
E Pervious	0.0002892	0.005	01Jan2000, 08:00	0.08
Rear Pond	0.0190050	0.280	01Jan2000, 08:15	5.88
B Impervious	0.0043734	0.102	01Jan2000, 08:00	1.58
B Pervious	0.0029156	0.054	01Jan2000, 08:00	0.81
Middle pond B	0.0072890	0.080	01Jan2000, 08:30	2.30
C Pervious	0.0018928	0.035	01Jan2000, 08:00	0.53
D Pervious	0.0016576	0.031	01Jan2000, 08:00	0.46
Stream	0.0698000	0.952	01Jan2000, 08:15	21.59

100yr Post- Development

Global Summary Results for Run "WQV"

Project: 18733 Stormwater design Simulation Run: WQV

Start of Run: 01Jan2000, 00:00 Basin Model: Post development
End of Run: 02Jan2000, 00:00 Meteorologic Model: WQV
Compute Time: 01Sep2021, 14:55:13 Control Specifications: 24hr

Show Elements: All Eleme... Volume Units: MM 1000 M3 Sorting: Hydrolo...

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Impervious	0.0138636	0.041	01Jan2000, 08:00	0.61
Front road	0.0097954	0.029	01Jan2000, 08:00	0.43
A Pervious	0.0092424	0.006	01Jan2000, 08:05	0.12
C Impervious	0.0028392	0.008	01Jan2000, 08:00	0.13
D Impervious	0.0024864	0.007	01Jan2000, 08:00	0.11
Front road pervious	0.0017286	0.001	01Jan2000, 08:05	0.02
Front Pond A	0.0399556	0.010	01Jan2000, 22:35	0.62
F, G Impervious	0.009348	0.028	01Jan2000, 08:00	0.41
F, G pervious	0.006232	0.004	01Jan2000, 08:05	0.08
Rear Road	0.0022967	0.007	01Jan2000, 08:00	0.10
E Impervious	0.0004338	0.001	01Jan2000, 08:00	0.02
Rear Road pervious	0.0004053	0.000	01Jan2000, 08:05	0.01
E Pervious	0.0002892	0.000	01Jan2000, 08:05	0.00
Rear Pond	0.0190050	0.007	01Jan2000, 14:00	0.44
B Impervious	0.0043734	0.013	01Jan2000, 08:00	0.19
B Pervious	0.0029156	0.002	01Jan2000, 08:05	0.04
Middle pond B	0.0072890	0.004	01Jan2000, 09:40	0.22
C Pervious	0.0018928	0.001	01Jan2000, 08:05	0.02
D Pervious	0.0016576	0.001	01Jan2000, 08:05	0.02
Stream	0.0698000	0.020	01Jan2000, 13:25	1.32

Water quality volumes