AUCKLAND COUNCIL:

PRIVATE PLAN CHANGE 48: DRURY CENTRE PRECINCT – KIWI PROPERTY HOLDINGS

PRIVATE PLAN CHANGE 49: DRURY EAST PRECINCT – FULTON HOGAN LAND DEVELOPMENT LTD

PRIVATE PLAN CHANGE 50: WAIHOEHOE PRECICNT – OYSTER CAPITAL

JOINT WITNESS STATEMENT (JWS) OF EXPERTS IN RELATION TO STORMWATER (TECHNICAL)

11 October 2021

Expert Witness Conferencing Topic: Stormwater (Technical)

Held on: 11 October 2021

Venue: 2:30pm online via Microsoft Teams during COVID-19 Level 3 Lockdown

Independent Facilitator: Marlene Oliver

Admin Support: Cosette Saville

1 Attendance:

1.1 The list of expert participants is included in the schedule to this Statement.

2 Basis of Attendance and Environment Court Practice Note 2014

2.1 All participants agree as follows:

(a) The Environment Court Practice Note 2014 provides relevant guidance and protocols for the expert conferencing session.

(b) They will comply with the relevant provisions of the Environment Court Practice Note 2014.

(c) They will make themselves available to appear at the hearing in person if required to do so by the Hearing Panel (as directed by the Hearing Panel's directions).

(d) This report is to be filed with the Hearing Panel.

3 Agenda – Issues considered at Conferencing

3.1 The issues identified as forming the agenda for conferencing were:

Technical Stormwater material

1) Continuation of Issue Two – Update on stormwater technical discussion on Plan Change 50 (JWS dated 17 September 2021)
2) Continuation of Issue Three – Stormwater treatment (JWS dated 17 September 2021)

3.2 The following sections of this Joint Witness Statement address each of these issues, noting where agreement has been reached and, in the event of disagreement, the nature of the disagreement and the reasons for that disagreement.

4 Continuation of Issue Two: Update on stormwater technical discussion on Plan Change 50

4.1 Further to item 5.1 of the Joint Witness Statement dated 17 September 2021, the applicant has provided Waihoehoe Plan Change 50 Southern Sub-Catchment Flood Modelling (dated 6 October 2021) and included in Appendix A to this JWS. The assessment shows that the flood management approach for the southern sub-catchment does not cause an increase in post-development peak water levels and peak-flows at the downstream end of the sub-catchment in comparison to the pre-development peak water levels and peak-flows. The assessment demonstrates the technical feasibility of the attenuation storage solution proposed in the SMP and provides more technical details that can be added to the SMP.

4.2 The applicants propose changing Section 8.2.3.1 of the Waihoehoe SMP to include Table 2.1, Figure 2 and explanatory text from the memo at Appendix A of this JWS. The memo, at Appendix A, will be provided as supplementary information in the Appendices of the Waihoehoe SMP.

4.3 The applicants are to add an overlay of the location of the attenuation basins, relative to the floodplain at Figure 1 of the memo (Appendix A); and to further clarify the text in Section 4.4.6 lag times.

4.4 All experts agree to the approach outlined above in paragraphs 4.2 and 4.3.

5 Continuation of Issue Three: Stormwater treatment

5.1 Further to item 6.5 of the Joint Witness Statement dated 17 September 2021, the applicant has provided Water Quality treatment for private trafficked impervious surfaces memo (dated 7 October 2021) and included in Appendix B to this JWS. The memo analyses likely contaminants from private trafficked impervious surfaces and proposes stormwater quality treatment targeting gross pollutants, course sediments and minor amounts of hydrocarbons. At a minimum, private trafficked impervious surfaces should use a catchpit with a grate, sump volume and submerged outlet.

5.2 The applicants propose changing the Drury East and Waihoehoe SMPs to include the text at paragraph 5.3 below, in the body of the Drury East and Waihoehoe SMPs, with the memo provided as supplementary information in the Appendices of the Drury East and Waihoehoe SMPs.

5.3 *The private trafficked impervious surfaces within the Drury East and Waihoehoe developments comprise private driveways, jointly owned access lots, private car parks (less than 30 parking spaces) and associated hardscapes. These surfaces are identified in the relevant Stormwater Management Toolboxes as mixed risk contaminant generating activity.*

This activity does not include private car parking areas which have more than 30 car parks nor publicly accessible car parks nor hardscapes which do not receive runoff from the trafficked surface, which are covered by other activities in the Toolboxes in the Stormwater Management Plan and require GD01 treatment.

However, there still is a risk of contamination from occasional anthropogenic activities such as from spills or washing cars (hydrocarbons), and from coarse sediment and rubbish collecting on the driveway (sediments and gross pollutants).

On that basis, the treatment solution should target gross pollutants, course sediments and minor amounts of hydrocarbons. At a minimum private trafficked impervious surfaces should use a catchpit with a grate, sump volume and submerged outlet.

Acknowledging that the stormwater management approach requires hydrological mitigation of all impervious surfaces, the developer should look for opportunities to integrate water quality treatment for private trafficked impervious surfaces with the hydrological mitigation solutions. At the very least, hydrological mitigation for private trafficked impervious surfaces is likely to be provided through a detention tank downstream of the catchment, which will provide further water quality treatment. At the other end of the spectrum, the developer may choose to utilise a GD01 device, such as a rain garden, for hydrological mitigation and water quality.

5.4 This approach is agreed by Tim Fisher, Pranil Wadan, Charlotte Peyroux and Trent Sunich.

5.5 Paula Vincent remains concerned that there is cumulative effect from the lower contaminant generating trafficked surfaces that will have a negative impact on the receiving environment. This is in addition to the anthropogenic activities stated. For these reasons some form of bioretention treatment should be included.

5.6 Danny Curtis will need to discuss this technical approach further with his manager to confirm that this is appropriate.

5.7 This group of experts agrees to discuss this topic further when Healthy Waters response is available.

6 PARTIES TO JOINT WITNESS STATEMENT

6.1 The participants to this Joint Witness Statement confirm that:

(a) They agree with the outcome of the expert conference as recorded in this statement. As this session was held online and there is an existing evidence exchange timetable, in the interests of efficiency, it was agreed that each expert would verbally confirm their position to the facilitator. This is recorded in the schedule below;

(b) They have read Appendix 3 of the Environment Court's Practice Note 2014 and agree to comply with it; and

(c) The matters addressed in this statement are within their area of expertise.

Confirmed on 11 October 2021:

EXPERT NAME	PARTIES	EXPERTS CONFIRMATION REFER PARA 6.1
Danny Curtis	Auckland Council (as submitter)	Yes
Paula Vincent	Auckland Council (as submitter)	Yes
David Mead (Plg)	Auckland Council (as regulator)	Yes
Trent Sunich	Auckland Council (as regulator)	Yes
Tim Fisher	Kiwi Property Holdings No2 Limited Oyster Capital	Yes
Charlotte Peyroux	Kiwi Property Holdings No2 Limited Oyster Capital	Yes
Pranil Wadan	Fulton Hogan Land Development Ltd	Yes for Item 5 as he is only an expert for PC49
Nick Roberts (Plg)	Kiwi Property Holdings No2 Limited Oyster Capital Fulton Hogan Land Development Ltd	Yes
Rachel Morgan (Plg)	Kiwi Property Holdings No2 Limited Oyster Capital Fulton Hogan Land Development Ltd	Yes

Appendix A

Appendix B

Appendix A

Tonkin+Taylor

Memo

To:	**Plan Change 50 Stormwater Conference**	**Job No:**	**1008200.3000**
From:	**Madeline Witney, Tim Fisher**	**Date:**	**6 October 2021**
Subject:	**Waihoehoe Plan Change 50 Southern Sub-Catchment Flood Modelling**		

1 Introduction

Oyster Capital is applying to Auckland Council for a Private Plan Change under the Auckland Unitary Plan, Operative in Part (AUP), to rezone 48.9 hectares of land in Drury East (referred to as the "Waihoehoe Precinct") from Future Urban Zone (FUZ) to Residential - Terrace Housing and Apartment Buildings zone (THAB).

The *Drury East – Waihoehoe Precinct Plan Change Area Stormwater Management Plan* (SMP) was previously prepared in August 2019, and most recently updated in July 2021. The SMP supports the application for the Private Plan Change. It outlines the stormwater management requirements for Waihoehoe Precinct.

As part of the plan change process, two expert witness statements have been prepared by Tim Fisher: Stormwater Evidence in Chief on the 27th of July 2021 and later, a Rebuttal Evidence on the 19th of August 2019. Mr Curtis as submitter for Auckland Council Heathy Waters stated within his evidence of 19 August 2021 that he wanted more detail on the appropriateness of the attenuation approach for the southern sub-catchment. The same issue was raised in the Stormwater Expert Conferencing and recorded in the Joint Witness Statement of 17 September 2021 as follows:

> **5 Issue Two: Update on stormwater technical discussion on Plan Change 50**
>
> 5.1 Tim Fisher for the Applicant has committed to bring back to the conferencing group following information:
>
> - An updated plan showing the indicative location and extent of permanent flood attenuation devices, building on the plan attached to his rebuttal evidence; and
> - Additional assessment of flooding effects due to development on the area upstream of the railway culvert.
> - The SMP will be updated accordingly.

The purpose of this memo is to address the comments made by Mr Curtis within his Stormwater Evidence and to fulfil the commitment made in the Joint Witness Statement.

The assessment shows that the flood management approach for the southern sub-catchment does not cause an increase in post-development peak water levels and peak-flows at the downstream end of the sub-catchment in comparison to the pre-development peak water levels and peak-flows. The assessment demonstrates the technical feasibility of the attenuation storage solution proposed in the SMP and provides more technical details in this memo that can be added to the SMP.

2 Proposal

The southern sub-catchment attenuation approach has previously been summarised within the *Drury East – Waihoehoe Precinct Plan Change Area Stormwater Management Plan*. The attenuation constraints and solution have been addressed in Sections 2.1-2.2 below.

2.1 Southern sub-catchment attenuation constraints

The southern sub-catchment drains in a western direction into a tributary of the Slippery Creek. The southern sub-catchment stream exits the Waihoehoe Precinct via an existing 900mm diameter culvert under the railway line and discharges further downstream into the Slippery Creek. During the 100-year ARI rainfall event, the southern sub-catchment stream has out of bank flooding caused by the throttle effect of the existing culvert (Figure 1). The culvert, which is owned by KiwiRail, is not intended to be upgraded. Therefore, the proposed approach for flood management in the southern sub-catchment avoids any dependency on upgrades to the railway culvert. If the railway culverts were upgraded, further flood hazard assessment would be required to understand the effects on downstream properties.

Upon previous discussions with the Auckland Council catchment manager, it was agreed that the southern sub-catchment should follow an “attenuation” approach where peak flows generated by development of the plan change area (PCA) are attenuated within the site and as close to the source as possible. As a result, the southern sub-catchment of the site will detain post-development flows of up to the 100-year ARI storm within the sub-catchment to the pre-development flows. This can be achieved via providing additional storage within a number of attenuation basins.

In the Stormwater Evidence in Chief, Mr Curtis expressed his concerns regarding an increased flood risk to the downstream end of the southern sub-catchment, despite attenuating post-development peak flows:

> *“While I agree with the approach to attenuate flows, limiting post development flows to no more than pre-development addresses only the flow component of stormwater effects resulting from the construction of impervious areas. More detailed analysis is required in the Waihoehoe SMP to consider the capacity of the KiwiRail culvert to demonstrate that attenuating flows will not increase flood risk to third party land in the PPC50 area. This is particularly relevant where staging is proposed, which appears to be the case where 115 Waihoehoe Road appears to be more advanced than the remaining plan change area.”*

Hence, further analysis has been carried out in response to the above concerns and to the restatement of these concerns at the stormwater conference.

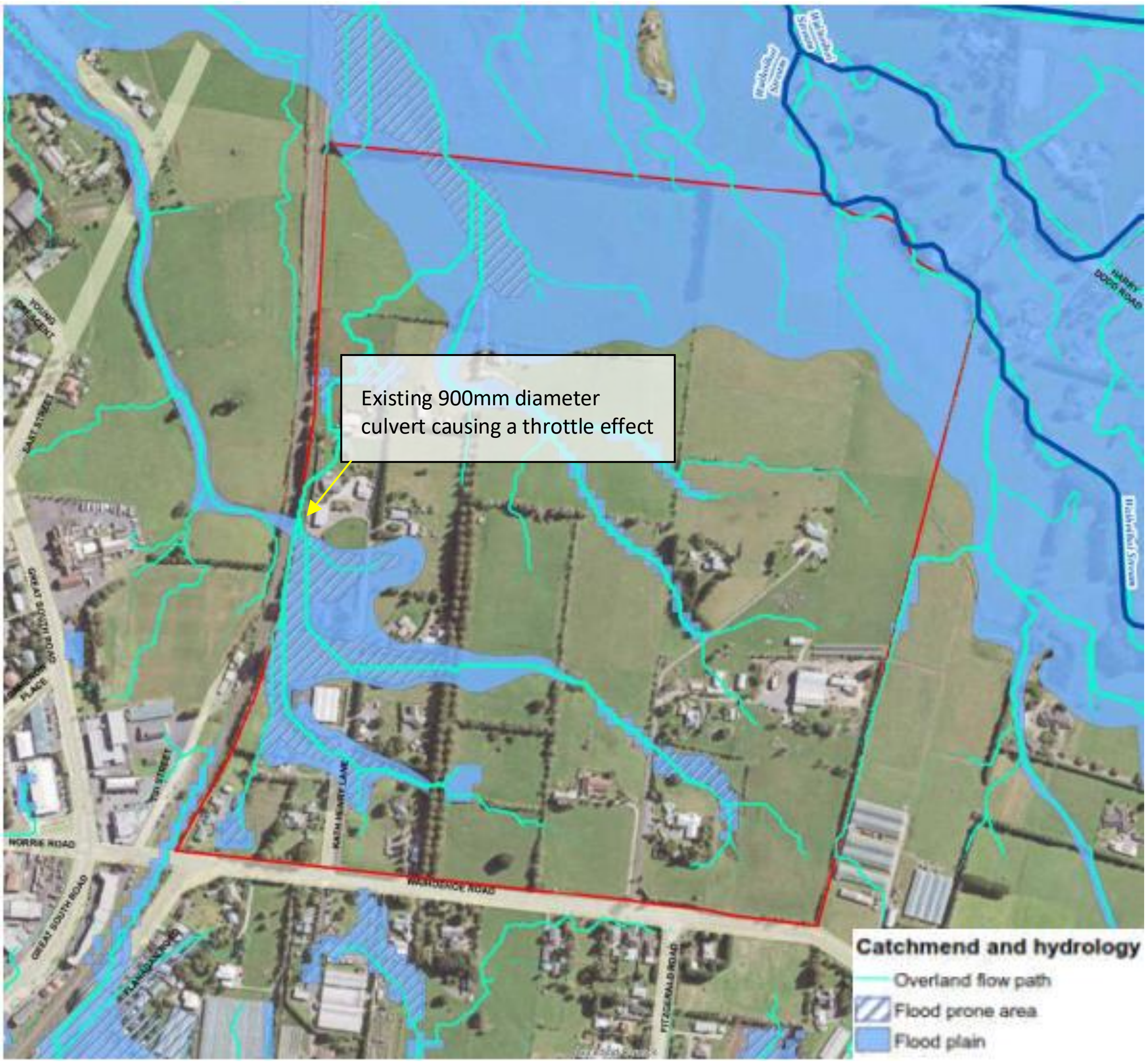

Figure 1: Flooding and overland flow paths within the Waihoehoe Precinct and railway culvert

2.2 Proposed southern sub-catchment solution

The proposed development will provide attenuation up to and including the 100-year ARI storm to achieve post-development flowrates equivalent to the pre-development flowrates. Further analysis has been completed to ensure that there is no increase in water levels within the flood plain located downstream of the southern sub-catchment. This is achieved by the proposal of four dry basins and the extension of the existing wetland (located within the 116 Waihoehoe Road property):

- The manmade basin and adjacent natural wetland located within the 116 Waihoehoe sub-catchment will be maintained and utilised to provide additional storage for the runoff generated within the 116 Waihoehoe sub-catchment.
- Runoff generated on 76 Waihoehoe will be directed into Basin 1.
- Three basins (Basin 2, 3 and 4) are proposed within the Downstream sub-catchment to tie in with the natural topography of the development. These three basins each receive one third of the total Downstream sub-catchment area.

The 112 Waihoehoe sub-catchment is proposed to discharge directly into the tributary (called Tributary Junction 1 within the flood model). As a result, Basins 2,3 and 4 over-attenuate to account for the runoff generated within the 112 Waihoehoe catchment area.

A summary of the proposed device type, indicative location and indicative volumes are outlined within Table 2.1 and are presented on Figure 2. It is important to note that the location and volumes of the preliminary devices shown are subject to change and will be confirmed at the subdivision consent stage.

Table 2.1: Indicative attenuation device details for the southern sub-catchment of the Waihoehoe Precinct

Device type	Receiving sub-catchment	Device approximate maximum volume (m^3)
Existing Basin/Wetland 1	116 Waihoehoe	1400
Basin 1	76 Waihoehoe	1400
Basin 2	Downstream	900
Basin 3	Downstream	900
Basin 4	Downstream	900

Figure 2: Indicative attenuation device locations within the southern sub-catchment of the Waihoehoe PCA

3 Sub-catchments

The southern sub-catchment has been split into four further sub-catchments: 116 Waihoehoe, 112 Waihoehoe, 76 Waihoehoe and Downstream (Figure 3).

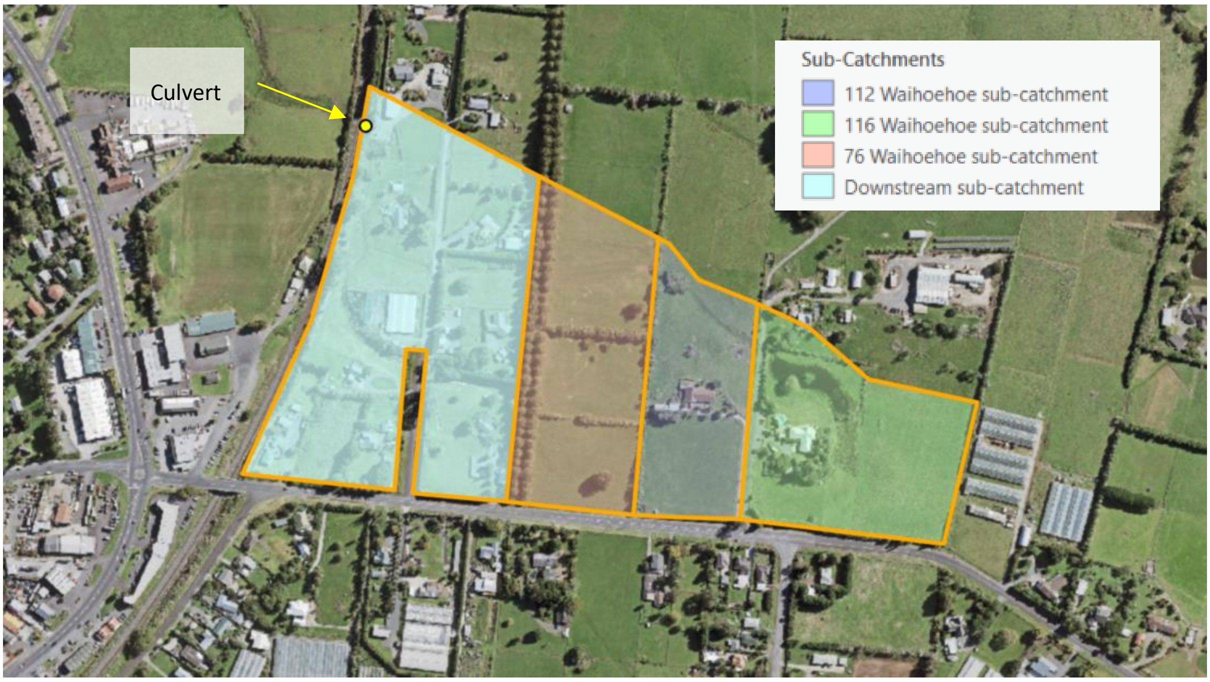

Figure 3 Sub-catchments within southern sub-catchment of Waihoehoe Precinct

4 Methodology

4.1 HEC-HMS Model

An assessment of the attenuation approach for the southern sub-catchment has been undertaken using HEC-HMS version 4.8. Two models were produced for post-development and pre-development scenarios. The following sections outline the inputs, assumptions and the comparison between the pre-development and post-development model results.

4.2 Pre-development basin model

Figure 4 presents the pre-development scenario basin model layout.

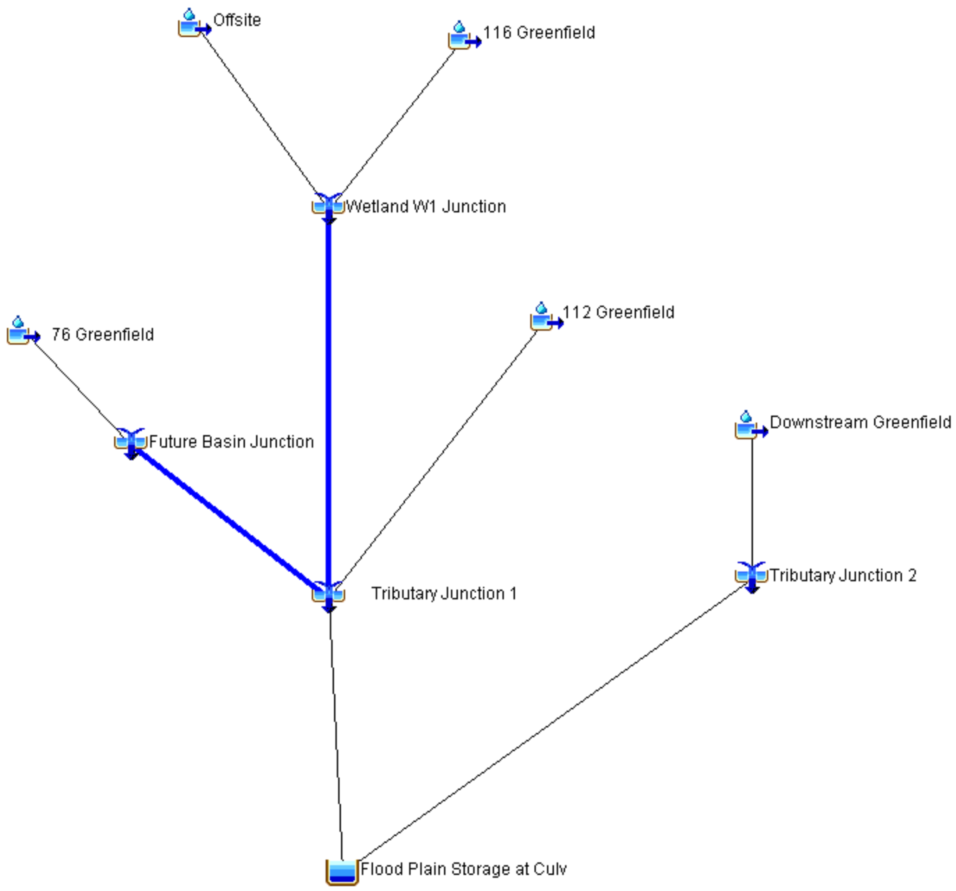

Figure 4: Pre-development basin model layout within HEC-HMS

4.3 Post-development basin model

Figure 5 presents the post-development scenario basin model layout.

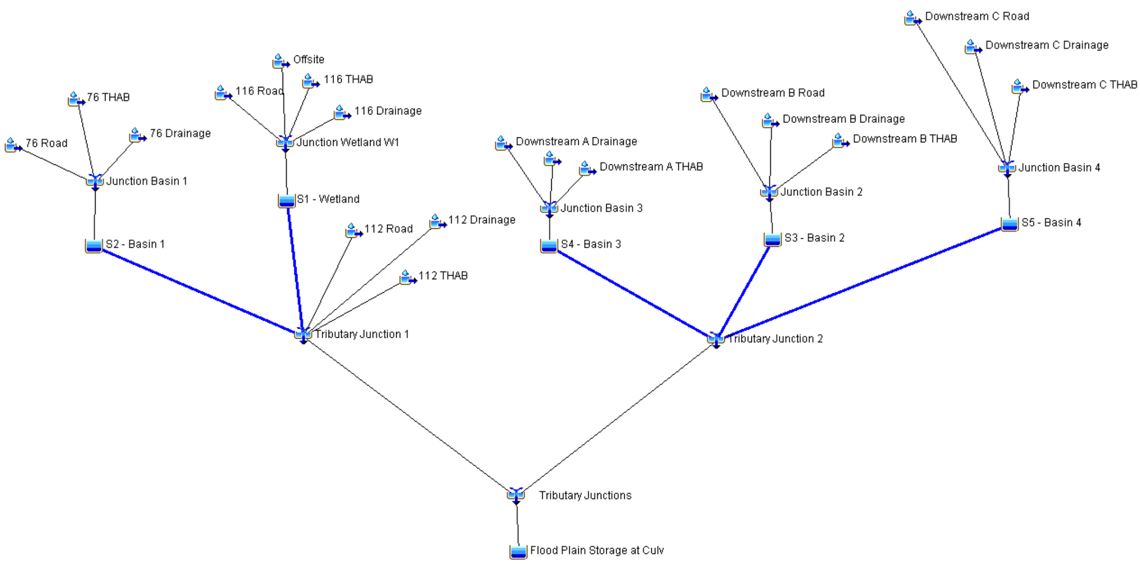

Figure 5: Post-development scenario basin model within HEC-HMS

4.4 Model input parameters and assumptions

4.4.1 Climate change factors

Climate change is expected to alter the intensity and frequency of significant rainfall events. In general, an increase of peak flow is expected. Hydrological calculations have been carried out in accordance with TP108, including allowances for climate change effects in the post-development scenario in accordance with Table 4.1 and Table 4.2 of the Stormwater Code of Practice– Version 2 (dated November 2015), using a temperature increase of 2.1 degrees by 2090.

We acknowledge that Auckland Council has recently released the Stormwater Code of Practice – Version 3 (dated September 2021), which has new climate change allowances. Stormwater Code of Practice – Version 3 is operative from 18 January 2022. Since this analysis was carried out prior to this revision, Version 2 has been used. The impact of these changes on the model are minor and a further update of the climate change factors can be made at the design and resource consent stages to align with Stormwater Code of Practice – Version 3.

4.4.2 Rainfall model

Design storms were established for both the pre-development and post-development models, based on specified hyetographs from TP108 for the 100-year ARI 24-hour rainfall event. A summary of the inputs is shown in Table 4.1

Table 4.1: Meteorological model inputs

Scenario	Rainfall event	Rainfall Intensity (mm/hr)	Climate change factor (%)	Rainfall depth
Pre and Post-development	100-year ARI	9.59	16.8	230

Rainfall distributions were established for both the pre-development and post-development scenarios based on the 100-year ARI 24-hour rainfall event from TP108.

4.4.3 Catchment areas

All pre-development sub-catchments have been conservatively assumed to be 100% pervious. The post-development sub-catchments consist of roading, drainage reserves, Terrace Housing and Apartment Buildings Zone (THAB) and external (to account for the upper contributing catchment south-east of the 116 Waihoehoe sub-catchment), where:

- Roading areas have assumed to be 100% impervious,
- Drainage reserves areas have assumed to be 100% pervious,
- THAB areas have assumed to be 70% impervious and 30% pervious, and
- Minor external areas to the Waihoehoe Precinct have assumed to be 100% pervious.

4.4.4 Curve Numbers

Curve numbers (CN) define the shape of the rainfall-runoff relationship and varies from 0 (no runoff) to 100 (complete runoff).

CNs have been generated for each sub-catchment and for each development scenario. The CN used for impervious areas was 98. The CN for pervious areas is based off the SCS hydrological soil groups. According to Auckland Council GeoMaps, Group B (alluvial sediments) are present throughout the site, therefore a pervious CN of 61 has been used.

Where a sub-catchment is made up of different area types (e.g., roading, drainage and THAB), a weighted CN has been calculated based on the overall impervious and pervious coverages for the entire sub-catchment.

4.4.5 Initial Abstractions

Initial abstractions (Ia) account for the rainfall losses that occur before the runoff begins (including storage in depressions, interception by vegetation, evaporation, and infiltration). An Ia of 0 and 5 have been used for impervious and pervious areas, respectively. Where a sub-catchment is made up of varying pervious and impervious areas, the weighted Ia has been calculated accordingly.

4.4.6 Lag times

The lag times were calculated based off the time of concentration, in accordance with Section 0 of TP108. A channelisation factor of 0.8 for engineered grass channels was used throughout all calculations.

4.4.7 Hydraulic features

The following hydraulic features were included within the pre-development and post-development basin models:

- The existing 900 mm diameter railway culvert called “Outlet 1” within the HEC-HMS model.
- The storage within the flood plain directly upstream of the existing culvert. An elevation-area curve was created based on the existing *Auckland South LiDAR 1m DEM (2016-2017)* data from Land Information New Zealand, and

  The existing streams (site conveyance) were included as reaches with corresponding lag times.

The proposed attenuation devices (four basins and one existing wetland/basin) were included within the post-development scenario only.

5 Findings

5.1 Attenuation basins

Table 5.1 summarises the conceptual design of the proposed attenuation devices. The spillway elevations for Basin 2, 3 and 4 have been based off the maximum water level within each basin from the HEC HMS modelling. The crest elevation for Basin 2, 3 and 4 have been based off a 500 mm freeboard above the spillway elevation. The peak volumes for Existing Basin/Wetland 1 and Basin 1 have been designed to meet the 2-year, 10-year and 100-year attenuation requirements. The peak volumes for Basin 2, 3 and 4 that are presented in Table 5.1 have been designed for 100-year attenuation only and should be considered as a minimum. It is expected that these volumes will increase to account for the different configuration’s that will be required for lesser design events (e.g., for the 2 and 10-year ARI rainfall events).

Table 5.1: Proposed attenuation device details

Device ID	Surface Area (m^2)	Peak volume (m^3)	Orifice size (m)	Orifice invert (m)	Number of spillways	Spillway length (m)	Spillway elevation (m)	Crest elevation (m)
Existing Basin/Wetland 1	4150	1400	0.150	15.2	3	0.5	15.4	16.4
						0.6	15.55	
						2.4	15.80	
Basin 1	1800	1400	0.200	12.2	2	0.3	12.75	14.3
						3	13.6	
Basin 2	1150	900	0.300	10.9	1	3.3	12.4	12.9
Basin 3	1150	900	0.300	10.9	1	3.3	12.4	12.9
Basin 4	1150	900	0.300	10.9	1	3.3	12.4	12.9

5.2 Peak flowrates

The peak flow rate within the downstream storage area is approximately 1.6 m^3/s for both the pre-development and post-development scenarios. There is a minor delay of approximately 10 minutes between the pre-development and post-development 100-year ARI flow peak. This will have negligible impacts to the Waihoehoe and Slippery Creek floodplain.

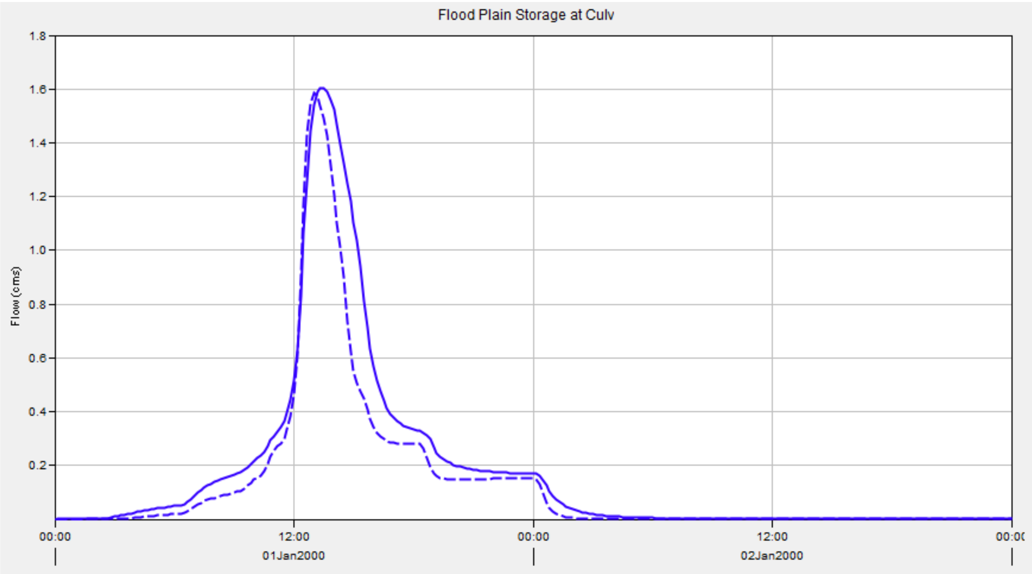

Figure 6: Peak flowrates at the railway culvert within the Downstream sub-catchment. Dashed line = pre-development scenario and the solid line = post-development scenario.

5.3 Storage

A peak runoff volume of approximately 3,500 m^3 during the pre-development scenario is produced within the southern sub-catchment floodplain upstream of the railway culvert. Attenuation of the post-development runoff has achieved a peak runoff volume of approximately 3,100 m^3, therefore there is no increase of the peak volume due to development (Figure 7).

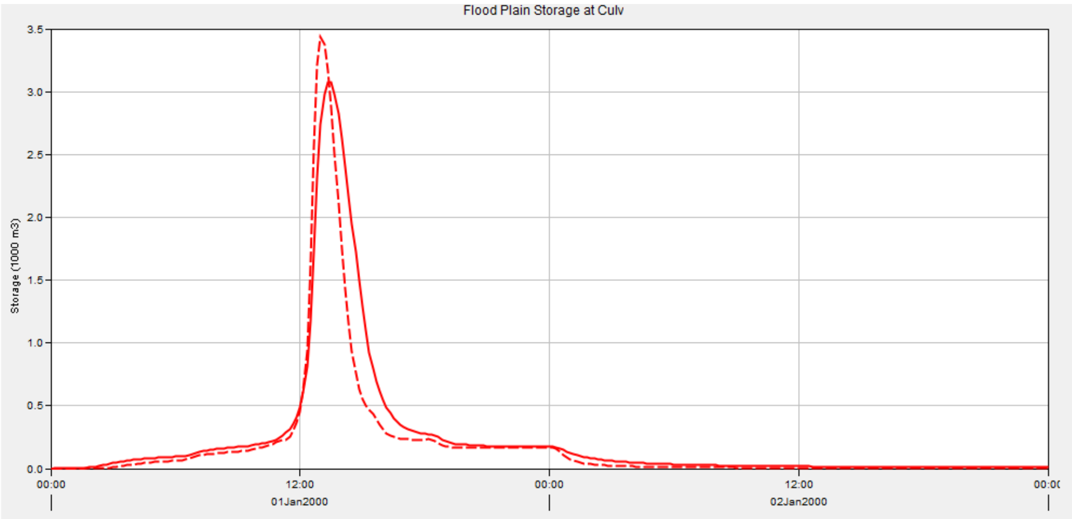

Figure 7: Storage within the southern sub-catchment floodplain upstream of the railway culvert. Dashed line = pre-development scenario and the solid line = post-development scenario.

5.4 Peak water levels

The peak water level is between 10.6 m to 10.7 m within the southern sub-catchment floodplain upstream of the railway culvert for both the pre-development and post-development scenario, with no increase in peak water levels from the pre-development to post-development scenario (Figure 8).

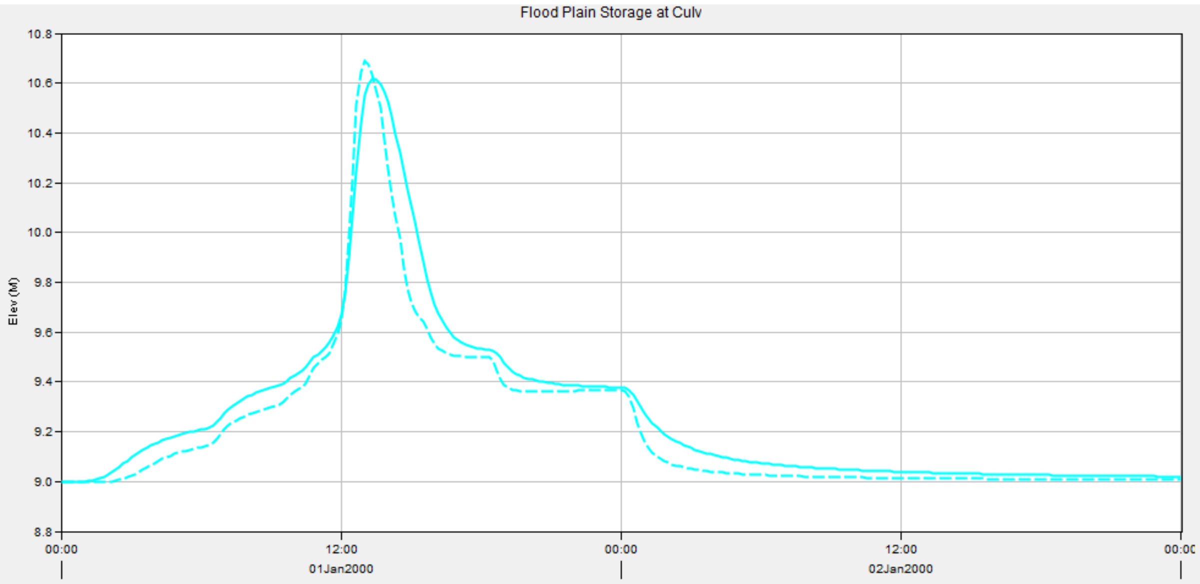

Figure 8: Peak water levels within the southern sub-catchment floodplain upstream of the railway culvert. Dashed line = pre-development scenario and the solid line = post-development scenario.

6 Conclusions

- The proposed development within the southern sub-catchment will provide attenuation up to and including the 100-year ARI rainfall event. The solution presented within this memo shows that this can be achieved via four new basins and an extension of an existing basin/wetland.
- A summary of the proposed device type, indicative location and indicative volumes are outlined within Table 2.1 and are presented on Figure 2. It is important to note that the location and volumes of the preliminary devices shown are subject to change and will be confirmed at the subdivision consent stage.

- The existing basin/wetland located within the 116 Waihoehoe sub-catchment will be maintained and utilised to provide additional storage for the runoff generated within the 116 Waihoehoe sub-catchment.
- Runoff generated at 76 Waihoehoe will be directed into Basin 1.
- Three basins (Basin 2, 3 and 4) are proposed within the Downstream sub-catchment to tie in with the natural topography of the development.
- The 112 Waihoehoe sub-catchment is proposed to discharge directly into the tributary (called Tributary Junction 1 within the flood model). As a result, Basins 2, 3 and 4 over-attenuate to account for the runoff generated within the 112 Waihoehoe catchment area.
- The peak flowrate at the railway culvert does not increase from the pre-development to the post-development scenario during the 100-year ARI rainfall event.
- There is a minor delay of approximately 10 minutes between the pre-development and post-development 100-year ARI rainfall peak flowrate. This is likely to have negligible impacts to the Waihoehoe and Slippery Creek floodplain.
- The peak water levels at the downstream end of the southern sub-catchment (at the culvert) do not increase during the 100-year ARI rainfall event from the pre-development to post-development scenario.

6-Oct-21
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Appendix B

Tonkin+Taylor

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Memo

To:	Marlene Oliver, Danny Curtis, Paula Vincent, Trent Sunich, David Mead, Nick Roberts, Rachel Morgan		
From:	Tim Fisher, Pranil Wadan and Charlotte Peyroux	Date:	7 October 2021
Subject:	Water Quality treatment for private trafficked impervious surfaces		

The Drury East (Drury Centre and Drury East Residential) and Waihoehoe Stormwater Management Plans identify private trafficked impervious surfaces as mixed risk contaminant generating surfaces. A 'risk- based' water quality treatment approach is proposed for these surfaces to provide treatment for the anticipated low contaminant loading and water quality risks from the anticipated activities. This memo demonstrates that alternative treatment options to those presented in GD01 are the best practicable option for these surfaces.

The memo has been prepared to inform Stormwater conferencing on 11 October that supports hearing for Plan Change 48, 49 and 50. It is intended that the Stormwater Management Plans are updated with the additional information presented in this memo.

1 Private trafficked impervious surfaces

The private trafficked impervious surfaces within the Drury East and Waihoehoe developments comprise private driveways, jointly owned access lots, private car parks (less than 30 parking spaces) and associated hardscapes. These surfaces are identified in the relevant Stormwater Management Toolboxes[1] as mixed risk contaminant generating activity. We anticipate that the lower and upper limits of this activity are represented by:

- a private driveway servicing a single dwelling and generating 4 - 6 vehicle movements per day.
- a private car park with up to 29 spaces and averaging 3 movements per car park per day (87 vehicles movements per day).
- a jointly-owned access lot servicing up to 8 units with two car parks per unit, generating up to 64 to 96 vehicle movements per day.

This activity does not include private car parking areas which have more than 30 car parks nor publicly accessible car parks nor hardscapes which do not receive runoff from the trafficked surface, which are covered by other activities in the Toolboxes in the Stormwater Management Plan and require GD01 treatment[2].

[1] Table 12: Stormwater Toolbox in the Drury East Stormwater Management Plan (June 2021) and Table 8.1 : Stormwater Management Toolbox in the Waihoehoe Stormwater Management Plan (July 2021)

2 Anticipated contaminants and loading

2.1 Estimates of contaminant loads private trafficked impervious surfaces

The contaminants of concern for private trafficked impervious surfaces within the Drury East developments are:

Total suspended solids (TSS)

TSS are generated from eroding trafficked surface material e.g. road surface, and include contaminants washed off buildings and other road surfaces. Based on the Contaminant Load Model presented in Auckland Council's Technical Report 35, TSS effluent concentrations from trafficked surfaces with 1,000 - 5,000 and less than 1,000 vehicles per day are expected to be in the order of 23 mg/L and 18 mg/L, respectively (refer to Table 4 in Appendix A).

The private-use surfaces in this activity are exposed to significantly less vehicles movements so are therefore likely to generate significantly less contaminants from eroding surface material. Based on the vehicle loading and the contaminant concentration relationships from the Contaminant Load Model, the TSS concentration from fine sediments on private trafficked impervious surfaces are anticipated to be in the order of 0.14 to 3.46 mg/L (refer to Appendix B).

Heavy metals

The primary indicators of heavy metals in the trafficked environment are Total Copper and Total Zinc, which are generated from vehicle brake pads and tyre wear. The Contaminant Load Model estimates an effluent concentration of Total Copper of 4.2 µg/L and 0.7 µg/L (refer to Table 5 in Appendix A) and Total Zinc of 27 µg/L and 4 µg/L (refer to Table 6 in Appendix A) for roads with 1,000 - 5,000 and less than 1,000 vehicles per day, respectively.

There is no known research on contaminant concentrations from private driveways, jointly owned access ways and private carparks as these surfaces hasn't been an area of concern on the past. We have estimated the contaminant concentration by interpolating loads in the Contaminant Load Model on a vehicle movement basis, which estimates Total Copper as 0.006 – 0.134 µg/L and Total Zinc as 0.03 – 0.77 µg/L (refer to Appendix B). There is more braking and turning in driveways than on the road, but at lower speed (less force applied to brake-pads), however the impact on contaminant concentration is not known.

Hydrocarbons

Hydrocarbons are associated with vehicle use, and thus are a contaminant of concern on trafficked roads. In the private application, hydrocarbons are associated with occasional activities such as spills or washing cars which are a low frequency activities. Hydrocarbons tend to bind to sediment so treatment processes should target removal of sediment.

2.2 Benchmarks

Auckland Council developed the Auckland Unitary Plan "*to better integrate the management of land use and development and associated adverse effects".*

In preparation for the Auckland Unitary Plan, Auckland Council developed an approach in Technical Report 35 for design effluent quality requirements (DEQR) that represented a reasonable expectation of the effluent water quality from most of the stormwater treatment practices currently regarded as 'best practice'. The approach recognised that "*where the water quality is not substantially worse than the design effluent quality requirements, there is minimal gain to be had from undertaking treatment*". While the DEQR approach was not carried into the final Auckland

Unitary Plan, it does provide a useful water quality “standard” to benchmark against. Table 1 below has the DEQRs for TSS, Total Copper and Total Zinc.

Subsequently, through the Unitary Plan hearings an alternative approach was developed to target treatment to High Contaminant Generating Activities (**HCGA**s). The HCGAs are land use activities that generate significantly high contaminant yields, which, in the context of trafficked surface, included:

- a road, motorway or state highway that carries more than 5,000 vehicles per day; and
- formal vehicle parking areas on a site that are exposed to rainfall and designed for a total of more than 30 vehicles.

The Auckland Unitary Plan policies in Chapter E9 require treatment of these HCGAs to GD01.

Table 1 below has estimated HCGA concentrations for TSS, Total Copper and Total Zinc based on the Contaminant Load Model concentrations for 5,000 vehicles per day.

2.3 Comparison of estimated contaminant concentrations to benchmarks

The table below compares the estimated contaminant concentrations for private trafficked impervious surfaces to the benchmarks of HCGA and the DEQRs requirements that Council has previously advocated.

Table 1- Estimated contaminant concentrations to benchmarks

Contaminant of concern	Benchmarks		Private trafficked impervious surfaces	
	HCGA concentrations	Design effluent quality requirement	Estimated contaminant concentrations	Percentage of HCGA concentrations
TSS	27.4 mg/L	20 mg/L	0.14 - 3.46 mg/L	0.5 – 12.6%
Total Copper	7.0 µg/L	10 µg/L	0.006 - 0.134 µg/L	0.08 – 1.92%
Total Nitrogen	44.7 µg/L	30 µg/L	0.03 - 0.77 µg/L	0.07 – 1.72%

[1] There are no Design Effluent Quality Requirements for hydrocarbons.

[2] Refer Section 1 and Appendix B

The estimate concentration levels of TSS and metals on private trafficked impervious surfaces is significantly lower than the HCGA concentrations and DEQRs. This suggests that there isn’t sufficient contamination load to warrant the ‘best practice’ stormwater treatment devices outlined in GD01. Furthermore, the influent stormwater quality is much better than the target performance of GD01 type devices. Requiring stormwater treatment of these private trafficked surfaces will result in an unnecessary investment (capital and operational costs) in stormwater treatment for a no measurable gain in water quality. Such an approach is considered to be un-effective, un-economic and therefore not considered the best practicable option.

3 Water quality treatment approach and best practicable options

A better outcome could be achieved by treating the private trafficked impervious surfaces for the anticipated water quality risks that actually exist. The previous section concludes that runoff from private trafficked impervious surfaces is likely to have low concentrations of heavy metals and fine sediments. However, there still is a risk of contamination from occasional anthropogenic activities such as from spills or washing cars (hydrocarbons), and from coarse sediment and rubbish collecting on the driveway (sediments and gross pollutants). On that basis, the treatment solution should target gross pollutants, course sediments and minor amounts of hydrocarbons. At a minimum private trafficked impervious surfaces should use a catchpit with a grate, sump volume and submerged outlet.

Acknowledging that the stormwater management approach requires hydrological mitigation of all impervious surfaces, the developer should look for opportunities to integrate water quality treatment for private trafficked impervious surfaces with the hydrological mitigation solutions. At the very least, hydrological mitigation for private trafficked impervious surfaces is likely to be provided through a detention tank downstream of the catchment, which will provide further water quality treatment. At the other end of the spectrum, the developer may choose to utilise a GD01 device, such as a rain garden, for hydrological mitigation and water quality.

This approach is considered to be the best practicable option as it:

- meets the water quality objectives of the Stormwater Management Plans.
- recognises that there is very little or marginal gain to be had from undertaking treatment using GD01 designed devices where contaminant loading is minimal.
- aligns the performance requirements to contaminants of concern and risk frequency and integrates with the options included in the stormwater management toolbox in the Stormwater Management Plans.
- provides an economic, achievable and realistic water quality treatment solution that targets the contaminants of concern.

Appendix A: Contaminant Load Model Effluent Concentration Tables from Technical Report 35

Table 4. Effluent concentration of TSS from the Contaminant Load Model (Auckland Regional Council, 2010)

Contaminant Load Model Effluent Concentration (mg/L)		
Roads	< 1,000 v.p.d.	18
	1,000 – 5,000 v.p.d.	23
	5,000 – 20,000 v.p.d.	44
	20,000 – 50,000 v.p.d.	80
	50,000 – 100,000 v.p.d.	132
	> 100,000 v.p.d.	195

INSERT GRAPH Based on concentration at middle of range.

Table 5. Effluent concentration of Total Copper from the Contaminant Load Model (Auckland Regional Council, 2010)

Contaminant Load Model Effluent Concentration (µg/L)		
Roads	< 1,000 v.p.d.	0.7
	1,000 – 5,000 v.p.d.	4.2
	5,000 – 20,000 v.p.d.	17.5
	20,000 – 50,000 v.p.d.	40.7
	50,000 – 100,000 v.p.d.	74.4
	> 100,000 v.p.d.	115.2

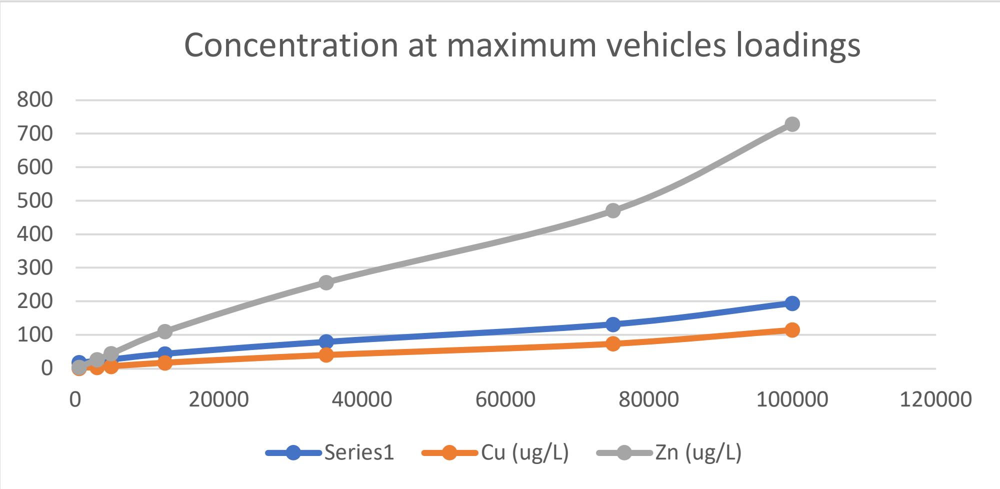
Table 6. Effluent concentration of Total Zinc from the Contaminant Load Model (Auckland Regional Council, 2010)

Contaminant Load Model Effluent Concentration (µg/L)		
Roads	< 1,000 v.p.d.	4
	1,000 – 5,000 v.p.d.	27
	5,000 – 20,000 v.p.d.	111
	20,000 – 50,000 v.p.d.	257
	50,000 – 100,000 v.p.d.	471
	> 100,000 v.p.d.	729

Appendix B: Estimated contaminant concentrations

Concentration at mid vehicles loadings

Vehicle Loadings	X - axis	TSS (mg/L)	Cu (ug/L)	Zn (ug/L)
<1000	500	18	0.7	4
1000 - 5000	3000	23	4.2	27
	5000	27.4	7.0	44.7
5000 - 20000	12500	44	17.5	111
20000 - 50000	35000	80	40.7	257
50000 - 100000	75000	132	74.4	471
>100000	100000	195	115.2	729



Low trafficked area concentrations			**Compare to HGCA (5000vpd)**	
Minimum loading		4		
Maximum loading		96		
TSS	0.144	3.456	0.53%	12.60%
Cu	0.0056	0.1344	0.08%	1.92%
Zn	0.032	0.768	0.07%	1.72%