Auckland Council Model Review

Section 3 Review Details

Item	Description	Rating Score	Modeller's Initial Notes	Reviewer's Comments	Modellers Response	Reviewer's Comments (2nd)
C:2.1	Compare TP108 graphical and modelled peak flows at a range of key locations, comment on any significant differences, and the impact on model predicted flows.	0	UHM and graphical method compared. No major differences in peak flow observed. Largest difference occurred at the impervious area of subcatchment AWA_SC3_Imp. The UHM method gives a flow of 2.91 whereas the tp108 graphical method gives a flow of 2.83 (UHM flow increased by 3%)	OK	rechecked with updated hydrology and no major differences in peak flow observed	
C:2.2	Check if overall flood extent sensible. Compare new flood extent with any previous floodplains.	0	flood extents in area of interest deemed sensible	Overall flood extent are reasonable.	-	
C:2.3	Validation against RFS records, anecdotal evidence?	0	validation not part of scope. Model is MPD future base scenario terrain, channels and land use so RFS records not applicable in area of interest	N/A	-	
C:2.4	Validation against gauged data or flood surveys?	0	as per comment above	N/A	-	

D - Additional Checks

D:1 - Additional Check Items

Item	Description	Rating Score	Modeller's Initial Notes	Reviewer's Comments	Modellers Response	Reviewer's Comments (2nd)
D:1.1	Does the model report provides adequate documentation on: - project objectives and purpose; - data analysis and model schematisation; - modelling methodology for key model components - assumptions and limitations.	0	report and options assessment programmed for after baseline model review	In future stage	-	
D:1.2	If applicable, are options represented adequately with appropriate levels of details? Comment on confidence level based on both model setup and model results.	0	report and options assessment programmed for after baseline model review	In future stage	-	
D:1.3	Should any aspects of the model be refined or redone in order to further investigate flooding effects?	0	model topography should be updated with new terrain of developments if smaller pipe networks are modelled	OK	-	
D:1.4	Which scenarios are modelled? Comment on the adequacy of scenarios modelled for achieving the project objectives	0	100 year MPD provided for initial review before options are modelled	100yr ARI MPD CC	-	
D:1.5	Any other assumptions used in the model that may have an impact on the overall model performance and meeting project objectives?	0	Model DEM at swamp Kauri development (see FIGURES tab) and culvert/pipe asset data required at Battalion Drive see FIGURES tab)	AC Project Manager will provide the available data.	The Battalion drive culvert has been added but the DEM at the developments has not been provided. The mesh has been updated at the edge of the developments to interpolate/smooth edges and remove the vertical drops previously experienced.	OK
D:1.6	Describe any additional checks or issues to raise	0	More recent survey (2017) of the McLennan wetland was recently provided in PDF format. If the survey is available in dwg format then the contours should be updated in the model (if required)	AC Project Manager will provide the available data.	The 2D mesh has been updated with 2017 survey data at McLennan wetland.	OK

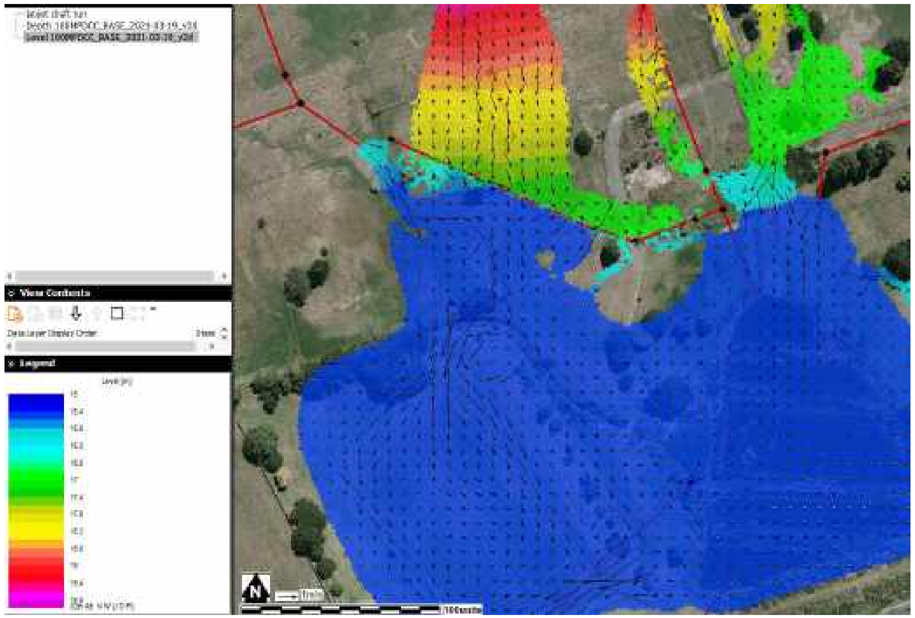
Artistry lane and Swamp Kauri developments:

There were significant differences observed at these developments between manhole lid levels and the 2016 LiDAR (the 2016 LiDAR appears to have been captured during earthworks of the development). A 2D surface has been created through interpolation of the manhole lid levels as these are more representative of the developed ground level. There are likely to be uncertainties in the overland flowpaths through these areas and it is recommended that the model is updated with surveyed ground levels/new LiDAR when available.

The model results show a sudden drop in terrain and water level at the Swamp Kauri development (area 1 in figures below) where the terrain created from the Lid levels does not tie in well with the LiDAR. The exact slope to the developed ground level is unknown.

UPDATE:

The steep drops between the development DEM's and the LiDAR/2017 survey contours have been smoothed through interpolation between the datasets.



asset data required for culvert/pipe discharging to wetland from Military camp

UPDATE: Data received and structures have been added to the model

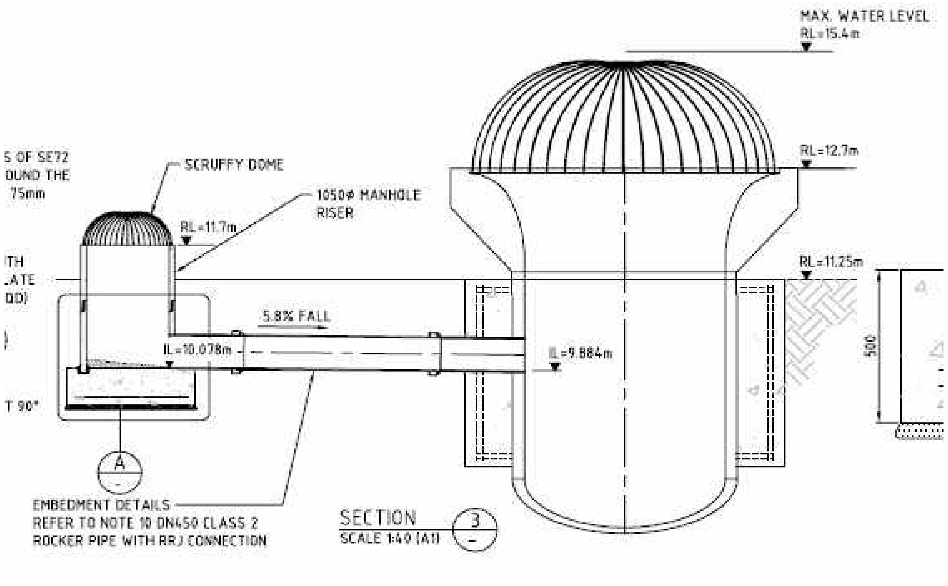

MAX. WATER LEVEL
RL=15.4m
RL=12.7m
SCRUFFY DOME
1050Ø MANHOLE
RISER
RL=11.7m
RL=11.25m
5.8% FALL
IL=10.078m
IL=9.884m
500
EMBEDMENT DETAILS
REFER TO NOTE 10 DN450 CLASS 2
ROCKER PIPE WITH RRJ CONNECTION
SECTION
SCALE 1:40 (A1)
3
A

Figure 1


Scruffy Dome

Appendix C: Flood extent figures

Figure Appendix C.1: Flood extent – 100 year ARI MPD CC Baseline

Figure Appendix C.2: Flood extent – 10 year ARI MPD CC Baseline

Figure Appendix C.3: Flood extent – 100 year ARI MPD CC Sensitivity scenario 2

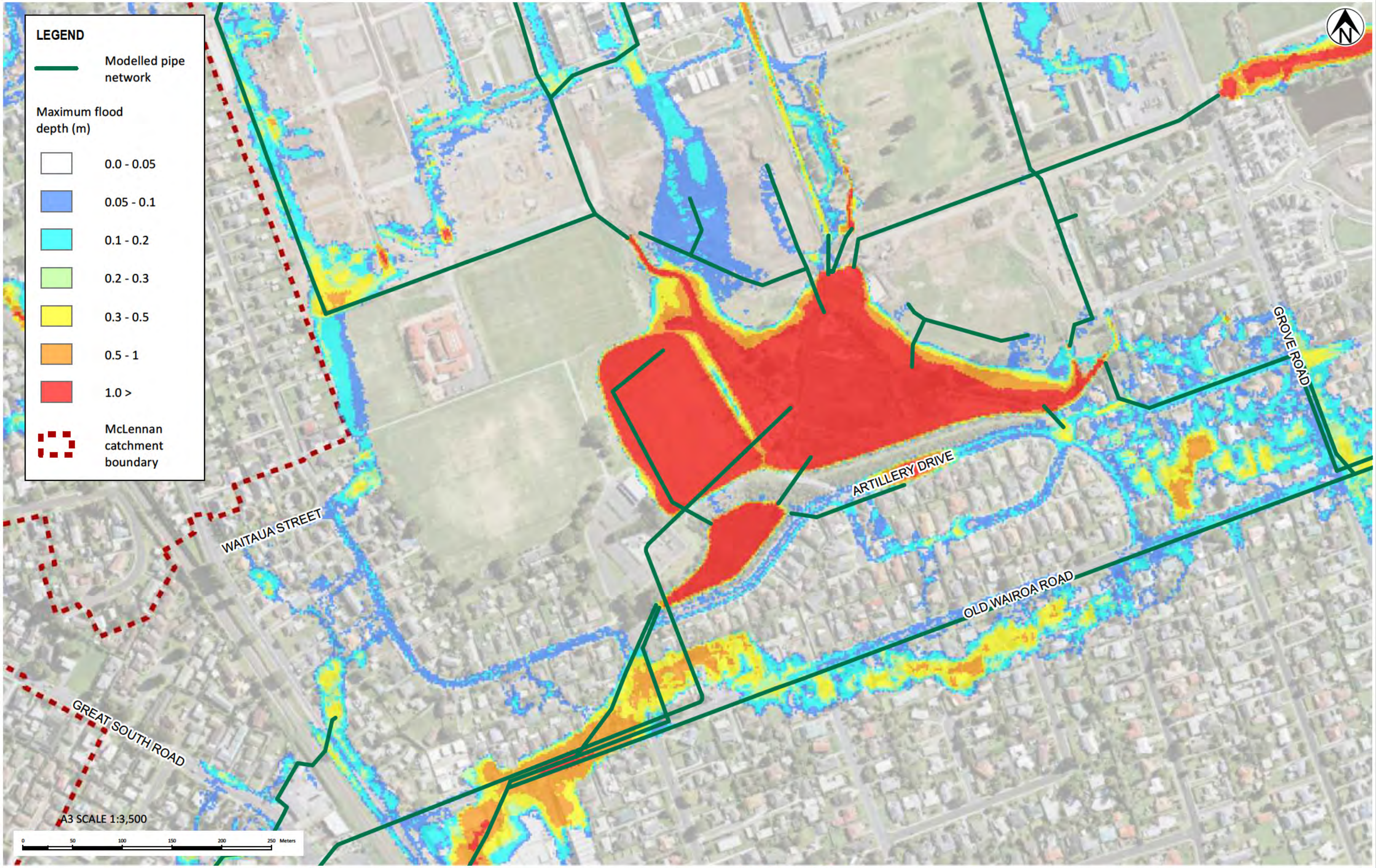
Figure Appendix C.4: Flood extent – 100 year ARI MPD CC Option scenario 1

Figure Appendix C.5: Flood extent – 100 year ARI MPD CC Option scenario 2

Figure Appendix C.6: Flood extent – 100 year ARI MPD CC Option scenario 2 and sensitivity scenario 2 (compared to baseline)

Figure Appendix C.7: Flood extent – 100 year ARI MPD CC Option scenario 2 and sensitivity scenario 2 (compared to sensitivity scenario 2)

P:\1012030\1012030.1040 McLennan wetland spillway\WorkingMaterial\01_GIS\FIGURES\FigureC1_Flood_Extent_100MPDCC_Baseline.mxd 2021-Jun-29 1:08:57 PM Drawn by JMOR



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REV	DESCRIPTION	GIS	CHK	DATE
0	First version	JMOR	SGB	25/05/21

LOCATION PLAN

PROJECT No.	1012030.1040	
DESIGNED	JMOR	JUN.21
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CHECKED	SGB	JUN.21
APPROVED		DATE

CLIENT **AUCKLAND COUNCIL**

PROJECT **MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING**

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC BASELINE

SCALE (A3) 1:3,500 FIG No. FIGURE C.1 REV 0

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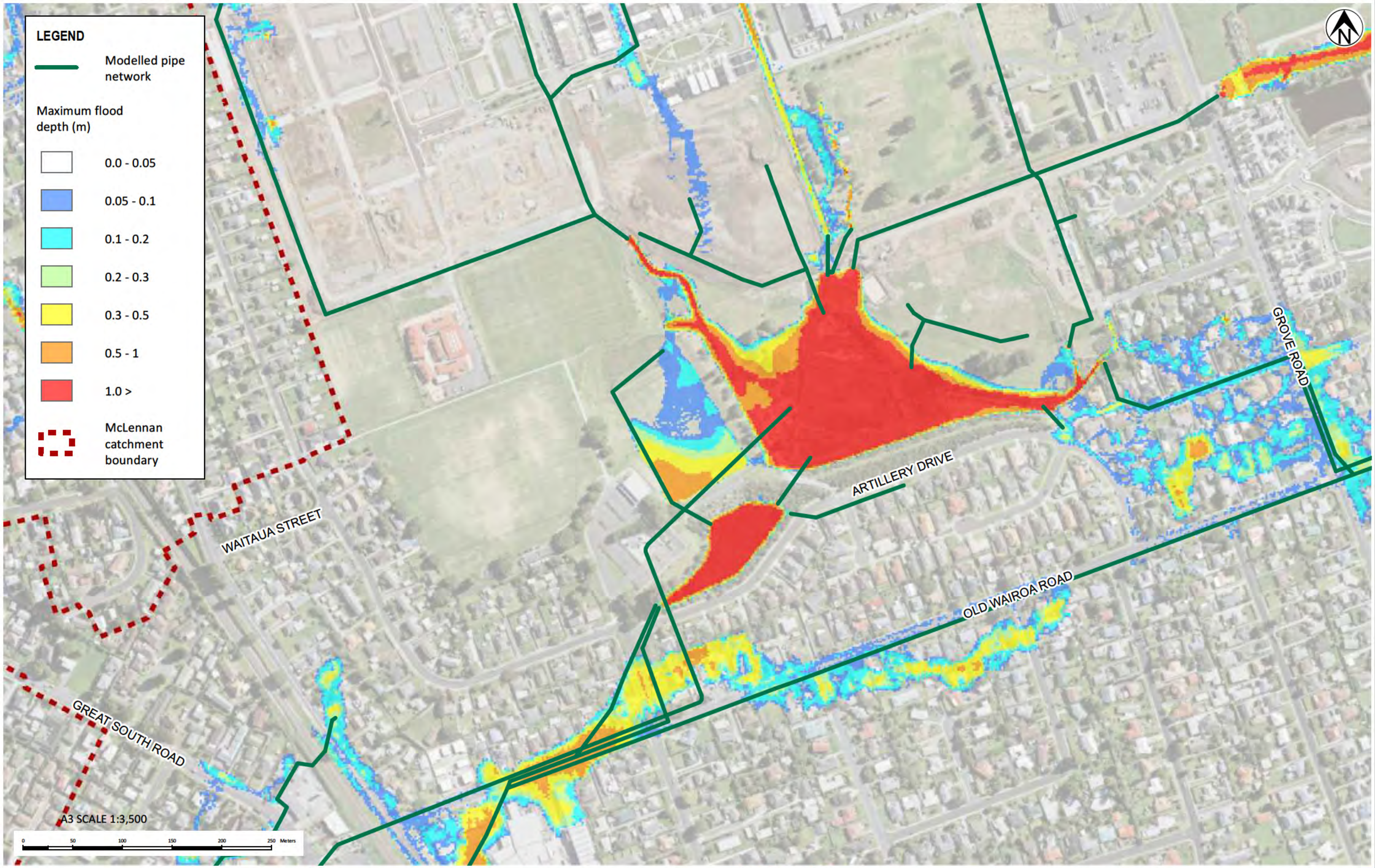

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CLIENT AUCKLAND COUNCIL

PROJECT MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING

TITLE FLOOD EXTENT - 10 YEAR ARI MPD CC BASELINE

SCALE (A3) 1:3,500 FIG No. FIGURE C.2 REV 0

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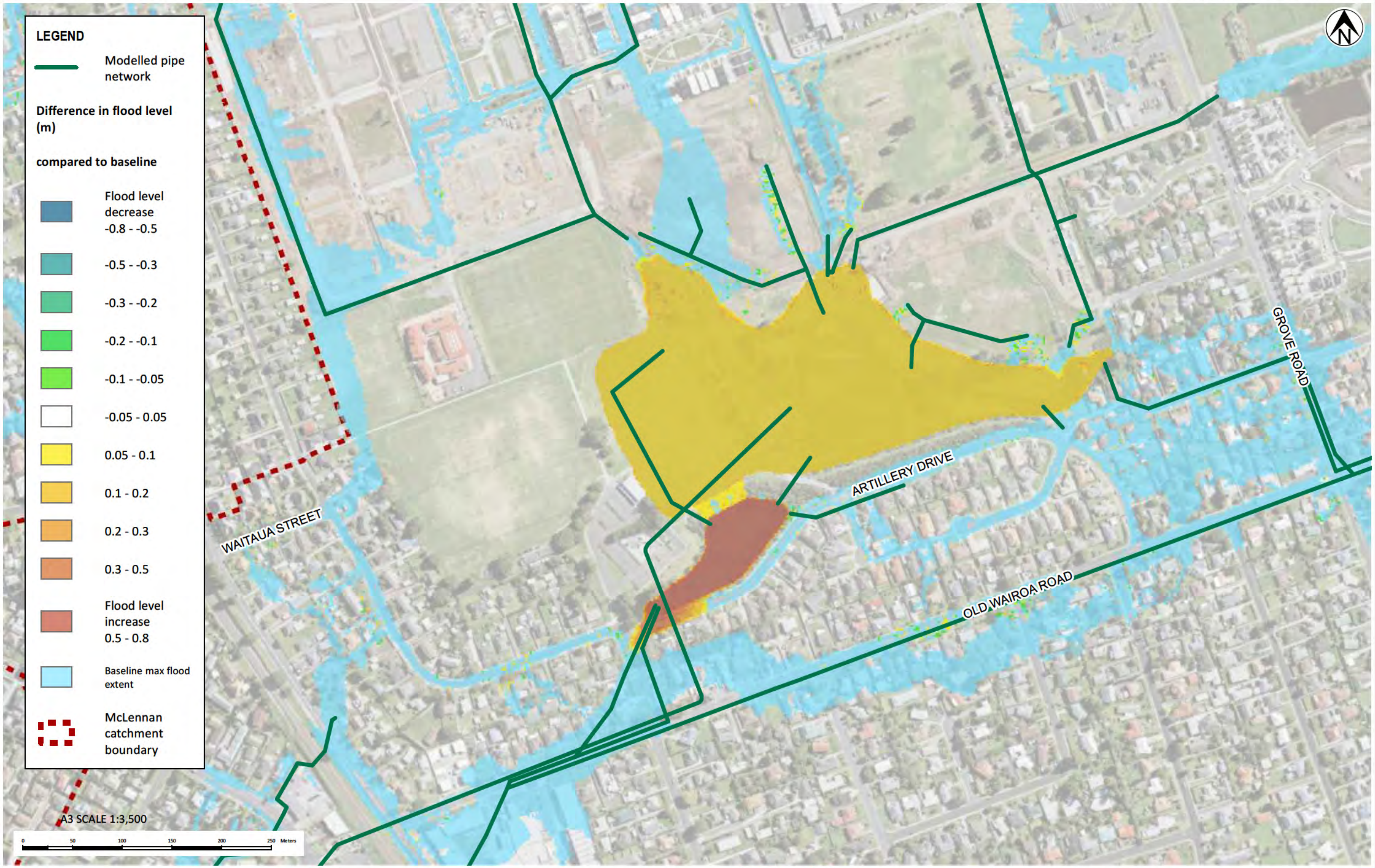

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PROJECT MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC SENSITIVITY SCENARIO 2 (ADST ROUGHNESS INCREASE)

SCALE (A3) 1:3,500   FIG No. FIGURE C.3   REV 0

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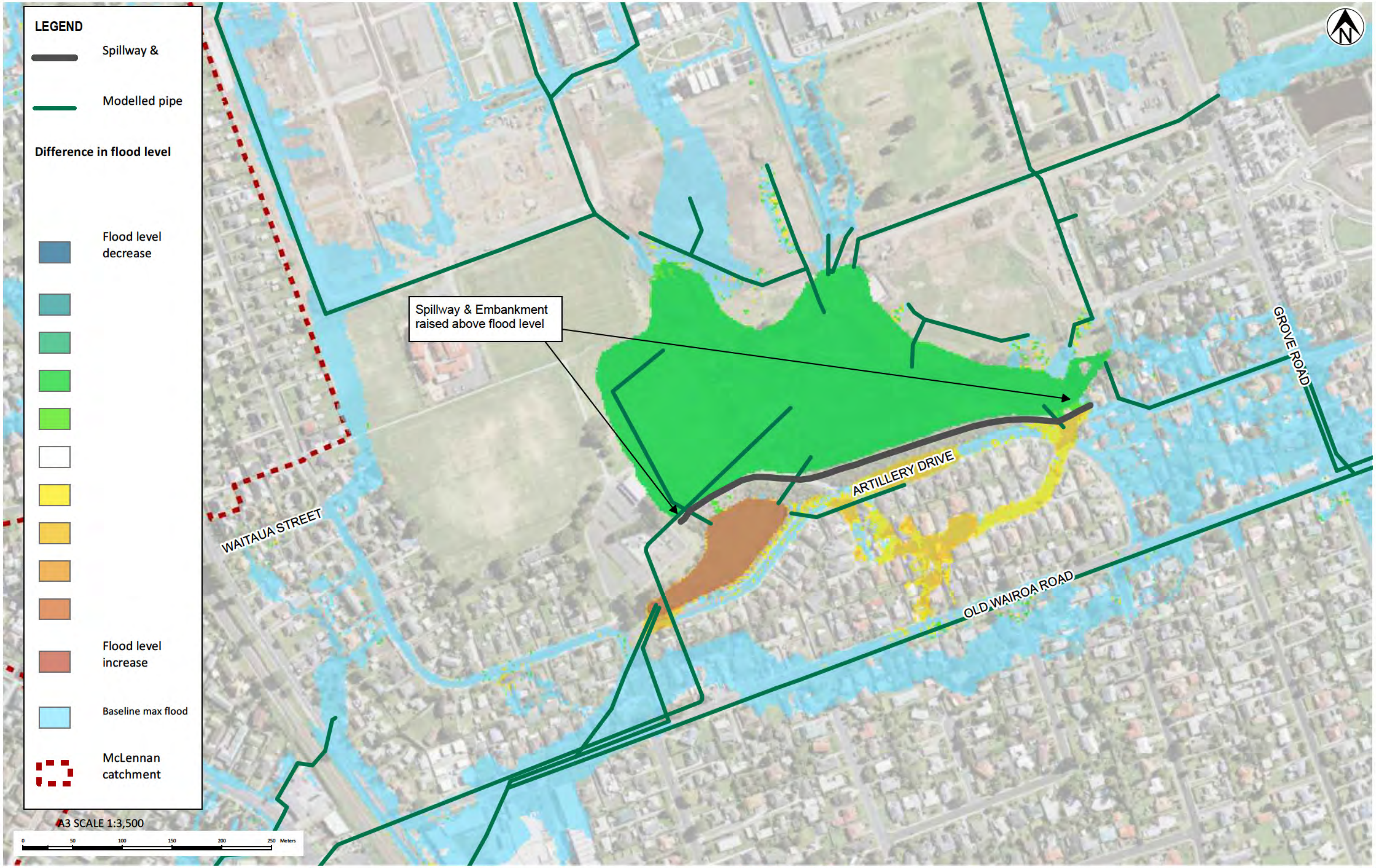

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PROJECT MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC OPTION SCENARIO 1

SCALE (A3) 1:3,500   FIG No. FIGURE C.4   REV 0

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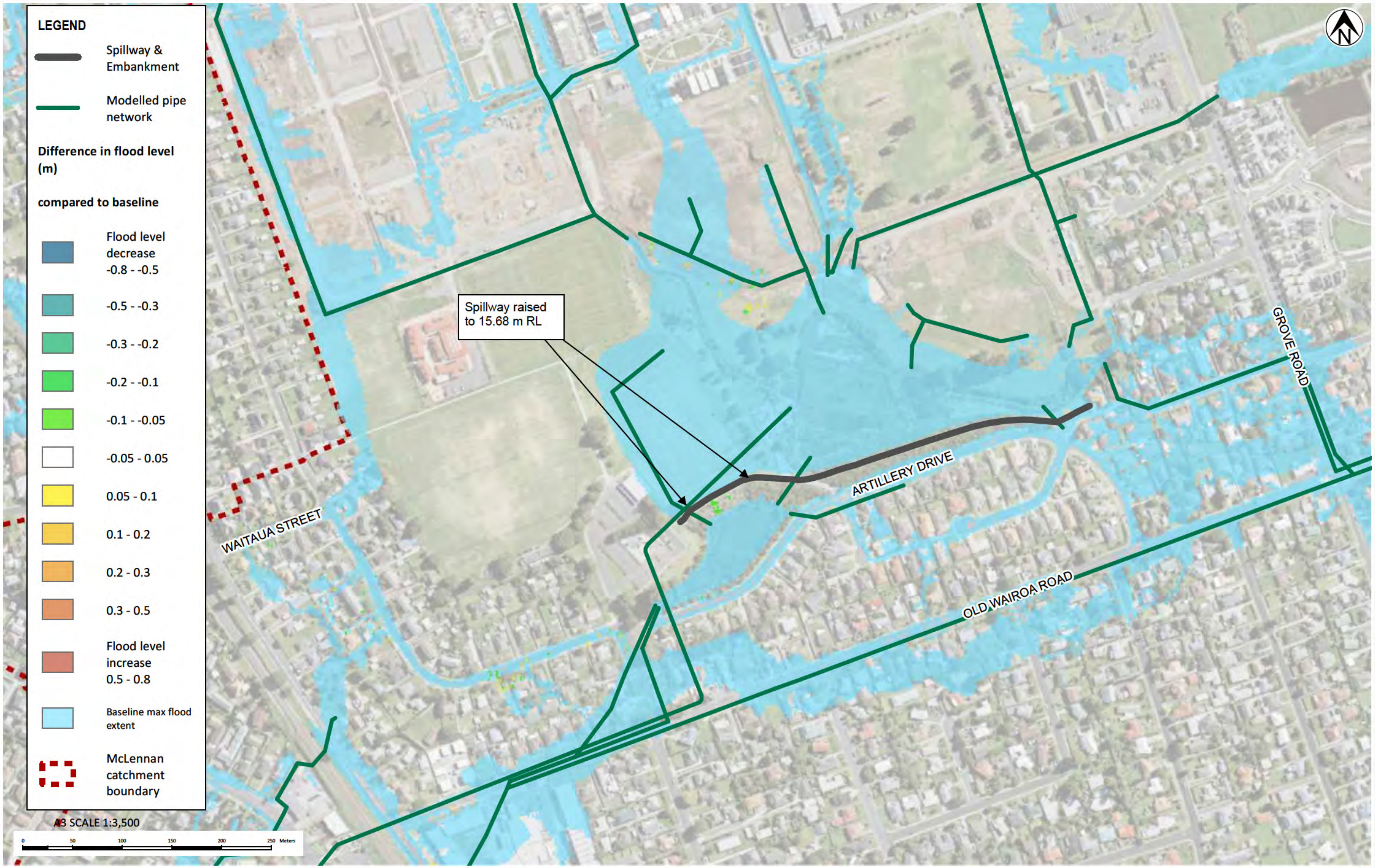

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CLIENT **AUCKLAND COUNCIL**

PROJECT **MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING**

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC OPTION SCENARIO 2

SCALE (A3) 1:3,500 FIG No. FIGURE C.5 REV 0

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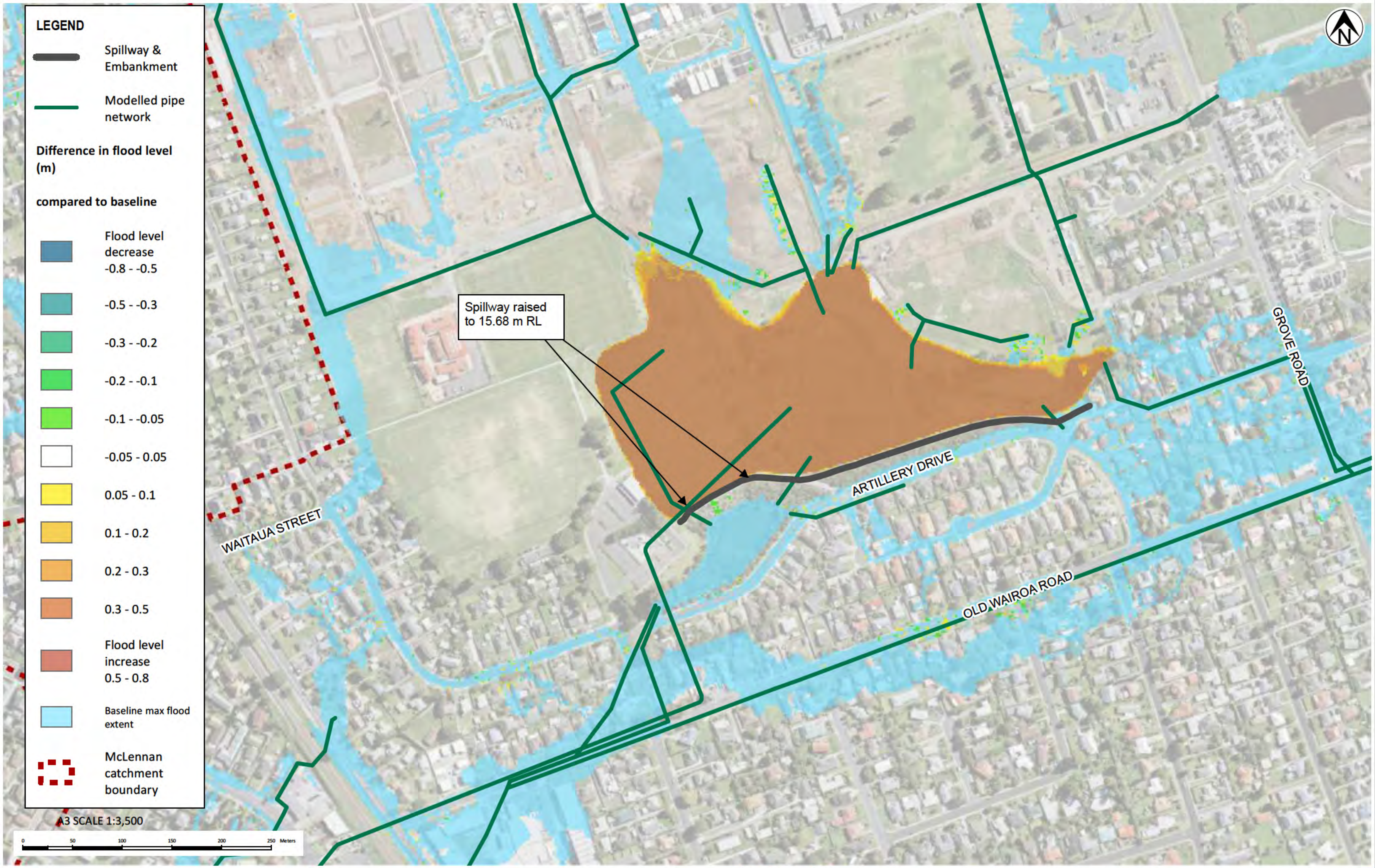

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PROJECT MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC
OPTION SCENARIO 2 & SENSITIVITY SCENARIO 2
(COMPARED TO BASELINE)

SCALE (A3) 1:3,500 FIG No. FIGURE C.6 REV 0

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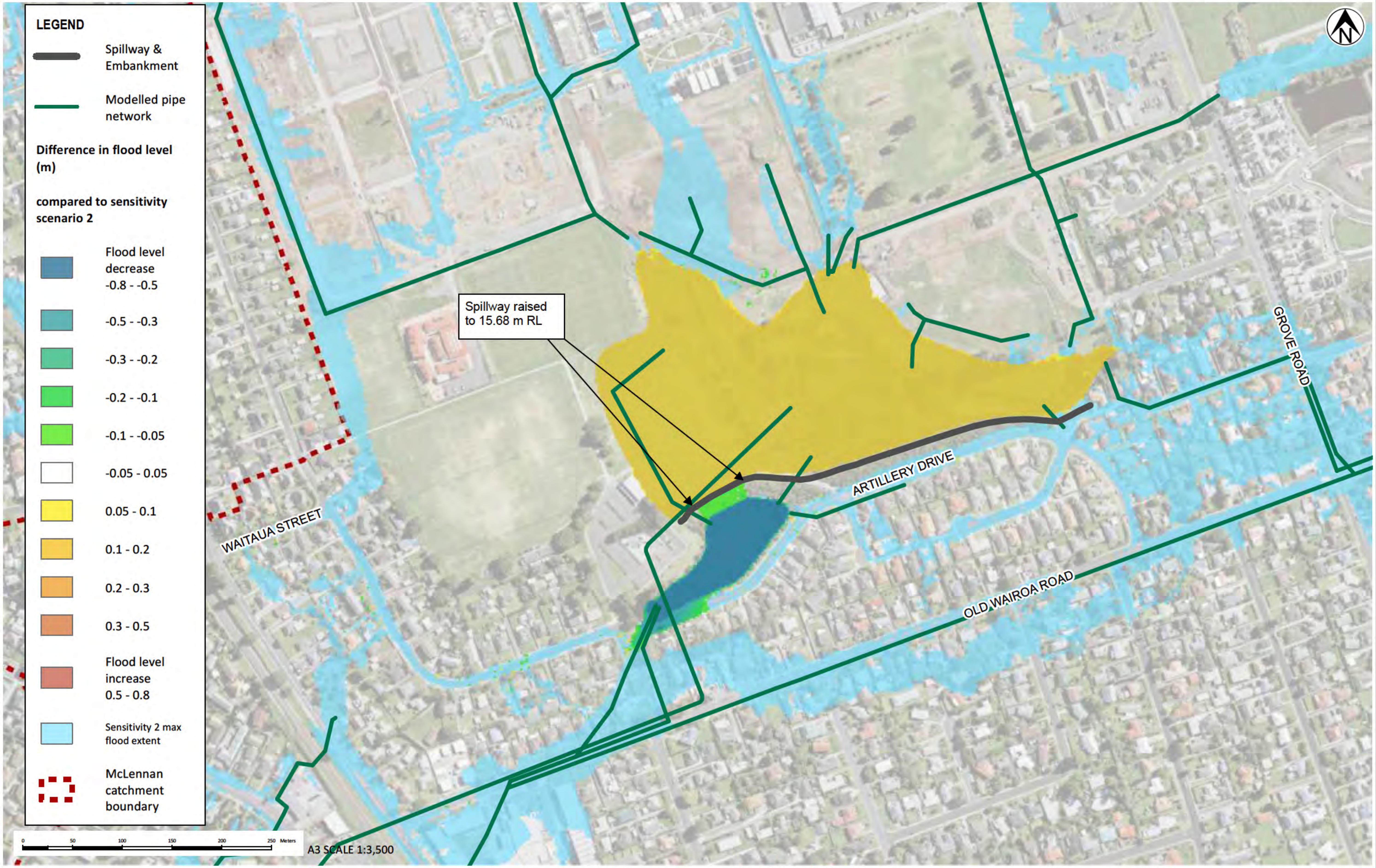

A3 SCALE 1:3,500

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CLIENT **AUCKLAND COUNCIL**

PROJECT **MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING**

TITLE FLOOD EXTENT - 100 YEAR ARI MPD CC
OPTION SCENARIO 2 & SENSITIVITY SCENARIO 2
(COMPARED TO SENSITIVITY SCENARIO 2)

SCALE (A3) 1:3,500 FIG No. FIGURE C.7 REV 0

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APPENDIX 13 – Auckland Council 2016 TSWCC – Stormwater Report

Takanini Stormwater Conveyance Channel

Volume Two

Appendix A – Stormwater Report

Prepared by Hill Young Cooper Limited

April 2016

Auckland Council

Takanini Stormwater Conveyance Channel

Stormwater Report

Technical Report A

April 2016

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Figure index

Appendices

1. Introduction

The Takanini Stormwater Conveyance Channel forms the fourth stage of a greater scheme to provide stormwater servicing for the Takanini south-east area. The Takanini Stormwater Conveyance Channel will pass forward flows from Old Wairoa Road, Cosgrave Road, Walters Road and Grove Road, for which there is currently no formal drainage system, to a proposed box culvert at Grove Road. The Grove Road Box Culvert conveys flows from the Takanini Stormwater Conveyance Channel to the McLennan wetland. During large storm events, flow is attenuated in the McLennan wetland before being discharged to the Pahurehure inlet via the proposed Artillery Drive tunnel. Refer to Drawing *51-3217404-C001* for an overview of the greater scheme.

The conveyance channel will consist of approximately 2.1 km of open waterway that will contain the existing 1% AEP floodplain allowing the surrounding land to be comprehensively developed. It is anticipated that the channel construction will take approximately 2-3 years to complete.

A Notice of Requirement was lodged in July 2014 for the designation of land to allow the development of the channel. The project is currently at the scheme design stage. The designation corridor will allow for the channel extents to convey both low flows and the full 1% AEP flows with both wetland and riparian planting. It will deliver an open public space with the provision for cycleways and footpaths that will increase the connectivity between new urban areas and allow for the development of the Special Housing Takanini Strategic Areas (including Special Housing Areas 2A, 2B and Wallace) and area 2B4 which is currently zoned rural.

1.1 Purpose

An Infrastructure Report was prepared in 2014 to assist Auckland Council process and lodge a Notice of Requirement (NoR) to designate the land required for the permanent works associated with the proposed stormwater conveyance channel. This report builds upon the 2014 Infrastructure Report and refines the stormwater effects to reflect the additional designs and investigations undertaken during scheme design.

Changes to this Stormwater Report compared to the NoR lodgement include:

- Further development of the scheme design of the Takanini Stormwater Conveyance Channel.
- Further geotechnical analysis, based on additional groundwater monitoring, as part of the scheme design of the Takanini Stormwater Conveyance Channel.
- Early construction of some sections of the channel by developers as temporary stormwater ponds. Refer to the Section 1.3.

The purpose of this report is to:

- Provide details relating to the Scheme design of the stormwater conveyance channel.
- Discuss the benefits and drainage related effects of the proposed channel, both short and long-term.
- Outline mitigation measures that will be employed by Council to minimise any adverse effects.
- Outline the updated design from the time of the Notice of Requirement.

1.2 Scope

The scope of this report is to:

- Detail the stormwater scheme design of the Takanini Conveyance Channel.
- Document the design philosophy and design practices relating the Scheme design that further advance the concept design outlined in the *Takanini Stormwater Conveyance Channel, Infrastructure Report, GHD July 2014.*
- Provide a record of any key decisions.
- Identify any further investigations or management plans required for detailed design, or prior to construction.

1.3 Assumptions and limitations

The following information and assumptions were used in the development of this Stormwater Report:

- This report has been prepared in conjunction with the other technical reports that make up the AEE; including Technical Reports A – M.
- That the proposed Grove Road Box Culvert will have been constructed and in place prior to the construction of the Takanini Stormwater Conveyance Channel.
- The channel between 989-999 Papakura-Clevedon Road and 55 Cosgrave Road (CH1250 m to 1540 m) has been constructed by developers to serve as a temporary stormwater pond. This section will require reshaping only to finished design levels. Note that the Old Wairoa Road culvert has been constructed as part of these developer works and consequently a reduction in the earthworks volumes for the formation of the Takanini Stormwater Conveyance Channel has been considered at this location.
- Auckland Council has an agreement in place with the developers of 94, 74, 64 and 54 Cosgrave Road who propose to construct part of the channel at 84 Cosgrave Road (CH275 m to 500 m) and consequently a reduction in the earthworks volumes for the formation of the Takanini Stormwater Conveyance Channel has been considered at this location. Construction is planned for October 2016.

2. Project Overview

2.1 Takanini Stormwater Conveyance Channel

The proposed Takanini Stormwater Conveyance Channel will extend from 989-999 Papakura-Clevedon Road in the south-east to 91 Grove Road in the west. A northern branch will extend northwards towards Walters Road.

In general the conveyance channel will provide stormwater servicing for future development of Areas 2A, 2B and part of Area 4 (2B4) of the Takanini Structure Plan. At present the area is significantly impacted by the 1% AEP (Annual Exceedance Probability) floodplain, restricting development of the area.

The proposed channel will:

- Provide for the full 1% AEP flows, effectively removing the floodplain from surrounding land.
- Offer an ecological corridor (both terrestrial and aquatic) that would otherwise not be provided.
- Deliver stormwater servicing for development within the catchment area that is not currently presented.
- Afford an open space with significant amenity value and the provision for pedestrian linkages and cycleways.

The Takanini Stormwater Conveyance Channel consists of two main branch channels; the main channel and the northern branch channel.

- **Main channel**

  The main channel has a length of 1.55 km of open waterway, ranging in depth between 2 m and 4 m below ground level. The channel has an approximate gradient of 0.28% and a total width (at the 1% AEP water level) ranging from 20 m to 37 m.

- **Northern branch**

  The northern branch channel has a length of 0.55 km of open waterway, ranging in depth between 2.4 m and 3.8 m below ground level. The channel has an approximate gradient of 0.24% and a total width (at the 1% AEP water level) of approximately 25 m.

The Takanini Stormwater Conveyance Channel is designed with a meandering low flow series of discrete water bodies or wetlands with a permanent water depth of about 0.8 m controlled by rock weirs at 100 m centres longitudinally along the base of the channel. These provide an ecological benefit and limit groundwater drawdown. Generally the low flow channel will have a 3.6 m wide base with slope batters 2H:1V, with an intermediate flat wetland bench. Above the wetland bench are riparian planted channel banks with slope batters 4H:1V and a grassed floodplain.

2.2 Catchment area

The Takanini 2A2B stormwater catchment (shown in Figure 1) represents the area to be serviced by the proposed stormwater conveyance channel.

The area is approximately 155 hectares (ha) and consists of areas 2A (50.3 ha), 'Wallace' (9.1 ha), 2B4 (57.3 ha), 2B (38.0 ha) as shown as a dotted purple line in Figure 1 (referred to as the Takanini 2A2B catchment herein.

This catchment is within the Central Papakura Integrated Catchment Management Plan (ICMP) area. The sub-catchments are similar to those in the ICMP and Old Wairoa Road Catchment Management Plan, with the exception of area 2B4 which, in the ICMP and Old Wairoa Road Catchment Management Plan, excludes a small triangular shaped area at the end of Pukeroa Place. The size of this area is approximately 1 hectare and is included in the catchment area of the proposed Takanini Stormwater Conveyance Channel.

Figure 1 Takanini 2A2B catchment

2.3 Takanini Stormwater Scheme

The Takanini Stormwater Conveyance Channel is part of a greater stormwater scheme (refer Drawing *51-3217404-C001*) to reduce flooding in the 1% AEP and provide servicing for the greater Old Wairoa Road catchment. The Takanini Stormwater Scheme is comprised of four sections including:

Part 1 - Artillery Drive Tunnel

A new 2.5 m diameter tunnel that will extend over approximately 1.1 km from the McLennan wetland to the Pahurehure Inlet. This effectively forms the downstream outlet for the stormwater scheme.

Part 2 - McLennan wetland

Constructed in 2002, this wetland already receives stormwater from the Housing New Zealand development and Papakura Military Camp through to Bruce Pulman Park in the north; and Willis Road and Clevedon Road to the south. The wetland provides attenuation and treatment for the greater catchment before discharge. Currently the wetland passes forward flows to the Gills Road pond and will continue to do so in the future with only high flows being conveyed through the new Artillery Drive tunnel.

The McLennan wetland is designed to accept flows from the Old Wairoa Road catchment, which includes the catchment area of the Takanini Stormwater Conveyance Channel. The wetland has been included in a hydrological model held by Auckland Council, which confirms that there is enough storage to attenuate flows to an acceptable level of which the Artillery Drive Tunnel has been designed in accordance with.

Part 3 - Grove Road Culvert

A new culvert that will convey flows from the Takanini 2A2B catchment to the McLennan wetland.

The location of the Grove Road Culvert was altered from the location shown in the Grove Road Structure Plan. The structure plan showed the channel running through the middle of 61 Grove Road and connecting to the proposed Grove Road Culvert at Matheson Street.

The property at 61 Grove Road has subdivision consent and physical works on site are near completion for Stage 1 of their development. As a consequence; the route defined in the Structure Plan is no longer viable. The optimal location for the box culvert connection is therefore to the north of the northern boundary of 61 Grove Road. This allows minimal dissection of private properties and optimises drainage potential of the surrounding land.

The Grove Road Culvert is being designed by Jacobs and is a separate project to the Takanini Stormwater Conveyance Channel.

Construction is anticipated in 2016/2017.

Part 4 - Takanini Stormwater Conveyance Channel

As outlined in this report, a new 2.1 km open channel that will convey flows from part of the Old Wairoa Road catchment (Old Wairoa Road in the south-west to Walters Road in the north) to the Grove Road Culvert. Construction of the conveyance channel cannot occur until the Grove Road Culvert is completed. It is expected that construction of the channel will take 2-3 years.

2.4 Zoning and Special Housing Areas

The zoning of the catchment is based on the Unitary Plan zoning within the special housing areas (Areas 2A, 2B and Wallace). Area 2B4 is not part of the SHA and is currently zoned rural. Refer to the Assessment of Environmental Effects Vol 1 and Drawing *51-3217404-C005* for more details on zoning.

2.5 Network Discharge Consent

The Old Wairoa Road CMP (2004) defines the catchment boundary for the McLennan wetland. In 2010 the boundary shown in the CMP increased to include part of the Takanini South Catchment through CMP Variation 33738 (2010). This additional area is shown as the 'Wallace' area.

A "trunk stormwater conveyance system to serve areas 2A, 2B and 2B4" is consented under the NDC. The Takanini Stormwater Conveyance Channel is the proposed infrastructure for servicing these areas and the Wallace area to the north.

2.6 Draft Central Papakura ICMP

The Draft Central Papakura ICMP (October 2007) documents the overarching stormwater conveyance approach for the catchment. The ICMP outlines a potential alignment for the Takanini Stormwater Conveyance Channel.

The ICMP alignment is similar to the main channel alignment proposed in this report; with the main difference at the eastern end where the ICMP alignment splits into two channels. The ICMP channel excludes the proposed Northern Branch channel and services part of the 2A catchment using a piped stormwater system.

2.1 Concept design

The concept design was developed by GHD in July 2014 as part of the Notice of Requirement process and is described in the *Takanini Stormwater Conveyance Channel Infrastructure Report (GHD, 2014)*. The Concept Design concluded that a conveyance channel was the most beneficial and recommended stormwater solution for the catchment, compared to a piped solution, or piped / pond hybrid system.

Refer to the Plan amendment 48 – Takanini stormwater conveyance corridor (Auckland Council, 2014) for more detail.

3. Existing Environment

3.1 Site setting

3.1.1 Land use

The majority of land use within the conveyance catchment is currently pastoral although of a relatively low intensive nature.

Consents have already been obtained for development of sites within the catchment subject to temporary stormwater solutions on the proviso that once the channel is built, these sites will be connected to it. These include:

- The Grove at 61 Grove Road (Equinox Group).
- Twin Parks Estate at 989 to 999 Papakura-Clevedon Road (Cappella Papakura Developments Ltd).
- Papakura Residential at 965 Old Wairoa Road and 965 to 973 Papakura-Clevedon Road (Cabra Investments Ltd).
- Part of Montgomery at 881 to 899 Papakura-Clevedon Road.

All of their sites are currently undergoing bulk earthworks with houses currently being established at 61 Grove Road (The Grove) and sale of design-build packages being promoted for the Cappella development (Twin Parks Estate).

The developments above are shown on drawing *51-3217404-C006*.

Planned development

There are 7 sites in the catchment currently subject to subdivision consent.

A proposed school site has been designated at 181 and 191 Walters Road at the north eastern end of Area 2A.

3.1.2 Temporary Stormwater

The Equinox and Cappella application’s for consent included temporary stormwater attenuation. It should be noted that these properties are an anomaly to those remaining sites within the catchment as they have the ability to convey flows to adjacent catchments, albeit on a temporary basis.

The Cabra application for consent included a permanent attenuation pond. The pond has been flow routed and included in the MIKE11 catchment model discussed in Section 4.2.3.

3.1.3 Topography

The catchment is essentially flat in nature; except for the eastern portion where it falls from approximately 67 m over a distance of 0.8 km to 26 m; with an average slope of about 3 %.

From here; the catchment falls from an RL of 26 m over 1.7 km to an RL of 22 m at Grove Road. This provides an average slope for the flat portion of about 0.24 %.

3.1.4 Existing stormwater and features

There is no formalised drainage across the catchment with small dissected channels and farm drains connecting to roadside table drains. The existing natural streams in the region are very short and have little to nil baseflow during the summer months (Draft Central Papakura ICMP, 2007).

The roadside table drains along Cosgrave Road collect overland flow and have limited conveyance capability. These roadside drains are deeply incised, up to about 2 to 2.5 m in depth. Generally, the roadside drains store water and discharge to ground soakage when water tables are low over summer. Figure 2 shows the table drain on Cosgrave Road.

Figure 2 Cosgrave Road table drain

To the west of Grove Road and south of Fernaig Street and Pukeroa Place stormwater is reticulated. Most of these flows are directed to the wetland located in McLennan Park. This wetland (the McLennan wetland) is designed to attenuate and treat flows from the Old Wairoa Road catchment before discharge via Gills Pond to the Pahurehure Inlet and is discussed further in Section 5.4.

Figure 3 McLennan wetland

3.1.5 Existing flooding

The vast majority of the Takanini 2A2B area and a portion of the Takanini South catchment to the north-west are predicted to be inundated in a 1% AEP storm event to a depth of 300 to

500 mm. Extensive ponding has been observed during rainfall events, particularly in winter when the groundwater table is high. This is primarily a result of ineffective stormwater drainage but also due to flat topography, high groundwater tables and limited soakage capacity of the peat fields.

3.1.6 Geological setting and extent of peat

The geotechnical investigation confirms that the ground beneath the Takanini Stormwater Conveyance Channel is predominantly made up of peats, organic silts and sands.

The peat is shown to extend throughout Areas 2A, part of 2B4 but does not extend significantly into Area 2B.

The geotechnical investigations carried out by GHD confirm the extent of peat, which matches very closely to the predictions in the Papakura District Peat Area Stormwater Discharge Review (PDP, 2006). Refer to Drawing *51-3217404-Q073* for GHD's mapped peat extent.

The Takanini Stormwater Conveyance Channel is within the inferred peat zone.

3.1.7 Surface water and discharge to ground

The majority of stormwater in the undeveloped areas of the Takanini 2A2B and surrounding rural areas enters the ground via direct infiltration. Impervious surfaces in areas designated as rural discharge to ground soakage or open channels. Soakage test results indicate some of the highest soakage rates were found within peat areas. However, sample testing indicated the peat also had low permeability.

The Takanini area is known to be underlain by a significant peat aquifer.

Geological units described generally as peat in this area consist of a material that ranges from humic, fibrous peat to amorphous organic clay and are generally horizontally stratified, somewhat explaining the variance in permeability. This is further discussed in the Geotechnical Investigations Report (Technical Report C).

3.1.8 Groundwater

Groundwater level monitoring data has been collected over the past 12 months to establish seasonal variation in groundwater levels. These data are included in Geotechnical Investigation Report (Technical Report C).

Depths to groundwater in the shallow unconfined aquifer system range from 0.0 m in the eastern part of the subject site to 1.0 m to 1.5 m near Cosgrove Road and are >1.5 m depth in the south western part of the site near Grove Road.

3.1.9 Design for ground conditions

Development in this area requires specific design and within sub-precincts D and E, the PAUP (Auckland Council, 2013) stipulates that specific consideration must be given to consolidation settlement, differential settlement and foundation bearing pressure (Part 3, Chapter K, Section 6.25, Rules 8, 10 and 11).

The Papakura District Plan also requires specific geotechnical design for this area (Section 3, Part 16.2.3.5.1). All applications for subdivision in the 2A or 2B area require a Geotechnical Report that assesses consolidation settlement, differential settlement and foundation bearing pressure.

3.1.10 Existing utilities

Existing services are outlined in Drawing *51-3217404-C008* which include:

Stormwater

As already noted, the Takanini 2A2B area is not serviced by a formal stormwater network, instead water is collected in roadside table drains and conveyed to the Papakura Stream (Stream No. 438810) to the north with a small portion of the catchment discharging to Slippery Creek in the south. A short length of reticulation on Grove Road drains a roadside swale to the McLennan wetland. The remaining table drains do not discharge and instead are subject to seasonal groundwater fluctuations.

Water

Watercare Services Limited (WSL) through Veolia Water provides reticulated drinking water to residential properties within the Takanini 2A2B area along Cosgrave Road and Grove Road.

Wastewater

There is no existing wastewater servicing for the undeveloped areas within the catchment. As development of the catchment commences, wastewater servicing is being constructed by developers. The wastewater will be owned and operated by Veolia.

Currently, rising mains from the 61 Grove Road development, the Cappella development, and the Cabra development are being constructed to service their sites. The proposed connection for future wastewater is to the north at Walters Road.

The residential areas adjacent to the catchment are reticulated with both services. Refer to Drawing *51-3217404-C008*.

Waikato No. 1 trunk watermain

A 1,200 mm diameter watermain owned by WSL runs along the western side of Cosgrave Road and has an estimated depth to invert varying between approximately 2.5 m to 3.0 m. This is considered a strategic main, supplying the bulk of potable water to east Auckland.

There is a fibre optic cable above the watermain for communication purposes.

Gas

A 356 OD PE Vector high pressure gas transmission pipeline traverses through areas 2B and 2B4 with an average depth of cover of 900 mm and a 12 m wide designation. The gas main travels in a north-south direction between Settlement Road and Hamlin Road, as shown in Drawing *51-3217404-C008*.

Power

Power is transmitted in overhead lines. There are no significant high voltage feeds in this area.

Telecom and Vodafone

There are existing Telecom and Vodafone services along Cosgrave Road, Grove Road and the local roads adjacent to the Takanini 2A2B catchment.

Rural Land Private Services

The rural zoned farm area bounded by Cosgrave and Old Wairoa Roads has a small diameter water supply for stock and a power feed for electrification of stock fences.

3.1.11 Planned future services

Mill Road corridor

Auckland Transport has indicated that the proposed Mill Road Corridor is likely to traverse areas 2B4 and 2B; however the exact alignment has not been finalised. It is possible that transport corridors will run perpendicular to the channel.

It was confirmed by Auckland Transport in November 2013 that the Mill Road alignment will likely not be finalised until after the Takanini 2A2B catchment conveyance system has been designated. For this reason, specific interconnection cannot currently be assessed.

It is expected that the Mill Road Corridor will run through 989 Papakura-Clevedon Road and 55 Cosgrave Road before connecting to either Cosgrave Road or Mill Road in the north. Auckland Transport has advised that the Mill Road extension is likely to be 10 to 15 years away.

3.2 McLennan wetland

Existing and consented wetland

The McLennan wetland was constructed in 2002, this wetland already receives stormwater from the Housing New Zealand development and Papakura Military Camp through to Bruce Pulman Park in the north; and Willis Road and Clevedon Road to the south. The wetland provides attenuation and treatment for of the Old Wairoa Road catchment as per Figure 4.

Figure 4 McLennan wetland sub-catchment map (Old Wairoa Road CMP Variations, 2009)

The wetland currently has an embankment top level of RL 16.00 m and an emergency spillway level of RL 15.1 m.

Network Discharge Consent 37205, 33738 and 33538 specify that prior to any further development commencing in areas 2A, 2B or 2B4 (ie. The construction of the Takanini Stormwater Conveyance Channel) the following works will be undertaken:

- Increase of embankment level from RL 16.0 m to RL 16.2 m
- Increase of spillway level from RL 15.1 m to RL 15.4 m

3.3 Documented / observed flooding

A 1% AEP surface flooding area with a maximum 0.5 m flood depth is noted across the Takanini 2A2B area in the ICMP. This floodplain is based on observational data. There have also been reports of historical flooding across the paddocks from landowners.

3.4 Water quality

For the pre-developed scenario, during the Water Quality rainfall event (1/3 50% AEP event), rainfall onto Takanini 2A2B catchment is expected to soak through the soil, with little runoff being produced.

For the developed areas adjacent to the proposed Takanini 2A2B catchment; water quality treatment is provided by the McLennan upper wetland discussed in Section 3.2. The efficiency of the upper McLennan wetland is estimated at 72%.

There is another stormwater treatment pond at the downstream end of the Old Wairoa Road catchment; the Gills Road Pond. The Gills Road Pond provides stormwater treatment for the Old Wairoa Road catchment prior to discharging to the Pahurehure Inlet.

There is a requirement for developments in the area to discharge stormwater into soakage devices.

4. Methodology and Design Parameters

4.1 Design requirements

The Takanini Stormwater Conveyance Channel has been designed to accommodate the following elements:

1. Convey the 1% AEP wholly within the channel extent and subsequently within the designation.
2. Provide a permanent water level to support the development of a natural aquatic ecosystem.
3. Provide low flow operation levels of the channel at a suitable depth to allow piped flow from adjacent catchment areas to flow with a free discharge at low flows (not drowned) where practical.
4. Provide suitable 1% AEP flow levels in the channel to allow properties at the catchment extents to design overland flow paths with sufficient capacity and grade to discharge to the channel.
5. Provide a safe environment for the community and for those staff undertaking the operation and maintenance of the channel.
6. Provide for additional amenity value within the designated area where possible.
7. Make provision of the development of footpaths and cycleways.

4.1.1 Design standards

The design requirements and considerations have been compiled from the Auckland Council Stormwater Code of Practice (CoP), relevant planning documents and consents. These are summarised in Table 1 below.

Note that some of these are development criteria, and cannot be directly controlled in the design of the Takanini Stormwater Conveyance Channel. However, provision can and has been made in the design of the channel to aid developers in achieving these criteria. Appendix G provides a more detailed table which outlines how these have been met / considered.

Table 1 Design requirements and considerations

	Criteria Summary	Reference Document
Flooding	Conveyance of up to the 10% AEP event through a primary stormwater system. The location of the primary system should align with the natural flow path as far as possible	Stormwater CoP
	Conveyance of up to the 1% AEP event flow through a secondary stormwater system assuming the primary system is completely blocked	Stormwater CoP, ICMP
	Provide sufficient freeboard to allow future development with habitable floor levels to be constructed at least 500mm above the 1% AEP event flood level (300mm in the Old Wairoa Road NDC)	Unitary Plan, Stormwater CoP
	Minimise infilling of the 1% AEP floodplain	ICMP
	Secondary flow path design for culverts shall assume culvert blockage of 50% for pipes larger than 1500 mm diameter. This criteria assumes that culverts are designed for the 10% AEP with a secondary overland flowpath available. In this case, culverts will be designed for the 1% AEP, and therefore it has been agreed with Auckland Council that lower blockage scenarios can be considered.	Stormwater CoP, Auckland Council
Ecological	Provision for climbing fish passage shall be made at the McLennan wetland, and shall also be provided in any other works within the bed of a watercourse	NDC
	Protection of the stream riparian margin	ICMP
Planning	If practicable, provide centralised community stormwater management devices to avoid ineffective, often expensive, piecemeal stormwater treatment solutions	ICMP
Cultural	Involve local iwi groups in the stormwater management process and incorporate iwi philosophy in the stormwater design where possible	ICMP

Note: refer to Appendix G for a table of how these criteria and considerations have been met

4.2 Hydrological parameters

The following section outlines the hydrological parameters assumed for the catchment.

4.2.1 Prescribed catchment

The proposed catchment area outlines the area that the stormwater conveyance channel can service for the 1% AEP event. This is controlled by the channel depth, capacity and the topography of the catchment.

The area is approximately 155 hectares (ha) and consists of areas 2A (50.3 ha), 'Wallace' (9.1 ha), 2B4 (57.3 ha), 2B (38.0 ha), as shown as a dotted purple line in Figure 1.

A large portion of the Takanini 2A2B catchment does not currently drain naturally to the McLennan wetland but will be picked up by the proposed stormwater conveyance system including:

- The eastern part of 2B and 2B4 currently drains north towards the Papakura Stream (Stream No. 438810).

- The topography of western portion of area 2B currently falls to the north, before being intercepted by a farm drain which discharges to the south-west to the Slippery Creek catchment.
- The Wallace area and the northern portion of 2A currently drain north to Takanini South catchment.

The intention is to drain these areas to the proposed stormwater conveyance system. Accommodating flows from the eastern portion of Area 2B and the Wallace area, that normally drain to adjacent catchments, will reduce downstream capacity and flooding issues in the Takanini South and Slippery Creek catchments.

4.2.2 Design rainfall and climate change

24 hour rainfall

For this project the design rainfall has been derived from Auckland Council's TP108 with a 24-hour storm profile. The 24-hour total rainfall for each of the design storms without climate change allowances are presented in Table 2 below:

Table 2 Design rainfall

Rainfall event	24 hr rainfall
1% AEP	220 mm
2% AEP	200 mm
5% AEP	165 mm
10% AEP	140 mm
20% AEP	110 mm
50% AEP	70 mm

Climate change

The adopted climate change scenario for this project is to year 2090, as per the AC COP. The MfE Guidance for local government recommends a warming value of 2.1°C for the 2090 A1B mid range scenario.

Based upon a 24-hour storm, the effect on rainfall per degree rise is set out in Table 3: (source MfE Preparing for Climate Change – A Guide for Local Government, 2008 Table 7).

Table 3 Adopted climate change scenarios

Rainfall event	Percentage increase in rainfall
1% AEP	8.0 % increase per 1°C rise
2% AEP	8.0 % increase per 1°C rise
5% AEP	7.2 % increase per 1°C rise
10% AEP	6.3 % increase per 1°C rise
20% AEP	5.4 % increase per 1°C rise
50% AEP	4.3 % increase per 1°C rise

Design rainfall values

The adopted 24-hour design rainfall with climate change to 2090 used in the design is as shown in Table 4 below:

Table 4 Adopted design rainfall

Rainfall event	Pre-development rainfall (not including climate change) (mm)	Adopted design rainfall after climate change (mm)
1% AEP	220	256
2% AEP	200	234
5% AEP	165	190
10% AEP	140	158
20% AEP	110	122
50% AEP	70	76

4.2.3 Modelling and hydrological parameters

Impervious areas

The Proposed Auckland Unitary Plan allows for 60% maximum impervious area in catchment 2A and 2B. Area 2B4 is currently zoned rural in the Proposed Auckland Unitary Plan, however it is expected that this land will be rezoned following the construction of the Mill Road Corridor.

The impervious areas noted in the ICMP are generally equal to or greater than the maximum allowable in the Proposed Auckland Unitary Plan zoning. The impervious areas in the ICMP have therefore been used as a base, from which they have been adjusted to account for additional impervious area from the Mill Road Block, as discussed below.

The Mill Road Corridor is proposed to run through areas 2B and 2B4, as shown in Figure 5. The alignment and size of the Mill Road Corridor has not been confirmed; however, for the purpose of this report, a possible route has been assumed which allows for a corridor approximately 1 km long, 20 m wide and 100% impervious. This additional impervious area will slightly increase the maximum impervious area (MPD) scenario as per the values in Figure 5. The three sub-catchments that Mill Road runs through will have impervious areas increased from 60% to 63%.

A sensitivity analysis was carried out on the impervious area assumptions for the catchment. The 1% AEP model was run using a base of 70% impervious area for each sub-catchment, adjusted further as above for the Mill Road Corridor (+3% for the three sub-catchment s that Mill Road runs through). This resulted in an increase in flow of approximately 1 m^3/s for the 1% AEP event (37.9 m^3/s). This is expected to have a negligible effect on the water level in the channel, and therefore the values in Figure 5 are considered reasonable.

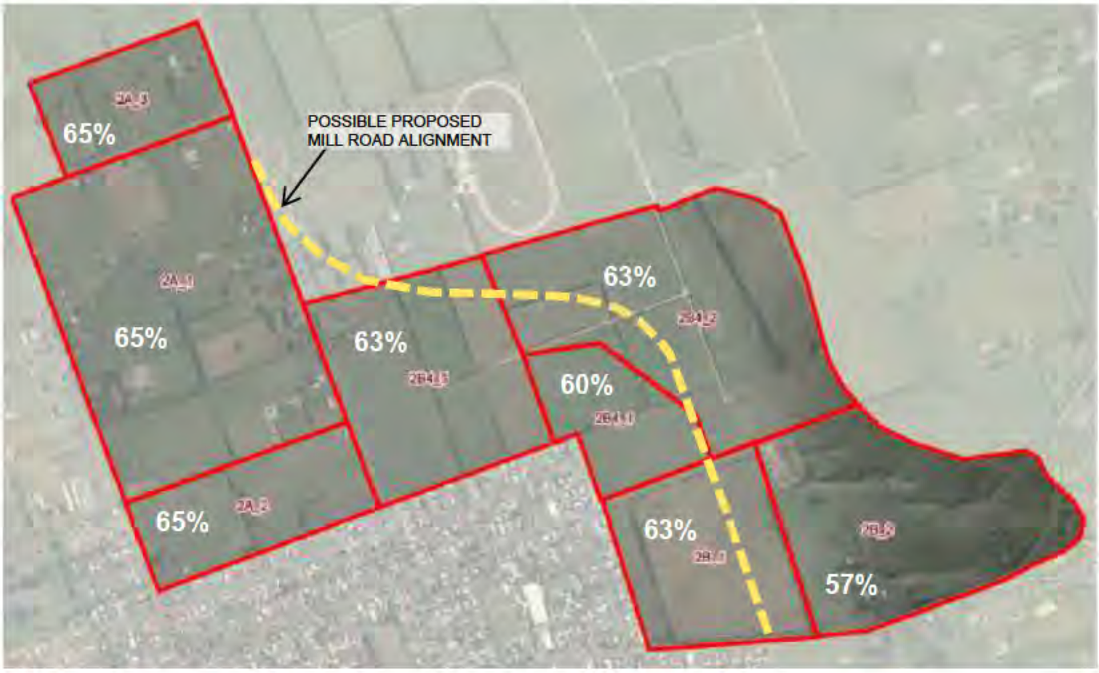

Figure 5 Impervious areas

Design curve numbers

An SCS Curve Number (CN) of 74 has been used for peat soils for the predevelopment scenario as per the Papakura ICMP. The post-developed scenario also uses a CN of 74 for pervious areas based on likely imported fill characteristics or existing peat soils as per above.

This aligns with the curve numbers being used by developers in the catchment.

Geotechnical observations indicate that the top crust of the soil can harden when exposed to oxygen and sheds water. This gives further evidence to using a curve number of 74.

An SCS Curve Number (CN) of 98 has been used for impervious areas as per the Papakura ICMP, this aligns with TP108 and other industry standards.

Channelisation factor

Channelisation factors as per Table 5 below were used.

Table 5 Channelisation factors

Surface	Factor	
Impervious areas	0.8	This is considered appropriate due to the fact that developers are required to implement recharge pits which will increase the time of concentration as water needs to pass through the granular material before discharging through a pipe. In addition, the catchment is very flat and overland flow to the channel for events greater than the 10% AEP event does not follow direct routes to the channel. Overland flow is expected to pass through “green corridors” in some areas.
Pervious areas	1.0	This is considered appropriate as the pervious areas in the catchment are expected to sheet flow onto the impervious areas once saturated with no formalised drainage pathways. In small events, water will likely soak into the ground before reaching the impervious areas. In larger events, the water will be slowed by grass / vegetation before sheet flowing onto the impervious areas.

The channelization factors in Table 5 were used for the 50%, 10% and 1% AEP events. A sensitivity check was carried out by changing the Channelisation factor for impervious areas to 0.6 for the 10% AEP model. This resulted in an increase in flow of less than 1 m^3/s in the 10% AEP (22.1 m^3/s). This is expected to have a negligible effect on the water level in the channel, and therefore using a Channelisation factor of 0.8 for impervious areas for all storm events has been considered reasonable; given the flat catchment, possible use of open stormwater systems for some areas of the catchment and recharge pits / soakage devices.

Time of concentration

The values for flow length and time of peak flow have been derived from calculations based on the TP108 methodology. The slopes and catchment lengths consider the developed slopes of the catchment draining to the proposed channel and therefore in some cases are slightly steeper than the existing gradient. These consider:

- Channel flow in the main channel.
- Pervious and impervious flow over the reduced length.

The effect of recharge pits on time of concentration has generally been ignored as the recharge pits are designed for small rainfall events (15 mm); whereas the smallest event modelled is the 50% AEP event (70 mm).

Catchment roughness

Catchment roughness has been determined based on the type of land use as shown in Table 6.

The Manning's numbers align with the Auckland Council modelling guidelines (Auckland Council, 2011).

Table 6 Manning's numbers for catchment surface

Surface type	Manning's number (n)	Inverse of Manning's number input for model (M)
Pre-development (ED)		
Roads	0.018	55
Buildings	0.200	5
Other	0.040	25
Maximum Probable Development (MPD)		
Developed catchment (all surfaces)	0.050	20

Depression storage

The significant area of flat land within the catchment area currently has the ability to store significant volumes of runoff.

Post development with the Takanini conveyance channel in place, the flow path lengths and depression storage will be significantly reduced due to filling and grading of the land. GHD has used reduced channel lengths to reflect the geometric layout of the proposed conveyance channel layout within the catchment.

For impervious and pervious areas; depression storage of 0 and 5 mm respectively, has been used. These are the recommended values in Auckland Council's TP108.

The development controls have a requirement for storage and soakage to ground for the first 15 mm of rainfall. Although this is acknowledged, we consider that the soakage will have negligible effect on the peak flows from larger events such as the 50%, 10% and 1% AEP events (which have been modelled). Therefore the 15mm soakage criteria has not been explicitly considered in the model, however, some representation is present in the consideration of Channelization factors. The presence of soakage devices has only been considered in the model for selection of Channelisation factors to account for drainage pathways.

Attenuation

Generally there is limited attenuation in the catchment, as the proposed Takanini Stormwater Conveyance Channel will convey post-development flows.

The exception is for the sub-catchment which is currently under development by Cabra Investments Ltd (refer to Figure 6). A permanent stormwater pond has been consented to attenuate flows from the Cabra development up to the 1% AEP event to pre-development levels.

The pond has been flow routed by GHD and incorporated into the model. The peak discharge from the pond in the 1% AEP event has been modelled as 3.6 m^3/s.

Figure 6 Cabra development and attenuation pond

4.3 Design flows

4.3.1 GHD 1D / 2D coupled model

The catchment and scheme design channel have been modelled in a 1D / 2D coupled model to determine peak flow in the catchment and flood levels within the catchment and channel. The channels were modelled using MIKE11 (1D model) and the surface has been modelled in MIKE 21 (2D model).

The sub-catchment runoff was computed by the model; using the parameters outlined in Section 4.2.

The model predicts a peak flow at the downstream end of the conveyance channel of 37.9 m^3/s for the 1% AEP storm event.

Sub-catchment loading

The sub-catchments were loaded into the Takanini Stormwater Conveyance Channel in the GHD model as per Table 7 below (refer to Figure 5 for sub-catchment boundaries).

Table 7 Loading of sub-catchments

Sub - catchment	Loading	Explanation
2B4_1	Distributed load along the channel.	Represents multiple incoming pipes and overland flow paths as per the expected development.
2B4_2	Point load at CH 950.	Represents an incoming pipe or open channel connection. This sub-catchment is large and it is expected that the developer will need to construct an open channel to service their development which will connect into the Takanini Stormwater Conveyance Channel at CH 950.
2B_2	Point load downstream of the Old Wairoa Road Culvert.	Represent the proposed connection location of the Cabra Pond discharge pipe.
2B_1	Point load at top (upstream end) of the main channel.	Assumes the development discharge to the top of the channel via a pipe or overland flowpath.
2A_1	Distributed load along the northern branch channel.	Represents multiple incoming pipes and overland flow paths as per the expected development.
2A_2	Distributed load along the main channel.	Represents multiple incoming pipes and overland flow paths as per the expected development.
2B4_3	Distributed load along the main channel.	Represents multiple incoming pipes and overland flow paths as per the expected development.
2A_3	Point load at top of northern branch channel.	The Wallace Block is expected to discharge to the top of the branch channel via an 1800 mm diameter pipe.

The modelled flow and hydraulic grade line are plotted on the channel longsection and cross sections in the respective drawings *51-3217404-C121-C127* and *51-3217404-C131-170*.

MIKE11 model outputs

Drawing *51-3217404-C002* shows the modelled Takanini Stormwater Conveyance Channel and the chainage along the channel. Refer to Table 8 for MIKE11 model outputs.

Table 8 Scheme design peak flows

	MIKE11 modelled peak flow (m^3/s)		
Chainage (m)	Q2	Q10	Q100
Main Channel			
0	8.7	22.1	37.9
100	8.6	21.9	37.6
150	8.6	21.8	37.4
200	5.3	14.0	24.2
300	5.1	13.7	23.6
400	5.0	13.4	23.2
500	4.9	13.1	22.7
600	4.8	12.9	22.3
700	4.5	12.2	21.0
800	4.3	11.5	19.8
900	4.0	10.7	18.5
950	3.9	10.5	17.9
1000	1.7	5.9	9.6
1100	1.6	5.7	9.2
1200	1.5	5.4	8.7
1300	1.4	5.1	8.2
1400	1.3	5.0	7.9
1500	1.2	2.8	4.7
Northern Branch			
60A	3.5	8.0	13.2
200A	2.9	6.7	11.1
300A	2.2	4.5	10.3
400A	1.4	3.2	5.4
500A	0.6	1.5	2.5
550A	0.6	1.4	2.4

4.3.2 HEC-HMS model

A HEC-HMS model was prepared by GHD to compare and confirm the predicted flows from the MIKE11 modelling. The peak flow predicted by the HEC-HMS model in the Takanini Stormwater Conveyance Channel at Grove Road is 36.9 m^3/s.

The channel was represented in HEC-HMS as a series of reaches linked together with junctions. Lag time for each reach was based on expected flow velocities along the length of each reach. Velocities and corresponding lag times for each reach have been assumed as per Table 9.

Table 9 Lag times and flow velocity

Reach	Velocity (m/s)	Lag time (min)
Main channel		
CH 0 - 160	1.50	1.8
CH 160 - 550	1.00	6.5
CH 550 - 950	1.00	6.7
CH 950 - 1400	0.80	9.4
CH 1400 - 1540	0.50	4.7
Northern branch		
CH 0 - 300	0.75	6.7
CH 300 - 550	0.90	4.6

The catchment was represented by a series of sub-catchments which were split into separate impervious and pervious catchments, with the catchment parameters as per Section 4.2. Each sub-catchment was loaded into the channel at junction points. This is expected to give a good representation of the flow at each junction. However between junctions the flow is unknown.

The Cabra pond has been represented in HEC-HMS by a reservoir linked to an Elevation-Area Function and an Elevation-Discharge Function which was derived from the pond routing carried out by GHD.

The flow predicted by the HEC-HMS model matches the MIKE11 modelling and confirms that the peak flow predictions are valid.

Refer to Appendix B for HEC-HMS model outputs.

4.4 Channel design

4.4.1 Design basis

The design of the Takanini Stormwater Conveyance Channel has been driven by a number of factors. These are recorded below along with a brief commentary of the effects of each on other aspects of the design.

- The design philosophy in having weirs along the channel length is to maintain low flow water as high as is practical in order to limit the groundwater drawdown and provide for the development of aquatic habitats.
- A second parameter is that the weirs should not cause more than a modest rise in the 1% AEP flow profile.
- The design has considered the ability to drain all of the catchment with minimal site filling to maintain minimum freeboard to habitable floor levels.
- The setting of the 1% AEP flood level has been determined at sufficient depth to allow the channel to operate as an open waterway whilst minimising the overall depth.
- During low flow there will be a series of discrete water bodies or wetlands. Each water body will be nominally 100 m long and be separated by a weir structure to maintain a permanent water surface.
- The wetland bench channel is important for flow, ecological, aesthetic and safety reasons. The wetland bench will contain plants, whereas the low flow channel will be deep enough to prevent or limit plant growth.

4.4.2 Channel alignment

The overall floodplain extent is linear. However the low flow channel would generally meander along the length of the channel. An asymmetric alignment along the main 1% AEP channel has been allowed for this. Refer to Drawing *51-3217404-C181* for a typical section of the channel.

The meander is gradual and velocities in the channel are low, therefore the meander is expected to cause minimal scour within the low flow channel.

4.4.3 Channel bed slope

The overall gradient of the main channel from Old Wairoa Road at IL 23.97 m at the top of the channel falls to IL 19.80 m at Grove Road over a distance of approximately 1.55 km. This is an approximate gradient of 0.28%.

The overall gradient of the northern branch channel from 131 Grove Road at IL 21.45 m at the top of the channel falls to IL 20.10 m at the junction with the main branch over a distance of approximately 0.55 km. This is an approximate gradient of 0.24%.

4.4.4 Channel geometry

Defined zones

The channel has been designed to allow for the following zones:

1. **Low flow channel**

   A meandering low flow channel with a permanent water depth of about 0.8 m controlled by the weirs at 100 m centres longitudinally along the base of the channel. The base of the low flow channel is typically 3.6 m wide with slope batters 2H:1V.

2. **Wetland bench**

   A slightly meandering wetland bench above the low flow channel that varies in width as the low flow channel meanders within it. The wetland bench is part of the permanent flow channel and the intention is for this zone to be within the permanent water level provided for by the weirs. The wetland bench will be planted with wetland species, is nominally flat and has a permanent water depth of 0.2 m.

3. **10% AEP water level**

   The channel bank is battered at 4H: 1V or flatter to a height between 0.70 m and 1.5 m to allow for conveyance of the 10% AEP. The batters will incorporate riparian planting, as per the planting plan in the Urban and Landscape Design Analysis Report (GHD, 2014). Generally, native grass species that would lay flat during large flow events have been proposed. Tree species will have most of their mass above the 1% AEP event and therefore would not have a significant impact on the channel roughness. These include cabbage tree and kahikatea.

4. **1% AEP water level**

   The channel above the 10% AEP water level continues at a gradient of 33H:1V to allow for conveyance of the 1% AEP. This portion of the channel will be grassed with amenity and has provision for footpaths and cycleways.

Side slopes / channel batters

Generally, slope batters have been designed at 4H:1V or flatter, as per the recommendations from the Geotechnical Investigations Report (Technical Report C). Steeper batters (2H:1V) in the low flow channel have been considered suitable as these will be fully submerged, and are a maximum of 0.6 m high. The channel sections have been modelled in the Geotechnical Investigations Report (Technical Report C).

Overall depth and width

The main channel ranges in depth from between 1.9 m to 4.0 m bgl to the base of the channel. The overall total width of the main channel at the 1% AEP water level ranges from 13 m to 39 m.

The northern branch channel ranges in depth between 2.4 m to 3.8 m bgl to the base of the channel. The total overall width of the northern branch channel at the 1% AEP level ranges from 12 m to 27 m.

Rock weirs

In order to maintain a permanent waterbody within the wetland channel, a series of rock weirs at notional 100 m centres will be used to maintain this body of water. The depth of water behind each weir is 800 mm with a depth of 200 mm along the wetland bench. As well as providing for aquatic habitat, the permanent water level will assist in reducing groundwater drawdown and related potential settlement.

The top surface of the weir is 14 m across at the largest section. The width of the low flow channel is approximately 6 m wide at the largest section.

The step between each weir varies from 0.18 m to 0.45 m to give an overall average gradient along the full channel length. At high flows these weirs will be totally drowned. The depth of the 1% AEP event flow above the top of the weir level has been calculated at about 1 m deep.

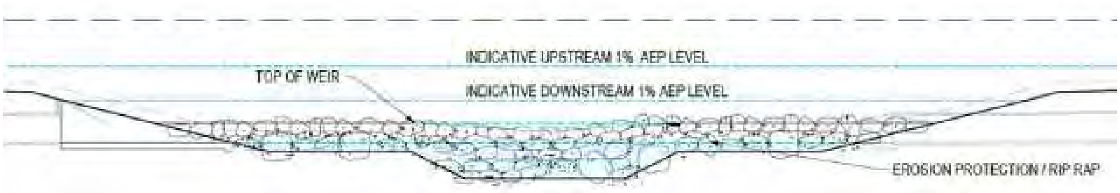

Figure 7 Rock weir cross section detail

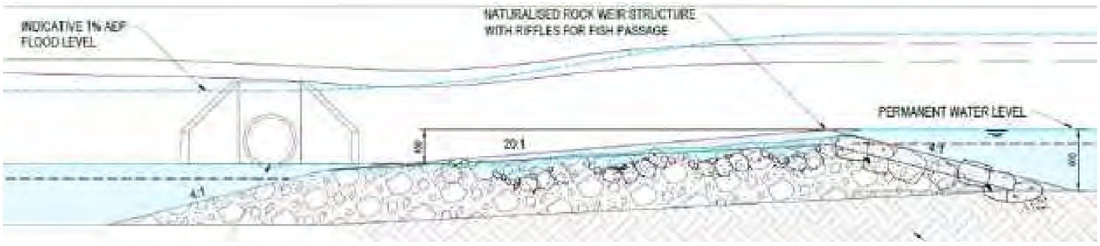

Figure 8 Rock weir longsection detail

As the flow increases (during a flood event) the flow over the weir increases and the flow in the channel downstream of the weir raises at a faster rate until the weir is almost drowned. Prior to the weir being drowned the flow becomes critical over the weir and the velocities will increase. The extent of increase will depend on the difference in water level above and below the weir. The design of the weirs will be further refined in detailed design to include energy dissipation to reduce the velocities back to subcritical flow downstream of the weir.

Operational water levels

The permanent water level in the channel is consistent throughout its length with a depth of 800 mm. The operational water levels for the 10% AEP and 1% AEP flows vary along the channel but typically are in the order of those shown in Table 10.

Table 10 Operational water levels

Channel zone	Typical water level above channel invert (m)
Low flow	0.80
10% AEP	1.40
1% AEP	1.70

Low flow channel

The low flow channel depth has been selected based on a combination of water quality, flow characteristics, safety and industry guidelines.

The low flow channel depth of 0.8 m helps to achieve:

- Sufficient flow capacity contributing to conveyance of large events
- Low velocities during low flow to minimise erosion
- A suitable volume of water to control temperature fluctuations
- Safe water depth and velocity in case of person entry

No design recommendations for low flow channel depths or widths have been found in any Auckland Council or New Zealand design standards for similar channel designs. The Queensland Urban Drainage Manual (Department of Energy and Water Supply, 2013) recommends a depth of 0.45 m for a low flow channel with a base width of 2.0 m.

The base width of the proposed Takanini Stormwater Conveyance Channel for the majority of its length is 3.6 m; a depth of 0.8 m for this width achieves a similar width/depth ratio as per the Queensland Channel Design Guideline. The width of the channel is based on allowing shading of the low flow channel, low velocities and reduced scour, and sufficient conveyance capacity for the 10% AEP event.

It is expected that the wetland grasses in the wetland bench adjacent to the low flow channel, and some of the larger plant and tree species in the riparian margin (cabbage tree, kahikatea) will provide shading to the stream. This will also help control temperature and provide additional ecological benefit. As discussed in Section 4.4.4, the tree species have been selected to have most of their mass above the 1% AEP event, and the larger plant species have been selected to lay flat during large storm events.

4.4.5 Channel hydraulics

Manning's numbers

The adopted Manning's numbers for the Takanini Stormwater Conveyance Channel align with the recommended values in *Christchurch City Council's Waterways, Wetlands and Drainage Guide* (Christchurch City Council, 2003). The above publication was used as it contains Manning's numbers for stream surfaces that are similar to the proposed vegetation and channel profiles of the proposed Takanini Stormwater Conveyance Channel. No local (Auckland) publications were found with Manning's numbers for similar surface types.

No channel example case studies with assessment Manning's numbers were found in local (Auckland or New Zealand) publications, however, example case studies are given in the *Natural Channel Design Guidelines (Brisbane City Council, 2003)*. Figure 9 outlines a channel with similar features to the proposed stormwater channel.

Figure 9 Similar channel with an average bankfull n = 0.035

The example channel is described as having mown grass banks, unmaintained wetland plants on bed, regular cross section, and a very slight meander. This example has no riparian margin.

The wetland plants in the Takanini Stormwater Conveyance Channel would ideally be maintained and would have a lower roughness coefficient than the example above. The Takanini Stormwater Conveyance Channel has riparian planting as per Section 4.4.4 which transitions into a mown grassed floodplain.

Overall the proposed conveyance channel is expected to have a similar or slightly higher average roughness coefficient as the example channel.

Adopted Manning's n numbers

The following Manning's numbers have been used for the hydraulic analysis. These have been selected assuming:

1. The low flow channel is maintained to keep clear obstructions and prevent excessive weed growth. n = 0.030
2. The wetland plants are lay flat species and will flatten during flood events. n = 0.045
3. The flax and native grasses on the channel bank are maintained to keep clear of excessive weeds. The plant species are assumed as a mixture of those that can flatten during flood events with some heavier shrubs less than 1 m tall. n = 0.060
4. The grass is maintained at a short length and specimen trees are scattered throughout the floodplain. n = 0.045

Table 11 Manning's numbers for conveyance channel design

Section	Surface Cover	Manning's number (n)
Low flow channel	Naturalised channel with pools and slight channel meander	0.030
Wetland bench	Wetland grasses	0.045
Channel bank	Flax and native grasses (<1 m tall)	0.060
Floodplain	Mowed grass with footpath and specimen trees	0.045

4.4.6 Grove Road Culvert Inlet

The Grove Road Box Culvert and the inlet structure are being designed by Jacobs, who have provided an invert level of the culvert of 17.5 m. The culvert entry has a tapered mouth to provide more efficient inlet conditions. The mouth has an invert level of 17.6 m. The mouth transitions into an apron which slopes up to RL19.6 m.

The downstream weir of the Takanini Stormwater Conveyance Channel has an RL of 20.6 m. Therefore a 1 m vertical transition is required between the inlet structure/apron and the last weir of the Takanini Stormwater Conveyance Channel. This section outlines the concept design of this transition. Drawing 51-3217404-C192 outlines the concept.

Design principle

The key considerations for the design of the transition between the Takanini Stormwater Conveyance Channel and the Grove Road Box Culvert inlet structure include:

- Low velocities to control erosion / scour
- Flood level to achieve suitable freeboard for Grove Road
- Fish passage
- Controlling groundwater drawdown

The key design features include a series of three concrete pools with small low flow weirs/riffles which spill/cascade into one another. The average longitudinal slope between the pools is approximately 12H:1V. The concrete pools will have rocks within them to provide ecological benefits and energy dissipation. Rocks will also be incorporated around the pools to control erosion and scour as flows approach the pools. The average cross sectional slope heading towards the low flow pools and riffles is approximately 5H:1V. Planting will be incorporated along the slopes and around the rock pools to provide shading and aesthetics.

The last weir of the Takanini Stormwater Conveyance Channel is located at the top of the slope and is approximately 35 m long with an RL of 20.6 m. This level sets the permanent water level in the channel, which has been maintained to control the groundwater level. A groundwater cut-off barrier is proposed underneath this weir to minimise any groundwater drawdown caused by the cut below this level to create the transition to the Grove Road Culvert Inlet.

Velocities

High flow events such as the 1% AEP event are not expected to produce the highest velocities, as the flow will be drowned out at the culvert entry; rather, the smaller events will produce the critical velocities for erosion and scour. Velocities are expected to reach up to 3-4 m/s for the critical storm events. These velocities are expected to be acceptable for planting and will be dissipated using rip rap / rocks and the concrete pools. Some sacrificial planting near the pools may be lost, which is acceptable.

Groundwater drawdown

The weir at the top of the slope will maintain the permanent water level in the channel. Downstream of this weir, the proposed ground level will drop into the Grove Road Culvert Inlet. To prevent groundwater drawdown due to the deeper cut; a physical groundwater cut-off barrier is proposed at RL 20.6 m and will surround the entire inlet structure, as per Drawing 51-3217404-C192. The barrier will be designed during detailed design, however it is expected to be up to 7 m deep below the existing ground surface.

A similar barrier has been modelled upstream near Cosgrave Road to mitigate groundwater drawdown due to the deep cut of the channel. This modelling will be updated during detailed design to confirm the required depth and properties of the cut-off wall for the Grove Road Box Culvert inlet.

4.4.7 Crossings

Watercare Waikato No.1 Watermain crossing

Description

The Waikato No.1 Watermain conveys potable water from the Waikato Water Treatment Plant to the Redoubt Road Reservoir and runs along Cosgrave Road.

The as-built drawings (dated 2006) show this section of pipe is a 1200 mm CLS (concrete lined steel) pipe with 9.5 mm thick steel and 16 mm concrete lining. Depth to invert is approximately 2.5 m. The pipe was laid on granular backfill and although not specified on the as-built drawings, Watercare have indicated that this is likely to be 19 mm aggregate.

There is an existing fibre optic cable which run on top of the Watercare pipeline. This link provides control of the Waikato and Ardmore Water Treatment Plants as well as the pipeline from the Watercare main control room.

Through consultation with Watercare, they have advised that they require a minimum separation between the base of their 1200 mm pipe and any new structure of 500 mm.

Proposed Cosgrave Road Culvert

The proposed Cosgrave Road Culvert has been designed for:

- Free water surface at low flow.
- The design 1% AEP event of 22.7 m^3/s flow with minimal head loss.

These criteria can be met with twin 3 m wide by 2 m deep culverts. The design involves head walls upstream and downstream to support the Cosgrave Road carriageway. The culvert invert will be approximately 1 m below the adjacent channel bed level, creating a drowned culvert. Refer to drawing *51-3217404-C192* for the preliminary design of the Cosgrave Road Culvert.

Culvert blockage

Two high level blockage scenarios for the Cosgrave Road Culvert have been considered to determine the effect of blockage on the inlet capacity of the culvert and the performance of the conveyance channel. The scenarios considered include:

- 10% blockage
- 20% blockage

The culvert is outlet controlled and therefore 10% blockage and 20% blockage have a negligible effect on the performance of the Cosgrave Road box culvert and the Takanini Stormwater Conveyance Channel. Refer to Appendix E for the blockage assessment.

Using twin culverts provides protection against significant blockage. Each culvert has an inlet area of 6 m^2, giving a total inlet area of 12 m^2. Significant blockage of such an area is unlikely, as most objects will be passed through the culvert.

Old Wairoa Road crossing

The proposed Takanini Stormwater Channel crosses Old Wairoa Road at the boundary of 999 Papakura-Clevedon Road. The upstream catchment drained by the proposed culvert is approximately 15 hectares and is being developed by Cappella Papakura Developments Ltd. The upstream catchment is expected to generate a peak flow of 4.3 m^3/s during the 1% AEP event.

Twin 1500 mm diameter culverts are proposed to drain the Cappella development with a 1200 mm diameter pipe draining the 11.1 ha Cabra development further upstream. The proposed 1200 mm diameter pipe will connect into the downstream headwall of the Old Wairoa Road Culvert.

This sizing and headwall design provides an acceptable freeboard during the 1% AEP event for Old Wairoa Road.

Detailed design for the Old Wairoa Road Culvert has been undertaken by MSC Consulting Group Ltd. on behalf of Cappella Papakura Developments Ltd. The detailed design is based on the levels from the GHD scheme design. The culvert has been consented and constructed by the developer.

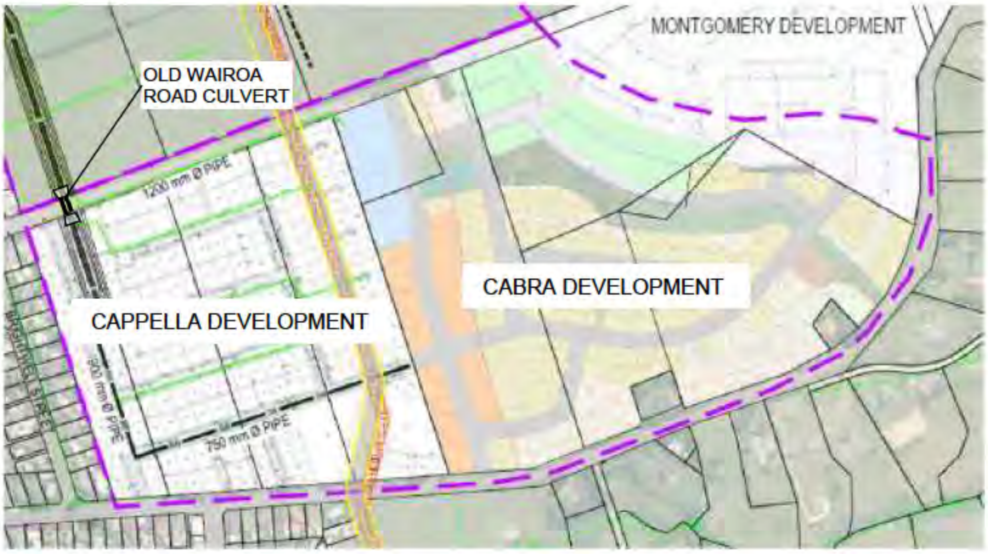

Figure 10 Old Wairoa Road Culvert location plan (Drawing 51-3217404-C310)

The Old Wairoa Culvert will be partially submerged with a permanent water level approximately 600 mm to 800 m deep.

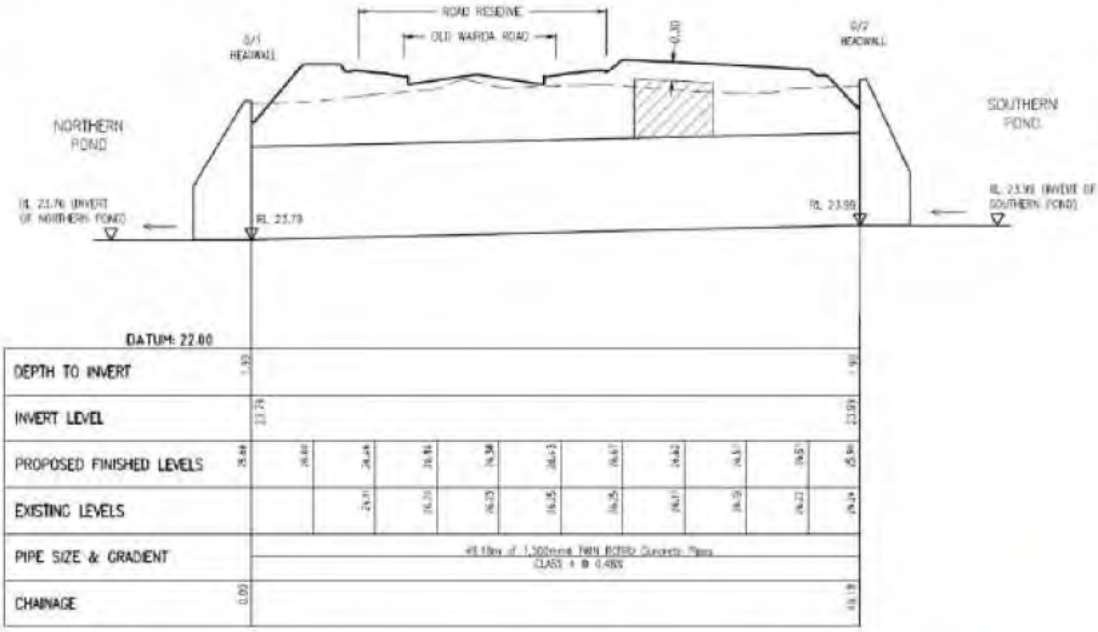

Figure 11 Old Wairoa Road Culvert longsection (MSC, October 2015)

4.5 Hydraulics and flooding

The Takanini Stormwater Conveyance Channel Scheme design was modelled in MIKE11 to determine the hydraulic grade line in the channel for the 50%, 10% and 1% AEP events. The model was checked using spreadsheet calculations based on Bernoulli's energy principle and Manning's flow equation (using Flowmaster).

4.5.1 1D/2D coupled flood model

To calculate the hydraulic grade line for the channel; the catchment and channel were modelled using MIKE11 and MIKE21. Channel cross sections were input into the model at 20 m spacing. Channel cross sections, roughness, culverts and catchment parameters were used to match the values described in Section 4.2 and 4.4 of this report.

The model confirms that the channel design is adequate for conveying the 1% AEP event with adequate freeboard. In addition, the hydraulic grade line is maintained at a low enough level to provide drainage of the surrounding land developments; this is further discussed in section 5.3.1. Refer to Drawing *51-3217404-C121-C127.*

Refer to Appendix A for the MIKE11 model outputs.

4.6 Safety in design

Safety has been considered throughout the design process. Each component of the Takanini Stormwater Conveyance Channel has been designed with safety as a key consideration.

The following section provides a summary of the safety considerations for the channel design.

4.6.1 Low flow channel

The low flow channel has been designed with a maximum permanent water level 0.8 m deep. Channel banks that are permanently underwater will have side slopes of 2:1.

The low flow has been designed to discourage entry by the public. If someone were to enter the low flow channel, the key features discussed below would mitigate the safety risk:

- Low velocity
- Shallow depth maintained by weirs (0.8 m)
- 2:1 side slopes constructed from granular material. As such, the ability for someone to walk up this drowned slope without slipping is enhanced
- Wetland bench provides warning of imposing deep water. The wetland bench also acts as a safety bench to assist anyone climbing out of the channel and reduces the chance of people falling into the deeper section.
- Riparian margin creates barrier to entry

4.6.2 Cosgrave Road box culvert

The proposed Cosgrave Road box culvert will be permanently drowned with a permanent water depth of approximately 1.7 m. At the upstream end, there is approximately 0.3 m between the roof of the box culvert and the permanent water level. At the downstream end there is a 0.25 m air pocket between the roof of the culvert and the permanent water level.

The velocity and turbulence in the culvert during low flow conditions will be low and would allow a person to swim through. The person will be able to escape the culvert at each end where the channel bed grades up to a shallower depth.

Key features include:

- Low velocity and turbulence during low flow conditions.
- Channel bed sloped at each end to provide a ramp up to shallower water.
- Entry into the culvert is discouraged by planting in the channel at each end and a permanent water level that is continuous between the channel and the culvert.

4.6.3 Old Wairoa Road box culvert

The Old Wairoa Road box culvert has been designed by Cappella's development engineers. Auckland Council Stormwater Operations have reviewed the design and have approved the twin 1.5 m diameter culvert size.

GHD have peer reviewed the structure. A brief assessment of safety is outlined below.

The proposed Old Wairoa Road Culvert is a twin 1.5 m diameter culvert and will have a permanent water level of 0.8 m at the downstream end and 0.54 m at the upstream end. At low flow, while discouraged, an adult would be able to safely walk through the culvert. During high flows, the culvert will be fully drowned, and entry into the culvert at this time is not expected. Key features include:

- Low velocity during low flow conditions.
- Shallow depth during low flow.
- Entry into the culvert is discouraged by planting in the channel at each end and a permanent water level that is continuous between the channel and the culvert.

5. Effects Assessment

5.1 Effects overview

The channel will have an overall positive effect on the community and environment. There is no existing drainage infrastructure for the catchment area, and therefore the land cannot be comprehensively developed. The construction of the Takanini Stormwater Conveyance Channel will provide a drainage pathway, which reduces the extent of the existing floodplain and thus allow development of the adjacent land.

Without the channel, there is no stormwater infrastructure for developers to connect into. To develop the land without the channel, houses would need to be raised above the existing floodplain and developers would need to attenuate flows to predevelopment levels (subject to approval from Auckland Council). The area of land required to attenuate flows in stormwater ponds would significantly reduce the area of developable land in the catchment and would be expensive. The implementation of the Takanini Stormwater Conveyance Channel provides a significant benefit for the landowners in the catchment.

The Takanini Conveyance Stormwater Conveyance channel will provide an ecological link through the existing area and future development area. The current environment has little ecological value, as discussed in Ecological Report (Technical Report J). The Takanini Stormwater Conveyance Channel will provide an opportunity to increase wildlife in the area by providing a potential habitat for aquatic life, birds, lizards and other wildlife. Native plant species can be incorporated into the riparian margins, wetland bench and floodplain areas of the channel.

The channel and designation area will also provide public space to provide amenity to the future communities in the area. The floodplain area can incorporate a footpath, cycleway and public recreational space.

5.2 Reduced flooding

The construction of the Takanini Stormwater Conveyance Channel will provide a drainage pathway. This allows for development of the site by reducing the floodplain to allow development of their land.

Overland flow from the adjacent developments is expected to be conveyed along roads and drainage corridors within the development to the Takanini Stormwater Conveyance Channel where flow will be contained within the designation area.

The capacity of the channel is adequate to convey the 1% AEP flow at a level that is reasonable for adjacent land developers to grade their overland flow paths towards. This is further discussed in Section 5.3.

5.3 Servicing development

5.3.1 Development connections to channel

The channel has been designed with a shallow depth to reduce potential for groundwater drawdown and ground settlement. The channel therefore requires a wide, shallow flow depth to allow connections for servicing the 10% AEP. Swales or multiple small diameter shallow pipes would be favourable for draining the catchment once developed due to the shallow channel.

Lateral connections to allow properties to drain have been assumed as piped flow, where practical, for events up to the 10% AEP. Overland flow paths will be required to convey flows up to the 1% AEP event (refer to Section 5.3.2).

Drawing *51-32174-C310* shows an indicative drainage configuration with pipe sizing (refer to Appendix F for pipe sizing calculations).

Piped connections to the channel will typically enter at the permanent water level. Piped connections are expected to discharge at the base of the 4H:1V channel banks downstream of the proposed weirs. Figure 12 and Figure 13 show a typical detail for connections.

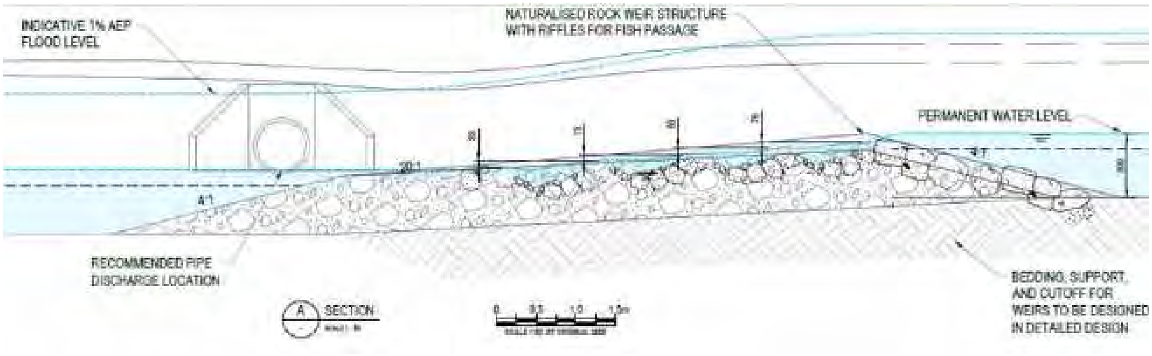

Figure 12 Typical connection longsection

Figure 13 Typical connection cross section

Key benefits of discharging downstream of the weir locations are:

- Limit outlet structures and associated energy dissipation to areas where energy dissipation is already required to control flow from the weirs.
- Allows maximum steepness of the hydraulic gradient of the piped flow and as such limiting pipe sizes to their respective minimum size.
- Increased cover over the discharging pipe.
- Visually less prominent within the riparian and wetland planting.

Each connection will be designed and constructed by the developer.

5.3.2 Overland flow

Overland flow will need to be conveyed to the channel via secondary overland flow paths from development within the adjacent land. The design of these flow paths will be undertaken by the developers of the land. Overland flow paths for developments are usually designed along walkways or roads. This will be done by individual developers as and when infrastructure for particular development is implemented.

The channel has been designed with a depth to allow sufficient hydraulic grade from the furthermost extent of the catchment to the channel. Some areas will require fill by the developer due to the existing topography sloping away from the catchment. Refer to drawing *51-3217404-C311-C312* for long sections showing a possible drainage solution for the catchment. The possible drainage solution considered uses pipes to convey the primary flow (10% AEP) and is not the optimal solution, ideally, developers would use swales and low impact design rather than piped networks.

5.4 Downstream effects

Downstream of the Takanini Stormwater Conveyance Channel is the Grove Road Box Culvert which discharges to the McLennan wetland. The McLennan wetland is to be drained by the proposed Artillery Drive Tunnel, which has been designed to convey the attenuated flows from the wetland. The overall drainage scheme which includes this infrastructure is discussed in Section 2.3.

Grove Road Box Culvert

The Grove Road Box Culvert is hydraulically steep and is being designed to convey the 1% AEP event without tail water effects on the conveyance channel. The culvert is currently being designed by Jacobs and construction is anticipated in 2016/2017. This will provide infrastructure for the Takanini Stormwater Conveyance Channel to discharge into.

McLennan wetland

The McLennan wetland was included in a previous model held by Auckland Council. This model includes the proposed Takanini Stormwater Conveyance Channel scheme design, the Grove Road Box Culvert and the proposed Artillery Drive Tunnel and is therefore considered a good representation of the downstream conditions.

The McLennan wetland was modelled with:

- Top of bund RL 16.40 m
- Emergency spillway RL 15.40 m
- Artillery Drive Tunnel outlet at RL 11.50 m
- Low flow outlet pipe IL 10.04 m

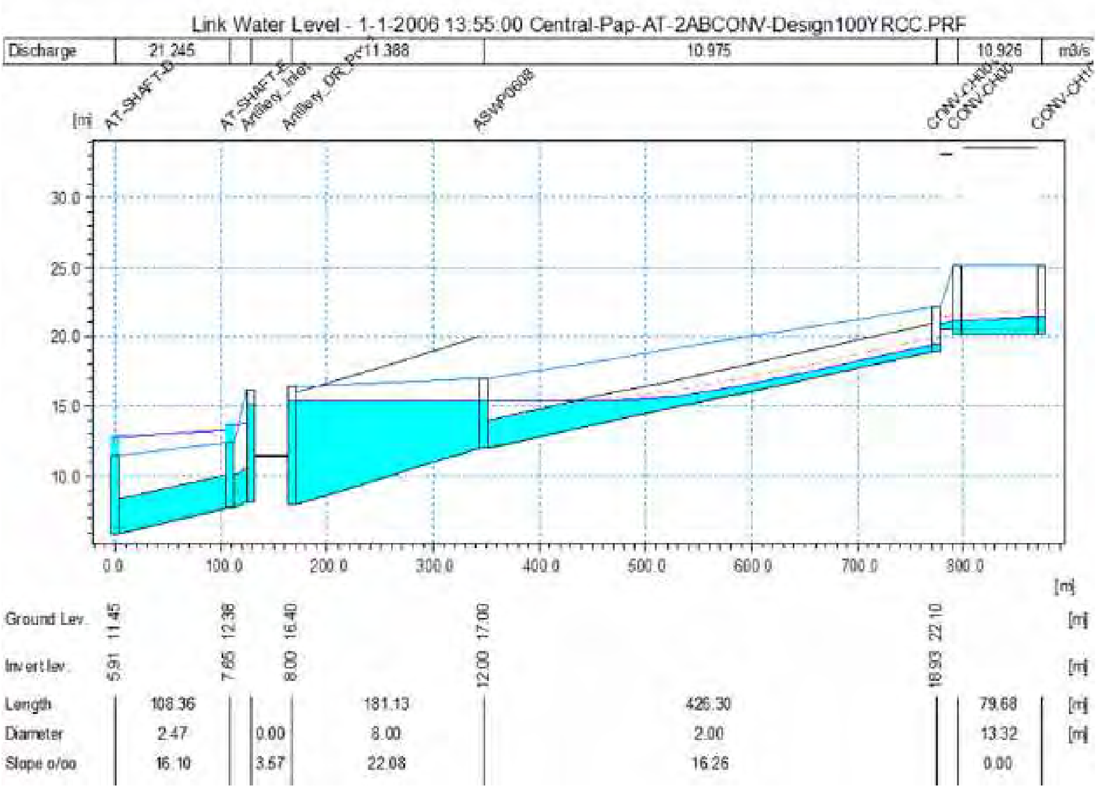

Figure 14 McLennan wetland model

As discussed in Section 3.2 the model indicates that following modification of the embankment, overflow levels and construction of the Artillery Drive Tunnel, there is sufficient storage in the wetland to accommodate the expected flow from the Old Wairoa Road catchment, as per the Draft Papakura Central ICMP.

The maximum flood level in the McLennan wetland during the 1% AEP event is RL 15.40 m.

5.5 Sediment deposition

5.5.1 Typical Auckland catchment

The typical runoff from a developed Auckland catchment will be in the order of 0.5 t/ha/annum. This is based on soil types generally consisting of Waitemata clays and would occur when all bulk earthwork development has been completed and individual housing sites are developed. In the case of this development there is expected to be areas of recent peat alluvium as per the existing soils, in addition, there is expected to be imported fill from developers. Slopes in this catchment are very flat and therefore it is expected that the runoff will be towards the lower range of any variance around 0.5 t/ha/annum. The steep portion of the 2B catchment will drain to a stormwater pond at the Cabra Development site, and therefore sediment removal is expected for this area.

We can also expect that a portion of sediment will be entrained and passed through the system down to the McLennan wetland and Pahurehure Inlet during high flow events. We therefore expect the residual sediment deposition in the channel to be in the order of 0.25 t/ha/annum. If this deposition is evenly distributed along the channel, then the catchment area/channel length (155 ha / 2100 m = 0.74 ha / lineal meter) relates to an annual deposition of 18 kg per lineal meter of channel per annum. We would expect some of this to be deposited below the permanent water level.

The annual estimated deposition rate is between 1.0 - 1.5 mm/annum. At this rate, it would take between 60-100 years for 100 mm of sediment to build up along the channel. This may not be distributed evenly, and would likely be distributed along the wetland planting area, the main low flow channel and behind the weirs. It is expected that maintenance to remove sediment would be required approximately every 20-50 years.

5.6 Scour and erosion potential

Scour and erosion potential is an important consideration for the design of the Takanini Stormwater Conveyance Channel. Scour and erosion of the channel could potentially result in poor amenity, discharge of sediment into the downstream receiving environment and bank stability issues for adjacent structures.

5.6.1 Channel velocities

Potentially high velocities in the channel pose the biggest risk of scour and erosion to the channel banks. Velocities are expected to be low during small rainfall events and scour and erosion is not considered to be an issue. In larger events, such as the 1% and 10% AEP, velocities are higher and scour and erosion protection has been incorporated in the design to address this.

The peak 1% AEP flow velocity is approximately 1.3 m/s just upstream of Grove Road (Refer to Table 12. This reduces to approximately 1.0 m/s above Cosgrave Road. This excludes water flowing over the weir sections, where there is an expected increase in velocity.

Average velocities have been calculated along the channel and are noted in Table 12.

Table 12 Average channel velocities

	10% AEP		1% AEP	
Chainage (m)	Q (m^3/s)	V (m/s)	Q (m^3/s)	V (m/s)
Main Channel				
100	21.9	1.06	37.6	1.31
150	21.8	0.96	37.4	1.25
200	14	0.63	24.2	0.81
300	13.7	0.74	23.6	0.93
400	13.4	0.77	23.2	0.96
500	13.1	0.72	22.7	0.94
600	12.9	0.82	22.3	0.92
700	12.2	0.66	21	0.79
800	11.5	0.62	19.8	0.79
900	10.7	0.59	18.5	0.76
1000	5.9	0.55	9.6	0.64
1100	5.7	0.54	9.2	0.66
1200	5.4	0.50	8.7	0.63
1300	5.1	0.42	8.2	0.52
1500	2.8	0.23	4.7	0.25
Northern Branch				
60A	8	0.87	13.2	0.90
200A	6.7	0.57	11.1	0.63
300A	4.5	0.45	10.3	0.68
400A	3.2	0.40	5.4	0.48
500A	1.5	0.24	2.5	0.32
550A	1.4	0.26	2.4	0.37

The velocities in Table 12 represent the average velocities over the full cross sectional flow area. These velocities are low and are generally less than 1 m/s. In storm events smaller than the 1% and 10% AEP, velocities are expected to be lower.

It is estimated that the velocity at the downstream end of the main channel is approximately 0.6 m/s in the 50% AEP and 0.3 m/s in the 100% AEP. These velocities are low and not expected to cause significant scour or erosion in the channel. A more detailed assessment of the velocity profile will be undertaken in detailed design to account for the variation in velocity across the channel section.

In reality, the velocity across each channel section is expected to vary vertically depending on surface cover and depth. A typical velocity profile is shown in Figure 15.

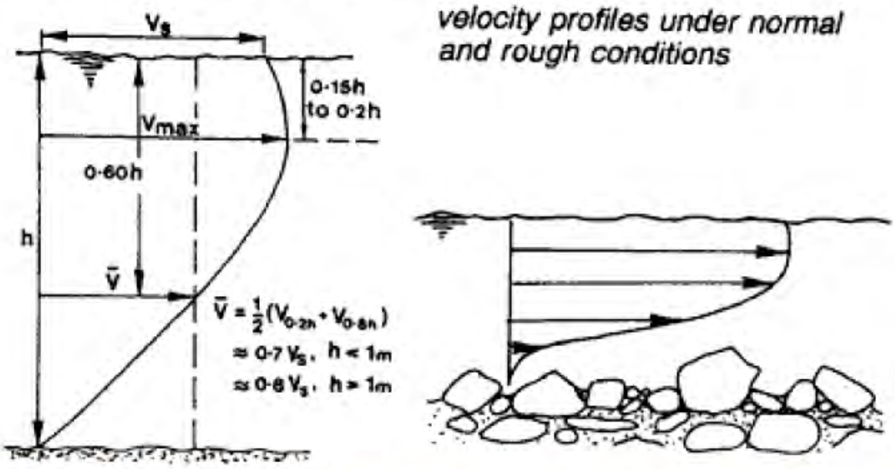

Figure 15 Typical velocity vertical profile (Australian Groundwater Research, 2013)

The velocity profile illustrates that velocities are expected to be moderately lower at the base of the channel.

5.6.2 Scour and erosion

The surface cover of different zones within the channel provides varying levels of resistance against scour and erosion. Table 13 outlines the surface cover types and the expected performance in regards to scour and erosion due to flow in the channel.

Table 13 Scour and erosion risk for channel zones

Zone	Surface Cover	Risk of scour / erosion	Possible protection measures
Low Flow Channel	Naturalised channel with pools and slight channel meander	High susceptibility to scour and erosion. However velocities are expected to be lower at the base of the channel.	To be further assessed in detailed design. Possible options include: • Rip rap. • Coir matting.
Wetland Bench	Wetland grasses	Low risk. Wetland grasses will slow velocities and roots will strengthen soils.	No additional protection required.

Channel bank	Flax and native grasses. Small unrestrictive trees with mass of branches above 1% AEP.	Low risk. Roots of grasses and trees will strengthen channel banks.	No additional protection required.
Floodplain	Mowed grass with footpath and specimen trees	Low risk. Grass will naturally protect from scour and erosion.	No additional protection required.

Table 13 identifies the low flow channel as the key area susceptible to scour and erosion. This is because there will likely be soils directly exposed to channel flow. The risk is reduced by having a large cross sectional area of permanent water, which will reduce velocities in the low flow channel. In addition, the expected velocity profile is expected to produce lower velocities at the base and slopes of the low flow channel.

The base of the low flow channel will not be lined to allow naturalisation of the channel over time. Subject to further assessment during detailed design, rip-rap may be required along the low flow channel to provide additional resting places for fish and reduced erosion and scour of the low flow channel.

Further assessment during detailed design will refine the velocities that the low flow channel will be subject to. This will determine whether rip rap at the base of the channel is suitable and the required size of rip rap or whether additional protection is required.

Edge protection at the point of potential wave action

Along the low flow portion of the channel, there is a need to prevent the peats from day to day erosion at the point of wave action as can be observed in the Bruce Pulman Park ponds. The channel is planted with wetland planting at this location, which will provide erosion mitigation.

Subject to further assessment during detailed design, additional mitigation may be required along the batter of the wetland bench. This requirement and the type of scour protection will be determined at detailed design. Figure 16 outlines the possible location of additional scour protection if required.

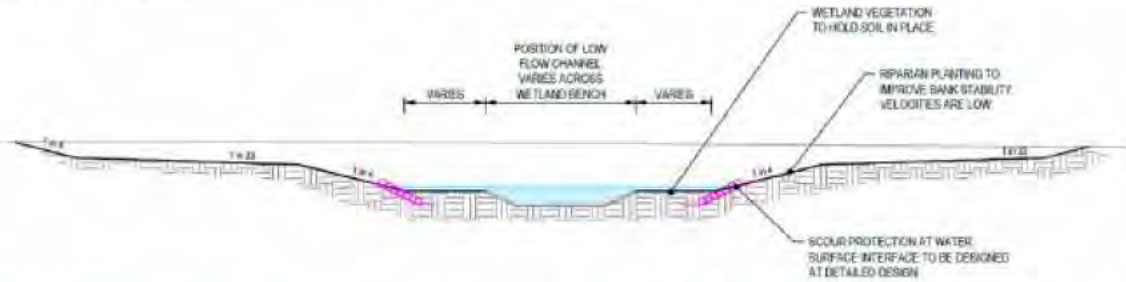

Figure 16 Possible channel erosion protection to be implemented if required

Planting

Wetland plants, flax, native grasses and small trees have an ability to withstand the expected velocities (<1.4 m/s) without adverse effect. The planting of the channel will provide stability to the soils to resist against scour and erosion. Treatment of the soil may be required to aid the growth of plants if the acidity of the soils increases significantly after construction of the channel.

Full development of the catchment is not expected to be completed for some years after the construction of the channel. As such peak flow rates will be less than the MPD scenario. This will allow time for the wetland plants to become established and grow.

Channel bend (Ch 1000)

In terms of the main alignment around chainage 1000, there is a gradual 90 degree bend. The channel bend is of such a large radius, that scour on the outside of the bend is anticipated to be negligible. The flow is less than 0.7 m/s in the 1% AEP event and less than 0.6 m/s in the 10% AEP event, therefore there is no need for additional protection on the outside of the bend.

Confluence main channel and northern branch (Ch 200)

The main channel at the confluence has a peak flow of 24.2 m^3/s in the 1% AEP event. The northern branch has a peak flow of 13.2 m^3/s in the 1% AEP event. Specific design measures will be undertaken for the confluence to control flow at the bend by strategic use of blown soil bags. This will be designed at the detailed design stage.

6. Conclusion

The proposed Takanini Stormwater Conveyance Channel will extend from 989-999 Papakura-Clevedon Road in the south-east to Grove Road in the west. A northern branch will extend northwards towards Walters Road.

In general the conveyance channel will provide stormwater servicing for future development of Areas 2A, 2B and part of Area 4 (2B4) of the Takanini Structure Plan and the Wallace area. At present the area is significantly impacted by the 1% AEP (Annual Exceedance Probability) floodplain, restricting development of the area. The Takanini Stormwater Conveyance Channel will reduce the extent of the floodplain within the Takanini 2A2B catchment to facilitate development of the land.

Development of the Takanini 2A2B area will increase peak flows from the catchment. The proposed Takanini Stormwater Conveyance Channel will direct the increased flows up to the 1% AEP event to the discharge location at the proposed Grove Road Box Culvert.

The main conveyance channel will consist of:

- 1.55 km of open waterway.
- Depth of 1.9 m to 4.0 m below ground level.
- Notional overall gradient of the channel invert 0.28%.
- Overall total width (of the 1% AEP level) ranging from 13 m to 39 m.

The northern branch channel will consist of:

- 0.55 km of open waterway.
- Depth of 2.4 m to 3.8 m below ground level.
- Notional overall gradient of the channel invert 0.24%.
- Overall total width (of the 1% AEP level) ranging from 12 m to 27 m.

The channel is designed with a meandering low flow series of discrete water bodies or wetlands with a permanent water depth of about 0.8 m controlled by rock weirs at 100 m centres longitudinally along the base of the channel. These provide an ecological benefit and limit the ground water drawdown. Generally the low flow channel will have a 3.6 m wide base with slope batters 2H:1V, with an intermediate wetland bench and upper 4H:1V riparian planted slopes.

There are two existing road crossings included:

- Twin 3 m x 2 m box culverts at Cosgrave Road.
- Twin 1.5 m diameter culverts at Old Wairoa Road.

The proposed Takanini Stormwater Conveyance Channel will provide an effective drainage solution for the Takanini 2A2B catchment.

7. References

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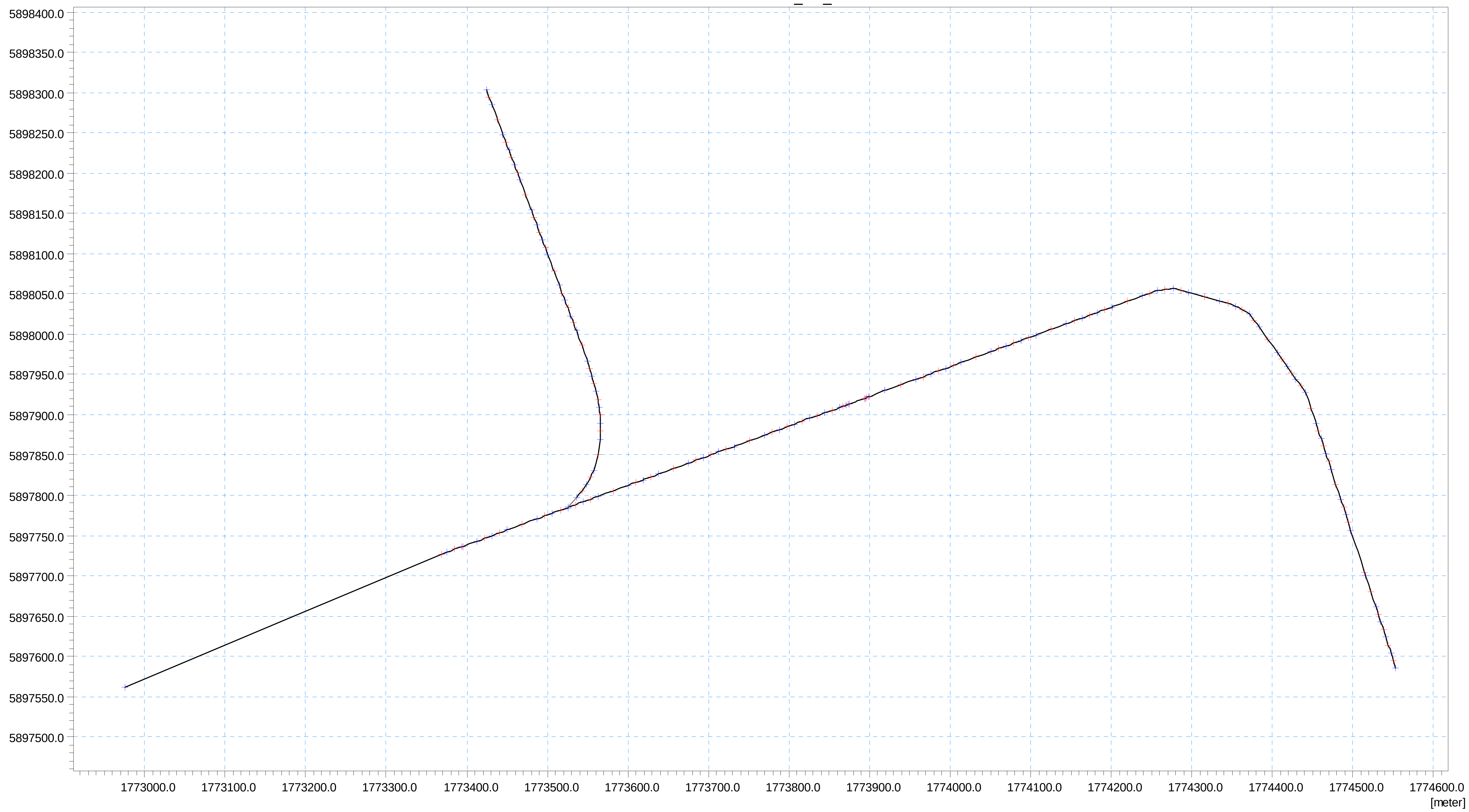
Appendices

Appendix A - (GHD MIKE11 modelling)

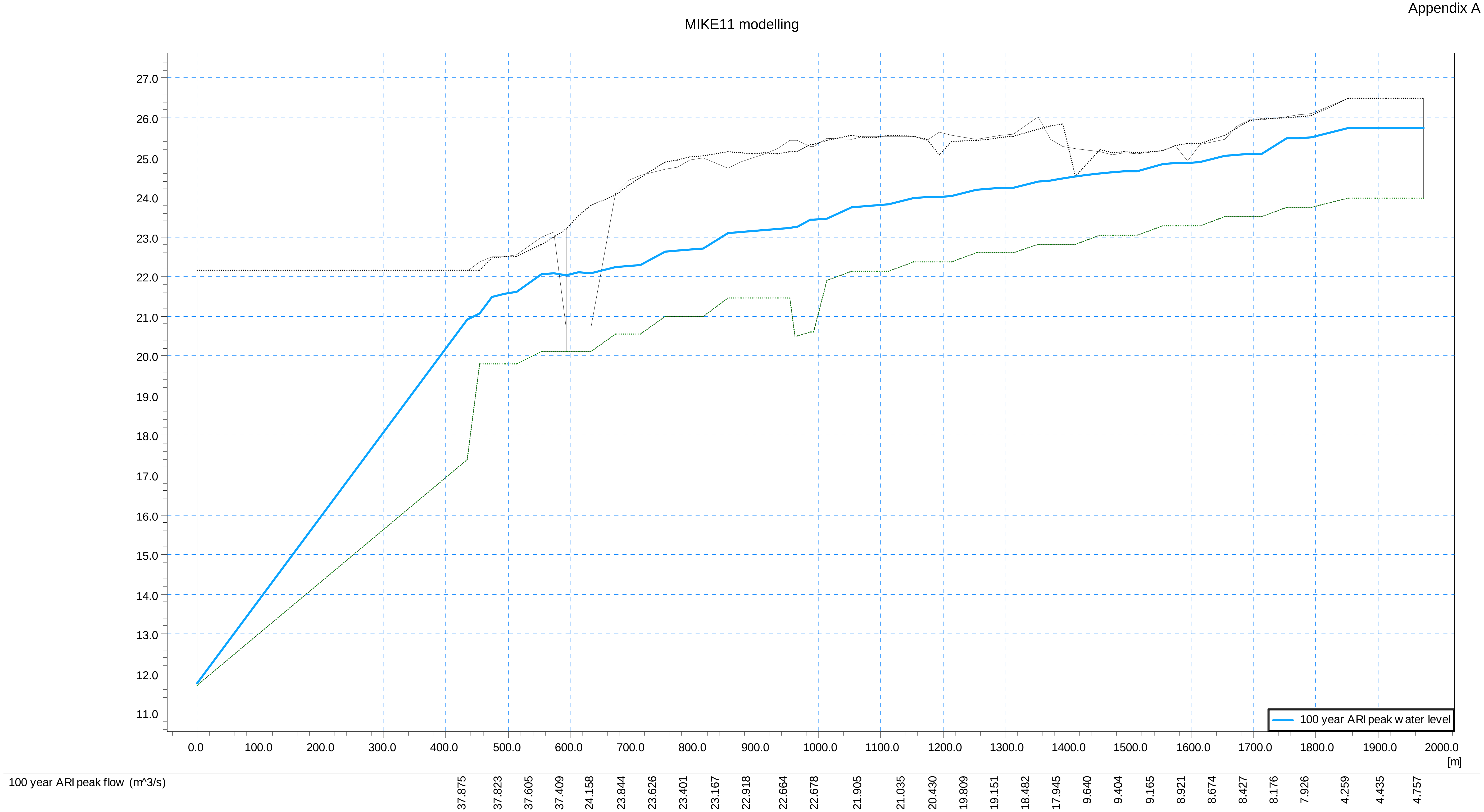
- MIKE11 model plan
- MIKE11 model long sections

Name	Area _Ha	Weighted CN	Channelisation factor	length (m)	slope (m/m)	tc (hr)	tp (hrs)	tp (min)	Design tp (min)	TP (hrs)	
2B4_1_IMP	5.060	98	0.80	250	0.0047	0.229	0.153	9.2	10.0	0.167	
2B4_1_PRV	3.373	74	1.00	250	0.0047	0.375	0.250	15.0	15.0	0.250	
2B4_2_IMP	18.060	98	0.80	700	0.0140	0.326	0.217	13.0	13.0	0.217	
2B4_2_PRV	10.607	74	1.00	700	0.0140	0.534	0.356	21.3	21.3	0.356	
2B_2_IMP	12.455	98	0.80	687	0.0370	0.240	0.160	9.6	10.0	0.167	Prior to pond routing
2B_2_PRV	9.396	74	1.00	687	0.0370	0.394	0.262	15.7	15.7	0.262	Prior to pond routing
2B_1_IMP	9.483	98	0.80	400	0.0070	0.277	0.184	11.1	11.1	0.184	
2B_1_PRV	5.569	74	1.00	400	0.0070	0.453	0.302	18.1	18.1	0.302	
2A_1_IMP	25.522	98	0.80	400	0.0050	0.307	0.204	12.3	12.3	0.204	
2A_1_PRV	13.742	74	1.00	400	0.0050	0.503	0.335	20.1	20.1	0.335	
2A_2_IMP	7.242	98	0.80	250	0.0078	0.197	0.131	7.9	10.0	0.167	
2A_2_PRV	3.900	74	1.00	250	0.0078	0.322	0.215	12.9	12.9	0.215	
2B4_3_IMP	12.492	98	0.80	400	0.0075	0.271	0.181	10.9	10.9	0.181	
2B4_3_PRV	7.337	74	1.00	400	0.0075	0.445	0.296	17.8	17.8	0.296	
2A_3_IMP	5.959	98	0.80	700	0.0050	0.443	0.296	17.7	17.7	0.296	
2A_3_PRV	3.208	74	1.00	700	0.0050	0.727	0.484	29.1	29.1	0.484	

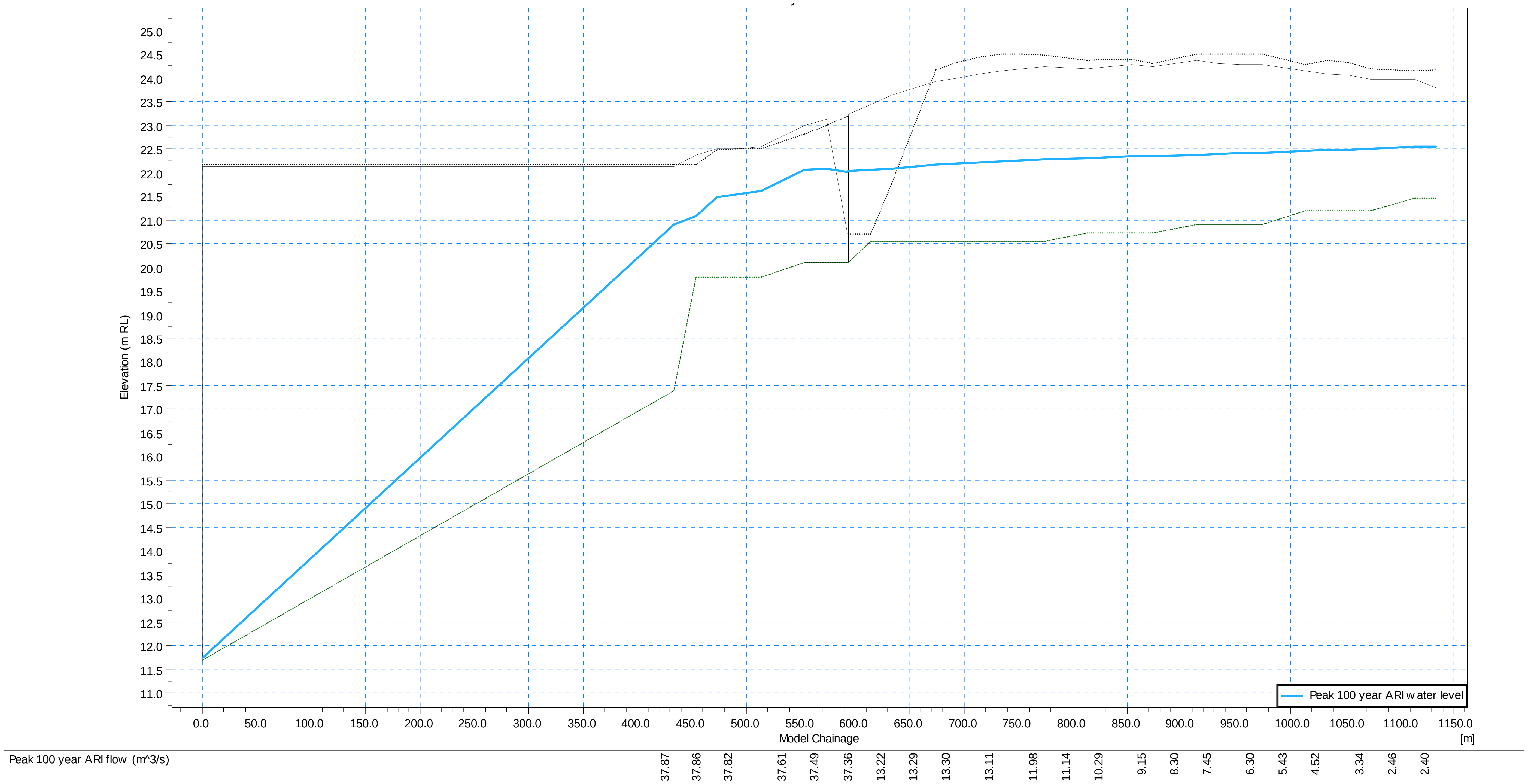
MIKE11 modelling



MIKE11 model plan



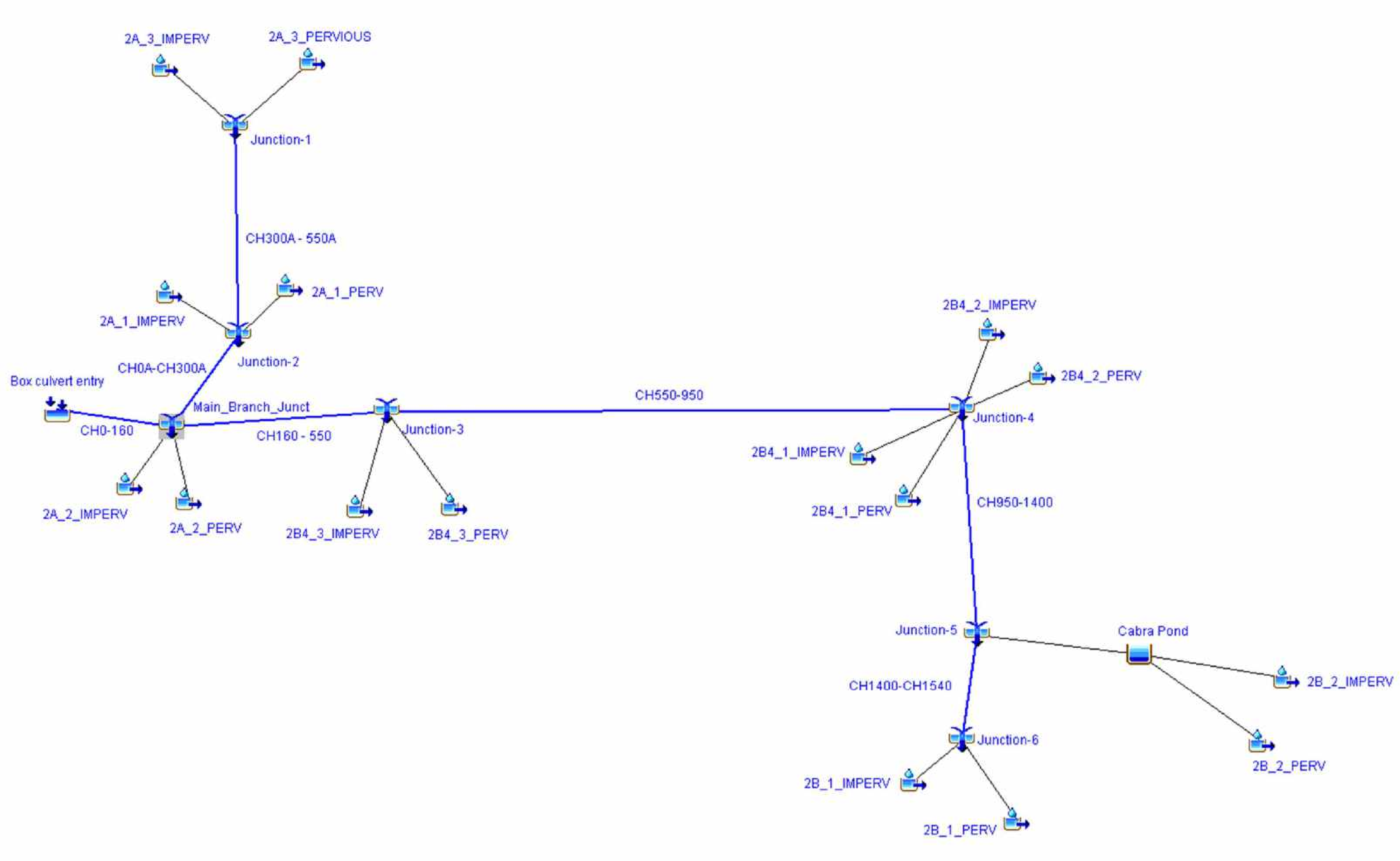
MIKE11 model long section – 1% AEP event + CC – MPD Scenario – Main Channel



MIKE11 model long section – 1% AEP event + CC – MPD Scenario – Branch Channel

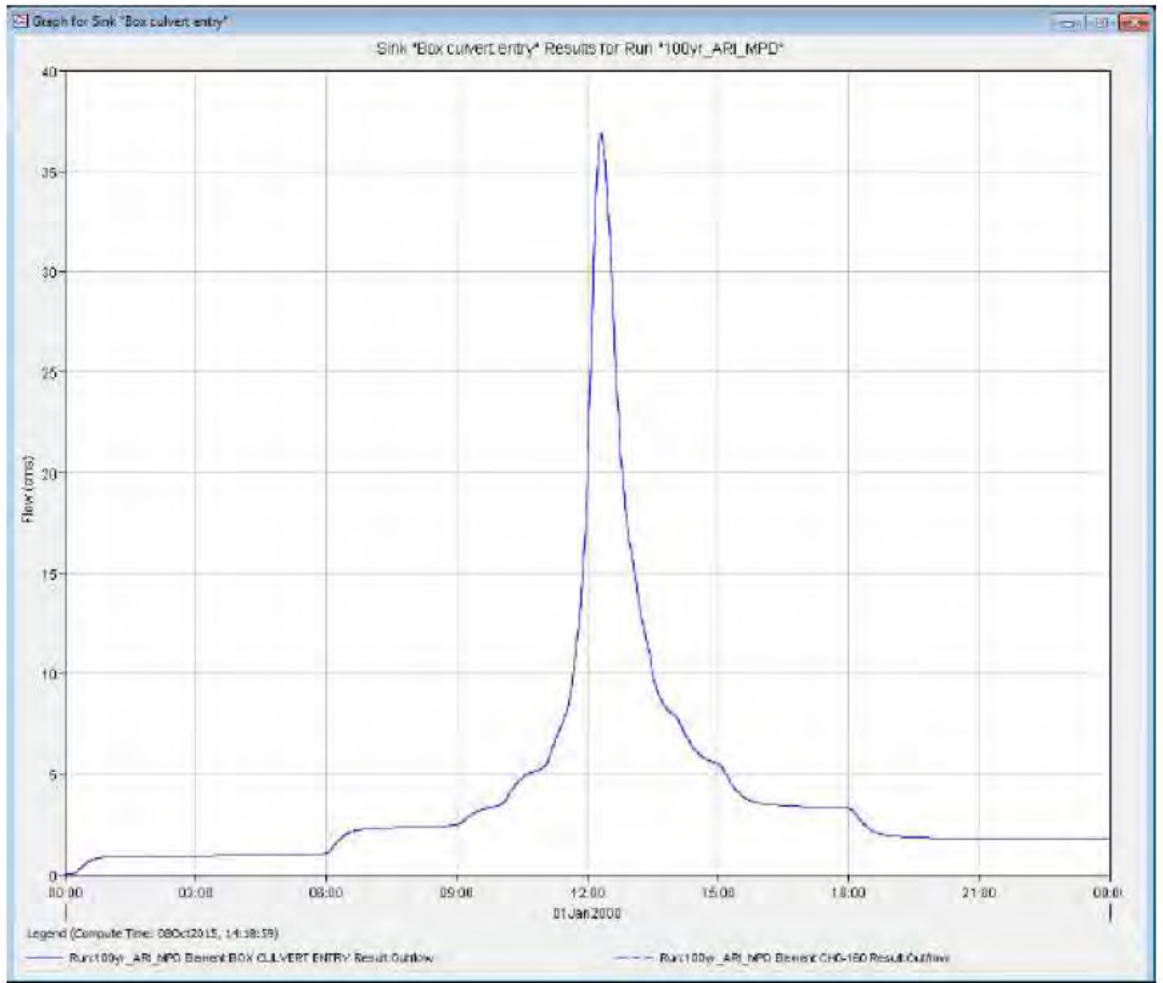
Appendix B - (HEC-HMS modelling)

- HEC-HMS model plan
- HEC-HMS global summary table



HEC-HMS model plan

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
2B_2_IMPERV	0.1245	4.8	01Jan2000, 12:05	31.8
2B_2_PERV	0.093955	2.4	01Jan2000, 12:11	17.1
Cabra Pond	0.218455	3.5	01Jan2000, 12:26	43.5
2B_1_IMPERV	0.094825	3.5	01Jan2000, 12:06	24. 2
2B_1_PERV	0.055691	1.4	01Jan2000, 12:13	10.3
Junction-6	0.150516	4.7	01Jan2000, 12:07	34.5
CH1400-CH1540	0.150516	4.7	01Jan2000, 12:11	34.5
Junction-5	0.368971	8.1	01Jan2000, 12:11	78
CH950-1400	0.368971	8.1	01Jan2000, 12:20	77.7
2B4_2_IMPERV	0.1806022	6.3	01Jan2000, 12:08	46.1
2B4_2_PERV	0.10607	2.4	01Jan2000, 12:16	19.5
2B4_1_IMPERV	0.0506018	1.9	01Jan2000, 12:05	12.9
2B4_1_PERV	0.0337345	0.9	01Jan2000, 12:10	6.2
Junction-4	0.7399795	17.4	01Jan2000, 12:13	162.5
CH550-950	0.7399795	17.4	01Jan2000, 12:19	162.2
2B4_3_IMPERV	0.1249192	4.6	01Jan2000, 12:06	31.9
2B4_3_PERV	0.0733652	1.8	01Jan2000, 12:13	13.5
Junction-3	0.9382639	21.7	01Jan2000, 12:18	207.7
CH160 - 550	0.9382639	21.7	01Jan2000, 12:24	207.3
2A_1_IMPERV	0.2552177	9.1	01Jan2000, 12:07	65.2
2A_1_PERV	0.1374249	3.2	01Jan2000, 12:15	25.3
2A_3_IMPERV	0.0595864	1.8	01Jan2000, 12:12	15.2
2A_3_PERVIOUS	0.032085	0.6	01Jan2000, 12:25	5.9
Junction-1	0.0916714	2.4	01Jan2000, 12:14	21.1
CH300A - 550A	0.0916714	2.4	01Jan2000, 12:18	21.1
Junction-2	0.484314	13.9	01Jan2000, 12:09	111.6
CH0A-CH300A	0.484314	13.9	01Jan2000, 12:15	111.4
2A_2_IMPERV	0.0724208	2.8	01Jan2000, 12:05	18.5
2A_2_PERV	0.0389958	1.1	01Jan2000, 12:08	7.2
Main_Branch_Junct	1.5339945	36.9	01Jan2000, 12:18	344.4
CH0-160	1.5339945	36.9	01Jan2000, 12:19	344.3
Box culvert entry	1.5339945	36.9	01Jan2000, 12:19	344.3



HEC-HMS global summary table – 1% AEP event + CC

Appendix C - (TP108 sub-catchment calculations)

	MPD Peak flow (m^3/s) 1% AEP event + CC		MPD Peak flow (m^3/s) 10% AEP event + CC	
Sub-catchment	TP108 calcs	GHD Model flows	TP108 calcs	GHD Model flows
2B4_1	2.88	2.83	1.68	1.66
2B4_2	8.72	8.57	5.09	5.05
2B_2	7.27	7.15	4.22	4.18
2B_1	4.86	4.82	2.84	2.84
2A_1	12.30	12.15	7.20	7.19
2A_2	4.06	3.92	2.38	2.31
2B4_3	6.45	6.39	3.77	3.77
2A_3	2.48	2.41	1.45	1.43

TP108 Large Catchment
2B4_1

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	5.06	5.06	5.06	5.06	5.06	5.06
Pervious Area	ha	3.37	3.37	3.37	3.37	3.37	3.37
Total area	ha	8.434	8.434	8.434	8.434	8.434	8.434
% Impervious		60%	60%	60%	60%	60%	60%
Catchment Slope (S_c)	m/m	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047
Catchment Length (l)	km	0.250	0.250	0.250	0.250	0.250	0.250
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		88.40	88.40	88.40	88.40	88.40	88.40
Initial Abstraction (Ia) weighted	mm	2.00	2.00	2.00	2.00	2.00	2.00
t_c	hours	0.25	0.25	0.25	0.25	0.25	0.25
t_p	hours	0.17	0.17	0.17	0.17	0.17	0.17
Storage (S)	mm	33	33	33	33	33	33
c*=(P24-2Ia)/(P24-2Ia+2S)		0.519	0.635	0.698	0.791	0.242	0.314
q* (from TP108 Fig. 6.1)	Approx!!	0.108	0.120	0.126	0.133	0.066	0.080
Peak Flowrate (q_p)	m^3/s	0.69	1.22	1.68	2.88	0.141	0.232
24 hour rainfall depth (Q_{24})	mm	51.0	92.0	128.5	224.5	9.6	16.0
24 hour runoff volume (V_{24})	m^3	4303	7760	10840	18937	810	1353

TP108 Large Catchment
2B4_2

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	18.06	18.06	18.06	18.06	18.06	18.06
Pervious Area	ha	10.61	10.61	10.61	10.61	10.61	10.61
Total area	ha	28.667	28.667	28.667	28.667	28.667	28.667
% Impervious		63%	63%	63%	63%	63%	63%
Catchment Slope (S_c)	m/m	0.014	0.014	0.014	0.014	0.014	0.014
Catchment Length (l)	km	0.700	0.700	0.700	0.700	0.700	0.700
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.12	89.12	89.12	89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85	1.85	1.85	1.85
t_c	hours	0.36	0.36	0.36	0.36	0.36	0.36
t_p	hours	0.24	0.24	0.24	0.24	0.24	0.24
Storage (S)	mm	31	31	31	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.652	0.713	0.803	0.259	0.332
q* (from TP108 Fig. 6.1)	Approx!!	0.098	0.108	0.112	0.119	0.061	0.073
Peak Flowrate (q_p)	m^3/s	2.13	3.70	5.09	8.72	0.445	0.724
24 hour rainfall depth (Q_{24})	mm	52.3	93.6	130.3	226.5	10.1	16.7
24 hour runoff volume (V_{24})	m^3	14989	26829	37347	64935	2901	4801

TP108 Large Catchment
2B_2

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	12.45	12.45	12.45	12.45	12.45	12.45
Pervious Area	ha	9.40	9.40	9.40	9.40	9.40	9.40
Total area	ha	21.850	21.850	21.850	21.850	21.850	21.850
% Impervious		57%	57%	57%	57%	57%	57%
Catchment Slope (S_c)	m/m	0.037	0.037	0.037	0.037	0.037	0.037
Catchment Length (l)	km	0.687	0.687	0.687	0.687	0.687	0.687
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		87.68	87.68	87.68	87.68	87.68	87.68
Initial Abstraction (Ia) weighted	mm	2.15	2.15	2.15	2.15	2.15	2.15
t_c	hours	0.269	0.269	0.269	0.269	0.269	0.269
t_p	hours	0.180	0.180	0.180	0.180	0.180	0.180
Storage (S)	mm	36	36	36	36	36	36
c*=(P24-2Ia)/(P24-2Ia+2S)		0.501	0.618	0.683	0.779	0.228	0.297
q* (from TP108 Fig. 6.1)	Approx!!	0.104	0.116	0.122	0.130	0.062	0.075
Peak Flowrate (q_p)	m^3/s	1.73	3.05	4.22	7.27	0.341	0.568
24 hour rainfall depth ($Q_{24)}$	mm	49.8	90.5	126.8	222.6	9.1	15.4
24 hour runoff volume (V_{24})	m^3	10879	19765	27708	48629	1995	3361

TP108 Large Catchment
2B_1

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	9.48	9.48	9.48	9.48	9.48	9.48
Pervious Area	ha	5.57	5.57	5.57	5.57	5.57	5.57
Total area	ha	15.052	15.052	15.052	15.052	15.052	15.052
% Impervious		63%	63%	63%	63%	63%	63%
Catchment Slope (S_c)	m/m	0.007	0.007	0.007	0.007	0.007	0.007
Catchment Length (l)	km	0.400	0.400	0.400	0.400	0.400	0.400
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.12	89.12	89.12	89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85	1.85	1.85	1.85
t_c	hours	0.31	0.31	0.31	0.31	0.31	0.31
t_p	hours	0.20	0.20	0.20	0.20	0.20	0.20
Storage (S)	mm	31	31	31	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.652	0.713	0.803	0.259	0.332
q* (from TP108 Fig. 6.1)	Approx!!	0.104	0.114	0.119	0.126	0.065	0.078
Peak Flowrate (q_p)	m^3/s	1.18	2.06	2.84	4.86	0.248	0.403
24 hour rainfall depth (Q_{24})	mm	52.3	93.6	130.3	226.5	10.1	16.7
24 hour runoff volume (V_{24})	m^3	7870	14087	19609	34094	1523	2521

TP108 Large Catchment
2A_1

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	25.52	25.52	25.52	25.52	25.52	25.52
Pervious Area	ha	13.74	13.74	13.74	13.74	13.74	13.74
Total area	ha	39.264	39.264	39.264	39.264	39.264	39.264
% Impervious		65%	65%	65%	65%	65%	65%
Catchment Slope (S_c)	m/m	0.005	0.005	0.005	0.005	0.005	0.005
Catchment Length (l)	km	0.400	0.400	0.400	0.400	0.400	0.400
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.60	89.60	89.60	89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75	1.75	1.75	1.75
t_c	hours	0.34	0.34	0.34	0.34	0.34	0.34
t_p	hours	0.22	0.22	0.22	0.22	0.22	0.22
Storage (S)	mm	29	29	29	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.664	0.724	0.811	0.270	0.345
q* (from TP108 Fig. 6.1)	Approx!!	0.101	0.111	0.116	0.122	0.065	0.077
Peak Flowrate (q_p)	m^3/s	3.02	5.25	7.20	12.30	0.646	1.041
24 hour rainfall depth (Q_{24})	mm	53.1	94.7	131.4	227.8	10.5	17.2
24 hour runoff volume (V_{24})	m^3	20868	37164	51612	89456	4115	6767

TP108 Large Catchment
2A_2

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	7.24	7.24	7.24	7.24	7.24	7.24
Pervious Area	ha	3.90	3.90	3.90	3.90	3.90	3.90
Total area	ha	11.142	11.142	11.142	11.142	11.142	11.142
% Impervious		65%	65%	65%	65%	65%	65%
Catchment Slope (S_c)	m/m	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078
Catchment Length (l)	km	0.250	0.250	0.250	0.250	0.250	0.250
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.60	89.60	89.60	89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75	1.75	1.75	1.75
t_c	hours	0.22	0.22	0.22	0.22	0.22	0.22
t_p	hours	0.14	0.14	0.14	0.14	0.14	0.14
Storage (S)	mm	29	29	29	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.664	0.724	0.811	0.270	0.345
q* (from TP108 Fig. 6.1)	Approx!!	0.118	0.130	0.135	0.142	0.076	0.090
Peak Flowrate (q_p)	m^3/s	1.00	1.73	2.38	4.06	0.213	0.344
24 hour rainfall depth (Q_{24})	mm	53.1	94.7	131.4	227.8	10.5	17.2
24 hour runoff volume (V_{24})	m^3	5921	10546	14645	25384	1168	1920

TP108 Large Catchment
2B4_3

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells	
Result cells	
Drop down menu	

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	12.49	12.49	12.49	12.49	12.49	12.49
Pervious Area	ha	7.34	7.34	7.34	7.34	7.34	7.34
Total area	ha	19.828	19.828	19.828	19.828	19.828	19.828
% Impervious		63%	63%	63%	63%	63%	63%
Catchment Slope (S_c)	m/m	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
Catchment Length (l)	km	0.400	0.400	0.400	0.400	0.400	0.400
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.12	89.12	89.12	89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85	1.85	1.85	1.85
t_c	hours	0.30	0.30	0.30	0.30	0.30	0.30
t_p	hours	0.20	0.20	0.20	0.20	0.20	0.20
Storage (S)	mm	31	31	31	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.652	0.713	0.803	0.259	0.332
q* (from TP108 Fig. 6.1)	Approx!!	0.104	0.115	0.120	0.127	0.066	0.078
Peak Flowrate (q_p)	m^3/s	1.57	2.74	3.77	6.45	0.329	0.535
24 hour rainfall depth (Q_{24})	mm	52.3	93.6	130.3	226.5	10.1	16.7
24 hour runoff volume (V_{24})	m^3	10367	18557	25832	44914	2007	3320

TP108 Large Catchment
2A_3

Project	51-32174 TAKANINI SCHEME DESIGN
Designer	Jesse Peeters
Consultant	GHD
Date	8/10/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

		50% AEP + CC	20% AEP + CC	10% AEP + CC	1% AEP + CC	WQ Event	34.5mm
Impervious Area	ha	5.96	5.96	5.96	5.96	5.96	5.96
Pervious Area	ha	3.21	3.21	3.21	3.21	3.21	3.21
Total area	ha	9.167	9.167	9.167	9.167	9.167	9.167
% Impervious		65%	65%	65%	65%	65%	65%
Catchment Slope (S_c)	m/m	0.005	0.005	0.005	0.005	0.005	0.005
Catchment Length (l)	km	0.700	0.700	0.700	0.700	0.700	0.700
Channelisation Factor (C)		0.8	0.8	0.8	0.8	0.8	g
SCS Curve Number (CN)		74	74	74	74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	120	158	256	25.33	34.5
Weighted Curve Number		89.60	89.60	89.60	89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75	1.75	1.75	1.75
t_c	hours	0.49	0.49	0.49	0.49	0.49	0.49
t_p	hours	0.32	0.32	0.32	0.32	0.32	0.32
Storage (S)	mm	29	29	29	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.664	0.724	0.811	0.270	0.345
q* (from TP108 Fig. 6.1)	Approx!!	0.087	0.096	0.100	0.106	0.056	0.066
Peak Flowrate (q_p)	m^3/s	0.61	1.06	1.45	2.48	0.130	0.210
24 hour rainfall depth (Q_{24})	mm	53.1	94.7	131.4	227.8	10.5	17.2
24 hour runoff volume (V_{24})	m^3	4872	8677	12050	20886	961	1580

Appendix D - (Culvert calculations)

Cosgrave Road Culvert losses calculation

Twin 3x2m box culverts	D/S channel			Culvert			U/S channel	
	1% AEP EVENT	10% AEP		1% AEP EVENT	10% AEP		1% AEP EVENT	10% AEP
Q (m^3/s)	22.7	13.1	Q (m^3/s)	22.7	13.1	Q (m^3/s)	22.7	13.1
A (m^2)	34	28.25	A (m^2)	12	12	A (m^2)	33.71	27.3
v_d= Q/A	0.668	0.464	v= Q/A	1.892	1.092	v_u= Q/A	0.673	0.480
$v_d^2/2g$	0.023	0.011	$v^2/2g$	0.182	0.061	$v_u^2/2g$	0.023	0.012
Expansion	0.352941176	0.424779				Contraction	0.356	0.440
k_e	0.5	0.36	$Sf = 10.3 \times n^2 \times d^{-\frac{16}{3}} \times Q^2$	0.010	0.003	k_c	0.28	0.31
$Ho = ke\left[\frac{v^2}{2g}\right]$	0.091	0.022	L (m)	20	20	$Ho = ke\left[\frac{v^2}{2g}\right]$	0.051	0.019
			H_f (m)	0.195	0.065			

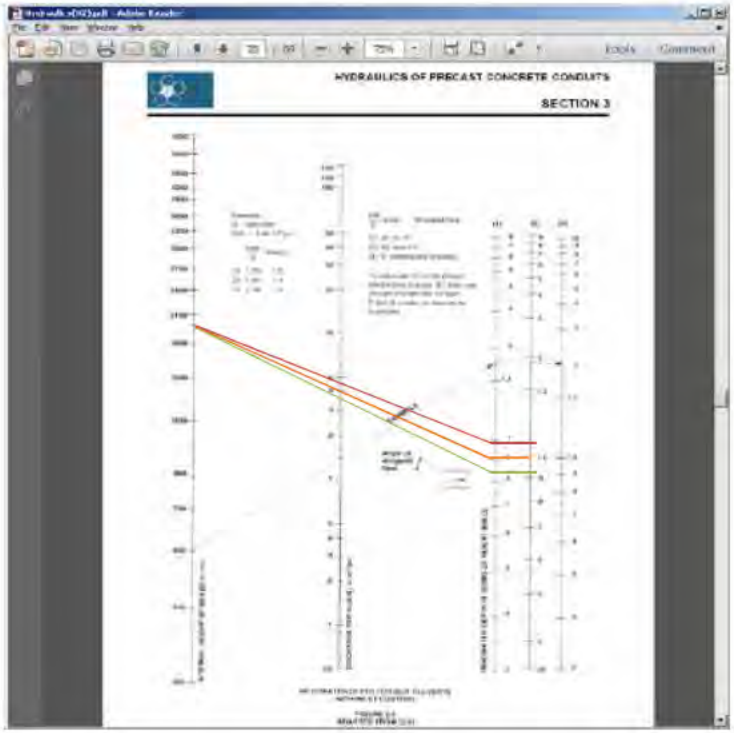
	d/s channel water level	d/s culvert water level	u/s culvert water level	u/s channel water level
1% AEP + CC	23.20	23.29	23.49	23.54
10% AEP + CC	22.95	22.97	23.04	23.06

Old Wairoa Road Culvert losses calculation

Twin 1.5m diameter culverts	D/S channel			Culvert			U/S channel	
	1% AEP EVENT	10% AEP		1% AEP EVENT	10% AEP		1% AEP EVENT	10% AEP
Q (m^3/s)	7.9	5	Q (m^3/s)	4.7	2.5	Q (m^3/s)	4.7	2.5
A (m^2)	14.2	11	A (m^2)	3.5	3.5	A (m^2)	16.16	9.05
v_d= Q/A	0.556	0.455	v= Q/A	1.343	0.714	v_u= Q/A	0.291	0.276
$v_d^2/2g$	0.016	0.011	$v^2/2g$	0.092	0.026	$v_u^2/2g$	0.004	0.004
Expansion	0.246478873	0.318182				Contraction	0.217	0.387
k_e	0.57	0.5	$Sf = 10.3 \times n^2 \times d^{-\frac{16}{3}} \times Q^2$	0.0013	0.0004	k_c	0.37	0.25
$Ho = ke\left[\frac{v^2}{2g}\right]$	0.052	0.013	L (m)	49.18	49.18	$Ho = ke\left[\frac{v^2}{2g}\right]$	0.034	0.007
			H_f (m)	0.063	0.018			

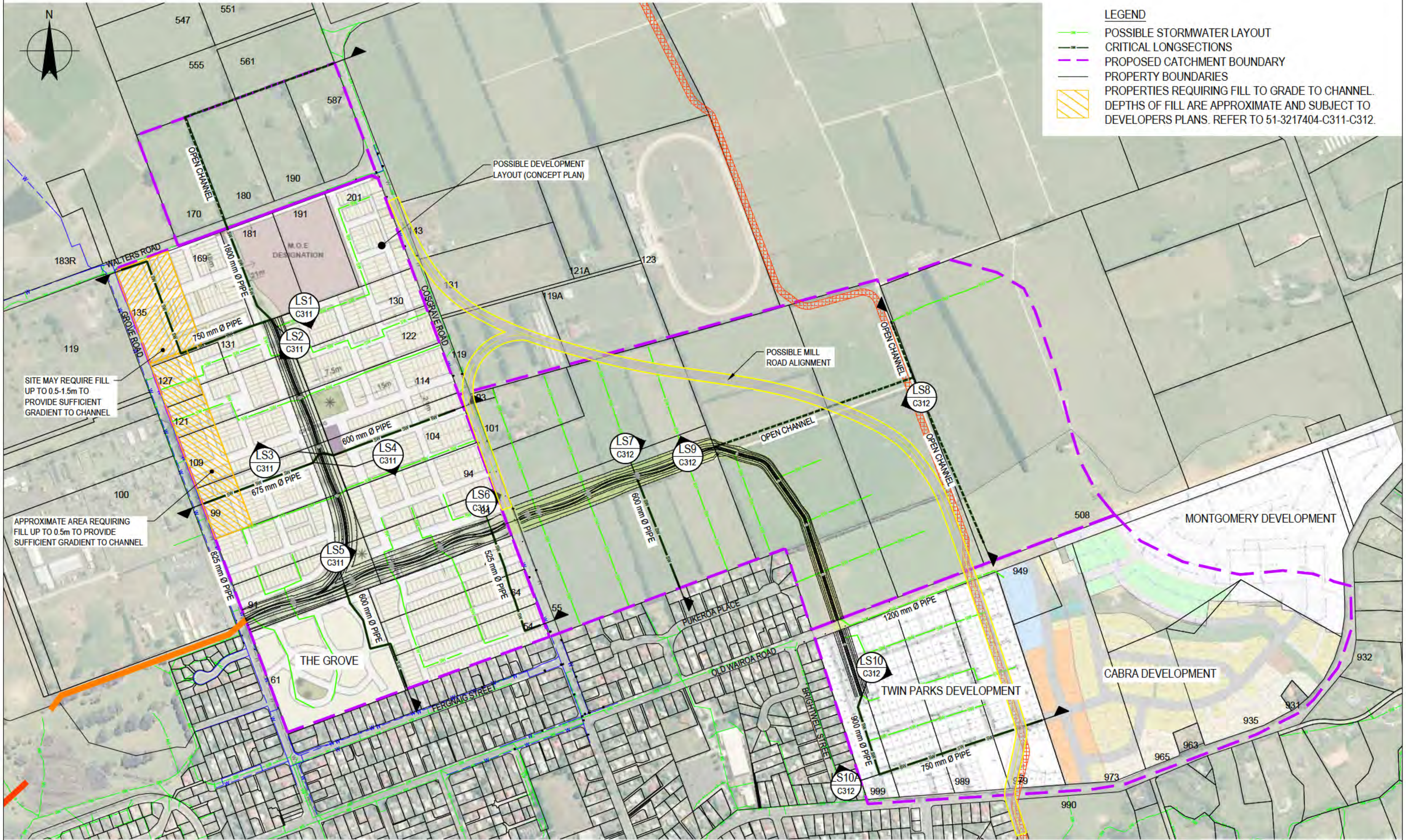
	d/s channel water level	**d/s culvert water level**	**u/s culvert water level**	**u/s channel water level**
1% AEP + CC	25.49	25.54	25.61	25.64
10% AEP + CC	25.32	25.33	25.35	25.36

Appendix E - (Cosgrave Road Culvert blockage)



Box Culvert Summary	TWIN 3m x 2m box		
Blockage scenario	0% blockage	10% blockage	20% blockage
Flow (m^3/s)	22.7	22.7	22.7
D (m)	2	2	2
B (m)	6	5.4	4.8
Q/B	3.78	4.20	4.73
HW/D	0.93	1	1.1
HW (m)	1.86	2	2.2
RL 100yr (inlet) - if inlet control assumed	22.46	22.6	22.8
RL 100yr (inlet) - if outlet control assumed (see Appendix D)	23.54	23.54	23.54
Control	Downstream controlled	Downstream controlled	Downstream controlled

Appendix F - (Development connection calculations)



SCHEME DESIGN

No	Revision	Drawn	Job Manager	Project Director	Date
B	RESOURCE CONSENT	JP			03/16
A	SCHEME DESIGN	D X			12/14

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 100 200 300m
SCALE 1:10,000 AT ORIGINAL SIZE

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Drawn: D XIE
Designer: J PEETERS
Drafting Check
Design Check
Approved (Project Director)
Date
Scale: 1:10000
This Drawing must not be used for Construction unless signed as Approved

Client: **AUCKLAND COUNCIL**
Project: **TAKANINI STORMWATER CONVEYANCE CHANNEL**
Title: **POSSIBLE FUTURE CONNECTIONS TO CHANNEL PLAN**

Original Size: A3
Drawing No: **51-3217404-C310**
Rev: **B**

Plot Date: 18 March 2016 - 5:35 p.m. Plotted By: Jesse Peeters Cad File No: G:\51\32174\03 Takanini\14 CAD\Drawings\51-3217404-C310.dwg

Connection	Area (m^2)	Impervious	Length (m)	Slope	10% AEP + CC flow (m^3/s)	1% AEP + CC flow (m^3/s)	Pipe size (mm)
LS1	39787	65%	408	0.50%	0.80	1.37	750 mm dia. Pipe
LS2	91134	65%	531	0.12%	1.47	2.51	12m wide swale and 1800mm dia pipe
LS3	26767	65%	326	0.78%	0.59	1.01	600 mm dia. Pipe
LS4	26780	65%	300	0.50%	0.58	0.99	675 mm dia. Pipe
LS5	21101	65%	250	0.68%	0.49	0.83	600 mm dia. Pipe
LS6	15382	65%	230	0.83%	0.37	0.63	525 mm dia. Pipe
LS7	22440	63%	260	0.65%	0.51	0.87	600 mm dia. Pipe
LS8	66597	63%	778	2.30%	1.35	2.31	10m wide swale
LS9	283422	63%	980	0.80%	4.82	8.25	15m wide swale
LS10	69783	63%	557	0.50%	1.30	2.23	900 mm dia. Pipe
LS10A	41583	63%	387	1.10%	0.91	1.56	750 mm dia. Pipe

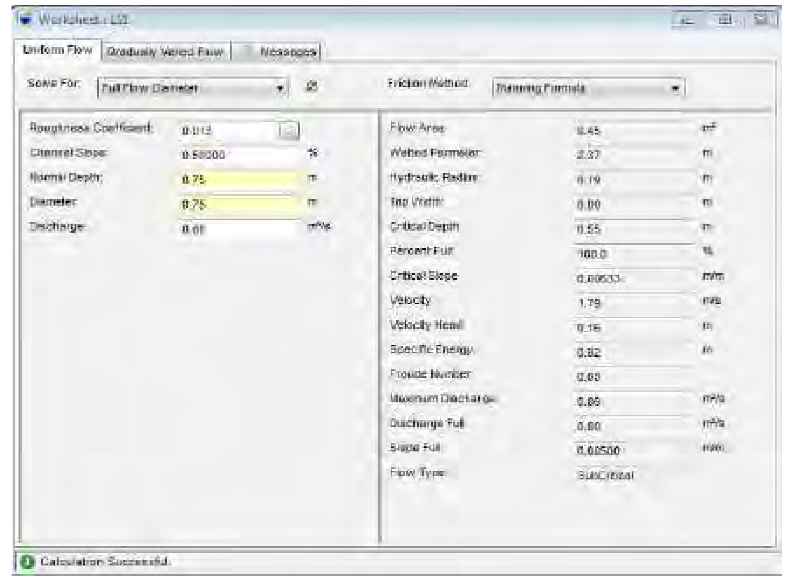
LS1

Data entry cells
Result cells
Drop down menu

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	2.586155	2.586155	2.586155
Pervious Area	ha	1.392545	1.392545	1.392545
total area	ha	3.9787		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.005	0.005	0.005
Catchment Length (l)	km	0.408	0.408	0.408
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.26	0.26	0.26
t_p	hours	0.17	0.17	0.17
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.112	0.128	0.135
Peak Flowrate (q_p)	m^3/s	0.34	0.80	1.37
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	2115	5230	9065



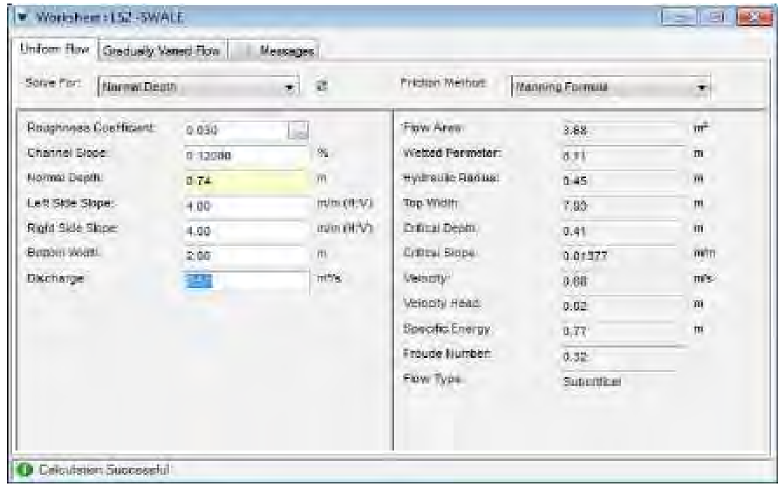
LS2

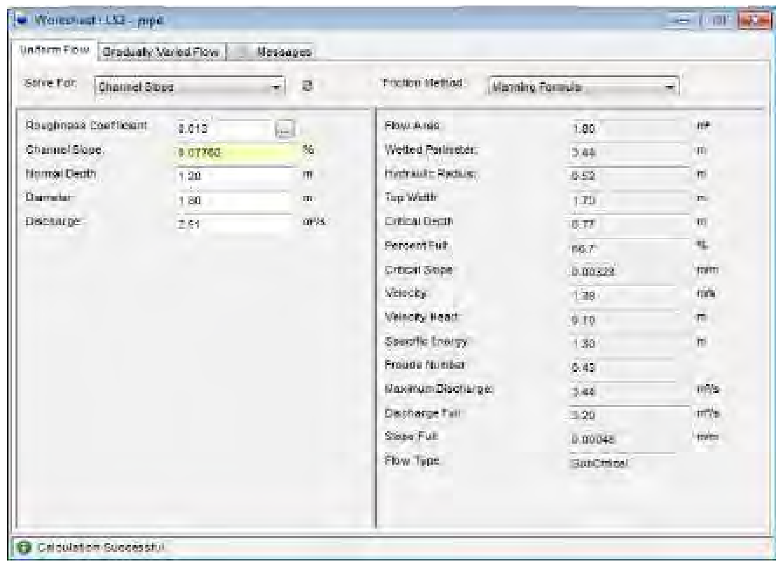
Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	5.92371	5.92371	5.92371
Pervious Area	ha	3.18969	3.18969	3.18969
total area	ha	9.1134		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.0012	0.0012	0.0012
Catchment Length (l)	km	0.531	0.531	0.531
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group C	Group C	Group C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.47	0.47	0.47
t_p	hours	0.31	0.31	0.31
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.089	0.102	0.108
Peak Flowrate (q_p)	m^3/s	0.62	1.47	2.51
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	4844	11979	20763





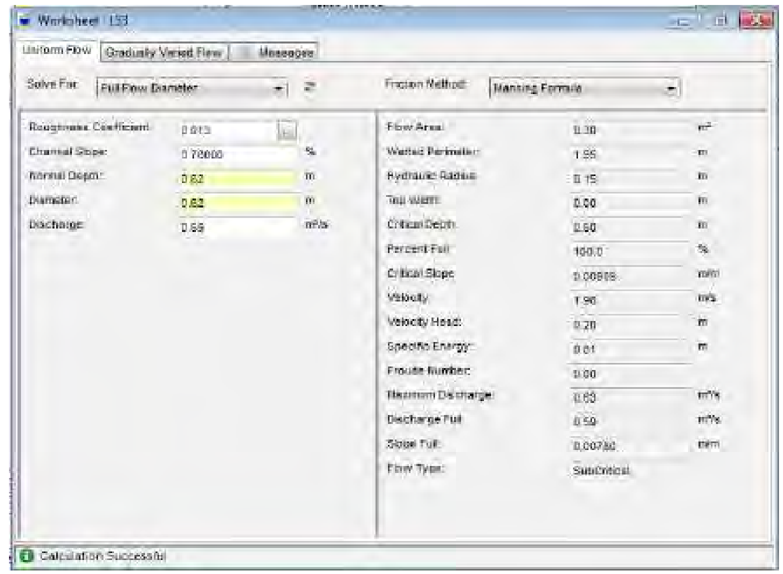
LS3

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

Select appropriate design storm	⟶	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	1.739855	1.739855	1.739855
Pervious Area	ha	0.936845	0.936845	0.936845
total area	ha	2.6767		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.0078	0.0078	0.0078
Catchment Length (l)	km	0.326	0.326	0.326
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.19	0.19	0.19
t_p	hours	0.13	0.13	0.13
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.122	0.140	0.148
Peak Flowrate (q_p)	m^3/s	0.25	0.59	1.01
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	1423	3518	6098



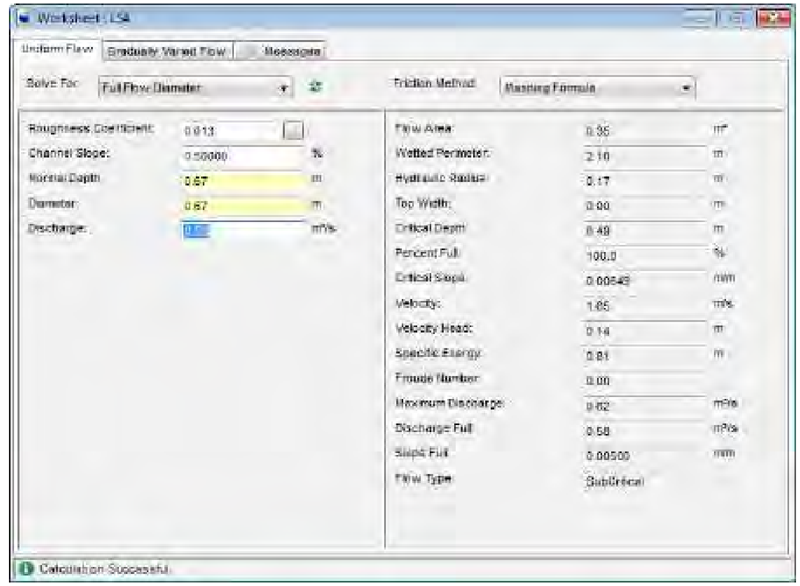
LS4

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

DEVELOPED CATCHMENT

Select appropriate design storm	⟶	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	1.7407	1.7407	1.7407
Pervious Area	ha	0.9373	0.9373	0.9373
total area	ha	2.678		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.005	0.005	0.005
Catchment Length (l)	km	0.3	0.3	0.3
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.21	0.21	0.21
t_p	hours	0.14	0.14	0.14
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.119	0.137	0.144
Peak Flowrate (q_p)	m^3/s	0.24	0.58	0.99
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	1423	3520	6101



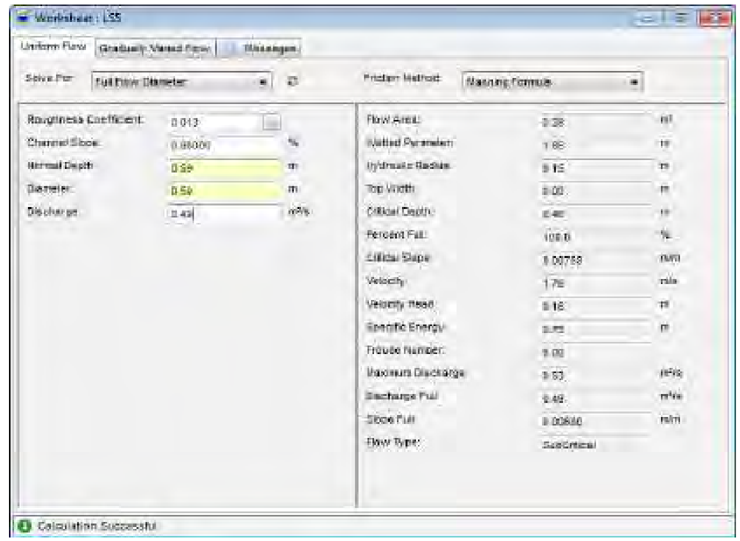
LS5

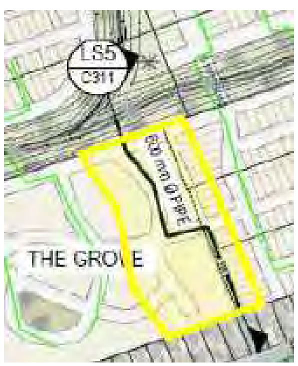
Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	1.371565	1.371565	1.371565
Pervious Area	ha	0.738535	0.738535	0.738535
total area	ha	2.1101		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.0068	0.0068	0.0068
Catchment Length (l)	km	0.25	0.25	0.25
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.17	0.17	0.17
t_p	hours	0.11	0.11	0.11
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.127	0.146	0.154
Peak Flowrate (q_p)	m^3/s	0.20	0.49	0.83
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	1121	2774	4807





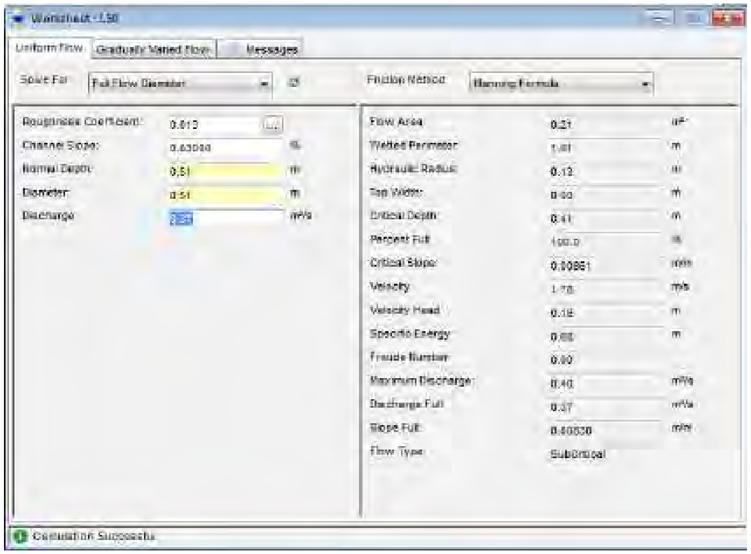
LS6

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells
Result cells
Drop down menu

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	0.99983	0.99983	0.99983
Pervious Area	ha	0.53837	0.53837	0.53837
total area	ha	1.5382		
% Impervious		65%	65%	65%
Catchment Slope (S_c)	m/m	0.0083	0.0083	0.0083
Catchment Length (l)	km	0.23	0.23	0.23
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.60	89.60	89.60
Initial Abstraction (Ia) weighted	mm	1.75	1.75	1.75
t_c	hours	0.15	0.15	0.15
t_p	hours	0.10	0.10	0.10
Storage (S)	mm	29	29	29
c*=(P24-2Ia)/(P24-2Ia+2S)		0.551	0.724	0.811
q* (from Fig. 6.1)	Approx!!	0.132	0.151	0.159
Peak Flowrate (q_p)	m^3/s	0.15	0.37	0.63
24 hour rainfall depth (Q_{24})	mm	53.1	131.4	227.8
24 hour runoff volume (V_{24})	m^3	818	2022	3505



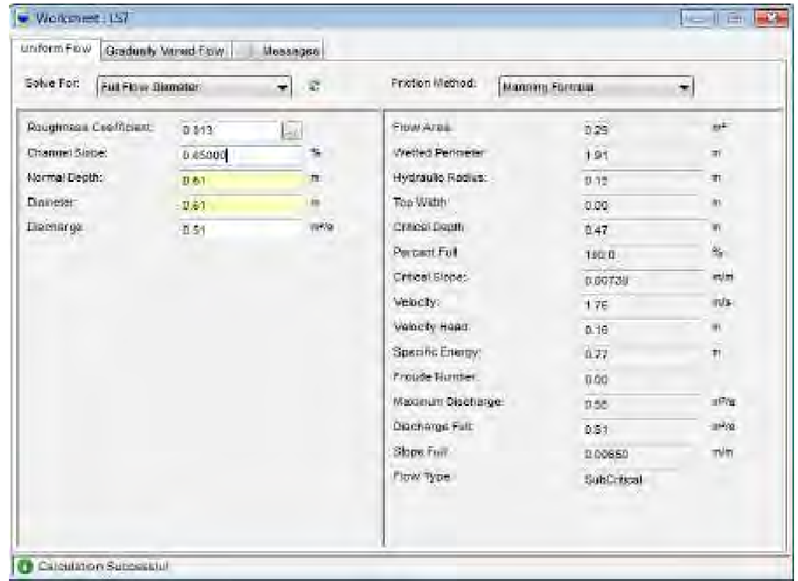
LS7

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	1.41372	1.41372	1.41372
Pervious Area	ha	0.83028	0.83028	0.83028
total area	ha	2.244		
% Impervious		63%	63%	63%
Catchment Slope (S_c)	m/m	0.0065	0.0065	0.0065
Catchment Length (l)	km	0.26	0.26	0.26
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85
t_c	hours	0.18	0.18	0.18
t_p	hours	0.12	0.12	0.12
Storage (S)	mm	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.713	0.803
q* (from Fig. 6.1)	Approx!!	0.124	0.143	0.151
Peak Flowrate (q_p)	m^3/s	0.21	0.51	0.87
24 hour rainfall depth (Q_{24})	mm	52.3	130.3	226.5
24 hour runoff volume (V_{24})	m^3	1173	2923	5083



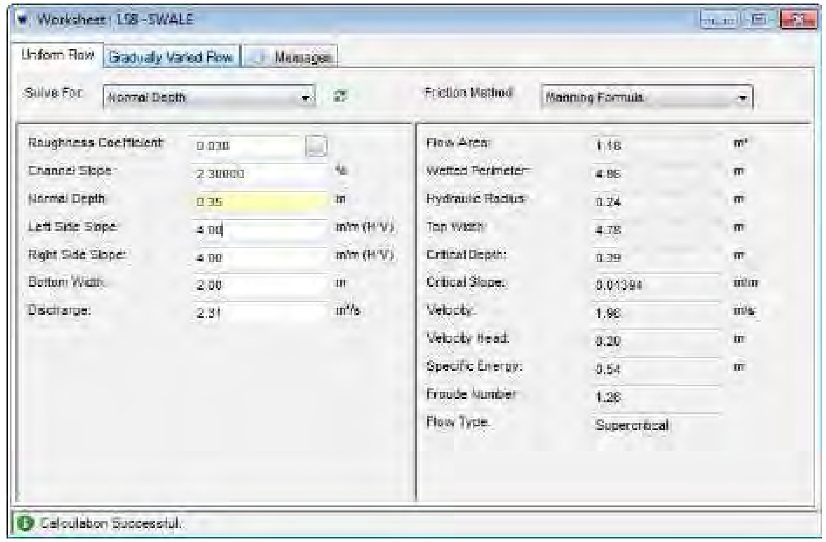
LS8

Data entry cells	
Result cells	
Drop down menu	

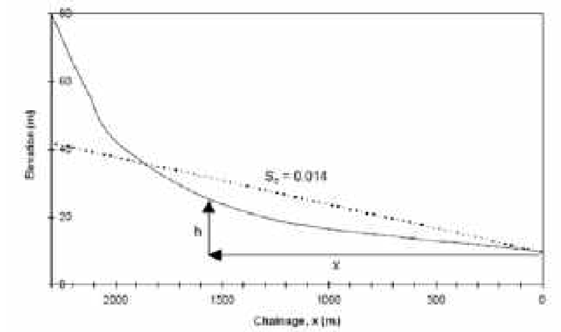
Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	4.195611	4.195611	4.195611
Pervious Area	ha	2.464089	2.464089	2.464089
total area	ha	6.6597		
% Impervious		63%	63%	63%
Catchment Slope (S_c)	m/m	0.023	0.023	0.023
Catchment Length (l)	km	0.778	0.778	0.778
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85
t_c	hours	0.25	0.25	0.25
t_p	hours	0.17	0.17	0.17
Storage (S)	mm	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.713	0.803
q* (from Fig. 6.1)	Approx!!	0.111	0.128	0.135
Peak Flowrate (q_p)	m^3/s	0.56	1.35	2.31
24 hour rainfall depth (Q_{24})	mm	52.3	130.3	226.5
24 hour runoff volume (V_{24})	m^3	3482	8676	15085



LS8 Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Survey Point	Elevation RL (m)	h (m)	x (m)	Δx(m)	$\bar{h}$ (m)	$\Delta A(=\bar{h}\Delta x)$
1	26.2	0	0	0		
2	26.2	0	110	110	0	0
3	32.4	6.2	316.7	206.7	3.1	640.77
4	43.8	17.6	516.7	200	11.9	2380
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	516.7	TOTAL =	3020.77

S_c 0.023

		h	x	Δx	$\bar{h}$	$\Delta A(=\bar{h}\Delta x)$

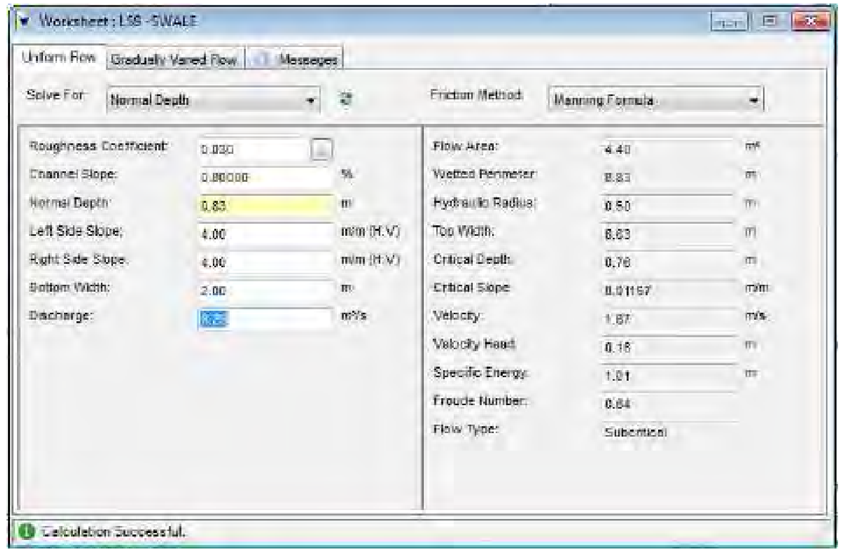
LS9

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

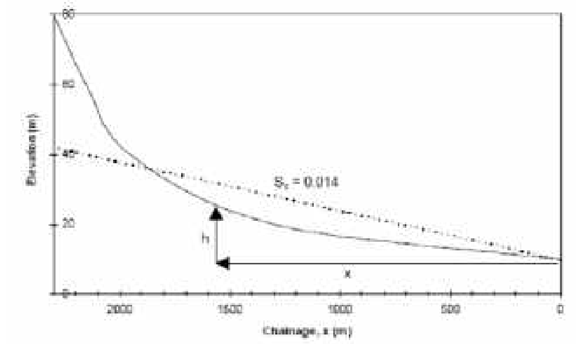
DEVELOPED CATCHMENT

Select appropriate design storm	→	**50% AEP + CC**	**10% AEP + CC**	**1% AEP + CC**
Impervious Area	ha	17.855586	17.855586	17.855586
Pervious Area	ha	10.486614	10.486614	10.486614
total area	ha	28.3422		
% Impervious		63%	63%	63%
Catchment Slope (S_c)	m/m	0.008	0.008	0.008
Catchment Length (l)	km	0.996	0.996	0.996
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85
t_c	hours	0.40	0.40	0.40
t_p	hours	0.27	0.27	0.27
Storage (S)	mm	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.713	0.803
q* (from Fig. 6.1)	Approx!!	0.093	0.108	0.114
Peak Flowrate (q_p)	m^3/s	2.01	4.82	8.25
24 hour rainfall depth ($Q_{24)}$	mm	52.3	130.3	226.5
24 hour runoff volume (V_{24})	m^3	14819	36924	64199



LS9 Catchment Slope

(Calculating the Slope (Sc) using the equal area method)



Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Survey Point	Elevation RL (m)	h (m)	x (m)	Δx(m)	$\bar{h}$ (m)	$\Delta A(=\bar{h}\Delta x)$
1	25	0	0	0		
2	27	2	770	770	1	770
3	53	28	996	226	15	3390
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	996	**TOTAL =**	4160

$\mathbf{S_c}$	0.008

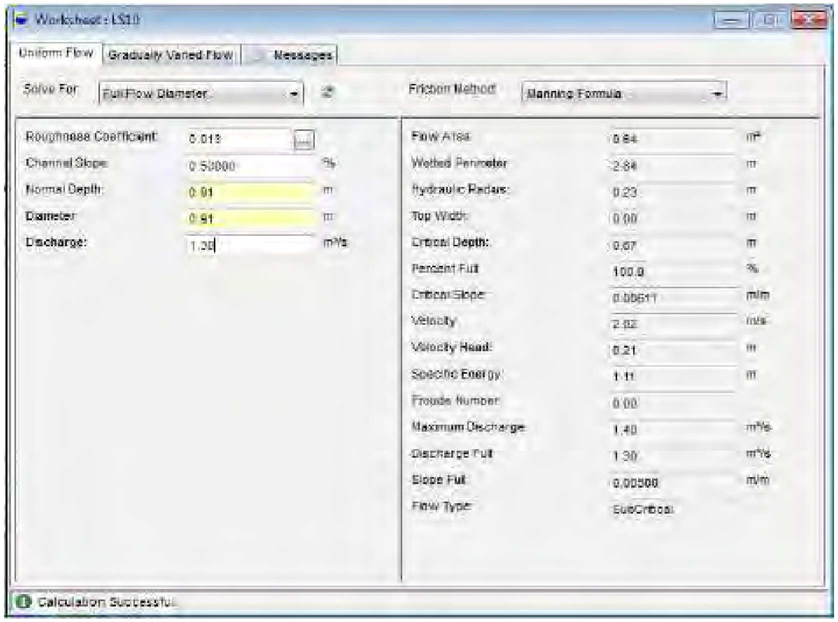
LS10

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells	
Result cells	
Drop down menu	

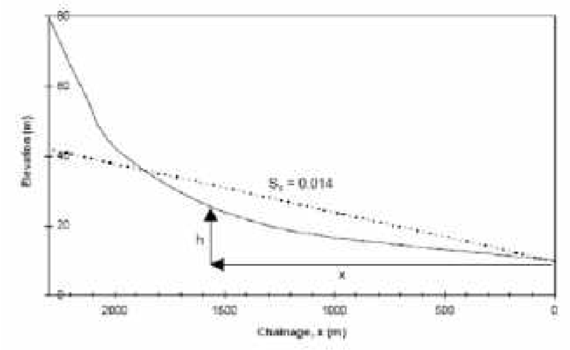
DEVELOPED CATCHMENT

Select appropriate design storm	→	50% AEP + CC	10% AEP + CC	1% AEP + CC
Impervious Area	ha	4.396329	4.396329	4.396329
Pervious Area	ha	2.581971	2.581971	2.581971
total area	ha	6.9783		
% Impervious		63%	63%	63%
Catchment Slope (S_c)	m/m	0.005	0.005	0.005
Catchment Length (l)	km	0.557	0.557	0.557
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85
t_c	hours	0.32	0.32	0.32
t_p	hours	0.21	0.21	0.21
Storage (S)	mm	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.713	0.803
q* (from Fig. 6.1)	Approx!!	0.102	0.118	0.125
Peak Flowrate (q_p)	m^3/s	0.54	1.30	2.23
24 hour rainfall depth (Q_{24})	mm	52.3	130.3	226.5
24 hour runoff volume (V_{24})	m^3	3649	9091	15807



LS10 - Catchment Slope

(Calculating the Slope (Sc) using the equal area method)



Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Survey Point	Elevation RL (m)	h (m)	x (m)	Δx(m)	$\bar{h}$ (m)	$\Delta A(=\bar{h}\Delta x)$
1	26.5	0	0	0		
2	26.5	0	190	190	0	0
3	28.5	2	379	189	1	189
4	31.5	5	557	178	3.5	623
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	557	**TOTAL =**	812

S_c	0.005

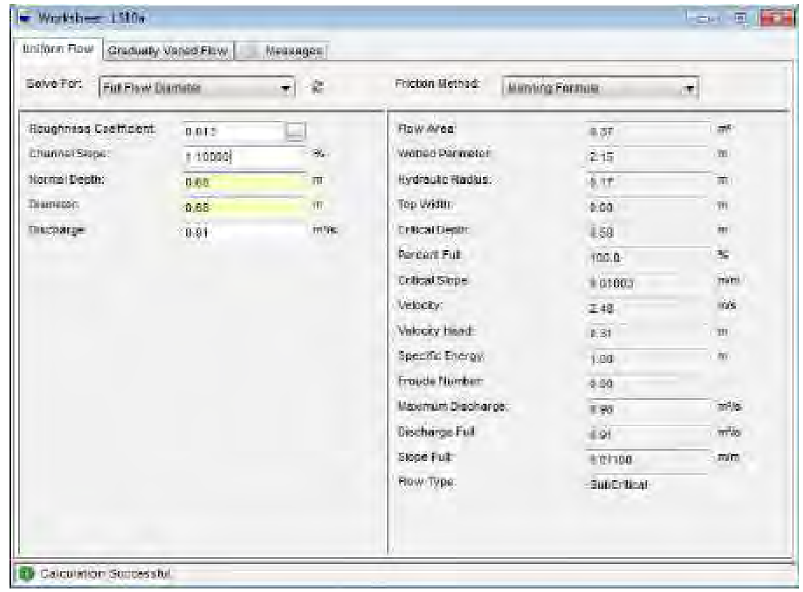
LS10A

Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

Data entry cells
Result cells
Drop down menu

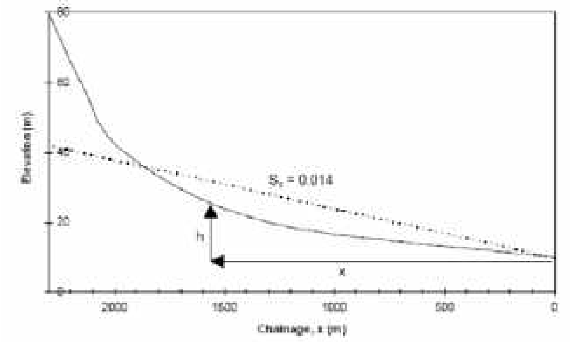
DEVELOPED CATCHMENT

Select appropriate design storm →		**50% AEP + CC**	**10% AEP + CC**	**1% AEP + CC**
Impervious Area	ha	2.619729	2.619729	2.619729
Pervious Area	ha	1.538571	1.538571	1.538571
total area	ha	4.1583		
% Impervious		63%	63%	63%
Catchment Slope (S_c)	m/m	0.011	0.011	0.011
Catchment Length (l)	km	0.387	0.387	0.387
Channelisation Factor (C)		0.6	0.6	0.6
Hydrological Soil Group		Group_C	Group_C	Group_C
SCS Curve Number (CN)		74	74	74
24-Hour Rainfall Depth (P_{24})	mm	76	158	256
Weighted Curve Number		89.12	89.12	89.12
Initial Abstraction (Ia) weighted	mm	1.85	1.85	1.85
t_c	hours	0.20	0.20	0.20
t_p	hours	0.13	0.13	0.13
Storage (S)	mm	31	31	31
c*=(P24-2Ia)/(P24-2Ia+2S)		0.538	0.713	0.803
q* (from Fig. 6.1)	Approx!!	0.120	0.138	0.146
Peak Flowrate (q_p)	m^3/s	0.38	0.91	1.56
24 hour rainfall depth (Q_{24})	mm	52.3	130.3	226.5
24 hour runoff volume (V_{24})	m^3	2174	5417	9419



LS10A - Catchment Slope

(Calculating the Slope (Sc) using the equal area method)



Project	Takanini 2a2b
Address	Takanini
Consultant	GHD
Date	22/01/2015

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Survey Point	Elevation RL (m)	h (m)	x (m)	Δx(m)	$\bar{h}$ (m)	$\Delta A (= \bar{h} \Delta x)$
1	26.5	0	0	0		
2	28.75	2.25	238	238	1.125	267.75
3	31.5	5	387	149	3.625	540.125
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	387	TOTAL =	807.875

S_c	0.011

Appendix G - (Design summary table)

	Criteria Summary	Reference Document	Proposed design to meet criteria
Flooding	Conveyance of up to the 10% AEP event through a primary stormwater system. The location of the primary system should align with the natural flow path as far as possible	Stormwater CoP	10% AEP flow channel for primary drainage.
	Conveyance of up to the 1% AEP event flow through a secondary stormwater system assuming the primary system is completely blocked	Stormwater CoP, ICMP	1% AEP floodplain within designation for secondary stormwater flows.
	Provide sufficient freeboard to allow future development habitable floor levels to be constructed at least 500mm above the 1% AEP event flood level (300mm in the Old Wairoa Road NDC)	Unitary Plan, Stormwater CoP	Sufficient depth and capacity for developers to connect to with minimum filling of their sites to achieve required freeboard.
	Minimise infilling of the 1% AEP floodplain	ICMP	Construction of channel allows floodplain to be reduced / contained within designation.
	Secondary flow path design for culverts shall assume culvert blockage of 50% for pipes larger than 1500 mm diameter. This criteria assumes that culverts are designed for the 10% AEP with a secondary overland flowpath available. In this case, culverts will be designed for the 1% AEP, and therefore it has been agreed with Auckland Council that lower blockage scenarios can be considered.	ICMP	Blockage assessment of 10% and 20% culvert blockage.
Ecological	Provision for climbing fish passage shall be made at the McLennan wetland, and shall also be provided in any other works within the bed of a watercourse	NDC	Fish passage to be designed in detailed design. Provision for fish passage has been allowed within the weir and culvert designs.
	Protection of the stream riparian margin	ICMP	Plants selected to withstand channel flows
Planning	If practicable, provide centralised community stormwater management devices to avoid ineffective, often expensive, piecemeal stormwater treatment solutions	ICMP	Implementation of the Takanini Stormwater Conveyance Channel achieves this
Cultural	Involve local iwi groups in the stormwater management process and incorporate iwi philosophy in the stormwater design where possible	ICMP	Iwi to be consulted and involved in detailed design.

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	Jesse Peeters	Tony Miller	Tony Miller	Edward Reid		29/01/16
2	Jesse Peeters	Tony Miller	Tony Miller	Edward Reid		07/04/16

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APPENDIX 14 – Auckland Unitary Plan E36 ASSESSMENT

AUP E36 Objective Assessment Table 1

E36 Objective	Related Policy	Assessment
1) Subdivision, use and development outside urban areas does not occur unless the risk of adverse effects to people, property, infrastructure and the environment from natural hazards has been assessed and significant adverse effects are avoided, taking into account the likely long-term effects of climate change.	Policy 1 (E36.3.1), Policy 17 (E36.3.17)	An assessment has been completed as per AUP36.3 in table 2 and 3 below. Flood modelling was completed taking into account climate change. All natural hazards have been assessed, and adverse effects have been avoided
2) Subdivision, use and development, including redevelopment in urban areas, only occurs where the risks of adverse effects from natural hazards to people, buildings, infrastructure and the environment are not increased overall and where practicable are reduced, taking into account the likely long-term effects of climate change.	Policy 21 (E36.3.21)	Flood modelling supports that there will be no increase in risks in the downstream urban environment.
3) Subdivision, use and development on rural land for rural uses is managed to ensure that the risks of adverse effects from natural hazards are not increased and where practicable are reduced.	Policy 1 (E36.3.1), Policy 17 (E36.3.17)	Not applicable for this application.
4) Where infrastructure has a functional or operational need to locate in a natural hazard area, the risk of adverse effects to other people, property, and the environment shall be assessed and significant adverse effects are sought first to be avoided or, if avoidance is not able to be totally achieved, the residual effects are otherwise mitigated to the extent practicable.	Policy 4 (E35.3.4)	The risk assessment has been completed in table 2 and 3below. where possible avoidance of hazards where infrastructure is needed has been sought. Where this is not possible the hazards have been mitigated.
5) Subdivision, use and development including redevelopment, is managed to safely maintain the conveyance function of floodplains and overland flow paths.	Policy 20 (E36.3.20), Policy 29 (E36.3.29), Policy 30 (E36.3.30)	The flood modelling assessment takes into account climate change assesses conveyance functions of flood plains and overland flow paths and has provided these are safely managed.
6) Where appropriate, natural features and buffers are used in preference to hard protection structures to manage natural hazards.	Policy 1 (E36.3.1), Policy 17 (E36.3.17)	Where practicable natural features and buffers are proposed to manage natural hazards.

E36 Natural Hazards Flood Risk Assessment Table 2

E36.3 Policy Assessment	Assessment
a) The type, frequency and scale of the natural hazard and whether adverse effects on the development will be temporary or permanent;	The main risk to the development is flooding in the 1%AEP storm event. The 1% AEP+CC design storm event is very infrequent, with associated flooding effects being temporary in nature. Although this will be mitigated onsite it won't remove the hazard completely from the site, but the flooding with be controlled through onsite channels and ponds/wetlands. All lots will have no flooding issues.
b) The type of activity being undertaken and its vulnerability to natural hazard events;	Master planned development. Habitable spaces, Community Facilities and Commercials spaces are vulnerable to natural hazards without appropriate mitigation.
c) The consequences of a natural hazard event in relation to the proposed activity;	The consequences would be flooding and potential loss of property unless proper mitigations are provided.
d) The potential effects on public safety and other property;	Flooding could be a risk to public safety by restricting movement and damaging property.
e) Any exacerbation of an existing natural hazard risk or the emergence of natural hazard risks that previously were not present at the location;	Western Catchment Flood modelling shows peak water levels and peak flow in the TSWCC (Takanini Stormwater Conveyance Channel) to remain unchanged or decrease for the modelled 50%, 10% and 1% AEP storms. Flow across the McLennan wetland spillway has a minor decrease post development. Flow and loading on the Artillery Driveway Tunnel remain unchanged. Flood levels in the McLennan wetland downstream also remain unchanged. There will be no exacerbation of existing natural hazards onsite or within the surrounding catchment areas, no new hazards will be created. Eastern Catchment Flood modelling shows water levels and peak flow downstream of the eastern catchment to remain unchanged or decrease for the modelled 50%, 10% and 1% AEP storms. Flood levels in the Papakura Stream downstream also remain unchanged. There will be no exacerbation of existing natural hazards onsite or within the surrounding catchment areas, no new hazards will be created.
f) whether any building, structure or activity located on land subject to natural hazards near the coast can be relocated in the event of severe coastal erosion, inundation or shoreline retreat;	There are no coastal areas within the site.

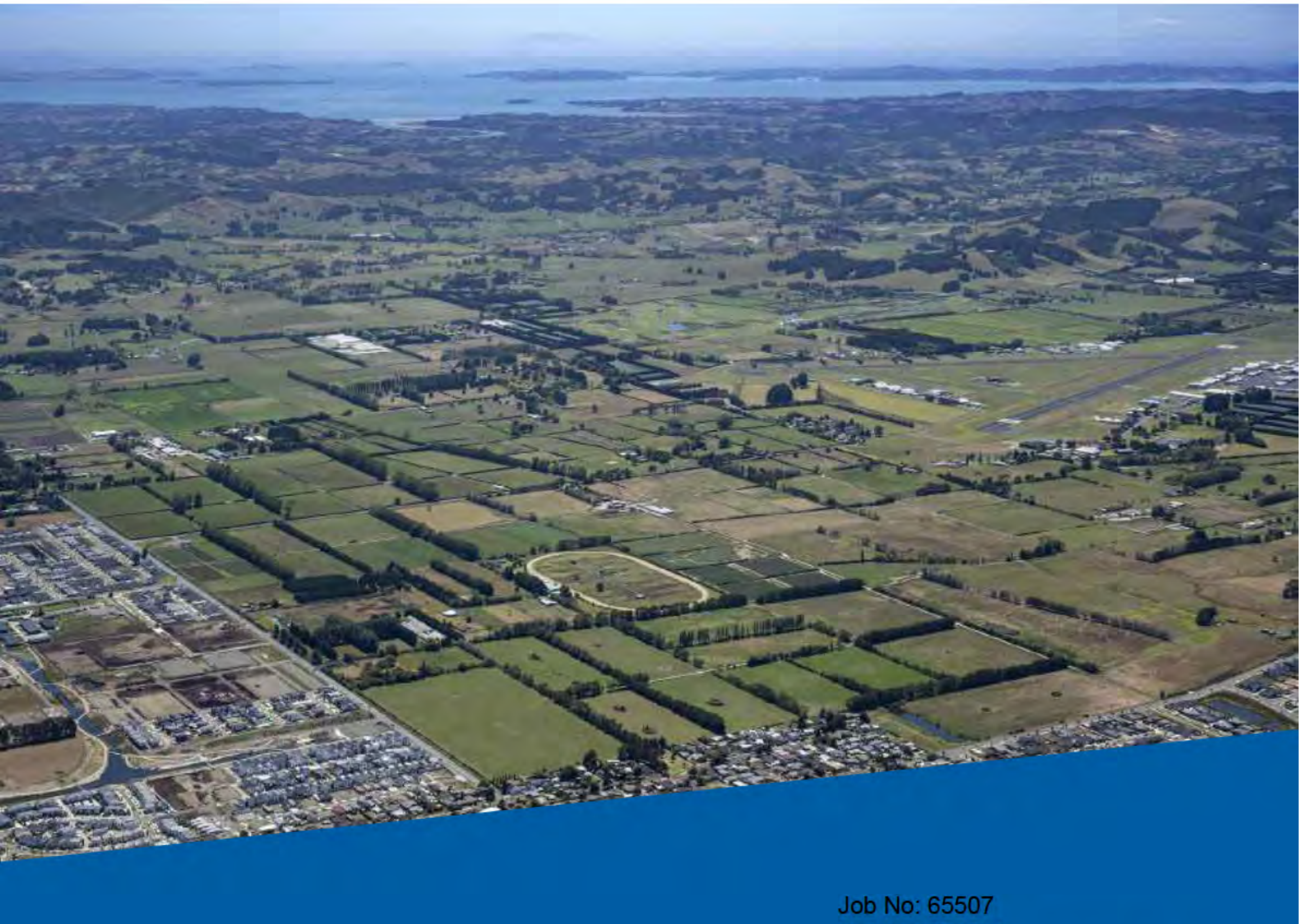
g) The ability to use non-structural solutions, such as planting or the retention or enhancement of natural landform buffers to avoid, remedy or mitigate hazards, rather than hard protection structures;	Hazard mitigation onsite will be completed though groundwater recharge (retention), onsite attenuation using ponds (wet/dry), swales and wetlands(detention) or passing through the upstream catchment (diversion). Western Catchment specifics Peak flow attenuation is provided to the Western catchment via stormwater pond 4. The pond's flow attenuation results in slight reduction in peak flows and water levels downstream of the site (including the TSWCC and McLennan wetland) during the 50%, 10% and 1% AEP storms. Eastern Catchment specifics A stormwater swale network within the site allows flow from Catchment B to be passed forward and discharged across Northern outflow 1. Flows from catchment D1 and D2 are attenuated via stormwater pond 2 and 3 respectively. Upstream flows from the east of the site are conveyed around the site perimeter via a diversion channel. Stormwater pond 1 provides flood storage for peak flow diversion. Stormwater management results in peak flows and water levels downstream of the site (including within the Papakura Stream) during the 50%, 10% and 1% AEP storms to remain unchanged.
h) The design and construction of buildings and structures to mitigate the effects of natural hazards;	No buildings will be proposed to mitigate the flooding hazard.
i) The effect of structures used to mitigate hazards on landscape values and public access;	The use of wetlands and dry ponds promotes landscape values given the natural forms which become amenity areas for public use.
j) Site layout and management to avoid or mitigate the adverse effects of natural hazards, including access and exit during a natural hazard event.	The design of the development aligns with the council code of practise which stipulates egress routes, flow depths, flow velocities and freeboard requirements.
k) The duration of consent and how this may limit the exposure for more or less vulnerable activities to the effects of natural hazards including the likely effects of climate change.	The consent will be for staged construction and will have no adverse effect on the hazards. The effects of climate change have been included in the assessment.

APPENDIX B – ECOLOGY REPORT

Bioresearches
A Babbage Company

Sunfield Baseline Ecological Assessment

for: Sunfield Developments Limited



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DOCUMENT APPROVAL AND REVISION HISTORY

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Reference: Bioresearches (2024). Sunfield Baseline Ecological Assessment. Report for Sunfield Developments Limited. pp 65

Cover Illustration: Aerial view of the Sunfeild area and surrounding landscape

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Capability Statement

Established in 1972, with offices in Auckland and Hamilton, Bioresearches has been providing sustainable solutions for resource use and development throughout New Zealand and the Pacific for over 40 years. We understand environmental legislation and how it applies to coastal, marine, freshwater and terrestrial ecosystems, and all aspects of land development and resource extraction. In 2015 Babbage Consultants merged with Bioresearches adding specialist ecology consultancy services to Babbage's existing offering.

Bioresearches works closely with all Babbage disciplines ensuring ecological issues and procedural requirements are integrated with and inform the engineering design processes at all stages of a project. Technical leaders of each discipline are highly experienced and recognised experts in their fields of practice and have a sound understanding of all relevant legislation, including the Resource Management Act and the Wildlife Act. Bioresearches services include;

- Independent technical review of ecological assessments and plans
- Strategic advice, environmental management plans and mitigation
- Assessments of environmental effects (AEE)
- Freshwater, wetland and marine surveys
- Terrestrial, freshwater and marine monitoring
- Vegetation and habitat assessment and mapping
- Fauna, flora and threatened species surveys
- Expert representation for Hearings, Board of Inquiry and Environment Court
- Biosecurity advice and monitoring

1 INTRODUCTION

Bioresearches were engaged by Sunfield Developments Limited to undertake an assessment of the baseline ecology within multiple properties of land at Ardmore, approximately 2 km north-east of Papakura (Figure 1). The areas have been separated into three blocks, referred to as the “Cosgrave Road”, “Sunfield South” and “Sunfield North” within this report.

Sunfield North and Sunfield South are zoned Rural – Mixed Rural and comprised of the following properties;

- NA258/245
- NA778/296
- NA1B/856
- NA477/291
- NA631/77
- NA636/71
- NA128A/553
- NA1666/17
- NA57A/1150
- NA57A/1151
- NA57A/1152
- NA61A/530
- NA477/75
- NA57A/1149
- Lot 7 Deposited Plan 103787
- NA578/1154

Cosgrave Road is zoned Future Urban, and comprised of the following properties;

- 828127
- 828128
- NA6c/1131
- NA258/245
- NA24c/216
- NA18B/646
- NA6C/1128
- 828126

Auckland Council Geomaps overlays indicate multiple overland flow paths to be present within the Sunfield Block, but no terrestrial Significant Ecological Area (SEA) overlays or recognised ecosystem types are present within the site.

This report describes the existing ecological values of the terrestrial and freshwater areas within the site.

Figure 1. Map of the site showing Sunfield North (yellow). Sunfield South (purple) and Cosgrave Road (red), and the overland flow paths predicted to flow through the area. Data sourced from Auckland Council Geomaps GIS viewer.

2 STATUTORY CONTEXT

This section summarises the legislation, policy, plans and strategies relevant to the protection, conservation and enhancement of nature conservation interests associated with the site. The ecological values described in this report allow significant ecological issues and adverse effects to be identified as they relate to the Resource Management Act 1991 (RMA). The identification of significant values and subsequent management recommendations to mitigate adverse effects are consistent with standards and objectives of the following legislative, policy statement and regional plan documents.

2.1 Legislation

2.1.1 Resource Management Act 1991 (RMA)

The purpose of the RMA is to achieve sustainable management. Important elements of this are the maintenance of indigenous biodiversity and protection of significant indigenous vegetation and habitats. The RMA requires that any adverse effects of development be avoided in the first instance, and where avoidance is not reasonably practicable, impacts should be minimised, remedied, or mitigated. These elements are given effect in Sections 5, 6 and 7, and Schedule 4 sets out the requirements for effects assessments.

2.1.2 Wildlife Act 1953

The Wildlife Act (WA, 1953) provides legal protection to listed species classed as wildlife. It controls how people interact with Wildlife, including all native birds, bats, frogs and lizards and some invertebrates. Note is does not cover plants or freshwater fish.

2.1.3 National Environmental Standards for Freshwater (NES-F, 2020)

The National Environmental Standards for Freshwater 2020 (NES-F) set requirements for carrying out certain activities that pose risks to freshwater and freshwater ecosystems.

2.2 National Policy Statements

2.2.1 Freshwater Management

The National Policy Statement for Freshwater Management 2020 (NPS-FM) provides direction under the RMA, to local authorities on managing activities that affect the health of freshwater, and provides protections to freshwater bodies, including natural inland wetlands, includes provisions for monitoring and reporting on freshwater quality and quantity, and for addressing the impacts of land use activities on freshwater resources.

2.2.2 National Policy Statement for Indigenous Biodiversity (NPS-IB)

The NPS-IB provides direction to councils to protect, maintain and restore indigenous biodiversity in the terrestrial environment, requiring at least no further reduction nationally. It is considered relevant to the proposal because the site is in the terrestrial environment, and it contains indigenous biodiversity as defined in Section 1.6 (Interpretation) of the NPS-IB.

The NPS-IB requires that indigenous biodiversity that is not protected by an SNA (or SEA for the purpose of this assessment):

a. Is managed by applying the effects management hierarchy (avoid, minimise, remedy, offset, compensate), where those effects are significant.

b. is managed to give effect to its Objective and Policies, where those effects are not significant (Section 3.16 (2)).

The terrestrial vegetation within the site is not subject to a SEA and therefore the proposed works would need to be consistent with Policy 8 (NPSIB), which addresses maintaining indigenous biodiversity outside of SNAs, and Section 3.16, which requires that significant adverse effects be managed by applying the management hierarchy (avoid, minimise, remedy, offset, compensate).

Tangata Whenua as Partners

The NPS-IB recognises tangata whenua as kaitiaki of, and partners, in the management of indigenous biodiversity (NPSIB, Policy 2). At the time of preparation of this report, no acknowledged taonga species have been identified in the public domain.

2.3 Regional plans and policies

The Auckland Unitary Plan (AUP) is the principal statutory planning document for Auckland. It was prepared by Auckland Council for the purpose of giving effect to the RMA as a regional council and as a territorial authority.

3 METHODOLOGY

The overarching approach of this analysis and reporting is to ascertain the existing ecological values on the site: species, communities and systems; as per the EIANZ Ecological Impact Assessment guidelines (EcIAGs) for use in New Zealand (Roper-Lindsay *et al*. 2018).

Using the EIANZ EcIAG framework, a simple ranking system is used to assign value to species as well as other matters of ecological importance such as species assemblages and levels of organisation.

The overall ecological value is then determined on a scale of 'Negligible' to 'Very High'. In addition to this assessment, all identified ecological values were assessed for significance against the Auckland Unitary Plan criteria to test ecological significant (where not already an SEA).

Table 1. Factors to be considered in assigning value to species (Roper-Lindsay et al. 2018).

Determining factors	Value
Nationally threatened species, found in the ZOI[1] either permanently or seasonally	Very High
Species listed as 'At-Risk' – declining, found in the ZOI, either permanently or seasonally	High
Species listed as any other category of 'At-Risk' found in the ZOI either permanently or seasonally	Moderate
Locally (ED) uncommon or distinctive species	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

Table 2: Attributes to be considered when assigning ecological value or importance to a site or area of vegetation / habitat / community (Roper-Lindsay et al. 2018).

Matters	Attributes to be considered
Representativeness	*Criteria for representative vegetation and aquatic habitats:* • Typical structure and composition • Indigenous species dominate • Expected species and tiers are present • Thresholds may need to be lowered where all examples of a type are strongly modified. *Criteria for representative species and species habitats:* • Species assemblages that are typical of the habitat • Indigenous species that occur in most of the guilds expected for the habitat type

[1] ZOI (Zone of Influence) in Roper-Lindsay *et al.* (2018) defines the Zone of Influence as "*the areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities.*"

Rarity/distinctiveness	*Criteria for rare/distinctive vegetation and habitats:* • Naturally uncommon or induced scarcity • Amount of habitat or vegetation remaining • Distinctive ecological features • National Priority for Protection *Criteria for rare/distinctive species or species assemblages:* • Habitat supporting nationally threatened or At-Risk species, or locally uncommon species • Regional or national distribution limits of species or communities • Unusual species or assemblages • Endemism
Diversity and Pattern	• Level of natural diversity, abundance and distribution • Biodiversity reflecting underlying diversity • Biogeographical considerations- pattern, complexity • Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	• Site history and local environment conditions which have influenced the development of habitats and communities • The essential characteristics that determine an ecosystems integrity, form, functioning and resilience (from 'intrinsic value' as defined in RMA) • Size, shape and buffering • Condition and sensitivity to change • Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material • Species role in ecosystem functioning - high level, key species identification, habitat as proxy

Table 3. Assigning value to areas (Roper-Lindsay et al. 2018)

Value	Determining Factors
Very High	Area rates 'High' for at least three of the assessment matters of Representativeness, Rarity/distinctiveness, Diversity and Pattern, and Ecological Context. Likely to be nationally important and recognised as such.
High	Area rates 'High' for two of the assessment matters, and 'Moderate' and 'Low' for the remainder OR area rates 'High' for one of the assessment matters and 'Moderate' for the remainder. Likely to be regionally significant and recognised as such.
Moderate	Area rates 'High' for one of the assessment matters, 'Moderate' or 'Low' for the remainder OR area rates as 'Moderate' for at least two of the assessment matters and 'Low' or 'Very Low' for the remainder. Likely to be important at the level of the Ecological District.
Low	Area rates 'Low' or 'Very Low' for majority of assessment matters, and 'Moderate' for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates 'Very Low' for three assessment matters and 'Moderate', 'Low' or 'Very Low' for the remainder.

3.1 Terrestrial Ecology

A desktop review of terrestrial characteristics was undertaken of the site, which included reviews of aerial imagery and consideration of the extent of vegetation present. Potential fauna habitats were assessed qualitatively, in conjunction with database reviews (e.g., Department of Conservation's BIOWEB database, Auckland Council's Herpetofauna database, and online eBird and iNaturalist citizen science databases) of historical lizard, bird, and bat records. Databases were used to determine likely presence lizards, birds, and bats.

3.2 Freshwater Ecology

Watercourses were classified under the Auckland Unitary Plan Operative in Part (AUP) to determine, in accordance with the definitions in these plans, the ephemeral, intermittent or permanent status of these watercourses. During the site assessments, the presence and extent of water was noted, reference photos were taken and freshwater habitats were marked using a handheld GPS unit. The quality of the aquatic habitat was assessed, noting ecological aspects such as channel modification, hydrological heterogeneity, riparian vegetation extent, substrate type and any fish or macroinvertebrate habitat observed. Riparian and catchment information was also reviewed.

Potential wetlands were assessed following the Ministry for the Environment's (MfE) wetland delineation protocols (Ministry for the Environment, 2020), including vegetation assessments and wetland hydrology to determine whether areas met the definition of a 'natural inland wetland' under the NPS-FM.

Vegetation was assessed based on the dominance and prevalence of:

- Obligate wetland vegetation (OBL) – almost always in wetlands, rarely in uplands;
- Facultative wetland (FACW) – usually occurs in wetlands but occasionally found in uplands;
- Facultative (FAC) – commonly occurs in either wetlands or uplands;
- Facultative upland (FACU) – occasionally occurs in wetlands but usually in uplands; and
- Upland (UPL) – rarely occurs in wetlands, almost always in uplands.

Where the dominance and/or prevalence tests showed unclear results, hydric soils and hydrology tests were undertaken in accordance with the associated protocols (Fraser *et al*., 2018; Ministry for the Environment., 2021).

4 SUNFIELD NORTH

4.1 Background and Ecosystem Classification

Historically (pre-human), the site would have comprised of the ecosystem extent 'bog/fen mosaic'. These fen mosaic ecosystems are characteristic of the Manukau ecological district, which is characterised by low altitude topography near the Manukau Harbour with a warm humid climate, with poorly drained and gleyed alluvial soils and peats on river flats and swamps.

Historic aerial images show the site has been devoid of vegetation for approximately 60 years, with the only vegetation observed in aerials from 1960 consisting of pasture and shelter belts (Figure 2). The site, and much of surrounding landscape, has consisted of agricultural farmland until present day, with the Ardmore Airfield directly adjacent to the east of the site. Currently, the site consists of rural land utilised for grazing, with exotic and indigenous shelter belts and livestock shade trees (Figure 3). A small kahikatea stand is established within a north-eastern paddock and has been present within the property for at least 60 years.

Due to the historical and current intensive agricultural and pastoral land use activities, the site contains predominantly pasture, with very limited shrub/tree vegetation. The key terrestrial ecological values of the site are associated with the shelter belts, riparian yards and isolated kahikatea stands (Figure 3). The site does not support a Significant Ecological Area (SEA), recognised ecosystem type, or notable tree overlay.

Figure 2. Historic aerial image of Sunfield North from 1960. Image sourced from Retrolens.

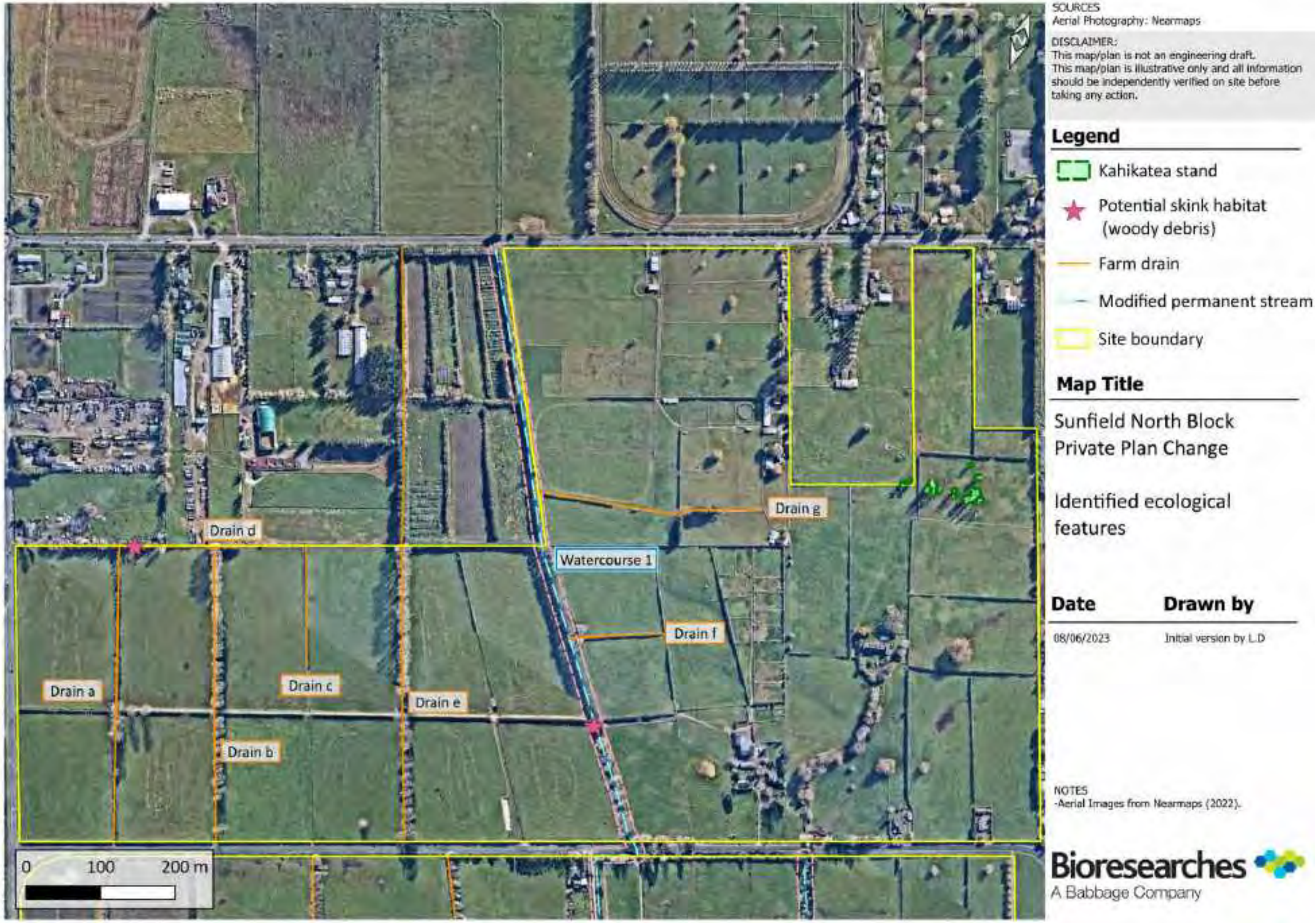

Figure 3. Identified ecological features within the Sunfield North Block.

4.2 Terrestrial Ecology

4.2.1 Vegetation

The overall ecological value of the vegetation was assessed to be **Low.**

The majority of the vegetation present within the site is exotic and consists of pastoral grazing land (Photo 1 and Photo 2). Woody vegetation and indigneous trees throughout the area consisted of trees within the shelter belts and riparian margins, stock shade trees, amenity planting and a stand of kahikatea (*Dacrycarpus dacrydioides*) within a northern paddock.

The riparian yards and shelter belts consisted of mixed exotic and native vegetation with exotic vegetation including barberry (*Berberis glaucocarpa*) poplars (*Populus deltoides*), Japanese cedar (*Cryptomeria japonica*), pine (*Pinus* sp.), immature tree privet (*Ligustrum lucidum*) and woolly nightshade (*Solanum mauritianum*) (Photo 3 and Photo 4). Lianes such as ivy (*Hedera helix*), moth plant (*Araujia hortorum*) and Japanese honeysuckle (*Lonicera japonica*) were overgrowing the woody vegetation. The understory vegetation throughout included sedges (*Carex* sp.), rank long grasses, and blackberry (*Rubus fruticosus*).

Photo 1. View of pasture grasses with deciduous shelter belt.

Photo 2. Pasture grasses with exotic shelter belts throughout the site.

Photo 3. Exotic woody trees were present in the riparian yard and shelter belts

Photo 4. Barberry shrubs were utilised as shelter belts

Native vegetation within the site was largely limited to the riparian yards and shelter belts, which contained tōtara (*Podocarpus totara*) and lemonwood (*Pittosporum eugenioides*) (Photo 5 and Photo 6). The kahikatea stands were fragmented, between 30 m^2 to 330 m^2 in size, and isolated from the remaining native vegetation within the site. The area within the stands had been impacted by stock; with pugging throughout the area, there was a lack of functional understory and groundcover tiers, and there was minor damage to the bark and trunk of the kahikatea (Photo 7 and Photo 8).

Photo 5. Small native shrubs within the shelter belt of Drain a

Photo 6. Drain a contained tōtara dense riparian yard and shelter belt.

Photo 7. Kahikatea stands on the northern side of the site.

Photo 8. The understory was bare and pugged with some bark damage on the lower trunk.

4.2.2 Connectivity and Ecological Function

The terrestrial vegetation, as it pertains to ecological connectivity and function, was considered to be of **Low** ecological value**.**

Connectivity between areas of vegetation is important to facilitate ecological function. Edge communities are heavily influenced by increased exposure to light, drying winds and competitive weeds. This 'edge effect' restricts some native flora and fauna to forest interiors. Patch fragmentation increases the edge effect and decreases the availability of habitat for interior species. Loss of ecological connectivity can also impair reproductive function in both flora and fauna.

All exotic and native vegetation within the site is isolated within the surrounding environment and there is no direct connectivity to significant terrestrial habitat. The nearest extensive area of vegetation is located more than 2 km to the south-east of the site. The vegetation within Sunfield North is limited to isolated, narrow strips such as shelter belts, riparian yards and the kahikatea stands. The contiguous areas of indigenous vegetation within the Sunfield North site are limited to the tōtara shelter belt lining Drain A, on the western side of the site; and kahikatea stands on the north-eastern side of the site. The vegetation is highly fragmented and is subject to edge effects.

4.2.3 Indigenous Fauna

4.2.3.1 Herpetofauna

Herpetofauna (reptiles and amphibians) comprise a significant component of New Zealand's terrestrial fauna. There are currently 125 terrestrial, endemic herpetofauna taxa recognised in New Zealand (Hitchmough *et al.*, 2021), approximately 85% of which are considered 'Threatened' or 'At Risk'. All indigenous reptiles and amphibians are legally protected under the Wildlife Act 1953 and vegetation and landscape features that provide significant habitat for native herpetofauna are protected by the Resource Management Act 1991. Statutory obligations require management of resident reptile and amphibian populations if they are threatened by land disturbance i.e. land development.

No formal herpetofauna surveys were undertaken as part of this assessment. A review of historic lizard records from within 10 km of the project area indicated that copper skink, forest gecko, elegant gecko, and pacific gecko have been recorded within the wider landscape (DOC BIOWEB Herpetofauna and Auckland Council Herpetofauna databases).

Table 4. Herpetofauna that may be present within Sunfield North and/or have been recorded within 10 km of the project footprint (mainland taxa only), including conservation threat status (Hitchmough et al., 2021), and potential occurrence within the site.

	Common Name	Species Name	NZ threat status	Distance to nearest record	Habitat potential within site
Indigenous	Copper skink	*Oligosoma aeneum*	At Risk – Declining	< 1 km	✓
	Forest gecko	*Mokopirirakau granulatus*	At Risk - Declining	< 7 km	×
	Elegant gecko	*Naultinus elegans*	At Risk – Declining	< 4 km	×
	Pacific gecko	*Dactylocnemis pacificus*	Not Threatened	< 7 km	×
Exotic	Plague skink	*Lampropholis delicata*	Introduced & naturalised	< 1 km	✓
	Southern bell frog	*Ranoidea raniformis*	Introduced & naturalised	< 6 km	✓
	Green and golden bell frog	*Ranoidea aurea*	Introduced & naturalised	< 5 km	✓

For gecko (pacific, forest and elegant gecko) populations to persist, vegetated areas with good connectivity needs to be relatively stable over time. Due to the lack of established indigenous vegetation and complete lack of connectivity to other suitable habitat, these geckos are not expected to be found within the site. Copper and ornate skinks are generally found in areas supporting dense ground cover (including exotic rank grasses) or under logs or other debris around forest floors or vegetated edge habitats. Copper skinks occur widely throughout the Auckland region. Throughout the site, low quality skink habitat is present in the form of rank long grasses within the shelter belts. Due to the presence of low-quality skink habitat, and recorded observations within 2 km of the site, copper skink may be present within Sunfield North.

4.2.3.2 Avifauna

Due to the isolated nature and high edge effects, the avifauna habitat value within the site was considered to be **Low**.

A formal avifauna survey was not undertaken; however, an opportunistic survey was carried out and all avifauna seen or heard were recorded. During the site assessment, a range of common 'Not Threatened' indigenous birds and exotic birds were seen or recorded including welcome swallow (*Hirundo neoxana*), swamp harrier (*Circus approximans*), pūkeko (*Porphyrio melanotus*), with exotic species consisting of sparrow (*Passer domesticus*), and rosella (*Platycercus eximius*).

Desktop investigations show a range of commonly seen indigenous avifauna are present within the general area of the site, including sacred kingfisher (*Todiramphus sanctus*), waxeye (*Zosterops lateralis*), black-backed gulls (*Larus dominicanus*) and red-billed gulls (*Chroicocephalus novaehollandiae*). No suitable habitat for gulls was considered to be present within the site, however the species may rarely visit the site for resting and scavenging, but it is highly unlikely that 'At Risk' or 'Threatened' species would utilise the site on a permanent basis.

Table 5. Avifauna observed within Sunfield North, and avifauna recorded within close proximity to the site, including conservation status (Robertson et al, 2021).

Species name	Common name	Classification	Observation
Larus dominicanus	Black-backed gull	Not Threatened	eBird
Fringilla coelebs	Chaffinch	Introduced & naturalised	On-site
Gerygone igata	Grey warbler	Not Threatened	eBird
Phasianus colchicus	Pheasant	Introduced & naturalised	On-site
Himantopus himantopus	Pied stilt	Not Threatened	On-site
Vanellus miles	Plover	Not Threatened	On-site
Porphyrio melanotus	Pūkeko	Not Threatened	On-site
Chroicocephalus novaehollandiae	Red-billed gull	At Risk – Declining	eBird
Platycercus eximius	Rosella	Introduced & naturalised	On-site
Todiramphus sanctus	Sacred kingfisher	Not Threatened	eBird
Alauda arvensis	Skylark	Introduced & naturalised	On-site
Passer domesticus	Sparrow	Introduced & naturalised	On-site
Circus approximans	Swamp harrier	Not Threatened	On-site
Zosterops lateralis	Waxeye	Not Threatened	eBird
Hirundo neoxena	Welcome swallow	Not Threatened	On-site
Egretta novaehollandiae	White-faced heron	Not Threatened	eBird

4.2.3.3 Bats

Long-tailed bats (pekapeka; *Chalinolobus tuberculatus*) are classified as 'Nationally Critical' (O'Donnell et al., 2023). No bat surveys have previously been undertaken within the site. There is one bat record within 5 km, situated 4.7 km north of the site. A number of bat passes have been recorded within 25 km of the Site, including (Figure 4):

- A large number of records associated with Hunua Ranges Regional Park, a known stronghold for long-tailed bats
- A large number of records to the south/ south-east of the Site in the Franklin District, which is known to harbour multiple pekapeka colonies
- Two records north of the site, in the rural landscape surrounding Flat Bush

There are a sizeable number of bat surveys with no detections in proximity to the Site, especially near to the higher density housing areas of Papakura.

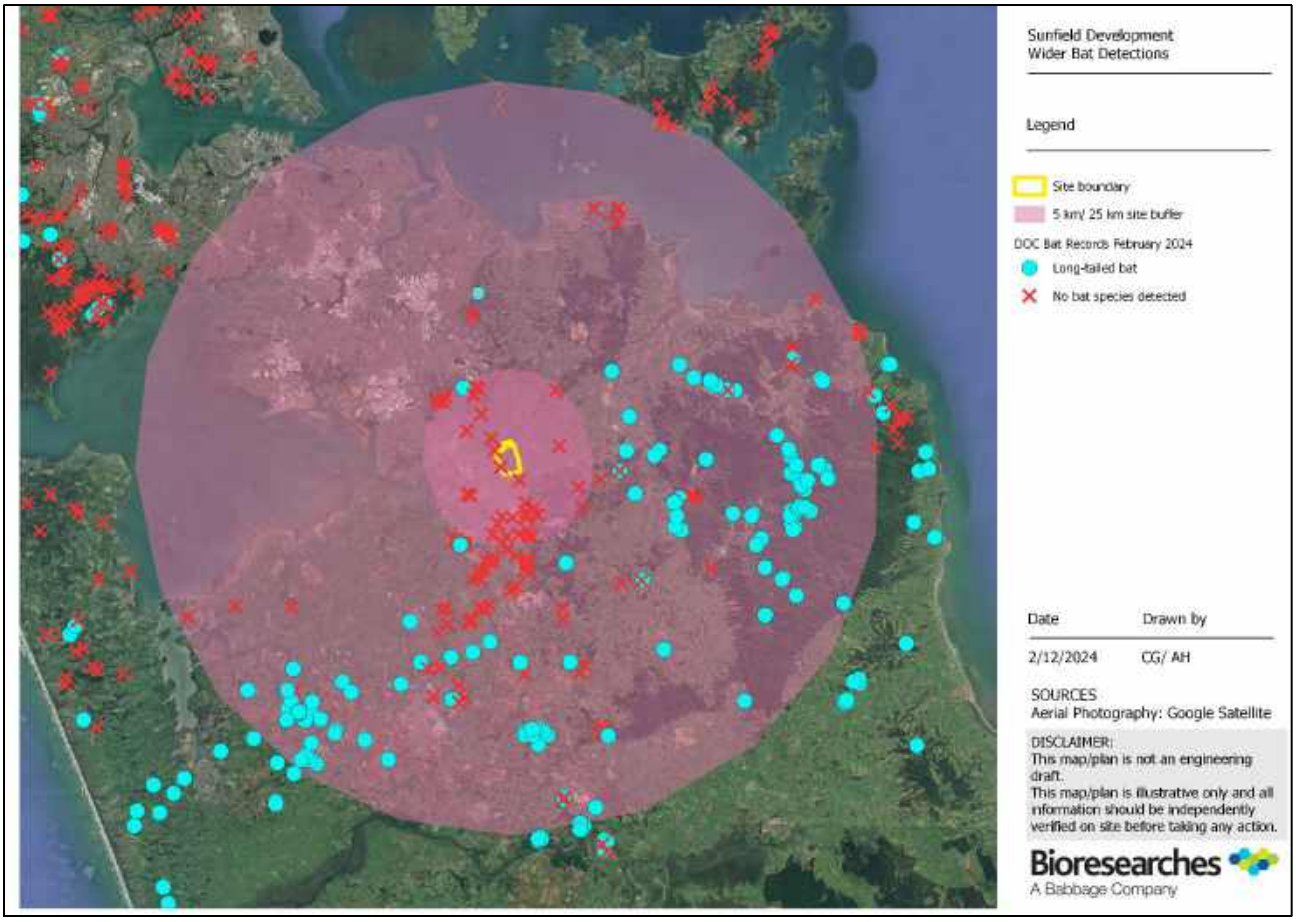

Figure 4. Map of wider bat detections with 5 km buffer (inner pink circle) and 25 km buffer (large pink circle) provided for context

Long-tailed bats typically use linear landscape features such as bush edges, gullies and water courses to transit between roosting and feeding sites (Borkin and Parsons 2009; Griffiths 1996). They also tend to forage in open areas, including clearings (Borkin and Parsons 2009; Griffiths 1996), along forest edges (Alexander 2001), over wetlands, open water, and along rivers and quiet roadways (Borkin and Parsons, 2009; Griffiths, 1996). Long-tailed bats may travel up to 19 km between roost sites and foraging areas (O'Donnell, 2001).

Bats are dependent on roosting cavities with specific microclimates, which are typically rare in anthropogenic landscapes. They require large trees (including exotic and standing dead trees) with cavities (e.g., knot holes, hollows), and from summer, communal roosts are dominated by females and young. However, individual bats may still refuge beneath other suitable features such as within epiphytes, loose bark, hollow tree ferns or under dense tree fern skirts. In other areas of New Zealand, long-tailed bats are known to roost in stands of kahikatea, albeit denser and larger than the stands present within the site (Photo 9).

Photo 9. Kahikatea stand in Rukahia (south Hamilton) which is used for roosting by the local long-tailed bat population. Photo from Google Maps.

A survey using Automatic Bat Monitors (ABMs; DOC AR4s) was conducted with 6 units from 4/4/24 – 19/4/24 across the Sunfield North and South sites, with placement targeting linear features such as tree rows which might be used as flyways and waterways which could support drinking/ foraging habitat for bats (Figure 5). One ABM failed (Unit 6), and no bats were detected with the remaining five units during the total 67 valid survey nights (Table 6).

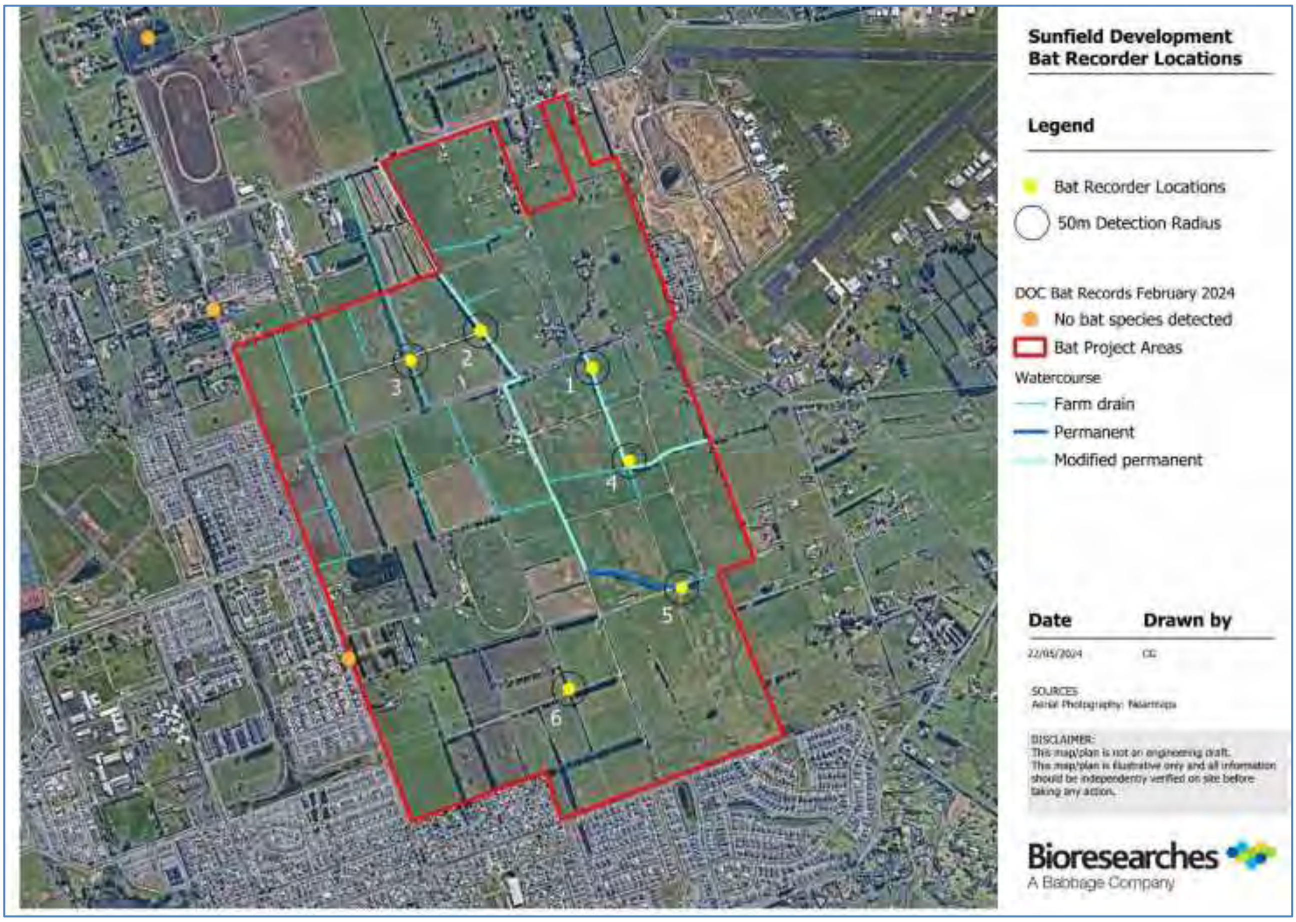

Figure 5. April 2024 bat survey ABM locations

Table 6. Summary of bat survey results

Recorder	Type	Date Set	Date Complete	Valid Survey Nights	Bat passes?
1	AR4	04/04/24	16/04/24	13	N
2	AR4	04/04/24	19/04/24	15	N
3	AR4	04/04/24	17/04/24	14	N
4	AR4	04/04/24	14/04/24	11	N
5	AR4	04/04/24	17/04/24	14	N
6	AR4	04/04/24	Unknown	-	-

While the survey detected no bats at the site, pekapeka are known to alter their habitat use throughout the year based on food availability and differing roost requirements across seasons and life stages. Without multiple surveys to span the breeding season, we cannot make conclusive statements regarding use of the site by long-tailed bats. However, the survey targeted the late-season period where young are volant and moving around the landscape, and breeding females have finished lactating/ care of young and broaden their home ranges (O'Donnell, 2001), likely increasing chance of detection during surveys.

The negative survey combined with the site's limited habitat and proximity to urban areas makes it unlikely the Sunfield site is used with high frequency by bats, but they may intermittently utilise the site for commuting, foraging, or potentially roosting – although it should be noted that the potential roosting habitat present is poor quality due to the sparse, exposed nature of existing tree stands (i.e. cavities would likely have poor thermal stability).

When considering the ecological value of the site for long-tailed bats, considerations were made in regard to to the presence of roost trees (being 'very high' value bat habitat) with an overall low risk of bats being present. Conservatively, the ecological value of bats was considered to be **Moderate.**

The closest records of short-tailed bats (*Mystacina tuberculata* – 'Nationally Vulnerable') are outside the Auckland region (excepting Little Barrier Island), with the nearest records within the Coromandel region. This species has far more specific habitat requirements than long-tailed bats (mature forest tracts with minimal introduced predators). No short-tailed bats were detected in the site survey. Consequently, this species is considered highly unlikely to be present within the Site and has not been considered further.

4.2.4 Terrestrial Ecological Values Overview of Sunfield North

Matter	Score and justification
Representativeness	**Low** Vegetation within the site is not representative of the ecological district, or historic ecosystem extents. Rare kahikatea stands are grazed and lack functional understory and groundcover tiers, with the ecological integrity compromised by browse pressure. Fauna diversity is not high and predominantly consists of exotic or common 'Not Threatened' indigenous fauna.
Rarity/distinctiveness	**Moderate** No naturally uncommon or rare flora species are present within the site. The diversity of indigenous flora is low and includes common 'Not Threatened' flora species. Fauna values generally considered to be low, with the diversity of avifauna typical of common or exotic species. There is the potential presence of 'At Risk' terrestrial fauna species (copper skink), often associated with edge and regenerating ecosystems, and also remaining (low) chance that 'Threatened' long-tailed bats are present at other times of year.
Diversity and pattern	**Low** Floral diversity and pattern are low due to the lack of the expected range and abundances of species within all vegetation tiers. Vegetation within the site is predominantly mixed exotic and native vegetation, with no diversity in structure. Indigenous vegetation is generally of small, isolated fragments providing no connectivity to the wider ecological area. The lack of diversity of fruiting and flowering species that would provide a year-round food source that would attract a wide diversity of native avifauna is low.
Ecological context	**Low** The vegetation is surrounded by residential subdivisions and rural land, and is generally of low botanic quality. The small areas of indigenous vegetation provide important linkages or stepping stone habitat within the local or wider landscape context. None are providing significant or important buffering to indigenous areas of vegetation.
Overall Ecological Value	**Moderate**

4.3 Freshwater Ecology

Auckland Council Geomaps indicate several watercourses to be present throughout the site (Figure 1). These were ground truthed and classified during the site assessment as to their artificial, intermittent or permanent classification. The watercourses within Sunfield North predominantly consisted of modified permanent streams or artificial drainage channels. No natural inland wetlands were observed within the site. (Figure 3).

4.3.1 Watercourse 1

The ecological values of Watercourse 1 were assessed as **Low.**

Watercourse 1 is a **permanent stream** which has been historically modified through straightening and deepening, and potentially diversion (Photo 10). Watercourse 1 is visible on historic aerials from 1960, and it is likely the natural stream channel has been modified for over 80 years. Watercourse 1 was considered to be a modified permanent stream, rather than artificial due to the connectivity to the wider freshwater catchment on the upstream and downstream reaches. Watercourse 1 enters the site through a roadside drain on the southern portion of the site, and flows in a northern direction through an unnaturally straight and deep channel (Photo 11) for approximately 400 m before discharging from the site.

Photo 10. Watercourse 1 consisted of a modified permanent channel.

Photo 11. Watercourse 1 was unnaturally straight and deep.

Watercourse 1 was wide and deep, with the channel approximately one metre in width and surface water approximately 0.5 m deep. An embedded culvert is present in the stream channel resulting in a drop-in stream bed levels by approximately 0.3 m (*Photo 12*). The channel banks were incised and steep, approximately 0.6 m, restricting connectivity to the floodplain. Substrate throughout Watercourse 1 was predominantly soft with the channel bed consisting of compacted earth and a layer of fine sediments (*Photo 13*). A high degree of organic matter is present within the stream channel with leaf litter and woody debris established throughout. Hydrological variation within the stream reach is low, with the channel predominantly consisting of a straight run and shallow pools, however some woody debris dams have resulted in minor riffle habitat.

Photo 12. An embedded culvert is present within the stream channel

Photo 13. Watercourse 1 contained incised banks and soft substrates.

Riparian vegetation throughout Watercourse 1 was variable, with shade higher on the downstream reach, with more riparian vegetation present on the stream bank. Vegetation observed included Japanese cedar, tree privet, tōtara, and deciduous trees. On the downstream reach, the proportion of indigenous vegetation increased with tōtara, and flax (*Phormium tenax*) more abundant (*Photo 14*). Ground cover throughout the riparian yard was low, and largely consisted of bare ground, leaf litter, and grasses, lacking complexity. Although the band of trees and shrubs in the riparian yard was very narrow ranging from 0.4 m to 1 m in width and provided an overall moderate degree of shading. Bank stability and filtration low due to the sparse ground cover with evidence of bank incision and collapse present.

Photo 14. Native vegetation established on the downstream reach.

Photo 15. Aquatic habitat was low and limited to runs and occasional pools.

There was a low degree of aquatic habitat and diversity throughout the reach, with available habitat consisting of runs, occasional pools and debris (including rubbish and wood) (*Photo 15*). An embedded culvert is present within Watercourse 1, with the culvert pipe below the stream bed resulting in a "drop" which likely acts as a partial barrier to fish passage. Shortfin eel and banded kōkopu have been recorded within 2 km of the site, within similar freshwater environments (i.e. highly modified farm drains and artificial channels), and are likely to access and reside within Watercourse 1.

4.3.2 Artificial channels

The artificial drainage channels were considered to be of **Low** ecological value.

Within the Sunfield North site, multiple farm drains were present, intersecting the edges of the paddocks. The drains were classified as **artificial watercourses**, as they are not present on historic aerials from 1960, and no natural overland flow paths are present in the area which may have been modified to form the farm drains (Figure 2). The farm drains on the western side of the site (Drain a, b, c; Figure 3, *Photo 16* - *Photo 18*) transport water in a northern direction and discharge to Drain d on the northern side of the site (*Photo 19*). Drain e bisects the length of the western portion of the site and enters the neighbouring property on the northern boundary (*Photo 20*), discharging into a roadside drain on Airfield Road. Drains f and g flow in a western direction and discharge into Watercourse 1 (*Photo 21*). The drainage channels pass under the farm tracks via culverts, with undersized culverts observed within the lower reaches of Drain c and Drain e.

Photo 16. Drain a

Photo 17. Drain b

Artificial Drain a, b, d and e were relatively uniform in stream morphology and shape, with the channels straight, approximately one metre in width and water depth between 0.2 m to 0.6 m. Drain c, f and g were narrower, approximately 0.5 m wide and were either dry or contained shallow (<0.1 m depth) standing water. Each drain consisted of a single run and occasional scour pools, with soft substrates and macrophytes such as willow weed (*Persicaria maculosa*) and starwort (*Callitriche stagnalis*) growing within the drain channel. Long filamentous brown algae dominated Drain d with a sulphuric smell present. Water clarity was variable throughout the drains with Drain a, d, and e, containing clear, but tannin coloured water while Drains b, c, f and g were opaque indicating a high degree of turbidity present.

Photo 18. Drain c

Photo 19. Drain d

Photo 20. Drain e

Photo 21. Drain f

Riparian vegetation lining the artificial drains consisted of shelter belts, with the vegetation observed mixed exotic and native. The dominant vegetation included poplars, Japanese cedar, barberry, and poplar, with rank grasses and occasional sedges forming the ground cover. The riparian yards of each drain was fenced and consisted of a narrow (0.5 m to 1 m) band of shrubs and trees before reverting to pasture grasses. The lower portion of Drain a, the shelter belt/riparian yard was formed by tōtara with juvenile lemonwoods, and exotic groundcover vegetation throughout.

Aquatic habitat within the drainage channels was low and restricted to single runs and occasional areas of woody debris. Due to the degraded state, indigenous aquatic fauna which would access and reside within the drainage channels would be restricted to robust species such as shortfin eel, and potentially banded kōkopu.

4.3.3 Freshwater Ecological Values Overview of Sunfield North

Matter	Score and justification
Representativeness	**Low** The permanent stream is highly modified through straightening and deepening to form a drainage channel for the surrounding landscape. The stream reach and artificial drainage channels are soft bottomed with fine sediments present throughout with reduced water quality and increased turbidity. Riparian vegetation narrow (<2 m) and consisting of mixed exotic and native vegetation which lacks functional understory and ground cover, consists of weedy shrubs, rank grasses and/or bare ground. Macrophyte species consist of exotic specimens, with no native species. Indigenous aquatic fauna that would be present within freshwater ecosystems consist of locally common, robust species and exotic species.
Rarity/distinctiveness	**Low** Watercourses are modified or artificially constructed with low aquatic habitat and riparian yard functions. Watercourses are unlikely to provide habitat to 'At Risk' species such as longfin eel due to highly degraded habitats. Contains low diversity in aquatic habitat which is limited to runs and occasional shallow pools.
Diversity and pattern	**Low** Low natural diversity in stream morphologies with the watercourses consisting of uniform channels due to modification and construction. Low natural diversity of aquatic fauna due to the degraded state of the watercourses, and lack of aquatic habitat variation Macroinvertebrate communities expected to consist of pollutant tolerant species. Low complexity in in-stream habitats, stream morphology and riparian yards.
Ecological context	**Low** Highly modified or constructed watercourses to facilitate farm drainage providing poor instream habitat, consisting of turbid, nutrient enriched waters with soft sediments and uniform channel shape and morphology. Riparian margins are narrow (>2 m), and consist of exotic and native shelter belt trees, lacking complex understory or groundcover with an overall low degree of overhanging vegetation. Watercourses within the site provide a low connectivity to the wider catchment
Overall Ecological Value	**Low**

5 SUNFIELD SOUTH

5.1 Background and Ecosystem Classification

Historically (pre-human), the site would have comprised of a mixture of bog/fen mosaic, pūriri forest (WF7-1), and kahikatea, pukatea forest (WF8) ecosystem types. These forest and fen mosaic ecosystems are characteristic of the Manukau Harbour with a warm humid climate (favouring WF8) and mild winters with either drained volcanic solids (favouring WF7-1) or poorly drained and gleyed alluvial soils and peats on river flats and swamps.

Historic aerial images show Sunfield South has been cleared of vegetation since 1960, with the only vegetation present situated within shelter belts throughout the site (Figure 6). The site has been used as agricultural land since the 1960s, with the surrounding landscaping consisting of farmland till present day. Agricultural activities undertaken in Sunfield South overtime consist of pasture grazing and horticulture crops. Currently, the site consists of a few small dwellings, and paddocks with a land use mixture of livestock grazing for horse and cattle, and cropping, including berries.

Due to historic and current intensive agriculture and pastoral land use, the site contains predominantly pasture, with very limited shrub and tree vegetation. The site does not support a SEA. The key terrestrial ecological values of the site are associated with occasional indigenous vegetation largely limited to the riparian yards, managed pasture, and shelterbelts (Figure 7). The ecological values of these features are linked to indigenous terrestrial fauna that may be utilising these as habitat.

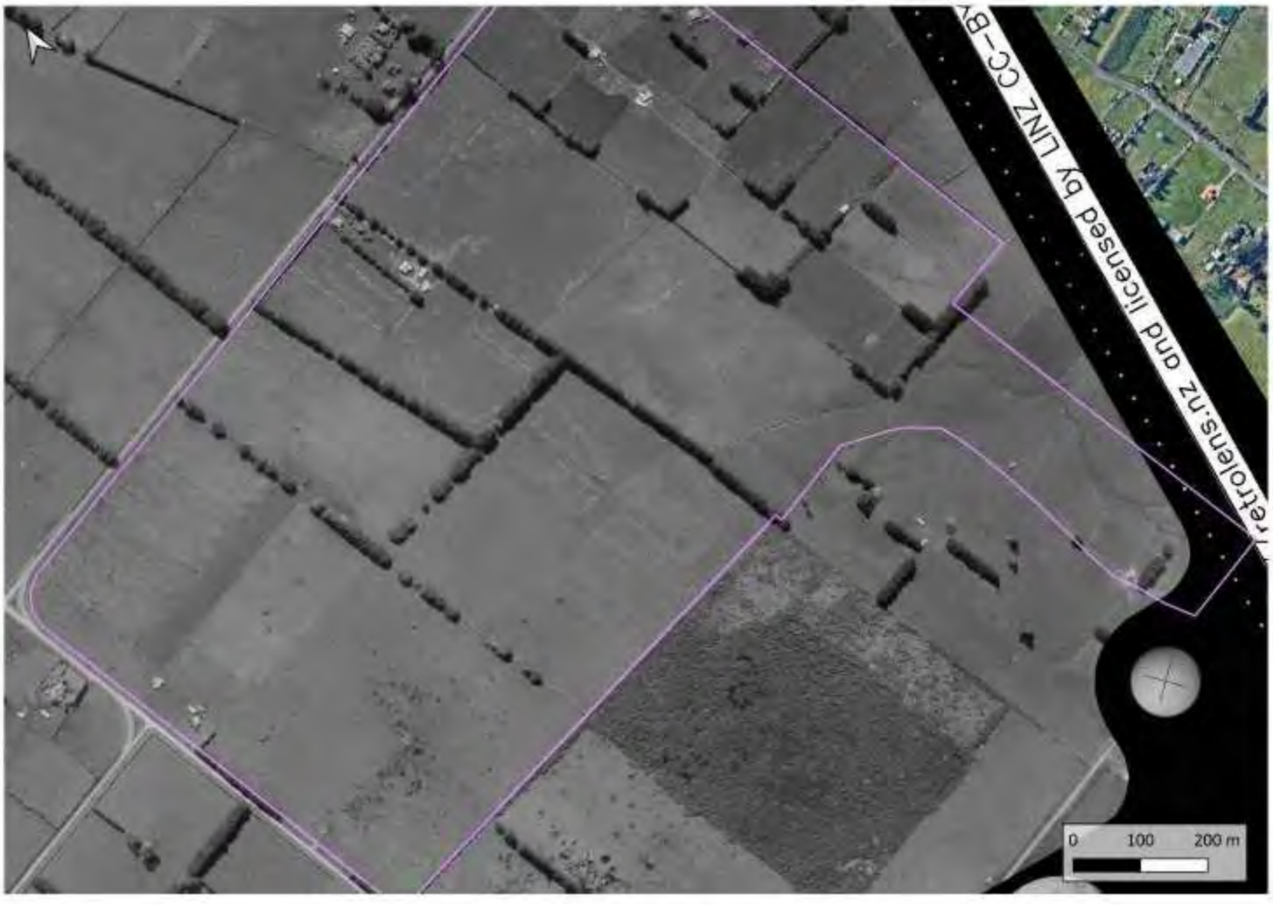

Figure 6. Historic aerial image of Sunfield South from 1960. Image sourced from Retrolens.

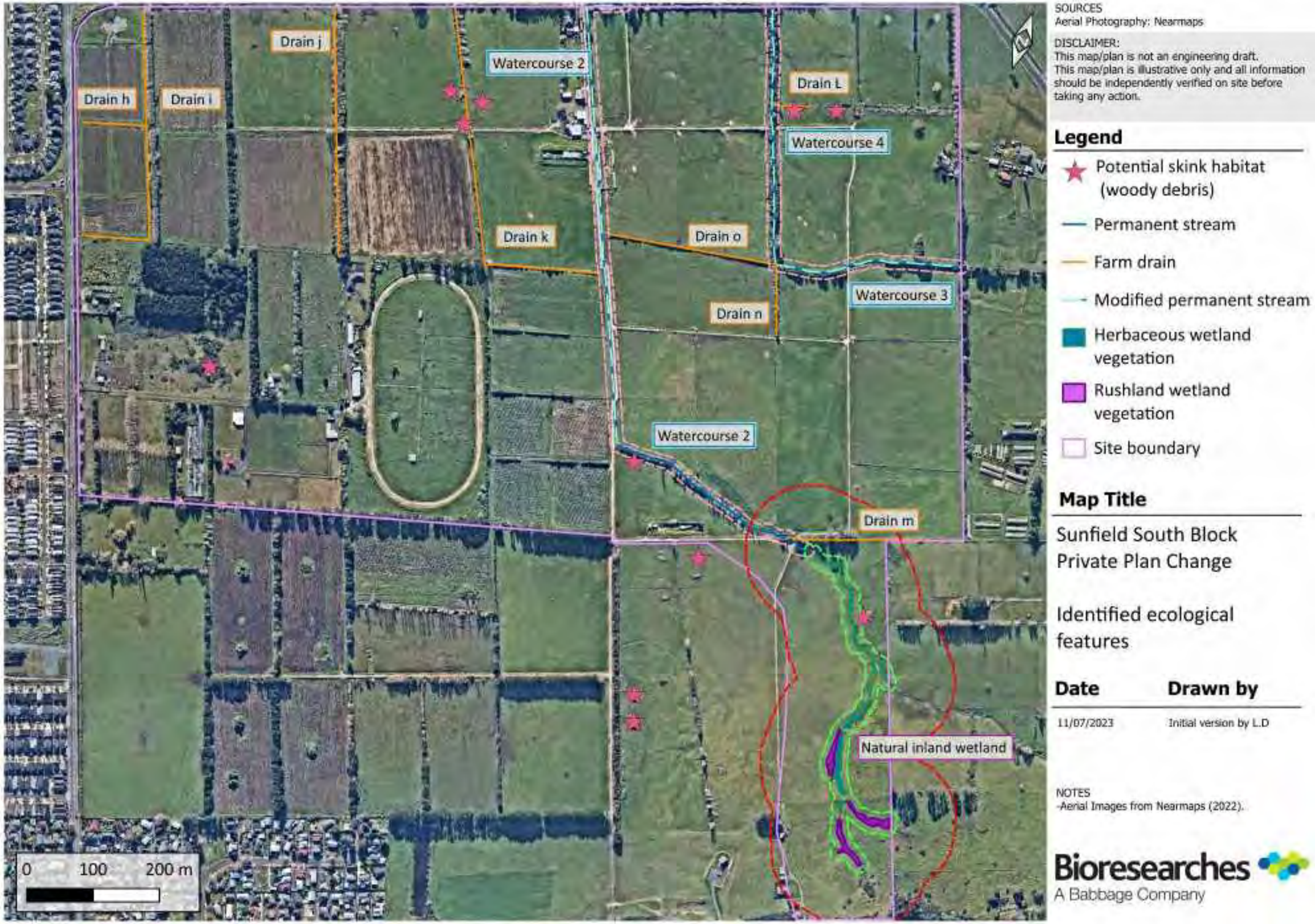

Figure 7. Identified ecological features within the Sunfield South block.

5.2 Terrestrial Ecology

5.2.1 Vegetation

The overall ecological value of vegetation areas within Sunfield South was assessed to be **Low**.

The majority of the vegetation present within Sunfield South is exotic and largely consists of vegetation for agricultural purposes (*Photo 22* & *Photo 23*). Woody vegetation such as trees and shrubs were largely limited to shelter belts and riparian yards which comprised of common, introduced species such as tree privet, poplars, willow (*Salix* sp.), cypress and pine (*Photo 24*). Within these shelter belts and riparian yards, pest infestation is present with gorse and woolly nightshade, with Japanese honeysuckle, morning glory, and ivy observed overgrowing the woody vegetation.

Native vegetation within the site is limited, and largely restricted to occasional tōtara trees within the shelter belts and riparian yard (Photo 25). The 'Ecosystem Current Extent' overlay in Geomaps does not classify any of the terrestrial features within the site as native ecosystems.

Photo 22. Horticultural paddocks within Sunfield South.

Photo 23. Pasture grazing vegetation within Sunfield South.

Photo 24. Woody vegetation was restricted to shelter belts and riparian yards.

Photo 25. Spare native vegetation was present in the shelter belts.

5.2.2 Connectivity and Ecological Function

The terrestrial vegetation, as it pertains to ecological connectivity and function, was assessed to be **negligible**.

Connectivity between areas of vegetation is important to facilitate ecological function. Edge communities are heavily influenced by increased exposure to light, drying winds, and competitive weeds. This 'edge effect' restricts some native flora and fauna to forest interiors. Patch fragmentation increases the edge effects and decreases the availability of habitat for interior species. Loss of ecological connectivity can also impair reproductive function for both flora and fauna.

All exotic and native vegetation within the site is isolated within the surrounding environment and there is no direct connectivity to significant terrestrial habitats. The nearest extensive area of vegetation is located approximately 1.5 km east of Sunfield South. As the vegetation within the site is limited to isolated, narrow strips of shelter belt and riparian yard, the vegetation is highly fragmented and subject to significant edge effects.

5.2.3 Indigenous Fauna

5.2.3.1 Herpetofauna

No formal herpetofauna surveys were undertaken as part of this assessment. A review of historic lizard records from within 10 km of the project area indicated that copper skink, forest gecko, elegant gecko, and pacific gecko have been recorded within the wider landscape (DOC BIOWEB Herpetofauna and Auckland Council Herpetofauna databases).

Table 7. Herpetofauna that may be present within Sunfield South and/or have been recorded within 10 km of the project footprint (mainland taxa only), including conservation threat status (Hitchmough et al., 2021) and potential occurrence in the site.

	Common Name	Species Name	NZ threat status	Distance to nearest record	Habitat potential within site
Indigenous	Copper skink	*Oligosoma aeneum*	At Risk – Declining	< 2 km	✓
	Forest gecko	*Mokopirirakau granulatus*	At Risk - Declining	< 7 km	×
	Elegant gecko	*Naultinus elegans*	At Risk – Declining	< 4 km	×
	Pacific gecko	*Dactylocnemis pacificus*	Not Threatened	< 7 km	×
Exotic	Plague skink	*Lampropholis delicata*	Introduced & naturalised	< 2 km	✓
	Southern bell frog	*Ranoidea raniformis*	Introduced & naturalised	< 6 km	✓
	Green and golden bell frog	*Ranoidea aurea*	Introduced & naturalised	< 5 km	✓

For gecko (pacific, forest and elegant gecko) populations to persist, vegetated areas with good connectivity needs to be relatively stable over time. Due to the lack of established indigenous vegetation and complete lack of connectivity to other suitable habitat, these geckos are not expected to be found within the site. Copper and ornate skinks are generally found in areas supporting dense ground cover (including exotic rank grasses) or under logs or other debris around forest floors or vegetated edge habitats. Copper skinks occur widely throughout the Auckland region. Throughout the site, low quality skink habitat is present in the form of wooden logs/materials and rank long grasses. Due to the presence of low-quality skink habitat, and recorded observations within 2 km of the site, it is expected that copper skink may be present.

5.2.3.2 Avifauna

Due to the isolated nature and high edge effects, the avifauna habitat value within the site was considered to be **Low**.

A formal avifauna survey was not undertaken; however, an opportunistic survey was carried out and all avifauna seen or heard were recorded. Desktop investigations of indigenous avifauna recorded within close proximity to the site was undertaken. During the site assessment, a range of not threatened indigenous avifauna species were observed, including fantail (*Rhipidura fuliginosa*), swamp harrier, welcome swallow and pūkeko. Additional exotic avifauna seen or heard included sparrow, chaffinch (*Fringilla coelebs*) and skylark (*Alauda arvensis*).

Desktop investigations show a range of commonly seen indigenous avifauna are present within the general area of the site and included sacred kingfisher, waxeye and blacked backed and red bill gulls. No suitable habitat for gulls was considered to be present within the site, however the species may rarely use the site for resting and scavenging, and it is highly unlikely that 'At Risk' or 'Threatened' species would utilise the site on a permanent basis.

Table 8. Avifauna observed within Sunfield South, and avifauna recorded within close proximity to the site, including conservation status (Robertson et al, 2021).

Species Name	Common Name	Threat Classification	Observation
Larus dominicanus	Black-backed gull	Not Threatened	eBird
Fringilla coelebs	Chaffinch	Introduced and Naturalised	On-site
Rhipidura fuliginosa	Fantail	Not Threatened	On-site
Chloris chloris	Greenfinch	Introduced and Naturalised	On-site
Gerygone igata	Grey warbler	Not Threatened	eBird
Acridotheres tristis	Myna	Introduced and Naturalised	On-site
Vanellus miles	Plover	Not Threatened	On-site
Porphyrio melanotus	Pūkeko	Not Threatened	On-site
Chroicocephalus novaehollandiae	Red-billed gull	At Risk – Declining	eBird
Todiramphus sanctus	Sacred kingfisher	Not Threatened	eBird
Alauda arvensis	Sky lark	Introduced and Naturalised	On-site
Passer domesticus	Sparrow	Introduced and Naturalised	On-site
Circus approximans	Swamp harrier	Not Threatened	On-site
Zosperops lateralis	Waxeye	Not Threatened	eBird
Hirundo neoxena	Welcome swallow	Not Threatened	On-site
Egretta novaehollandiae	White-faced heron	Not Threatened	eBird

5.2.3.3 Bats

The April bat survey targeted both the Sunfield North and South areas, with no bats detected (Figure 5).

Available habitat for bats within the Sunfield South site is largely restricted to scattered mature trees and exotic shelter belts. Pines within the site may provide roost habitat for bats on an intermittent basis.

The trees present within the Sunfield South block are considered less likely to support roosting bats than those in the Sunfield North block, due to lower availability of roosting features within the trees. Nonetheless, it is possible that long-tailed bats may visit the site; and could roost within the mature trees if suitable roost features are present, although the likelihood is considered low.

Although no bats were detected during the April 2024 survey and the habitat potential is limited, the presence bats during other times of the year cannot be ruled out. The ecological value of the site for bats is therefore conservatively considered to be **Low.**

5.2.4 Terrestrial Ecological Values Overview of Sunfield South

Matter	Score and justification
Representativeness	**Low** The site is dominated by exotic woody vegetation and pasture grasses, with indigneous vegetation consisting of sparse common trees. Vegetation within the site is not representative of the ecological district, or historic ecosystem extents.
Rarity/distinctiveness	**Moderate** No naturally uncommon or rare flora species are present within the site. The diversity of indigenous flora is low and includes common 'Not Threatened' Fauna values generally considered to be low, with the diversity of avifauna typical of common or exotic species. There is the potential presence of 'At Risk' terrestrial fauna species (copper skink), often associated with edge and regenerating ecosystems, as well as potential for 'Threatened' long-tailed bats
Diversity and patter	**Low** Floral diversity and pattern are low due to the lack of the expected range and abundance of species within all vegetation tiers. Vegetation within the site is predominantly mixed exotic and native vegetation, with no diversity in structure. Indigenous vegetation is restricted to isolated specimens present within the shelter belts and riparian yards. The site lacks diversity and abundance of fruiting and flowering species which would provide a year-round food source.
Ecological context	**Low** The vegetation is surrounded by residential subdivisions and rural land, and is generally of low botanic quality. The vegetation within Sunfield South does not provide linkages or steping stone habitat within the local or wider landscape context. None are providing significant or important buffering to indigenous areas of vegetation.
Overall Ecological Value	**Low**

5.3 Freshwater Ecology

The Auckland Council GeoMaps indicated several watercourses to be present thought Sunfield South (Figure 1). These were ground-truthed and classified during the site assessment as to their permanent, intermittent, ephemeral or artificial status. These watercourses are tributaries of the Papakura Stream, which flows in a western direction before discharging into the Manukau Harbour. One wetland was identified within the site and delineated per the Ministry for the Environments wetland delineated protocol guidelines, and contributes to the aquatic habitat present within the site (Figure 7).

5.3.1 Watercourse 2

The ecological values of Watercourse 2 were assessed as **Low.**

Watercourse 2 was present within the lower half of Sunfield South, forming the headwater of the tributary and flowed through a natural flow path (*Photo 26*) for approximately 750 m before being diverted and deepened into a farm drain (*Photo 27*). Watercourse 2 was classified as a **permanent stream** which has been modified through historic straightening and deepening. The upper reach and headwater of Watercourse 2 flowed through a natural inland wetland, further described in Section 5.3.4. Watercourse 2 had an average width, including the modified reach, of approximately 1 m, with an average depth of 0.5 m. The bank morphology throughout the reach was variable, with some sections containing highly incised, near vertical banks up to 0.5 m high or relatively low sloping banks with connectivity to the floodplain.

Photo 26. Upstream reach of Watercourse 2

Photo 27. Downstream reach of Watercourse 2

Flow was generally slow through Watercourse 2, with hydrological variation relatively low and consisting of runs and pools, with the uneven channel bed around tree roots creating occasional shallow cascades (*Photo 28*). The dominant substrate throughout the reach was soft with a layer of fine silt present on the stream bed (*Photo 29*). Macrophytes growing within the stream reach consisted of water celery (*Helosciadium nodiflorum*), and willow weed, with the density of these macrophytes dependant on shade provided by the riparian yard (*Photo 30*). The riparian yard was fenced, extending approximately one metre from the edge of the stream. Vegetation observed within the riparian yard consisted of occasional willow, poplars and Chinese privet, with understory vegetation consisting of rank pasture grasses (*Photo 31*). Shade was variable and ranged between high to very low, due to the lack of evergreen trees throughout the entire reach.

Photo 28. Root mats present in the upper reach

Photo 29. Watercourse 2 was soft bottomed with a fine layer of silt.

Photo 30. Macrophytes dominated the channel were shade was lowest.

Photo 31. The riparian yard was fenced and consisted of exotic trees.

Aquatic habitat within Watercourse 2 was considered to be low and largely restricted to the upper reach of the stream. Aquatic habitat included runs with of root mats, undercut banks, and occasional pools which would be suitable for common indigenous fish such as shortfin eel and banded kōkopu.

5.3.2 Watercourse 3

The ecological values of Watercourse 3 were assessed as **Low.**

Watercourse 3 was located on the eastern side of Sunfield South, and was classified as a **permanent stream**, which has largely been modified through straightening and deepening (*Photo 32*). Watercourse 3 flowed in an east to west direction for 208 m before forming a confluence with Watercourse 4. Watercourse 3 had an average width of 0.4 m and an average depth of 0.35 m with a relatively consistent channel morphology. The channel banks throughout the reach were steep and incised restricting the connectivity to the floodplain. Hydrological variation throughout Watercourse 3 was low, with the stream reach predominantly consisting of a single slow run and small pools present (*Photo 33*). The dominant substrate throughout Watercourse 3 was soft with fine sediments overlaying the compacted clay bed, and with suspended sediments present within the water column increasing the turbidity.

Photo 32. Watercourse 3 had been modified through straightening and deepening.

Photo 33. The reach consisted of a straight run with little variation.

The riparian yard of Watercourse 3 was fenced approximately 2 m to 4 m from the edge of the stream banks. Riparian vegetation adjacent to the stream was variable, comprised of tōtara, pine, tree privet, Chinese privet (*Ligustrum sinense*), and bamboo (*Bambusa glaucescens*) and overgrown with morning glory (*Ipomoea purpurea*) and bindweed (*Calystegia silvatica*) (*Photo 34* and *Photo 35*). Ground cover consisted of rank pasture grasses and weedy vegetation. The riparian yard provided a moderate degree of shade to the watercourse, particularly on the upstream reach. Filtration and bank stability were considered to be low, as evident by the turbid water and lack of sufficient rooting groundcover.

Photo 34. Occasional woody trees and shrubs present within the riparian yard.

Photo 35. Riparian yard was fenced approximately 2 m from the edge of the stream banks.

Aquatic habitat within Watercourse 3 was low, with a low degree of abundance and diversity. Habitat observed throughout Watercourse 3 consisted of straight runs and occasional pools and overhanging vegetation. Species which could access and reside within Watercourse 3 would be similar to those described in Watercourse 2, consisting of common, robust species.

5.3.3 Watercourse 4

Watercourse 4 flowed in a general south to north direction for approximately 400 m and discharges from the site to a roadside drain. Watercourse 4 had been modified through straightening and deepening with some variation in terms of depth, width, meanders and channel shape than the remaining modified watercourses within the site. Watercourse 4 was more reflective of a natural stream channel (*Photo 36*) and had an average width of 0.3 m and an average water depth of 0.25 m, with the downstream reach widening to approximately 0.6 m in width and deeper water. Channel banks throughout Watercourse 4 were variable with some incision occurring and some relatively low bank profiles providing some connectivity to the floodplain (*Photo 37*).

Photo 36. Watercourse 4 was more reflective of a natural stream channel.

Photo 37. Some sections of the stream bank contained connectivity to the floodplain.

The dominant substrate throughout Watercourse 4 was soft with compacted clay bed and banks and a layer of fine sediment. Root mats, woody debris and leaf litter were prevalent throughout the watercourse with the macrophyte willow weed present along the channel banks and sparse patches of red ludwigia within the stream channel. There was a low degree of hydrological heterogeneity, with the reach consisting of a slow run with occasional fast runs present (Photo 38). Within the slow runs, water clarity was poor indicating turbidity with the fast runs containing clearer water. Vegetation observed throughout Watercourse 4 included poplars, willows, Chinese privet, bamboo and pine, with morning glory, English ivy and Japanese honeysuckle smothering the woody vegetation. Ground cover throughout the riparian yard consisted of rank grasses and leaf litter, with lianes covering the ground and woody vegetation (Photo 39). The riparian yard was fenced approximately 4 m from the banks of the stream, with the vegetation providing a moderate degree of shade to the watercourse. Filtration and bank stability are likely to be low, due to the shallow rooting long grasses and trailing plant groundcover.

Photo 38. Hydrological variation was low and consisted of runs and occasional pools.

Photo 39. The riparian yard was smothered by climbing lianes.

Aquatic habitat abundance and diversity was low, and consisted of slow runs and occasional pools. Some exposed root mats are present on the edges of the stream, which may provide some low-quality fish cover. Aquatic fauna that is likely to be present within Watercourse 4 would be similar to Watercourse 1-3, and include shortfin eel and potentially banded kōkopu.

5.3.4 Artificial Watercourses

The ecological values of the artificial watercourses were assessed as **Negligible**.

Within the Sunfield South site, multiple artificial channels were present throughout the site on the paddock boundaries. The farm drains were classified as **artificial watercourses** as no natural overland flow paths are present within the vicinity of the drains in historic aerial images, and the drains contain no natural portions between their confluence and headwater were present. Drain h, L, m and o transported water in an east to west direction, while Drain i, j, k and n drained water flowing in a south to north direction. The drains were unnaturally straight and uniform in shape (Photo 40 to Photo 43). No natural overland flow paths present within historic aerials which may have been modified to form artificial watercourses. The drainage channels discharged into roadside drains, with the exception of Drain m, which discharges into Watercourse 2.

Photo 40. Drain j

Photo 41. Drain k (northern reach)

Photo 42. Drain k (eastern reach)

Photo 43. Drain m

The drains were approximately 0.6 m in width and water depth between 0.1 m to 0.2 m, with the banks steep and incised. Each drain consisted of a single run, with the substrate soft and consisting of compacted clay bed and banks with willow weed growing within the drain channel. Riparian vegetation lining the artificial drains consisted of shelter belts, with the vegetation observed mixed exotic and native. The dominant vegetation included tree privet, poplars and pines with rank grasses and occasional sedges forming the ground cover.

Aquatic habitat within the drainage channels was low and restricted to single runs and occasional areas of woody debris. Due to the degraded state, indigenous aquatic fauna which would access and reside within the drainage channels would be restricted to robust species such as shortfin eel, and potentially banded kōkopu.

5.3.5 Natural Inland Wetland

The ecological values of the natural inland wetland were assessed as **Low.**

A natural inland wetland (the wetland), was established within the headwaters and upper reach of Watercourse 1 with a defined flow path meandering through the hydric vegetation. The natural inland wetland was approximately 3,930 m^2 in size and consisted of two distinct plant communities of which herbaceous hydric vegetation formed 2,340 m^2 of the wetland, established within the stream channel and edges, and rush fields covering 1,590 m^2 of the floodplain. Vegetation within the herbaceous community consisted of common, weedy plants including the notified pest plant reed-sweet grass (*Glyceria maxima*), willow weed, water celery and red ludwigia (*Ludwigia repens*) (Photo 44). Within the rush community, soft rush (*Juncus effusus*) dominated the area with lotus (*Lotus pedunculatus*), buttercup (*Ranunculus* sp.) and occasional willow weed (*Photo 45*). Both the herbaceous vegetation and rush field passed the rapid dominance test and the collective area was classified as **natural inland wetland**.

Photo 44. Herbaceous plant community

Photo 45. Rushland plant community

Photo 46. Deep standing water was present throughout the wetland.

Photo 47. The natural inland wetland discharged to Watercourse 2 through an undersized culvert.

At the time of assessment, the wetland contained boggy ground and standing water outside of the flow path, with deep standing water in the stream channel (Photo 46). The wetland was severely pugged, with areas not subject to stock impacts within the neighbouring property consisting of a grassed swale. Multiple undersized culverts supporting farm crossings extend over the flow path and wetland. Riparian vegetation established around the natural inland wetland consisted of grazed pasture grasses, with sparse barberry, and privet. The upper 30 m of flow path which contained dense stands of gorse and some fencing. Aquatic habitat was low throughout the wetland and solely consisted of the defined flow path through the centre, however the thick rhizomes and root mats of the reed-sweet grass likely restricts fish passage through the area. The natural inland wetland discharges into the stream reach of Watercourse 1 through an undersized culvert (Photo 47).

5.3.6 Freshwater Ecological Values Overview of Sunfield South

Matter	Score and justification
Representativeness	**Low** Surface water systems within the site consist of artificially constructed farm drains or permanent streams which have been modified through straightening and deepening to form drainage channels. Water within these channels are highly turbid and provide a very low degree of aquatic habitat. The wetland is dominated by exotic plant species, including listed pest plant, and has been highly modified from its original vegetation. Streams within the site have been highly modified through straightening and deepening to form drainage channels for the surrounding landscape
Rarity/distinctiveness	**Low** No rare or 'At Risk' species are expected to live within the watercourses due to their degraded state. Macrophytes consist of exotic species, with exotic woody vegetation dominating riparian yards, with occasion, common native trees present. Wetland is entirely vegetation with non-native plant species. Dominance of reed-sweet grass would prevent the establishment and growth of indigenous wetland, or floodplain appropriate vegetation.
Diversity and pattern	**Low** Watercourses within the site consist of straight and deep channels, with no diversity in channel morphology and aquatic habitat. The surface water systems would support a low natural diversity of aquatic fauna, with macroinvertebrate communities expected to consist of pollutant tolerant species. Low complexity in in-stream habitats, stream morphology and riparian yards. The degraded wetland and exotic vegetation community would limit the degree of food resources to native fauna. Furthermore, the degraded state of the wetland and presence of reed-sweet grass would restrict the degree of aquatic habitat and movement of aquatic fauna through the area.
Ecological context	**Low** No stock damage to watercourses due to fencing, however riparian yards narrow (<2m) restricting riparian yard functions. Vegetation consists of exotic species with sparse native shelter belt trees, lacking complexity. Highly modified or constructed watercourses to facilitate farm drainage providing poor instream habitat, consisting of turbid, nutrient enriched waters with soft sediments and uniform channel shape and morphology. Watercourses within the site provide a low connectivity to the wider catchment Vegetation types within the wetland are relatively uniform throughout the wetland, and consisted of only herbaceous tier vegetation with no living trees or other structural tiers present. The wetland is impacted by stock access through pugging and grazing, with no riparian buffer. In some areas, gorse bushes are present however these offer little riparian function or benefits to the wetland. The wetland is linked to a modified permanent stream, however has no connectivity to moderate quality and above freshwater ecosystems.
Overall Ecological Value	**Low**

6 COSGRAVE ROAD

6.1 Background and Ecosystem Classification

Historically (pre-human), the site would have comprised of a mixture of bog/fen mosaic, pūriri forest (WF7-1), and kahikatea, pukatea forest (WF8), ecosystems types with a small section of tararie, tawa, podocarp forest (WF9) (Singers *et al*., 2017). These forest and fen mosaic ecosystems are characteristic of the Manukau ecological district, which are characterised by low altitude topography near the Manukau Harbour with a warm humid climate (favouring WF8) and mild winters with drained volcanic soils (favouring WF7-1).

Historic aerial images show the site has been partially cleared of vegetation for approximately 60 years, with shrub-like vegetation present in the centre of the site (Figure 8). The scrub vegetation was subsequently cleared prior to 1981 (Figure 9), with the site and surrounding landscape consisting of agricultural farmland until the present day. Agricultural activities within the site overtime include horticultural activities and pasture grazing. Currently, the site consists of a few small dwellings, and paddocks with a land use mixture of livestock and crops, including horses and fruit (watermelon and strawberry).

Due to historical and current intensive agricultural and pastoral land use activities, the site contains predominantly pasture, with very limited shrub/tree vegetation. The key terrestrial ecological values of the site are associated with occasional indigenous vegetation, managed pasture, exotic shelterbelts and planted tree stands. The site does not support a Significant Ecological Area (SEA). The ecological values of these features are linked to the indigenous terrestrial fauna that may be utilising these as habitats.

Figure 8. Historic aerial image from 1960 showing a section of vegetation within the centre of the site and lack of natural overland flow paths. Image sourced from Retrolens.

Figure 9. Historic aerial image from 1981 showing the remnant of the vegetation after bush clearance and natural overland flow paths are absent. Image sourced from Retrolens.

6.2 Terrestrial Ecology

6.2.1 Vegetation

The overall ecological value of vegetation areas was conservatively assessed to be of low ecological value.

The majority of the vegetation present within the site is exotic and largely consists of vegetation for agricultural purposes, with pasture grasses utilised for horse grazing, and horticulture (Photo 48 and Photo 49). Woody vegetation such as trees and shrubs were largely limited to shelterbelts, which comprised of commonly utilised introduced species such as wattles (*Acacia* sp.), poplars (*Populus alba*), Japanese cedar (*Cryptomeria japonica*) and bald cypress (*Taxodium distichum*) (Photo 50 and Photo 4).

Photo 48. Vegetation was predominantly used for horse grazing

Photo 49. Failed watermelon crop present within the site.

Photo 50 & Photo 51. Woody vegetation throughout the site was limited to shelter belts.

Native vegetation within the site is limited, and is largely restricted to occasional indigenous trees within the shelter belts and riparian margins (Photo 52 and Photo 6). Vegetation observed included kānuka (*Kunzea ericoides*), tōtara (*Podocarpus totara*) and flax (*Phormium tenax*). The 'Ecosystems Current Extent' overlay in Geomaps does not classify any of the terrestrial features within the site as native ecosystems.

Photo 52 & Photo 53. Indigenous vegetation was limited to riparian yards.

The terrestrial vegetation within the site is predominantly comprised of exotic and common indigenous species; therefore, the botanical values are considered to be low. The vegetation may provide habitat for common indigenous avifauna and lizards.

6.2.2 Connectivity and Ecological Function

The terrestrial vegetation, as it pertains to ecological connectivity and function, was considered to be of negligible ecological values.

Connectivity between areas of vegetation is important to facilitate ecological function. Edge communities are heavily influenced by increased exposure to light, drying winds and competitive weeds. This 'edge effect' restricts some native flora and fauna to forest interiors. Patch fragmentation increases the edge effect and decreases the availability of habitat for interior species. Loss of ecological connectivity can also impair reproductive function for both flora and fauna.

All exotic and native vegetation within the site are isolated within the surrounding environment and there is no direct connectivity to significant terrestrial habitat. The nearest extensive area of vegetation is located more than 2 km to the south-east of the site. As the vegetation within the site is limited to isolated, narrow strips such as shelter belts and riparian areas, the vegetation is highly fragmented, and is subject to significant edge effects.

6.2.3 Indigenous Fauna

6.2.3.1 Herpetofauna

No formal herpetofauna surveys were undertaken as part of this assessment. A review of historic lizard records from within 10 km of the project area indicated that copper skink (*Oligosoma aeneum*), forest gecko (*Mokopirirakau granulatus*), elegant gecko (*Naultinus elegans*), and Pacific gecko (*Dactylocnemis pacificus*) have been recorded within the wider landscape (DOC BIOWEB Herpetofauna and Auckland Council Herpetofauna databases).

Table 9. Herpetofauna that may be present within the project footprint and/or have been recorded within 10 km of the project footprint (mainland taxa only), including conservation threat status (Hitchmough et al., 2021) and potential occurrence in the site.

	Common name	Species name	NZ threat status	Distance to nearest record	Habitat potential within site
Indigenous	*Mokopirirakau granulatus*	Forest gecko	At Risk – Declining	< 8 km	x
	Naultinus elegans	Elegant gecko	At Risk – Declining	< 3 km	x
	Dactylocnemis pacificus	Pacific gecko	Not threatened	< 8 km	x
	Oligosoma aenuem	Copper skink	At Risk – Declining	< 1 km	✓
Exotic	*Lampropholis delicata*	Plague skink	Introduced & Naturalised	< 1 km	✓
	Litoria aurea	Green and golden bell frog	Introduced & Naturalised	< 8 km	✓
	Litoria sp.	Unidentified frog	Introduced & Naturalised	< 6 km	✓

Forest, pacific and elegant geckos are arboreal (tree dwelling) species that are typically associated with regenerating scrubland and forests. Pacific and forest geckos will also inhabit clay banks and rock walls within and around such forests or scrubland, and elegant geckos inhabiting a variety of forest ecosystems, including swamps and scrublands. For populations of these species to persist, vegetated areas with good connectivity need to be relatively stable over time. Due to the lack of established indigenous vegetation and complete lack of connectivity to other suitable habitats, these gecko species are not expected to be found within the site.

Copper skinks are generally found in areas supporting dense ground cover (including exotic rank grasses) or under logs or other debris around forest or vegetation edge habitats. Copper skinks occur widely across the Auckland Region. Throughout the site, low quality skink habitat is present in the form of woody debris piles, wooden pallets, and felled fence posts (Photo 54 and Photo 8) (Figure 10). Due to the presence of low-quality skink habitat, and recorded observations within 500 m of the site, it is expected that copper skink may be found within the site.

Overall, the complete lack of connectivity to other terrestrial habitats decreases the likelihood of stable populations of native lizards to persist; therefore, the lizard habitat value within the site was considered low.

Photo 54 & Photo 55. Potential copper skink habitats present within the site.

Figure 10. Identified ecological features within the Cosgrave Block. Note pink hashed polygon represents land owned by Auckland Council

6.2.3.2 Avifauna

Due to the isolated nature and high edge effects the avifauna habitat value within the site was considered to be very low.

A formal avifauna survey was not undertaken; however, an opportunistic survey was carried out and all avifauna seen or heard were recorded. During the site assessment, a range of not threatened indigenous avifauna species was observed, including pūkeko (*Porphyrio melanotus*), swamp harrier (*Circus approximans*), welcome swallow (*Hirundo neoxena*), fantail (*Rhipidura fuliginosa*), and shining cuckoo (*Chrysococcyx lucidus*). It is unlikely that 'At Risk' or 'Threatened' species utilise the site even on an intermittent basis.

6.2.3.3 Bats

Long-tailed bats (*Chalinolobus tuberculatus*) are classified as 'Nationally Critical' (O'Donnell et al., 2023). Long-tailed bats are highly mobile and have large home ranges of up to 5,629 ha (O'Donnell, 2001). No bat surveys have been undertaken within the site, and the closest bat records are 6 km south of the site and 6km north of the site (DOC bat records database, Feb 2024 version).

The closest records of short-tailed bats (*Mystacina tuberculata* – 'Nationally Vulnerable') are outside of the Auckland region (excepting Little Barrier Island), with the nearest records within the Coromandel region. This species has far more specific habitat requirements than long-tailed bats (mature forest tracts with minimal introduced predators).

The April 2024 bat survey had one unit at the edge of the Cosgrove area (unit 5) and one within (unit 6), although this latter unit failed to record. No bats were recorded across the Sunfield sites during the survey.

Due to recorder failure and change in habitat use by bats across seasons and life stages, the potential intermittent use of mature trees/ exotic shelterbelts by bats within the site for feeding, roosting, or as ecological corridors cannot be dismissed. Nonetheless, the ecological value of the available habitat for bats within the site is considered **Low**.

6.2.4 Terrestrial Ecological Values within Cosgrave

Matter	Score and justification
Representativeness	**Low** Riparian margins provide only native canopy which lacks sufficient ground cover. It is unlikely to support moderate or high value native fauna on a permanent basis.
Rarity/distinctiveness	**Moderate** No rare or distinct plant species were observed on site and none are considered likely, even on an intermittent basis. Fauna values generally considered to be low, however there is consideration of likelihood of two 'At Risk' terrestrial fauna species.
Diversity and pattern	**Low** The riparian vegetation on site is mixed exotic with some common natives, with no diversity in structure. Remainder of the site consists of pasture grasses and horticulture.
Ecological context	**Negligible** The vegetation is surrounded by residential subdivisions and rural land, and is of generally low botanic quality. Dense vegetation, approximately 1-2 km south-east of the site is more likely to provide resting habitat and corridors/linkages for native fauna.

6.3 Freshwater Ecology

The watercourses within Cosgrave Road were all artificial drainage channels, and were likely created to drain the surrounding landscape, and all flow from the site on the western boundary drain into a roadside drain. No natural inland wetlands, or areas indicative of a natural inland wetland, were observed within the site.

6.3.1 Drain 1

The ecological values of Drain 1 were assessed as **Negligible**.

Drain 1 was present on the western side of the site and consisted of a straightened and uniform channel, flowing in a south to north direction before a right-angle bend diverts the channel to a western flow. Drain 1 was approximately 1-2 m in width and was entirely straight with no natural portions throughout the entire length of the reach. As such, Drain 1 was classified as an **artificial watercourse.** The earliest historic aerial images of the site (1960) do not show a natural stream path to be present within the vicinity of Drain 1, however the watercourse may have been constructed prior to 1960 as the presence of a straight shelterbelt obscures the location of Drain 1.

The watercourse contained slow flowing run habitat between 0.2 m to 1 m in depth, with surface scums present (Photo 56). No variation on hydrological heterogeneity was observed. Water clarity was poor and opaque indicating a high degree of suspended sediments present throughout and a very high level of turbidity (Photo 57). Silt substrates dominated the watercourse, with willow weed (*Persicaria maculosa*) covering approximately 10% of the watercourse. At the time of assessment, the drains were completely full and no evidence of bank collapse was obvious on the upper banks, however the banks appear to be vertical.

Drain 1 was fenced with some indigenous riparian planting present on the true left bank and included kānuka and flax. Additional vegetation observed throughout the riparian yard included poplars, privet (*Ligustrum lucidum*), and wattles, with groundcover consisting of long grasses and blackberry (*Rubus fruticosus*) (Photo 58 and Photo 59). The riparian vegetation provided low-moderate shading to the drain, and the narrow width of vegetation would provide low riparian functions such as filtration and bank stability. Aquatic habitat was of low value and limited to macrophytes and some woody debris present within the channel. As such, it is expected only shortfin eel (*Anguilla australis*) would reside within the farm drain.


Photo 56. Drain 1 was wide and deep.


Photo 57. Water clarity was poor.


Photo 58. Upstream ripairan vegetation for Drain 1.


Photo 59. Downstream riparian vegetation for Drain 1.

6.3.2 Drain 2

The ecological values of Drain 2 were assessed to be **Negligible.**

Drain 2 flowed in an east to west direction, with the headwaters forming at a farm track intersection and drained into Drain 1. Drain 2 was classified as an **artificial watercourse** as it contained no natural portions from its headwaters to its confluence. Furthermore, historic aerial images do not indicate a stream to be present within the vicinity of Drain 2. Multiple farm drains discharge into Drain 2.

The flow path of Drain 2 was straight and uniform, approximately 1.5 m in width. Water depth was highly variable at the time of assessment, with the upper reaches completely dry (Photo 60) and the lower reaches of Drain 2 containing slow flowing water, which overtopped the channel banks in some locations (Photo 61 and Photo 62). The drain is likely dominated by silt substrates with heavy loading of fine sediments and turbidity present within the water column where water is present.

Drain 2 was lined by a shelter belt consisting of exotic trees including wattles, bald cypress and willow (*Salix* sp.) (Photo 63). Shade was variable throughout Drain 2, with drain reaches with lower shade containing willow weed macrophytes. The riparian vegetation is expected to provide only a low degree of filtration due to the lack of ground cover, and low bank stability due to the narrow width of the riparian vegetation. Aquatic habitat is similar to Drain 1 and limited to macrophytes and woody debris which has the potential to support robust indigenous fauna such as shortfin eel.

Photo 60. The upper section of Drain 2 was dry.

Photo 61. The downstream reach contained standing water.

Photo 62. Sections of Drain 2 overtopped the banks.

Photo 63. Riparian vegetation consisted of an exotic shelter belt.

6.3.3 Drain 3, Drain 4 and Drain 7

The ecological values of Drain 3, Drain 4 and Drain 7 were assessed to be **negligible**.

Drain 3, Drain 4 and Drain 7 have been grouped as they contain similar channel characteristics (Photo 64, Photo 65 and Photo 66). The entirety of the three drains is approximately 450 m in length with Drain 2 dividing the drains in the centre. The drains are each formed by two channel segments; one channel flowing from north to south and entering Drain 2 (Drain 3a, Drain 4a and Drain 7a), and the second section draining south to north before discharging into Drain 2 (Drain 3b, Drain 4b and Drain 7b). Each segment is approximately 220 m in length. The drains are entirely straight and uniform in size, and do not contain any natural portions from their headwaters to their confluence with Drain 2. No natural streams are present in historic aerials in the same location as Drain 3, Drain 4 or Drain 7. As such, these drains were classified as **artificial watercourses**.

Standing water was present throughout the three drains, approximately 0.10 m to 0.60 m in depth and 0.60 m in width. No discernible flow was observed throughout the two drains and water was highly turbid with water murky and dirty in colour. The drains are entirely soft bottomed and there is heavy loading of fine sediments throughout. The drains were lined by shelter belts, with exotic vegetation such as sweetgum (*Liquidambar styraciflua*), wattles, willow, Japanese ceder, and bald cypress. Shade throughout the drain is variable, and as a result, willow weed has clogged over 60% of Drain 4. Aquatic habitat was very low, with the dense macrophyte growth limiting the abundance of habitat, and it is expected only shortfin eel would be present.

Photo 64. Drain 3.

Photo 65. Drain 4.

Photo 66. Drain 7.

6.3.4 Drain 5 and 6

The ecological values of Drain 5 and Drain 6 were assessed to be **negligible**.

Drain 5 was present within the central area of the site, parallel to Drain 2, and discharges into Drain 4. Drain 6 is present within the southern area of the site, flowing in a general south to north direction, and discharges into Drain 2. Drain 5 and Drain 6 were approximately 200 m – 220 m in length. The upstream reach of Drain 6 falls within property owned by Auckland Council. Drain 5 and Drain 6 are entirely straight and uniform in channel shape with no natural section from their headwater to their confluence, and do not appear in historic aerial images prior to 2001. As such, Drain 5 and Drain 6 were classified as **artificial watercourses**.

Drain 5 and Drain 6 were uniform in channel shape, with an average wetted width of 0.6 m and an average depth of 0.3 m. The two drain reaches were soft bottomed and dominated by silt with occasional patches of willow weed present throughout the drains. There was very low hydrological heterogeneity, with the drains consisting of very slow runs with the water clarity murky, indicating a high degree of turbidity. Riparian vegetation throughout Drain 5 and Drain 6 consisted of mature, exotic trees forming a shelter belt. Vegetation observed throughout Drain 6 included Japanese ceder, sweet gum and willow. Drain 5 was lined by poplars with occasional flax interspersed throughout.

6.3.5 Drain 8

The ecological features of Drain 8 were considered to be **Low**.

Drain 8 was present on the eastern side of the site and flows in a general south to north direction, and discharges through a culvert into a farm drain, located outside of the property boundary. Drain 8 was approximately 450 m in length, and 0.70 m wide, with the channel straight and uniform throughout the reach. Drain 8 contained no natural portions from its headwaters to its confluence. Approximately 200 m of the downstream reach drain is present in aerial images from 1960, with the remainder of the upstream reach constructed prior to 1996. No natural stream features for the upstream reach are present in the 1960's aerial. As such, Drain 8 was classified as an **artificial watercourse**.

Standing water was present throughout the entire length of Drain 8 and was approximately 0.3 m deep at the time of assessment (Photo 67). The dominant substrate throughout the reach was silt, with a high loading of suspended sediment present within the water column, made evident by the murky and opaque colouration. Duck weed (*Lemna minor*), and willow weed were abundant throughout the reach, covering approximately 60% of the channel (Photo 68), with hydrological heterogeneity limited to a single slow run. The drain banks were steep, approximately 0.5 m to 0.7 m high, however no bank incision or collapse was observed, and the bank height was likely created when the drain was constructed (Photo 69).

The riparian yard on the true right bank has been planted, and included indigenous vegetation such as tōtara, mānuka (*Leptopermum scorparium*), and flax, with pest infestation occurring with gorse (*Ulex europaeus*), woolly nightshade (*Solanum mauritianum*), blackberry, pampas (*Cortaderia selloana*) and privet present (Photo 70). Riparian vegetation on the true left bank consisted of scrubby ground cover such as buttercup (*Ranunuculus* sp.), cocksfoot (*Dactylis glomerata*) and yarrow (*Achillea millefolium*), with some overhanging vegetation. Shade and filtration was considered to be low due to the lack of riparian vegetation on the true right bank. Aquatic habitat was low and limited to macrophytes, woody debris and overhanging vegetation. Species expected to reside within Drain 8 consists of shortfin eel.

Photo 67. Drain 8 contained slow flowing water and was relatively straight and uniform.

Photo 68. Macrophytes covered the surface of Drain 8.

Photo 69. The banks of Drain 8 were relatively steep.

Photo 70. Riparian vegetation was limited to the true right bank.

6.3.6 Freshwater Ecological Values Overview of Cosgrave Road

Matter	Score and justification
Representativeness	**Low** Catchment within the site entirely artificial and constructed for farm drainage with highly turbid water and very low aquatic habitat. Do not represent natural streams.
Rarity/distinctiveness	**Moderate** Freshwater systems within the site consist of constructed farm drains with visually poor water quality. No rare or distinct fauna species were observed on site and none are considered likely, even on an intermittent basis to access and reside within the site. Species assemblages would likely consist of robust fauna and pest species.
Diversity and pattern	**Low** Surface water systems consist of straight and narrow channels with no variation in aquatic habitat. Soft bottomed channels consisting of a single run which would support a very low diversity of freshwater fish and macroinvertebrates.
Ecological context	**Negligible** The surface water systems are surrounded by residential subdivisions and rural land, with little to no connectivity to the wider freshwater catchment. Low quality aquatic habitat and riparian yard complexity which would provide habitat to common, robust fauna.

6.4 Summary of Ecological Values

The terrestrial ecological value of the site is largely limited to the planted exotic vegetation and shelterbelts, and some small, isolated patches of planted native vegetation. The majority of the site is largely comprised of low-ecological value managed pasture.

The freshwater values of the site are limited to artificial watercourses created to facilitate farm drainage. No natural watercourses are apparent in aerial images, and the presence of highly-modified permanent/intermittent streams has been excluded. No natural inland wetlands area present, and aquatic fauna that may inhabit the artificial watercourses would be restricted to robust species such as shortfin eel.

7 POTENTIAL ECOLOGICAL CONSTRAINTS AND LIMITATIONS

7.1 Terrestrial Ecology

Low value vegetation is present throughout Sunfield South, predominantly consisting of mixed exotic and native riparian yards and shelter belts. Terrestrial vegetation within Sunfeild North is considered to be of moderate value, due to the likelihood of threatened bats and lizards. The site does not support an SEA overlay, notable tree overlay, or high-value vegetation which may meet the criteria of an SEA.

Based exclusively on the desktop assessment results, the potential presence of native lizards (e.g., copper skink) and long-tailed bats cannot be dismissed. As such, it is recommended a lizard survey is carried out across the site prior to the commencement of the development to determine the presence of native skinks. It is also recommended that an additional bat survey is conducted earlier during the breeding season (i.e. Dec-Jan) to give confidence that bats are absent, or that Bat Roost Protocols (Department of Conservation, 2024) are followed as a precaution when felling trees.

Under the AUP there are a number of constraints that apply to developing land near/in terrestrial ecosystems. The following rules in the AUP, relating to vegetation removal outside of riparian yards and the rural urban boundary Activity Table E15.4.1; Vegetation Management and Biodiversity):

- (A10) – Vegetation alteration or removal, including cumulative removal on a site over a 10-year period, of greater than 250 m^2 of indigenous vegetation that is contiguous vegetation on a site existing on 30 September 2012 and is outside the rural urban boundary is a restricted discretionary activity.

7.1.1 NPS-IB and Managing Indigenous Biodiversity Outside SNAs

The NPSIB (2023) provides direction to Council's to protect, maintain and restore indigenous biodiversity in the terrestrial environment. The NPSIB is considered relevant to the proposal because the site is in the terrestrial environment, and it contains indigenous biodiversity as defined in Section 1.6 (Interpretation) of the NPS-IB.

Section 3.16 (1) (NPSIB) states that any significant adverse effects must be managed by applying the effects management hierarchy (avoid, minimise, remedy, offset, compensate). The potential adverse effects, as assessed herein, are considered low level and therefore not significant.

Section 3.16 (2) (NPSIB) states that all other adverse effects that may adversely affect indigenous biodiversity outside an SNA must be managed to give effect to the objective and policies of the NPSIB. The overall objective of the National Policy Statement is (2.1, NPSIB):

a. to maintain indigenous biodiversity across Aotearoa New Zealand so that there is at least no overall loss in indigenous biodiversity after the commencement date; and
b. to achieve this:
    i. through recognising the mana of tangata whenua as kaitiaki of indigenous biodiversity; and
    ii. by recognising people and communities, including landowners, as stewards of indigenous biodiversity; and
    iii. by protecting and restoring indigenous biodiversity as necessary to achieve the overall maintenance of indigenous biodiversity; and while providing for the social, economic, and cultural wellbeing of people and communities now and in the future.

7.2 Freshwater Ecology

The current ecological values of freshwater ecosystems within the Sunfield Blocks and Cosgrave Block were assessed to range from negligible to low. A number of modified permanent streams, and artificial watercourses flow through the sites, with a natural inland wetland present within Sunfield South. Under the AUP, the National Policy Statement for Freshwater Management 2020 (NPS-FM) and National Environmental Standards for Freshwater 2020 (NES-F), there are a number of constraints that apply to developing land near/in freshwater ecosystems.

AUP Activity Table E3.4.1 (E3; Lakes, rivers, streams and wetlands) applies to potential works within the modified permanent streams at the site. Where there are the same rules within the NES-F and AUP, the more stringent of the two rules would apply. These AUP rules apply to activities in, on or over the bed of lakes, rivers, streams (including intermittent stream) and wetlands:

- (A19) – Diversion of a river or stream to a new course and associated disturbance and sediment discharge is a discretionary activity;
- (A23) Replacement, upgrading or extension of existing structures[2] complying with the standards in E3.6.1.12 is a permitted activity;
- (A24) – demolition or removal of structures lawfully existing[2] on or before 30 September 2013 is a permitted activity;
- (A29) - Bridges or pipe bridges complying with the standards in E3.6.1.16 is a permitted activity;
- (A32) - Culverts or fords less than 30 m in length when measured parallel to the direction to the direction of water flow complying with the standards in E3.6.1.8 is a permitted activity. Culverts or fords over 30 m in length is a discretionary activity (A33;
- (A49) – New reclamation or drainage, including filling over a piped stream is a non-complying activity; and
- (A53) – Any activity that is undertaken in, on, over or within the bed of an ephemeral river and stream complying with the standards in E3.6.1.1 is a permitted activity.

The following rules in the AUP, relating to vegetation removal near freshwater bodies (modified permanent streams and wetlands) (Activity Table E15.4.1; Vegetation Management and Biodiversity) may apply to the development of the site:

- (A6) – Pest plant removal is a permitted activity;
- (A17) – Vegetation alteration or removal within 10 m of rural streams in the Rural – Rural Production Zone and Rural – Mixed Rural Zone is a restricted discretionary activity; and
- (A18) – Vegetation alteration or removal within 20 m of a natural wetland or in the bed of a river is stream (permanent or intermittent) is a restricted discretionary activity.

Under the NES-F regulations, constraints may apply to developing land near natural inland wetlands. Wetland protections will be established through appropriate earthworks designs and the implementation of a construction management plan, which includes the requirement for appropriate erosion and sediment controls within Sunfield South.

[2] Structures lawfully existing on or before 30 September 2013 and the associated bed disturbance or depositing any substance, diversion of water and incidental temporary damming of water.

Drainage of natural inland wetlands

- 52 (1) – Earthworks outside, but within a 100 m setback from, a natural inland wetland is a non-complying activity if it
    - (a) results or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland; and
    - (b) does not have another status under any of regulations 38 to 51.
- 52(2) – The taking, use, damming or diversion of water outside, but within a 100 m setback from, a natural inland wetland is a non-complying activity if it –
    - (a) results or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland; and
    - (b) does not have another status under any of regulations 38 to 51.

Other activities

- 54 – the following activities are non-complying activities if they do not have another status under this subpart:
    - (a) Vegetation clearance within, or within a 10 m setback from, a natural inland wetland:
    - (b) Earthworks within, or within a 10 m setback from, a natural inland wetland
    - (c) The taking, use damming or diversion of water within, or within a 100 m setback from, a natural inland wetland if –
        - (i) There is a hydrological connection between the taking, use, damming or diversion and the wetland; and
        - (ii) The taking, use, damming, or diversion will change, or is likely to change, the water level range or hydrological function of the wetland:
    - (d) The discharge of water into water within, or within a 100 m setback from, a natural inland wetland if –
        - (i) There is a hydrological connection between the discharge and the wetland; and
        - (ii) The discharge will enter the wetland; and
        - (iii) The discharge will change, or is likely to change, the water level range or hydrological function of the wetland.

The proposal should apply the effects management hierarchy under the National Policy Statement for Freshwater Management 2020 (NPS-FM) where:

a) Adverse effects on wetlands and streams are first avoided, where practicable; and
b) Where adverse effects cannot be avoided, they are minimised where practicable; and
c) Where adverse effects cannot be minimised, they are remedied where practicable; and
d) Where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; and
e) If aquatic offsetting of more than more than minor residual adverse effects is not possible, aquatic compensation is provided; and
f) If aquatic compensation is not appropriate, the activity itself is avoided.

Offset Requirements

Where it is not possible to remediate or mitigate effects to freshwater as there is a complete and permanent loss of aquatic habitat (such as stream reclamation). While stream reclamation cannot be mitigated, it can be offset or compensated. The loss of stream area would be considered a significant residual adverse effect under the AUP and the NPS-FM, and would require offset environmental compensation.

Under Section E3 Lakes, rivers, streams and wetlands of the AUP, E3.2. Objectives [rp] (3) states:

Significant residual adverse effects on lakes, rivers, streams or wetlands that cannot be avoided, remedied or mitigated are offset where this will promote the purpose of the Resource Management Act 1991.

The standard offset procedure for stream loss requires the use of Stream Ecological Valuation (SEV) methodology and Environmental Compensation Ratio (ECR) to quantify the amount of offset stream bed area required to achieve 'no-net-loss' of stream bed area (Stream length and average width). The requirements for stream environmental compensation and mitigation and the procedure to follow is detailed below.

Stream Offset Procedure

The following procedure summarises the steps required to calculate the amount of offset compensation required for stream works using the SEV and ECR methodology[3,4].

1. Characterise the quality of the aquatic habitat that will be lost as a result of the proposed development - undertake Stream Ecological (SEV) assessments of the impacted stream/s if appropriate.
2. Identify a compensation/offset site. Ideally this would be onsite either upstream or downstream of the site, within the same catchment, and as close to 'like for like' in character as the section of stream being impacted (similar stream width, characteristics) as outlined in the AUP (OP) Section E3.3(4). Initially onsite options would be investigated and if these options were not accepted as 'like for like', did not have enough length for mitigation works or were not suitable due to land ownership, then other options would be investigated offsite.
3. Once an offset site has been identified the habitat quality of the proposed offset stream would be characterised and an assessment undertaken.
4. The information would then be used to calculate the Environmental Compensation Ratio (ECR), which determines the area of compensation stream required based on the restoration/enhancement works taking place.
5. The section of compensation stream to be restored/enhanced would be defined. Restoration typically consists of undertaking native riparian planting to a minimum of 10m each side of the stream channel.

[3] SEV is the favoured method by Auckland Council, but an ecological value may also be based on the "Guidance of Good Practice Biodiversity Offsetting in New Zealand" document, which is an accepted alternative to SEV for offsetting (E3.3(4) AUP(OP)). Both documents have equal precedence within the AUP (OP).

[4] Storey, R. G., Neale, M. W., Rowe, D. K., Collier, K. J., Hatton, C., Joy, M. K., Maxted, J. R., Moore, S.,Parkyn, S. M., Phillips, N. & Quinn, J. M. (2011). Stream Ecological Valuation (SEV): A Method for Assessing the Ecological Function of AucklandStreams. Auckland Council Technical Report 2011/009. 66p.

6. A detailed restoration/riparian planting management plan would be developed. This plan would describe the areas and plant species to be planted, outline maintenance plans (e.g. weed management, pest management, plant replacement and fencing) and include any other restoration actions to be undertaken.
7. Legal agreement of the landowner to proceed would be obtained.
8. The restoration plan is then implemented.
9. Monitoring may be needed to confirm the riparian planting has been successful and that the ecological gains have been achieved.

The principles for aquatic offsetting within the NPS-FM[5], are

a. Adherence to effects management hierarchy
b. When aquatic offsetting is not appropriate
c. Scale of aquatic compensation
d. Additionally
e. Leakage
f. Long term outcomes
g. Landscape context
h. Time lags
i. Trading up
j. Financial contribution
k. Science and mātauranga Māori
l. Tangata whenua or Stakeholder participation
m. Transparency

Recommendations for stream loss offset

Offsetting, restoration and enhancement recommendations:

a. The site be located as close as possible to the subject site.
b. Be 'like-for-like'.
c. Achieve no net loss.
d. Preferably achieve biodiversity gains.
e. Offset ratios calculated by the ECR are adhered to, which are dependent on current and potential SEV values.
f. Minimum of 20 m (10 m either bank) of riparian planting undertaken within the offset site.
g. Consideration of the use of biodiversity offsetting.
h. The use of Storey et al. (2011), Appendix 8 (AUP) and the Ministry for the Environment et al. (2014) for guidance.
i. Legal protection of the offset site in perpetuity.

[5] Ministry for the Environment (2022. National Policy Statement for Freshwater Management 2020, amended December 2022.

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APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of Sunfield Developments Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Sunfield Developments Limited.

Appendix A Bat Survey Memorandum

MEMORANDUM

TO:	Sunfield Developments Limited	Date:	2 December 2024
COPY TO:	Simon Ash - Winton		
FROM:	Charlotte Garrett	Job No:	65507

BAT SURVEY 2024 – SUNFIELD DEVELOPMENTS

Bioresearches was engaged by Simon Ash, on behalf of Sunfield Developments Limited, to undertake a bat survey during the late summer season in 2024.

Previous bat survey work in the area has indicated that bats have been recorded within 5 km and 10 km of the site (Bioresearches, 2024). Some survey work has been undertaken immediately adjacent to the site (Department of Conservation bat records, Figure 2), with no bats detected. However, no survey work has been undertaken within the site.

Recorders were installed for three weeks at six locations during April 2024 (Figure 11). One recorder failed during this process (Recorder 6), and five recorders amassed a total of 67 valid survey nights across the survey period. Watercourses and areas of potential roost habitat were targeted.

Survey Period – Recording Methodology and Valid Nights

Department of Conservation (DOC) AR4s were used throughout the survey period to record activity. The first recorders were set on the 4th April, and the last data recorded on the 19th April. Time was set to record from one hour before official sunset, and one hour after official sunrise. AR4s were processed via DOC BatSearch 3.12.

Department of Conservation bat survey protocol was followed to determine the number of valid survey nights at each recorder. Nights were excluded when temperatures dropped below 10°C within the first four hours after official sunset. Nights were also excluded if rainfall exceeded 2.5mm within the first two hours after official sunset, and/or 5mm four hours after official sunset.

Table 1 above shows the recorders at each location, recorder type, total number of valid survey nights, and whether bat passes were detected. A table showing weather data on each survey night, including sunset time, rainfall and temperature, can be found in Appendix II.

Results

No bat recorders detected any bats. One recorder (Recorder 6) failed.

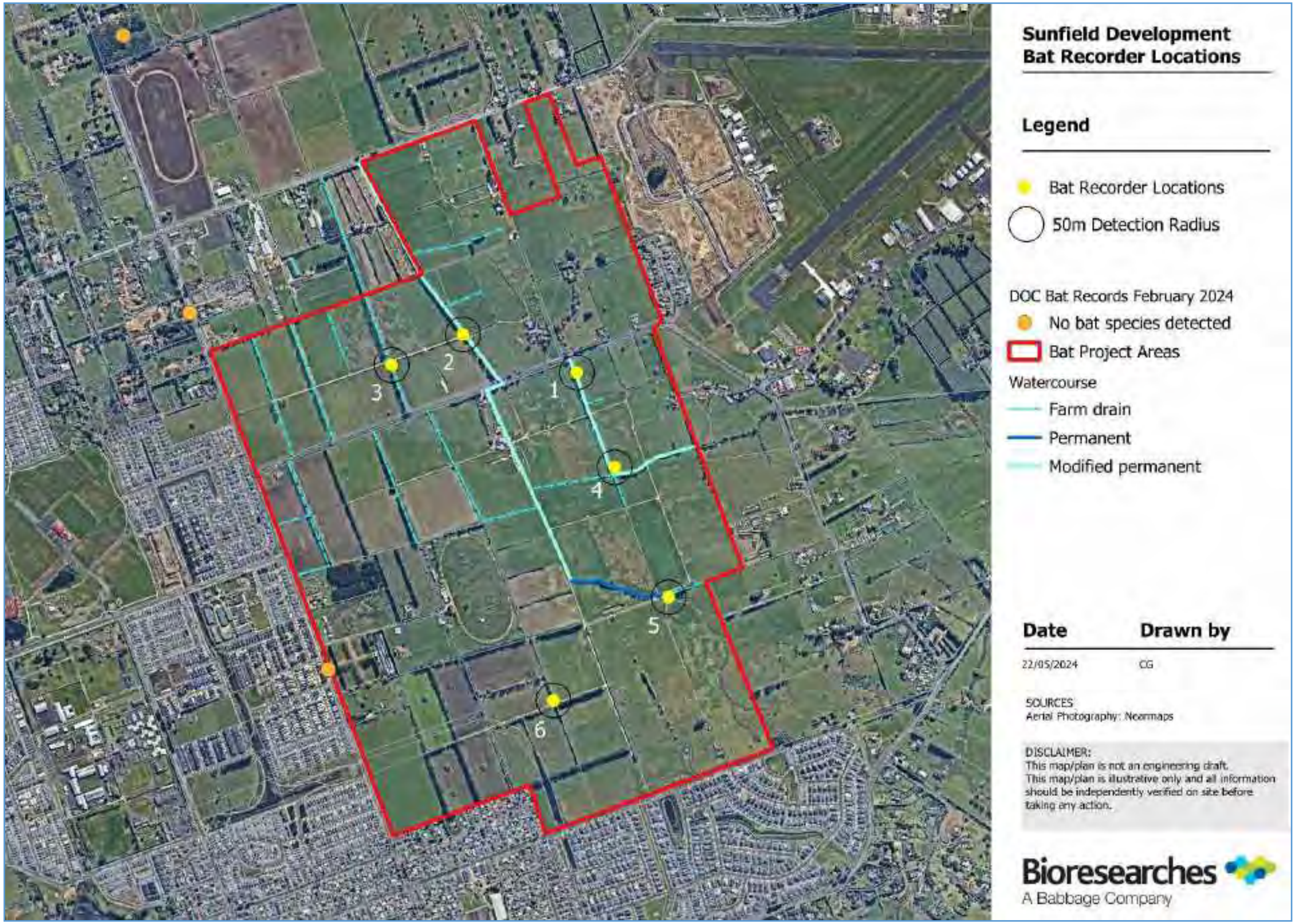

Figure 11: Map showing location of recorders within the Sunfield site, as well as local DOC records of previous bat survey work

Table 10: Table showing valid survey nights per recorder, and whether bat passes were detected

Recorder	Type	Date Set	Date Complete	Valid Survey Nights	Bat passes?
1	AR4	04/04/24	16/04/24	13	N
2	AR4	04/04/24	19/04/24	15	N
3	AR4	04/04/24	17/04/24	14	N
4	AR4	04/04/24	14/04/24	11	N
5	AR4	04/04/24	17/04/24	14	N
Total Valid Survey Nights				67	N

Conclusions

Overall, no bats were detected during the survey. The probability of bats using the site is low, given the surrounding urban environment, and lack of bat detections in previous surveys immediately adjacent to the site (DOC records, Figure 12). While the site is in proximity to longtail bat detections (Figure 2), the surrounding urban environment lowers the suitability of the site to LTBs, and previous detections have been made typically within remnant forest patches, or along extents of forested riparian margins.

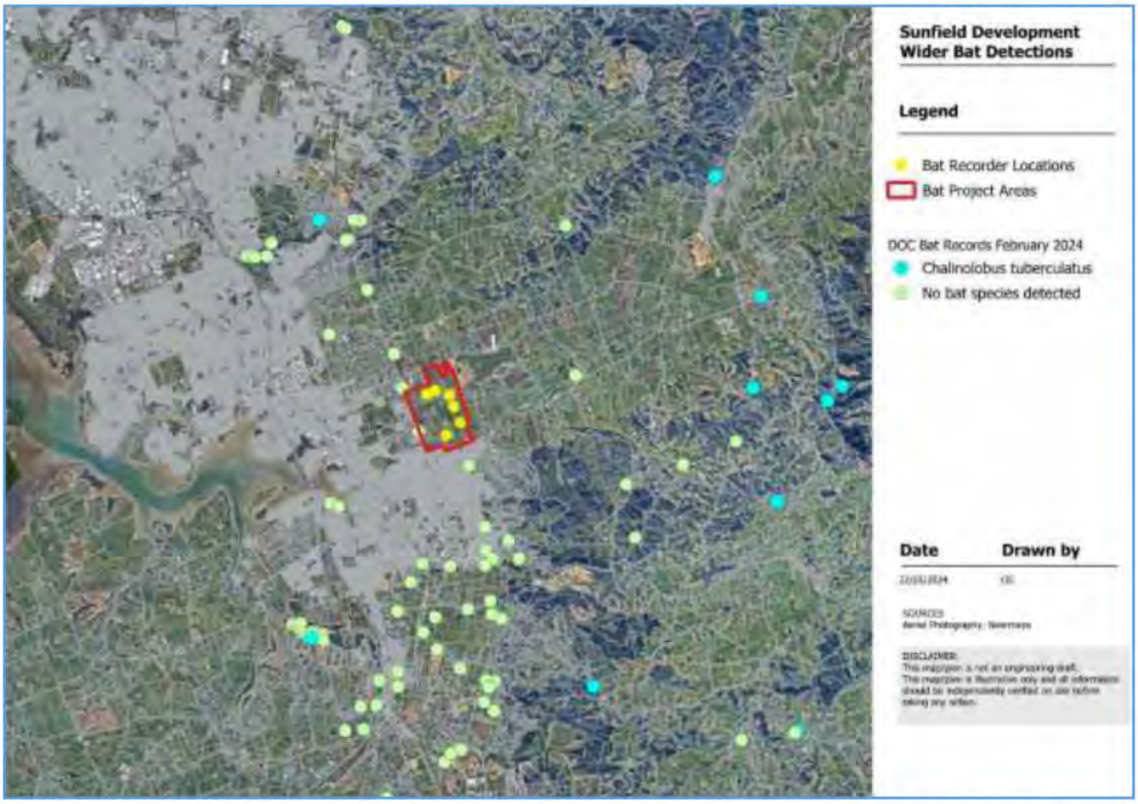

Figure 12: Map showing wider bat survey records surrounding the project area (survey records sourced from Department of Conservation)

Many thanks,

Charlotte Garrett B.Sc.

Ecologist

Bioresearches
A Babbage Company

Babbage Consultants Limited

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APPENDIX C – CONTAMINATION REPORT

DETAILED SITE INVESTIGATION
LOT 1 DP5548 COSGRAVE ROAD
ARDMORE
AUCKLAND

For the Attention of:

Winton Land Limited

Reference: FES 1443.011 December 2023 (R5)

Company Information

Focus Environmental Services Limited

PO Box 11455

Ellerslie

Auckland 1542

Telephone: +64 9 579 4155

Email: mail@focusenvironmental.co.nz

Quality Information

Project Name	Detailed Site Investigation Lot 1 DP55480, Cosgrave Road, Ardmore
Project Number	1443.011 (R5)
File Reference	M:\2023 Jobs\Winton\Sunfield Development\Completed Reports\Lot 1 Cosgrave Road\R5\1443.011_DSI_MT (R5).docx
Date Issued	April 2021
Date Revised	December 2023

Author

Megan Thomas
Environmental Scientist

Reviewed

Claire Johnson
Environmental Scientist

Authorised

David O'Reilly
Principal Environmental Consultant

Distribution List

Parties	Copies
Winton Land Limited	1
Focus Environmental Services Limited	1

Contents

Executive Summary

This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

Focus Environmental Services Limited was contracted by Winton Land Limited to carry out a Detailed Site Investigation (DSI) at Lot 1 DP 55480 Cosgrave Road, Ardmore, Auckland. The legal description of the site is Lot 1 DP 55480 with an area of 5.80 ha.

It should be noted that this report has been revised following the request of the client.

The Sunfield Urban Development Area (UDA) consists of nineteen properties located across Cosgrave Road, Old Wairoa Road, Hamlin Road and Airfield Road, Papakura, Auckland.

The scope of this report is limited to the property of Lot 1 DP 55480 Cosgrave Road, Ardmore and should be read in conjunction with the cover letter summarising the findings of the PSIs and DSIs completed for the Sunfield UDA.

This DSI has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 1 DP55480, Cosgrave Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the Hazardous Activities and Industries List (HAIL) was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's, used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified, it is considered that there is evidence to suggest that an activity outlined in the HAIL has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, twelve discrete samples were composited at the laboratory (4:1) to form three composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Submitted By,

Principal Environmental Consultant
Focus Environmental Services Limited

1.0 Scope

1.1 This report has been prepared at the request of Winton Land Limited ("the Client") in terms of the Focus Environmental Services Limited Agreement ("Agreement").

1.2 The following report is based on:

- *Information provided by the Client;*
- *The report titled 'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 1 DP 55480, Cosgrave Road, Ardmore Auckland' dated December 2020 and prepared by Focus Environmental Services;*
- *A site walkover and inspection; and*
- *Site investigation and soil sampling.*

1.3 We have not independently verified the information provided to us by the Client or its completeness. We do not express an opinion on the accuracy or the reliability of such information.

1.4 No warranties are given, intended or implied.

1.5 Opinion, inferences, assumptions and interpretations made in this report should not be construed as legal opinion.

1.6 Where an assessment is given in this report, the Client must also rely upon their own judgement, knowledge and assessment of the subject of this report before undertaking any action.

1.7 This report must not be used in any other context or for any other purpose other than that for which it has been prepared without the prior written consent of Focus Environmental Services Limited.

1.8 This report is strictly confidential and intended for the sole use of the Client and shall not be disclosed without the prior written consent of Focus Environmental Services Limited.

1.9 This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

2.0 Site Identification

The property is located at Lot 1 DP 55480 Cosgrave Road, Ardmore as shown in Figure 1 attached. The legal description of the site is Lot 1 DP 55480 with an area of 5.80 ha. The site is located at national grid reference 1774088mE and 5898124mN.

The site is irregular in shape and is zoned 'Future Urban Zone' under the Auckland Unitary Plan – Operative in Part (AUP: OP).

The site location plan is presented as Figure 1.

3.0 Proposed Site Redevelopment Activity

It is proposed that the site will be redeveloped for residential purposes. As part of the redevelopment, the site will undergo subdivision, a change of land use and disturbance of soils.

The illustrative masterplan is attached as Appendix A.

4.0 Geology and Hydrology

Published geological maps[1] indicate the subject sites are typically underlain by alluvial deposits of the Tauranga Group Formation. A description of the underlying geologies is presented in Table 1 below.

Table 1: Geology: Lot 1 DP 55480, Cosgrave Road, Ardmore

Key name	OIS1 (Holocene) river deposits
Simple name	Holocene river deposits
Main rock name	Mud
Description	Sand, silt mud and clay with local gravel and peat beds
Subsidiary rocks	Sand silt clay peat
Key group	Holocene sediments
Stratigraphic lexicon name	Tauranga Group
Absolute age (min)	0.0 million years
Absolute age (max)	0.014 million years
Rock group	Mudstone
Rock class	Clastic sediment

No groundwater investigation was carried out as part of this investigation.

The nearest surface water body to the site, as identified in the ecological report titled *'Cosgrave Road Plan Change: Baseline Ecology'* and dated April 2023, is an artificial drainage channel which runs through the western boundary of the plan change area.

[1] Geology of the Auckland Area (Institute of Geological &Nuclear Sciences 1:250,000 geological map 3, 2011)

5.0 Regulatory Framework

5.1 The National Environmental Standard

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect on the 1st of January 2012 and supersedes any District Plan rules that related to contaminated land. Any Regional Plan rules relating to contaminated land are still applicable.

In brief, the objective of the NES is to ensure that land affected by contaminants is identified and assessed and, if necessary, remediated or managed to protect human health. The NES only applies to the activities: removing or replacing all, or part of, a fuel storage system; sampling the soil; disturbing the soil; subdividing the land; and changing the land use, and where an activity or industry described in the Hazardous Activities and Industries List (HAIL) is being, has been, or is more likely than not to have been undertaken on the piece of land.

The NES also contains reference to the soil contaminant standards for human health ($SCSs_{(health)}$), for a variety of land use scenarios along with reference to best practice reporting documents.

The environmental HAIL is attached as Appendix B.

5.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules of the AUP: OP must be considered.

In brief, the objective of the AUP: OP is to manage land containing elevated levels of contaminants to protect human health and the environment and to enable the effective use of the land.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

6.0 Background

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 1 DP 55480, Cosgrave Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the HAIL was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation.

This document is intended to confirm the contamination status of the site at Lot 1 DP 55480, Old Wairoa Road, Ardmore.

In addition, at the time of writing this report, the results of a detailed geotechnical investigation covering the site was not available.

7.0 Potentially Contaminating Activities or Land Uses

Three potentially contaminating activities were identified at the site, these are outlined in Table 2 below.

Table 2: Potentially Contaminating Activities: Lot 1 DP 55480, Cosgrave Road, Ardmore

Activity Description	HAIL Category
Historical Horticulture/Persistent Pesticide Use	A10

It should be noted that following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation. In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

8.0 Conceptual Model of Exposure Pathways

The preliminary conceptual site model provided in Table 3 below expands on the potential sources of contamination (as identified above) and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 3: Preliminary Conceptual Site Model: Lot 1 DP 55480, Cosgrave Road, Ardmore

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Incomplete: No evidence of potential vapours or fibres identified at the site.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No evidence of potential vapours or fibres identified at the site.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.

9.0 Sampling and Analysis Plan and Sampling Method

Environmental Sampling was carried out in accordance with the Contaminated Land Management Guidelines No. 5 (MfE, revised 2021).

Twelve discrete soil samples were collected from across the site and composited at the laboratory (4:1) to form three composite samples which are indicative and representative of the areas of the site potentially subject to historical horticultural, organo-chlorine pesticide spray use onsite. All samples were sent under full chain of custody documentation to an IANZ accredited laboratory. Sampling and Analysis information is provided in Table 5 below.

Table 4: Sample Analysis Information: Lot 1 DP 55480, Cosgrave Road, Ardmore

Sample Name	Sample Depth	Number of Samples	HAIL Activity	Analysis Suite
COMP01-COMP03	0 - 0.15m	3	Historical Horticulture/Pesticide Use	• Total recoverable Arsenic, Copper & Lead; and • Organo-chlorine Pesticides

The sample location plan is presented as Figure 2.

10.0 Field Sampling Quality Assurance

All sampling implements were triple washed between samples using clean tap water, followed by a solution of laboratory grade phosphate free detergent (Decon 90), and a final rinse with clean water.

Clean, nitrile gloves were worn when handling each sample. Samples were stored in laboratory cleaned glass jars and immediately placed in an iced cooler. The samples were transported under chain of custody documentation to an IANZ accredited laboratory for analysis.

11.0 Laboratory Quality Assurance

Routine laboratory quality assurance procedures include analysis of laboratory blanks and spiked samples. All analyses were carried out using industry standard methods as follows:

- Total Recoverable Metals – Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICPMS. In accordance with in-house procedure based on US EPA method 200.8.
- Organo-chlorine Pesticides – sonication extraction – OCP Screen method, air dry, grind, sonication extraction GC-ECD.

12.0 Basis for Guideline Values

Following the plan change it is proposed that the site will be developed for residential land use, therefore the guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption), as outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES), and the discharge criteria of the Auckland Unitary Plan: Operative in Part (AUP: OP) are considered relevant and have been adopted as the site assessment criteria.

Furthermore, the concentrations of heavy metals detected will be compared to the maximum background levels for non-volcanic soils in Auckland[2] (TP153).

The relevant values of the above guidelines have been reproduced in Table 5 below:

Table 5: Site Assessment Criteria: Lot 1 DP 55480, Cosgrave Road, Ardmore (mg/kg)

Parameter	NES ($SCSs_{(health)}$)	AUP: OP	TP153 (Non-Volcanic)
Arsenic	20	100	12
Copper	NL	325	45
Lead	210	250	65
Total DDT	70	12	-
Dieldrin	2.6	-	-

Note: NL = Not Limited. This is where the derived values exceed 10,000mg/kg;

It is considered that the natural background levels of organo-chlorine pesticides are below the analytical levels of detection, hence if analysis shows any concentrations above the limit of detection, this would restrict material from being classified as cleanfill.

[2] Background Concentrations of Inorganic Elements in Soils from the Auckland Region, Technical Publication No.153, Auckland Regional Council, 2001.

13.0 Soil Sampling Results

Tabulated soil sampling results are presented in Tables 6 & 7 below and laboratory transcripts are provided in Appendix A.

13.1 Heavy Metals

Table 6: Heavy Metals Results: Lot 1 DP 55480, Cosgrave Road, Ardmore (mg/kg).

Sample	As	Cu	Pb
COMP01	3	26	30
COMP02	<4	22	16.6
COMP03	<4	25	18.6

Note: Results in red exceed the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the maximum Auckland background concentrations for non-volcanic soils outlined in the Auckland Regional Council Technical Publication No.153, Oct 2001.

The concentrations of arsenic, copper and lead detected in all samples analysed were below the maximum Auckland background concentrations for non-volcanic soils and therefore below the $SCSs_{(health)}$ for residential land use and the discharge criteria as outlined in the AUP: OP.

13.2 Organo-chlorine Pesticides

Table 7: Organo-chlorine Pesticide Results: Lot 1 DP 55480, Cosgrave Road, Ardmore (mg/kg).

Sample	Total DDT	Dieldrin
COMP01	<0.09	<0.014
COMP02	<0.09	<0.015
COMP03	<0.09	<0.015

Note: * = Residual levels of contaminants detected. Results in red exceed the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part. Results in *Italics* exceed the cleanfill criteria.

The concentrations of organo-chlorine pesticides in all samples analysed were below the analytical levels of detection, therefore below the cleanfill criteria, the $SCSs_{(health)}$ for residential land use as outlined in the NES and the discharge criteria of the AUP: OP.

14.0 Revised Conceptual Model of Exposure Pathways

The revised conceptual site model provided in Table 8 below expands on the potential sources of contamination (as identified above), following sampling and analysis, and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 8: Revised Conceptual Site Model: Lot 1 DP 55480, Cosgrave Road, Ardmore

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Incomplete: No evidence of potential vapours or fibres identified at the site.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No evidence of potential vapours or fibres identified at the site.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP

15.0 Regulatory Requirements

15.1 The National Environmental Standard

Due to the potentially contaminating land uses identified above, it is considered that an activity described in the HAIL is being, has been, or is more likely than not to have been undertaken at the site.

Resource Consent will therefore likely be required for the site under the District Plan, following the introduction of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

In reference to the NES the following assessment was made in determining the activity status of the proposed works:

- The land is covered by the NES under regulation 5.7(b) 'an activity or industry described in the HAIL has been undertaken on it'.
- The activity is disturbing soil under regulation 5(4)(a) 'means disturbing the soil of the piece of land for a particular purpose'.
- The activity will unlikely comply with regulation 8(3)(c) 'the volume of the disturbance of the soil of the piece of land must be no more than 25m^3 per 500m^2' and '…a maximum of 5 m^3 per 500 m^2 of soil may be taken away'.
- A detailed site investigation for the piece of land does exist.

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

15.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules must be considered.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

As there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

16.0 Conclusions and Recommendations

This DSI has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 1 DP55480, Cosgrave Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the Hazardous Activities and Industries List (HAIL) was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's, used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified, it is considered that there is evidence to suggest that an activity outlined in the HAIL has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, twelve discrete samples were composited at the laboratory (4:1) to form three composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

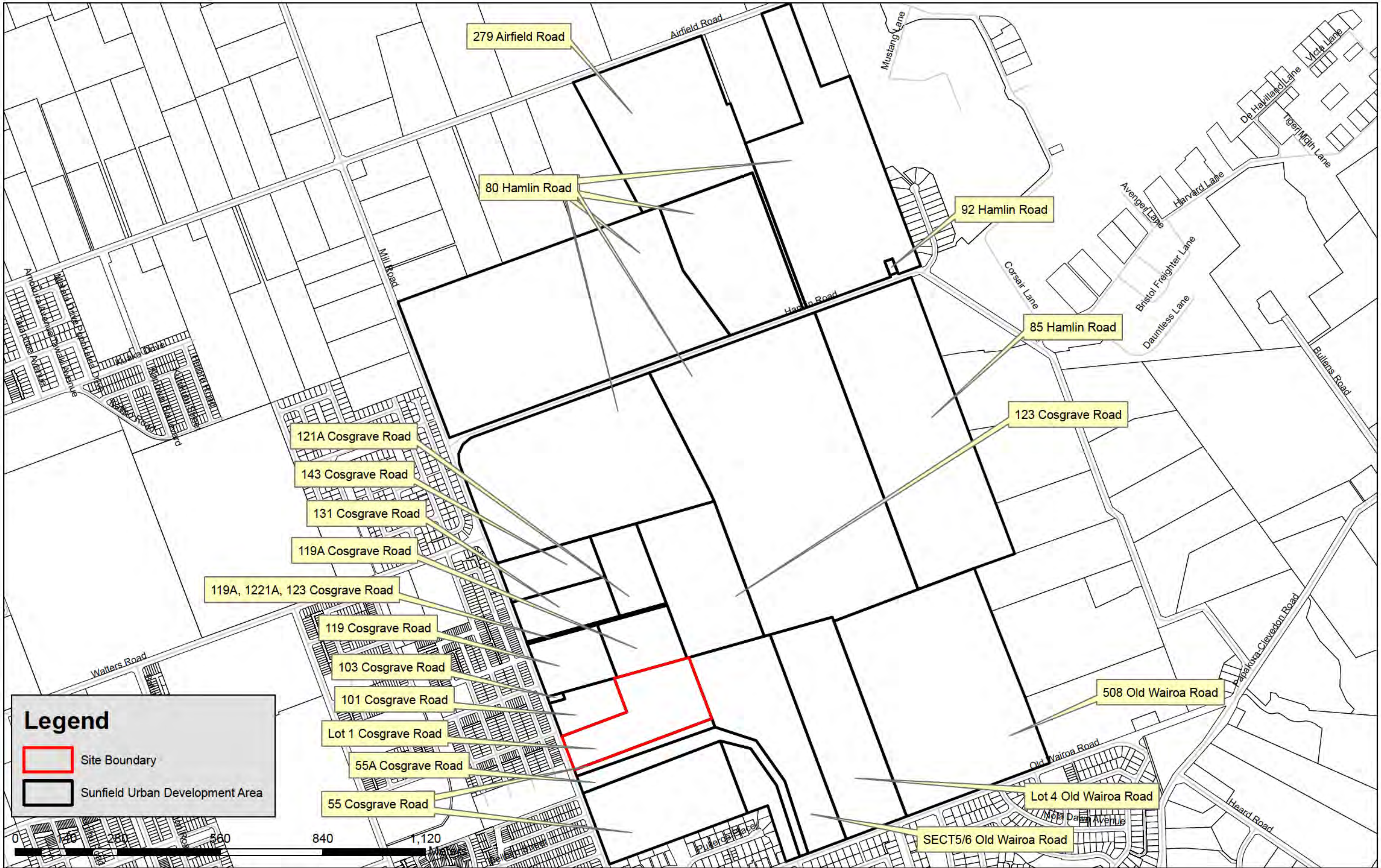
As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Figures

Figure 1 –Site Location Plan

Figure 2 – Sample Location Plan



Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** Lot 1 DP55480 Cosgrave Road Sunfield Urban Development Area Papakura Auckland	**Figure 1: Site Location Plan** Detailed Site Investigation	N 1443.011 R5	Drawing Number: 1443.011.01 Drawn By: MT Checked By: DO'R Date: 19/12/2023

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Winton Land Limited
Lot 1 DP 55480 Cosgrave Road
Sunfield Urban Development Area
Papakura
Auckland

Figure 2: Sample Location Plan

Detailed Site Investigation

1443.011 R5

Drawing Number: 1443.011.02
Drawn By: MT
Checked By: DO'R
Date: 19/12/2023

Appendices

Appendix A – Illustrative Masterplan

Appendix B – Environmental HAIL

Ministry for the Environment
Manatū Mō Te Taiao

Hazardous Activities and Industries List (HAIL)

October 2011

A Chemical manufacture, application and bulk storage

1. Agrichemicals including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application
2. Chemical manufacture, formulation or bulk storage
3. Commercial analytical laboratory sites
4. Corrosives including formulation or bulk storage
5. Dry-cleaning plants including dry-cleaning premises or the bulk storage of dry-cleaning solvents
6. Fertiliser manufacture or bulk storage
7. Gasworks including the manufacture of gas from coal or oil feedstocks
8. Livestock dip or spray race operations
9. Paint manufacture or formulation (excluding retail paint stores)
10. Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds
11. Pest control including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application
12. Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides
13. Petroleum or petrochemical industries including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground
14. Pharmaceutical manufacture including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges
15. Printing including commercial printing using metal type, inks, dyes, or solvents (excluding photocopy shops)
16. Skin or wool processing including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products
17. Storage tanks or drums for fuel, chemicals or liquid waste
18. Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside

B Electrical and electronic works, power generation and transmission

1. Batteries including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)

2. Electrical transformers including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
3. Electronics including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices
4. Power stations, substations or switchyards

C Explosives and ordinances production, storage and use

1. Explosive or ordinance production, maintenance, dismantling, disposal, bulk storage or re-packaging
2. Gun clubs or rifle ranges, including clay targets clubs that use lead munitions outdoors
3. Training areas set aside exclusively or primarily for the detonation of explosive ammunition

D Metal extraction, refining and reprocessing, storage and use

1. Abrasive blasting including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material
2. Foundry operations including the commercial production of metal products by injecting or pouring molten metal into moulds
3. Metal treatment or coating including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds
4. Metalliferous ore processing including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals
5. Engineering workshops with metal fabrication

E Mineral extraction, refining and reprocessing, storage and use

1. Asbestos products manufacture or disposal including sites with buildings containing asbestos products known to be in a deteriorated condition
2. Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)
3. Cement or lime manufacture using a kiln including the storage of wastes from the manufacturing process
4. Commercial concrete manufacture or commercial cement storage
5. Coal or coke yards
6. Hydrocarbon exploration or production including well sites or flare pits
7. Mining industries (excluding gravel extraction) including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

F Vehicle refuelling, service and repair

1. Airports including fuel storage, workshops, washdown areas, or fire practice areas
2. Brake lining manufacturers, repairers or recyclers
3. Engine reconditioning workshops
4. Motor vehicle workshops
5. Port activities including dry docks or marine vessel maintenance facilities

6. Railway yards including goods-handling yards, workshops, refuelling facilities or maintenance areas
7. Service stations including retail or commercial refuelling facilities
8. Transport depots or yards including areas used for refuelling or the bulk storage of hazardous substances

G Cemeteries and waste recycling, treatment and disposal

1. Cemeteries
2. Drum or tank reconditioning or recycling
3. Landfill sites
4. Scrap yards including automotive dismantling, wrecking or scrap metal yards
5. Waste disposal to land (excluding where biosolids have been used as soil conditioners)
6. Waste recycling or waste or wastewater treatment

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

Appendix C – Laboratory Transcripts

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	Focus Environmental Services Limited	**Lab No:**	2566804 SPv1
Contact:	Elliot Dillon-Herzog	**Date Received:**	25-Mar-2021
	C/- Focus Environmental Services Limited	**Date Reported:**	30-Mar-2021
	PO Box 11455	**Quote No:**	80876
	Ellerslie	**Order No:**	
	Auckland 1542	**Client Reference:**	1443.011
		Submitted By:	Elliot Dillon-Herzog

Sample Type: Soil

Sample Name:		Composite of COMP01 A, COMP01 B, COMP01 C and COMP01 D	Composite of COMP02 A, COMP02 B, COMP02 C and COMP02 D	Composite of COMP03 A, COMP03 B, COMP03 C and COMP03 D		
Lab Number:		2566804.13	2566804.14	2566804.15		
Individual Tests						
Dry Matter	g/100g as rcvd	70	67	67	-	-
Total Recoverable Arsenic	mg/kg dry wt	3	< 4	< 4	-	-
Total Recoverable Copper	mg/kg dry wt	26	22	25	-	-
Total Recoverable Lead	mg/kg dry wt	30	16.6	18.6	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
alpha-BHC	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
beta-BHC	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
delta-BHC	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
cis-Chlordane	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
trans-Chlordane	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
2,4'-DDD	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
4,4'-DDD	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
2,4'-DDE	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
4,4'-DDE	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
2,4'-DDT	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
4,4'-DDT	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Total DDT Isomers	mg/kg dry wt	< 0.09	< 0.09	< 0.09	-	-
Dieldrin	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endosulfan I	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endosulfan II	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endrin	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endrin aldehyde	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Endrin ketone	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Heptachlor	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-
Methoxychlor	mg/kg dry wt	< 0.014	< 0.015	< 0.015	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	13-15
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	13-15
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	13-15
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	13-15
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	13-15
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	13-15
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	13-15
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	13-15

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 26-Mar-2021 and 30-Mar-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

DETAILED SITE INVESTIGATION
LOT 4 DP 55480
OLD WAIROA ROAD
ARDMORE
AUCKLAND

For the Attention of:

Winton Land Limited

Reference: FES 1443.012 December 2023 (R5)

Company Information

Focus Environmental Services Limited

PO Box 11455

Ellerslie

Auckland 1542

Telephone: +64 9 579 4155

Email: mail@focusenvironmental.co.nz

Quality Information

Project Name	Detailed Site Investigation Lot 4 DP 55480, Old Wairoa Road, Ardmore
Project Number	1443.012 (R5)
File Reference	M:\2023 Jobs\Winton\Sunfield Development\Completed Reports\Lot 4 Old Wairoa Road\R5\1443.012_DSI_MT (R5).docx
Date Issued	April 2021
Date Revised	December 2023

Author

Megan Thomas
Environmental Scientist

Reviewed

Claire Johnson
Environmental Scientist

Authorised

David O'Reilly
Principal Environmental Consultant

Distribution List

Parties	Copies
Winton Land Limited	1
Focus Environmental Services Limited	1

Contents

Executive Summary

This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

Focus Environmental Services Limited was contracted by Winton Land Limited to carry out a Detailed Site Investigation (DSI) at Lot 4 DP 55480, Ardmore, Auckland. The legal description of the site is Lot 4 DP 55480 with an area of 10.35 ha.

It should be noted that this report has been revised following the request of the client.

The Sunfield Urban Development Area (UDA) consists of nineteen properties located across Cosgrave Road, Old Wairoa Road, Hamlin Road and Airfield Road, Papakura, Auckland.

The scope of this report is limited to the property of Lot 4 DP 55480 Old Wairoa Road, Ardmore and should be read in conjunction with the cover letter summarising the findings of the PSIs and DSIs completed for the Sunfield UDA.

This DSI has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 4 DP 55480, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the Hazardous Activities and Industries List (HAIL) was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's, used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified, it is considered that there is evidence to suggest that an activity outlined in the HAIL has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, twelve discrete samples were composited at the laboratory (4:1) to form three composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Submitted By,

Principal Environmental Consultant
Focus Environmental Services Limited

1.0 Scope

1.1 This report has been prepared at the request of Winton Land Limited ("the Client") in terms of the Focus Environmental Services Limited Agreement ("Agreement").

1.2 The following report is based on:

- *Information provided by the Client;*
- *The report titled 'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 4 DP 55480, Old Wairoa Road, Ardmore Auckland' dated December 2020 and prepared by Focus Environmental Services;*
- *A site walkover and inspection; and*
- *Site investigation and soil sampling.*

1.3 We have not independently verified the information provided to us by the Client or its completeness. We do not express an opinion on the accuracy or the reliability of such information.

1.4 No warranties are given, intended or implied.

1.5 Opinion, inferences, assumptions and interpretations made in this report should not be construed as legal opinion.

1.6 Where an assessment is given in this report, the Client must also rely upon their own judgement, knowledge and assessment of the subject of this report before undertaking any action.

1.7 This report must not be used in any other context or for any other purpose other than that for which it has been prepared without the prior written consent of Focus Environmental Services Limited.

1.8 This report is strictly confidential and intended for the sole use of the Client and shall not be disclosed without the prior written consent of Focus Environmental Services Limited.

1.9 This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018by SGS New Zealand.

2.0 Site Identification

The property is located at Lot 4 DP 55480 Old Wairoa Road, Ardmore as shown in Figure 1 attached. The legal description of the site is Lot 4 DP 55480 with an area of 10.35 ha. The site is located at national grid reference 1774602mE and 5898062mN.

The site is rectangular in shape and is zoned 'Future Urban Zone' under the Auckland Unitary Plan – Operative in Part (AUP: OP).

The site location plan is presented as Figure 1.

3.0 Proposed Site Redevelopment Activity

It is proposed that the site will be redeveloped for residential purposes. As part of the redevelopment, the site will undergo subdivision, a change of land use and disturbance of soils.

The illustrative masterplan is attached as Appendix A.

4.0 Geology and Hydrology

Published geological maps[1] indicate the subject sites are typically underlain by alluvial deposits of the Tauranga Group Formation. A description of the underlying geologies is presented in Table 1 below.

Table 1: Geology: Lot 4 DP 55480, Old Wairoa Road, Ardmore

Key name	OIS1 (Holocene) river deposits
Simple name	Holocene river deposits
Main rock name	Mud
Description	Sand, silt mud and clay with local gravel and peat beds
Subsidiary rocks	Sand silt clay peat
Key group	Holocene sediments
Stratigraphic lexicon name	Tauranga Group
Absolute age (min)	0.0 million years
Absolute age (max)	0.014 million years
Rock group	Mudstone
Rock class	Clastic sediment

No groundwater investigation was carried out as part of this investigation.

The nearest surface water body to the site, as identified in the ecological report titled *'Cosgrave Road Plan Change: Baseline Ecology'* and dated April 2023, is an artificial drainage channel which runs through the western boundary of the plan change area.

[1] Geology of the Auckland Area (Institute of Geological &Nuclear Sciences 1:250,000 geological map 3, 2011)

5.0 Regulatory Framework

5.1 The National Environmental Standard

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect on the 1st of January 2012 and supersedes any District Plan rules that related to contaminated land. Any Regional Plan rules relating to contaminated land are still applicable.

In brief, the objective of the NES is to ensure that land affected by contaminants is identified and assessed and, if necessary, remediated or managed to protect human health. The NES only applies to the activities: removing or replacing all, or part of, a fuel storage system; sampling the soil; disturbing the soil; subdividing the land; and changing the land use, and where an activity or industry described in the Hazardous Activities and Industries List (HAIL) is being, has been, or is more likely than not to have been undertaken on the piece of land.

The NES also contains reference to the soil contaminant standards for human health ($SCSs_{(health)}$), for a variety of land use scenarios along with reference to best practice reporting documents.

The environmental HAIL is presented as Appendix B.

5.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules of the AUP: OP must be considered.

In brief, the objective of the AUP: OP is to manage land containing elevated levels of contaminants to protect human health and the environment and to enable the effective use of the land.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

6.0 Background

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 4 DP 55480, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the HAIL was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation.

This document is intended to confirm the contamination status of the site at Lot 4 DP 55480, Old Wairoa Road, Ardmore.

In addition, at the time of writing this report, the results of a detailed geotechnical investigation covering the site was not available.

7.0 Potentially Contaminating Activities or Land Uses

Three potentially contaminating activities were identified at the site, these are outlined in Table 2 below.

Table 2: Potentially Contaminating Activities: Lot 4 DP 55480, Old Wairoa Road, Ardmore

Activity Description	HAIL Category
Historical Horticulture/Persistent Pesticide Use	A10

It should be noted that following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation. In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

8.0 Conceptual Model of Exposure Pathways

The preliminary conceptual site model provided in Table 3 below expands on the potential sources of contamination (as identified above) and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 3: Preliminary Conceptual Site Model: Lot 4 DP 55480, Old Wairoa Road, Ardmore

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Incomplete: No evidence of potential vapours or fibres identified at the site.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No evidence of potential vapours or fibres identified at the site.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.

9.0 Sampling and Analysis Plan and Sampling Method

Environmental Sampling was carried out in accordance with the Contaminated Land Management Guidelines No. 5 (MfE, Revised 2021).

Twelve discrete soil samples were collected from across the site and composited at the laboratory (4:1) to form three composite samples which are indicative and representative of the areas of the site potentially subject to historical horticultural, organo-chlorine pesticide spray use onsite. All samples were sent under full chain of custody documentation to an IANZ accredited laboratory. Sampling and Analysis information is provided in Table 4 below.

Table 4: Sample Analysis Information: Lot 4 DP 55480, Old Wairoa Road, Ardmore

Sample Name	Sample Depth	Number of Samples	HAIL Activity	Analysis Suite
COMP01 - COMP03	0 - 0.15m	3	Historical Horticulture/Pesticide use	• Total recoverable Arsenic, Copper & Lead; and • Organo-chlorine Pesticides.

The sample location plan is presented as Figure 2.

10.0 Field Sampling Quality Assurance

All sampling implements were triple washed between samples using clean tap water, followed by a solution of laboratory grade phosphate free detergent (Decon 90), and a final rinse with clean water.

Clean, nitrile gloves were worn when handling each sample. Samples were stored in laboratory cleaned glass jars and immediately placed in an iced cooler. The samples were transported under chain of custody documentation to an IANZ accredited laboratory for analysis.

11.0 Laboratory Quality Assurance

Routine laboratory quality assurance procedures include analysis of laboratory blanks and spiked samples. All analyses were carried out using industry standard methods as follows:

- Total Recoverable Metals – Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICPMS. In accordance with in-house procedure based on US EPA method 200.8.
- Organo-chlorine Pesticides – sonication extraction – OCP Screen method, air dry, grind, sonication extraction GC-ECD.

12.0 Basis for Guideline Values

Following the plan change it is proposed that the site will be developed for residential land use, therefore the guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption), as outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES), and the discharge criteria of the Auckland Unitary Plan: Operative in Part (AUP: OP) are considered relevant and have been adopted as the site assessment criteria.

Furthermore, the concentrations of heavy metals detected will be compared to the maximum background levels for non-volcanic soils in Auckland[2] (TP153). The relevant values of the above guidelines have been reproduced in Table 5 below:

Table 5: Site Assessment Criteria: Lot 4 DP 55480, Old Wairoa Road, Ardmore (mg/kg)

Parameter	NES ($SCSs_{(health)}$)	AUP: OP	TP153 (Non-Volcanic)
Arsenic	20	100	12
Copper	NL	325	45
Lead	210	250	65
Total DDT	70	12	-
Dieldrin	2.6	-	-

Note: NL = Not Limited. This is where the derived values exceed 10,000mg/kg;

It is considered that the natural background levels of organo-chlorine pesticides are to be below the analytical levels of detection and if analysis shows any concentrations above the limit of detection would restrict material from being classified as cleanfill.

---

2 Background Concentrations of Inorganic Elements in Soils from the Auckland Region, Technical Publication No.153, Auckland Regional Council, 2001.

13.0 Soil Sampling Results

Tabulated soil sampling results are presented in Tables 6 & 7 below and laboratory transcripts are provided in Appendix A.

13.1 Heavy Metals

Table 6: Heavy Metals Results: Lot 4 DP 55480, Old Wairoa Road, Ardmore (mg/kg).

Sample	As	Cu	Pb
COMP01	<2	20	21
COMP02	<5	21	26
COMP03	2	20	15.5

Note: Results in red exceed the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the maximum Auckland background concentrations for non-volcanic soils outlined in the Auckland Regional Council Technical Publication No.153, Oct 2001.

The concentrations of arsenic, copper and lead detected in all samples analysed were below the maximum Auckland background concentrations for non-volcanic soils and therefore below the $SCSs_{(health)}$ for residential land use and the discharge criteria as outlined in the AUP: OP.

13.2 Organo-chlorine Pesticides

Table 7: Organo-chlorine Pesticide Results: Lot 4 DP 55480, Old Wairoa Road, Ardmore (mg/kg).

Sample	Total DDT	Dieldrin
COMP01	<0.02	<0.05
COMP02	<0.02	<0.05
COMP03	<0.02	<0.05

Note: * = Residual levels of contaminants detected. Results in red exceed the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part. Results in *Italics* exceed the cleanfill criteria.

The concentrations of organo-chlorine pesticides in all samples analysed were below the analytical levels of detection, therefore below the cleanfill criteria, the $SCSs_{(health)}$ for residential land use as outlined in the NES and the discharge criteria of the AUP: OP.

14.0 Revised Conceptual Model of Exposure Pathways

The revised conceptual site model provided in Table 8 below expands on the potential sources of contamination (as identified above), following sampling and analysis, and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 8: Revised Conceptual Site Model: Lot 4 DP 55480, Old Wairoa Road, Ardmore.

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Incomplete: No evidence of potential vapours or fibres identified at the site.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No evidence of potential vapours or fibres identified at the site.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP

15.0 Regulatory Requirements

15.1 The National Environmental Standard

Due to the potentially contaminating land uses identified above, it is considered that an activity described in the HAIL is being, has been, or is more likely than not to have been undertaken at the site.

Resource Consent will therefore likely be required for the site under the District Plan, following the introduction of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

In reference to the NES the following assessment was made in determining the activity status of the proposed works:

- The land is covered by the NES under regulation 5.7(b) 'an activity or industry described in the HAIL has been undertaken on it'.
- The activity is disturbing soil under regulation 5(4)(a) 'means disturbing the soil of the piece of land for a particular purpose'.
- The activity will unlikely comply with regulation 8(3)(c) 'the volume of the disturbance of the soil of the piece of land must be no more than 25m^3 per 500m^2' and '…a maximum of 5 m^3 per 500 m^2 of soil may be taken away'.
- A detailed site investigation for the piece of land does exist.

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

15.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules must be considered.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

As there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

16.0 Conclusions and Recommendations

This DSI has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, Lot 4 DP 55480, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, during the desktop study as part of the PSI, the Auckland Council Site Contamination Enquiry stated that the site had potentially been used for horticultural purposes. During an interview with the property owner it was stated that this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. No other activity or industry described in the Hazardous Activities and Industries List (HAIL) was identified onsite.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's, used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified, it is considered that there is evidence to suggest that an activity outlined in the HAIL has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, twelve discrete samples were composited at the laboratory (4:1) to form three composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

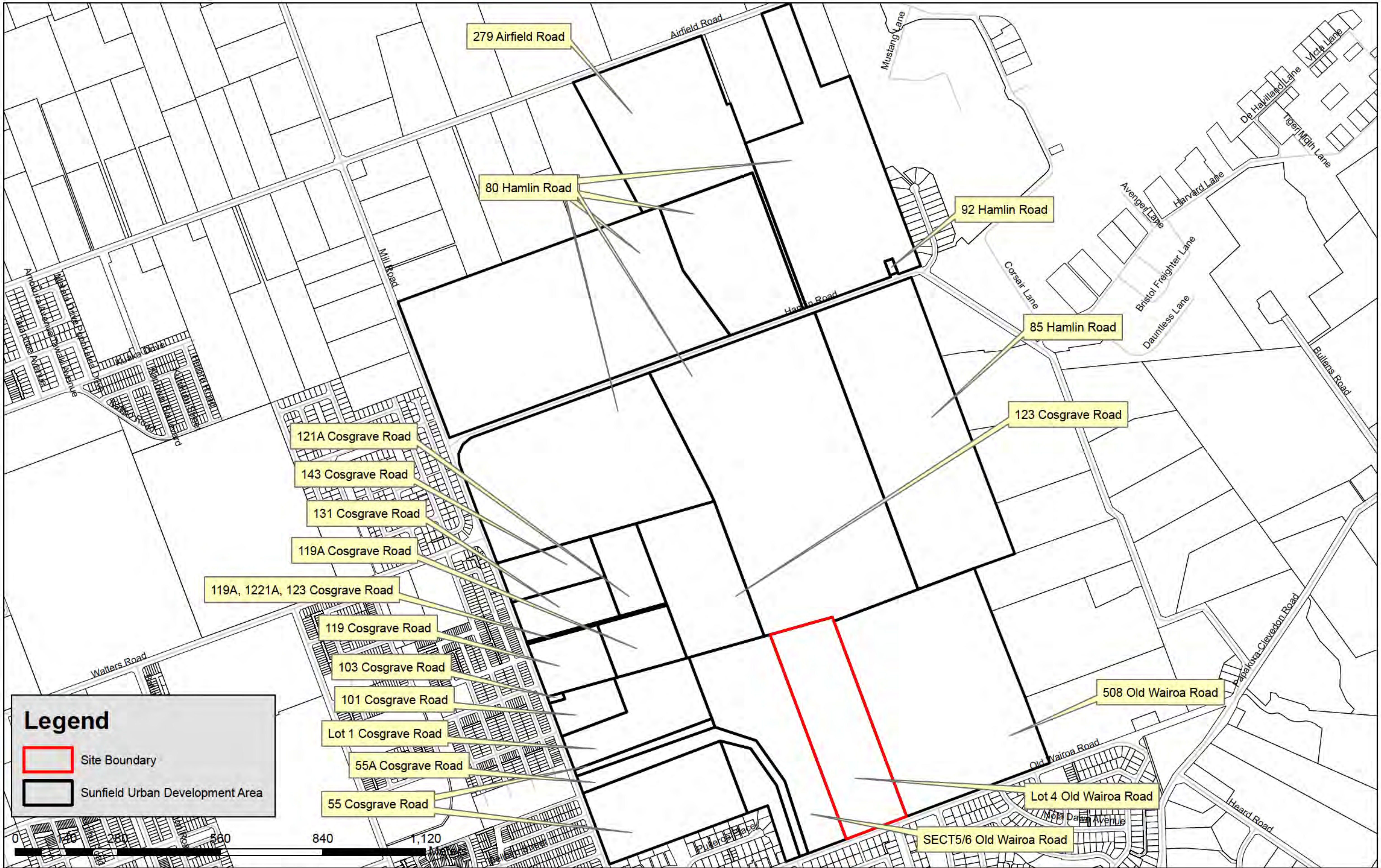
As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Figures

Figure 1 –Site Location Plan

Figure 2 – Sample Location Plan



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Sunfield Urban Development Area
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Auckland

Figure 1: Site Location Plan
Detailed Site Investigation

1443.012 (R5)

Drawing Number: 1443.012.01	
Drawn By: MT	
Checked By: DO'R	
Date: 19/12/2023	

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Figure 2: Sample Location Plan

Detailed Site Investigation

1443.012 R5

Drawing Number: 1443.012.03
Drawn By: MT
Checked By: DO'R
Date: 19/12/2023

Appendices

Appendix A – Illustrative Masterplan

Appendix B – Environmental HAIL

Ministry for the Environment
Manatū Mō Te Taiao

Hazardous Activities and Industries List (HAIL)

October 2011

A Chemical manufacture, application and bulk storage

1. Agrichemicals including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application
2. Chemical manufacture, formulation or bulk storage
3. Commercial analytical laboratory sites
4. Corrosives including formulation or bulk storage
5. Dry-cleaning plants including dry-cleaning premises or the bulk storage of dry-cleaning solvents
6. Fertiliser manufacture or bulk storage
7. Gasworks including the manufacture of gas from coal or oil feedstocks
8. Livestock dip or spray race operations
9. Paint manufacture or formulation (excluding retail paint stores)
10. Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds
11. Pest control including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application
12. Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides
13. Petroleum or petrochemical industries including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground
14. Pharmaceutical manufacture including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges
15. Printing including commercial printing using metal type, inks, dyes, or solvents (excluding photocopy shops)
16. Skin or wool processing including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products
17. Storage tanks or drums for fuel, chemicals or liquid waste
18. Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside

B Electrical and electronic works, power generation and transmission

1. Batteries including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)

2. Electrical transformers including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
3. Electronics including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices
4. Power stations, substations or switchyards

C Explosives and ordinances production, storage and use

1. Explosive or ordinance production, maintenance, dismantling, disposal, bulk storage or re-packaging
2. Gun clubs or rifle ranges, including clay targets clubs that use lead munitions outdoors
3. Training areas set aside exclusively or primarily for the detonation of explosive ammunition

D Metal extraction, refining and reprocessing, storage and use

1. Abrasive blasting including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material
2. Foundry operations including the commercial production of metal products by injecting or pouring molten metal into moulds
3. Metal treatment or coating including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds
4. Metalliferous ore processing including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals
5. Engineering workshops with metal fabrication

E Mineral extraction, refining and reprocessing, storage and use

1. Asbestos products manufacture or disposal including sites with buildings containing asbestos products known to be in a deteriorated condition
2. Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)
3. Cement or lime manufacture using a kiln including the storage of wastes from the manufacturing process
4. Commercial concrete manufacture or commercial cement storage
5. Coal or coke yards
6. Hydrocarbon exploration or production including well sites or flare pits
7. Mining industries (excluding gravel extraction) including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

F Vehicle refuelling, service and repair

1. Airports including fuel storage, workshops, washdown areas, or fire practice areas
2. Brake lining manufacturers, repairers or recyclers
3. Engine reconditioning workshops
4. Motor vehicle workshops
5. Port activities including dry docks or marine vessel maintenance facilities

6. Railway yards including goods-handling yards, workshops, refuelling facilities or maintenance areas
7. Service stations including retail or commercial refuelling facilities
8. Transport depots or yards including areas used for refuelling or the bulk storage of hazardous substances

G Cemeteries and waste recycling, treatment and disposal

1. Cemeteries
2. Drum or tank reconditioning or recycling
3. Landfill sites
4. Scrap yards including automotive dismantling, wrecking or scrap metal yards
5. Waste disposal to land (excluding where biosolids have been used as soil conditioners)
6. Waste recycling or waste or wastewater treatment

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

Appendix C – Laboratory Transcripts

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

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E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

SPv1

Client:	Focus Environmental Services Limited	**Lab No:**	2566806
Contact:	Elliot Dillon-Herzog	**Date Received:**	25-Mar-2021
	C/- Focus Environmental Services Limited	**Date Reported:**	30-Mar-2021
	PO Box 11455	**Quote No:**	80876
	Ellerslie	**Order No:**	
	Auckland 1542	**Client Reference:**	1443.012
		Submitted By:	Elliot Dillon-Herzog

Sample Type: Soil

Sample Name:		Composite of COMP01 A, COMP01 B, COMP01 C and COMP01 D	Composite of COMP02 A, COMP02 B, COMP02 C and COMP02 D	Composite of COMP03 A, COMP03 B, COMP03 C and COMP03 D		
Lab Number:		2566806.13	2566806.14	2566806.15		
Individual Tests						
Dry Matter	g/100g as rcvd	77	72	76	-	-
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 5	2	-	-
Total Recoverable Copper	mg/kg dry wt	20	21	20	-	-
Total Recoverable Lead	mg/kg dry wt	21	26	15.5	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
alpha-BHC	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
beta-BHC	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
delta-BHC	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
cis-Chlordane	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
trans-Chlordane	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
2,4'-DDD	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
4,4'-DDD	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
2,4'-DDE	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
4,4'-DDE	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
2,4'-DDT	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
4,4'-DDT	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Total DDT Isomers	mg/kg dry wt	< 0.08	< 0.09	< 0.08	-	-
Dieldrin	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endosulfan I	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endosulfan II	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endrin	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endrin aldehyde	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Endrin ketone	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Heptachlor	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-
Methoxychlor	mg/kg dry wt	< 0.014	< 0.014	< 0.013	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

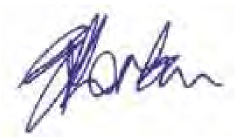
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	13-15
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	13-15
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	13-15
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	13-15
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	13-15
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	13-15
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	13-15
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	13-15

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 29-Mar-2021 and 30-Mar-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.



Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

FOCUS ENVIRONMENTAL SERVICES LTD

DETAILED SITE INVESTIGATION
SECT 5 SO 495342, SECT 6 SO 495342
OLD WAIROA ROAD &
55A COSGRAVE ROAD
ARDMORE
AUCKLAND

For the Attention of:

Winton Land Limited

Reference: FES 1443.013 December 2023 (R5)

JAS-ANZ

Company Information

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Email: mail@focusenvironmental.co.nz

Quality Information

Project Name	Detailed Site Investigation
	Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road & 55A Cosgrave Road, Ardmore
Project Number	1443.013 (R5)
File Reference	M:\2023 Jobs\Winton\Sunfield Development\Completed Reports\Sect 5 Old Wairoa Road\R5\1443.013_DSI_MT (R5).docx
Date Issued	April 2021
Date Revised	December 2023

Author	Reviewed
Megan Thomas Environmental Scientist	Claire Johnson Environmental Scientist

Authorised

David O'Reilly
Principal Environmental Consultant

Distribution List

Parties	Copies
Winton Land Limited	1
Focus Environmental Services Limited	1

Contents

Executive Summary

This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

Focus Environmental Services Limited was contracted by Winton Land Limited to carry out a Detailed Site Investigation (DSI) at Sect 5 SO 495342, Sect 6 SO 495342 Old Wairoa Road and the eastern portion of 55A Cosgrave Road, Ardmore, Auckland. The legal description of the sites are Sect 5 SO 495342, Sect 6 SO 495342 & SECT 1 SO 495342, SECT 2 SO495342 with an area of 11.81 and 1.13 ha respectively.

It should be noted that this report has been revised following the request of the client.

The Sunfield Urban Development Area (UDA) consists of nineteen properties located across Cosgrave Road, Old Wairoa Road, Hamlin Road and Airfield Road, Papakura, Auckland.

The scope of this report is limited to the properties of Sect 5 SO 495342, Sect 6 SO 495342 Old Wairoa Road and the eastern portion of 55A Cosgrave Road, Ardmore and should be read in conjunction with the cover letter summarising the findings of the PSIs and DSIs completed for the Sunfield UDA.

This DSI has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, 2021).

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, SECT 5 SO, 495342, SECT SO, 49534, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, due to the age of the former site building, the potential for ground contamination from the historic use of lead-based paints and asbestos containing materials was identified. Furthermore, the site contamination enquiry stated that the site had potentially been used for horticultural purposes. An interview with the property owner stated this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified it is considered that there is evidence to suggest that an activity outlined in the Hazardous Activities Industries List (HAIL) has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, a single discrete surface soil sample was taken from the area of the historical building identified at the site, and twenty discrete samples were composited at the laboratory (4:1) to form 5 composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

At the request of the client, 55A Cosgrave Road has been included in the report. Given the site is in use for the same purposes as the neighbouring sites on which the sample analysis was carried out it is reasonable to assume the concentrations of contaminants would also be below the maximum Auckland background concentrations for non-volcanic soils.

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Submitted By,

Principal Environmental Consultant
Focus Environmental Services Limited

1.0 Scope

1.1 This report has been prepared at the request of Winton Land Limited ("the Client") in terms of the Focus Environmental Services Limited Agreement ("Agreement").

1.2 The following report is based on:

- *Information provided by the Client*
- *The report titled 'Preliminary Site Investigation, Ardmore Block Plan Change Area, SECT 5 SO, 495342, SECT SO, 49534, Old Wairoa Road, Ardmore Auckland' dated December 2020 and prepared by Focus Environmental Services;*
- *A site walkover and inspection; and*
- *Site investigation and soil sampling.*

1.3 We have not independently verified the information provided to us by the Client or its completeness. We do not express an opinion on the accuracy or the reliability of such information.

1.4 No warranties are given, intended or implied.

1.5 Opinion, inferences, assumptions and interpretations made in this report should not be construed as legal opinion.

1.6 Where an assessment is given in this report, the Client must also rely upon their own judgement, knowledge and assessment of the subject of this report before undertaking any action.

1.7 This report must not be used in any other context or for any other purpose other than that for which it has been prepared without the prior written consent of Focus Environmental Services Limited.

1.8 This report is strictly confidential and intended for the sole use of the Client and shall not be disclosed without the prior written consent of Focus Environmental Services Limited.

1.9 This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

2.0 Site Identification

The property is located at Sect 5 SO 495342, Sect 6 SO 495342 Old Wairoa Road and the eastern area of 55A Cosgrave Road, Ardmore, Auckland as shown in Figure 1 attached. The legal description of the sites are Sect 5 SO 495342, Sect 6 SO 495342 & SECT 1 SO 495342, SECT 2 SO495342 (henceforth referred to as the site) with an area of 11.81 and 1.13 ha respectively. The site is located at national grid reference 1774320mE and 5898108mN.

The site is rectangular in shape and is zoned 'Future Urban Zone' under the Auckland Unitary Plan – Operative in Part (AUP: OP).

The site location plan is presented as Figure 1.

3.0 Proposed Site Redevelopment Activity

It is proposed that the site will be redeveloped for residential purposes. As part of the redevelopment, the site will undergo subdivision, a change of land use and disturbance of soils.

The illustrative masterplan is attached as Appendix A.

4.0 Geology and Hydrology

Published geological maps[1] indicate the subject sites are typically underlain by alluvial deposits of the Tauranga Group Formation. A description of the underlying geologies is presented in Table 1 below.

Table 1: Geology: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road & 55A Cosgrave Road, Ardmore

Key name	OIS1 (Holocene) river deposits
Simple name	Holocene river deposits
Main rock name	Mud
Description	Sand, silt mud and clay with local gravel and peat beds
Subsidiary rocks	Sand silt clay peat
Key group	Holocene sediments
Stratigraphic lexicon name	Tauranga Group
Absolute age (min)	0.0 million years
Absolute age (max)	0.014 million years
Rock group	Mudstone
Rock class	Clastic sediment

No groundwater investigation was carried out as part of this investigation.

The nearest surface water body to the site, as identified in the ecological report titled *'Cosgrave Road Plan Change: Baseline Ecology'* and dated April 2023, is an artificial drainage channel which runs through the western boundary of the site.

[1] Geology of the Auckland Area (Institute of Geological &Nuclear Sciences 1:250,000 geological map 3, 2011)

5.0 Regulatory Framework

5.1 The National Environmental Standard

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect on the 1st of January 2012 and supersedes any District Plan rules that related to contaminated land. Any Regional Plan rules relating to contaminated land are still applicable.

In brief, the objective of the NES is to ensure that land affected by contaminants is identified and assessed and, if necessary, remediated or managed to protect human health. The NES only applies to the activities: removing or replacing all, or part of, a fuel storage system; sampling the soil; disturbing the soil; subdividing the land; and changing the land use, and where an activity or industry described in the Hazardous Activities and Industries List (HAIL) is being, has been, or is more likely than not to have been undertaken on the piece of land.

The NES also contains reference to the soil contaminant standards for human health ($SCSs_{(health)}$), for a variety of land use scenarios along with reference to best practice reporting documents.

The environmental HAIL is attached as Appendix B.

5.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules of the AUP: OP must be considered.

In brief, the objective of the AUP: OP is to manage land containing elevated levels of contaminants to protect human health and the environment and to enable the effective use of the land.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

6.0 Background

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, SECT 5 SO, 495342, SECT SO, 49534, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, due to the age of the former site building, the potential for ground contamination from the historic use of lead-based paints and asbestos containing materials was identified. Furthermore, the site contamination enquiry stated that the site had potentially been used for horticultural purposes. An interview with the property owner stated this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this. Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation.

This document is intended to confirm the contamination status of the site at Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore.

In addition, at the time of writing this report, the results of a detailed geotechnical investigation covering the site was not available.

7.0 Potentially Contaminating Activities or Land Uses

Three potentially contaminating activities were identified at the site, these are outlined in Table 2 below.

Table 2: Potentially Contaminating Activities: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road & 55A Cosgrave Road, Ardmore

Activity Description	HAIL Category
Historical Horticulture/Persistent Pesticide Use	A10
Maintenance and Use of Lead Based Paint	I
Demolition of Historic Structures Potentially Containing Asbestos, Products Potentially Containing Asbestos in a Degraded Condition, and Potentially Asbestos Containing Material intermixed with the Site Soils	E1

It should be noted that following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation. In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site

8.0 Conceptual Model of Exposure Pathways

The preliminary conceptual site model provided in Table 3 below expands on the potential sources of contamination (as identified above) and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 3: Preliminary Conceptual Site Model: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road & 55A Cosgrave Road, Ardmore

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.

9.0 Sampling and Analysis Plan and Sampling Method

Environmental Sampling was carried out in accordance with the Contaminated Land Management Guidelines No. 5 (MfE, Revised 2021).

Twenty discrete soil samples were collected from across the site and composited at the laboratory (4:1) to form five composite samples which are indicative and representative of the areas of the site potentially subject to historical horticultural, organo-chlorine pesticide spray use onsite.

Furthermore, one discrete surface soil sample was collected from the area of the historical building on site. All samples were sent under full chain of custody documentation to an IANZ accredited laboratory. Sampling and Analysis information is provided in Table 4 below.

Table 4: Sample Analysis Information: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore

Sample Name	Sample Depth	Number of Samples	HAIL Activity	Analysis Suite
COMP01 - COMP05	0 - 0.15m	5	Historical Horticulture/Pesticide Use	• Total recoverable Arsenic, Copper & Lead; and • Organo-chlorine Pesticides
HB01	0 - 0.15m	1	Potential ACM Demolition Debris	• Semi-quantitative Asbestos in Soil (NZ Guidelines).
			Application of Lead Based Paint	• Total recoverable Lead

It should be noted that no visual evidence of asbestos containing materials was observed within the vicinity of the historical building.

The sample location plan is presented as Figure 2.

10.0 Field Sampling Quality Assurance

All sampling implements were triple washed between samples using clean tap water, followed by a solution of laboratory grade phosphate free detergent (Decon 90), and a final rinse with clean water.

Clean, nitrile gloves were worn when handling each sample. Samples were stored in laboratory cleaned glass jars or laboratory supplied 500ml plastic containers and immediately placed in an iced cooler. The samples were transported under chain of custody documentation to an IANZ accredited laboratory for analysis.

11.0 Laboratory Quality Assurance

Routine laboratory quality assurance procedures include analysis of laboratory blanks and spiked samples. All analyses were carried out using industry standard methods as follows:

- Total Recoverable Metals – Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICPMS. In accordance with in-house procedure based on US EPA method 200.8.
- Organo-chlorine Pesticides – sonication extraction – OCP Screen method, air dry, grind, sonication extraction GC-ECD.
- Semi–quantitative Asbestos in Soil - Sample analysis was performed using polarised light microscopy with dispersion staining in accordance with AS4964-2004 Method for the qualitative identification of asbestos in soil samples.

12.0 Basis for Guideline Values

Following the plan change it is proposed that the site will be developed for residential land use, therefore the guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption), as outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES), and the discharge criteria of the Auckland Unitary Plan: Operative in Part (AUP: OP) are considered relevant and have been adopted as the site assessment criteria.

In addition, as the NES does not contain a reference value for asbestos in soil, in accordance with the hierarchy described in the Contaminated Land Management Guidelines No. 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values (MfE, 2011), the soil guideline value for asbestos in New Zealand for residential land use, taken from the New Zealand Guidelines for Assessing and Manging Asbestos in Soil (BRANZ Limited, 2017) of 0.001% combined fibrous asbestos and asbestos fines (FA/AF) and/or 0.01% asbestos containing material (ACM) has been adopted as the site assessment criteria.

Furthermore, the concentrations of heavy metals detected will be compared to the maximum background levels for non-volcanic soils in Auckland[2] (TP153).

The relevant values of the above guidelines have been reproduced in Table 5 below:

[2] Background Concentrations of Inorganic Elements in Soils from the Auckland Region, Technical Publication No.153, Auckland Regional Council, 2001.

Table 5: Site Assessment Criteria: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore (mg/kg)

Parameter	NES ($SCSs_{(health)}$)	AUP: OP	TP153 (Non-Volcanic)
Arsenic	20	100	12
Copper	NL	325	45
Lead	210	250	65
Total DDT	70	12	-
Dieldrin	2.6	-	-
Asbestos (AF/FA)	0.001%[1]/0.01%[2]	-	-
Visual ACM	No Visual Evidence of ACM[3]	-	-

Note: NL = Not Limited. This is where the derived values exceed 10,000mg/kg; 1 = Soil guideline values for asbestos in Soil of 0.001% combined fibrous asbestos and asbestos fines (FA/AF), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 2 = Soil guideline values for asbestos in Soil of 0.01% asbestos containing material (ACM), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 3 = No visual evidence of asbestos containing material in the upper 0.1m of soil in accordance with New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017).

It is considered that the natural background levels of organo-chlorine pesticides and asbestos in soils are below the analytical levels of detection, and hence the detection of these analytes would restrict material from being classified as cleanfill.

13.0 Soil Sampling Results

Tabulated soil sampling results are presented in Tables 6 - 8 below and laboratory transcripts are provided in Appendix C.

13.1 Heavy Metals

Table 6: Heavy Metals Results: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore (mg/kg).

Sample	As	Cu	Pb
COMP01	3	27	19.8
COMP02	3	21	16.2
COMP03	3	24	17.4
COMP04	6	28	46
COMP05	<4	20	20
HB01	-	-	29

Note: Results in red exceed the Soil Contaminant Standards for health (SCSs$_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the maximum Auckland background concentrations for non-volcanic soils outlined in the Auckland Regional Council Technical Publication No.153, Oct 2001.

The concentrations of arsenic, copper and lead detected in all samples analysed were below the maximum Auckland background concentrations for non-volcanic soils and therefore below the SCSs$_{(health)}$ for residential land use and the discharge criteria as outlined in the AUP: OP.

13.2 Organo-chlorine Pesticides

Table 7: Organo-chlorine Pesticide Results: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore (mg/kg).

Sample	Total DDT	Dieldrin
COMP01	<0.02	<0.05
COMP02	<0.02	<0.05
COMP03	<0.02	<0.05
COMP04	<0.02	<0.05
COMP05	<0.02	<0.05

Note: * = Residual levels of contaminants detected. Results in red exceed the Soil Contaminant Standards for health (SCSs$_{(health)}$) for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part. Results in *Italics* exceed the cleanfill criteria.

The concentrations of organo-chlorine pesticides in all samples analysed were below the analytical levels of detection, therefore below the cleanfill criteria, the SCSs$_{(health)}$ for residential land use as outlined in the NES and the discharge criteria of the AUP: OP.

13.3 Asbestos

Table 8: Asbestos in Soil Results: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road, Ardmore (Semi-quantitative, %)

Sample	Asbestos Type	Asbestos (FA/AF %)	Asbestos (% ACM)
HB01	Asbestos Not Detected	<0.001	<0.001

Note: * - denotes residual concentrations detected. Results in red exceed the adopted human health criteria. Results in *Italics* exceed the cleanfill criteria.

The concentration of asbestos fibres detected in the single sample collected was below the analytical levels of detection, therefore below the cleanfill criteria, and the adopted human health criteria.

At the request of the client, 55A Cosgrave Road has been included in the report. Given the site is in use for the same purposes as the neighbouring sites on which the sample analysis was carried out it is reasonable to assume the concentrations of contaminants would also be below the maximum Auckland background concentrations for non-volcanic soils.

14.0 Revised Conceptual Model of Exposure Pathways

The revised conceptual site model provided in Table 9 below expands on the potential sources of contamination (as identified above), following sampling and analysis, and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 9: Revised Conceptual Site Model: Sect 5 SO 495342, Sect 6 SO 495342, Old Wairoa Road & 55A Cosgrave Road, Ardmore.

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Residential land use.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No concentrations of contaminants detected in exceedance of the SCS Commercial/industrial worker
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Incomplete: No evidence of potential vapours or fibres identified at the site.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No evidence of potential vapours or fibres identified at the site.
	Surface Water Run-off	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP
	Migration of Groundwater	Ecological Receptors - Artificial Drainage Channel	Incomplete: No concentrations of contaminants detected in exceedance of the AUP: OP

15.0 Regulatory Requirements

15.1 The National Environmental Standard

Due to the potentially contaminating land uses identified above, it is considered that an activity described in the HAIL is being, has been, or is more likely than not to have been undertaken at the site.

Resource Consent will therefore likely be required for the site under the District Plan, following the introduction of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

In reference to the NES the following assessment was made in determining the activity status of the proposed works:

- The land is covered by the NES under regulation 5.7(b) 'an activity or industry described in the HAIL has been undertaken on it'.
- The activity is disturbing soil under regulation 5(4)(a) 'means disturbing the soil of the piece of land for a particular purpose'.
- The activity will unlikely comply with regulation 8(3)(c) 'the volume of the disturbance of the soil of the piece of land must be no more than 25m^3 per 500m^2' and '…a maximum of 5 m^3 per 500 m^2 of soil may be taken away'.
- A detailed site investigation for the piece of land does exist.

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

15.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules must be considered.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

As there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

16.0 Conclusions and Recommendations

The history of the site has been described in the report titled *'Preliminary Site Investigation, Ardmore Block Plan Change Area, SECT 5 SO, 495342, SECT SO, 49534, Old Wairoa Road, Ardmore, Auckland'* dated December 2020 and prepared by Focus Environmental Services Limited (henceforth referred to as the "PSI").

In brief, due to the age of the former site building, the potential for ground contamination from the historic use of lead-based paints and asbestos containing materials was identified. Furthermore, the site contamination enquiry stated that the site had potentially been used for horticultural purposes. An interview with the property owner stated this area of the site was only used for growing maize for cattle feed, and that the paddocks had been subject to a Thrip infestation and therefore pesticide sprays were used to eliminate this.

Following a review of the available historical photographs, no horticultural activities other than the maize growing described by the property owner was identified and the only sprays used were modern post 2000's used to control the Thrip infestation.

In order to confirm this, as a conservative approach, indicative representative sampling of the site soils in these areas was recommended to determine if any organo-chlorine pesticides had been used on the site.

Due to the potential sources of contamination identified it is considered that there is evidence to suggest that an activity outlined in the Hazardous Activities Industries List (HAIL) has been, or is more likely than not to have been undertaken at the site.

Following the desk top assessment, the intrusive site investigation was carried out by Focus Environmental Services Limited personnel on 24th March 2021.

As part of the investigation, a single discrete surface soil sample was taken from the area of the historical building identified at the site, and twenty discrete samples were composited at the laboratory (4:1) to form 5 composite samples from the area where organo-chlorine pesticide sprays were potentially used.

The results of the sample analysis have shown the concentrations of all contaminants of concern detected were below the maximum Auckland background concentrations for non-volcanic soils and therefore the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES) and the discharge criteria as outlined in the Auckland Unitary Plan: Operative in Part (AUP: OP).

At the request of the client, 55A Cosgrave Road has been included in the report. Given the site is in use for the same purposes as the neighbouring sites on which the sample analysis was carried out it is reasonable to assume the concentrations of contaminants would also be below the maximum Auckland background concentrations for non-volcanic soils.

As the concentrations of contaminants detected were below the background concentrations for the site, in accordance with Regulation 5(9), the regulations of the NES do not apply to site.

In addition, as there were no contaminants detected above the levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP, the contaminated land rules of the AUP: OP will unlikely be triggered by the current proposal.

Figures

Figure 1 – Site Location Plan

Figure 2 – Sample Location Plan

Appendices

Appendix A – Illustrative Masterplan

Appendix B – Environmental HAIL

Appendix C – Laboratory Transcripts

Ministry for the Environment
Manatū Mō Te Taiao

Hazardous Activities and Industries List (HAIL)

October 2011

A Chemical manufacture, application and bulk storage

1. Agrichemicals including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application
2. Chemical manufacture, formulation or bulk storage
3. Commercial analytical laboratory sites
4. Corrosives including formulation or bulk storage
5. Dry-cleaning plants including dry-cleaning premises or the bulk storage of dry-cleaning solvents
6. Fertiliser manufacture or bulk storage
7. Gasworks including the manufacture of gas from coal or oil feedstocks
8. Livestock dip or spray race operations
9. Paint manufacture or formulation (excluding retail paint stores)
10. Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds
11. Pest control including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application
12. Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides
13. Petroleum or petrochemical industries including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground
14. Pharmaceutical manufacture including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges
15. Printing including commercial printing using metal type, inks, dyes, or solvents (excluding photocopy shops)
16. Skin or wool processing including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products
17. Storage tanks or drums for fuel, chemicals or liquid waste
18. Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside

B Electrical and electronic works, power generation and transmission

1. Batteries including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)

2. Electrical transformers including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
3. Electronics including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices
4. Power stations, substations or switchyards

C Explosives and ordinances production, storage and use

1. Explosive or ordinance production, maintenance, dismantling, disposal, bulk storage or re-packaging
2. Gun clubs or rifle ranges, including clay targets clubs that use lead munitions outdoors
3. Training areas set aside exclusively or primarily for the detonation of explosive ammunition

D Metal extraction, refining and reprocessing, storage and use

1. Abrasive blasting including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material
2. Foundry operations including the commercial production of metal products by injecting or pouring molten metal into moulds
3. Metal treatment or coating including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds
4. Metalliferous ore processing including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals
5. Engineering workshops with metal fabrication

E Mineral extraction, refining and reprocessing, storage and use

1. Asbestos products manufacture or disposal including sites with buildings containing asbestos products known to be in a deteriorated condition
2. Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)
3. Cement or lime manufacture using a kiln including the storage of wastes from the manufacturing process
4. Commercial concrete manufacture or commercial cement storage
5. Coal or coke yards
6. Hydrocarbon exploration or production including well sites or flare pits
7. Mining industries (excluding gravel extraction) including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

F Vehicle refuelling, service and repair

1. Airports including fuel storage, workshops, washdown areas, or fire practice areas
2. Brake lining manufacturers, repairers or recyclers
3. Engine reconditioning workshops
4. Motor vehicle workshops
5. Port activities including dry docks or marine vessel maintenance facilities

6. Railway yards including goods-handling yards, workshops, refuelling facilities or maintenance areas
7. Service stations including retail or commercial refuelling facilities
8. Transport depots or yards including areas used for refuelling or the bulk storage of hazardous substances

G Cemeteries and waste recycling, treatment and disposal

1. Cemeteries
2. Drum or tank reconditioning or recycling
3. Landfill sites
4. Scrap yards including automotive dismantling, wrecking or scrap metal yards
5. Waste disposal to land (excluding where biosolids have been used as soil conditioners)
6. Waste recycling or waste or wastewater treatment

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

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Certificate of Analysis

SPv2

Client:	Focus Environmental Services Limited	**Lab No:**	2566801
Contact:	Elliot Dillon-Herzog	**Date Received:**	25-Mar-2021
	C/- Focus Environmental Services Limited	**Date Reported:**	30-Mar-2021
	PO Box 11455	**Quote No:**	80876
	Ellerslie	**Order No:**	
	Auckland 1542	**Client Reference:**	1443.013
		Submitted By:	Elliot Dillon-Herzog

Sample Type: Soil

Sample Name:		HB01 24-Mar-2021	Composite of COMP01 A, COMP01 B, COMP01 C & COMP01 D	Composite of COMP02 A, COMP02 B, COMP02 C & COMP02 D	Composite of COMP03 A, COMP03 B, COMP03 C & COMP03 D	Composite of COMP04 A, COMP04 B, COMP04 C & COMP04 D
Lab Number:		2566801.21	2566801.22	2566801.23	2566801.24	2566801.25
Individual Tests						
Dry Matter	g/100g as rcvd	-	68	59	60	58
Total Recoverable Arsenic	mg/kg dry wt	-	3	3	3	6
Total Recoverable Copper	mg/kg dry wt	-	27	21	24	28
Total Recoverable Lead	mg/kg dry wt	29	19.8	16.2	17.4	46
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
alpha-BHC	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
beta-BHC	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
delta-BHC	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
gamma-BHC (Lindane)	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
cis-Chlordane	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
trans-Chlordane	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
2,4'-DDD	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
4,4'-DDD	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
2,4'-DDE	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
4,4'-DDE	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
2,4'-DDT	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
4,4'-DDT	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Total DDT Isomers	mg/kg dry wt	-	< 0.09	< 0.11	< 0.10	< 0.11
Dieldrin	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endosulfan I	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endosulfan II	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endosulfan sulphate	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endrin	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endrin aldehyde	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Endrin ketone	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Heptachlor	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Heptachlor epoxide	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Hexachlorobenzene	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018
Methoxychlor	mg/kg dry wt	-	< 0.015	< 0.017	< 0.017	< 0.018

Sample Type: Soil						
	Sample Name:	Composite of COMP05 A, COMP05 B, COMP05 C & COMP05 D				
	Lab Number:	2566801.26				
Individual Tests						
Dry Matter	g/100g as rcvd	71	-	-	-	-
Total Recoverable Arsenic	mg/kg dry wt	< 4	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	20	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	20	-	-	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.014	-	-	-	-
alpha-BHC	mg/kg dry wt	< 0.014	-	-	-	-
beta-BHC	mg/kg dry wt	< 0.014	-	-	-	-
delta-BHC	mg/kg dry wt	< 0.014	-	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.014	-	-	-	-
cis-Chlordane	mg/kg dry wt	< 0.014	-	-	-	-
trans-Chlordane	mg/kg dry wt	< 0.014	-	-	-	-
2,4'-DDD	mg/kg dry wt	< 0.014	-	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.014	-	-	-	-
2,4'-DDE	mg/kg dry wt	< 0.014	-	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.014	-	-	-	-
2,4'-DDT	mg/kg dry wt	< 0.014	-	-	-	-
4,4'-DDT	mg/kg dry wt	< 0.014	-	-	-	-
Total DDT Isomers	mg/kg dry wt	< 0.09	-	-	-	-
Dieldrin	mg/kg dry wt	< 0.014	-	-	-	-
Endosulfan I	mg/kg dry wt	< 0.014	-	-	-	-
Endosulfan II	mg/kg dry wt	< 0.014	-	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.014	-	-	-	-
Endrin	mg/kg dry wt	< 0.014	-	-	-	-
Endrin aldehyde	mg/kg dry wt	< 0.014	-	-	-	-
Endrin ketone	mg/kg dry wt	< 0.014	-	-	-	-
Heptachlor	mg/kg dry wt	< 0.014	-	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.014	-	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.014	-	-	-	-
Methoxychlor	mg/kg dry wt	< 0.014	-	-	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	21-26
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	21-26
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	22-26
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	22-26
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	21-26
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	22-26
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	22-26

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	21-26

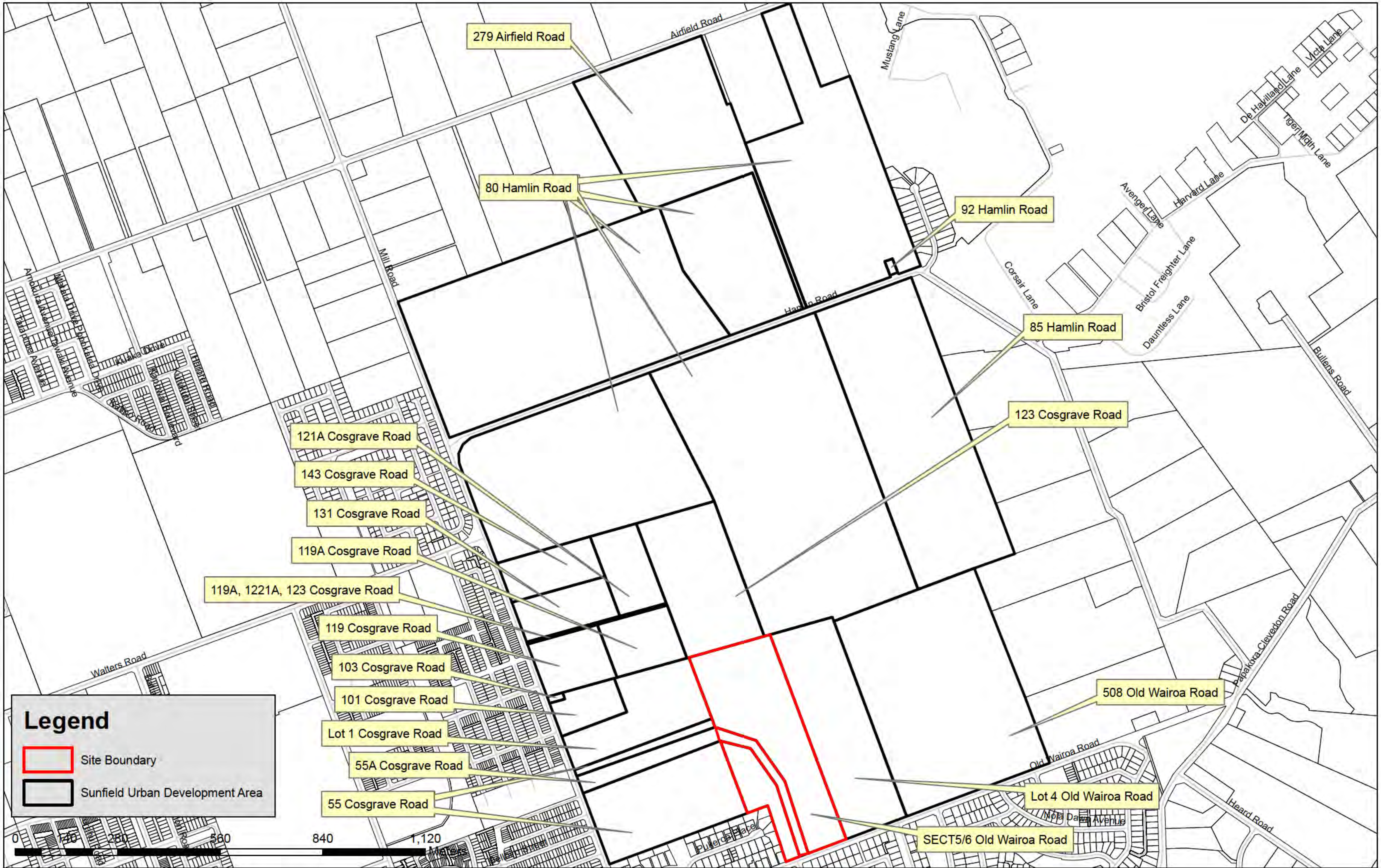
These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 26-Mar-2021 and 30-Mar-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Martin Cowell - BSc
Client Services Manager - Environmental



Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** Sect 5 SO 495342, Sect 6 SO 495342 Old Wairoa Road Sunfield Urban Development Area Papakura Auckland	**Figure 1: Site Location Plan** Detailed Site Investigation	1443.008 R5	Drawing Number: 1443.008.01 Drawn By: MT Checked By: DO'R Date: 19/12/2023

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Winton Land Limited
Sect 5 SO 495342, Sect 6 SO 495342
Old Wairoa Road
Sunfield Urban Development Area
Papakura
Auckland

Figure 3: Sample Location Plan

Detailed Site Investigation

1443.013 R5

Drawing Number: 1443.013.02	
Drawn By: MT	
Checked By: DO'R	
Date: 19/12/2023	

FOCUS ENVIRONMENTAL SERVICES LTD

DETAILED SITE INVESTIGATION
REMEDIATION ACTION PLAN
&
ASSESSMENT OF ENVIRONMENTAL EFFECTS
279 AIRFIELD ROAD
ARDMORE
AUCKLAND

For the Attention of:

Winton Land Limited

Reference: FES 1686.001 December 2023 (R1)

Company Information

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Quality Information

Project Name	DSI, RAP & AEE 279 Airfield Road, Ardmore, Auckland
Project Number	1686.001 (R1)
File Reference	M:\2023 Jobs\Winton\Sunfield Development\Completed Reports\279 Airfield Road, Ardmore - PSI\01 Report\R1\1686.001_DSI_RAP_AEE_MT (R1).docx
Date Issued	September 2022
Date Revised	December 2023

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Authorised

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Principal Environmental Consultant

Distribution List

Parties	Copies
Winton Land Limited	1
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Executive Summary

This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

Focus Environmental Services Limited was contracted by Winton Land Limited to carry out a Detailed Site Investigation, Remediation Action Plan and Assessment of Environmental Effects (DSI, RAP & AEE) at 279 Airfield Road, Ardmore, Auckland. The legal description of the site is Lot 2 BLK XV DP 199521 with an area of 14.42 ha.

It should be noted that this report has been revised following the request of the client.

The Sunfield Urban Development Area (UDA) consists of nineteen properties located across Cosgrave Road, Old Wairoa Road, Hamlin Road and Airfield Road, Papakura, Auckland.

The scope of this report is limited to the property at 279 Airfield Road, Ardmore and should be read in conjunction with the cover letter summarising the findings of the PSIs and DSIs completed for the Sunfield UDA.

This DSI, RAP & AEE has been prepared in accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

It is proposed that the site will be subdivided into residential lots. As part of the redevelopment, the site will undergo a change of land use, subdivision and disturbance of soils, therefore the rules of the National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health apply. The guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption) as outlined in the NES are considered relevant. Additionally, in order to accurately perform a risk assessment and to assess whether any discharges from contaminated land will result in significant adverse effects on the environment, the contaminated land rules as outlined in Chapter E30 of the Auckland Unitary Plan: Operative in Part (AUP: OP) also require consideration.

The history of the site was researched by Focus Environmental Services personnel, which involved a review of the available historical aerial photographs of the site, a search of the Auckland Council property file, a contaminated sites enquiry to Auckland Council and a review of the historical certificate of tile.

During the review of the available information, it was noted that due to the age of the current and former site buildings there was potential for ground contamination from the historic use of lead-based paints and potentially asbestos containing building materials. In addition, historical horticulture land use was noted on neighbouring properties, therefore contamination associated with spray-drift may have occurred at the site.

The site was visited and a site inspection and walk over was carried out by Focus Environmental Services Limited personnel on 15th of August 2022. During the site inspection, potential spray race operations, two areas of refuse burning and three areas of potential asbestos containing materials in a degraded condition were noted.

Due to the potential sources of contamination identified it is considered that there is evidence to suggest that an activity outlined in the Hazardous Activities Industries List (HAIL) has been, or is more likely than not to have been undertaken at the site.

Following the site inspection and walkover, the intrusive investigation was carried out by Focus Environmental Services Limited personnel where a total of twenty-one discrete surface soil samples were taken from the potential sources of contamination identified.

In addition, twelve samples were taken from the areas of horticultural activity and composited at the laboratory to form three composite samples (4:1). Furthermore, three bulk asbestos samples were collected from areas of potentially asbestos containing materials observed in a degraded condition.

The samples were analysed for contaminants that could be present due to the potentially hazardous activities carried out at the site. The results of the site investigation have indicated that the activities carried out at the site have impacted the site soils.

Elevated concentrations of arsenic, cadmium, lead and zinc were detected in the site soils in the locations of the two burn piles. In addition, elevated concentrations of arsenic were detected in the spray race/stock loading area (2). Elevated concentrations of lead were detected in the areas around the stables (2), HB05 and the dwelling (1). Furthermore, elevated concentrations of asbestos fibres and visual evidence of asbestos were identified in the area of the outdoor toilet, and visual evidence of asbestos was observed in contact with the soils on the northern side of the stables (2).

Concentrations of arsenic, cadmium, lead and zinc were detected in the site soils in two locations at levels elevated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and/or the discharge criteria as outlined in the AUP: OP.

Concentrations of arsenic were detected in another location at levels elevated above the $SCSs_{(health)}$ for residential land use as outlined in the NES.

In addition, concentrations of lead were detected in the site soils in two areas at levels elevated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and/or the discharge criteria as outlined in the AUP: OP.

Furthermore, visual evidence of asbestos containing material was observed in contact with the site soils in two locations, and concentrations of asbestos fibres was detected in one of these areas at levels above the adopted human health criteria.

Due to the elevated levels of arsenic, cadmium, lead, zinc and asbestos fibres detected, the site at 279 Airfield Road, Ardmore will require remediation of the affected soils prior to being redeveloped. The estimated volume of soil requiring remediation is 58.4m^3. It should be noted that this volume may change during the remedial process.

A restricted discretionary consent is required under Regulation 10 of the NES as the proposed subdivision, change of use and disturbance of soils do not meet the requirements of a permitted activity under Regulation 8 of the NES, and as this detailed site investigation for the piece of land has shown that the soil contamination does exceed the applicable standard for residential land use.

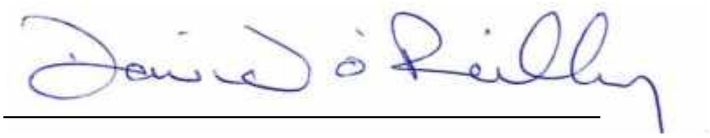
Due to the estimated volume of material containing concentrations of contaminants elevated above those values specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP being 35.94m^3, which is below 200 m^3, it is considered that the proposed remediation will likely meet the permitted activity requirements under rule E30.6.1.2 of the AUP: OP and therefore resource consent under the AUP: OP may not be required.

In addition, due to low-level concentrations of lead and residual concentrations of organochlorine pesticides detected above natural background concentrations in localised areas of the site, the soils in these areas will require management during development works, and if removed from site, will require disposal to a suitably licensed managed fill facility.

The objective of this Remediation Action Plan is to ensure that the soils contaminated above the adopted site assessment criteria and the materials contaminated above natural background concentrations in the management areas of the site, are handled, removed, or managed in a controlled manner, and disposed of to a suitable disposal location. All earthworks required as part of the remedial works should be carried out in accordance with this Remediation Action Plan.

An assessment of the effects which may occur as a result of the proposed works has been made in order to mitigate any potential adverse environmental and/or human health effects. If the controls outlined in this Remediation Action Plan are implemented during the development works it is considered that the effects on the environment and human health are likely to be effectively mitigated.

This report is certified by David O'Reilly, Suitability Qualified and Experienced Practitioner (SQEP):



Principal Environmental Consultant
Focus Environmental Services Limited

1.0 Scope

1.1 This report has been prepared at the request of Winton Land Limited ("the Client") in terms of the Focus Environmental Services Limited Agreement ("Agreement").

1.2 The following report is based on:

- *Information provided by the Client*
- *A review of historical aerial photographs available for the site;*
- *A search of the Auckland Council Property File;*
- *A search of the Auckland Council Contaminated Sites Database;*
- *A review of the Historical Certificate of Title;*
- *A site walkover and inspection; and*
- *Site investigation and soil sampling.*

1.3 We have not independently verified the information provided to us by the Knight Investment Limited Ltd or its completeness. We do not express an opinion on the accuracy or the reliability of such information.

1.4 No warranties are given, intended or implied.

1.5 Opinion, inferences, assumptions and interpretations made in this report should not be construed as legal opinion.

1.6 Where an assessment is given in this report, the Client must also rely upon their own judgement, knowledge and assessment of the subject of this report before undertaking any action.

1.7 This report must not be used in any other context or for any other purpose other than that for which it has been prepared without the prior written consent of Focus Environmental Services Limited.

1.8 This report is strictly confidential and intended for the sole use of the Client and shall not be disclosed without the prior written consent of Focus Environmental Services Limited.

1.9 This Focus Environmental Services Limited report is produced under a management system certified as complying with ISO 45001:2018 by SGS New Zealand.

2.0 Site Identification

The property is located at 279 Airfield Road, Ardmore, Auckland as shown in Figure 1 attached. The legal description of the site is Lot 2 BLK XV DP 199521 with an area of 14.42 ha. The site is located at national grid reference 1774133mE and 5899713mN.

The site is irregular in shape and is zoned 'Rural – Mixed Rural Zone' under the Auckland Unitary Plan: Operative in Part.

The site location plan is presented as Figure 1.

3.0 Proposed Site Redevelopment Activity

It is proposed that the site will be redeveloped for residential purposes. As part of the redevelopment, the site will undergo subdivision, a change of land use and disturbance of soils.

The illustrative masterplan is attached as Appendix A.

4.0 Site Topography

The property at 279 Airfield Road, Ardmore had a relatively flat, level landscape.

The site contour plan is presented in Appendix B.

5.0 Geology and Hydrology

Published geological maps[1] indicate the site is typically underlain with non-volcanic turbidite deposits of the Puketoka Formation. A description of the underlying geology is presented in Table 1 below.

Table 1: Geology: 279 Airfield Road, Ardmore

Key name	Late Pliocene to Middle Pleistocene pumiceous river deposits
Simple name	Neogene sedimentary rocks
Main rock name	Sand
Description	Pumiceous mud, sand and gravel with muddy peat and lignite: rhyolite pumice, including non-welded ignimbrite, tephra and alluvia
Subsidiary rocks	Mud gravel peat lignite tephra pumice
Key group	Late Pliocene to Middle Pleistocene sediments
Stratigraphic lexicon name	Puketoka Formation
Absolute age (min)	0.071 million years
Absolute age (max)	3.6 million years
Rock group	Sandstone
Rock class	Clastic sediment

No groundwater investigation was carried out as part of this investigation.

The nearest surface water body is an unnamed tributary of the Papakura Stream which lies approximately 715m north east of the subject site.

[1] Geology of the Auckland Area (Institute of Geological &Nuclear Sciences 1:250,000 geological map 3, 2011)

6.0 Regulatory Framework

6.1 The National Environmental Standard

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect on the 1st of January 2012 and supersedes any District Plan rules that related to contaminated land. Any Regional Plan rules relating to contaminated land are still applicable.

In brief, the objective of the NES is to ensure that land affected by contaminants is identified and assessed and, if necessary, remediated or managed to protect human health. The NES only applies to the activities: removing or replacing all, or part of, a fuel storage system; sampling the soil; disturbing the soil; subdividing the land; and changing the land use, and where an activity or industry described in the Hazardous Activities and Industries List (HAIL) is being, has been, or is more likely than not to have been undertaken on the piece of land.

The NES also contains reference to the soil contaminant standards for human health ($SCSs_{(health)}$), for a variety of land use scenarios along with reference to best practice reporting documents.

The environmental HAIL is attached as Appendix C.

6.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules of the AUP: OP must be considered.

In brief, the objective of the AUP: OP is to manage land containing elevated levels of contaminants to protect human health and the environment and to enable the effective use of the land.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

7.0 Site History

The history of the site was researched by Focus Environmental Services Limited personnel, which involved a review of the available historical aerial photographs of the site, a search of the Auckland Council property file, a contaminated sites enquiry to Auckland Council and a review of the historical certificate of title.

7.1 Historical Aerial Photographs

Descriptions of the historical aerial photographs for the subject site are presented in Table 2 below. The historical aerial photographs are presented in Appendix D.

Table 2: Historical Photographs: 279 Airfield Road, Ardmore

Date	Description
1939	The 1939 historical photograph shows the subject site potentially forming a larger parcel of land, in use for rural purposes. A shed (HB01) can be seen along the southern boundary of site, in the central southern portion, in addition to anther shed (HB02) slightly north of this. Dwelling (1) can be seen in the south eastern quadrant of the site, adjacent to the eastern boundary, with what appears to be a small garage (HB05) directly to the north of the dwelling. A larger shed (stables 1) can be seen slightly further north of this again. Airfield Road can be seen directly to the north of the subject site The neighbouring property to the north east is in use for horticultural purposes, while the remaining properties appear to be in use for rural purposes.
1959 & 1960	The 1959 and 1960 historical photographs show that two further sheds (HB03 & HB04) have now been constructed in the central southern portion of the site. An access road can be seen running from Airfield Road along the western boundary for the site, and into the southern central portion of the site, leading to HB01. An additional access road can be seen running along the eastern boundary of the site to the dwelling (1) in the central portion of the site. Directly opposite the dwelling a large garage (1) has been constructed along the eastern boundary. A small shed (HB06) can be seen in the central eastern portion of the site, adjacent to a hedge-row which runs east to west through the centre of the site. The site continues to be in use for rural purposes, as does the surrounding environment. Ardmore Airport can be seen to the east of the subject site and a horse training track on the property to the north.
1975, 1981 & 1988	The 1975 historical photograph shows an access road has been constructed leading from Airfield Road to a turning area in the northern portion of the site, adjacent to a shed (3). Historical buildings HB02, HB03 & HB04 have now all been removed. The 1981 historical photograph shows the addition of two further sheds (1 & 2) in the northern portion of the site adjacent to the access road. Historical buildings HB05 & HB06 have now been removed. The 1988 historical photograph, shows the subject site much the same as the 1981 photograph, however HB01 has now also been removed. The subject site and surrounding environment continue to be in use for rural purposes.
2001, 2006, 2010, 2015 & 2017	The 2001 historical photograph shows the addition of a large shed (stables 2) north of stables (1), and the addition of a dwelling (2) and garage (2) in the south eastern corner of the site. No significant changes can be seen throughout the 2006 -2017 historical photographs. The site continues to be in use for rural purposes, while the neighbouring property to the west is in use for horticultural purposes. The wider surrounding environment is in use for a mix of rural/residential purposes.

Due to the age of the current and former site buildings (pre-2001) there is the potential for lead-based paint and asbestos containing materials (ACM) to have been used on the external building materials, and therefore there is the potential for lead and asbestos contamination to be present in the soils surrounding the site buildings.

The site features plan is shown in Figures 2, 2-1 & 2-2 attached.

7.2 Previous Investigations

There are no previous environmental investigations relating to soil or groundwater contamination associated with the site at 279 Airfield Road, Ardmore on file with Auckland Council.

7.3 Auckland Council Property File Search

The results of the council search showed one resource consent for 279 Airfield Road, Ardmore. The relevant details of the property file search are presented in Table 3 below.

Table 3: Relevant Property File Information: 279 Airfield Road, Ardmore.

Proposed Activity	Applicant	Reference	Date
Right of Way Easement	Michael Drennan	LUC 7222 16/03/087	03/12/2003

7.4 Historical Certificate of Title Review

The historical certificate of title review was completed for the property at 279 Airfield Road, Ardmore.

Following the review of the historical certificate of title no companies/entities were listed that would suggest that the site has been utilised for an activity described in the HAIL.

The historical certificate of title is presented in full as Appendix E.

7.5 Auckland Council Site Contamination Enquiry

An enquiry with Auckland Councils Contamination, Air & Noise Team of the Resource Consent Department did not reveal any contamination issues in relation to the site at 279 Airfield Road, Ardmore. However foul animal manure odours were reported from the neighbouring property at 323 Airfield Road, Ardmore.

The Auckland Council Site Contamination Enquiry is presented in full as Appendix F.

8.0 Site Walkover and Inspection

The site inspection and walk over was carried out by Focus Environmental Services Limited personnel on the 15th of August 2022. The site inspection was carried out during a period of fine weather.

The site was accessed from Airfield Road in the northern area of the site via a gravel driveway leading to a turning area.

An excavated pit containing concrete and minor potentially asbestos containing material (PACM) fragments was located to the east of the driveway.

To the south of the excavated pit, a corrugated metal shed (1) was located. A portion of the wall on the northern side was painted. It was in use for the storage of hay on exposed ground.

Directly adjacent to shed (1), a carport and painted corrugated metal shed (2) was located. It was in use for the storage of hay and farming equipment on exposed ground.

To the south of the sheds, a concrete lined livestock loading area (1) was located with attached livestock shed. The livestock shed was constructed of unpainted concrete and cinderblock. The base was concrete lined.

A toilet constructed of unpainted plywood and PACM cladding was located to the south of the livestock shed. Minor damage was observed to the PACM cladding with fragments visible on the ground both on the exterior and interior of the toilet.

To the east of the toilet a livestock spray race/loading area (2) was present.

In the centre of the turning area a burn/refuse pit was located. It was comprised of vegetation, hay, tyres, brick, plastics and general rubbish.

The stables (1) were constructed of unpainted corrugated metal and concrete lined, and were located in the eastern portion of the site.

To the south of the stables (1) was a second stable building (2) constructed of painted PACM and metal cladding. A horse arena was located to the west of the stables.

A concrete driveway extended from the northern portion of the site to the central portion along the eastern boundary. A shipping container was located at the end of the concrete driveway.

A garage (1) constructed of painted corrugated metal with a concrete lining was located close to the eastern boundary of the site. A raised single storey dwelling (1) constructed of PACM baseboards and soffits with painted wooden cladding was located in the same area of the site.

A small burn barrel was located in the yard area of the dwelling (1), with burnt wood and aluminium cans observed.

In the south-eastern area of the site a painted metal clad garage (2) was located.

A raised single storey dwelling (2) constructed of painted PACM baseboards and metal cladding was located to the west of the garage (2). In the south-western portion of the yard area a septic tank vent was located.

The remainder of the site was comprised of paddocks and farm tracks.

Site inspection photographs are presented in Appendix G.

9.0 Surrounding Environment

The surrounding environment appeared to be rural residential in use. The neighbouring property to the west appeared to be in use for horticultural purposes.

The surrounding environment is presented in Figure 3.

10.0 Asbestos Management

External PACM products of the site structures are likely restricted to the exterior toilet cladding, the exterior cladding of the stables (2), the baseboards and soffits of dwelling (1), and the baseboards of dwelling (2). With the exception of the exterior toilet cladding, and exterior cladding of the stables (2), these materials appeared painted and in relatively good condition, and are considered unlikely to present as a source of ground contamination in their current state.

Any removal of asbestos materials from the site will need to be conducted in accordance with the Health and Safety at Work (Asbestos) Regulations (MBIE, 2016) and the Approved Code of Practice for the Management and Removal of Asbestos (WorkSafe New Zealand, 2016) by a licensed asbestos removals specialist under an approved asbestos removal control plan.

It should be noted that ACM, other than that described, may also be present at the site and a thorough inspection should be carried out by a suitably qualified and competent asbestos surveyor prior to any demolition activities at the site.

11.0 Potentially Contaminating Activities or Land Uses

Following a review of the history and the available information relating to the subject site, potentially contaminating activities were identified and are outlined in Table 4 below.

Table 4: Potentially Contaminating Activities and/or Land Uses: 279 Airfield Road, Ardmore.

Activity Description	HAIL Category
Spray Drift from Neighbouring Historic Horticultural Activities	A10
Livestock Dip or Spray Race Operations	A8
Demolition of Historic Structures Potentially Containing Asbestos, Products Potentially Containing Asbestos in a Degraded Condition, and Potentially Asbestos Containing Material intermixed with the Site Soils	E1
Maintenance and Use of Lead-based Paint	I
Burning of Refuse	

It is recommended that the septic tank present onsite is to be removed by a trained operator in accordance with industry best practice. Additionally, the contaminants of concern associated with domestic tanks are primarily microbiological (E.Coli and Faecal Coliforms) and, if present in the soils surrounding the tank, are likely to naturally attenuate following the removal of the septic tank, and therefore pose no long term risk to human health or the environment.

12.0 Conceptual Model of Exposure Pathways

The preliminary conceptual site model provided in Table 5 below expands on the potential sources of contamination (as identified above) and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 5: Preliminary Conceptual Site Model: 279 Airfield Road, Ardmore.

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
		Human Health – Commercial/Industrial Outdoor Worker	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Surface Water Run-off	Ecological Receptors - Unnamed Tributary of Papakura Stream	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.
	Migration of Groundwater	Ecological Receptors - Unnamed Tributary of Papakura Stream	Potentially Complete: Sampling and analysis is recommended to confirm the concentrations of contaminants in soil.

13.0 Sampling and Analysis Plan and Sampling Method

Environmental Sampling was carried out in accordance with the Contaminated Land Management Guidelines No. 5 (MfE, revised 2021).

A total of twenty-one discrete samples, three (4:1) laboratory composite samples and three bulk asbestos samples were collected from across the site and were sent under full chain of custody documentation to an IANZ accredited laboratory. Sampling and Analysis information is provided in Table 6 below.

Table 6: Discrete Sample Analysis Information: 279 Airfield Road, Ardmore.

Sample Name	Sample Depth	Number of Samples	HAIL Activity	Analysis Suite
Pb01-Pb10	0 - 0.15m	10	Application of Lead Based Paint	• Total recoverable lead
HB01-HB05	0 – 0.15m	5	Application of Lead Based Paint	• Total recoverable lead
			Demolition of Historical Structures Potentially Containing Asbestos	• Semi-quantitative asbestos in soil (BRANZ)
BP01 & BP02	0 - 0.15m	2	Burning of Refuse	• Total recoverable arsenic, cadmium, chromium, copper, lead, nickel, zinc; and • Polycyclic aromatic hydrocarbons
SR01	0 - 0.15m	1	Potential Spray Race Operations	• Total recoverable arsenic; and • Organochlorine pesticides.
ASB01-ASB03	0 - 0.15m	3	Products Potentially Containing Asbestos in a Degraded Condition, and Potentially Asbestos Containing Material intermixed with the Site Soils	• Semi-quantitative asbestos in soil (BRANZ)
PACM01-PACM03	-	3		• Asbestos in bulk materials - presence/absence
COMP01 A-D, COMP02 A-D, COMP03 A-D	0 - 0.15	3	Spray Drift from Historical Horticulture	• Total recoverable arsenic, copper, lead; and • Organochlorine pesticides.

In addition, two samples (Pb01 & Pb10) were selected at random and duplicated for quality control purposes. This is discussed further in Section 17.

The sample location plans are presented as Figures 4, 4-1, 4-2 & 4-3.

14.0 Field Sampling Quality Assurance

All sampling implements were triple washed between samples using clean tap water, followed by a solution of laboratory grade phosphate free detergent (Decon 90), and a final rinse with water.

Clean, nitrile gloves were worn when handling each sample. Samples were stored in laboratory cleaned glass jars or laboratory supplied 500ml plastic containers and immediately placed in an iced cooler. The samples were transported under chain of custody documentation to an IANZ accredited laboratory for analysis.

15.0 Laboratory Quality Assurance

Routine laboratory quality assurance procedures include analysis of laboratory blanks and spiked samples. All analyses were carried out using industry standard methods as follows:

- Total Recoverable Metals – Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2 Complies with NES Regulations. ICP -MS Screen level, interference removed by Kinetic Energy Discrimination if required.
- Polycyclic Aromatic Hydrocarbons - Sonic extraction, GC-MS analysis. Tested on as received sample. In house based on US EPA 8270.
- Organochlorine Pesticides – Sonic extraction, GC-ECD analysis. Tested on as received sample. In house based on US EPA 8081.
- Asbestos Presence/Absence – AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples.
- Asbestos Semi-Quantitative – Calculated from weight of fibrous asbestos plus asbestos fines, weight of asbestos in ACM and sample dry weight. New Zealand Guidelines for Assessing and Managing Asbestos in Soil, November 2017.

16.0 Basis for Guideline Values

It is proposed that the site will be developed for residential purposes, therefore the guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption) as outlined in the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES), and the discharge criteria of the Auckland Unitary Plan: Operative in Part (AUP: OP) are considered relevant and have been adopted as the site assessment criteria.

Furthermore, due to the underlying non-volcanic geology at the site, the concentrations of heavy metals detected will be compared to the maximum background levels for non-volcanic soils in Auckland[2] (TP153). The relevant values of the above guidelines have been reproduced in Table 7 below.

Table 7: Site Assessment Criteria: 279 Airfield Road, Ardmore (mg/kg).

Parameter	NES $SCSs_{(health)}$	AUP: OP	TP153 (Non-volcanic)
Arsenic	20	100	12
Cadmium	3	7.5	0.65
Chromium	460	400	55
Copper	NL	325	45
Lead	210	250	65
Nickel	400[1]	105	35
Zinc	7,400[1]	400	180
BaP eq.	10	20	-
Total DDT	70	12	-
Dieldrin	2.6	0.5[2]	-
Asbestos (FA/AF)	0.001%[3] / 0.01%[4]	-	-
Visual ACM	No Visual Evidence of ACM[5]	-	-

Note: NL = Not Limited. This is where the derived values exceed 10,000mg/kg; 1. = No $SCSs_{(health)}$ given, guideline values derived in accordance with the Contaminated Land Management Guidelines number 2 – Hierarchy and Application in New Zealand of Environmental Guideline Values (MfE, 2011), and taken from the National Environment Protection (Assessment of Site Contamination) Measure 1999 for Residential land use; 2 = Soil Guideline Values to protect on-site ecological receptors taken from Ministry for the Environment Guidelines for identifying, investigating and managing risks associated with former sheep dip sites, November 2016; 3 = Soil guideline values for asbestos in Soil of 0.001% combined fibrous asbestos and asbestos fines (FA/AF), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 4= Soil guideline values for asbestos in Soil of 0.01% asbestos containing material (ACM), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 5 = No visual Evidence of asbestos containing material in the upper 0.1m of soil in accordance with New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017).

Furthermore, the natural background levels of polycyclic aromatic hydrocarbons, organochlorine pesticides, and asbestos fibres are considered to be below the analytical

[2] Background Concentrations of Inorganic Elements in Soils from the Auckland Region, Technical Publication No.153, Auckland Regional Council, 2001.

levels of detection and hence the detection of these analytes would restrict material from being classified as cleanfill material.

17.0 Quality Control

17.1 Laboratory Verification

Two samples (Pb01 & Pb10) were selected at random for duplicate analysis and Relative Percentage Difference (RPD) calculations. It is considered that an RPD value of less than 30-50% is generally considered acceptable. If the results were below the laboratory detection limits the RPD was not calculated.

The results of the RPD analysis are presented in Table 8 below.

Table 8: RPD Summary: 279 Airfield Road, Ardmore.

Parameter	Pb01 (RPD %)	Pb10 (RPD %)
Lead	3.21	10.99

Note: Results in *Italics* exceed 30% RPD. Results in red exceed 50% RPD.

The RPD value calculated for lead in samples Pb01 and Pb10 were less than the acceptable range. Therefore, based on the results of the RPD analysis, the sample results are likely to be relatively consistent and repeatable.

The RPD calculations are presented as Appendix H.

18.0 Soil Sampling Results

Tabulated soil sampling results are presented in Tables 9 - 13 below and laboratory transcripts are provided in Appendix I.

18.1 Heavy Metals

Table 9: Heavy Metals Results: 279 Airfield Road, Ardmore (mg/kg).

Sample	As	Cd	Cr	Cu	Pb	Ni	Zn
Pb01	-	-	-	-	*95*	-	-
Pb02	-	-	-	-	25	-	-
Pb03	-	-	-	-	*81*	-	-
Pb04	-	-	-	-	*470*	-	-
Pb05	-	-	-	-	*116*	-	-
Pb06	-	-	-	-	***1,420***	-	-
Pb07	-	-	-	-	***1,730***	-	-
Pb08	-	-	-	-	33	-	-
Pb09	-	-	-	-	*113*	-	-
Pb10	-	-	-	-	*96*	-	-
HB01	-	-	-	-	61	-	-
HB02	-	-	-	-	34	-	-
HB03	-	-	-	-	32	-	-
HB04	-	-	-	-	23	-	-
HB05	-	-	-	-	***480***	-	-
BP01	*58*	*3.3*	*57*	*83*	*240*	10	***480***
BP02	*68*	*3.3*	54	*104*	***1,040***	33	***840***
SR01	*43*	-	-	-	-	-	-
Composite of COMP01A-D	5	-	-	19	22	-	-
Composite of COMP02A-D	4	-	-	16	23	-	-
Composite of COMP03A-D	5	-	-	29	28	-	-

Note: Results in red exceed the $SCSs_{(health)}$ for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the maximum Auckland background concentrations for non-volcanic soils outlined in the Auckland Regional Council Technical Publication No.153, Oct 2001.

The concentrations of arsenic detected in samples BP01, BP02 and SR01 were elevated above the Auckland background concentrations for non-volcanic soils and the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES.

The concentrations of cadmium detected in samples BP01 & BP02 were elevated above the Auckland background concentrations for non-volcanic soils and the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES.

The concentration of chromium detected in sample BP01 was elevated above the Auckland background concentrations for non-volcanic soils.

The concentrations of copper detected in samples BP01 & BP02 were elevated above the Auckland background concentrations for non-volcanic soils.

The concentrations of lead detected in Pb01, Pb03, Pb04, Pb05, Pb06, Pb07, Pb09, Pb10, HB05, BP01 and BP02 were all elevated above the Auckland background concentrations for non-volcanic soils. In addition, the concentrations of lead detected in samples Pb04, Pb06, Pb07, HB05, BP01 and BP02 were elevated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES. Furthermore, the concentrations of lead detected in samples Pb06, Pb07, HB05 and BP02 were elevated above the discharge criteria as outlined in the AUP: OP.

The concentrations of zinc detected in samples BP01 & BP02 were elevated above the Auckland background concentrations for non-volcanic soils and the discharge criteria as outlined in the AUP: OP.

The concentrations of all other heavy metals in all other samples were below the Auckland background concentrations for non-volcanic soils, the $SCSs_{(health)}$ residential land use (10% produce consumption) as outlined in the NES, and the discharge criteria as outlined in the AUP: OP.

18.2 Polycyclic Aromatic Hydrocarbons

Table 10: Polycyclic Aromatic Hydrocarbon Results: 279 Airfield Road, Ardmore (mg/kg).

Sample	BaP eq.
BP01	*<0.05**
BP02	*0.08*

Note: * = Residual levels of contaminants detected. Results in red exceed the $SCSs_{(health)}$ for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the cleanfill criteria.

Low-level concentrations of polycyclic aromatic hydrocarbons were detected in sample BP02, in addition to residual concentrations detected in sample BP01, both of which are above the analytical levels of detection.

The concentrations of polycyclic aromatic hydrocarbons detected in both samples were below the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and the discharge criteria of the AUP: OP.

18.3 Organochlorine Pesticides

Table 11: Organochlorine Pesticides Results: 279 Airfield Road, Ardmore (mg/kg).

Sample	Total DDT	Dieldrin
SR01	*<0.13**	*<0.03**
Composite of COMP01A-D	<0.10	<0.016
Composite of COMP02A-D	<0.10	<0.016
Composite of COMP03A-D	*<0.11**	*<0.019**

Note: * = Residual levels of contaminants detected. Results in red exceed SCSs$_{(health)}$ for residential land use. Results in **Bold** exceed the discharge criteria as outlined in the AUP: OP. Results in *Italics* exceed the cleanfill criteria.

Residual concentrations of organochlorine pesticides were detected in samples SR01 and COMP03 A-D above the analytical levels of detection.

The concentrations of organochlorine pesticides detected in both samples were below the SCSs$_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and the discharge criteria of the AUP: OP.

18.4 Asbestos

Table 12: Asbestos in Bulk Material Results: 279 Airfield Road, Ardmore.

Sample	Asbestos Type
PACM01	Asbestos Not Detected
PACM02	*Chrysotile (White Asbestos) Detected*
PACM03	*Chrysotile (White Asbestos) Detected*

Note: Results in red exceed the adopted human health criteria.

Asbestos was identified in both PACM02 & PACM03.

Table 13: Semi-quantitative Asbestos in Soil Results: 279 Airfield Road, Ardmore.

Sample	Asbestos Type	Asbestos (FA/AF %)	Asbestos (% ACM)
ASB01	Asbestos Not Detected	-	-
ASB02	*Chrysotile (White Asbestos) Detected*	*0.022*	<*0.001*
ASB03	Asbestos Not Detected	-	-
HB01	Asbestos Not Detected	-	-
HB02	Asbestos Not Detected	-	-
HB03	Asbestos Not Detected	-	-
HB04	Asbestos Not Detected	-	-
HB05	Asbestos Not Detected	-	-

Note: * = Residual levels of contaminants detected. Results in red exceed the adopted human health criteria. Results in *Italics* exceed the cleanfill criteria.

Elevated concentrations of asbestos fibres were detected in sample ASB02, above the adopted human health criteria, and therefore above the cleanfill criteria.

19.0 Extent of Contamination

The results of the sample analysis indicate that the site soils in the areas of the burn piles (BP01 & BP02) are contaminated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES for arsenic, cadmium and lead. In addition, the site soils in these areas are also contaminated above the discharge criteria of the AUP: OP for lead and zinc, therefore remediation of these areas are required (Areas 1 & 6).

The site soils in the area of the spray race/stock loading activities (2) (SR01) are contaminated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES for arsenic, and therefore this area requires remediation (Area 3).

Furthermore, the site soils in the areas of the stables (2) (Pb04), HB05, and the dwelling (Pb06 & Pb07), are contaminated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES for lead (Areas 5 & 7). In addition, the soils in the areas of HB05, Pb06 & Pb07 are also contaminated above the discharge criteria of the AUP: OP for lead (Area 7).

In addition, the site soils in the area of the outdoor toilet (ASB02) are contaminated above the adopted human health criteria for asbestos fibres, therefore remediation of this area is required (Area 2). Furthermore, visual evidence of asbestos containing material in the area of PACM03, will also require remediation (Area 4).

The estimated volume required to remove the contaminated soils from the site is presented in Table 14 below.

Table 14: Extent of Contamination: 279 Airfield Road, Ardmore.

Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Area 1	19	0.3	As, Cd, Pb, Zn	5.7
Area 2	8.4	0.3	Asbestos (Visual ACM & FA/AF)	2.52
Area 3	11.5	0.3	As	3.45
Area 4	10.8	SUR	Visual ACM	-
Area 5	54.9	0.3	Pb	16.47
Area 6	3.1	0.3	As, Cd, Pb, Zn	0.93
Area 7	97.7	0.3	Pb	29.31
Total Volume				58.38
Total Tonnes (m^3 x 1.5)				**87.6 t**

The inferred extent of the contaminated soil at the site is presented in Figures 5 & 5-1. This estimate is based on the sampling and results available following the site investigation and it should be noted that the volume may increase or decrease following inspection and validation sampling.

All contaminated materials removed from site will require disposal at a suitably licensed landfill facility.

19.1 Management Areas

Low-level contamination was detected in five areas of the site. Concentrations of lead were detected in four areas in exceedance of natural background concentrations, and one area contained residual organochlorine pesticides, therefore exceeding the clean fill criteria.

Any topsoil removed from these areas will require disposal to a suitably licensed managed fill facility, unless further sampling and analysis demonstrate otherwise.

The approximate areas of management are shown in Table 15 below.

Table 15: Management Areas – 279 Airfield Road, Ardmore (mg/kg).

Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Management Area 1	17.2	0.3	Pb	5.2
Management Area 2	5,284.4	0.3	OCP's	1,585.26
Management Area 3	20	0.3	Pb	6
Management Area 4	43.4	0.3	Pb	13.0
Management Area 5	52.2	0.3	Pb	15.6
Total Volume				1,625.1
Total Tonnes (m^3 x 1.5)				**2,437.6 t**

The inferred areas and depths requiring management are shown in Figures 6 & 6-1.

20.0 Revised Conceptual Model of Exposure Pathways

The revised conceptual site model provided in Table 16 below expands on the potential sources of contamination (as identified above), following sampling and analysis, and exposure pathways and was based on the potential effects of the proposed subdivision, change of use and soil disturbance activities on human health and the environment.

Table 16: Revised Conceptual Site Model: 279 Airfield Road, Ardmore

Potential Source	Potential Pathways	Potential Receptors	Assessment
Contaminated Soil	Dermal Contact with Contaminated Soils	Human Health – Residential Land Use	Complete: Remediation or management of the contaminated area required.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No exceedances of Commercial/Industrial Outdoor Worker
	Ingestion of Contaminated Soils	Human Health – Residential Land Use	Complete: Remediation or management of the contaminated area required.
		Human Health – Commercial/Industrial Outdoor Worker	Incomplete: No exceedances of Commercial/Industrial Outdoor Worker
	Inhalation of Vapours/Fibres	Human Health – Residential Land Use	Complete: Remediation or management of the contaminated area required.
		Human Health – Commercial/Industrial Outdoor Worker	Complete: Remediation or management of the contaminated area required.
	Surface Water Run-off	Ecological Receptors - Unnamed Tributary of Papakura Stream	Complete: Remediation or management of the contaminated area required.
	Migration of Groundwater	Ecological Receptors - Unnamed Tributary of Papakura Stream	Complete: Remediation or management of the contaminated area required.

21.0 Regulatory Requirements

21.1 The National Environmental Standard

Due to the potentially contaminating land uses identified above, it is considered that an activity described in the HAIL is being, has been, or is more likely than not to have been undertaken at the site.

Resource Consent will therefore be required for the site under the District Plan, following the introduction of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

In reference to the NES the following assessment was made in determining the activity status of the proposed works:

- The land is covered by the NES under regulation 5.7(b) 'an activity or industry described in the HAIL has been undertaken on it'.
- The activity is changing the use of a piece of land under regulation 5(6) 'means changing it to a use that, because the land is described in subclause (7), is reasonably likely to harm human health'.
- The activity is subdividing land under regulation 5(5)(c) 'means subdividing land that has part if the piece of land within its boundaries'.
- The activity of changing use and subdivision does not comply with regulation 8(4).
- The activity is disturbing soil under regulation 5(4)(a) 'means disturbing the soil of the piece of land for a particular purpose'.
- The activity is unlikely to comply with regulation 8(3)(c) 'the volume of the disturbance of the soil of the piece of land must be no more than 25m^3 per 500m^2' and '…a maximum of 5 m^3 per 500 m^2 of soil may be taken away'.
- A detailed site investigation for the piece of land does exist.

A restricted discretionary consent is required under Regulation 10 of the NES as the proposed subdivision, change of use and disturbance of soil do not meet the requirements of a permitted activity under Regulation 8 of the NES, and as this detailed site investigation for the piece of land has shown that the soil contamination does exceed the applicable standard for residential land use.

21.2 Auckland Unitary Plan: Operative in Part

The contaminated land rules of the Auckland Unitary Plan: Operative in Part (AUP: OP) have immediate legal effect following its notification. As the AUP: OP was notified on the 15th of November 2016 the contaminated land rules must be considered.

The contaminated land rules of the AUP: OP apply when the land contains contaminants above those levels specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP.

Due to the estimated volume of material containing concentrations of contaminants elevated above those values specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP being 35.94m^3, which is below 200 m^3, it is considered that the proposed remediation will likely meet the permitted activity requirements under rule E30.6.1.2 of the AUP: OP and therefore resource consent under the AUP: OP may not be required.

22.0 Remediation Action Plan

This Remediation Action Plan & Assessment of Environmental Effects (RAP & AEE) provides the soil specific management controls to be implemented at the site to ensure that any adverse effects on human health, as a result of the removal of asbestos and the heavy metal contaminated soils identified at the site, will be effectively mitigated.

It is therefore considered that this RAP & AEE meets the requirements of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

Due to the concentration of asbestos fibres identified in the site soils and the presence of visual evidence of asbestos, in accordance with the New Zealand Guidelines for Assessing and Manging Asbestos in Soil (BRANZ Limited, 2017), the soils within Remediation Areas 2 & 4 will require removal by a Class B licensed asbestos removalist.

In order to meet the requirements of the Health and Safety at Work (Asbestos) Regulations (MBIE, 2016), it is recommended that the selected contractor incorporates the procedures set out in this RAP & AEE into site-specific asbestos removal control plan and that the works are carried out in accordance with the Approved Code of Practice for the Management, Removal of Asbestos (WorkSafe New Zealand, 2016).

Following the removal of any asbestos contaminated soils or ACM, a certificate of clearance is to be produced by a suitably licensed asbestos assessor.

Should any ACM be discovered during any future works, its removal from the site shall be conducted in accordance with the Health and Safety at Work (Asbestos) Regulations (MBIE, 2016) and the Approved Code of Practice for the Management and Removal of Asbestos (WorkSafe New Zealand, 2016).

22.1 Remediation Criteria

The objectives for the remediation of the site are to remediate the affected soils to levels below the applicable guideline values (as specified in Table 7) to address the immediate human health and environmental concerns at the site. Remediation of the site in the areas shown in Figures 5 & 5-1 will be necessary to achieve compliance with the above guidelines.

The remediation strategy for the site will involve the machine excavation and loading of the affected site soils prior to transport and disposal. The site will then be subject to a process of validation whereby the remaining soils will be sampled to confirm that the objectives of the remediation for the site have been achieved.

The remediation criteria for the site are presented in Tables 17 - 21 below.

Table 17: Remediation criteria for Area 1 & Area 6: 279 Airfield Road, Ardmore (mg/kg).

Parameter	Value
Arsenic	20
Cadmium	3
Lead	210
Zinc	400

Table 18: Remediation criteria for Area 2: 279 Airfield Road, Ardmore (%w/w).

Parameter	Value
Asbestos	0.001%[1]/0.01%[2]
	No visible evidence of asbestos on surface soil[3]

Note: 1 = Soil guideline values for asbestos in Soil of 0.001% combined fibrous asbestos and asbestos fines (FA/AF), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 2 = Soil guideline values for asbestos in Soil of 0.01% asbestos containing material (ACM), taken from the New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017); 3 = No visual Evidence of asbestos containing material in the upper 0.1m of soil in accordance with New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017).

Table 19: Remediation criteria for Area 3: 279 Airfield Road, Ardmore (mg/kg).

Parameter	Value
Arsenic	20

Table 20: Remediation criteria for Area 4: 279 Airfield Road, Ardmore (%w/w).

Parameter	Value
Asbestos	No visible evidence of asbestos on surface soil[1]

Note: 1 = No visual Evidence of asbestos containing material in the upper 0.1m of soil in accordance with New Zealand Guidelines for Assessing and Managing Asbestos in Soil (BRANZ Limited, 2017).

Table 21: Remediation criteria for Area 5 & Area 7: 279 Airfield Road, Ardmore (mg/kg).

Parameter	Value
Lead	210

As stated above, the remediation of the asbestos contaminated soils in Areas 2 & 4 are to be undertaken under the supervision of a Class B licensed asbestos removalist. It is recommended that a licensed asbestos removalist is present for the duration of the removal works to ensure that the procedures outlined in this plan and the ARCP are adhered to in order to mitigate the potential effects on human health.

Following the removal of any visual evidence of asbestos containing material (Area 2 & 4), a third-party clearance certificate will be obtained by a licensed asbestos assessor.

22.2 Work Programme

It is considered that the health & safety and environmental controls, as detailed below, will be sufficient to ensure that any adverse human health and/or environmental effects, as a result of the contaminated soils identified at the site, will be effectively mitigated.

A contractor experienced in remediation of contaminated sites will undertake the earthworks, excavation & disposal of contaminated soils at the site. The contractor will:

- Prior to works occurring, install a 3.0m fenced buffer surrounding each inferred area of contamination.
- Prepare a site-specific Asbestos Removal Control Plan and notify WorkSafe of the remediation of the asbestos contaminated soils.
- Provide adequate Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE) to all staff involved in the removal works.
- Install facilities on site which include a clean area for staff, a decontamination unit and washing facilities.
- Connect a water source and/or misting system to control any dusts that may be generated as a result of the works. This misting system must be capable of reaching all areas of the site during the ground-breaking works.
- It is recommended that the client engages a third-party asbestos assessor to complete representative asbestos fibre monitoring during the remedial works in Area 2.
- Install sediment and erosion controls for the development works in accordance with industry best practice (Auckland Council's Erosion and Sediment Control Guide for Land Disturbing Activities [3].
- Ensure that the soils within Area 2 are sufficiently wet prior to starting works.
- Machine excavate the contaminated soils from the site and load the materials onto waiting trucks.
- Asbestos contaminated soils will be loaded into trucks lined with 200µm heavy-gauge polythene and wrapped.
- Ensure that the trucks leaving the site have their contents wrapped, are fitted with close fitting tarpaulins and have sealed tailgates.
- Once the trucks have been inspected to ensure that the tarpaulins are properly fitted and the tires are free from any soil materials, transport contaminated soils to a suitable disposal location and retain any weighbridge dockets obtained.
- Obtain certificate of clearance by a suitably licensed asbestos assessor or a competent person for the areas of asbestos contamination (Areas 2 & 4).
- Carry out the validation process and undertake any further remedial works required to achieve the remediation goals.
- Prior to plant being removed from the asbestos removal area, a visual assessment for the presence of asbestos, visible debris and soil shall be carried out by a qualified asbestos assessor and a clearance certificate issued.

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[3] Auckland Council, Erosion & Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016, Guideline Document 2016/005.

- Once all contaminated soil has been removed, clearance certificate obtained and the remediation goals achieved then the site will be reinstated with clean fill materials if required and the site stabilized.

22.3 Establishment and Site Preparation

Prior to works commencing the contractor should be familiar with this remediation action plan (RAP) which outlines all environmental and health & safety controls to be implemented when dealing with the contaminated soils.

No unauthorised access to the remedial area will be allowed during the removal of the contaminated soils. Access to the site and the contaminated materials will be restricted during the project.

In addition, the asbestos contaminated area of the site will be fenced off to enclose the work areas. No unauthorised access to the asbestos works areas (Areas 2 & 4), will be allowed during the entirety of the works. Access to the site and the contaminated materials will be restricted during the project.

Appropriate warning signage shall be posted in visible locations during the works and surrounding the stockpile material. All visitors and contractors will sign in and out of the site each day during the removal of the asbestos containing soils.

22.4 Asbestos Fibre Monitoring

In order to confirm that the mitigation controls are sufficient in the areas of asbestos remediation (Area 2) asbestos fibre monitoring is required to confirm that asbestos in air is below trace level (0.01 f/ml).

It is recommended that the client engages a third-party asbestos assessor to complete representative asbestos fibre monitoring during the remedial works in Area 2.

In the event that trace levels are exceeded, cease works, dampen, cover and fence off (barrier tape) the area of works and contact the Contaminated Land Specialist.

22.5 Excavation, Haulage and Disposal of Materials

Excavation works will not commence at the site until all the environmental controls have been put in place. The exposed excavated areas will be kept to a minimum to minimise the risk of erosion due to storm water runoff. Where possible, the excavated materials will be loaded directly onto the removal trucks.

All trucks carting asbestos contaminated soils should be lined with 200µm heavy-gauge polythene. All trucks with asbestos contaminated soils (Area 2) will have their contents wrapped.

All trucks will be fitted with close fitting tarpaulins and have sealed tailgates. All trucks will be inspected prior to leaving the loading area, to ensure that no loose contaminated materials leave the site. During loading wheel covers will be used where possible and any loose materials will be collected for later disposal.

In addition, due to the low-level contamination identified in the areas of Management Areas 1-5, these site soils are not suitable for classification as cleanfill and any topsoil removed from these areas of the site will require disposed at a suitably licensed managed fill facility.

All materials leaving the site will be disposed of to a suitably licensed disposal facility and will be tracked by way of weighbridge dockets which include the disposal location and the weight of the load.

22.6 Validation Sampling

Following the excavation of the asbestos contaminated soils (Area 2) and the visual evidence of asbestos observed (Areas 2 & 4) a clearance certificate will be produced by a suitably licensed asbestos assessor or a competent person. Following receipt of the clearance certificate for Area 2, the base and side walls of the excavated area will be sampled by a suitably qualified and experienced practitioner and the soils analysed by an accredited laboratory to determine if the remediation works have been successful.

In addition, following the excavation of the heavy metal contaminated materials, the soils from the base and walls of the excavated areas will be sampled and the soils analysed by an accredited laboratory to determine if the remediation works have been successful. The results of all validation sampling and clearance certificates will be included in the site validation report.

Site validation sampling will be completed at a frequency sufficient to meet the requirements of the Contaminated Land Management Guidelines No. 5 (MfE, Revised 2021) by a suitably qualified and experienced contaminated land professional.

The clearance certificate/s and the results of all validation sampling will be included in the site validation report.

22.7 Clean Fill Validation (if required)

Any materials imported onto the site if required to reinstate the ground will have to be tested to ensure their suitability as clean fill materials. Any soil material imported to the site shall comply with the definition of 'cleanfill material', as per the Auckland Unitary Plan: Operative in Part.

All imported materials shall be sourced from a site which has been determined by a Suitably Qualified Contaminated Land Professional to have had no known history of potentially contaminating activities, as detailed on the Ministry for the Environment's Hazardous Activities and Industries List (HAIL); or adequately investigated by a

Suitably Qualified Contaminated Land Professional, in accordance with Contaminated Land Management Guidelines (Ministry for the Environment, 2011) to meet the 'Cleanfill material' definition as prescribed in the AUP: OP.

23.0 Assessment of Environmental Effects

The following sections deal with the potential adverse effects which could have a negative impact on the environment and or human health as a result of the remediation project. If the controls outlined in this RAP are implemented during the development works the effects on the environment are likely to be effectively mitigated.

The required site management controls are detailed below and include, but should not be limited to, the following: dust control, health and safety measures, stormwater, erosion and sediment control, odour control and contingency measures.

23.1 Dust Control

During the disturbance process, the area of asbestos contamination (Area 2) should be adequately wet. Soil should have water applied at the point of contact. The excavator or other excavation equipment should handle the material wet.

A continuous water supply should be available at all times. The water source and/or misting system should be capable of applying water or a water mist directly to the materials to minimize dust and prevent fibre emissions. This misting system must be capable of reaching all areas of the remediation area during the ground-breaking works.

For areas of chemical contamination, if conditions are dry during the remedial works dust deposition could occur. Dust will be controlled in accordance with the Good Practice Guidelines for Assessing and Managing the Environmental Effects of Dust Emissions, Ministry for the Environment (2016). In order to mitigate against the effects of dust regular damping down of soil with a misting system will be required.

23.2 Health and Safety Measures

The level of asbestos specific PPE and RPE shall be determined by the asbestos removalist, however, in order to minimise the potential effects or the likelihood of cumulative effects, all personnel likely to come into contact with asbestos contaminated soils and asbestos containing materials (Areas 2 & 4) shall be provided with and wear the following PPE at all times when working in the asbestos contaminated areas of the site:

- Disposable coveralls (Type 5);
- Half-face P3 respirator with particulate filter;
- Steel toe capped gumboots or safety footwear with disposable overshoes;
- Nitrile gloves (if handling any contaminated soils is required);
- Hard Hat (if working around plant and excavators);
- Hearing protection (if required);
- Safety Glasses (to be worn in particularly dry weather conditions); and
- Safety Visibility Vest

All meal breaks are to be taken in designated clean areas following appropriate decontamination.

For the areas of chemical contamination, the level of soil contamination is unlikely to present a short-term risk to site workers. However, in order to minimise the potential effects or the likelihood of cumulative effects, all personnel likely to come into contact with contaminated soils during development works shall be provided with and wear the following PPE at all times when working on the site:

- Tyvek overalls (to be changed immediately if these become highly soiled);
- Dust masks (to be worn in particularly dry weather conditions);
- Approved safety footwear (rubber boots, work boots with toe protection);
- Gloves (if handling any contaminated soils is required);
- Hard Hat (if working around plant and excavators);
- Hearing protection (if required);
- Safety Glasses (to be worn in particularly dry weather conditions); and
- Safety Visibility Vest

All meal breaks are to be taken in designated clean areas or off site, with all personnel washing their hands and mouth area prior to eating, drinking or smoking. Used PPE is to be doffed by all personnel before leaving the site.

23.3 Stormwater, Erosion & Sediment Control

When carrying out any earthworks where soils are disturbed there is a risk of erosion and pollution by sediment being emitted to the receiving water courses. This type of pollution can have a negative effect on the water quality and the ecosystems effecting both plant and fish life.

Install sediment and erosion controls for the development works in accordance with the Auckland Council's Erosion and Sediment Control Guide for Land Disturbing Activities [4].

Earthworks are not to be carried out during periods of significant rainfall. Excavation will be carried out a rate that matches the rate at which soil can be carted off the site. Any contaminated water generated by rainfall impacting on contaminated soils will be retained within the excavation.

It is not anticipated that stockpiling of soils will be required. If required, soil stockpiles will be covered by tarpaulins if left overnight, and when rain is anticipated during the working day. Tarpaulins will be anchored at the edges. As a general management strategy, the size of stockpiles will be kept to a minimum by ensuring that as far as possible, excavation is carried out a rate that matches the rate at which soil is carted off the site.

[4] Auckland Council, Erosion & Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016, Guideline Document 2016/005.

23.4 Odour Control

It is considered unlikely that nuisance odour will be an issue on site. However, in the event that there may be odorous materials encountered, where possible these will be loaded as soon as possible onto the removal trucks. If this is not possible the odorous material will be covered with non-odorous material prior to being loaded.

23.5 Contingency Measures

The following contingency measures have been developed to support the contractor should the underlying contamination conditions vary significantly from the conditions outlined following the site investigation.

If any unexpected materials are identified during the excavation process, which differ from previous observations, and the site soil assessment (i.e., odorous, unusually coloured), the contractor shall immediately contact the environmental specialist to inspect the material and provide advice for the safe handling and disposal of the material.

Visual and olfactory indicators of contamination include the following:

- Asbestos containing materials (ACM) (board, pipe, free fibres or fragments)
- Demolition debris (polystyrene, steel and timber)
- Refuse materials (other than concrete or brick)
- Odour (petroleum, oil, creosote, solvent, sulphur, landfill gas)
- Discoloured soil (black/green staining is most common)
- Incinerator ash (black coarse sand)
- Gasworks wastes (clinker – black gravel, blue billy, black tar)
- Harmful non Cleanfill materials

If any potential ACM or unexpected materials are identified during site works, the area shall immediately be fenced off (barrier tape) with a 2.0m buffer zone, photographs taken and the Contaminated Land Specialist contacted. The Contaminated Land Specialist will then inspect the material and provide advice for the sampling and analysis, safe handling and disposal of the material.

Following the discovery of any unexpected materials, an environmental investigation is to be carried out in general accordance with the Contaminated Land Management Guidelines No. 1 and No. 5 (MfE, Revised 2021).

In the event that soils are found to contain concentrations of contaminants elevated above the relevant site acceptance criteria, the site soils will require remediation and subsequent validation.

All contaminated materials removed from site will require disposal at a suitably licensed disposal facility and site validation sampling is to be completed at a frequency sufficient to meet the requirements of the Contaminated Land Management Guidelines No.5 (MfE, Revised 2021).

In the event that ACMs are identified at the site, its removal from the site shall be conducted in accordance with the Health and Safety at Work (Asbestos) Regulations (MBIE, 2016) and the Approved Code of Practice for the Management and Removal of Asbestos (WorkSafe New Zealand, 2016).

Following the removal of any ACM, a certificate of clearance is to be produced by a suitably licensed asbestos assessor.

If ground water or surface water collects within the excavation during the works, this water shall be allowed to soak into the ground. Any perched groundwater, groundwater, or surface run-off encountered within the excavation area requiring removal shall be considered as potentially contaminated, and shall either be disposed of by a licensed liquid waste contractor, pumped to sewer, provided relevant permits have been obtained, or discharged to the stormwater system or surface waters provided testing demonstrates compliance with the Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality (2000) for the protection of 95 percent of species.

In the event that unexpected materials are encountered at the site, Auckland Council are to be notified of the nature and extent of the contamination along and provided with details of the management procedures undertaken at the site.

23.6 Equipment Decontamination & Clearance

Following remediation of the asbestos contaminated soils (Area 2), remove visible debris and soil from all plant, paying attention to the tracks and bucket of excavators.

Prior to plant being removed from the site, a visual assessment for the presence of asbestos, visible debris and soil shall be carried out by an independent assessor or competent person.

Cleaning procedures should be conducted in such a manner as to ensure that all residual soil and contaminants are safely removed and disposed of.

23.7 Site Validation Report

Following the proposed works, it is recommended that a site validation report is prepared. The site validation report should contain sufficient detail to address the following matters:

- A summary of the works undertaken including volume of soil removed from site;
- A summary of the validation testing undertaken, including tabulated analytical results;
- Copies of the disposal dockets for the material removed from the site;
- A copy of the clearance certificate/s for the asbestos contaminated soils and visual evidence of asbestos removed from site;
- Records of any unexpected contamination encountered during the works, if applicable; and
- A summary of any additional soil sampling undertaken, tabulated analytical results, and interpretation of the results in the context of the current contaminated land regulatory requirements.

24.0 Conclusions and Recommendations

This DSI, RAP & AEE has been prepared in accordance with the requirements of the Contaminated Land Management Guidelines No. 1 and No. 5 (Ministry for the Environment, Revised 2021).

It is proposed that the site will be subdivided into residential lots. As part of the redevelopment, the site will undergo a change of land use, subdivision and disturbance of soils, therefore the rules of the National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health apply. The guideline values of the Soil Contaminant Standards for health ($SCSs_{(health)}$) for residential land use (10% produce consumption) as outlined in the NES are considered relevant. Additionally, in order to accurately perform a risk assessment and to assess whether any discharges from contaminated land will result in significant adverse effects on the environment, the contaminated land rules as outlined in Chapter E30 of the Auckland Unitary Plan: Operative in Part (AUP: OP) also require consideration.

The history of the site was researched by Focus Environmental Services personnel, which involved a review of the available historical aerial photographs of the site, a search of the Auckland Council property file, a contaminated sites enquiry to Auckland Council and a review of the historical certificate of tile.

During the review of the available information, it was noted that due to the age of the current and former site buildings there was potential for ground contamination from the historic use of lead-based paints and potentially asbestos containing building materials. In addition, historical horticulture land use was noted on neighbouring properties, therefore contamination associated with spray-drift may have occurred at the site.

The site was visited and a site inspection and walk over was carried out by Focus Environmental Services Limited personnel on 15th of August 2022. During the site inspection, potential spray race operations, two areas of refuse burning and three areas of potential asbestos containing materials in a degraded condition were noted.

Due to the potential sources of contamination identified it is considered that there is evidence to suggest that an activity outlined in the Hazardous Activities Industries List (HAIL) has been, or is more likely than not to have been undertaken at the site.

Following the site inspection and walkover, the intrusive investigation was carried out by Focus Environmental Services Limited personnel where a total of twenty-one discrete surface soil samples were taken from the potential sources of contamination identified. In addition, twelve samples were taken from the areas of horticultural activity and composited at the laboratory to form three composite samples (4:1). Furthermore, three bulk asbestos samples were collected from areas of potentially asbestos containing materials observed in a degraded condition.

The samples were analysed for contaminants that could be present due to the potentially hazardous activities carried out at the site. The results of the site investigation have indicated that the activities carried out at the site have impacted the site soils.

Elevated concentrations of arsenic, cadmium, lead and zinc were detected in the site soils in the locations of the two burn piles. In addition, elevated concentrations of arsenic were detected in the spray race/stock loading area (2). Elevated concentrations of lead were detected in the areas around the stables (2), HB05 and the dwelling (1). Furthermore, elevated concentrations of asbestos fibres and visual evidence of asbestos were identified in the area of the outdoor toilet, and visual evidence of asbestos was observed in contact with the soils on the northern side of the stables (2).

Concentrations of arsenic, cadmium, lead and zinc were detected in the site soils in two locations at levels elevated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and/or the discharge criteria as outlined in the AUP: OP.

Concentrations of arsenic were detected in another location at levels elevated above the $SCSs_{(health)}$ for residential land use as outlined in the NES.

In addition, concentrations of lead were detected in the site soils in two areas at levels elevated above the $SCSs_{(health)}$ for residential land use (10% produce consumption) as outlined in the NES and/or the discharge criteria as outlined in the AUP: OP.

Furthermore, visual evidence of asbestos containing material was observed in contact with the site soils in two locations, and concentrations of asbestos fibres was detected in one of these areas at levels above the adopted human health criteria.

Due to the elevated levels of arsenic, cadmium, lead, zinc and asbestos fibres detected, the site at 279 Airfield Road, Ardmore will require remediation of the affected soils prior to being redeveloped. The estimated volume of soil requiring remediation is 58.4m^3. It should be noted that this volume may change during the remedial process.

A restricted discretionary consent is required under Regulation 10 of the NES as the proposed subdivision, change of use and disturbance of soils do not meet the requirements of a permitted activity under Regulation 8 of the NES, and as this detailed site investigation for the piece of land has shown that the soil contamination does exceed the applicable standard for residential land use.

Due to the estimated volume of material containing concentrations of contaminants elevated above those values specified in Table E30.6.1.4.1 of Chapter E30 of the AUP: OP being 35.94m^3, which is below 200 m^3, it is considered that the proposed remediation will likely meet the permitted activity requirements under rule E30.6.1.2 of the AUP: OP and therefore resource consent under the AUP: OP may not be required.

In addition, due to low-level concentrations of lead and residual concentrations of organochlorine pesticides detected above natural background concentrations in localised areas of the site, the soils in these areas will require management during development works, and if removed from site, will require disposal to a suitably licensed managed fill facility.

The objective of this Remediation Action Plan is to ensure that the soils contaminated above the adopted site assessment criteria and the materials contaminated above natural background concentrations in the management areas of the site, are handled, removed, or managed in a controlled manner, and disposed of to a suitable disposal location. All earthworks required as part of the remedial works should be carried out in accordance with this Remediation Action Plan.

An assessment of the effects which may occur as a result of the proposed works has been made in order to mitigate any potential adverse environmental and/or human health effects. If the controls outlined in this Remediation Action Plan are implemented during the development works it is considered that the effects on the environment and human health are likely to be effectively mitigated.

Figures

Figure 1 –Site Location Plan
Figure 2 – Site Features Overview & Historical Building Plan
Figures 2-1 & 2-2 – Site Features Plan
Figure 3 – Surrounding Environment
Figure 4 – Sample Location Plan Overview
Figures 4-1 & 4-2 – Discrete Sample Location Plan
Figure 4-3 – Composite Sample Location Plan
Figures 5 & 5-1- Inferred Area and Depth of Contamination
Figures 6 & 6-1 – Inferred Areas Requiring Management

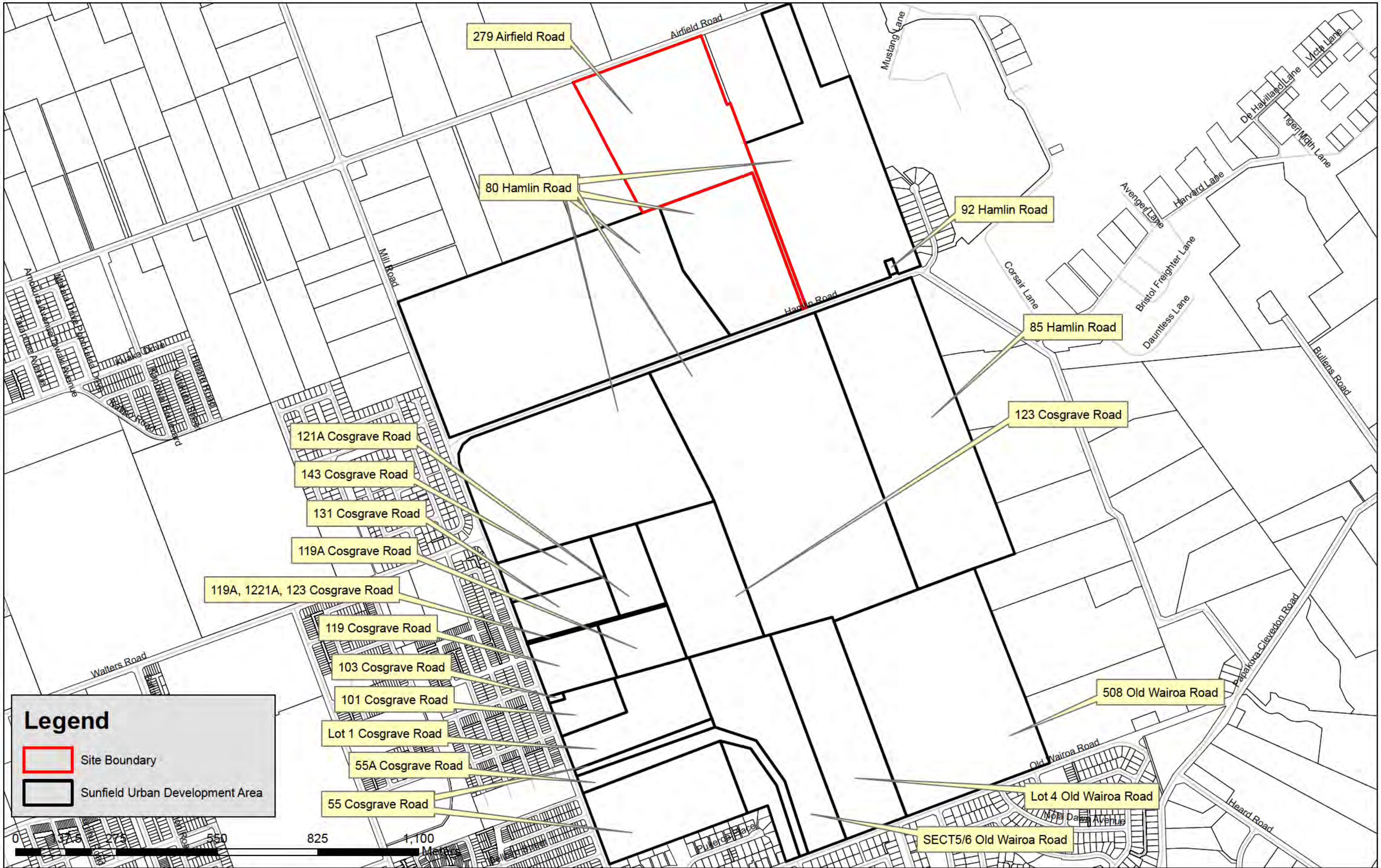

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Figure 1: Site Location Plan

DSI, RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.01
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

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Figure 2: Site Features Overview & Historical Building Plan

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.02
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Site Feature	Description
1	Site Entrance via Gravel Driveway
2	Excavated Pit with Concrete & Minor PACM Fragments
3	Corrugated Painted Metal Hay Shed (1)
4	Carport & Shed 2 - Painted Corrugated Metal Storage of Hay & Farm Equipment
5	Livestock Loading Area - Concrete Lined
6	Shed 3 - Livestock Shed - Unpainted Cinderblock, Concrete Lined.
7	Toilet - Unpainted Plywood & PACM Cladding with Minor Damage
8	Livestock Loading Area
9	Burning of Refuse

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Figure 2-1: Site Features Plan

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.02-1
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Site Feature	Description
10	Stables (1) - Unpainted Corrugated Metal, Concrete Lined
11	Stables (2) - Painted PACM & Metal Cladding
12	Horse Arena
13	Garage (1) - Painted Corrugated Metal, Concrete Lined
14	Dwelling (1) - Raised Single Storey, PACM Baseboards & Soffits, Wooden Cladding
15	Shipping Container
16	Burn Barrell
17	Garage (2) - Painted Metal Cladding
18	Dwelling (2) - Raised Single Storey, PACM baseboards, Painted Metal Cladding
19	Septic Tank Vent

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Figure 2-2: Site Features Plan

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.02-2
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** 279 Airfield Road Sunfield Urban Development Area Papakura Auckland	**Figure 3: Surrounding Environment** DSI RAP & AEE	1686.001 (R1)	Drawing Number: 1686.001.03 Drawn By: MT Checked By: DO'R Date: 20/12/2023

Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** 279 Airfield Road Sunfield Urban Development Area Papakura Auckland	**Figure 4: Sample Location Plan Overview** DSI RAP & AEE	1686.001 (R1)	Drawing Number: 1686.001.04 Drawn By: MT Checked By: DO'R Date: 20/12/2023

Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** 279 Airfield Road Sunfield Urban Development Area Papakura Auckland	**Figure 4-1: Discrete Sample Location Plan** DSI RAP & AEE	N	Drawing Number: 1686.001.04-1	
				Drawn By: MT	
			1686.001 (R1)	Checked By: DO'R	
				Date: 20/12/2023	

Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Winton Land Limited** 279 Airfield Road Sunfield Urban Development Area Papakura Auckland	**Figure 4-2: Discrete Sample Location Plan** DSI RAP & AEE	N	Drawing Number: 1686.001.04-2	Drawn By: MT
			1686.001 (R1)	Checked By: DO'R	Date: 20/12/2023

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Figure 4-3: Composite Sample Location Plan

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.04-3	
Drawn By: MT	
Checked By: DO'R	
Date: 20/12/2023	

Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Area 1	19	0.3	As, Cd, Pb, Zn	5.7
Area 2	8.4	0.3	Asbestos	2.52
Area 3	11.5	0.3	As	3.45
Total Volume				11.67
Total Tonnes (m^3 x 1.5)				**17.5 t**

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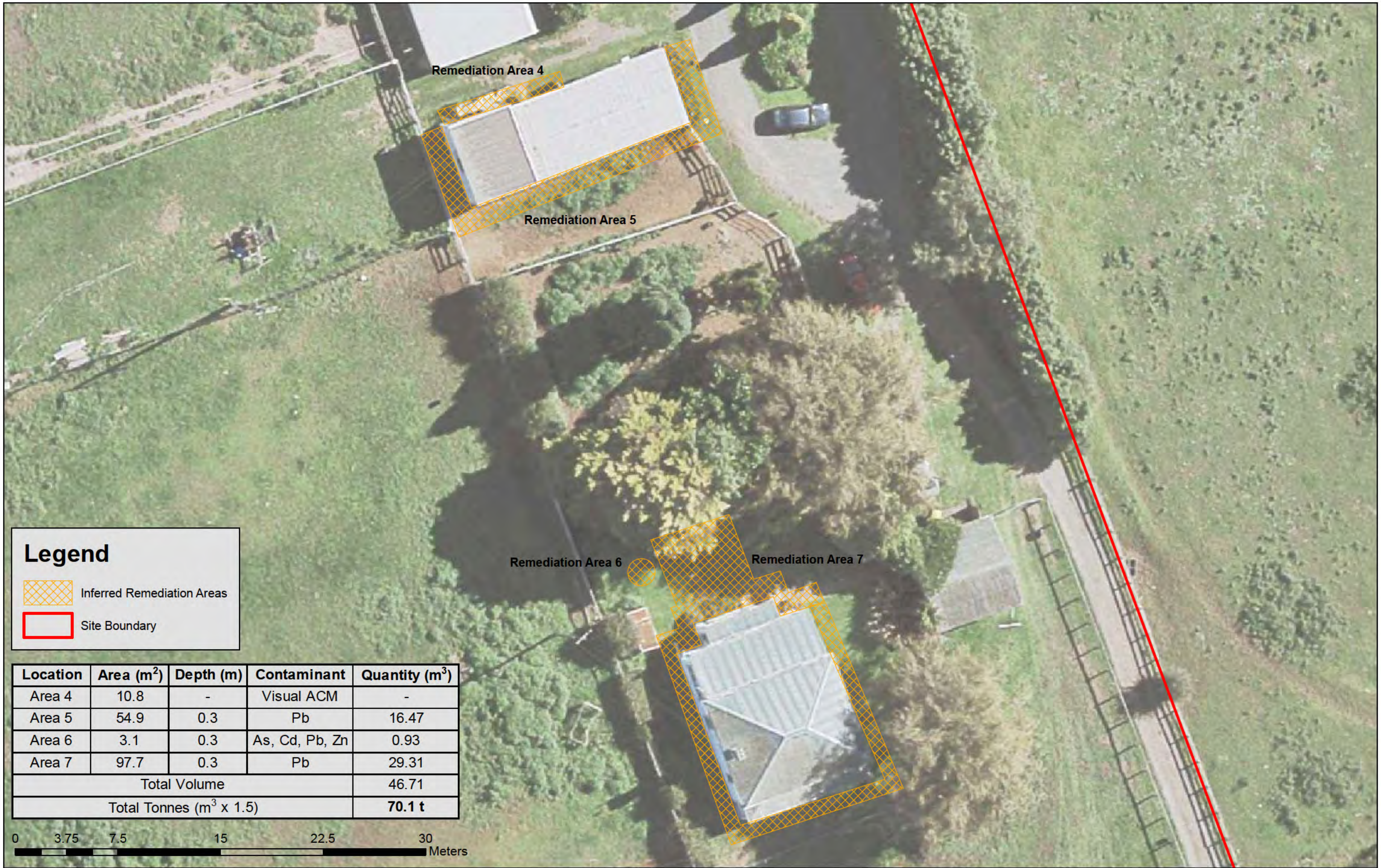
Figure 5: Inferred Area and Depth of Contamination

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.05
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023



Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Area 4	10.8	-	Visual ACM	-
Area 5	54.9	0.3	Pb	16.47
Area 6	3.1	0.3	As, Cd, Pb, Zn	0.93
Area 7	97.7	0.3	Pb	29.31
Total Volume				46.71
Total Tonnes (m^3 x 1.5)				**70.1 t**

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Figure 5-1: Inferred Area and Depth of Contamination

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.05-1
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Management Area 1	17.2	0.3	Pb	5.16
Management Area 2	5,284.2	0.3	OCP's	1585.26
Total Volume				1,590.42
Total Tonnes (m^3 x 1.5)				**2,385.6 t**

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Figure 6: Inferred Areas Requiring Management

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.06
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Location	Area (m^2)	Depth (m)	Contaminant	Quantity (m^3)
Management Area 3	20	0.3	Pb	6
Management Area 4	43.4	0.3	Pb	13.02
Management Area 5	52.15	0.3	Pb	15.645
Total Volume				34.67
Total Tonnes (m^3 x 1.5)				**52.0 t**

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Figure 6-1: Inferred Areas Requiring Management

DSI RAP & AEE

1686.001 (R1)

Drawing Number: 1686.001.06-1
Drawn By: MT
Checked By: DO'R
Date: 20/12/2023

Appendices

Appendix A – Illustrative Masterplan

Appendix B – Site Contour Plan

Auckland Council

Map

Site Contour Plan

0 20 40 60
Meters

Scale @ A3
= 1:2,500

Date Printed:
2/08/2022

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Appendix C – Environmental HAIL

Ministry for the Environment
Manatū Mō Te Taiao

Hazardous Activities and Industries List (HAIL)

October 2011

A Chemical manufacture, application and bulk storage

1. Agrichemicals including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application
2. Chemical manufacture, formulation or bulk storage
3. Commercial analytical laboratory sites
4. Corrosives including formulation or bulk storage
5. Dry-cleaning plants including dry-cleaning premises or the bulk storage of dry-cleaning solvents
6. Fertiliser manufacture or bulk storage
7. Gasworks including the manufacture of gas from coal or oil feedstocks
8. Livestock dip or spray race operations
9. Paint manufacture or formulation (excluding retail paint stores)
10. Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds
11. Pest control including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application
12. Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides
13. Petroleum or petrochemical industries including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground
14. Pharmaceutical manufacture including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges
15. Printing including commercial printing using metal type, inks, dyes, or solvents (excluding photocopy shops)
16. Skin or wool processing including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products
17. Storage tanks or drums for fuel, chemicals or liquid waste
18. Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside

B Electrical and electronic works, power generation and transmission

1. Batteries including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)

2. Electrical transformers including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
3. Electronics including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices
4. Power stations, substations or switchyards

C Explosives and ordinances production, storage and use

1. Explosive or ordinance production, maintenance, dismantling, disposal, bulk storage or re-packaging
2. Gun clubs or rifle ranges, including clay targets clubs that use lead munitions outdoors
3. Training areas set aside exclusively or primarily for the detonation of explosive ammunition

D Metal extraction, refining and reprocessing, storage and use

1. Abrasive blasting including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material
2. Foundry operations including the commercial production of metal products by injecting or pouring molten metal into moulds
3. Metal treatment or coating including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds
4. Metalliferous ore processing including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals
5. Engineering workshops with metal fabrication

E Mineral extraction, refining and reprocessing, storage and use

1. Asbestos products manufacture or disposal including sites with buildings containing asbestos products known to be in a deteriorated condition
2. Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)
3. Cement or lime manufacture using a kiln including the storage of wastes from the manufacturing process
4. Commercial concrete manufacture or commercial cement storage
5. Coal or coke yards
6. Hydrocarbon exploration or production including well sites or flare pits
7. Mining industries (excluding gravel extraction) including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

F Vehicle refuelling, service and repair

1. Airports including fuel storage, workshops, washdown areas, or fire practice areas
2. Brake lining manufacturers, repairers or recyclers
3. Engine reconditioning workshops
4. Motor vehicle workshops
5. Port activities including dry docks or marine vessel maintenance facilities

6. Railway yards including goods-handling yards, workshops, refuelling facilities or maintenance areas
7. Service stations including retail or commercial refuelling facilities
8. Transport depots or yards including areas used for refuelling or the bulk storage of hazardous substances

G Cemeteries and waste recycling, treatment and disposal

1. Cemeteries
2. Drum or tank reconditioning or recycling
3. Landfill sites
4. Scrap yards including automotive dismantling, wrecking or scrap metal yards
5. Waste disposal to land (excluding where biosolids have been used as soil conditioners)
6. Waste recycling or waste or wastewater treatment

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

Appendix D – Historical Aerial Photographs

APPENDIX D – WETLAND MEMO

MAVEN
Ref: 215010

7nd February 2025

Wetland 1 Design Memo for Proposed Sunfield FAA Application

- **Background**

Wetland design is required by Heathy Water to demonstrate the proposed wetland space is adequate to provide the required mitigation volumes. Wetland 1. This memo, as a supplement to the SMP, details the Wetland 1 design principles and sizing method.

- **Catchment and Storm Intensities**

As shown on civil drawing M-C480 Catchment Plan set, the total catchment for Wetland 1 is 639,656m^2. The pre-development and post-development catchment areas are summarised in Table 1 below.

Table 1 – Wetland 1 Catchment Summary

Total Catchment Area	639,656m^2		
Pre-Dev Pervious Area	639,656m^2 (100%)	CN=74	ToC = 0.44hr
Post-Dev Pervious Area	189,517m^2 (30%)	CN=74	ToC = 0.167hr
Post-Dev Impervious Area	450,139m^2 (70%)	CN=98	ToC = 0.167hr

The following storm intensities have been applied based on TP108 and SWCoP Revision 4 requirements, see Tabel 2.

Table 2 – Storm Intensities

Design Storm	Rainfall Across 24hr (mm) – TP108	Climate allowance as per SWCoP Rev 4	Rainfall+CC (mm)
90th	25	-	-
95th	33	-	-
50%AEP	75	15.10%	86
10%AEP	145	17%	170
1%AEP	225	32.70%	298

- **Design Principles**

As stated in the SMP and flood report regarding flooding management of the Eastern Catchment Outflow 1, a pass forward flow strategy is proposed, it is recommended not to provide attenuation for 10-year and 100-year storm event. In this case, Wetland 1 has been designed to provide treatment and partial mitigation for SMAF 1 only (with some of the SMAF volume being provided in the sites swale network). It is anticipated the wetland is to be used as peak a peak flow diversion basin during 2yr, 50yr and 100-year.

- **Hydrologic Calculations**

engineering new zealand

TP108 has been utilized to conduct the hydrologic calculations. The results are summarized in Table 3 below. Hydraulic modelling was undertaken in HEC RAS and results may be found in Stormwater Modelling Report.

Table 3 – Hydrologic Calculations Results

Item	Value
PWV -	7,673 m^3
Minimum Forebay Volume (15% of PWV)	1,150 m^3
Sediment Drying Area (10% of PWV)	767 m^2
Detention Volume for SMAF	9,828 m^3

Table 4 – Elevation-Storage Relationship

Water Level (m, RL)	Storage Volume (m^3)
20.7	0
21.0	11,000
21.5	31,150
22.0	52,420
22.5	75,700
23.0	100,000

Note: An additional 76,000 m3 flood storage is available below water level 23.0. This is only used for 100yr flood storage with a spillway RL 22.57

Table 6: Wetland Design Summary

ITEM	COMMENTS
Permanent Water Level (PWL) Proposed	RL20.70m
Standard PWV Required (Table 3 above)	7,673 m^3
Minimum PWV Required When Stream Protection is provided As per GD01 C8.2.3.1	3,836m^3 (50% of Standard PWV)
PWV Provided	4,683m^3 (>50% of Standard PWV)
Wetland Length to Width Raito	Approximately 4:1
Forebay Volume Proposed	575m^3, 12% of PWV
Forebay Depth	1.4m
Shallow Marsh Zone Depth	0.1m
Deep Marsh Zone Depth	0.4m
Deep Pool Depth	1.4m
Slope	Internal wetland banks below the PWL: 1V:4H Internal side slope above the PWL: 1V: 3H Forebay bund slope: 1V:3H External side slope: 1V:3H
Maintenance Access	Provided, 3.5m wide, maximum gradient 1 in 8.
Sediment Drying Area	Provided, 468m^2, >10% of PWV
Safety Bench	Provided, 3m wide, maximum water depth 300mm below PWL
Emergency Spillway	Provided
Overland Flow into Wetland	Yes, for peak flow diversion of Swale
Flooding Risk	Wetland is designed for 100yr ARI storm event flood storage.
Inlet and Outlet	Inlet is sized to convey WQF WQF peak flow of 1,142l/s Outlet is sized to drain down flood storage after storm event 750mm SW pipe Orifice at outlet manhole: SMAF 1 release: 344mm diameter at RL20.70 (invert level) Across Norther Outflow 1 spillway bund Reno Mattress or Rock Riprap has been proposed for erosion protection and velocity control

Please do not hesitate to contact me should you have any queries.

Kind regards,

Designed By:

Yotsak Wansong
Civil Engineer
Maven Associates Limited

Appendices:

- **Appendix 1** – Calculations

Appendix 1 – Calculation

TP108 Calculations

MAVEN ASSOCIATES	Job Number 215010	Sheet 1	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Pre-Development Wetland 1	Author AO	Date 19/12/2024	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Residential lots	89.6		0.00
C	Road pavement	98		0.00
C	Carpark	98		0.00
C	Open space (Pervious)	74	63.9656	4733.45
* from Appendix B		Totals =	63.9656	4733.45

CN (weighted) = total product / total area = 4733.45 / 63.966 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 63.9656 / 63.966 = 5.0 mm

2. Time of Concentration

Contours level in meters — High Level — Lower level

Channelisation factor — C = 1 (From Table 4.2)

Catchment length — L = 1.2 km (along drainage path)

Catchment Slope — Sc= 0.010 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.13 1.34 3.98 = 0.17 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 2	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Pre-Development Wetland 1	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.63966	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	90th %	95th %	(yr)
4. 24 hour rainfall depth	25	33	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	
6. Specific peak flow rate q*	0.020	0.028	
7. Peak flow rate, q_p=q*A*P_{24}	**0.320**	**0.591**	m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.7	6.7	mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2342.13	4277.35	(m3)

Worksheet 2: Graphical Peak Flow Rate

MAVEN ASSOCIATES	Job Number 215010	Sheet 3	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland1 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98		0.00
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74	18.9517	1402.42
* from Appendix B		Totals =	18.9517	1402.42

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{1402.42}{18.952}$ = 74.0   23.7400

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 18.9517}{18.952}$ 5.0 mm

2. Time of Concentration

Channelisation factor   C = 1 (From Table 4.2)

Catchment length   L = 1.2 km (along drainage path)

Catchment Slope   Sc= 0.010 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{74.0}{200 - 74.0}$ = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.13   1.34   3.98   = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 4	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 1 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.18952	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

		PWV	SMAF	
3.	Average recurrence interval, ARI	90th %	95th %	(yr)
4.	24 hour rainfall depth	25	33	(mm)
	Percentage Increase			(%)
4.	24 hour rainfall depth, P24	25	33	(mm)
5.	Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	
6.	Specific peak flow rate q*	0.170	0.170	
7.	Peak flow rate, q_p=q*A*P_{24}	**0.805**	**1.063**	m3/s
8.	Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.7	6.7	mm
9.	Runoff volume, $V_{24} = 1000xQ_{24}A$	693.92	1267.29	(m3)
10	Retention volume, imp*5mm	0	0	m^3

MAVEN ASSOCIATES	Job Number 215010	Sheet 5	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 1 - Impervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98	45.0139	4411.37
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74		0.00
* from Appendix B		Totals =	45.0139	4411.37

CN (weighted) = total product / total area = 4411.37 / 45.014 = 98.0 23.7400

Ia (average) = 5 x pervious area / total area = 5 x 0.0000 / 45.014 = 0.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.2 km (along drainage path)

Catchment Slope Sc= 0.010 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 98.0 / (200- 98.0) = 0.96

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.13 1.02 3.98 = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 6	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 1 - Impervious	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.45014	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5.2 mm

	PWV - SMA	SMAF1			
3. Average recurrence interval, ARI	90th %	95th %			(yr)
4. 24 hour rainfall depth	25	33			(mm)
Percentage Increase					(%)
4. 24 hour rainfall depth, P24	25	33			(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.71	0.76			
6. Specific peak flow rate q*	0.170	0.170			
7. Peak flow rate, q_p=q*A*P_{24}	**1.913**	**2.525**			m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	20.7	28.5			mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	9320.84	12837.99			(m3)
10 Retention volume, imp*5mm	2251				m³
Combined v24	10015	14105.28			
Post V24- Pre V24	**7673**	**9828**			m³
Detention volume	5422				m³
			Design	*Excess*	
50% PWV - Live storage provided	3836		**4,961.0**	*1,124.69*	m³
Ponding Depth Coefficient	0.5				m
Minimum Wetland Area	7673		**9,798.8**	*2,126.20*	m^2
Forebay volume	575		**1,143.6**	*568.19*	m^2
Live Storage Required		**9828**			m^2

Length	200	Ratio 1:	3.960396
Width	**50.50**	Area	**10100.00**

Worksheet 2: Graphical Peak Flow Rate

Transverse Deep Pools	432.96		
	956.68	Outlet	1389.64
Forebay Area	1260		13% >10%
"wetland area""	8538.83		
Percentatge of transverse deep poc	16%		<20% excl forebay

MAVEN ASSOCIATES	Job Number 215010	Sheet 7	Rev A
Job Title Sunfield FAA Calc Title Catchment Summary for Wetland Design 1	Author AO	Date 19/12/2024	Checked 0

Total Area (ha)	Pervious (ha)	%	Impervious (ha)	%
Pre Developmnet	63.9655904	100%	0	0%
Post Development	18.95165079	30%	45.01393961	70%

	Runoff Volume V24 (m3)		Peak Flow Rate (m3/s)		Volume Required
	Pre	Post	Pre	Post	
90th %	2342	10015	0.32	2.72	7672.6
95th %	4277	14105	0.59	1.06	9827.9

SMAF Orifice Sizing Calculation

Maven Associates		Job Number 215010	Sheet 1	Rev A
Job Title Calc Title	Sunfield FAA SW Pond 1 SMAF Orifice Size Calc	Author YW	Date 13/01/2025	Checked

Detention Volume

12121.00 m^3 *(See SMAF Summary)*

Flow Rate (Q_p) if released over 24 hours

0.14029 m^3/sec (Average Discharge Flow-Rate)

Tank Details

Tank Height 0.450 m
Orifice Height 0.000 m (Above tank base)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P 0.14029 m^3/sec (Peak Discharge Flow-Rate)
G= 9.810 m^2/sec
H_T= 0.450 m (Height of water above Discharge Point)
$H_{2/3}$= 0.300 m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.0932659 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A= 0.0932659 m^2 (Cross-Sectional of the Discharge Pipe)
D= 0.344601 m (Diameter of Discharge Pipe)

Use 10mm Orifice (minimum size)

344.60098 (Diameter of Discharge Orifice in mm)

Qmax = 0.2806 m^3/sec
Qi (265mm) 0.0830 m^3/sec

Post Storm Draindown Orifice Sizing Calculation

Maven Associates		Job Number 215010	Sheet 1	Rev A
Job Title Calc Title	Sunfield SW Pond 1 Post 1%AEP Draindown Orifice Size Calc	Author YW	Date 13/01/2025	Checked

Detention Volume

129000.00 m^3 *(1%AEP Flood Storage)*

Flow Rate (Q_p) if released over 30 hours

1.19444 m^3/sec (Average Discharge Flow-Rate)

Tank Details

Tank Height 1.600 m

Orifice Height 0.000 m (Above tank base)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P 1.19444 m^3/sec (Peak Discharge Flow-Rate)

G= 9.810 m^2/sec

H_T= 1.600 m (Height of water above Discharge Point)

$H_{2/3}$= 1.067 m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.4211244 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A= 0.4211244 m^2 (Cross-Sectional of the Discharge Pipe)

D= 0.7322515 m (Diameter of Discharge Pipe)

Use 10mm Orifice (minimum size)

732.25148 (Diameter of Discharge Orifice in mm)

Qmax = 2.3889 m^3/sec

Qi (265mm) 0.1564 m^3/sec

Ref: 215010

7nd February 2025

Wetland 2 Design Memo for Proposed Sunfield FAA Application

❖ Background

Wetland design is required by Heathy Water to demonstrate the proposed wetland space is adequate to provide the required mitigation volumes. Wetland 2. This memo, as a supplement to the SMP, details the Wetland 2 design principles and sizing method.

❖ Catchment and Storm Intensities

As shown on civil drawing M-C480 Catchment Plan set, the total catchment for Wetland 2 is 152,738 m^2. The pre-development and post-development catchment areas are summarised in Table 1 below.

Table 1 – Wetland 2 Catchment Summary

Total Catchment Area	152,738 m^2		
Pre-Dev Pervious Area	152,738 m^2 (100%)	CN=74	ToC = 0.44hr
Post-Dev Pervious Area	32,297m^2 (21%)	CN=74	ToC = 0.167hr
Post-Dev Impervious Area	120,441m^2 (79%)	CN=98	ToC = 0.167hr

The following storm intensities have been applied based on TP108 and SWCoP Revision 4 requirements, see Tabel 2.

Table 2 – Storm Intensities

Design Storm	Rainfall Across 24hr (mm) – TP108	Climate allowance as per SWCoP Rev 4	Rainfall+CC (mm)
90th	25	-	-
95th	33	-	-
50%AEP	75	15.10%	86
10%AEP	145	17%	170
1%AEP	225	32.70%	298

❖ Design Principles

As stated in the SMP and flood report regarding flooding management of the Eastern Catchment Outflow 2, it is recommended to provide attenuation for 2-year, 10-year and 100-year storm event. In this case, Wetland 2 has been designed to provide treatment and live storage for SMAF 1, 2yr, 10yr and 100yr peak flow attenuation.

❖ Hydrologic Calculations

TP108 and HEC-HMS has been utilized to conduct the hydrologic calculations. The results are summarized in Table 3 below.

Table 3 – Hydrologic Calculations Results

Item	Value
PWV -	2,053 m^3
Minimum Forebay Volume (15% of PWV)	308 m^3
Sediment Drying Area (10% of PWV)	205 m^2
Detention Volume for SMAF	2,629 m^3

❖ Hydraulic Calculations and Wetland Design Summary

Autodesk Civil 3D software has been used to build the Wetland 2 3D model and Elevation-Storage relationship (Table 4) has been extracted from the Wetland 2 3D model contours for HEC-HMS hydraulic calculation.

The final Wetland 2 design is summarised in Table 5 below.

Table 4 – Elevation-Storage Relationship

Water Level (m, RL)	Storage Volume (m^3)
19.4	0
20.0	6,085
21.0	17,415
22.0	30,300

Table 6: Wetland Design Summary

ITEM	COMMENTS
Permanent Water Level (PWL) Proposed	RL19.40m
PWV - (Table 3 above)	2,053 m^3
Minimum PWV Required When Stream Protection is provided As per GD01 C8.2.3.1	1,026m^3 (50% of Standard PWV)
PWV Provided	2,629m^3 (>50% of Standard PWV)
Wetland Length to Width Raito	Approximately 3.6:1
Forebay Volume Proposed	154m^3, 15% of PWV
Forebay Depth	1.75m
Shallow Marsh Zone Depth	0.2m
Deep Marsh Zone Depth	0.5m
Deep Pool Depth	1.2m
Slope	Internal wetland banks below the PWL: 1V:4H Internal side slope above the PWL: 1V: 3H Forebay bund slope: 1V:3H External side slope: 1V:3H
Maintenance Access	Provided, 3.5m wide, maximum gradient 1 in 8.
Sediment Drying Area	Provided, 1,200m^2, >10% of PWV
Safety Bench	Provided, 3m wide, maximum water depth 300mm below PWL
Emergency Spillway	Provided
Overland Flow into Wetland	Yes
Flooding Risk	Wetland is designed for 100yr ARI storm event flood attenuation
Inlet and Outlet	Inlet is sized to convey pre-mitigation 10yr peak flow of 4,182l/s Outlet is sized to convey post-dev mitigated 2yr peak flow of 60l/s mitigated 10yr peak flow of 639l/s mitigated 100yr peak flow of 4,142l/s 2m manhole cutout at RL20.40 Orifice at outlet manhole: SMAF 1 release: 180mm diameter at RL19.40 (invert level) Reno Mattress or Rock Riprap has been proposed for erosion protection and velocity control

Designed By:

Yotsak Wansong
Civil Engineer
Maven Associates Limited

Appendices:

- **Appendix 1** — Calculations

Appendix 1 – Calculation

TP108 Calculations

MAVEN ASSOCIATES	Job Number 215010	Sheet 1	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Pre-Development Wetland 2	Author AO	Date 19/12/2024	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Residential lots	89.6		0.00
C	Road pavement	98		0.00
C	Carpark	98		0.00
C	Open space (Pervious)	74	15.2738	1130.26
* from Appendix B		Totals =	15.2738	1130.26

CN (weighted) = total product / total area = 1130.26 / 15.274 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 15.2738 / 15.274 = 5.0 mm

2. Time of Concentration

Contours level in meters — High Level ___ Lower level ___

Channelisation factor — C = 1 (From Table 4.2)

Catchment length — L = 0.5 km (along drainage path)

Catchment Slope — Sc= 0.016 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   0.63   1.34   3.48   = 0.17 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 2	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Pre-Development Wetland 2	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.15274	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	86	170	298	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	0.30	0.47	0.62	
6. Specific peak flow rate q*	0.020	0.028	0.065	0.090	0.110	
7. Peak flow rate, q_p=q*A*P_{24}	**0.076**	**0.141**	**0.854**	**2.337**	**5.007**	m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.7	6.7	38.5	107.1	224.6	mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	559.26	1021.35	5886.37	16355.58	34303.86	(m3)

MAVEN ASSOCIATES	Job Number 215010	Sheet 3	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 2 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98		0.00
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74	3.2297	239.00
* from Appendix B		Totals =	3.2297	239.00

CN (weighted) = total product / total area = 239.00 / 3.230 = 74.0 23.7400

Ia (average) = 5 x pervious area / total area = 5 x 3.2297 / 3.230 5.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.5 km (along drainage path)

Catchment Slope Sc= 0.016 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.63 1.34 3.48 = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD
use
0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 4	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 2 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area A= 0.03230 km2(100ha =1km2)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction Ia= 5.0 mm (from worksheet 1)

Time of concentration tc= 0.17 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

	PWV	SMAF				
3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	86	170	298	(mm)
Percentage Increase			15.1	17.0	32.7	(%)
4. 24 hour rainfall depth, P24	25	33	98.986	198.9	395.446	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	0.33	0.51	0.68	
6. Specific peak flow rate q*	0.170	0.170	0.170	0.170	0.170	
7. Peak flow rate, q_p=q*A*P_{24}	**0.137**	**0.181**	**0.543**	**1.092**	**2.171**	m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	3.7	6.7	48.2	132.8	317.8	mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	118.26	215.97	1557.02	4288.56	10264.18	(m3)
10. Retention volume, imp*5mm	0	0				m^3

MAVEN ASSOCIATES	Job Number 215010	Sheet 5	Rev A
Job Title: Sunfeild FAA Calc Title: TP108 Calculation - Post Development Wetland 2 - Impervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98	12.0441	1180.32
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74		0.00
* from Appendix B		Totals =	12.0441	1180.32

CN (weighted) = total product = / total area = 1180.32 / 12.044 = 98.0   23.7400

Ia (average) = 5 x pervious area / total area = 5 x 0.0000 / 12.044 = 0.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.5 km (along drainage path)

Catchment Slope Sc= 0.016 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 98.0 / (200- 98.0) = 0.96

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.63 1.02 3.48 = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 6	Rev A
Job Title Sunfeild FAA **Calc Title** TP108 Calculation - Post Development Wetland 2 - Impervious	**Author** AO	**Date** 19/12/2024	**Checked** 0

1. Data

Catchment Area	A=	0.12044	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5.2 mm

	PWV - SMA	SMAF1				
3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	86	170	298	(mm)
Percentage Increase			15.1	17.0	32.7	(%)
4. 24 hour rainfall depth, P24	25	33	98.986	198.9	395.446	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.71	0.76	0.91	0.95	0.97	
6. Specific peak flow rate q*	0.170	0.170	0.170	0.170	0.170	
7. Peak flow rate, q_p=q*A*P_{24}	**0.512**	**0.676**	**2.027**	**4.072**	**8.097**	m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})$+S	20.7	28.5	94.1	193.8	390.3	mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	2493.92	3434.99	11328.73	23347.28	47011.73	(m3)
10 Retention volume, imp*5mm	602					m³
Combined v24	2612	3650.96	12885.75	27635.84	57275.91	
Post V24- Pre V24	**2053**	**2630**	**6999**	**11280**	**22972**	m³
Detention volume	1451					m³

			Design	checks	
50% PWV - Live storage provided	1026		1261	234.54	m³
Ponding Depth Coefficient	0.5				m
Minimum Wetland Area	2053		2778.55	725.63	m^2
Forebay volume	154		499.00	345.03	m^2
Live Storage Required		**2630**			m^2

Length	100	Ratio 1:	3.5714286
Width	**28.00**	Area	**2800.00**

Worksheet 2: Graphical Peak Flow Rate

Transverse Deep Pools	199.5		
	72	Outlet	271.5
Forebay Area	708		25% >10%
"wetland area""	2070.55		
Percentatge of transverse deep poc	13%		<20% excl forebay

MAVEN ASSOCIATES	Job Number 215010	Sheet 7	Rev A
Job Title / Calc Title: Sunfeild FAA Catchment Summary for Wetland 2 Design	Author AO	Date 19/12/2024	Checked 0

Total Area (ha)	Pervious (ha)	%	Impervious (ha)	%
Pre Developmnet	15.2738169	100%	0	0%
Post Development	3.229699707	21%	12.04411719	79%

	Runoff Volume V24 (m3)		Peak Flow Rate (m3/s)		Volume Required
	Pre	Post	Pre	Post	
90th %	559	2612	0.08	0.65	2052.9
95th %	1021	3651	0.14	0.18	2629.6
2yr	5886	12886	0.85	0.54	6999.4
10yr	16356	27636	2.34	1.09	11280.3
100yr	34304	57276	5.01	2.17	22972.0

HEC-HMS Calculation Results

2YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 2 Ex"

Project: FAB_Swale_Sizing   Simulation Run: 2yr_FAB v2
Subbasin: Subbasin-Outflow 2 Ex

Start of Run:	01Jan2000, 00:00	Basin Model:	2yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_2yr_86mm
Compute Time:	14Jan2025, 13:57:54	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Dischar...	0.82457 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:25
Precipitation Volu...	13.13564 (1000 M3)	Direct Runoff Volume:	5.88644 (1000 M3
Loss Volu...	7.24920 (1000 M3)	Baseflow Volume:	0.00000 (1000 M3
Excess Volu...	5.88644 (1000 M3)	Discharge Volume:	5.88644 (1000 M3

2YR POST-DEV WITH WETLAND 2 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_2"

Project: FAB_Swale_Sizing   Simulation Run: 2yr_FAB v2
Reservoir: Reservoir-SW_Pond_2

Start of Run:	01Jan2000, 00:00	Basin Model:	2yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_2yr_86mm
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	2.01036 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.05980 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 18:15
Inflow Volume:	11.01380 (1000 M3)	Peak Storage:	8.38783 (1000 M3)
Discharge Volume:	7.03886 (1000 M3)	Peak Elevation:	20.20325 (M)

10YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 2 Ex"

Project: FAB_Swale_Sizing   Simulation Run: 10yr_FAB v2
Subbasin: Subbasin-Outflow 2 Ex

Start of R...	01Jan2000, 00:00	Basin Model:	10yr_Pr v2
End of R...	03Jan2000, 00:00	Meteorologic Model:	TP108_10yr_170mm_CoPv4
Compute Ti...	14Jan2025, 14:00:31	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Disch...	2.34580 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:2
Precipitation Vol...	25.96580 (1000 M3)	Direct Runoff Volume:	16.35578 (1000
Loss Vol...	9.61002 (1000 M3)	Baseflow Volume:	0.00000 (1000 M
Excess Vol...	16.35578 (1000 M3)	Discharge Volume:	16.35578 (1000

10YR POST-DEV WITH WETLAND 2 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_2"

Project: FAB_Swale_Sizing   Simulation Run: 10yr_FAB v2
Reservoir: Reservoir-SW_Pond_2

Start of Run:	01Jan2000, 00:00	Basin Model:	10yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_10yr_170mm_CoPv4
Compute Time:	22Jan2025, 14:25:09	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	4.18201 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.63895 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 13:10
Inflow Volume:	23.3276 (1000 M3)	Peak Storage:	13.5827 (1000 M3)
Discharge Volume:	17.3799 (1000 M3)	Peak Elevation:	20.66176 (M)

M A V E N

100YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 2 Ex"

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2
Subbasin: Subbasin-Outflow 2 Ex

Start of Run:	01Jan2000, 00:00	Basin Model:	100yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_100yr_298mm
Compute Time:	14Jan2025, 14:01:39	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Disch...	4.17135 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:28
Precipitation Vol...	45.51652 (1000 M3)	Direct Runoff Volume:	34.30427 (1000 M
Loss Vol...	11.21225 (1000 M3)	Baseflow Volume:	0.00000 (1000 M
Excess Vol...	34.30427 (1000 M3)	Discharge Volume:	34.30427 (1000 M

100YR POST-DEV WITH WETLAND 2 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_2"

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2
Reservoir: Reservoir-SW_Pond_2

Start of Run:	01Jan2000, 00:00	Basin Model:	100yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_100yr_298mm
Compute Time:	22Jan2025, 14:36:45	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	7.27751 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:14
Peak Discharge:	4.14206 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:28
Inflow Volume:	42.5314 (1000 M3)	Peak Storage:	22.2910 (1000 M3)
Discharge Volume:	33.6255 (1000 M3)	Peak Elevation:	21.37843 (M)

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SMAF Detention Orifice Sizing Calculation

Maven Associates		Job Number 215010	Sheet 1	Rev A
Job Title Calc Title	Sunfield SW Pond 2 SMAF Orifice Size Calc	Author YW	Date 13/01/2025	Checked

Detention Volume

2628.80 m^3 *(See SMAF Summary)*

Flow Rate (Q_p) if released over 24 hours

0.03043 m^3/sec (Average Discharge Flow-Rate)

Tank Details

Tank Height 0.280 m
Orifice Height 0.000 m (Above tank base)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.03043	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	0.280	m (Height of water above Discharge Point)
$H_{2/3}$=	0.187	m (Average Head of Water in pond = Two-Thirds of H_T)
A=	0.025643	m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A= 0.025643 m^2 (Cross-Sectional of the Discharge Pipe)
D= 0.1806923 m (Diameter of Discharge Pipe)

Use 10mm Orifice (minimum size)

180.69231 (Diameter of Discharge Orifice in mm)

Qmax =	0.0609 m^3/sec
Qi (265mm)	0.0654 m^3/sec

MAVEN

Ref: 215010

7nd February 2025

Wetland 3 Design Memo for Proposed Sunfield FAA Application

- **Background**

Wetland design is required by Heathy Water to demonstrate the proposed wetland space is adequate to provide the required mitigation volumes. Wetland 3. This memo, as a supplement to the SMP, details the Wetland 3 design principles and sizing method.

- **Catchment and Storm Intensities**

As shown on civil drawing M-C480 Catchment Plan set, the total catchment for Wetland 3 is 27,555m^2. The pre-development and post-development catchment areas are summarised in Table 1 below.

Table 1 – Wetland 3 Catchment Summary

Total Catchment Area	27,555m2m^2		
Pre-Dev Pervious Area	27,555m2 (100%)	CN=74	ToC = 0.44hr
Post-Dev Pervious Area	21,285m^2 (23%)	CN=74	ToC = 0.167hr
Post-Dev Impervious Area	6,269m^2 (77%)	CN=98	ToC = 0.167hr

The following storm intensities have been applied based on TP108 and SWCoP Revision 4 requirements, see Tabel 2.

Table 2 – Storm Intensities

Design Storm	Rainfall Across 24hr (mm) – TP108	Climate allowance as per SWCoP Rev 4	Rainfall+CC (mm)
90th	25	-	-
95th	33	-	-
50%AEP	75	15.10%	86
10%AEP	145	17%	170
1%AEP	225	32.70%	298

- **Design Principles**

As stated in the SMP and flood report regarding flooding management of the Eastern Catchment Outflow 3, it is recommended to provide attenuation for 2-year, 10-year and 100-year storm event. In this case, Wetland 3 has been designed to provide treatment and live storage for SMAF 1, 2yr, 10yr and 100yr peak flow attenuation.

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- **Hydrologic Calculations**

TP108 and HEC-HMS has been utilized to conduct the hydrologic calculations. The results are summarized in Table 3 below.

Table 3 – Hydrologic Calculations Results

Item	Value
PWV -	363 m^3
Minimum Forebay Volume (15% of PWV)	54 m^3
Sediment Drying Area (10% of PWV)	36 m^2
Detention Volume for SMAF	465 m^3

- **Hydraulic Calculations and Wetland Design Summary**

Autodesk Civil 3D software has been used to build the Wetland 3 3D model and Elevation-Storage relationship (Table 4) has been extracted from the Wetland 3 3D model contours for HEC-HMS hydraulic calculation.

The final Wetland 3 design is summarised in Table 5 below.

Table 4 – Elevation-Storage Relationship

Water Level (m, RL)	Storage Volume (m^3)
25.4	0
26.0	630
27.0	2,010
27.7	3,250

Table 6: Wetland Design Summary

ITEM	COMMENTS
Permanent Water Level (PWL) Proposed	RL25.40m
PWV - (Table 3 above)	363 m^3
Minimum PWV Required When Stream Protection is provided As per GD01 C8.2.3.1	181m^3 (50% of Standard PWV)
PWV Provided	181m^3 (>50% of Standard PWV)
Wetland Length to Width Raito	Approximately 3:1
Forebay Volume Proposed	27m^3, 15% of PWV
Forebay Depth	1. 5m
Shallow Marsh Zone Depth	0.2m
Deep Marsh Zone Depth	0.5m
Deep Pool Depth	1.2m
Slope	Internal wetland banks below the PWL: 1V:4H Internal side slope above the PWL: 1V: 3H Forebay bund slope: 1V:3H External side slope: 1V:3H
Maintenance Access	Provided, 3.5m wide, maximum gradient 1 in 8.
Sediment Drying Area	Provided, 20m^2, >10% of PWV
Safety Bench	Provided, 3m wide, maximum water depth 300mm below PWL
Emergency Spillway	Provided
Overland Flow into Wetland	Yes
Flooding Risk	Wetland is designed for 100yr ARI storm event flood attenuation
Inlet and Outlet	Inlet is sized to convey pre-mitigation 10yr peak flow of 766l/s Outlet is sized to convey post-dev mitigated 2yr peak flow of 75l/s mitigated 10yr peak flow of487 l/s mitigated 100yr peak flow of 874l/s 0.7m manhole cutout at RL26.16 Orifice at outlet manhole: SMAF 1 release: 68mm diameter at RL25.40 (invert level) Reno Mattress or Rock Riprap has been proposed for erosion protection and velocity control

Please do not hesitate to contact me should you have any queries.

Kind regards,

Designed By:

Yotsak Wansong
Civil Engineer
Maven Associates Limited

Appendices:

- **Appendix 1**– Calculations

Appendix 1 – Calculation

TP108 Calculations

MAVEN ASSOCIATES	Job Number 215010	Sheet 1	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Pre-Development Wetland 4	Author AO	Date 19/12/2024	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Residential lots	89.6		0.00
C	Road pavement	98		0.00
C	Carpark	98		0.00
C	Open space (Pervious)	74	53.5004	3959.03
* from Appendix B		Totals =	53.5004	3959.03

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{3959.03}{53.500}$ = 74.0

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 53.5004}{53.500}$ 5.0 mm

2. Time of Concentration

Contours level in meters High Level Lower level

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.1 km (along drainage path)

Catchment Slope Sc= 0.016 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{74.0}{200- 74.0}$ = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.22 1.34 3.48 = 0.17 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 2	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Pre-Development Wetland 4	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.53500	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	80	140	228	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	0.28	0.42	0.55	
6. Specific peak flow rate q*	0.020	0.028	0.065	0.090	0.110	
7. Peak flow rate, $q_p=q^*A^*P_{24}$	**0.268**	**0.494**	**2.782**	**6.741**	**13.418**	m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	3.7	6.7	34.2	81.3	159.3	mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1958.94	3577.54	18322.79	43481.53	85206.62	(m3)

MAVEN ASSOCIATES	Job Number 215010	Sheet 3	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Post Development Wetland 4 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98		0.00
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74	7.7132	570.78
* from Appendix B		Totals =	7.7132	570.78

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{570.78}{7.713} = 74.0$ 23.7400

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 7.7132}{7.713}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.5 km (along drainage path)

Catchment Slope Sc= 0.016 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200- 74.0} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.63 1.34 3.48 = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 4	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Post Development Wetland 4 - Pervious	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.07713	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

	PWV	SMAF				
3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	80	140	228	(mm)
Percentage Increase			15.1	17.0	32.7	(%)
4. 24 hour rainfall depth, P24	25	33	92.08	163.8	302.556	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.08	0.11	0.32	0.46	0.62	
6. Specific peak flow rate q*	0.170	0.170	0.170	0.170	0.170	
7. Peak flow rate, q_p=q*A*P_{24}	0.328	0.433	1.207	2.148	3.967	m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	3.7	6.7	43.0	101.7	228.9	mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	282.42	515.78	3317.14	7841.69	17655.81	(m3)
10. Retention volume, imp*5mm	0	0				m^3

MAVEN ASSOCIATES	Job Number 215010	Sheet 5	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Post Development Wetland 4 - Impervious	Author AO	Date 19/12/2024	Checked 0

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1 ha	Product of CN x area
C	Urban-commercial and bussiness	98		0.00
C	Road pavement	98	45.7901	4487.43
C	Berms + Footpath	85		0.00
C	Open space (Pervious)	74		0.00
* from Appendix B		Totals =	45.7901	4487.43

CN (weighted) = total product / total area = 4487.43 / 45.790 = 98.0   23.7400

Ia (average) = 5 x pervious area / total area = 5 x 0.0000 / 45.790 = 0.0 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.5 km (along drainage path)

Catchment Slope Sc= 0.016 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 98.0 / (200- 98.0) = 0.96

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   0.6   0.63   1.02   3.48 = 0.17 hrs

10.0

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.11 hrs

6.71 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 215010	Sheet 6	Rev A
Job Title: Sunfield FAA Calc Title: TP108 Calculation - Post Development Wetland 4 - Impervious	Author AO	Date 19/12/2024	Checked 0

1. Data

Catchment Area	A=	0.45790	km2(100ha =1km2)
Runoff curve number	CN=	98.0	(from worksheet 1)
Initial abstraction	Ia=	0.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 5.2 mm

	PWV - SMA	Live - SMAF1				
3. Average recurrence interval, ARI	90th %	95th %	2	10	100	(yr)
4. 24 hour rainfall depth	25	33	80	140	228	(mm)
Percentage Increase			15.1	17.0	32.7	(%)
4. 24 hour rainfall depth, P24	25	33	92.08	163.8	302.556	(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.71	0.76	0.90	0.94	0.97	
6. Specific peak flow rate q*	0.170	0.170	0.170	0.170	0.170	
7. Peak flow rate, q_p=q*A*P_{24}	**1.946**	**2.569**	**7.168**	**12.751**	**23.552**	m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	20.7	28.5	87.2	158.8	297.5	mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	9481.56	13059.36	39916.44	72703.43	136207.16	(m3)
10 Retention volume, imp*5mm	2290					m³
Combined v24	9764	13575.14	43233.58	80545.12	153862.97	
Post V24- Pre V24	**7805**	**9998**	**24911**	**37064**	**68656**	m³
Recharge pit		6868.52				
Detention volume	5516	3129				m³
				checks		
50% PWV - Live storage provided	3903		4968.48	1,065.96		m³
Ponding Depth Coefficient	0.5					m
Minimum Wetland Area	7805		10310	2,504.96		m^2
Forebay volume	585		1,311.00	725.62		m^2
Live Storage Required		**3129**				m^2

Length	230	Ratio 1:	5
Width	**46.00**	Area	**10580.00**

Worksheet 2: Graphical Peak Flow Rate

MAVEN ASSOCIATES	Job Number 215010	Sheet 7	Rev A
Job Title / Calc Title: Sunfield Stage 2 / Catchment Summary for Wetland Design 4	Author AO	Date 19/12/2024	Checked 0

Total Area (ha)	Pervious (ha)	%	Impervious (ha)	%
Pre Developmnet	53.5004	100%	0	0%
Post Development	7.7132	14%	45.7901	86%

	Runoff Volume V24 (m3)		Peak Flow Rate (m3/s)		Volume Required
	Pre	Post	Pre	Post	
90th %	1959	9764	0.27	2.27	7805.0
95th %	3578	13575	0.49	0.43	9997.6
2yr	18323	43234	2.78	1.21	24910.8
10yr	43482	80545	6.74	2.15	37063.6
100yr	85207	153863	13.42	3.97	68656.4

HEC-HMS Calculation Results

2YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 3 Ex"

Project: FAB_Swale_Sizing   Simulation Run: 2yr_FAB v2
Subbasin: Subbasin-Outflow 3 Ex

Start of Run:	01Jan2000, 00:00	Basin Model:	2yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_2yr_86mm
Compute Time:	14Jan2025, 15:24:24	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.17724 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:18
Precipitation Volume:	2.36971 (1000 M3)	Direct Runoff Volume:	1.06193 (1000 M3
Loss Volume:	1.30778 (1000 M3)	Baseflow Volume:	0.00000 (1000 M3
Excess Volume:	1.06193 (1000 M3)	Discharge Volume:	1.06193 (1000 M3

2YR POST-DEV WITH WETLAND 3 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_3"

Project: FAB_Swale_Sizing   Simulation Run: 2yr_FAB v2
Reservoir: Reservoir-SW_Pond_3

Start of Run:	01Jan2000, 00:00	Basin Model:	2yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_2yr_86mm
Compute Time:	14Jan2025, 15:24:24	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	0.36600 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.07489 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 13:03
Inflow Volume:	1.96810 (1000 M3)	Peak Storage:	1.02456 (1000 M3)
Discharge Volume:	1.68934 (1000 M3)	Peak Elevation:	26.28592 (M)

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10YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 3 Ex"

Project: FAB_Swale_Sizing   Simulation Run: 10yr_FAB v2
Subbasin: Subbasin-Outflow 3 Ex

Start of Run:	01Jan2000, 00:00	Basin Model:	10yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_10yr_170mm_CoPv4
Compute Time:	14Jan2025, 15:23:16	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.50244 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:18
Precipitation Volume:	4.68432 (1000 M3)	Direct Runoff Volume:	2.95064 (1000 M3)
Loss Volume:	1.73368 (1000 M3)	Baseflow Volume:	0.00000 (1000 M3)
Excess Volume:	2.95064 (1000 M3)	Discharge Volume:	2.95064 (1000 M3)

10YR POST-DEV WITH WETLAND 3 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_3"

Project: FAB_Swale_Sizing   Simulation Run: 10yr_FAB v2
Reservoir: Reservoir-SW_Pond_3

Start of Run:	01Jan2000, 00:00	Basin Model:	10yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_10yr_170mm_CoPv4
Compute Time:	14Jan2025, 15:23:16	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	0.76620 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.48687 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:21
Inflow Volume:	4.18280 (1000 M3)	Peak Storage:	1.50543 (1000 M3)
Discharge Volume:	3.79048 (1000 M3)	Peak Elevation:	26.63437 (M)

100YR PRE-DEV –Calculation Results

Summary Results for Subbasin "Subbasin-Outflow 3 Ex"

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2
Subbasin: Subbasin-Outflow 3 Ex

Start of Run:	01Jan2000, 00:00	Basin Model:	100yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_100yr_298mm
Compute Time:	14Jan2025, 15:23:46	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Discharge:	0.90075 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:20
Precipitation Volume:	8.21133 (1000 M3)	Direct Runoff Volume:	6.18861 (1000 M3)
Loss Volume:	2.02273 (1000 M3)	Baseflow Volume:	0.00000 (1000 M3)
Excess Volume:	6.18861 (1000 M3)	Discharge Volume:	6.18861 (1000 M3)

100YR POST-DEV WITH WETLAND 3 –Calculation Results

Summary Results for Reservoir "Reservoir-SW_Pond_3"

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2
Reservoir: Reservoir-SW_Pond_3

Start of Run:	01Jan2000, 00:00	Basin Model:	100yr_Pr v2
End of Run:	03Jan2000, 00:00	Meteorologic Model:	TP108_100yr_298mm
Compute Time:	14Jan2025, 15:23:46	Control Specifications:	48hr

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	1.19668 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:15
Peak Discharge:	0.87376 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:23
Inflow Volume:	7.64268 (1000 M3)	Peak Storage:	1.82041 (1000 M3)
Discharge Volume:	7.26074 (1000 M3)	Peak Elevation:	26.86261 (M)

SMAF Detention Orifice Sizing Calculation

Maven Associates	Job Number 215010	Sheet 1	Rev A
Job Title: Sunfield Calc Title: SW Pond 3 SMAF Orifice Size Calc	Author YW	Date 13/01/2025	Checked

Detention Volume

465.00 m^3 *(See SMAF Summary)*

Flow Rate (Q_p) if released over 24 hours

0.00538 m^3/sec (Average Discharge Flow-Rate)

Tank Details

Tank Height 0.460 m
Orifice Height 0.000 m (Above tank base)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.00538	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	0.460	m (Height of water above Discharge Point)
$H_{2/3}$=	0.307	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.0035389 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A= 0.0035389 m^2 (Cross-Sectional of the Discharge Pipe)
D= 0.0671255 m (Diameter of Discharge Pipe)

Use 10mm Orifice (minimum size)

67.125483 (Diameter of Discharge Orifice in mm)

Qmax =	0.0108	m^3/sec
Qi (265mm)	0.0839	m^3/sec

MAVEN

Ref: 215010

7nd February 2025

Heathy Water Department
Auckland Council

To whom it may concern,

Re: Wetland 4 Design Memo for Proposed Sunfield FAA Application

- **Background**

Wetland design is required by Heathy Water to demonstrate the proposed wetland space is adequate to provide the required mitigation volumes. Wetland 4. This memo, as a supplement to the SMP, details the Wetland 4 design principles and sizing method.

- **Catchment and Storm Intensities**

As shown on civil drawing M-C480 Catchment Plan set, the total catchment for Wetland 4 is 535,004m^2. The pre-development and post-development catchment areas are summarised in Table 1 below.

Table 1 – Wetland 4 Catchment Summary

Total Catchment Area	535,004m^2		
Pre-Dev Pervious Area	535,004m^2 (100%)	CN=74	ToC = 0.44hr
Post-Dev Pervious Area	77,132m^2 (14%)	CN=74	ToC = 0.167hr
Post-Dev Impervious Area	457,901m^2 (86%)	CN=98	ToC = 0.167hr

The following storm intensities have been applied based on TP108 and SWCoP Revision 4 requirements, see Tabel 2.

Table 2 – Storm Intensities

Design Storm	Rainfall Across 24hr (mm) – TP108	Climate allowance as per SWCoP Rev 4	Rainfall+CC (mm)
90th	25	-	-
95th	33	-	-
50%AEP	70	15.10%	76
10%AEP	140	17%	164
1%AEP	220	32.70%	292

- **Design Principles**

As stated in the SMP and flood report regarding flooding management of the Western Catchment, it is recommended to provide attenuation for 2-year, 10-year and 100-year storm event. In this case, Wetland 4

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has been designed to provide treatment and live storage for SMAF 1, 2yr, 10yr and 100yr peak flow attenuation. All live storage has been modelled in the flood modelling report. Only treatment calculations are provided in this report.

- **Hydrologic Calculations**

TP108 has been utilized to conduct the hydrologic calculations. The results are summarized in Table 3 below. Hydraulic modelling was undertaken in HEC RAS and results may be found in Stormwater Modelling Report.

Table 3 – Hydrologic Calculations Results

Item	Value
PWV -	7,805 m^3
Minimum Forebay Volume (15% of PWV)	1,170 m^3
Sediment Drying Area (10% of PWV)	781 m^2
Detention Volume for SMAF	3,129 m^3

Table 4 – Elevation-Storage Relationship

Water Level (m, RL)	Storage Volume (m^3)
27.72	0
24.0	7,920
24.5	33,650
25.0	63,840
25.5	96,550
26.0	131,840

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Table 6: Wetland Design Summary

ITEM	COMMENTS
Permanent Water Level (PWL) Proposed	RL23.72m
Standard PWV Required (Table 3 above)	7,805 m^3
Minimum PWV Required When Stream Protection is provided As per GD01 C8.2.3.1	3,903m^3 (50% of Standard PWV)
PWV Provided	4,968m^3 (>50% of Standard PWV)
Wetland Length to Width Raito	Approximately 5:1
Forebay Volume Proposed	1311m^3, 26% of PWV
Forebay Depth	1.5m
Shallow Marsh Zone Depth	0.2m
Deep Marsh Zone Depth	0.5m
Deep Pool Depth	2.0m
Slope	Internal wetland banks below the PWL: 1V:4H Internal side slope above the PWL: 1V: 3H Forebay bund slope: 1V:3H External side slope: 1V:3H
Maintenance Access	Provided, 3.5m wide, maximum gradient 1 in 8.
Sediment Drying Area	Provided, 500m^2, >10% of PWV
Safety Bench	Provided, 3m wide, maximum water depth 300mm below PWL
Emergency Spillway	Provided
Overland Flow into Wetland	Yes, for peak flow diversion of Swale
Flooding Risk	Wetland is designed for 100yr ARI storm event flood storage.
Inlet and Outlet	Inlet is Swale network conveying all storm events Outlet is a 1m x 1m box culvert (per flood modelling report) at RL23.80 Reno Mattress or Rock Riprap has been proposed for erosion protection and velocity control

Please do not hesitate to contact me should you have any queries.

Kind regards,

Designed By:

Yotsak Wansong
Civil Engineer
Maven Associates Limited

Appendices:

- **Appendix 1** – Calculations