DELMORE

FLOOD ASSESSMENT REPORT

Vineway Ltd

MCKENZIE & CO.

DOCUMENT CONTROL RECORD

PROJECT: Delmore

CLIENT: Vineway Ltd

PROJECT LOCATION: 53A, 53B & 55 Russell Road and 88, 130 & 132 Upper Ōrewa Road

Revision	Date	Originator	Checker	Approver	Description
A	29/01/25	HS			DRAFT
B	11/02/2025	HS	JK	JK	Resource consent
C	21/07/2025	HS	JK	JK	Modelling Update

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1. INTRODUCTION

McKenzie & Co. Consultants have been engaged by Vineway Ltd to provide a Flood Assessment Report in support of the proposed 109Ha development located at 53A, 53B & 55 Russell Road and 88, 130 & 132 Upper Ōrewa Road, Ōrewa. The development is a residential development for approximately 1250 residential lots.

This report is prepared in support of Vineway Ltd's application for approvals under the Fast-track Approvals Act 2024 by addressing the key flooding matters that relate to this proposal. It is important to note that this report only covers flood hazards, while other infrastructure matters, including earthworks, sediment and erosion control, roading and access, stormwater, wastewater, water supply and utility works, are addressed in separate infrastructure reports.

The primary objective of this flood hazard assessment report is to demonstrate how the proposed system is designed to manage stormwater runoff to minimise flood damage and adverse effects on both the built and natural environments. This report will evaluate the minimum floor levels required for the proposed development, ensuring compliance with the Auckland Unitary Plan (AUP). Additionally, it will assess potential impacts on flood behaviour, specifically examining any effects on water levels and flow velocities both upstream and downstream due to the proposed development activities. The flood assessment report is a critical component of the Stormwater Management Plan for the Delmore development. It will support planning and decision-making by identifying necessary flood mitigation measures and establishing safe floor levels to protect infrastructure and surrounding properties.

To fully comprehend this report, it should be read together with the application, plan drawings, and other supporting documents referred to in this report.

2. STANDARDS

Auckland Council Stormwater Code of Practice Version 4,

Auckland Council Modelling Guideline,

Auckland Technical Publication TP108.

3. SITE DESCRIPTION

The proposed development site is legally described as Lot 1 DP 336616, Lot 1 DP 497022 & Lot 2 DP 497022, Lot 2 DP 418770, Lot 1 DP 153477 & Lot 2 DP 153477, as illustrated in Figure 1 below. The site is zoned Future Urban Zone (FUZ).

The development is accessed from Grand Drive in the northeast, and Russell Road and Upper Ōrewa Road from the south.

Currently, the site is used for agricultural purposes with livestock roaming across a significant portion of the site. Some bush areas subject to consent notices, and a pine tree stand in the North Eastern portion of the site.

All properties are contained within a single stormwater catchment, which discharges out a single point under the Northern Motorway.

The location of the development is shown below in Figure 1.

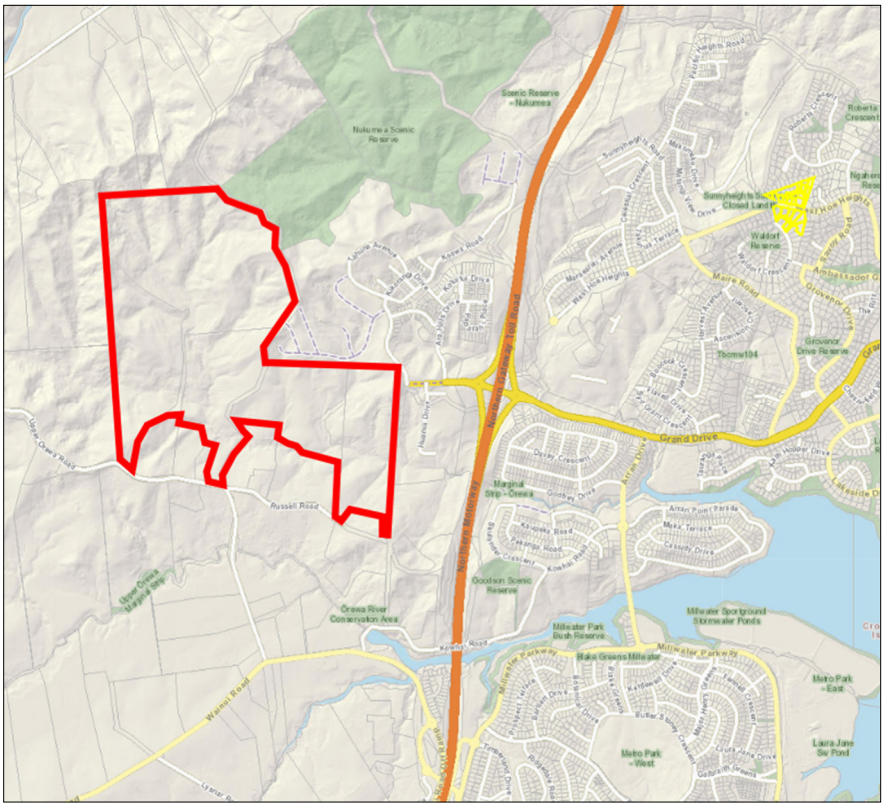


Figure 1 - Site Location – Extent of affected properties

AC Geomaps shows extensive flow paths and flood plains on the site and across the contributing catchment. These are shown in Figure 2 below.

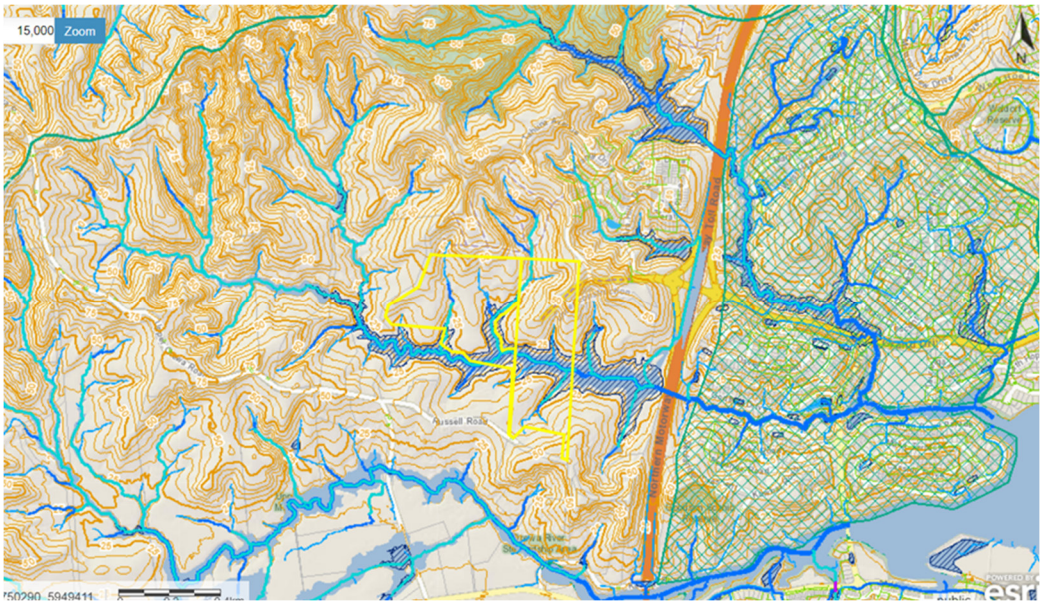


Figure 2 - Site Location with AC Geomaps flow paths and flood plains

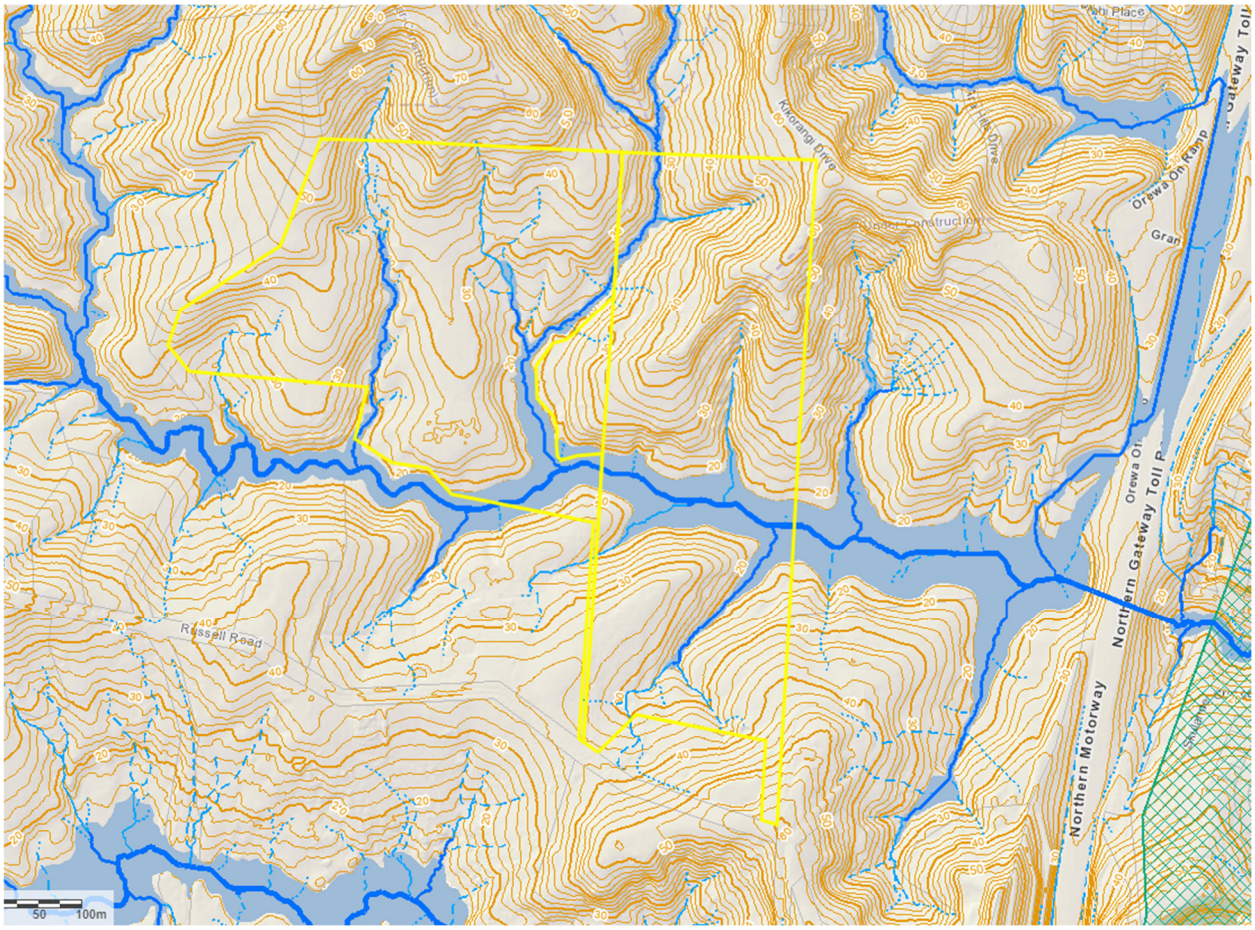


Figure 3 - Development Site with topography, flow paths and flooding (AC Geomaps)

The outlet of the catchment is to the east where flows exit via a 2100mm diameter culvert under the northern motorway SH1. The culvert discharges into the Southern Stream [1] (refer Ōrewa West ICMP). A catchment plan showing the sub-catchments is appended.

4. CATCHMENT DESCRIPTION

The catchment is part of the Ōrewa West Catchment per the 'Auckland Council – Catchment Management Plan Update, Ōrewa West Catchment – January 2014'. The Delmore site is within the Southern Tributary of the Ōrewa West Catchment. The southern tributary discharges via an existing motorway culvert and continues downstream until it reaches the confluence with the Grand Drive catchment before discharging into the coast.

[1] Ōrewa West ICMP 2011

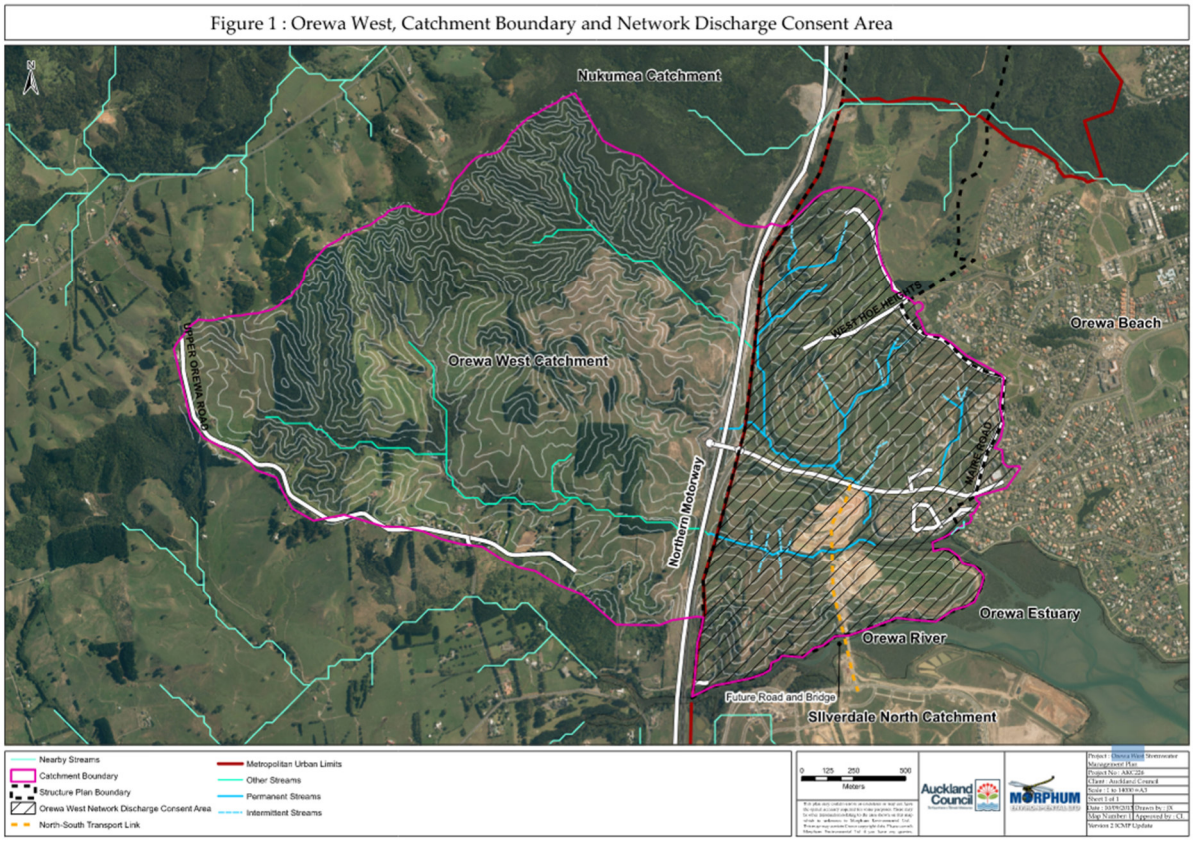


Figure 4 - Ōrewa West Catchment

4.1. Land Use

This property and upstream catchments are within the FUZ and Rural Production Zone defined by AUP. The Maximum Probable Development (MPD) for impervious surfaces in the FUZ has been taken as 60% based on the average lot typology proposed in the Masterplan.

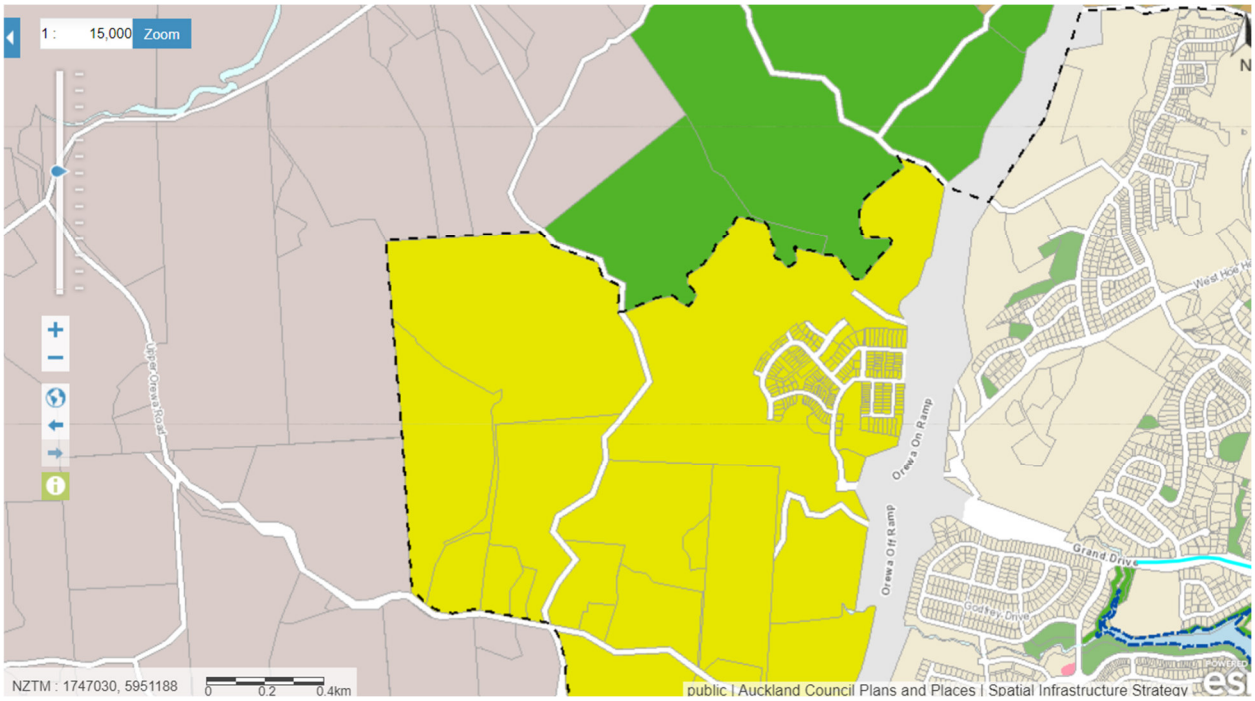


Figure 5 - Land Use

5. SITE SURVEY

5.1. Culvert and Bridges Structure

A topographical survey has been conducted to determine any hydraulic structures within the ICMP catchment areas.

A visual survey was conducted to assess the condition of the existing motorway culvert. During the survey, no obstructions were observed at the culvert's inlet or outlet. A minor baseflow was noted just above the culvert inlet, and shrubs around the outlet wing wall were present. The culvert is measured at approximately 133m with and inlet invert level of 6.84mRL and outlet invert level of 6.29mRL, which equates to a gradient of approximately 0.4%.

Figure 6 - Photo of culvert under State Highway 1

Figure 7 - Inlet of Culvert under State Highway 1

Further downstream of the motorway culvert, there are 2 bridges that are within the main flow path of the Delmore contributing catchment. The 2 bridges are the Tauhere Road footbridge and the Arran Drive bridge. The bridges have been included in the model.

Figure 8 - Downstream bridge piles

Figure 9 - Downstream bridge piles

For the purpose of modelling, all existing culverts have been modelled with zero percent blockage, in line with the condition observed on-site. A 50% and 100% blocked scenario (Scenario 1 and 2) has also been prepared to determine whether there is still sufficient headwater clearance from the motorway due to the increase in impervious areas from the FUZ.

6. HYDROLOGICAL MODEL

6.1. Method Used

The hydrological model was developed using the TP108 SCS methodology. Sub-catchments were delineated based on the current and proposed topography, and the surface type was based on the current land use for the pre-development model and the proposed land use for the proposed development model.

6.2. Hydrological Model Extent

Catchment Delineation is based on the terrain from a combination of Topographical, Drone, Design Surfaces, and Auckland Council DEM 2016 data. The catchment extent is on Drawing 4500, shown below in Figure 10.

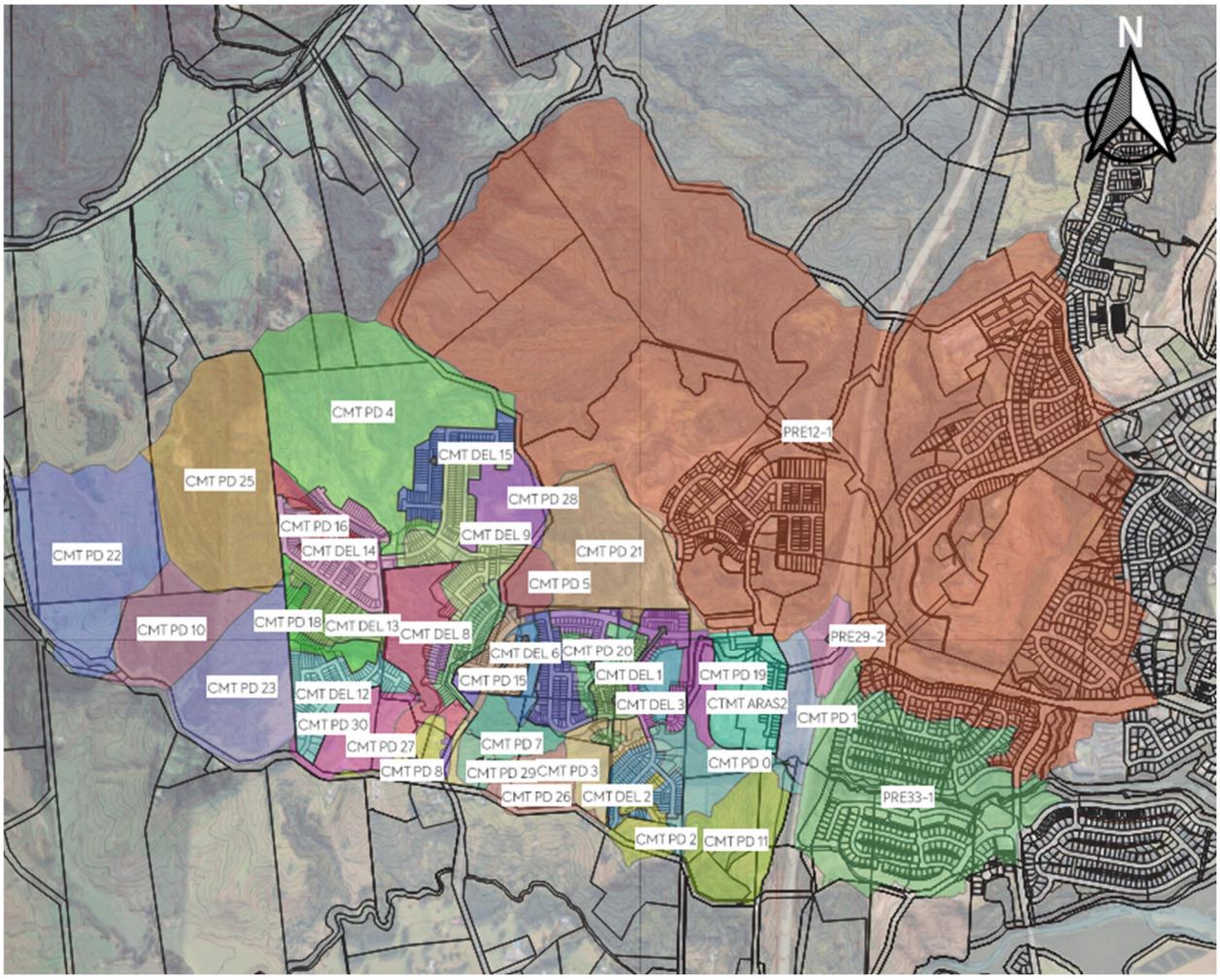


Figure 10 - Catchment extents

6.3. Model Set-up

A total of 16 scenarios of the hydrologic model have been developed. The existing scenarios aim to establish a baseline for the flood model with and without climate change. The MPD within the

development extent will assess the impact of flooding due to the development. The MPD within the wider FUZ boundaries will determine that there is capacity in the proposed culverts taking into consideration future upstream development outside of the Delmore Masterplan.

Table 1 - Scenarios

Scenario Number	SCENARIO_ID	ARI (Year)	CLIMATE CHANGE	LAND USE (Development Extent)
1	EXDHCLM050AEP	2	EXISTING	EXISTING DEVELOPMENT
2	EXDHCLM020AEP	5	EXISTING	EXISTING DEVELOPMENT
3	EXDHCLM010AEP	10	EXISTING	EXISTING DEVELOPMENT
4	EXDHCLM001AEP	100	EXISTING	EXISTING DEVELOPMENT
5	EXD21CC050AEP	2	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT
6	EXD21CC020AEP	5	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT
7	EXD21CC010AEP	10	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT
8	EXD38CC001AEP	100	3.8DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT
9	MPD21CC050AEP	2	2.1DC INCREASE IN TEMPERATURE	MAXIMUM PROBABLE DEVELOPMENT
10	MPD21CC020AEP	5	2.1DC INCREASE IN TEMPERATURE	MAXIMUM PROBABLE DEVELOPMENT
11	MPD21CC010AEP	10	2.1DC INCREASE IN TEMPERATURE	MAXIMUM PROBABLE DEVELOPMENT
12	MPD38CC001AEP	100	3.8DC INCREASE IN TEMPERATURE	MAXIMUM PROBABLE DEVELOPMENT
13	D_MPD21CC050AEP	2	2.1DC INCREASE IN TEMPERATURE	DELMORE MPD
14	D_MPD21CC020AEP	5	2.1DC INCREASE IN TEMPERATURE	DELMORE MPD
15	D_MPD21CC010AEP	10	2.1DC INCREASE IN TEMPERATURE	DELMORE MPD
16	D_MPD38CC001AEP	100	3.8DC INCREASE IN TEMPERATURE	DELMORE MPD

7. HYDROLOGICAL PARAMETERS

The 24-hour rainfall depth has been obtained from the TP108 rainfall maps. A climate change uplift has been adopted from the Auckland Council Stormwater Code of Practice Version 4.

Table 2 - Hydrological parameters

ARI (Years)	Percent Increase 2.1 Climate Change	Percent Increase 3.8 Climate Change	Historical Rainfall Depth (mm)	Rainfall Depth with 2.1 Climate Change (mm)	Rainfall Depth with 3.8 Climate Change (mm)
2	15.1%	27.4%	91	104.7	115.9
5	16.4%	29.6%	127	147.8	164.6
10	17.0%	30.8%	155	181.4	202.7
20	17.2%	31.2%	180	211.0	236.2
50	17.6%	31.9%	210	247.0	277.0
100	18.1%	32.7%	233	275.2	309.2

Based on the Geotechnical Report conducted by Riley Consultants, the underlying soil is predominantly clay. Hydrological Soil Type C has been adopted for the analysis, and a Curve Number (CN) of 74 has been adopted. For impervious surfaces, a curve number of 98 is adopted, which is in accordance with the TP108 guidelines. The table below outlines the hydrological parameters adopted.

Table 3 - Curve Numbers

Parameters	Pervious Soil (Type C Assumed)	Impervious Surface
Curve Number (CN)	74	98
Initial Abstraction (Ia)	5	0
Channelisation Factors (Primarily Grass Channels)	0.8	0.8
Time of Concentration (Mins)	Varies depending on catchment length and slope. Minimum of 10	Varies depending on catchment length and slope. Minimum of 10

	minutes	minutes

Inflow nodes have been applied at the top of sub-catchment boundaries, and a time of concentration of 10 minutes has been adopted except for sub-catchments 'PRE12-1', 'PRE29-1', and 'PRE33-1', for which the node has been applied as a lumped inflow at the bottom of catchments. This is to ensure consistency in the model and the lag time of flow can be determined by the model.

The hydrological data has been calculated using HEC-HMS and is included in the Appendix.

8. HYDRAULIC MODEL

8.1. Method Used

The hydraulic model will be run in HEC-RAS. It is a 2D model, with minor hydraulic structures represented as 1D nodes. A full 2D model is considered appropriate due to the limited pipe networks in the area, and stormwater is primarily conveyed through a very well-defined overland flow path (OLFP).

The flow run-off calculated in the hydrologic model is applied as a lumped inflow boundary condition in its sub-catchments.

For the hydraulic modelling, 18 scenarios will be prepared for the flood assessment. The standard cell size adopted is a 4x4m grid, with a refinement of 2x2m cells applied in OFLPs and watercourses. This corresponds to cell areas of 16m^2 and 4m^2, respectively, aligning with the Auckland Modelling Guidelines' Table 3-2, which recommends cell areas of 20m^2 for general areas and 4m^2 for watercourses and OFLPs. The total modelling area is 386.3 ha with 204544 generated cells with an average cell area 9.0m2. The model is 2D, with culverts modelled in 1D.

Each sub-catchments peak and temporal flows are calculated by the HEC-HMS SCS method using the normalised hydrograph Auckland Council TP108 over a 24-hour storm duration and applied as an inflow node in RAS. The temporal pattern has been adopted from the Auckland Council Code of Practice Version 4.

The coordinate system for the surface model will be under NZGD2000 – Mount Eden 2000 (EPSG2105) and the Vertical Datum will be on New Zealand Vertical Datum 2016 (NZVD2000)

8.2. 1D-2D Linkage

All hydraulic structures identified on the survey have been applied as a 1D element. The meshes are then adjusted to account for any barriers and openings of the structure. The table below outlines the proposed structure in the hydraulic model.

Table 4 - Structures

Location	Structure Type	Size / Diameter	Model ID	Northing (mN)	Easting (mE)

Northern Gateway Toll Road	Culvert	2100mm	Motorway_Culv	832004.0131	390984.8906
Tauhere Road	Footbridge	-	TauhereRd_FtBr	831911.839	391318.647
Arran Drive	Bridge	-	ArranDr_Bridge	831932.0558	391652.6631

For the proposed scenarios, there will be an additional 9 box culverts and four circular culverts. The dimensions and embedment depth of the culverts are summarised below.

Table 5 - Culverts

Proposed Culvert	Culvert Parameters		
	Span (mm)	Rise (mm)	Embedment (mm)
Culvert 1	4000	2000	500
Culvert 2	2000	1500	400
Culvert 3	4000	5000	350
Culvert 4	4000	5000	350
Culvert 5	4000	1000	350
Culvert 6	4000	3000	350
Culvert 7	6000	2000	350
Culvert 8	2000	1000	600
Culvert 9 (circular)	900	900	150
Culvert 10 (circular)	1900	1900	735
Culvert 11	4000	1700	350
Culvert 12 (circular)	900	900	225
Culvert 13 (circular)	1500	1500	400

8.3. Model Extent

Figure 11 illustrates the extent of the hydraulic model, shown on Drawing 4501. The extent captures the upstream contributing catchment to the Delmore development and the downstream area up to 50m downstream of the Arran Drive bridge. This extent has been adopted as it allows for assessing any upstream and downstream effects from the development.

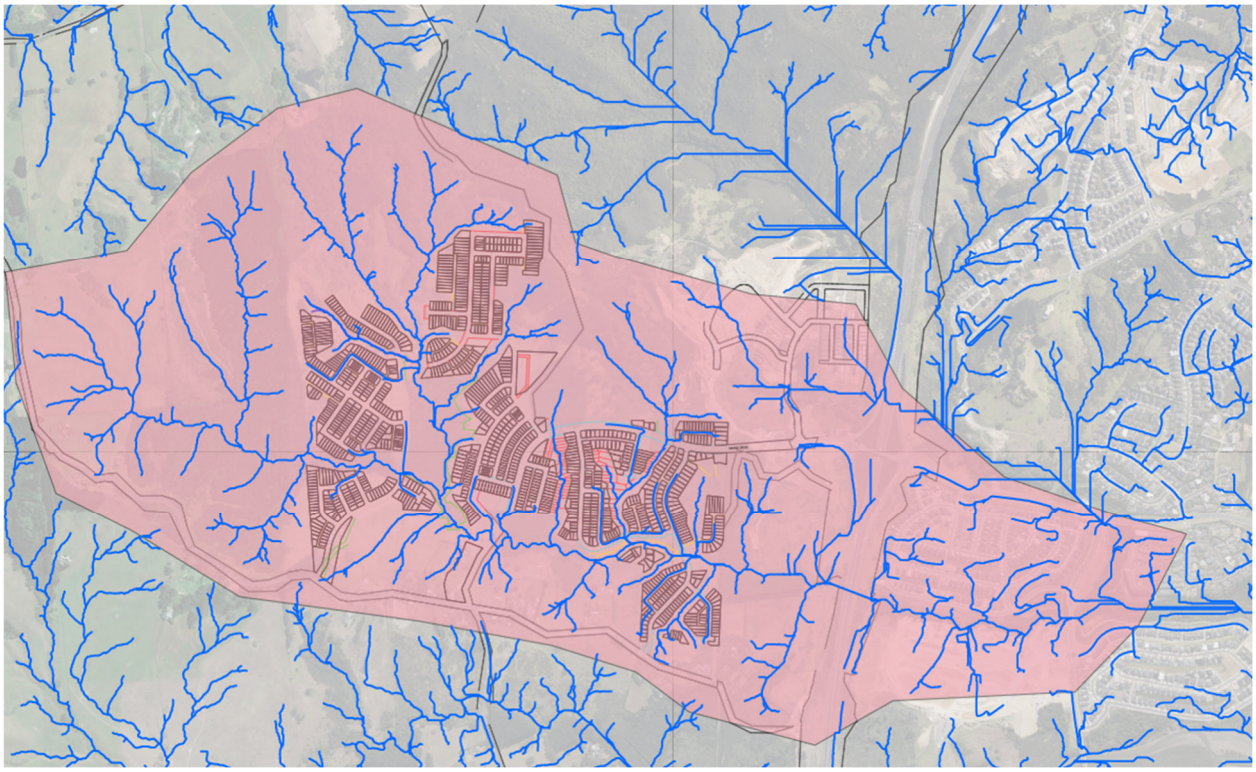


Figure 11 - Extent of the hydraulic model

8.4. Tidal Boundary Conditions

A review of the 'Development of an Updated Coastal Marine Area Boundary for the Auckland Region – Prepared for Auckland Council – July 2012' shows in Table A-2 a Mean High-Water Springs-10 (MHWS10) of 1.42mRL based on the Auckland Vertical Datum of 1946. Adjusting this to the New Zealand Vertical Datum 2016 with an offset value of 302mm yields an MHWS of 1.12mRL.

The Auckland Council 'Regionwide Rural Rapid Flood Model Build Report – May 2023' indicates that the MHWS10 for the Ōrewa region (Model Unit I) ranges from 1.42 to 2.30mRL, with an NZVD adjustment of 1.12mRL to 2.00mRL.

A MHWS10 of 2.10mRL (NZVD2016) has been adopted. In the climate change scenario, an uplift of 1m, equivalent to 3.10mRL, has been added to the MHWS.

The MHWS will be applied as a downstream boundary condition approximately 50m downstream of the Arran Drive bridge.

8.5. Losses

Manning's roughness coefficient will be applied to the model surface as per the following table. The manning's value will be applied as a land cover polygon in HEC-RAS.

Table 6 - Mannings Values

2D Surfaces	Adopted Mannings Value, n
Building Footprints	0.5

Delmore Development	0.1
Roads	0.02
Other Impervious	0.035
External Development	0.1
Internal Streams	0.06
External Undeveloped	0.1
Downstream Comp	0.1
Grand Drive	0.1

For hydraulic structures, the following losses has been assumed:

Table 7 - Mannings Numbers

Structure Type	Adopted Mannings Value, n
Culvert (1D)	0.02
Culvert - Embedded (1D)	0.06

Refer to Drawings 4515 & 4516 for the land cover plan.

9. MODEL SCENARIOS

For the hydraulic models, 18 scenarios have been undertaken. The table below summarises the total number of scenarios that will be prepared along with the scenario identifier.

Table 8 - Scenarios

Number	SCENARIO_ID	ARI (Year)	CLIMATE CHANGE	LAND USE (Development Extent)	Tailwater Condition	Network
1	EXDHCLM001AEPTWBBASE_EXT	100	EXISTING	EXISTING DEVELOPMENT	MHWS10	Base
2	EXDHCLM050AEPTWABASE_EXT	2	EXISTING	EXISTING DEVELOPMENT	MHWS10	Base
3	EXDHCLM020AEPTWABASE_EXT	5	EXISTING	EXISTING DEVELOPMENT	MHWS10	Base
4	EXDHCLM010AEPTWABASE_EXT	10	EXISTING	EXISTING DEVELOPMENT	MHWS10	Base
5	MPD38CC001AEPTWBBASE_PDT	100	3.8DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base
6	MPD38CC001AEPTWBBL01_PDT	100	3.8DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base
7	MPD38CC001AEPTWBBBL050_PDT	100	3.8DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base

8	EXD38CC001AEPTWBBASE_EXT	100	3.8DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT	MHWS10 + 1m	Base
9	D_MPD38CC001AEPTWBBASE_PDT	100	3.8DC INCREASE IN TEMPERATURE	Delmore Post Development	MHWS10 + 1m	Base
10	MPD21CC050AEPTWABASE_PDT	2	2.1DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base
11	MPD21CC010AEPTWABASE_PDT	10	2.1DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base
12	MPD21CC020AEPTWABASE_PDT	5	2.1DC INCREASE IN TEMPERATURE	Delmore + External FUZ	MHWS10 + 1m	Base
13	EXD21CC050AEPTWABASE_EXT	2	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT	MHWS10 + 1m	Base
14	EXD21CC010AEPTWABASE_EXT	10	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT	MHWS10 + 1m	Base
15	EXD21CC020AEPTWABASE_EXT	5	2.1DC INCREASE IN TEMPERATURE	EXISTING DEVELOPMENT	MHWS10 + 1m	Base
16	D_MPD21CC050AEPTWABASE_PDT	2	2.1DC INCREASE IN TEMPERATURE	Delmore Post Development	MHWS10 + 1m	Base
17	D_MPD21CC020AEPTWBBASE_PDT	5	2.1DC INCREASE IN TEMPERATURE	Delmore Post Development	MHWS10 + 1m	Base
18	D_MPD21CC010AEPTWBBASE_PDT	10	2.1DC INCREASE IN TEMPERATURE	Delmore Post Development	MHWS10 + 1m	Base

The following table summarises the purpose of the scenarios.

Table 9 - Scenario purpose

Number	SCENARIO_ID	Purpose
1	EXDHCLM001AEPTWBBASE_EXT	Baseline of current flood risk
2	EXDHCLM050AEPTWABASE_EXT	Baseline of current flood risk
3	EXDHCLM020AEPTWABASE_EXT	Baseline of current flood risk
4	EXDHCLM010AEPTWABASE_EXT	Baseline of current flood risk
5	MPD38CC001AEPTWBBASE_PDT	Assessing proposed culvert capacity and minimum floor levels
6	MPD38CC001AEPTWBBL01_PDT	Assessing overtopping risk on Motorway
7	MPD38CC001AEPTWBBBL050_PDT	Assessing overtopping risk on Motorway

8	EXD38CC001AEPTWBBASE_EXT	Baseline of current flood risk with climate change
9	D_MPD38CC001AEPTWBBASE_PDT	Comparison against baseline for upstream and downstream effects assessment
10	MPD21CC050AEPTWABASE_PDT	Assessing proposed culvert capacity and minimum floor levels
11	MPD21CC010AEPTWABASE_PDT	Assessing proposed culvert capacity and minimum floor levels
12	MPD21CC020AEPTWABASE_PDT	Assessing proposed culvert capacity and minimum floor levels
13	EXD21CC050AEPTWABASE_EXT	Baseline of current flood risk with climate change
14	EXD21CC010AEPTWABASE_EXT	Baseline of current flood risk with climate change
15	EXD21CC020AEPTWABASE_EXT	Baseline of current flood risk with climate change
16	D_MPD21CC050AEPTWABASE_PDT	Comparison against baseline for upstream and downstream effects assessment
17	D_MPD21CC020AEPTWABASE_PDT	Comparison against baseline for upstream and downstream effects assessment
18	D_MPD21CC010AEPTWABASE_PDT	Comparison against baseline for upstream and downstream effects assessment

10. VALIDATION METHODOLOGY

Multiple locations will be selected within the model area and compared against the TP108 graphical model to verify the model data against the graphical method. An additional check will be compared against the Auckland Council RFHA model to assess consistency with council output.

Flows and volumes will be compared to determine the difference between them. Any significant differences will be reviewed and assessed as appropriate.

10.1. Existing Surface (Pre Development)

A topographical and drone survey for the proposal area was undertaken, and this data has been used for all land within the proposed development site.

LiDAR data 2016 NZVD2016 provided by LINZ Data services, at 1m resolution, is used as the existing ground surface model for the wider area around the contributing catchment where topographic data was not available.

The terrain is shown in Figure 12 below.

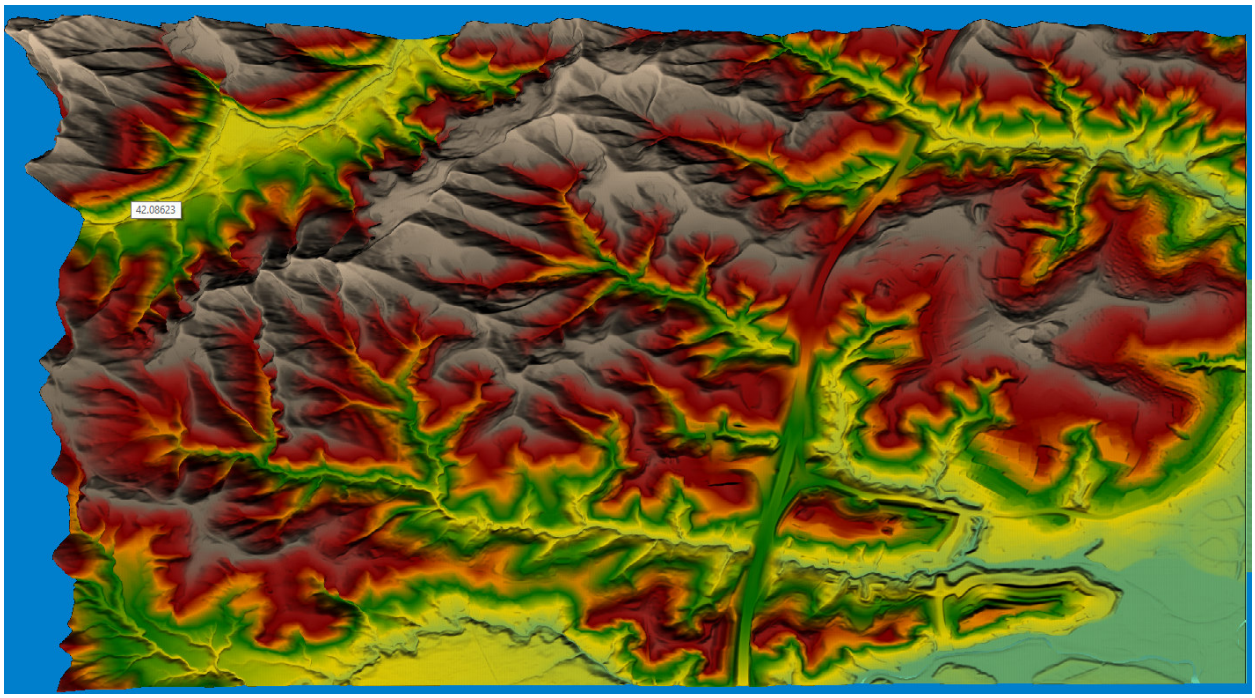


Figure 12 – Existing surface Terrain model

10.2. Design Surface (Post development)

A detailed design surface was used to prepare a terrain model for the post-development scenario models. Figure 13 below shows these at the development site.

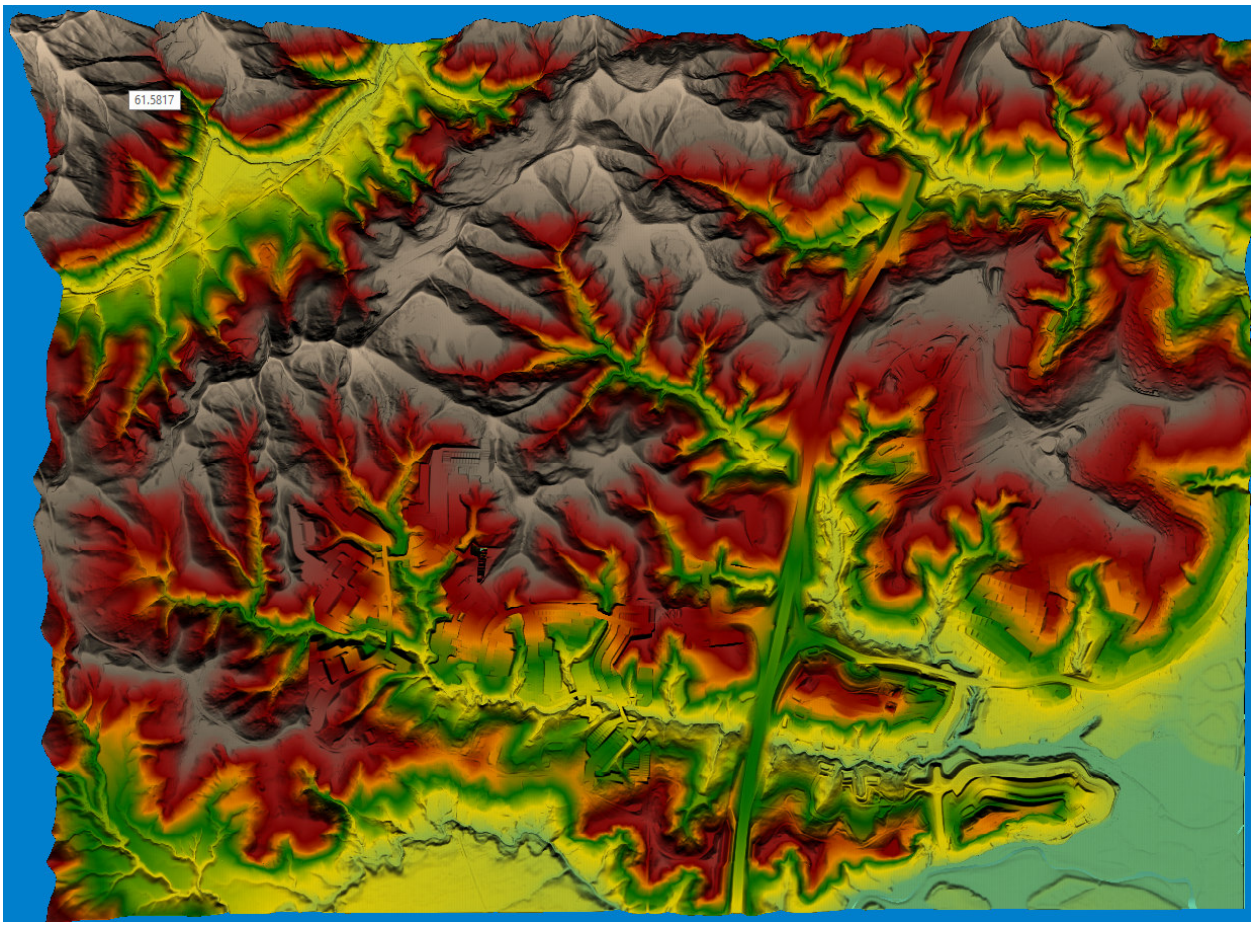


Figure 13 - Post-Development Surface

10.3. Model Time Steps

An adaptive time step based on a maximum Courant of 4 and a minimum Courant number of 1 was adopted. The base time step is 1 second with a maximum halving of 0.5 seconds and maximum doubling of 4 seconds. The time step was chosen to aid with stability within the model during computation.

10.4. Contributing Catchment

Figure 14 below shows the contributing catchment named "15L" of the Ōrewa West ICMP. The size of this catchment is 275ha.

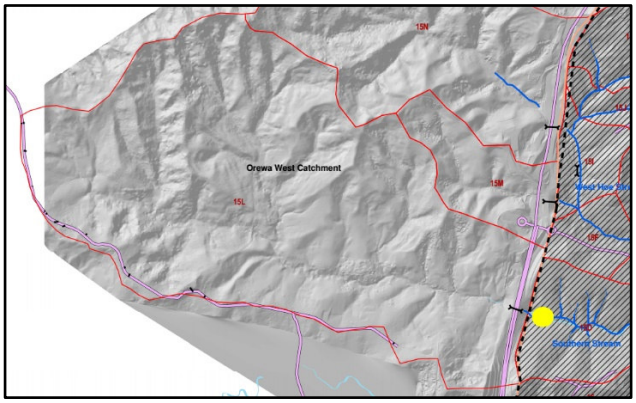


Figure 14 - Ōrewa West ICMP Catchment 15L

Based on the terrain data, an independent catchment analysis has been conducted. The total number of sub-catchments demarcated is 32, which accounts for the cut-off for the future proposed culvert within the Delmore development. Refer to **Error! Reference source not found.** for details.

The following table lists each sub-catchment area.

Table 10 – Sub-catchment areas

SUBCATCHMENT NAME	AREA (ha)	SUBCATCHMENT NAME	AREA (ha)	SUBCATCHMENT NAME	AREA (ha)
CMT DEL 2	3.75	CMT PD 28	6.10	CMT PD 18	2.78
CMT DEL 3	2.80	PRE33-1	38.04	CMT PD 2	3.09
CMT DEL 1	3.78	PRE12-1	265.42	CMT PD 3	4.21
CMT DEL 6	3.69	CMT PD 25	24.49	CMT PD 29	1.70
CMT DEL 8	3.36	CMT PD 22	23.87	CMT PD 8	0.50
CMT DEL 10	0.86	CMT PD 10	10.79	CMT PD 30	6.09
CMT DEL 15	4.70	CMT PD 23	14.72	CMT PD 4	32.88
CMT DEL 9	8.23	CMT PD 27	2.44	CMT PD 21	15.83
CMT DEL 12	6.10	CMT PD 1	4.34	CMT PD 16	2.21
CMT DEL 14	7.61	CMT PD 26	4.77	CMT PD 15	1.86
CMT DEL 13	4.24	CMT PD 0	6.55	CMT PD 20	2.55
CMT DEL 4	2.33	CMT PD 11	9.89	CMT PD 17	2.17
CMT DEL 16	4.24	PRE29-2	3.14	CMT DEL 17	0.57
CMT DEL 11	0.62	CTMT ARAS2	8.26	CMT PD 6	8.63
CMT PD 7	3.42	CMT PD 19	2.74	CMT PD 5	2.86

The total sum equivalent to the ICMP boundaries is 266ha. An additional 306ha (consisting of catchments PRE12-1, PRE29-2 and PRE33-1) is applied downstream to determine the full extent of downstream flow.

10.5. Inflow Boundary Conditions

Contributing catchments have been delineated as per Catchment Plan drawing 3725-0-4500. Each sub-catchment is assigned a 1D node with the relevant catchment areas and appropriate land cover.

The hydrological inflow is configured with a 10-minute time of concentration, and each node is positioned at the highest point of its corresponding sub-catchment to ensure the full time of concentration is accurately represented in the model.

For catchments PRE12-1, PRE29-2, and PRE33-1, the time of concentration has been calculated using the equal area method based on the potential flow length and slope. The inflow nodes have been applied at the bottom of the respective sub-catchments. This approach is used because the model has not considered the hydraulic structures within these sub-catchments. The purpose of these inflows is to determine the total downstream flows to assess downstream effects.

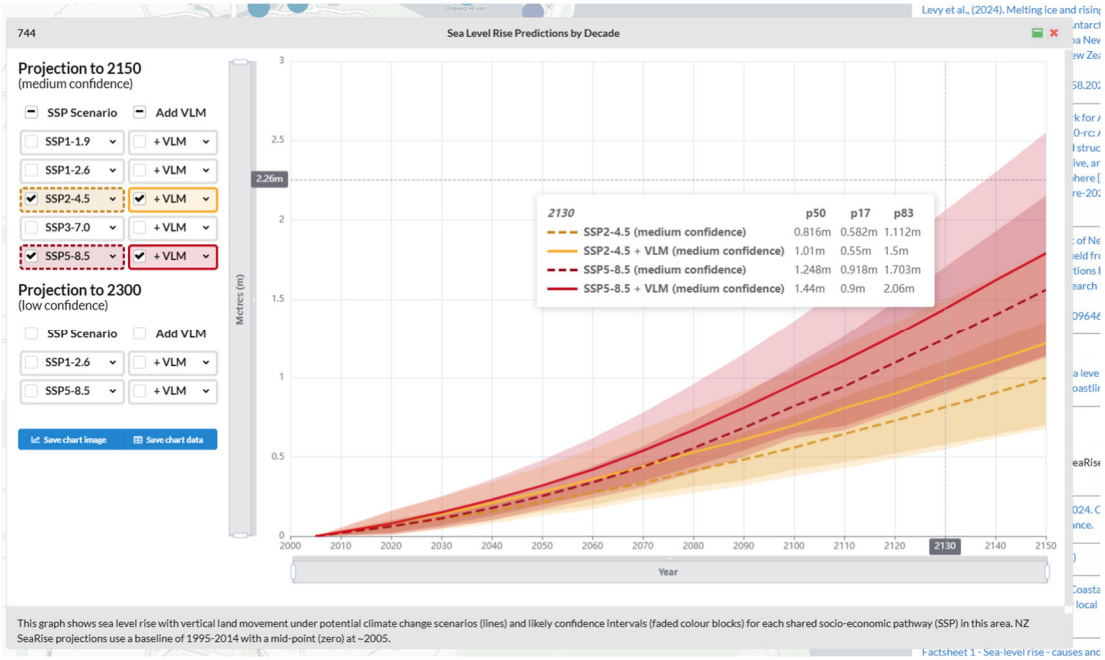
The 24-hour inflow hydrographs for each node have been calculated using HEC-HMS, as discussed in the

chapter 6.

10.6. Outflow Boundary Conditions

The outflow boundary condition for the flood analysis is located approximately 50m downstream of the Arran Drive bridge.

A review of the 'Development of an Updated Coastal Marine Area Boundary for the Auckland Region – Prepared for Auckland Council – July 2012' shows in Table A-2 a Mean High-Water Springs-10 (MHWS10) of 1.42mRL based on the Auckland Vertical Datum of 1946. Adjusting this to the New Zealand Vertical Datum 2016 with an offset value of 302mm yields an MHWS of 1.12mRL.



The Auckland Council 'Regionwide Rural Rapid Flood Model Build Report – May 2023' indicates that the MHWS10 for the Ōrewa region (Model Unit I) ranges from 1.42 to 2.30mRL, with an NZVD adjustment of 1.12mRL to 2.00mRL.

For modelling, A constant level boundary conditions accounting for sea level rise and vertical land movement based on 50th percentile (SSP2-8.5m) of 3.54mRL is applied which consists of SLR and VLM of 1.44m and MHWS of 2.1m.

11. RESULTS

11.1. Model Mass Error

All model runs reported less than 1% of mass volume error.

11.2. Drawing Output

Drawings have been developed to visualise the results of the flood model, outlined in Table 11 below.

Table 11 – Flood Modelling Results Drawings

Drawing Number	Description	Scenario
3725-0-4500	Catchment Plan	N/A
3725-0-4501	2D Model Extent	N/A
3725-0-4502	1% AEP Post vs Pre-Development	Comparison between Scenario 8 and 9
3725-0-4503	1% AEP Post-Development Flood Plain	9
3725-0-4504	1% AEP Pre-Development Flood Plain	8
3725-0-4505	1% AEP Post-Development Flood Plain (FUZ MPD)	5
3725-0-4506	50% AEP Post-Development Flood Plain	16
3725-0-4507	50% AEP Pre-Development Flood Plain	13
3725-0-4508	50% AEP Post vs Pre-Development	Comparison between Scenario 13 and 16
3725-0-4509	20% AEP Post-Development Flood Plain	17
3725-0-4510	20% AEP Pre-Development Flood Plain	15
3725-0-4511	20% AEP Post vs Pre-Development	Comparison between Scenario 15 and 17
3725-0-4512	10% AEP Post-Development Flood Plain	18
3725-0-4513	10% AEP Pre-Development Flood Plain	14
3725-0-4514	10% AEP Post vs Pre-Development	Comparison between Scenario 14 and 18
3725-0-4515	Post Development Mannings Extent	N/A
3725-0-4516	Pre Development Mannings Extent	N/A
3725-0-4518	1% AEP Post-Development Flood Plain – Rain on Grid	9
3725-0-4519	1% AEP Pre-Development Flood Plain – Rain on Grid	8

11.3. Results Discussion

A total of 7 locations have been assessed and shown on Figure 15 below.

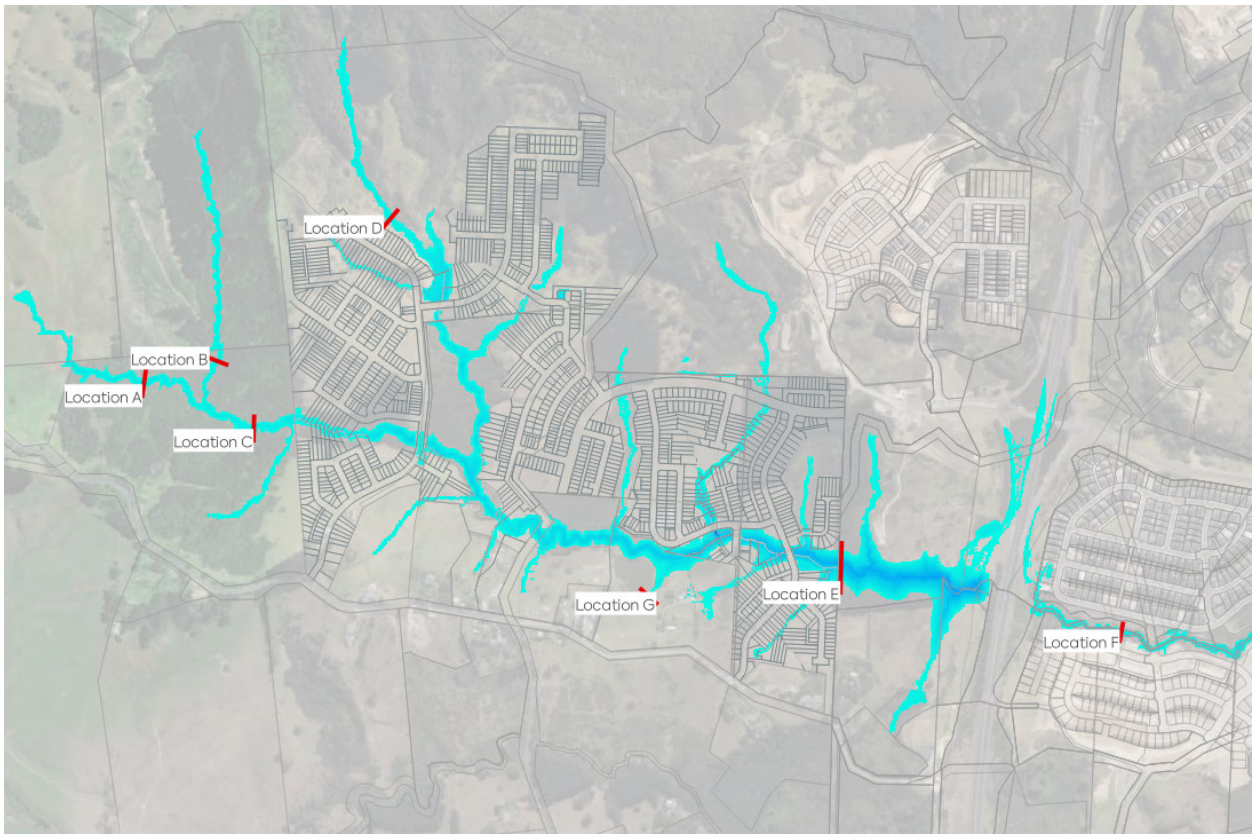


Figure 15 - Locations of pre-development and MPD water level comparisons

The following table shows the water surface elevation, peak velocity, peak flow, and water depth for location A, B, E & F.

Table 12 – Recorded Results at Location A

Scenario Number	Scenario ID (Location A)	Water Surface Elevation (m)	Peak Velocity (m/s)	Peak Flow (m3/s)	Depth (m)
1	EXDHCLM001AEPTWBBASE_EXT	30.99	1.04	8.80	1.81
2	EXDHCLM050AEPTWABASE_EXT	30.60	0.38	2.50	1.42
3	EXDHCLM020AEPTWABASE_EXT	30.71	0.58	3.96	1.53
4	EXDHCLM010AEPTWABASE_EXT	30.79	0.72	5.16	1.61
5	MPD38CC001AEPTWBBASE_PDT	*30.91*	*1.37*	*10.58*	*0.97*
6	MPD38CC001AEPTWBBL01_PDT	31.50	1.16	14.40	2.32
7	MPD38CC001AEPTWBBBL050_PDT	31.50	1.18	14.45	2.32
8	EXD38CC001AEPTWBBASE_EXT	*30.88*	*1.43*	*10.00*	*1.68*
9	D_MPD38CC001AEPTWBBASE_PDT	*30.91*	*1.37*	*10.58*	*1.72*
10	MPD21CC050AEPTWABASE_PDT	30.74	0.47	3.49	1.56
11	MPD21CC010AEPTWABASE_PDT	31.05	0.79	7.33	1.87
12	MPD21CC020AEPTWABASE_PDT	30.92	0.66	5.61	1.74
13	EXD21CC050AEPTWABASE_EXT	*30.47*	*0.46*	*2.34*	*1.28*

14	EXD21CC010AEPTWABASE_EXT	*30.64*	*0.85*	*4.88*	*1.45*
15	EXD21CC020AEPTWABASE_EXT	*30.57*	*0.70*	*3.75*	*1.38*
16	D_MPD21CC050AEPTWABASE_PDT	*30.49*	*0.46*	*2.49*	*1.29*
17	D_MPD21CC020AEPTWABASE_PDT	*30.59*	*0.69*	*4.01*	*1.40*
18	D_MPD21CC010AEPTWABASE_PDT	*30.66*	*0.84*	*5.20*	*1.47*

Scenario Number	Scenario ID (Location B)	Water Surface Elevation (m)	Peak Velocity (m/s)	Peak Flow (m3/s)	Depth (m)
1	EXDHCLM001AEPTWBBASE_EXT	31.29	1.43	7.43	0.90
2	EXDHCLM050AEPTWABASE_EXT	30.94	0.79	1.78	0.55
3	EXDHCLM020AEPTWABASE_EXT	31.03	1.03	3.21	0.64
4	EXDHCLM010AEPTWABASE_EXT	31.10	1.18	4.34	0.71
5	MPD38CC001AEPTWBBASE_PDT	*31.17*	*3.32*	*10.09*	*0.53*
6	MPD38CC001AEPTWBBL01_PDT	31.14	3.09	10.17	0.74
7	MPD38CC001AEPTWBBBL050_PDT	31.18	2.99	10.05	0.76
8	EXD38CC001AEPTWBBASE_EXT	*31.17*	*3.31*	*10.08*	*0.74*
9	D_MPD38CC001AEPTWBBASE_PDT	*31.17*	*3.32*	*10.09*	*0.53*
10	MPD21CC050AEPTWABASE_PDT	30.80	1.56	2.54	0.42
11	MPD21CC010AEPTWABASE_PDT	30.95	2.20	5.19	0.57
12	MPD21CC020AEPTWABASE_PDT	30.89	1.95	4.01	0.51
13	EXD21CC050AEPTWABASE_EXT	*30.80*	*1.76*	*2.38*	*0.25*
14	EXD21CC010AEPTWABASE_EXT	*30.96*	*2.47*	*4.92*	*0.366*
15	EXD21CC020AEPTWABASE_EXT	*30.89*	*2.20*	*3.79*	*0.32*
16	D_MPD21CC050AEPTWABASE_PDT	*30.80*	*1.76*	*2.38*	*0.25*
17	D_MPD21CC020AEPTWABASE_PDT	*30.89*	*2.20*	*3.78*	*0.32*
18	D_MPD21CC010AEPTWABASE_PDT	*30.96*	*2.47*	*4.91*	*0.37*

Scenario Number	Scenario ID (Location E)	Water Surface Elevation (m)	Peak Velocity (m/s)	Peak Flow (m3/s)	Depth (m)
1	EXDHCLM001AEPTWBBASE_EXT	15.20	1.96	38.50	6.00
2	EXDHCLM050AEPTWABASE_EXT	10.97	1.81	10.64	1.76
3	EXDHCLM020AEPTWABASE_EXT	12.06	1.93	18.13	2.86
4	EXDHCLM010AEPTWABASE_EXT	13.09	2.01	24.17	3.89
5	MPD38CC001AEPTWBBASE_PDT	*17.03*	*1.31*	*37.49*	*7.59*
6	MPD38CC001AEPTWBBL01_PDT	19.49	0.29	13.44	10.28

7	MPD38CC001AEPTWBBBL050_PDT	19.70	0.94	34.97	10.49
8	EXD38CC001AEPTWBBASE_EXT	*17.11*	*1.19*	*56.91*	*7.52*
9	D_MPD38CC001AEPTWBBASE_PDT	*16.90*	*1.33*	*37.53*	*7.46*
10	MPD21CC050AEPTWABASE_PDT	12.49	1.67	19.05	3.28
11	MPD21CC010AEPTWABASE_PDT	14.97	1.64	36.28	5.76
12	MPD21CC020AEPTWABASE_PDT	14.02	1.70	28.63	4.82
13	EXD21CC050AEPTWABASE_EXT	*11.73*	*1.28*	*14.45*	*2.13*
14	EXD21CC010AEPTWABASE_EXT	*13.95*	*1.33*	*25.12*	*4.35*
15	EXD21CC020AEPTWABASE_EXT	*12.67*	*1.31*	*17.82*	*3.07*
16	D_MPD21CC050AEPTWABASE_PDT	*12.02*	*1.50*	*17.44*	*2.58*
17	D_MPD21CC020AEPTWABASE_PDT	*13.37*	*1.54*	*24.39*	*3.93*
18	D_MPD21CC010AEPTWABASE_PDT	*14.26*	*1.49*	*29.06*	*4.82*

Scenario Number	Scenario ID (Location F - Downstream Assessment)	Water Surface Elevation (m)	Peak Velocity (m/s)	Peak Flow (m3/s)	Depth (m)
1	EXDHCLM001AEPTWBBASE_EXT	6.63	1.10	18.22	2.94
2	EXDHCLM050AEPTWABASE_EXT	6.00	0.87	9.64	2.31
3	EXDHCLM020AEPTWABASE_EXT	6.29	0.99	13.33	2.61
4	EXDHCLM010AEPTWABASE_EXT	6.42	1.03	15.13	2.74
5	MPD38CC001AEPTWBBASE_PDT	*6.83*	*1.19*	*20.73*	*3.10*
6	MPD38CC001AEPTWBBL01_PDT	5.12	0.12	0.15	1.43
7	MPD38CC001AEPTWBBBL050_PDT	5.56	1.01	6.24	1.87
8	EXD38CC001AEPTWBBASE_EXT	*6.83*	*1.19*	*20.89*	*3.10*
9	D_MPD38CC001AEPTWBBASE_PDT	*6.82*	*1.19*	*20.59*	*3.09*
10	MPD21CC050AEPTWABASE_PDT	5.86	1.38	13.50	2.16
11	MPD21CC010AEPTWABASE_PDT	6.09	1.50	17.42	2.40
12	MPD21CC020AEPTWABASE_PDT	6.01	1.46	16.04	2.32
13	EXD21CC050AEPTWABASE_EXT	*6.23*	*1.01*	*12.74*	*2.51*
14	EXD21CC010AEPTWABASE_EXT	*6.51*	*1.11*	*16.69*	*2.78*
15	EXD21CC020AEPTWABASE_EXT	*6.38*	*1.06*	*14.69*	*2.65*
16	D_MPD21CC050AEPTWABASE_PDT	*6.29*	*1.03*	*13.43*	*2.56*
17	D_MPD21CC020AEPTWABASE_PDT	*6.46*	*1.09*	*15.84*	*2.73*
18	D_MPD21CC010AEPTWABASE_PDT	*6.55*	*1.11*	*17.18*	*2.82*

11.4. Results Comparison

Results of pre-development scenarios with climate change has been compared with the Delmore MPD scenarios with climate change to assess any increase or decrease in water level and if there any associated increase in risk upstream and downstream due to the change. The table below summarises the findings across four scenarios of interests.

Table 13 - Depth and velocity difference between pre-development and MPD

Scenario Number (Post)	Scenario Number (Pre)	AEP (Years)	Location	ARI (Years)	Depth Difference (-ve = decrease), (m)	Velocity Difference (m/s)
16	13	2	A	2	*0.01*	*0.01*
			B		*0.00*	*0.07*
			C		*0.01*	*0.04*
			D		*0.49*	*0.10*
			E		*0.29*	*0.18*
			F		*0.05*	*0.03*
			G		*0.00*	*0.01*
17	15	5	A	5	*0.02*	*0.00*
			B		*0.00*	*0.00*
			C		*0.02*	*0.02*
			D		*1.25*	*0.00*
			E		*0.70*	*0.20*
			F		*0.08*	*0.02*
			G		*0.00*	*0.00*
18	14	10	A	10	*0.02*	*-0.01*
			B		*0.00*	*0.00*
			C		*0.02*	*0.02*
			D		*1.78*	*-0.07*
			E		*0.32*	*0.13*
			F		*0.04*	*0.01*
			G		*0.00*	*0.00*
9	8	100	A	100	*0.03*	*-0.06*
			B		*0.00*	*0.00*
			C		*0.00*	*0.00*
			D		*3.71*	*-0.31*
			E		*-0.21*	*0.08*
			F		*-0.01*	*-0.01*
			G		*0.00*	*-0.02*

From the comparison above, there is an observed increase in location A and E for all storm events. Location A, which is upstream of the Delmore development, reported an increase of up to 256mm during

the 100 Year ARI event. However, the area is in bush land and the run-off is contained within the existing channel profile without any spilling anticipated so there are no anticipated consequences. Figure 16 below shows the cross-section profile along with the water level during various storm events.

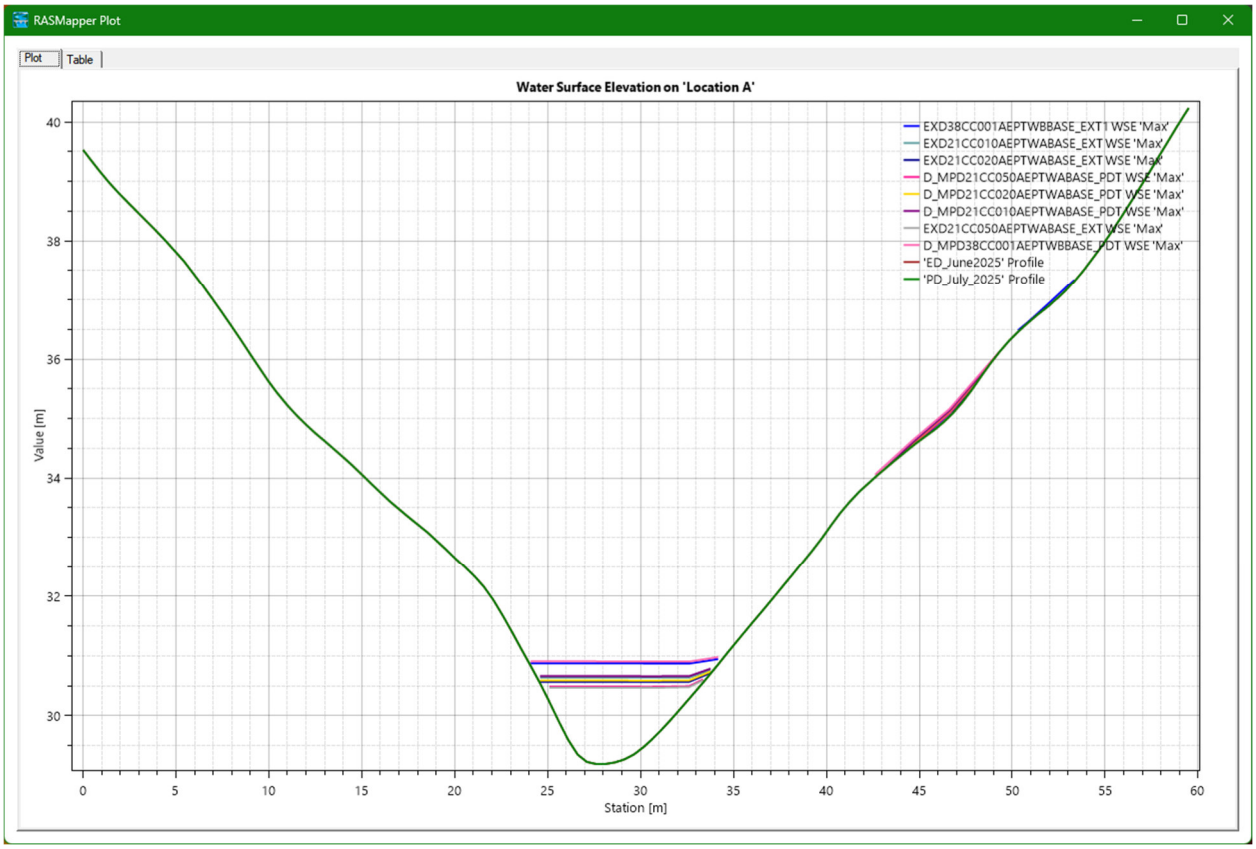


Figure 16 - Water surface elevation at Location A for various scenarios

As for location E, which is taken approximately 320m upstream of the motorway culvert, there is a reported increase across all storm events. The largest depth difference increase is during the 2-year event, where the water level during the Delmore MPD scenario is 12.1mRL and the pre-development is 11.4mRL giving a difference of approximately 700mm. The flood extent on location E is contained within the existing channel as per the figure below, with no anticipated consequences.

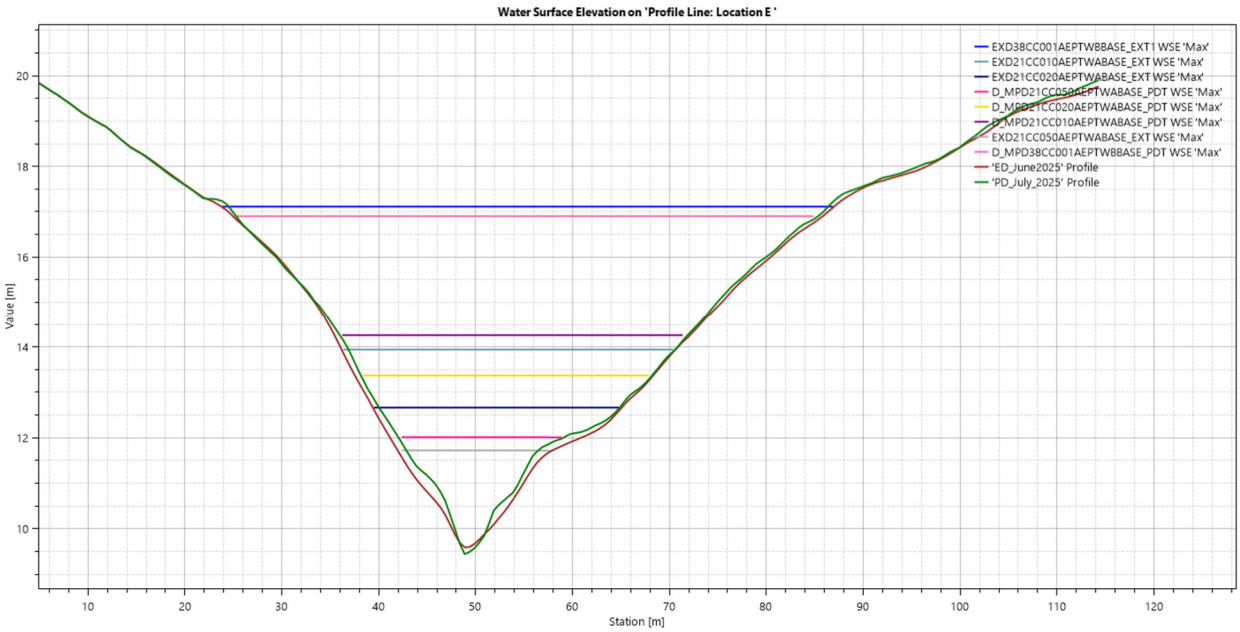


Figure 17 - Water surface elevation at Location E for various scenarios

Downstream of the motorway culvert, reduction in water levels is observed for all storm events. The culvert flow and headwater level for the 100-year storm are as per the table below.

Table 14 - Flow and water depth comparison downstream of motorway culvert between pre-development and MPD

Scenario ID	Measurement Criteria	Value	Time to Peak
D_MPD38CC001AEPTWBBASE_PDT	Headwater (m)	16.90	01Jan2024 1330
	Tailwater (m)	8.66	01Jan2024 1330
	Total Flow (m^3/s)	20.38	01Jan2024 1330
	Total Culvert Flow (m^3/s)	20.38	01Jan2024 1330
EXD38CC001AEPTWBBASE_EXT	Headwater (m)	17.11	01Jan2024 1320
	Tailwater (m)	8.67	01Jan2024 1320
	Total Flow (m^3/s)	20.63	01Jan2024 1320
	Total Culvert Flow (m^3/s)	20.63	01Jan2024 1320

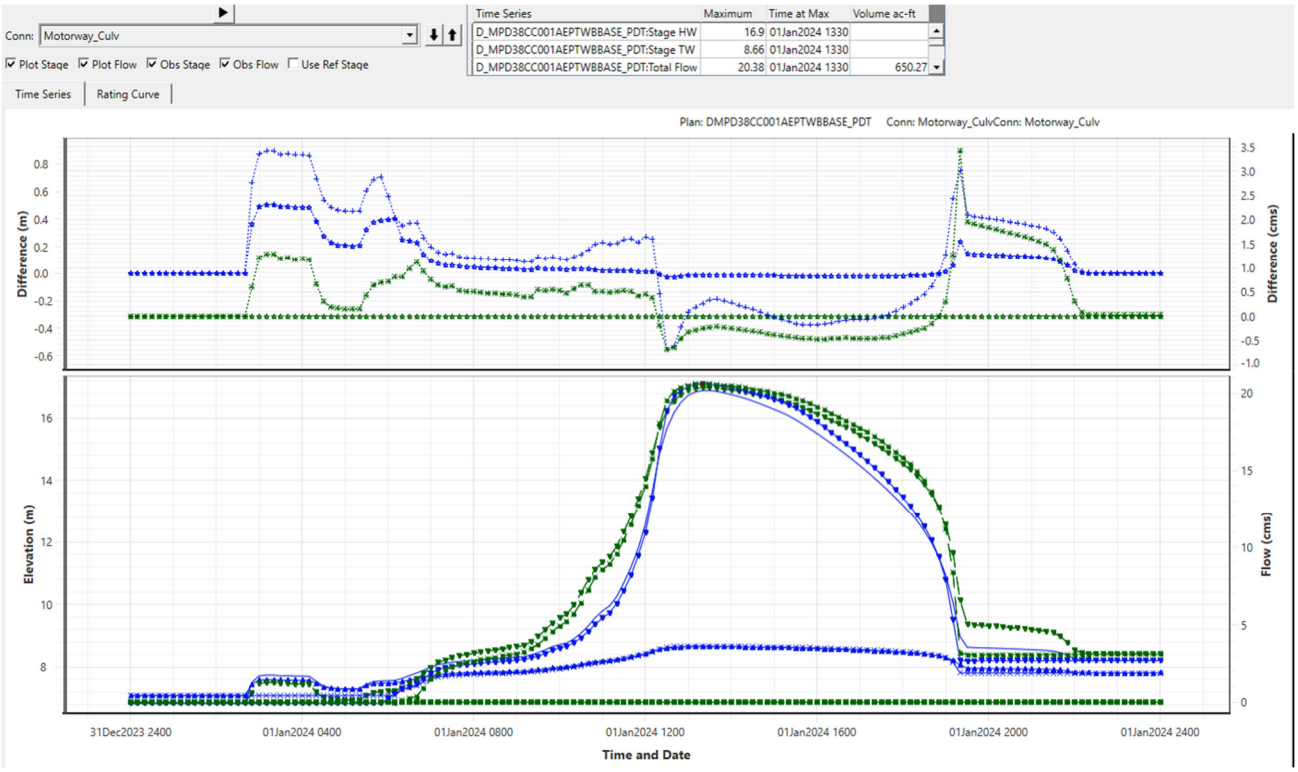


Figure 18 – Motorway culvert inflow hydrograph

Figure 18 shows the difference in water level between the pre- and post-development scenario at 1% AEP storm event.

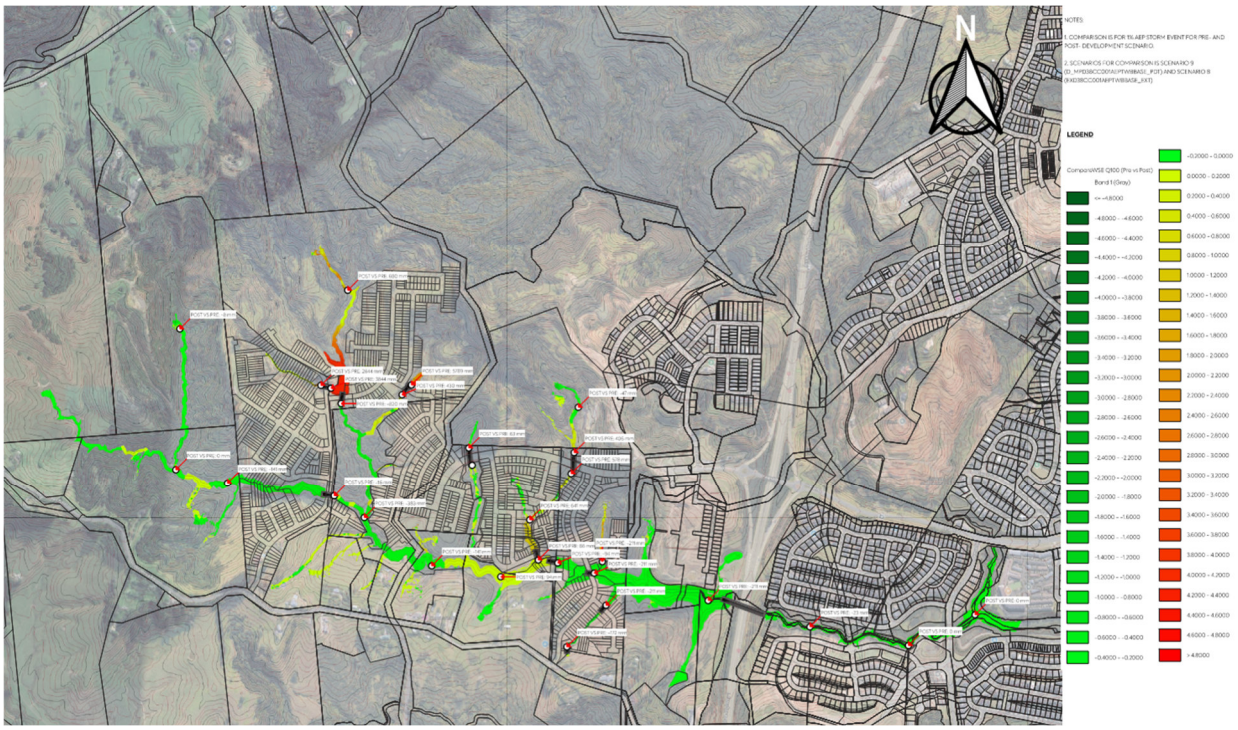


Figure 19 - Flood difference for 1% MPD plus CC, for pre- and post-development

11.5. Maximum Probable Development – Future Development Zone

Scenario with the full Delmore development and the maximum probable development within the Future Urban Zone outside the Delmore development zone have been assessed to determine the minimum floor

level and the ultimate pipe capacity, The purpose of this scenario is to ensure that the culvert network have sufficient capacity to accommodate future development outside the Delmore Masterplan that is within the AUP FUZ zone. The identification of this scenario is MPD38CC001AEPTWBBASE_PDT which also known as Scenario number 5.

All proposed culverts within the Delmore development are embedded a minimum of 35% of their total height for circular culvert and 350mm for box culverts for ecological requirements except for culverts on a wetland where it matches the invert of the existing wetland.

Based on the wider FUZ, all minimum ground levels for individual lot platforms are above the 1% AEP MPD flood level by a minimum of 200mm, and minimum proposed floor levels are 300mm above lot platforms. This provides a total freeboard of 500mm for habitable areas.

11.6. Auckland Council RFHA Results comparison

Figure 20 below shows the RFM peak elevation and velocity (Source: Healthy Waters). The snippet from the Council RFHA model can be best represented by location E scenario number 5 (MPD38C001AEPTWBBASE_PDT).

The model prepared by McKenzie & Co reported a flood level of 17.65mRL which is comparable to the Council model. The velocity is reported higher (1.49m/s) which is likely due to the variation in location where the measurements is taken.

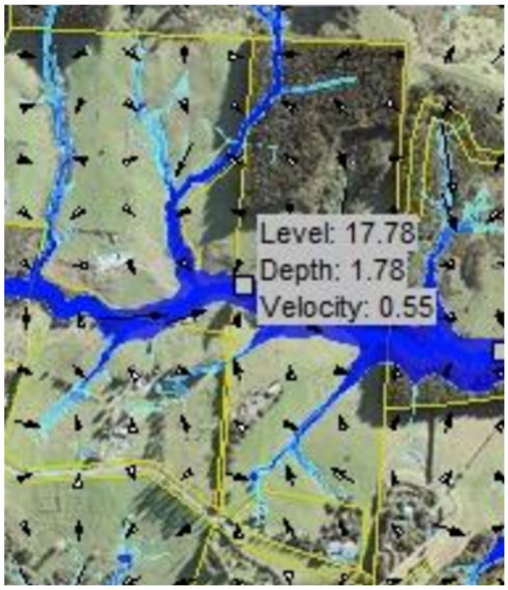


Figure 20 - RFM peak elevation and velocity (Source: Healthy Waters)

12. RISK ASSESSMENT

A risk assessment against E36 of the Auckland Unitary plan has been completed and is included in the Appendix. This shows that the overall flood risk from the development is low.

13. CONCLUSION

The flood assessment for the Delmore development demonstrates that the proposed development

has been designed to manage stormwater runoff effectively. The assessment confirms that the minimum floor levels for the proposed lots are above the 1% AEP flood levels (unblocked scenario) and overland flow paths are contained within existing streams and channels.

Modelling results indicate that the proposed development has resulted in minor increase in flood depth upstream of the proposed development, however, since it is within the existing channel and away from any habitable area, the risk is considered less than minor.

14.LIMITATION

This flood assessment report has been prepared by McKenzie and Co for Vineway Limited to evaluate the flood risks associated with the Delmore development. This report is intended solely for this purpose, and McKenzie and Co accept no responsibility for its use by other parties or for any other purpose.

The results rely on the accuracy of available data and modelling assumptions, including rainfall events, catchment response, and boundary conditions. The assessment does not account for future changes in land use, except for those indicated in the Auckland Unitary Plan. Simplifications in model geometry, such as terrain and drainage structures, may result in localized impacts not being fully represented.

Any use of this report outside its intended purpose is at the sole risk of the user, and McKenzie and Co accept no liability for such use.

APPENDIX A – Flood Hazard Risk Assessment

APPENDIX B – Engineering Flood Drawings

See Engineering Plans 3725-0-4500 to 3725-0-4519

APPENDIX C – HEC HMS inflow input

APPENDIX D – HEC RAS Results